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Mountaintop Mining/Valley Fills in Appalachia
Draft Programmatic
Environmental Impact Statement

APPENDIX G

SOCIOECONOMIC TECHNICAL STUDIES

APPENDIX G: SOCIAL AND ECONOMIC DATA TABLES

Table G-1
State Cultural Resource Contacts for Kentucky, Tennessee, Virginia, and West Virginia

State Agency	Contact Person	Address	Telephone/Fax/Email
Kentucky Heritage Council	Mr. David Morgan, SHPO and Dir. Kentucky Heritage Council	300 Washington St. Frankfort, KY 40601	Tel: (502) 564-7005 Email: dmorgan@mail.state.ky.us
University of Kentucky, Department of Anthropology	State Archaeologist	Lexington, KY 40506-0024	(606) 258-5735 Email: ant131@ukcc.uky.edu
Tennessee Department of Environment and Conservation	Mr. Ollie Keller, Deputy Commissioner and SHPO	2941 Lebanon Road Nashville, TN 37243-0435	Tel: (615) 535-0105
Tennessee Department of Environment and Conservation Div. of Archaeology	Nick Fielder, State Archaeologist	5103 Edmonson Pike Nashville, TN 37211-5129	Tel: (615) 741-1588 Fax: (615) 741-7329 Email: nfielder@mail.state.tn.us
Tennessee Historical Commission	Herbert Harper, Director	Clover Bottom Mansion 2941 Lebanon Road Nashville, Tennessee 37243-0442	Tel: (615) 532-1550
Virginia Department of Historic Resources	H. Alexander Wise, Jr., Director	2801 Kensington Avenue Richmond, VA 23221	Tel: (804) 367-2323
Virginia Department. of Historic Resources	M. Catherine Slusser, State Archaeologist	2801 Kensington Ave. Richmond, VA 23219	Tel: (804) 367-2323 Fax: (804) 225-4261 Email: cslusser@dhr.state.va.us
West Virginia Division of Culture and History	Patrick Trader, Senior Archaeologist	The Cultural Center 1900 Kanawha Blvd. East Charleston, WV 25305-0300	Tel: (304) 558-0220, ext. 179 Fax: (304) 558-2779
West Virginia Division of Culture and History	Renay Conlin, Commissioner	Capitol Complex Charleston, West Virginia 25305	Tel: (304) 558-0200

Sources: U.S. Department of Interior. "National Park Service Homepage." Online. http://www2.cr.nps.gov/shpo/. July 21, 1999.
State of Tennessee. "Tennessee Department of Environment and Conservation Homepage." Online. http://www.state.tn.us/environment/hist/hist.htm. July 21, 1999.
University of Kentucky. Online. http://www.uky.edu/AS/Anthropology/Faculty/faculty.html#Staff. July 21, 1999.

Socio-Economic Study Category, **Appendix G**

Study Topic	**File Date**
Post Mining Land Use Study	3/18/2002
The Mountaintop EIS Technical Report	6/6/2000
Mine Dust and Fumes Study	10/09/2001
Blasting-Related Citizen Complaints in Kentucky, West Virginia, Virginia and Tennessee	7/10/2002
Impact of Blasting on Domestic Wells	6/28/2002
Workshop on Mountaintop Mining Effects on Ground water	9/14/2000
Comparative Study of Structure Response to Coal Mine Blasting – Non Traditional Structures	2/01/2003
Phase I Economics	3/08/2002
Phase II Economics Sensitivity Analysis	12/12/2001 1/13/2003
Case Studies Report on Demographic Changes Related to Mountaintop Mining	8/30/02

These reports are included in the appendix in black and white. Color versions may be viewed on the following website. http://www.epa.gov/region3/mtntop/index.htm

Post Mining Land Use Study by Dr. Charles Yuill, WVU

This study is designed to assess the impacts of historic, current, and potential mountaintop removal mining on land use and development patterns in West Virginia. This study, along with other related studies, was designed to answer the following general question:

> *What are the socio-economic impacts, both positive and negative, associated with mountaintop mining and valley fills? These may include values associated with post mining land use change, removal from market of coal not economically accessible by other mining methods (and associated takings claims), aesthetics, tourism, the heritage of mountain residents, and other factors.*

More specifically, the EIS Steering Committee wanted this particular study to determine if changes in land uses following mountaintop mining and reclamation provide marketable lands beneficial to the coal field region of southern West Virginia. The study concludes:

The opinions and views in the studies in this Appendix do not necessarily reflect the position or view of the agencies preparing this EIS. These appendix cover sheets are provided as an aid to the reader to summarize the studies and also do not necessarily reflect the opinions and views of the EIS agencies.

> "Significant additional acreages of land with development opportunities and potentials greater than the potentials that are currently present will result from reclamation in the potential future mountaintop mining areas." However, the report adds that, "Development limitations such as poor accessibility and infrastructure proximity will continue in nearly all of these areas." Regarding the prospects for future developed land uses, the study concludes that, "Given current and foreseeable future land use demands, it is unlikely that any more than 2 to 3% of the future post-mining land uses will be developed land uses such as housing, commercial, industrial, or public facility development."

The study also indicates the scope of land use changes from past, present and potential coal mining:

> "Almost 88%, or slightly over four million acres were classified as mature forest land with the diverse mesophytic forest type being most prevalent at almost three million acres of area. All developed land uses (intensive urban, moderately intensive urban, light urban, populated areas, major roads, and infrastructure such as power lines) only accounted for 155,000 acres or roughly three percent of the area. Agricultural land uses were found on approximately a quarter of a million acres or five percent of the area. Other general land use/ land cover categories include: shrub land and woodland areas with slightly over 63,000 acres; water/ wetlands with 56,000 acres or one percent of the area; and barren land–mining being 74,000 acres or 1.5% of the study area. The barren land–mining category significantly underestimates the acreage in mining because it includes only areas that were essentially in bare or nearly bare soil at the time of image acquisition–so it does not include reclaimed areas."

The report corrected the underestimated mining category of land use as follows:

> "Total identified disturbed acreage (all mining disturbances) = 244,664 acres, 5.01% of region. Estimate does not include areas that have been fully reclaimed or converted to a post-mining land use. Current permitted coal mine area in the mountaintop mining region of West Virginia [is] 247,364 acres. Of the total permitted area in the region, over one quarter is in mountaintop mines–the remaining are contour mines, surface areas impacted by underground mines, and coal preparation and cleaning facilities that often contain very large coal waste disposal areas."

The report shows that 91% of the permitted area had a pre-mining land use of various types of forest cover, with 68% of the proposed post-mining land use area comprising various types of forest cover or wildlife habitat. The report projected from 56,000 to 228,000 acres affected due to potential future mountaintop removal (does not include projections of future contour mining).

However, the reader must be cautioned on the use of specific study data regarding **future** land use impacts due to MTM/VFoperations. The future projected mining data provided in the study is based on GIS data generated by the "Phase I Economic" study, which was not designed for siting purposes. The Phase I study was also subsequently determined to have limitations because the data did not necessarily represent potential future mining sites and the model was insensitive to localized land uses and mining engineering assumptions. The portions of the study that are not based

The Mountaintop EIS Technical Report - by the Mountaintop Technical Team

This study was designed to determine how coal recovery at proposed mine sites would be impacted if valley fills were prohibited in intermittent and perennial stream segments. Use of alternative methods to mine available coal were analyzed. This studyand other related studies were designed to answer the following general question:

> *If regulatory action limits mountaintop mining and/or associated valley fills, what impacts would the possible alternative mining methods have on environmental and socio-economic resources?*

Specifically, for this particular study, the EIS Steering Committee wanted to know the impacts to coal recovery by limiting valley fill construction to ephemeral stream segments. The study concludes:

> Of the ten mines examined, coal recovery would be reduced by 78%, if the altered economics of revised mine configurations are not considered. The coal recovery from these sites would be reduced by 86%. A combination underground/contour mine with a coal processing facility was also examined, and the study determined that recovery of coal from this complex is completely infeasible if fills would be restricted to ephemeral streams. Adding the reductions for this eleventh facility, the total coal recovery (compared to the original mine plan recovery) is reduced by over 92%.

The limiting factor of this study was the relatively small sample size.

Mine Dust and Blasting Fumes Study by Dr. Lloyd English, WVU

The study was designed to determine if blasting was causing measurably higher concentrations of dust and fumes outside of the permit area. The study was performed primarily because of public comments and concerns raised during EIS scoping meetings that dust from mine blasts was a significant problem and a health risk to people living in communities adjacent to mountaintop mines.

The study concluded that dust and fume emissions from blasting pose no potential health problems outside of the mine area. Visible and measurable fugitive dust--a quality of life issue--rarely migrated more than 1000 feet from the actual blast.

The limiting factor of this study is the relatively small sample size and the ability to capture/measure the dust and gas fumes emanating from the blast.

<u>Blasting-Related Citizen Complaints in Kentucky, West Virginia, Virginia and Tennessee</u> by OSM

This survey was adapted for the EIS from a nationwide study of citizens' blasting complaints, The report characterized the nature of the complaints and responsive actions of the regulatory authorities. The survey characterized the nature, number, and disposition of the complaints within the EIS study area.

The survey found 'annoyance' is the most common blasting complaint, followed by damage and water concerns. Dust, fumes, and flyrock were of much less concern. None of the complaints concerned injury to a person, and only one complaint investigation substantiated property damage. Regulatory authorities most often cited coal operators for record-keeping violations.

The limiting factor of the survey is reliance on available regulatory authority records as opposed to site-specific investigations to discern if allegations were legitimate or complaints were appropriately investigated.

<u>Impact of Blasting on Domestic Wells</u> by Daniel B. Stephens & Associates, Inc

The study was designed to investigate possible effects of mining operations on groundwater quality and supply in domestic wells. OSM performed this study to supplement existing studies to ascertain whether blasting operations were having a profound affect on domestic wells and groundwater sources.

Consistent with earlier U.S. Bureau of Mines research, the study found few changes in the water quality and well yield data that could be directly attributed to blasting. Water quality parameters changed slightly over time, but seem to be unrelated to blasting. The report concluded changes were likely the result of sensor drift and mixing of the water in the well due to pump cycling. Well yield and water level remained constant.

The limiting factor of this study is that only one of the original ten wells could be monitored over entire study period.

<u>Comparative Study of Structure Response to Coal Mine Blasting – Non Traditional Structures</u> by Aimone Martin & Associates

The objective of this study was to observe the response characteristics of atypical (e.g., mobile, earth, log, adobe homes) residential structures to blast-induced ground vibration and airblast. The response of these type home to blasts were compared to findings from existing research to determine if the atypical residential structures are afforded the same level of protection as typical residential structures (e.g., frame, masonry, etc. homes) under the existing OSM rules. OSM performed this study to supplement current research. The findings are relevant to scoping issues suggesting that large scale blasting conducted as part of mountaintop mining was damaging homes and other structures.

The study concluded that most of the structures responded in a similar way to structures in earlier blasting studies. The structural response (i.e. the amplification of vibrations within a man-made structure as the result of induced ground vibrations) was greater in earth, masonry structures, and two-story camp homes than traditional structures. When these structures are present near coal mine blasting, lower site-specific vibration and airblast limits (provided for in the OSM regulations) may be prudent.

Phase I Economics by Resource Technology Corporation

The study was designed to determine the effects on coal resource recovery from limiting valley fills to certain size watersheds (35, 75, 150, and 250 acres). The study was designed to ascertain the economic effects of various actions and alternatives under consideration to restrict the valley fills. This phase of the study examined the effects on coal resource recovery related to available valley fill disposal sites. The study was also designed to aid in the cumulative impact analysis by identifying areas that could be affected by future MTM/VF construction.

The study concluded that there would be a 17, 23, 46, and 77 percent reduction in coal resources extracted if fills were limited to 250-, 150-, 75-, and 35-acre watershed scenarios, respectively. While the study addressed the questions posed, the EIS Steering Committee found limitations with the study.

Valley fills locations used in the study exceeded the watershed size thresholds established by the study (i.e. fills were placed in watersheds greater than the scenario limits). The Phase I study fill locations were inconsistent with basic engineering principles and typical mining practice to locate fills in valleys as opposed to on hillsides. The impacts to coal resources that may be recovered by future contour mining (as opposed to mountaintop removal) were not considered due to the applied slope-steepness criteria.

Further, the Phase I study relied on consideration of future mining based on areas where past mining had not occurred. A number of the potential mining sites utilized in the Phase I analysis have subsequently been determined to have been mined, consequently overestimating the available future resource for the Phase I scenarios. The study attempted to take into account mining engineering considerations such as overburden ratios, the volume of resource block, topography, etc., to assess resource recovery feasibility. However, the computer model was not designed, nor did the data exist, to account for every critical mining engineering factor, such as coal quality, mineral and surface ownership conflicts, and other very site-specific elements.

The Steering Committee consequently found that the site-specific results of the Phase I Economics study have limitations and should not be relied on to be representative of potential future mining and fill areas or precise with respect to production change estimates. Methodology, assumptions, and data limitations were presented in a public meeting with stakeholders in Charleston, West Virginia in November 2002 in preparation for the sensitivity analysis described below in the Phase II Economic Study synopsis. Despite the study limitations, the computer modeling clearly indicates a trend related to reduction in available valley fill storage and the amount of coal reserves recoverable. The study illustrates, from a regional modeling perspective, that restricting valley fills to small watersheds would commensurately restrict mining feasibility and minimizes full resource utilization.

<u>Phase II Economics</u> by Hill and Associates

This study was designed to utilize the results of the Phase I economics study; i.e., what impacts will valley fill restrictions and the reduced ability to recover mine coal resources have on coal prices, coal production, electricity generation/pricing, mining employment, and tax losses. The production reduction numbers generated by the Phase I Economics Study of RTC (described above) were input with Hill and Associates proprietary information and models. The Phase II Economic Study projected that, overall, the price of coal would continue to fall in the study area and fill placement restrictions would raise the price of coal by approximately $2.50-$3.50 under the most restrictive scenario (fills limited to 35-acre watersheds) over the base case "no constraints" scenario. However, in most situations the restriction would change the price of coal to less than one dollar per ton. The most restrictive scenario would, under the worst condition, cause up to a 20 percent reduction in direct coal mining employment in the region. The total electricity generated in the region would also be affected by fill restrictions. Under the most restrictive scenario, electricity production would be reduced by 11 percent over the base scenario. Generally, electricity production reduction would range from 2 to 6 percent in most years, because of the restrictions. The price of electricity would continue to rise approximately 1 to 2 percent across the scenarios; the impacts due to restrictions will have little effect on price.

Because the Phase II Economic Study used the results of the Phase I Economic Study, the study results also have limitations. The EIS Steering Committee sanctioned a sensitivity study by Hill and Associates to evaluate these limitations. The sensitivity study was designed to determine how results of the initial Phase II study would change if a different set of Phase I assumptions and inputs were used. Modeling inputs, drawn from mining experience were used to indicate the direction and the magnitude of Phase II study output change resulting from adjusted sensitivity inputs.

In the original Phase II study, no adjustments in costs were made to reflect changes in material handling and haulage methods resulting from fill restrictions. The costs were also not adjusted to reflect the reality that fill restrictions would likely necessitate a change from large mining equipment to smaller equipment. A shift from fewer larger fills to many smaller fills would require construction costs for additional sediment ponds–not part of the initial Phase II assumptions. Finally, the initial modeling runs in the Phase II Economic Study did not project an increase the required return on investment (ROI) capital, which was estimated to be as high as 20%percent. This unwillingness to invest, because of perceived increased risk, occurs largely due to regulatory uncertainty. These factors were used in adjusting the modeling sensitivity runs to reflect higher mining costs and lower mine capacity and reserve recovery.

The sensitivity runs confirmed earlier results indicating that coal production was sensitive to lower reserve recovery due to smaller fills. Production decreased by approximately 20 percent over the initial study results. The price of coal was somewhat sensitive to the model assumption adjustments, reflected by approximately $2.00 more per ton under the most restrictive scenario over the base scenario. This impact is double that of the original Phase II run for the same scenario. The change in ROI had very little impact on the results.

Case Studies Report on Demographic Changes Related to Mountaintop Mining by Gannett Fleming, Inc

The purpose of the study was to evaluate what, if any, demographic changes can be observed in communities located adjacent to large-scale mountaintop mines. The study concluded that population, family income, and levels of employment have declined since the 1970's. Personal accounts by a sample of residents attributed these changes with the onset of mountaintop mining; however, the control areas where no mountaintop mining occurred showed some similar demographic shifts. Therefore, the limitations of the study are that the conclusions of demographic shifts due to mining are based on perception. The shifts may actually be attributable in part or more directly related to complex Appalachian societal, generational, economic, governmental, and quality of life issues and factors.

LAND USE ASSESSMENT

MOUNTAINTOP MINING IN WEST VIRGINIA

DRAFT REPORT

LAND USE ASSESSMENT

MOUNTAINTOP MINING IN WEST VIRGINIA

DRAFT REPORT

PREPARED BY:

Charles Yuill
West Virginia University
Natural Resource Analysis Center
Davis College of Agriculture, Forestry, and Consumer Sciences
Agricultural Sciences Building
Morgantown, West Virginia 26505 – 6108.

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Introduction

Scope

This study was conducted to examine land use issues associated with mountaintop mining in southern West Virginia – the mountaintop-mining region of the state. For this study, the mountaintop-mining region is defined as the fourteen county area illustrated in Figure 1. These fourteen counties represent counties that historically have contained mountaintop-mining operations and / or have coal reserves that are suitable for recovery with future mountaintop mining. Also for this study:

- Land use is defined as a purposeful intended use of the land – e.g. commercial forestry or outdoor recreation.
- Land cover is defined as the physical component of the land – e.g. mature trees or grassland.
- Land use / land cover is an approach to classification of land use and land cover that considers both perspectives within a single classification framework.

Mountaintop mining is defined as a surface mining method that is designed to mine multiple seams of coal by mining either parallel to or cross mountain ridges – removing all of the coal in and above a base coal seam. The mining method generally results in the following conditions:

- Complete or near-complete removal of a mountaintop resulting in significant quantities of spoil material which must be returned to the mined area as backstacked fill or placed in adjacent valley fills.
- Efficient recovery of the coal reserves in and above the base coal seam.
- Because of the above, the resulting mines are generally significantly larger than with the various forms of contour mining that are practiced in the steep slope mining region of southern West Virginia.

The overall goal of the study was to identify and assess the major land use impacts of current and potential mountaintop mining in the region. To meet this goal, the study was structured with the following components:

- Current land use / land cover (lu / lc) patterns in the region to establish baseline land use conditions in the region.
- General historic land use / land cover trends.
- The contributions of past and current coal mining in determining land use and land cover patterns in the region.
- The roles various land use programs and regulatory controls contribute to land use development on mountaintop mines, as well as the region in general.

- Characterization of development patterns, opportunities, and limitations in the region to place land use opportunities and problems associated with mountaintop mining in a larger regional perspective.
- Identification of current land use / land cover patterns and conditions in areas with potentials for future mountaintop mining to assess potential land use impacts of future mountaintop mining in the region.
- Discussion of a few case studies to identify the conditions that contribute to the development of both typical and atypical land uses on mountaintop mines.

The Study Area

The fourteen county study region comprises part of the Appalachian Plateau, which is a maturely dissected plateau characterized by high hills, sharp ridges, and narrow valleys. Exceptions are portions of the Kanawha River Valley and Teays Valley, which have expanses of open relatively level floodplain lands. Local relief in the region exceeds 2,000 ft along the New River Gorge, but is generally much less. Surface drainage is generally dendritic, with associated environmental problems related to flooding, soil erosion, and mass wasting (land slides). The major land cover is mature forestland (generally greater than 80 years of age) which resulted from forest regeneration after extensive clear-cutting during the early 20th century with patchy younger forests, which resulted from agricultural land abandonment during much of the mid-part of the century. Most of this forest area is classified as diverse/mesophytic forest with additional areas of mountain hardwoods, mixed oaks, cove hardwoods and floodplain forests. The major watersheds of the region include: Tug Fork, the Lower and Upper Kanawha, the Lower and Upper Guyandotte, New, Gauley, Coal, Elk, Big Sandy, and Twelvepole Creek watersheds.

Since the time of European settlement during the 18th century, development has been focused primarily along major rivers and tributaries. Beginning in the mid 19th century, development became more and more dispersed and distributed throughout the entire region, resulting in one of the most rural populations of anywhere in the United States – even to this day. Major present-day communities in the region include: Charleston, South Charleston, Dunbar, Nitro, Beckley, Mt Hope, Welch, Logan, and Summersville. Numerous smaller towns and communities are scattered throughout the region, generally located on river and tributary floodplains. Present-day population densities range from fewer than 40 persons per square mile in portions of Boone, Lincoln, and Mingo Counties to between 1,500 and 3,500 persons per square mile in portions of Charleston and other communities in the Kanawha Valley. Land that was level enough for agriculture was generally cleared, especially in the stream valleys and on ridge tops. Most of this agricultural land has since been abandoned or converted to other land uses. Most slopes were logged repeatedly. However, the region is presently almost 88% forested.

Mining in the Region

The mountaintop mining study area is comprised of two major coal areas – the Allegheny – Kanawha and New River – Pocahontas areas. Within these areas the major coalfields include the Gauley – Greenbrier, New River, Pocahontas, Williamson, Logan, Kanawha, and Elkins coal fields. Beginning in 1817, the Kanawha coalfields were one of the leading coal producing and consuming areas in the country – surpassed only by Mercer County, Pennsylvania (Workman 1994). Nearly all of this early mining was deep or underground mining. By the Civil War, there were over forty companies operating in this region – Kanawha, Lincoln, Boone, and Clay Counties. The northern portion (Braxton and Webster Counties) of the region began to be developed after the Civil War, and extensive mine development began in the New River area beginning in the 1870's. It was the incremental development of the railroads that provided most of the impetus for coal mine development in these areas. Prior to World War II, the predominate method of coal removal in the study area was underground mining. Beginning in the 1940's, contour strip mining, which can be practiced on very steep terrain began to be utilized in the region. Contour surface mining consists of removing overburden material from above the coal seam or seams starting at the outcrop (where the coal seam daylights on the ground) and proceeding around the hillside. Prior to contemporary mining regulations, the overburden was generally cast down the hillside. Today regulations mandate that the overburden is initially stacked and then replaced with successive cuts, with the resulting reclamation approximating the original terrain of the land, though there are provisions for placing portions of the resulting overburden into constructed valley fills.

<u>Mountaintop Mining</u>. First demonstrated in 1967, early mountaintop mining was initially merely an extension of contour mining. Series of contour cuts were developed to encircle the mountain ridge proceeding toward the center of the mountain. The entire mountaintop might have been removed or the topmost portion of the mountain might have been left resulting in a partial "apple core" landform pattern where coal removal was not completed. Auger mining was often utilized to remove the coal that remained under the topmost portions of the mountain ridge. This method of mining had a number of disadvantages, including: increasing overburden depths to retrieve additional coal resulting in increasingly poor mine economics (discouraging coal removal at the ridge tops); a lack of sufficient room for backfilling of the mined areas resulting in numerous valley fills around the ridge; and the need for extensive erosion and sedimentation control systems because of the vast areas of land that were disturbed at the same time.

Most modern mountaintop mining generally involves some form of cross-ridge mining (Skelly and Loy 1983). With this form of mining, series of benches (active coal recovery areas) are aligned perpendicular to the long axis of the mountain ridge and mining advances along the ridgeline, usually from one end of the mountain to the other. This method has a number of important advantages over earlier forms of mountaintop mining. These advantages include: consistent economics over the life of the mine; backstack (backfill) space is provided in closer proximity to the active mining area resulting in concurrent mining and reclamation; and the need to numerous valley fills is reduced because of improved backstack potentials. In general terms, the following are generally recognized attributes of mountaintop mining as it has been practiced in southern West Virginia:

- Mountaintop mining has allowed for the recovery of coal that would be difficult to recover with other mining methods;
- Extraction costs are reduced because of the simultaneous extraction of coal from multiple coal seams;
- Mountaintop mining is used to permit efficient handling of overburden with mountaintop mining regrading provisions allowing for some overburden disposal into hollows or valleys resulting in additional spoil storage space for effective mining to the lowest recoverable coal seam; and
- The technique has created large valley fills and significantly altered the topographic configuration of the original mountain terrain above the lowest mined coal seam (Resource Technologies Corporation 2000) throughout much of the 14 county mountaintop mining region of southern West Virginia.

Background – Land Use in the Mountaintop Mining Region of West Virginia

Existing Land Use / Land Cover.

Table 1 summarizes current land use / land cover in the study area. These results were derived from classification of recent Landsat satellite data (1994- 1995 initial dates and 2000-2001 update dates). The satellite data were classified, mosaiced and converted to a GIS (geographic information system) coverage for analysis and display. Figure 2 presents a map of current land use / land cover that was derived from that same classification effort. The land use / land cover classes that were utilized were selected to provide the greatest amount of meaningful detail about the area yet be efficiently obtainable using remote sensing.

These classification results confirm the forested / lightly developed character of the mountaintop mining region. Almost 88%, or slightly over four million acres were classified as mature forestland with the diverse mesophytic forest type being most prevalent at almost three million acres of area. All developed land uses (intensive urban, moderately intensive urban, light urban, populated areas, major roads, and infrastructure such as power lines) only accounted for 155,000 acres or roughly three percent of the area. Agricultural land uses were found on approximately a quarter of a million acres or five percent of the area. Other general land use / land cover categories include: shrub land and woodland areas with slightly over 63,000 acres; water / wetlands with 56,000 acres or one percent of the area; and barren land – mining being 74,000 acres or 1.5% of the study area. The barren land – mining category significantly underestimates the acreage in mining because it includes only areas that were essentially in bare or nearly bare soil at the time of image acquisition – so it does not include reclaimed areas. So subsequent mined area acreage estimates were developed using other methods.

Land Use Data and Methods. Landsat satellite data from two different time periods were utilized for this classification. Various date mid-1990's data that had been previously classified to identify the major forest / natural land types in the area provided the basis for this analysis. Leaf-off various date years 2000 / 2001 imagery were utilized to augment this classification with greater detail and a more up-to-date classification for the developed land use / land cover classes. Details concerning the natural land cover classes can be found in the WVU – NRAC, 2001 WVGAP Final Report. The developed land use classes that were utilized are described below.

- Intensive urban – areas where a majority of the land surface is impervious covered by buildings or surface paving – includes city and town centers.
- Moderately intensive urban – areas where approximately half of the land area is impervious – primarily includes town centers and areas adjacent to city centers.

Table 1. Current land use/land cover in the West Virginia mountaintop-mining region, WVU-NRAC classification.

Cover Type	Area (Acres)	Percent
Major power lines	16,191	0.33
Major roads	2,794	0.06
Populated areas	19,450	0.40
Light intensity urban	75,645	1.55
Moderate intensity urban	19,584	0.40
Intensive urban	21,330	0.44
All developed	*154,994*	*3.18*
Planted grassland	1,201	0.02
Conifer plantation	204	0.00
Row crop agriculture	3,127	0.06
Pasture/grassland	241,589	4.95
All agriculture	*246,120*	*5.04*
Shrubland	46,451	0.95
Woodland	16,880	0.35
All shrubland/woodland	*63,332*	*1.30*
Floodplain forest	31,367	0.64
Cove hardwood forest	414,186	8.49
Diverse/mesophytic hardwood forest	2,930,112	60.05
Hardwood/conifer forest	52,387	1.07
Oak dominant forest	391,735	8.03
Mountain hardwood forest	463,760	9.50
Mountain hardwood/conifer forest	1,022	0.02
Mountain conifer forest	81	0.00
All forest	*4,284,651*	*87.82*
Surface water	53,084	1.09
Forested wetland	1,185	0.02
Shrub wetland	1,303	0.03

Herbaceous wetland	968	0.02
All water/wetland	*56,540*	*1.16*
Barren land - mining, construction	73,499	1.51
All barren/other	*73,499*	*1.51*
TOTAL	4,879,135	100.00

- Light intensity urban – areas where less than half of the land area is impervious but impervious areas still cover a significant amount of the area – includes rural communities and small town centers.
- Populated areas – areas with mixed land cover that has significant amounts of development in checkerboard patterns with significant population densities – includes suburban and lightly populated residential areas.
- Major roads – includes primarily highways and interstate highways.
- Major power lines – includes primarily high voltage power lines.

The basic method that was utilized for satellite data classification was based on unsupervised cluster labeling (ISOCLUSS classification with cluster separation and aggregation) using over 10,000 aerial and ground sample points that had been previously classified as part of an earlier project. Unsupervised cluster labeling is a proven technique for developing regional land cover classifications from satellite data. It must be noted that there are certain limitations in this classification. It certainly underestimates areas in very small communities and other dispersed developed areas. This is due to many of these developed areas being under heavy forest cover or in agricultural areas, and were not detected, and as such were placed into other land use classes. Other methods were utilized in later analyses to better estimate the number of locations of populated places in the region.

The results of a second land use / land cover classification that was available are summarized in Table 2 and Figure 3. These results are from the National Land Cover Dataset (NLCD) that is available for West Virginia (USGS 2000). These results are close to the results that were achieved by the WVU – NRAC classification. However, the results from the WVU classification were focused on in this report because they were developed using classification and intensive accuracy assessment methods that were designed to specifically respond to local vegetative, development, and topographic conditions throughout the region. The NLCD dataset was developed using methods more suitable to wide-area regional assessment requirements.

Land Use / Land Cover Change

Table 3 presents general land use / land cover changes for the study area examining three different time periods – 1950, 1976, and current conditions. Four general land use / land cover classes were utilized because class aggregations were required to make the data that were available for the different time periods comparable. These results indicate the following general patterns of land use change in the region:

- The acreage of developed area increased from 42,533 acres in 1950 to 154, 966 acres currently. This acreage probably does not include much of the dispersed developed that dominates the region.
- Agricultural acreages decreased from almost a million acres in 1950 to 188,000 acres in 1976 and increased from 1976 to current time to 246,000 acres. Much of this acreage is actually due to coalmine reclamation that converted areas from forestland to grassland / pasture.
- Forest areas increased from under four million acres in 1950 to almost 4.5 million acres in 1976 and then fell to under 4.3 million acres currently.

Table 2. Current land use/land cover in the West Virginia mountaintop-mining region, EPA MRLC/NLCD classification.

Cover Type	Area (Acres)	Percent
Low intensity developed	51,780	1.06
High intensity developed	9,885	0.20
All developed	*61,665*	*1.26*
Hay, pasture, grass	101,733	2.09
Row crops	52,213	1.07
Mixed pasture, low intensity agriculture	101,958	2.09
All agriculture	*255,904*	*5.25*
Conifer forest	111,027	2.28
Mixed forest	466,961	9.57
Deciduous forest	3,872,449	79.37
All forest	*4,450,436*	*91.22*
Palustrine forested wetland	1,133	0.02
Palustrine shrub/scrub wetland	1,236	0.03
Palustrine emergent wetland	1,221	0.03
Other palustrine wetland	3,027	0.06
Open water	44,341	0.91
All water/wetland	*50,957*	*1.04*
Barren - quarry and mining	52,146	1.07
Barren - transitional	7,769	0.16
All barren/other	*59,916*	*1.23*
TOTAL	4,878,878	100.00

Table 3. Summary Land Use Statistics for the West Virginia Mountaintop Mining Region.

Land Use	area (acres)			percentage		
	1950	1976	Present	1950	1976	Present
developed	42,533	135,566	154,966	0.9	2.8	3.2
agricultural/open	950,135	188,363	246,082	19.5	3.9	5.0
forest	3,873,619	4,450,580	4,284,141	79.4	91.2	87.8
disturbed (includes some mining)	3,015	85,598	73,502	0.5	1.8	1.5

Land Use Changes	area (acres)		
	1950-1976	1976-Present	1950-Present
developed	92,933	19,501	112,433
agricultural/open	-763,772	57,719	-706,503
forest	576,961	-166,439	412,522
disturbed	84,583	-12,096	72,488

- Current loss of forestland is due to patterns in mine reclamation converted land from forest to open – grassland / pasture and to new urban development in the region.
- Disturbed areas increased from just over 3,000 acres in 1950 (indicating low amounts of surface mining) to a high of 85,000 acres in 1976 and over 73,000 acres currently. Again this acreage does not reflect mined areas so much as it indicates areas mined areas that were unvegetated in those time periods.

Land Use / Land Cover Change Data and Methods. The data that were assembled for this assessment were obtained from a couple of different data sources. 1950 data were obtained from detailed paper maps that were compiled during a four-year land cover-mapping project that was completed by the U.S. Forest Service for West Virginia. These data were published in 1950. The data had been previously digitized on a 15minute quadrangle map basis by WVU – NRAC. A seamless dataset for the mountaintop mining study area was developed by mosaicing the individual maps and removing numerous map-to-map discrepancies that were observed. The 1976 data were the available were USGS GIRAS land use data that were digitized by USGS from 1976 vintage 1:48,000 scale aerial photography. A seamless data set of the 1976 date data set for the study area was developed by mosaicing the individual 1:100,000 quadrangle maps that form the base for this mapping and then removing map to map inconsistencies that were detected. The current land use data were again the results of the WVU – NRAC satellite data classification effort. These data were developed by mosaicing the data that were developed on a large watershed / ecological areas basis with potential applicability at 1:24,000 scales and larger.

Extent of Mining and Land Use / Land Cover

A separate estimation of the extent of mining as a separate land use / land cover class was developed because the land use classification that was developed by WVU or the classifications that were available from other sources are generally felt to significantly underestimate mined areas by placing reclaimed areas into other land use / land cover categories such as grassland / pasture and forest. Table 4 and Figure 4 present the results of this mapping compilation. This was an attempt to compile the best available data sources for the mined areas that were identified; cross reference the different data sources; and then check the compiled data using sources such as current aerial photography. Cross-referencing and checking were utilized to remove duplication and rectify discrepancies between the different data sets. It is recognized that differences in the data sets that were utilized (e.g. aerial photography vs. satellite data vs. field sketch mapping) potentially does reduce the utility and comparability of these data. However, a compilation of the best available data did seem to be the most efficient method for developing an extent of past mining assessment for the study area. This assessment potentially does, again, underestimate the area of past mining because the majority of the data sources that were utilized potentially did not capture mined areas that had little or no physical evidence that mining had taken place. This was generally due to reclamation or natural regeneration of forest cover over the mined areas.

Extent of Past Mining Methods and Results. Table 4 lists the major data sources that were tabulated. New photo-interpretation of color infrared aerial photography and SPOT panchromatic satellite data (fall 2000 dates) was completed to verify or rectify inconsistencies in the other data sources.

Results of this compilation indicated that over 244,000 acres or approximately 5% of the area contained evidence as having been disturbed by past or current mining. This indicates that mining related land uses are the second most prevalent land use / land cover in the region – after forestland. This total includes a number of different mine types – unreclaimed abandoned mines, unreclaimed mines with forfeited bonds, reclaimed mines (where the resulting post-reclamation land use allowed for identification and delineation), and active mines. Again it is probable that significant mined areas were undetected by the various data sources, as well as subsequent checking and verification. However, Figure 4 mapping results could be combined with Figure 2 to develop a more realistic indication of the importance of past and current in the land use / land cover of the region.

Current Mining – Land and Land Use

Current mining was examined focusing on permit data rather than physical evidence of past or current mining. Permits were utilized as an indicator of current mining activities because permits contain land in three different conditions – areas that have been mined and reclaimed awaiting bond release, areas that are actively being mined, and areas that potentially will be mined in the near future.

Current Mining Permits Methods and Results. Table 5 presents a number of different summary statistics for current mining in West Virginia and the mountaintop-mining region. These data were obtained from two different data sources:

- Surface and deep mine permit records from WVDEP that were available in digital form in various WVDEP databases.

- Digitized permit boundaries that are being digitized by WVU-NRAC under contract to WVDEP.

Table 4. Extent of Past Mining Disturbances in the West Virginia Mountaintop Mining Region

Total identified disturbed acreage (all mining disturbances) * = 244,664 acres
5.01% of region

Data Sources:

1. Photointerpretation of 1997 West Virginia digital ortho quarter-quadrangles by WVU-NRAC.
2. Photo interpretation of 2000 SPOT panchromatic imagery by WVU – NRAC.
3. Automated classification of Landsat TM data for 1994, 1995, and 2000-year dates.
4. Landsat satellite data (year 2000) NDVI classification by Tennessee Valley Authority.
5. Photointerpretation of West Virginia digital ortho quarter-quadrangles by WVDEP – TAGIS.
6. West Virginia Abandoned Mined Land Inventory - WVDEP.
7. West Virginia DEP files – bond forfeiture sites.

* Estimate does not include areas that have been fully reclaimed or converted to a post-mining land use.

Table 5. Current Mining Permits – Summary Statistics for the West Virginia Mountaintop Mining Region.

1. Current permitted coal mine area in West Virginia	307,802 acres
2. Current permitted coal mine area in the mountaintop mining region of West Virginia	247,364 acres
3. Current permitted mountaintop-mining area in the mountaintop mining region of West Virginia**	65,354 acres
4. Average area for current mountaintop mining permits	585 acres
5. Average area of 20 largest current mountaintop permits	1728 acres

6. 100 largest area permits in West Virginia
   - 40 are mountaintop mining permits
   - 60 are deep mine and coal processing complexes (surface acreage only – underground mined acreage is not included.

** Figure includes currently permitted mountaintop mines that have active / inspected by WVDEP. Does not include new permits where mining has not been initiated.

These results indicate that almost three-quarters of the total coal mine permit area for West Virginia is in the fourteen mountaintop-mining region. Of the total permitted area in the region, over one quarter is in mountaintop mines – the remaining are contour mines, surface areas impacted by underground mines, and coal preparation and cleaning facilities that often contain very large coal waste disposal areas. The results also indicate that the average permitted mountain area is almost 600 acres and the average area for the twenty largest mountaintop mine permits is 1,728 acres. This pattern indicates a tiering pattern in the size of West Virginia mountaintop mines – with a number of mines in the 400 – 700 acre range and a relatively small number of very large mountaintop mines. For comparison purposes, in examining the 100 largest permit areas for West Virginia, it was found that 60 of these areas are actually deep mine and coal processing complexes and 40 are mountaintop mines.

Table 6 presents pre-mining land uses for the current mountaintop mining permit areas. Figure 9 presents a map of current mountaintop mining permits in the region.

These data were developed by overlaying 1976 and 1995 land use / land cover data (used as a pre-mining estimate) with the permit boundaries that were digitized by WVU-NRAC under contract to the WVDEP. These results show that the majority of the pre-mining permit areas are forested (app. 92%) and almost 5% were previously disturbed mined areas. The remaining areas include small amounts of shrubland, woodland, power lines and light intensity urban development (small populated areas). Table 7 shows the proposed post-mining land uses for the same permit areas. These data were obtained from WVDEP digital permit data files. This table indicates a minor shift in land use between the pre-mining and proposed post-mining land use conditions. Almost 50% of the proposed post mining land uses include forms of open land including hay / pasture, animal grazing, and some additional open-land in combined / multiple use areas (generally a combination of forest and open land areas). Most of the remaining area is proposed for various forestry related land uses (over 50%), with less than 2% of the total area proposed for new residential / housing and public service / public use (infrastructure development) land uses.

Table 6. Pre-mining Land Uses in Current Mountaintop Mining Permit Areas.

Land Use	%
Shrubland	0.97
Woodland	0.32
Major Power Lines	0.32
Light Intensity Urban	0.32
Pasture / Grassland	0.97
Barren Land - mining, construction	4.85
Cove Hardwood Forest	16.50
Diverse / Mesophytic Hardwood Forest	60.19
Hardwood / Conifer Forest	0.97
Oak Dominant Forest	9.39
Mountain Hardwood Forest	5.18
Total Acreage	65,354 acres

Table 7. Proposed Post-mining Land Uses in Current Mountaintop Mining Permit Areas**

Land Use	Percentage of permitted area
Forest / wildlife	36%
Commercial woodland	5%
Woodland	27%
Hay / pasture	20%
Animal grazing / pasture	4%
Combined (multiple land uses)	7%
Residential / housing	<1%
Public Service / public use	<1%

** Land use categories utilized by WVDEP in describing proposed post-mining land uses in mining permits.

Land Use and Development in the Mountaintop Mining Region

Mining Regulations and Post-mining Land Use

The Federal Surface Mining Control and Reclamation Act (SMCRA) is the source of the rules and regulations that must be followed when planning and implementing post-mining land uses on mountaintop mined lands. In general terms, SMCRA provisions are designed to minimize the environmental and health and safety effects of surface coal mining. One of the most important provisions of SMCRA, in terms of how steep slope mining is practiced through most of southern West Virginia, relate to the general requirement that disturbed lands be reclaimed to approximate original contour (AOC) (OSMRE 1999). However, when Congress passed SMCRA, it did allow for exemptions to AOC in situations where excess post mining spoil may be present or where beneficial post mining land uses would compensate for the potential adverse impacts of not returning the land to AOC, such the number and size of valley fills that are required for disposal of the excess spoil that is generated when AOC is not desirable.

AOC requirements are addressed in the regulations, in terms of methods and allowances for disposal of excess spoil material, in three general areas:

- Excess spoil disposal requirements for steep slope contour mines in conditions where spoil material swell results in post mining material volumes exceeding the volumes needed for return the post mining topography to approximate original contour. There are detailed procedures for determining the amounts of material that must be backfilled to achieve AOC and how much material can be placed into valley fills. Highly detailed specifications for the construction of such fills are also included.
- Excess spoil disposal requirements for steep slope mountaintop mines where spoil material swell results in material volumes that exceed the volumes needed for return to AOC. Again, there are very specific detailed procedures for determining the amounts of backfill (backstacking on mountaintop mines) material vs. the amount of material that can be placed into valley fills.
- Excess spoil disposal requirements for steep slope mountaintop mines where alternatives to AOC might be warranted when beneficial post mining land uses would result from the proposed mining and reclamation. The legislative intent of these provisions relate to certain post mining land uses compensating for the negative impacts of not returning the land to an AOC condition. For example, the regulations could be used for creating relatively level, stable, flood hazard free land capable of supporting development types that require such land for successful development – residential, industrial, agricultural, or public facility development. It is the excess spoil material requirements that relate to post mining land use planning and development that most critically relate to mountaintop mine post mining land use planning and implementation.

In passing SMCRA, Congress did foresee that the land use provisions could be utilized merely as a method for circumventing AOC requirements and not as a device for improved land use and economic development in the region, as the Act intended. Congress, therefore, provided specific guidance for using the land use exceptions for potentially ensuring that economic or public benefits actually result from the planned reclamation post mining land uses. Three general sets of requirements were provided:

1. The post mining land use must provide for equal or better economic or public use of the land compared to the pre-mining land use.
2. The specific land use types that actually would require modifications to AOC to be successfully implemented – industry, commercial, agriculture, residential, and public facility, including public recreation development. Other potential land uses did not qualify for consideration for AOC exemption, at least based on land use.
3. Specific criteria for plan development by the mining companies and plan review by the relevant regulatory agencies. Included are the requirements that:
    a. The proposed land use is compatible with adjacent land uses;
    b. It is an attainable land use according to market, need, and other socio-economic data;
    c. The required public and / or private investment is present;
    d. Public agency support / cooperation is evidenced for all land uses requiring some form of public involvement;

e. The required mining / reclamation plan that is required in mine permitting and monitoring procedures specifically considers the planned post mining land use; and
f. The reclamation / land use plan be developed by professionals using appropriate professional standards.

The OSMRE codified these requirements through the regulations that have been developed and revised over time (since app. 1978) to implement these provisions from SMCRA. For a review of these regulatory provisions see OSMRE 1999. The regulations have been modified and adjusted over time always considering the initial intent of the AOC and land use provisions of SMRCA – the exemptions from AOC due to the planned post mining land use are permitted only where beneficial post mining land uses actually result and compensate for not returning the land to AOC. Two guiding principles have played significant roles in how the relevant regulatory provisions have been developed and interpreted by OSMRE.

1. A post mining land / AOC variance will not be approved when the proposed land use can be achieved without waiving the AOC requirement. The only exceptions are when significant public benefits or economic benefits will result from the development. Over the years this provision has been interpreted very differently when considering land uses such as agriculture, pastureland, and wildlife habitat.
2. In cases where the AOC exemption is required for implementing the proposed post mining land use, the post mining land use must always offer a net benefit to the public or to the economy of the locale or region. Again, there have been different interpretations of this provision over time. At a minimum, it appears that currently the proposed post mining land use can be similar to the pre-mining land use only if the reclamation results in site improvements that enhance to post mining land use.

It appears that current interpretations of these provisions can allow for AOC exemptions for the following land uses:

- Forestry – managed forest lands are generally allowed.
- Agriculture – allowed though low intensity agricultural uses such as grazing and pastureland are not encouraged.
- Fish and wildlife habitat – generally not allowed except in cases when serving as an adjunct to other land uses such as recreation.
- Public facilities – are generally allowed.
- Commercial – generally allowed.
- Industrial – generally allowed.
- Residential – generally allowed.

West Virginia implements these provisions with the West Virginia Surface Coal Mining Act and the regulations that have been promulgated to support that Act. These provisions generally mirror the provisions of the Federal Act and regulations. However, until recently there were a couple of key areas in which West Virginia's implementation of the regulations somewhat diverged from Federal interpretations on how the regulations should be implemented. From the early 1980's until the mid- 1990's, West Virginia appeared to be more willing to accept less intense land uses such as fish and wildlife habitat, pasture land, and grazing as post mining land uses suitable for AOC variances for mountaintop mining. As such, mountaintop mining AOC variances appeared to be provided somewhat matter-of-factly, rather than after careful consideration of the above AOC / land use provisions. This has changed over the last couple of years, and West Virginia is now rigorously subjecting post mining land use plans to the above evaluation criteria.

In addition, until recently, review of proposed post mining land use plans was primarily a part of the permit review processes that are utilized by the West Virginia Division of Environmental Protection. As such, in many instances proposed post mining land use reviews often only anecdotally considered the requirements related to land use compatibility and need, land use feasibility and economics, and economic and public benefits that can realized by the locale and region from implementation of the potential land use. To compensate for this acknowledged shortfall in post mining land use review, the West Virginia Legislature enacted Senate Bill 681 in 1999. This bill established the West Virginia Office of Coalfield Community Development (OCCD) within the West Virginia Development Office. The bill also established the requirement that coal operators (with operations above a prescribed minimum annual production) prepare Community Impact Statements, that detail their operations describing the location, extent, duration and impacts of the mines on the land use and economics of the surrounding area. The OCCD then prepares Coalfield Community Development Statements for the mines and the potentially impacted communities. These statements include locale specific and regional land use and infrastructure development strategies, so that the land use and economic impacts of the mining and subsequent reclamation can be incorporated into regional community and economic development efforts. An initial Coalfield Community Development Statement is under preparation and a number of affected coal operations have prepared and submitted their initial Community Impact Statements.

Land Use Planning in the Mountaintop Mining Region

In West Virginia, land use planning can be performed by municipalities, counties, and consortiums such as city / county combinations (any incorporated public entity has the power to plan). State and Federal agencies also conduct land use planning efforts in the state. However, these efforts generally only involve lands that the agencies control or manage, or only indirectly impact land use through activities such as road and infrastructure construction. As in other states, enabling legislation provides the basis for this local planning activity. In typical fashion, city and regional plans are constructed to implement the community's land use and development goals and visions for the future.

These plans can also provide the basis for plan implementation using devices such as zoning and subdivision regulations.

Historically, there has not been a strong consensus for planning or plan implementation throughout most of West Virginia. This is certainly true for the mountaintop-mining region. Table 8 summarizes plan and plan implementation activities for the mountaintop-mining region.

Table 8. Extent of Land Use Planning in the West Virginia Mountaintop Mining Region

County	Planning	Land Use Controls	Municipalities with Planning
Boone	no	no	Madison
Braxton	no	no	none
Clay	no	no	none
Fayette	yes	yes	Fayetteville, Oak Hill
Kanawha	yes	yes	Charleston, S. Charleston, Nitro, Montgomery, St. Albans, Dunbar
Lincoln	yes (limited)	no	Hamlin, West Hamlin
Logan	yes (limited)	no	none
McDowell	no	no	none
Mingo	no	no	Williamson
Nicholas	no	no	Summersville, Richwood
Raleigh	yes	yes	Sophie, Beckley
Wayne	no	no	Seredo
Webster	no	no	Webster Springs
Wyoming	no	no	Mullens, Oceana

This table indicates that there is a consensus for local planning in the three more heavily developed counties in the region – Fayette, Kanawha, and Raleigh Counties, but not in a majority of the region. However, there are various levels and forms of planning and plan implementation in a number of cities and municipalities in the region.

Because Federal and State governments control mining and reclamation (including post-mining land use planning), local communities (even those with planning) do not really have any direct control over post-mining land use planning and reclamation. However, post-mining land use compatibility with community zoning or subdivision ordinances is be required or at least considered during permit review. Local plan and ordinances may also be considered during WVDEP’s review of the mining permit and proposed post-mining land use plans.

Local communities cannot develop or implement plans or ordinances that conflict with Federal and state activities related to post-mining land use review and control. However, though it has not been done on a widespread basis, local communities can use their planning and plan implementation to potentially limit mining in certain locations (such as special-use zones). Inclusion of mining related concerns in local communities planning or plan implementation ordinances, at least may require that some form of coordination or cooperation be required in the development of post-mining land use plans.

Regional Patterns and Trends in Land Use and Development

Land Use Development Opportunities in the Region. An analysis of region-wide land development potentials, limitations, and demands was completed to develop a broader context in which to assess land use needs, potentials, and demands for mountaintop mining sites for supporting various forms of development. This larger context is necessary for assessing the roles that mountaintop mine post-mining land use has, is, and can assume in determining regional land use development patterns. This larger context is important for addressing a number of important land use / development issues. For example:

- Conventional assessments indicate that much of the development that has occurred in the region has occurred on land that is often unsuitable for development (such as on floodplains and on unstable difficult to develop steep slopes);
- Reclaimed mountaintop mining sites have been and can continue to be a source of land that is more developable than adjacent un-mined areas; and
- Reclaimed mountaintop mine sites are often situated to be of limited development value because of poor transportation and infrastructure access even when the resulting land has high physical development potentials.

The first aspect of establishing this context was development and application of a regional land development potentials analysis analysis that considered mined and non-mined areas throughout the entire region. To accomplish this, a development / growth model was selected and adapted for use in the study area. Such growth models are often utilized to explain current development patterns and predict or determine the potential patterns and impacts of future development. A review of potentially relevant growth models revealed that a model referred to as the Clarke Urban Growth Model (CUGM) has been utilized in range of urban, suburbanizing, and rural settings – making it suitable for application in the Mountaintop Mining Study Area. The model has been used by a variety of agencies and organizations to examine land use development and potential development patterns in varying landscape conditions – coastal California, eastern Pennsylvania, South Dakota, Michigan, and South Carolina (USGS 2001). The model has also been adapted for use in areas undergoing rapid growth, as well as areas undergoing minimal or no measurable growth. Rather than determining or predicting future growth rates, the model examines potential development and landscape patterns independent of potential growth rates or trends instead relying physical and socio-economic landscape attributes.

Regional Development Potentials Methods and Results. Models such as Clarke Model assume that growth patterns are determined by a combination of factors that encourage and factors that inhibit potential new development. The model is landscape based and does not consider socio-economic factors such as ownership parcel size, presence of willing landowners, zoning, and other governmental / regulatory factors that also can determine development pattern.

As implemented for this project, the model required development of a number of spatial data sets that represent the major development encouraging and inhibiting factors that have been identified for use in this study. Table 9 summarizes the parameters that were selected for inclusion in this analysis and Table 10 summarizes the results of the analysis placing the resulting development potentials values into five levels ranging from highest development potentials to highly restricted development potentials. Figure 5 presents the results of this analysis as a map.

The parameters that are included were selected because they appear to be the significant determinants of current development patterns as well as future development potentials. This analysis is not development specific but rather addresses any development opportunity that might require some level of investment or ongoing maintenance or management. This can range from relatively un-intense development such as managed forest or timberland to more intensive land uses such as housing or public infrastructure development.

Data Development.

- Opportunities for development
    - Proximity to paved roads – measured using proximity analysis for a GIS coverage of major paved roads in the region. High, medium, and poor proximity levels were utilized based on distance.
    - Proximity to infrastructure – measured using a GIS coverage of power lines and other major utilities. High, medium, and poor proximity levels. Does not include site-specific data such as proximity to local sewer and water service.
    - Proximity to existing development. Existing development is nearly always a source for new development. High, medium, and low levels were utilized using the Existing Development GIS coverage that was derived from the regional Land use / Land cover map.

- Constraints to development
    - Steep and unstable slopes – a 30% cutoff was arbitrarily established with slopes > 30% classified as steep and slopes < 30% classified as more developable. USGS digital elevation models (DEM's) were utilized for

this classification. A mosaiced 30-meter DEM was developed for the study area.

- Poor / unstable soils – NRCS STATSGO data were used to identify areas with high amounts of unusable / unstable soils. A 50% or greater cover of poor soils cutoff was utilized.
- High flood potentials – USGS DEM data were utilized to map areas with high flood potentials using a method developed by WVU-NRAC for mapping potential floodplains based on terrain. Flood potential areas were mapped for all major perennial streams using a stream coverage that was developed from existing USGS data and mosaiced for the entire study area.
- Proximity to mining related problems – proximity to abandoned mine health and safety and environmental problems was measured using distance from identified problems from the WV AML Inventory.

Table 9. Development Potentials Analysis Parameters

Opportunities for Development Parameters

1. Proximity to paved roads / accessibility
2. Proximity to utilities and infrastructure / accessibility
3. Proximity to existing development

Constraints to Development Parameters

1. Steep and unstable slopes >30%
2. Poor / unstable soils
3. High flood potentials
4. Proximity to mining related environmental problems and hazards
5. Proximity to other environmental problems and hazards
6. Land ownership that prevents / limits development opportunities

Table 10. Development Potentials Based on Proximity to Infrastructure, Anticipated Costs and Legal Restrictions in the West Virginia Mountaintop Mining Region.

Development Potential	Area (acres)	Percent of Region
Highest	1,357,703	27.8
Moderate	1,005,914	20.6

Limited	760,600	15.6
Severely limited	537,519	11.0
Highly restricted	1,169,903	24.0
Surface water	46,626	1.0

- Proximity to other health and safety and environmental problems – CERCLIS, RCRA, TRIS, and other potential problem sites were mapped from existing USEPA data and distance to the sites measured.
- Land Ownership – public land ownership patterns that essentially take land out of consideration for future development were mapped and identified as significant development constraints.

The data were combined through map overlay using a non-weighted overlay scheme. This approach was judged to be the simplest and most unbiased. The raw results included a numeric range in which the absolute numeric values really did not have any intrinsic meaning or significance. The resulting numeric range was divided into five equal levels according the numeric values and not the percentage of area in each class to determine area percentages of the region in each of the five development potentials classes. The results indicate that over 1.3 million acres or 28% of the land in the region were placed into the highest category that was judged to be land with some opportunity for development – though some development restrictions might be present (e.g. unstable soils). An additional 20% of the region was placed into a moderate development potentials category indicating development potential with potentially significant development restrictions (e.g. flood potentials). The remaining three classes – limited, severely limited, and highly restricted, represent areas where development restrictions generally far outweigh the development opportunities that are present.

These results indicate that though much of the undeveloped land in the region has limited development potentials, there is a significant supply of undeveloped developable land – though moderate development restrictions may need to be addressed in developing a majority of these areas (e.g. flood protection or special methods for steep slope conditions). Almost 50% of the region has limited development potentials due to the presence of what are often multiple severe development restrictions.

Regional Development Restrictions. Results from the previous analysis represented a balancing of development opportunities and development constraints. This analysis was completed to isolate only the factors that present severe limitations or constraints for development in the region – not balancing these factors with other positive development factors. This analysis better represents actual difficulties that may be encountered when developing areas in the region. The factors in this analysis were slightly modified from the factors included in the previous analysis. This analysis did not exclude publicly owned or managed areas so that those areas might be included in the analysis, and it did exclude currently developed areas from consideration for future development assuming that current development precluded these areas from being considered for new development – though this is often not the case. Table 11 and Figure 6 present the results of this analysis.

Table 11. Development Restrictions Analysis

Area classified as having severe restrictions for development	1,918,141 acres	39.7% of the West Virginia Mountaintop Mining Region

Restrictions to Development Parameters

1. Steep and unstable slopes >30%
2. Poor / unstable soils
3. Flood potentials
4. Proximity to mining related environmental problems and hazards
5. Proximity to other environmental problems and hazards
6. Existing developed areas – unavailable for future development.

Again, a simple map overlay operation using the previously described data that had been developed for this project was utilized. Rather than place the results into a five level range, the results were presented as the presence of severe restrictions for development vs. presence of less severe restrictions for development. The area that was classified as having severe restrictions for development was isolated according to the following criteria:

- Presence of steep or unstable slopes - > 30% slopes plus soils with high potentials for slope failure and slides, or
- High flood potential areas, or
- Close proximity to mining and other health and safety and environmental problems - < .10 mile proximity, or .25 mile proximity in combination with any other factors, or
- Existing development.

The results of this analysis indicate that almost 40% of the region has severe restrictions for new development. The remaining 60% may have significant development restrictions that were judged to be not as severe as the parameters identified as severe.

County Patterns in Development Restrictions and Potentials. Table 12 summarizes regional development potentials on a county basis. These results indicate that the supply of both high development potential and highly restrictive potential land varies significantly throughout the study area on a county basis. For example, Nicholas, Raleigh, and Wayne Counties have significantly more land in the high and moderate development potentials categories than in the severely limited and highly restricted classes. Mingo, Wyoming, Logan, and Boone Counties, on the other hand, have significantly more area in the severely limited and highly restricted classes than in the more favorable development potentials classes. As such, it is apparent that the impacts of developable and undevelopable land supplies are differentially felt throughout the mountaintop-mining region.

Table 12. Development potentials analysis by county (in acres).

County	High Potential	Moderate Potential	Limited Potential	Severly Limited Potential	Highly Restrictive Potential
Boone	44,299	55,984	63,249	55,145	102,391
Braxton	74,754	81,536	64,277	42,014	61,873
Clay	30,821	45,397	44,340	39,485	58,138
Fayette	174,105	92,786	48,609	27,735	79,149
Kanawha	229,339	130,626	82,192	50,943	82,511
Lincoln	109,141	55,432	29,939	20,769	62,724
Logan	39,418	50,618	55,243	49,313	94,713
McDowell	64,162	77,667	69,935	49,352	79,308
Mingo	45,250	55,066	55,986	42,306	70,985
Nicholas	128,637	91,971	57,672	37,402	97,416
Raleigh	177,968	74,056	42,818	24,710	66,417
Wayne	143,297	76,216	34,264	17,668	51,109
Webster	38,458	46,663	43,559	35,405	189,490
Wyoming	58,442	72,215	68,734	45,428	73,851
Totals	1,358,091	1,006,233	760,855	537,675	1,170,077

Table 13 presents county summaries for the development restrictions analysis that was summarized earlier. Again, it is apparent that a pattern of potential development restrictions varies in the region with counties such as Boone and Logan having significantly more of their area with severe physical limitations for new development.

Table 13. Development restrictions in the mountaintop mining region by county.

	Area (acres)	
County	**Potentially Limited**	**Severe Physical Limitations**
Boone	137,743	184,089
Braxton	258,770	71,465
Clay	161,833	58,038
Fayette	287,718	139,782
Kanawha	349,235	233,066
Lincoln	212,742	67,893
Logan	91,169	200,228
McDowell	146,587	195,001
Mingo	92,617	178,150
Nicholas	310,629	107,733
Raleigh	251,116	138,237
Wayne	261,469	65,903
Webster	234,469	121,165
Wyoming	163,573	157,391
TOTAL	2,959,670	1,918,141

Development Potentials and Restrictions and Flood Hazard Potentials. The impact of floodplains in providing land that would otherwise be developable (e.g. low slopes, proximity to infrastructure, developable soils, etc.) was examined. Table 14 summarizes the development potentials for floodplains in the study area. Floodplains were delineated using topographic data (landforms, slope, stream proximity, etc.) for all perennial streams in the study area. Approximately 434,000 acres were identified as being floodplain / riparian areas with potential flood hazard potentials. Table 14 indicates that except for potential flood hazards, that these floodplain / riparian areas include a great deal of land that is otherwise suitable for development. These are many of the areas that have been historically where development in the region has occurred.

Table 14. Development potentials in floodplains/ riparian areas in the mountaintop mining region.

Development Potential	Riparian Area (Acres)
High	197,185
Moderate	63,391
Limited	40,447
Severely limited	26,272
Highly restricted	67,579
Water	39,746

Table 15 summarizes development restrictions for the same floodplain / riparian area. If flood hazard potential is identified a critical development limiter then the entire 434,000 acre area should be regarded as unsuited for development. However, much of the existing highways, utility and development infrastructure is actually present in these areas.

Table 15. Development restrictions in floodplain / riparian areas in the Mountaintop mining region.

Development Restrictions	Riparian Area (Acres)
Potentially less severe restrictions	263,193
Severe physical restrictions	170,754

Mining and Development Potentials and Restrictions. Mine permit areas were combined with the development potentials and restrictions analyses that are summarized above to examine mine sites relative to the landscape in general. Simple map overlays of mine permit areas and Figure 5 and 6 results were utilized to complete this analysis. The results of this analysis are presented in Table 16. The first part of the table shows that

Table 16. Development Potentials and Restrictions Associated With Existing Permit Areas in the West Virginia Mountaintop Mining Region.

Development Potential	% of Area
Highest	23.17
Moderate	20.71
Limited	18.14
Severely Limited	14.89
Highly Restrictive	22.89
Surface Water	0.21
Restrictions for Development	**% of Area**
Potentially Less Severe	40.53
Severe Physical Restrictions	59.47

nearly 25% of all mining permits occur in areas with the highest development potential while 40% occur in areas with severely limited or highly restricted development potentials. Perhaps more significant is the bottom of the table, which indicates that almost 60% of all mining permits are in areas with severe physical restrictions for most types of development. As such, in many of these areas, the post-mining reclamation conditions that may result after mining can serve to improve the development potentials or reduce the severity of the development restrictions in these areas by reducing slopes, improving surface drainage, or improving soil and slope stability conditions.

Development Potentials and Restrictions, Mining, and Present Development Patterns.

The current land use and land cover map that was developed for the study area potentially under-represents the potential exposure of many residents of the mountaintop mining region to both restricted (and potentially unsafe) development conditions and to past and current mining. This is due to the highly dispersed pattern of residential development that occurs through most of the region. This results in many small residential areas being classified as other land uses (e.g. forest land) when using data sources such as satellite data for the land use / land cover classification. To compensate for this, an additional assessment of residential patterns in the region was completed using mapping of populated places rather than land use areas.

For this analysis, populated places are defined as any places in which it appears that there are two or more inhabited structures. This approach should better capture the dispersed development patterns of the region by considering the unincorporated small mountain and valley communities that dominate the region along with the larger municipalities, towns and cities.

Populated Places Mapping and Analysis.

Populated places were initially identified and mapped using an available USGS data set that mapped populated places using the above definitions. This data set was combined with another data set of known cities, towns, and municipalities. These data were also then cross-referenced with the urban and other developed areas that were identified as part of the land use / land cover mapping effort. The resulting mapping was verified using comparison with recent aerial photography to document the present-day existence of these small communities and residential areas. When no trace of an area could be observed it was eliminated from the database. The resulting database also contains a category called historic places – older communities for which current-day habitation could not be verified using aerial photography or other maps such as county highway maps or the West Virginia Gazetteer. These areas are included separately. The result of this data collection was a more complete view of residential development patterns in the region. This pattern is presented in Figure 7.

Populated Places and Development Potentials and Restrictions

The results of a comparison of populated places and development potentials and restrictions are presented in Table 17. Results in the top portion of the table indicate that the majority of existing small communities and residential areas do occur in areas with high and moderate development potential and only a small fraction of areas occur in areas with severely limited or highly restricted development potentials. This logically follows because the development potentials criteria weigh factors such as transportation and infrastructure accessibility – which intrinsically are attributes of most developed areas. More revealing is the bottom portion of the table, which indicates that when considering development restrictions only, almost 60% of these areas are in areas with severe physical restrictions for development primarily including steep unstable slopes and areas with severe flooding potentials.

Table 17. Development Potentials and Restrictions Associated with Populated Places in the Mountaintop Mining Region of West Virginia.

Development Potential	Populated Places					
	Current	Historic	Current	%	Historic	%
Highest	1077	29	73		1.5	
Moderate	108	16	8		<1	
Limited	75	7	5		<1	
Severely limited	37	14	3		<1	
Highly restricted	97	31	7		1.5	

Development Restrictions	Populated Places			
	Current		Historic	
	Number	%	Number	%
Severe physical restrictions	876	57.6	36	2
Potentially less severe Restrictions	548	35.7	71	4.7

Populated Places and Proximity to Mining

Populated places were evaluated in terms of proximity to mining for past mining, mountaintop mining permits, and all mining permits (Table 18.). This proximity analysis could be utilized as surrogate for assessing the impacts of mining on residential areas and small communities in the region. The results show that 99% of the populated places in the region are within two miles of one or more past mining features and almost 88% percent are within ½ mile of one or more mining features. Past mining proximity was determined by map overlay of mining features (Figure 4) and populated places (Figure 7). This result clearly indicates the pervasive importance of past mining in the lives of residents in the region, due and the close proximity of past mining features and many of these small communities.

Mountaintop mining permits present a very different pattern with only 18% of the identified populated areas occurring within two miles of one or more permits and under 5% occurring within one half mile. All mining permits present a different pattern with 55% of residential places within two miles of a current mining permit and less than 20% within one half mile of a current mining permit. This pattern clearly illustrates the separation of current mountaintop mining permits and most residential areas. This is due to mountaintop mining permits generally occurring on large unbroken ridge tops, where there is minimal or no existing residential development. Mining permits in general can occur throughout the landscape because they include contour surface mines, as well as deep mines and coal cleaning and handling facilities that often are found adjacent to roads and railroads in the stream and river valleys.

Table 18. Proximity of Existing Populated Places to Mining in West Virginia Mountaintop Mining Region

Extent of Mining	Distance From Mining (mi)	Populated Places Number	Percent
Past mining	0.5	1255	87.9
	1.0	1366	95.7
	2.0	1414	99.0
Mountaintop mining permits only	0.5	63	4.4
	1.0	136	9.5
	2.0	253	17.7
All mining permits	0.5	271	19.0
	1.0	481	33.7
	2.0	774	54.2

Analysis limited to existing populated places only (Not including historic).
Percentage refers to percentage of all existing populated places in the mountaintop region

Other Land Use Development Issues in the Region.

Public lands and public land demands. A variety of public agencies and organizations own or manage land throughout the region. These agencies extend from local municipal governments (app. 100+) to Federal and state agencies that control significant amounts of land. Table 19 summarizes land holdings for the major public land owner/ managers in the region. It does not include smaller municipal and county public lands including schools, parks, public buildings, and facilities such as fire houses and police stations. These areas tend to be relatively small and located within existing developed areas.

Table 19 indicates that there are almost 300,000 acres of public lands in the study area. The major land owner / management types include wildlife management areas (WVDNR), The U.S. Forest Service forest lands, U.S. Department of Interior national recreation areas, and state parks and forests. The state of West Virginia and West Virginia University are also minor landowners in the region.

Table 19. Public Lands Stewardship in the West Virginia Mountaintop Mining Region.

Owner	Area (ha)	Area (acres)
Private (inholding in public areas)	24,592	60,767
Recreational Lake	3,818	9,433
National Recreation Area – USD1	23,838	58,905
National Forest – USFS	34,774	85,926
National Forest Wilderness Area – USFS	1,399	3,457
State of WV	36	90
West Virginia University	216	533
WVDNR State Parks	8,836	21,833
WVDNR State Forests	10,292	25,431
Wildlife Management Areas – WVDNR	54,978	135,851

(Land stewardship within 14 county Mountaintop Removal study area)

Recreation. Public land needs and demands are very heavily tied to recreation development in the region. There are certainly localized demands for public lands for uses such as schools, community parks, and other public facility developments. However, the acreage requirements for most of this development are minimal, and will be linked to existing community locations in most cases. Table 20 presents a compilation of the major demands for public lands in the region that have been identified by various Federal and state agencies. This table shows significant differences between counties in the region in the need / demand for hunting and fishing, water recreation, and special needs recreation areas – facilities that generally require large areas.

Table 20. Demand / Need for Public Land in the Mountaintop Mining Region of West Virginia.

County	Hunting/Fishing*	Water Recreation*	Special Access /Needs* Recreation
Boone	medium	medium	low
Braxton	medium	medium	medium
Clay	medium	medium	low
Fayette	medium	medium	medium
Kanawha	high	high	medium
Lincoln	high	medium	high

Logan	high	medium	medium
McDowell	medium	medium	medium
Mingo	medium	medium	low
Nicolas	low	medium	low
Raleigh	medium	high	medium
Wayne	high	medium	high
Webster	low	low	low
Wyoming	medium	medium	medium

Region-wide High Priority Needs**

Hiking trails
Swimming facilities
Picnic areas
Bicycle routes
Playgrounds
Playgrounds / courts and sports fields
Community and neighborhood parks

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*West Virginia Division of Natural Resources Capital Improvements Plan – 1998.
**West Virginia State Comprehensive Outdoor Recreation Plan – 1997.

Non-recreation Needs. The most critical major non-recreation needs include land for new public water service and sewer facilities. In the study region, the most pressing needs are in Wyoming, McDowell, Mingo and Lincoln Counties. Five of the fourteen counties have less than 40% of the residents serviced by public water and seven counties have less than 30% of residents served by public sewers. Additionally identified needs include additional land for new and replacement schools, public health facilities, and public service buildings.

Land Use and Development Needs / Priorities in the Region. Future land use development needs are difficult to estimate for the study region because it is anticipated that the majority of the region will continue to loose population or current population levels will remain static. Population projections (U.S. EPA 1998) for current conditions to 2010, estimate that only Raleigh County will have a significant demand for new land use development based on anticipated population growth. This demand is estimated to range between six and sixteen square kilometers of required new development for the ten-year time period. Kanawha County is also expected to require new land for urban expansion. However, much of this area is actually due to shifting development patterns rather than new growth. Projections indicate between sixteen and thirty new square kilometers of new urban land uses will be potentially developed in Kanawha County between 2000 and 2010. The other counties in the study area will require insignificant acreages for the new development that is anticipated during the ten year 2000 to 2010 time period.

Land Use Planning and Decision Making for Specific Mine Sites

General Background. On most land, land use decision-making is at least in part, a response to one or both of the following questions:

1. What is the optimum or at least desirable land use(s) for a given site or parcel of land?
2. What sites might be identified that are optimal or suitable for particular land uses of interest in a given region or locale of concern? (Skelly and Loy 1981)

Asking the questions together about a particular site or sites is often the concern of public planning and development organizations. Asking the questions together allows such organizations to develop plans that may address land use development and land protection comprehensively – considering the potential utility of any parcel of land within a context of also considering a larger public good. This type of land use decision-making is generally undertaken in order to:

- Take stock of a region's resources and developable land for activities such as economic development planning;
- Establish a data base for making regional growth and land protection decisions including potential public investments; and
- Provide a defensible base for potential public involvement in growth guidance or development through planning or regulation.

Such land use decision-making is generally undertaken within the contexts of various public planning and economic development activities where overall regional economic development and environmental protection are the focus. Asking the same questions separately, land owners, managers, developers and even mining companies are often interested in determining suitable land uses for specific parcels of land rather than searching for parcels suitable for development of specific land uses. As such, organizations such as land development companies, economic development agencies, and other development interests are generally concerned with finding and implementing feasible land uses for specific parcels. The context for such land use decision-making is generally focused on identifying site-specific rather than regional development potentials.

In fact, throughout much of Appalachia, it is obvious that many times these questions are not asked, or if asked, are not correctly answered. This is evidenced in the large percentage of Appalachia's historic, as well as, recent development that has occurred in: areas where access and development amenities are poor; areas with potential environmental hazard situations (e.g. floodplains); areas with steep slopes or unstable soils presenting slide prone conditions; and, in areas with potentially valuable environmental resources resulting in destruction or degradation to many potentially valuable regional landscape resources such as scenic areas, wildlife habitats, and rare landscapes such as wetlands.

There are three general land use planning principles, which if adhered to by public and private development interests alike, will improve opportunities for avoidance of the above conditions through the landscape in general, as well as, specifically for reclaimed mine sites. These principles are:

1. Development should be discouraged in areas with significant resource preservation or protection values;
2. Development should be discouraged in areas with significant natural or man-made hazards present that cannot be reasonably abated or corrected; and
3. Development should be encouraged in areas best suited for it given the range of physical, contextual, and location parameters that can determine the desirability of a given land use or land uses.

Methods for Land Use Decision Making. Land use decision making often involves various forms of land use suitability analysis or development suitability, which present general planning frameworks based on the concept of determining what parts of the landscape in a given area are most capable of supporting one or more proposed land uses. Such land uses can include housing, wildlife, agriculture, recreation, and intensive development such as industry. This involves identifying the relevant natural and developed landscape features are for a given land use and how they can be managed or utilized to support the proposed land use. Land use suitability methods can range from very complex / systematic approaches to approaches that may be more informal and even anecdotal. The landscape characteristics used to determine suitability are often derived from: physical factors such as soils, slope, geology, hydrology, and climate; social/economic factors such as on-site and adjacent land uses, legal restrictions, proximity to and availability of utilities and infrastructure, land ownership; and the presence of potential problems / hazards such as high noise areas, air pollution patterns, potential flood problems, and other natural and manmade hazards. Typically included secondary factors often include:

- Vegetation and wildlife resources
- Cultural resources – on-site and adjacent
- Visual / scenic amenities

Therefore, in general terms, land use suitability factors generally include:

- On-site physical factors such as topography and soils;
- Site context including accessibility, utilities, and adjacent land uses; and
- Avoidance of environmental problems that may prove costly to overcome;

General Land Use Selection Considerations for Coal Mined Lands. In examining the above, as well as the previously discussed post-mining regulatory provisions, it becomes apparent that mining companies, land owners, and the public (adjacent land owners, people in the locale and region, local and regional governments) may have very different sets of objectives when viewing the land use potentials for particular mine sites. For example, mine operators often may be most interested in the following:

- Efficiently satisfying post-mining land use regulatory requirements with the least amount of risk;
- Ensuring that satisfying other permit requirements (e.g. for soil protection and erosion control) are linked to post-mining land use development efforts for operational and economic efficiency;
- If the operator owns the surface rights to the land, the operator may also be interested in maximizing return on the investment associated with reclamation.

Landowners may be interested in considerations such as potential economic return or at least ensuring that the post mining land use reclamation does not reduce the value of the surface of the land after coal recovery and reclamation have been completed. Likewise, the previously discussed post-mining land use regulations were developed and implemented because the "public" may be interested in the following aspects of post-mining land use planning and development:

- Ensuring that post-mining land uses potentially minimize potential off-site damages and maximize public benefits; and
- Ensuring consideration of public land use and economic development priorities and needs by participating in the post-mining land use decisions that are made.

The same general approaches that have been developed for determining land use suitabilities for non-mined areas can and have been applied to post-mining reclamation land use planning for coal-mined areas throughout Appalachia. However, this can generally only be accomplished with the recognition that many of these mine sites may have characteristics that are somewhat unique to mined areas and are typically not encountered on most non-mined sites that are being planned for a given land use or land uses. Such conditions can include:

- Decreased soil stability due to expansive backfill areas;
- Decreased topsoil productivity due to disturbances encountered during mining, storage, and reclamation;
- Poor proximity to transportation and infrastructure systems due to many surface mines being located away from existing development; and
- Presence of adjacent mining related health and safety and environmental problems that may stem from other mining that was completed prior to implementation of modern reclamation standards.

A comprehensive review of methods and criteria for land use decision-making for coal mined lands in central Appalachia was completed for this project. These results are summarized in the following table. The references utilized for constructing the table are included in the bibliography of this report.

Table 21. Post-mining Land Use Mine Site Requirements / Needs (Summary of current literature and regional expert opinion)

General Requirements

Post-mining Land Use	Available water	Suitable Area	Non-severe Terrain / Slope
Agriculture (cropland)	1	3	1
Agriculture (pasture)	1	2	3
Forestland / fish and wildlife	2	3	3
Commercial woodland	2	3	3
Residential / housing	3	3	2
Industrial / commercial	2	2	1
Public facilities	3	2	2

Post-mining Land Use	Suitable Soil	Proximity to Infrastructure/ Utilities	Overburden Stability
Agriculture (cropland)	1	3	2
Agriculture (pasture)	2	3	1
Forestland / fish and wildlife)	3	3	2
Commercial woodland	2	3	2
Residential / housing	3	2	1
Industrial / commercial	2	1	1
Public facilities	2	1	1

Post-mining Land Use	Site Accessibility	Site shape / Configuration	Surrounding Land Use Compatibility
Agriculture (cropland)	3	1	3
Agriculture (pasture)	3	2	3
Forestland / fish and wildlife	3	3	2
Commercial woodland	3	2	3
Residential / housing	1	2	1

Industrial / commercial	1	1	2
Public facilities	1	1	1

1 = high degree of influence
2 = moderate degree of influence
3 = low degree of influence in most cases

There are also numerous specific requirements that have been identified that can relate to the feasibility of various more intensive land uses. Examples of such specific requirements follow.

- **Commercial forest land**
  i. Determine feasibility based on site size, location, and markets
  ii. Careful placement of overburden materials on the surface
  iii. Reducing compaction during regrading and revegetation
  iv. Using tree compatible ground covers during the early stages of reclamation revegetation

- **Industrial / commercial development**
  i. Determine feasibility based on site size, location and available infrastructure
  ii. Careful regrading to develop relatively flat surface configurations
  iii. Develop areas of suitable size and configuration
  iv. Careful / well planning spoil replacement
     1. Uniformity in materials replacement patterns
     2. Constructed internal drainage systems
     3. Prepared surface material replacement allowing for fine regrading, construction, and revegetation

- **Row crop agriculture**
  i. Determine feasibility based on site size, location, and markets
  ii. Careful placement of overburden materials
  iii. Regrading gently sloping terrain insuring suitable drainage, slopes, and accessibility for required agricultural machinery.
  iv. Careful / well planned spoil replacement at the surface
     1. Uniformity in materials replacement
     2. Augmented topsoil replacement and productivity improvement

Such detailed criteria can be developed to evaluate or plan any potential post-mining land use.

Reclaimed Mine Land Use Development Case Studies. Developing reclaimed mined sites for various land uses is not a recent concept. Though a majority of reclaimed mine sites in southern West Virginia have been reclaimed to pasture / grassland, wildlife habitat, and forestry, there are examples of reclaimed and abandoned coal mine sites being reclaimed to more intensive land uses. Many of these sites include reclaimed mountaintop mining sites. For example, Green (1976) and Skelly and Loy (1981) list examples of developed land uses on reclaimed mines. Examples are included in the following table.

Table 22. Examples of developed post mining land uses from the study area.

Land Use	Location
Commercial / Institutional	
Airport	Williamson
Airport	Logan
High school and Vocational School	Welch
Athletic Complex	Welch
Consolidated High School	Coal City
High School	Raleigh County
Housing	
Planned Community	Ward
Residential Subdivision	Beckley
Residential Subdivision	Corrine
Residential Subdivision	Rush Creek
Residential Subdivision	Peach Creek
Recreation / Open Space	
Hunting club	Summersvillle
Agriculture	
Orchard	Buffalo
Orchard	Buffalo
Truck Farm	Ward

More recently, there are a number of examples of reclaimed mountaintop and contour mines that have been reclaimed to various developed land uses in the 14 county study region. Some of the more noteworthy examples of such developments include the following:

Economic Development

1. Mingo County Wood Products Industrial Park (wood processing industrial facility) – Hobet #7 / Arch Minerals Site.

2. Mountain Greeneries, LLC (plant nursery) – Mount Olive – Fayette County.

3. Mingo County Redevelopment Authority Industrial Park (industrial park) – Mingo County.

4. Mingo County Fish Hatchery (fish raising facility) – Pigeon Creek, Mingo County.

5. Ragland Truck Farm (farm products) – Ragland, Mingo County.

6. Columbia Wood Mill (timber processing facility), Craigsville, Nicholas County.

Institutional and Recreation Development

7. Mt. Olive Correctional Facility (prison) – Fayette County.

8. Southwestern Regional Jail (regional correctional facility) – Logan County.

9. McCoy Hatfield Trail – Boone, Lincoln, Logan, Mingo, Wayne and Wyoming Counties – extensive regional trail system involving numerous reclaimed mine sites.

10. Beckley Recreational Complex (sports field complex) Raleigh County.

11. Twisted Gun Golf Course – Gilbert, Mingo County.

Other Land Uses

12. Calvin, Nicholas County – high quality hay land, forage, and pasture land development.

13. McDowell County – Virginia Energy Company – agriculture, pasture, outdoor recreation, and home site development.

14. Yolyn, Logan County – mixed development including aquatic wildlife habitat, pasture and grassland, fruit trees.

15. Bluestone Mining Site – Wyoming County – commercial forestry.

Assessment of Potential Land Use Impacts of Future Mountaintop Mining in West Virginia

Resource Technologies Corporation (RTC 2000, 2001) recently completed a study that was designed to estimate the effects of various valley fill restrictions on the quantity of coal potentially available for mountaintop mining operations in West

Virginia. That study generated a number of potential future mountaintop mining scenarios based on the various levels of mining that can take place under different sets of environmental constraints that can potentially limit the use of mountaintop mining methods. These constraints mostly relate to changes in mining as available drainage basin areas become more restrictive for mining and valley fill construction. These limitations also relate to the pattern that as drainage basin limitations become more severe (for mining / backstacking spoil, and valley fill construction), the area available for mining and reclamation becomes more limited using mountaintop mining methods. The constraints reflect different interpretations of environmental parameters such as ephemeral, intermittent, and perennial stream definitions and typical headwater watershed areas for various types of streams. These scenarios were utilized to estimate the potential impacts of future mountaintop mining in the study region using the RTC study generated GIS maps of areas potentially available for future surface mining based on this set of scenarios reflecting the different levels of potential environmental constraints. These scenarios are summarized below:

1. Unconstrained mountaintop mining – all areas suitable for future mountaintop mining will be mined using mountaintop-mining methods.
2. Slight constraints – composite 250-acre drainage areas are available in each headwater watershed for mining and reclamation.
3. Moderate constraints – 150-acre areas are available in each watershed for mining and reclamation.
4. Severe constraints – 75-acre areas are available for mining and reclamation.
5. Most constrained – only 35 acre areas are available in each headwater watershed for mining and reclamation.

The detailed GIS based analysis procedures and databases were utilized to develop region-wide maps of the resulting mountaintop mining mineable areas and relate those areas to current land use and residential patterns. These maps and supporting statistics form the basis for the analyses that follow.

Impact on current land uses. Table 23 summarizes current land use / land cover in these potential future mountaintop mining areas. As would be anticipated, these breakdowns reflect the land use and land cover patterns that are present in the landscape types that are suitable for future mountaintop mining – high forested ridges and steep slopes. There are therefore, few expected impacts on land uses such as medium and high intensity development, wetlands, or agricultural lands because these land uses were either precluded from mountaintop mine development or occur in areas with no potential for mountaintop mining (e.g. in the stream and river valleys). Instead, the major impacts will be felt on various types of forest lands, areas already impacted by past mining, shrublands and woodlands, and to a lesser extent in lightly developed areas and pasture / grasslands. It is therefore, the conversion of mature forested land to other land use / land covers that is anticipated to be the major land use impact of mining under any of the future mining scenarios.

Table 23. Current Land Use in Potential Mountaintop Mining Areas from Future Mining Scenarios (in acres).

Land Cover / Land Use	Future Mining Scenarios		
	Unconstrained	Slight Constraints	Moderate Constraints
Developed			
Major power lines	595	595	552
Populated areas	161	161	133
Light intensity urban	1,250	1,250	1,016
Moderate intensity urban	262	262	247
Intensive urban	360	360	316
Agriculture			
Row crops	84	84	82
Conifer plantation	6	6	5
Pasture / grassland	3,592	3,597	3,167
Shrubland / woodland			
Shrubland	2,679	2,679	1,905
Woodland	302	302	250
Forested			
Floodplain forest	431	431	424
Cove hardwood forest	35,671	35,671	26,842
Diverse mesophytic forest	135,372	135,832	108,437
Hardwood / conifer forest	2,180	2,196	2,043
Oak forest	14,188	14,214	11,587
Mountain hardwoods	23,612	23,612	17,563
Mountain hardwoods / conifers	353	353	345
Mountain conifers	173	173	183
Water / wetlands			
Surface water	726	726	587
Forested wetland	64	64	61
Shrub wetland	73	73	48
Herbaceous wetland	163	163	66
Other			
Barren / disturbed land	5,825	5,825	4,627
Total	228,117	228,625	180,482

Table 23. (continued)

Land Use / Land Cover	Severe Constraints	Most Constrained
Developed		
Major power lines	280	129
Populated areas	90	26
Light intensity urban	216	576
Moderate intensity urban	197	55
Intensive urban	301	106
Agriculture		
Row crops	81	55
Conifer plantations	29	0
Pasture / grassland	2,488	2,016
Shrubland / woodland		
Shrubland	1,088	563
Woodland	88	41
Forested		
Floodplain forest	284	99
Cove hardwood forest	15,423	4,133
Diverse mesophytic forest	69,450	34,148
Hardwood / conifer forest	1,507	948
Oak forest	8,553	4,454
Mountain hardwood forest	11,160	6,724
Mountain hardwoods/ conifers	350	348
Mountain conifers	173	181
Water / wetlands		
Surface water	243	145
Forested wetland	24	34
Shrub wetland	56	54
Herbaceous wetland	60	44
Other		
Barren / disturbed land	2,699	1,162
Total	115,199	55,727

*Acreage totals do not represent all past and current mining – only areas that were barren for the 1994,1995, and 2000 satellite imagery. These totals underestimate total previously mined acreage in the potential mountaintop mining areas.
**Future mining scenarios were developed by other mountaintop mining economic impact background studies. Acreages represent the acreages available for future

mountaintop mining with increasing constraints on backstack spoil material placement and valley fill construction (see Resource Technologies Corp., 2000)
***Summation inconsistencies represent rounding errors in calculations.

Impact on existing small communities. Table 24 summarizes the relationships between these potential mining areas and existing populated places in the region. The potential future mining areas data were combined with the populated places data (Figure 7) to complete this analysis. Simple GIS data overlays were utilized to combine the data. These results do indicate a pattern of potentially close proximity between existing populated places (the rural population in the region) and many of the areas suitable for future mountaintop mining. Resulting proximity values range from over 500 populated places which may be within two miles of potential mining for the unconstrained scenario to a low of six areas that could be directly impacts by mining with the most constrained scenario. These results do indicate a pattern of significantly differing impacts on existing populated areas with each of the future mining scenarios. In summary, these results indicate that:

Table 24. Potential impacts of future mining scenarios on existing populated places (number of populated places).

Constraints	within mine area	½ mile or less	1 mile or less	2 miles or less
unconstrained	42	222	320	536
minor constraints	42	222	320	536
moderate constraints	35	205	306	524
severe constraints	23	146	248	476
most severe constraints	6	95	183	389

- Significant numbers of rural residents may be impacted by future mountaintop mining in terms of the potential impacts that are felt due to close mine proximities (noise, roadway traffic and congestion, temporary land use incompatibility).
- Significant numbers of rural residents may be within two miles or less of potential future mountaintop mining.
- The various levels of constraints for potential future mining do strongly impact the proximity of rural residents to potential mining areas with the unconstrained

and slight constraints scenarios impacting almost double of number of populated areas than the most constrained scenario.

Summary of Potential Future Mountaintop Mining Land Use Impacts

It is anticipated that the potential land use related impacts of future mountaintop mining will be most strongly felt in three general areas:

- Loss and conversion of existing land use / land covers;
- Temporary and permanent impacts on small communities and dispersed residential areas in the region; and
- Provision of new land uses and land use opportunities.

Loss and conversion of existing land use / land covers.

1. Future mountaintop mining under all of the future mining scenarios will significantly reduce mature forestland acreages in southern West Virginia – at least for the near term. The estimated acreages of lost forestland range from over 200,000 acres for the unconstrained scenario to just over 50,000 acres for the most constrained mining scenario.

2. Re-disturbance of previously mined areas is the second-most likely land use conversion. Acreages range from over 6,000 acres for the unconstrained scenario to nearly 2,000 acres for the most constrained scenario. Reclamation and post-mining land use potentials of these previously mined areas will be greatly improved in nearly all cases because of the improvements that are required in remining previously mined areas.

3. Future mountaintop mining will permanently impact only minor acreages of light intensity development, infrastructure such as power lines, and agricultural and pasture lands.

Temporary and permanent impacts on small communities.

1. Future mountaintop mining may impact numerous existing small communities and other populated places due to close proximities between mining and the communities. Impacts will include noise, dust, added vehicular traffic, etc. Such impacts can be regarded as temporary land use incompatibility impacts.

2. Potential permanent impacts will likely include some resident population relocation due to close proximities of people and potential future mining. For example, 222 populated places are .5 miles or closer to potential future mining areas and nearly 100 are .5 miles or closer even under the most constrained mining scenario. These small communities would be likely impacted by any potential future mountaintop mining.

Provision of new land uses and land use opportunities.

1. Most potential future mountaintop mining areas will be reclaimed to various forest cover related land uses- e.g. intensive forest and woodland management, recreation, and wildlife management. It is likely that current reclamation requirements will cause greater post-mining forested acreages to be managed for intensive woodland development than at present due to AOC / land use provisions, often resulting improved site topography (for management) and accessibility with reclamation. This is due to the refocusing of the AOC / post mining reclamation provisions in West Virginia granting AOC variances only in improved / more developed land use conditions.

2. Agricultural land uses will likely account for the next greatest acreage of post-mining land uses – potentially emphasizing specialized crops, row crops, animal production, aquaculture, etc., to utilize potential AOC / land use exemptions.

3. Given current and foreseeable future land use demands, it is unlikely that any more than 2 to 3% of the future post-mining land uses will be developed land uses such as housing, commercial, industrial, or public facility development. However, significant acreages of land suitable for developed post-mining land uses will result from future mining under all of the mining scenarios.

4. Significant additional acreages of land with development opportunities and potentials greater than the potentials that are currently present will result from reclamation in the potential future mountaintop mining areas in all of the future mining scenarios. Much of the acreage available for future mountaintop mining is in areas with current severe development restrictions (over 55% of the future potential mountaintop mining acreage). Development restrictions will be reduced on the majority of the reclaimed sites with implementation of current reclamation standards and practices. Development limitations such as poor accessibility and infrastructure proximity will continue in nearly all of these areas.

5. Land use plans for current and future potential mountaintop mining sites will be developed and evaluated with greater emphasis on locale and regional land use and economic development needs and potentials. This is due to amended review procedures and changes in the mountaintop mining regulations in West Virginia. The requisite mine site land use and community impact studies will potentially result in improved integration of post-mining land use plans and regional economic and infrastructure development activities throughout the mountaintop-mining region.

6. Recent regulatory changes will continue to result in greater placement of spoil materials in backstack areas rather than in valley fills. This actually may reduce future land use opportunities on many mountaintop sites, when compared with previous mountaintop mining practices, which resulted in flatter land because greater amounts of spoil material, were placed in valley fills. However, the land use potentials of such sites will still be greater than with pre-mining conditions due to required site regrading, stabilization, and revegetation, as well as the presence of new roads and infrastructure features that may remain after mining.

Literature Cited

Bogner, Jean and Alan Perry. 1977. Integrated Mined-Area Reclamation and Land Use Planning. Energy and Mineral Resources, Argonne National Laboratory – Prepared for US Geological Survey.

Burley, Jon B (ed.). 2000. Environmental Design for Reclaiming Surface Mines. Mellen Press, Emsworth ME.

Candau, Jeannette. 2000. The Clarke Urban Growth Model. University of California. Santa Barbara. Unpublished manuscript.

Greene, Benjamin. 1976. Restoring Grossly Disturbed Land to Agricultural and Other Uses. Northern Branch of the American Society of Agronomy Annual Meeting, July. Morgantown, WV.

Grim, Elmore. 1974. Environmental Protection in Surface Mining of Coal. EPA, Washington, D.C.

Harbridge House, Inc. 1979. Postmining Alternative Land Use Evaluation Methodology. OSMRE – NTIS. Washington, D.C.

Kentucky Department for Surface Mining Reclamation and Enforcement. 2001. Post Mining Land Use. Unpublished url - /dsmremap13/post_miningland_use.htm.

Office of Surface Mining Reclamation and Enforcement. 1999. Post mining Land use. USDI OSMRE, Washington, DC. October. Unpublished report.

Office of Surface Mining Reclamation and Enforcement. 1998. Draft Report. An Evaluation of Approximate Original Contour and Postmining Land Use in West Virginia. November. Washington, DC.

Penn State University. 1998. Chapter 5 – Land Use Planning. Handbook of Mining and Reclamation. Pennsylvania State University. State College PA.

Penn State University. 1998. Chapter 14 – Revegetation. Handbook of Mining and Reclamation. Pennsylvania State University. State College PA.

Resource Technologies Corporation. 2000. Phase 1 – Mountaintop Mining Economic Background Study. Unpublished. September 13.

Resource Technologies Corporation. 2001. Unpublished data – statistical summaries and maps for areas suitable for future mountaintop mining under various future mining scenarios. February.

Skelly and Loy. 1981. A Land Use Decision Methodology for Mined Lands in Appalachia. Appalachian Regional Commission. Washington, D.C.

Skelly and Loy. 1984. Environmental Assessment: Head-of-hollow Fill and Mountaintop Removal Mining – Final Report. USEPA, Washington, D.C.

Skelly and Loy. 1983. Demonstration of Cross-ridge Mountaintop Mining. USDI Bureau of Mines, Washington, D.C.

USDA Forest Service 1996. Ecological Subregions of the United States. USDA Forest Service, Washington, D.C.

USGS. 2000. National Land Cover Dataset for West Virginia – version 3. (Digital GIS data). USGS Sioux Falls, SD.

West Virginia Development Office. 1993. West Virginia State Comprehensive Outdoor Recreation Plan. Charleston, WV.

Virginia Cooperative Extension Service. 1996. Commercial Forestry as a Post-mining Land Use. Powell River Project Series. Virginia Tech, Blacksburg, VA

Virginia Cooperative Extension Service. 1997. Stabilizing Reclaimed Mines to Support Buildings and Development. Powell River Project Series. Virginia Tech, Blacksburg, VA.

West Virginia Development Office. 1997. West Virginia State Economic Development Plan. Charleston, WV.

West Virginia Development Office. 2000. EDA Program Narrative – Office of Coalfield Development (unpublished). Charleston, WV.

West Virginia Division of Environmental Protection. 2001. Unpublished mining permit data, digital map data, and permit summary statistics. WVDEP, Charleston WV.

West Virginia Division of Environmental Protection. 2000. AOC and Excess Spoil Material – Chapter 29 West Virginia Coal Mine Permitting Handbook. Charleston, WV.

West Virginia Division of Environmental Protection. 2000. An Evaluation of Future Mining Island Creek Watershed. (unpublished), Charleston, WV.

West Virginia Division of Natural Resources. 1997. Capitol Improvements Plan. Elkins, WV.

West Virginia Division of Environmental Protection. 2000. Postmining Land Use – Chapter 30 West Virginia Coal Mine Permitting Handbook. Charleston, WV.

West Virginia Surface Mining and Reclamation Association. 2000. Making the Most of Reclaimed Mined Land. Green Lands. Vol 30. no. 4.

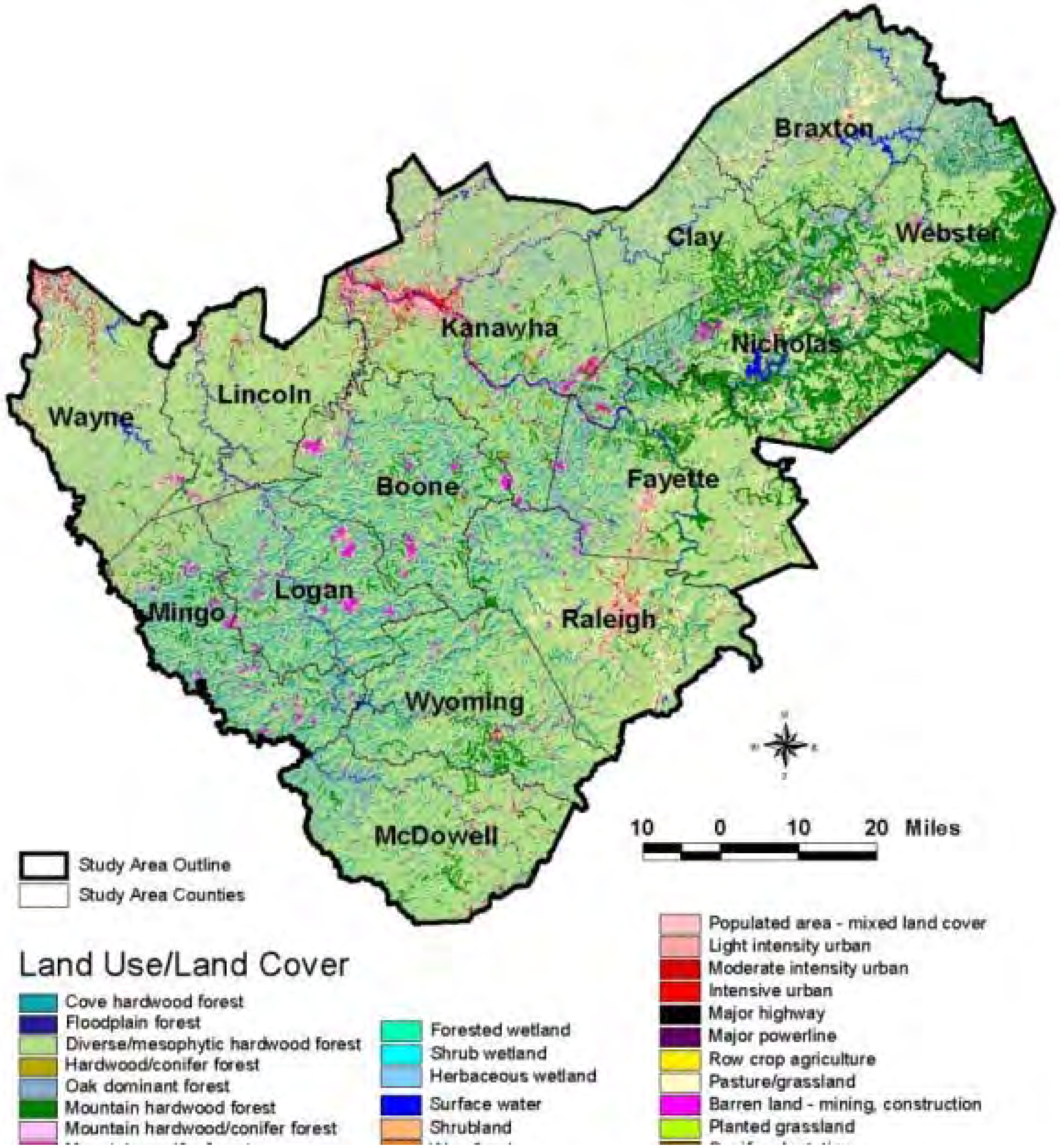
West Virginia Surface Mining and Reclamation Association. 2000. Post Mining Land Use. Green Lands vol. 30. no 3.

West Virginia University – Natural Resource Analysis Center. 2001. GAP Analysis for West Virginia – Draft Final Report. Morgantown, WV. September.

Workman, Michael, Paul Salstrom and Philip Ross. 1994. Northern West Virginia Coal Fields Historical Context. Institute for History of Technology and Industrial Archeology Technical Report 10. Morgantown, WV.

Report Figures.


Hancock
Brooke
Ohio
Marshall
Wetzel
Monongalia
Marion
Preston
Tyler
Pleasants
Taylor
Harrison
Doddridge
Wood
Ritchie
Barbour
Tucker
Grant
Wirt
Lewis
Gilmer
Upshur
Randolph
Mason
Jackson
Calhoun
Roane
Braxton
Pendleton
Putnam
Clay
Webster
Cabell
Kanawha
Nicholas
Pocahontas
Wayne
Lincoln
Boone
Fayette
Greenbrier
Mingo
Logan
Raleigh
Wyoming
Summers
Monroe
Mercer
McDowell
Mineral
Hampshire
Morgan
Berkeley
Jefferson
Hardy
Study Area Outline
Study Area Counties
West Virginia Counties
10 0 10 20 Miles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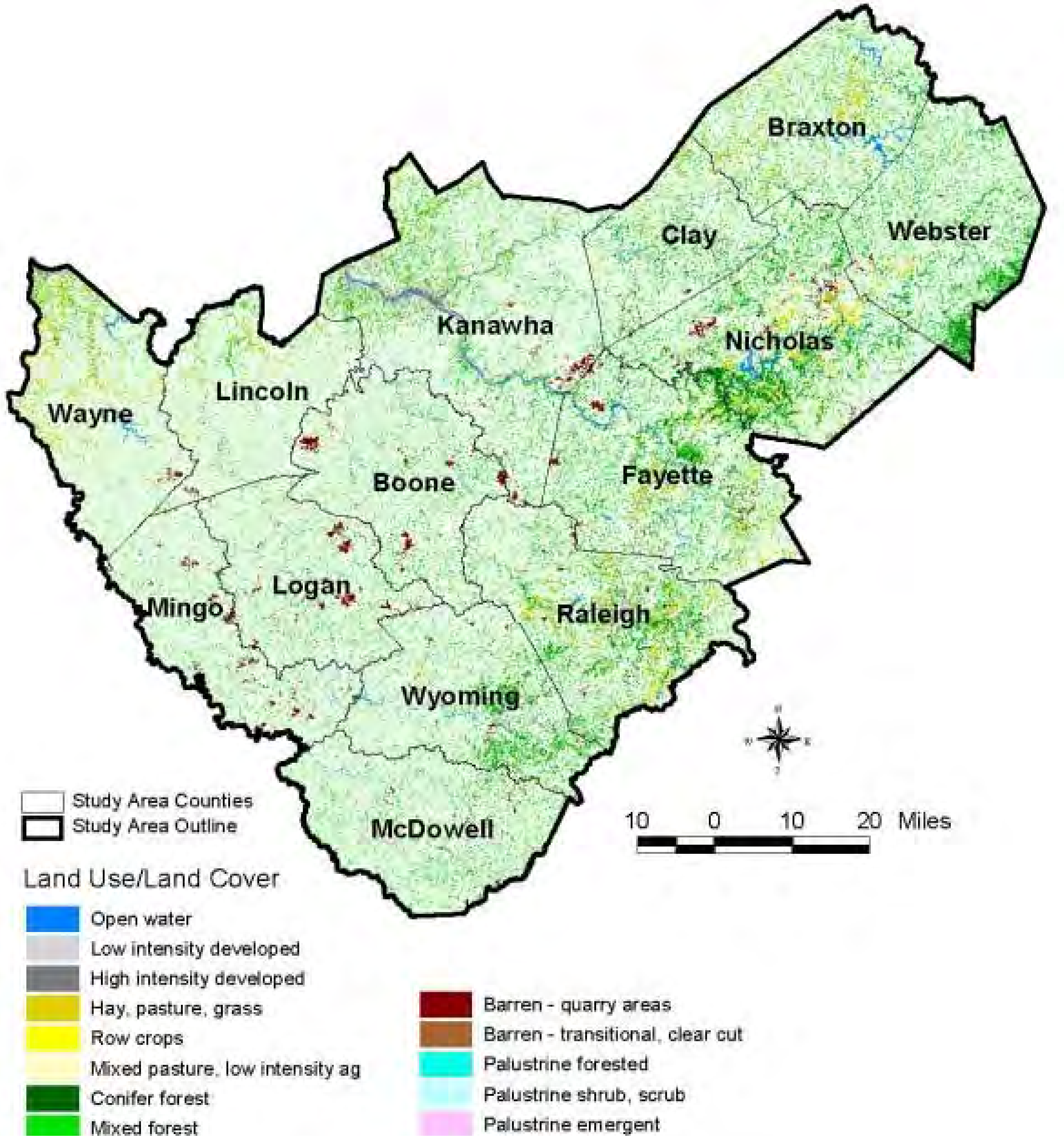
Study Area Outline
Study Area Counties
Land Use/Land Cover
Cove hardwood forest
Floodplain forest
Diverse/mesophytic hardwood forest
Hardwood/conifer forest
Oak dominant forest
Mountain hardwood forest
Mountain hardwood/conifer forest
Forested wetland
Shrub wetland
Herbaceous wetland
Surface water
Shrubland
Populated area - mixed land cover
Light intensity urban
Moderate intensity urban
Intensive urban
Major highway
Major powerline
Row crop agriculture
Pasture/grassland
Barren land - mining, construction
Planted grassland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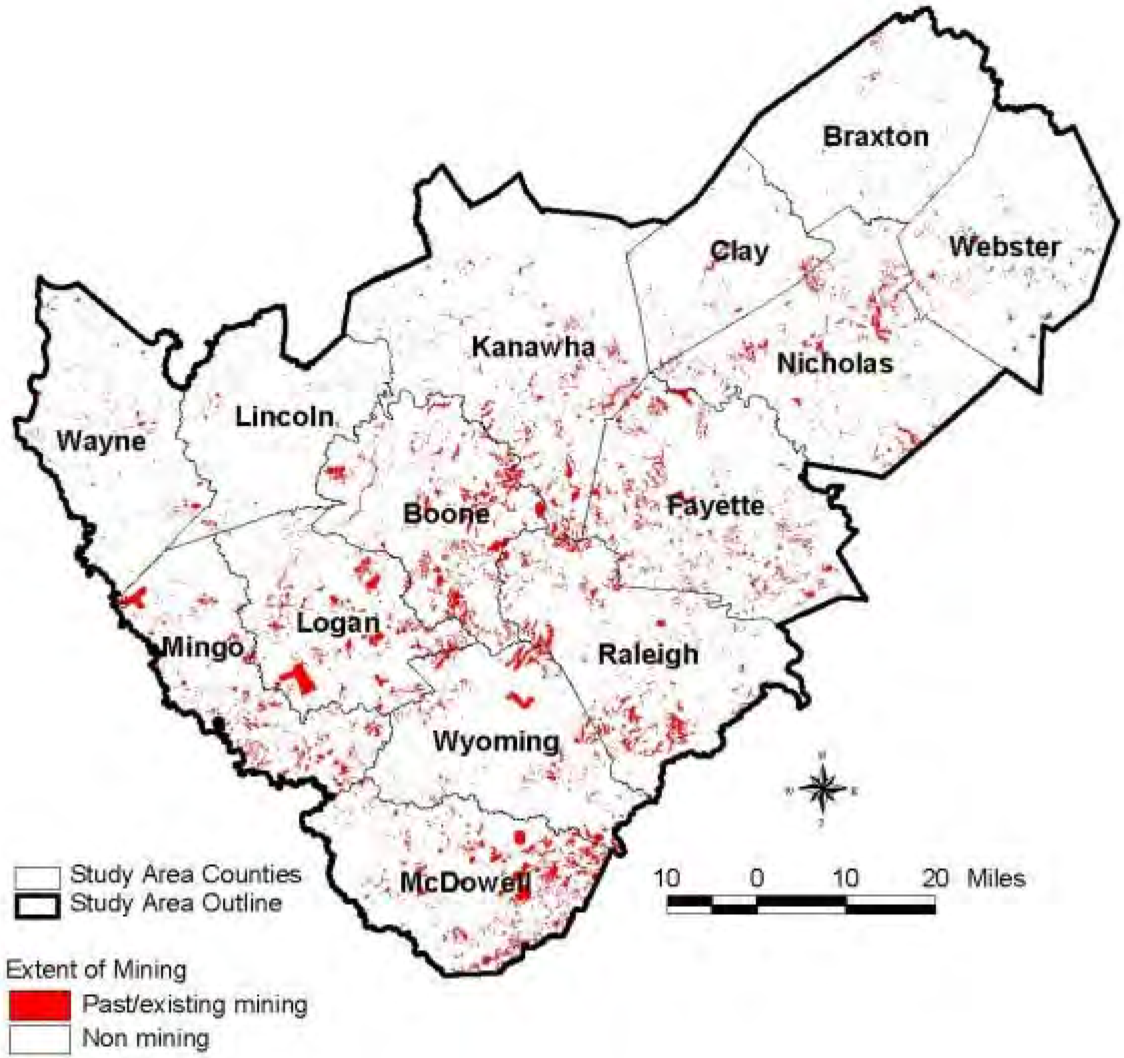
Study Area Counties
Study Area Outline
10 0 10 20 Miles
Land Use/Land Cover
Open water
Low intensity developed
High intensity developed
Hay, pasture, grass
Row crops
Mixed pasture, low intensity ag
Conifer forest
Mixed forest
Barren - quarry areas
Barren - transitional, clear cut
Palustrine forested
Palustrine shrub, scrub
Palustrine emergent



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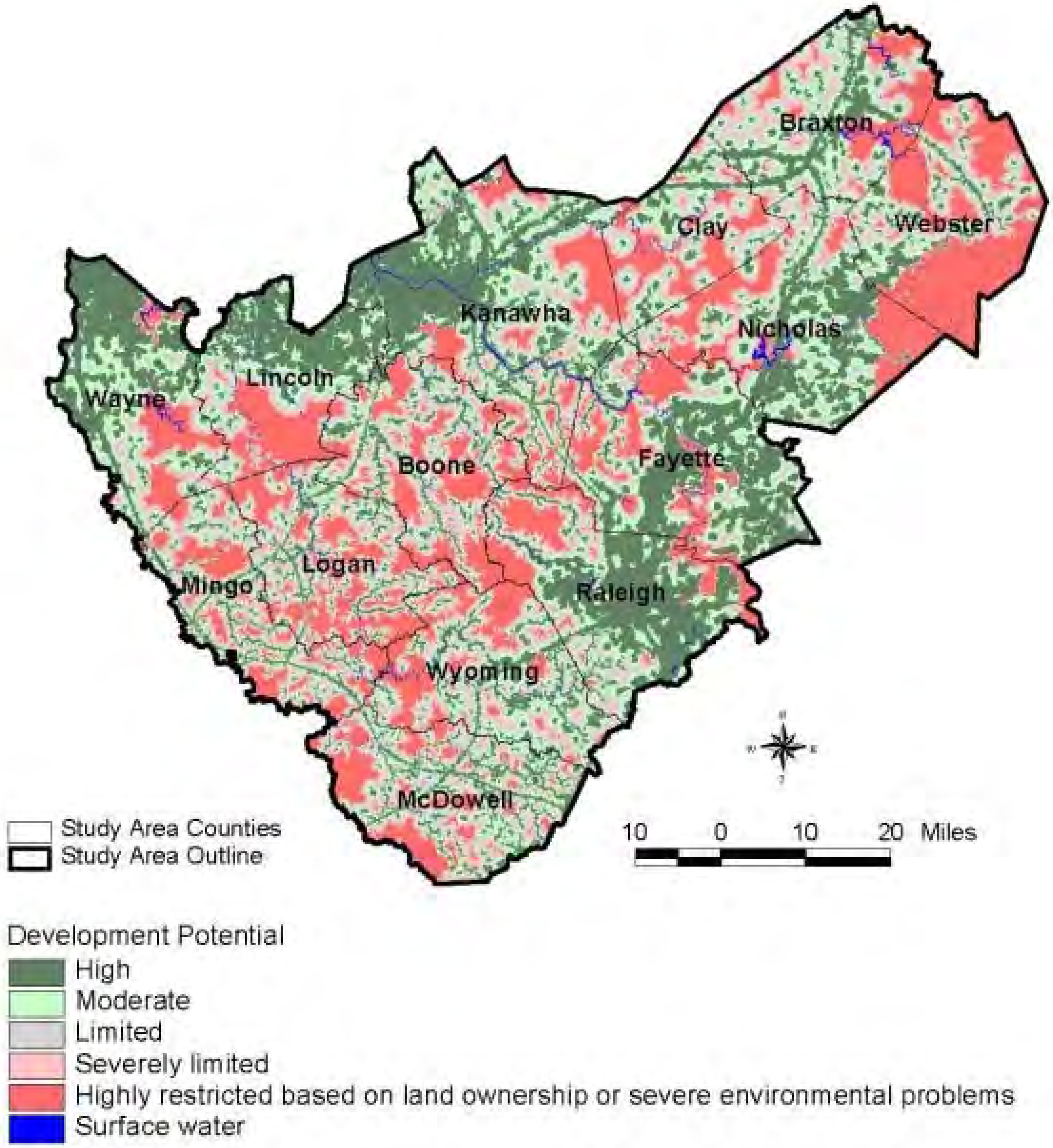
Study Area Counties
Study Area Outline
Extent of Mining
Past/existing mining
Non mining
10 0 10 20 Miles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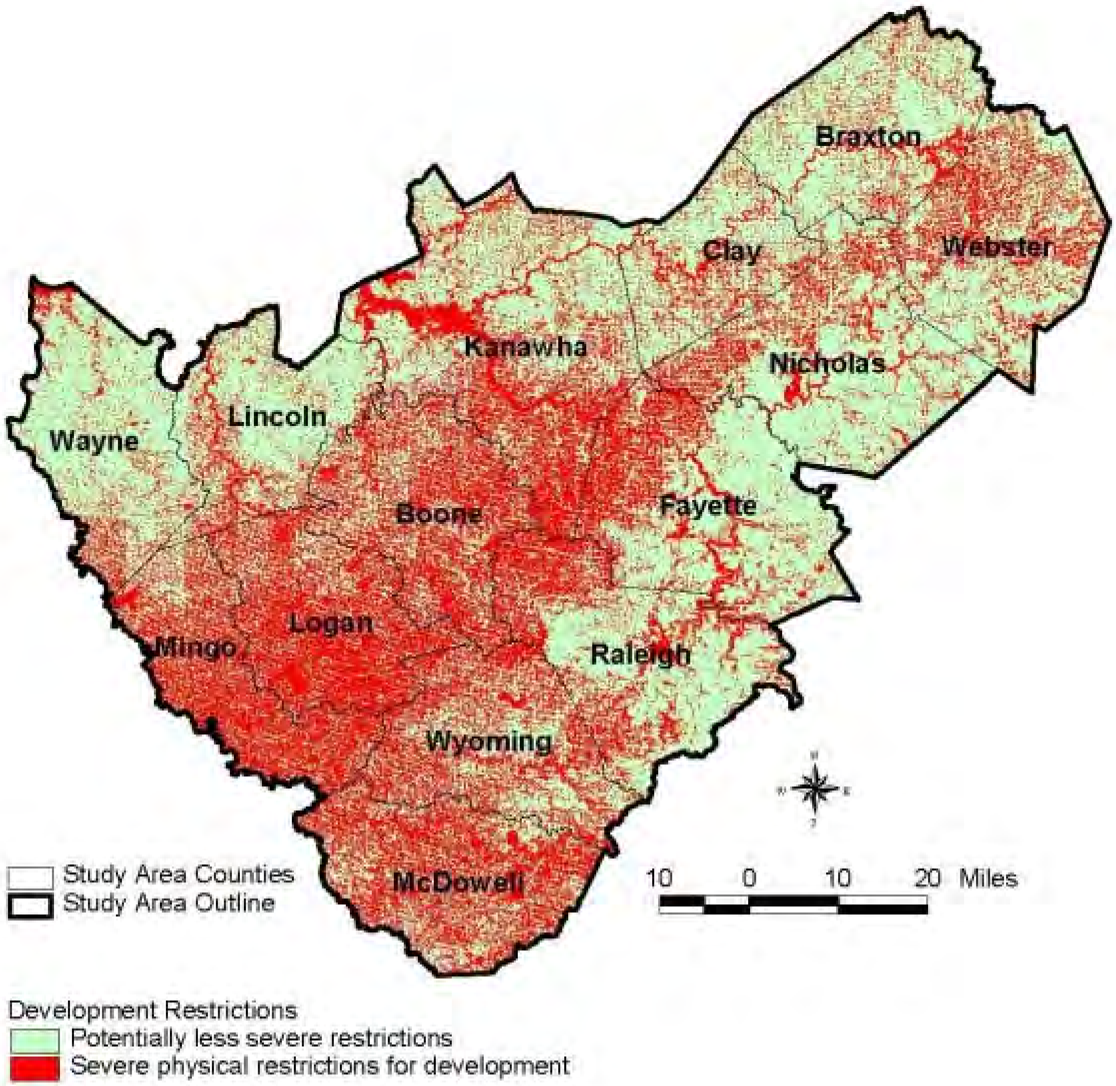
Study Area Counties
Study Area Outline
10 0 10 20 Miles
Development Potential
High
Moderate
Limited
Severely limited
Highly restricted based on land ownership or severe environmental problems
Surface water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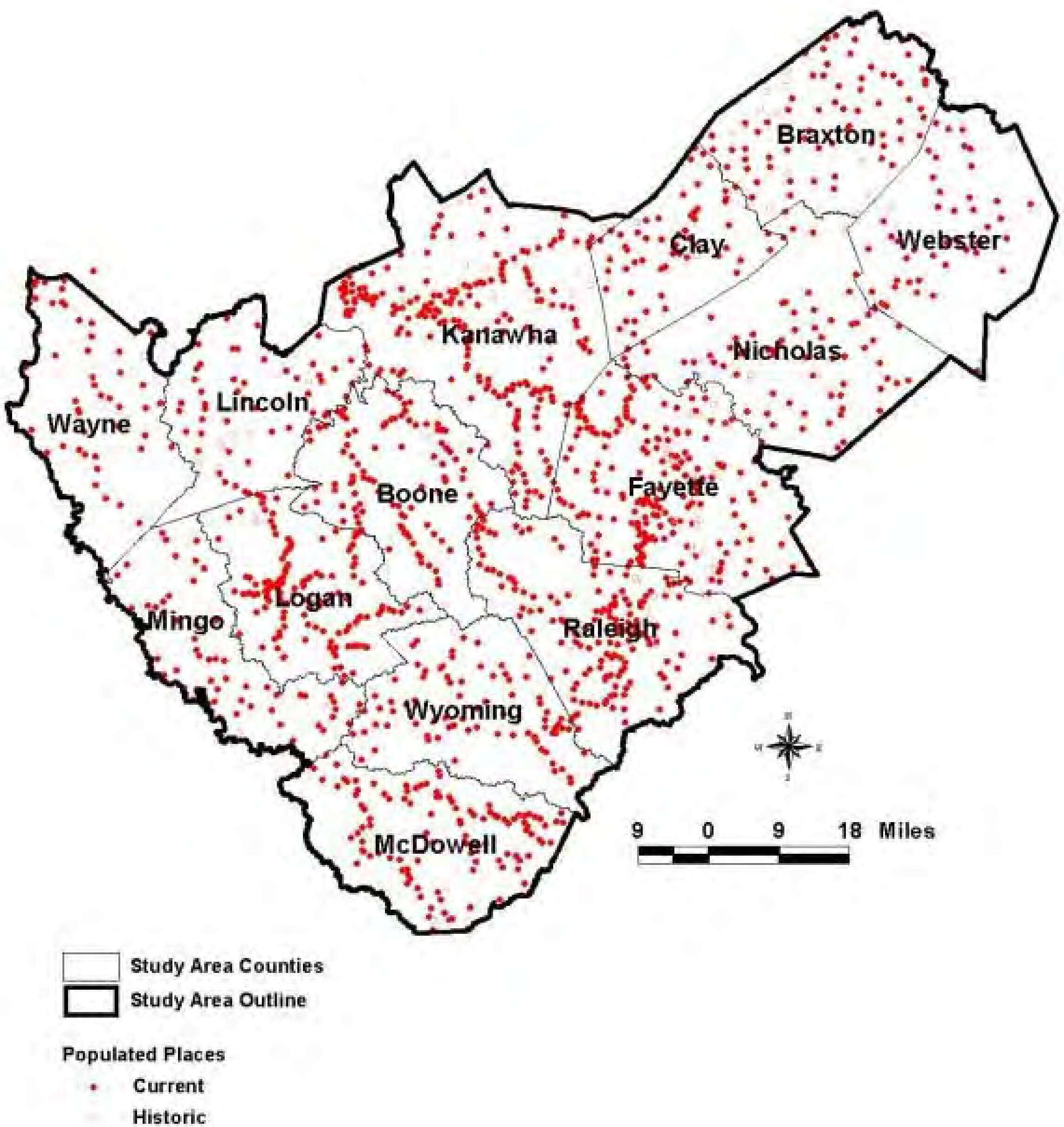
Study Area Outline
10 0 10 20 Miles
Development Restrictions
Potentially less severe restrictions
Severe physical restrictions for development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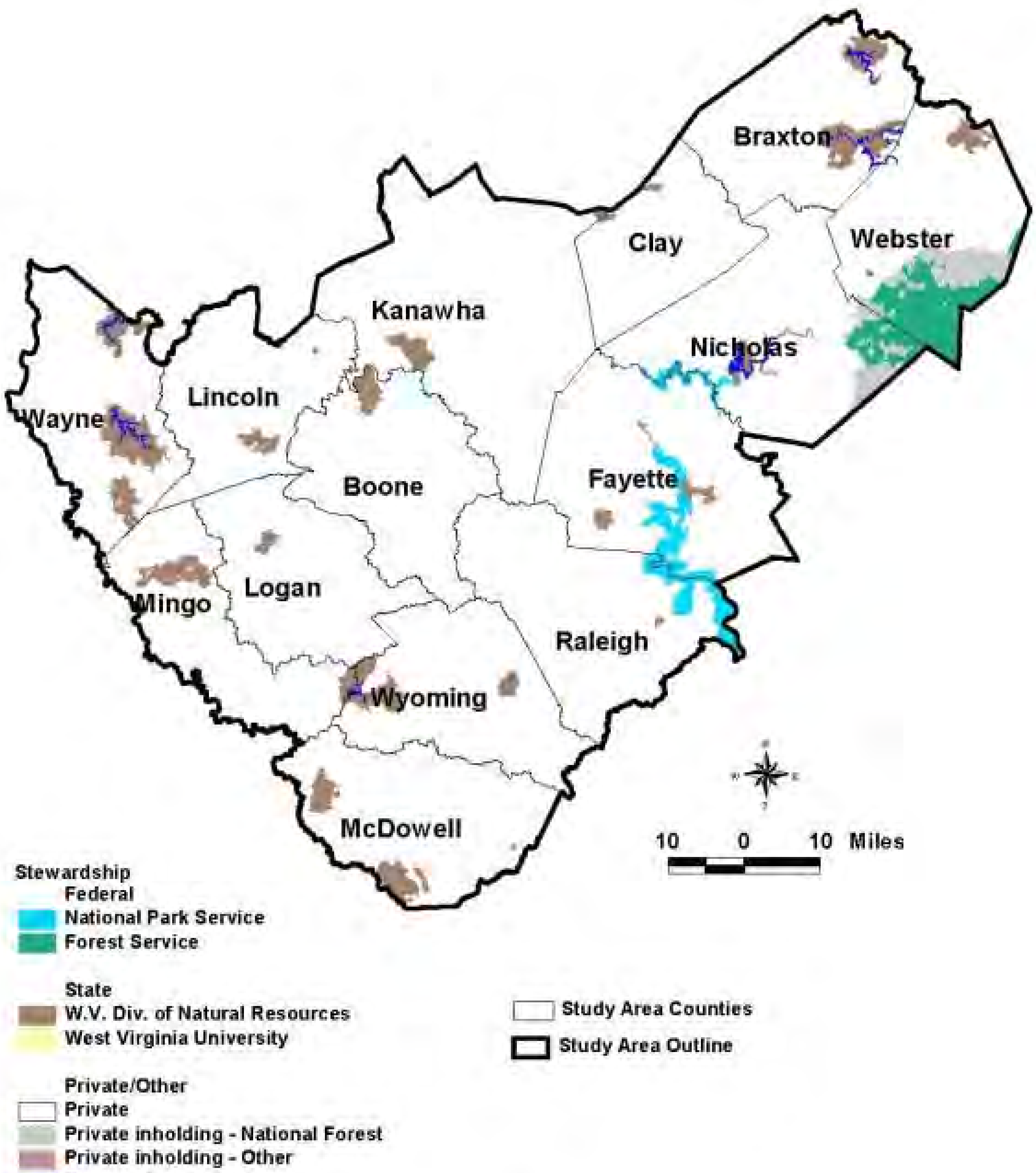
Study Area Counties
Study Area Outline
Populated Places
Current
Historic



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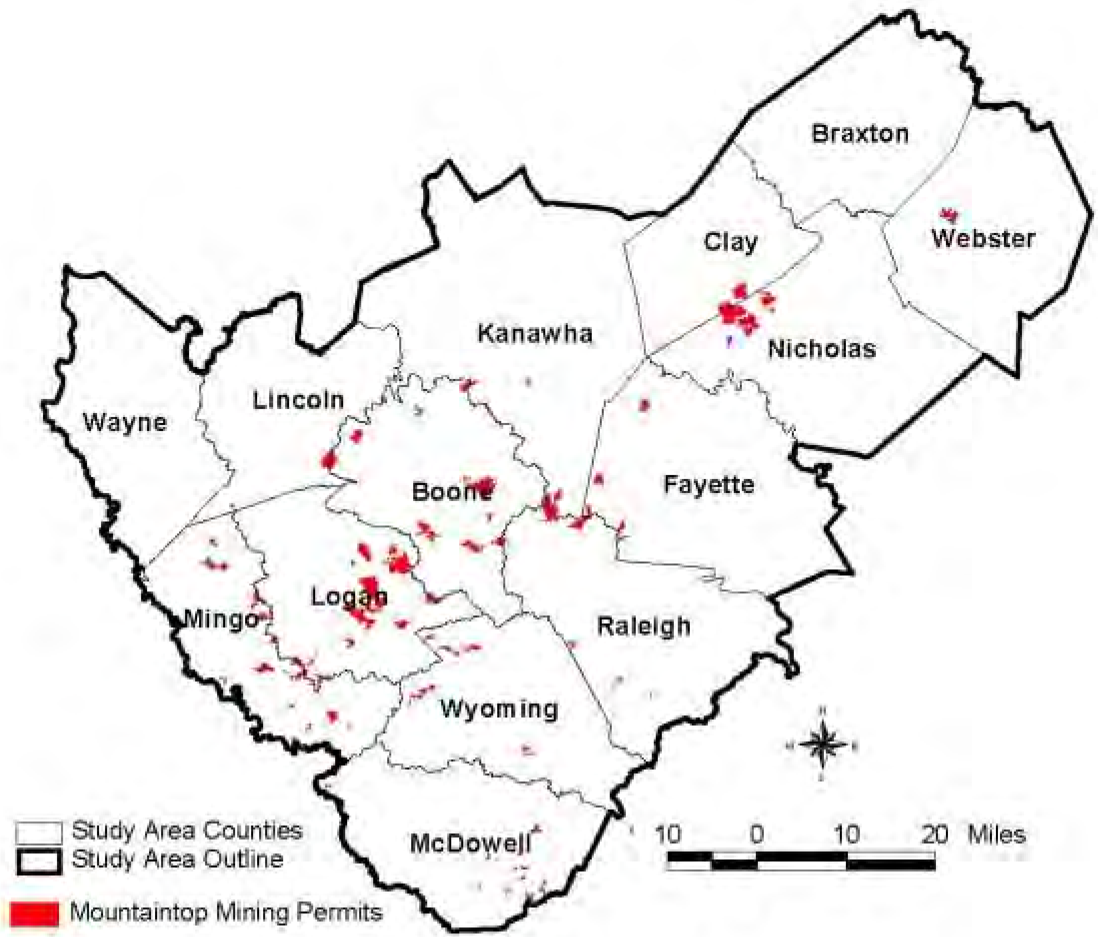
10 0 10 Miles
Stewardship
Federal
National Park Service
Forest Service
State
W.V. Div. of Natural Resources
West Virginia University
Private/Other
Private
Private inholding - National Forest
Private inholding - Other
Study Area Counties
Study Area Outline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Study Area Counties
Study Area Outline
Mountaintop Mining Permits
10 0 10 20 Miles

Mountaintop EIS
Technical Report

by the

Mountaintop Technical Team

Team Members

Charles Sandberg	Office of Surface Mining
Barry Doss	Coal Industry
Dr. Erkan Esmer	Coal Industry
Joe Ross	WVDEP
John Morgan	Morgan Worldwide
Ken Eltschlager	Office of Surface Mining
Mike Superfesky	Office of Surface Mining

Executive Summary

During December 1999, the Office of Surface Mining (OSM), in cooperation with other federal and state agencies developed a work plan for comparing different mining and reclamation scenarios of mountaintop removal surface coal mining operations in West Virginia. The purpose of the comparisons was to evaluate the impact that limiting valley fills to ephemeral streams would have on coal resource recovery. The results of the comparisons will be included in the Environmental Impact Statement (EIS) required by a settlement agreement arising from the July 1998 *Bragg v. Robinson* litigation concerning mountaintop mining and associated valley fill construction in West Virginia.

An engineering team (Team) consisting of representatives from OSM, the West Virginia Division of Environmental Protection (WVDEP), Industry, and the Plaintiffs completed the evaluation. The Team first selected 14 proposed mine sites which were a representative sample of proposed mining sites in West Virginia and provided the permit applicants with a backfill template. The backfill template was designed to approximate the results that would be expected under the (then pending) Consent Decree AOC/Backfill Optimization Model. That model generally results in more spoil material being returned to the mined area and the tops of the valley fills being constructed higher than the lowest coal seam being mined. The Team requested the applicants to redesign their mine proposals so that the proposed valley fill toes were no closer than 100 feet from the beginning of an intermittent stream (i.e. completely within the ephemeral stream). When possible, the applicants in consultation with WVDEP established the ephemeral limit points. The Team received redesign proposals for 11 mines sites (10 surface mines and 1 refuse disposal impoundment).

The team critically reviewed each of the redesign proposals in order to assure the redesigns were objective and consistent with the stated purposes of the workplan, the backfill template, and the associated instructions. Once the Team was satisfied that these requirements were met, it requested the applicants to provide the estimated tonnage of coal reserves that could be extracted not only by the initially proposed mining method, but by alternative methods as well.

The Team did not request nor evaluate any of the economic information provided verbally by some of the applicants, nor was this information used in reaching the Team's conclusions.

Limiting valley fills to the ephemeral streams resulted in significant or total loss of the coal resource for 9 of the 11 mine sites when compared to the original mine site plans. All of the coal resource was lost for 6 of the 11 mine sites. By restricting fills to the ephemeral streams, the total coal recovery is estimated at 18.6 million tons, a 90.9 percent reduction. The original estimate was 186 million tons. The team noted that even if smaller fills could be constructed, they would impact nearly every available valley, possibly increasing the overall environmental impact.

Mountaintop Mining Technical Team Report

Background

A settlement agreement in West Virginia involving litigation over mountaintop mining and associated valley fills (*Bragg v. Robertson*) required an Environmental Impact Statement (EIS) to address the issues. As part of the EIS effort, the Office of Surface Mining (OSM) in cooperation with other federal and state agencies developed a work plan for comparing different mining and reclamation scenarios of mountaintop mining. The purpose of the comparisons was to evaluate the impact that the different scenarios would have on coal resource recovery. As a result of the subsequent decision by the federal judge in the case, the workplan was revised to evaluate what the impact of limiting valley fills to ephemeral streams would have on coal resource recovery.

Between January and May 2000, an engineering team (Team) consisting of representatives from OSM, the West Virginia Division of Environmental Protection (WVDEP), the West Virginia Coal Industry, and the Plaintiffs in the case completed the evaluation.

Methodology

The Team established a mine selection process, agreed upon the definition "ephemeral streams," and developed a procedure to gauge the impact of limiting fills to ephemeral streams on existing mine applications. The Team selected mines from pending applications in the five main mining regions. The geographic and geologic differences throughout West Virginia delineated the five main mining regions. In turn, each area was predisposed to different mining methods. The end result was a selection of mines representing various mining methods taking place in different geographic and geologic settings. The Team chose 14 pending surface mine applications submitted by coal companies who agreed to participate in the evaluation. Because of the possible impact of the ephemeral stream limit for refuse fill permits, the Team included one refuse fill in the evaluation.

Next, the Team developed a template for configuring the backfill and the valley fills for the 14 selected mine applications (see Attachment A). The backfill template required additional fill to be placed above the lowest coal seam, resulting in more backfill being returned to the mountain. Although not equivalent, the requirements of the backfill template exceeded the fill optimization requirements of the Consent Decree AOC Process template (also known by the working title of "AOC Plus") at the time of the study. It also approximated the results that may be expected under the Consent Decree AOC Process template.

The first step of the analysis was to obtain information from the pending applications concerning coal tonnage, overburden volumes, and numbers and sizes of valley fills. This provided the base information for each analysis. (This information is listed as Scenario 1 in the attached tables.) The second step was to ask the applicants to use the template to revise their original applications, limiting valley fills to the ephemeral stream, but using every available hollow as a disposal site. (Scenario 2 in the tables). In most cases, the revisions yielded a spoil imbalance. In some cases, applicants submitted information from original applications because ephemeral points were above the coal seam to be mined. The last step of the analysis was to estimate the coal tonnage which could be extracted from the site by alternative mining methods, using every available hollow as a disposal site, but limiting the fills to the ephemeral stream. The applicants were asked to consider all mining methods, including mountaintop removal, area mining, contour, highwall miner, augering, and underground mining.

Each applicant developed the plans for these evaluations independently. The Team reviewed the evaluations to assure that all possible fill sites were analyzed, the evaluations represented the maximum coal recovery, the evaluations met Attachment A backfill requirements, and the applicants had limited the fills to the ephemeral zone. The completed tables for each mine are attached.

The limits of the ephemeral stream (and therefore the beginning of the intermittent stream) were established using WVDEP procedures, "Guidance for Delineation of Ephemeral/Intermittent Streams," dated October 26, 1999 (included in Attachment D). The Team considered the state guidance document to be consistent with the Federal Surface Mining Control and Reclamation Act (SMCRA) definitions of ephemeral and intermittent streams. A separate team, led by the U.S. Geological Survey (USGS), field verified the ephemeral reach for five of the fourteen sampled sites during February and March 2000. Maps indicating the team's results are attached and identified as Attachment E. Only three of the five companies whose sites were field verified ultimately submitted data for this study.

Team Evaluation Process

During March and April 2000, the Team met with several of the participating companies to discuss their progress in completing the two scenarios. In addition, the Team reviewed the analyses and maps of those companies that had completed both scenarios. In every case, the Team believed the companies had indeed used every available fill site, established appropriate ephemeral limits, and met the backfill requirements of the template. Furthermore, for those sites where the USGS team had field verified the ephemeral points, the differences between the team's findings and the company's finding were insignificant. In all but one case, the USGS team's findings were generally consistent with the company's ephemeral limits in the field.

Results

The Team received data on ten surface mines and one refuse fill. The data as received is attached in tabular form (Attachment C). Summary discussions for each of the sites precede the tables (Attachment B). For the refuse fill, the reported coal production is from the underground mine that would generate the refuse. Table 1 of this report summarizes the data from the sites.

Conclusion

In nearly every valley reviewed, the lower end of the ephemeral stream was very high in the valley. This resulted in very small fills or no room for any fill. One site had been significantly impacted by underground mining, resulting in a much lower ephemeral point. Therefore, the coal recovery proposed in the original plan was not impacted. Still, even when using every available fill site, there was a major reduction in the total amount of excess spoil that could be placed in these fills. The reduction of available fill volume resulted in a significant reduction in coal resources recovered. The original plans for the 11 sites reviewed would have produced 186 million tons of coal. By restricting fills to the ephemeral streams, the total coal recovery is 16.8 million tons, a 90.9 percent reduction.

TABLE 1

MINE	FINAL EXCESS SPOIL		NUMBER OF FILLS		TONS OF COAL RECOVERED		ECONOMIC VIABILITY ##	% COAL LOST
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2		
“A”	31,400,000	3,100,000	2	0	24,700,000	4,800,000	No	81
“E”	31,900,000	3,600,000	4	2	4,000,000	350,000	No	92
“F” #	24,700,000	5,700,000	7	2	7,100,000	1,400,000	No	81
“G”	38,900,000	33,700,000	2	1	3,100,000	0	No	100
“L”	577,000	0	5	0	980,000	0	No	100
“P” #	10,600,000	0	3	0	2,600,000	0	No	100
“Q”	95,400,000	51,400,000	11	17	9,300,000	8,400,000	Questionable	10
“R” #	35,100,000	5,600,000	5	7	4,200,000	0	No	100
“S”	12,000,000	9,500,000	10	8	2,500,000	1,900,000	Yes	22
“U”	81,200,000	3,500,000	7	5	17,600,000	0*	No	100
“V” **	81,500,000	31,900,000	1	45	110,000,000	0	No	100
TOTAL	411,877,000	144,900,000	55	87	186,080,000	16,850,000		90.9%

* Due to toxic nature of top seam, entire resource lost as acid material cannot be put in valley fill.

\# Ephemeral Point Field Verified

** Refuse fill

\## As determined by the applicant

ATTACHMENTS

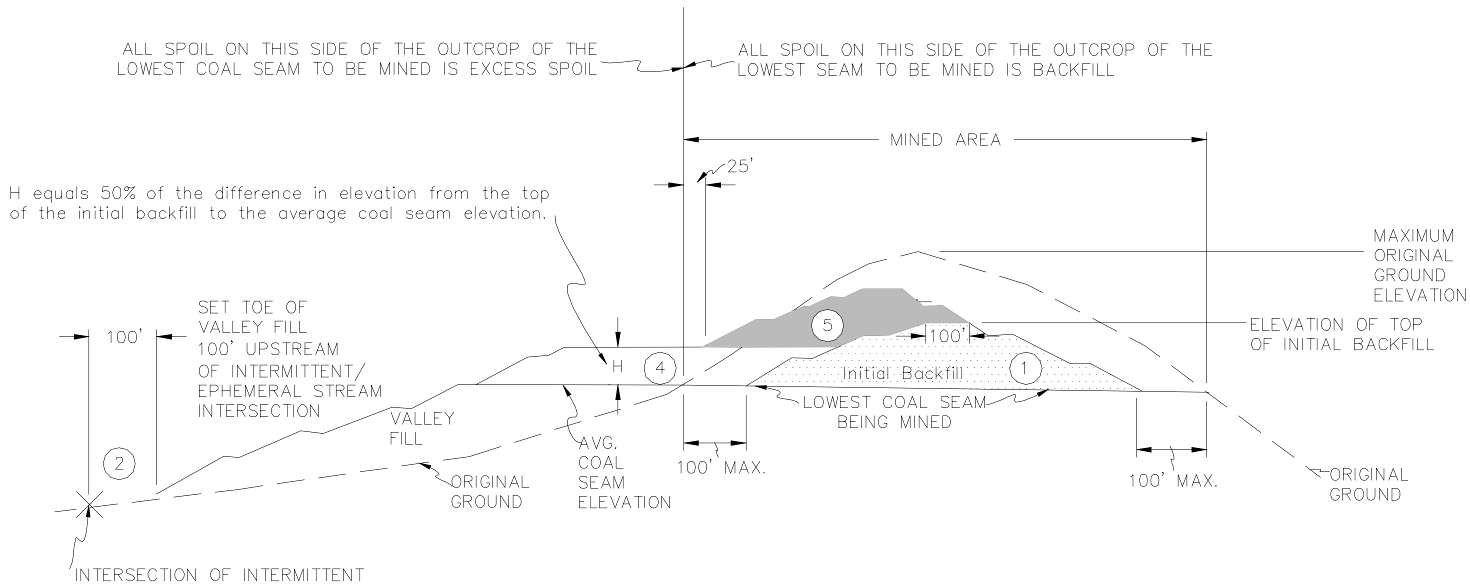
Attachment A

NOTES:
1) 2H:1V SLOPE BETWEEN TERRACES (BENCHES)
2) 50' VERTICAL (MAX.) BETWEEN TERRACES
3) TERRACES 20' WIDE
4) ASSUME ALL BACKFILLED SURFACES ARE LEVEL

MOUNTAINTOP MINING EIS
BACKFILLING/EXCESS SPOIL DISPOSAL TEMPLATE

Aτταχημ εντA

FOR ALL AREAS OF MINING EXCEPT FOR AREAS WHICH ARE STRICTLY CONTOUR MINING



-- NOT TO SCALE --

1. Determine initial backfill volume and configuration by placing spoil in the mined area to the configuration shown. Spoil is to be placed until the width of the top of the backfill is no greater than 100 feet or until the height of the backfill reaches the maximum elevation of original ground in the permit area.
2. Set the toe of all valley fills at a point 100 feet horizontally from the intermittent and ephemeral stream intersection.
3. Calculate the additional height (H) of valley fill required. H equals 50 % of the difference in elevation from the top of the initial backfill to the average coal seam elevation. H is added to the average coal seam elevation to determine the top of fill elevation.
4. Place spoil in the valley fill up to the (Average coal seam elevation + H) elevation.
5. Place additional spoil in the mined area adjacent to all valley fills. The toe of the spoil will be offset 25 feet from the outcrop line projected upward. Spoil will be placed upward until the width of the top of the backfill is no greater than 100 feet or until the height of the backfill reaches the maximum elevation of original ground in the permit area.

Please note: This template is for Mountaintop Mining EIS evaluation purposes only. This template does not represent the WV-DEP position on Approximate Original Contour.

Attachment B

Individual Mine Summaries

Mine A Summary

Mine A as originally planned was a combination mountaintop and contour mine with highwall mining planned. This original plan included two valley fills and would have recovered 24.7 million tons of clean coal. The requirement to limit fills to the ephemeral stream resulted in a contour mine with highwall mining and NO valley fills with the recovery of 4.8 million clean tons; an 80.6% reduction of recoverable reserves. Excess spoil storage was only available by hauling up-hill and stacking on an existing reclaimed valley fill.

Mine E Summary

Mine E is contour mining, and is not feasible due to slope of the original ground (Highwall Reclamation).

Coal seams are not conducive to auger or highwall mining due to low thickness and cost of washing produced coal.

Capital expenditures for the mine are not feasible due to minimal recoverable reserves.

Mine F Summary

Mine F is a contour/highwall mining operation with limited point removal areas. The site is adjacent to an inactive site that currently has some disturbed area associated with it. Scenario 1 represents a current SMCRA application that has been revised from the original submittal to provide less stream impacts by using the reasonable portions of the fill minimization guidelines of the new AOC policy. The main seams of removal are Stockton and Coalburg. Minor additional tonnage is taken from the No. 6 Block, No. 5 Block, and Clarion seams. Some areas above the mine permit have been previously surface mined in the upper seams and have small fills in the heads of the hollows.

Scenario 1 is designed for removal of 7.06 million recoverable surface and highwall mining tons at a cost comparable to the current coal market. Scenario 2 allows for the removal of 1.39 million tons at a significantly increased cost. This represents a reduction of 5.67 million tons, an 80 % reduction in reserves. Scenario 2 uses the available fill space in fills 4 and 5, plus hauls an additional 2.56 million cubic yards to the adjacent mined area in order to mine the estimated 1.39 million tons. It is important to note that this mine as revised in Scenario 2 is not feasible and would not be permitted or started in this market or foreseeable near term market. It would take estimated revenue of over $30 per ton to justify Scenario 2.

The ephemeral stream ending points for use in Scenario 2 were obtained from the OSM/EPA teams that recently visited the site. In five of the seven fills, the ephemeral portion of the stream was near or above the Middle Coalburg seam level, making the fills spatially and economically impossible. The ephemeral stream ended low enough in fill 4 to allow a small fill. Fill 5 was not affected since the stream was totally ephemeral due to stream loss from previous underground mining.

Mine G Summary

Scenario 1

Mine G as originally planned consists of mountaintop removal of one knob, and area mining (up to centerline of ridge) of a second knob. A total of eight distinct seam horizons were to be mined across the ridge. No contour, highwall mining, or augering was proposed. Permit area is steeply sloped with a maximum depth of cover of nearly 400 feet.

The original project proposed to recover 3.1 million tons of saleable coal and would generate roughly 64 mmcy of (loose) spoil. Just over 60% of this spoil was excess and proposed for disposal in two adjacent valley fills. The requirement to limit valley fills to ephemeral stream reaches resulted in the complete loss of one fill site, and a reduction in storage capacity at the second site of 55%. A third fill site was evaluated, but rejected due to its small volume, inaccessibility, and stability concerns. Even with super-elevation of the remaining valley, a 30% deficit in excess storage capacity resulted. Thus by mountaintop removal method, a 100% reduction in recoverable reserves would occur.

Scenario 2

Contour mining, outside the confines of a valley fill site, was not deemed practical due to difficulties associated with blasting in steep slopes (65%-80%) and the inability to conduct stable backfilling. Deep mining of any remaining seams was ruled out as none of the eight coal seams consistently averaged 36" or greater in thickness. Augering and highwall mining were rejected both due to the inability to create contour benches and due to the lack of sufficient seam thickness.

Contour and cross-ridge mining adjacent to valley fill site 2 was felt to be the only remaining option. It was estimated that through super-elevation of the fill site and backfilling per the prescribed criteria, a total of 25.5 mmcy of (loose) spoil storage could be made available. After correcting for bulking factor and strip ratio, this implies roughly 1.2 mm tons of saleable product could be extracted.

Scenario 2 would result in a loss of just over 60% of the reserve base.

The applicant submits, however, that mining and reclamation of the eight coal seams, which have an average depth of cover in excess of 300 feet, within a mineral removal area of about 75 acres, would not be possible without significant rehandling of materials. This lack of operation room and associate rehandling would result in production costs significantly above expected market realizations (currently at $23.50 to $24.00 per ton).

Mine L Summary

Mine L is a contour surface permit in the Coalburg seam. The contour cut is currently being permitted to approximately 13:1 strip ratio, with highwall mining to follow. Total tons estimated recoverable, as permitted, are approximately 978,000 tons with required initial excess spoil storage area of 1,807,988 cu. yds. None of the proposed valley fills occupy watersheds of 250 acres or greater. As the ephemeral/intermittent stream contact occurs at or above the Coalburg seam outcrop, it is not possible to build any hollow fills if only the ephemeral stream can be utilized. Such a restriction would result in a loss of 100% of estimated reserves for this permit.

Mine P Summary

Mine P is a combination contour and point-removal surface mine permit in the 5-block seam. Approximately 2,628,672 tons of strip and highwall mining reserves are estimated recoverable. The average ratio of cubic yards of O.B. to ton of coal is approximately 12:1, with an estimated initial excess spoil of 11,943,289 cubic yards. None of the designed valley fills were 250 acres or larger. Requiring valley fills to be confined to the ephemeral stream results in storage capacity of only 82,589 cubic yards. Only 31,500 tons would be recoverable under this scenario. However, due to economic considerations, this reserve would probably not be mined, so the effective loss of reserves is 100%.

Mine Q Summary

Mine Q proposes a combination of mountaintop/area mining, contour mining, and mining with a highwall miner. Four major coal horizons will be mined with a total of eight individual seams being mined. Several of the seams have been previously mined by contour and underground mining methods. The mine plan includes eleven (11) valley fills and would recover 9.3 million tons of coal. The in-site ratio is approximately 14:1.

Limiting mining and spoil placement to areas above the ephemeral stream limit and placement of spoil in all available hollows result in a spoil imbalance of 21.7 million cubic yards. (It should be noted that the mining area was slightly reduced in this scenario.) The spoil imbalance should be slightly greater if mining of all areas proposed in the permit application was evaluated.

The company re-evaluated the mining plan with the fills limited to the ephemeral limits. This scenario results in the recovery of 8.4 million tons of coal. Although this results in a reduction of only about 2 million tons of reserves, the company states that is doubtful that this scenario could fully be implemented.

Reasons stated for doubts about implementation:
(a) amount of pre-law contour mining on old rim cut benches;
(b) increased mining costs; and
(b) spoil placement requirements would possibly “spoil bound” operation.

Mine R Summary

Mine R was originally planned as a combination mountaintop, area, and contour mine with no augering proposed. All of the mineral removal area is classified as re-mining since the entire site has previously been extensively contour mined and augered. The plan included five (5) valley fills and would have recovered approximately 4.2 million tons of coal. The in-situ strip ratio is approaching 20:1.

As shown by the provided analysis, mining of this area if limited above the ephemeral point will not be economically feasible. By using the guidelines for this exercise, there is an imbalance of roughly 30 mm cubic yards of spoil. Attempting to re-balance the mining area is not feasible. Significant contour/augering in the 3, 4, and 5 seams (as well as excessive deep mining in the 3 seam) has already taken place. Surface mining above those areas would result in unacceptable strip ratios.

Deep mining of the 4 seam would be questionable due to the close proximity of the underlying 3 seam. Deep mining of the 5 seam could be considered, but only about 10% of the tonnage originally proposed to be mined by the mountaintop method might be recoverable. There is approximately 1,150,300 tons of in-place coal within the 5 seams. Assuming a 55% mining recovery and a 35% reject, it is estimated 411,200 saleable tons of 5 seam coal could be deep mined. This compares very unfavorably to the 41,186,000 tons proposed by the area mine.

The mineability of the 5 seam coal by underground methods, however, is presently impeded by several factors:

(a) the small reserve block size (<500,000 tons);
(b) lack of preparation facility (closest plant 30+ miles);
(c) presumed restrictions on constructing new coal refuse facility;
(d) unfavorable economy of scale due to lack of complimentary reserves.

In short, it is unlikely the deep mine block would "stand alone" as recoverable given today's economic and market conditions.

Mine S Summary

Mine S as originally planned was a combination mountaintop and contour mine with auger mining planned. This original plan included 10 valley fills and would have recovered approximately 2.5 million tons clean coal. The requirements to limit the fills to the ephemeral stream resulted in the following:

(a) eliminated 2 fills;
(b) reduced the recoverable reserves to approximately 2 million tons, or a 20% reduction in recoverable reserves; and
(c) eliminated the planned mountaintop and the highest seam and changed it to contour and highwall mining.

Mine V Summary

The company needs to store 110,000,000 tons of coarse and fine refuse from processing its reserves. These coal reserves are from two (2) large deep mines and a possible small contour strip mine. An impoundment was designed to store this amount of refuse in the same watershed that the prep plant and mine was located at. This was done in an effort to provide the most technically sound and environmentally friendly facility to disturb as few watersheds as possible. It required 1.6 miles of haulroad construction at a cost of $1,300,000.00. The site preparation cost was about $500,000.00 for a total initial construction cost of $1,800,000.00. Thus, the initial construction cost per ton of refuse was $0.016.

A refuse disposal system was developed for the post-Haden scenario. Forty-five (45) fills were designed within 100 feet of intermittent streams in every hollow, on all of the lands owned by the company. It will require one bridge and 30.2 miles of road construction and unnecessary environmental damage to every watershed on the company's property. It costs approximately $500,000 to build diversion ditches and sediment ponds per refuse facility area. The bridge to transport refuse over the railroad tracks to some of these disposal areas will cost approximately $2,000,000. Road construction, at the site, to date has cost approximately $800,000/mile. Thus, initial construction costs are as follows:

Site Preparation:	45	@	$500,000/site	= $22,500,000
Bridge Construction:				= $ 2,000,000
Road Construction:	30.2 miles	@	$800,000/mile	= $24,160,000
Approximate Total				= $48,660,000

Furthermore, these facilities can only store approximately 43,000,000 tons of refuse. Therefore, just the initial construction cost per ton of refuse of $1.13 will make coal mining and processing unfeasible. Stability analysis of these fills, show that because they are placed on such steep terrain, they are not stable. Their factor of safety against static failure is 1.34, whereas, it is 1.08 against dynamic failure. The factors of safety required by MSHA and WVDEP are 1.5 and 1.2 respectively. Since these factors of safety are inadequate and unsafe per criteria required by state and federal governments, they cannot be built. Thus, it makes the mine complex unfeasible, since refuse cannot be disposed of due to the Haden decision.

Attachment C

Mine Tables

MINE: "A"	**Scenario 1**	**Scenario 2**
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	455,738,815	12,362,512
2. Bulking factor (Swell-Shrinkage) (%) BF	25%	25%
3. Total spoil material TSM (OB+IB) Times (BF)	569,673,815	15,453,140
4. Initial spoil in backfill (BKF) (cu.yds)	467,476,644	12,362,512
5. Initial excess spoil (TSM-BKF) (cu.yds)	102,196,875	3,090,628
6. Final volume of excess spoil yds (cu.yds.)	31,363,469	3,090,628
7. Final volume of backfill (cu.yds.)	538,310,049	12,362,512
8. Clean, recoverable (tons)	24,675,018	4,791,500
a. Number of seams mined	10	10
9. Number of fills	2	0
10. Volume of excess spoil in each fill (cu.yds.)	27,794,097	0
Fill 1	8,392,291	0
Fill 2	19,401,806	0
11. Acreage of footprint of each fill (acres)		
Fill 1	114	0
Fill 2	193	0
12. Contributing drainage each fill (acres)		
Fill 1	809.8	0
Fill 2	1018.7	0
13. Spoil Imbalance (cu.yds.)	3,569,382 excess	Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill 1	Ephemeral point is above the crop of coal. No fill possible.	

MINE: "A"	**Scenario 1**		**Scenario 2**	
Fill 2	Ephemeral point is above the crop of coal. No fill possible.			
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	51.1%	98.9%	0%	0%
Contour (Including multiple cuts, point removal)	43.3%	Incl. In mtn-top	21.6%	29.7%
Highwall miner/auger	5.6%	1.2%	27.5%	20.4%
Underground	0%	0%	50.9%	49.9%

MINE: "F"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden)(OB + IB)	67,159,576	15,933,045
2. Bulking factor (Swell-Shrinkage) (%) BF	30	30
3. Total spoil material TSM (OB+IB) Times (BF)	87,307,449	20,112,960
4. Initial spoil in backfill (BKF) (cu.yds)	49,531,066	12,782,356
5. Initial excess spoil (TSM-BKF) (cu.yds)	37,776,383	7,930,602
6. Final volume of excess spoil yds (cu.yds.)	24,655,893	5,672,938
7. Final volume of backfill (cu.yds.)	62,651,556	15,040,022
8. Clean, recoverable (tons)	7,063,006	1,392,516
a. Number of seams mined	6	5
9. Number of fills	7	2
10. Volume of excess spoil in each fill (cu.yds.)	24,655,893	3,115,073
Fill 1	2,238,028	0
Fill 1A	576,650	0
Fill 2	3,255,838	0
Fill 2A	331,260	0
Fill 3	3,312,378	0
Fill 4	12,844,929	1,018,263
Fill 5	2,096,810	2,096,810
11. Acreage of footprint of each fill (acres)		
Fill 1	23.45	
Fill 1A	7.58	
Fill 2	38.12	
Fill 2A	5.27	
Fill 3	25.73	
Fill 4	80.45	23.40
Fill 5	20.40	20.40
12. Contributing drainage each fill (acres)		
Fill 1	176.59	
Fill 1A	60.83	

MINE: “F”	Scenario 1	Scenario 2
Fill 2	209.73	
Fill 2A	70.90	
Fill 3	121.84	
Fill 4	228.00	76.25
Fill 5	119.10	119.10
13. Spoil Imbalance (cu.yds.)		Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill # 1	Ephemeral stream ends above mine contour cut	
Fill #1A	Ephemeral stream ends 60' below Coalburg outcrop	
Fill #2	Ephemeral stream ends above mine contour cut	
Fill #2A	Ephemeral stream ends near Coalburg outcrop	
Fill #3	Ephemeral stream ends 60' above Coalburg outcrop	

MINE: “F”	Scenario 1		Scenario 2	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	15%	21%	12%	31%
Contour (Including multiple cuts, point removal)	85%	57%	88%	58%
Highwall miner/auger	0	22%	0	11%
Underground	0	0	0	0

MINE: “G”	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	51,600,000	51,600,00
2. Bulking factor (Swell-Shrinkage) (%) BF	25%	25%
3. Total spoil material TSM (OB+IB) Times (BF)	64,400,000	64,400,000
4. Initial spoil in backfill (BKF) (cu.yds)	25,500,000	25,500,00
5. Initial excess spoil (TSM-BKF) (cu.yds)	38,900,000	38,900,000
6. Final volume of excess spoil yds (cu.yds.)	38,900,000	33,700,000
7. Final volume of backfill (cu.yds.)	25,500,000	30,700,000
8. Clean, recoverable (tons)	3,100,000	--
a. Number of seams mined	8	--
9. Number of fills	2	1
10. Volume of excess spoil in each fill (cu.yds.)	39,100,000	15,300,000
Fill 1	4,500,000	–
Fill 2	34,600,000	15,300,000
11. Acreage of footprint of each fill (acres)		
Fill 1	32	--
Fill 2	125	53
12. Contributing drainage each fill (acres)		
Fill 1	86	---
Fill 2	285	
13. Spoil Imbalance (cu.yds.)	200,000 excess storage	18,400,000 deficit storage
14. Fills not feasible (List as applicable)	REASON	
Fill 1 & 2	No access to toe area due to WV turnpike Small fill volume (0.9mm) to face area and # of benches (10) Stability borderline at toe with +/- 20% slopes	

MINE: "G"	**Scenario 1**		**Scenario 2**	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	100%	100%	0	0
Contour (Including multiple cuts, point removal)				
Highwall miner/auger				
Underground				

MINE: "L"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	6,374,857	N/A
2. Bulking factor (Swell-Shrinkage) (%) BF	120%	N/A
3. Total spoil material TSM (OB+IB) Times (BF)	7,649,828	N/A
4. Initial spoil in backfill (BKF) (cu.yds)	5,841,840	N/A
5. Initial excess spoil (TSM-BKF) (cu.yds)	1,807,988	N/A
6. Final volume of excess spoil yds (cu.yds.)	576,098	N/A
7. Final volume of backfill(cu.yds.)	7,073,730	N/A
8. Clean, recoverable (tons)	978,000	N/A
a. Number of seams mined		
9. Number of fills	5	N/A
10. Volume of excess spoil in each fill(cu.yds.)	2,366,501	0
Fill 1	171,407	N/A
Fill 2	551,848	N/A
Fill 3	757,700	N/A
Fill 4	757,700	N/A
Fill 5	127,846	N/A
11. Acreage of footprint of each fill (acres)		
Fill 1	2.55	N/A
Fill 2	6.89	N/A
Fill 3	9.38	N/A
Fill 4	4.01	N/A
Fill 5	2.55	N/A
12. Contributing drainage each fill (acres)		
Fill 1	32.07	
Fill 2	39.01	
Fill 3	55.87	
Fill 4	15.65	
Fill 5	32.07	
13. Spoil Imbalance (cu.yds.)		Not Applicable

MINE: “L”	**Scenario 1**	**Scenario 2**
14. Fills not feasible (List as applicable)	REASON	
Fill # 1	Ephemeral zone located at or above seam proposed to be mined	
Fill # 2	Ephemeral zone located at or above seam proposed to be mined	
Fill # 3	Ephemeral zone located at or above seam proposed to be mined	
Fill # 4	Ephemeral zone located at or above seam proposed to be mined	
Fill # 5	Ephemeral zone located at or above seam proposed to be mined	

MINE: “L”	**Scenario 1**		**Scenario 2**	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop				
Contour (Including multiple cuts, point removal)	100%	100%	0	0
Highwall miner/auger				
Underground				

MINE: "P"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	23,971,230	N/A
2. Bulking factor (Swell-Shrinkage) (%) BF	125%	N/A
3. Total spoil material TSM (OB+IB) Times (BF)	29,964,038	N/A
4. Initial spoil in backfill (BKF) (cu.yds)	18,020,749	N/A
5. Initial excess spoil (TSM-BKF) (cu.yds)	11,943,289	N/A
6. Final volume of excess spoil yds (cu.yds)	10,606,601	N/A
7. Final volume of backfill (cu.yds)	19,357,437	N/A
8. Clean, recoverable (tons)	2,628,672	N/A
a. Number of seams mined	1	1
9. Number of fills	3	N/A
10. Volume of excess spoil in each fill (cu.yds.)	11,012,792	82,589
Fill 1	6,480,931	N/A
Fill 2	1,864,143	82,589
Fill 3	2,667,718	N/A
*Fill 4	0	0
11. Acreage of footprint of each fill (acres)		
Fill 1	40.92	
Fill 2	16.61	1.46 & 1.24
Fill 3	21.39	
12. Contributing drainage each fill (acres)		
Fill 1	46.32	
Fill 2	31.25	20.51 & 9.11
Fill 3	37.98	
Fill 4	0	0
13. Spoil Imbalance (cu.yds.)		Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill 1	Ephemeral zone located at or above seam proposed to be mined	
Fill 2	Fill volumes to small to support any surface mining activities worthy of any financial investment	
Fill 3	Ephemeral zone located at or above seam proposed to be mined	

MINE: "P"	Scenario 1	Scenario 2
Fill 4	2 Gas wells + "E" Point C coal burns	
15. Tonnage w/ losses	2,629,000	31,500*

MINE: "P"	Scenario 1		Scenario 2	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop				
Contour (Including multiple cuts, point removal)	100%	100%	0%	
Highwall miner/auger				
Underground				

* Scenario 2 reserves should be considered "zero" as it is economically infeasible to construct the small valley fills for such small tonnage.

MINE: "Q"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	133,694,419	112,282,436
2. Bulking factor (Swell-Shrinkage) (%) BF	25%	25%
3. Total spoil material TSM (OB+IB) Times (BF)	167,118,024	140,353,045
4. Initial spoil in backfill (BKF) (cu.yds)	71,768,341	64,698,907
5. Initial excess spoil (TSM-BKF) (cu.yds)	95,349,683	75,654,138
6. Final volume of excess spoil yds (cu.yds)	95,448,606	51,358,847
7. Final volume of backfill (cu.yds)	71,768,341	88,994,198
8. Clean, recoverable (tons)	9,269,323	8,380,016
a. Number of seams mined		
9. Number of fills	11	17
10. Volume of excess spoil in each fill (cu.yds)	72,235,241	56,503,152
Fill 1	360,840	363,840
Fill 1A	0	6,920,711
Fill 2	2,503,164	3,145,338
Fill 3	3,202,391	3,767,438
Fill 4	1,611,428	1,810,210
Fill 5	2,664,755	2,167,610
Fill 6	12,308,235	0
Fill 7	33,461,735	0
Fill 7A	0	9,245,603
Fill 7C	0	312,268
Fill 7D	0	1,789,743
Fill 7E	0	1,099,779
Fill 7F	0	870,468
Fill 7G	0	902,612
Fill 7H	0	2,767,839
Fill 8	4,119,157	4,542,669
Fill 9	2,415,196	3,879,469
Fill 10	6,140,609	9,472,824

MINE: "Q"	Scenario 1	Scenario 2
Fill 11	3,344,731	3,444,731
11. Acreage of footprint of each fill (acres)	245	239
Fill 1	6	6
Fill 1A	0	25
Fill 2	14	14
Fill 3	16	16
Fill 4	10	10
Fill 5	7	7
Fill 6	43	0
Fill 7	76	0
Fill 7A	0	34
Fill 7C	0	3
Fill 7D	0	12
Fill 7E	0	10
Fill 7F	0	9
Fill 7G	0	7
Fill 7H	0	14
Fill 8	18	18
Fill 9	15	15
Fill 10	24	23
Fill 11	16	16
12. Contributing drainage each fill (acres)	939	916
Fill 1	34	34
Fill1A	0	45
Fill 2	41	41
Fill 3	52	52
Fill 4	67	67
Fill 5	141	141
Fill 6	169	0
Fill 7	240	0

MINE: "Q"	**Scenario 1**	**Scenario 2**
Fill 7A	0	80
Fill 7C	0	17
Fill 7D	0	71
Fill 7E	0	56
Fill 7F	0	45
Fill 7G	0	32
Fill 7H	0	41
Fill 8	50	50
Fill 9	45	45
Fill 10	47	46
Fill 11	53	53
13. Spoil Imbalance (cu.yds)	0	Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill 1		
Fill 2		
Fill 3		
Fill 4		

MINE: "Q"	**Scenario 1**		**Scenario 2**	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	yes	*	*	*
Contour (Including multiple cuts, point removal)	yes	*	*	*
Highwall miner/auger	yes	*	*	*
Underground	no	*	no	*

* Not reported

MINE: "R"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	75,050,426	75,050,426
2. Bulking factor (Swell-Shrinkage) (%) BF	138%	138%
3. Total spoil material TSM (OB+IB) Times (BF)	103,569,588	103,569,588
4. Initial spoil in backfill (BKF) (cu.yds)	68,741,822	67,333,957
5. Initial excess spoil (TSM-BKF) (cu.yds)	34,827,766	36,235,631
6. Final volume of excess spoil yds (cu.yds)	---	5,576,589
7. Final volume of backfill (cu.yds)	---	68,313,689
8. Clean, recoverable (tons)	4,186,044	0
a. Number of seams mined	3	
9. Number of fills	5	7
10. Volume of excess spoil in each fill (cu.yds.)	35,115,484	6,363,702
Fill 1	3,164,172	1,651,046
Fill 2	20,210,841	A. 439,148 B. 2,171,732
Fill 3	2,930,953	1,303,475
Fill 4	6,484,611	11,188
Fill 5	2,324,907	782,887
Fill 6		3,226
11. Acreage of footprint of each fill (acres)		
Fill 1	24.19	7.52
Fill 2	86.26	A. 3.58 B. 20.16
Fill 3	24.57	3.94
Fill 4	36.74	0.80
Fill 5	17.06	4.23
Fill 6		0.47
12. Contributing drainage each fill (acres)		
Fill 1	189.48	101.15
Fill 2	176.68	A. 26.75
Fill 3	97.19	B. 33.77

MINE: "R"	Scenario 1	Scenario 2
Fill 4	78.18	56.17
Fill 5	89.08	11.98
Fill 6		49.88
Fill 7		14.85
13. Spoil Imbalance (cu.yds.)	N/A	29,538,895
14. Fills not feasible (List as applicable)	REASON	
Fill 4	Not economical to construct	
Fill 5	Not economical to construct	

MINE: "R"	Scenario 1		Scenario 2	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	97	97	-	-
Contour (Including multiple cuts, point removal)	3	3	-	-
Highwall miner/auger				
Underground				

MINE: "S"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	32,256,300	18,706,800
2. Bulking factor (Swell-Shrinkage) (%) BF	30	30
3. Total spoil material TSM (OB+IB) Times (BF)	9,676,890	5,612,040
4. Initial spoil in backfill (BKF) (cu.yds)	30,513,370	16,578,848
5. Initial excess spoil (TSM-BKF) (cu.yds)	11,963,750	7,738,952
6. Final volume of excess spoil yds (cu.yds)	11,963,750	9,547,799
7. Final volume of backfill(cu.yds)	30,513,370	16,578,848
8. Clean, recoverable (tons)	2,480,560	1,944,000
a. Number of seams mined	4	4
9. Number of fills	10	8
10. Volume of excess spoil in each fill (cu.yds)	11,964,144	9,547,799
Fill 1	2,656,048	0
Fill 2	155,759	155,759
Fill 3	224,321	224,321
Fill 4	927,778	927,778
Fill 5	786,625	786,625
Fill 6	389,978	389,978
Fill 7	1,092,950	1,092,950
Fill 8	1,176,741	2,985,194
Fill 9	2,985,194	2,985,194
Fill 10	1,568,750	0
11. Acreage of footprint of each fill (acres)		
Fill 1	37	0
Fill 2	3.2	3.2
Fill 3	5.25	5.25
Fill 4	14.94	14.94
Fill 5	8.36	8.36
Fill 6	6.94	6.94
Fill 7	11.48	11.48

MINE: "S"	**Scenario 1**	**Scenario 2**
Fill 8	9.96	9.96
Fill 9	21.26	21.26
Fill 10	13.7	0
12. Contributing drainage each fill (acres)		
Fill 1	158.7	0
Fill 2	23.2	23.2
Fill 3	18.86	18.86
Fill 4	42.61	42.61
Fill 5	29.18	29.18
Fill 6	22.8	22.8
Fill 7	28.64	28.64
Fill 8	25	25
Fill 9	68.23	68.23
Fill 10	75.35	0
13. Spoil Imbalance (cu.yds.)	543,930	Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill 1	Located in intermittent stream	
Fill 10	Located in intermittent stream	

MINE: “S”	Scenario 1		Scenario 2	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	80	74	90	84
Contour (Including multiple cuts, point removal)	20	20	10	7
Highwall miner/auger	0	6	0	9
Underground	0	0	0	0

MINE: "U"	Scenario 1	Scenario 2
1. Bank cu. yds. (Overburden plus Interburden) (OB + IB)	215,517,000	0
2. Bulking factor (Swell-Shrinkage) (%) BF	25%	
3. Total spoil material TSM (OB+IB) Times (BF)	287,356,000	
4. Initial spoil in backfill (BKF) (cu.yds)	188,429,000	
5. Initial excess spoil (TSM-BKF) (cu.yds)	98,927,000	
6. Final volume of excess spoil yds (cu.yds)	81,155,824	
7. Final volume of backfill (cu.yds)	206,026,000	
8. Clean, recoverable (tons)	17,629,000	
a. Number of seams mined	5 major horizons	
9. Number of fills	7	
10. Volume of excess spoil in each fill (cu.yds)	95,466,247	3,486,702
Fill 1	7,020,200	197,088
Fill 2	24,737,800	2,273,176
Fill 3	19,272,200	67,636
Fill 4	22,057,549	257,683
Fill 5	2,174,198	---
Fill 6	3,326,600	---
Fill 7	16,877,700	691,119
11. Acreage of footprint of each fill (acres)		
Fill 1	40.36	4.17
Fill 2	98.72	16.72
Fill 3	72.51	3.46
Fill 4	64.95	11.54
Fill 5	22.10	---
Fill 6	30.62	---
Fill 7	93.63	9.75
12. Contributing drainage each fill (acres)		
Fill 1	171.80	85.30
Fill 2	224.70	16.72

MINE: "U"	**Scenario 1**	**Scenario 2**
Fill 3	210.00	43.34
Fill 4	189.90	68.16
Fill 5	83.70	---
Fill 6	74.60	---
Fill 7	191.10	40.99
13. Spoil Imbalance (cu.yds)		Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill 1	Too small	
Fill 2	Too small	
Fill 4	Too small	
Fill 5 & 6	Fill won't fit above intermittent stream	
Fill 7	Too small	

MINE: "U"	**Scenario 1**		**Scenario 2**	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	95%	95%	0	0
Contour (Including multiple cuts, point removal)	5%	3%		
Highwall miner/auger	0	2%		
Underground	0	0		

MINE: "V"	**Scenario 1**	**Scenario 2**
1. Bank cu. yds. (Overburden plus Interburden)(OB + IB)	NA	NA
2. Bulking factor (Swell-Shrinkage) (%) BF	NA	NA
3. Total spoil material TSM (OB+IB) Times (BF)	NA	NA
4. Initial spoil in backfill (BKF) (cu.yds)	NA	NA
5. Initial excess spoil (TSM-BKF) (cu.yds)	NA	NA

MINE: “V”	**Scenario 1**	**Scenario 2**
6. Final volume of excess spoil yds (cu.yds.)	NA	NA
7. Final volume of backfill(cu.yds.)	NA	NA
8. Clean, recoverable (tons)	110,000,000	0
a. Number of seams mined		
9. Number of fills	1	45
10. Volume of excess spoil in each fill(cu.yds.)		
Fill 1	81,480,000	
Fill 1-45		31,850.000
11. Acreage of footprint of each fill (acres)		
Fill 1		
Fill 1-45		
12. Contributing drainage each fill (acres)		
Fill 1		
Fill 1-45		
13. Spoil Imbalance (cu.yds.)		Not Applicable
14. Fills not feasible (List as applicable)	REASON	
Fill #1-45	All smaller fills were unstable (Toes on steep slopes) Cost prohibitive-Requires bridge, 30.2 miles of additional haul roads	

MINE: "V"	Scenario 1		Scenario 2	
Mine Characteristics	% Acre	% Ton	% Acre	% Ton
Mountaintop	NA	NA	NA	NA
Contour (Including multiple cuts, point removal)	NA	NA	NA	NA
Highwall miner/auger	NA	NA	NA	NA
Underground	90	90	0	0
Refuse Disposal	100	100	0	0

Attachment D

US Geological Survey Report

Prepared by:
U.S. Geological Survey *304-347-5* 130x225
11 Dunbar Street Jim Eychaner
Charleston, West Virginia 25301 eychaner~usgs.gov

Introduction: The mountaintop mining engineering team will be receiving and reviewing alternative mine plans for a series of sites, assuming that excess spoil can be placed only in ephemeral stream reaches. The team needs to know the boundary between ephemeral and intermittent flow in each drainage at 3-7 mine sites. The legal definitions of stream categories suggest the boundary is the highest point in a stream channel that contains water on a dry day during the wet season. Anyone who can walk along a stream channel could find the place.

Problem: In humid climates like West Virginia, ephemeral streams, in general, drain the highest and smallest headwater basins, intermittent streams generally drain the slightly larger basins next downstream, and perennial streams drain still larger basins.

Stream categories are defined in the federal SMCRA regulations (30 C.F.R § *701.5):*

Ephemeral stream means a stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table.
Intermittent stream means (a) a stream or reach of a stream that drains a watershed of at least one square mile, or (b) a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and ground water discharge.
Perennial stream means a stream or part of a stream that flows continuously during all of the calendar year as a result of ground-water discharge or surface runoff

These definitions, which draw on many decades of hydrological experience, differ first by describing when flow is present. Field determinations on this basis generally require observations at many sites over an extended time, which would be expensive. The definitions also describe interactions between surface and ground water, which could be more useful for field identification of the point at which an ephemeral stream becomes intermittent or perennial.

An intermittent stream obtains its flow from both surface runoff and ground water discharge, and therefore the channel is below the local water table for at least some part of the year. The channel elevation does not change, of course. This definition recognizes that the local water table rises and falls during the year. When the water table adjacent to the stream is above the stream channel, the intermittent stream will have continuous base flow. In contrast, the channel of an ephemeral stream is above the local water table even during the season when the water table is at maximum elevation; the ephemeral stream does not have any base flow.

The problem of identifying the boundary between ephemeral and intermittent flow thus becomes one of identifying the intersection of the channel bottom with the local water table, when the water table is at its maximum. Similarly, the boundary between intermittent and perennial flow is at the intersection of the channel bottom with the local water table, when the water table is at its minimum.

In southern West Virginia, ground-water recharge rates generally are greatest between December and April, when trees and other vegetation are dormant. Water table elevation is greatest during March and April. Recharge rates decrease and the water table begins to decline when the forest begins to leaf out in late April and May. Water levels in wells in the study area commonly begin to decline in April, but the change is small compared to May and June. Minimum water levels in wells occur between June and November, but temporary increases can occur any time during that period.

Approach to be Followed by the Ephemeral Field Team

An ephemeral stream goes dry when there has been no recent rain or snow melt, even during the wettest time of the year. An intermittent or perennial stream continues flowing on dry days because ground water sustains it. The boundary between ephemeral and intermittent flow is the place where the ground water table meets the bed of the stream. The ephemeral part of the stream is uphill from this boundary, and the intermittent part is downhill. We are interested only in streams that have not been changed by mining uphill from the boundary.

To find the boundary, choose a dry day in February, March, or April when the ground is not frozen. Searching downhill along a stream channel is best. Look for the highest point where water is pooled or ground water is entering the stream channel. Expect the ground to be moist, soft, or muddy near the boundary. If water is standing or flowing on the land surface, even over bare rock, you are downhill from the ephemeral part. You may find part of the stream with no visible flow at the surface, even though both higher and lower parts of the stream are flowing. The ephemeral part is above the highest part that is flowing.

Choose the lowest point that is clearly dry along the channel. Dig a hole in the streambed, about a foot deep. If water stands in the hole within a few minutes, you are at the boundary. If the hole remains dry, move downhill and try again, but stay above any standing or flowing water.

The most important observation is that water is flowing in a channel on the land surface. Any observation of shallow ground water in a nearby hole supports th surface observation , but is of secondary importance.

This process will be repeated in each valley within the permit area on the five selected sites. The ephemeral stream limit will be located using GPS units and the location transferred to maps developed for each site. In addition, the team will locate the point in each valley at which the stream slope becomes 10 % or less. (The Norris Method). This point will also be transferred to the map for the site.

Office of Mining and Reclamation
#10 McJunkin Road
Nitro, West Virginia 25143-2506
Phone: 304-759-0510
Fax: 304-759-0528

West Virginia Division of Environmental Protection

Cecil H. Underwood
Governor

Michael C. Castle
Director

MEMORANDUM

TO: Rocky Parsons
Joe Parker
Permit Supervisors
Permit Review Team
Inspection and Enforcement Supervisors
Inspectors

FROM: John C. Ailes

DATE: October 26, 1999

RE: Guidance for Delineation of Ephemeral/Intermittent Streams

A Guidance document for the delineation of Ephemeral/Intermittent Streams has been developed to conform with the Memorandum of Opinion and Order dated October 20, 1999 pertaining to buffer zones and water quality standards for intermittent streams and is effective immediately.

As stated in the procedure, it applies to structures for both pending applications and issued permits in order to delineate ephemeral/intermittent streams. Please ensure that all applicants and permittees receive a copy of this guidance document.

Please note that the field evaluation is conducted jointly by applicant and agency. If you have any questions pertaining to the guidance document, contact Lewis Halstead, Charlie Sturey or Ken Politan.

JCA:sl

Division of Environmental Protection
OFFICE OF MINING AND RECLAMATION

SERIES:	PERMIT APPLICATION PROCEDURE
SUBJECT:	**Guidance for Delineation of Ephemeral/Intermittent Streams For Purposes of the Memorandum Opinion and Order of October 20, 1999**
DATE:	**October 26, 1999**

Introduction

This guidance is being developed to conform with the Memorandum Opinion and Order of October 20, 1999 pertaining to buffer zones and water quality standards for intermittent/perennial streams.

Definitions

The Federal SMCRA definition of **ephemeral stream** which means "a stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table" and **wet weather streams** defined in 46CSR1-2.22 "as streams that flow only in direct response to precipitation or whose channels are at all times above the water table" are synonymous.

Intermittent streams are defined in part, in 38CSR2-2.69, as "a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and groundwater discharge".

Intermittent streams are defined in 46CSR1-2.9 as those streams which have no flow during sustained periods of no precipitation and which do not support life whose life history requires residence in flowing waters for a continuous period of at least six (6) months.

Ordinary high water mark as defined in 33 CFR 329.11 is the line on the stream bank established by the fluctuation of water levels and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in soil characteristics, destruction or limits of terrestrial vegetation, and the presence of litter and debris.

Rationale

If a buffer zone waiver was requested in the application, the presumption is that the proposed fills, refuse facilities, sediment control facilities and ponds ("structures") are in intermittent or perennial streams, unless clearly documented in the application.

The procedure below applies to structures for both pending applications and issued permits. It will be utilized to determine the local water table in order to delineate the point between of the Director, that each structure is not located in an intermittent / perennial streams.

Procedure

Step 1. The applicant may utilize information contained in the application to demonstrate that the structure is not in the intermittent stream. If the data in the application shows stream flow (**not direct response to precipitation)** within the footprint of the structure, then it is in intermittent reaches of the stream. However, if the data in the application contains no documentation that the stream channel within the footprint of the structure is ephemeral, the applicant must proceed to Step 2.

Step 2. Field Evaluation (conducted jointly by applicant and agency).

Delineate the upper most extent of the ordinary high water for each stream channel within the footprint. Locate this point on a map and provide sufficient supporting documentation.

Begin walking downstream, until pooled or flowing water is observed in channel within the footprint. Locate this point on a map and provide sufficient supporting documentation.

Dig a hole, preferably 12 inches or deeper, in the streambed outside the area of the pool to see if water is entering the hole, this should be apparent within a few minutes. If not, repeat process down stream until local water table is established or outside the buffer zone area. If no consensus can be reached between applicant and agency proceed to Step 3.

Step 3. A biological survey using the "single habitat EPA Rapid Bioassessment Protocol " must be conducted for the footprint of the structure. If the footprint of the structure is void of indications of aquatic life then the area is deemed to be an ephemeral reach of the stream. However, if there is evidence of aquatic life present in the stream that requires less than six months of water flow to complete its life cycle, then the section of stream is deemed to be intermittent.

MOUNTAINTOP MINING/VALLEY FILL TECHNICAL STUDIES

STUDY OF FUGITIVE DUST AND FUMES

by

Lloyd M. English

and

Yi Luo

Department of Mining Engineering
College of Engineering and Mineral Resources
West Virginia University

ABSTRACT

We find no indication that there are any significant health risks due to exposure when no personnel are in close proximity to the blast zone. This is the standard procedure for safety purposes anyway. A common safety zone for large blasts from which all personnel are excluded is a 2,000-ft radius. As blasts grow smaller, the required safety zone also shrinks. But even within 1,000 feet, measurements of adverse levels are infrequent and of short duration.

This investigation is concerned with fugitive dust and fumes, meaning that which escapes the confines of the mining property. This investigation indicates that these emissions present no potential health problem for the following reasons.

- No event produced any harmful levels of any duration at distances exceeding 1,000 feet, except one measurement of 3.6 ppm NO_2 at 1251 feet.
- This measurement, and all others were of very short duration.
- Fugitive emissions are those that leave the property; if the property boundary is closer than 2,000 feet, persons within this area are evacuated.

Quality of life issues other than health, that is the enjoyment of life and the potential of reducing that enjoyment, is harder to define because of its very subjective nature. Photographs of dust settling out of blasting clouds do not show significant deposition beyond 1000 feet. When viewed alongside the fact that four-wheel drive vehicles can produce 75 pounds of fugitive dust per mile traveled on a dirt road (Hesketh, 1983), and that many county roads in the vicinity of a surface mine are unpaved, blasting would appear to be an unlikely source of significant dust at off-site locations.

Dust and fume emissions from 11 blasting events at three mines were measured, 10 of which were useable. Both respirable and non-respirable dust was measured, as well as nitrogen dioxide (NO_2), nitric oxide (NO), carbon monoxide (CO), and ammonia (NH_3). Nitrogen dioxide, total dust, and respirable dust were measured at 10 points for each event; the remaining fumes were measured at only one. At four events, settled dust at the monitoring stations was caught on filter paper and photographed.

Results are consistent, but the statistical correlations are not all good. The suspected primary reason for poor correlations is the inability to account for wind velocity and direction across the measurement sites close to ground level. Surprisingly, the best average correlation ($r = 0.86$) was an inverse relationship between NO_2 and humidity. The CO and NH_3 highs were also a surprise. Topographical constraints, although expected, were worse than expected. Topographical constraints were such that all sites were within 1900 feet, with an average distance of 943 feet. This was actually a fortuitous turn of events because of the very low levels of anything that were detectable as the stations approached 2000 feet.

ACKNOWLEDGMENTS

The investigators received a substantial amount of help from a number of organizations and individuals that enabled us top accomplish far more than originally planned. It also enabled us to stretch our budget dollars substantially.

The Office of Surface Mining supported a trip for the primary investigator to Gillette, Wyoming, where a conference was held on blasting fumes. This trip provided a substantial insight on explosive fumes that would have been available in no other way. One of the cooperating companies also underwrote a trip to talk to a number of experts investigating explosive fume emissions, and this also was a great aid in performing this work.

Rich Mainaro, James Roland, Steve Page, and John Organiscak of the NIOSH research facility in Bruceton, Pennsylvania, provided us with substantial background information on the measurement of fumes and dusts. This information enabled us to avoid a number of instrumentation mistakes we might have otherwise made, and pointed the most reasonable directions for us to proceed, given budget and time constraints.

In particular, the authors would like to express thanks to Ken Eltschlager who made his substantial expertise and experience available to us at all times, and also reviewed the rough draft of this manuscript, capturing a number of typographical and referential errors for us in the process.

Above all, credit must be given to the cooperating mining companies who granted us free access to their facilities and operations and provided us with information. They did so in a spirit of cooperation and in agreement that this information was worth pursuing and potentially useful, regardless of the outcomes. Cooperation such as this is what enables us to reach beyond theory and into practicality, which does not always agree with the theoretical. Our special thanks goes to these companies who were willing to take risks to advance the state of knowledge about mining and blasting.

TABLE OF CONTENTS

LIST OF FIGURES AND ILLUSTRATIONS

[1]*Note: Because it is desirable to keep the photographs of blasting events together in sequence to aid sequential viewing, the standard practice of placing figures after the first page that cites them was not followed.*

LIST OF TABLES

1.0 INTRODUCTION AND BACKGROUND

1.1 Problem Statement

A question has been raised about the impact of fugitive fumes and dust generated by blasting at Mountain-Top Removal (MTR) sites upon the quality of life in the surrounding area. Is it substantial (i.e., is there a health impact), and/or is it a significant nuisance affecting enjoyment of daily living? A lot of emotion has surrounded this issue, and yet surprisingly little data exists that addresses either topic; one could almost say no data. Complaints exist, but there is no real way do correlate these complaints to any specific levels of dust, of fumes, of the size of the explosive shot, nor anything else. There is no current way to determine which complaints are supportable and which are not. If the history of blast vibration complaints made versus those substantiated by vibration monitoring is any indication, the proportion of legitimate complaint is probably very low. But — how far can fugitive emissions be expected to travel and at what concentrations, anyway?

1.2 Literature Search

The literature search was disappointing, to say the least. In fact, the PI considered redoing the entire literature search from scratch until attending the Gillette, Wyoming, seminar on blasting fumes (see section 1.3). There is no available literature on the fume and dust content of moving clouds generated by surface blasting. There is some on the total content of fumes generated by blasting, but none on the content of visible clouds, and none on the dust content of the same clouds. The literature encountered was primarily aimed at identifying noxious airborne elements, on preventing such airborne contamination, and making measurements of them. Even the measurement information was of little use. It was primarily directed at making long-duration exposure measurements in a workplace, not the assessment of emissions from a single event .

Even so, some information is useful as background and for comparative purposes. Figure 1.1 shows the relative size of dust particles carried suspended in air vs. wind velocity and particle density. At lower velocities, particles would drop out of the airstream at calculable settling velocities. (To be strictly correct, the word "velocity" should really be "speed.") The graph readily shows that very small particles do not require much air speed to remain in suspension (1.00 ft/sec equals 0.682 miles/hour). However, there is no real way to use this information in a blasting event. Dust particles are imparted an undefined quantity of momentum by the blast, and initially the air and gases containing the dust is very turbulent. Also, if the dust cloud is heavy enough it will show some gas-like properties. In still air, the particles will diffuse rather than drop straight down, as this graph would imply. This phenomenon may be seen in the cast blast photographs in section 1.3 where in the later pictures when turbulence is no longer noticeable the cloud continues to expand as well as become thinner. The thinning could be a result of both phenomena, diffusion and settling. Some experts attribute some initial dispersion to the temperature difference between the emitted gases and ambient air. Not knowing the ration of emitted gas volume to air volume, this difference is impossible to calculate with any precision, and photographs do not indicate any continued rapid cloud rise as would be expected from a temperature difference after the initial force of the explosion has been expended. Continued rise is a slow-to-moderate rate as might be expected from diffusion, settling, and wind dispersion. Until actual cloud temperature measurements are made, this conjecture remains unproven.

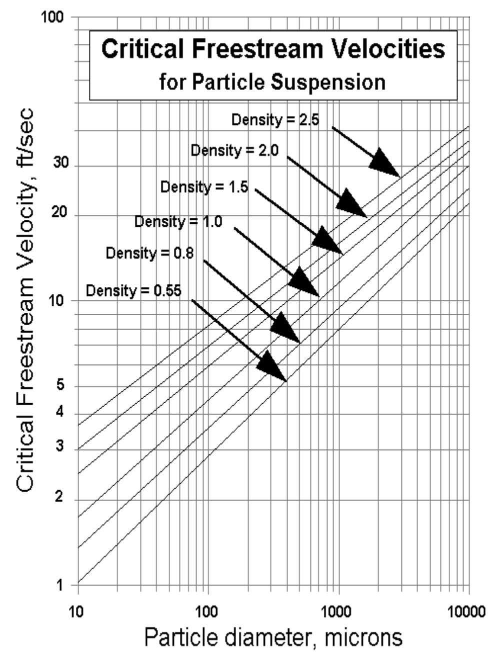


Figure 1.1. Particle suspension velocities (Adapted from Hesketh and Cross, 1983)

The single most useful reference on fugitive emissions was "Fugitive Emissions and Controls, by Hesketh and Cross, 1983, and this work focused on dust, only mentioning fumes. They did mention primary fugitive dust sources as being unpaved roads; mining, excavating, and crushing operations; and heavy construction operations as the first, fourth, and sixth primary sources. Of particular interest is their citing EPA's emissions study showing that automobiles unpaved roads may produce up to 75 pounds of fugitive dust per vehicle mile traveled (VMT).[1] The EPA developed an emission factor for vehicles on unpaved roads:

$$E = (0.81)\,(s)\left(\frac{S}{30}\right)\left(\frac{365 - w}{365}\right)$$

Where E = lb of fugitive emissions / VMT
s = silt content of road surface material, %
S = average vehicle speed, mph
w = mean annual number of days with 0.01 in. or more of rainfall

Hesketh and Cross also cite an expert as stating that this equation might be modifiable for trucks on haul roads by pro-rating for truck tire surface. They cited no numbers for blasting.

1.3 Fume and Dust Standards

Numerous standards exist for fumes and dusts according to the environment, the work being performed, the governing agency, and more. These standards frequently vary. In fact, while the current American Conference of Governmental Industrial Hygienists (ACGIH) sets the TLV for carbon monoxide at 25 ppm, 30 CFR 75.322 sets it at 50 ppm for underground coal mines. Since the ACGIH is the most frequently cited and used set of standards in the United States, those standards are used as a basis for comparison in this study.[2] For this study, the substances of interest include nitrous oxide (NO), nitrogen dioxide (NO_2), carbon monoxide (CO), ammonia (NH_3), and dust. Table 1.1 lists the current (year 2000) exposure limits foer these substances as set by the ACGIH.

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[1]"Compilation of Air Pollutant Emission Factors," U.S. EPA #AP - 42 with supplements, February 1976.

[2]In fact, the carbon monoxide discrepancy used for this illustration results from an unfortunate line in 30 CFR that refers directly to the 1972 version of the ACGIH standards; thus those levels have become fixed in law and 29 years of increased understanding of chemical substances has gone unrecognized by federal law in this particular application.

Substance	TWA[a] (ppm or mg/m^3)	STEL[b] / C[c]	TLV Basis
Nitrous Oxide	50 ppm	—	Reproductive; blood; neuropathy; asphyxiation
Nitrogen Dioxide	3 ppm	5ppm	Irritation; pulmonary edema
Carbon Monoxide	25 ppm	—	Anoxia; CVS[d]; CNS[e]; reproductive
Ammonia	25 ppm	35 ppm	Irritation
Dust (PNOC)[f]	10 mg/m^3 (E[g],I[h]) 3 mg/m^3 (E,R[i])	— —	Lung Lung
Quartz	0.05 mg/m^3	—	Silicosis; pulmonary function; pulmonary fibrosis; cancer

Table 1.1 Threshold Limit Values (TLV's) as set by the American Council of Governmental Industrial Hygienists, 2000

a: TWA – Time Weighted Average
b: STEL – Short Term Exposure Limit
c: C – Ceiling Limit
d: CVS – Cardiovascular System
e: CNS – Central Nervous System
f: PNOC - Particulates Not Otherwise Classified (insoluble)
g: E – particulate matter containing no asbestos and <1% crystalline silica
h: I – inhalable fraction
i: R – respirable fraction

1.4 Familiarization Trip

The investigators made a trip in December of 1999 to observe a blast and obtain a feel for the distances and terrains involved. The following pages of photographs document that visit. Several major insights were gained on this visit.

There are three blasts in the following photographs. The first eight pages (pictures labeled DecBCast_xx) are of a major cast blast taken fro a distance of approximately 2,000 feet. The wind was very slight and to the left of the pictures at the blast initiation, and to the right for the last several pictures. The wind was primarily still for the majority of the pictures, which also meant for the majority of the cloud life. The pit is toward the right of the pictures. This shot produced a very visible fume cloud. Items to notice in the pictures include:

- The dust cloud issued primarily from the cast material, which was cast substantially to the right.
- The fume cloud issued primarily from the shot location and did not move with the dust cloud.
- The wind died and the cloud did not move. (Contrast this to the shovel shot pictures following.)
- The cloud thinned out and became very diffuse, with the fumes intermingling, and when it did move, it moved toward the pit.
- If this had been an instrumented shot, it is unlikely that we would have obtained any measurements. The cloud did not travel to any spot where our devices might have been set.

This visit underscored the difficulties we had already anticipated regarding the forecast of wind velocity and locating adequate sites for instrumentation.

The photographs labeled DecBCush_xx are of a trim shot on a contour bench in excess of 2500 feet from our location (the same spot we photographed the cast shot from, but 90° to the right). Although we had light-to-no wind, the cloud travel from this shot indicates substantial air movement just ½ mile away at the same approximate elevation. There are no apparent fumes in this cloud.

Finally, the photographs labeled DecBShov_xx are of a shovel production shot a bit further to the right on the same bench as the trim shot. Both dust and fumes are apparent. From the pictures, it appears that the fumes traveled further and faster than the dust. This was not the case with the cast blast.

The immediate impact of this familiarization trip was to impress us with the variations inherent in surface blasting. At the same mining site where we could expect similar conditions, at spots withing 2500 feet of each other where weather variations would not be expected, we saw three very different clouds, one of which probably would not have reached our instrumentation.

Cast Shot

Cast Shot - 1

Cast Shot - 2

Cast Shot - 3

Cast Shot (Cont'd)

Cast Shot - 4

Cast Shot - 5

Cast Shot - 6

Cast Shot (Cont'd)

Cast Shot - 7

Cast Shot - 8

Cast Shot - 9

Cast Shot (Cont'd)

Cast Shot - 10

Cast Shot - 11

Cast Shot - 12

Cast Shot (Cont'd)

Cast Shot - 13

Cast Shot - 14

Cast Shot - 15

Cast Shot (Cont'd)

Cast Shot - 16

Cast Shot - 17

Cast Shot - 18

Cast Shot (Cont'd)

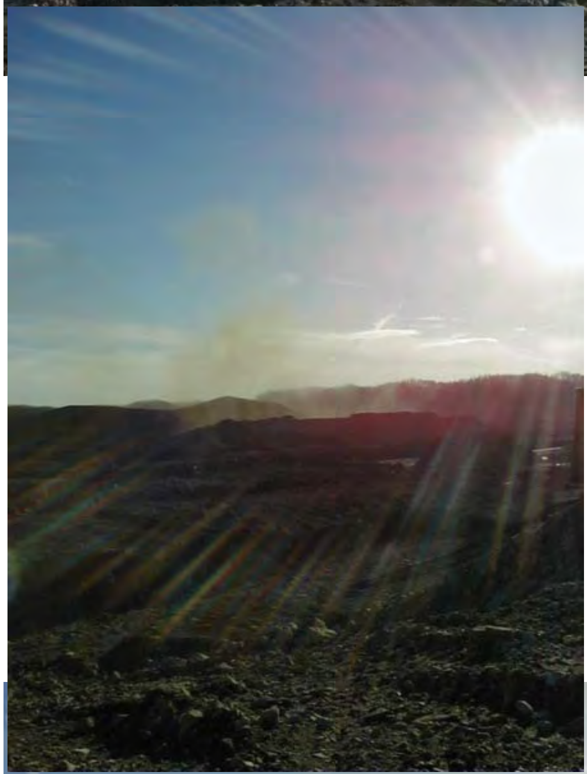
Cast Shot - 19

Cast Shot - 20

Cast Shot - 21

Cast Shot (Cont'd)

Cast Shot - 22



Cast Shot - 23

Cast Shot - 24

Cushion Shot

Cushion Shot - 1

Cushion Shot - 2

Cushion Shot - 3

Shovel Shot

Shovel Shot - 1

Shovel Shot - 2

Shovel Shot - 3

Shovel Shot (cont'd)

Shovel Shot - 4

Shovel Shot - 5

Shovel Shot - 6

Shovel Shot (cont'd)

Shovel Shot - 7

Shovel Shot - 8

Shovel Shot - 9

1.5. Wyoming Seminar

The PI attended a blasting seminar in Gillette, Wyoming, January 12-13, 2000. In conjunction with this seminar, on the 11th and again on the 13th of January, 2000, the PI was given a tour of the area around the Eagle Butte Mine, where much of the current controversy about NOx and post-blast emissions has centered in Wyoming. The Eagle Butte Mine in Wyoming is directly beside the major highway into Gillette and very close to a housing subdivision. This subdivision frequently finds itself in the path of the fume clouds from the adjacent mine. If the wind is in the right (or, more to the point, wrong) direction, the lay of the land is such that the clouds are funneled directly toward this subdivision. Most of the subdivision has been bought by the mining company, but there are still a few residents there fighting the mining company over this issue. This has been the focal point for much of the current western controversy.

The blasting seminar on January 12th and 13th in Gillette, Wyoming, focused on the NOx generation from blasting. This seminar seemed likely to provide information that would be useful in our investigation of fugitive fumes and dust from mountain-top removal blasting, and the principal investigator's (PI) visit was sponsored by the office of surface mining. The trip was substantially informative, especially from the perspective of determining what is not known. This seminar was established specifically to address this problem; there were no technical papers nor research papers presented. Rather it was a collection of experts from the mining industry, the explosive providers, government agencies, consultants, and the public who were brought together to address this specific issue. Presentations were intended to establish the state-of-the-art in the understanding and mitigation of fume clouds, and included a fair amount of anecdotal information as well. A number of issues and perspectives were immediately noticeable.

The seminar in Wyoming was an opportunity to determine exactly what the state of the art is insofar as fugitive fume analysis, monitoring, and control is. Although the technical blasting techniques are the same in the east and the west, there are a number of substantial differences in MTR blasting from that done in Wyoming, as highlighted during the conference:

- Wyoming charges are larger than for MTR (Up to 8,000,000 lbs vs. 500,000 to 1,000,000 lbs. with the average MTR round being smaller).

, In the west, there is a direct correlation to cloud size versus charge size, other factors remaining equal.

, Wyoming terrain is relatively flat, whereas MTR occurs in rugged terrain; also the west is primarily open plain whereas the east is totally forested. Lrge differences in air turbulence and directional changes may be expected.

, On average, territory around the Wyoming sites are sparsely populated (with exceptions), while there are more residents around MTR sites.

, There is currently a high level of interest and emotion surrounding the issue in Wyoming, whereas the issues around MTR revolve more about damage to the environment and ecosystems and until recently has not received much public attention.

These differences need to be considered when applying the Wyoming experience to our evaluation of MTR fugitive fume issues. Keeping these differences in mind, and others, is essential to determining which western experiences are applicable in the east.

The problem is undefined.

It was quite surprising to find out that no experts in attendance had any concrete evidence concerning the actual noxious gas levels in the visible clouds. Their relative concentrations remain unidentified. The associated impacts of various NOx levels as presented by the EPA at the seminar include:

ppm	Exposure time	Impact
0.1 - 0.8	Not given	Increased permeability (in vitro)
0.4	Not given	Asthmatic reaction
1.0	2 hours	Increased airway resistance
		Decreased T lymphocytes, NK cells
1.5	3 - 15 minutes	Bronchospasm
		Increased airway resistance
2.0	10 minutes	Decreased ciliary beat frequency
		Increased airway resistance
5.0	10 - 15 minutes	Impaired gas transport
		Decreased lung compliance [compressibility]
		Increased airway resistance
25.0	Not given	Immediate pulmonary edema
200	1 minute	Death

As can be seen from the above listing, exposure may lead to significant consequences, including death. However, there is no current knowledge of the concentrations of NO_2 to be found within a visible cloud. Although these clouds may be quite compelling in appearance, large and a very deep rusty-brown fading to red and then yellow, no-one has any correlation as to appearance versus concentration. Intuitively on would think that a cloud that visible would contain more than 200 ppm (0.02%), but there is no evidence of death or serious health impairment. Several industry personnel present stated (to me, in response to questioning) that they have driven through, walked through, and even worked in such clouds without any impact to health.[3] This anecdotal evidence would indicate concentrations substantially less than 200 ppm if the above table is accurate.

Nor is there other field evidence. The region around the mines contains substantial wildlife. On this visit I observed a small herd of mule deer feeding on mining property between two surface operations, and I am told other wildlife is abundant. While mule deer may be large enough (and perceptive enough) to observe an approaching cloud and avoid it, the same is not true of smaller wildlife — rabbits, ground squirrels, birds, etc. There are no reports of dead wildlife being found in the wake of any of these clouds (nor has anyone admitted overtly searching for any). Given the level of emotional involvement of some of the attending groups, one would have to assume that any such discovery would have been given considerable attention.

In essence then, this is an undefined problem. There are no known concentration data, no real evidence of health damage, death, or even temporary impairment, only anecdotal incidents that cannot be weighed without some sort of official and scientific assessment. The current status is that strong debate and substantial activity is revolving around an issue that has not been truly defined.

No previous real attempt to define the issue has been made. One monitoring study was done, but not in such a manner as to define cloud concentrations. Six recording monitors were established at points of potential public access and run 24 hours per day for 30 days. The intent was to use blasting, weather, and wind records to determine sources when the monitors noted any concentrations of NOx. After 30 days, 5 monitors showed nothing, one monitor showed a brief exposure to 1 ppm. A professor from the University of Wyoming (Merl F. Raisbeck, DVM, PhD) stated that he tried to make such measurements about 15 years ago, but was able to

[3]This is not to say *no* impact; several did describe watering eyes, some burning, and some labored breathing; they also said such effects disappeared immediately when no longer exposed to the cloud.

find nothing.

No recommendations for measurements were made, and no effort is ongoing. NIOSH in Pittsburgh, through the work of Richard Mainero and James Rowland, is pursuing work on blasting fumes, but on a laboratory basis. This would provide information on total NOx's produced by an explosion under predetermined conditions of confinement, but would provide no dispersion or diffusion information. They have no, and at this time were preparing for no, field work. Most of the approaches discussed at this seminar were aimed at determining the total quantity of NOx generated by blasts; even the proposed monitoring attempts as described had this end as a goal. No discussion was made of assessing dispersion or diffusion, except for the guest speaker who discussed computer modeling.

Since actual levels of NOx are not known, discussions revolved around reducing or eliminating them. NOx's occur when blasting is inefficient, and most of the meeting was spent discussing causes of inefficiency and efficiency improvement.[4] There was limited discussion about reducing fumes by introducing another chemical into the ANFO or emulsion to act as an excess oxygen scavenger, which would reduce the produced NOx's. (There was no discussion of the fact that this approach could well elevate levels of ammonia.)

There was a limited discussion of things that might be done to treat the cloud itself. There was discussion of treating the surface of the site to be blasted. For example, what about a substance spread on the blast site prior to blasting that would react with NO_2? One person did mention the possibility of wetting the location down. (This may not be possible since this could damage the blasting circuit, electrical or nonel.) An aerosol might be developed that could be sprayed or released in a fume cloud. There might be artificial means of increasing dispersion rates. The meeting disbanded with no concrete suggestions or direction established.

Meeting Notes

What follows are summaries of some of the PI's notes taken during the meeting. Certain items were repeated numerous times, such as the assumed causes of inefficient blasts and red

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[4]Efficient blasting may reduce the problem, but the view as expressed tended to overlook the fact that blast efficiency is the goal of every explosives engineer, fume issues aside. Efficiency is an economic issue.

smoke, so the original notes are very repetitive.

James Roland III — NIOSH — A paper in the handout, but no handout of the talk.

- As fuel oil goes up, CO goes up
- As fuel oil goes down, NOx goes up.
- As water content increases, so does NOx
- Tried using Schedule 80 steel pipe (strong) vs. galvanized pipe (weak) for lab testing:
  - Loss of velocity in galvanized pipe
  - Little change in CO, but dramatic increase in NOx
- Thus deviation from 6% FO, loss of confinement, and water contamination all contribute to NOx.

Rich Mainero — NIOSH

Common exposure standards for 10 hours per day, 40 hours per week:

NO — 25 ppm NO_2 — 1 ppm

Therefore concentrate on NO_2.

Water stemming lowered all NOX, but NO more than NO_2

Rock dust and sodium bicarbonate also lowered NOx's.

2. Ricky Vance — Nelson Brothers

Causes of NOx:

- Environmental
  - Water
  - Geology
  - Confinement
  - Competency (of rock)
- Application
  - Powder factor
  - Hole diameter
  - Hole depth
  - Burden & spacing
  - Initiation type
- Product
  - Product sensitivity
  - Loading contamination
  - AN prill quality
  - Density and reactivity
  - Additives
- Primer size
- Timing
- Sleep time

Worst blend for producing NOx — 50/50 ANFO/emulsion

Conclusions as to major causes:

Groundwater contamination

Effective diameter (D_e)being reduced by product being driven into cracks and fractures

Critical diameter and sensitivity — dropping below both because of loss in D_e

This is a problem with detonation becoming deflagration

Smaller holes lead to a smaller detonation front and less prill consumption within the detonation zone; is consumed by deflagration after the detonation front passes.

Q & A Session

ANFO/emulsion blends do not stratify with extended sleep time because of emulsion viscosity.[5]

Critical diameter of 40/60 is smaller than that of emulsion alone. (This underscores the importance of the stratification question.)

Correlation with explosive gas products versus theoretical models:

CO, CO_2 — Good correlation with theory

NO, NO_2 — poor correlation individually, but good correlation as a total

Jim Armstrong — Apogee Scientific — Measuring plumes

Good idea: tethered balloon system (Out of our budget range)

Used tracers for back-calculation to quantity generated. No mention of forward calculation for concentration (downstream).

A number of instruments were discussed in overview. Unfortunately, NOx's fall in a range difficult for most of them to measure accurately. The exception, and a good candidate for us to examine, are:

Differential Optical Adsorption Spectroscopy (DOAS) — in the UV range

Use photogrammetry for estimating plume volumes

(Both of these were subsequently determined to be infeasible for us.)

Q & A Session

Armstrong's recommendations:

At first, big jumps are better than small steps (in instrument resolution)

Try a number of methods — don't place all eggs in one basket

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[5] I later debated this point with the speaker. These were laboratory tests, and he conceded that field conditions may not be a match.

Minimize dust visual impact by looking at cloud vertically instead of horizontally.

Cloud color is not an indicator of concentration (this was repeated by several persons)

Sun angle, brightness, cloud cover, background, visible light path, etc, all change color

(It seemed obvious that this had been a topic discussed before; our own field work verified this.)

William R. Monnett — McVehil-Monnett Associates, Inc.

There is a lack of ability to calculate the NO to NO_2 conversion process

Discussed "puff" models (not useful to our application)

EPA Representative

Presented an interesting argument that the Cx/Nx ratio should be constant for any point in the cloud; therefore C, easier to measure, could be used to determine N.

Richard Turcotte — ICA/Orica.

Stated NOx problem is not in the chemistry, it is in the sensitivity

Stephen Burchell — Nelson Brothers

NOx causes: (note repetition)

- Ground conditions
  - Soft materials
  - Water saturation
  - Ground easily compressed and deformed (not like ours in WV!)
- Application
  - Large number of holes
  - Multiple rows — up to 5 (seems low to me)
  - Higher powder factor
  - Long delay times — often as long as 2 seconds. Typically use detonating cord, therefore down-hole delays can be long also.
- Product formulation and quality

Results:

- Considerable and repetitive stresses on undetonated holes
- Large fractures produced around undetonated holes
- Wet conditions make this worse
- Product is being driven into fractures
- The explosive environment is already poor without these additions
- Holes [may] drop below critical diameter
- Detonation becomes deflagration

Det cord shocks the explosive column, injects gases into it while it is waiting for detonator.

One cure: product with smaller critical diameter D_c

Emulsion, D_c <=1.25"
50/50 blend, D_c = 2.55"
30/70 blend, D_c = 3.05"

Recommendations:

Ground conditions:
- Dewater
- Learn more about the local ground conditions

Application:
- Avoid close burdens and spacings
- Avoid excess confinement [this seems to be contradictory]
- Avoid large numbers of rows
- Avoid initiation systems that disrupt the columns

Product:
- Load emulsions for increased sensitivity and smaller critical diameter

Q & A Session

ANFO is less likely to go into cracks than emulsion: "60/40 is like a solid, 40/60 is like a liquid"

Seismic velocity is around 2000 fps or less

1st row damages ground for 2nd row

Suzanne Wuerthele — EPA

Most available data comes from case histories and accident reports

$T_{1/2}$ of NO_2 in air is about 35 hours
1 ppm = 1.88 mg/m^3
Vapor density = 1.58
Odor threshold = 0.1 to 10.0 ppm
Acts on hemaglogin in the same fashion as CO
Welders have high exposure to NO_2
It "solubilizes" — ie, is soluble in water

Government Limits:

EPA NAAQS	0.05 - 0.09	[A TLV with a range???]
NIOSH STEL (15 min.)	1 ppm	
EPA significant harm level (1 hour)	2 ppm	
OSHA PEL (8 hour)	3 ppm	
OSHA STEL (15 minutes)	5 ppm	
NIOSH IDLH	20 ppm	

NAAQS = National Ambient Air Quality Standard

STEL = Short Term Exposure Limit

PEL = ? I assume this is equivalent to TWE or Time Weighted Exposure

IDLH = Immediate Danger to Life and Health

A risk analysis was promised, but not given. A list of risks was presented without statistical or mathematical analysis.

Liz Vandel — Kennecott Energy

Holding a blast for the proper wind direction has taken as long as two weeks.

Donnie Fullenwinder — Powder River Coal

"We overfuel to ensure that the product has enough fuel."

Q & A Session

Kennecott warns all persons within a 5-mile radius before blasting

Hole liners — time consuming, need extra labor, they twist and hang up, create cut-offs; best avoided whenever possible

Another perspective: Holes squeeze as they stand. Liners hang up, but you don't know it until you load and then the liner rips. They lost 13 of 122 holes, and the shot smoked anyway. (The holes were 105 - 107 feet long on a 20 degree angle.)

Aforementioned public area monitoring attempt: one person said monitors were "as close as three miles" while another said within 800 or 900 feet on I-90. There were 11 mines in the area.

Initiation systems: consensus — det cord

Move is to lower grain det cords to minimize shock and gas

At the end — a citizen mentioned a red-cloud study performed by New Mexico Tech in 1995 in conjunction with the Research Study Center for Energetic Materials. ("Chemical Kinetics ....." NFS grant CTS - 9417526.) This study measured levels of 64 ppm at the heart of a surface blast0. This raises some interesting questions:

1. This study was to find out more about the explosive reaction itself. Therefore these sensors were placed very close to the blasts (one blast destroyed 2 of 3 sensors). Therefore it isn't really applicable to blasting plumes.

2. If these sensors measured 64 ppm very close to a detonation's ground zero, what would the concentration be after it travels and disperses, even a little bit? Eg, a doubling of cloud diameter cubes the volume, resulting in a concentration of 4 ppm (assuming, of course, uniform diffusion). Even with non-uniform dispersion, the concentration will diminish at an inverse-exponential rate.

3. It is interesting that no one mentioned this report until a citizen brought it up at meetings end, yet several of the speakers were familiar with it after it was brought up.

At the end of the seminar the PI was able to arrive at three conclusions:

1. The literature search's results were, in fact, accurate. There were no materials published on fugitive emissions from blasting clouds.
2. The primary source of NOx fumes appears to be blasting inefficiency.
3. Blasting conditions in the east are much more favorable:

   Better confinement due to substantially stronger strata

   Less "sleep time" in the holes, even the larger blasts

   Smaller blasts, and therefore better control over them.

2.0 EXPERIMENTAL APPROACH

2.1 Parameters

The goal is to obtain adequate data to objectively assess the quantities of dust and fumes escaping the mine property, and identify if these levels constitute either a health risk (as defined by existing regulations) and/or a nuisance. The focus will be blasting. Originally, time and resources permitting, we had hoped also to obtain some limited measurements of drilling, hauling, and casting operations. Time and resources did not allow us to do this. Therefore, the decision was made to obtain measurements for:

- Nitrogen Dioxide
- Nitrous Oxide
- Carbon Monoxide
- Ammonia
- Total Dust
- Respirable Dust

2.2 Experimental Protocol

<u>2.2.1 Anticipated Difficulties</u>

The major anticipated problem was wind and weather. Fume and dust clouds have not been studied in this manner before. Although a couple of attempts have been made, all failed because of the inability to predict the cloud path. Until more is known, it is not permissible to "chase" a cloud, because we do not wish to expose any investigators to the cloud. Forecasting wind direction is more than strictly "weather forecasting." Even without change in the prevailing winds, local ground features such as ridges, pits, tree lines, etc., make ground level wind more turbulent and less predictable than that on a bare, flat surface. This difficulty was addressed on a site-by-site basis.

A lesser problem is the magnitude of the constituents of interest. Since this type of investigation has not been done before, we did not know for sure what target range to design our sensors for. Since all of the anecdotal evidence we obtained indicated that the levels of toxic gases would be very low, we used monitors for low-level measurement, ones that cover official TLV ranges. This meant if higher levels were encountered we ran the risk of poisoning the sensors. This did not happen. Dust is less of a problem; dust collectors can cover a wide range of exposure limits without difficulty.

Coordination was another difficulty. With 17 different sensing units distributed (two multi-units at the main station and three single-sensing/pumping units at each of five other locations) over a broad area, coordinating the timing of unit operation is important, especially with the dust sensors. Therefore all of the pumping units obtained not only may be programmed to turn themselves on and off at predetermined times, and the gas units have time-based data-logging capacity. In practice, it turned out to be unrealistic to program the dust pumps ahead of time, so everything was turned on at the latest possible minute.

2.2.2 Method

The data collection effort has been designed to obtain the maximum quantity of data with the minimum number of instruments. A primary measurement station was established that produced the greatest quantity of information on a real-time basis. Measurements included total dust, NO, NO_2, NH_3, and CO. Every attempt was made to position this station so that the primary blasting cloud would pass over it.

If terrain permitted, two wings of instrument stations were established, one each to the right and left of the main station. Each of these stations contained three instruments: one for total dust, one for respirable dust, and one real-time data-logging NO_2 gas monitor. Our original hope was that if our main station is positioned correctly, these stations would give us an idea of the lateral dispersion and/or diffusion. If the main cloud passed to the right or left, all gas quantities could still be determined by correlation. The laws of diffusion indicate that the various gases should be uniformly dispersed. Thus the quantity of any gas at any station could be determined by:

$$Concentration\ Gas_{i,j} = \frac{Concentration\ (NO_2)_j}{Concentration\ (NO_2)_{base}} \times (Concentration\ GAS_i)_{base}$$

where i = specific gas of interest

j = location j

When conditions permitted, one station containing the same set of monitors will be established on the anticipated direct flow direction line from the base station. If the chosen direction of flow was close to accurate, it provided information on attenuation along the axis of cloud travel. Figure 2.1 shows an ideal station layout.

Other data collected included:

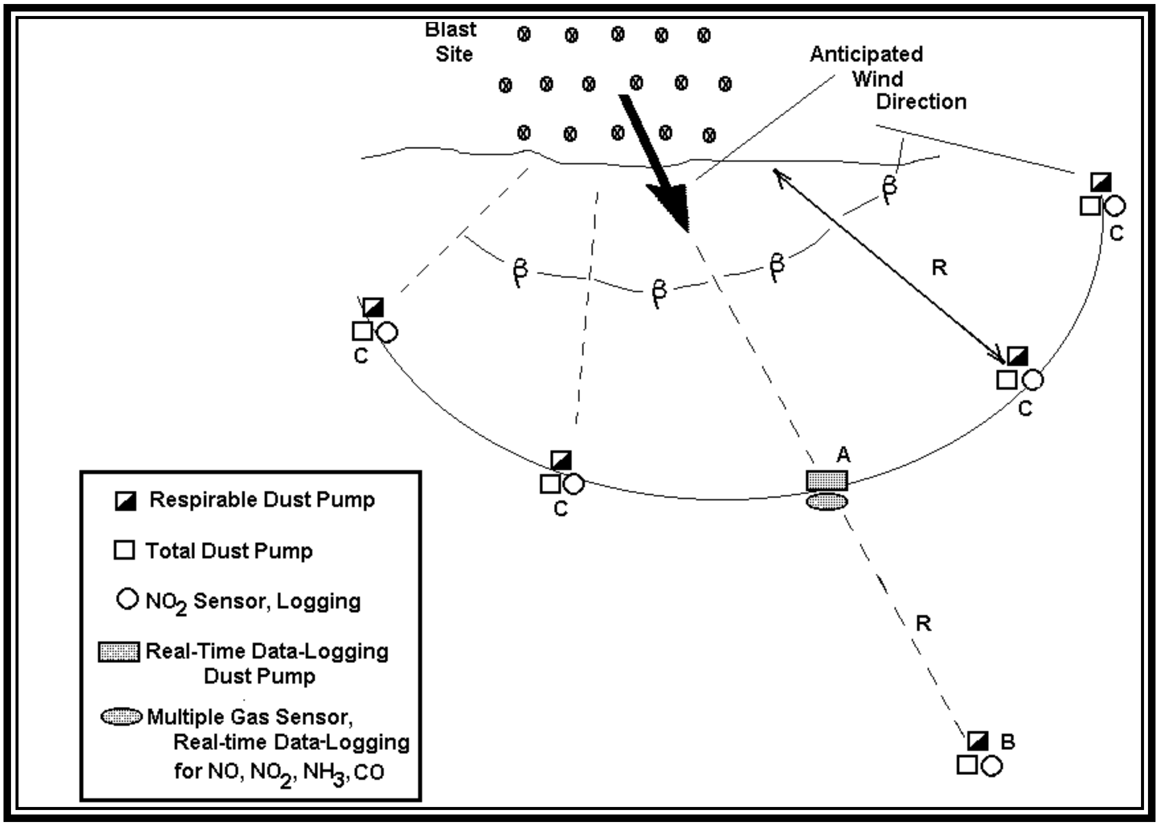
- Topographic map of site
- Mine map of site
- Information on blast size and design
- Relative position of all units as determined by GPS
- Photographic images of the blast

During the performance of the project, the NO_2 sensor on the main station never operated reliably enough to trust any ratio calculations performed with them. There were indications, such as the similarity of time-histories of the other gases, to indicate that this as a reasonable assumption.

Also, we expected difficulty in situating our stations in an ideal fashion because of terrain, but we under-estimated that difficulty. An examination of the maps in section 4 shows that on occasions we approached that configuration, but did not exactly match it. And more often we just had to accept what man and nature provided.

A final comment: This is a "quality-of-life" study. We have little interest in the <u>*total*</u> quantities created by an individual blast, as seems to be the focus of much of the Wyoming effort. We are interested in it only so far as it will help us determine concentrations of constituents in lateral movement of the cloud. This study has no agenda; we do not wish to prove these clouds "good" or "bad." We hope only to obtain real data that can be used to understand what is occurring in this phenomenon.

We would also like to note that this study touches on a lot of other interesting issues that are tempting to follow, such as improving blast design, researching dust and fume mitigation techniques,



and more. But since the resources available for this study are limited we must stick to the original scope of work: Is it harmful? Does it impact the quality of life?

Figure 2.1 Ideal Experimental Layout

1. Determine most likely direction for cloud travel
2. Distances to be governed by site layout and requirements.
   - "Beta's" and "R's" to be as close to equal as possible
     - R = radii from station to blast center, beta = angle between radii
3. Establish base station A
   - Real-time dust monitor, data logging
     - Total dust
     - Dust distribution over time
   - Real time gas monitor, data logging
     - Monitor NO, NO_2, NH_3, CO
4. Establish wing stations C
   - Total dust
   - Respirable dust
   - NO_2 data logger, concentration vs. time
5. Establish down-wind station B
   - Total dust
   - Respirable dust
   - NO_2 data logger, concentration vs. time

2.3 Equipment

The following pages are excerpts from the product literature for the instruments that we used, providing specifications and basic overview information. Selection was based on the lowest thresholds available, by unit capability, and ultimately by cost. Dust units from SKC enabled us to program the units and download operational data. Although the gas units from Quest were not programmable, they did have the capacity to store and download data. More importantly, the Quest Multi-Log unit enabled the use of four toxic sensors, whereas competing four sensor units were limited to two toxic and two non-toxic gases.

We considered more sophisticated units, even remote gas sensing technologies. The original proposal called for gas chromatography and "one or two" blasts to be monitored. When we found out (thanks to an extended discussion with experts at NIOSH) that chromatography was not a reasonable option, we elected to use electro-chemical sensors and make more mine visits. For the information required, these units provided the best combination of accuracy and economy.

The final photograph in this section is of an assembled monitoring station. The dust pumps are housed in a sturdy plastic housing, with tubes leading out side. A pole is mounted on the case to suspend the dust cyclone and filter and the total dust filter above ground level. The NO_2 monitor is also hung here, housed in a protective foam rubber covering. Finally, crepe paper streamers are attached as a visual indicator of wind velocity.

AirChek 2000

The AirChek® 2000 with patented internal flow sensor brings advanced electronic flow control to air sampling from 5 to 3000 ml/min. This new technology allows the user to program a desired flow rate with an accuracy of ± 5% using the three-button keypad or a PC with optional DataTrac® 2000 Software; no tools needed. The internal flow sensor measures flow directly and acts as a secondary standard, constantly maintaining the flow rate. Flow can be calibrated by the user to an external primary standard and adjusted. The flow setting, achieved immediately at start-up, is automatically corrected for variations in temperature and pressure by built-in sensors. The AirChek 2000 samples up to eight hours on one battery charge.

Easy Three-button Programmability

Using the simple three-button keypad, set flow rate and run-time without screwdrivers. A convenient timed shutdown feature allows you to set the AirChek 2000 to run from 1 to 999 minutes.

Sampling Parameters at the Touch of a Button

Easily scroll through sampling parameters including time, flow rate, air volume, atmospheric pressure, and battery status.

CalChek™ — Direct Communication to a Primary Standard

Automatically calibrate your AirChek 2000 sample pump (v. 2.59 or higher) to a desired flow using the CalChek feature with CalChek Communicator and a DC-Lite Calibrator. CalChek provides complete calibration flexibility with two calibration options:

CalChek
Direct Communication to a Primary Standard

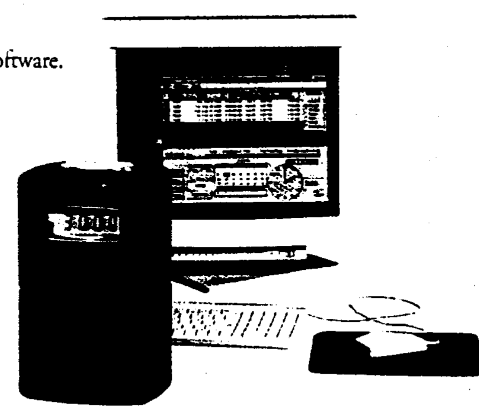
Single Point quickly verifies flow before and after sampling

Multiple Point corrects across a range of flows (750 to 3000 ml/min) after maintenance or to meet calibration requirements for quality programs

For complete documentation of calibration and sampling history, use DataTrac 2000 Software (v. 3.59 or higher).

PC Programmability

Program the AirChek 2000 with a PC using DataTrac 2000 Software.



- **Program a complete running sequence, even at different flow rates.**
- **Program delayed start, timed shutdown, or perform sequential sampling.**
- **Save an AirChek 2000 program in pump memory for later use.**
- **Download CalChek calibration data from pump to PC for complete documentation.**
- **Download sampling data to a PC for a complete history of exposure monitoring.**
- **Create a complete report, save to a file, and import into a word processing document, or print a hard copy.**

AirChek 2000

➤ Wide flow range - 5 to 3000 ml/min

- The AirChek 2000 is the best choice for most sampling applications: low flow range of 5 to 500 ml/min requires an easy-to-use low flow adapter kit. (Low flow does not include some electronic readout options.)

➤ Security system protects data

- Security code requirement minimizes accidental changes and maintains sample validity

➤ Automatic features maintain sample integrity

- Auto shut-off with low battery or restricted flow
- Adjustable flow fault shutdown from 5 seconds to 4 minutes with a PC and DataTrac 2000 Software
- Auto-restart from flow fault attempted every 5 minutes for a maximum of 10 times
- Run-time data stored in memory

➤ Intrinsically safe

- Versatile for all industries and safe in explosive environments: UL and cUL Listed

➤ Large, easy-to-read LCD displays:

- Flow rate
- Temperature
- Battery status
- Time-of-day
- Run-time
- Atmospheric pressure
- Volume
- Flow fault

➤ Automatically corrects for temperature and atmospheric pressure

➤ Multi-tube sampling feature

- Optional multiple adjustable low flow holders allow simultaneous 2-, 3-, or 4- tube sampling

➤ Lightweight, with water-resistant case

- Lightweight (22 oz)
- RFI/EMI-shielded, impact-resistant case
- Covers protect ports from water
- CE-approved

➤ Lithium backup battery

- Internal lithium battery preserves data when the battery pack is removed

➤ Real-time clock

- Displays 12-hour standard or 24-hour military time

➤ CalChek — Direct communication* to a primary standard

- Fast & easy calibration without manual adjustments

Performance Profile

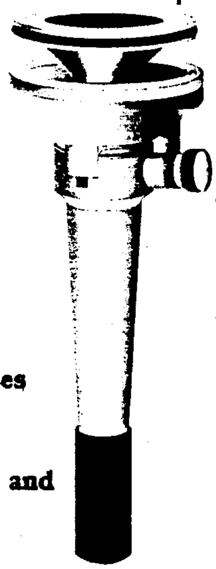
Flow range:	750 to 3000 mL/min (5 to 500 mL/min requires optional low flow adapter kit)	
Compensation range:	3000 mL/min at 15" water back pressure 2500 m L/min at 20" water back pressure 2000 mL/min at 30" water back pressure 750 mL/min at 40" water back pressure	
Accuracies:	**Timing:**	1 min/month @ 25 C
	Atmospheric Pressure:	± 0.3" Hg
	Flow Rate:	± 3% of setpoint after calibration to desired flow
Battery Charge Level Indicator:	Icon displays at full, mid, and low charge	
Temperature range:	**Operating:**	32 to 113 F (0 to 45 C)
	Charging:	32 to 113 F (0 to 45 C)
	Storage:	-4 to 113 F (-20 to 45 C)
Run-time:	With battery pack, run-time is 10 hrs for 2000 ml/min and up to 30 inches back pressure.	
Timer Display Range:	1 to 9999 minutes (6.8 days). If the run-time exceeds 6.8 days, the timer display rolls over to 1. Times greater than 9999 minutes are only displayed on a PC using DataTrac 2000 software.	
Time Display:	Time-of-day in hours and minutes (12- or 24-hour clock) with AM and PM indicators.	
Flow Fault:	If flow drops by more than 5%, pump stops and holds historical data. Auto-restart attempted every 5 minutes up to 10 times.	
Battery Pack:	Removable battery pack with rechargeable NiCad battery, 4.8 V x 2.0 Ah. Optional removable battery pack with rechargeable NiMH battery, 4.8 V x 4.0 Ah.	
Size:	5.6 x 3 x 2.3 (14.2 x 7.6 x 5.8 cm)	
Weight:	22 oz (624 gm)	
RFI/EMI Shielding:	RFI/EMI-shielded case, CE-approved	
Intrinsic Safety:	UL and cUL Listed	

Cyclones Used With AirChek 2000

GS Respirable Dust Cyclone

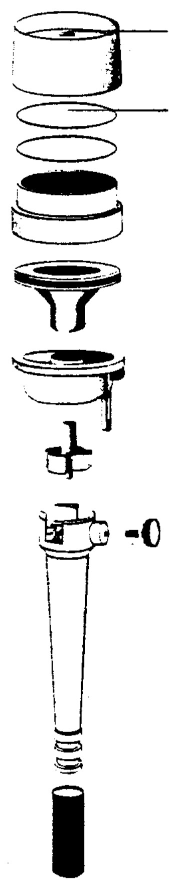
Meets ACGIH Sampling Criteria

- **Prevents static collection effects**
- **2.75 L/min flow rate provides greater sensitivity and sampling accuracy**
- **Meets ACGIH sampling criteria for respirable dust**
- **Tangential inlet design decreases particle impaction**
- **Eliminates ambient wind speed and orientation effects**
- **Designed to overcome problems with the Dorr-Oliver cyclone**



GS Cyclone's Unique Design

- **Conductive plastic construction** prevents static collection problems with charged particles
- **Tangential inlets** lessen sampling errors that can occur when particles impact on the wall of the cyclone opposite the inlet
- **Multiple inlets** eliminate sensitivity to wind velocity and user orientation to the contaminant source



GS Cyclone Superior Performance

With low mean bias and higher flow rate requirements, the GS Cyclone provides better sampling accuracy and greater sensitivity when compared to the performance of other cyclones at the same cut-point. Furthermore, the multiple inlet GS Cyclone overcomes sampling problems that have been reported with the single inlet Dorr-Oliver cyclone.

The Multiple Inlet GS Cyclone

The GS Cyclone is a 10 mm lightweight conductive plastic unit that holds a standard 3-piece cassette with filter for the collection of respirable dust particles. The GS Cyclone's removable cassette adapter securely holds the filter cassette in place during sampling. Designed to meet the ACGIH/CEN/ISO curve, the GS Cyclone has a 50% cut-point of 4.0 µm (bias within ISO/NIOSH requirements) at 2.75 L/min.*

** Calibrated at U.K. Health and Safety Laboratory and University of Minnesota (wind tunnel).*

SafeLog 100

FEATURES

- **Single Gas Portable Monitor**
  - Selection of ten different interchangeable sensors
- **Quest Smart Sensor Technology:**
  - CO, H_2S, O_2, NH_3, Cl_2, HCN, SO_2, NO, NO_2, ETO
  - On-board memory contains sensor specific data
  - Automatic sensor recognition
- **Datalogging extended memory capacity:**
  - Over 60 hours at one minute sample intervals
  - Download via an RS-232 interface
  - Real-time clock and date stamps all data & alarm occurrences
  - Parallel Printer
- **Supported by *QuestSuite™* for Windows software**

- **Ease of operation via oversized four button key pad**
- **Large four digit display with backlighting**
- **Simple zero and calibration functions**
- **Piercing two tone horn and flashing bright LED alarms**
- **Powered by a single, user replaceable, 9 volt battery. No tools required.**
- **RFI/EMI Resistant**
- **Lightweight and extremely rugged impact resistant ABS housing**
- **Quest Quality, Performance and Dependability**

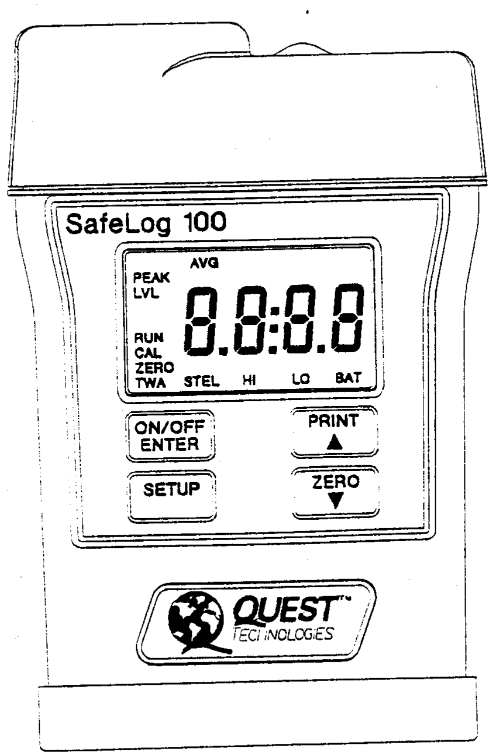
The Quest SafeLog 100 is an extremely rugged, lightweight personal single gas datalogging monitor. Designed for today's demanding work environments, the unit features a large four digit display with backlighting and pulsating warning horn and visual alarms.

The SafeLog 100 is protected in an impact resistant ABS housing to take the punishments of real life work conditions. The unit is powered by a user replaceable 9 volt battery that will supply approximately 100 hours of continuous operation.

User flexibility is as simple as selecting from ten different interchangeable electrochemical sensors to meet your specific application requirements. Quest smart sensor technology includes automatic sensor recognition and on-board memory which contains specific sensor identification: alarm set points, calibration data and temperature compensation information that can travel with the sensor from one unit to another.

The SafeLog 100 measures gas concentration at one sample per second. Featuring an extended memory capacity, it datalogs 60 plus hours (continuous or multiple sessions) of 1 minute historical data including the high level for the minute, STEL, TWA and temperature. The real-time 24-hour clock times and date stamps all data and alarming events. All recorded information can be easily transferred to a printer or computer for record keeping and further data manipulation. In addition, the SafeLog 100 is uniquely supported by QuestSuite™ for Windows, a totally integrated data analysis software package.

All unit operations are easily employed through an oversized 4 - button keypad. Once the unit is activated, it automatically conducts a brief function self check and then proceeds to the run mode. Zeroing and calibration are only a button away. This translates into uncomplicated, but very reliable instrument operation so the user can concentrate on other matters at hand.



SafeLog 100

In addition to having an Ingress Protection (IP54) rating and offering excellent Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) protection, the SafeLog 100 was designed to meet or exceed internationally recognized approvals. Necessary requirements for today's gas monitoring applications.

Combining the above with Quest proven quality, performance and dependability makes the SafeLog 100 the right choice for your single gas monitoring needs.

SPECIFICATIONS

Size:
4.5" x 3.0" x 1.5"
(11.4 cm x 7.6 cm x 3.8 cm)

Weight:
8.8 ounces (250 g)

Power:
9 volt alkaline battery

Sensors:
Electrochemical

Battery Life:
100 hours

Measurement:
Continuous (1 sample/second)

Display:
4 digit backlit LCD

Alarms:
Pulsating dual tone and flashing LED.
Remote alarm jack

Alarm Thresholds:
High level, High level pre-alarm (through *QuestSuite™* only), Low level (O_2 only), STEL, TWA, Low battery

Memory:
Over 60 hours at 1 minute sample intervals

Output:
Jack for data output
Serial and Parallel

Operating Safety Chirp Indicator:
User has choice of ON/OFF

Temperature Range:
-10 to 40°C (14 to 104°F) operating
-15 to 60°C (5 to 140°F) storage

Humidity Range:
0 to 99% relative humidity, non-continuous, non-condensing
15 to 90% relative humidity, continuous, non-condensing

Ingress Protection Rating:
Certified to IP54

Intrinsic Safety:
UL, cUL, Class I, II & III, Division 1, Groups A thru G, EEx (European)

RFI/EMI Protection:
Special shielded case and internal circuit protection meets or exceeds ANSI Standard C95.1-1982 and EN50082-2

Sensor Specifications:

Gas	Range	Resolution
Oxygen O_2	0-30%	0.1%
Carbon Monoxide CO	0-999 ppm	1 ppm
Hydrogen Sulfide H_2S	0-500 ppm	1 ppm
Chlorine Cl_2	0-20 ppm	0.1 ppm
Hydrogen Cyanide HCN	0-50 ppm	0.1 ppm
Ammonia NH_3	0-50 ppm	1 ppm
Sulphur Dioxide SO_2	0-50 ppm	0.1 ppm
Nitric Oxide NO	0-100 ppm	0.1 ppm
Nitrogen Dioxide NO_2	0-50 ppm	0.1 ppm
Ethylene Oxide ETO	0-20 ppm	0.1 ppm

HAZ-DUST II

HAZ-DUST II Real-time Personal Dust Monitor

The HAZ-DUST II real-time personal dust monitor, with internal sampling pump, datalogger, and communications software, uses near-forward light scattering technology to measure airborne dust particle concentration. Unique signal processing internally compensates for noise and drift, while allowing high resolution, low detection limits, and excellent baseline stability.

➤ **Instantaneous readings in mg/m^3**

- The HAZ-DUST II uses optical light scattering to calculate and display airborne dust concentrations immediately and continuously when activated; real-time data reported in mg/m^3

➤ **Displays TWA, STEL, min, and max levels**

- Instantaneous readouts of all data on the 4-line backlit LCD

➤ **High sensitivity — 0.01 to 200 mg/m^3**

- Selectable dual-range feature for measurement between 0-20 or 0-200 mg/m^3 with an ultimate sensitivity down to 0.01 mg/m^3

➤ **Compact and lightweight**

- Small and lightweight, 3.5 x 9 x 2.5 inches (8.9 x 22.9 x 6.4 cm), 3 lbs (1.4 kg), the rechargeable NiCad battery, electronics, and datalogger are enclosed in a compact case that attaches to a worker's waist

➤ **True breathing zone measurements of inhalable, thoracic, and respirable dust**

- Attach the miniature sensor to a worker's pocket or collar for true breathing zone measurements; unique sensor design allows interchangeable sampling heads to collect concurrent filter samples

➤ **Four-key programmable operation**

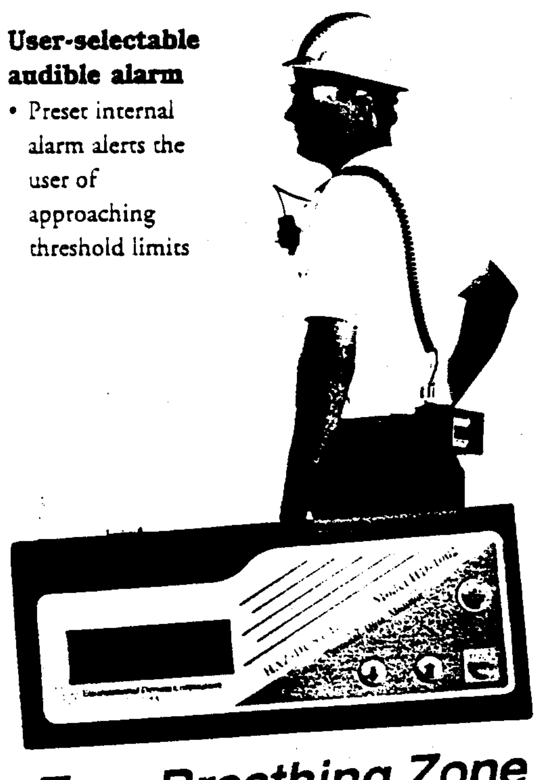
- Access features and programming options through easy menu selection

➤ **Displays respirable, thoracic, or inhalable particulate mass**

- Respirable display is calibrated using Arizona Road Dust (ARD) and compared to a sample using NIOSH Method 0600 for respirable dust (accuracy ± 10%); menu-select alternate displays of either thoracic or inhalable particulate mass on the LCD

➤ **User-selectable audible alarm**

- Preset internal alarm alerts the user of approaching threshold limits



➤ *True Breathing Zone Measurements*

HAZ-DUST II

SPECIFICATION	RANGE
Calibration	NIOSH 0600 with ARD
Accuracy	± 10%
Precision	0.02 mg/m^3
Sensing range	0.01 to 200 mg/m^3
Particle size range	0.1 to 10 μm Respirable 0.1 to 50 μm Thoracic 0.1 to 100 μm Inhalable (IOM)
Recording time	1 second. 1 minute and 10 minute averages
Flow rate	1.5 to 2.3 LPM
Memory	21.500 data points
Locations	Up to 999 storage locations
Output	RS-232
Operating temperature	32 to 120° F (0° -50°C)
Humidity range	95% non-condensing
Battery	Rechargeable NiCad
Battery life	8 hours
Charging time	8 hours
Size	9 x 3.5 x 2.5 in (22.9 x 8.9 x 6.4 cm)
Weight	3 lbs. (1.4 kg)

MultiLog 2000
SPECIFICATIONS

The "Industrial Hygiene" selection is the most advanced level and, in addition to all the features supplied in the Basic Mode, this mode displays average level, TWA, peak values, STEL, and peak STEL for all installed sensors.

The MultiLog 2000 has an extended memory capacity for storing information while in the RUN mode. The user can select logging intervals from a wide time history selection. For example, the unit will log for 78 hours at one minute intervals. There are three ways of logging; summary data for the session, continuous, or action level triggered. You can retrieve logged information by sending the data to a computer via a serial RS-232 interface or to a printer via a parallel interface.

Choice of three long lasting interchangeable power supplies including standard user replaceable Alkaline batteries, or rechargeable Nickel Cadmium and Nickel Metal Hydride battery packs. The battery pack can be changed in a hazardous environment and the rechargeable packs can be rapidly recharged in less than two hours.

For remote sampling applications, the optional sample draw pump will draw a sample in excess of 50 feet and uses the unit's electronics to sense a flow restriction. Dedicated confined space kits are available to enhance your specific gas monitor applications.

Several notable standard features include automatic one button calibration, password protection, and an intelligent zero function that prevents the user from zeroing in a contaminated environment.

Supported by the totally integrated data analysis software, QuestSuite™ for Windows, the MultiLog 2000 is the answer to your rigorous portable multi-gas data logging requirements today and into the future.

Sensor Specifications:

Gas	Range
Combustible Gases	0-100% LEL or 0-5.0% by volume CH_4

Size:
6.9" x 3.4" x 2.0"
(17.5 cm x 8.6 cm x 5.1 cm)

Weight:
22 ounces (0.6 kg)

Power:
Alkaline battery pack (uses two replaceable "C" cells) or rechargeable Nickel Cadmium or Nickel Metal Hydride battery packs

Battery Life:
16 hours with alkaline. Minimum 10 hours with the NiCad or NiMH battery packs

Display:
Two line alphanumeric back lighted LCD

Alarms:
Pulsating dual tone and flashing visual alarms

Alarm Thresholds:
High level. High level pre-alarm (through *QuestSuite™* only), Low level (O_2 only), STEL, TWA. Low battery

Operating Safety Chirp Indicator:
User has choice of ON/OFF and frequency of occurrence

Sensors:
Combustible gases/methane (catalytic diffusion type), oxygen and toxic electrochemical gas sensors

Sensor Specifications:

Gas	Range	Resolution
Oxygen O_2	0-30%	0.1%
Carbon Monoxide CO	0-999 ppm	1 ppm
Hydrogen Sulfide H_2S	0-500 ppm	1 ppm
Chlorine Cl_2	0-20 ppm	0.1 ppm
Hydrogen Cyanide HCN	0-50 ppm	0.1 ppm
Ammonia NH_3	0-50 ppm	1 ppm
Sulphur Dioxide SO_2	0-50 ppm	0.1 ppm
Nitric Oxide NO	0-100 ppm	0.1 ppm
Nitrogen Dioxide NO_2	0-50 ppm	0.1 ppm
Ethylene Oxide ETO	0-20 ppm	0.1 ppm

Sensor Configurations:
Oxygen and Combustibles, and up to two toxic gases, or oxygen or combustibles and up to three toxic gases, or up to four toxic sensors simultaneously

Measurement:
Continuous (one sample/second)

Data Logging:
78 hours at one minute sample intervals: summary, continuous or level triggered. Serial RS-232 interface. Battery backed up memory (via lithium battery)

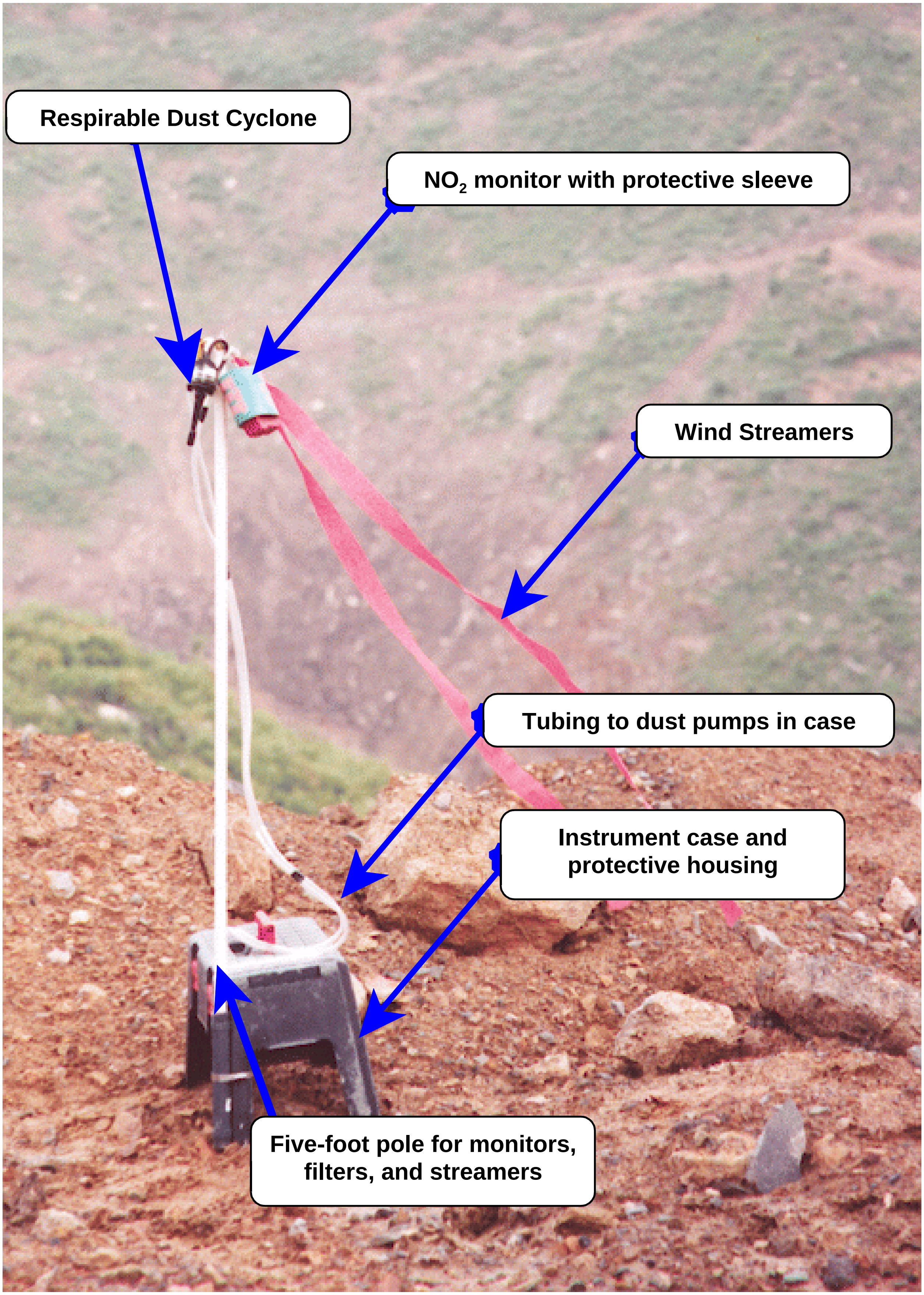
Temperature Range:
-10 to 40°C (14 to 104°F) operating
-15 to 60°C (5 to 140°F) storage

Humidity Range:
0 to 99% relative humidity, non-continuous, non-condensing
15 to 90% relative humidity, continuous, non-condensing

Ingress Protection Rating:
Certified to IP54

Intrinsic Safety:
UL, cUL, Class I, II & III, division 1, Groups A thru G, EEx (European)

RFI/EMI Protection:
Special shielded case and internal circuit protection meets or exceeds ANSI Standard C95.1-1982 and EN50082-2


Respirable Dust Cyclone
NO_2 monitor with protective sleeve
Wind Streamers
Tubing to dust pumps in case
Instrument case and
protective housing
Five-foot pole for monitors,
filters, and streamers

3.0 SITE DESCRIPTIONS

All of the cooperating mines were located in south-western West Virginia in different counties. All were mountain-top removal operations, and all three mines belonged to different coal operating companies. Probably most important for this study, each was distinctly different in its production characteristics.

All three mines provided maximum access to their operations and gave full cooperation. The investigators were permitted to choose the blasting events to monitor and choose how and where to locate their monitoring equipment. It is unusual for researchers to receive such a free hand at mining facilities, but these mining operations deemed the work to be important enough to facilitate our activities and permit us to perform our tasks as we though best.

Table 3.1 following provides a basic comparison of these mining sites.

	Mine A	Mine B	Mine C
Annual Production Tonnage	2,000,000 tons	5,500,000 tons	800,000 tons
Approximate Burden Moved, yd^3/year	20,000,000 to 24,000,000 yd^3	60,000,000 yd^3	8,000,000 to 10,000,000 yd^3
Approximate Number of Production shots per year	260	300	> 240
Approximate Weight of Explosives Used per Year, Lbs	14,400,000 lbs	64,000,000 lbs	6,000,000 lbs
Primary Excavation Method	Front-End Loader Scraping	85% Dragline & Shovel 15% Front-End Loader	Front-End Loader Scraping

Table 3.1 Comparison of Cooperating Mine Sites

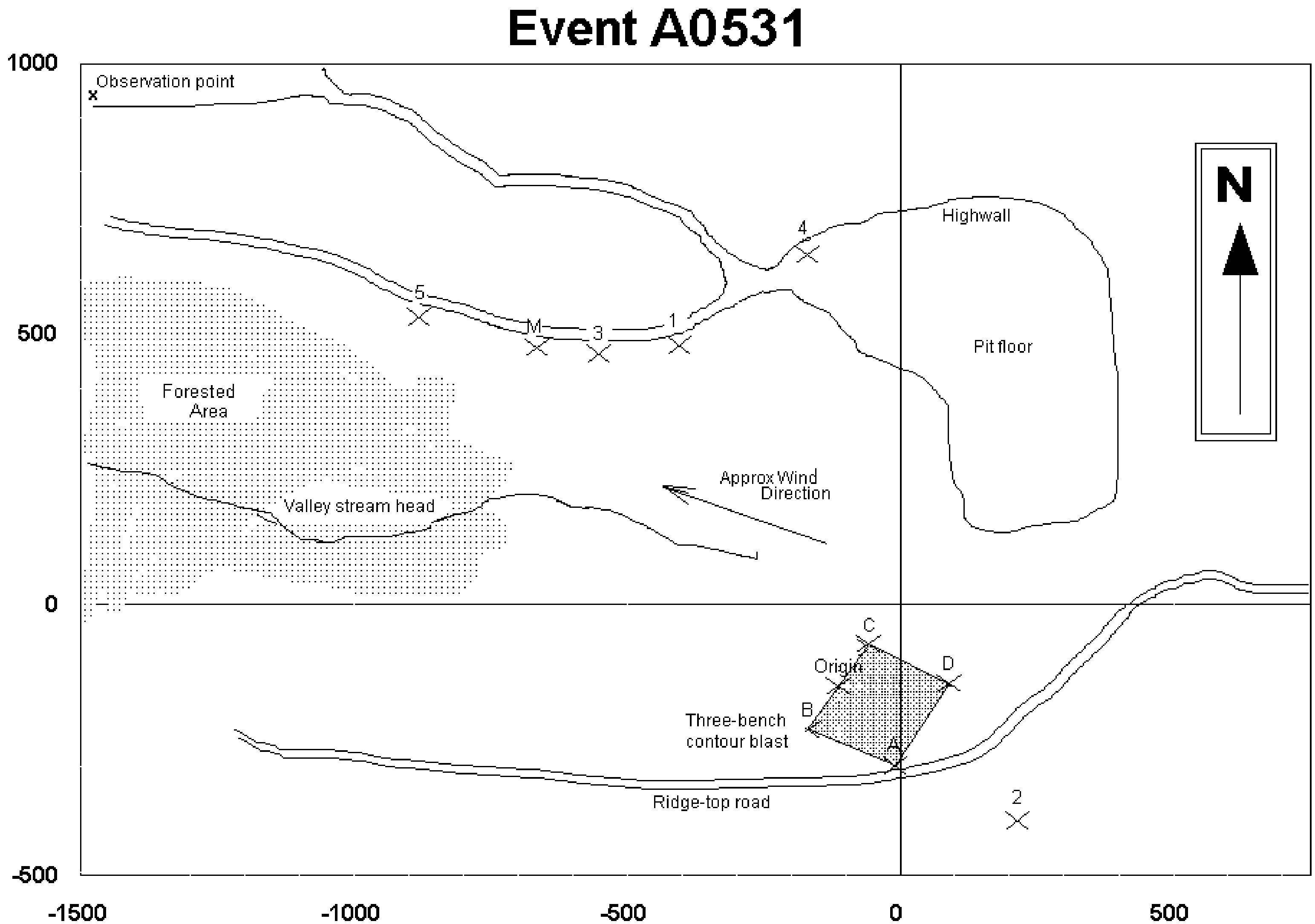
4.0 FIELD MEASUREMENTS

Field measurements were made over the spring and summer of 2000. Miners vacation stopped most mining activities, and therefore most field work, in the first two weeks of July, three weeks at one mine.

4.1 Preliminary Familiarization Trip

A trip to mine A on May 31 was the first one where measurements were taken, and it was the one where lessons in application and equipment usage were learned. It was originally hoped that this data would be useable in the pool of overall information for the project, but too many errors occurred to be comfortable with the values obtained, at least those that *were* obtained.

Figure 4.1-1 shows the layout of the blasting arrangement. It was a three-bench contour blast that was close to the top of the ridge. The stations were selected with regard to the prevailing wind, and one was placed on the ridge behind, but close to, the blast. This latter station was situated here in case material or fumes were thrown up and behind the blast. Pages 4.3 through 4.5 are the photographs of the blast. In a close examination of photo A0531_12 one can see one of the measurement stations just below and to the right of the picture center. In the next picture the blast initiation can be seen, and the following five photographs show the cloud development and movement. It is clear, especially in photo A0531_18, that the bulk of the cloud moved down the valley behind the trees. There were no locations suitable for measurement stations in the valley. Only stations 3 and 5 and the main station were exposed to any fumes or dust, and that was quite minimal, especially station three. The station placed on top of the ridge behind the blast recorded nothing at all. More importantly, immediately after the blast the crew returned to work. The driver in the backhoe in photo A0531_25 had not been told to wait until we recovered our equipment. He drove past all measurement stations while they were still in operation. It is highly likely that the bulk of any measured dust and any CO detected by the main station would have been the result of this machine's passing rather than the blast. It would not



Event A0531
1000
500
0
-500
-1500
-1000
-500
0
500
Observation point
Highwall
4
5
M
3
1
Pit floor
N
Forested
Area
Approx Wind
Direction
Valley stream head
C
D
Origin
B
Three-bench
contour blast
A
2
Ridge-top road

Figure 4.1 - 1

Event A0531 - 1

Event A0531 - 2

Event A0531 - 3

Event A0531 - 4

Event A0531 - 5

Event A0531 - 6

Event A0531 - 7

Event A0531 - 8

Event A0531 - 9

have been possible separate the dust, although it would have been possible to separate the CO according to the time of detection. But this was just one of many lessons learned on this trip.

We had originally hoped to control the running time on all of our instruments. The dust pumps are all programmable, and we set them to start 30 minutes before the blast. (The main station and the gas detectors all record real-time data, so setting the start time was not crucial on them.) After all of our stations were set and we were ready for the blast, we were told that the shot initiation time had been moved up an hour. We then had to quickly return to each station and reprogram the pumps. At this point we still hoped to let each pump run two hours, but subsequently the reality of moving equipment after the shot eliminated that as a possibility. Even if it hadn't been for the backhoe, traffic on the pit floor would still have raised dust that would have reached the measurement stations. It became obvious that instruments would have to be set and turned on just before the blast, and turned off as soon after the blast as possible. This represented a major change to our original plans.

We had originally hoped to photograph the cloud resulting from the blast from two different angles approximately 90° apart and try to determine cloud size from the opposing pictures. In practice we found that the cloud appearance will change according to viewing angle relative to sunlight, according to the background behind the cloud (which will always differ when shooting from opposing angles), and even with different exposure settings on the camera. Later on, we found out that clouds passing overhead could change the appearance of the blast plume. These effects are especially noticeable with regard to colors within in the plume and when the plume becomes diffuse and thin.

Initially we had hoped for the possibility of recording two blasts on the same day. The length of time required for data down-loading, site evaluation, and equipment movement and re-setup demonstrated that this would only be possible if the two blasts were on the same property and had a minimum time window of four hours between them. Travel time between mines, even relatively close mines, was too great. Also, since most mines try to set off their major blasts during shift change, so even two on one site was not possible.[1]

Finally, no matter how much practice one has in the laboratory, it is not the same as using equipment in the field. On this trip we learned about mistakes easily made in equipment set-up

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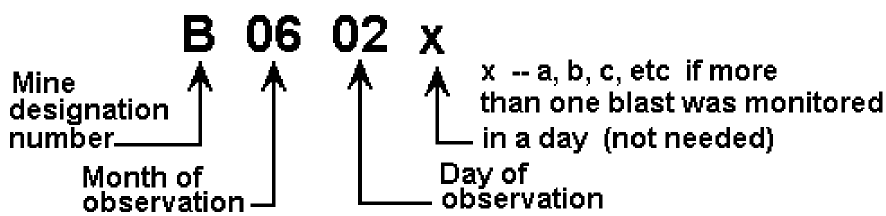
[1]In addition, if a mine did have several shots in one day, the extra shots were normally "utility shots," events that are smaller and drilled shallower than standard production shots.

and programming. And it was our first actual experience in determining how difficult determining average wind direction was going to be. Wind directions on the ridge, in the valley, and at the observation site were all different, at least what minimal wind there was. We had anticipated this difficulty, but this experience verified these concerns.

4.2 Field Measurements

A simple system was set up for identifying the blasting events from their data record names. Illustrated simply:



Thus event B0602 was a blast that was monitored at mine B on June 2nd. (The year 2000 is implicit since this was a single-season research effort.)

The following ten sections summarize each successful set of blast measurements made and contain photographs of all but one (event B0627). We did not keep records of all attempts, but this represents about half of all visits made. Reasons for failure to collect data during unsuccessful visits include:

Lack of any adequate site to locate instruments. This was the most common reason. If the prevailing wind direction was moving from the site directly over an adjoining valley, and there were no roads or other development for access close to the shot in the valley, measurements could not be made. Setting up within forested area would certainly yield biased or altered data.[2] As it was, we had difficulty achieving the distances we had initially wanted to maintain between the stations and the shot.

Change in weather during or after set-up. Twice we had all instruments set and ready to go, and

[2]These sites may be more reasonable to try in a larger project that could provide a greater quantity of data points for statistical validity. However, for a limited number of data points, the trees represent an insulating barrier that can not be correlated to open-air measurements and thus are an additional unquantifiable variable.

just before the shot the wind changed direction, in one case by 180° when a weather front moved in. Even if there had been time to relocate, in both cases the new wind direction was toward an area where there were no adequate areas to reset the stations.

Rain. Our gas detectors are exposed to the elements and are not water-proof. We did take measurements in light drizzle or intermittent rain, but not in steady rain. Also, it was our feeling that such weather would reduce the levels of dust and fumes in the plume, and the data pool would be too small to be able to separate out precipitation impacts.

Severe weather. Twice, blasts were postponed indefinitely due to lightening in the area.

4.2.1 Event A0622

Weather

Observations: 79°F, 73.0% relative humidity, partially cloudy
Wind: 7.5 mph

Blasting Data

Time of ignition:	1309 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	7.785"
Hole Depth:	70'
Number of holes:	76
Stemming used:	13' of drill cuttings
Explosive types used:	ANFO, Trojan C-20 1-lb primer, nonel
Weight of explosive used:	78,052 lbs
Weight of explosive used per hole:	1,026 lbs
Cubic Yardage Moved:	63,840 yd^3
Powder Factor:	1.22

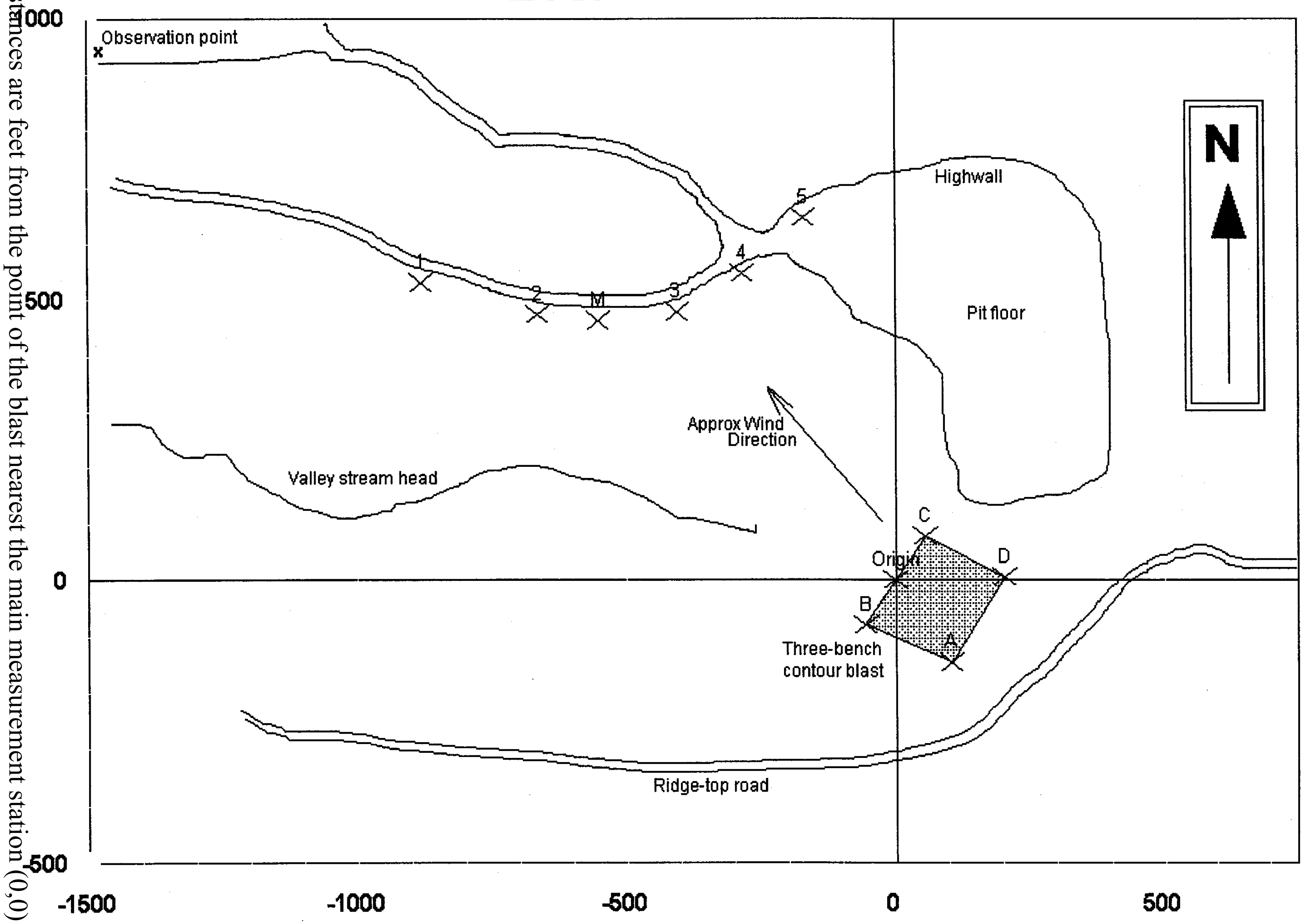
Event Summary Data for Satellite Stations

Total Dust Maximum:	0.09 mg
Respirable Dust Maximum:	0.11 mg
NO_2 high:	0.4 ppm
Duration of maximum NO_2 exposure:	1.0 min
Duration of maximum dust exposure:	Not detected

Main Station Data

NO High:	0.6 ppm
CO High:	5 ppm
NH_3 High:	7 ppm
Dust:	Not detected

Event A0622



Axis distances are feet from the blast point nearest the main measurement station (0,0)

Event A0622 -1

Event A0622 -2

Event A0622 -3

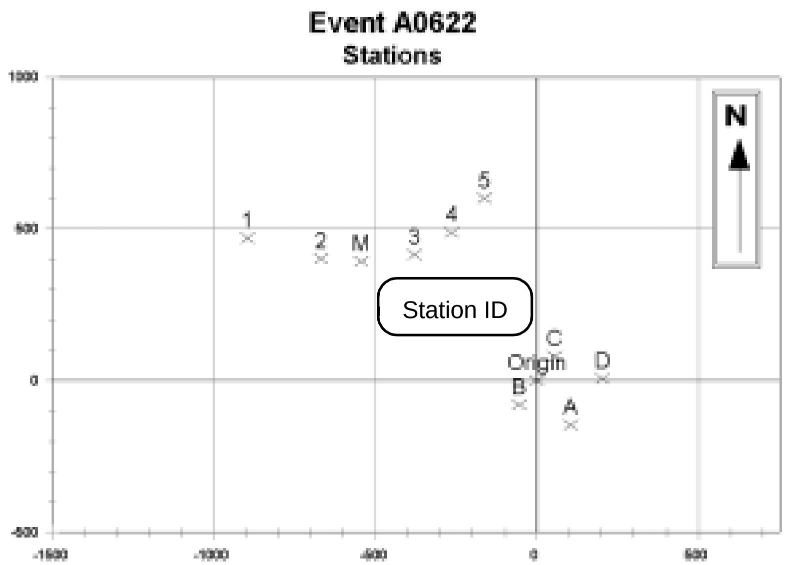
Event A0622 -4

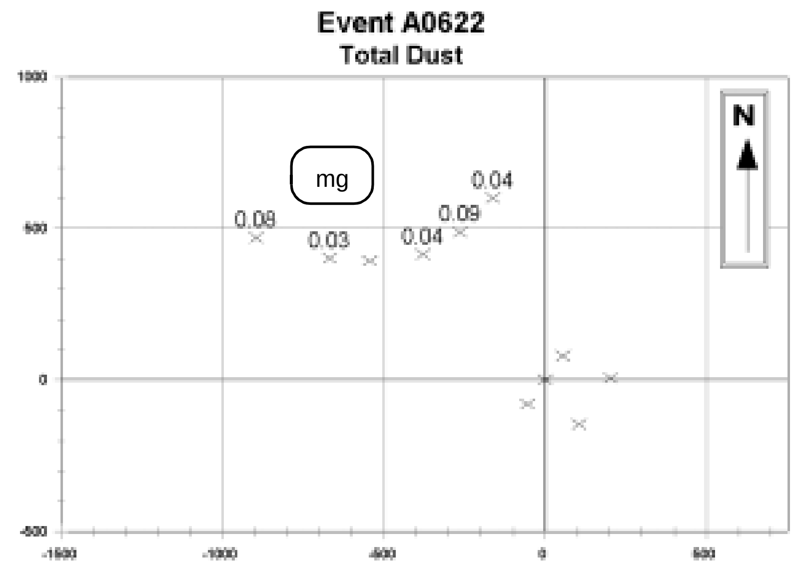
Event A0622 -5

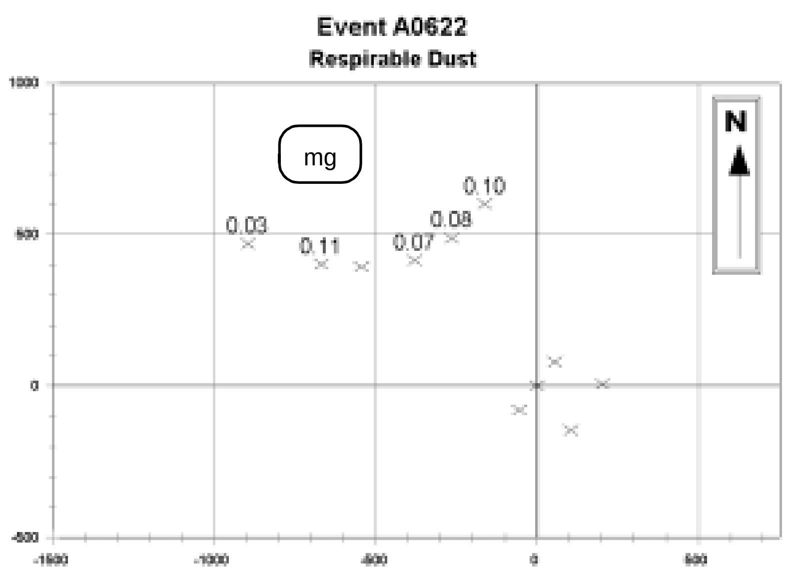
Event A0622 -6

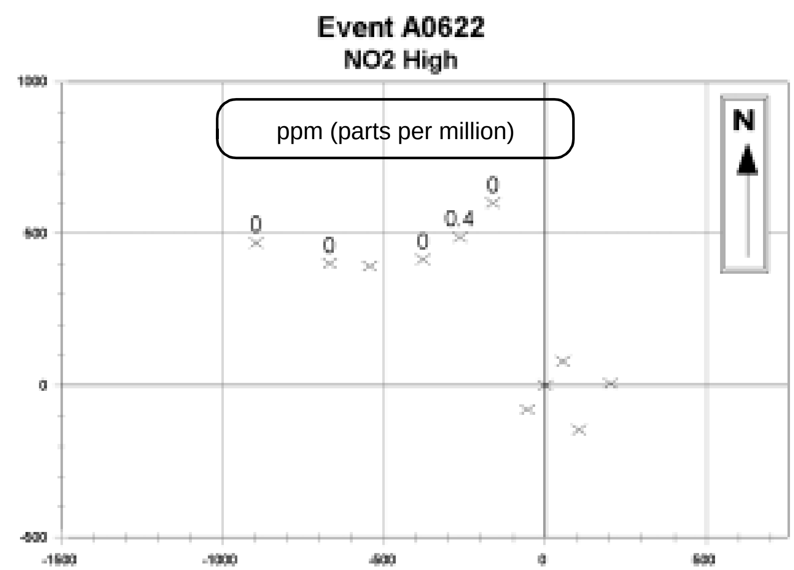
Event A0622 -7

Event A0622 -8



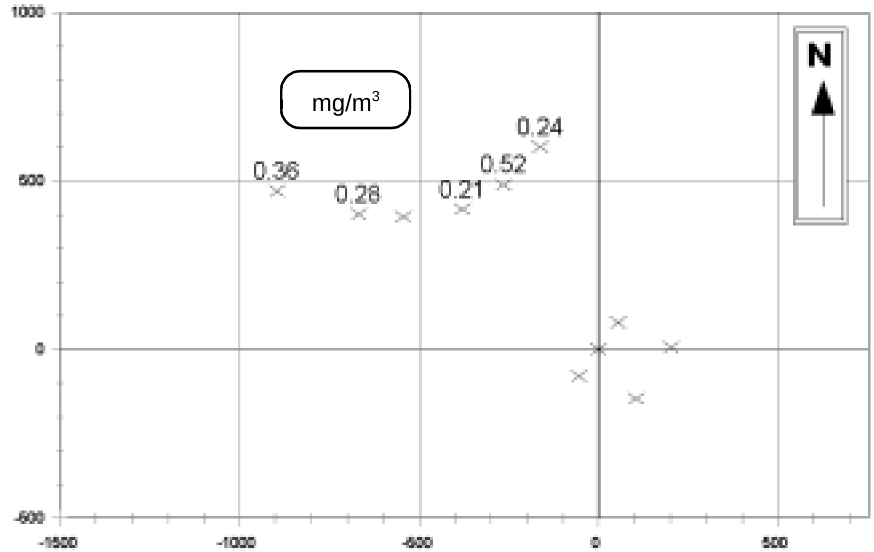




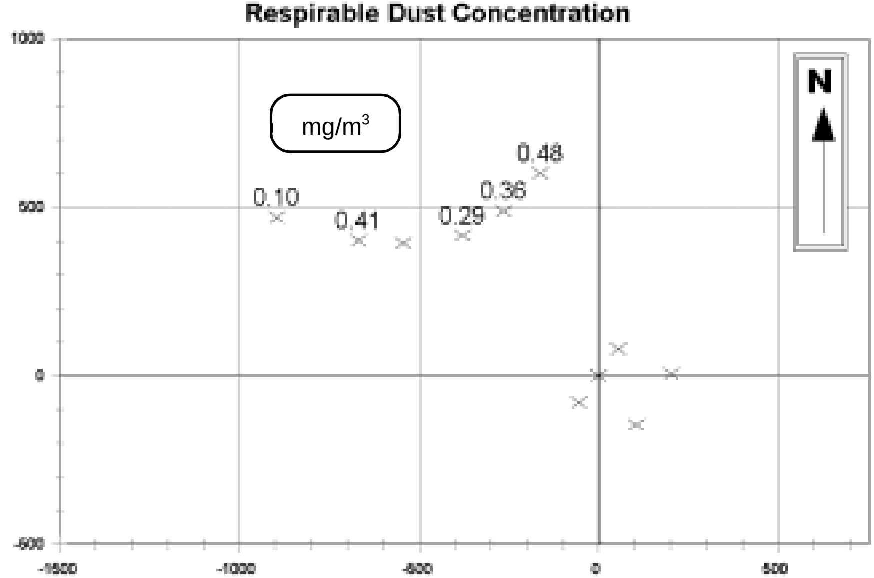


Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

Event A0622
Total Dust Concentration



Event A0622
Respirable Dust Concentration



Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.2 Event A0727

Weather

Observations:	88°F, 48.0% relative humidity, sunny and clear
Wind:	6.6 mph

Blasting Data

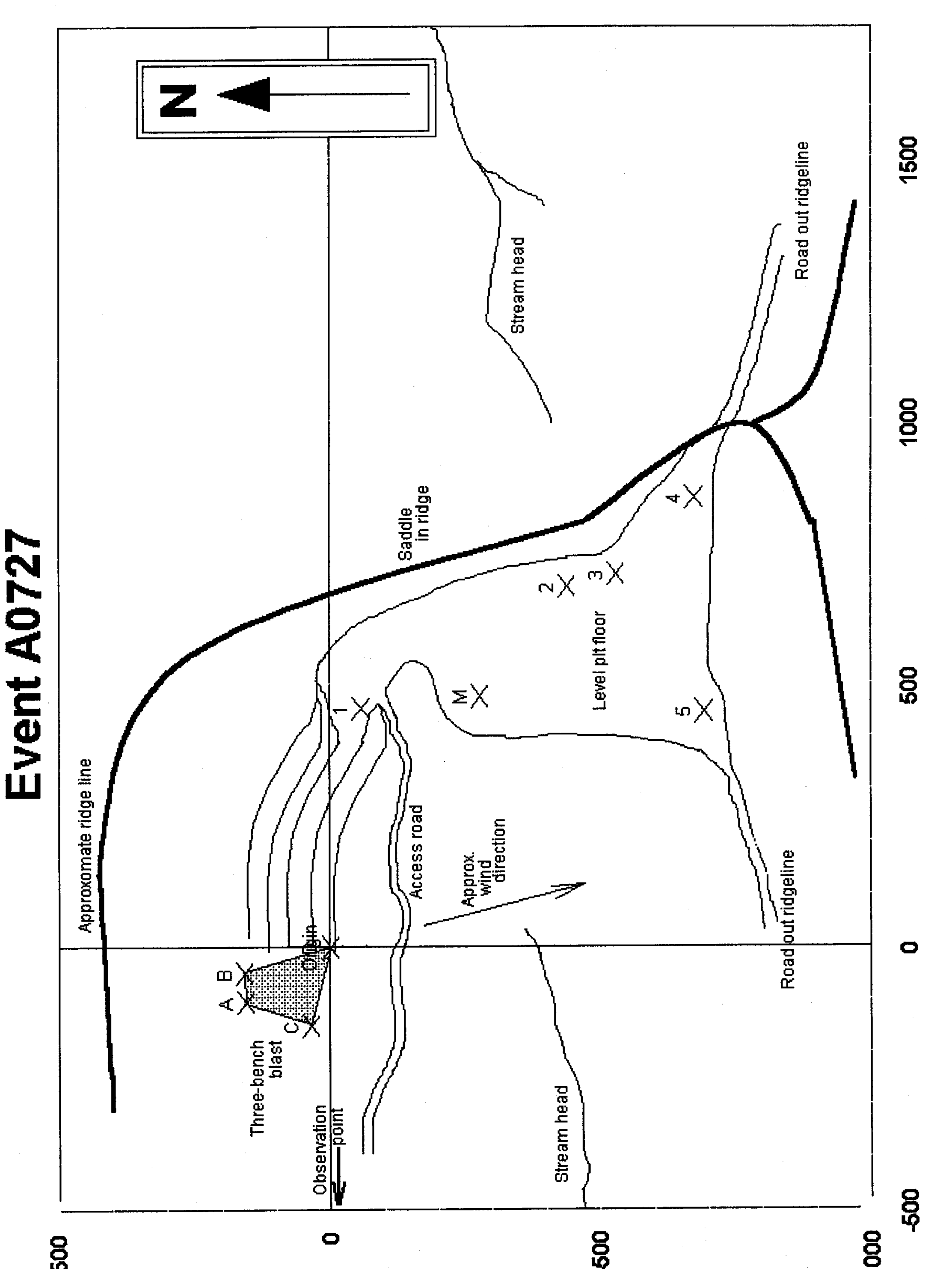
Time of ignition:	1453 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	7.825”
Hole Depth:	103’, 86’, 71’, and 67’
Number of holes:	10, 12, 12, and 14, respectively
Stemming used:	13’ of drill cuttings
Explosive types used:	ANFO, 1.25 cast primers, nonel
Weight of explosive used:	58,164 lbs
Weight of explosive used per hole:	1,212 lbs
Cubic Yardage Moved:	46,224 yd^3
Powder Factor:	1.26

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.23 mg
Respirable Dust Maximum:	0.17 mg
NO_2 high:	1.4 ppm
Duration of maximum NO_2 exposure:	2.00 min
Duration of maximum dust exposure:	2.44 min

Main Station Data

NO High:	48.7 ppm
CO High:	694 ppm
NH_3 High:	168 ppm
Dust:	64.92 mg/m^3



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event A0727 -1

Event A0727 -2

Event A0727 -3

Event A0727 -4

Event A0727 -5

Event A0727 -6

Event A0727 -7

Event A0727 -8

Event A0727 -9

Event A0727 -7

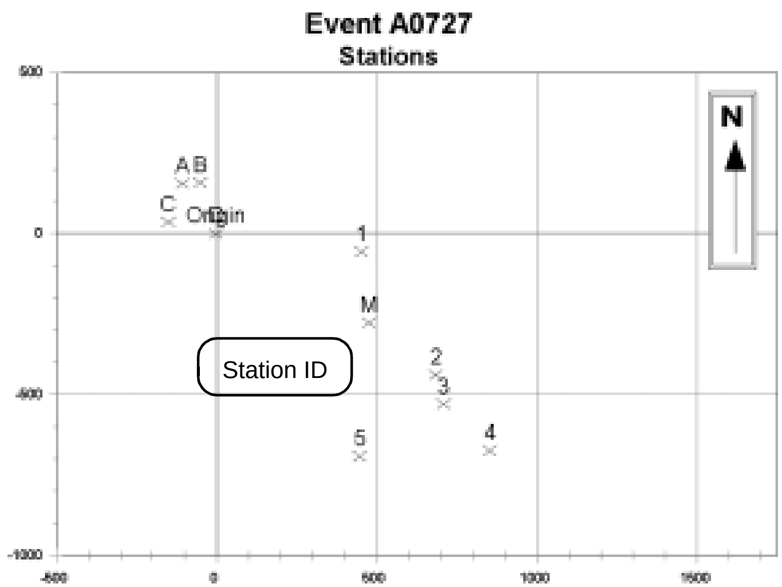
Event A0727 -8

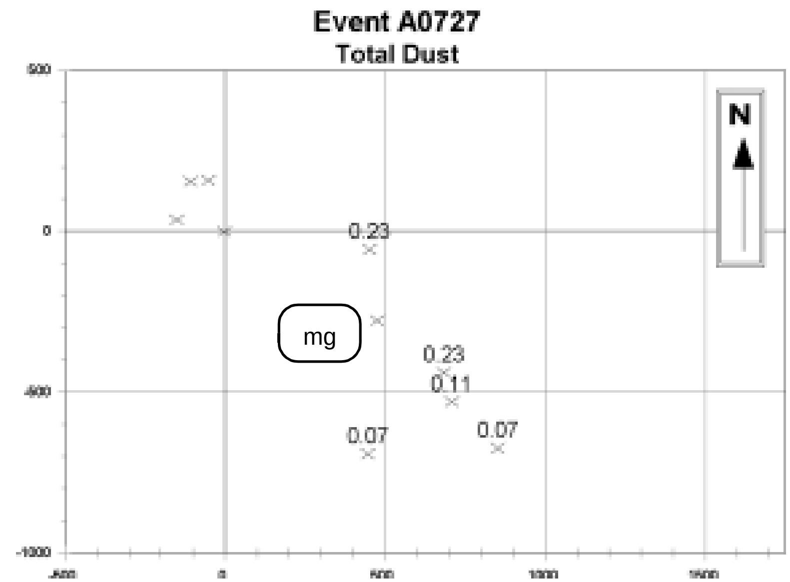
Event A0727 -9

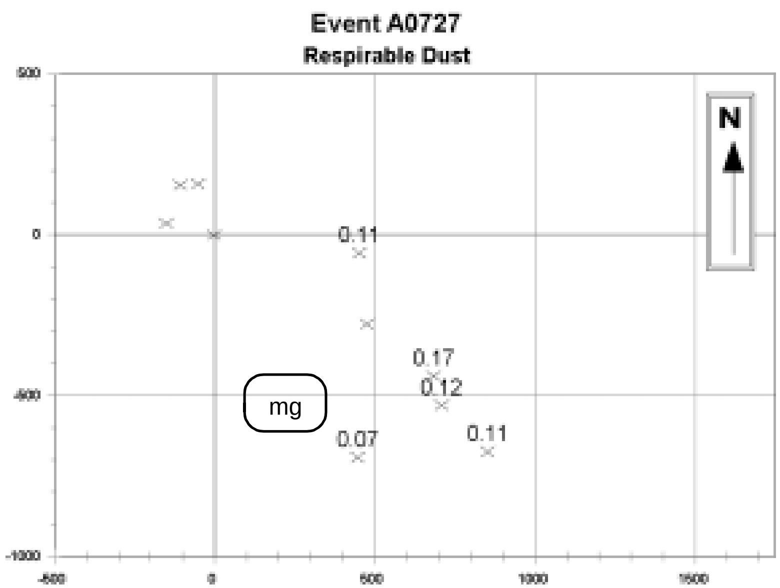
Event A0727 -10

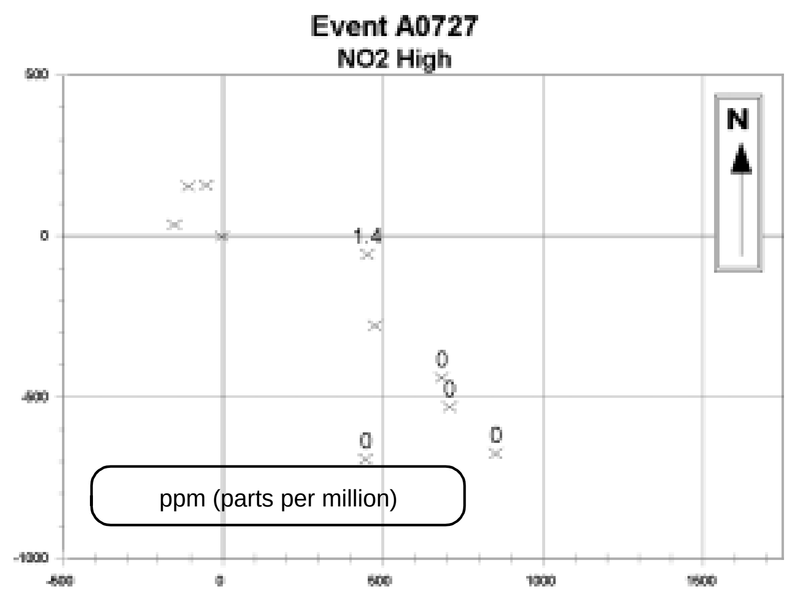
Event A0727 -11

Event A0727 -12

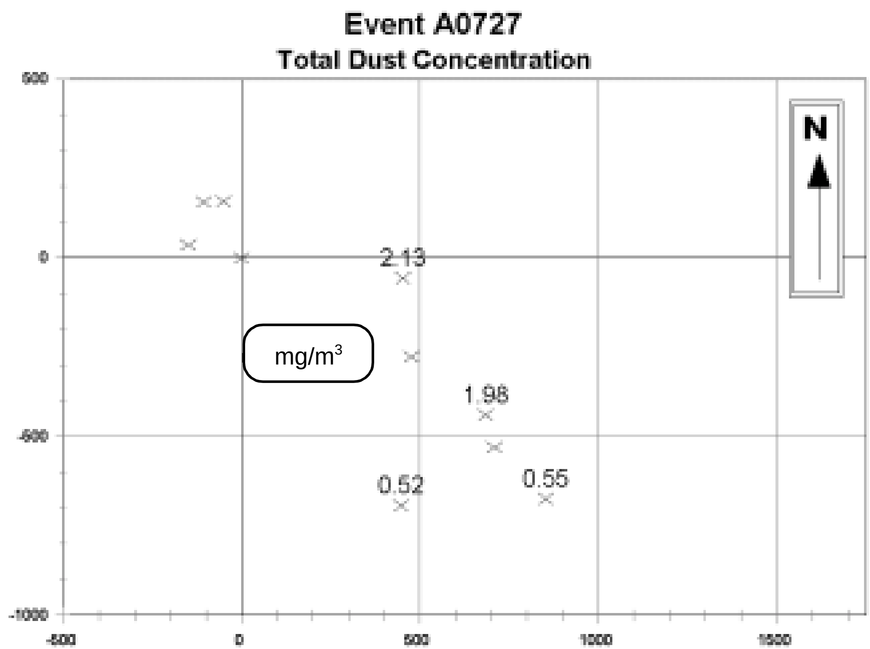


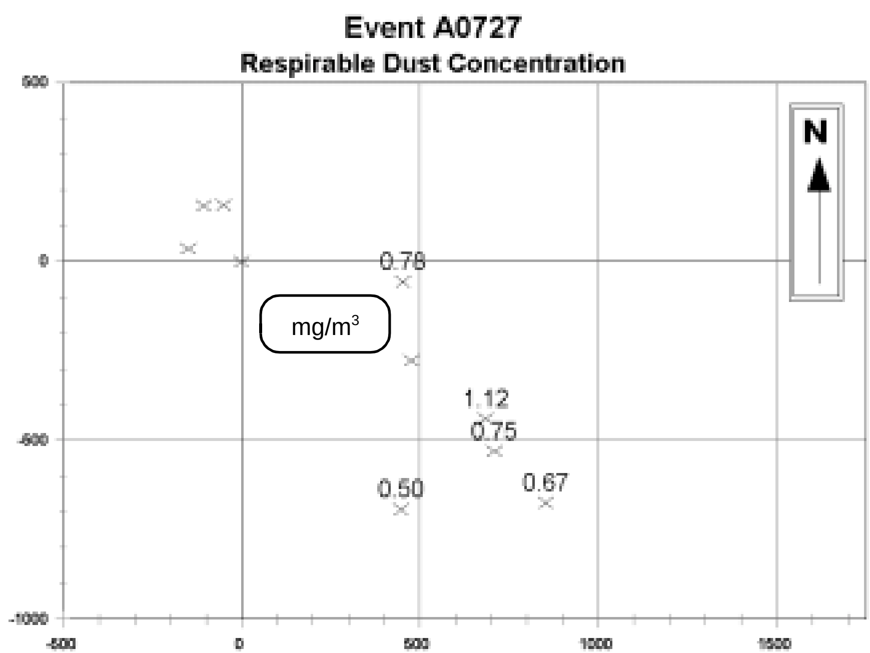






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.3 Event B0602

Weather

Observations:	94°F, 40.8% relative humidity, clear and sunny
Wind:	8.2 mph

Blasting Data

Time of ignition:	1538 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	9”
Hole Depth:	53’
Number of holes:	126
Stemming used:	12’ drill cuttings
Explosive types used:	ANFO 60/40, Pentex 3/4-lb primers, nonel
Weight of explosive used:	192,270 lbs
Weight of explosive used per hole:	1,526 lbs
Cubic Yardage Moved:	154,583 yd^3
Powder Factor:	1.24

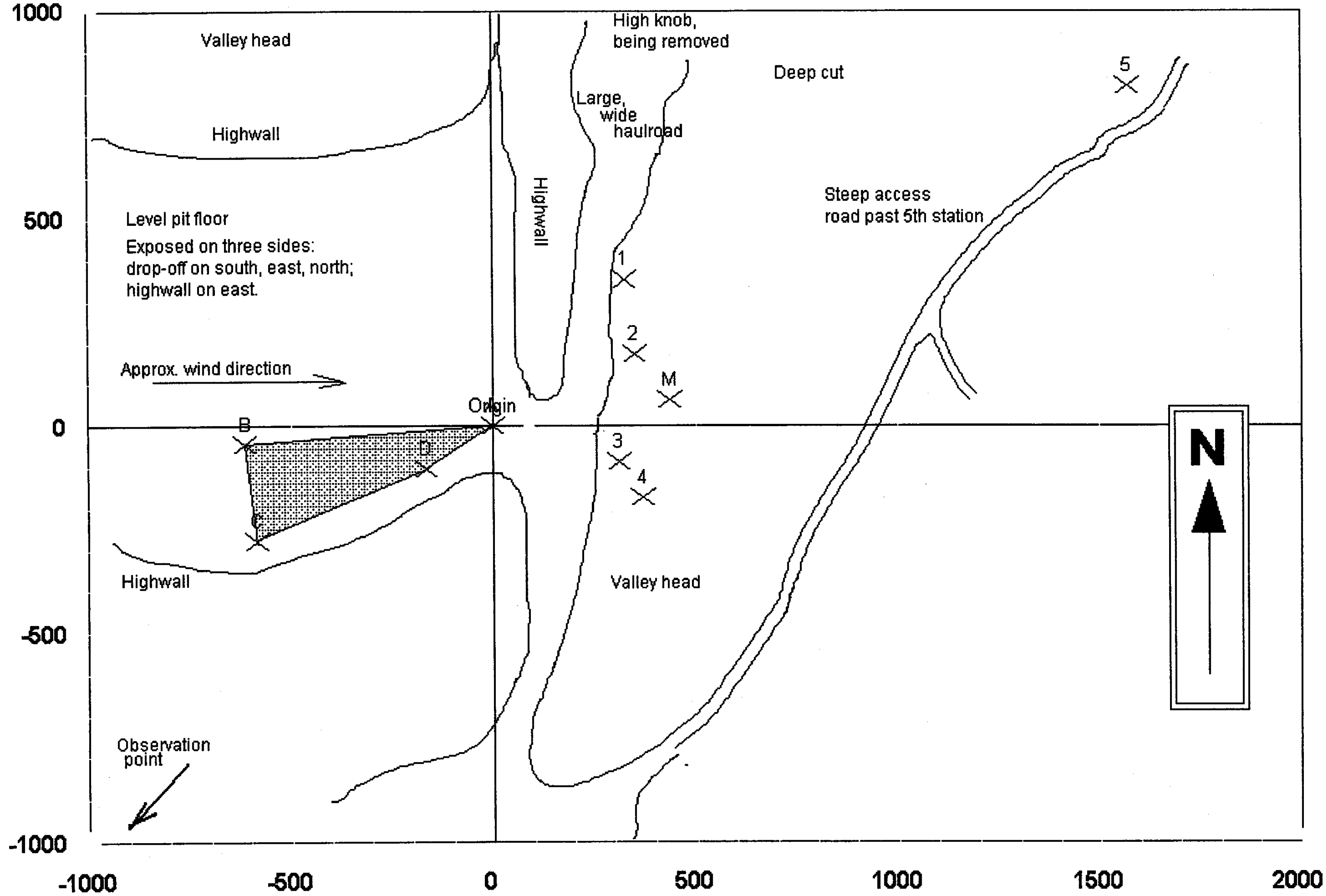
Event Summary Data for Satellite Stations

Total Dust Maximum:	0.48 mg
Respirable Dust Maximum:	0.34 mg
NO_2 high:	2.2 ppm (main station)
Duration of maximum NO_2 exposure:	1 min
Duration of maximum dust exposure:	0.37 min

Main Station Data

NO High:	20.7 ppm
CO High:	780 ppm
NH_3 High:	28 ppm
Dust:	47.67 mg/m^3

Event B0602



Axis distances are feet from th point of the blast nearest the main measurement station (0,0)

Event B0602 - 1

Event B0602 - 2

Event B0602 - 3

Event B0602 - 4

Event B0602 - 5

Event B0602 - 6

Event B0602 - 7

Event B0602 - 8

Event B0602 - 9

Event B0602 - 10

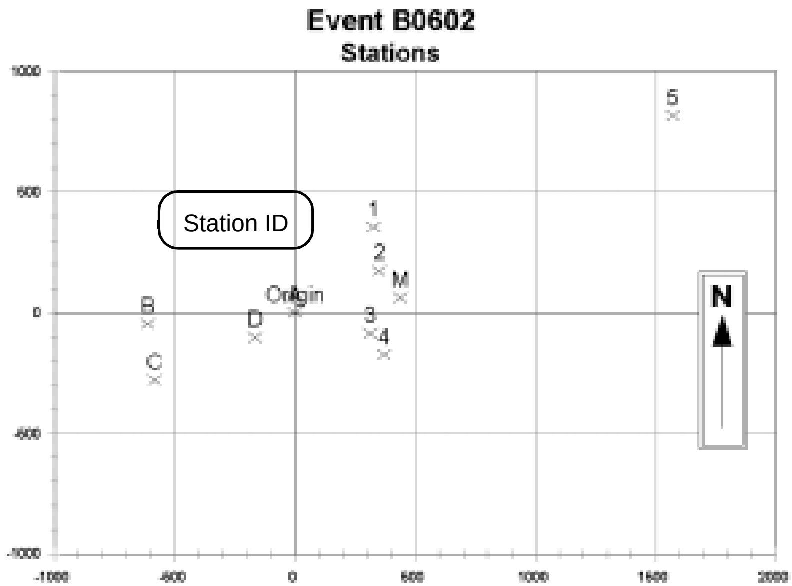
Event B0602 - 11

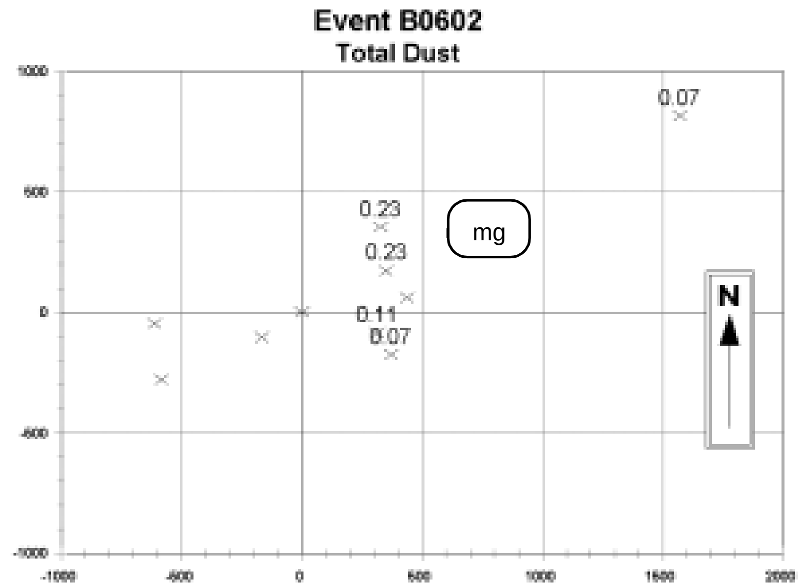
Event B0602 - 12

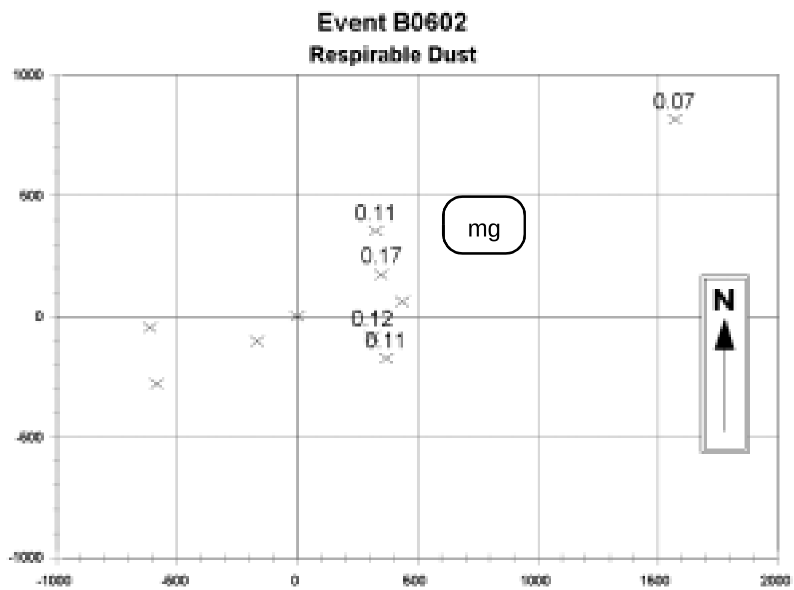
Event B0602 - 13

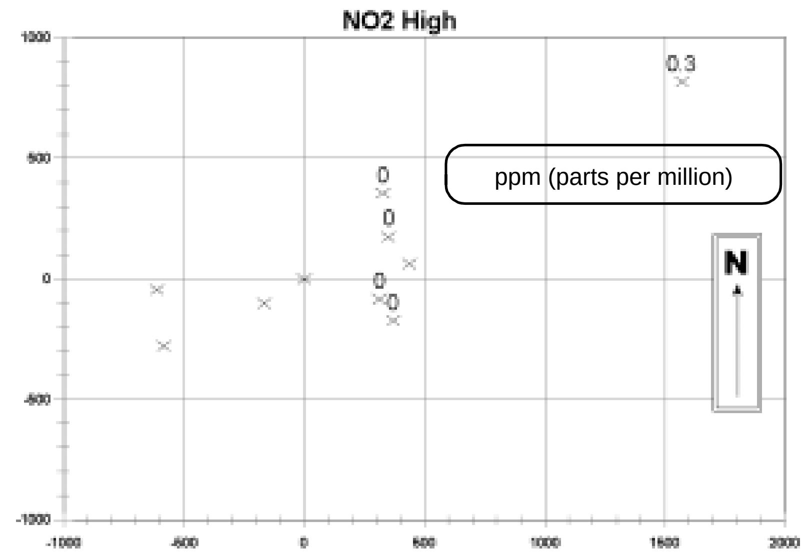
Event B0602 - 14

Event B0602 - 15

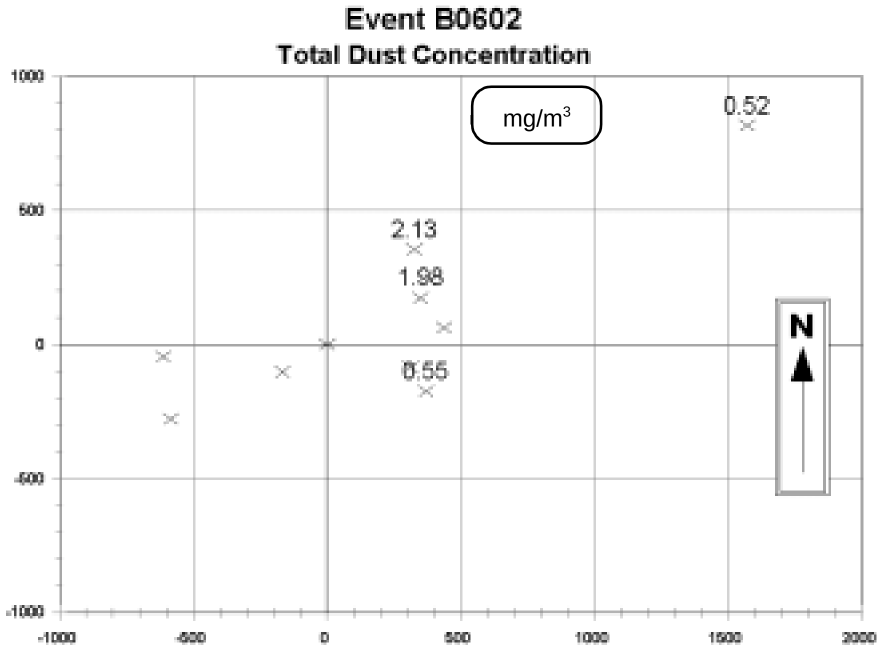


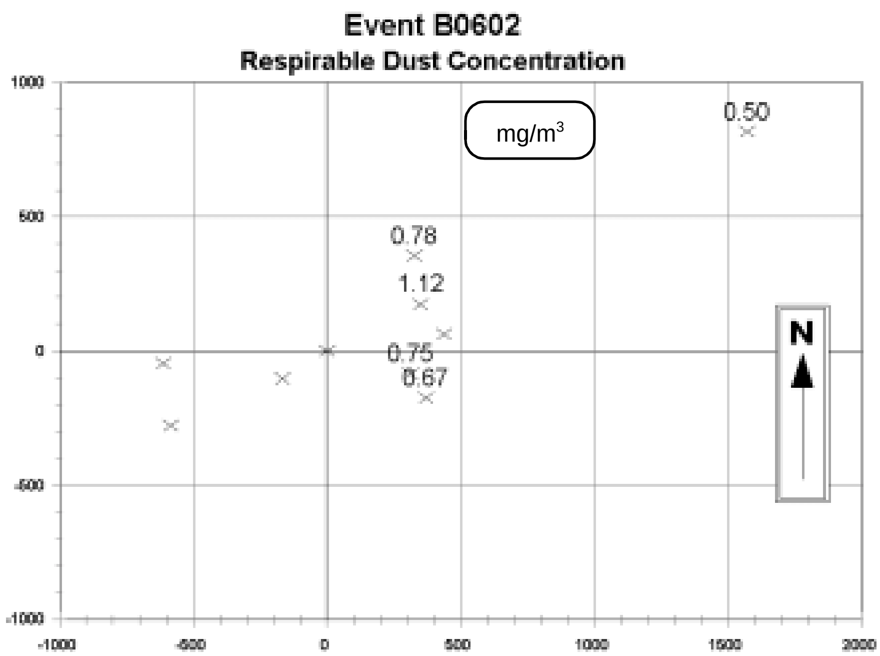






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.4 Event B0619

Weather

Observations:	74°F, relative humidity 86.0%, cloudy with intermittent drizzle
Wind:	4.9 mph

Blasting Data

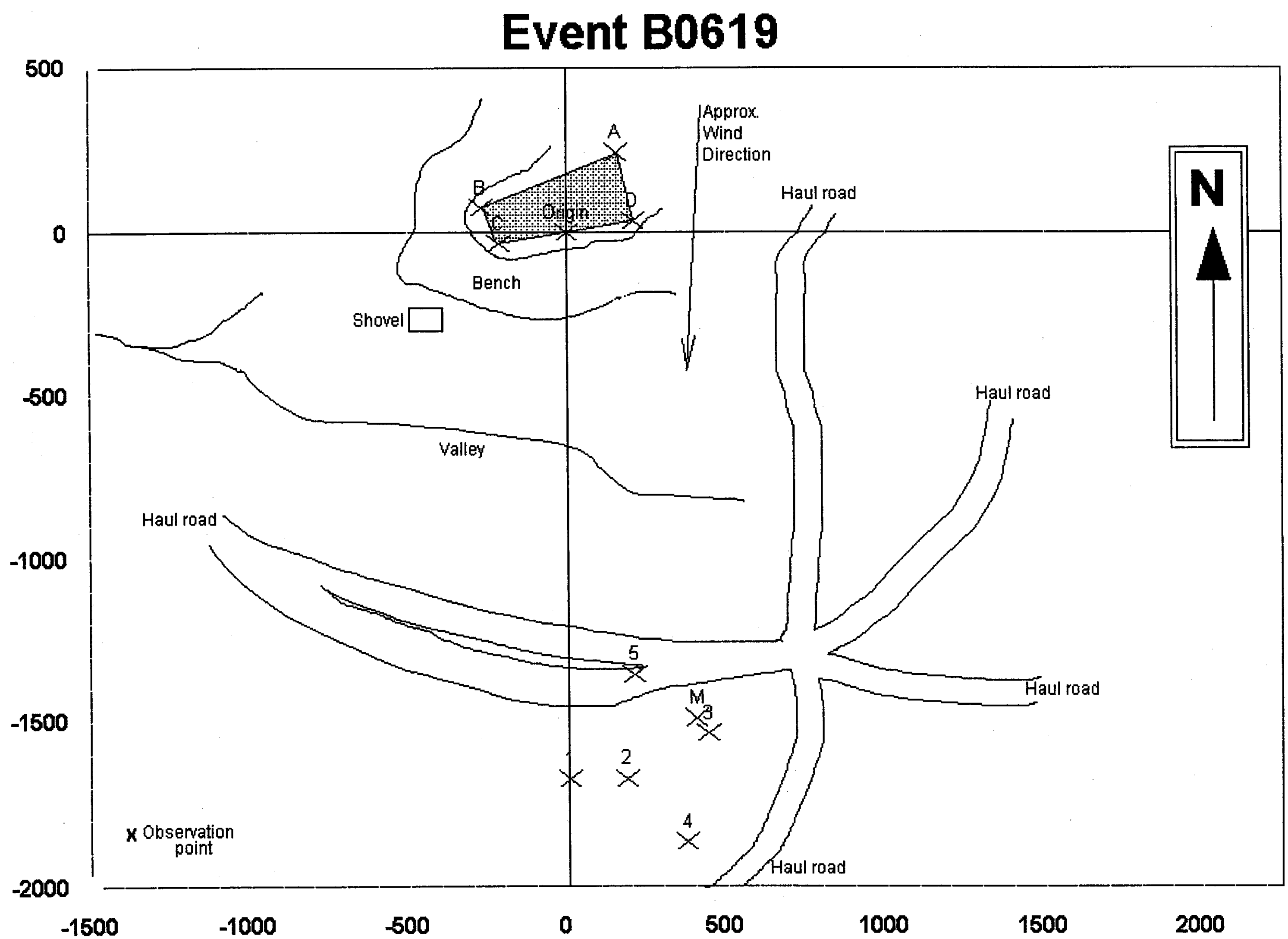
Time of ignition:	1531 hrs
Strata blasted:	Shale and sandstone
Hole Diameter:	9”
Hole Depth:	54’
Number of holes:	120
Stemming used:	11’ drill cuttings
Explosive types used:	ANFO 60/40, 3/4-lb cast primers, nonel
Weight of explosive used:	191,011 lbs
Weight of explosive used per hole:	1,592 lbs
Cubic Yardage Moved:	150,000 yd^3
Powder Factor:	1.27

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.10 mg
Respirable Dust Maximum:	0.12 mg
NO_2 high:	1.4 ppm
Duration of maximum NO_2 exposure:	4 min
Duration of maximum dust exposure:	0

Main Station Data

NO High:	9.8 ppm
CO High:	88 ppm
NH_3 High:	11 ppm
Dust:	0.23 mg/m^3



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event B0619 - 1

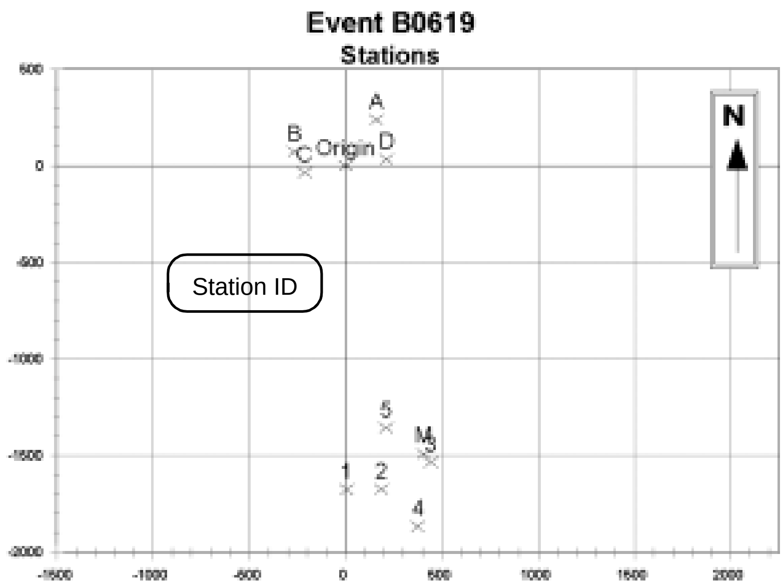
Event B0619 - 2

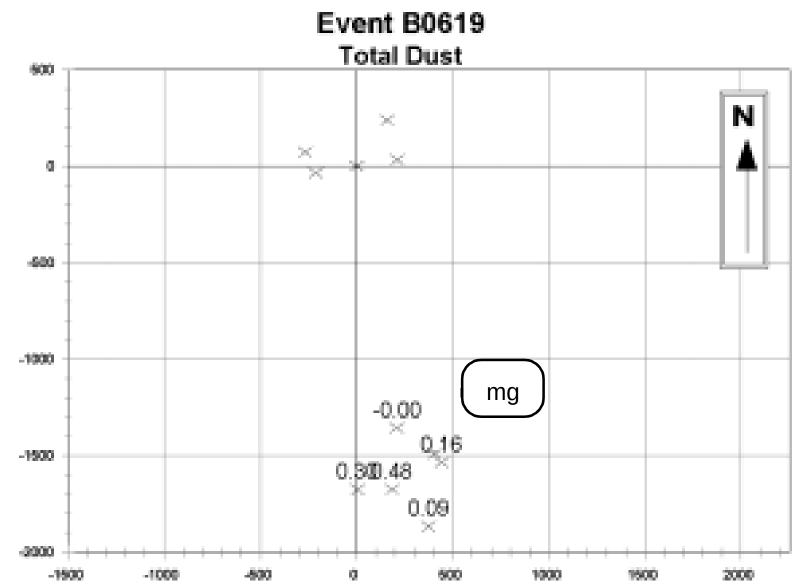
Event B0619 - 3

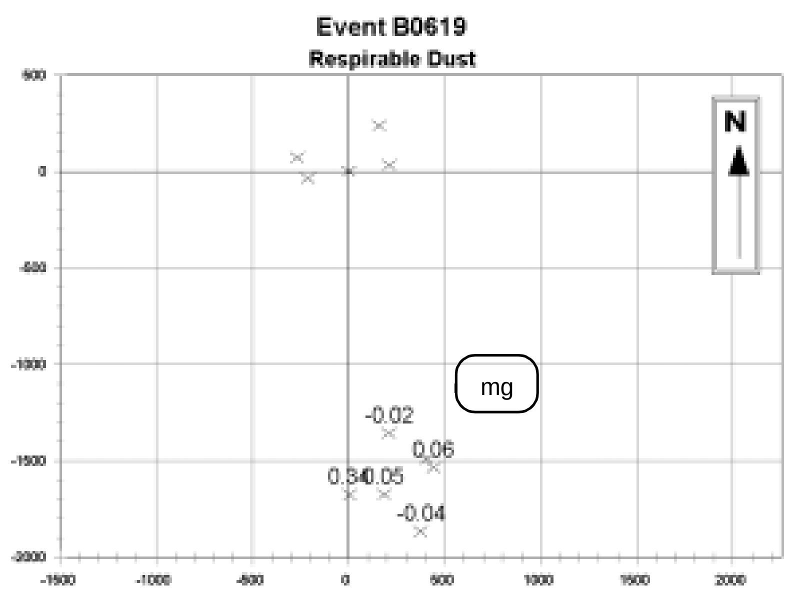
Event B0619 - 4

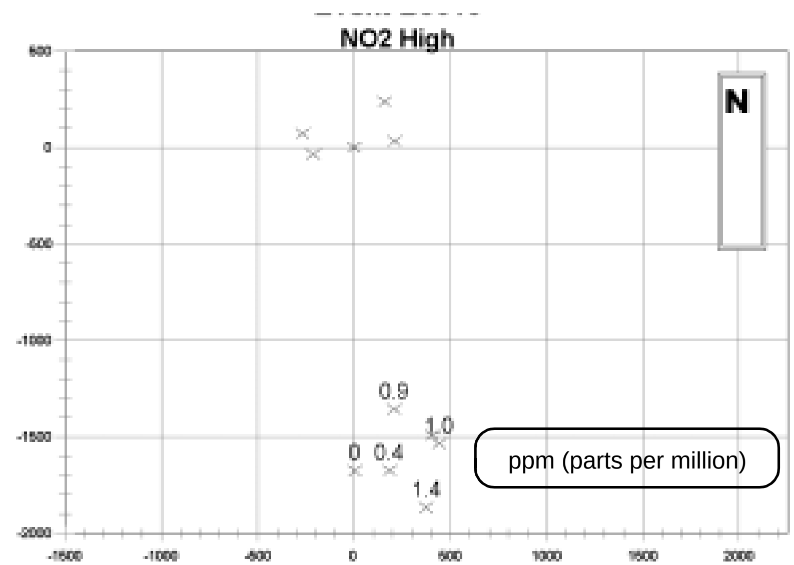
Event B0619 - 5

Event B0619 - 6

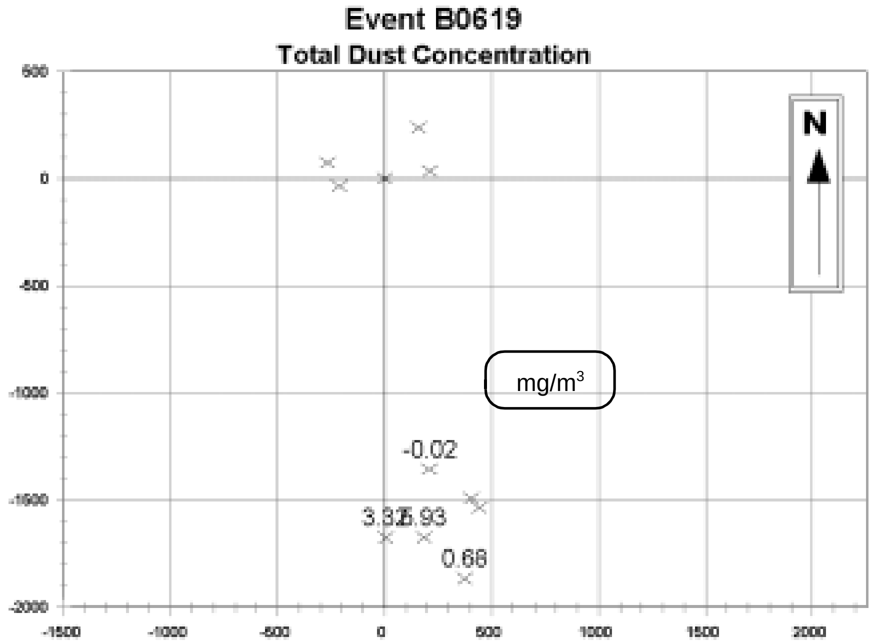


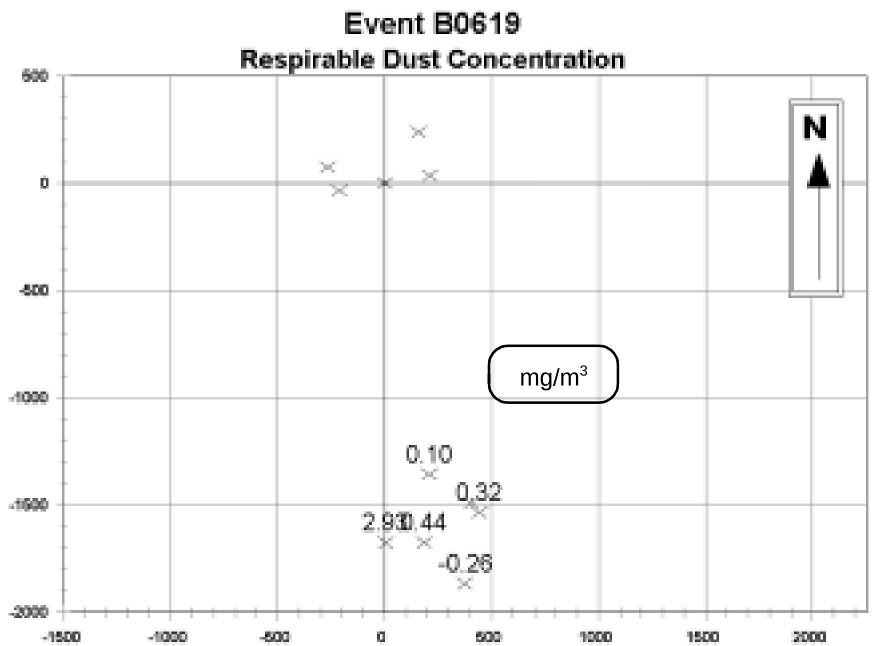






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.5 Event B0620

Weather

Observations:	105°F (approx 85 in shade), 54.0% relative humidity, sunny and clear
Wind:	1.0 mph

Blasting Data

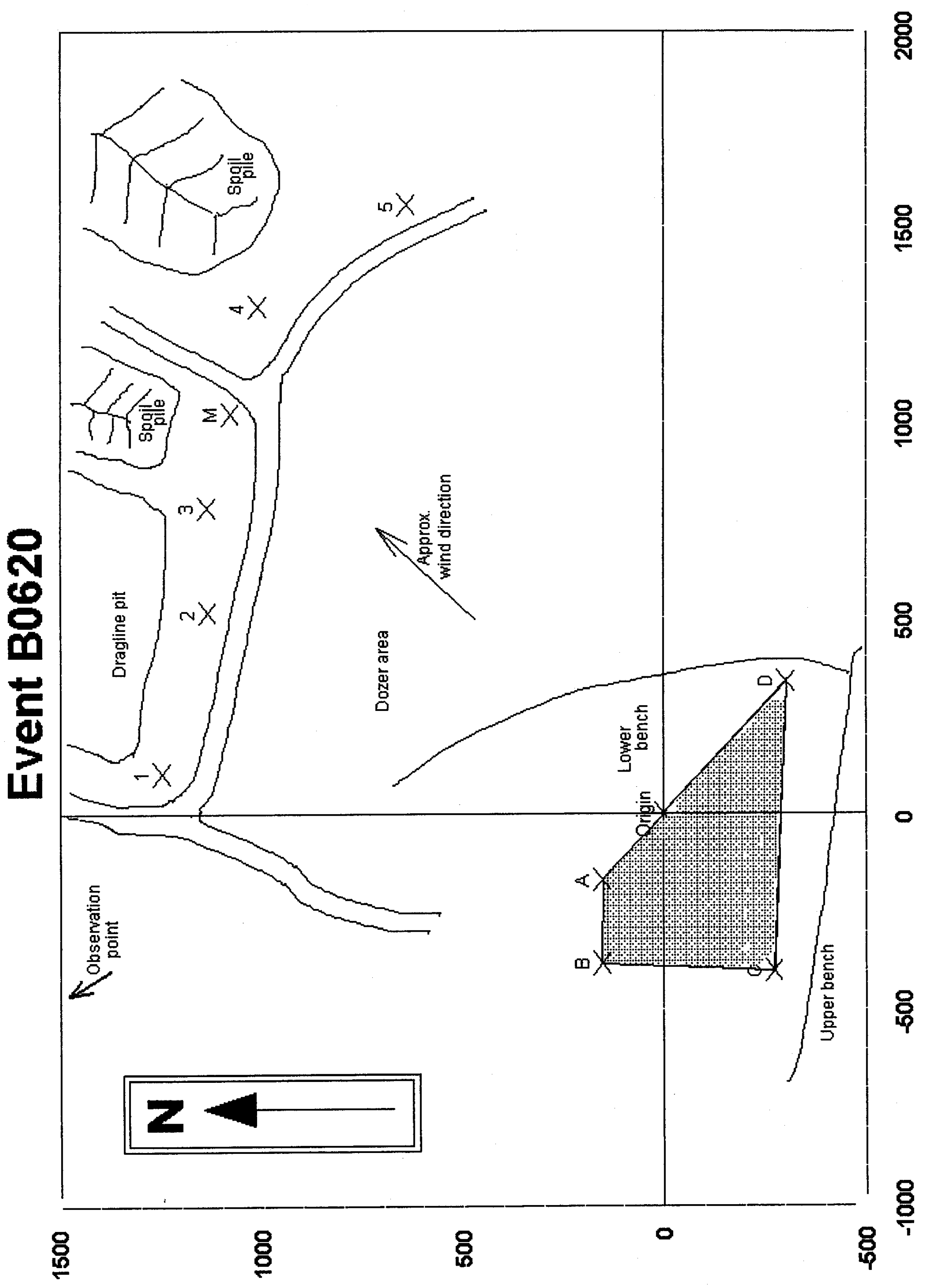
Time of ignition:	1532 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	10.625”
Hole Depth:	67’
Number of holes:	253
Stemming used:	16’ drill cuttings
Explosive types used:	ANFO 50/50, 3/4-lb pentex primers, nonel
Weight of explosive used:	669,863 lbs
Weight of explosive used per hole:	2,648 lbs
Cubic Yardage Moved:	492,207 yd^3
Powder Factor:	1.36

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.09 mg
Respirable Dust Maximum:	0.10 mg
NO_2 high:	3.6 ppm
Duration of maximum NO_2 exposure:	4 min
Duration of maximum dust exposure:	0

Main Station Data

NO High:	1.6 ppm
CO High:	20 ppm
NH_3 High:	25 ppm
Dust:	0



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event B0620 - 1

Event B0620 - 2

Event B0620 - 3

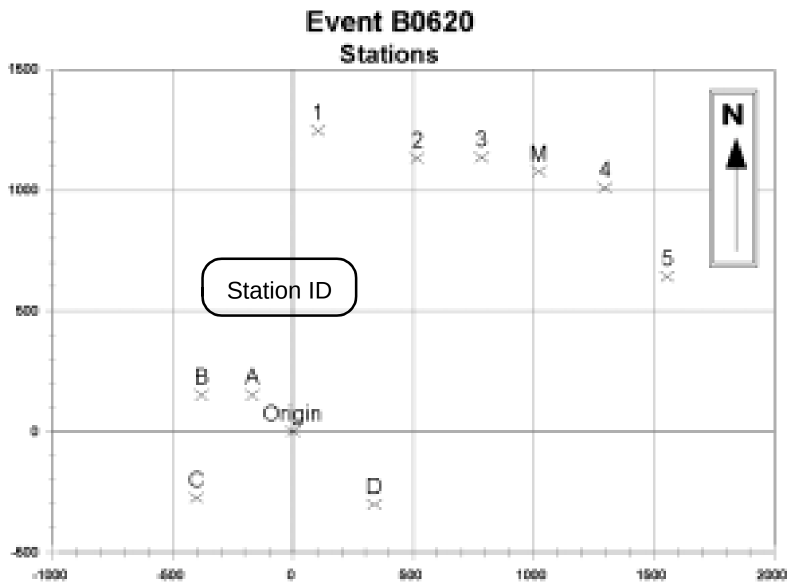
Event B0620 - 4

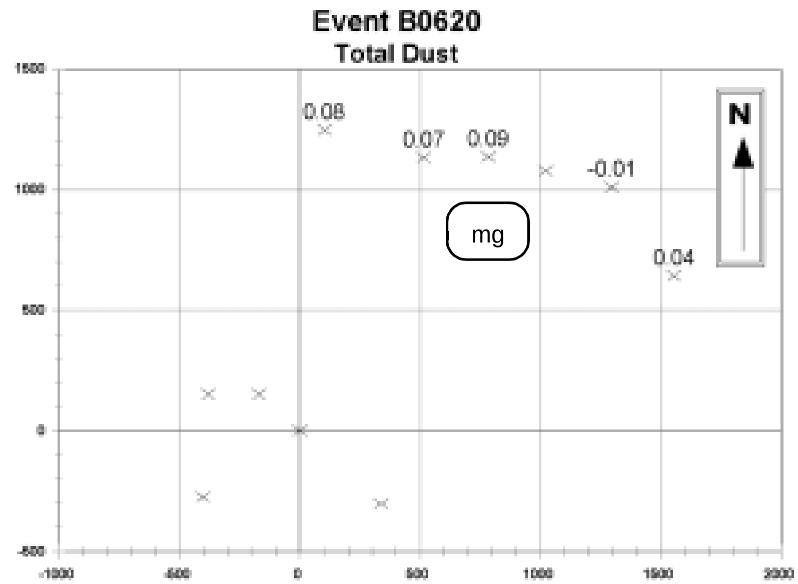
Event B0620 - 5

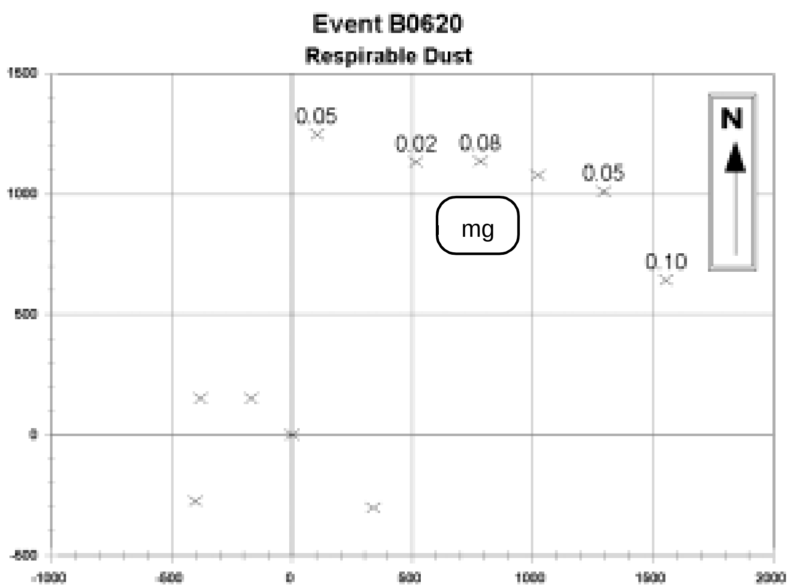
Event B0620 - 6

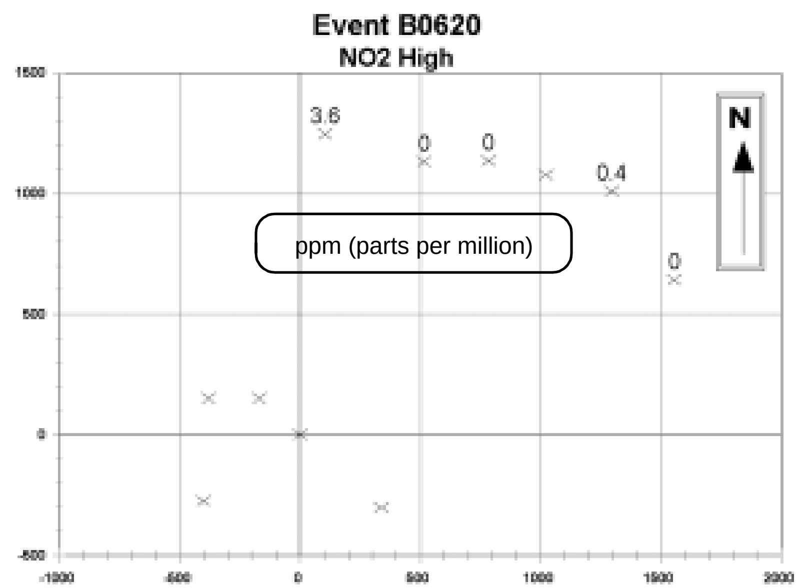
Event B0620 - 7

Event B0620 - 8

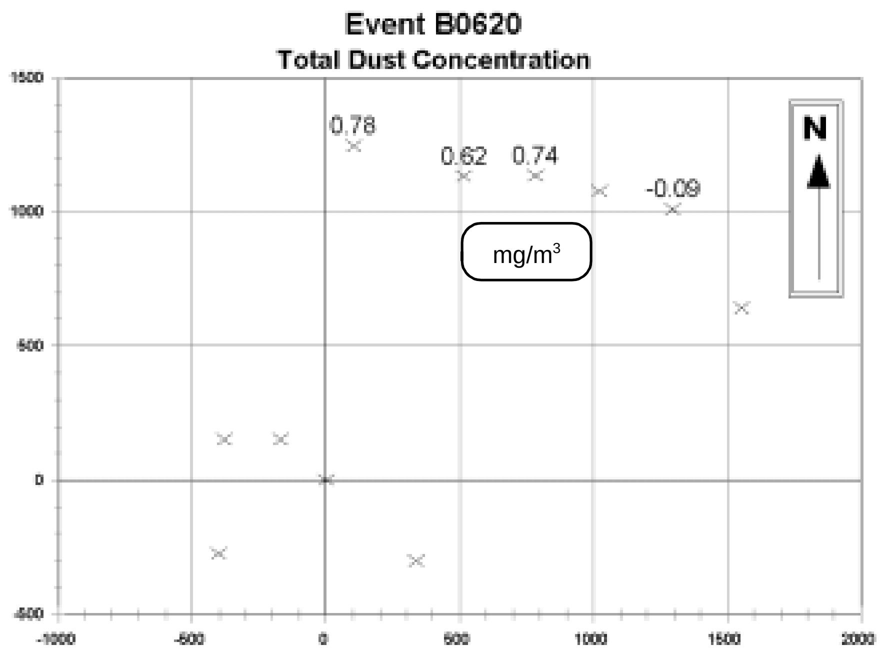


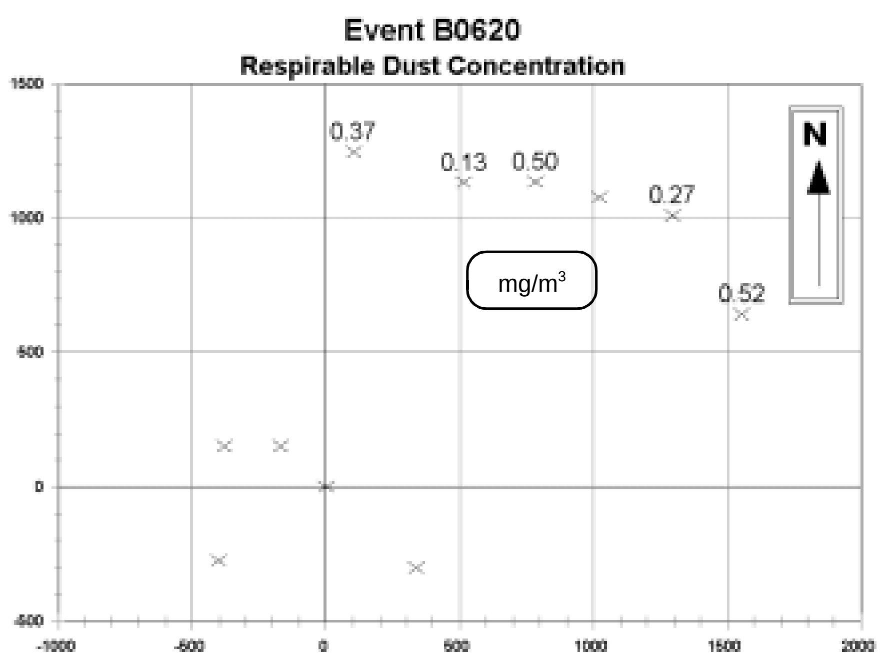






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.6 Event B0627

Weather

Observations:	77°F, 83.0% relative humidity, cloudy, intermittent rain
Wind:	2.3 mph

Blasting Data

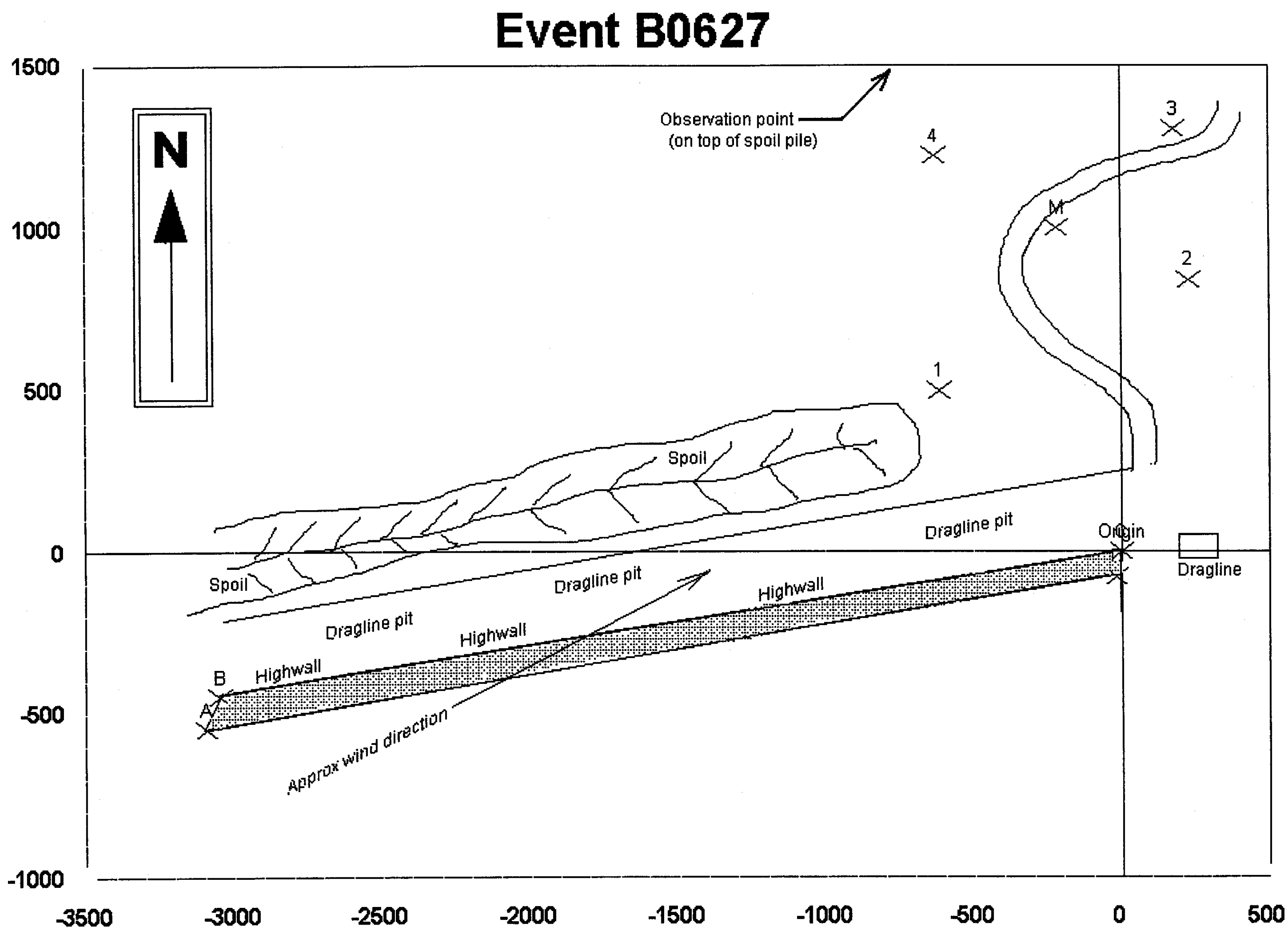
Time of ignition:	1125 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	10,625”
Hole Depth:	92’
Number of holes:	346
Stemming used:	12.5’ of drill cuttings and #57 crushed limestone
Explosive types used:	ANFO 50/50, optimizer 3/4-lb primers, nonel
Weight of explosive used:	1,159,517 lbs
Weight of explosive used per hole:	3,351 lbs
Cubic Yardage Moved:	1,018,624 lbs
Powder Factor:	1.14

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.15 mg
Respirable Dust Maximum:	0.12 mg
NO_2 high:	0.5 ppm
Duration of maximum NO_2 exposure:	1 min
Duration of maximum dust exposure:	0

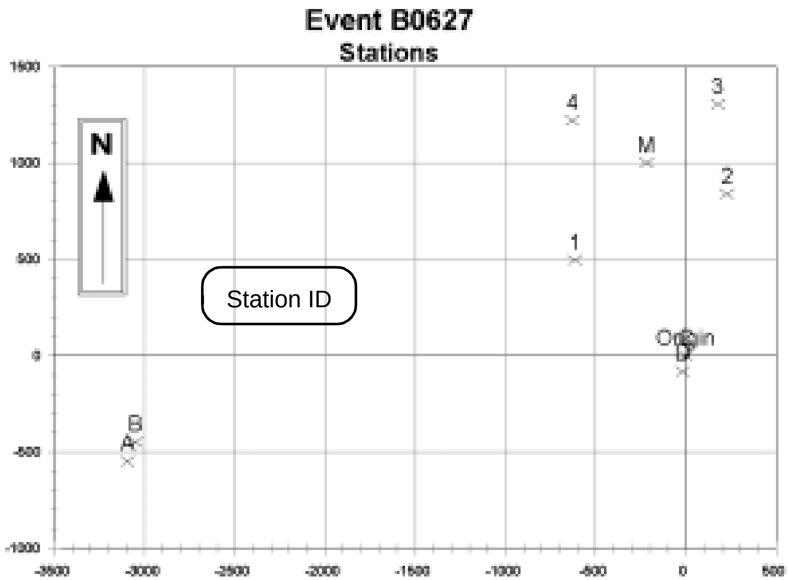
Main Station Data

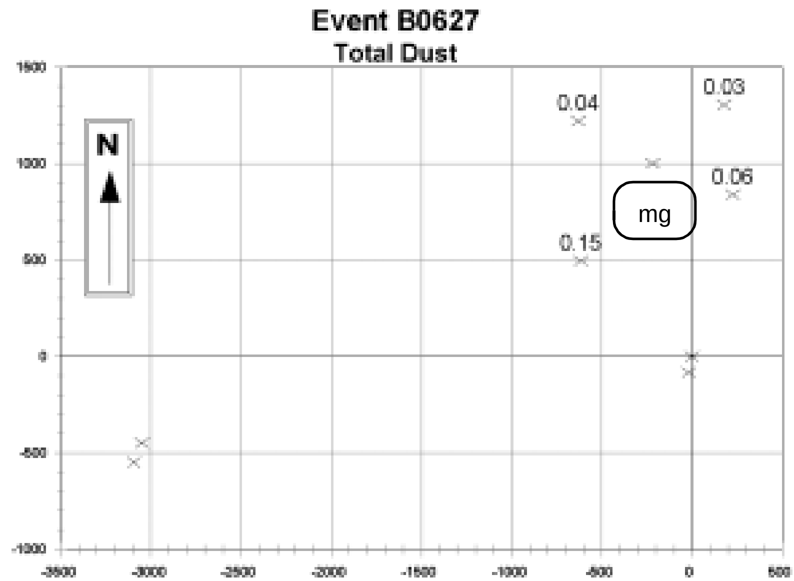
NO High:	0
CO High:	2 ppm
NH_3 High:	N/A
Dust:	0

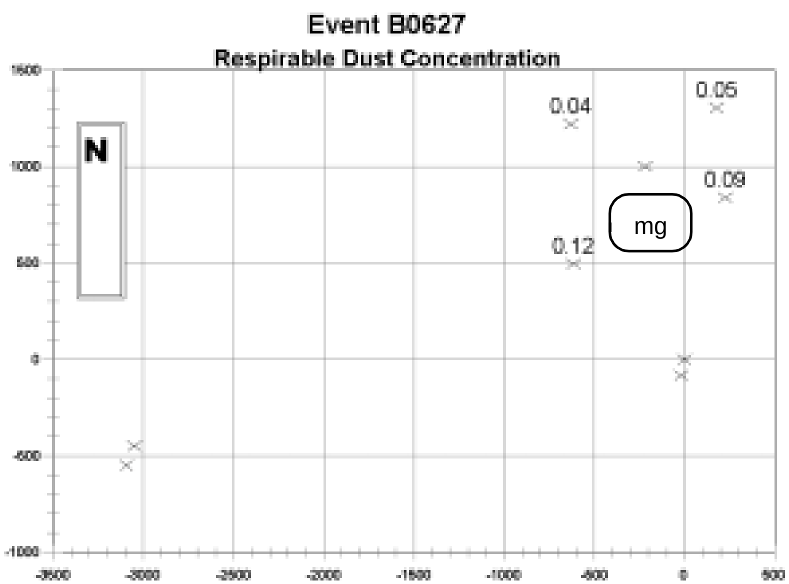


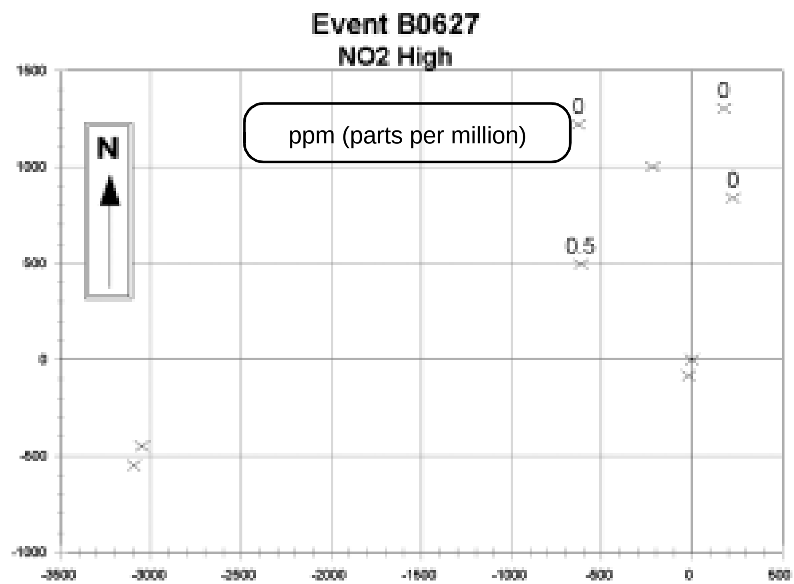
Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

No Photographs For Event B0627

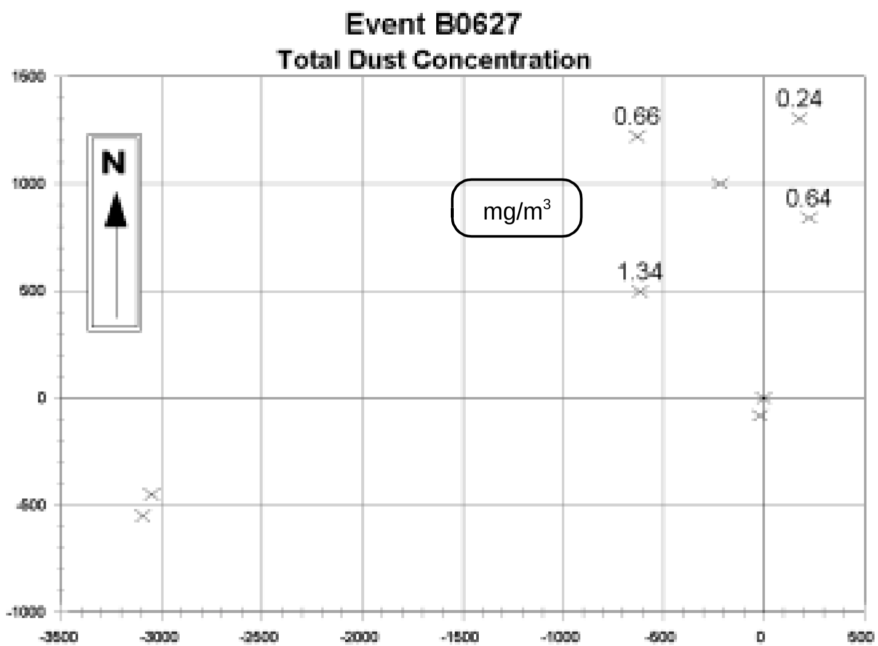


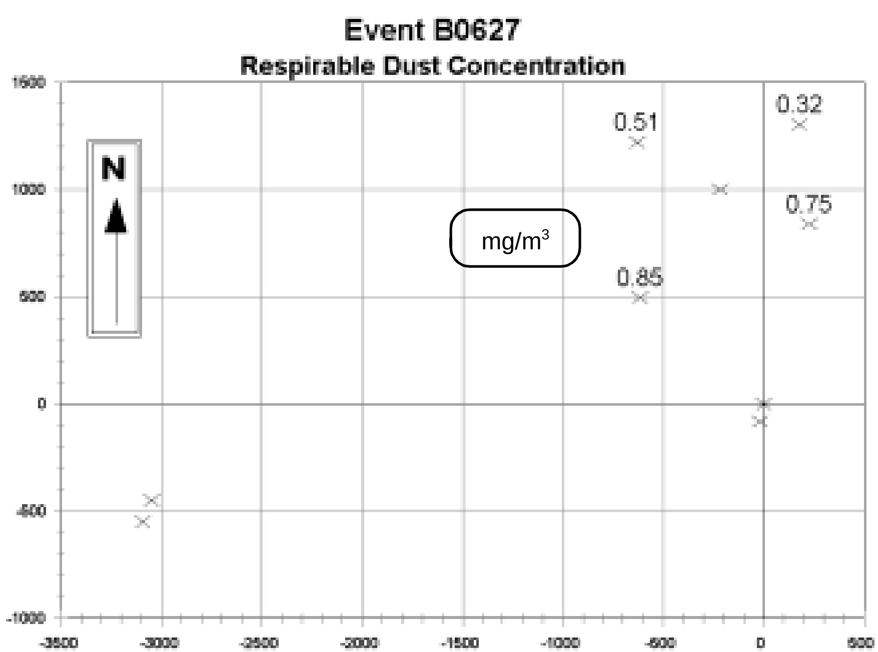






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.7 Event B0816

Weather

Observations:	90°F, 52.0% relative humidity, sunny and clear
Wind:	5.2 mph

Blasting Data

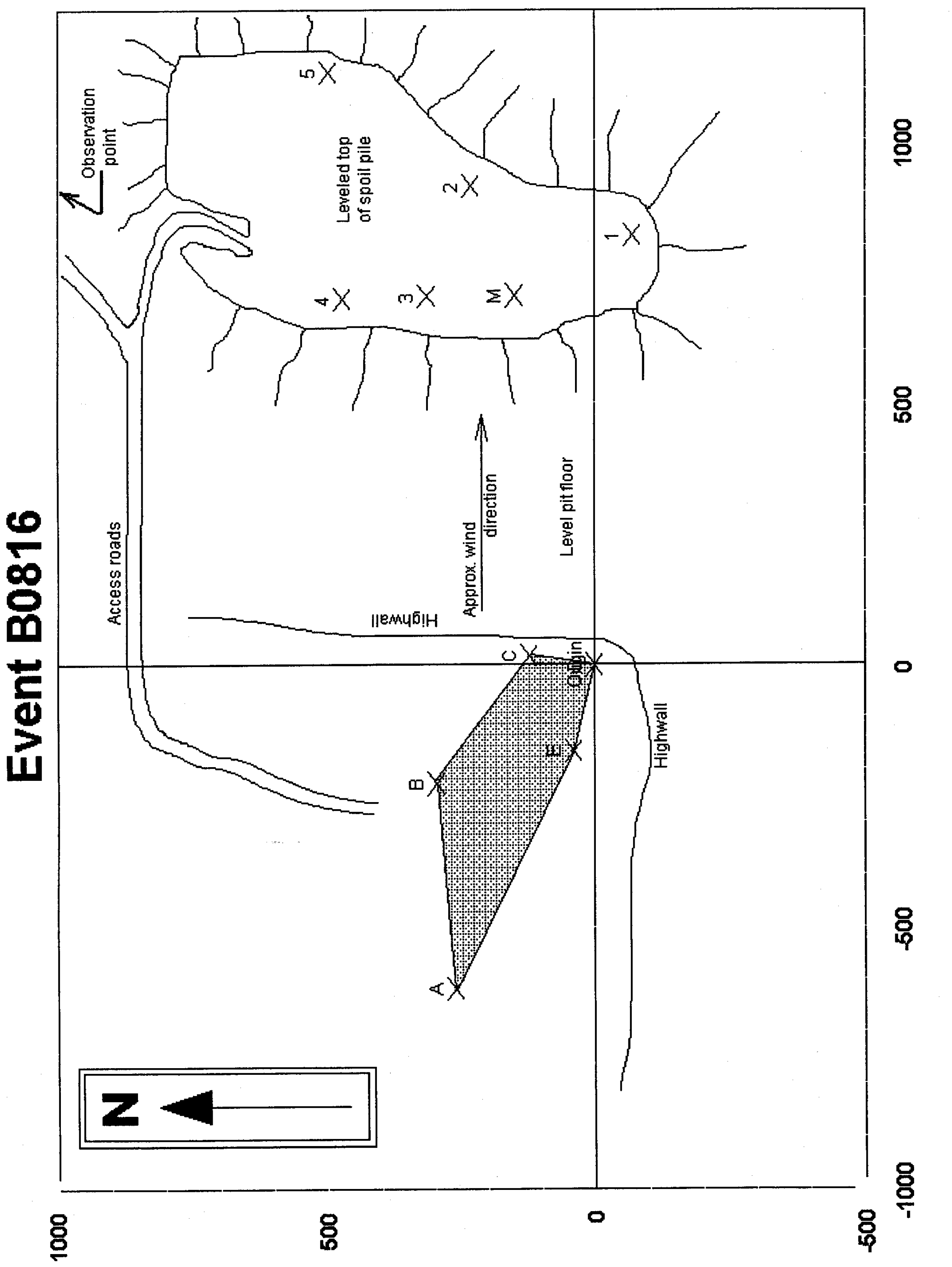
Time of ignition:	1531 hrs
Strata blasted:	Sandstone and shale
Hole Diameter:	10.625”
Hole Depth:	58’
Number of holes:	118
Stemming used:	11’ drill cuttings
Explosive types used:	ANFO 60/40, pentex 3/4-lb primers, nonel
Weight of explosive used:	287,930 lbs
Weight of explosive used per hole:	2,440 lbs
Cubic Yardage Moved:	198,730 yd^3
Powder Factor:	1.45

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.66 mg
Respirable Dust Maximum:	0.10 mg
NO_2 high:	0.8 ppm
Duration of maximum NO_2 exposure:	2 min
Duration of maximum dust exposure:	0

Main Station Data

NO High:	6.5 ppm
CO High:	196 ppm
NH_3 High:	68 ppm
Dust:	15.95 mg/m^3



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event B0816 - 1

Event B0816 - 2

Event B0816 - 3

Event B0816 - 4

Event B0816 - 5

Event B0816 - 6

Event B0816 - 7

Event B0816 - 8

Event B0816 - 9

Event B0816 - 10

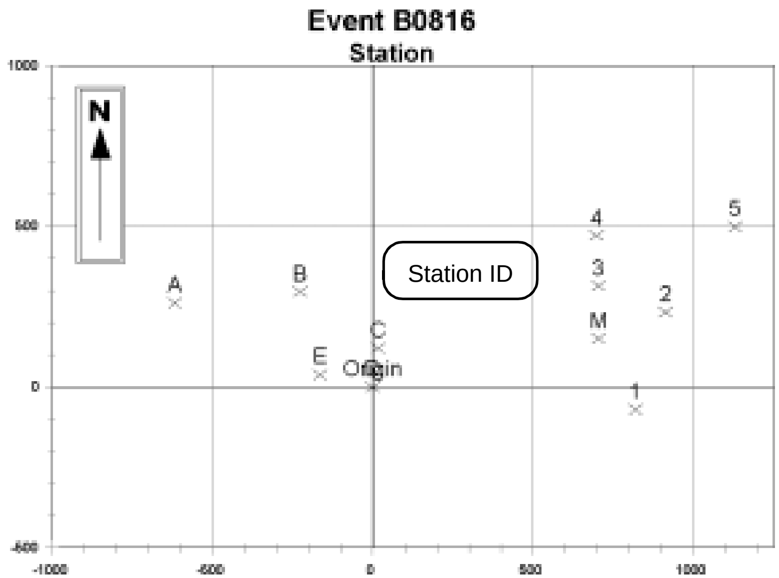
Event B0816 - 11

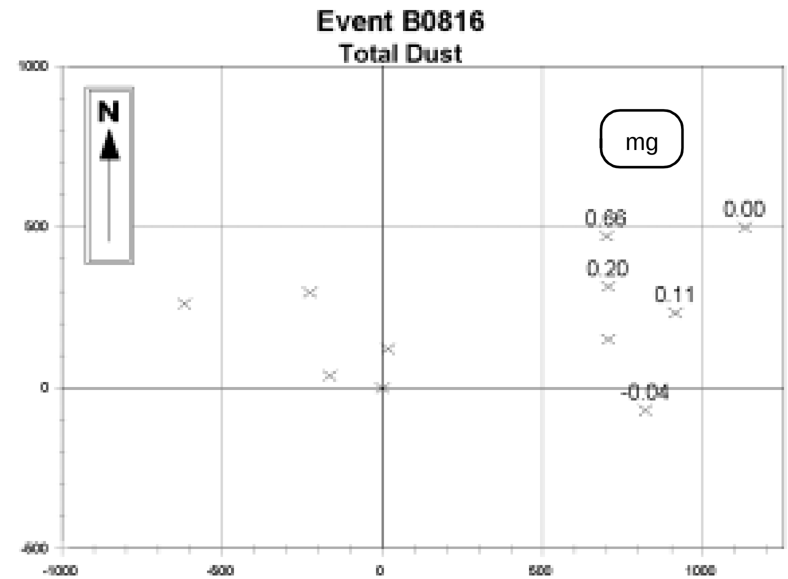
Event B0816 - 12

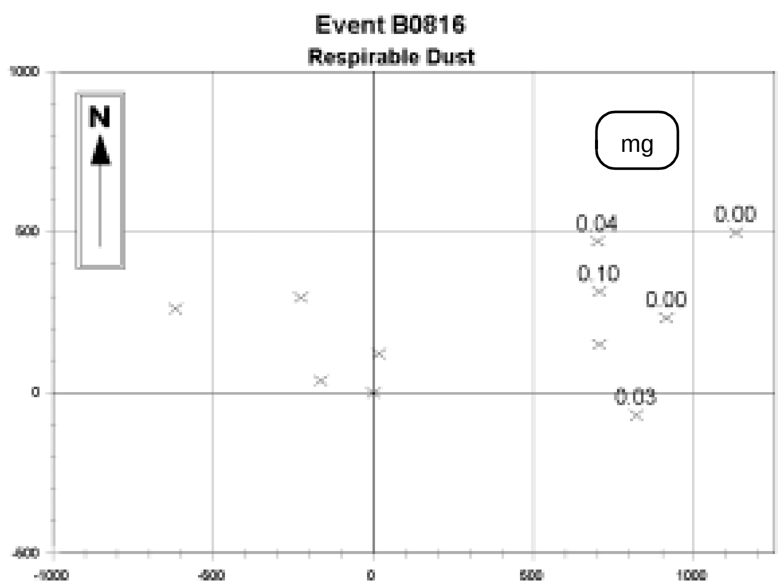
Event B0816 - 13

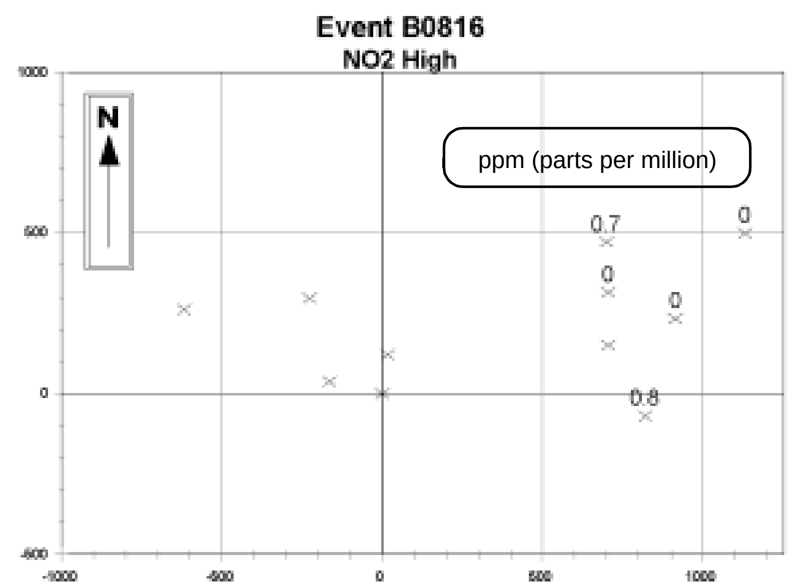
Event B0816 - 14

Event B0816 - 15

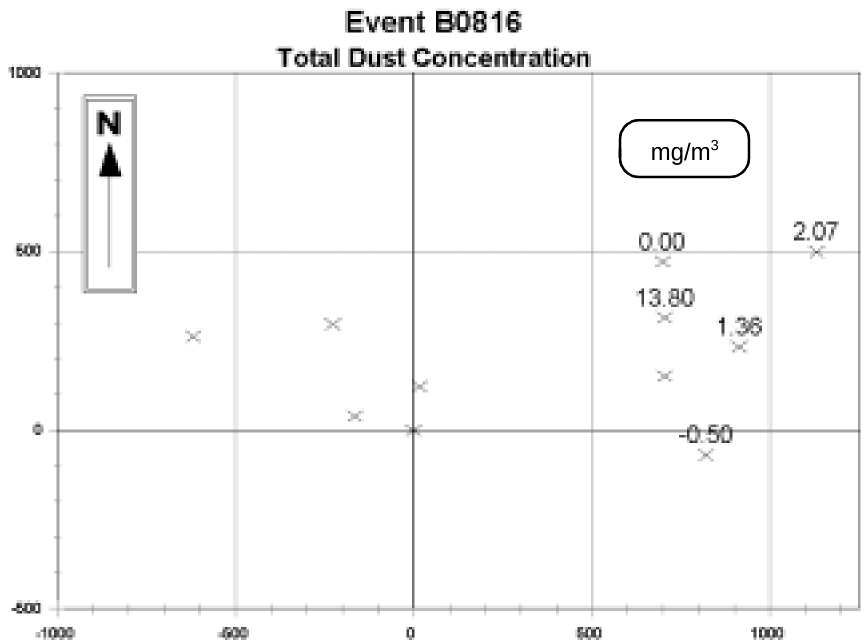


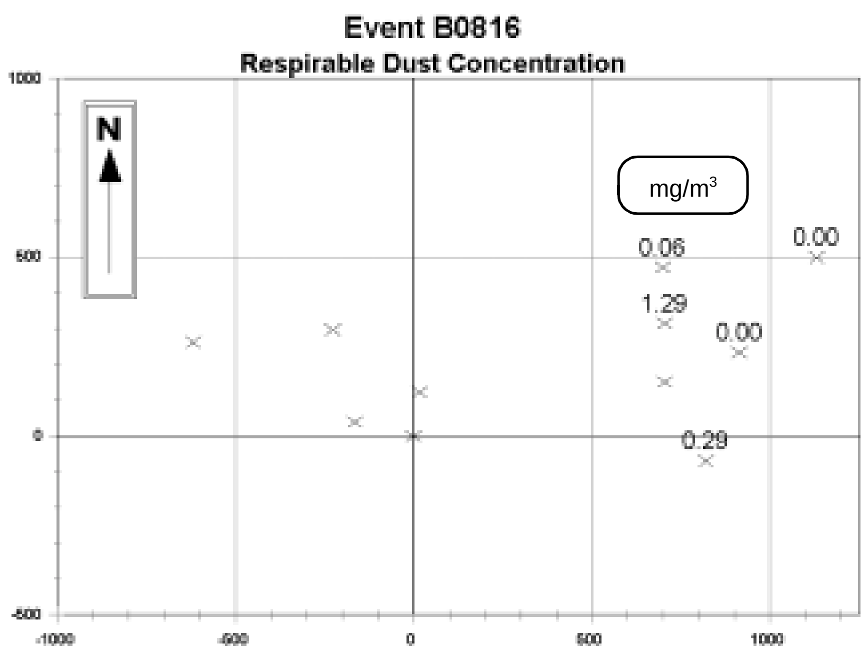






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.8 Event C0712

Weather

Observations:	89°F, 62.0% relative humidity, sunny and clear
Wind:	0.0 fpm

Blasting Data

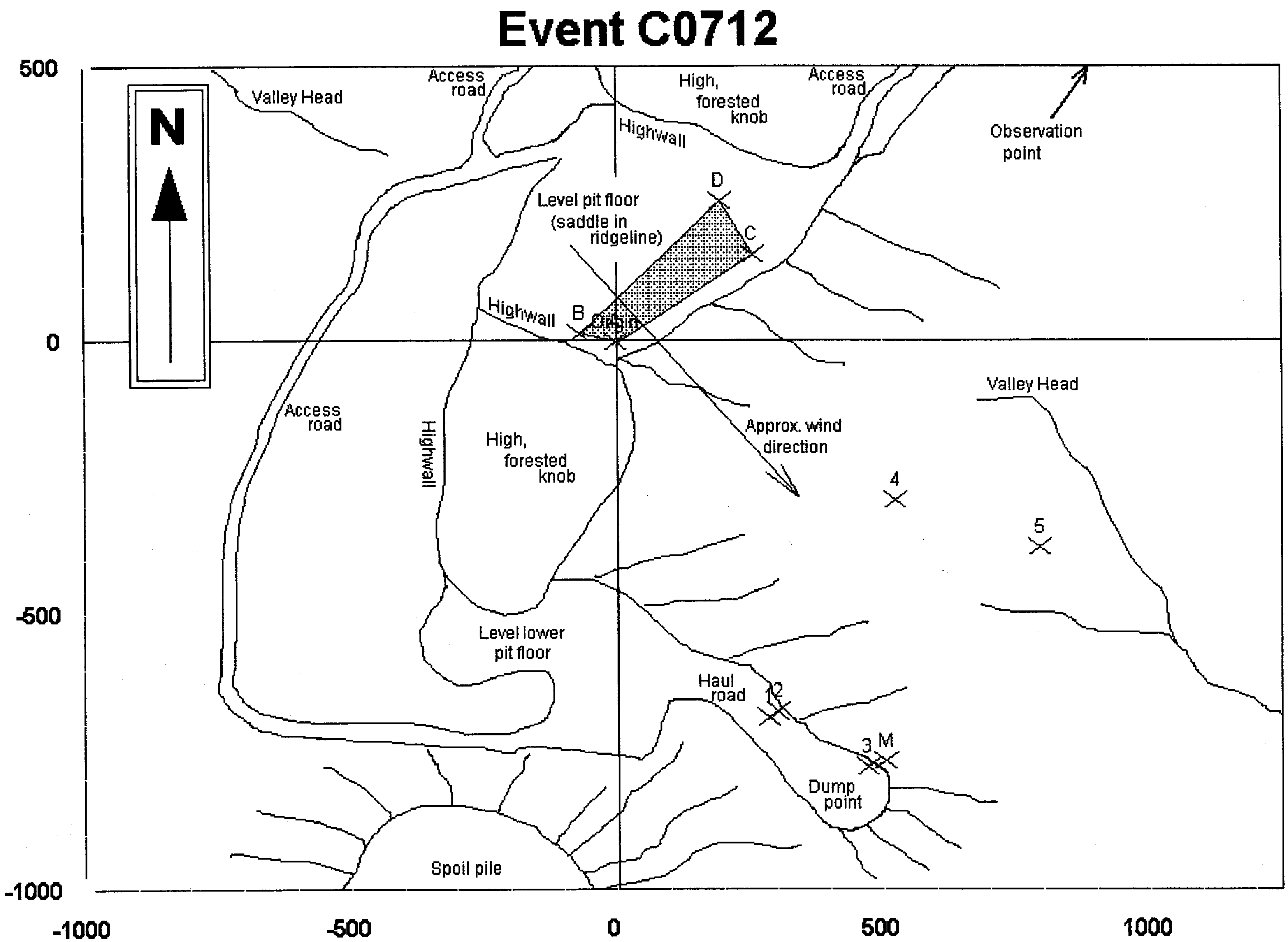
Time of ignition:	1520 hrs
Strata blasted:	Sandrock and shale
Hole Diameter:	7.875”
Hole Depth:	53’
Number of holes:	105
Stemming used:	8’ drill cuttings
Explosive types used:	ANFO, Austin 3/4-lb primers, nonel
Weight of explosive used:	85,156 lbs
Weight of explosive used per hole:	811 lbs
Cubic Yardage Moved:	70,490 yd^3
Powder Factor:	1.21

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.13 mg
Respirable Dust Maximum:	0.15 mg
NO_2 high:	0.5
Duration of maximum NO_2 exposure:	1 minute
Duration of maximum dust exposure:	0

Main Station Data

NO High:	0.7 ppm
CO High:	3 ppm
NH_3 High:	N/A
Dust:	15.87 mg/m^3



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event C0712 - 1

Event C0712 - 2

Event C0712 - 3

Event C0712 - 4

Event C0712 - 5

Event C0712 - 6

Event C0712 - 7

Event C0712 - 8

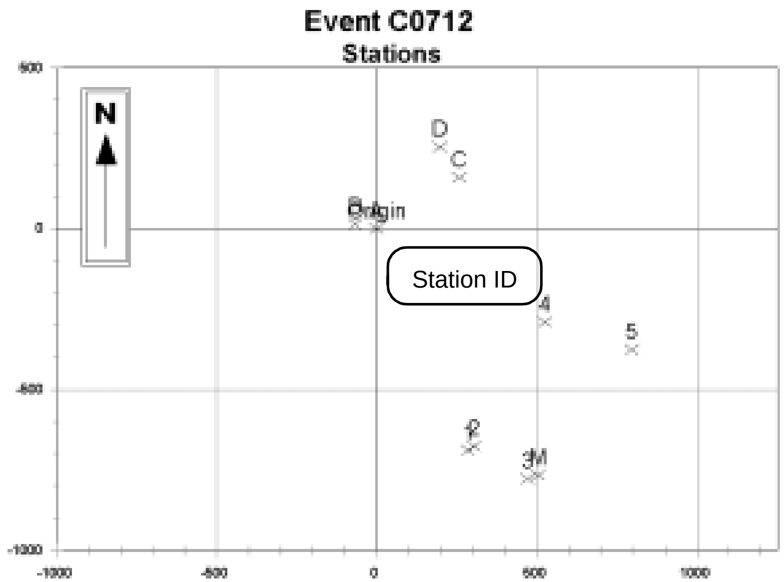
Event C0712 - 9

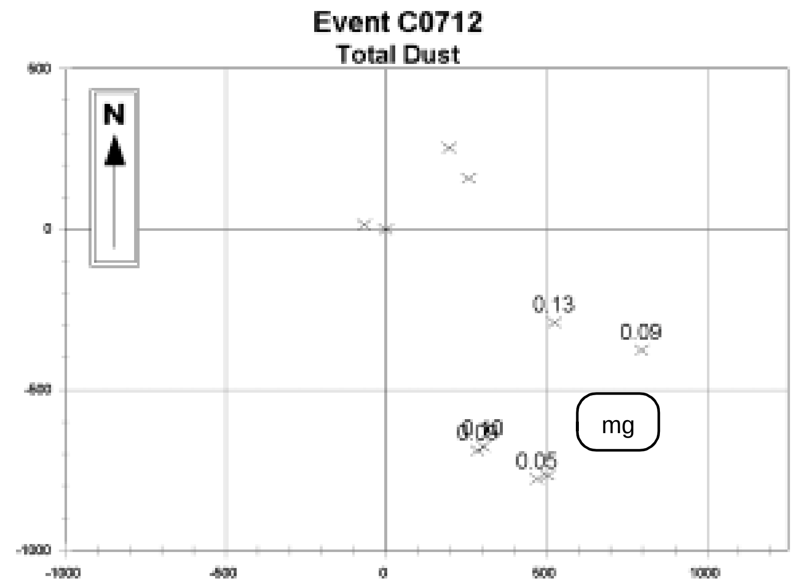
Event C0712 - 10

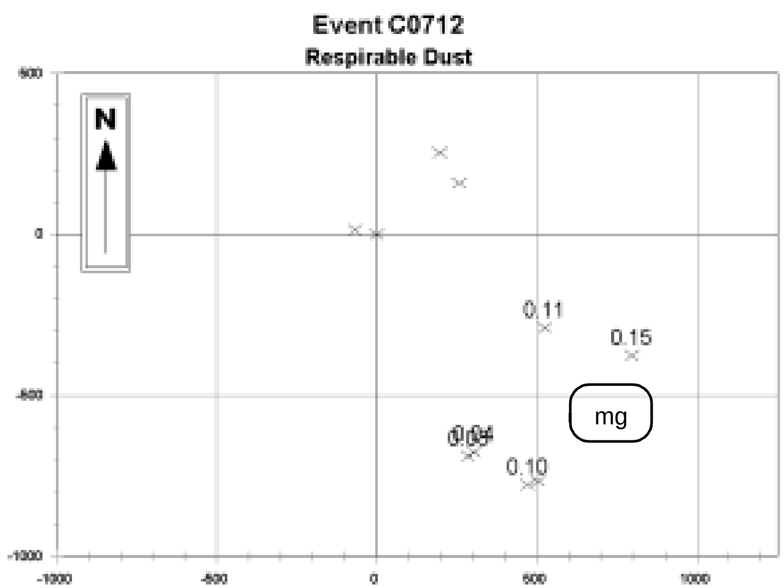
Event C0712 - 11

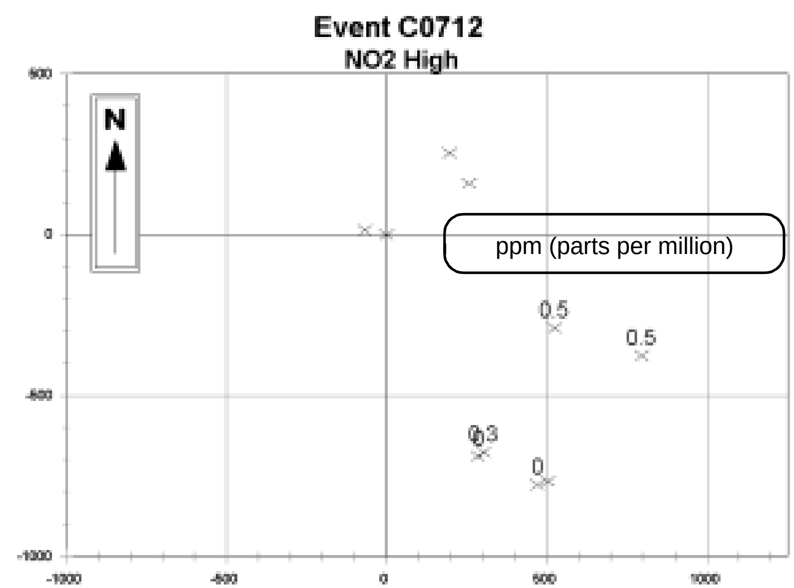
Event C0712 - 12


Note gas cloud at bottom of freshly blasted pit

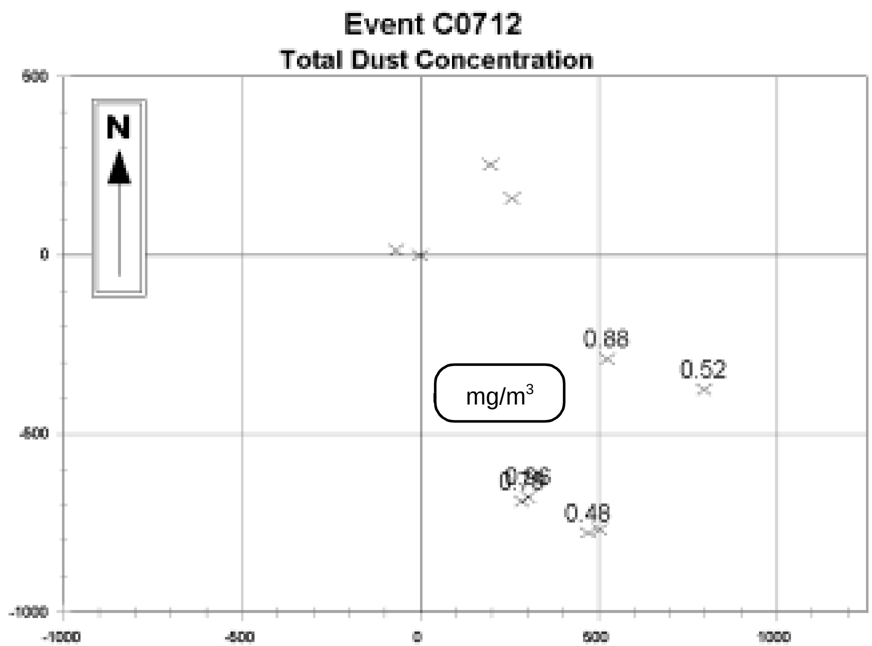


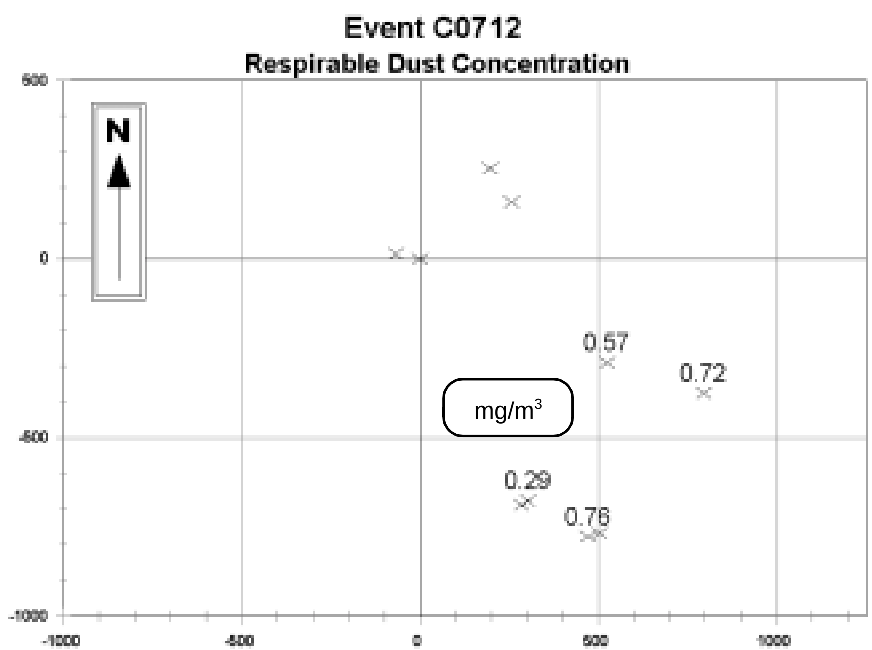






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.9 Event C0714

Weather

Observations:	89°F, 36.0% relative humidity, scattered clouds
Wind:	2.8 mph

Blasting Data

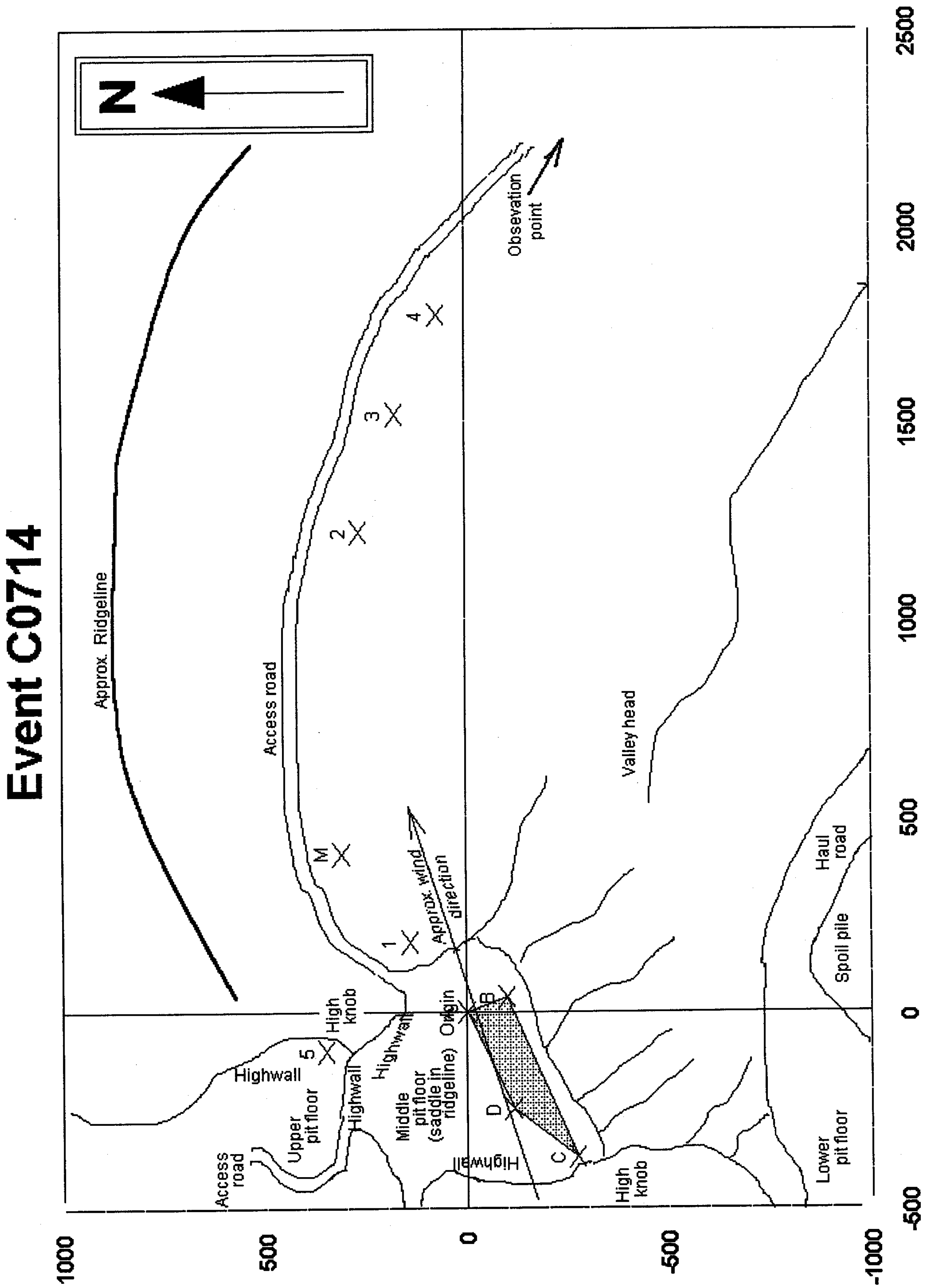
Time of ignition:	1456 hrs
Strata blasted:	Sandrock and shale
Hole Diameter:	7.825”
Hole Depth:	57’
Number of holes:	120
Stemming used:	8’ drill cuttings
Explosive types used:	ANFO, Austin 3/4-lb primers, nonel
Weight of explosive used:	99,465 lbs
Weight of explosive used per hole:	829 lbs
Cubic Yardage Moved:	82,080 yd^3
Powder Factor:	1.21

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.38 mg
Respirable Dust Maximum:	0.21 mg
NO_2 high:	4.2 ppm
Duration of maximum NO_2 exposure:	4 min
Duration of maximum dust exposure:	0

Main Station Data

NO High:	4.7 ppm
CO High:	8 ppm
NH_3 High:	13 ppm
Dust:	N/A



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event C0714 - 1

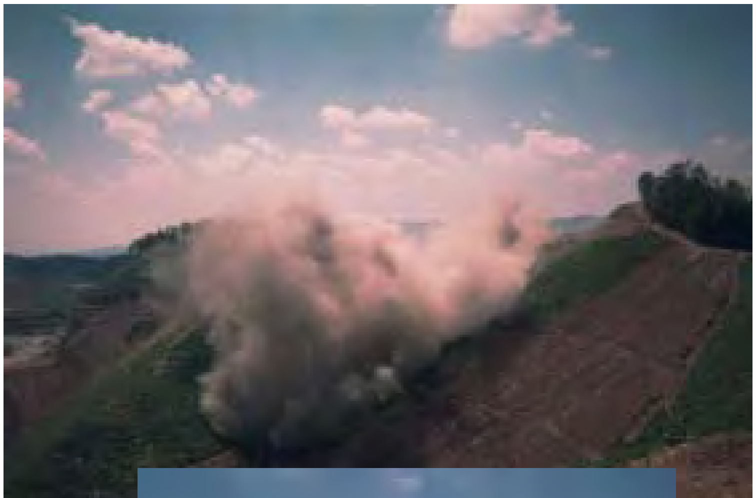
Event C0714 - 2

Event C0714 - 3

Event C0714 - 4

Event C0714 - 5

Event C0714 - 6



Event C0714 - 7

Event C0714 - 8

Event C0714 - 9

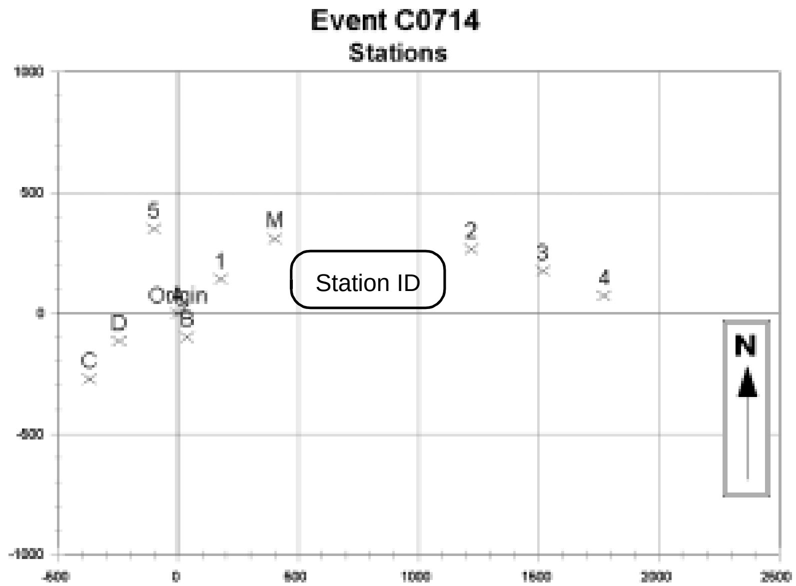
Event C0714 - 10

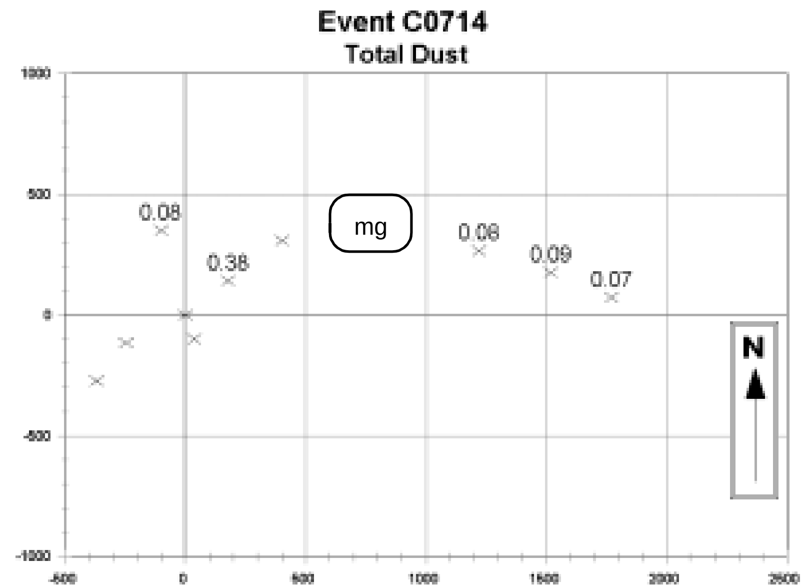
Event C0714 - 11

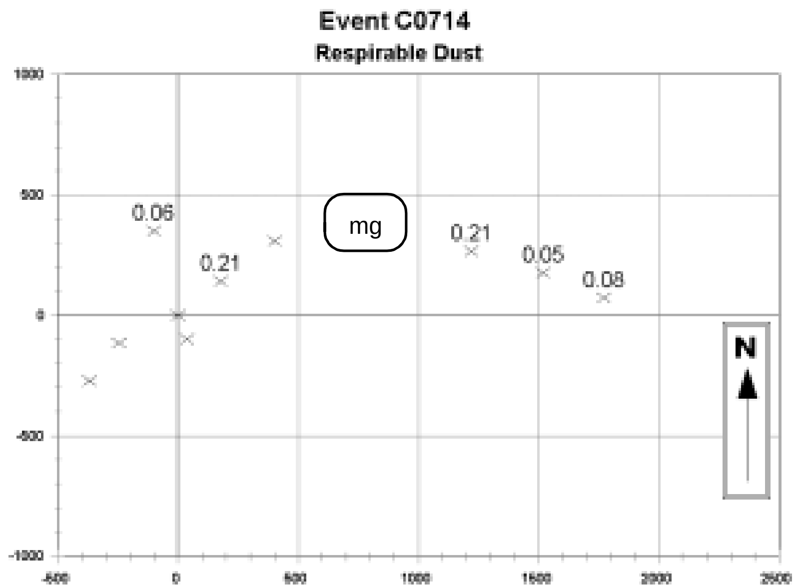
Event C0714 - 12

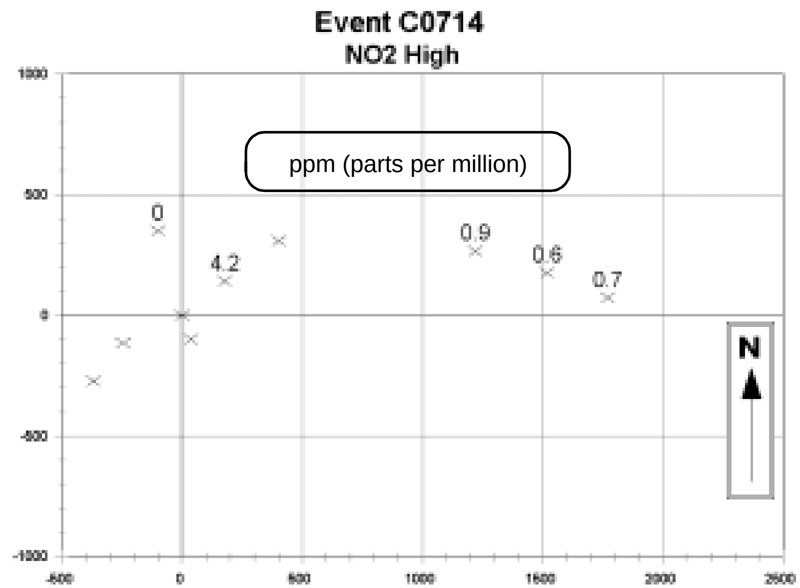
Event C0714 - 13

Event C0714 - 14

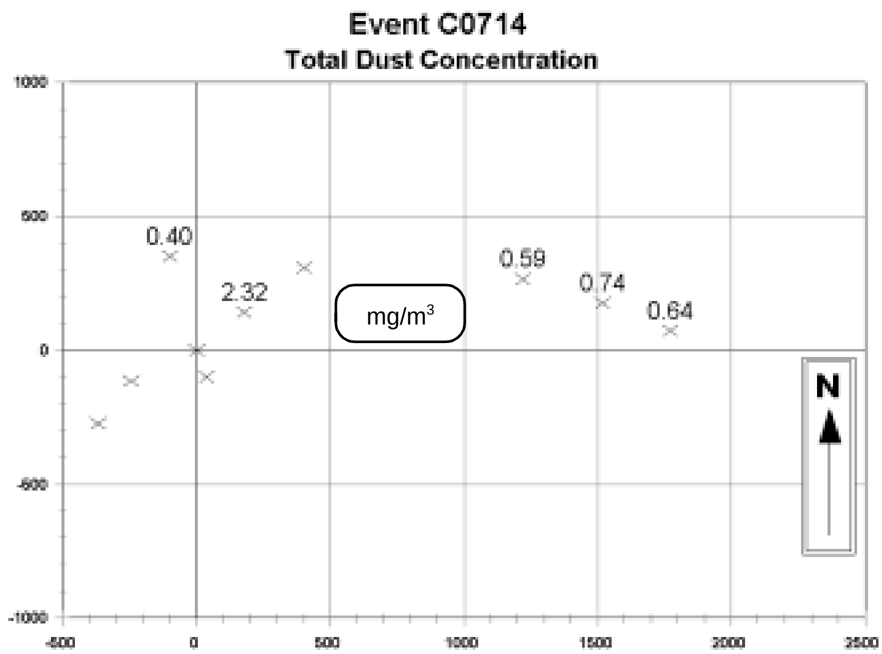


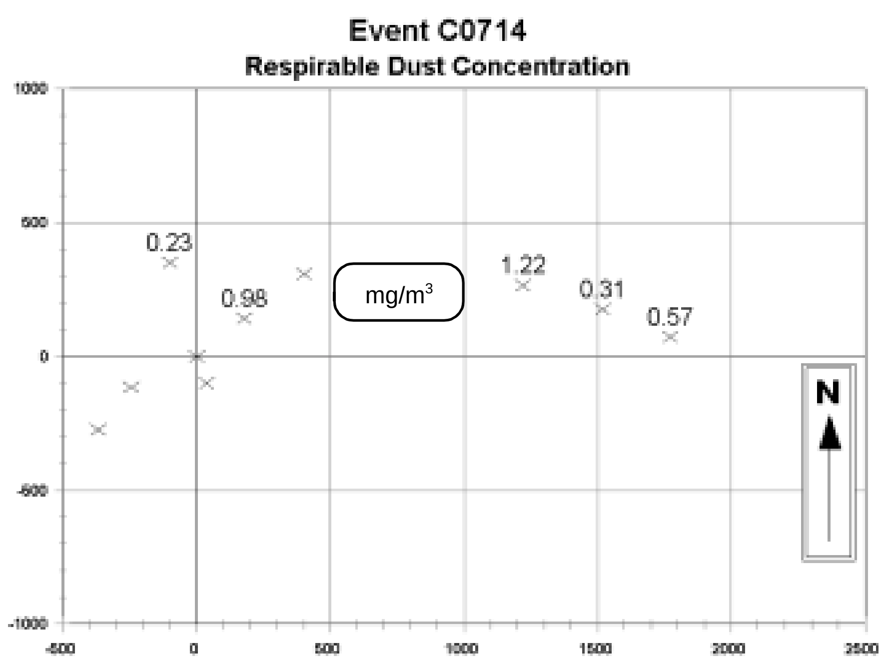






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

4.2.10 Event C0726

Weather

Observations: °F, cloudy
Wind:

Blasting Data

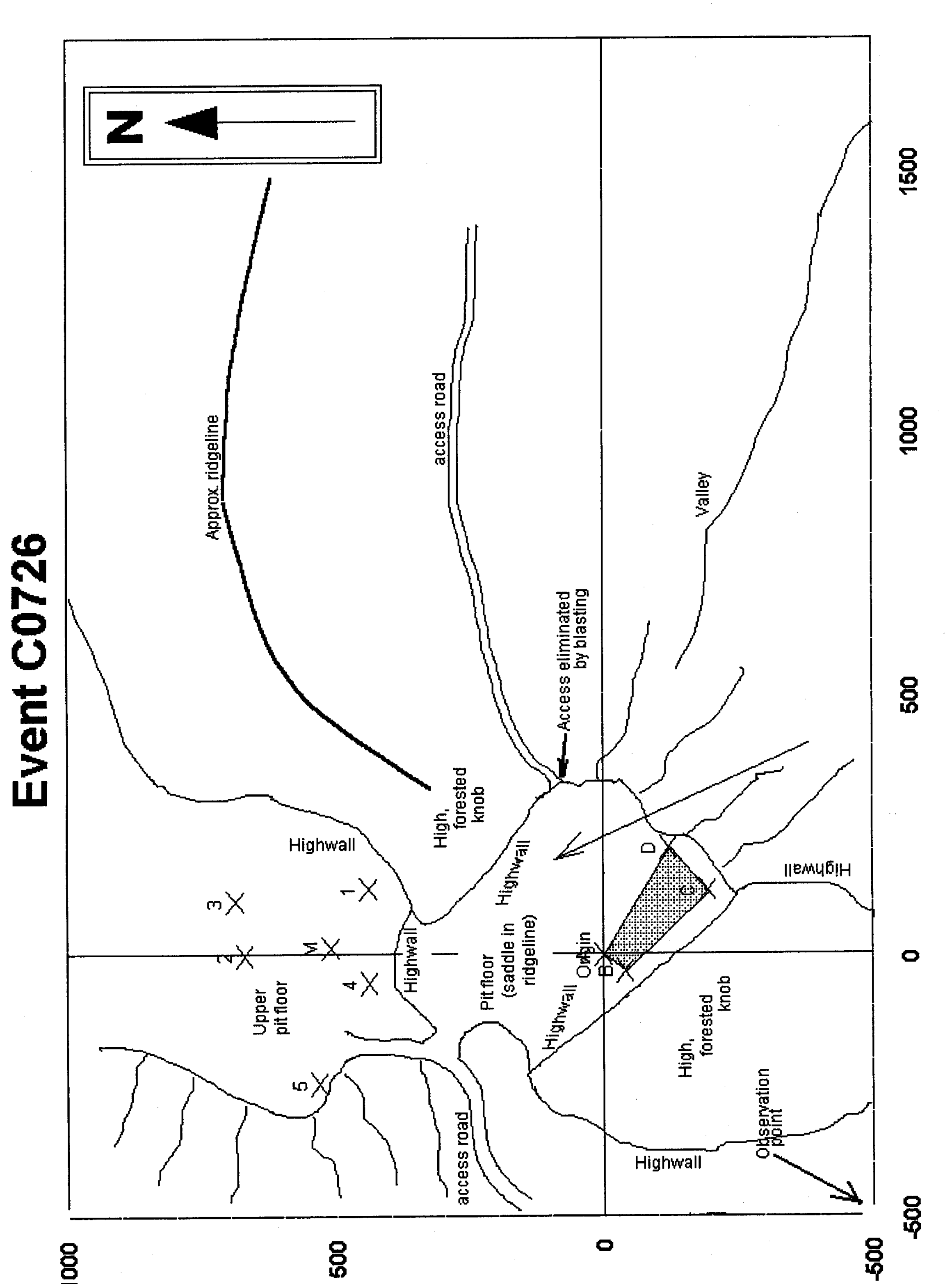
Time of ignition:	1627 hrs
Strata blasted:	Shale
Hole Diameter:	7.825”
Hole Depth:	57’
Number of holes:	72
Stemming used:	10’ drill cuttings
Explosive types used:	ANFO, Austin 3/4-lb primers, nonel
Weight of explosive used:	60,900 lbs
Weight of explosive used per hole:	846 lbs
Cubic Yardage Moved:	49,248 yd^3
Powder Factor:	1.24

Event Summary Data for Satellite Stations

Total Dust Maximum:	0.29 mg
Respirable Dust Maximum:	0.10 mg
NO_2 high:	0.8 ppm
Duration of maximum NO_2 exposure:	2 min
Duration of maximum dust exposure:	0

Main Station Data

NO High:	15.6 ppm
CO High:	54 ppm
NH_3 High:	N/A
Dust:	N/A



Axis distances are feet from the point of the blast nearest the main measurement station (0,0)

Event C0726 - 1

Event C0726 - 2

Event C0726 - 3

Event C0726 - 4

Event C0726 - 5

Event C0726 - 6

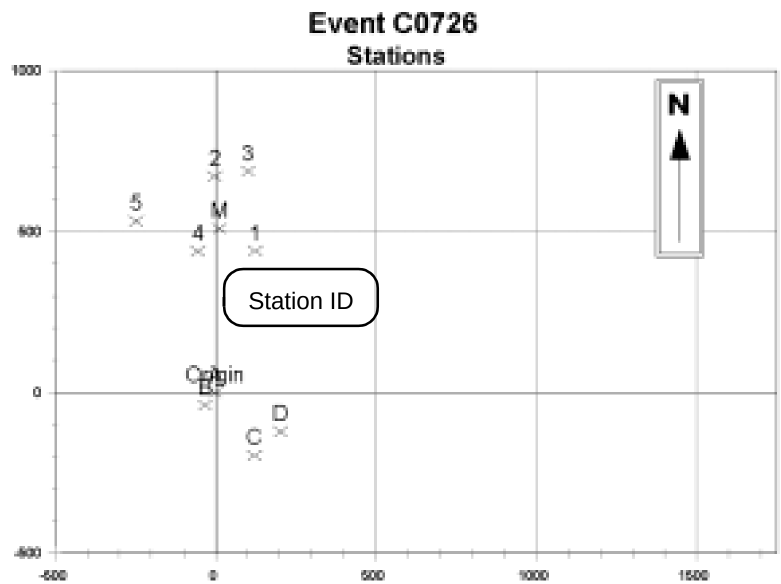
Event C0726 - 7

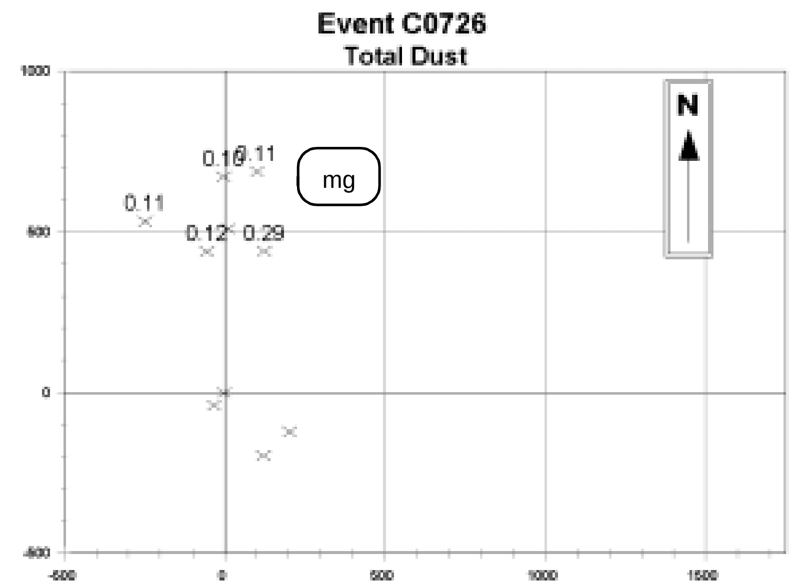
Event C0726 - 8

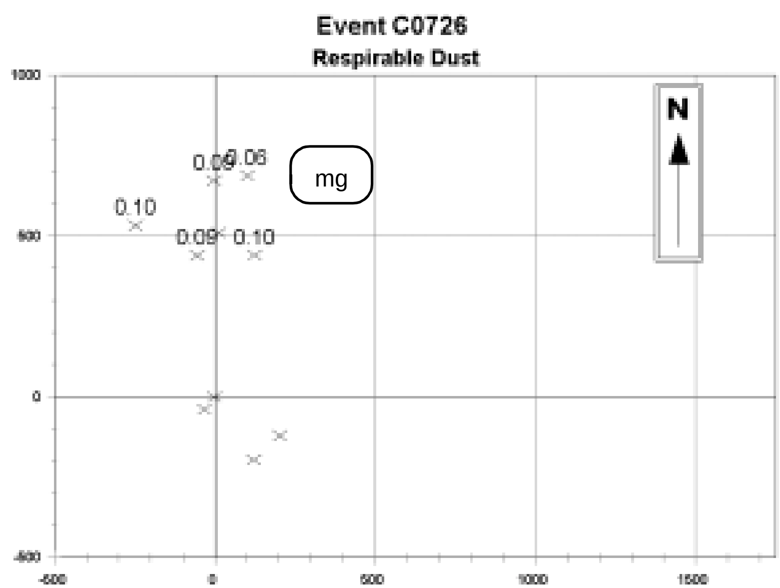
Event C0726 - 9

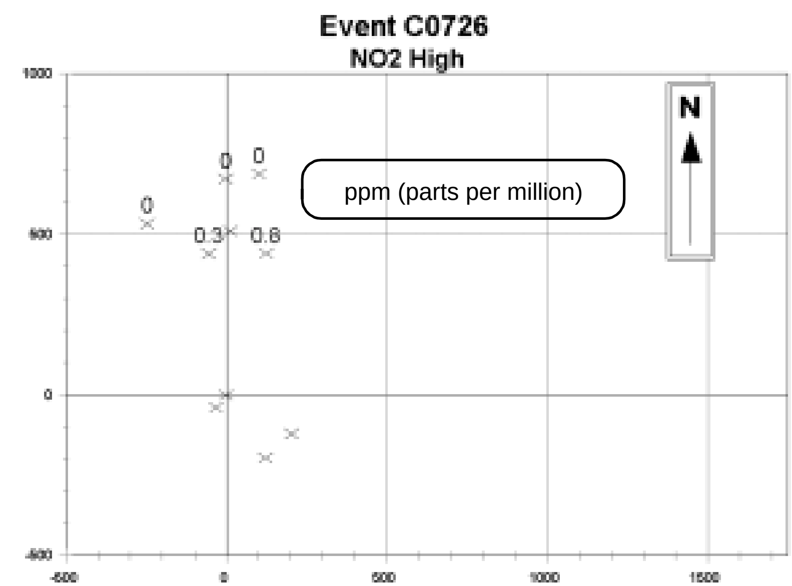
Event C0726 - 10

Event C0726 - 11

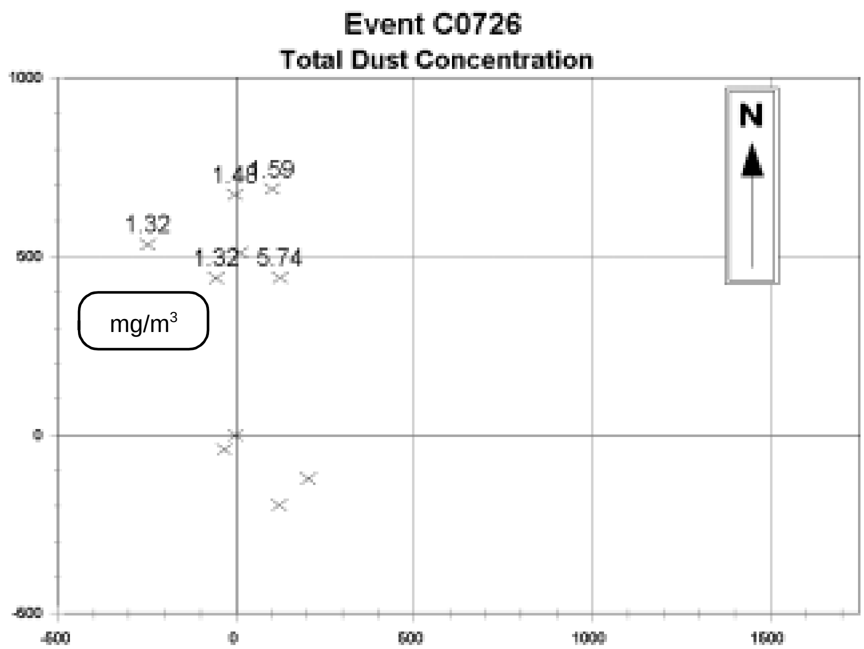


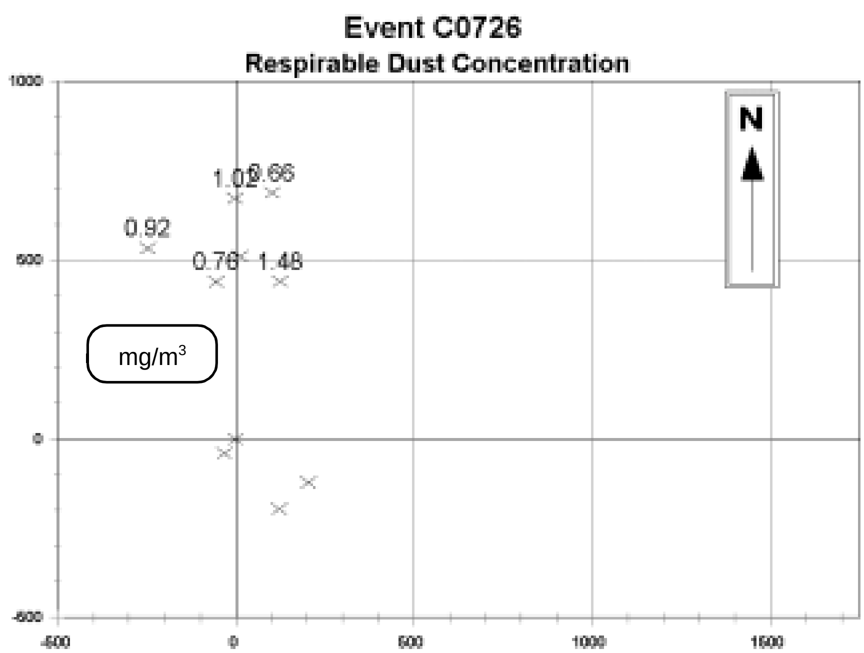






Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)





Note: All axis are feet distance from point of blast nearest to main measurement station (0,0)

5.0 DISCUSSION

The results may viewed in various fashions, and here we have tried to present the information in as broad a manner as possible. A visual representation of shot-and-measurement layouts helps provide a feel for what was actually occurring in the field. Statistical analyses of the chosen parameters versus distance provide a view of what happens as the plume travels as well as helping to quantify the observations in a logical fashion. Similar statistical analyses of the chosen parameters versus individual blasting events provides yet another way of observing the same data, but versus differences in the events themselves rather than by distance. In our investigation we have a data pool of ten events with 1, 5, or 6 values available for each of several variables of interest. These are:

Measured Variable	Where measured	Number of data points available per event
Total Dust	Satellite stations, main station	6
Respirable Dust	Satellite stations	5
Nitrogen Dioxide	Satellite Stations, main Station	6
Nitrous Oxide	Main Station	1
Carbon Monoxide	Main Station	1
Ammonia	Main Station	1

Table 5.1. Accounting of data collection points

Thus for distance variables (dust, fume concentration, etc.) we have 50 or 60 data points to assess; for blasting variables (powder factor, weather, etc.) there are 10 data points. Of course, this is with all instruments running properly. In the course of the investigation there were times when some instruments failed to perform as expected. The largest single disappointment was the failure to obtain good NO_2 data at the main station. We never were able to properly balance the MultiLog unit with the NO_2 sensors. Two items need discussion here before viewing the measurement data: wind velocity and sample weighing results.

Wind velocity[1] proved to be very difficult to determine with any precision, or even with much confidence in the general direction. We originally expected difficulty with this determination, but field experience demonstrated it to be most troublesome. On one blasting location, *on the drilled, explosive-loaded portion only*, it was possible to measure wind directions over a +200° spread depending upon where the investigator stood. It was possible to stand in one spot and measure a 90° variation over a 10-minute period. Similar variations in speed were also measurable. Then, at the measuring stations, it was frequently possible to determine different values for each. The assumption is, of course, that this was all due to terrain. Still, the investigators could frequently judge a general direction to expect a cloud to travel in. In every case we attempted to locate the main station so that it would intercept the main body of the cloud from the blast. On occasions we missed (which always resulted in a total miss by all stations), but frequently we managed to come very close. In the end, we used the orientation of the main station from the blast site as the best indicator of primary wind direction, and then made adjustments if needed based on our observation of cloud travel direction.

Dust sampling cassette weights were determined by standard procedure, but to 0.01 milligram rather than 0.001 milligram. The equipment we had available was purchased in line with the original dust measurement standards and for this kind of initial investigation was quite adequate. We had some wider-than-expected variation in the control cassettes that we used (we weighed and assembled our own). Even with dessication, the control filters occasionally had more pre- and post-measurement variation than the active sample filters. These variations were small enough to be negligible, but where monitors recorded close to zero dust this infrequently resulted in a slight negative dust reading. We reported these and all dust weights as calculated.

[1]Remember, for calculation and analysis, velocity is a vector consisting of both magnitude and direction. Thus use of the term velocity implies consideration of both wind direction and wind speed.

5.1 Viewing the Data by Relative Location

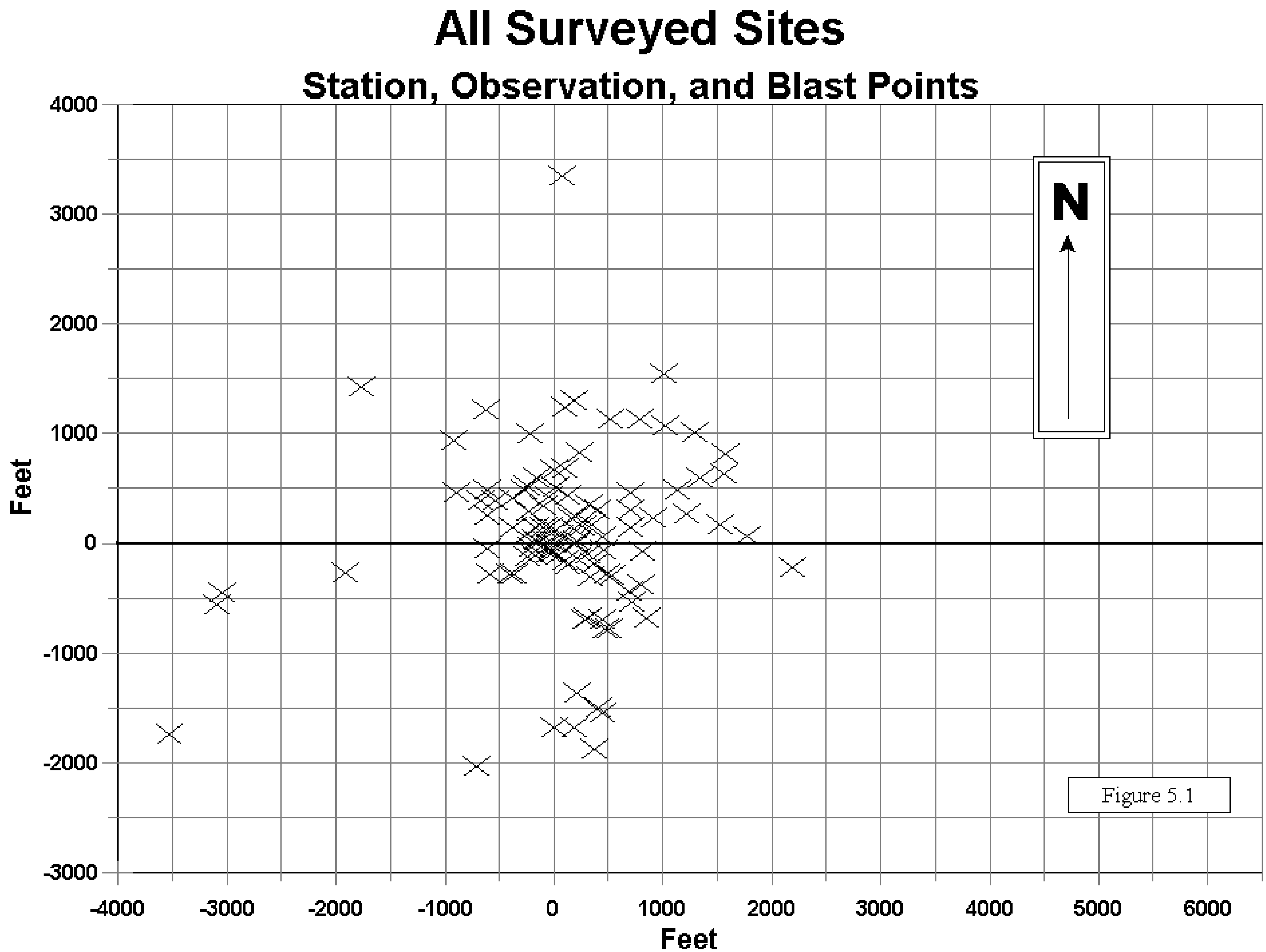
The positions of the monitoring stations, the observation points, and the corners of the shot being fired were all determined by use of a hand-held global positioning (GPS) unit. These points were then used to map all of the locations, with the point of the shot closest to the main monitoring station serving as the origin for the plot maps, or "ground zero."

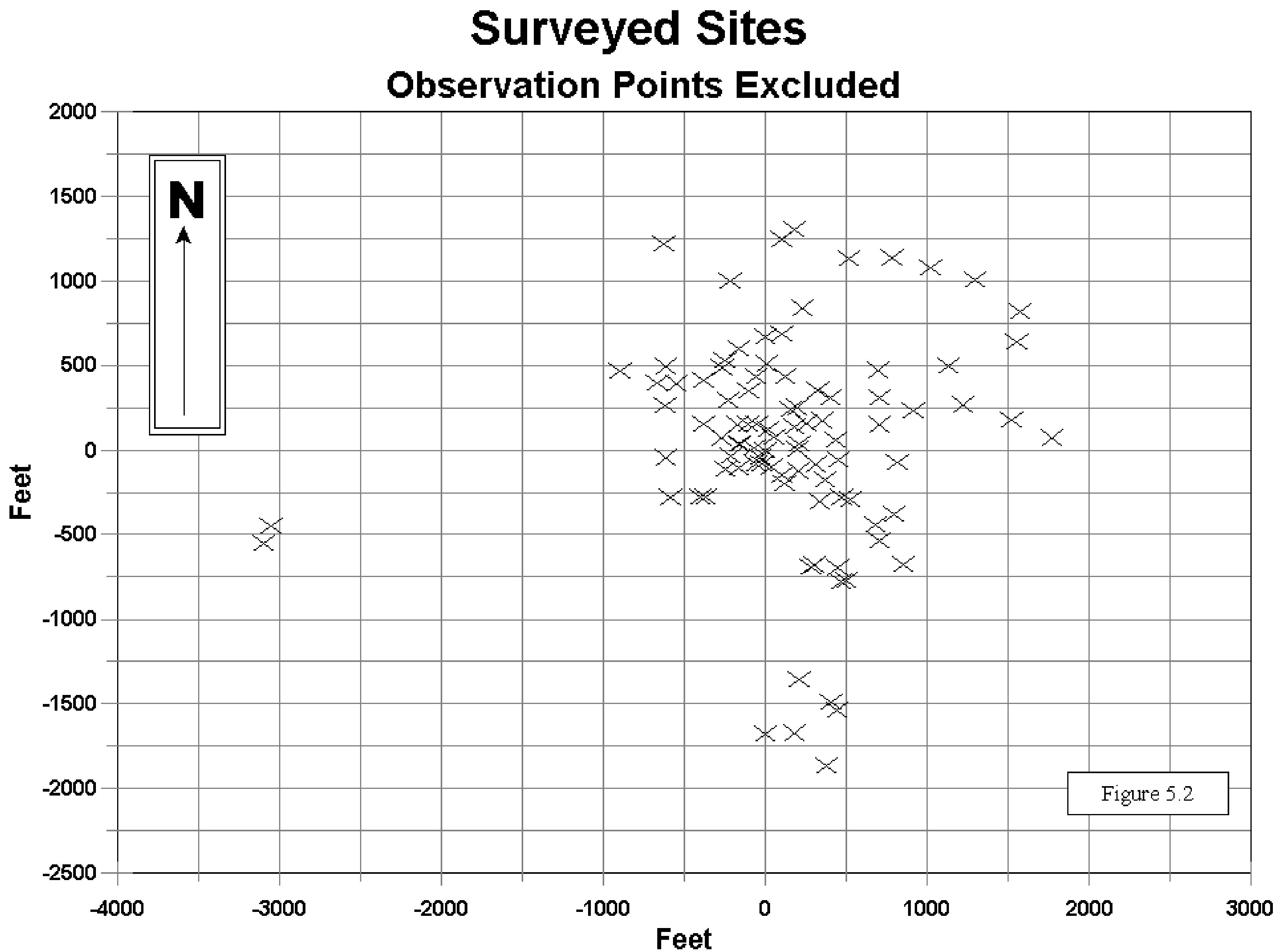
5.1.1 Relative Locations Mapped by True North

Figure 5.1 is a map of all surveyed points. Because the observation points tended to be at greater distances from the blasts and in directions that were not chosen for monitoring considerations but for viewer safety, another map was generated that eliminated the observation points (Figure 5.2), leaving the shot area corners and the station locations. Even this is a bit confusing because of some shot layouts. (The two points at approximately -3100, -500 are the corners of a dragline cast shot). So we also generated a map of monitoring locations only (Figure 5.3). This map also has labeled which monitoring units were located on which sites. A number of things may be noticed in this figure.

These stations were all set as closely as possible to the expected down-wind directions for the blasting events. The map clearly shows that the most expectable wind direction was from the south-east, and the least expectable from the south-west. There were both north winds and south winds, the former being somewhat surprising and possibly a phenomena due to ridge-and-valley configuration. The maximum station distance from the blast was 1903 feet, and the minimum 228 feet, with an average station distance of 943 feet. While these distances were closer than originally desired, it was a fortuitous occurrence due to the rapid fall-off in dust and fume concentrations versus distance. Because of public complaints we had originally expected to see substantial values at 2,000 feet and beyond.

Figures 5.4, 5.5, 5.6, and 5.7 show the measured values for total dust, respirable dust, nitrogen dioxide, and nitrogen dioxide adjusted for zero values, respectively. These maps also have 500-foot and 1000-foot radii drawn on them as a visual aid. With the exception of a couple of outliers, the decline in values is quite noticeable.


All Surveyed Sites
Station, Observation, and Blast Points
4000
3000
2000
1000
0
-1000
-2000
-3000
Feet
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
5000
6000
Feet
N
Figure 5.1


Surveyed Sites
Observation Points Excluded
N
Feet
Feet
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-4000
-3000
-2000
-1000
0
1000
2000
3000
Figure 5.2

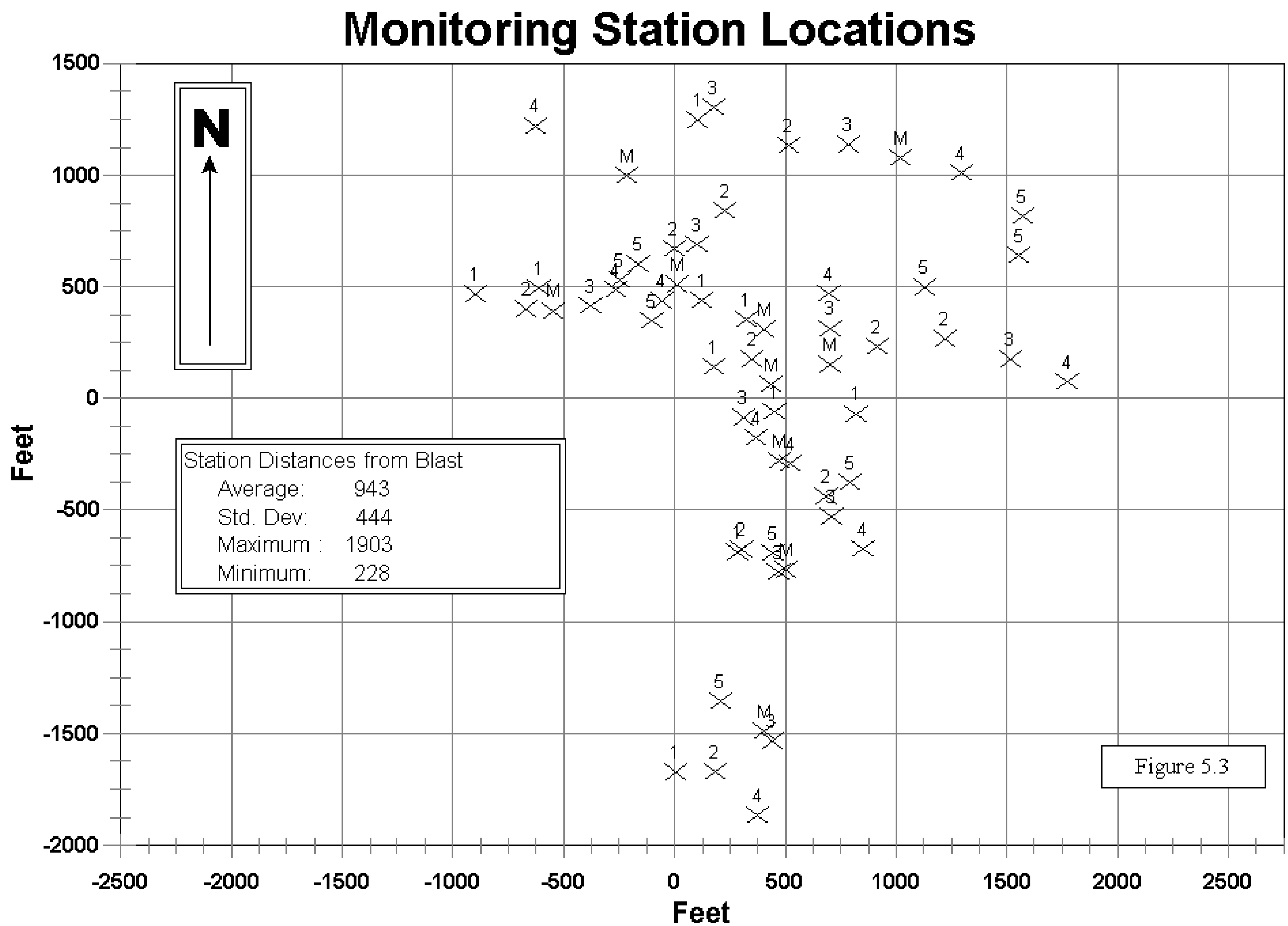

Monitoring Station Locations
N
Station Distances from Blast
Average: 943
Std. Dev: 444
Maximum : 1903
Minimum: 228
Feet
Feet

Figure 5.3

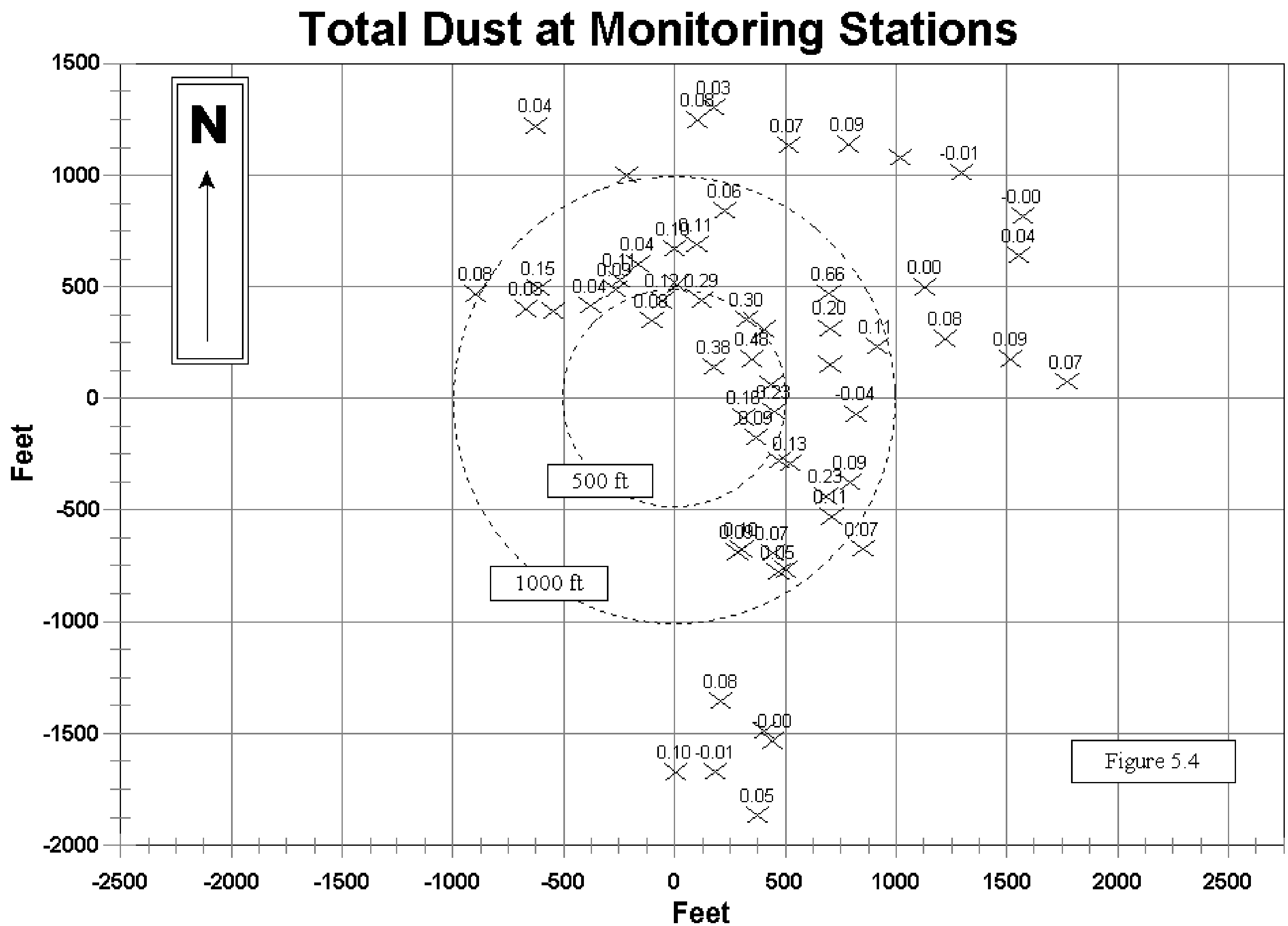
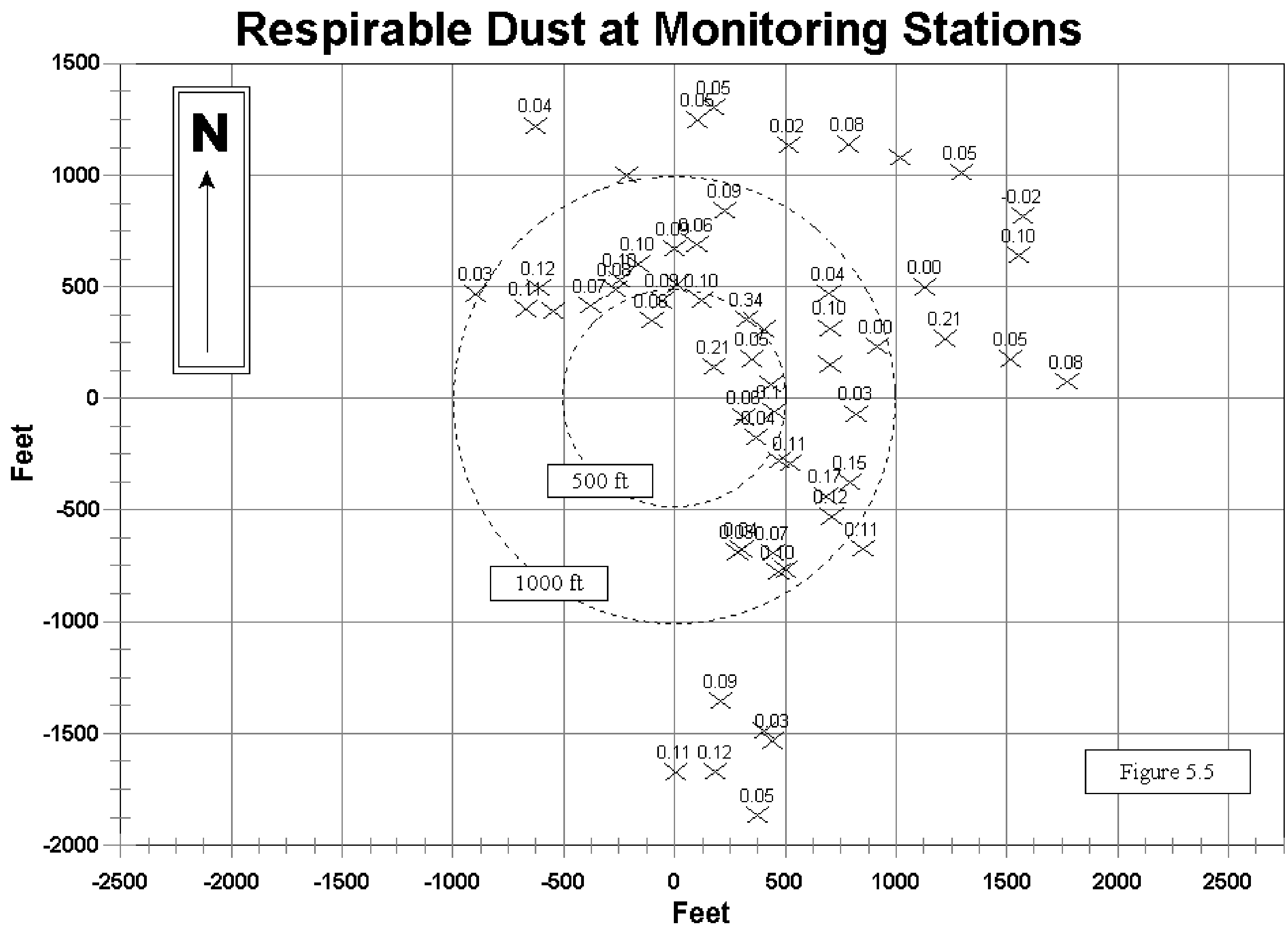
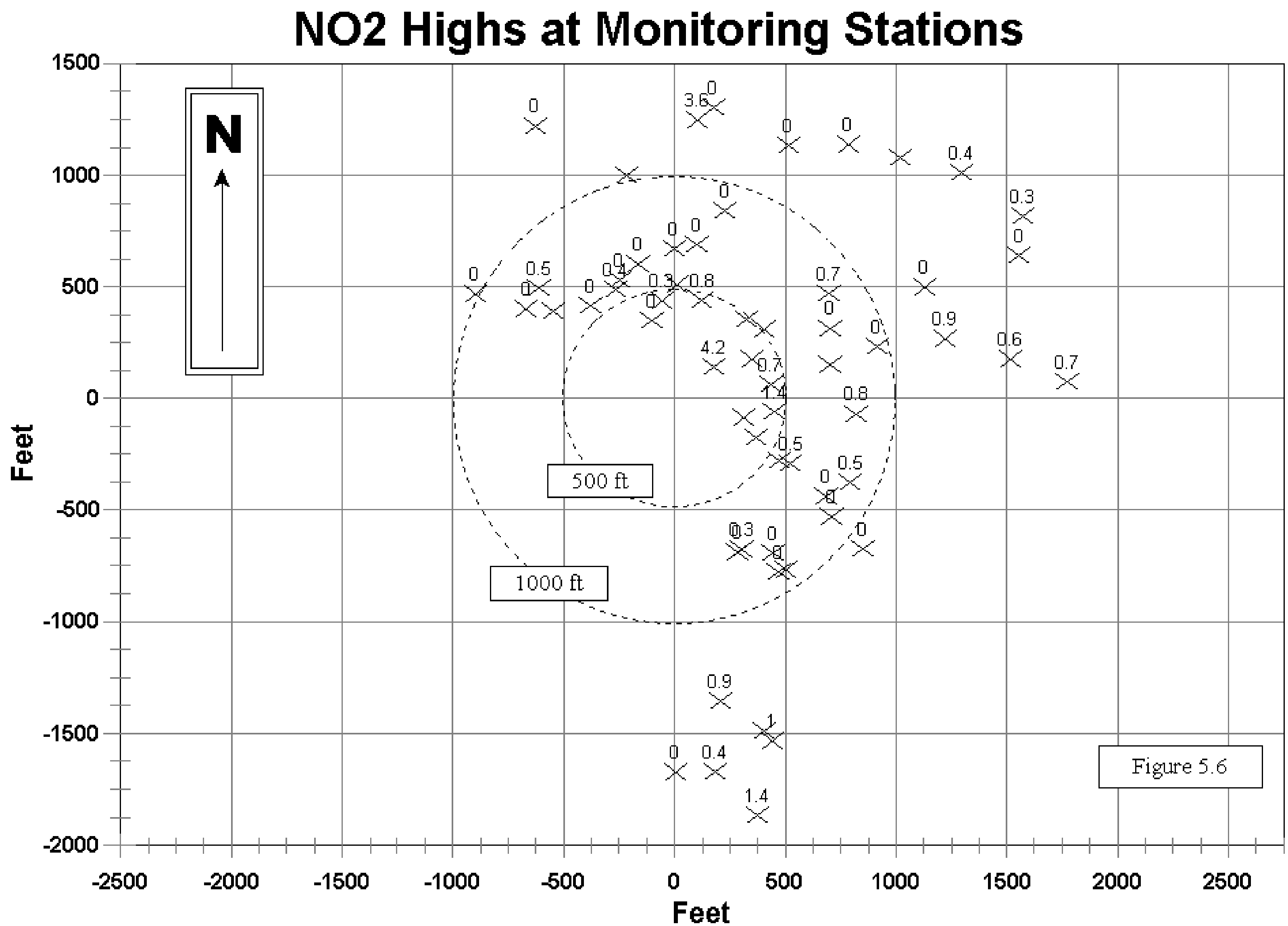
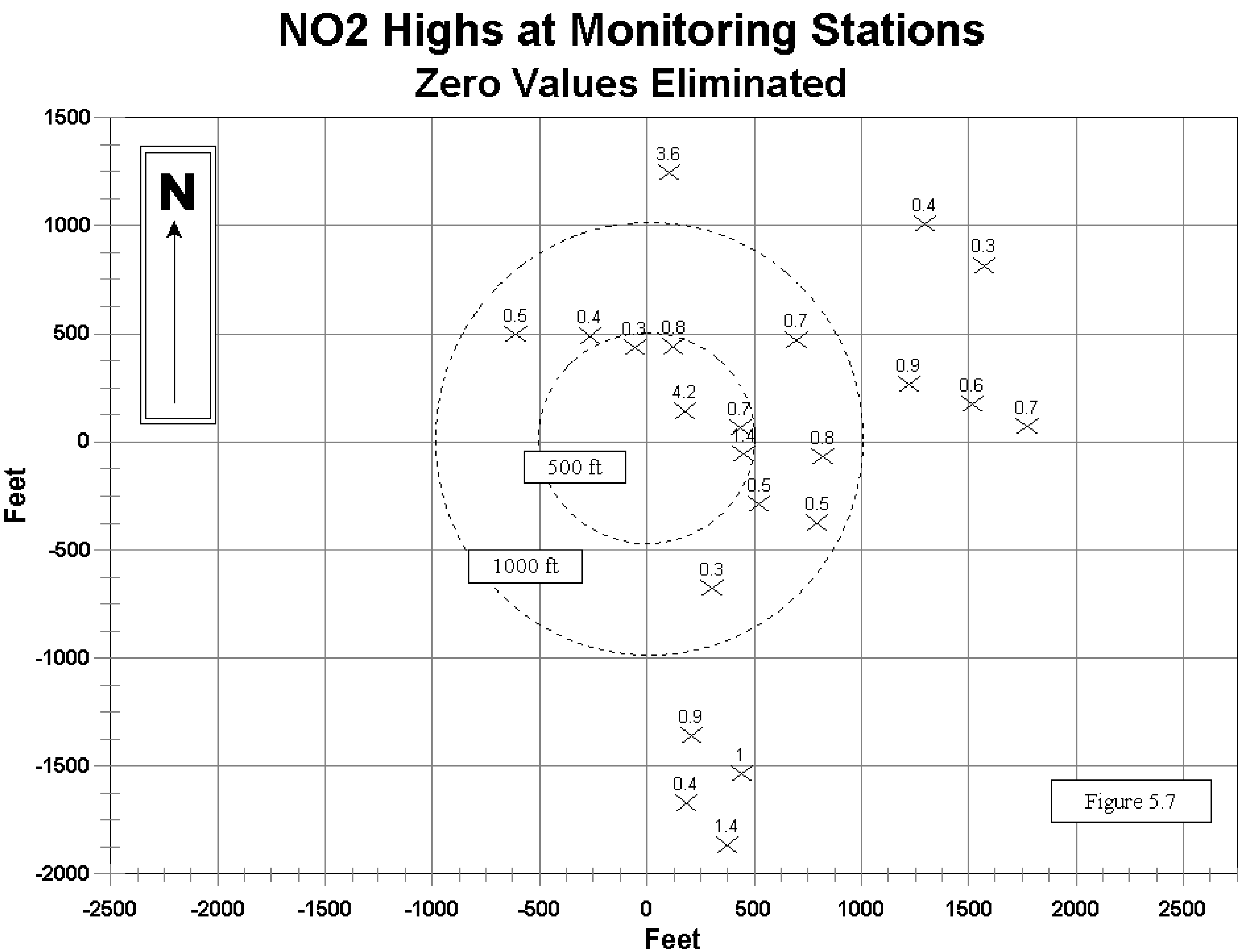

Total Dust at Monitoring Stations
N
500 ft
1000 ft
Feet
Feet
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500

Figure 5.4


Respirable Dust at Monitoring Stations
N
500 ft
1000 ft
Feet
Feet
Figure 5.5

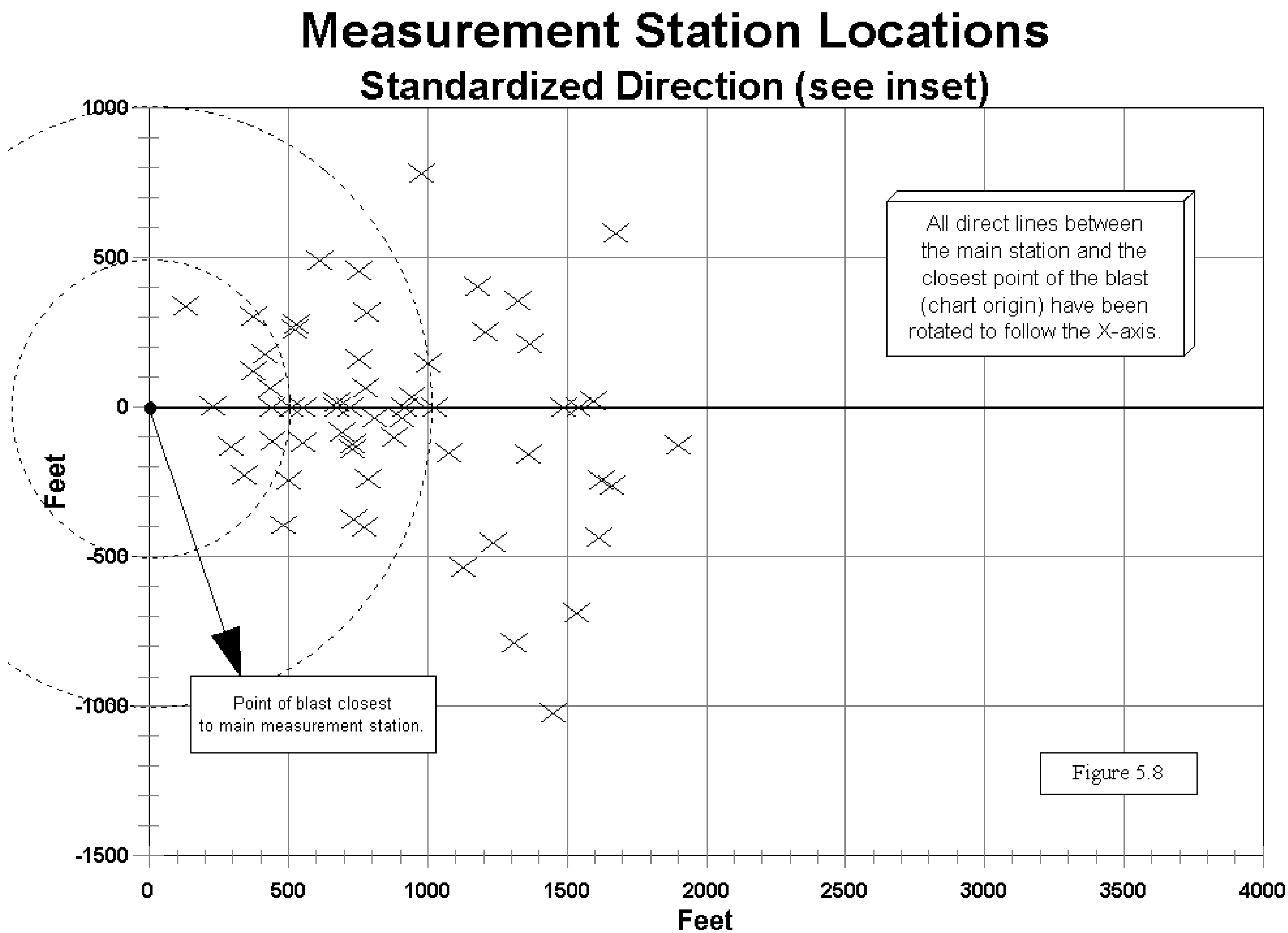

NO2 Highs at Monitoring Stations
N
Feet
Feet
500 ft
1000 ft
Figure 5.6


NO2 Highs at Monitoring Stations
Zero Values Eliminated
N
500 ft
1000 ft
3.6
0.4
0.3
0.5
0.4
0.3
0.8
0.7
0.9
0.6
0.7
4.2
0.7
1.4
0.8
0.5
0.5
0.3
0.9
1
0.4
1.4
Feet
Feet
Figure 5.7

The extra graph for NO_2 values was to see what the data looked like if the very high number of stations that read no NO_2 emissions were eliminated. (A similar approach was used for all variables in section 5.3.) It is not easy to tell which stations were in the cloud but registered no NO_2, and which registered zero because they were bypassed by the cloud. The "correct" zeros — those that were in the cloud — may be inferred by comparing dust measurements at the same station locations, but this would be inexact at best. Looking at both graphs is a visual aid. We also treated each grouping, with and without zeros, statistically. Correlations generally improved.

5.1.2 Relative Locations Mapped by General Wind Direction

The best way to compare data from different events is to place them on a uniform basis for comparison. Since we always strived to place the main station directly downwind of the blast, the line connecting the closest point of the blast with the main station should provide a basis of comparing blasts in the same direction of cloud travel. So as another visual aid, we rotated all of the maps so that line connecting these points would fall on the x-axis, and the main station location would have a y-value of zero. The result of these rotations is shown in Figure 5.8. All of the monitoring stations fall within an approximate 90° arc drawn from the closest point of the blast and centered on the x-axis. Figures 5.9, 5.10, 5.11, and 5.12 reproduce the total dust, respirable dust, nitrogen dioxide, and nitrogen dioxide adjusted for zero values given earlier, but now on a uniform direction basis.



Measurement Station Locations
Standardized Direction (see inset)
1000
500
0
-500
-1000
-1500
Feet
0
500
1000
1500
2000
2500
3000
3500
4000
Feet
All direct lines between the main station and the closest point of the blast (chart origin) have been rotated to follow the X-axis.
Point of blast closest to main measurement station.

Figure 5.8

Total Dust at Monitoring Stations

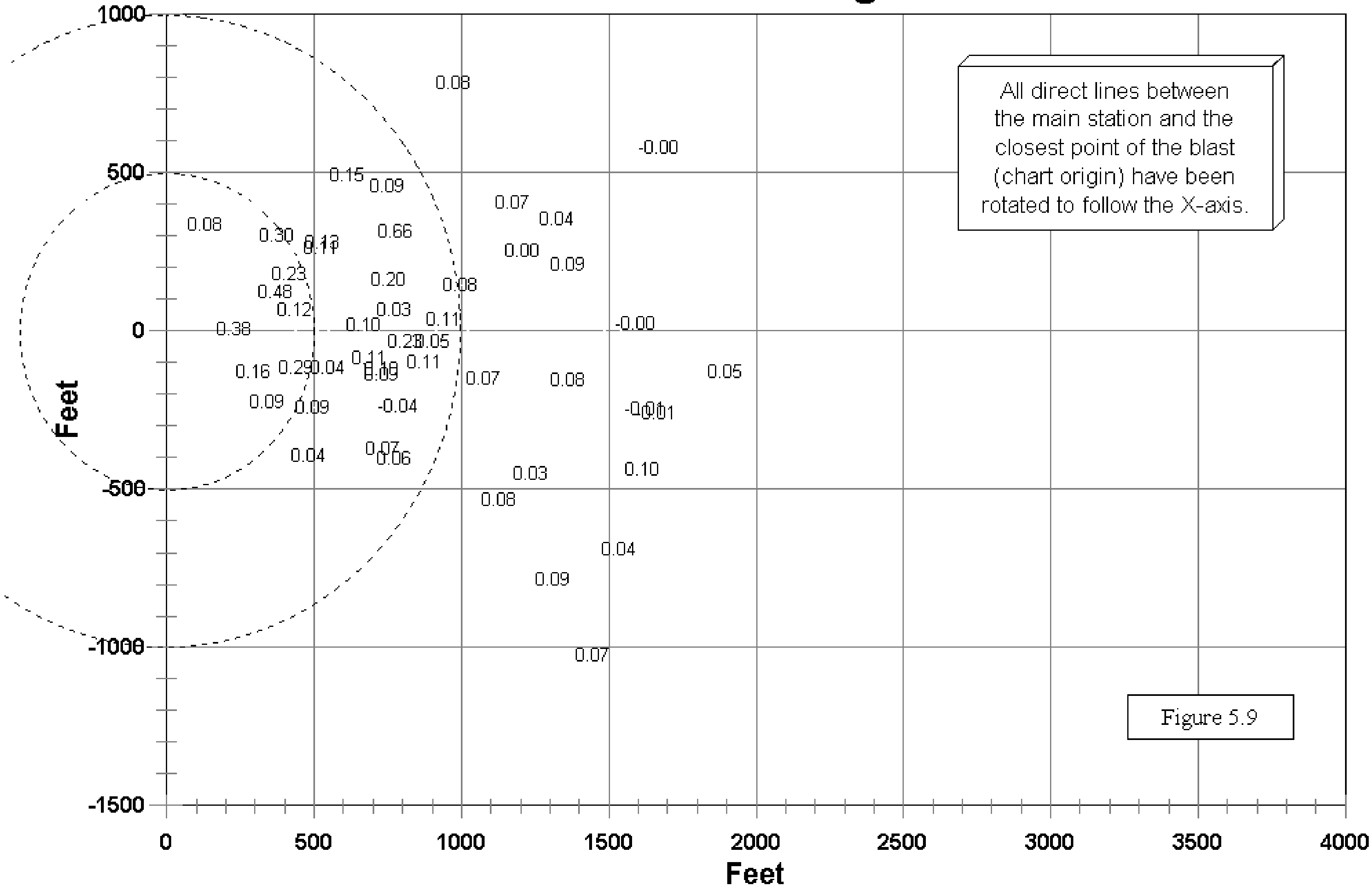


Figure 5.9

Respirable Dust at Monitoring Stations

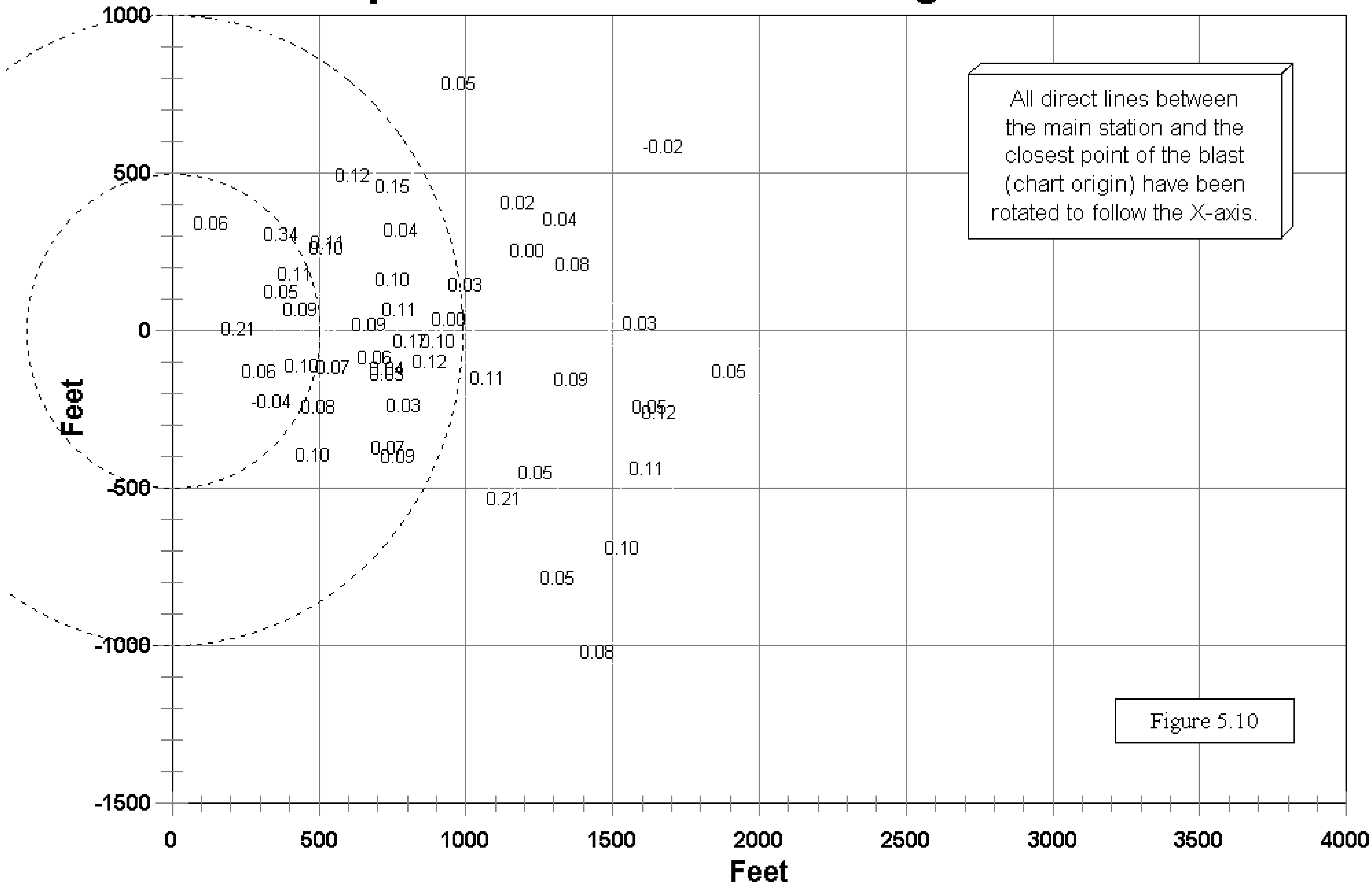
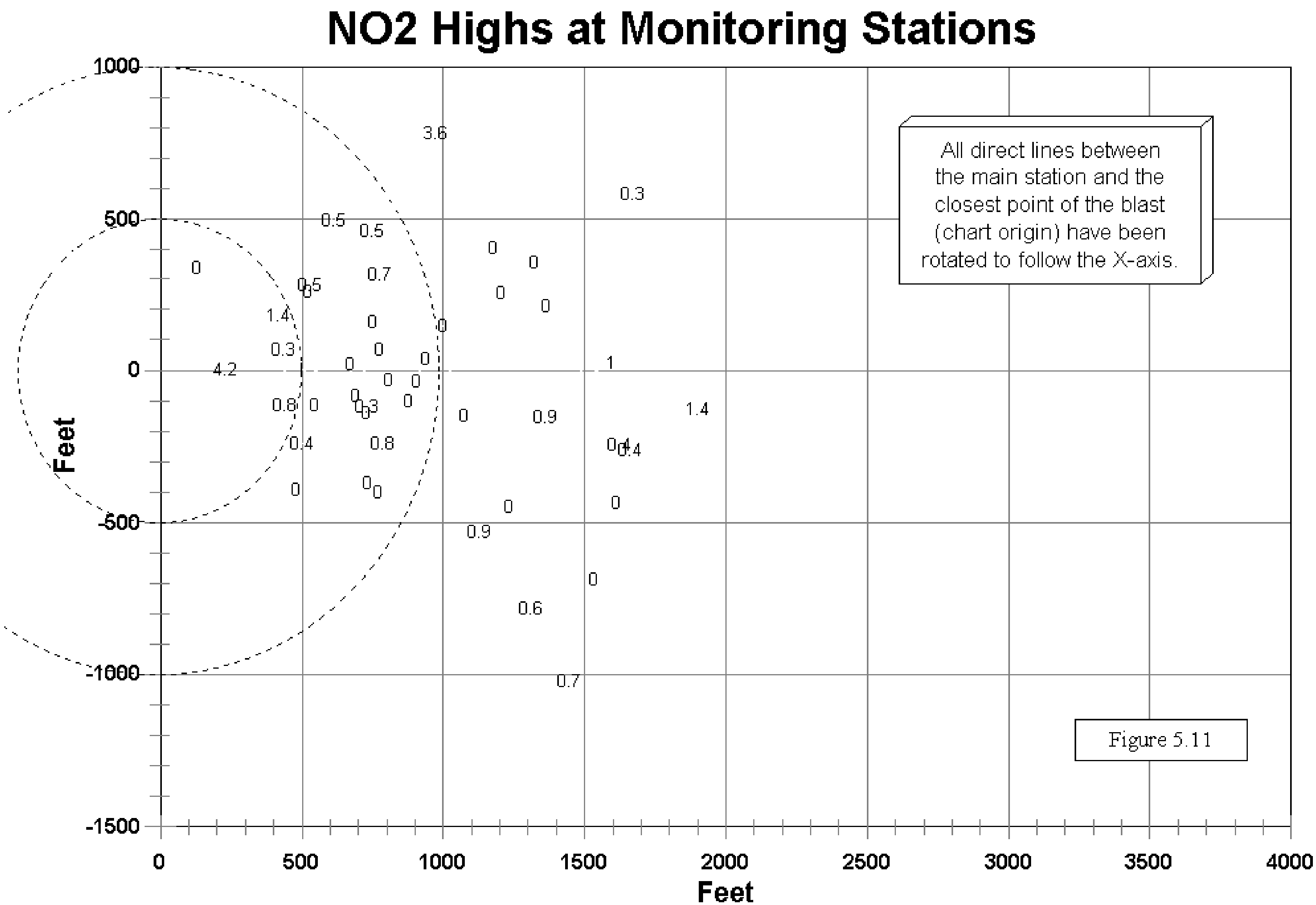
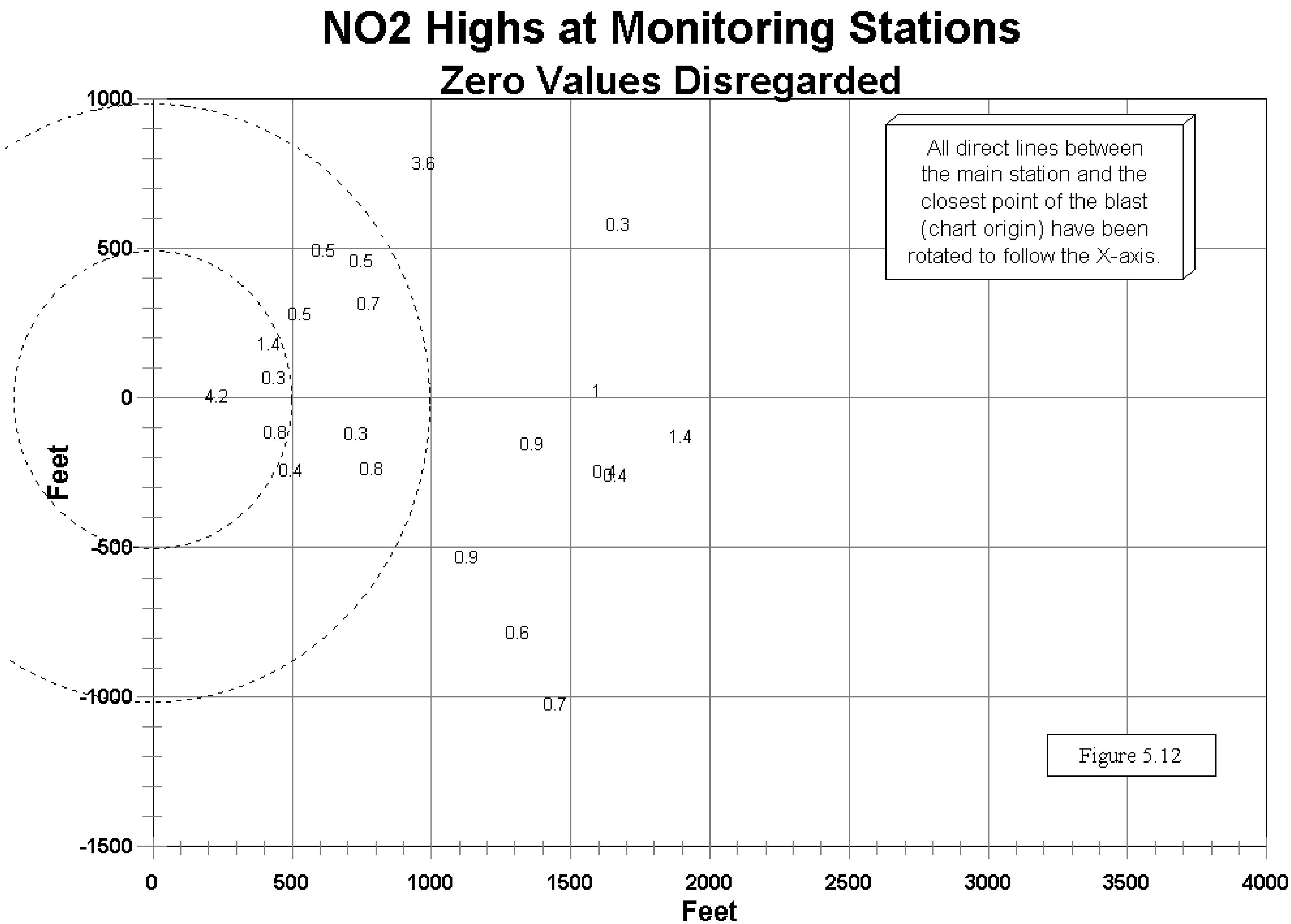


Figure 5.10


NO2 Highs at Monitoring Stations
All direct lines between the main station and the closest point of the blast (chart origin) have been rotated to follow the X-axis.
Feet
Feet
Figure 5.11


NO2 Highs at Monitoring Stations
Zero Values Disregarded
All direct lines between the main station and the closest point of the blast (chart origin) have been rotated to follow the X-axis.
Feet
Feet
1000
500
0
-500
-1000
-1500
0
500
1000
1500
2000
2500
3000
3500
4000
3.6
0.3
0.5
0.5
0.7
0.5
1.4
0.3
4.2
1
0.8
0.3
1.4
0.9
0.4
0.8
0.4
0.4
0.9
0.6
0.7
Figure 5.12

5.2 Assessing the Data by Distance

Although the results from statistical analyses it is still of value to look at the data in this fashion. The trends all follow the expected patterns, that is decreasing with distance from the blast location. Total dust decreases more rapidly than respirable dust, as one would expect based on Stoke's Law. The same is true of NO_2 concentrations. But there are enough exceptions and variations that individual correlation coefficients are not good. There are a lot of variables in operation in the dispersion/dilution process of the blast cloud that are not easily measurable, nor statistically isolatable without a substantially larger pool of information and data. We have just 5 individual data for each contaminant at each of ten individual blasting events, a very limited data pool. The primary parameters that most logically could improve the correlations are 1) a reliable way to include and account for wind velocity, and 2) develop a method to account for not only the distance from the blast site but the lateral off-set from the line of wind direction. We have not found a way to obtain data good enough for the first, and we do not have enough data for the second. When one considers that wind velocity is probably the largest single controlling variable, the correlations with the data we do have become interesting, indeed.

The over-all evidence is clear. Substantial quantities of dust and fumes just do not travel very far from the blasting sites. If we had been able to place the majority of our instrumentation at 1,500 to 2,000 feet away or more as was our original intent, we may not have been able to obtain many measurable results at all. Viewed in this light, the limited station placement options presented to us by the terrain was a fortuitous situation that provided more data than we otherwise would have acquired.

Figure 5.13 is a very busy graph showing all of the data obtained at the monitoring stations. With the exception of a couple of outliers, the trend of lesser values as distance increases is clearly visible. (One point for total dust, 0.66 mg at 750 feet, is off of the chart.) All of these values are examined individually in subsequent figures.

Two fits were found for each set of data, a linear best-fit, and then the best fit model was selected from several different options. These included the following:

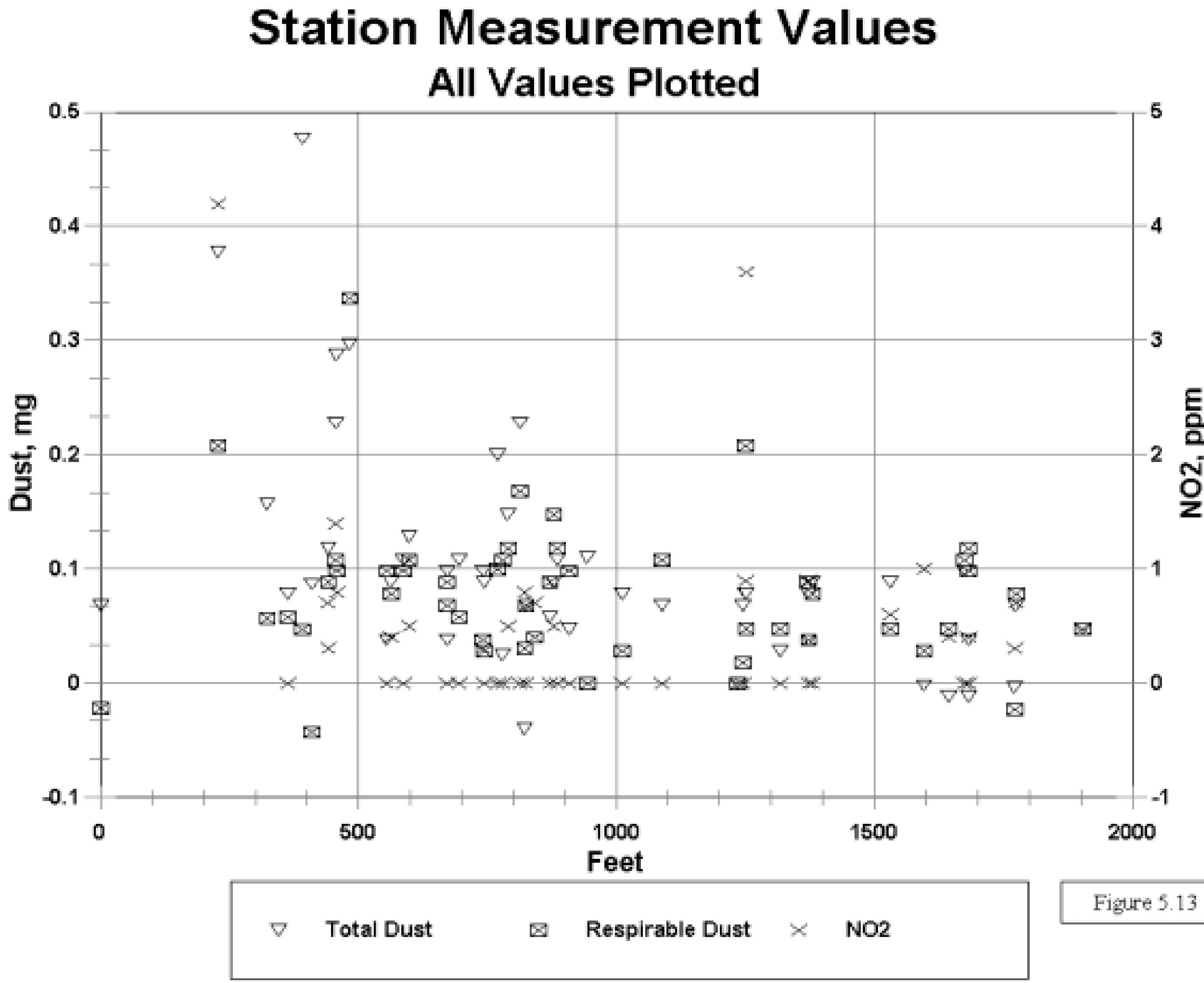

Station Measurement Values
All Values Plotted
Dust, mg
NO2, ppm
Feet
0.5
0.4
0.3
0.2
0.1
0
-0.1
5
4
3
2
1
0
-1
0
500
1000
1500
2000
Total Dust
Respirable Dust
NO2

Figure 5.13

1. Linear: $y = a + bx$

2. Quadratic: $y = a + bx + cx^2$

3. Power Law: $y = a + x^b$

4. Geometric Series: $y = ax^{bx}$

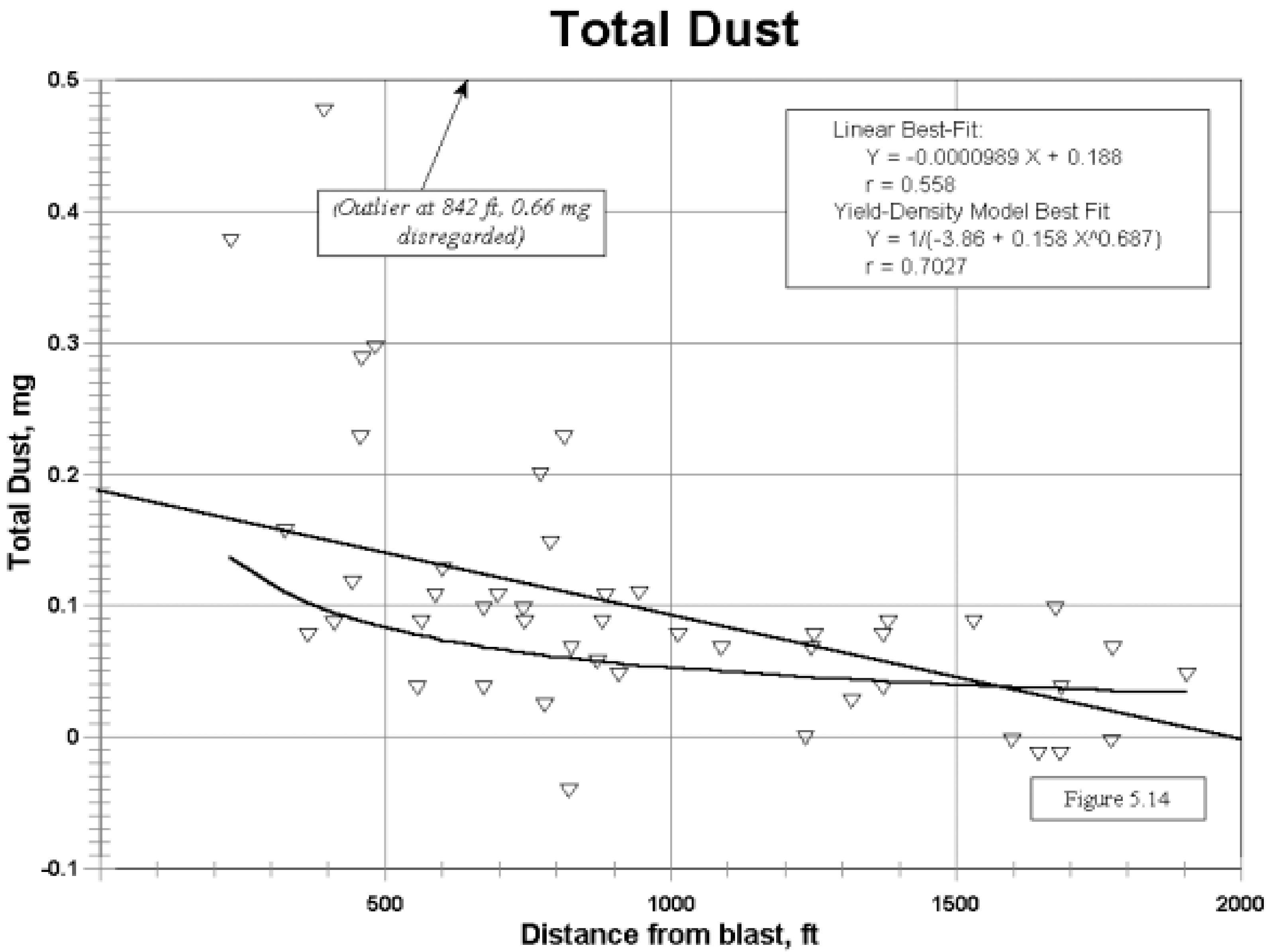
5. Logarithmic: $y = a + b\ln(x)$

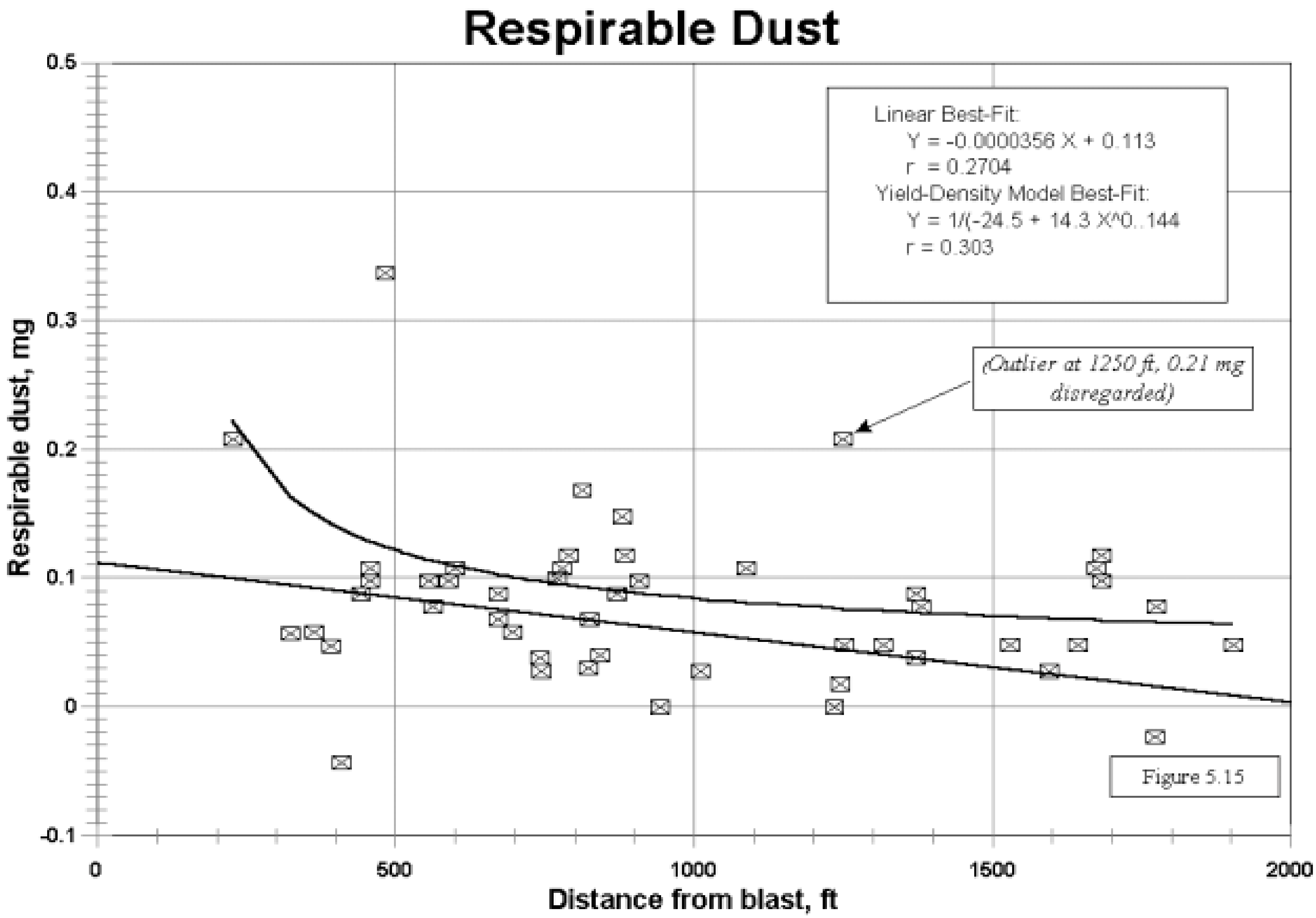
6. Yield-Density Model (Harris): $y = \frac{1}{a + bx^c}$

7. Saturation Growth Rate Model: $y = \frac{ax}{b + x}$

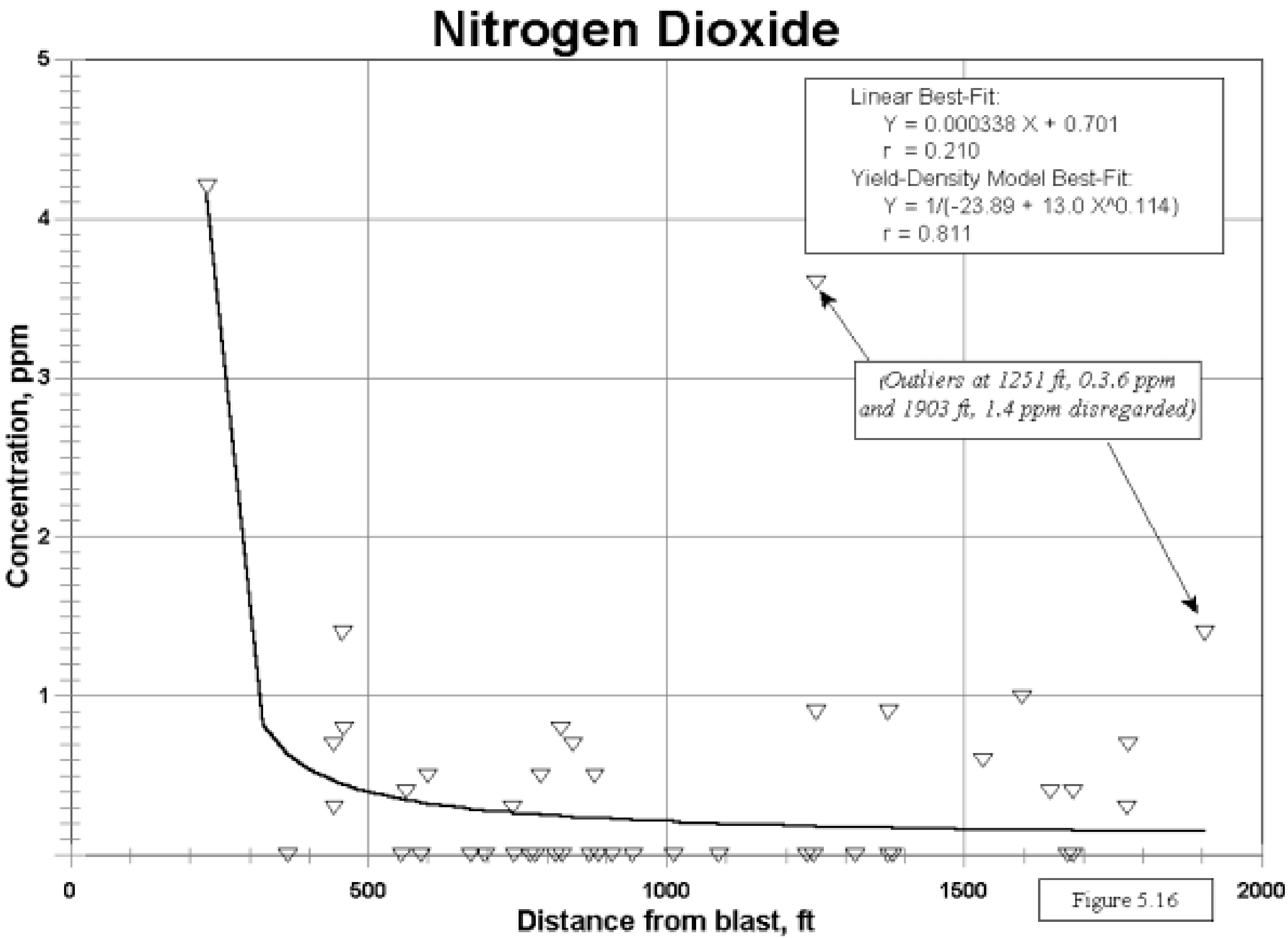
After examining all four data sets with all 6 models, it was found that the Harris Yield-Density model fit best, if not superbly (note the fit on respirable dust). Figures 5.14 through 5.17 show the data, the linear fit, and the Harris Yield-Density model fit for total dust, respirable dust, nitrogen dioxide, and nitrogen dioxide adjusted for zero values, respectively.

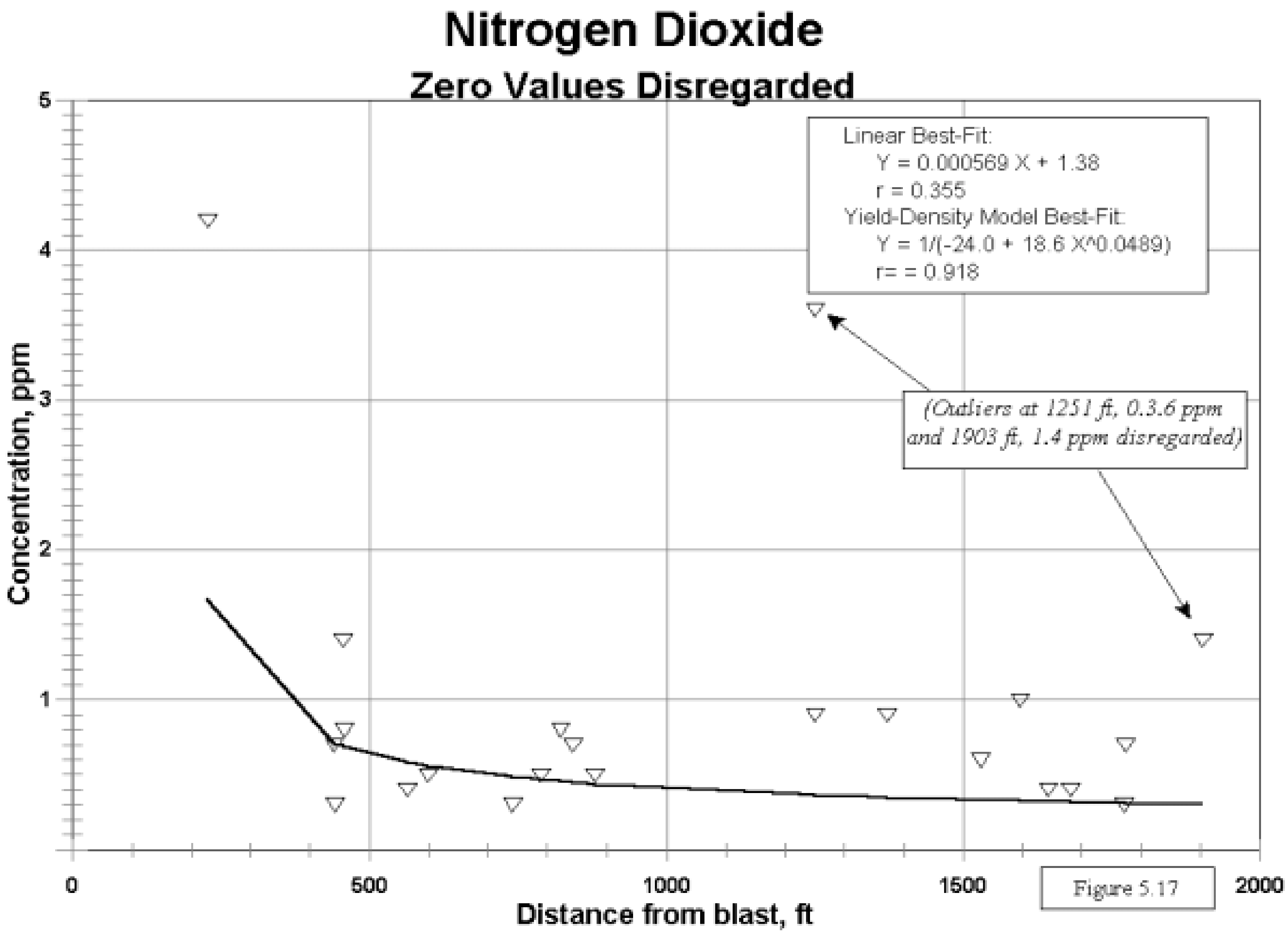
A word of caution about comparing blasting events: Each blasting event is truly unique. No two blasts have the same quantity of explosives, the same number of holes, the same depth of drilling, the same drilling diameter, and, most importantly, the same geology. All of these would have to be equivalent for the shots to be equivalent. Even at one mine where the same drill is used, on a long contour repeating the same pattern, depth, and charging procedures, there is still the ever-changing stratigraphy. The spacing may be close, but not precisely the same. The holes will have slight deviations. And more. Then for measurements at a distance, there is the changing weather, including wind, on top of everything. In other words, it is very difficult to combine information from different blasts and be sure that “apples and apples” are being compared.


Total Dust
Linear Best-Fit:
Y = -0.0000989 X + 0.188
r = 0.558
Yield-Density Model Best Fit
Y = 1/(-3.86 + 0.158 X^0.687)
r = 0.7027
(Outlier at 842 ft, 0.66 mg disregarded)
Total Dust, mg
Distance from blast, ft
0.5
0.4
0.3
0.2
0.1
0
-0.1
500
1000
1500
2000
Figure 5.14



Respirable Dust
Linear Best-Fit:
Y = -0.0000356 X + 0.113
r = 0.2704
Yield-Density Model Best-Fit:
Y = 1/(-24.5 + 14.3 X^0..144
r = 0.303
(Outlier at 1250 ft, 0.21 mg disregarded)
Figure 5.15
Respirable dust, mg
Distance from blast, ft
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
500
1000
1500
2000


Nitrogen Dioxide
Concentration, ppm
Distance from blast, ft
0
1
2
3
4
5
500
1000
1500
2000
Linear Best-Fit:
Y = 0.000338 X + 0.701
r = 0.210
Yield-Density Model Best-Fit:
Y = 1/(-23.89 + 13.0 X^0.114)
r = 0.811
(Outliers at 1251 ft, 0.3.6 ppm
and 1903 ft, 1.4 ppm disregarded)
Figure 5.16


Nitrogen Dioxide
Zero Values Disregarded
Linear Best-Fit:
Y = 0.000569 X + 1.38
r = 0.355
Yield-Density Model Best-Fit:
Y = 1/(-24.0 + 18.6 X^0.0489)
r= = 0.918
(Outliers at 1251 ft, 0.3.6 ppm and 1903 ft, 1.4 ppm disregarded)
Concentration, ppm
Distance from blast, ft
0
500
1000
1500
2000
1
2
3
4
5
Figure 5.17

Summarizing the linear fits and the best fits:

Total Dust:

$$y = 0.188 - 0.0000989\,x \qquad r = 0.558$$

$$y = \frac{1}{2.86 + 0.158\,x^{0.687}} \qquad r = 0.703$$

Respirable Dust:

$$y = 0.113 - 0.0000356\,x \qquad r = 0.270$$

$$y = \frac{1}{24.5 + 14.3\,x^{0.144}} \qquad r = 0.303$$

Nitrogen Dioxide:

$$y = 0.701 + 0.000338\,x \qquad r = 0.210$$

$$y = \frac{1}{23.0 + 13.0\,x^{0.114}} \qquad r = 0.811$$

Nitrogen Dioxide Adjusted for Zero Values:

$$y = 1.38 + 0.000569\,x \qquad r = 0.355$$

$$y = \frac{1}{24.0 + 18.6\,x^{0.0489}} \qquad r = 0.918$$

Note the substantial improvement in the correlation factor made in the nitrogen dioxide fit resulting from neglecting the zero values.

The main station values provide a single data point for each parameter per event. Thus there is no real way to compare them versus distance because of the various differences between blasting events. None-the-less, figures 5.18 and 5.19 show these values, with the individual events labeled on graphs. These graphs provide a couple of unexpected surprises. The dust concentrations shown in Figure 5.18 for events A0727 and B0602 are quite high, but they are maximums not average exposures. While it would be easy to count these as anomalous, event A0727 also had a very high NO concentration — almost triple the second highest reading. Looking at figure 5.19, these same two sites show anomalously high readings for CO. Taken in conjunction, it is apparent that these high readings are not instrument aberrations. Quite possibly a portion of the blasting cloud reached these sites relatively undiffused and undispersed. This conjecture is strengthened by the stations' close proximity to the blast, 550 feet and 460 feet, respectively. Given the turbulent and chaotic nature of a blasting cloud as compared to, say, a stack plume, this is probably reasonable.

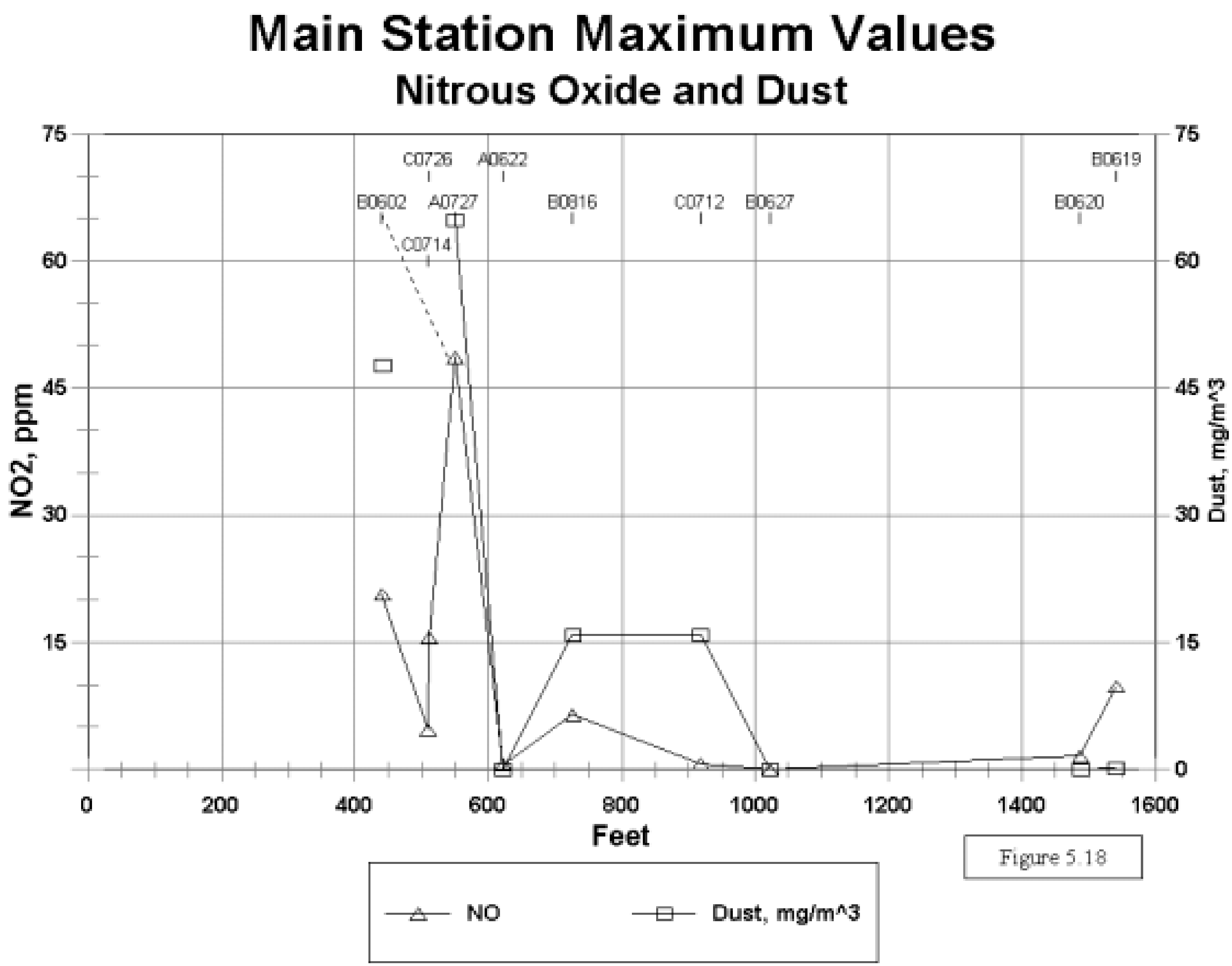
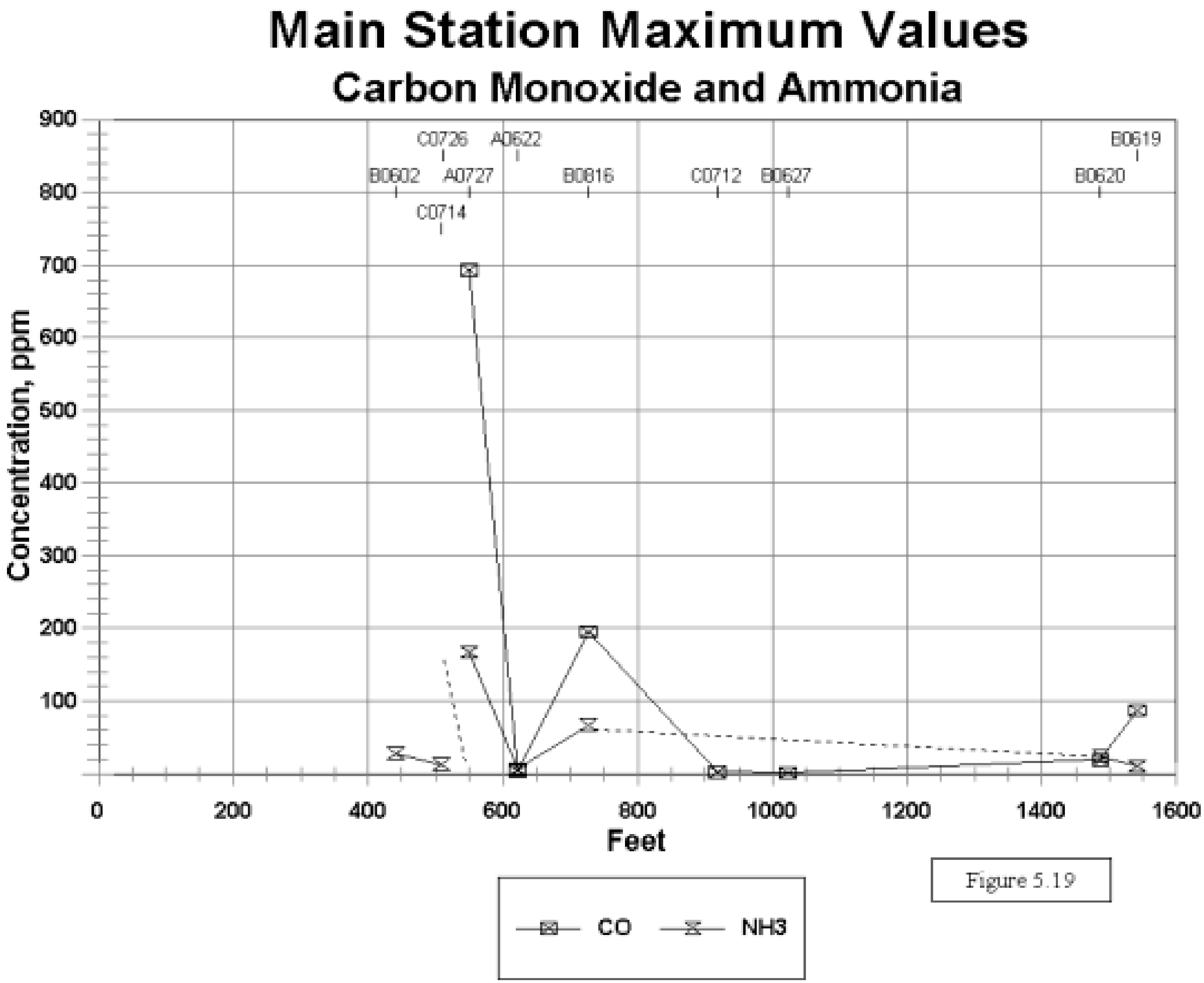

Main Station Maximum Values
Nitrous Oxide and Dust
NO2, ppm
Dust, mg/m^3
Feet
C0726
A0622
B0619
B0602
A0727
B0816
C0712
B0627
B0620
C0714
NO
Dust, mg/m^3
0
200
400
600
800
1000
1200
1400
1600
15
30
45
60
75

Figure 5.18



Main Station Maximum Values
Carbon Monoxide and Ammonia
Concentration, ppm
Feet
C0726
A0622
B0619
B0602
A0727
B0816
C0712
B0627
B0620
C0714
CO
NH3

Figure 5.19

5.3 Assessing the Data by Comparison of Individual Events

Up to this point, all of the data have been combined and looked at as a body. There are a number of things that are unique to each individual event and would impact all of the monitoring station readings in similar fashion. Some of them are not easily quantifiable, such as geology, spacing irregularities, accrued damage from adjacent, prior shots. Others are difficult to assess in a useful fashion, such as weather (wind velocity in particular), adjacent terrain, and so forth. And there are differences that are well quantified, including powder factor, total weight of explosives used, delay pattern, and more. Here we have examined the individual events versus powder factor, weight of explosives used, and humidity. The values for each variable were averaged for each event.

As discussed on page 5.11 concerning NO_2, there were stations with zero values for total dust, respirable dust and for NO_2. Also as discussed, it is difficult or impossible to separate the legitimate zeros, ie those in the cloud path, from those that were zero because they were outside of the cloud path. Therefore all three values were averaged both ways, with and without zeros, for all events. Thus there are six sets of data for each variable examined, with 10 points in each set. Then each set was analyzed for best fits using the same 7 models used in section 5.5, and the correlation for each method was determined. Finally, the correlations were compared.

5.3.1 Powder Factor

Figure 5.20 shows total and respirable dust versus powder factor, and Figure 5.21 shows NO_2 versus powder factor. Any potential trend is not obvious. Figure 5.22 compares the correlations, and it is easily noticeable that the best is for respirable dust vs. powder factor, and the worst is total dust vs. powder factor, more than a little surprising. However, eliminating the zero values from the total dust data elevates it to second-best. Eliminating the zeros from the respirable dust data actually worsens the correlations!

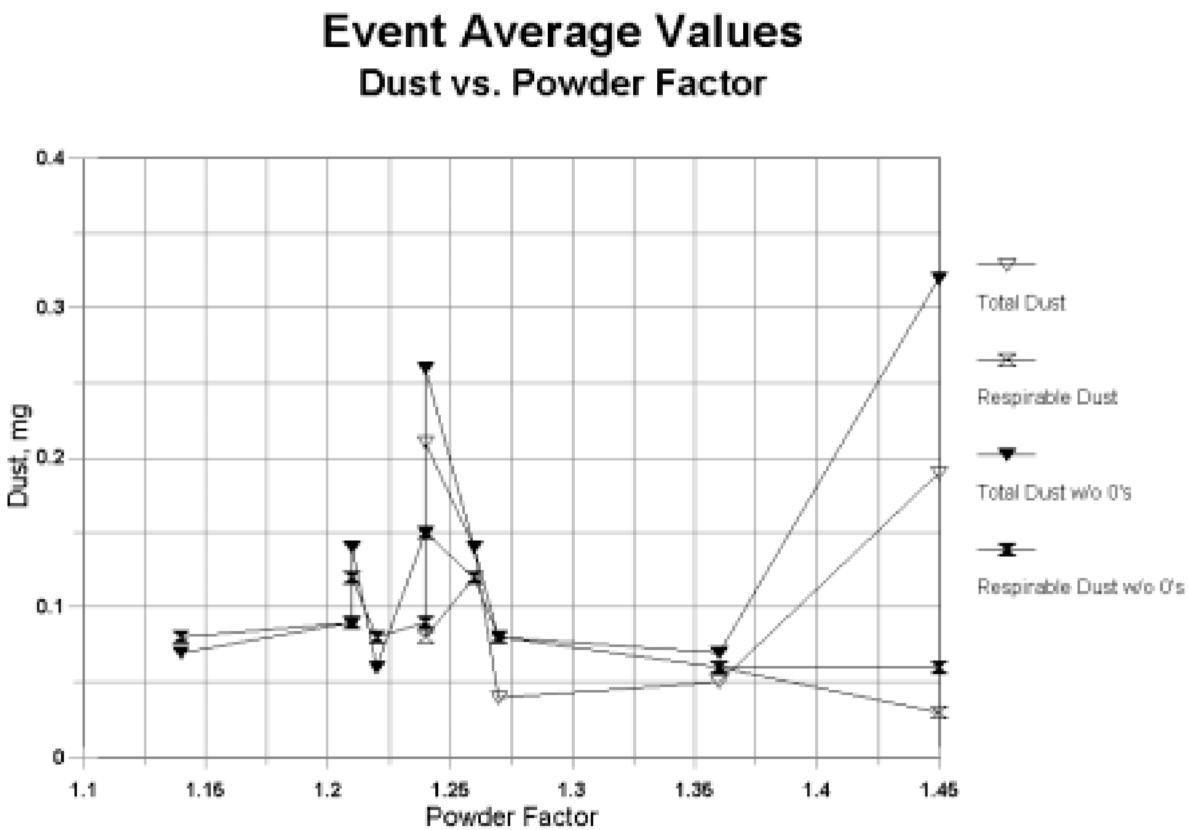

Event Average Values
Dust vs. Powder Factor
0.4
0.3
0.2
0.1
0
Dust, mg
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
Powder Factor
Total Dust
Respirable Dust
Total Dust w/o 0's
Respirable Dust w/o 0's

Figure 5.20

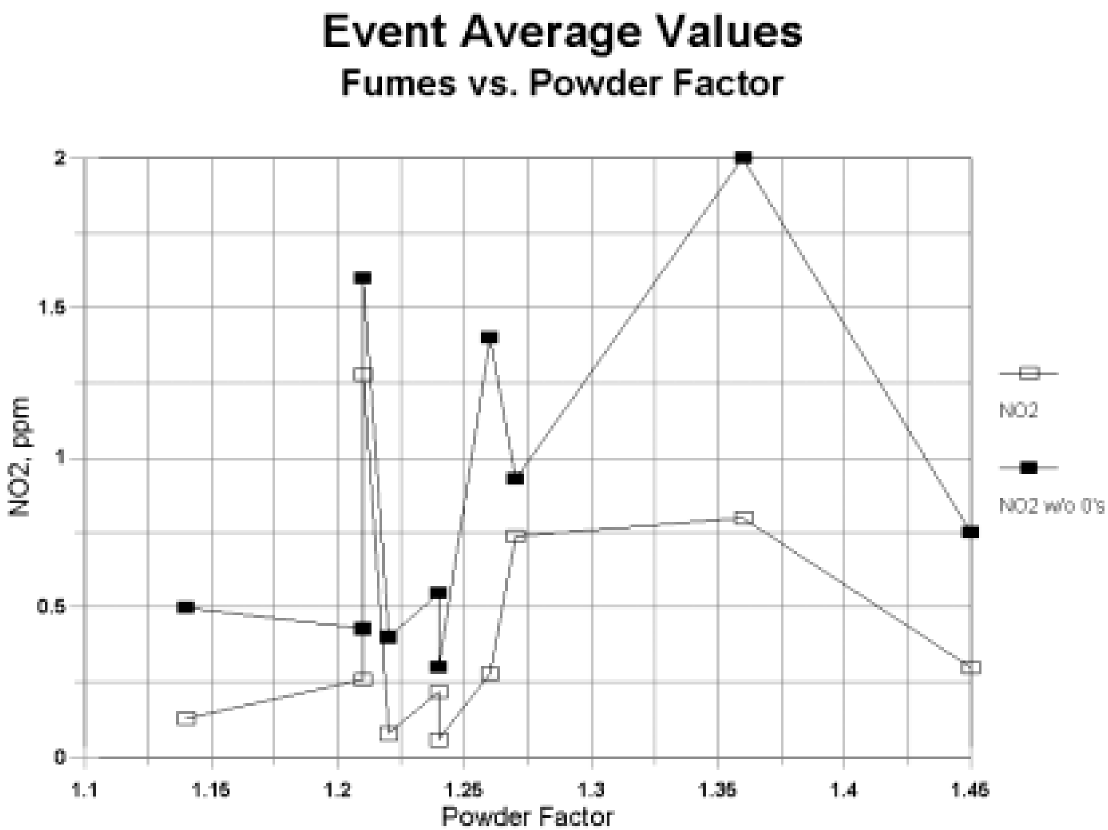

Event Average Values
Fumes vs. Powder Factor
NO2, ppm
2
1.5
1
0.5
0
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
Powder Factor
NO2
NO2 w/o 0's

Figure 5.21

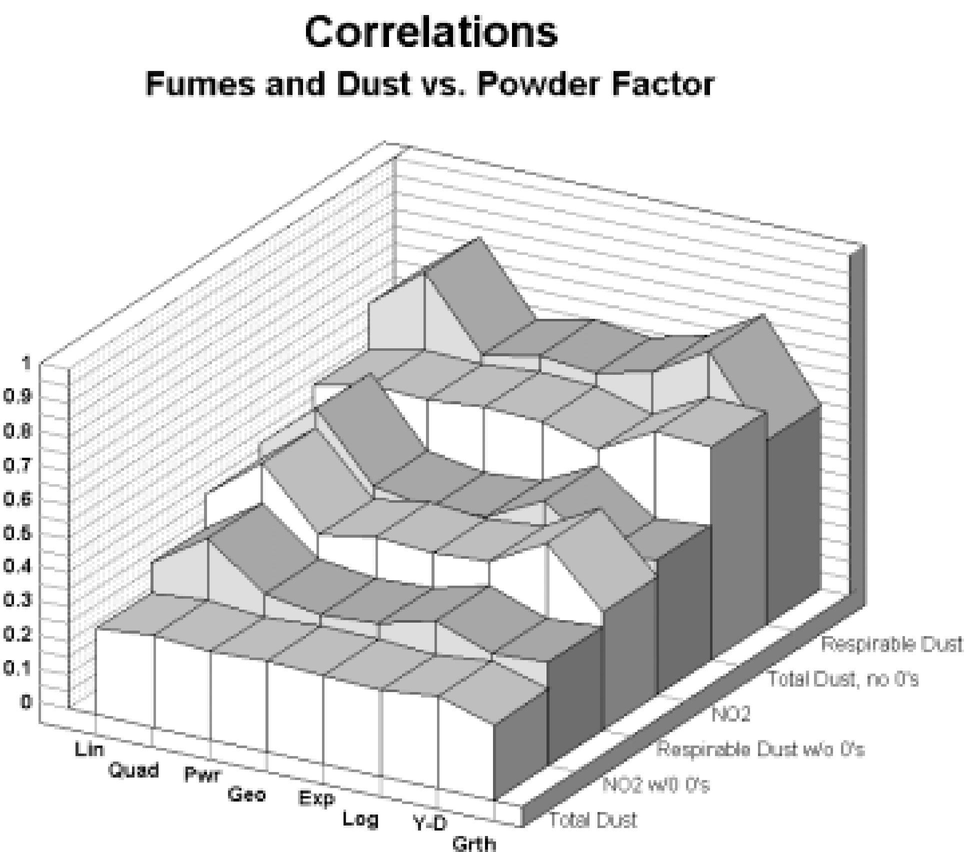

Correlations
Fumes and Dust vs. Powder Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Lin
Quad
Pwr
Geo
Exp
Log
Y-D
Grth
Respirable Dust
Total Dust, no 0's
NO2
Respirable Dust w/o 0's
NO2 w/0 0's
Total Dust

Figure 5.22

5.3.2 Weight of Explosives

Figures 5.23 and 5.24 compare total dust, respirable dust, and NO_2 versus the total weight of explosives used.[1] Once again, there is no real visible trend. A look at the correlations justifies this initial opinion; the correlations are very poor. The respirable dust correlations are the best, the NO_2 the worst.

[1] We originally wanted to separate this category into two parts, shots of less than 500,000 pounds, and shots of more than 500,000 pounds. As it turned out, only two of the measured events would have fallen into the second category, and such a division would not have been meaningful.

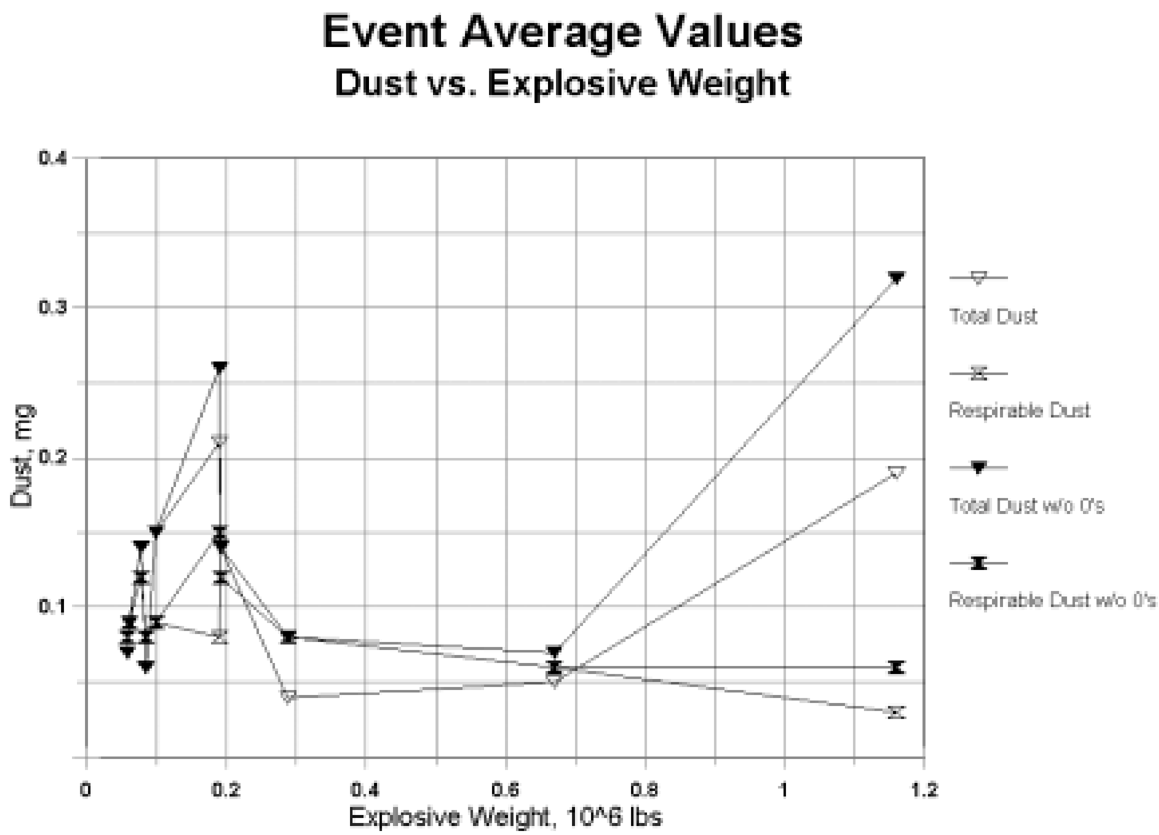

Event Average Values
Dust vs. Explosive Weight
0.4
0.3
0.2
0.1
Dust, mg
0
0.2
0.4
0.6
0.8
1
1.2
Explosive Weight, 10^6 lbs
Total Dust
Respirable Dust
Total Dust w/o 0's
Respirable Dust w/o 0's

Figure 5.23

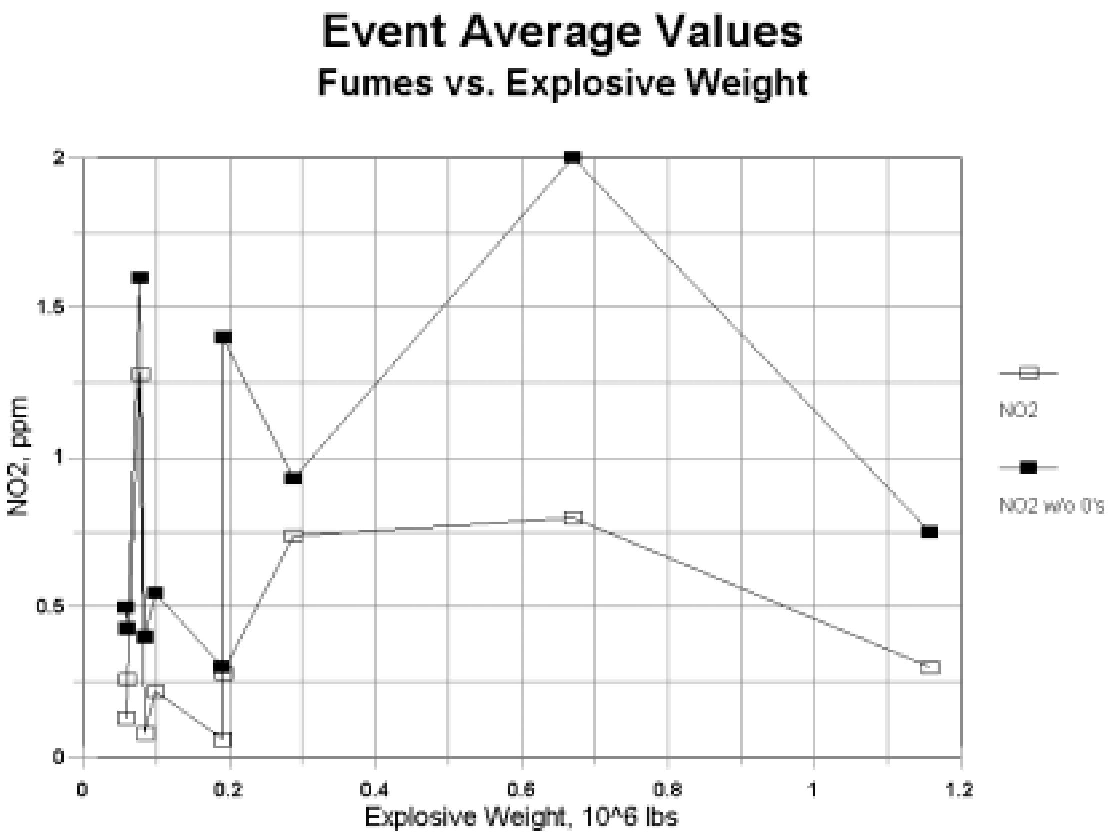

Event Average Values
Fumes vs. Explosive Weight
NO2, ppm
Explosive Weight, 10^6 lbs
0
0.5
1
1.5
2
0
0.2
0.4
0.6
0.8
1
1.2
NO2
NO2 w/o 0's

Figure 5.24

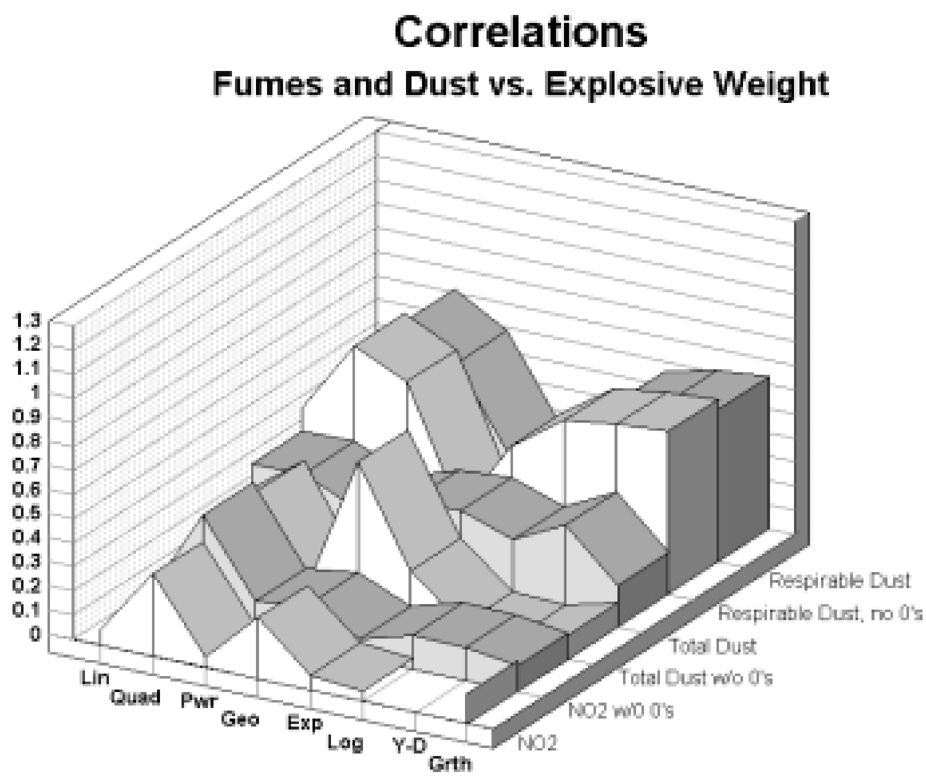

Correlations
Fumes and Dust vs. Explosive Weight
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Lin
Quad
Pwr
Geo
Exp
Log
Y-D
Grth
Respirable Dust
Respirable Dust, no 0's
Total Dust
Total Dust w/o 0's
NO2 w/0 0's
NO2

Figure 5.25

5.3.3 Humidity

This correlation was run primarily because the investigators expected to see a correlation with dust, especially on those days where a higher humidity was associated with precipitation. Not only does Figure 5.26 not show such a correlation, the high dust measurements were taken on the second most humid day. The real surprise was Figure 5.27, NO_2 versus humidity. Even though several experts assured the investigators the weather would have no impact on NO_2, the trend in Figure 5.28 is clear and strong, an inverse relationship between the fumes and the humidity. The comparison of correlations in Figure 5.28 is superb for NO_2, especially with the zero values removed. The correlations for dust are uniformly bad (except for one quadratic fit which is most likely an artifact).

This deviation from common knowledge highlights the lack of work in the area of transient blasting fumes. The experts are most likely right if one is discussing the initial quantity of fumes generated by the blast. However, they have no experience in identifying changes that occur after initial generation as the fume cloud travels, and do not make allowances for it beyond recognizing the dispersion and diffusion occur. Even the conversion rate of NO to NO_2 is not well quantified, especially in regard to ambient conditions, although the process is well known.

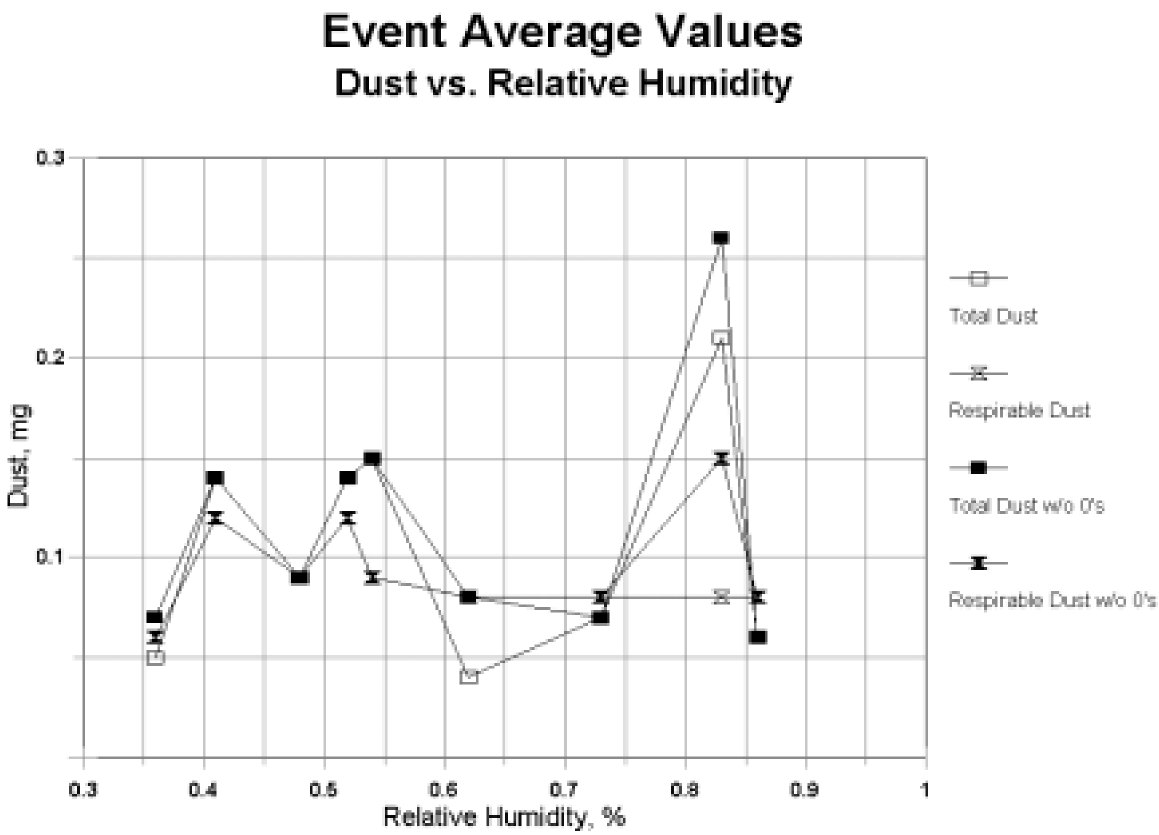
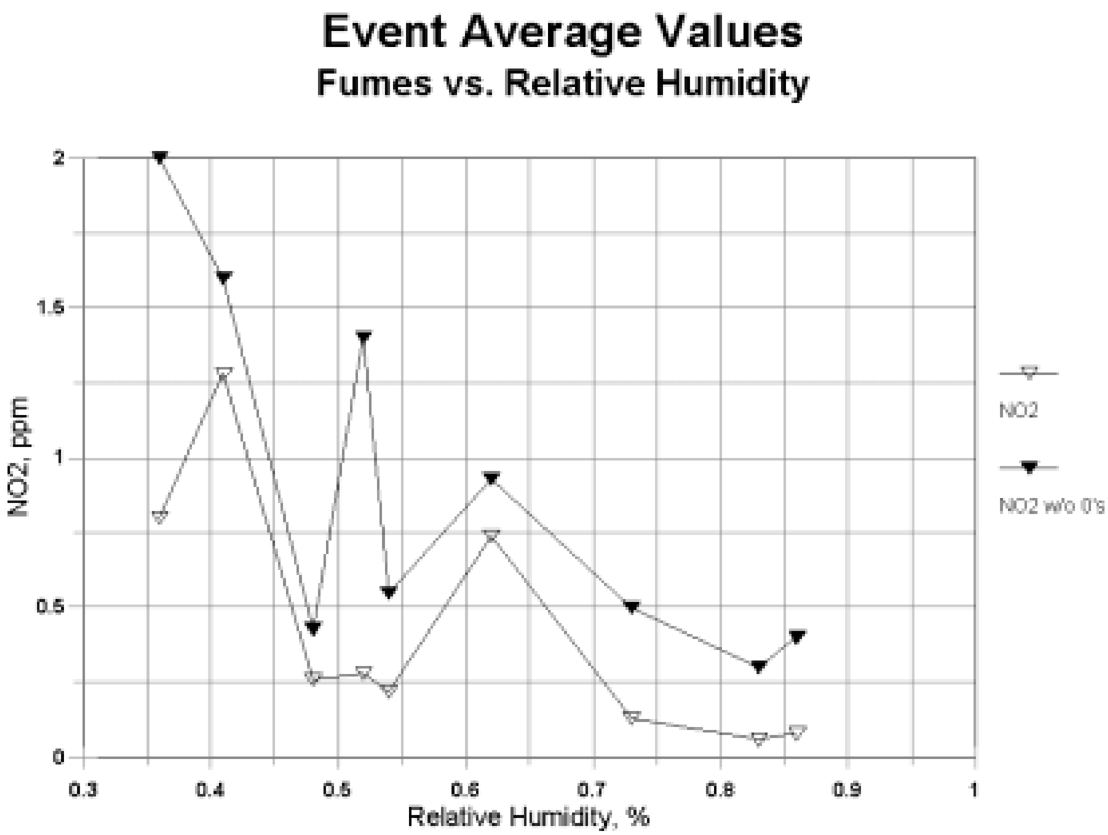

Event Average Values
Dust vs. Relative Humidity
0.3
0.2
0.1
Dust, mg
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Relative Humidity, %
Total Dust
Respirable Dust
Total Dust w/o 0's
Respirable Dust w/o 0's

Figure 5.26



Event Average Values
Fumes vs. Relative Humidity
2
1.5
1
0.5
0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
NO2, ppm
Relative Humidity, %
NO2
NO2 w/o 0's

Figure 5.27

Correlations

Fumes and Dust vs. Humidity

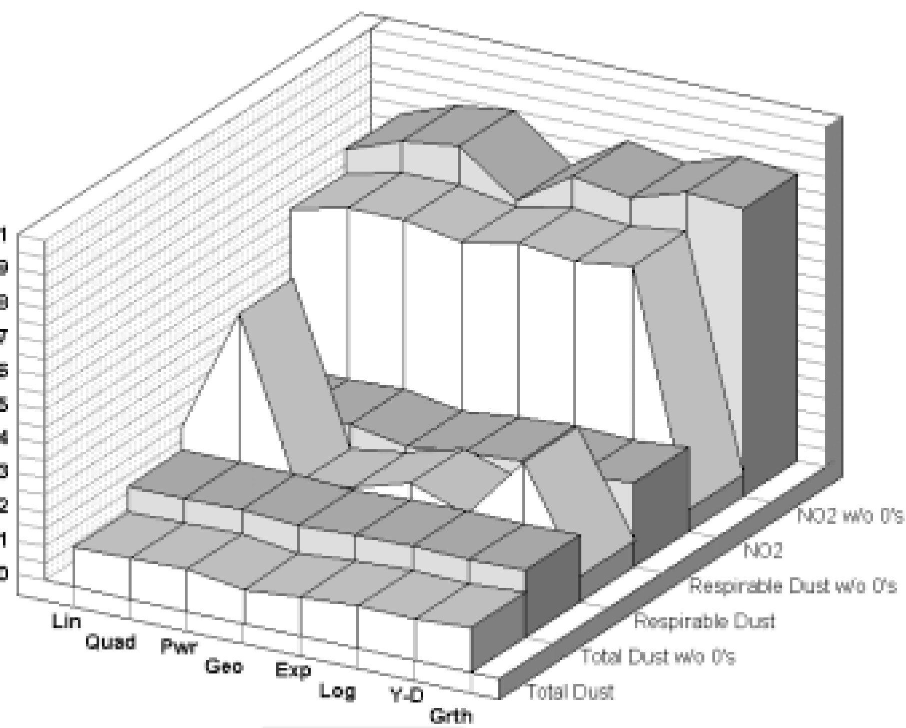


Figure 5.20

5.3.4 Summary of Correlations

The following tables (5.2 through 5.4) summarize all of the correlations illustrated in the graphs. For each variable, the correlations themselves are analyzed at the bottoms of the tables, listing the best, the worst, and the standard deviation of the correlations. This is a different way of examining the correctness of the correlation values themselves. The tighter the spread, the more valid those correlations are likely to be for that data set; the wider the spread, the less valid. It is worth noting that the values for NO_2 without zeros change to an average correlation of 0.726 with a standard deviation of 0.017 (2.31%) if the growth model is neglected.

	Total Dust	Total Dust, 0 values disregarded	Resp. Dust	Resp. Dust, 0 values disregarded	NO_2	NO_2, 0 values disregarded
Linear	0.2547	0.5556	0.6910	0.4410	0.4863	0.3434
Quadratic	0.2694	0.5916	0.8199	0.5702	0.6270	0.4506
Power	0.2577	0.5849	0.6128	0.3946	0.4335	0.3226
Geometric	0.2657	0.5998	0.6482	0.4245	0.4047	0.3010
Exponential	0.2622	0.5934	0.6316	0.4115	0.4175	0.3106
Logarithm	0.2520	0.5475	0.6736	0.4260	0.5008	0.3538
Yield-Density	0.2697	0.6335	0.7697	0.5138	0.3803	0.2931
Growth	0.2226	0.6249	0.5394	0.3479	0.3953	0.3051
Best Correlation	*0.2697*	*0.6335*	*0.8199*	*0.5702*	*0.627*	*0.4506*
Avg. Correlation	*0.257*	*0.591*	*0.673*	*0.441*	*0.456*	*0.335*
Standard Deviation	*0.014*	*0.028*	*0.083*	*0.065*	*0.076*	*0.048*
Std. Dev. as % Avg:	*5.56%*	*4.71%*	*12.32%*	*14.82%*	*16.68%*	*14.29%*

Table 5.2 Correlations: Dust and Fumes vs. Powder Factor

	Total Dust	Total Dust, 0 values disregarded	Resp. Dust	Resp. Dust, 0 values disregarded	NO_2	NO_2, 0 values disregarded
Linear	0.3449	0.2439	0.3395	0.4458	0.0666	0.0844
Quadratic	0.3524	0.4082	0.7135	0.7467	0.3413	0.4526
Power	0.2534	0.0453	0.5905	0.6449	0.0405	0.1392
Geometric	0.3292	0.6293	0.2538	0.1597	0.2537	0.1704
Exponential	0.3429	0.2230	0.3735	0.4751	0.0593	0.0763
Logarithm	0.2686	0.0511	0.5580	0.6252	0.0447	0.1394
Yield-Density	0.3785	0.0405	0.6100	0.6560	No Fit	0.1368
Growth	0.1718	0.1005	0.6326	0.6724	0.1246	0.1084
Best Correlation	*0.3785*	*0.6293*	*0.7135*	*0.7467*	*0.3413*	*0.4526*
Avg. Correlation	*0.305*	*0.218*	*0.509*	*0.553*	*0.133*	*0.163*
Standard Deviation	*0.064*	*0.197*	*0.154*	*0.176*	*0.110*	*0.113*
Std. Dev. as % Avg:	*21.04%*	*90.27%*	*30.17%*	*31.84%*	*82.50%*	*69.23%*

Table 5.3 Correlations: Dust and Fumes vs. Weight of explosives, 10^6 lbs

	Total Dust	Total Dust, 0 values disregarded	Resp. Dust	Resp. Dust, 0 values disregarded	NO_2	NO_2, 0 values disregarded
Linear	0.1158	0.1934	0.2618	0.2294	0.6959	0.7671
Quadratic	0.1201	0.1934	0.6310	0.2323	0.7362	0.8293
Power	0.1230	0.1949	0.1664	0.2365	0.7347	0.8493
Geometric	0.1010	0.1859	0.1919	0.2102	0.7078	0.7255
Exponential	0.1150	0.1934	0.2408	0.2286	0.7404	0.8310
Logarithm	0.1256	0.1960	0.1854	0.2391	0.7214	0.8039
Yield-Density	0.1208	0.1939	0.3743	0.2319	0.7441	0.8566
Growth	0.1319	0.1959	0.0744	0.2457	0.0634	0.8430
Best Correlation	*0.1319*	*0.196*	*0.631*	*0.2457*	*0.7441*	*0.8566*
Avg. Correlation	*0.119*	*0.193*	*0.266*	*0.232*	*0.643*	*0.813*
Standard Deviation	*0.009*	*0.003*	*0.160*	*0.010*	*0.220*	*0.043*
Std. Dev. as % Avg:	*7.15%*	*1.55%*	*60.12%*	*4.18%*	*34.16%*	*5.24%*

Table 5.4 Correlations: Dust and Fumes vs. Humidity

5.4 Visual Dust

It is hard to quantify the impact of dust as a nuisance. This is a subjective criterion based upon personal expectations. What bothers some may not bother others. It was not until relatvely late in the investigation that the investigators decided to try to record, if not measure, the visual impact if the passing of blasting clouds.

Complaints about blasting dust center around the residual dust left behind after the clouds pass. They normally involve things like having to wash cars, rewash laundry, the coating that they leave upon structures, and so forth. At four events, we placed white filter papers exposed on the ground beside all monitoring locations. After the blast, these filters were sealed with clear tape, placed into holders, and photographed under the same conditions. Figures 5.29 through 5.33 show those photographs. The main station filter paper at event A0727 was place to close to a highwall and was buried by 5 to 10 pounds of dirt that slipped because of blast vibration.

These photos indicate that the heaviest visible dust deposits occurred on filters within 1000 feet of the blast, and frequently not then. The exceptions are stations 2 and 3 for event C0714, which show some speckling, Of the five filters beyond 1000 feet, only these showed dust, and these were light amounts. Station 1 for this event, at 228 feet the closest station of any blast, actually caught some large pieces physically thrown from the blast.

On caveat is that some of the dust caught may have come from local activities other than blasting. There is truck traffic in the area as the workers finish final preparations and depart the area. The investigators set out these filters at the last possible minute, but in order to control the timing as much as possible we, too, frequently had to travel by truck between stations. We took as much care as possible. If such impacts were made on the measurements, they would be conservative errors; in other words, they can only adversely affect the filters, not favorably.

A0727

Event:____________________

BURIED BY HIGHWALL SLIP

Location: Main

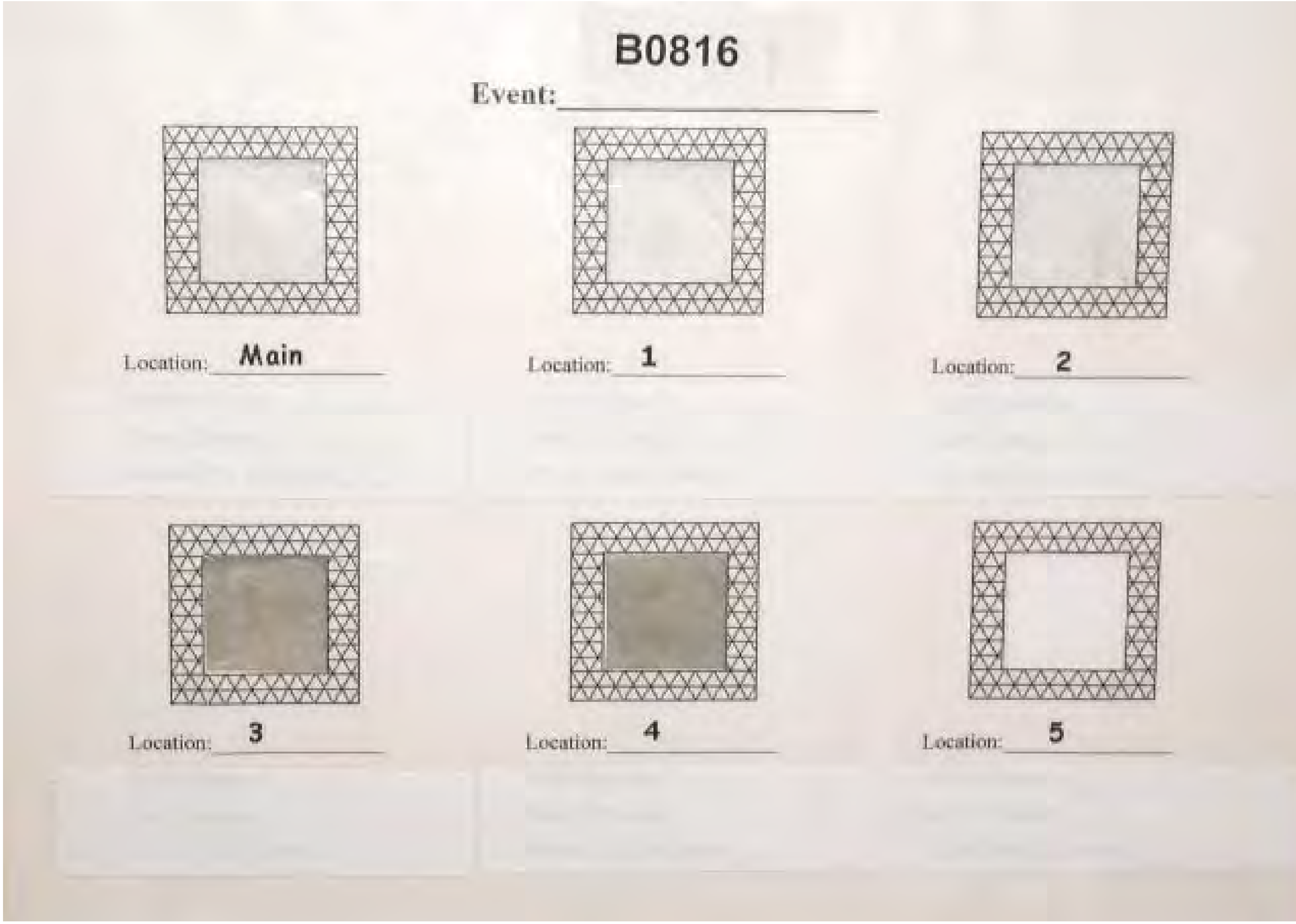
Location: 1

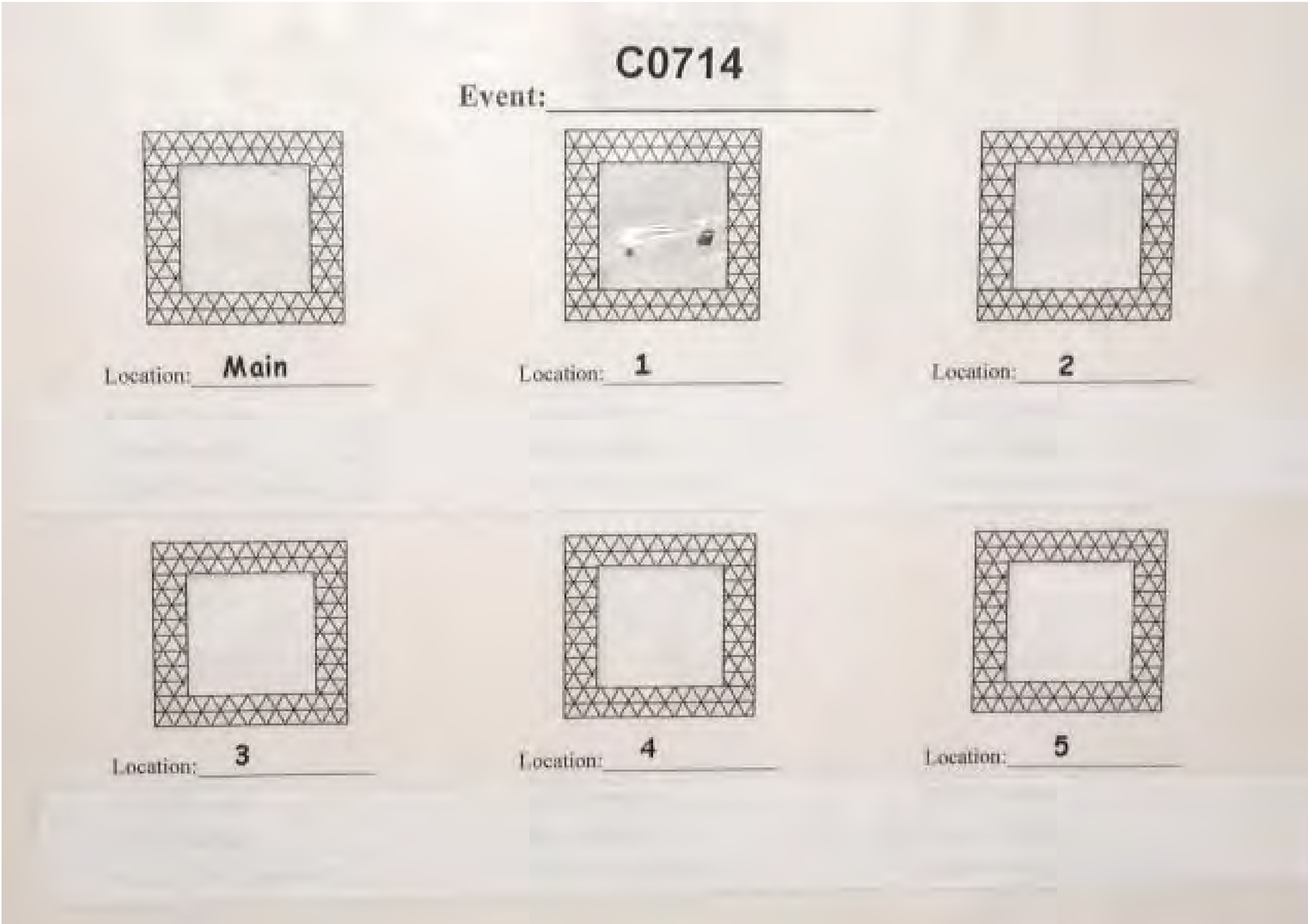
Location: 2

Location: 3

Location: 4

Location: 5


B0816
Event:
Location: Main
Location: 1
Location: 2
Location: 3
Location: 4
Location: 5



C0714

Event:

Location: Main

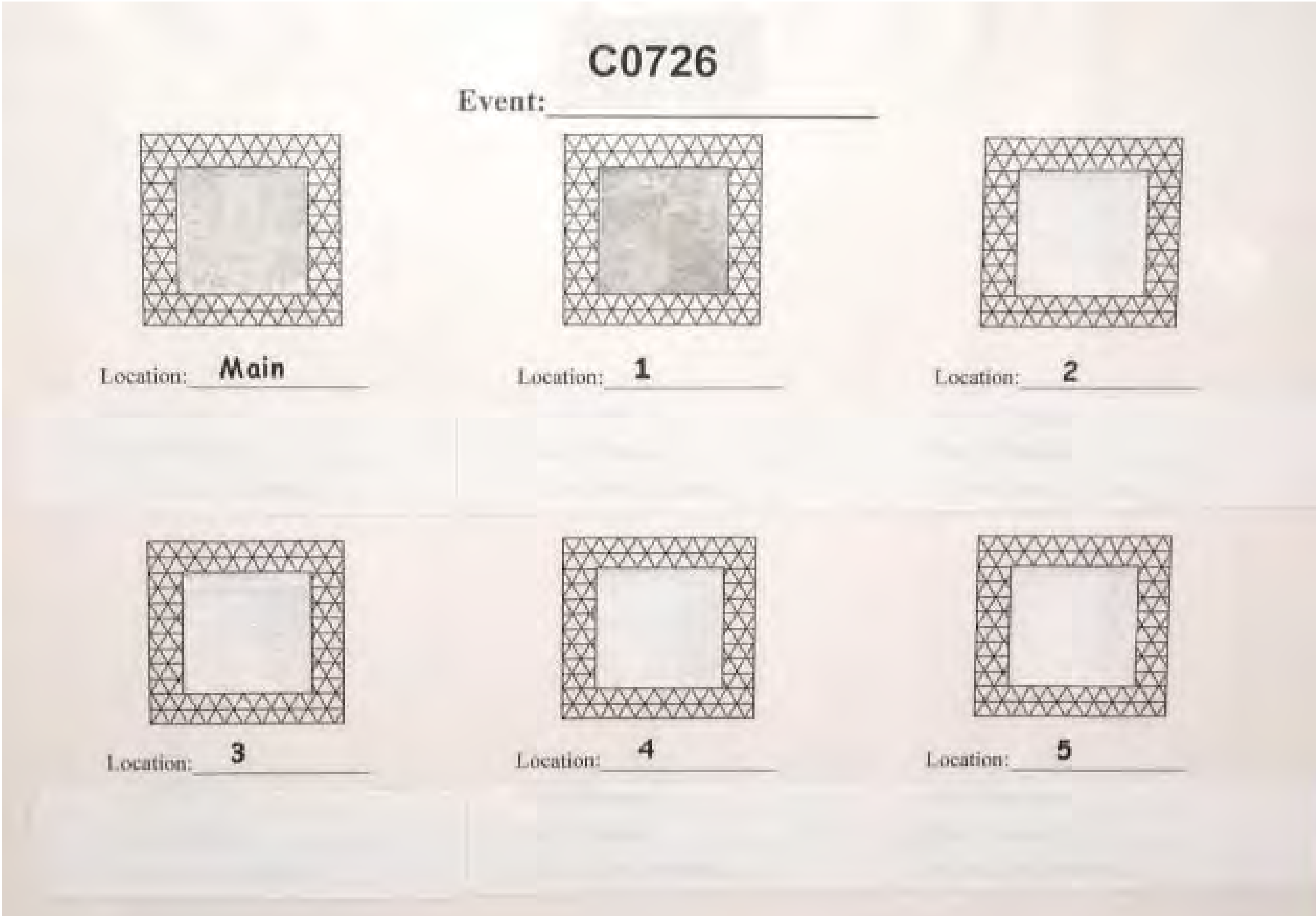
Location: 1

Location: 2

Location: 3

Location: 4

Location: 5


C0726

Event:

Location: Main

Location: 1

Location: 2

Location: 3

Location: 4

Location: 5

Page intentionally blank

5.5 Measurement Durations

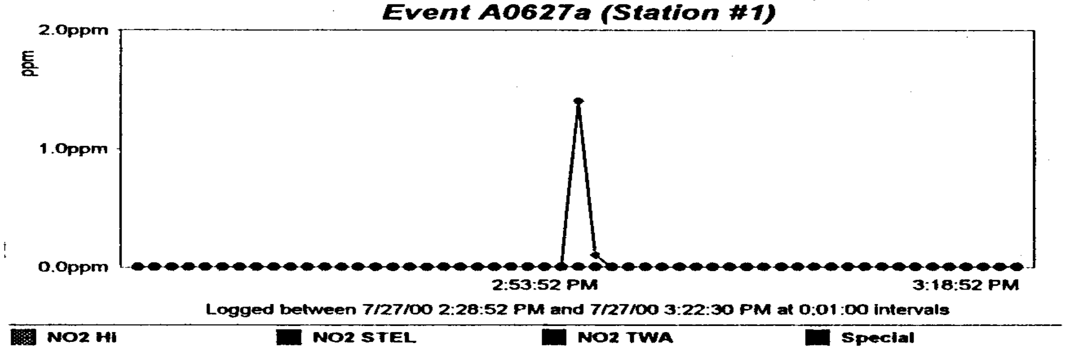
The nine pages that follow (5.48 through 5.56) show the durations of the measurements indicating the presence of fumes. Pages 5.48 to 5.53 are graphs from every montitoring station that recorded nitrogen dioxide. With the exception of stations 2 and 4 at event B0602, all of the events are of very short duration, usually less than two minutes. Event B0602 stations 2 & 4 show longer and more frequent exposures, but at levels less than 1 ppm (pages 5.48 and 5.49). The highest single measurement, 4.2 ppm at event C0714 station 1, the peak was for one measurement cycle only (1 minute duration), followed immediately by a reduction to below 1 ppm (page 5.51). Page 5.53 shows a sample illustrating a main station NO_2 measurement and why we were reluctant to use them. Even though the highs tended to be in accordance with highs from neighboring stations, the unstable baseline with the frequent less-than-zero readings indicated a problem with the unit we were never able to define or correct.

Pages 5.54 and 5.55 are graphs of carbon monoxide readings. Five events had main station readings of 2, 3, 5, 8, and 9 ppm, respectively, only one of those is reproduced here for purposes of illustration. Once again, although the readings are high in several cases, they are of exceptionally short duration.

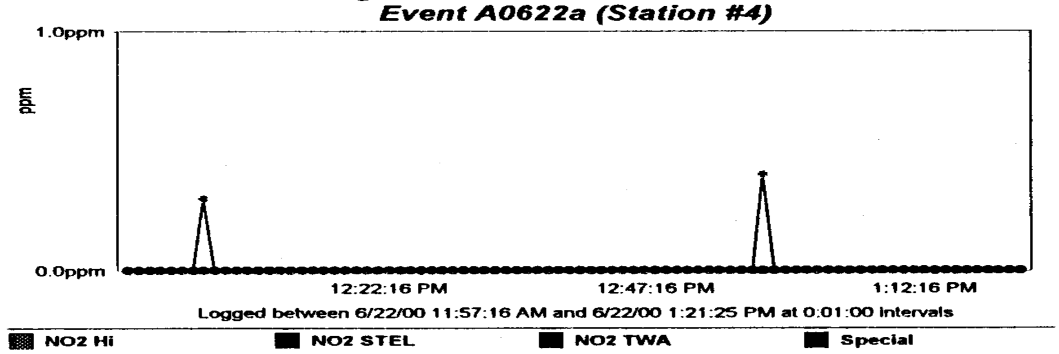
Finally, page 5.56 provides one graph each of an ammonia reading and a nitric oxide reading. These readings tended to follow the form of the other fumes where they occurred as can be seen by comparing these two graphs with the carbon monoxide graphs from the same events.

No readings indicate the possibility of prolonged exposure to unhealthy levels of fumes. Those readings that are high enough to be concerned for long-term exposure are of very brief duration, in the neighborhood of one minute.

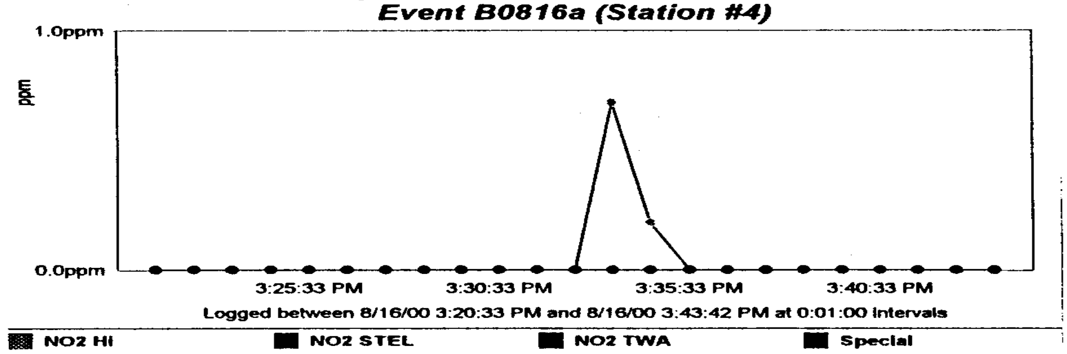
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event A0627a (Station #1)



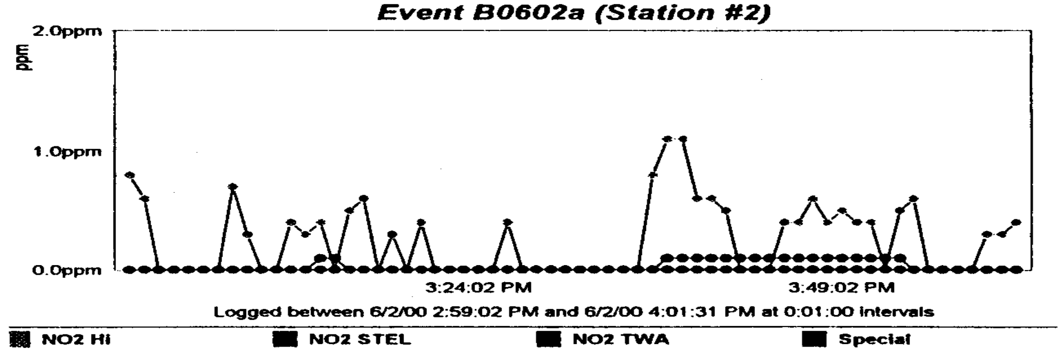
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event A0622a (Station #4)



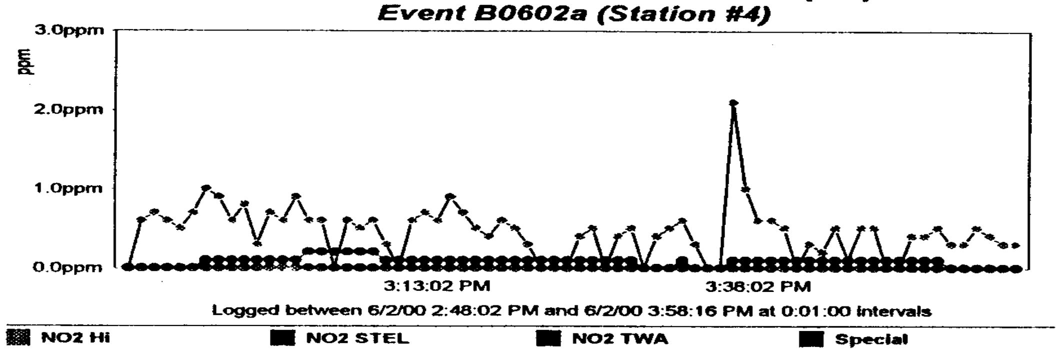
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0816a (Station #4)



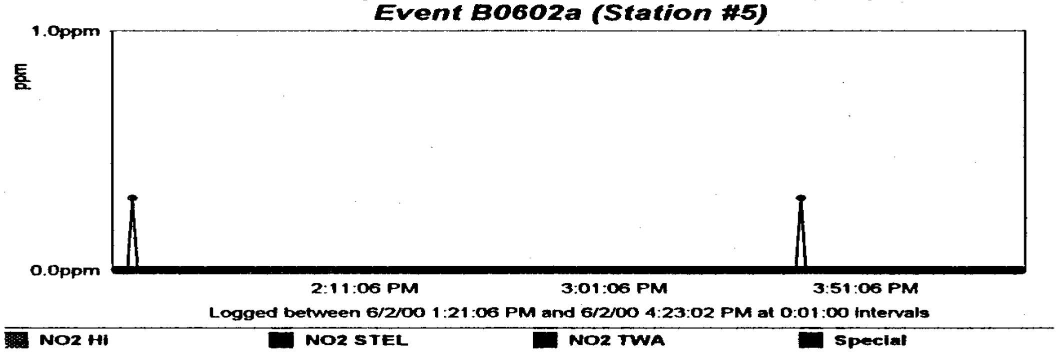
Session #3 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0602a (Station #2)



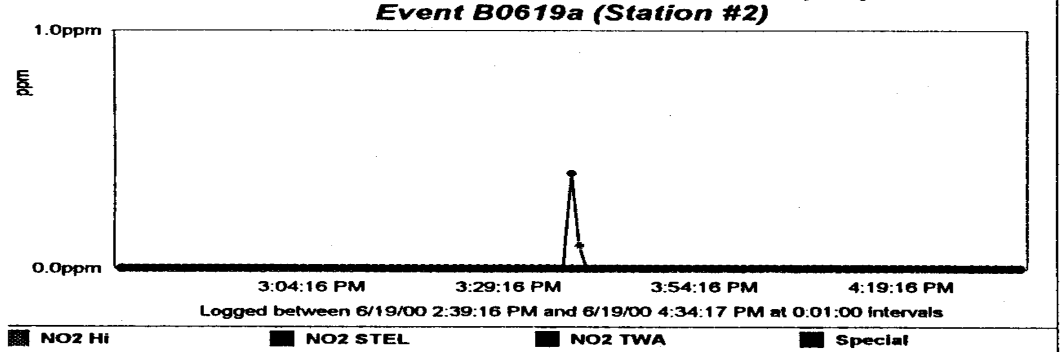
Session #7 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0602a (Station #4)



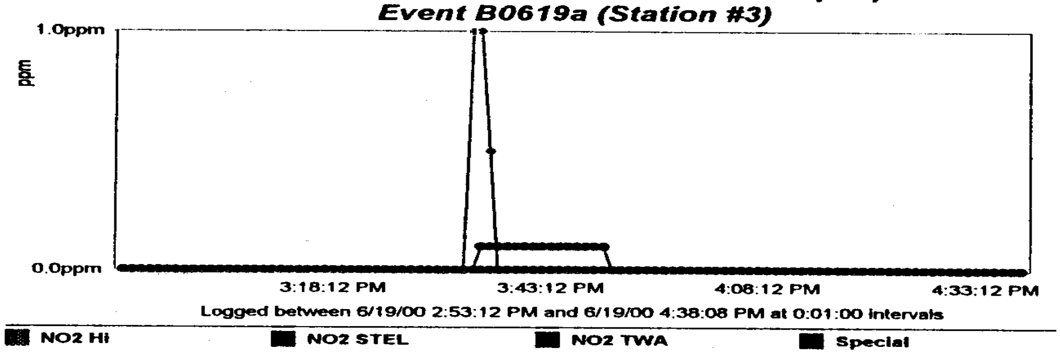
Session #11 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0602a (Station #5)



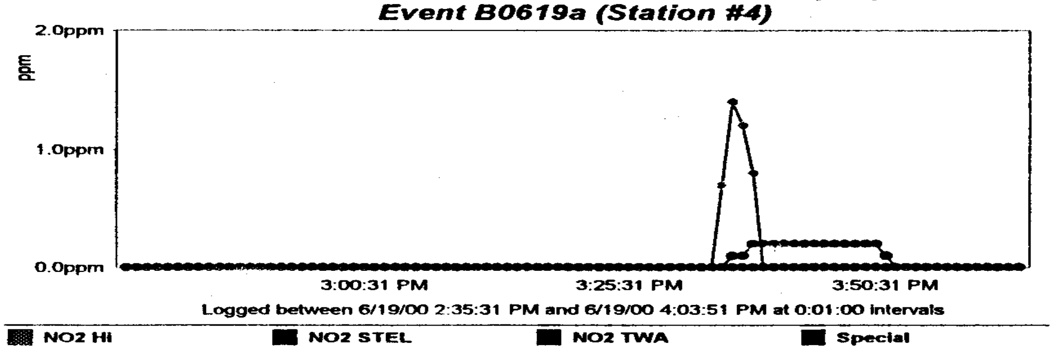
Session #4 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0619a (Station #2)



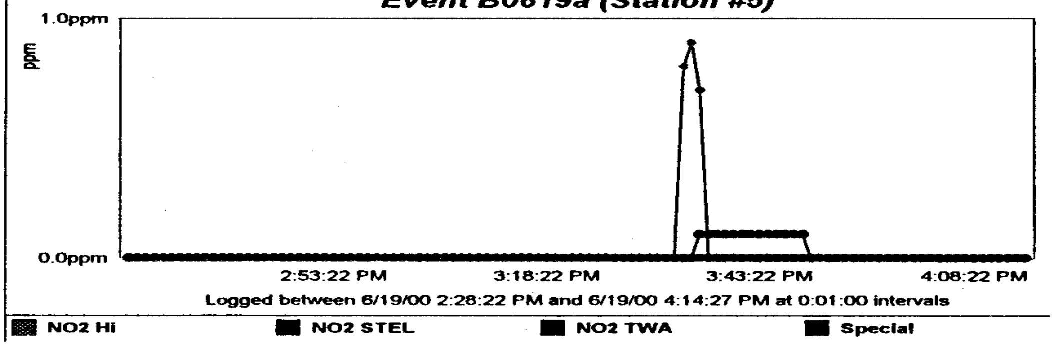
Session #14 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0619a (Station #3)



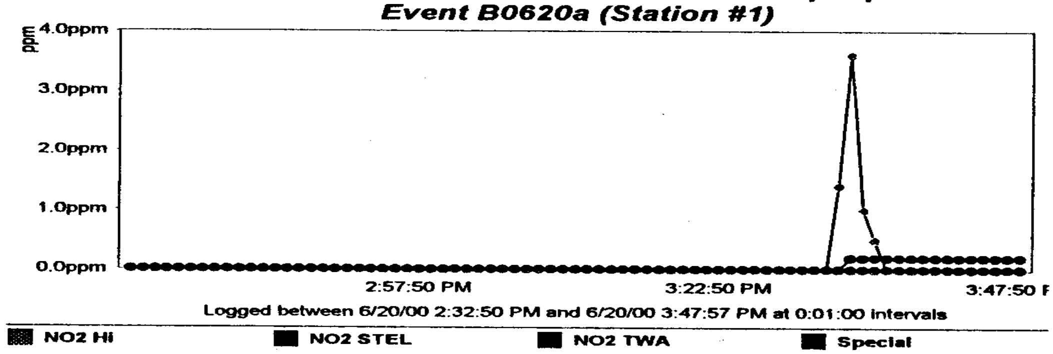
Session #11 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0619a (Station #4)



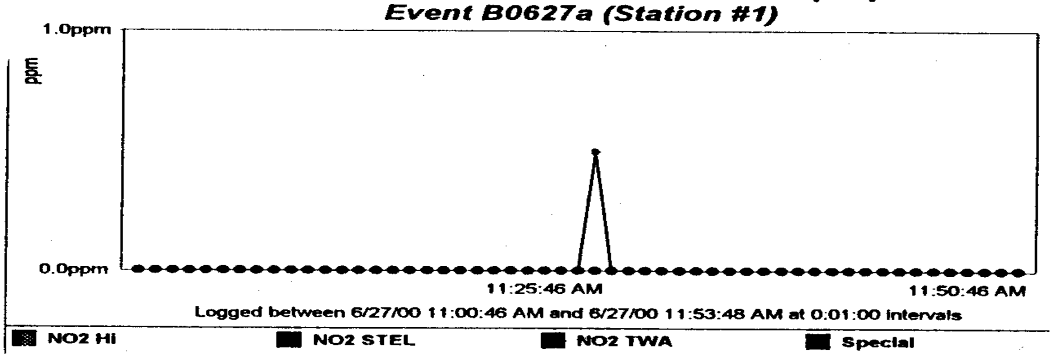
Session #13 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0619a (Station #5)



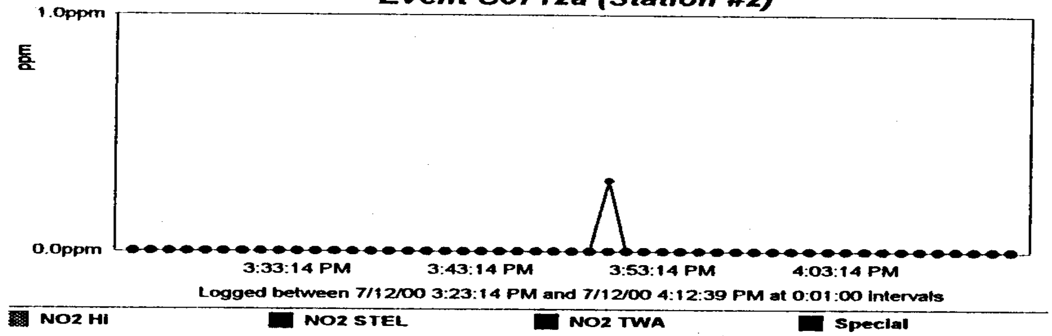
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0620a (Station #1)



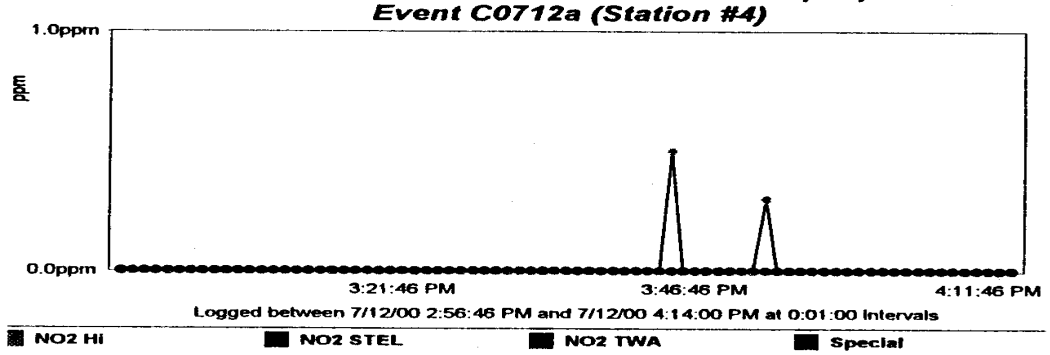
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event B0627a (Station #1)



Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event C0712a (Station #2)



Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event C0712a (Station #4)



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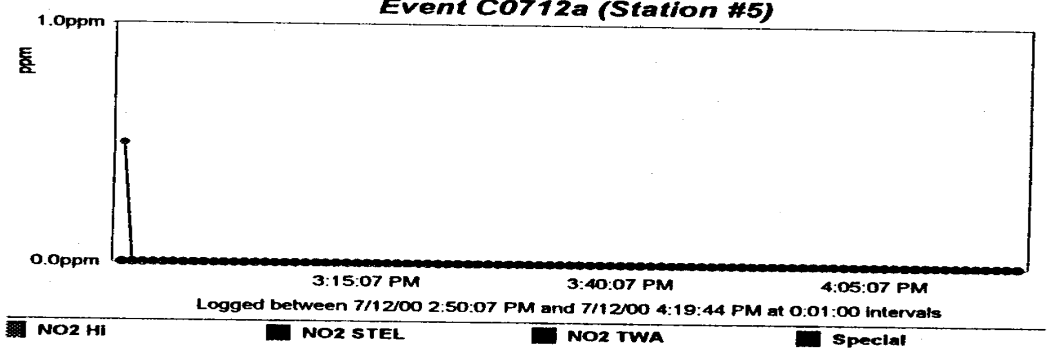
Event C0712a (Station #5)



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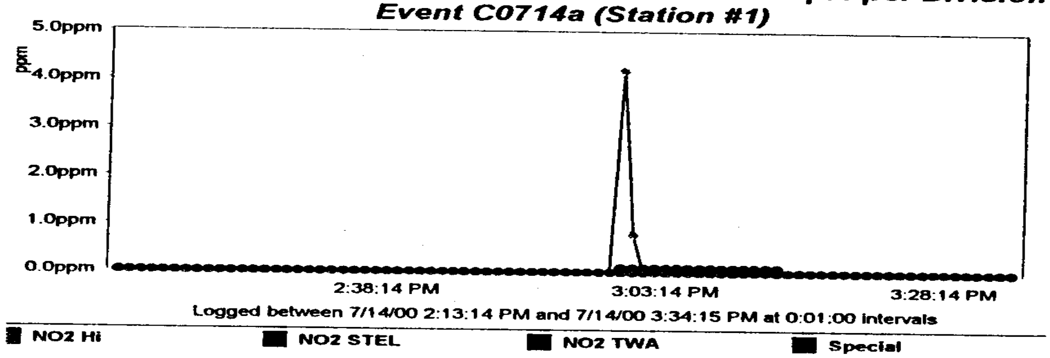
Event C0714a (Station #1)



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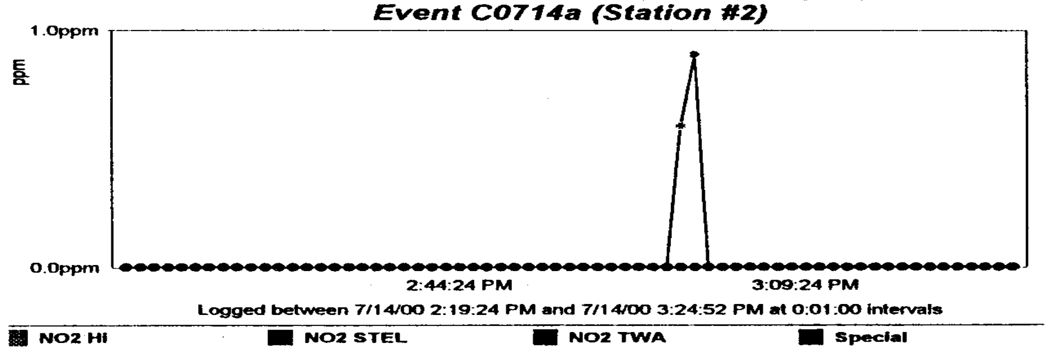
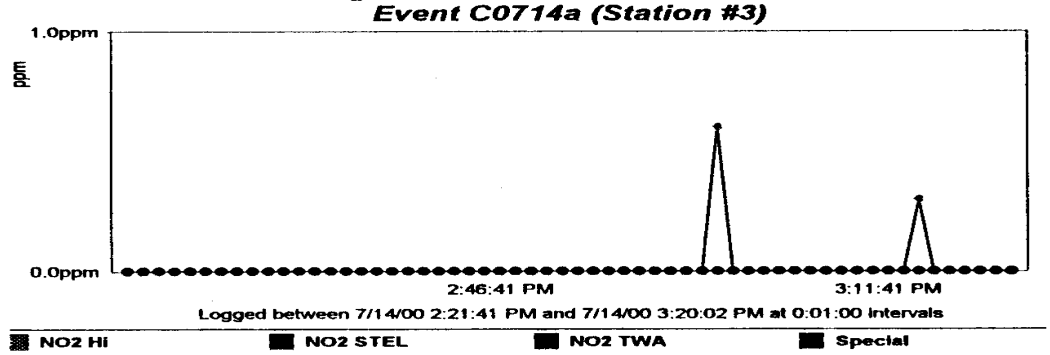
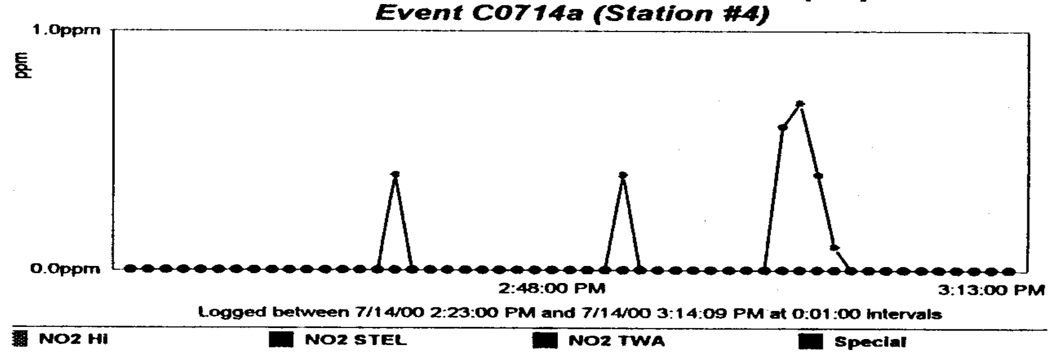
Event C0714a (Station #2)



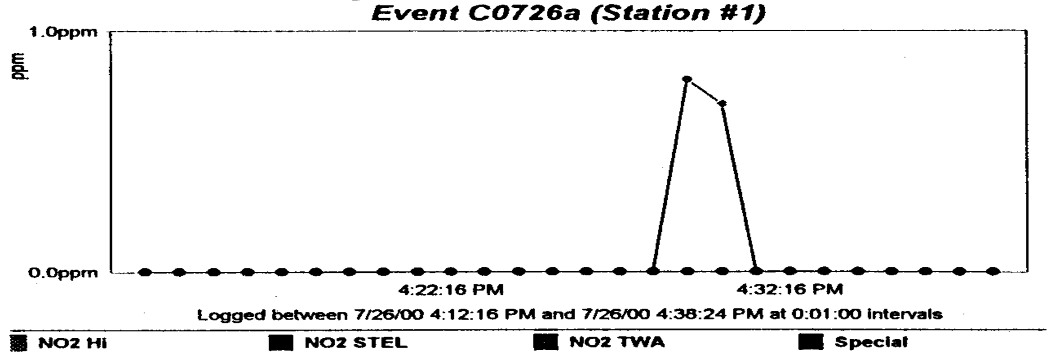
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event C0714a (Station #3)

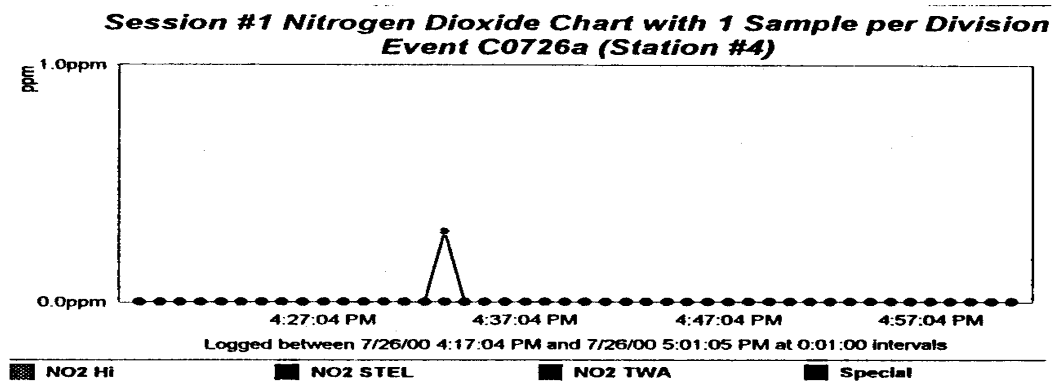


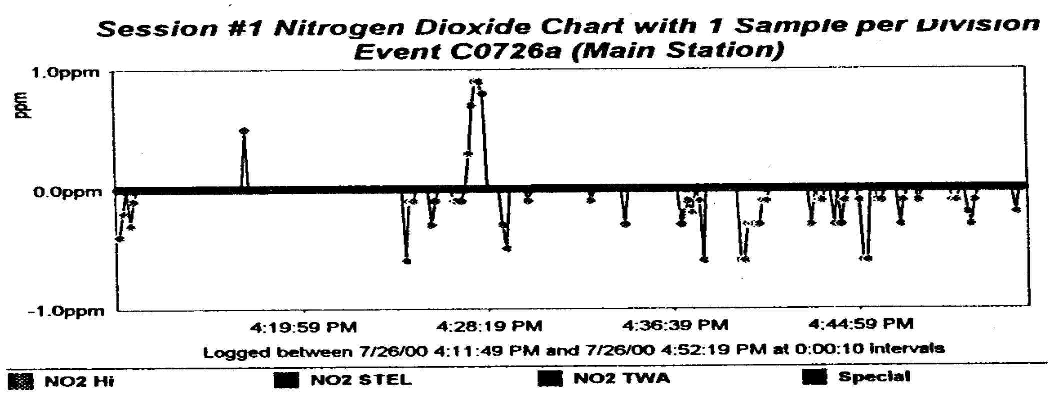
Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event C0714a (Station #4)



Session #1 Nitrogen Dioxide Chart with 1 Sample per Division
Event C0726a (Station #1)

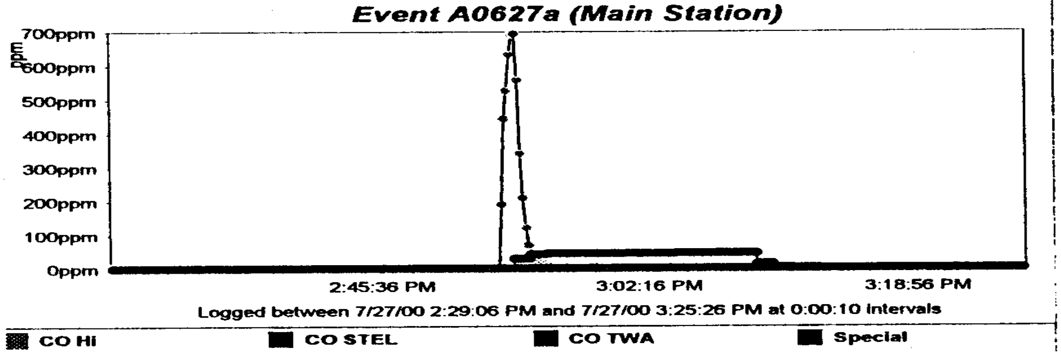




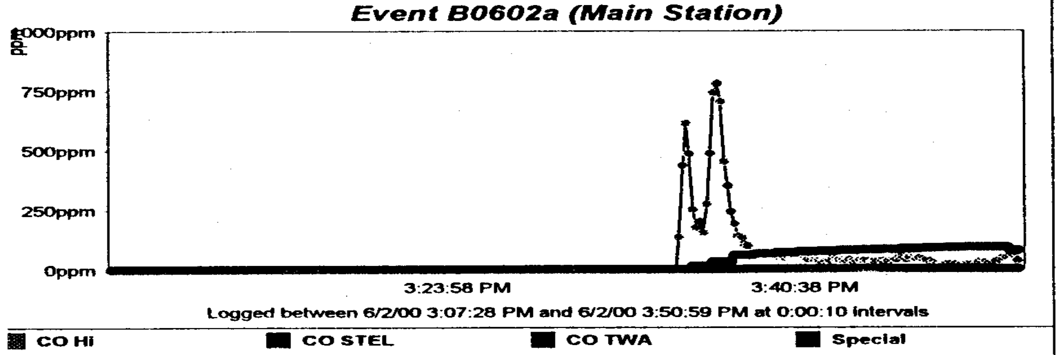


Example of bad main station output for nitrogen dioxide.
Even though the highs are in the expected range, the inconsistencies in the baseline make this data suspect.

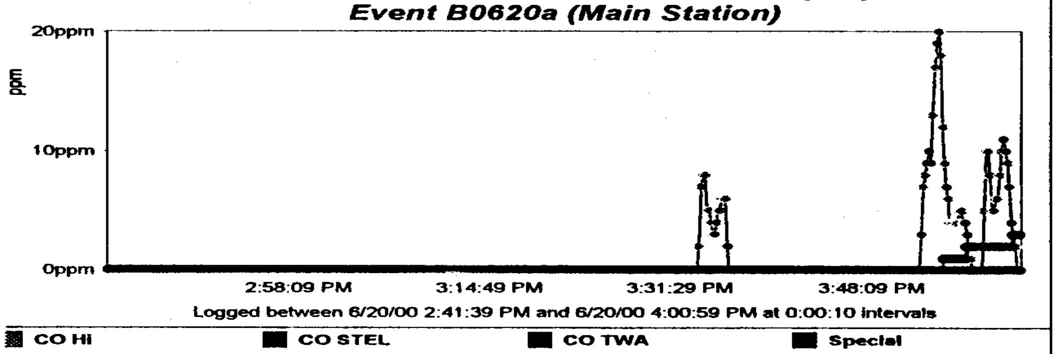
Session #1 Carbon Monoxide Chart with 1 Sample per Division
Event A0627a (Main Station)



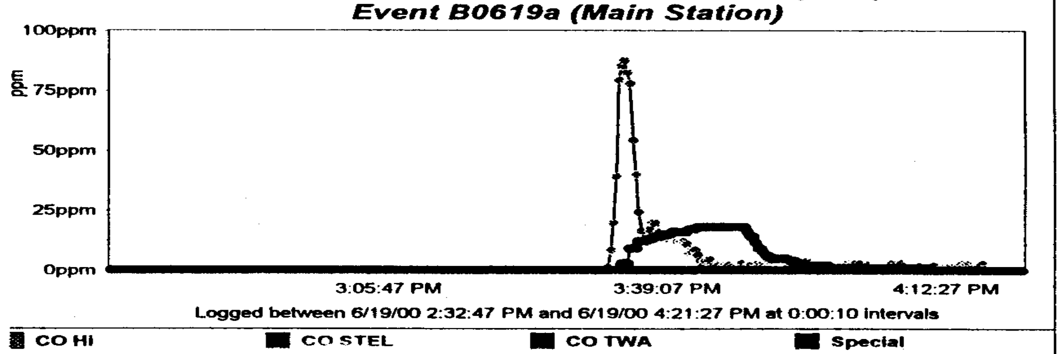
Session #1 Carbon Monoxide Chart with 1 Sample per Division
Event B0602a (Main Station)



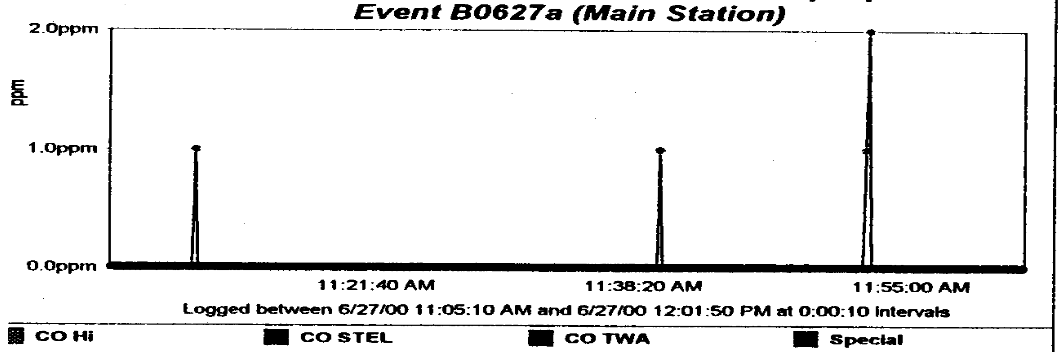
Session #2 Carbon Monoxide Chart with 1 Sample per Division
Event B0620a (Main Station)



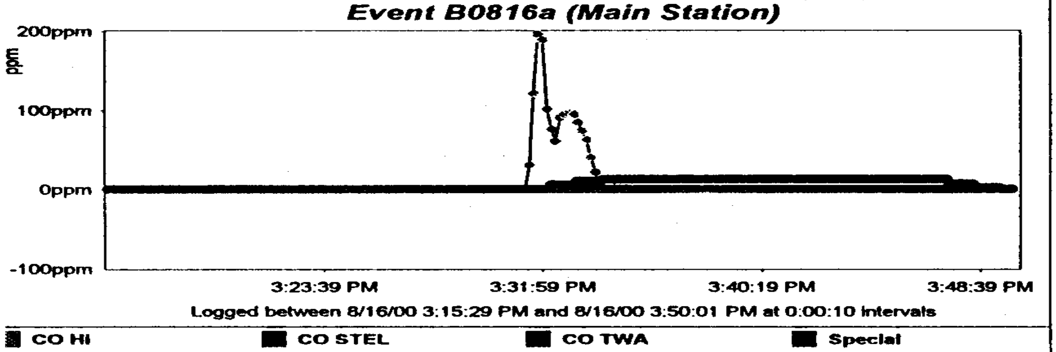
Session #3 Carbon Monoxide Chart with 2 Samples per Division
Event B0619a (Main Station)



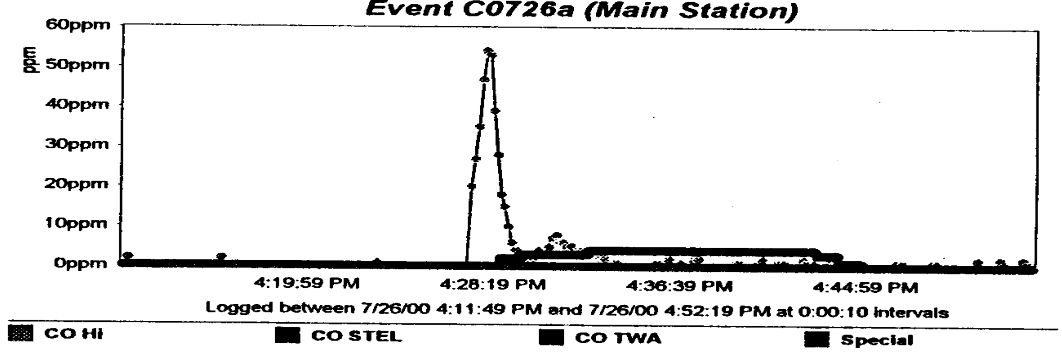
Session #1 Carbon Monoxide Chart with 1 Sample per Division
Event B0627a (Main Station)



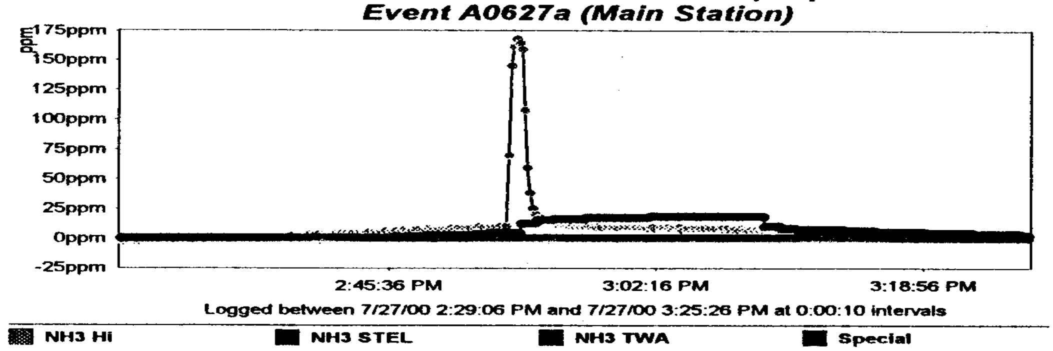
Session #1 Carbon Monoxide Chart with 1 Sample per Division
Event B0816a (Main Station)



Session #1 Carbon Monoxide Chart with 1 Sample per Division
Event C0726a (Main Station)

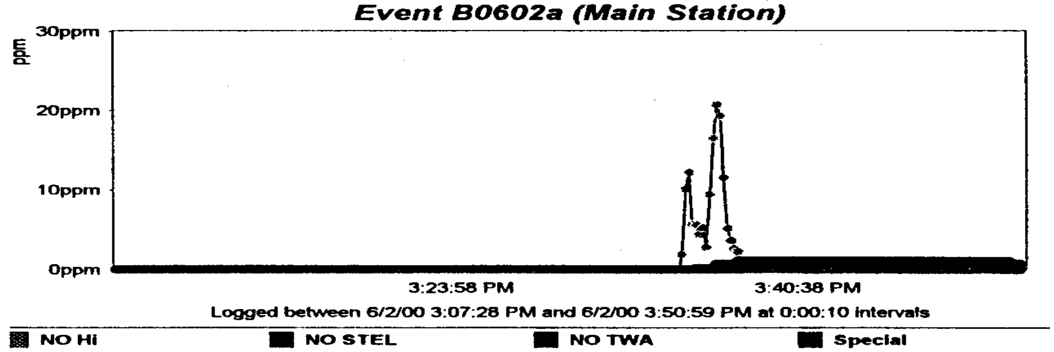


Session #1 Ammonia Chart with 1 Sample per Division
Event A0627a (Main Station)



Compare form of curve to same event curve for carbon monoxide.

Session #1 Nitric Oxide Chart with 1 Sample per Division
Event B0602a (Main Station)



Conpare form of curve to same event curve for carbon monoxide.

5.6 Conclusions

Dust and fume emissions from 11 blasting events at three mines were measured, 10 of which were useable. Both respirable and non-respirable dust was measured, as well as nitrogen dioxide (NO_2), nitric oxide (NO), carbon monoxide (CO), and ammonia (NH_3). Nitrogen dioxide, total dust, and respirable dust were measured at 10 points for each event; the remaining fumes were measured at only one. At four events, settled dust at the monitoring stations was caught on filter paper and photographed. Results are consistent, but the statistical correlations are poor. The suspected primary reason for poor correlations is the inability to account for wind velocity across the measurement sites close to ground level. Surprisingly, the best correlation (r = 0.86) was an inverse relationship between NO_2 and humidity. The CO and NH_3 highs were also a surprise. Topographical constraints, although expected, were worse than expected. Topographical constraints were such that all sites were within 1900 feet, with an average distance of 943 feet. This was actually a fortuitous turn of events because of the very low levels of anything that were detectable as the stations approached 2000 feet.

The basic results are presented in Table 5.5:

Dust, Respirable::	**Max:**	**0.34 mg**	**Min:**	**0 mg**
	Max over 1000 ft:	**0.21 mg**	**Min over 1000 ft:**	**0 mg**
Dust, Total:	**Max:**	**0.66 mg**	**Min:**	**0 mg**
	Max over 1000 ft:	**0.10 mg**	**Min over 1000 ft:**	**0 mg**
Nitrogen Dioxide:	**Max:**	**4.2 ppm**	**Min:**	**0 ppm**
	Max over 1000 ft:	**1.0 ppm**	**Min over 1000 ft:**	**0 ppm**
Nitric Oxide:	**Max:**	**48.7 ppm**	**Min:**	**0 ppm**
	Max over 1000 ft:	**9.8 ppm**	**Min over 1000 ft:**	**0 ppm**
Carbon Monoxide:	**Max:**	**780 ppm**	**Min:**	**2 ppm**
	Max over 1000 ft:	**88 ppm**	**Min over 1000 ft:**	**2 ppm**
Ammonia:	**Max:**	**168 ppm**	**Min:**	**0 ppm**
	Max over 1000 ft:	**25 ppm**	**Min over 1000 ft:**	**0 ppm**

Table 5.5 Summary of collected data
(Compare these to the ACGIH TLV's in Table 1.1)

Maximum measurements were of very short duration. Even where measurements exceeded thresholds for the workplace, they were 1) of exceptionally short duration and 2) located within a zone where no individual would be permitted during blasting. There were some equipment difficulties, the primary one being the failure to achieve proper operation of the main station NO_2 monitor. Therefore the ratio calculations that we had anticipated being able to do are not possible. Still, where the main station is close to another monitoring station and the distances are equivalent, inferences may be made.

We find no indication that there are any significant health risks due to exposure to large blasts when no personnel are in close proximity to the blast zone. This is the standard procedure for safety purposes anyway; as the blasts become smaller, the safety zone may decrease. Vibration limitation requirements result in very small blasts when as the distance to off-site structures is reduced . Even within 1,000 feet of a large blast, measurements of adverse levels of fumes and dusts are infrequent and of short duration.

This investigation is concerned with fugitive dust and fumes, meaning that which escapes the confines of the mining property. This investigation indicates that these emissions present no potential health problem for the following reasons.

C No event produced any harmful levels of any duration at distances exceeding 1,000 feet, except one measurement of 3.6 ppm NO_2 at 1251 feet.

C This measurement, and all others were of very short duration.

C Fugitive emissions are those that leave the property; if the property boundary is closer than 2,000 feet, persons within this area are evacuated.

Quality of life issues other than health, that is the enjoyment of life and the potential of reducing that enjoyment, is harder to define because of its very subjective nature. Photographs of dust settling out of blasting clouds do not show significant deposition beyond 1000 feet.

6.0 RECOMMENDATIONS

6.1 A Word About Approach

When is enough enough? Buried in this cliché is a very real problem. Just because it is possible to measure something, or measure it more accurately, does not mean it is best to do so. There were a lot of expectations coming into this project, not all of them reasonable. Would we be able to determine dispersion and diffusion factors? Could we pick out the quartz? Could we separate the gases? Some of these expectations were ours, some from others. Limiting factors on these expectations were resources: time, manpower, budget. Ultimately, of course, multiple times, we had to return to two basic controlling guidelines: What was the scope of work, and what were the resources? The two questions in the scope of work were to determine if hazardous levels of dust and fumes traveled far enough from the blast site, and if they represented an annoyance that impacted the quality of life. The first is a simple yes-or-no question, not requiring information in enough detail to model. Simply put, has a threshold been crossed? The second is a value judgement, much more difficult to answer and even more difficult to obtain objective input for. And the budget was $63,000.

For much of my professional life I have used Occam's Razor[1] as a guide. When I share this with someone, the most frequent response I receive is, "Ah, yes, the Law of Parsimony!" This is absolutely wrong, but understandable since many references themselves make the same mistake, especially internet sources. The difference is crucial. The Law of Parsimony (also known under several other names) states that when multiple explanations are available for a cause or event, the simplest is most likely true and should be used. Occam's Razor states, "Thou shalt not multiply complexities unnecessarily," an instruction to avoid adding unnecessary components. The first is a statement about the nature of reality, the second is a directive governing the observer's behavior.

In the scientific and engineering community there is a great tendency to use tools just

[1]Also known as Ockham's Razor -- first expressed circa 1358.

because we have them. Why measure to an inch when we can measure to a micron? Why weigh an once when we can weigh a microgram? And more. The broad general assumption is that more information is better. If this information cannot be used now, perhaps in the future. But by analogy, it is easily seen not to be the case. Does an individual buying a fifty-foot piece of rope really need to know that it is 50.002364 feet long? No. Does the mechanical engineer really need to know that the piston is 5.0000±0.0001 inches? Yes. So the answer is based on a need to know, the application, and the question to be answered.

I have seen more than one project where basic information, the really important stuff, was lost in a flood of extraneous information. (And don't forget that added resources were expended to obtain that extraneous information.) The resulting clutter of data can bury or obscure the simple underlying principle. There is *so much* to look at that the simple relationships just aren't discernable. This is especially true in initial work. Often orders-of-magnitude for variables of interest are not even known, and thus a good choice of instruments is difficult. In practice, budget withstanding, the "best" instruments are chosen. However, in a case such as this, a "tape-measure" approach is best; obtain a general measurement as a starting point. A decision on whether a micrometer, a vernier, or a theodolite is needed can be made afterwards with some assurance. This is the situation we found ourselves in for this project.

Occam's Razor has long been an indispensable item tool in my toolbox. If an approach, an instrument, or a technique does not add either understanding or increased accuracy to the answer, I do not use it. What is the point of creating a differential model if the rate functions that should drive it are not known? It helps me avoid this tendency to over-use tools, especially mathematics, when the underlying principles are neither defined nor understood. Many models are created that do not produce useable output for this reason.

So was Occam's Razor used here? First, limited funding meant limited instruments. Either we could learn a lot about a single point, or learn less about multiple points. Knowing that we would have difficulty in placing a single point in context, we chose to measure multiple points. With the uncontrolled variables of weather, wind speed and direction, shot confinement and efficiency, and more, it would have been impossible to place one point in context, and it would have been at least difficult and probably impossible to compare two points from two different shots in any meaningful way with all of those variables operating. Multiple points at least provided multiple measurements within each blasting event. In this initial investigation of an eastern blasting cloud we did not even know what magnitudes to expect, an important criterion for selecting instrument sensors. None of the experts we consulted could even suggest a starting point. So we opted to purchase as many basic instruments as we could afford that had the option of changeable sensors. For determining station locations, what accuracy was needed? Again, with the distances involved, with the rapid changes of terrain within the measurement areas, and with the variations in plume movements that we expected, we decided that surveying-precision and the attendant cost and labor involved were not warranted, especially in light of the time available for station set-ups. Global Positioning Surveys would be adequate; measurement errors are a small fraction of the distances involved. (We were also fortunate in that the government ended GPS scrambling just weeks before our first field trip.) How do we measure the impact of dust on the quality of life? In other words, with real data, weights-and-measures, just how would one judge these dust weights or size distributions as perceived nuisances? Late in the project we decided that nuisance essentially meant visible dust (health is another matter, of course). After all, this is the basis of most dust complaints. Therefore we decided to set up large filter papers to collect dust and actually *see* what the dust deposition *looked* like. And there are other examples as well. The point is that a simple question was asked about a phenomenon that has not really been investigated before, and ultimately we translated a limited budget and a very specific question in the most useful approach possible. Occam's Razor pointed the most direct path.

This is a very detailed explanation to arrive at the next point I wish to make. We strongly recommend that a similar but much broader approach be used in any follow up activity. For example, the largest variables of concern are time, wind, and distance. Rather than setting up six more sophisticated instruments, setting up fifty or a hundred simpler instruments in a plume path. This would add immensely to the ability to define the plume, whereas a couple of detailed points would not This approach would require a lot of sensors, and a field team, not just two investigators in a single vehicle. But this approach could very well help produce data leading to the definition of dispersion and diffusion factors. It is our current belief that each individual shot is so unique that it will be very difficult to combine individual data points from different blasting events in a meaningful, trustworthy way without a substantial database. Comparing dispersions, however would be easier. It would take a large number of stations to do this. Fortunately, personal monitoring devices would be accurate enough to do this and represent a real value over research-level instruments. In this case the difference between 2. 4 and 2.8 milligrams or parts per million is important. The difference between 2.44 and 2.46 probably is not; it is the difference of moving a station 20 or 30 feet one way or another, or difference turbulence makes in moving one portion of a cloud this way or that.. More than one individual expressed concern when we indicated that we were using personal monitoring devices instead of research-level instruments. However, these instruments *are* accurate enough to entrust individual safety and health to them and have thus already passed regulatory scrutiny for accuracy within their stated limits. And the required added research *is still* in the mode of having to measure fifty-foot pieces of rope.

6.2 Recommendations for Future Work

This investigation gives an insight into the hazards and nuisances to be expected from blasting. It is based on a small number of blasts, ten, and data points, six per blast, plus a photographic record. It is enough to show that fugitives from blasting are minimal, but not enough to accurately define cloud movement, dispersion, or diffusion of clouds from blasting. Additional work needs to be done

6.2.1 Information to Obtain

6.2.1.1 Blasting-Related Information

More information points need to be obtained, and not only more blasting events, but more data points per event. More information on wind velocity needs to be obtained. The strong correlation between fumes and humidity indicates that there may be greater weather impacts than originally suspected; data needs obtained under a wider range of weather conditions, including extreme cold, heavy precipitation, and stronger winds. None of the measured events occurred during a wind strong enough to move a blasting cloud at a high velocity.

6.2.1.2 Non-Blasting Related Information

To answer the quality-of-life issue regarding fugitive emissions for residents near MTR blasting (or all MTR operations for that matter), the dust in these residential areas needs to be assessed by source. In other words, the dust that does exist needs to be identified by source: What comes from mining operations, and what comes from local road traffic and agricultural and recreational activities. (Several times during this investigation, the PI observed local residents running on the back roads and trails on ATV's, twice trespassing on mine property.)

6.2.2 Potential Methods

If the investigators had this work to perform again, they would make at least two substantial changes.

First, we would use helium balloons to determine wind direction. Such balloons would be relatively inexpensive, and if launched from a blast site would travel in the same direction as the average cloud movement until an altitude was reached that was above ground effects. Launching of several balloons from different locations or from one spot at different times would identify local variations.

Second, we would make much fuller use of the large filter disks to catch settled dust. These are inexpensive, and a large number could be place in the area of expected cloud travel. The use of a GPS system greatly simplifies locating them in relation to the blast site. With some advance design work, perhaps a better way to use these filters, or an alternative method for obtaining the same information might be developed. An adhesive surface sounds attractive, but we tried them and they were disappointing; once a thin covering develops, subsequent dust does not adhere.

We are of the opinion that this work is still at the level where there is a larger payback for using more less expensive monitors than fewer more expensive ones. Ultimately, the success of any follow-up work will depend upon having many more points at many more events. Specific recommendations would include:

- The use of more dust pump placed more broadly around the blast, covering a larger area.
- The use of more gas monitors, not only at more sites, but more per site to cover more gases. (Our experience is that the individual monitors were more dependable than the

larger multi-gas unit.)

- Use of a method to measure the visual impact of settled dusts, and using this method as broadly as possible.
- Use the same methods around other dust sources, such as haul roads, drilling, draglines, etc. It is important to map these values over distance, not just to find single-point values.
- Use the same methods off-site in the area of received complaints.
- Use the same methods off-site and in an area substantially removed from MTR mining, but with similar roads and similar agricultural and recreational activity.
- Use the same methods during weather extremes.

7.0 BIBLIOGRAPHY AND REFERENCES

References

1. ACGIH. (1999). *Particle Size-Selective Sampling for Particulate Air Contaminants* (J. H. Vincent, Ed.) (p. 252). Cincinnati: Author.

2. ACGIH. (2000). *TLV's and BEI's* (p. 192) [Abbreviated reference]. Cincinnati: Author.

3. ACGIH Committee on Industrial Ventilation. (1991). *Guide for Testing Ventilation Systems* (p. 34). Cincinnati: ACGIH.

4. Centers for Disease Control (National Institute for Occupational Safety and Health). (1999). *Collection of publications. Respirable coal dust - surface mining*. CDC (Year is assumed, not given).

5. Conti, R. S., Cashdollar, K. L., & Liebman, I. (1982, March). Improved optical probe for monitoring dust explosions. *Review of Scientific Instruments, 53*(3), 311-313.

6. Cooper, P. W. (1997). *Explosives Engineering* (p. 460). Wiley-VCH.

7. Dowding, C. H. (1985). *Blast Vibration Monitoring and Control* (p. 297). Evanston, Illinois: Northwestern University.

8. Hesketh, H. E., & Cross, F. L. J. (1983). *The environment and energy handbook series* (H. E. Hesketh, Ed.) (p. 145). Ann Arbor, Michigan: Ann Arbor Science Publishers.

9. Hesketh, H. E., & Mainiero, R. J. (1997, February 2-5). *A technique for measuring toxic gases produced by blasting.* Paper presented at the 23rd Annual Conference on Explosives and Blasting Technique. Reno, Nevada: National Institute for Occupational Safety and Health.

10. Lawrence, L. D. (1997). *A study on post blast generation of nitrogen dioxide.* [Incomplete reference information]. International Society of Explosives Engineers.

11. Litton, C., & Page, S. J. (1994). Letter to editor on coal proximate analysis correlations with airborne respirable dust and spontaneous combustion temperature. *Fuel, 73*(8), 1369-1370.

12. Mody, V., & Jakhete, R. (1988). *Dust Control Handbook* (p. 203) [Reprint Edition]. Westwood, New Jersey: Noyes Publications.

13. NIOSH. (1994). *NIOSH Manual of Analytical Methods, 4th Ed.* (M. E. Cassinelli & P. F. O'Connor, Eds.) (p. NA) [DHHS (NIOSH) Publication 94-113 (August 1994)]. United States Center for Disease Control.

14. Office of Surface Mining Reclamation & Enforcement. (1999, 30/11). Air quality. Available: www.wrcc.osmre.gov/BlkMsaQ&A/air_quality.htm.

15. Page, S. J., Organiscak, J. A., & Quattro, J. (1993). Coal proximate analyses correlation with airborne respirable dust. *Fuel, 72*(7), 965-970.

16. Page, S. J., & Organiscak, J. A. (1995, November). Taming the dust devil. *Engineering and Mining Journal,* pp. 30-WW - 31-WW.

17. U. S. Environmental Protection Agency (Office of Research and Development). (1996). *Research Report. EPA/600/R-95/115.* U. S. Government Printing Office.

18. Zimmer, R. A., & Lueck, S. R. (1986). *Investigation of Quartz Dust Sources and Control Mechanisms on Surface Coal Mine Operations* (U. S. Department of the Interior, Bureau of Mines No. Contract No. J0348032). Pittsburgh: Bureau of Mines.

Blasting-Related Citizen Complaints in Kentucky, West Virginia, Virginia and Tennessee

{tc \l1 "Blasting Related Citizen Complaints}Mountaintop Mining/Valley Fill Environmental Impact Statement

{tc \l1 "Mountaintop Environmental Impact Statement Segment}

July, 2002

Kenneth K. Eltschlager, Mining Engineer
Office of Surface Mining
Appalachian Regional Coordinating Center
3 Parkway Center
Pittsburgh, PA 15220
(412) 937-2169

Introduction

{tc \l2 "Introduction}

Blasting complaints continue to be the most common type of complaint to the Office of Surface Mining Reclamation and Enforcement (OSM) and the state regulatory authorities (RA). Citizens and citizen's groups have expressed concern for many years that the various regulatory authorities do not serve the interests of the citizens on blasting damage complaints. As a result, in FY 1999, the OSM Executive Council formed an OSM blasting team to conduct a national study. The study was designed to identify blasting trends in the regulatory program states. The survey did not assess the technical merits of the investigations.

The study entailed collecting and analyzing readily available data in Federal and State files on citizen's complaints related to surface coal mine blasting. For the purpose of the mountaintop mining environmental impact statement, 708 complaints from West Virginia, Kentucky, Virginia, and Tennessee were extracted from the national study. The national study tabulated 1,317 complaints, with 338 complaints at one surface mine in Pennsylvania.

Background

{tc \l2 "Background}

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) requires the prevention of injury to people and damage to public and private property outside the permit area when blasting at surface coal mines. The regulations specifically address the adverse effects of blasting, which include ground vibrations, air blast and flyrock. In addition to setting limits, the regulations also give the RA the latitude to lower to limits to ensure the prevention of damage on a case-by-case basis.

However, people often feel their house shake and hear rattling caused by blast-induced ground and air vibration levels well below those levels necessary to cause damage to structures. To some people the blasts are annoying. Other citizens "feel" the blasting and are afraid that the blasting is doing or will do damage to their home. Damage is sometimes alleged as blasting events cause citizens to look more closely at their home after they feel it shake. Many times the cracks were preexisting as documented in preblast surveys and are the result of construction methodology, ageing or environmental factors. Furthermore the citizens can rarely identify a *specific* blast that resulted in *specific* damage. In the experience of OSM and the RAs, damage is rarely found where blasting vibrations are kept within the regulatory limits.

The investigation of a blasting complaint requires personnel with technical training in blasting, seismology, acoustics and construction engineering. Any or all of these disciplines may be used depending on the type of complaint. For example, an annoyance complaint would not require specialized training in construction engineering. But the better trained investigators are more capable of discussing the impact of blast induced vibrations on houses in terms the homeowner understands.

The study was limited to data readily available in the complaint files, frequently only the written response back the citizen. No evaluation of the adequacy of the RA complaint review were undertaken. However notes were made on the RA review methodology

Complaint Study Data
{tc \l2 "Complaint Study Data}

The study gathered data in three general categories: 1) the reason of the complaint; 2) the methods of investigation used in the resolution; and 3) the resolution of the complaint. The following blasting complaint data was distilled from the national study for the mountaintop mining EIS study area for the period 7/98 to 6/99. Table 1 shows the number of complaints by state within the study area. These complaints may have been related to annoyance, damage, fear of damage, well damage, flyrock, dust, noise, blasting schedules, preblast surveys, warning signals, access control to the blast site, record keeping, signs, advertisements, etc. Some complaints may be from the same person numerous times.

Table 1. Summation of all the complaint.

State	Blasting Related Complaints
Kentucky	263
West Virginia	352
Virginia	87
Tennessee	6
Total	**708**

The following general observations are made from the national data minus the one Pennsylvania mine. Eliminating the one Pennsylvania mine keeps the data from being strongly skewed to one state.

1. The study area accounted for 72% of the complaints. If the one mine in Pennsylvania is considered, the study area accounted for 54% of the complaints.

2. The greatest number of complaints were lodged in West Virginia (40%) and Kentucky (27%). Virginia and Tennessee followed with 9% and 1%, respectively.

<u>Reasons for the Complaints</u>

{tc \l3 "Reason for the complaint.}

The reason for a complaint or type of complaint determines the level of investigation necessary to resolve the complaint. For example, a damage claim warrants a review of the structure where the damage is alleged and an annoyance complaint does not. Table 2 shows the complaints by type. Consolidated in Table 2 are the other types of complaints not pertinent to the issues of damage or injury such as record keeping, advertisements, schedules, warning signals, signs, access control, pre-blast survey offerings. These were not issues identified during scoping of the EIS. Some complaints listed multiple types, i.e. annoyance and damage and resulted in counting one complaint in more than one category, thus the total complaint types (960) will exceed the number of complaints filed (708).

Table 2. Distribution of the complaints by type (Appendix A).

Complaint Type	WV	KY	VA	TN	Total
Dust and Fumes	11	9	9	0	29
Flyrock	5	7	3	0	15
Annoyance/noise	278	177	75	4	534
Water Quantity/Quality	38	44	8	6	96
Structure Damage	85	110	38	3	236
Other	10	31	8	1	50
Total	427	378	141	14	**960**

The following general observations are made from the study area data. Since some complaints cited more than one area of concern, the reported percentages are based on the number of individual complaints (708). Therefore the percentages will add to more than 100%.

1. Annoyance/noise, which relate to concerns for excessive vibration (house shaking), fear of damage, startle, irritation, etc. accounted for 75% of the complaints in the four state area. This percentage is high, because anyone alleging damage or water problems was generally annoyed.

2. Alleged damage to structures (residential dwellings) accounted for 33% of the complaints. Damage allegations include interior cracks, foundation cracks, concrete floor cracks, brick veneer cracks, roof leaks, door misalignments, windows, personal property, etc.

3. Alleged complaints of damage to domestic water well systems accounted for 14 percent of the complaints. Most of the concerns focused on changes in the quantity or quality of well water.

4. Complaints of excessive dust and fumes accounted for 4 percent of the complaints. Dust from blasting travels off site to cover cars, houses, laundry, etc. If fumes drift off site they may cause respiratory problems.

5. Complaints of flyrock accounted for 2 percent of the blast related citizen complaints. Flyrock is any material that leaves the permit area either through the air or along the ground. Flyrock has the greatest potential for causing damage to property and injury or death to persons who reside near the mining areas.

6. Other types of complaints accounted for 7%. Mostly these are administrative type complaints pertaining to preblast surveys, blasting schedules, record keeping, advertisements, warning signals, etc.

<u>Methods Of Investigation Used In The Resolution of Complaints</u>
{tc \l3 "Methods of investigation used in the resolution}

When a complaint is received, the RA locates the house relative to the mine and decides if a violation has been committed. Often, the investigator is the mine inspector who is intimately familiar with the mine and surrounding areas. Sometimes a blasting specialist is involved. The investigation can be a simple compliance check of records and vibration levels for annoyance complaints or a more detailed investigation for damage complaints.

The RA can use some or all of the following investigative procedures to help resolve the complaint.

1. Document the location of the complainant relative to the mine,
2. Review blast records for the period relative to the complaint,
3. Observe and document the alleged damage,
4. Compare alleged damage to the condition of the structure as documented in a pre-blast survey,
5. Document the location of flyrock,
6. Estimate the maximum ground vibrations at the complainant's house for the claim period,
7. Conduct monitoring with blasting seismographs,
8. Require the mine operator to conduct monitoring with a blasting seismograph,
9. Perform regression analysis techniques on the blast vibration data,
10. Conduct structural response monitoring,
11. Conduct hydrologic review.

For compliance checks, the investigator does not always document the exact location of the house relative to the mining. For administrative type complaints, locations may not be needed either. Thus in review of responses back to the citizen, conclusive data on the number of houses within ½ - mile of the permit area were not always available. Based on the survey, Table 3 is a summary of houses within ½-mile.

Table 3. Houses within ½-mile of the permit area.

	W/in ½-mile	Outside ½-mile	Unknown	Total
Kentucky	83	43	137	263
Tennessee	0	6	0	6
Virginia	45	15	27	87
West Virginia	18	91	243	352
Total	146	155	407	708

Likewise, for preblast survey documentation, the investigator reviews the survey if a damage claim was filed. No review of the preblast survey is required for an annoyance complaint. Therefore the true number of surveys conducted at residences within ½-mile of the permit is unknown. Table 4 is a summary of the available data for preblast surveys.

Table 4. Availability of preblast surveys.

	Preblast Survey	No Preblast Survey	Unknown	Total
Kentucky	15	95	153	263
Tennessee	0	6	0	6
Virginia	9	22	56	87
West Virginia	9	58	285	352
Total	33	181	494	708

Appendix B shows the items reviewed for each complaint by the RA as outlined in the response back to the homeowner. The following general observations are made from the data.

1. Blast logs at the mine were reviewed in response to almost all the complaints within each state.
2. The average number of investigative proceedures used to resolve annoyance or damage complaints were in 4.3 in Tennessee, 1.6 in Kentucky, 1.1 in Virginia and 0.9 in West Virginia.
3. Dust or fumes investigations only resulted in a review of the blast records relative to the complaint period.
4. 54 out of 96 water complaints resulted in hydrology investigations.
5. Flyrock resulted in review of the blast logs and observation of the alleged damages in almost all 15 occurrences.

These data reflect information contained in the response letter sent to the citizen. The RA may have looked at more information than reported. But it does indicate that the citizens may feel they are not getting a thorough review based on the RA's response.

Resolution of the complaint

{tc \l3 "Resolution of the complaint}
Each complaint warrants a written response that outlines the finding of the investigation. Depending on the type of complaint, the letter can be simple (for a annoyance complaint that discusses compliance with the rules) or complex (if all of the items discussed in methods of investigations are used). Ultimately, either action or inaction must be substantiated. When action is taken, the types of violations to be issued and the mitigative measure to be taken should be discussed.

The following general observations are made from the data on violations written as a result of the complaint investigation (Appendix C). Often more than one violation was written as a result of an investigation.

1. 36 violations were issued in Kentucky in response to 23 of 263 complaints (9%).
2. 17 violations were issued in Virginia in response to 12 of 87 complaints (14%).
3. 44 violations were issued in West Virginia in response to 30 of 352 complaints (9%).
4. Zero violations were issued in Tennessee in response to 6 complaints.
5. Flyrock was the only substantiated cause of damage to homes (2 – Kentucky, 1 - Virginia).
6. West Virginia found 1 case of damage to a water supply.
7. Most of the violations were for exceeding vibration limits or inadequate records.
8. West Virginia issued one violation for dust off the permit.

Almost all the violations issued were unrelated to the original complaint allegation. Data were scarce or non-existent for cases of damage, whether the complainant was compensated or whether the insurance company was involved.

Lastly the date of the written response back to the citizen was compared to the date the complaint was received. Timely responses are generally viewed as a positive factor when providing a public service but may not necessarily be the most thorough. Each RA had the following average response time for each complaint:

1. Kentucky …………. 46 days
2. Tennessee ………… 109 days
3. Virginia …………… 25 days
4. West Virginia …….. 16 days

West Virginia had the quickest response time and Tennessee had the slowest. From the number of investigative procedures used to resolve a complaint as discussed above, the time to resolve the complaint is inversely proportional to the number of procedures used to resolve the complaint. In other words, the response time was quickest for the RAs who used the least investigative procedures to resolve a complaint and lowest for the RA that used the most procedures to resolve the complaint. This suggests a trade off exists between timeliness and quality.

Discussion of the Data{tc \l2 "Discussion}

Dust and Fumes
{tc \l3 "Dust and Fumes}
The data do not indicate that excessive dust and fumes are a significant problem with a complaint percentage of only 4 percent. One violation was written during the study period on this issue.

Fumes are either nitrogen dioxide or carbon monoxide. Nitrogen dioxide is visible as an orange/brown cloud that moves away from a blast area and can cause health problems at low concentrations (2 ppm). Any visible cloud may be dangerous. Carbon monoxide is colorless and is dangerous at concentrations of 500 ppm in confined spaces. Generally, coal mine blasts do not occur in confined places.

Dust from blasting is more of a nuisance than a health risk at coal mines. To date, no study has identified dust from mining to be in quantities large enough to be a health concern. However, the dust can soil houses, laundry, cars, swimming pools, etc. While no OSM rules on dust exist, the RAs sometimes use their state rules on air quality. The one violation written for dust was for depositing spoil off the permit area.

Flyrock

Complaints of flyrock, material traveling through the air or along the ground outside the permit area, makes up 2 percent of the blasting complaints. Flyrock has the greatest potential for causing death and injury to persons as well as damage to private property. No allegations of injury occurred during the study period. Three violations were written during the study period for damage from flyrock. However, since flyrock is such a dangerous occurrence, the regulatory authorities frequently find and take action even before a complaint is lodged. Therefore, the actual number of events are probably higher than found during this complaint review.

The primary cause of flyrock is inadequate blast design, failure to pay attention to detail when loading blast holes or changing geology. Proper supervisory controls, training of blasters (both certified blasters and the blasting crew) and the establishment of set procedures are the best methods to eliminate flyrock. To protect the public, the blaster is responsible for clearing the blast area (any place flyrock might be expected) prior to the detonation. RAs have the authority to suspend or revoke the license of any certified blaster who causes flyrock off the permit area.

Water Well Quantity and Quality

Fourteen percent of the complaints in the study area were related to domestic water wells. One violation was written during the study period on this issue.

Scientific studies have determined that there is an extremely low probability of causing damage to a domestic water well by blasting activities associated with mining, quarrying or road construction. When a water well is damaged by mining activity, quarrying or road construction, it is almost always caused by an interruption of the aquifer--either by draining the aquifer, or cutting off the recharge to the aquifer as a result of the mining excavation. Problems with the quality of well water are almost always the result of an increase in dissolved solids at the well from groundwater percolating through the rubble zone of the backfill area.

Annoyance

Complaints of annoyance accounts for a over 75 percent of the complaints in the study area. No violations were written during the study period on this issue.

Annoyance includes, startle, noise, fear of damage, "blasting too hard", objects moving on shelves, windows rattle, "frightens the children", etc. SMCRA does not allow OSM to regulate or prevent annoyance. Peoples' homes may be shaken by the blasting, which is annoying to most people. However, while blast-induces vibrations do shake houses, vibrations may not lead to property damage.

Both ground vibrations and air vibrations cause homes to shake. Ground vibrations enter a house through the ground and airblast through the roof or building side. As a result, the house will respond or shake. A typical house will respond 1 to 3 times the ground vibration level. The higher shaking is caused when the vibration frequency of the ground matches the natural frequency of the house, causing it to resonate. The natural frequency of typical homes is 4 to 12 Hertz. In other words, when the frequency of the incoming vibrations match the natural frequency of the house, the house will "ring," much like an opera singer can vibrate a glass with her voice. The greater the difference in frequencies between the vibration of the ground and the house, the less the house responds. This significantly impacts people's perception of a blast. It also explains why the same vibration will cause a complaint at one house but not the neighbors (i.e. the neighbor's house has a different natural frequency).

Complaints of annoyance can stem from the lack of communication between the coal operators and the citizens in the community. A well-implemented public relations program sometimes significantly reduces complaints. OSM's experience is that the coalfield citizens typically desire more information from the regulatory authority and the mine operator. The regulations require, at a minimum, information notices to citizens such as blasting warning signs and warning signals, pre-blasting surveys, pre-permit public involvement and a comment period for the citizen to express their concerns.

Some operators and regulatory authorities hold public meetings in order to involve the public and inform them on what they can expect to experience when living near a mining operation. This includes a dialog on blasting and the possible effects on the community. Exchanges of information prior to mining and blasting may reduce the number of annoyance complaints.

Structure Damage

Allegations of blast damage to property were lodged in 33% of the complaints. No violations were written during the survey period on damage other than flyrock.

Property damage could be broken windows, cracked walls, broken bricks, wall separations, doors sticking, chimney cracks, foundation cracks, driveway cracks, roof leaks, etc. When damage is alleged, the regulatory authority is required to evaluate the damage potential.

Scientific investigations by various investigative groups, including the U. S. Bureau of Mines, has related the occurrence of damage at typical structures to the intensity and frequency of blast-induced vibrations. The data collected by the Bureau of Mines shows that no damage[1] (threshold, minor or major) is expected at ground vibration levels at or below 0.5 in/s. Within a 95-percent confidence interval, major damage is not expected below about 2.34 in/s; nor is minor damage below about 1.80 in/s. Airblast damage below 134 dB has never been documented. These observations pertain to typical residential structures of 1-2 stories.

While the regulations specify various methods to show compliance, they also allow the RAs to reduce the ground vibration and airblast levels when blasting activity may impact structures. This permits the RA to protect homes regardless of their age, construction methodology or quality of materials. For example, the regulatory limits at a typical home may not be appropriate for a historic structure where the walls and ceiling are made of plaster. Since no violations of damage were found, none of the RAs established a lower ground vibration or airblast level in response to a complaint.

The level of documented effort in addressing the complaint is reflected in the number of investigative procedures used by the RA. Some RAs simply respond back to citizens that the mine was in compliance and that damage was not caused by the blasting. While, the study did not entail appropriateness of the responses, the review team felt that more of the RA responses could have expounded on the level of investigation. This would serve the citizens better and bolster their confidence in the RA.

Conclusions

Both SMCRA and the OSM regulations make it clear that people must be protected from injury and private property must be protected from damage when blasting at surface coal mines. Furthermore, the rules provide for citizens to be part of the regulatory process by requiring RAs

[1]There are three classifications of damage-*Threshold* -Loosening of paint, small plaster cracking at joints, lengthening of old cracks. *Minor*-Loosening and falling of plaster, fall of loose mortar, hairline to 3-mm wide cracks. *Major*-Cracks of several mm in walls, structural weakening, fall of masonry. (U.S. Bureau of Mines RI 8507)

to respond to allegations of improper activities or complaints. This survey identified trends in blasting-related citizen complaints based on readily available data.

Based upon the results of the survey, annoyance is the most common citizen complaint about blasting, followed by damage and water concerns. Dust, fumes and flyrock were of much lesser concern. None of the complaints concerned injury to a person. The survey did not attempt to discern if allegations were legitimate or appropriately investigated by the RAs.

Usually, a citizen complaint can be resolve in a short time. However there are cases where a complainant may file repeated complaints and the investigation may remain open for an extended period. The survey did reveal that the RAs conducting the most in-depth investigation took the longest to respond on their findings and resolve the complaint. While quality of the investigation is important, the response timeliness is essential too.

Most of the violations found during the complaint investigations were related to record keeping and exceeding vibration limits. The only substantiated occurrences of damage to homes were from flyrock.

Ultimately the gauge of success in resolving citizen complaints is in the response back to the citizen. Complaints need to be addressed in a timely and sound manner. If the blasting data is verified and adequately compiled, a conclusive, defensible decision on the disposition of the complaint can be made. A good report that clearly describes the findings will show the complainant the level of effort expended in the investigation, boost their confidence in the reviewer and provide adequate information by which the complainant can go for a "second opinion" if they are uncertain of the findings. While the RAs may look at the appropriate technical items, this survey found that blasting complaint report improvements could be made in describing the effort expended and justifying the conclusions made as a result of an investigation.

APPENDIX A
COMPLAINT TYPE BY REGULATORY AUTHORITY

Appendix Headings:

RA – Regulatory Authority
Rec ID – Record identification number
Annoy/Noise/Vib/Fear - Complaint of Annoyance, noise, vibrations or fear of damage from blasting
Damage – Complaint alleging damage from blasting
Dust/Fumes – Complaint of either dust or fumes
Flyrock – Complaint of flyrock off the permit area
Water Quality/Quantity – Complaint of change in domestic water supply
Other – Blasting related complaints not in one of the above categories

APPENDIX B
INVESTIGATIVE EFFORT BY REGULATORY AUTHORITY

Appendix Headings:

RA – Regulatory authority
ID – Record identification number
Blast Record – Blast records reviewed
Docum. Dam. – Documented the alleged damage
Comp. To PBS – compared alleged damage to the preblast survey
Est. PPV – estimated the peak particle velocity at the residence
Est. PPV to BOM – Compared the estimated PPV to damage criteria of the US Bureau of Mines
Cond. Seis. Mon. – RA conducted seismic monitoring in response to the complaint
Req. Seis. Mon. – Required the mine operator to conducted seismic monitoring in response to the complaint
Regress. Analysis – RA conducted regression analysis of the blast log and seismic data
Structure Response – Structure vibrations were measured in response to the complaint.
Hydro. Rev. – Hydrology review of water complaint

APPENDIX C
MTR BLASTING COMPLAINTS, VIOLATIONS ONLY

Appendix Headings:

RA – Regulatory Authority
ID – Record identification number
Violation Description – Description of the violations issued in response to the complaint
Annoy/Noise/Vib/Fear - Complaint of Annoyance, noise, vibrations or fear of damage from blasting
Damage – Complaint alleging damage from blasting
Dust/Fumes – Complaint of either dust or fumes
Flyrock – Complaint of flyrock off the permit area
Water – Complaint of change in domestic water supply
Other – Blasting related complaints not in one of the above categories
Blast Cause – Blasting caused the alleged damage

Office of Surface Mining
Impact of Blasting on Domestic Wells

Executive Summary

Daniel B. Stephens & Associates, Inc. (DBS&A) was contracted by the Office of Surface Mining Reclamation and Enforcement (OSMRE) to design and initiate a long-term study to investigate possible effects of mining operations on groundwater quality and supply in domestic wells. The study was conducted between November 2000 and December 2001 and consisted of four field data collection periods and subsequent data analysis.

During each of the monitoring periods, field personnel attempted to collect data deemed necessary to determine effects of mining operations on nearby domestic wells, including vibration/blasting, water quality, and well yield data. Data from the initial monitoring period are the most complete. Unforeseen issues in data collection and removal of sites from the study for various reasons resulted in progressively less complete data sets in each of the remaining data collection periods, and during the final period, only one site of the original ten selected could be monitored.

Vibration data became more sparse as the study progressed because mine blasting was conducted at increasingly larger distances from the study sites, compared to the distances involved during the initial monitoring period. Ground movements produced by blasting activities were attenuated by the greater distances and were in many instances not strong enough to trigger the seismographs, indicating little vibratory effect in the ground surrounding the wells.

Few changes that could be directly attributed to a blast event were observed in the water quality and well yield data collected. Water quality parameters did change slightly over time during measuring periods, but these changes seem to be unrelated to blasting, but rather a result of sensor drift and mixing of the water in the well due to pump cycling. Well yield and water level remained in a constant range throughout each individual monitoring season.

Comparative Study of Domestic Water Well Integrity to Coal Mine Blasting Summary Report

Prepared for Office of Surface Mining Reclamation and Enforcement
Pittsburgh, Pennsylvania

June 28,2002

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

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1. Introduction

The Appalachian coal region in the southeastern portion of the United States has been an important source of coal since it was first mined in the mid-1800s. Even after extensive mining, this region today still accounts for approximately 40 percent of total US. coal production (USGS, 1999). Surface coal mining is an important economic resource for residents of the Appalachian region and an important source of energy for the United States. However, many people living close to active mining operations believe that mining activities, such as blasting to remove overburden, adversely affect their well's yield and water quality.

To date, few studies have been performed looking at the possible effects of mining on domestic well water quality and quantity. Accordingly, the Office of Surface Mining Reclamation and Enforcement (OSMRE) contracted with Daniel B. Stephens & Associates, Inc. (DBS&A) to design and initiate a long-term study to investigate whether coal mining operations located close to domestic wells have caused or will contribute to the loss, diminution, or degradation of groundwater supplies and/or negatively affect domestic wells and their ability to supply water. The scope of work for this study included:

- Selecting suitable sites
- Equipping the selected wells with monitoring instruments
- Collecting data during an initial monitoring period
- Training state employees to collect monitoring data during the study

To ascertain the induced effects of blasting and pumping vibrations from nearby coal mining sites on domestic well integrity, water quality/chemistry, and well yield, DBS&A designed and initiated a quarterly monitoring program for domestic wells located near active mining operations in a tri-state (Virginia, West Virginia, and Kentucky) area. Following a discussion of groundwater conditions in the study areas (Section 2), this report describes the monitoring program, including site selection and descriptions (Section 3) and monitoring methods used (Section 4). The results obtained over the year of monitoring are discussed in Section 5.

2. Occurrence of Groundwater

Groundwater in Appalachian coal country is obtained from sedimentary rocks, glacial deposits, and alluvial fill. Most of the groundwater found in the sedimentary, coal-bearing rocks occurs in nearly vertical fractures and joints and along bedding planes. Some of these fractures are undoubtedly tectonic in origin and exhibit a regional pattern, but most of the fractures are more localized in nature and are the result of lateral stress relief associated with natural topographic development. The fractures tend to form networks that exhibit some of the characteristics of a water table aquifer, including:

- Water levels that respond to rainfall within 24 hours
- Water levels that do not respond to changes in atmospheric pressure
- Pumping rates (during pump tests) that decrease as the drawdown increases even though the power supply remains constant

A fracture system may not have a large lateral extent, but may form small sub-systems. In a study looking at blasting effects on groundwater supplies in Appalachia, Robertson et al. (1980) found that during pump tests, wells located 35 to 65 feet from the pumped wells exhibited more drawdown than observation wells only 10 feet away, while in other wells, no response to pumping was observed.

Coal-bearing strata found throughout the Pennsylvanian and Permian strata are very brittle and have a low tensile strength and, therefore, extensive vertical fracturing. Coal seams may act as conduits through which water from the overlying units can move downward to deeper units (Robertson et al., 1980). Groundwater is often associated with coal seams because (1) the high degree of fracturing in these strata increases the chances that water will move vertically from the surface to depth and (2) coal seams are often underlain by low-permeability plastic clays, causing groundwater to perch in the coal strata.

Wells constructed in Appalachia for industrial and municipal purposes may provide large yields, but domestic wells commonly have yields of 1 gallon per minute or less. This is due to many factors, including:

- Well locations selected based on convenience of access and proximity to the residential dwelling it will serve rather than sound geologic evidence
- Poor design, construction, and completion
- Inadequate formation transmissivity
- Inadequate well maintenance

Wells in the hollow valleys generally produce more water than those located near the tops of the hill. This is because the water table tends to mimic local topography, with recharge areas at the high points and groundwater moving toward discharge points in the valley (Robertson et al., 1980).

Groundwater in Appalachia tends to be high in manganese and iron and often exceeds regulatory limits for turbidity. Often, water in wells has higher dissolved oxygen than formation water, resulting in a reddish tint as ferrous iron is oxidized in the well. Iron-consuming bacteria may also be found in well water and, if *so,* contribute to the reddish color and unpleasant odor. The pH of the groundwater is relatively neutral, ranging between 6 and ***8*** (Robertson et al., 1980).

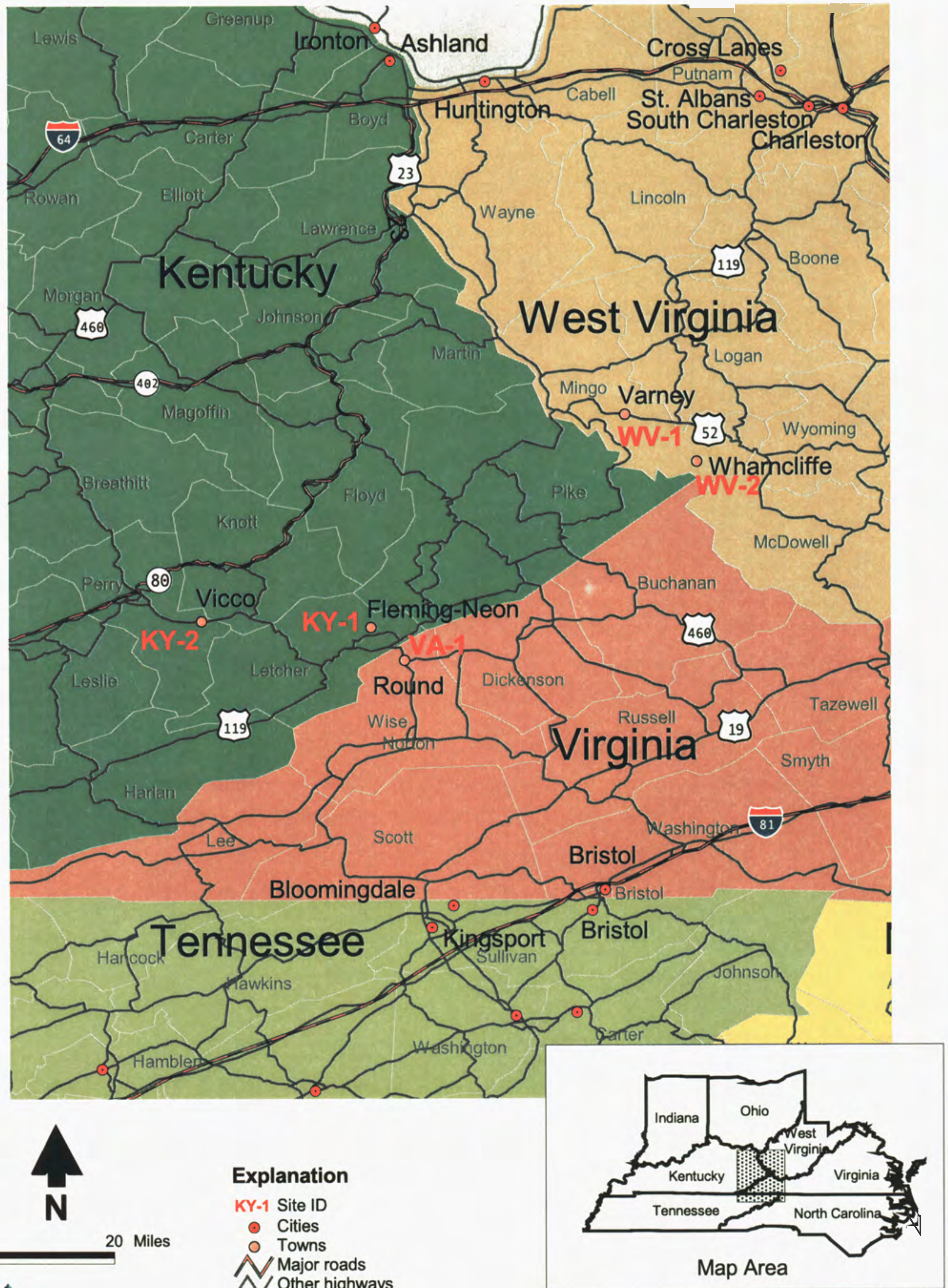
3. Site Selection and Descriptions

The domestic wells used in this study were selected by Office of Surface Mining **(OSM)** officials, with input by Virginia, West Virginia, and Kentucky state officials based upon current and past complaint information. To identify suitable sites that meet the study criteria, state representatives were to review sites and:

- Identify mine sites that would be blasting at least once a day
- Contact the individual coal mines to determine their blasting schedules.
- Find at least one, and preferably two, domestic well near each mine.
- Contact with the owners of the domestic wells to request and secure their participation in the study.
- Complete a nomination package that provides the location of the well site, the five most recent blast logs with plotted blast locations, pictures of the well installation, any technical reports done on the site, and anticipated dates of blasting near the wells.

Based on the nomination packages provided by the state representatives, five mine sites were selected for this study: one site in Virginia and two sites each in Kentucky and West Virginia (Figure 1, Table 1). At each of the sites in Kentucky and West Virginia, at least two domestic wells were selected for monitoring after OSM officials secured right-of-entry agreements from the individual homeowners. Only one domestic well suitable for this study was identified at the Virginia site. The wells selected represent a range of well construction types and proximity to surface coal mining operations. The ages of the wells were not determined, but it is assumed that the wells were completed when the homes were first occupied.

Blasting had been occurring near all of the sites for a significant time prior to the arrival of monitoring personnel and the installation of monitoring equipment. The data collected represent only a small amount of time compared to the total amount of time the well has been within the range of influence of an active mining/blasting operation.



Explanation

- KY-1 Site ID
- Cities
- Towns
- Major roads
- Other highways
- County boundaries

OSM WELL STUDY

Study Area

Figure 1

Daniel B. Stephens & Associates, Inc.
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Table 1. Monitor Well Identifiers

State	County	Site ID	Well ID	Well owner
Virginia	Wise	VA-1	Well-1	Hylton
Kentucky	Letcher	KY-1	Well-1	Banks
			Well-2	Ratliff
	Perry	KY-2	Well-I	G. Hurley
			Well-2	Sumner
			Well-3	A. Hurley
West Virginia	Mingo	WV-1	Well-I	L. Dean Sr.
			Well-2	L. Dean Jr.
		WV-2	Well-I	G. Abbott
			Well-2	D. Abbott

The study sites were typical of Appalachian coal country, where residents live within hollows below coal outcrops, which generally exist where the slopes are steepest. Within the hollows, residential sites are typically founded on valley alluvial fills and glacial deposits comprising cobbles, gravels, and sands with some clay. Wells can penetrate sandstone formations that may be recharged by water moving through naturally occurring fractures in the upper elevation coal seams and porous rock units.

The domestic water wells at all the study sites are drilled within hollows at elevations far below mining activity. The photographs in Figure **2** show the typical terrain at all the sites investigated. Mining activity takes place beyond the ridgeline (shown at the top of each photograph) at the head of the hollow in which the houses are located. The ridgeline between the head of the hollow and the mining operations is formed of overburden fill (waste rock). Blasting activities take place within sandstone and shale formations along mountain contours and across the mountaintop (full mountaintop removal) (Figure **3).** Rock blasting along contours produces blasting bench faces directed away from the hollow (Figure **4)** or toward the hollow. At the Virginia study site, mountaintop removal has left a pinnacle of rock that rises above the surrounding mining operations upslope and below the waste rock ridgeline (Figure 3a). **A** typical mining scenario encountered at each site is shown in Figure 4.

2!a. View of a hollow in Kentucky.

2!b. View of a hollow in West Virginia.

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OSM **WELL** STUDY

Typical Terrain at Investigation Sites

Figure 2

3a. Final stages of mountain top removal in Virginia.

3b. Contouring overburden blasting in Perry County, Kentucky.

3c. Mountain top blasting in Perry County, Kentucky.

3d. Contour blasting at a mine in Letcher County, Kentucky.

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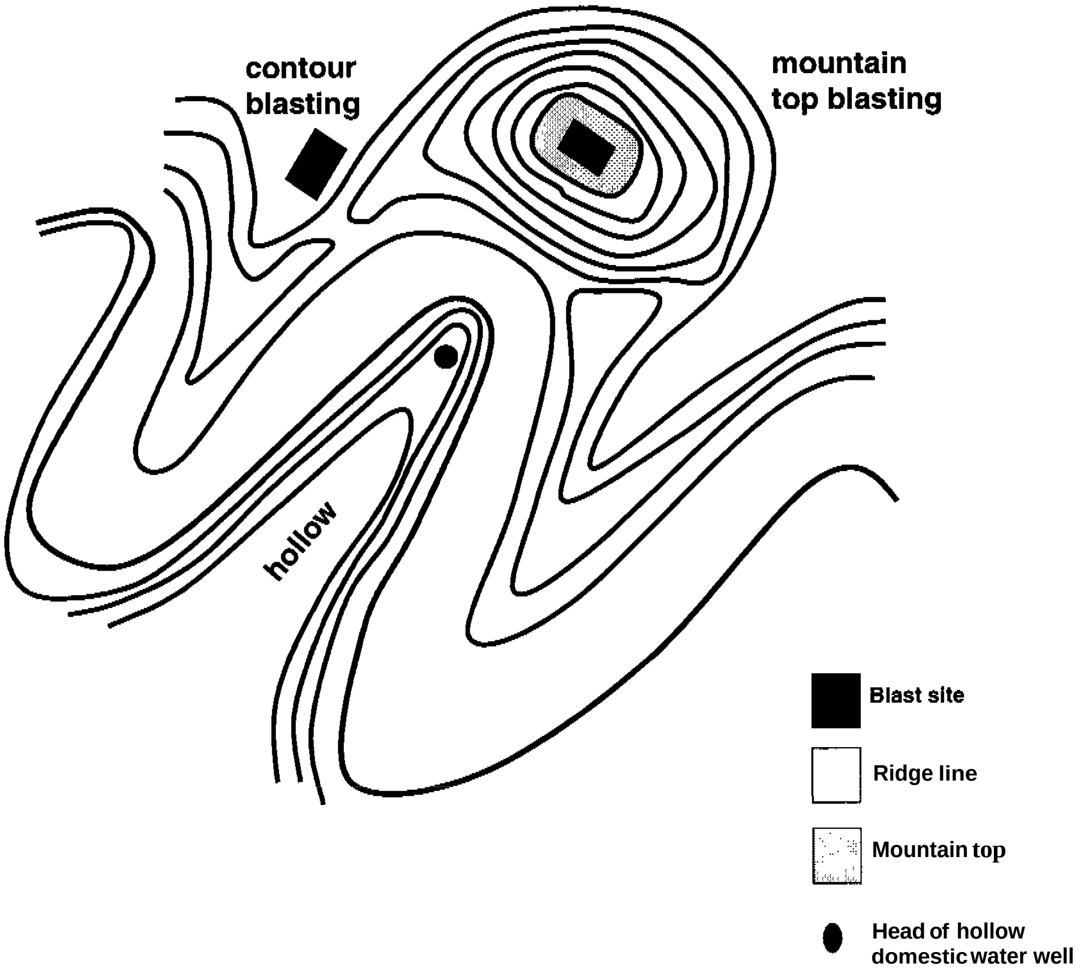
OSM WELL STUDY

Typical Blasting Activities

Figure 3



OSM WELL S 'UDY

Typical Mining Scenario

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Figure 4

4. Monitoring Methods and Training

Upon completion of site selection, collection of field data began. Fieldwork and instrumentation was conducted in two phases. Phase I took place during a three-week period in the Fall-Winter 2000 season and involved an intensive commitment to field instrument installation and data collection over four consecutive days of blasting at each site. Phase II involved the collection of data during the subsequent three seasons.

During Phase I, prior to the start of monitoring at each site, representatives of DBS&A and Aimone-Martin Associates (subcontractor to the project) met with mining operations personnel to obtain blasting information and general information on the anticipated locations of blasting during the monitoring phase. Representatives of DBS&A and Aimone-Martin Associates also visited individual homeowners to assess the nature of complaints regarding well responses to blasts and pumping vibrations (if any), to obtain previous water quality data for the domestic wells (if available), and to obtain well construction details (if available).

Following the initial meetings, a DBS&A hydrogeologist accessed the domestic wells at the sites to equip them with continuous water quality and well yield monitoring instrumentation. All instrumentation (seismic, water quality, and well yield monitoring instruments) was calibrated, tested, and quality-control checked prior to installation and the initiation of monitoring. During the Fall-Winter 2000 four-day monitoring event, DBS&A personnel measured turbidity and well yield, collected groundwater samples for laboratory analysis, and collected and analyzed data from the field instruments. In addition, state personnel were trained in the use of field data acquisition systems and retrieval of data so that they could collect data during subsequent monitoring events.

Each state agency assigned an employee to perform the following activities:

- Contacting mine officials and well owners and coordinating blasting and monitoring efforts at each site

- Field calibrating, testing, and installing the monitoring instruments

- Initiating continuous monitoring at each site (well yield, water quality, and vibration) during the monitoring period

- Collecting pre- and post- blast turbidity readings at a point between the well and the pressure tank of each residence with the use of a portable turbidimeter

- Downloading all water quality, well yield, and vibration data from dataloggers and transferring the data to DBS&A and Aimone-Martin Associates

- Removing all instrumentation from the well sites and preparing them for storage or shipment to DBS&A or the next monitoring site

Specific methods for each of the types of monitoring are described in Sections 4.1 through 4.3. The training conducted for state personnel is described in Section 4.4.

4.1 Domestic Well Water Quality Monitoring

The water quality of the individual domestic wells was evaluated using both field monitoring equipment and laboratory analysis. Field water quality monitoring was conducted prior to, during, and after a series of blasts at the five study sites.

Field water quality monitoring was conducted using electronic sensors (EC-Campbell Scientific CSI-247, pH-Innovative Sensors M11) connected to a Campbell Scientific 21X datalogger. The datalogger allowed for automated measurement at a frequency of the operator's discretion. The sensors (temperature, pH, and electrical conductivity [EC]) were installed in each well below the water level. If it was not possible to place the sensors in a particular well, they were inserted in a flow-through cell extending from a discharge line between the well and the pressure tank at the ground surface. Additionally, the turbidity of the domestic well water was measured at the surface using a Hach 2100P portable turbidimeter.

During the initial monitoring period (Fall-Winter 2000), water quality samples were collected from each of the individual domestic wells for laboratory analysis of total aluminum, iron, manganese, sulfate, total dissolved solids, and total suspended solids (TSS). At each well, samples were collected from faucets connected to the pressure tanks. The water quality samples were collected in laboratory-supplied containers, immediately preserved on ice in an insulated cooler with full chain-of-custody documentation, and shipped to Inter-Mountain Laboratories, Inc. in Farmington, New Mexico for analysis. A duplicate sample analysis was conducted at the KY-1 Well-2 site.

4.2 Domestic Well Yield and Discharge Monitoring

In order to determine the effects of mine blasting on the normal usage of the individual study wells, DBS&A and state personnel monitored variations in well yield by continuously monitoring volumetric flow and water level in the individual domestic wells before, during, and after blasting events. For the purposes of this study, well yield is defined as the volumetric flow rate of water from the well during a pumping cycle. Monitoring of well yield helps determine whether blasting affects the ability of a well to produce water at a reliable rate. A decrease in well yield could be due to blasting or other causes such as compaction of the material surrounding the well, changes in the fracture size or occurrence, deterioration of the well due to age, improper maintenance, and/or biological or mineral fouling. In order for this study to identify changes due to blasting, an acute change would have to be associated to a blast during a monitoring event.

Well yield was monitored using a Controlotron 1010n flow meter installed on the pipe between the well and the pressure tank. The Controlotron is equipped with an internal datalogger that was programmed to record data at approximately the same interval as that of the Campbell equipment (Section 4.1). Wells were also equipped with water level sensors (Druck 150 psi pressure transducers) connected to a Campbell Scientific 21X datalogger to record water levels (pressure head) within the wells at specified time intervals.

Continuous measurements of well yield and water levels were obtained for a period beginning one day prior to blasting and ending approximately one day following the tests. The durations of the pre- and post-blast monitoring periods were adjusted slightly, depending on the degree of water level fluctuations observed in each well.

4.3 Vibration Monitoring

Ground motions adjacent to nine domestic water wells (ten during the initial monitoring period) were recorded during blasting events to determine the ground motion variation with depth below the ground surface. At each well selected for study, one tri-axial transducer was buried 0.42 foot from the surface near each wellhead. A second transducer was buried at depth, as outlined below:

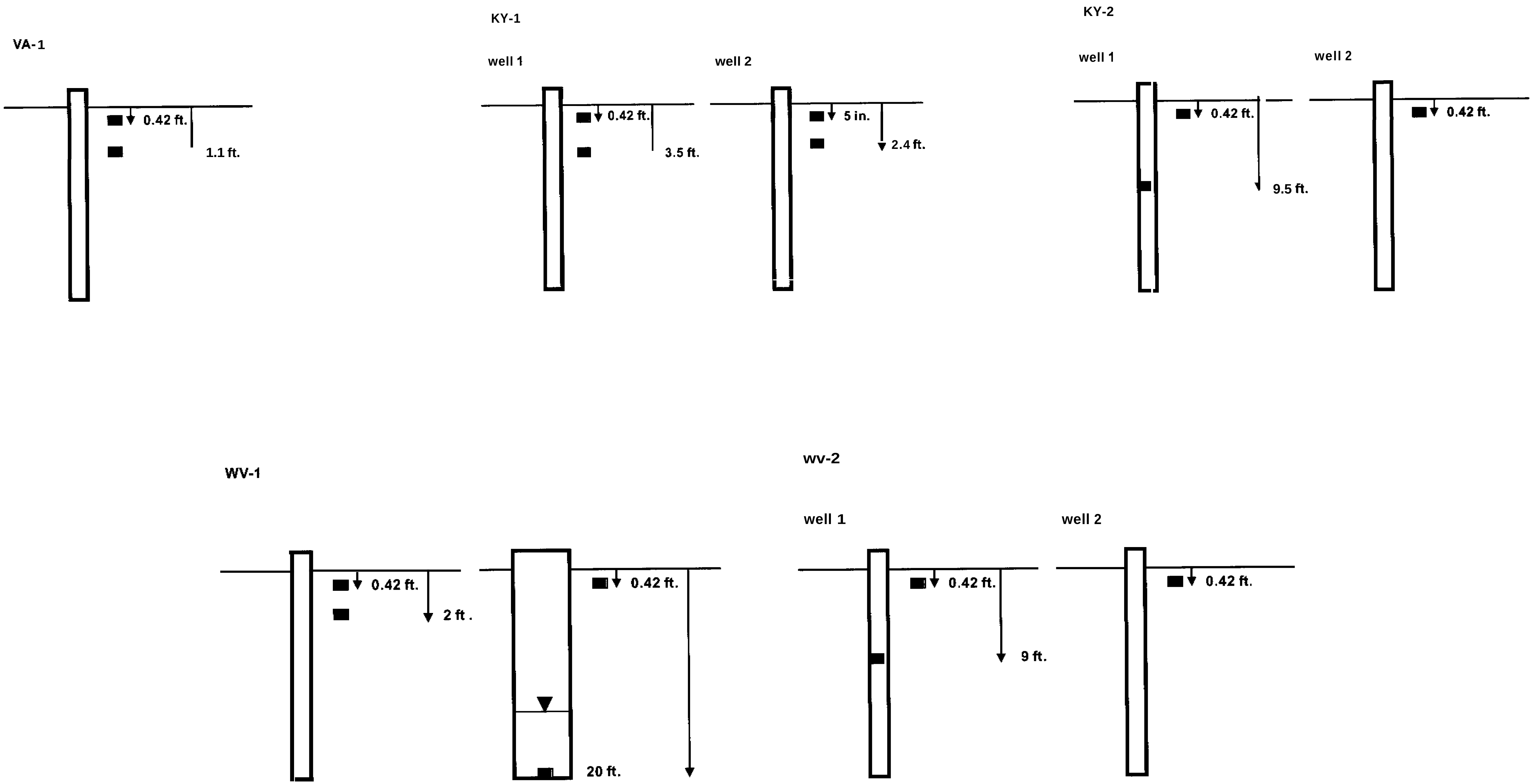
- At three sites the second transducer was placed at depths between 9 and 20 feet in either an abandoned well casings (two sites) or a hand-dug well (one site).

- At four sites, an attempt was made to hand-dig holes as deep as possible to record ground motions. At most of these sites, however, the subsurface soils contained large gravels and cobbles, making it difficult to dig holes deeper than 3.5 feet from the surface.

- At two sites, it was not possible to dig into the ground any deeper than 0.42 foot from the surface. Therefore, no second transducer was used at these sites.

Figure 5 shows the locations of transducers placed in or adjacent to wells. Transducers placed in abandoned wells were either grouted in place or encapsulated in crushed stone. Those placed within the ground adjacent to wells were tamped with pressure to ensure good coupling.

Blasting-type seismographs manufactured by **LARCOR** of Dallas, Texas were used to monitor ground motions near wells. Sensors were embedded in epoxy within a watertight housing for long-term survivability. The sensors were attached to the housing using 50-foot cables aligned with the vertical transducer for ease of inserting at depth. Airblast was recorded using the surface seismograph.



OSM WELL STUDY

Transducer Locations within or Adjacent to Wells

Daniel B. Stephens & Associates, Inc.
5-29-02 JN 9290

Figure 5

The following settings were used:

- Ground trigger level 0.02 inch per second (ips)
- Air trigger level 125 decibels (dB)
- Sample rate **1248** samples per second
- Record length 5 to 10 seconds
- Range 2.5 ips
- Lowest velocity detected 0.005 ips

4.4 Training

During the initial Fall-Winter 2000 m nitoring p riod, the following state personnel from Kentucky, Virginia, and West Virginia were trained by DBS&A personnel to conduct the remaining three seasons of monitoring for the OSM well study:

- Leslie Bright, a geologist with the Division of Mined Land Reclamation, Department of Mines Mineral and Energy in Virginia

- Darcy White, Assistant Chief with the Office of Explosives and Blasting in West Virginia

- Ralph King, a Staff Scientist III with the Office of Surface Mining in Kentucky

These personnel were trained in the following tasks:

- Programming and data collection using the Campbell Scientific 21X datalogger and a laptop computer

- Wiring, calibrating, installing, and maintaining the Innovative Sensors MI1 downhole pH sensor

- Wiring, calibrating, installing, and maintaining the Campbell Scientific **CSI-247** downhole EC sensor

- Wiring and placement of the two Druck pressure transducers

- Calibrating and using the HACH 2100p turbidimeter

- Installing, programming, and collecting data from the Controlotron 1010n flow meter

- Using and calibrating the YSI-63 handheld pH, specific conductance, and temperature meter

Where applicable, the personnel were also trained in special procedures required at some of the sites (i.e., flow-through setups at the **VA-1** Well-I and KY-2 Well-2 locations).

5. Results

During each of the monitoring events, field personnel attempted to collect all three categories of data, including vibration/blasting data, water quality data, and well yield data. Throughout the study, wells were dropped from the monitoring program for various reasons. For example, the Kentucky sites were flooded before the second monitoring event, compromising the wells. The West Virginia sites were not monitored during the fourth quarter because blasting activities occurred too far from the well sites, and the Virginia site was dropped prior to the third monitoring event for the same reason, as well as discontinued use of the well due to hookup of the residence to a municipal water supply. Further details regarding the reasons for removing wells from the study are outlined in Table 2.

5.1 Vibration Data from Blasting

Ground motions adjacent to nine domestic water wells were recorded during blasting events to determine the ground motion variation with depth below the ground surface. Full waveform vibration data and summary tables are shown in Appendix A for all blast events that were recorded.

Detailed blasting records were available only during the Fall-Winter 2000 monitoring period. Hence, this data set is the most complete, with 54 shots recorded at nine wells. As the study continued mine blasting was being conducted at farther distances from the wells, and as a result, many mine blasts did not trigger the seismographs.

The maximum ground motion recorded during the study was 0.125 ips. The Fall-Winter 2000 data set shows average near-surface (0.42 foot) and at depth (from 1.1 to 20 feet) peak particle velocities (PPV) of 0.043 ips and 0.033 ips, respectively. In the Spring of 2001 as mining progressed away from the well site, the average PPV values decreased to 0.038 ips and 0.029 ips for the near-surface and at depth locations, respectively. In the Fall of 2001 ground motion was measured at the surface only and averaged 0.026 ips. In no case did the average ground motions at depth exceed those measured at the surface.

Table 2. Quarterly Monitoring Activities in Virginia, Kentucky, and West Virginia

State	Site ID	Well ID	2000	Spring 2001	Fall 2001	Winter 2001	Comments
Virginia	VA-1	Well-1	FWQ, WY, LWQ. V	FWQ,WY	---	---	Resident on city water (third quarter) and no longer using well; dropped from study
Kentucky	KY-1	Well-1	FWQ, WY, LWQ, V				No access to wells due to flooding from sediment pond overflow (second quarter); site dropped from study
		Well-2	FWQ, WY, LWQ, V				No access to wells due to flooding from sediment pond overflow (second quarter); site dropped from study
	KY-2	Well-1	V				Well used only for vibration monitoring during initial monitoring period {well was **dry).**
		Well-2	FWQ, WY, LWQ, V	FWQ	V	---	Data not received (third quarter); residents refused access (fourth quarter)
		Well-3	FWQ, WY, LWQ	FWQ	V	---	Data not received (third quarter); residents refused access (fourth quarter)
West Virginia	wv-1	Well-1	FWQ, WY, LWQ, V	FWQ, WY, V	---	FWQ	West Virginia state personnel not on-site to supervise monitoring (third quarter)
		Well-2	FWQ, WY, LWQ, V	FWQ, WY, V	---	FWQ, V	West Virginia state personnel not on-site to supervise monitoring (third quarter)
	WV-2	Well-1	FWQ, WY, LWQ, V	FWQ,V	WY	---	West Virginia state personnel not on-site to supervise monitoring (third quarter); blasting took place too far away from site (fourth quarter)
		Well-2	FWQ, WY, **LWQ,** V	FWQ, WY,V	---	---	West Virginia state personnel not on-site to supervise monitoring (third quarter); blasting took place too far away from site (fourth quarter)

FWQ = Downhole field water quality parameter monitoring
WY = Well yield monitoring
LWQ = Laboratory water quality monitoring
V = Vibration monitoring
--- = No monitoring conducted; see Comments column for explanation

Frequencies at the **PPV** also tended to decrease with depth as the degree of confinement increased. Similarly, average frequencies decreased with successive monitoring periods. The average frequencies near the ground surface and at depth in 2000 were 17.5 Hz and 14.8 Hz. In the Spring of 2001, an average surface frequency of 18.8 Hz was measured. The ground motion data at depth fell within the resolution of the instrumentation and frequencies could not be reliably calculated.

The Fast Fourier Transform (FFT) frequency is a measure of the predominant frequency over the entire waveform and indicates the frequency containing most of the ground motion energy. In contrast, the frequency at the PPV (or peak frequency) **is** the frequency calculated from the zone-crossings for the cycle containing the PPV. Average values for PPV and frequency at the PPV by well site, as well as dominant waveform frequency obtained from the FFT are plotted on Figures 1 through 5 in Appendix A. The decrease in ground motion with depth is shown in Figure 1 (Appendix A) for the Fall-Winter 2000 monitoring season and Figures 2 and **3** (Appendix A) for 2000 and Spring 2001 combined. The linear trend for the averaged combined data is:

$$V \text{ (average)} = -0.0015\, D + 0.0421 \qquad (1)$$

where V = the average PPV
D = the burial distance

The correlation coefficient (R^2) for the data is 0.38.

The average decrease in ground motion velocity was 0.0015 ips per foot below the ground surface, dependent **on** geology and coupling. Individual well site rates are provided in Figure 1 in Appendix **A.** For well-coupled burial depths **(2** feet and below), this rate ranges between -0.002 and -0.0026 (the negative indicating a decrease with depth) ips per foot of burial. The best-fit trend line giving the decrease in frequency at the PPV with burial depth, shown in Figure **4** of Appendix A, is:

$$F \text{ (average)} = -0.232\, D + 16.7 \qquad (2)$$

where F = the average peak frequency
D = the burial distance

Figure 5 of Appendix A shows the relationship between peak particle velocity and frequency at the peak for 2000 data, plotted on the OSM blasting level chart (1986).

It is difficult to distinguish the frequency differences between surface and buried ground motions. All data fell between 5.4 Hz and 34.1 Hz

5.2 Water Quality and Well Yield Data

As was the case with vibration monitoring, the data sets for field and laboratory water quality and well yield were most complete for the initial monitoring period. Analytical reports from water quality sampling and time-series graphs showing the results of downhole and well yield monitoring are included as Appendices B and C, respectively.

During the Fall-Winter 2000 monitoring event, water samples were collected from wells at each of the study sites prior to and after blasting (Table 3), and the results of the analyses are summarized in Table 4. Generally, parameters were stable throughout the monitoring period and showed no effects from blasting, as exemplified by the KY-1 Well-1 site. However, iron and TSS concentrations measured prior to and after blasting differed significantly in many wells (Table 4). It is theorized that these differences were caused by the stirring of sediments and sloughing of scale from both normal well operation and the introduction of monitoring equipment. Laboratory analysis was not performed during any of the subsequent monitoring events.

The dates and times of blasting events were placed on time-series graphs of data collected from field water quality monitoring, allowing identification of any changes in any of the parameters related to blasting (Appendix C). Throughout the study, where data are available, well yield and water level trends remained unchanged due to blasting. For example:

Table 3. Water Quality Sample Inventory

State	Site ID	Well ID	Pre-Test		Post-Test	
			Date	Sample ID	Date	Sample ID
Virginia	VA-1	Well-1	11/06/00	Boggs 1	11/18/00	Boggs 2
Kentucky	KY-1	Well-1	11/09/00	Ratliffe 1	11/18/00	Ratliff 2
		Well-2	11/09/00	Banks 1[a]	11/18/00	Banks 2
	KY-2	Well-1	Well not sampled			
		Well-2	11/18/00	Sumner 1	11/25/00	Sumner-2
		Well-3	11/20/00	Hurley #1	11/25/00	Hurley-2
West Virginia	WV-1	Well-1	11/26/00	Dean 1-1	12/4/00	Dean 1-2
		Well-2	11/26/00	Dean 2-1	12/4/00	Dean 2-2
	WV-2	Well-1	12/04/00	Abbott 1-1	12/7/00	Abbott 1-2
		Well-2	12/04/00	Abbott 2-1	12/7/00	Abbott 2-2

Note: All samples analyzed by Inter-Mountain Laboratories, Inc. of Farrnington, New Mexico
[a] Duplicate analysis performed on sample

Table 4. Results of Laboratory Water Quality Analyses, Initial Quarterly Monitoring Event

				Concentration (mg/L)					
				General Parameters			Total Metals		
State	Site ID	Well ID	Date	TDS	TSS	Sulfate	Aluminum	Iron	Manganese
Virginia	VA-1	Well-1	11/06/00	1,740	19	991	<0.05	17.7	1.10
			11/18/00	1,710	9	955	<0.05	0.03	0.88
Kentucky	KY-1	Well-1	11/09/00	274	3	72	<0.05	3.48	0.44
			11/18/00	260	21	72	<0.05	24.8	0.35
		Well-1 Dup	11/09/00	272	10	72	<0.05	3.34	0.42
		Well-2	11/09/00	448	4	109	<0.05	4.17	0.36
			11/18/00	430	14	108	0.07	5.71	0.42
	KY-2	Well-1	Well not sampled						
		Well-2	11/18/00	250	<2	7	<0.05	20.8	0.89
			11/25/00	250	103	5	0.06	67.0	3.86
		Well-3	11/20/00	700	22	36	<0.05	12.9	1.51
			11/25/00	650	26	37	<0.05	14.7	1.46
West Virginia	WV-1	Well-1	11/26/00	400	75	145	0.07	28.4	1.00
			12/04/00	380	<2	144	<0.05	5.42	0.85
		Well-2	11/26/00	320	7	109	<0.05	4.62	0.39
			12/04/00	280	<2	109	<0.05	1.84	0.24
	wv-2	Well-1	12/04/00	180	<2	7	<0.05	0.89	0.10
			12/07/00	140	6	<5	<0.05	0.34	0.03
		Well-2	12/04/00	160	58	15	<0.05	16.4	0.55
			12/07/00	130	35	12	<0.05	5.16	0.07

mg/L = Milligrams per liter   TDS = Total dissolved solids   TSS = Total suspended solids

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- The well yield from VA-1 Well-1 remained between 8 and 10 gallons per minute (gpm) during the entire Fall-Winter 2000 monitoring period, unaffected by blast timing. When VA-1 Well-1 was monitored again in Spring 2001 the well yield was in the same range.

- Where well yields were erratic, such as in KY-1 Well-2 during the Fall-Winter 2000 monitoring period, the erratic behavior did not correspond to the blast timing.

- Water level changes in wells, if any, were very regular and predictable and were related to household schedules, During periods of high water use for activities such as bathing and washing dishes, the pump cycles more often, resulting in a short-term lowering of the water level in the well. **WV-2** Well-2 is a good example of these types of water level changes.

Field water quality parameters remained in similar ranges throughout the study (Table 5). The data from the downhole sensors fall into three categories:

- *Very little change in measured parameters.* A good example of this result can be seen in the temperature, pH, and EC data for WV-1 Well-1 during the Winter 2001 monitoring period, which remained nearly unchanged throughout the monitoring period.

- *Spikes in measured parameters related to household schedules.* For instance, during the Fall-Winter 2000 monitoring, VA-1 Well-I showed spikes in temperature related to ground water being brought into the well during high use periods of the day.

- *Sensor drift.* Fouling of the instrument in the well can cause a gradually drifting data trend, or sensor drift. The slowly rising pH in well **WV-2** Well-1 over the Spring 2001 monitoring period is a prime example of sensor drift. The continually increasing pH trend in this well is not disrupted by the blasts.

Table 5. Results of Field Turbidity Monitoring

Site	Date	Time	Turbiditv
VA-1 Well-1	11/05/00	15:45	30.9
	11/05/00	15:50	61.1
	11/05/00	15:59	54
	11/06/00	09:20	30.2
	11/06/00	09:40	22.7
	11/07/00	09:40	34.6
	11/07/00	10:00	30.5
	11/07/00	10:15	27.7
	11/07/00	16:01	29.4
	11/08/00	05:49	38.7
	11/08/00	06:04	11.3
	11/09/00	08:30	25.9
	11/09/00	09:00	23.4
	11/09/00	13:58	17.7
	11/09/00	16:14	39.1
	11/09/00	16:30	61
	11/09/00	16:43	61.5
	11/09/00	16:52	46.1
	11/09/00	17:00	40.1
	11/10/00	15:20	26.9
	11/10/00	15:35	25.8
	11/10/00	15:45	39.8
	11/11/00	13:54	30.5
	11/11/00	14:46	68.4
	11/11/00	15:50	18.3
KY-1 Well-I	11/09/00	13:58	17.7
	11/10/00	13:00	>1,000
	11/12/00	16:00	192
	11/13/00	09:53	NA
	11/13/00	10:14	26.3
	11/13/00	16:45	23.9
	11/14/00	12:59	23.2
	11/15/00	11:00	43.8
	11/16/00	09:53	24.2
	11/16/00	11:35	21.2
	11/17/00	11:55	90.9
	11/17/00	12:52	31.9

Table 5. Results of Field Turbidity Monitoring
Page 2 of 3

Site	Date	Time	Turbidity
KY-1 Well-2	11/09/00	11:25	2.59
	11/09/00	11:30	2.34
	11/09/00	13:30	13
	11/10/00	11:38	5.28
	11/12/00	09:03	177
	11/12/00	12:30	170
	11/13/00	10:08	20.3
	11/13/00	16:40	7.59
	11/14/00	13:10	20.9
	11/15/00	10:55	2.64
	11/16/00	09:58	24.2
	11/16/00	11:36	20.1
	11/17/00	12:03	2.78
	11/17/00	12:52	0.99
KY-2 Well-2	11/19/00	14:15	19
	11/20/00	17:10	24
	11/22/00	09:45	56.5
	11/25/00	18:50	101
KY-2 Well-3	11/20/00	14:55	2.82
	11/20/00	17:20	8.1
	11/22/00	09:25	4.22
	11/25/00	17:50	60.6
WV-1 Well-1	11/26/00	16:00	29.80
	11/27/00	12:57	54.1
	11/27/00	13:30	30.2
	11/28/00	12:54	67.9
	11/28/00	13:29	58.2
	11/29/00	11:24	54.8
	11/29/00	12:40	45.2
	12/02/00	10:40	17.9
	12/02/00	12:10	25.8
WV-1 Well-2	11/26/00	16:00	58
	11/27/00	12:58	29.2
	11/27/00	13:32	60.2
	11/28/00	12:50	35.6
	11/28/00	13:24	37.8
	11/29/00	11:22	**6.48**

Table 5. Results of Field Turbidity Monitoring
Page 3 of 3

Site	Date	Time	Turbidity
WV-1 Well-2 (cont.)	11/29/00	12:30	9.3
	12/02/00	10:40	9.22
	12/02/00	12:10	11.1
WV-2 Well-1	12/03/00	12:40	2.28
	12/04/00	11:50	3.45
	12/05/00	11:30	9.69
WV-2 Well-2	12/03/00	12:45	81.6
	12/04/00	11:50	39.9
	12/05/00	11:30	45.2

6. Summary and Conclusions

DBS&A was contracted by the OSMRE to design and initiate a long-term study to investigate possible effects of mining operations on groundwater quality and supply in domestic wells. The study was conducted between November 2000 and December 2001 and consisted of four field data collection periods and subsequent data analysis.

During each of the monitoring periods, field personnel attempted to collect data deemed necessary to determine effects of mining operations on nearby domestic wells, including vibration/blasting, water quality, and well yield data. Data from the initial monitoring period are the most complete. Unforeseen issues in data collection and removal of sites from the study for various reasons resulted in progressively less complete data sets in each of the remaining data collection periods, and during the final period, only one site of the original nine selected could be monitored.

Vibration data became more sparse as the study progressed because mine blasting was conducted at increasingly larger distances from the study sites. Ground movements produced by blasting activities were attenuated by the greater distances and were in many instances not strong enough to trigger the seismographs, indicating little vibratory effect in the ground surrounding the wells. No adverse impacts to domestic water wells from surface coal mine blasting were measured during this study. This lack of impact is valid for peak surface ground motions that fall within 0.125 ips (the maximum ground motion recorded at the surface during the study).

Few changes that could be directly attributed to a blast event were observed in the water quality and well yield data collected. Water quality parameters did change slightly over time during measuring periods, but none of these changes seem to be related to blasting, but appeared instead to be the result of sensor drift and mixing of the water in the well due to pump cycling. Well yield and water level remained in a constant range throughout each individual monitoring season.

References

U.S. Geological Survey (USGS). 1999. *Coal resource assessment in the northern and central Appalachian coal region.* USGS Fact Sheet 115-99. October 1999.

Office of Surface Mining. 1986. Federal Register Cite: **51** FR 19444 (19461).

Robertson **D.A., J.A.** Gould, **J.A.** Straw, and **M.A.** Dayton. 1980. *Survey of blasting effects on ground water supplies in Appalachia.* Prepared by Philip R. Berger & Associates, Bradfordwoods, Pennsylvania. Bureau of Mines, Washington, D.C. November 1980.

Appendix A

Vibration Monitoring Methods and Results

Ground Motions Measurements Adjacent to Domestic Water Wells

Ground motions adjacent to nine domestic water wells were recorded during blasting events to determine the ground motion variation with depth below the ground surface. At each well selected for study, one tri-axial transducer was buried 0.42 ft. from the surface near each wellhead. **A** second transducer was buried at depth.

Two abandoned well casings and one hand-dug well were used to place transducers at depths between **9** and **20** ft. **At** four wells, an attempt was made to hand-dig holes **as** deep as possible to record ground motions. At most sites, the subsurface soils contained large gravels and cobbles, making it difficult to dig holes deeper than **3.5** ft. from the surface. At two sites, it was not possible to dig into the ground any deeper than 0.42 ft from the surface. Therefore, no second transducer was used at these two wells,

During the initial monitoring period in 2000, detailed information on the blasting activities were obtained from the mine operators. The distances from the blasting site to the wells ranged 1293 ft. to 5140 ft. away and averaged 2607 ft. Charge weights used for blasting ranged from 126 to 2076 lbs. per 8 ms (rnilliscondj delay. The scaled distances ranged from 56 to **343** ft./lbs.$^{1/2}$.

Seismograph Equipment

Blasting-type seismographs, manufactured by LARCOR or Dallas, Texas, were used to monitor ground motions near wells. Sensors were embedded in epoxy within a water-tight housing for long-term survivability. Fifty-foot cables were used and attached to the housing aligned with the vertical geophone for ease of inserting at depth. Airblast was recorded using the surface seismograph.

Figure (1) shows the locations of geophones placed in or adjacent to wells. Geophones placed in abandoned wells were either grouted in place or encapsulated in crushed stone. Geophones placed within the ground adjacent to wells were tamped with pressure to ensure good coupling.

The following settings were used:

Ground trigger level	0.02 ips
Air trigger level	125 dB
Sample rate	**1248** samples/sec.
Record length	5 to 10 sec.
Range	*2.5* ips
Lowest velocity detected	0.005 ips

Results

Vibration Data from Blasting

Full waveform vibration data are shown in Volume II for all blast events that were recorded. Tables (1) through (4) summarize the seismographs data recorded during fall-winter 2000, spring 2001, fall 2001, and winter 2001, respectively. **Peak** particle velocity (PPV), in ips (inches **per** second), the frequency at the PPV, in **Hz** (Hertz), and the airblast, in dB (decibels) **are** given. Detailed blasting records were available only during the fall-winter 2000 monitoring period. Hence, Table (1) provides information on distances from the blast to the seismographs, maximum pounds per 8 ms delay and scaled distance. This data set is the most complete with 54 shots recorded at nine wells. Subsequent monitoring periods were not **as** complete due to the loss of in Kentucky site **KY-** 1 and Virginia **as previously explained,** Difficulties fielding equipment contributed to smaller data sets in the 2001 monitoring periods. Additionally, mine blasting was being conducted at farther distances from the wells during 2001, compared to the distances involved during the initial 2000 monitoring period, as mining moved away from the study sites. As such, many of the mine blasts did not trigger the seismographs.

The extensive 2000 data set shows average near-surface (0.42 ft.) and at depth (from 1.1 to 20 ft.) peak particle velocities (PPV) of 0.043 ips and 0.033 ips, respectively. In the spring of 2001 as mining progressed away from the well site, the average PPV values were 0.038 ips and 0.029 ips for the near-surface and at depth locations, respectively. The maximum ground motion recorded at the surface was 0.125 ips. In the fall of 2001, only surface measurements were taken. These averaged 0.026 ips, less than the average in 2000. In all cases, a decrease in average ground motions with depth was measured. In no case did ground motions at depth exceed those measured at the surface.

Frequencies at the PPV also tended to decrease with depth as the degree of confinement increased. Similarly, average frequencies decreased with successive monitoring periods. The average frequencies near the ground surface and at depth in 2000 were 17.5 Hz and 14.8 Hz. In the spring of 2001, an average surface frequency of 18.8 **Hz** was measured. The ground motion data at depth fell within the resolution of the instrumentation and frequencies could not be reliably calculated.

Average values for PPV and frequency at the PPV by well site are given in Tables *(5)* through **(8).** The dominant waveform frequency obtained from the Fast Fourier Transform (FFT) is also shown. The FFT frequency is a measure of the predominant frequency over the entire waveform and indicates the frequency containing most of the ground motion energy. In contrast, the frequency at the PPV (or peak frequency) is the frequency calculated from the zone-crossings for the cycle containing the PPV.

Data contained in these tables are plotting in Figures (1) through *(5)*. The decrease in ground motion with depth is shown in Figure (1) for the initial monitoring season (2000) and Figures (2) and **(3)** for 2000 and spring 2001 combined. The linear trend for the averaged combined data is

$$V \text{ (average)} = -\, 0.0015\, D + 0.0421 \qquad (\ )$$

where V is the average PPV, in ips, and D is the burial distance, in ft. The correlation coefficient (R^2) for the data is 0.38. The best-fit line through the data indicates that an average decrease in ground motion velocity of 0.0015 ips occurs per foot of depth below the ground surface. The rate of decrease is dependent on geology and coupling. Individual well site rates are given in Figure (1). For well-coupled burials depths **(2** ft. and below), this rate ranges between -0.002 and -0.0026 (the negative indicating a decrease with depth) ips per ft. of burial.

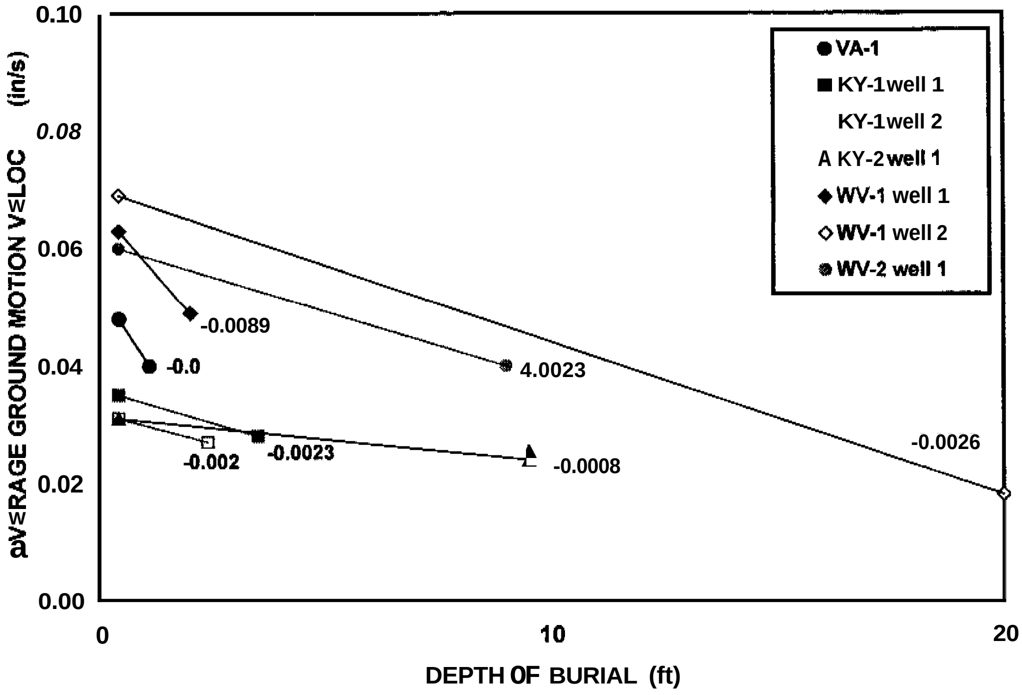


Figure (1) Average ground motion velocity versus depth of burial for fall-winter 2000 data showing the rate of decrease in ground motion velocity with depth

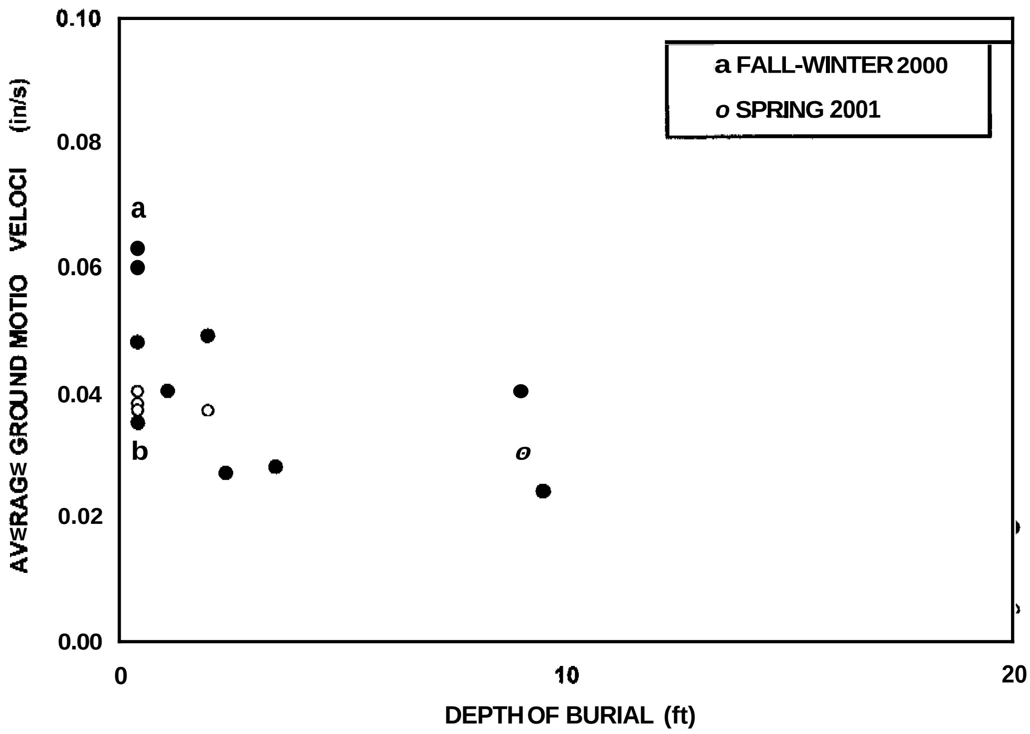


Figure (2) Average ground motion velocity versus depth of burial for fall-winter 2000 **and** spring 2001

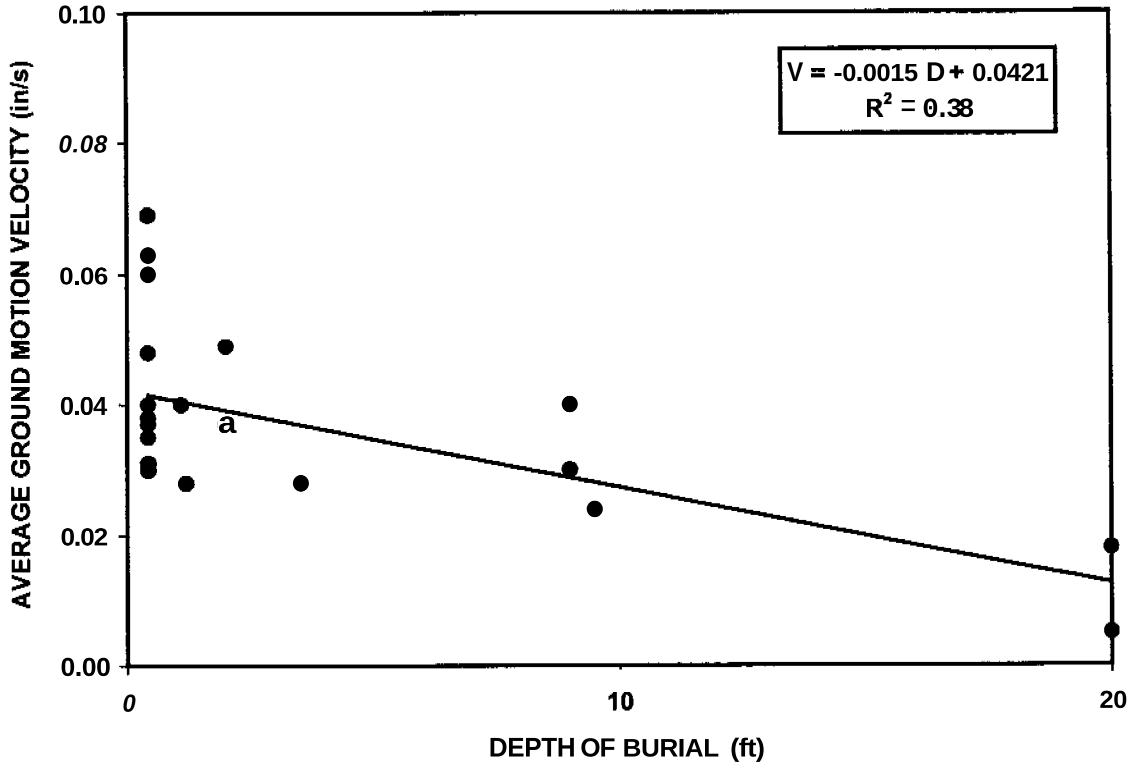


Figure (2) Average ground motion velocity versus depth of burial for fall-winter 2000 and spring 2001

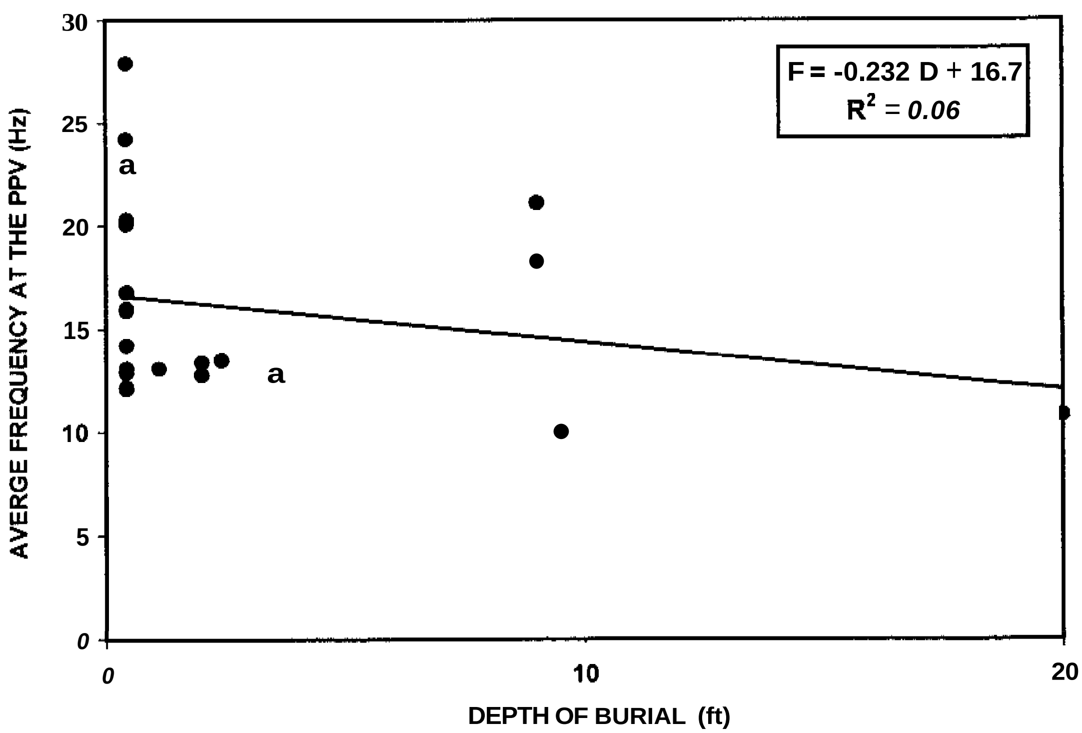


Figure (4) Average peak frequency versus depth of burial for fall-winter 2000 and spring 2001

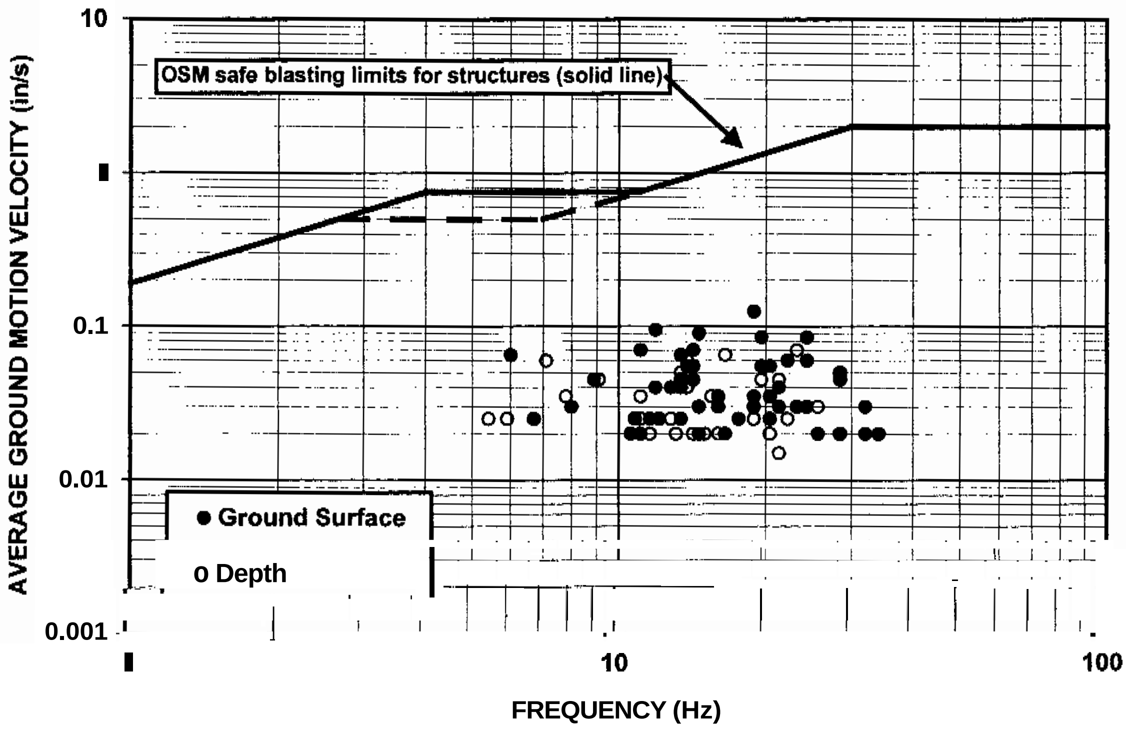


Figure (5) Peak particle velocity versus peak frequency for 2000 data

The best-fit trend line giving the decrease in frequency at the PPV with burial depth, shown in Figure (4), is

F (average) = - 0.232 D + 16.7 ( )

where F is the average peak frequency, in Hz, and D is the burial distance, in ft.

Figure (5) shows the relationship between peak particle velocity and frequency at the peak for 2000 data, plotted on the Office of Surface Mining **(OSM)** blasting- level chart **(1986).** It is difficult to distinguish the frequency differences between surface and buried ground motions. All data fell between 5.4 Hz and 34.1 Hz

*Vibration Data from Well **Pumping***

Well pumping did not produce detectable ground motions. The geophone placed in WV-1 well 2 at 20 ft. depth did not trigger during the 2000 monitoring period. **All** other geophones at depth were placed in dry (abandoned) wells or in the ground near the pumping well. It is expected that ground water pumping may produce localized ground motions that are well below the detectable limits of blasting seismographs. Hence no motion data was recorded.

References

Office of Surface Mining, (1**986)** Federal Register Cite: 51 FR 19444 (19461)

Table Summary of shot records and vibration and airblast monitoring at wells during the fall and winter of 2000

Well location	Shot Date	Time	Distance	Charge Weight per Delay	Scaled Distance	GROUND MOTION AND AIRBLAST				AT DEPTH			
						UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
			(ft)	(lb)	($ft/lb^{1/2}$)		(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	11/6/00	16:57	1293	337	70.4	1181	0.04	12.8	118	1.1	1180	0.04	11.9
	11/7/00	16:41	1380	361	72.6	1181	NO	TRIGGER			1180	0.02	15
	11/8/00	16:45	1293	361	68.1	1181	0.045	13.4	117		1180	0.04	13.8
	11/9/00	12:55	1380	313	78.0	1181	0.055	19.6	119		1180	0.045	19.6
	11/10/00	13:20	1353	361	71.2	1181	0.055	13.8	118		1180	0.055	13.8
	11/11/00	14:48	1298	361	68.3	1181	0.045	8.9	126		1180	0.045	9.1
KY-1 well 1	11/13/00	16:04	4800	684	183.5	804	0.030	24.3	100	3.5	809	NO	TRIGGER
	11/14/00	16:18	5000	936	163.4	804	0.025	13.4	106		809	0.020	16
	11/15/00	11:49	2020	828	70.2	804	0.055	20.4	112		809	NO	TRIGGER
	11/16/00	9:07	5140	1026	160.5	804	0.020	10.6	106		809	0.020	14.2
	11/16/00	16:00	2240	414	110.1	804	0.025	10.8	110		809	0.020	15
	11/17/00	12:15	1830	936	59.8	804	0.025	12.1	110		809	0.020	11.6
	11/17/00	12:34	2020	1044	62.5	804	0.065	6.0	120		809	0.060	7.1
KV-1 well 2	11/13/00	16:04	4760	684	182.0	849	0.03	21.3	<100	2.4	853	0.025	22.2
	11/14/00	16:18	4880	936	159.5	849	0.035	16.0	106		853	0.025	12.8
	11/15/00	11:49	2200	828	76.5	849	0.04	11.9	112		853	0.035	11.1
	11/16/00	9:07	5020	1026	156.7	849	0.025	17.6	100		853	0.02	20.4
	11/16/00	16:00	2420	414	118.9	849	0.025	11.6	106		853	0.025	11.1
	11/17/00	12:15	1720	936	56.2	849	0.025	20.4	110		853	0.02	15
	11/17/00	12:34	2310	1044	71.5	849	0.04	18.9	118		853	0.035	7.8
KV-2 well 1	11/20/00	13:03	2000	274	120.8	849	0.025	6.7	114	9.5	809	0.025	5.9
	11/20/00	16:08	2010	495	90.3	849	0.030	23.2	119		809	0.02	16.5
	11/20/00	16:45	2380	211	163.8	849	0.020	28.4	100		809	NO	TRIGGER
	11/21/00	14:37	2110	274	127.5	849	0.020	32.0	114		809	NO	TRIGGER
	11/21/00	15:35	1560	211	107.4	849	0.045	14.2	110		809	0.025	12.1
	11/21/00	16:43	3720	807	131.0	849	0.045	28.4	100		809	NO	TRIGGER
	11/22/00	10:13	1960	678	75.3	849	0.030	8	110		809	0.025	5.4
KV-2 well 2	11/20/00	10:32	4640	183	343.0	804	0.02	14.6	100	NOT MONITORED			
	11/20/00	16:09	1810	495	81.4	804	0.035	16	120				
	11/21/00	14:38	1960	274	118.4	804	0.03	16	118				
	11/21/00	15:35	1740	211	119.8	804	0.04	13.4	116				
	11/21/00	16:41	3810	808	134.0	804	0.03	14.6	110				
	11/21/00	16:43	2500	209	172.9	804	0.04	21.3	110				
	11/22/00	10:14	2210	678	84.9	804	0.02	11.1	114				
wv-1 well 1	11/27/00	16:56	2500	1037	77.6	1782	0.07	11.1	117	2.0	1781	0.065	16.5
	11/28/00	17:03	2230	126	198.7	1782	NO	TRIGGER			1781	0.02	13.1
	11/29/00	9:51	4300	2076	94.4	1782	0.055	14.2	110		1781	0.05	13.4
	11/30/00	11:53	3880	2076	85.2	1782	0.065	13.4	110		1781	0.06	13.8
wv-1 well 2	11/27/00	16:01	2600	1037	80.7	1780	0.095	11.9	122	20.0	1779	0.025	10.8
	11/28/00	17:05	2310	126	205.8	1780	0.020	14.6	114		1779	NO	TRIGGER
	11/29/00	9:56	3960	2076	86.9	1780	0.090	14.6	110		1779	0.015	
	11/30/00	11:58	3980	2076	87.4	1780	0.070	14.2	112		1779	0.015	
wv-2 well 1	12/4/00	12:23	1710	481	78.0	1782	0.125	18.9	112	9.0	1780	0.07	23.2
	12/4/00	17:01	2240	415	110.0	1782	0.085	24.3	112		1780	0.045	21.3
	12/5/00	12:05	2440	973	78.2	1782	0.05	28.4	116		1780	0.03	25.6
	12/5/00	16:51	2070	625	82.8	1782	0.06	22.2	116		1780	0.035	15.5
	12/5/00	16:52	2520	901	84.0	1782	0.02	34.1	112		1780	NO	TRIGGER
	12/6/00	12:22	2460	901	82.0	1782	0.02	25.6	112		1780	0.015	21.3
	12/6/00	16:48	1560	452	73.4	1782	0.085	19.6	114		1780	0.06	22.2
	12/7/00	12:13	2460	793	87.4	1782	0.035	20.4	106		1780	0.025	18.9
wv-2 well 2	12/5/00	12:05	2520	973	80.8	1779	0.030	18.9	117	NOT MONITORED			
	12/5/00	16:53	2130	625	85.2	1779	0.030	32	116				
	12/6/00	16:50	1630	452	76.7	1779	0.060	24.3	117				
	12/7/00	12:13	2520	793	89.5	1779	0.020	16.5	110				

Table **Summary** of vibration **and airblast** monitoring at **wells** during **the** spring of 2001

			GROUND MOTION AND AIRBLAST				AT DEPTH			
			UNIT	Peek Particle Velocity (in/sec)	Peak Frequency (Hz)	Airblast (dB)	Geophone Depth (ft)	UNIT	Peak Velocity (in/sec)	Peak Frequency (Hz)
	resident on citv water - no lonaer usina well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2	seismographs did not trigger for 15 shots (trigger level not indicated)									
WV-1 well 1	4/3/01	8:41	1781	0.03	12.1	114	2.0	1782	0.025	12.4
	4/3/01	13:51	1781	0.03	15	110		[illegible]	[illegible]	[illegible]
	4/3/01	17:06	1781	0.025	10.8	114				TRIGGER
	4/4/01	11:20	1781	0.05	12.8	110		1782	0.045	
	4/5/01	10:34	1781	0.055	16	106		1782	0.05	[illegible]
	4/6/01	10:22	1781	0.05	12.1	106		1782	0.05	12.4
	4/6/01	15:43	1781	0.06	13.8	112		1782	0.06	13.4
	4/9/01	12:41	1781	0.04	14.2	114		1782	0.03	15.5
	4/9/01	16:35	1781	0.025	12.8	110		1782	NO	TRIGGER
	4/10/01	15:45	1781	0.045	14.2	116		1782	0.04	13.8
	4/10/01	16:53	1781	0.035	13.4	100		1782	0.035	14.2
	4/11/01	9:57	1781	0.025	8.6	116		1782	NO	TRIGGER
	4/12/01	10:37	1781	0.035	11.6	114		1782	0.03	13.8
	4/12/01	12:22	1781	0.03	14.2	114		1782	0.03	12.4
	4/13/01	10:30	1781	0.035	11.9	112		1782	0.03	12.1
WV-1 well 2	4/2/01	8:38	1779	0.025	15.5	114	20.0	1780	NO	TRIGGER
	4/3/01	13:48	1779	0.035	14.2	110		1780	NO	TRIGGER
	4/3/01	17:03	1779	0.025	13.1	118		1780	0.005	
	4/4/01	11:18	1779	0.045	11.9	110		1780	NO	TRIGGER
	4/5/01	10:31	1779	0.080	14.2	106		1780	NO	TRIGGER
	4/6/01	10:19	1779	0.055	13.8	106		1780	NO	TRIGGER
	4/6/01	15:40	1779	0.055	14.6	114		1780	NO	TRIGGER
	4/9/01	12:39	1779	0.035	13.1	116		1780	NO	TRIGGER
	4/10/01	15:42	1779	0.035	18.2	118		1780	0.005	
	4/11/01	9:54	1779	0.005		119		1780	0.005	
	4/12/01	10:35	1779	0.030	12.8	119		1780	0.005	
	4/12/01	12:20	1779	0.030	14.2	116		1780	NO	TRIGGER
	4/12/01	17:02	1779	0.025	13.4	118		1780	0.005	
	4/13/01	10:27	1779	0.040	12.8	114		1780	NO	TRIGGER
WV-2 well 1	4/16/01	16:50	1781	0.075	32	110	9.0	1782	0.04	22.2
	4/18/01	16:51	1781	0.035	10.8	116		1782	NO	TRIGGER
	4/18/01	16:54	1781	0.03	22.2	106		1782	0.025	10.4
	4/19/01	8:55	1781	0.035	24.3	110		1782	0.025	22.2
	4/19/01	16:52	1781	0.025	12.4	106		1782	NO	TRIGGER
WV-2 well 2	4/16/01	16:49	1779	0.035	30.1	112	na	1780	0.03	34.1
	4/18/01	16:50	1779	0.025	25.6	118		1780	NO	TRIGGER

na not available

Well location	Shot Date	Time								
			UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
				(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	resident on city water - no longer using well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2 well 2	9/21/01	14:25	809	0.020	14.2	125	NOT MONITORED			
	9/24/01	13:53	809	0.030	14.6	100				
	9/25/01	12:37	809	0.030	11.6	<100				
	3/25/01	15:44	809	0.025	23.2	116				
KY-2 well 3	9/21/01	10:32	813	0.03	9.4	118	NOT MONITORED			
	9/22/01	11:43	813	0.02	16.5	106				

Table Summary of vibration and airblast monitoring at wells during the winter of 2001

Well location	Shot Date	Time	GROUND MOTION AND AIRBLAST				AT DEPTH			
			UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
				(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	resident on city water - no longer using well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2	seismographs did not trigger for 15 shots (trigger level not Indicated)									
WV-1 well 1	well not monitored -transducer at depth missing (NOTHING IN BUDROW'S NOTES!!)									
WV-1 well 2	12/4/01	16:44	1769	0.033	13.4	106	20.0	1905	NO	TRIGGER
	12/5/01	16:46	1769	0.033	15.5	110		1905	NO	TRIGGER
	12/5/01	16:50	1769	0.053	16	114		1905	NO	TRIGGER
WV-2 well 1	well not monitored									
WV-2 well 2	well not monitored									

Table Average ground motion, airblast and frequency values for wells measured during the fall of 2001

SITE	WELL	FALL 2001						
		Surface				At Depth		
		Peak Particle Velocity	Peak Frequency	FFT Frequency	Airblast	Peak Particle Velocity	Peak Frequency	FFT Frequency
		(ips)	(Hz)	(Hz)	(dB)	(ips)	(Hz)	(Hz)
VA-1	well 1	resident on city water - no longer using well						
KY-1	well 1	site flooded from sediment pond overflow - no access to wells						
	well 2							
KY-2	well-1	deep transducer cable cut						
	well-2	0.026	15.9	8.7	114	not monitored		
	well 3	0.025	13.0	NA	112	not monitored		
WV-1	well 1	not monitored						
	well 2	not monitored						
WV-2	well 1	not monitored						
	well-2	not monitored						

NA not available; data within the resolution of the seismograph and frequencies cannot be reliably calculated

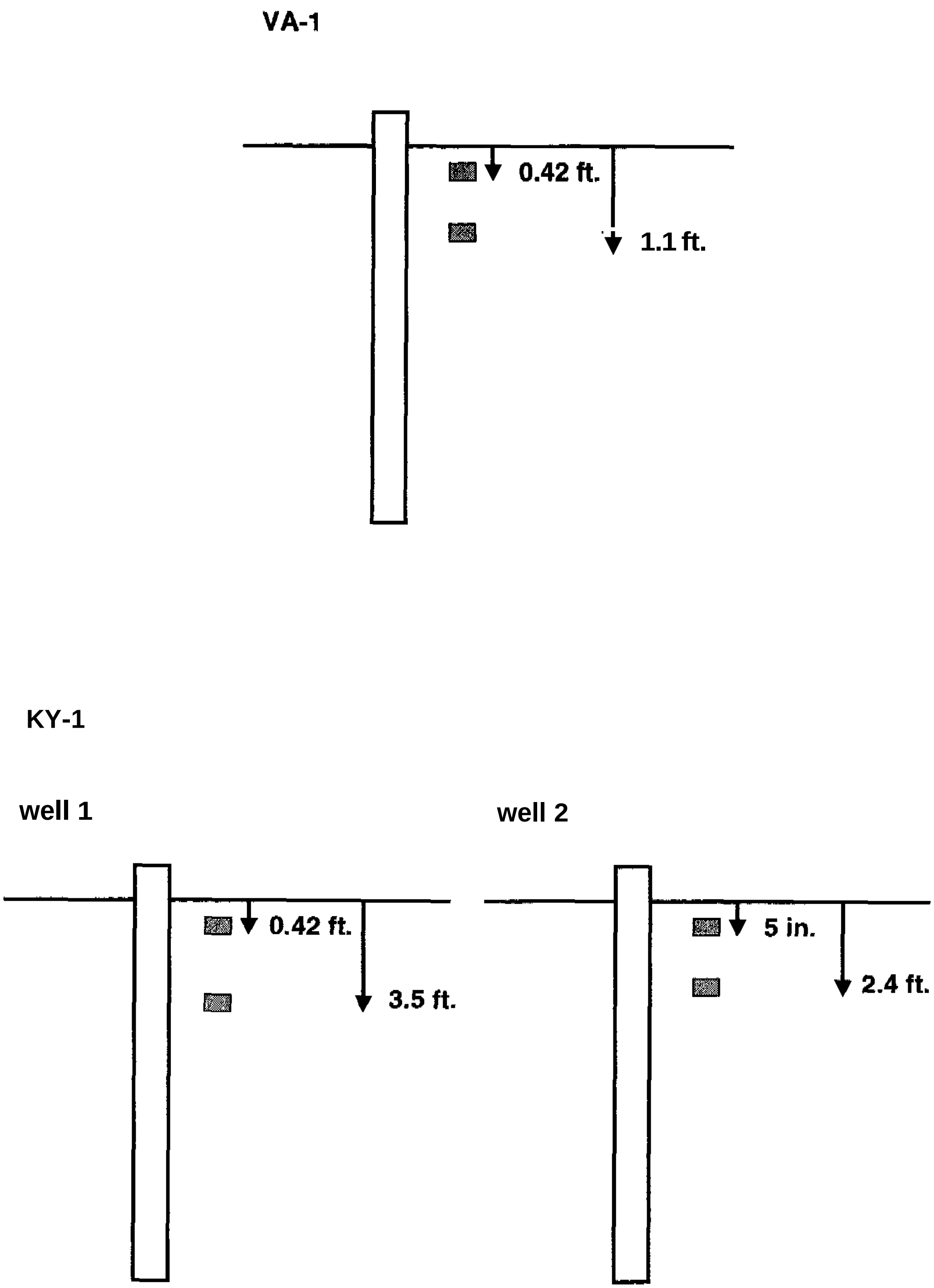


Figure 1 Geophone locations within or adjacent to wells

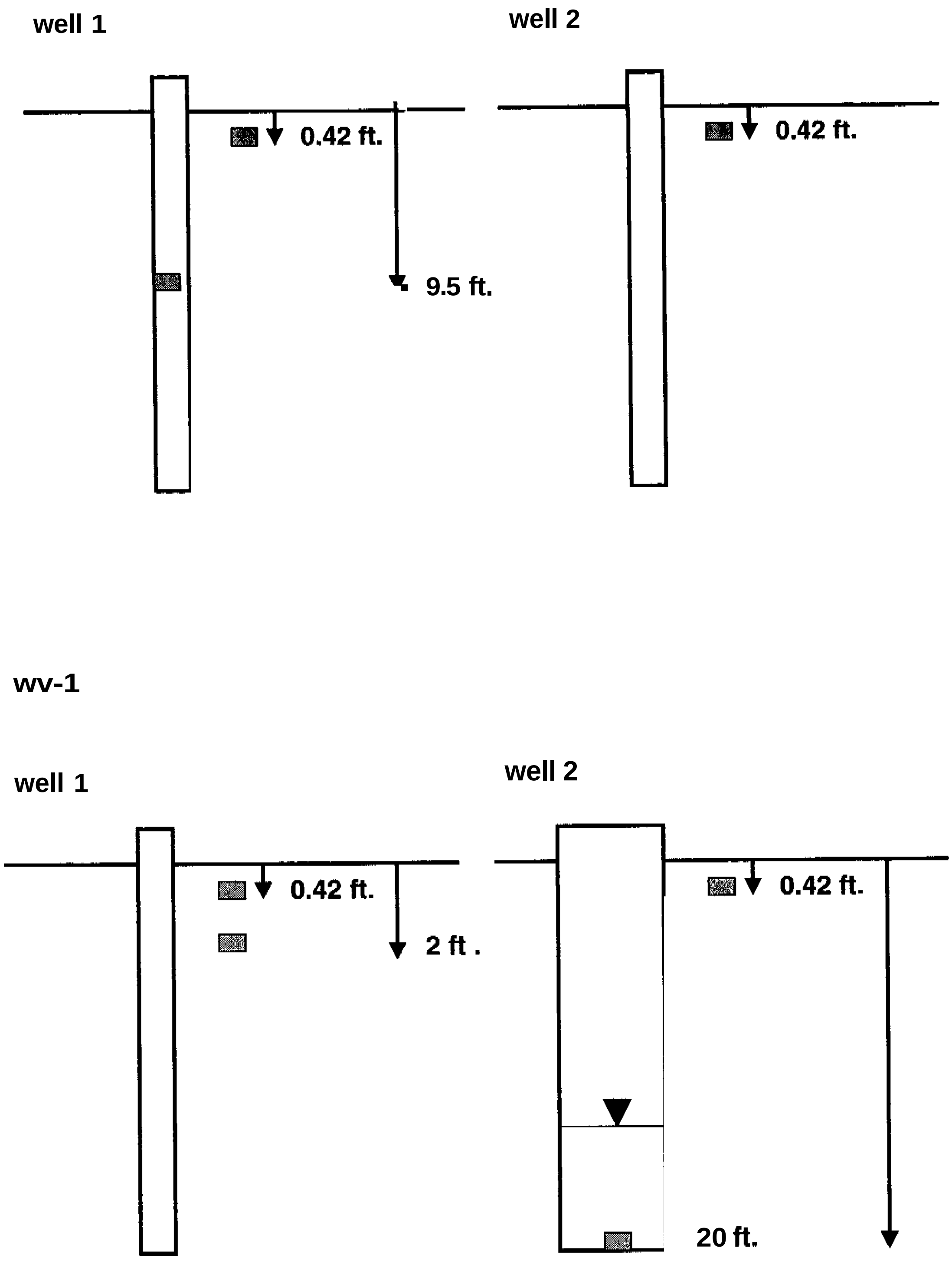


Figure 1 (cont.)

wv-2

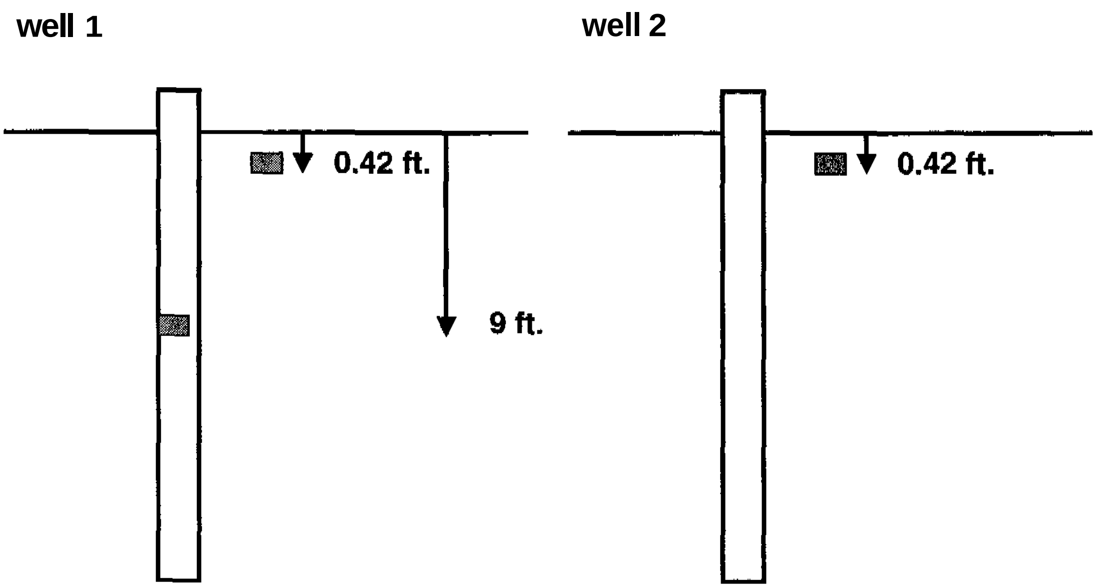


Figure I (cont.)

Volume II

Full Waveform Vibration Data

FALL-WINTER 2000

Hylton Well

File: 01181062.DTB Event Number: 062 Date: 11/06/2000 Time: 16:57
Acoustic Trigger: 126dB Seismic Trigger: 0.03in/s 0.762mm/s Serial Number: 1181

Amplitudes and Frequencies

Acoustic **(A):** 118 dB @ 2.1 Hz
(0.16Mb 0.0023psi 0.0160kPa)

Radial (R): **0.025in/s 0.635mm/s** @ 21.3Hz

Vertical (V): **0.04in/s 1.016mm/s @ 12.8Hz**

Transverse (T): 0.035in/s 0.889mm/s @ 10.6Hz

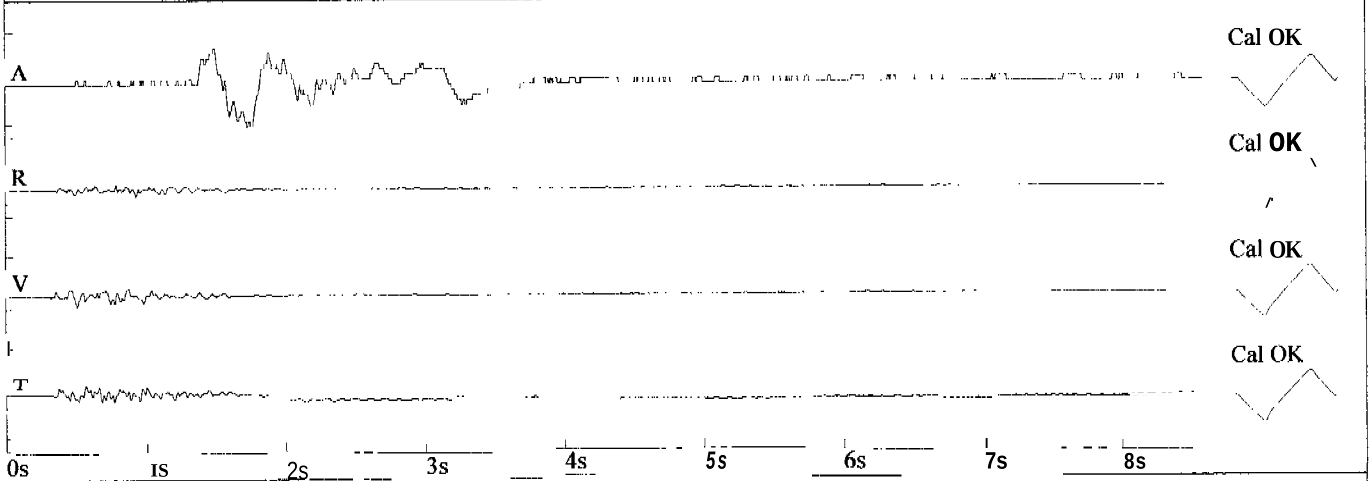
Graph Information

Duration: 0.000 sec To: **8.500**sec

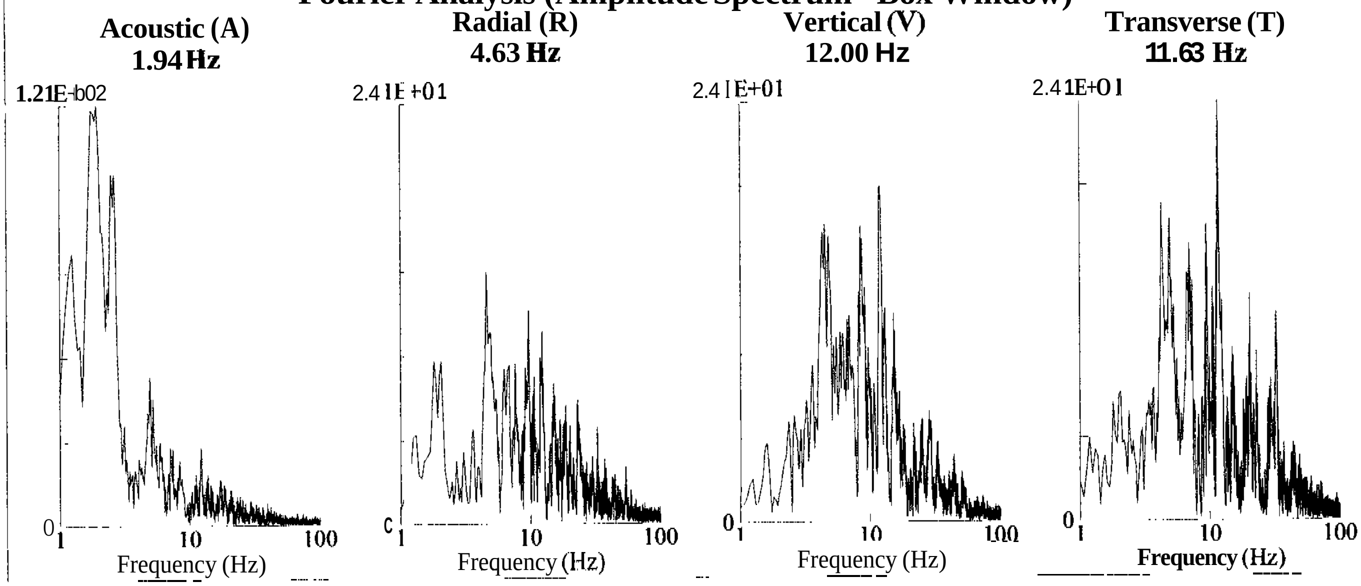
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals

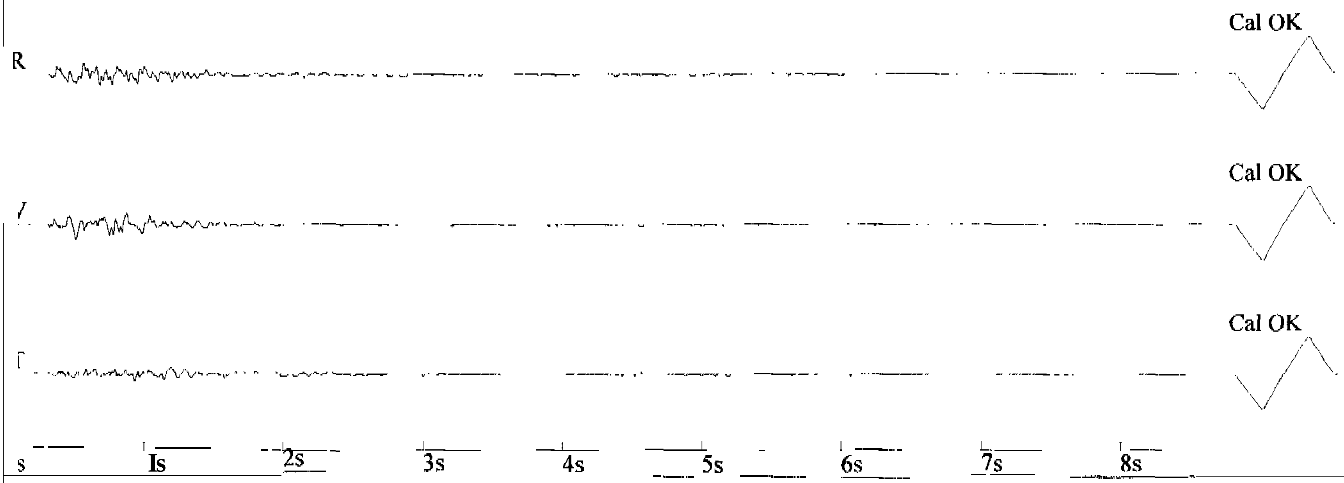


Fourier Analysis (Amplitude Spectrum - Box Window)



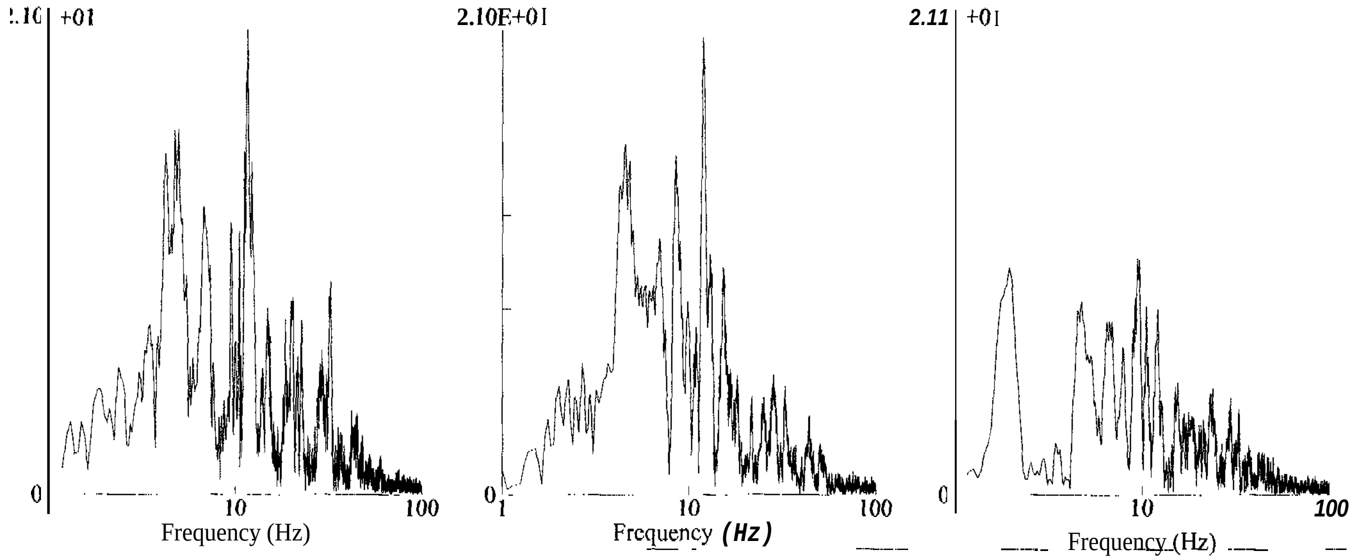
Hylton Well
26 in. deep

Amplitudes and Frequencies	**Graph Information**
Radial (R): 0.03in/s 0.762mm/s @ 11.1Hz	*Duration:* 0.000 sec **To:** 8.500 sec
Vertical *(V):* **0.04in/s 1.016mm/s @ 11.9Hz**	*Seismic* Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.02in/s 0.508mm/s @ 20.4Hz	*Time Lines at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

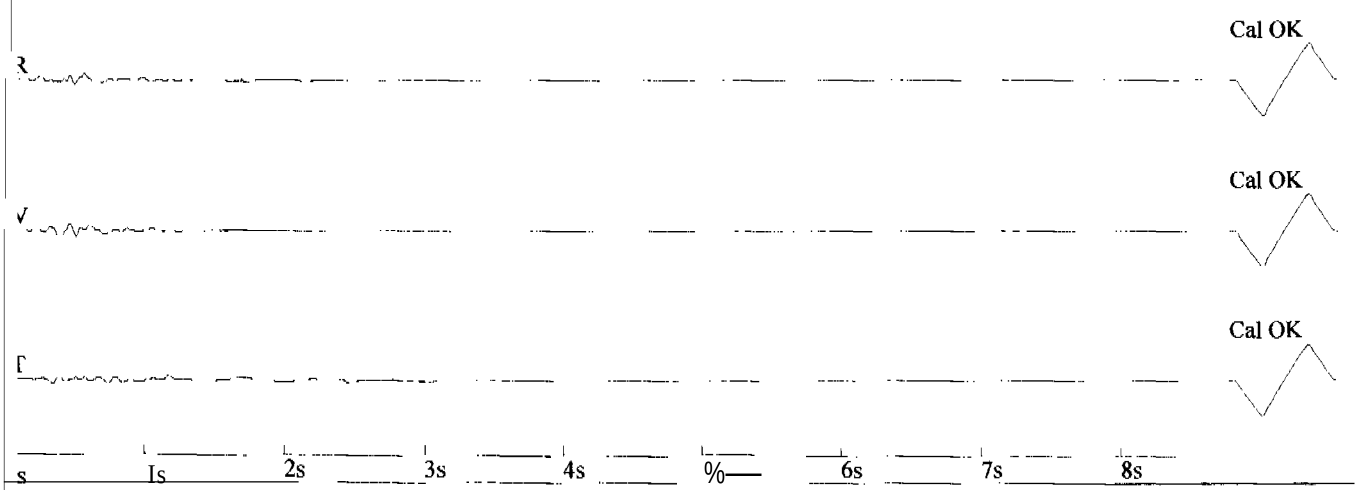
Radial (R)	Vertical (V)	Transverse (T)
11.63 Hz	11.94 Hz	9.44 Hz



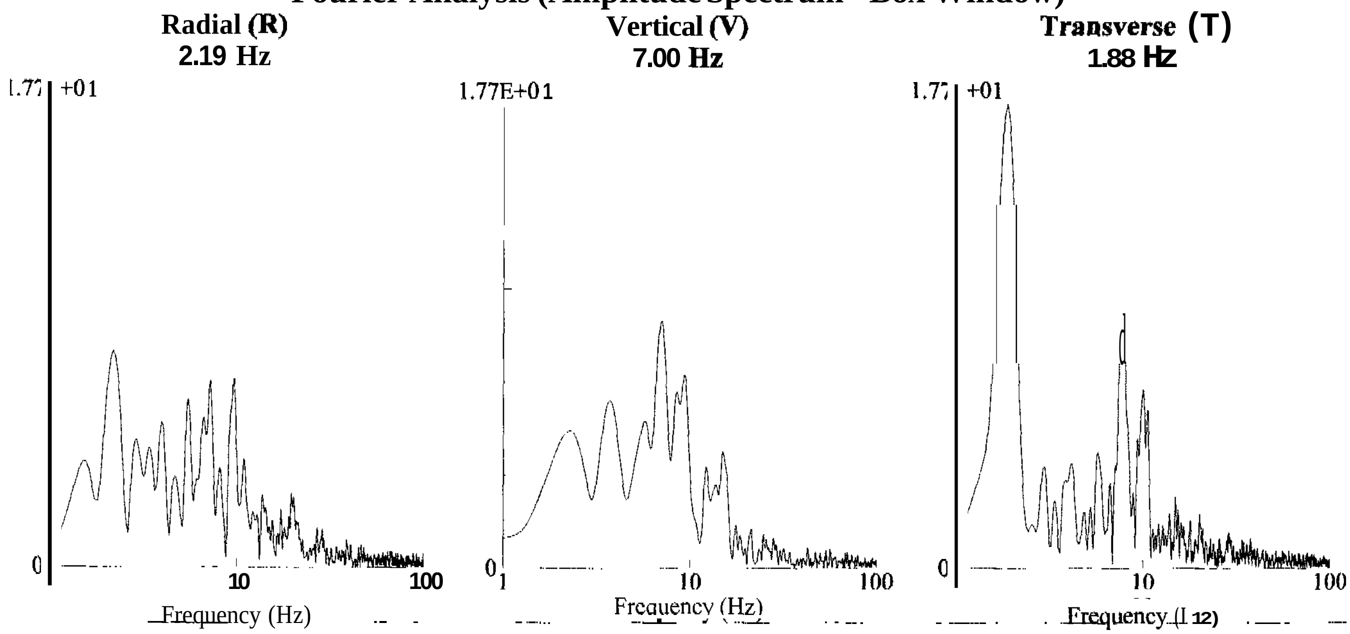
Hylton Well
26 in. deep

File: 01180001.DTB Event Number: 001 Date: 11/07/2000 Time: 16:41
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies	Graph Information
Radial (R): 0.015in/s 0.381mm/s @ 11.9Hz	*Duration:* 0.000 sec To: 8.500 sec
***Vertical (V):* 0.02in/s 0.508mm/s @ 15.0Hz**	*Seismic* Scale:
Transverse (T): 0.01in/s 0.254mm/s @ 10.0Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well

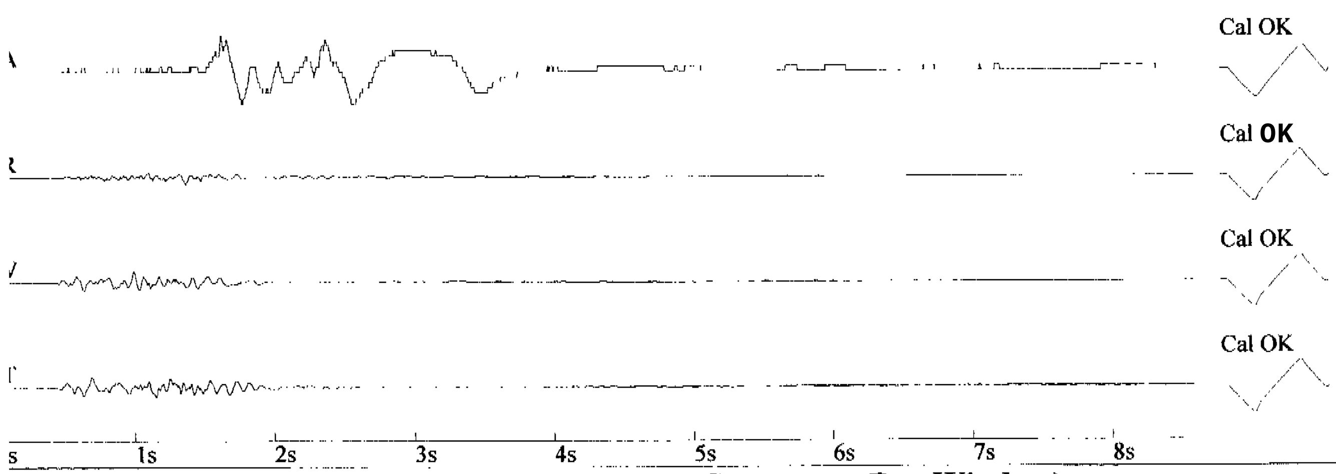
File: 01181063.DTB Event Number: 063 Date: 11/08/2000 Time: 16:45
Acoustic Trigger: 126dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1181

Amplitudes and Frequencies

Acoustic (A): 117 dB @ 2.9 **Hz**
(0.14Mb 0.0020psi 0.0140kPa)
Radial **(R):** 0.025in/s 0.635mm/s @ 12.4Hz
***Vertical (V):* 0.045in/s 1.143mm/s @ 13.4Hz**
Transverse (T): 0.04in/s 1.016mm/s @ 8.2Hz

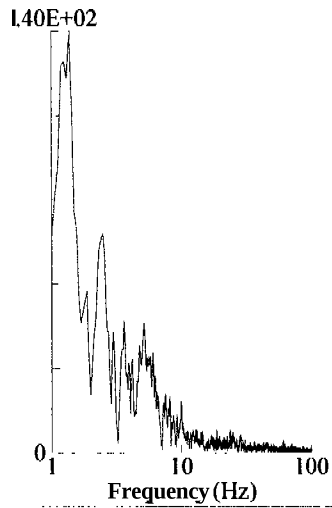
Graph Information

Duration: 0.000 **sec** To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

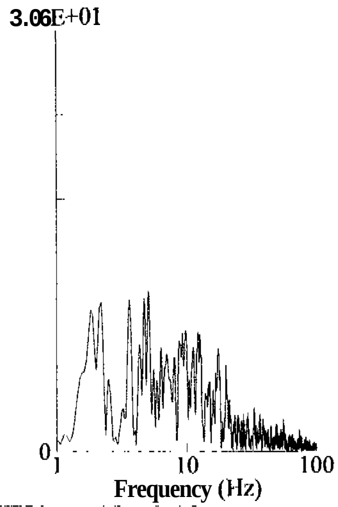


Fourier Analysis (Amplitude Spectrum - Box Window)

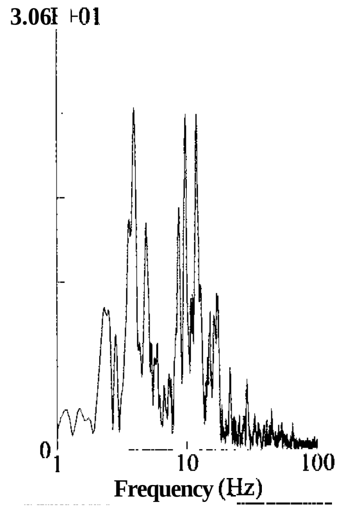
Acoustic (A)
1.38 Hz



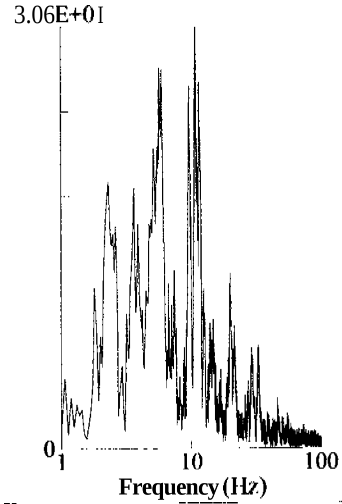
Radial (R)
5.06 Hz



Vertical (V)
3.94 Hz



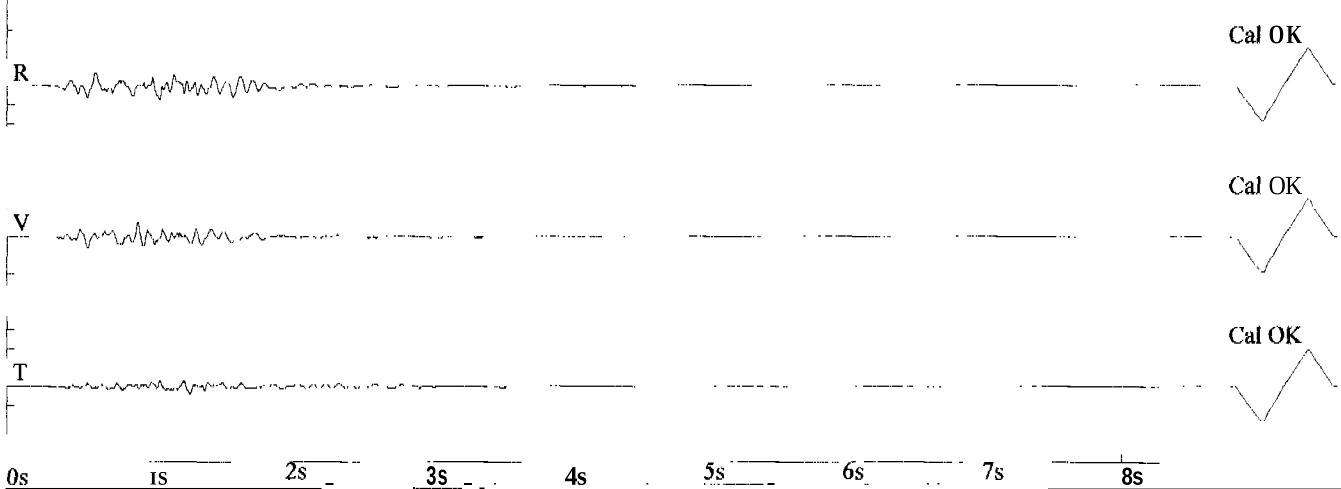
Transverse (T)
10.88 Hz



Hylton Well
26 in. deep

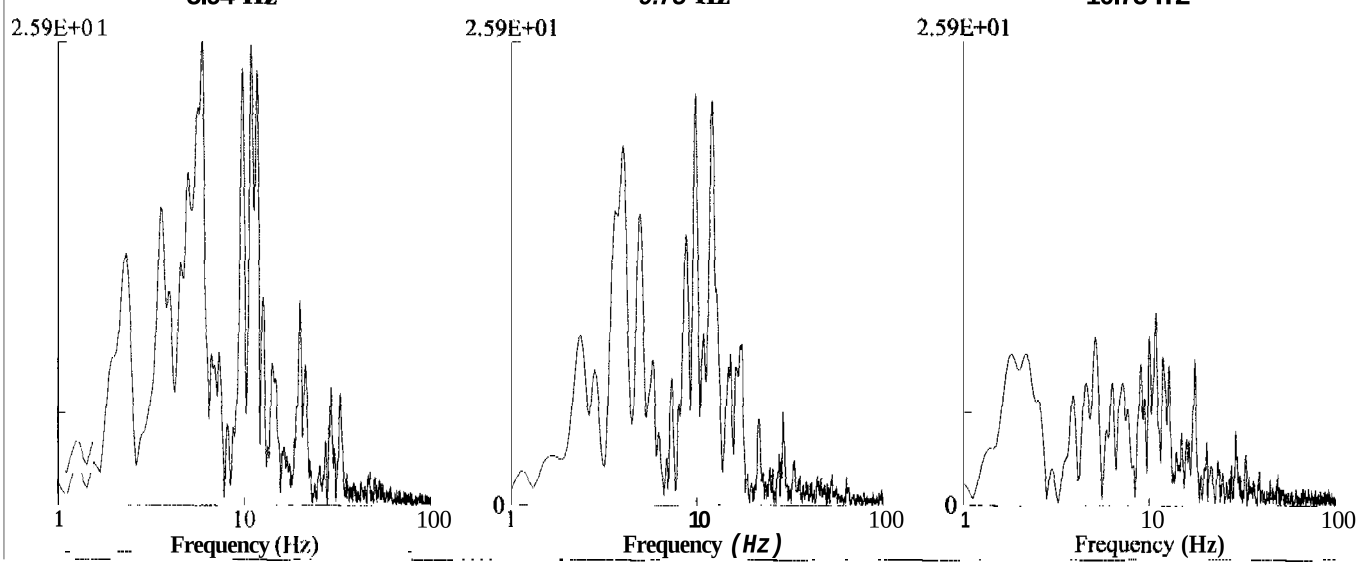
File: 01180002.DTB **Event Number:** 002 **Date:** 11/08/2000 **Time:** 16:45
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s **Serial Number:** 1180

Amplitudes and Frequencies	Graph Information
Radial (R): 0.035in/s 0.889mm/s @ 9.4Hz	***Duration:*** 0.000 sec To: **8.500** sec
Vertical (V): 0.04in/s **1.016mm/s** @ 13.8Hz	*Seismic Scale:*
Transverse *(T):* 0.02in/s 0.508mm/s @ 11.6Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

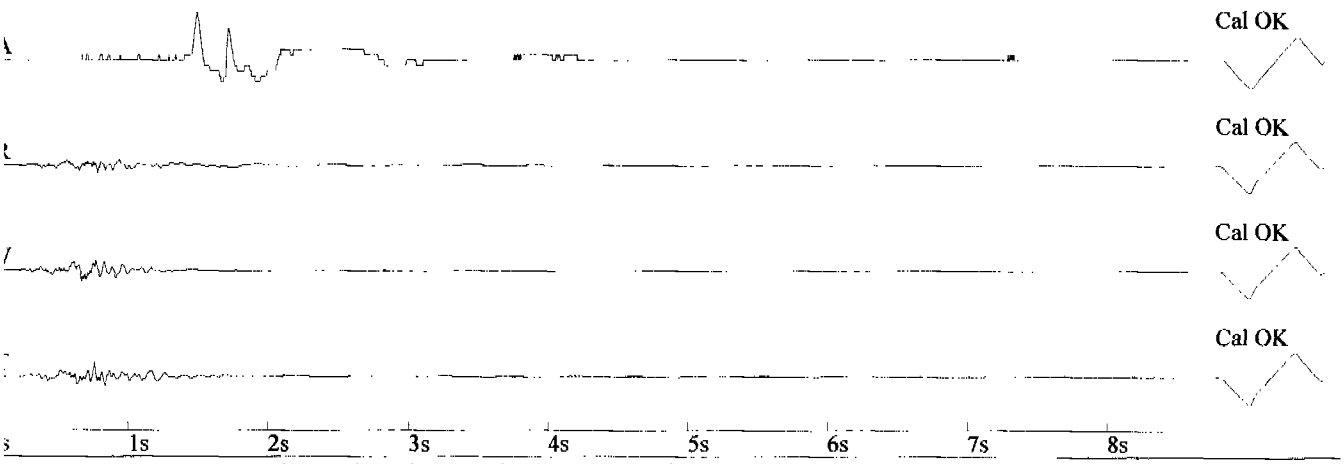
Radial (R) **5.94 Hz** | **Vertical (V)** ***9.75* Hz** | **Transverse (T)** **10.75 Hz**



Hylton Well

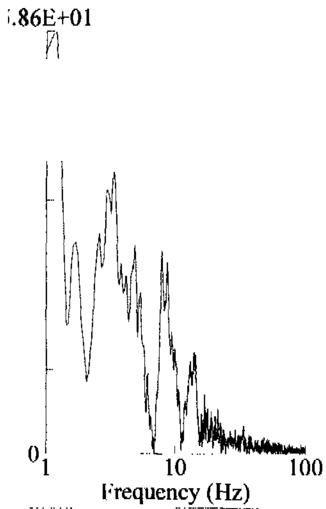
File: 011

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): **119 dB @ 6.5 Hz** (0.18Mb 0.0026psi 0.0180kPa)	Duration: 0.000 sec To: 8,500 sec
Radial (R): 0.025in/s 0.635mm/s @ 8.2Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.04in/s 1.016mm/s @ 10.6Hz	***Seismic*** Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.055in/s 1.397mm/s @ 19.6Hz**	***Time*** Lines at: 1.00 sec intervals

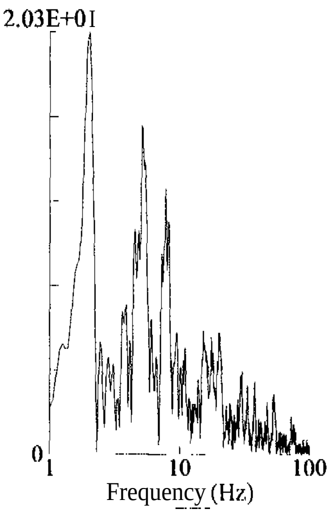


Fourier Analysis (Amplitude Spectrum - Box Window)

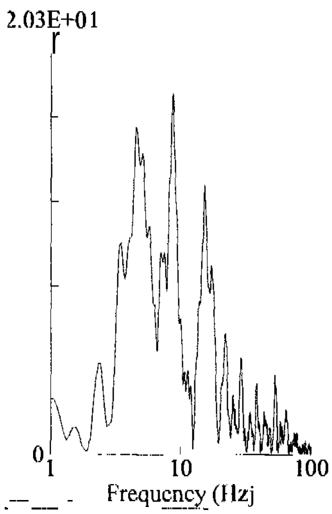
Acoustic (A)
1.19 Hz



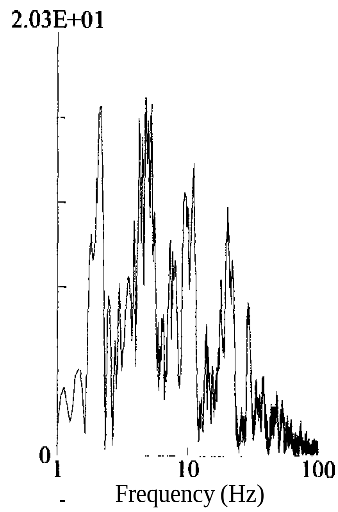
Radial (R)
2.00 Hz



Vertical (V)
8.63 Hz



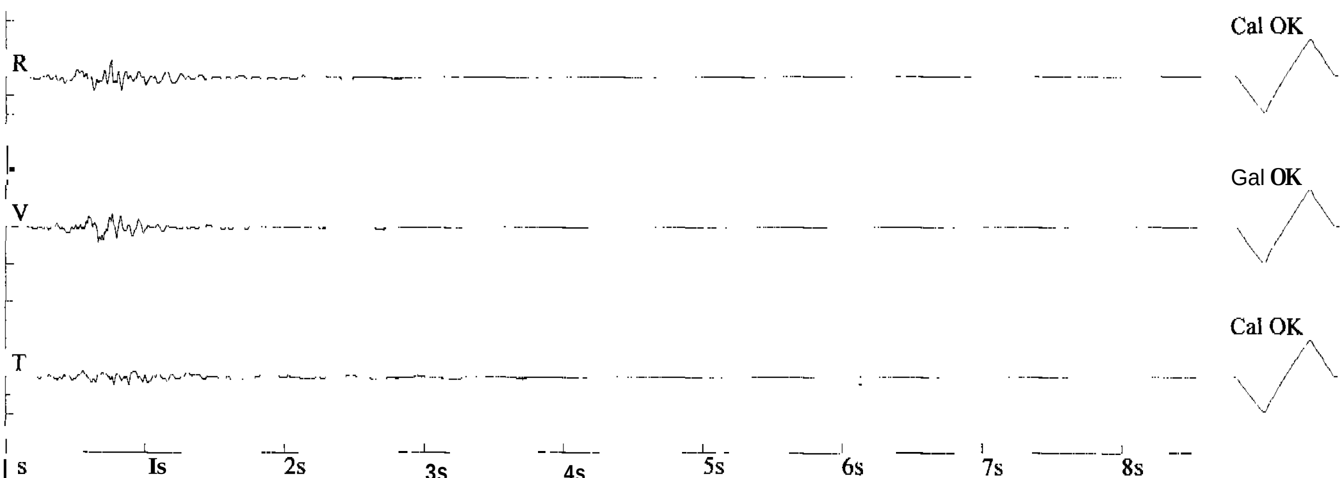
Transverse (T)
4.69 Hz



Hylton Well—
26 in. deep

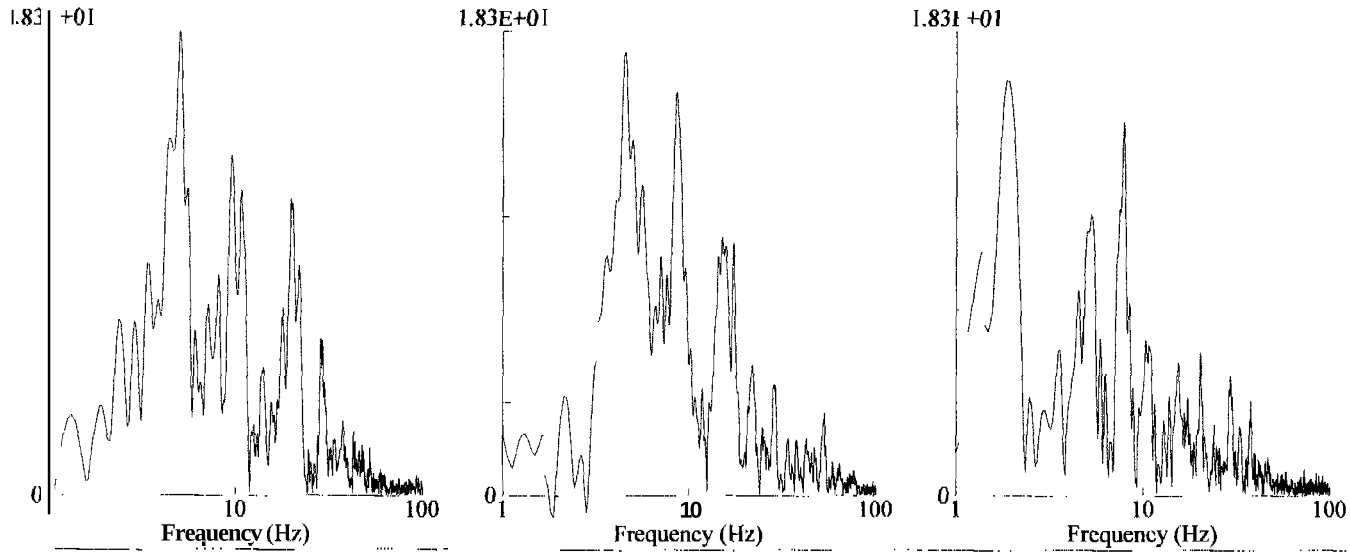
File: 01180003.DTB Event Number: 003 Date: 11/09/2000 Time: 12:55
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies	**Graph Information**
Radial (R): **0.045in/s 1.143mm/s @ 19.6Hz**	***Duration:*** 0.000 sec To: 8.500 sec
Vertical *(V)*: 0.04in/s 1.016mm/s @ 6.4Hz	***Seismic*** *Scale:*
Transverse *(T)*: 0.02in/s 0.508mm/s @ 26.9Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R) *5.06* Hz | Vertical (V) 4.56 Hz | Transverse (T) 1.88 Hz



Hylton Well

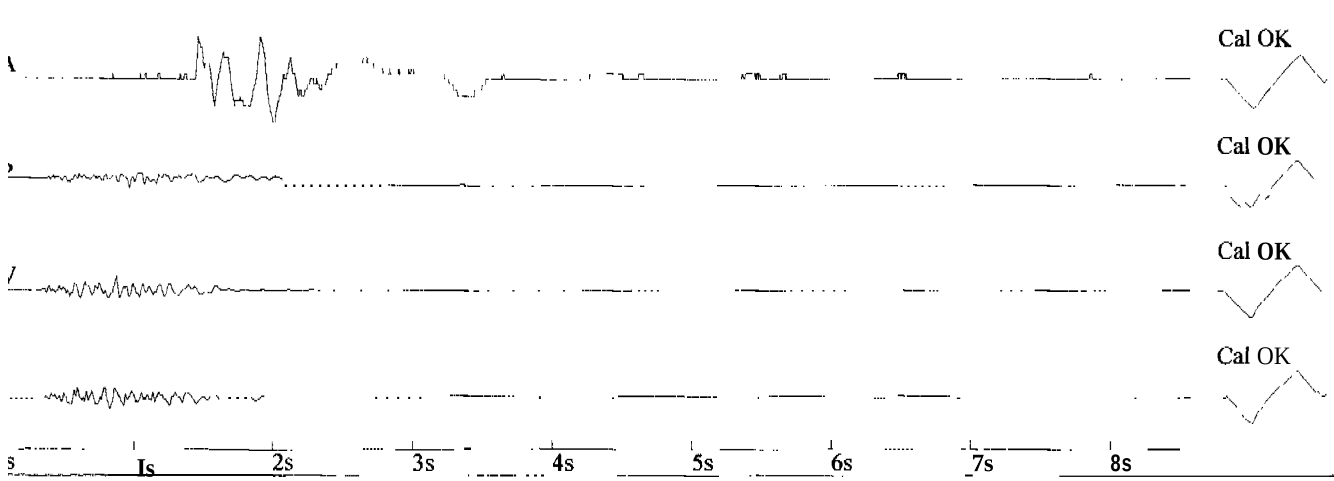
Fil :01181066.DTB Event Number: 066 Date: 11/10/2000 Time 13:20
Acoustic Trigger: 126dB **Seismic Trigger:** 0.02in/s 0.508mm/s Serial **Number:** I 181

Amplitudes and Frequencies

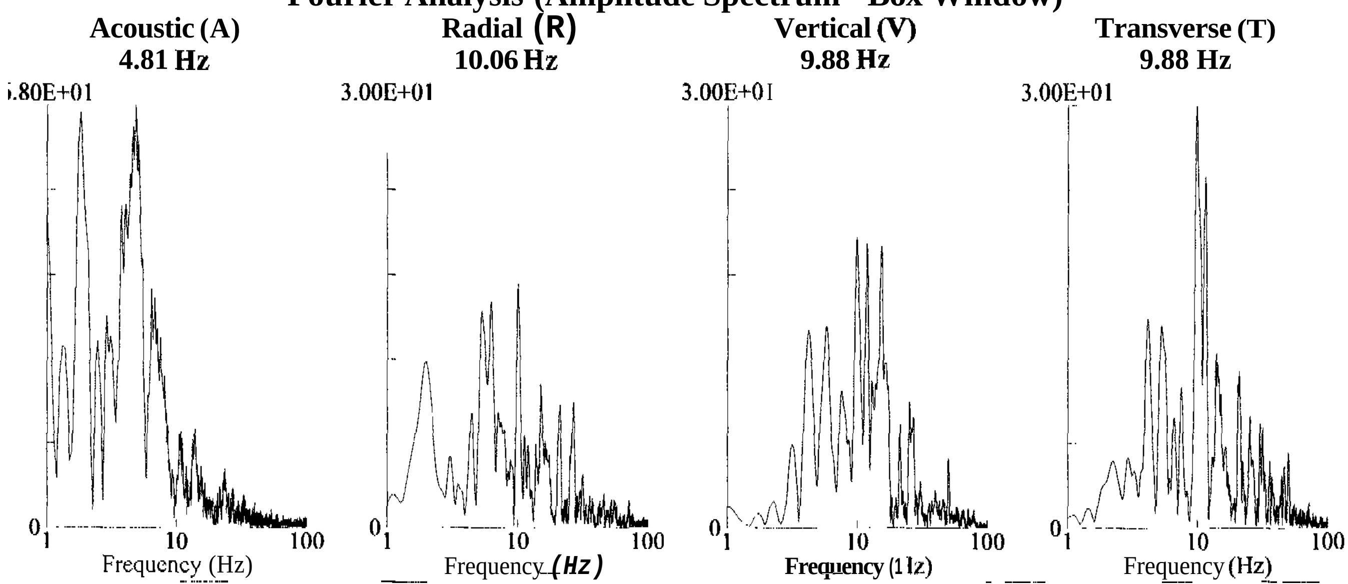
Acoustic (A): **118 dB @ 4.6 Hz**
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.035in/s 0.889mm/s @ 18.2Hz
***Vertical (V):* 0.055in/s 1.397mm/s @ 13.8Hz**
Transverse (T): 0.04in/s 1.016mm/s @ 14.6Hz

Graph Information

Duration: 0.000 sec To: ***8.500*** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

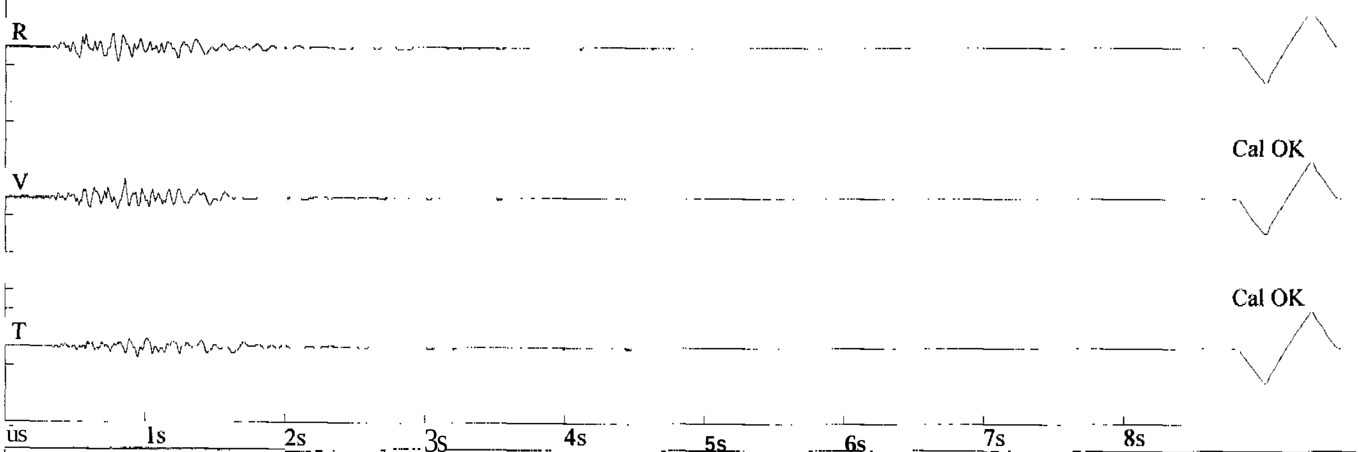


Fourier Analysis (Amplitude Spectrum - Box Window)



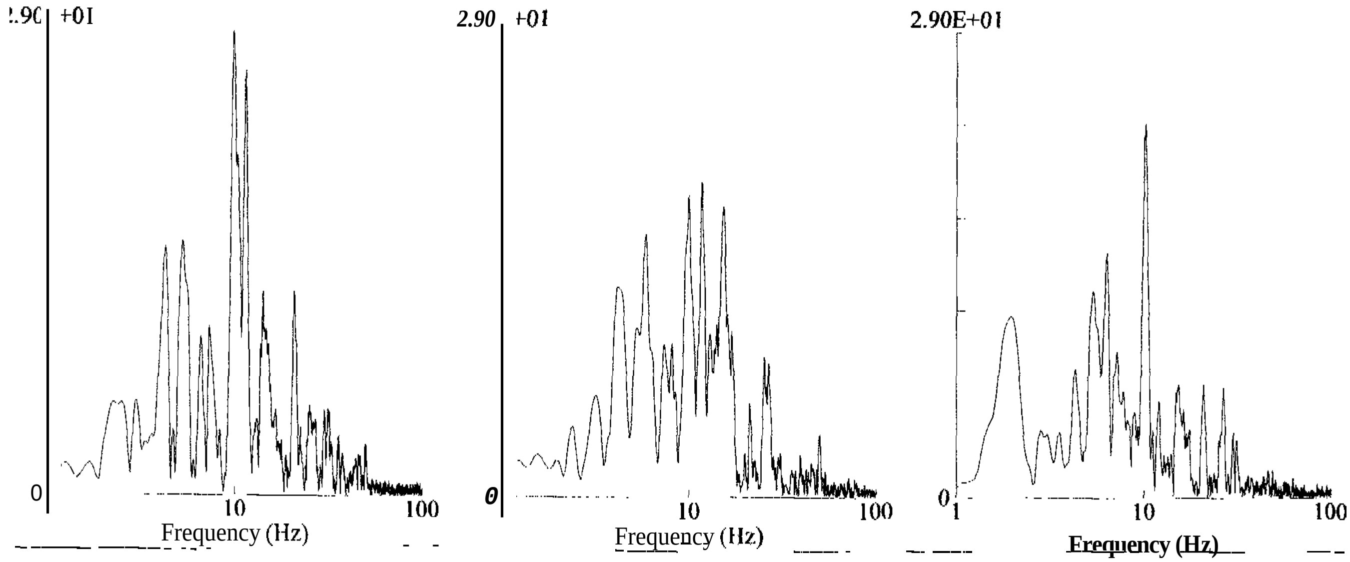
Hylton Well
26 in. deep

Amplitudes and Frequencies	**Graph Information**
Radial (R): 0.04in/s 1.016mm/s @ 12.4Hz	***Duration:*** *0.000* sec To: ***8.500*** sec
Vertical (V): **0.05in/s 1.27mm/s @ 14.6Hz**	***Seismic*** *Scale:*
Transverse *(T):* 0.03in/s 0.762mm/s @ 8.2Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



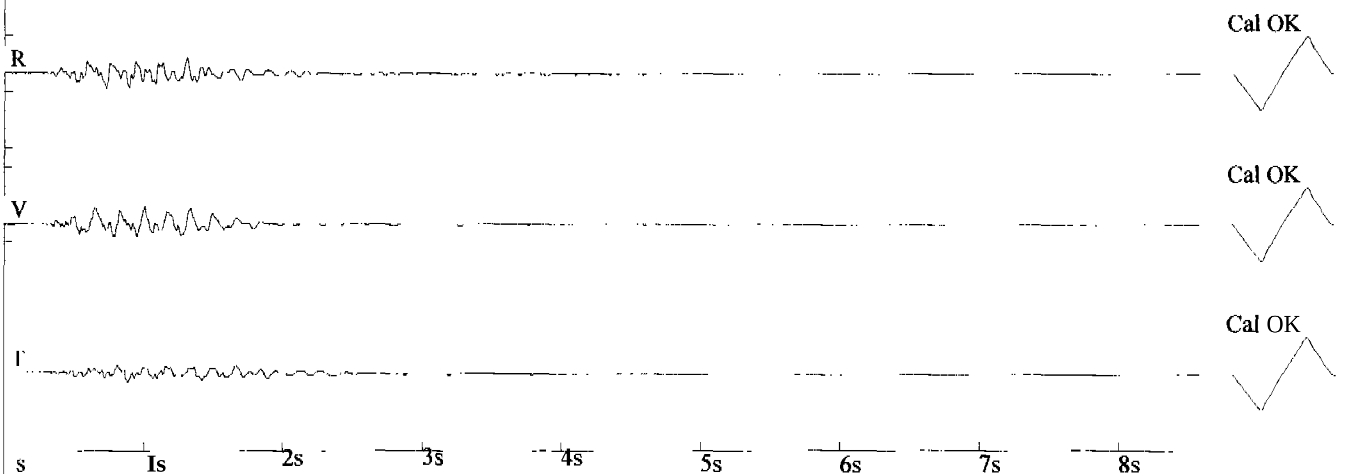
Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R) ***9.88*** **Hz** | **Vertical (V)** **11.69 Hz** | **Transverse (T)** **10.13 Hz**



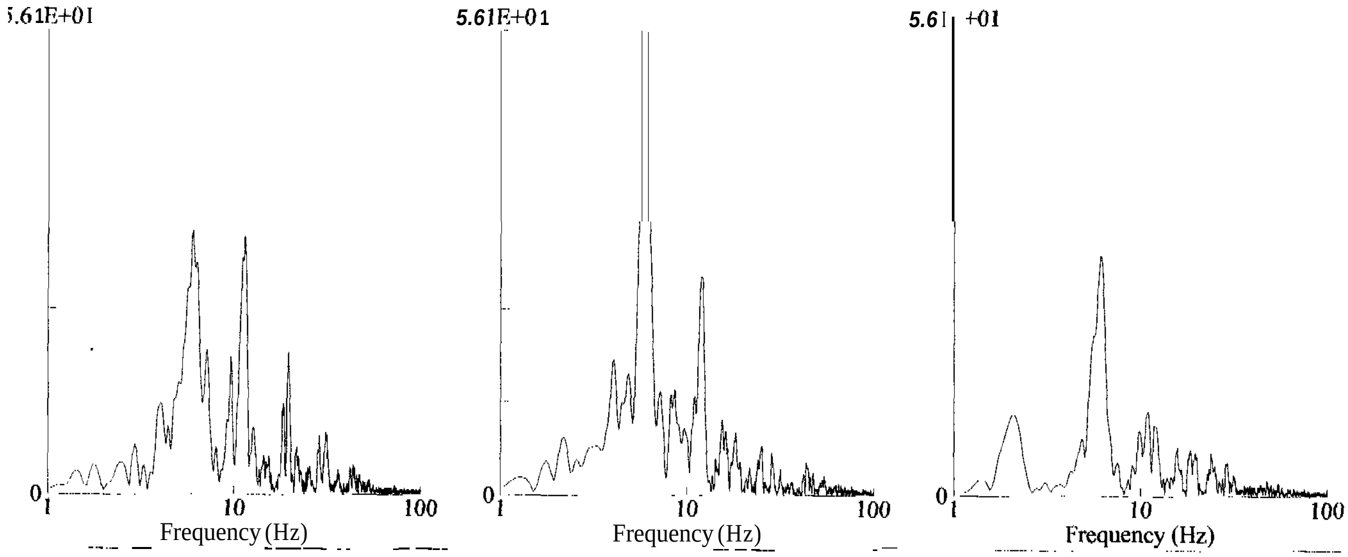
Hylton Well
26 in. deep

Amplitudes and Frequencies	Graph Information
Radial (R): **0.045in/s 1.143mm/s @ 10.0Hz**	*Duration:* 0.000 sec To: 8.500 sec
Vertical (V): **0.045in/s 1.143mm/s @ 9.1Hz**	Seismic *Scale:*
Transverse (T): 0.025in/s 0.635mm/s @ 10.8Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R)	Vertical (V)	Transverse (T)
6.00 Hz	5.94 Hz	6.13 Hz



Hylton Well

Amplitudes and Frequencies

Acoustic (A): **126 dB @ 5.5** Hz
(0.42Mb 0.0061psi 0.0420kPa)

Radial (R): 0.035in/s 0.889mm/s @ 11.6Hz

Vertical ***(V):* 0.045in/s 1.143mm/s @ 8.9Hz**

Transverse *(T):* 0.04in/s 1.016mm/s @ 11.3Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec

Acoustic Scale:
126dB 0.40Mb (0.100Mb/div)

Seismic *Scale:*
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

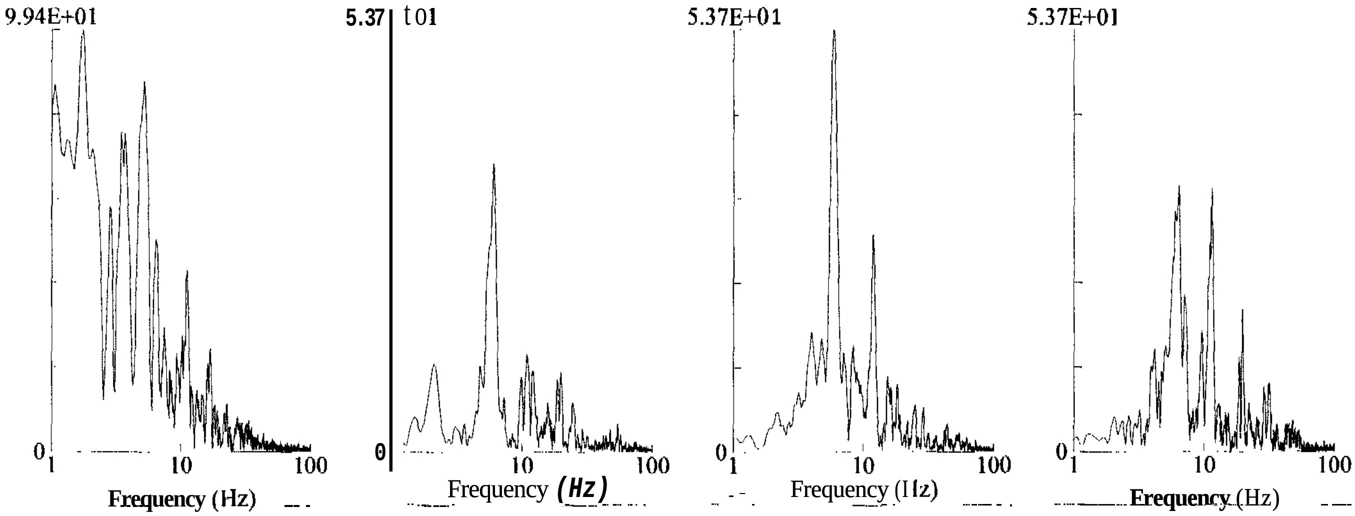
Time ***Lines*** *at:* 1.00 sec **intervals**

Acoustic (A)
1.75 Hz

Radial (R)
6.13 Hz

Vertical (V)
5.88 Hz

Transverse (T)
6.38 Hz



Banks Well

File: 00804032.DTB Event Number: 032 Date: 11/13/2000 Time: 16:04
Acoustic Trigger: 126dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

Acoustic (A): **100** dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)

Radial ***(R):*** **0.03in/s 0.762mm/s @ 24.3Hz**

Vertical (V): 0.015in/s ***0.38***1mm/s @ 0.0Hz

Transverse (T): 0.025in/s **0.635mm/s** @ 18.2Hz

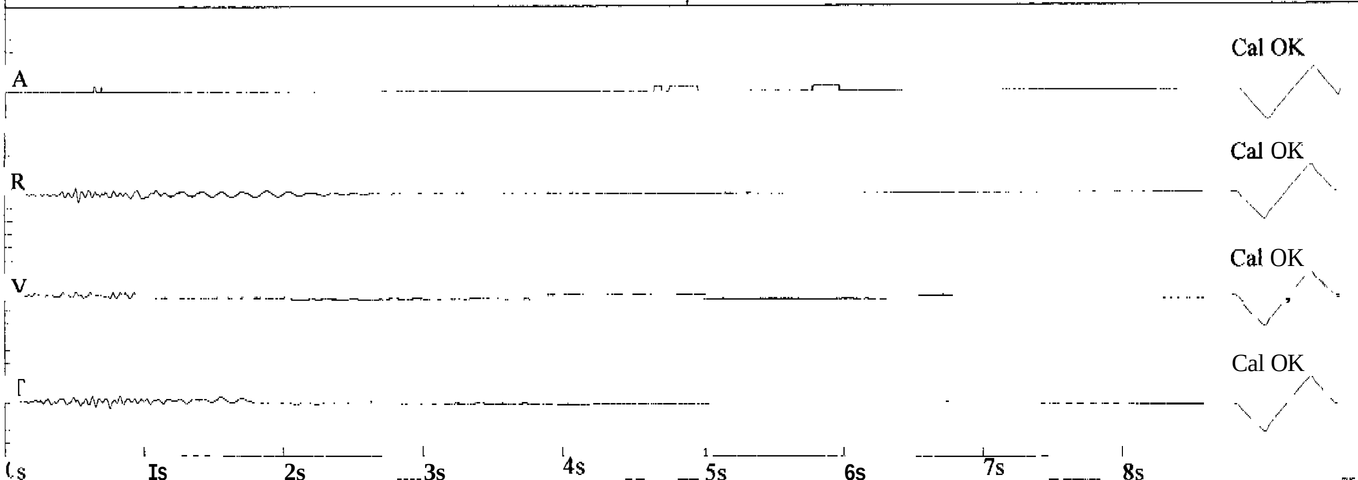
Graph Information

Duration: **0.000** sec To: 8.500 sec

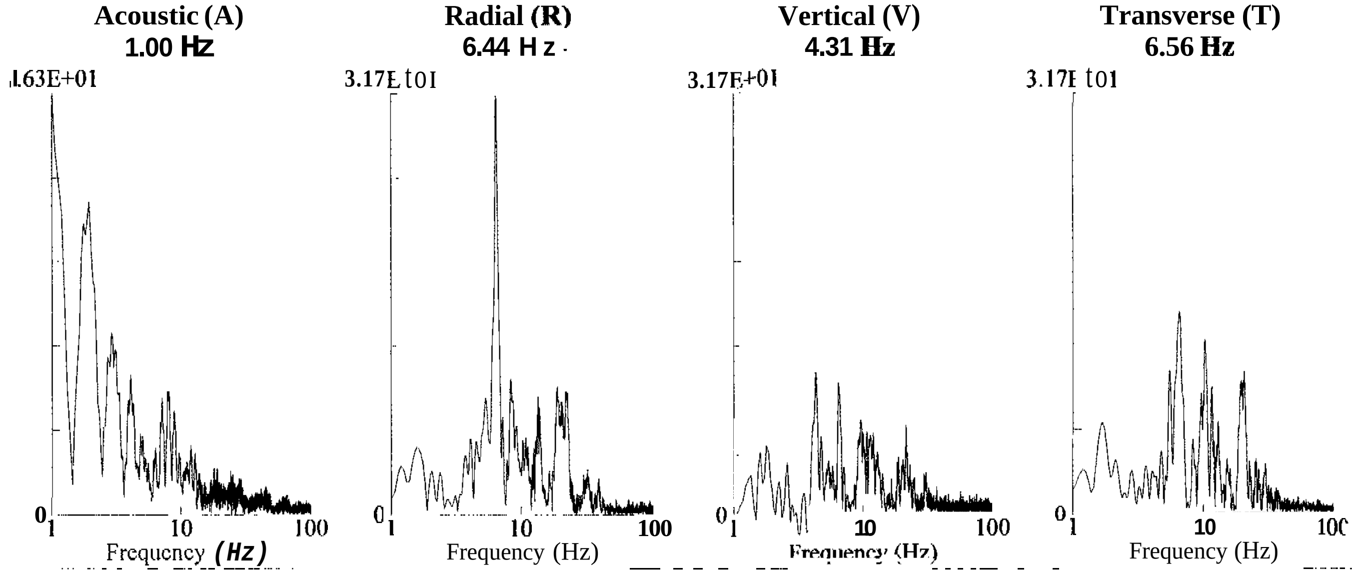
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

Amplitudes and Frequencies

Acoustic (A): **106** dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

Radial (R): 0.02in/s 0.508mm/s @ 8.3Hz

Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz

***Transverse (T):* 0.025in/s 0.635mm/s @ 13.4Hz**

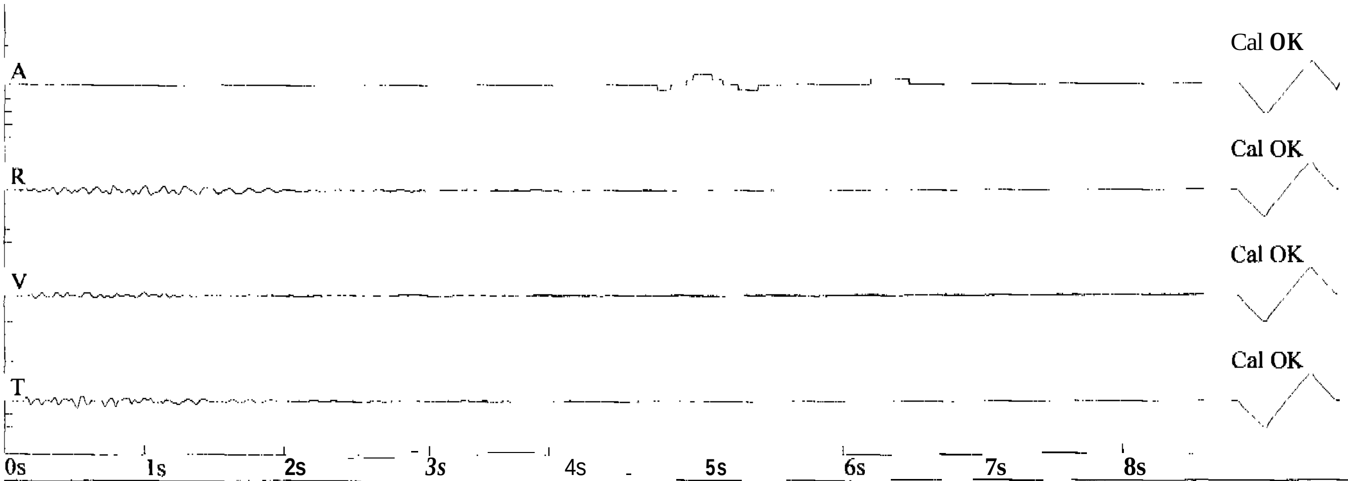
Graph Information

Duration: 0.000 **sec** To: 8.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

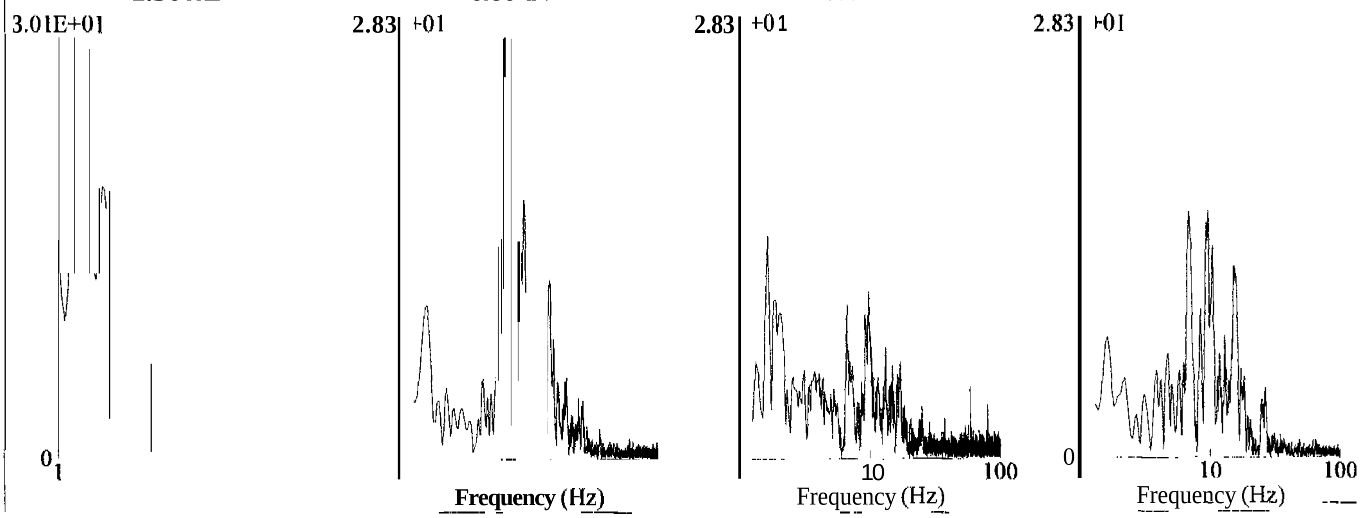
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.50 *Hi*	*6.50* Hz	1.63 Hz	9.56 Hz



Banks Well
3.5 ft. deep

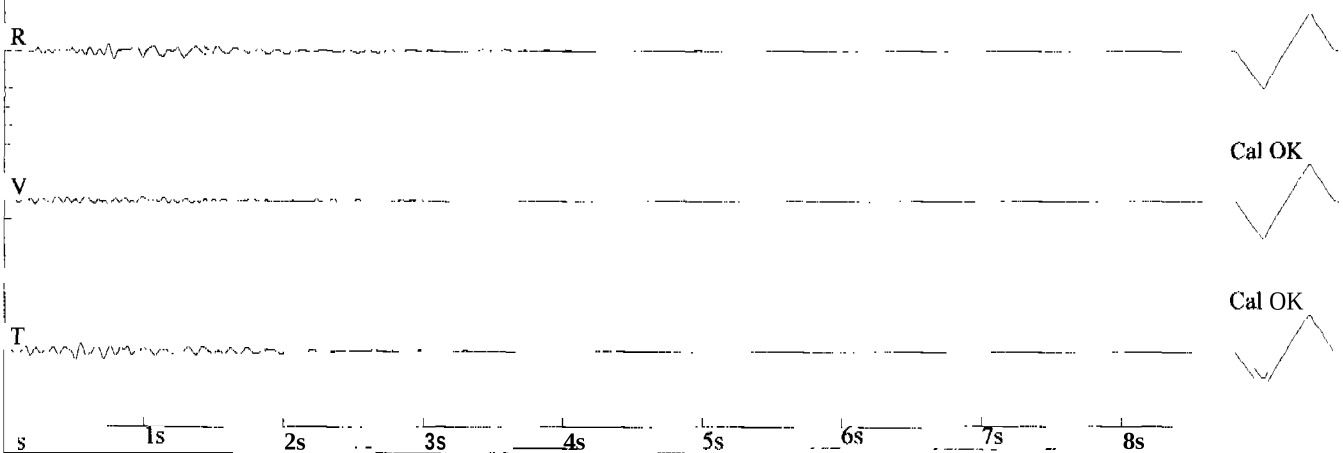
File: 00809081.DTB **Event Number: 081** **Date:** 11/14/2000 Time: **15:**15
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 809

Amplitudes and Frequencies

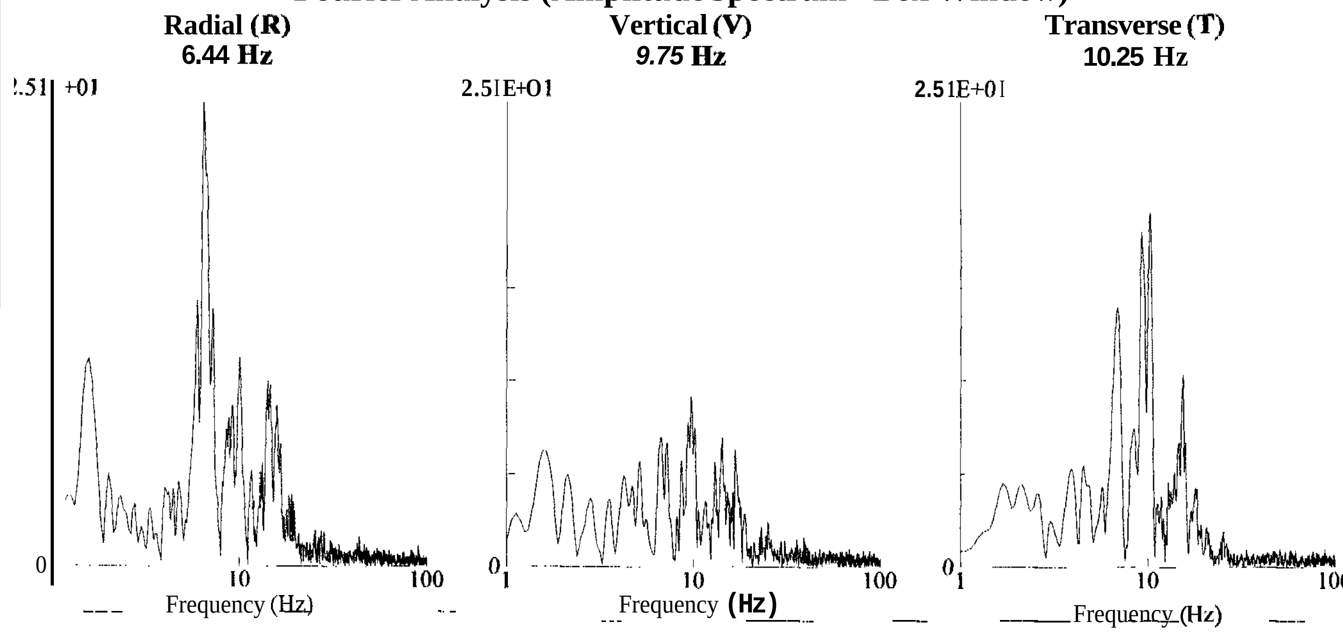
Radial (R):**0.02in/s 0.508mm/s @ 16.0Hz**
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): **0.02in/s 0.508mm/s @ 14.2Hz**

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: **1.00 sec intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well
(no depth)

File: 00804042.DTB   Event Number: 042   Date: 1 1/15/2000   Time: 11:49
Acoustic Trigger: 126 dB   Seismic Trigger: 0.02in/s 0.508mm/s   Serial Number: 804

Amplitudes and Frequencies

Acoustic (A): 112 dB @ 2.1 Hz
(0.08Mb 0.0012psi 0.0080kPa)

Radial (R): **0.055in/s 1.397mm/s @ 20.4Hz**

Vertical *(V)*: 0.025in/s 0.635mm/s @ 11.9Hz

Transverse *(T)*: 0.025in/s 0.635mm/s @ 7.0Hz

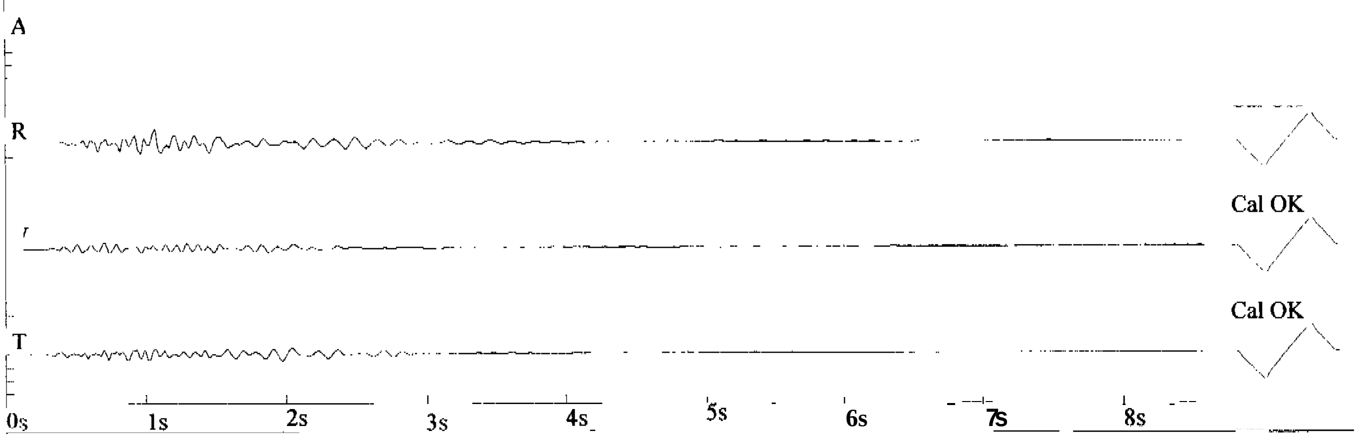
Graph Information

Duration: 0.000 sec **To:** *8.500* sec

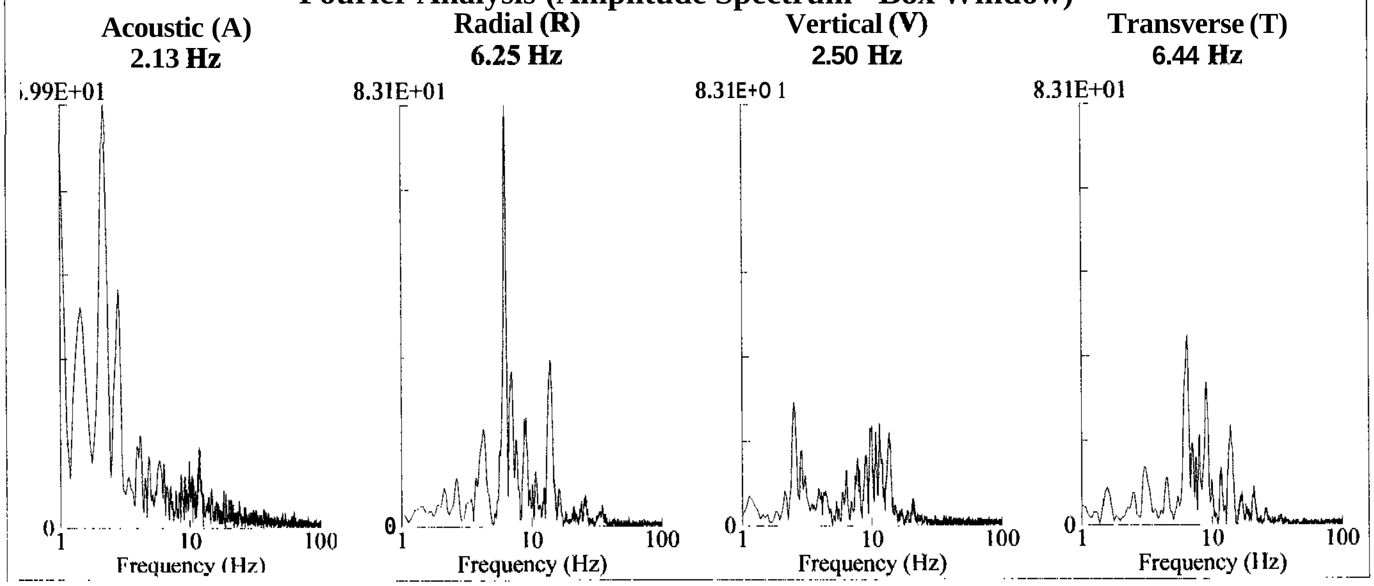
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: *1.00* sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

File: 00804045.DTB Event Number: 045 Date: 11/16/2000 Time: 09:07
Acoustic Trigger: 106dB Seismic Trigger: 0.02in/s 0.508mm/s **Serial Number: 804**

Amplitudes and Frequencies

Acoustic (A): **106** dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

***Radial (R):* 0.02in/s 0.508mm/s @ 10.6Hz**

Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz

***Transverse (T):* 0.02in/s 0.508mm/s @ 16.0Hz**

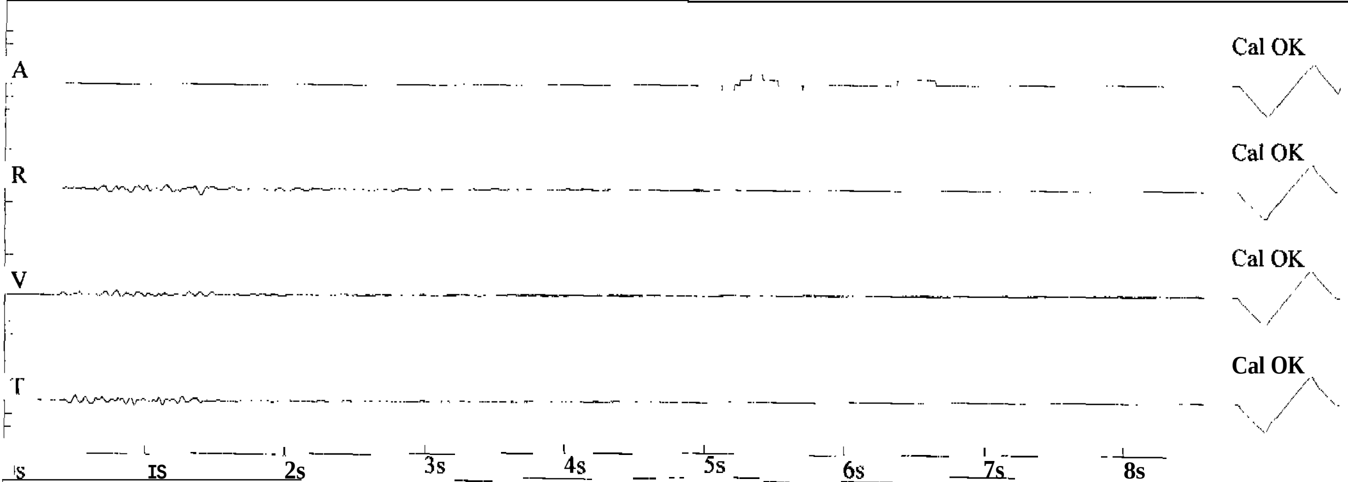
Graph Information

Duration: 0.000 sec To: 8.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec **intervals**

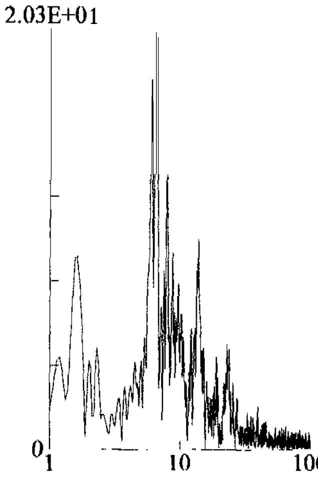


Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)
1.00 Hz

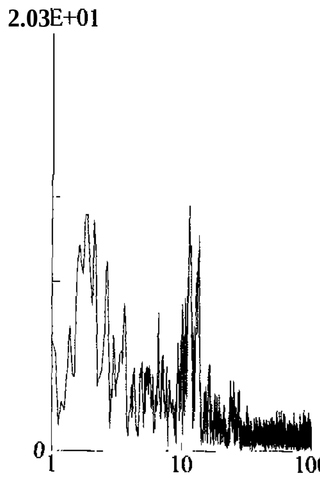
Frequency (Hz)

Radial (R)
6.44 Hz



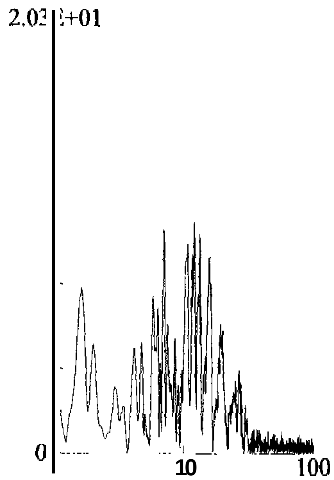
Frequency (Hz)

Vertical (V)
11.38 Hz



Frequency (Hz)

Transverse (T)
11.88 Hz

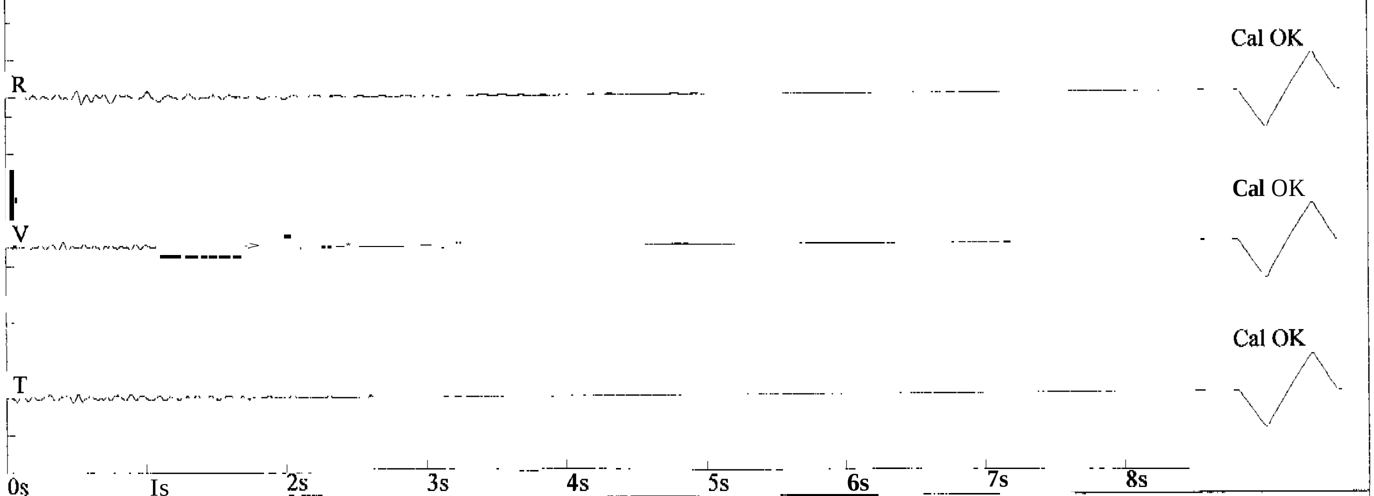


Frequency (Hz)

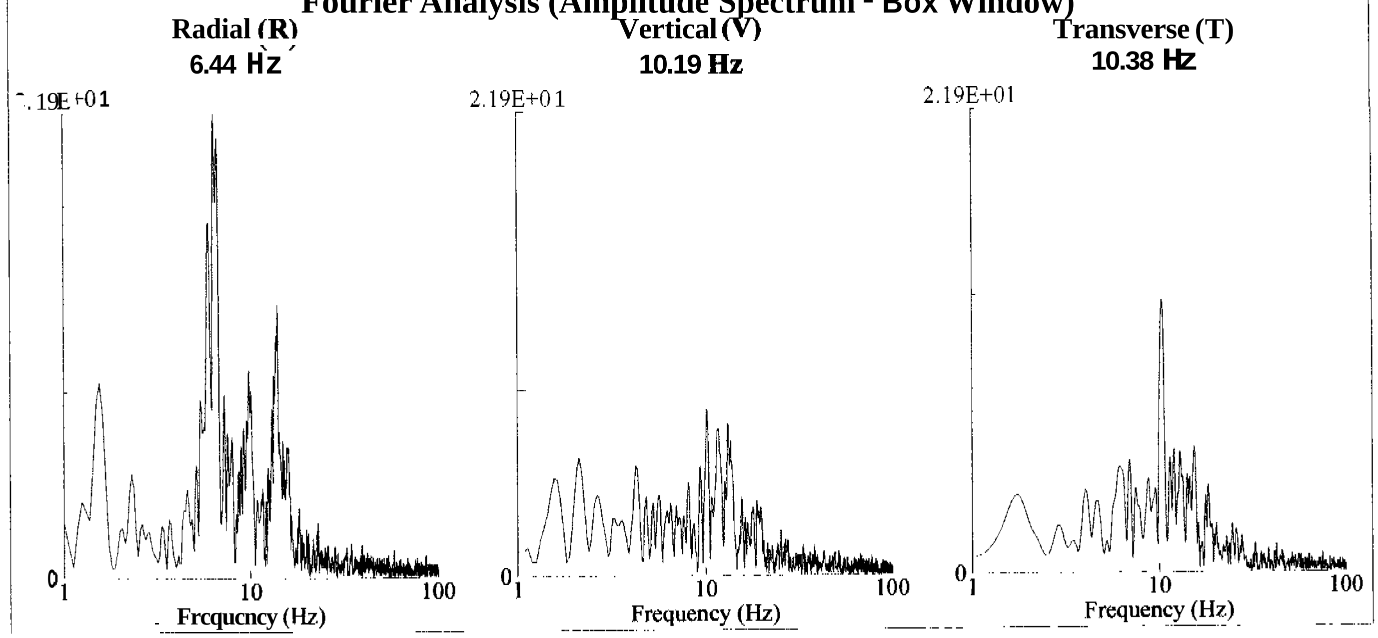
Banks Well—
3.5 ft. deep

File: 00809083.DTB Event Number: 083 Date: 11/16/2000 Time: 09:06
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies	Graph Information
***Radial (R):*0.02in/s 0.508mm/s @ 14.2Hz**	*Duration;* 0.000 sec To: **8.500** sec
Vertical (V): 0.01ids 0.254mm/s @ 0.0Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz	*Time Lines* at; 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

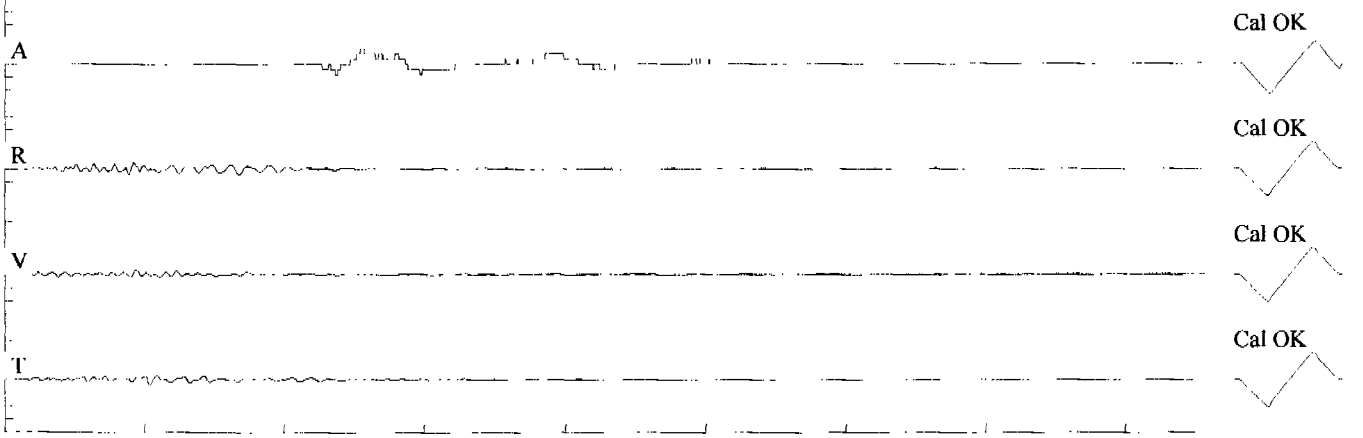
File: 00804048.DTB   Event Number: **048**   Date: 11/16/2000   Time: 16:00
Acoustic Trigger: 106 dB   Seismic Trigger: 0.02in/s 0.508mm/s   Serial Number: **804**

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 0.0 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 10.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 11.6Hz
Transverse (T): 0.02in/s 0.508mm/s @ 13.8Hz

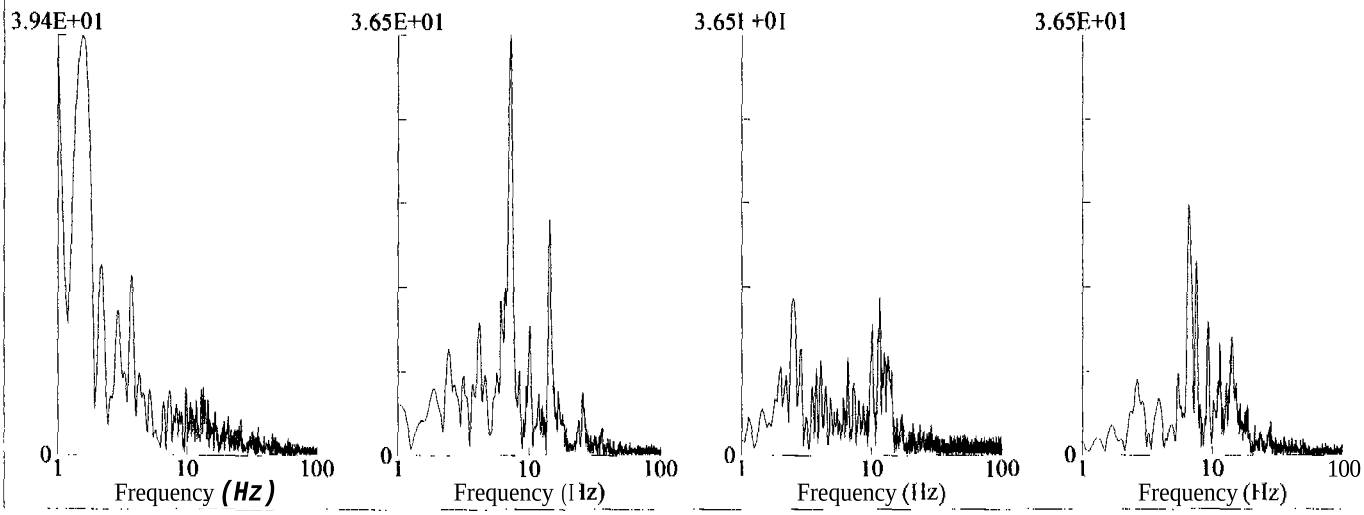
Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.56 Hz	7.25 Hz	12.56 Hz	6.56 Hz



Banks Well

File: 00809084.DTB Event Number: 084 Date: 11/16/2000 Time: 15:59
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

***R'adial(R):* 0.02in/s 0.508mm/s @ 15.0Hz**

'ertical (V): 0.015in/s 0.381mm/s @ 0.0Hz

***'ransverse (T):* 0.02in/s 0.508mm/s @ 14.2Hz**

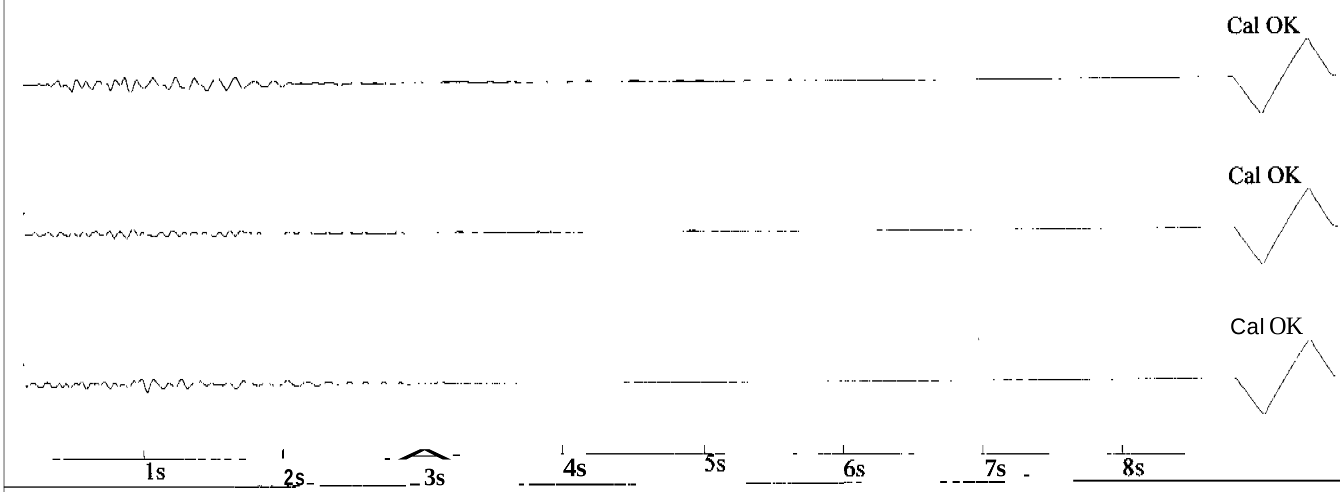
Graph Information

Duration: 0.000 sec To: 8.500 sec

Seismic Scale:

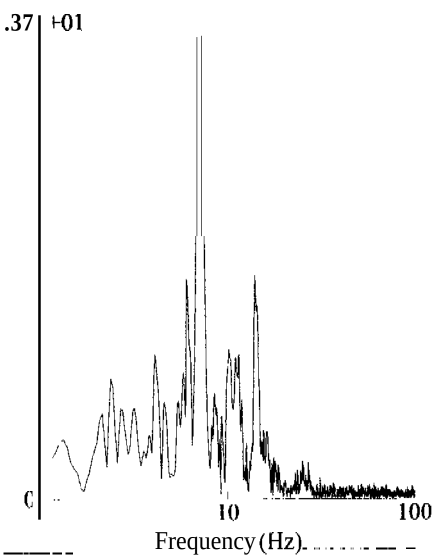
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals

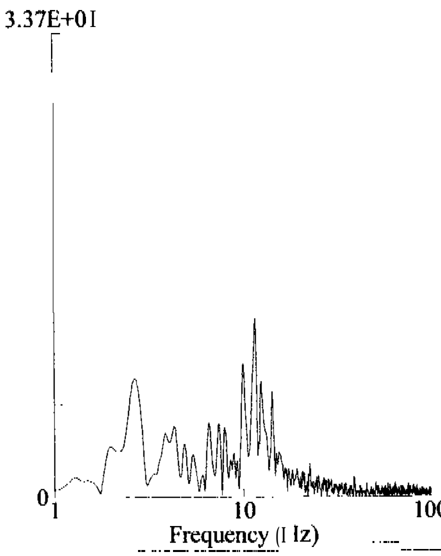


Fourier Analysis (Amplitude Spectrum - Box Window)

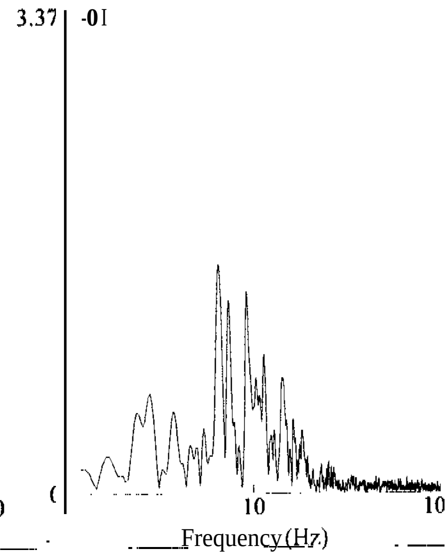
Radial (R)
7.19 Hz



Vertical (V)
11.56 Hz



Transverse (T)
6.56 Hz



Banks Well

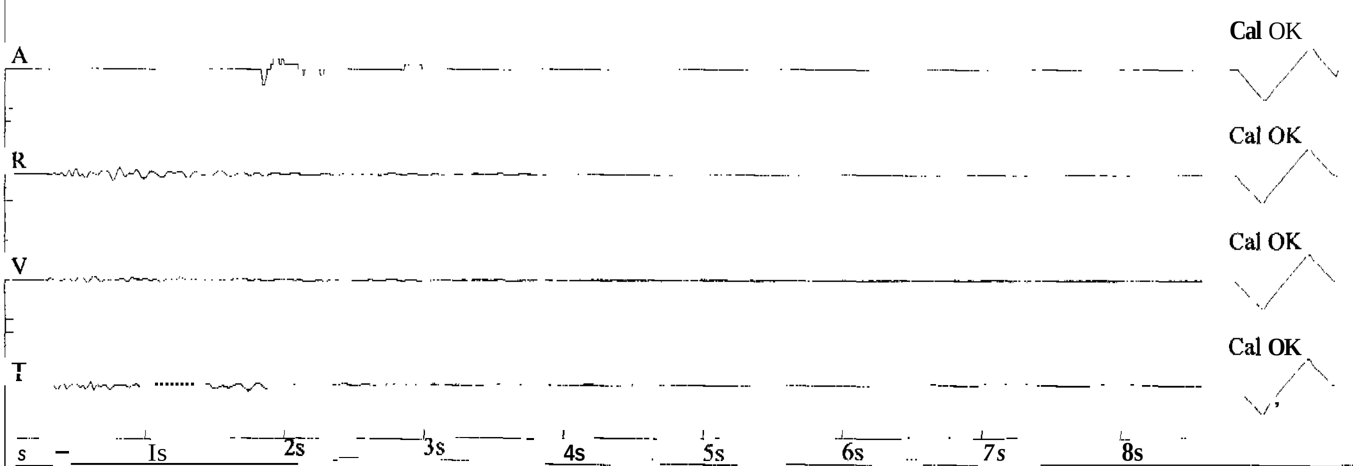
File: 00804056.DTB Event Number: 056 Date: 11/17/2000 Time: 12:15
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 0.0 Hz
(0.06Mb 0.0009psi 0.0060kPa)
***Radial (R):* 0.025in/s 0.635mm/s @ 12.1Hz**
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse *(T):* 0.015in/s 0.381mm/s @ 0.0Hz

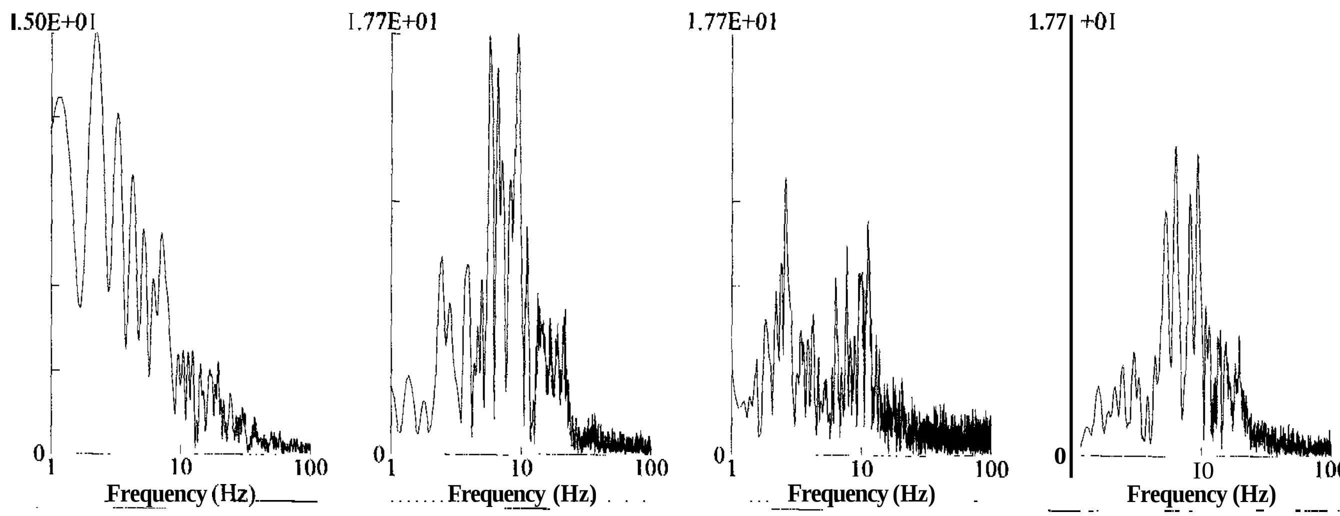
Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

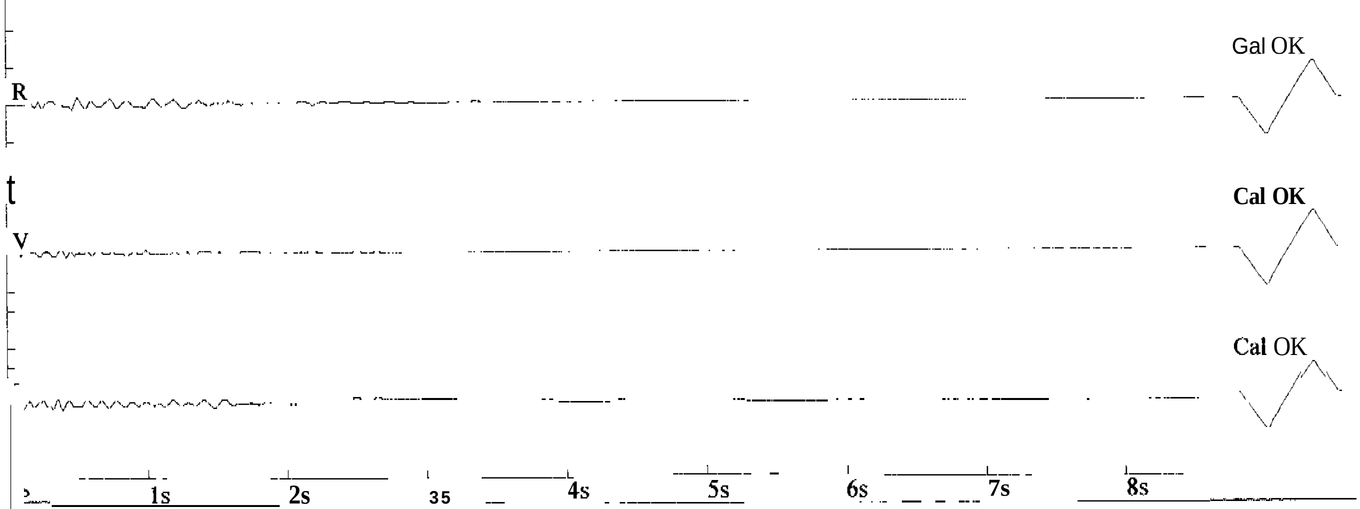
Acoustic (A) 2.25 Hz | Radial (R) 9.44 Hz | Vertical (V) 2.63 Hz | Transverse (T) 6.31 Hz



Banks Well
3.5 ft. deep

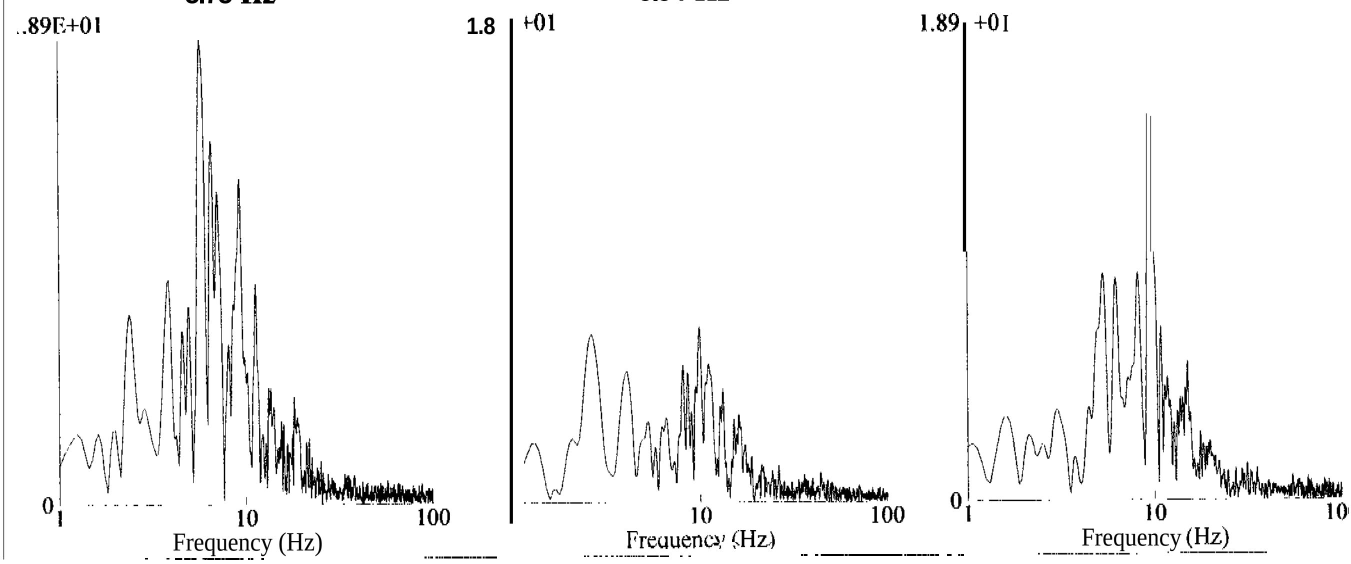
File: 00809085.DTB   Event Number: 085   Date: 11/17/2000   Time: 12:14
Acoustic Trigger: 142 dB   **Seismic Trigger: 0.02in/s 0.508mm/s**   **Serial Number: 809**

Amplitudes and Frequencies	**Graph Tnformation**
Radial (R): **0.02in/s 0.508mm/s @ 11.6Hz**	***Duration:*** 0.000 sec To: **8.500** sec
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz	***Seismic*** Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz	**Time *Lines at:*** 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R) **5.75 Hz**   **Vertical (V)** **9.94 Hz**   **Transverse (T)** ***9.50*** **Hz**



Banks Well

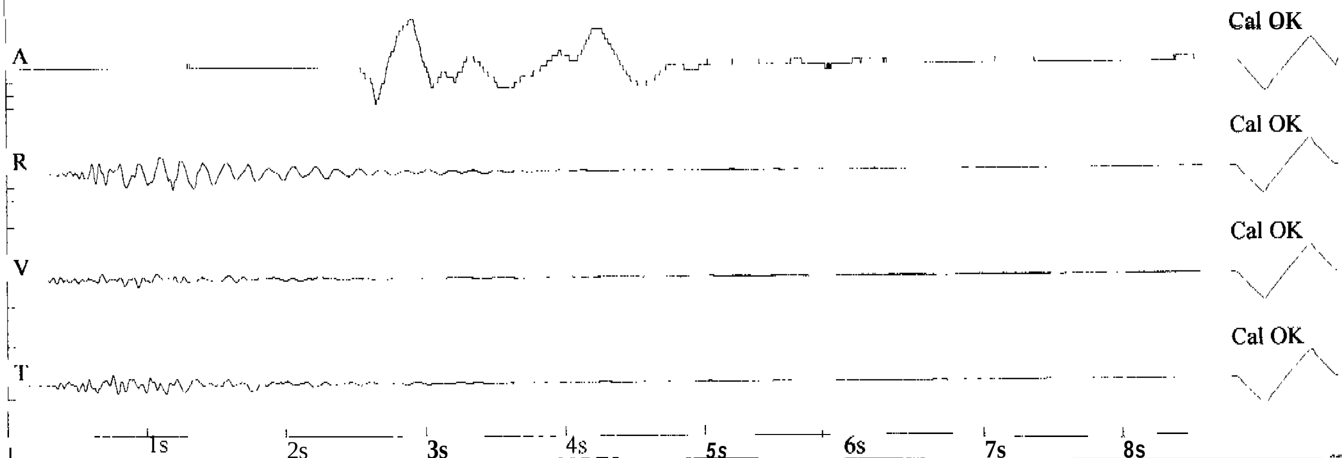
File: **00804058.DTB** Event Number: 058 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 106 **dB** Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 804

Amplitudes and Frequencies

Acoustic (A): 120 dB @ 2.0 Hz
(0.20Mb 0.0029psi 0.0200kPa)
Radial (R): **0.065in/s 1.651mm/s @ 6.0Hz**
Vertical (V): 0.025in/s 0.635mm/s @ 12.4Hz
Transverse *(T):* 0.04in/s **1.016mm/s** @ 15.0Hz

Graph Information

Duration: **0.000sec** To: ***8.500*** **sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time **Lines** at: 1.00 sec intervals

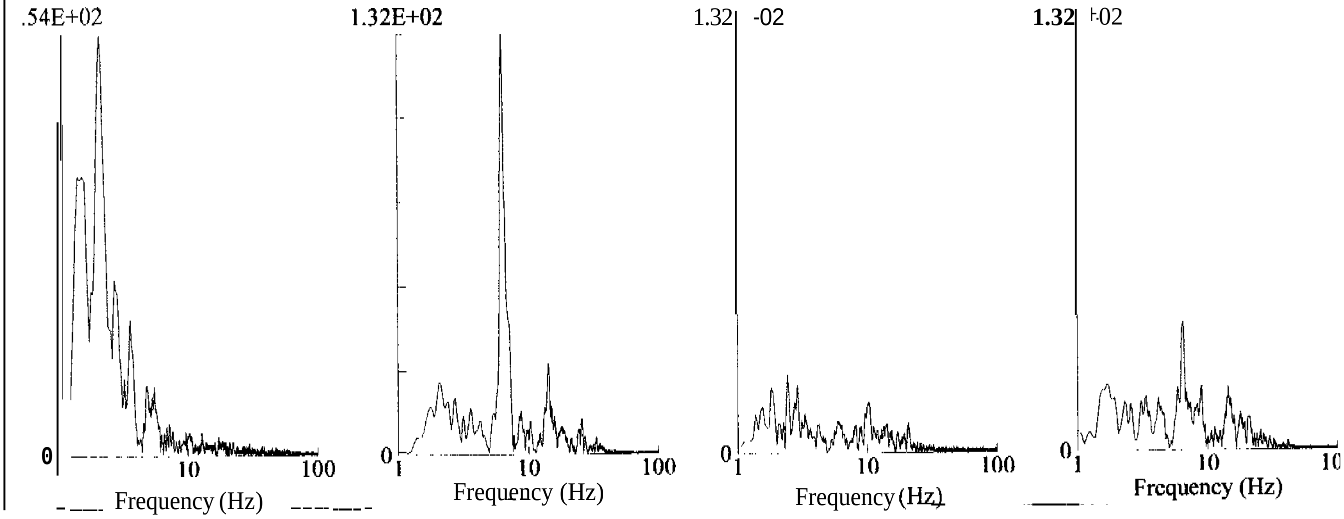


Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)
2.13 Hz

Radial (R)
6.31 Hz

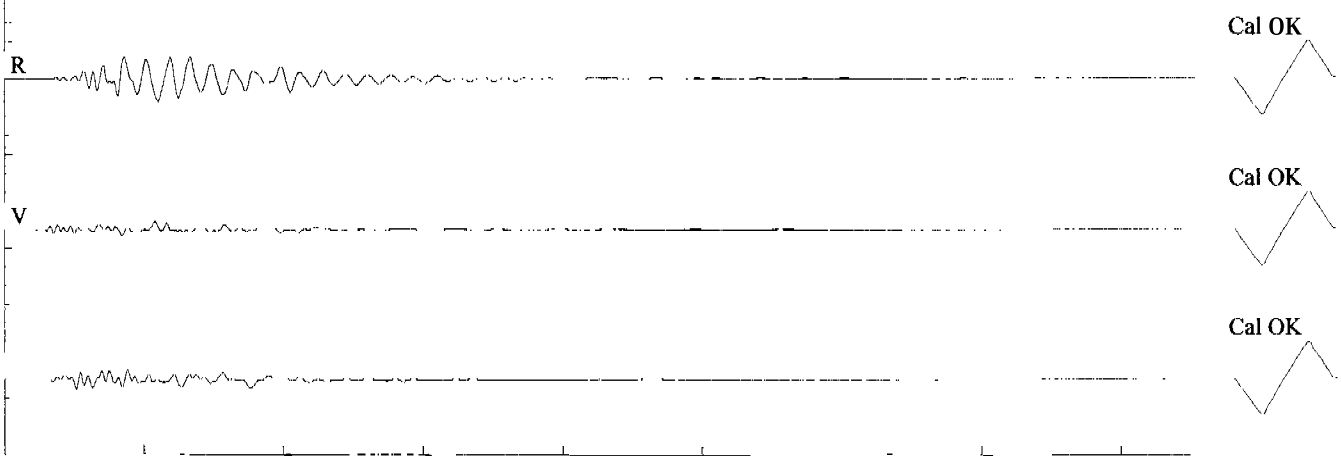
Transverse (T)
6.50 Hz



Banks Well
3.5 ft. deep

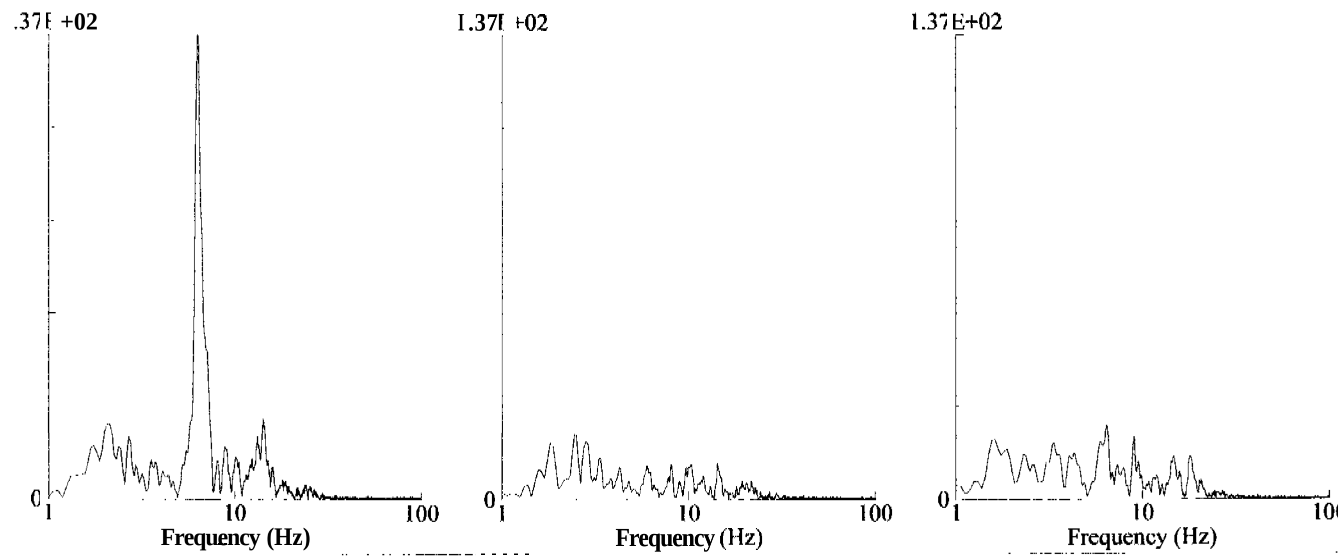
File: 00809086.DTB Event **Number:** 086 **Date:** 11/17/2000 Time: 12:33
Acoustic Trigger: 142 **dB** Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 809

Amplitudes and Frequencies	Graph Information
***radial (R):* 0.06in/s 1.524mm/s @ 7.1Hz**	***Duration:*** 0.000 sec To: **8.500** sec
Vertical (V): 0.025in/s 0.635mm/s @ 8.8Hz	***Seismic Scale:***
Transverse (T): 0.03in/s 0.762mm/s @ 13.4Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

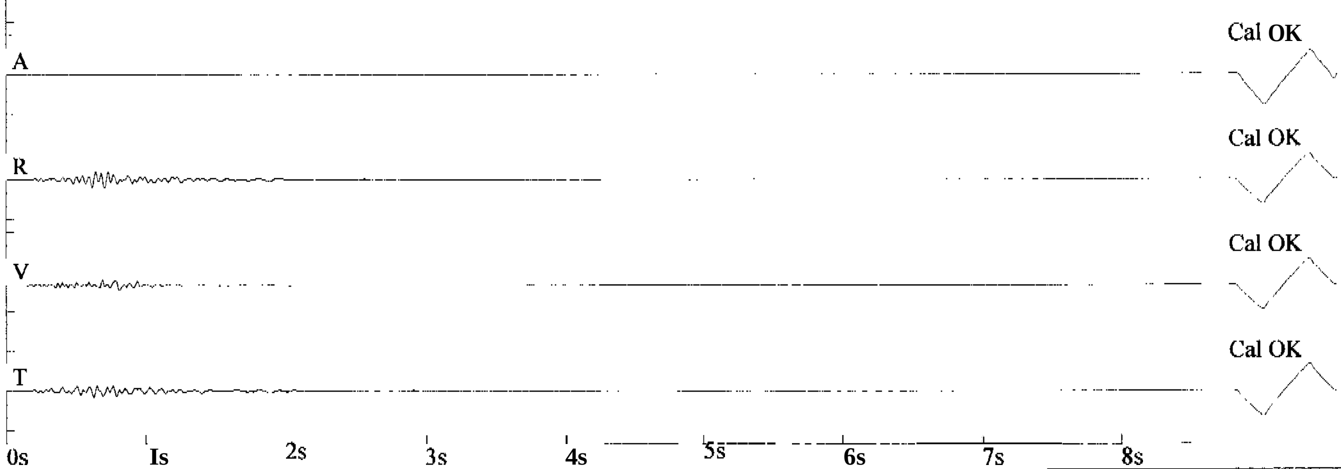
Radial (R) **6.38 Hz** **Vertical (V)** **2.44 Hz** **Transverse (T)** **6.44 Hz**



Ratliff Well
(surface - no airblast)

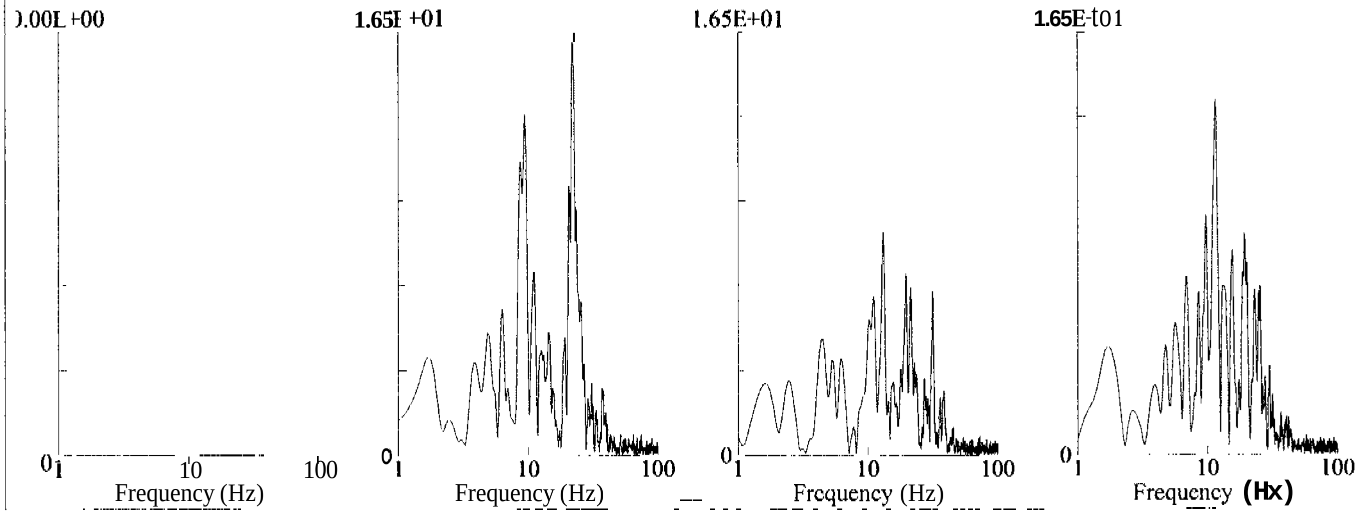
File: 00849025.DTB Event Number: 025 Date: 11/13/2000 Time: 16:04
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s **Serial Number: 849**

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): <100 dB	*Duration: 0.000* sec To: 8.500 sec
***Radial (R):* 0.03in/s 0.762mm/s @ 21.3Hz**	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 26.9Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.025in/s 0.635mm/s @ 20.4Hz	***Time** Lines at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

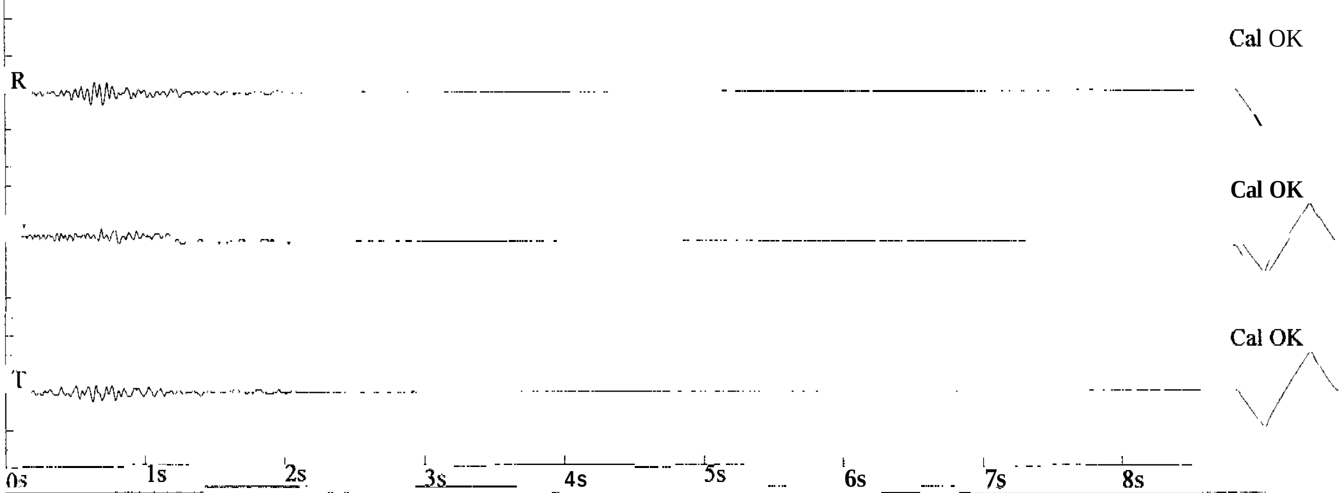
Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
0.00 Hz	**21.94 Hz**	**13.13 Hz**	**11.56 Hz**



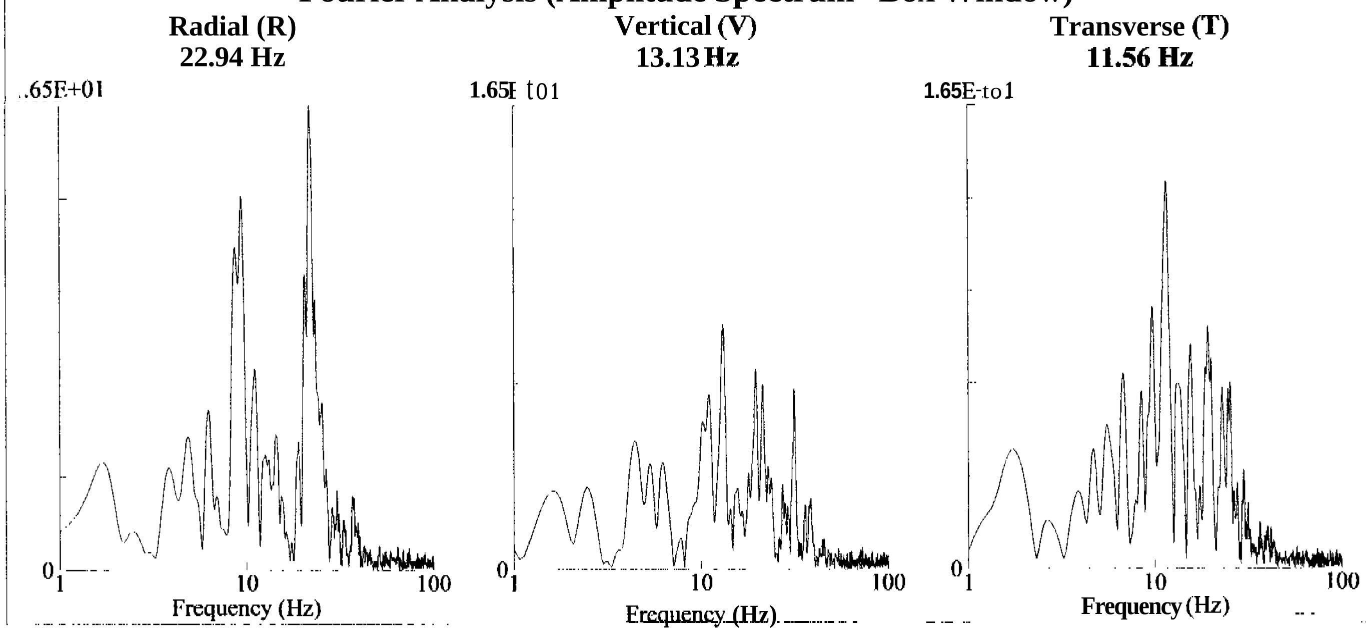
Ratliff Well
29 in. deep

File: 00849025.DTB **Event Number:** 025 **Date:** 11/13/2000 **Time:** 16:04
Acoustic Trigger: 126 dB **Seismic Trigger:** 0.02in/s 0.508mm/s **Serial Number:** 849

Amplitudes and Frequencies	Graph Information
Radial (R): **0.03in/s 0.762mm/s @ 21.3Hz**	*Duration:* 0.000 sec To: **8.500** sec
Vertical (V): 0.02in/s 0.508mm/s @ 26.9Hz	*Seismic Scale:*
Transverse (T): 0.025in/s 0.635mm/s @ 20.4Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

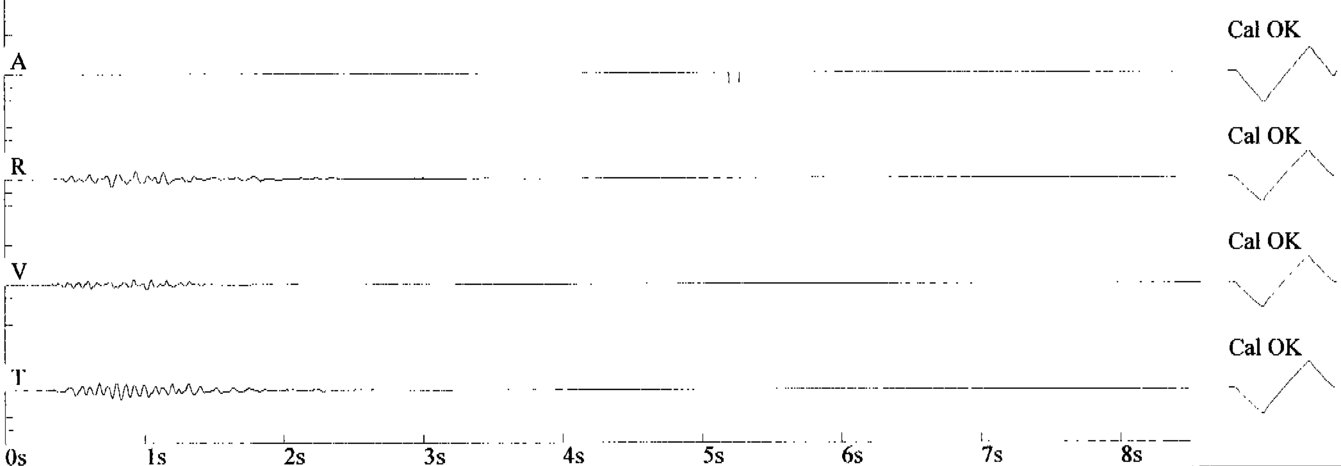
File: 00849026.DTB Event Number: 026 Date: 11/14/2000 Time: 16:18
Acoustic Trigger: 126dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 849

Amplitudes and Frequencies

Acoustic (A): **106** dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.03in/s **0.762mm/s** @ 13.1Hz
Vertical *(V):* 0.02in/s 0.508mm/s @ 19.6Hz
***Transverse (T):* 0.035in/s 0.889mm/s @ 16.0Hz**

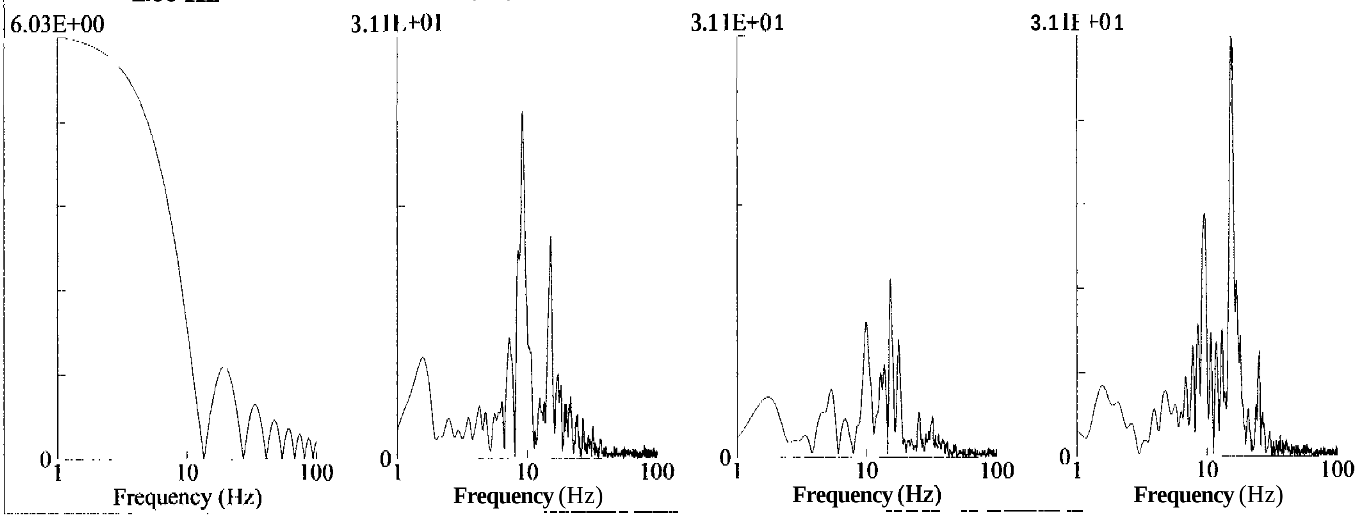
Graph Information

Duration: **0.000** sec To: **8.500** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

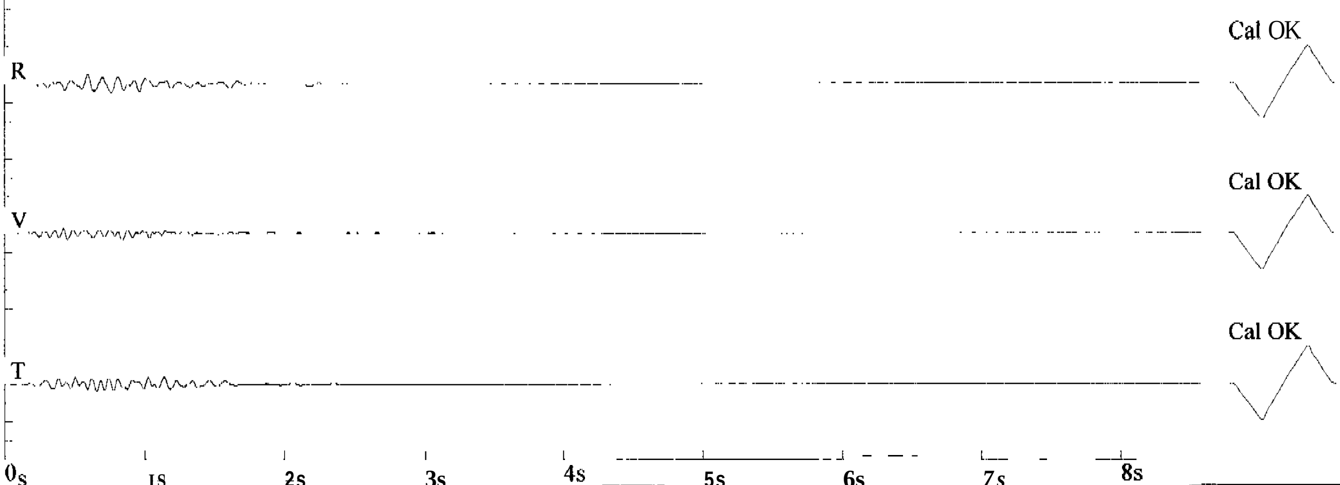
Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	***9.25*** **Hz**	**15.19 Hz**	**15.38 Hz**



Ratliff Well
29 in. deep

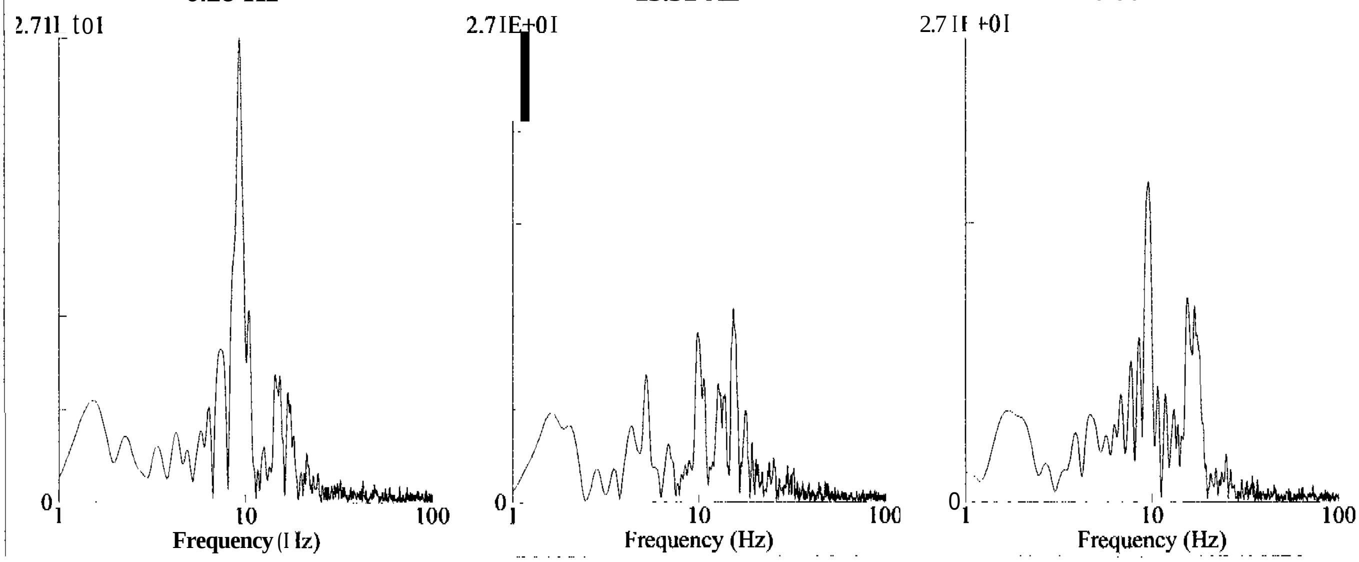
File: 00853078.DTB Event Number: 078 Date: 11/14/2000 Time: 16:18
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies	Graph Information
***Radial (R):* 0.025in/s 0.635mm/s @ 12.8Hz**	***Duration:*** 0.000 sec To: 8.500 sec
Vertical (V): 0.015in/s 0.381mm/s @ 14.6Hz	***Seismic*** Scale:
Transverse (T): 0.02in/s 0.508mm/s @ 16.0Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box. Window)

Radial (R)	Vertical (V)	Transverse (T)
9.25 Hz	15.31 Hz	*9.56* Hz



Ratliff Well

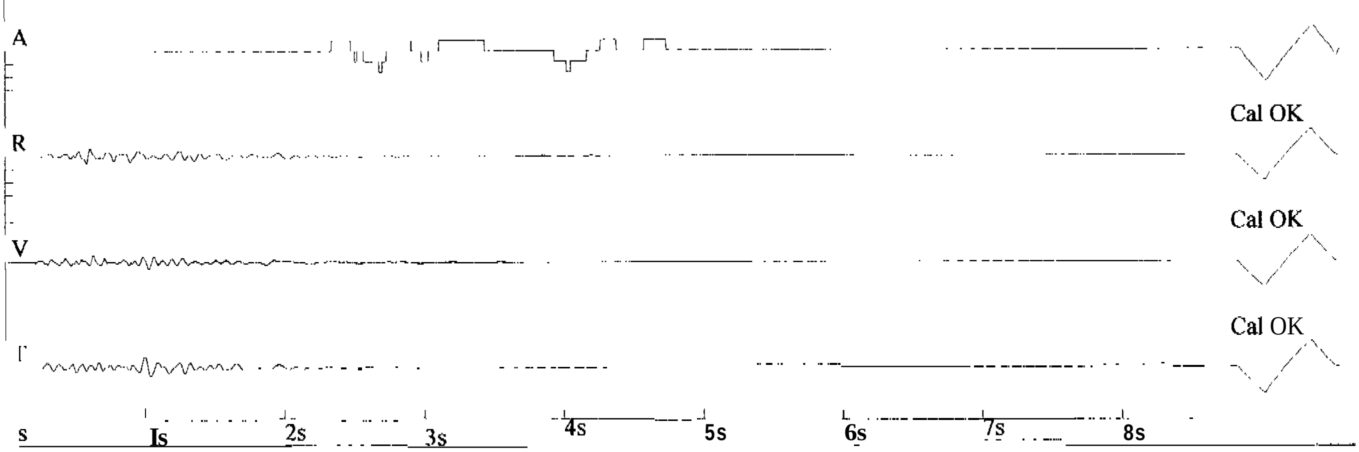
File: 00849027.DTB   Event Number: 027   Date: I 1/I 5/2000   Time: 11:49
Acoustic Trigger: 126 dB   Seismic Trigger: 0.02in/s 0.508mm/s   Serial Number: 849

Amplitudes and Frequencies

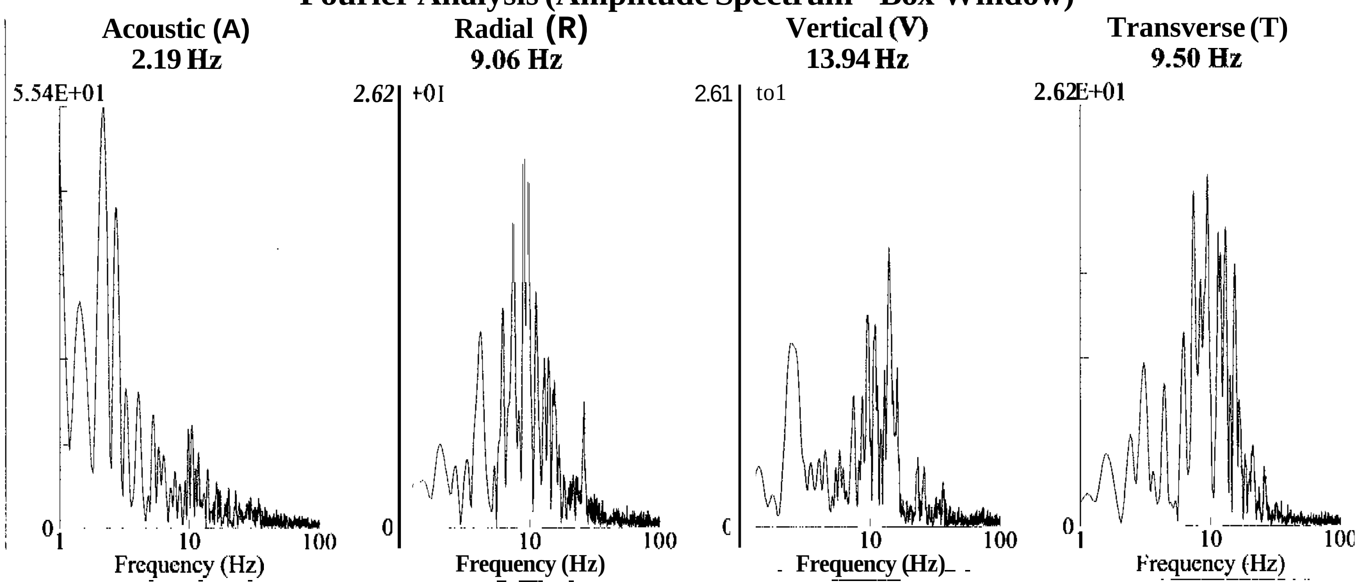
Acoustic (A): 112 dB @ 0.0 Hz
(0.08Mb **0.001**2psi 0.0080kPa)
Radial (R): 0.03in/s 0.762mm/s @ 12.1Hz
vertical (V): 0.025in/s 0.635mm/s @ 15.5Hz
***Transverse (T):* 0.04in/s 1.016mm/s @ 11.9Hz**

Graph Information

Duration: 0.000 sec **To: 8.500** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

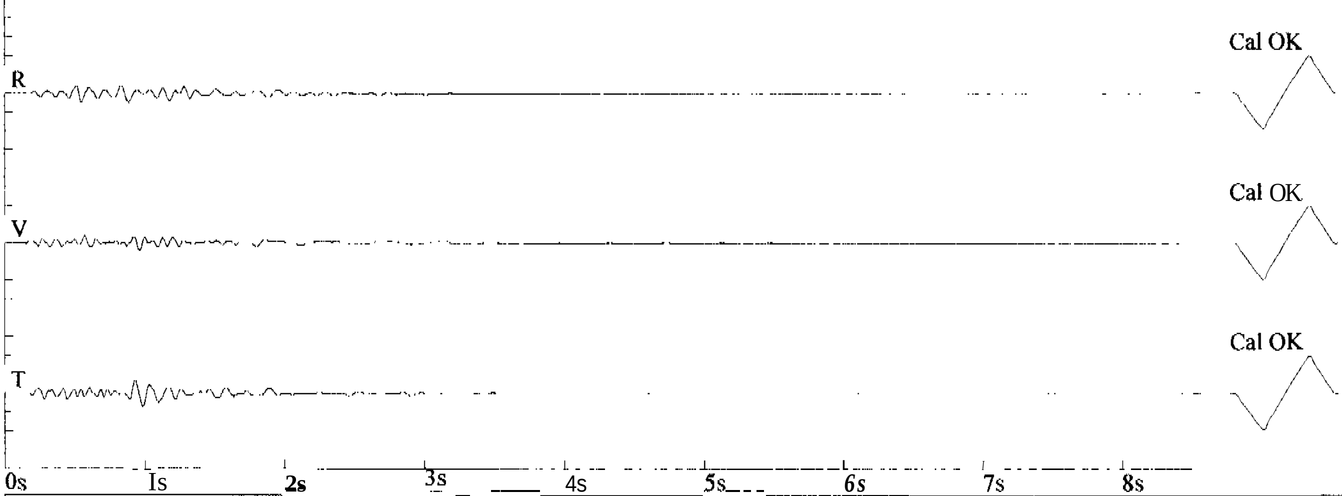
File: 00853079.DTB Event Number: 079 Date: 11/15/2000 **Time:** 11:48
Acoustic Trigger: 142 dB **Seismic Trigger:** 0.02in/s 0.508mm/s **Serial** Number: 853

Amplitudes and Frequencies

Radial (R): 0.025in/s 0.635mm/s @ 13.4Hz
Vertical (V): 0.02in/s 0.508mm/s @ 15.5Hz
***Transverse (T):* 0.035in/s 0.889mm/s @ 11.1Hz**

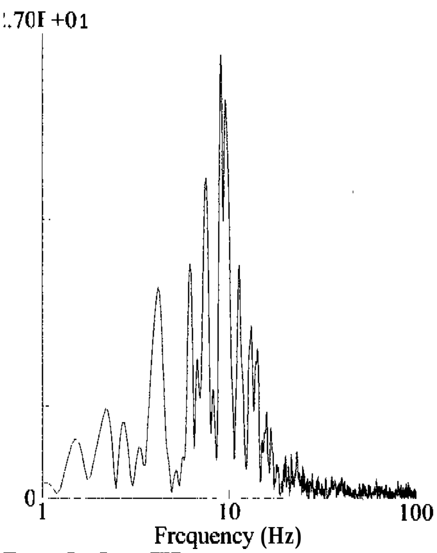
Graph Information

Duration: **0.000** sec To: **8.500** sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

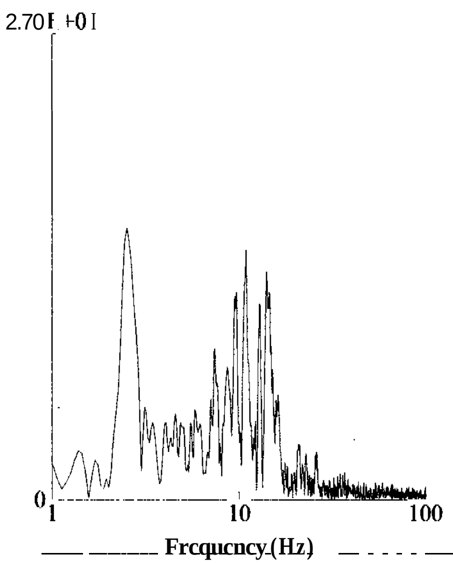


Fourier Analysis (Amplitude Spectrum - Box Window)

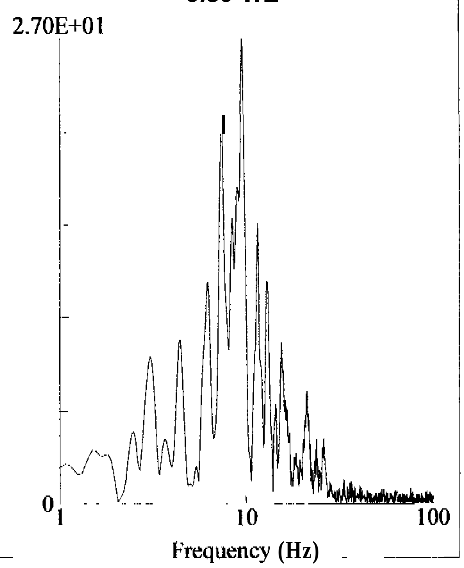
Radial (R)
9.06 Hz



Vertical (V)
2.50 Hz



Transverse (T)
***9.50* Hz**



Ratliff Well

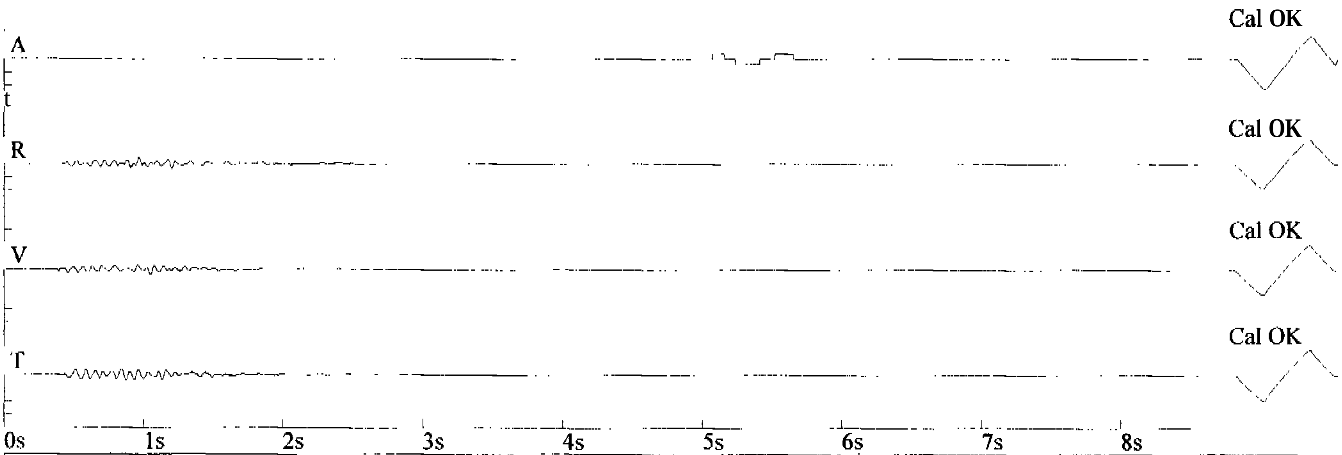
File: 00849028.DTB Event Number: 028 Date: 11/16/2000 Time: 09:07
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

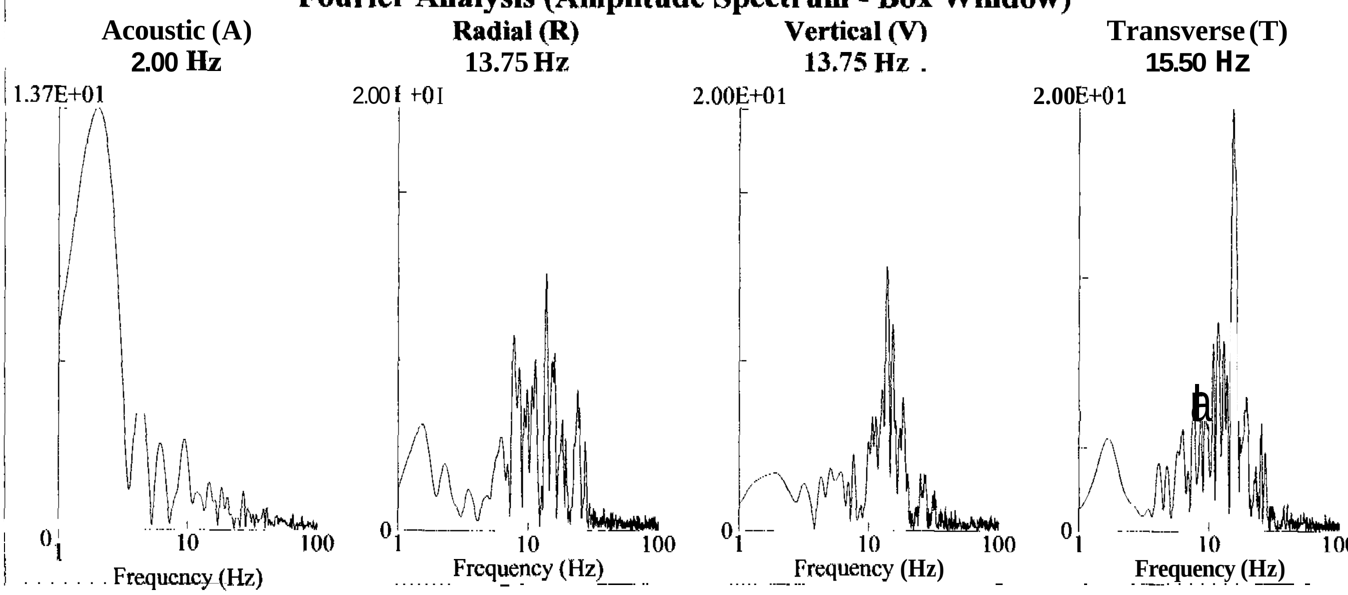
Acoustic (A): 100 dB @ 0.0Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): **0.025in/s 0.635mm/s @ 17.6Hz**
Vertical (V): 0.02in/s 0.508mm/s @ 19.6Hz
***Transverse (T):* 0.025in/s 0.635mm/s @ 18.2Hz**

Graph Information

Duration: 0.000 sec **To:** 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

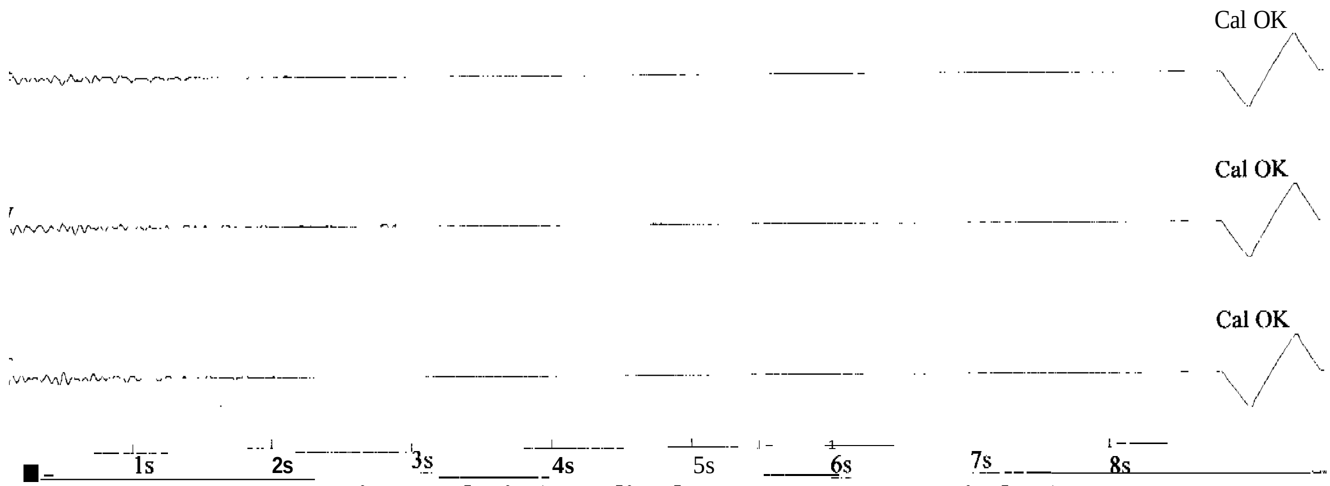


Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

Amplitudes and Frequencies	Graph Information
Radial (R): 0.015in/s 0.381mm/s @ 20.4Hz	***Duration:*** 0.000 sec To: 8.500 sec
Vertical (V): 0.015in/s 0.381mm/s @ 16.5Hz	Seismic *Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.02in/s 0.508mm/s @ 20.4Hz**	***Time Lines*** at: 1.00 sec intervals

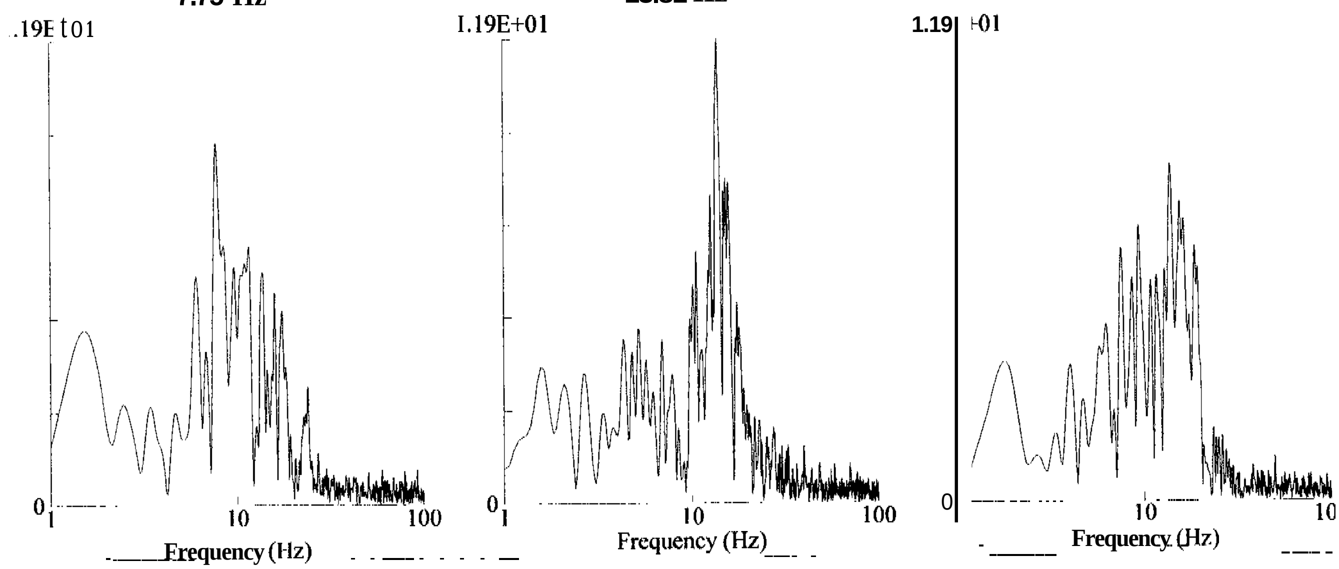


Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R) **7.75 Hz**

Vertical (V) **13.81 Hz**

Transverse (T) **13.88 Hz**



Ratliff Well

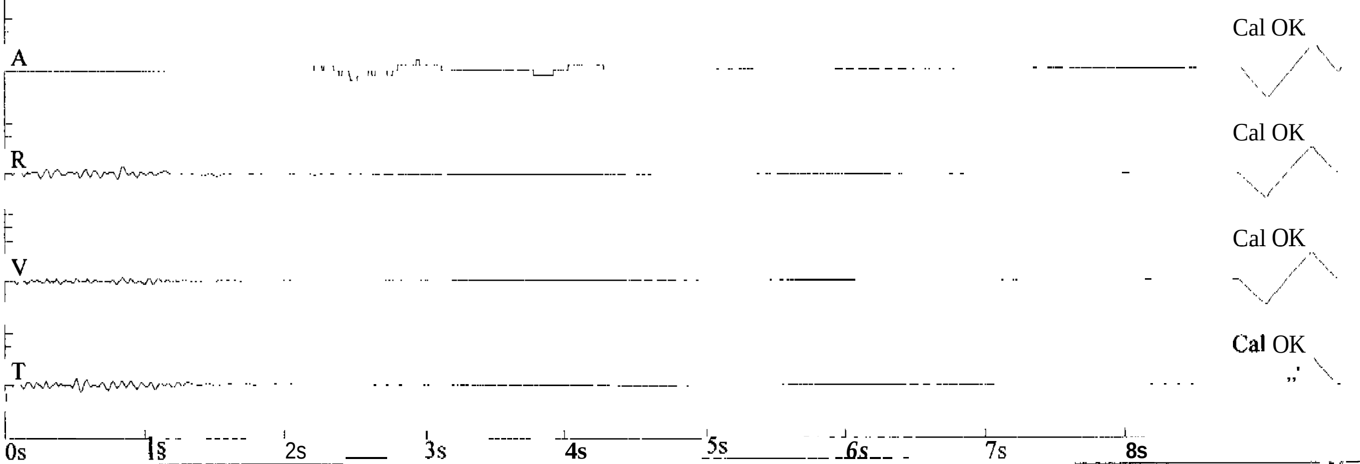
File: 00849029.DTB Event Number: 029 Date: 11/16/2000 Time: 16:00
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: **849**

Amplitudes and Frequencies

Acoustic (A): **106 dB @ 0.0 Hz**
(0.04Mb 0.0006psi 0.0040kPa)
***Radial (R):*0.025in/s 0.635mm/s @ 11.6Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 19.6Hz
Transverse ***(T):* 0.025in/s 0.635mm/s @ 17.0Hz**

Graph Information

Duration: 0.000 sec To: ***8.500*** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



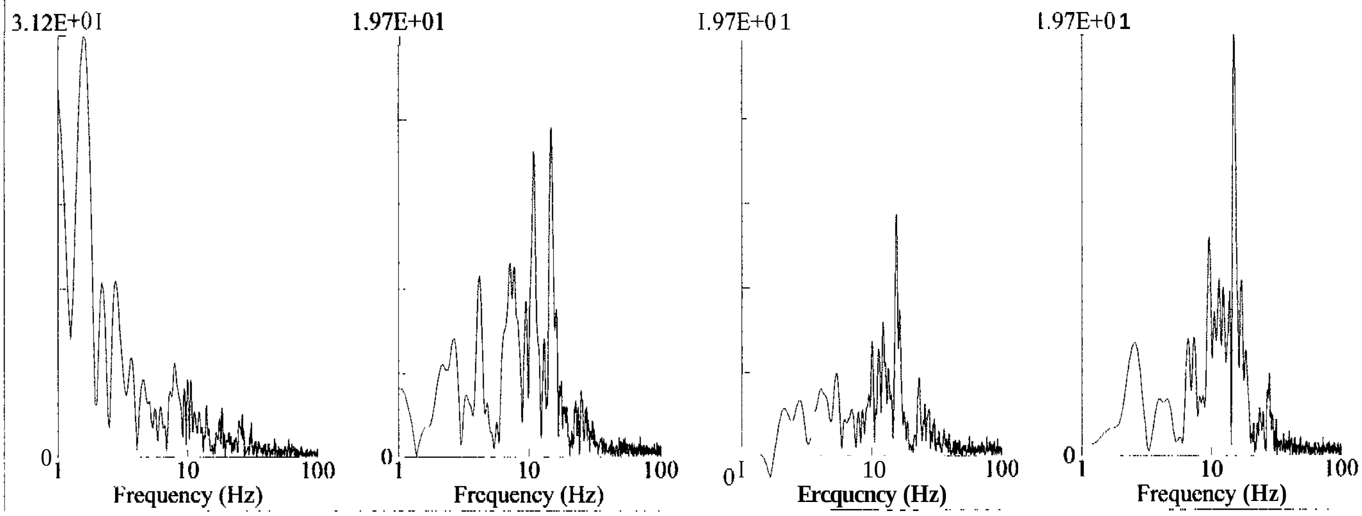
Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)
1.56 Hz

Radial (R)
14.88 Hz

Vertical (V)
15.44 Hz

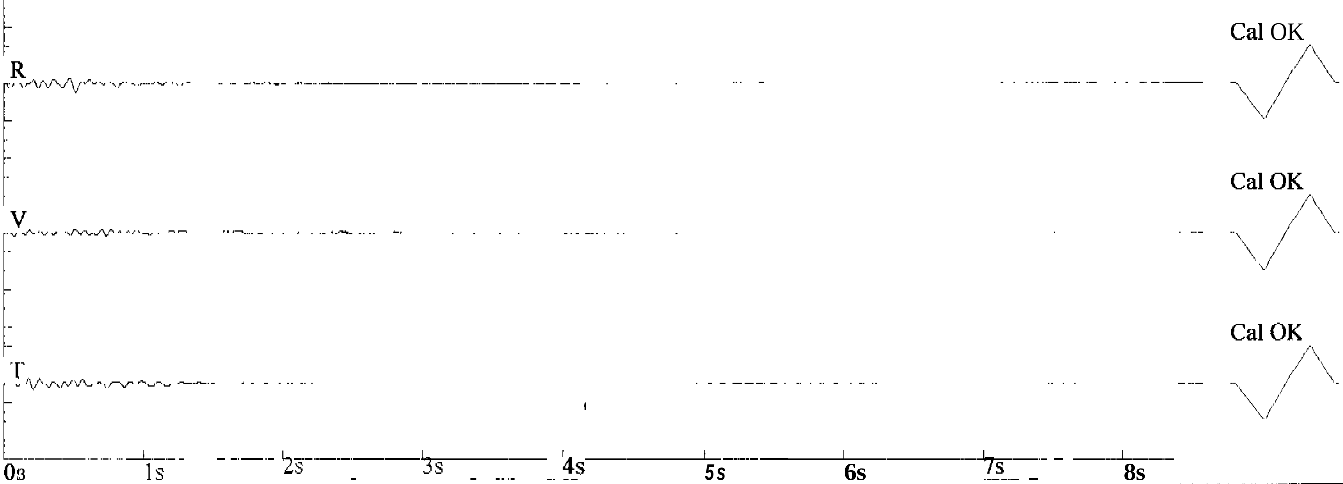
Transverse (T)
15.00 Hz



Ratliff Well

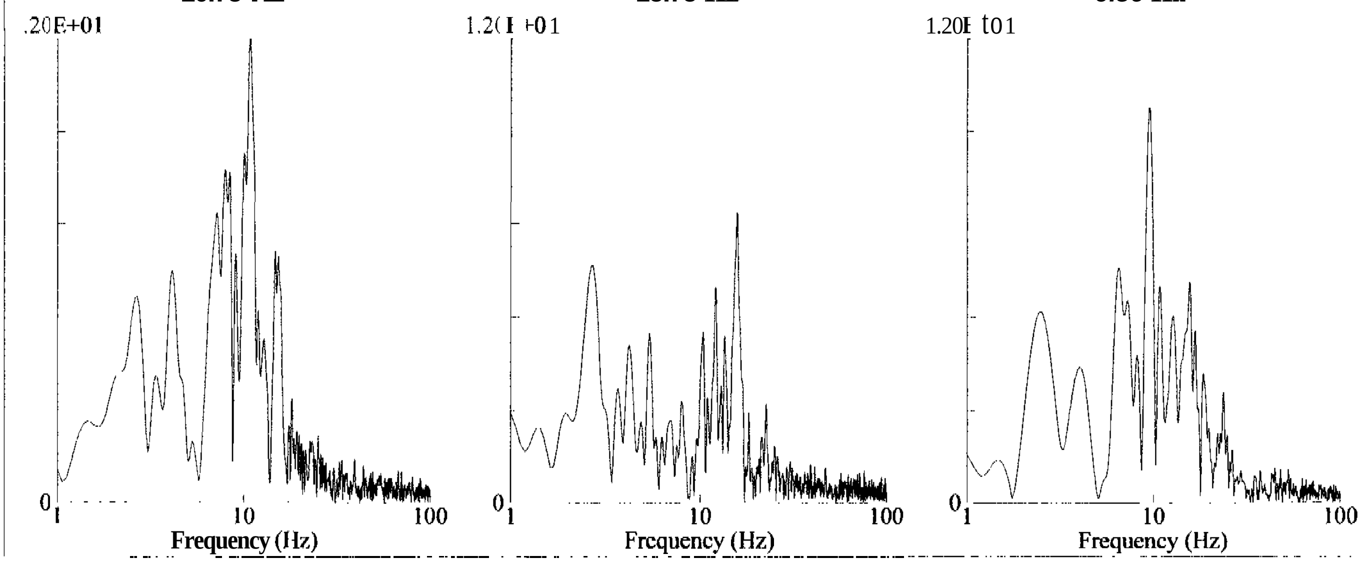
File: 00853081.DTB Event Number: 081 Date: 11/16/2000 **Time:** 15:59
Acoustic Trigger: 142 dB Seismic Trigger: **0.02in/s 0.508mm/s** Serial Number: 853

Amplitudes and Frequencies	Graph Information
***Radial (R):* 0.025in/s 0.635mm/s @ 11.1Hz**	***Duration:*** 0.000 sec To: 8.500 sec
Vertical (V): 0.01in/s 0.254mm/s @ 14.6Hz	***Seismic Scale:***
Transverse (T): 0.015in/s 0.381mm/s @ 17.0Hz	0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
	Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Radial (R) 10.75 Hz | **Vertical (V)** 15.75 Hz | **Transverse (T)** 9.56 Hz



Amplitudes and Frequencies

Acoustic (A): 110 dB @ 10.2 Hz
(0.06Mb 0.0009psi 0.0060kPa)

***Radiul (R):* 0.025in/s 0.635mm/s @ 20.4Hz**

Vertical (V): 0.02in/s **0.508mm/s** @ 20.4Hz

***Transverse** (T):* 0.02in/s 0.508mm/s @ 15.5Hz

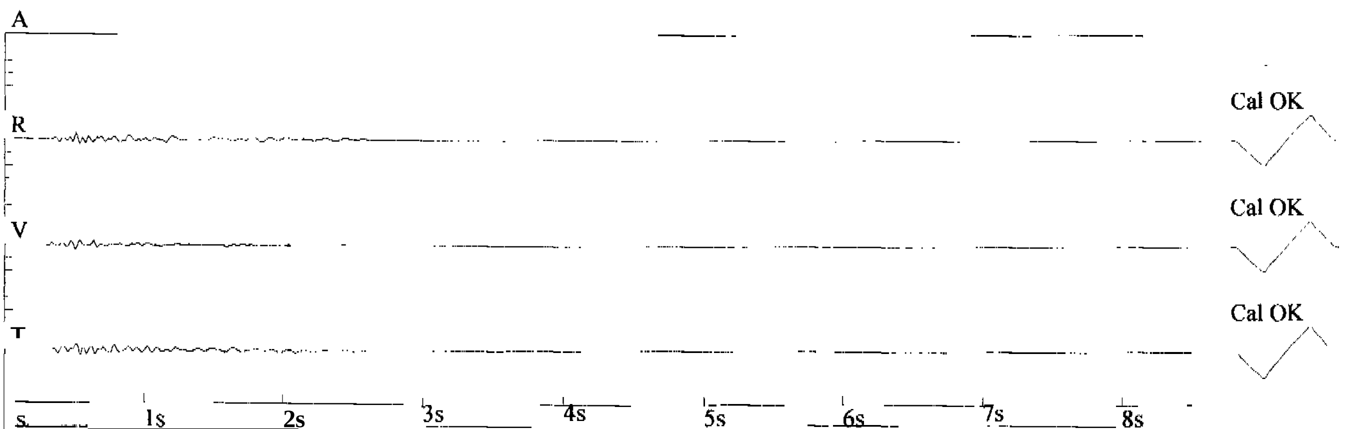
Graph Information

Duration: 0.000 sec To: 8.500 sec

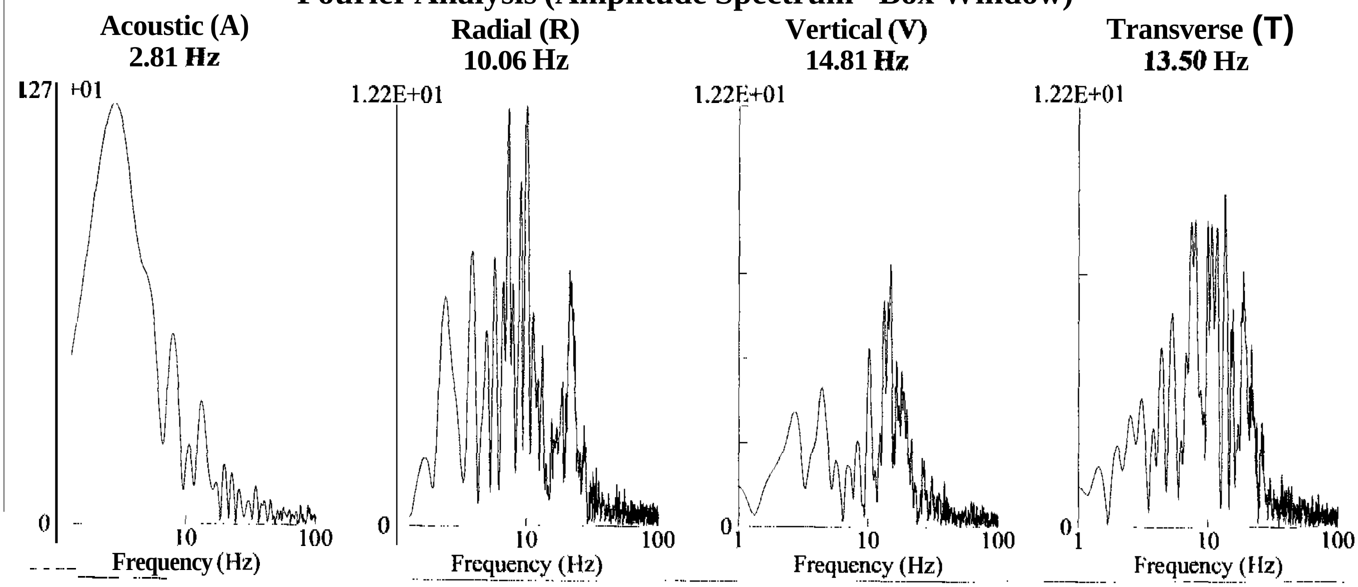
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)

***Time* Lines** at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well-
29 in. deep

File: 00853082.DTB Event Number: 082 Date: 11/17/2000 Time: 12:14
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 853

Amplitudes and Frequencies

Radial (R): 0.015in/s 0.381mm/s @ 22.2Hz

Vertical (V): 0.015in/s 0.381mm/s @ 15.5Hz

***Transverse (T):* 0.02in/s 0.508mm/s @ 15.0Hz**

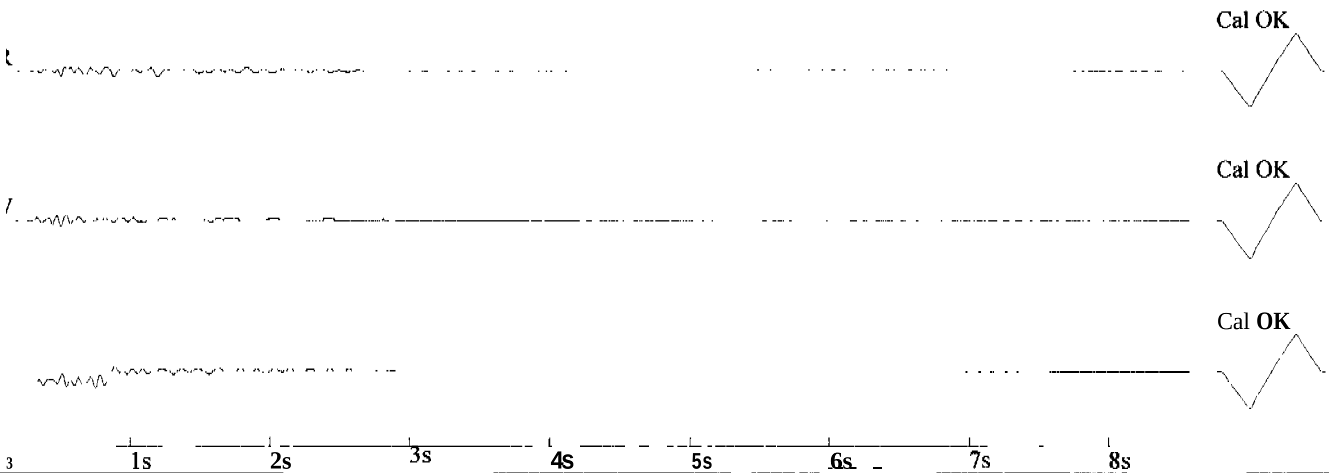
Graph Information

Duration: 0.000 sec To: 8.500 sec

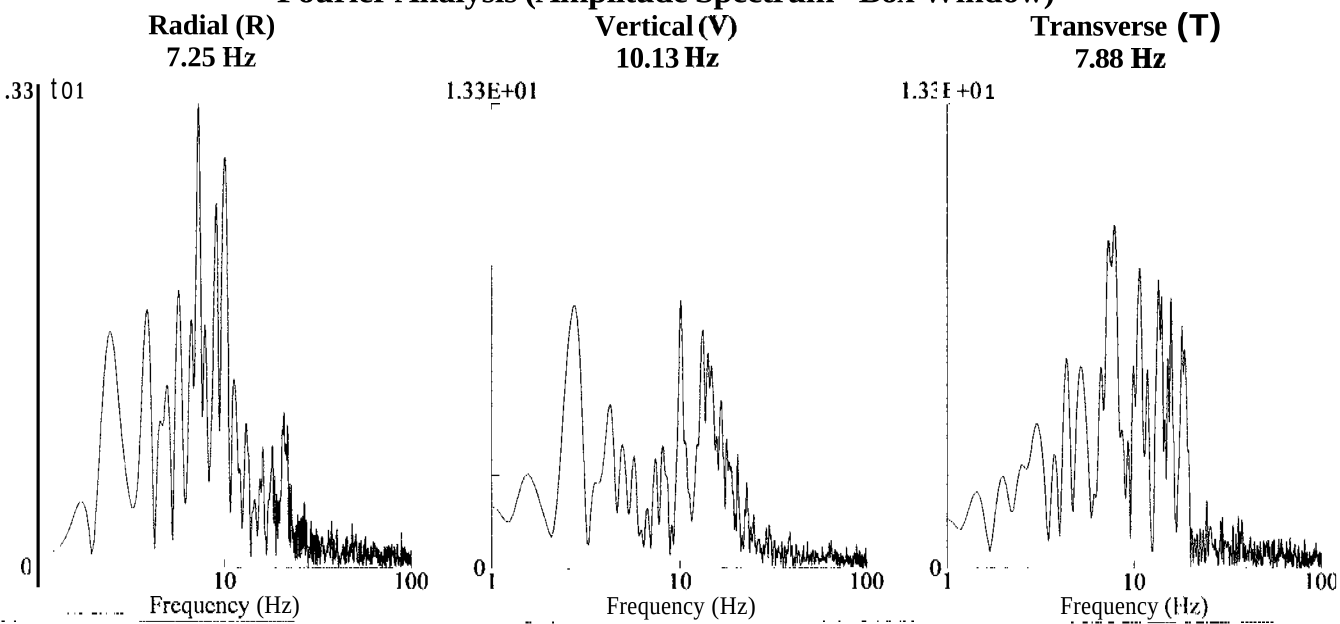
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (**1.270mm/s/div**)

Time Lines at: 1.00 sec intervals



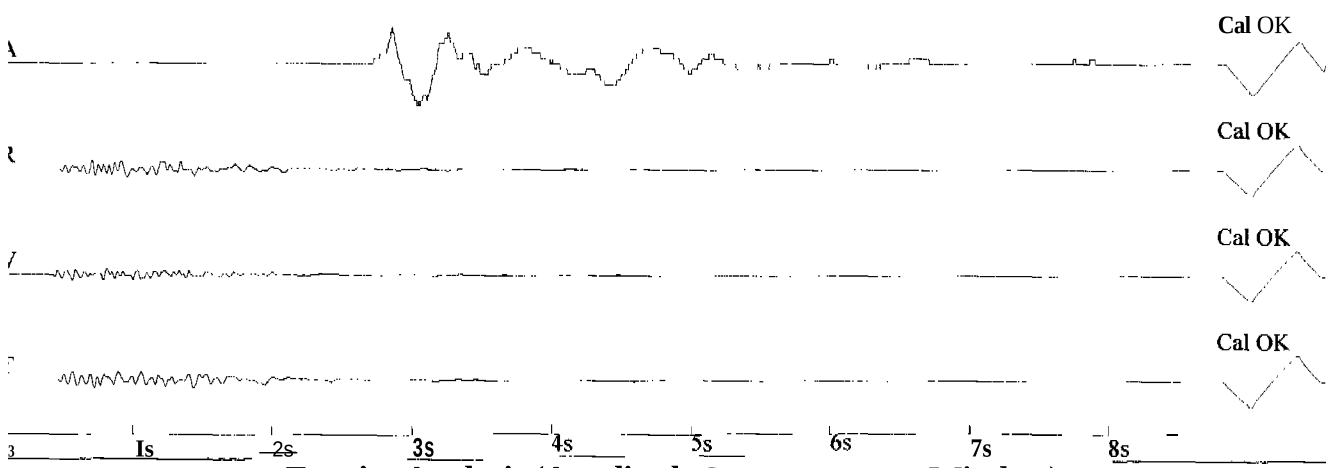
Fourier Analysis (Amplitude Spectrum - Box Window)



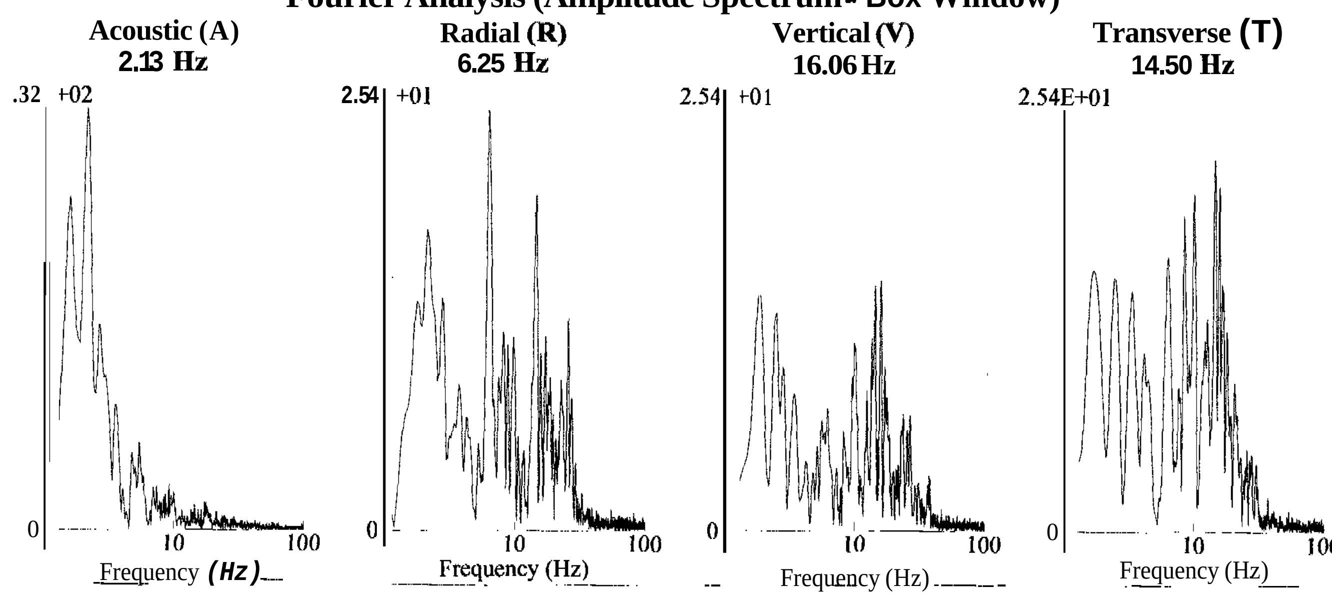
Ratliff Well

File: 00849034.DTB Event Number: 034 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 106dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies	Graph Information
Acoustic (A): 118dB @ 2.0 Hz (0.16Mb 0.0023psi 0.0160kPa)	*Duration:* 0.000 sec **To:** 8.500 sec
Radial (R): 0.03in/s 0.762mm/s @ 21.3Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.025in/s 0.635mm/s @ 20.4Hz	*Seismic* Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.035in/s 0.889mm/s @ 18.9Hz**	*Time Lines at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

File: 00853083.DTB Event Number: 083 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

***Radial (R):* 0.035in/s 0.889mm/s @ 7.8Hz**

Vertical (V): 0.02in/s 0.508mm/s @ 22.2Hz

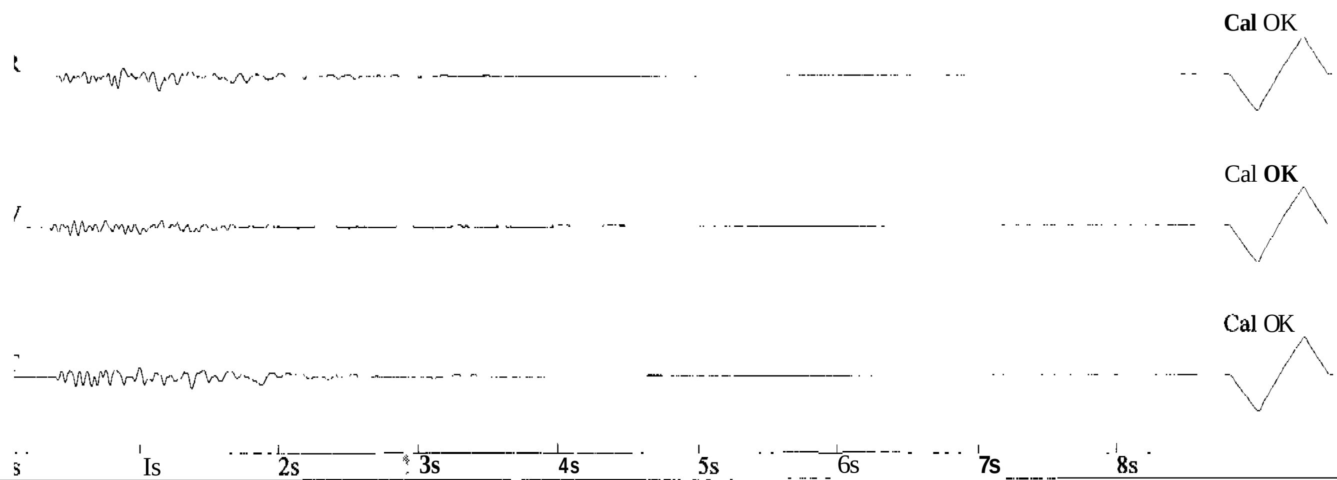
Transverse (T): 0.03in/s 0.762mm/s @ 12.4Hz

Graph Information

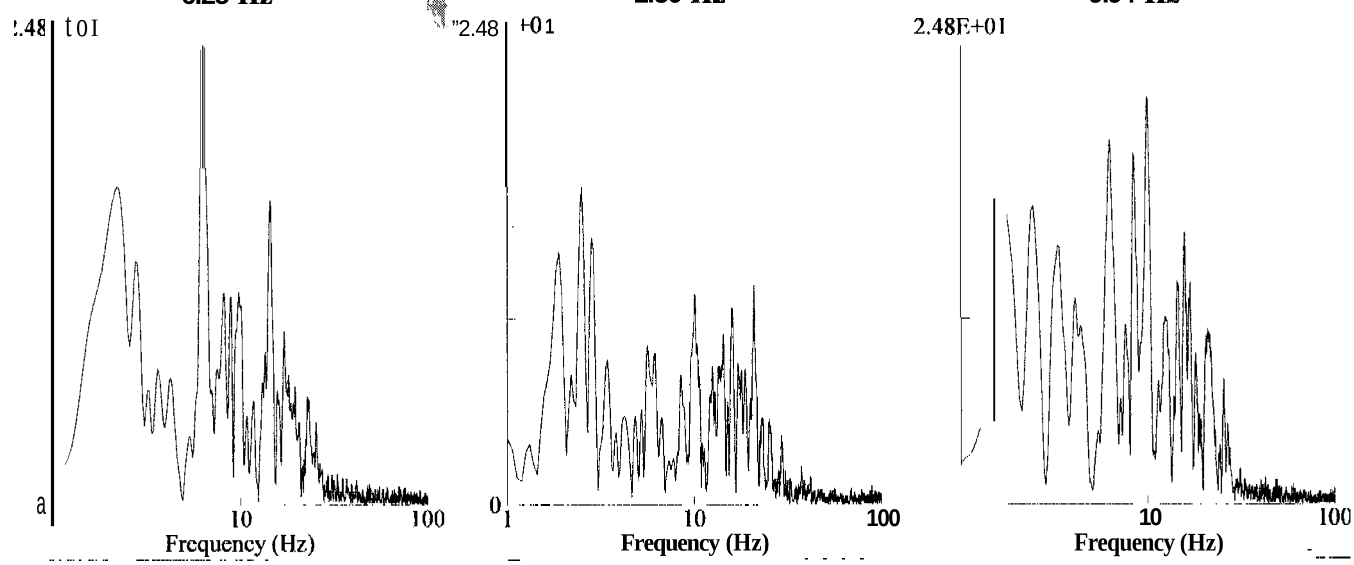
Duration: 0.000 sec To: 8.500 sec

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

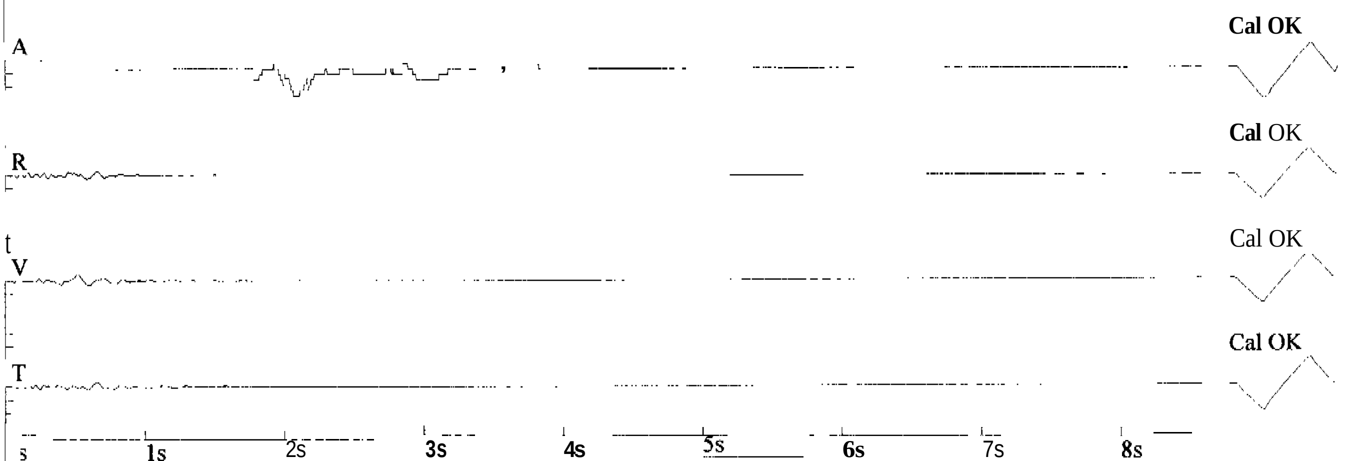
File: 00849036.DTB Event Number: 036 Date: 11/20/2000 Time: 13:03
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 849

Amplitudes and Frequencies

Acoustic (A): 114 dB @ 2.6 Hz
(0.10Mb **0.0015psi** 0.0100kPa)
Radial (R): 0.015in/s 0.381mm/s @ 11.3Hz
***Vertical (V):* 0.025in/s 0.635mm/s @ 6.7Hz**
Transverse (T): 0.015in/s 0.381mm/s @ 8.6Hz

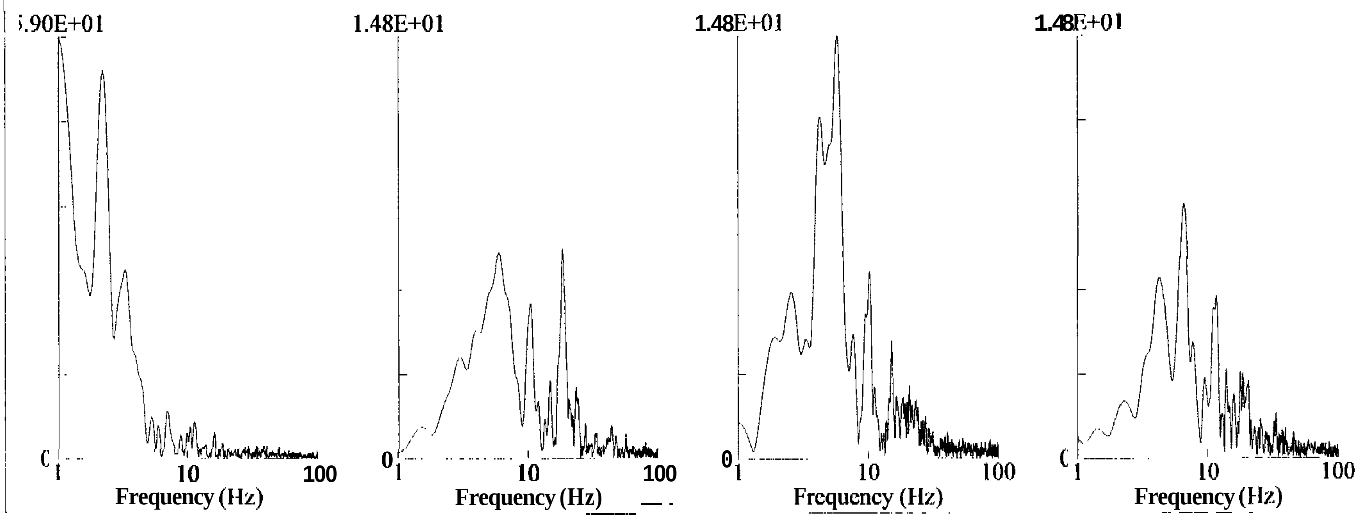
Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.00 Hz** | **Radial (R)** **18.19 Hz** | **Vertical (V)** **5.81 Hz** | **Transverse (T)** **6.50 Hz**



G. Hurley Well
9.5 ft. deep

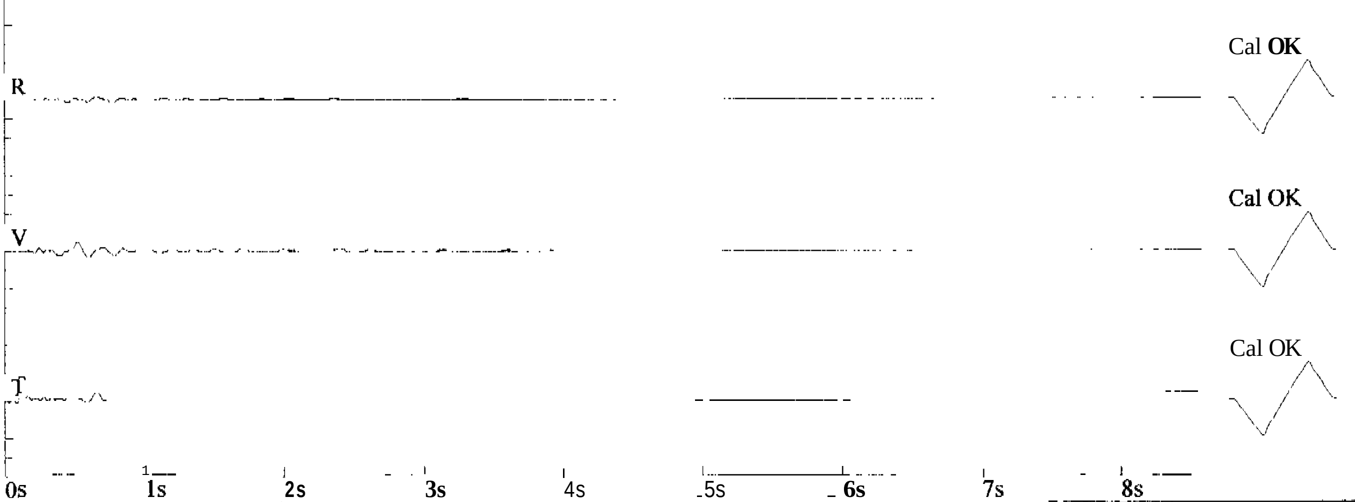
File: 00809090.DTB Event Number: 090 Date: 11/20/2000 Time: 13:03
Acoustic Trigger: **142** dB Seismic Trigger: **0.02in/s 0.508mm/s** Serial Number: 809

Amplitudes and Frequencies

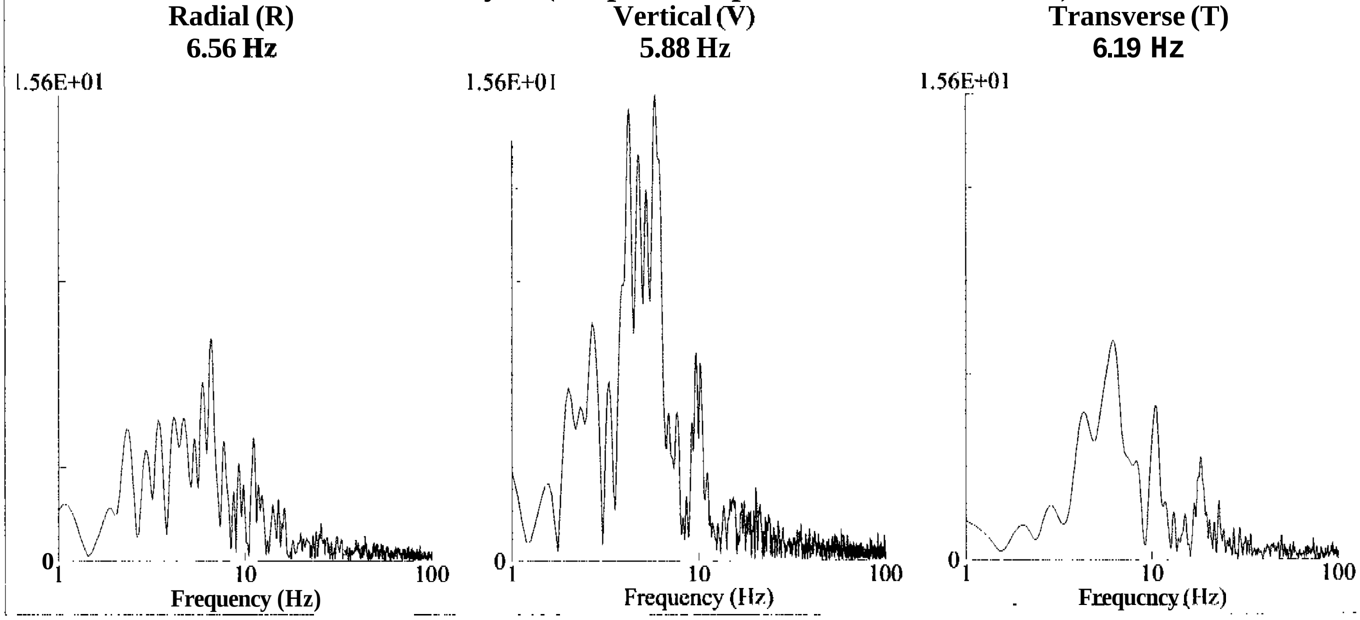
Radial (R): 0.01in/s 0.254mm/s @ 0.0Hz
Vertical (V): 0.025in/s 0.635mm/s @ 5.9Hz
Transverse (T): 0.02in/s 0.508mm/s @ 9.1Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

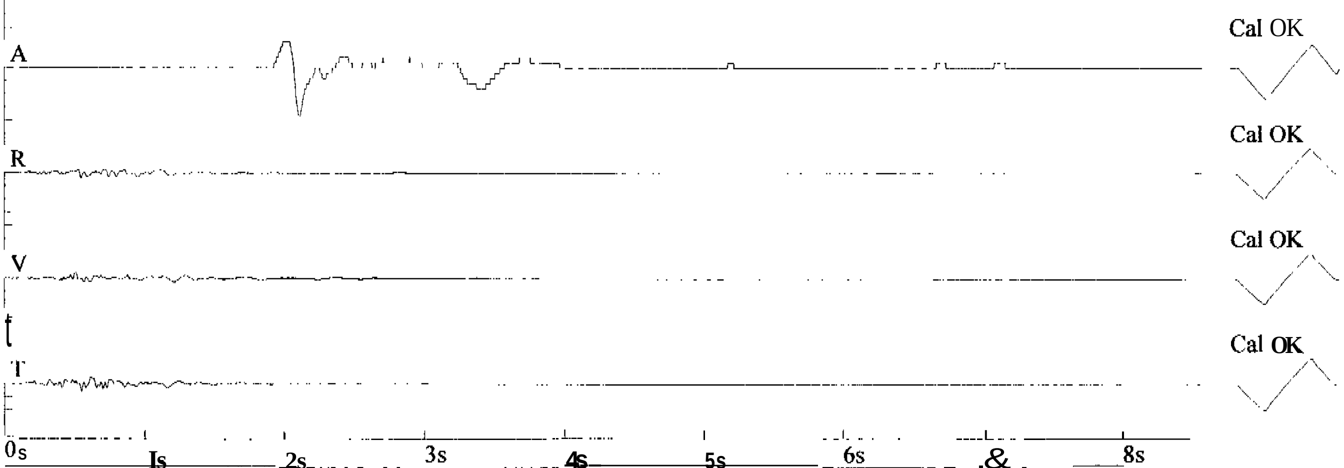
File: 00849037.DTB Event Number: 037 Date: 11/20/2000 Time: 16:08
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

Acoustic (A): 119 dB @ 3.3 Hz
(0.18Mb 0.0026psi 0.0180kPa)
Radial (R): 0.02in/s **0.508mm/s** @ 23.2Hz
Vertical (V): 0.02in/s **0.508mm/s** @ 19.6Hz
Transverse ***(T):* 0.03in/s 0.762mm/s @ 23.2Hz**

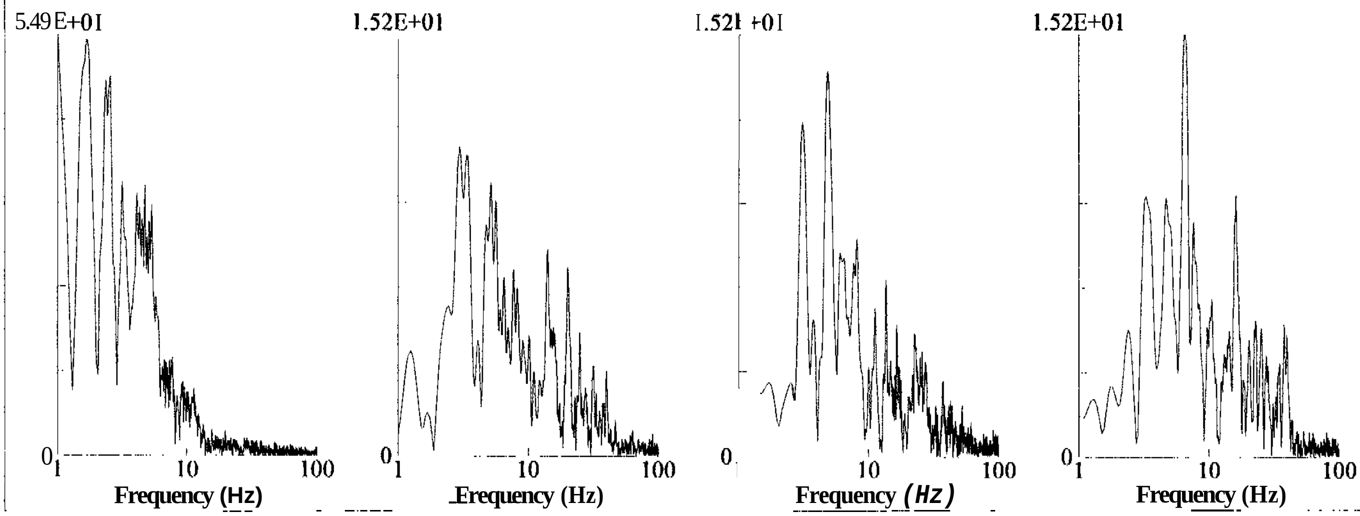
Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB **0.20Mb (0.050Mb/div)**
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.00 Hz**   **Radial (R)** **2.94 Hz**   **Vertical (V)** **4.88 Hz**   **Transverse (T)** **6.50 Hz**



G. Hurley Well
9.5 ft. deep

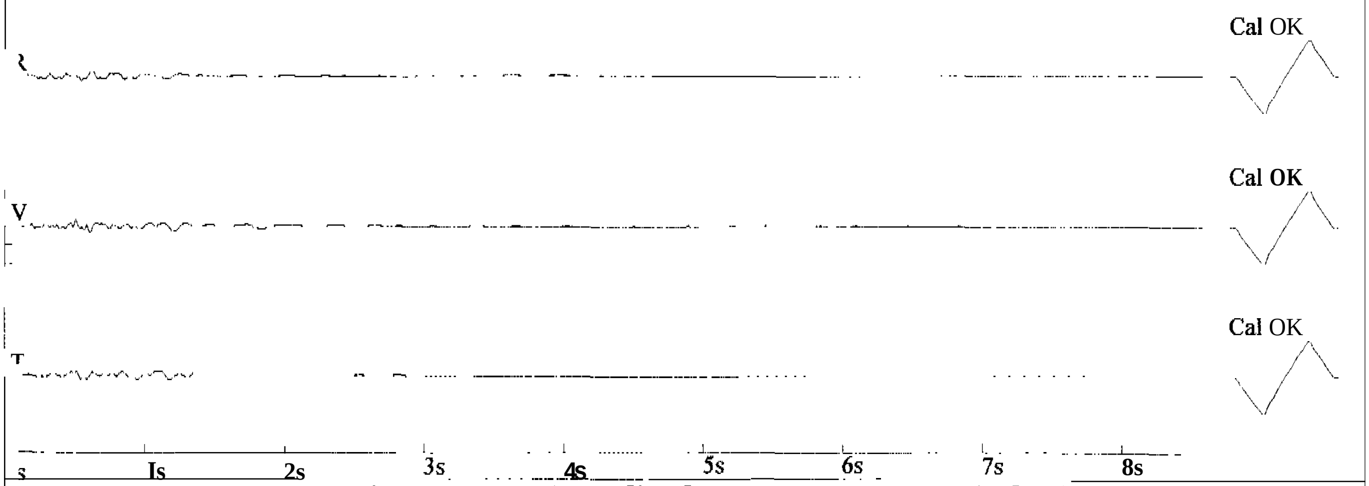
File: 00809091.DTB Event Number: 091 **Date:** 11/20/2000 Time: 16:08
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 809

Amplitudes and Frequencies

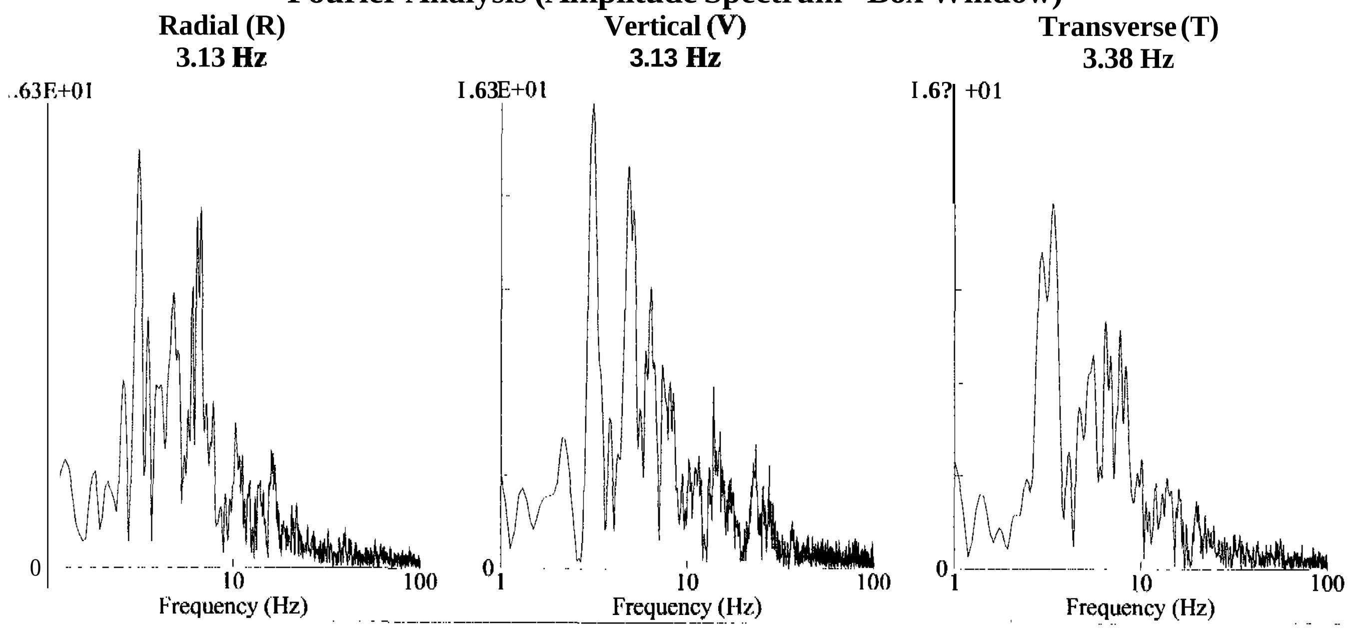
Radial (R): 0.015in/s **0.381mm/s** @ 0.0Hz
***Vertical (V):* 0.02in/s 0.508mm/s @ 16.5Hz**
Transverse (T): **0.01in/s** 0.254mm/s @ 0.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

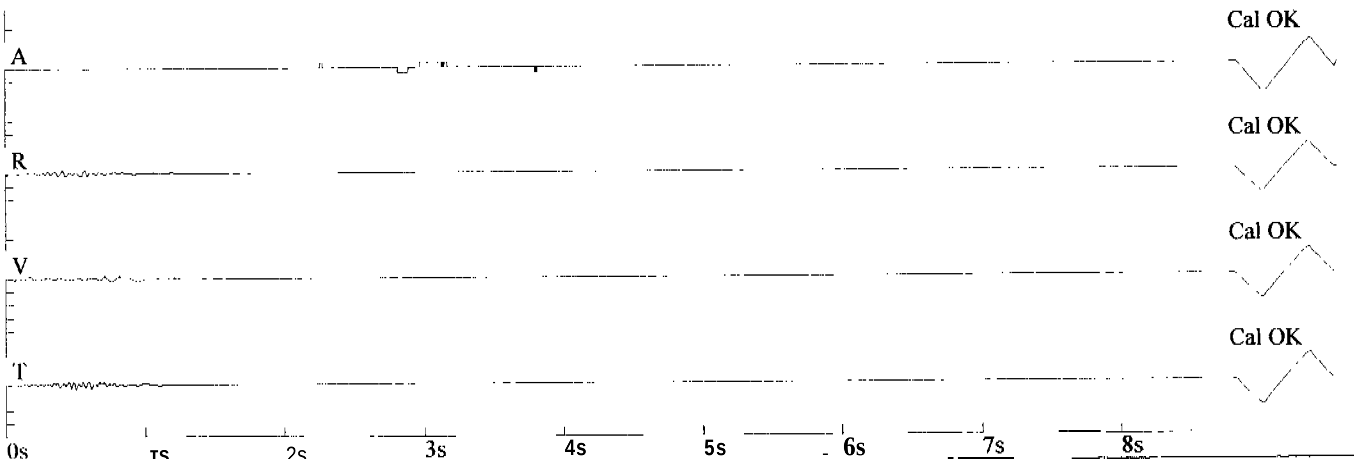
File: 00849038.DTB Event Number: 038 Date: 11/20/2000 Time: 16:45
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s **Serial** Number: 849

Amplitudes and Frequencies

Acoustic (A): **100** dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.015in/s 0.381mm/s @ 24.3Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.02in/s 0.508mm/s @ 28.4Hz**

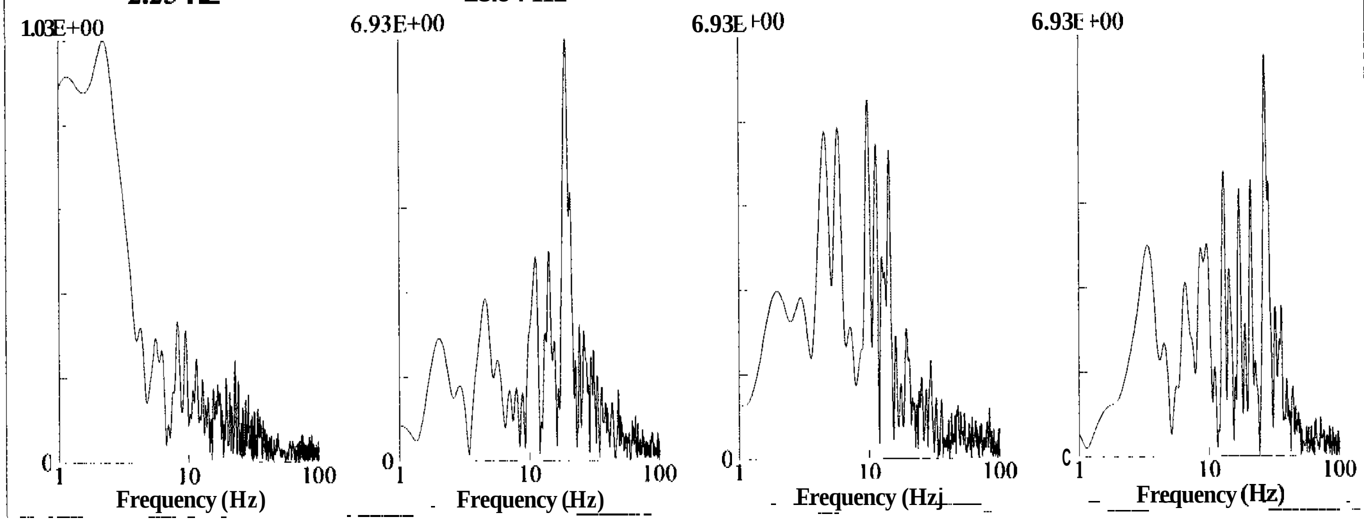
Graph Information

Duration: 0.000 sec To: 8.500 sec
***Acoustic** Scale:*
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

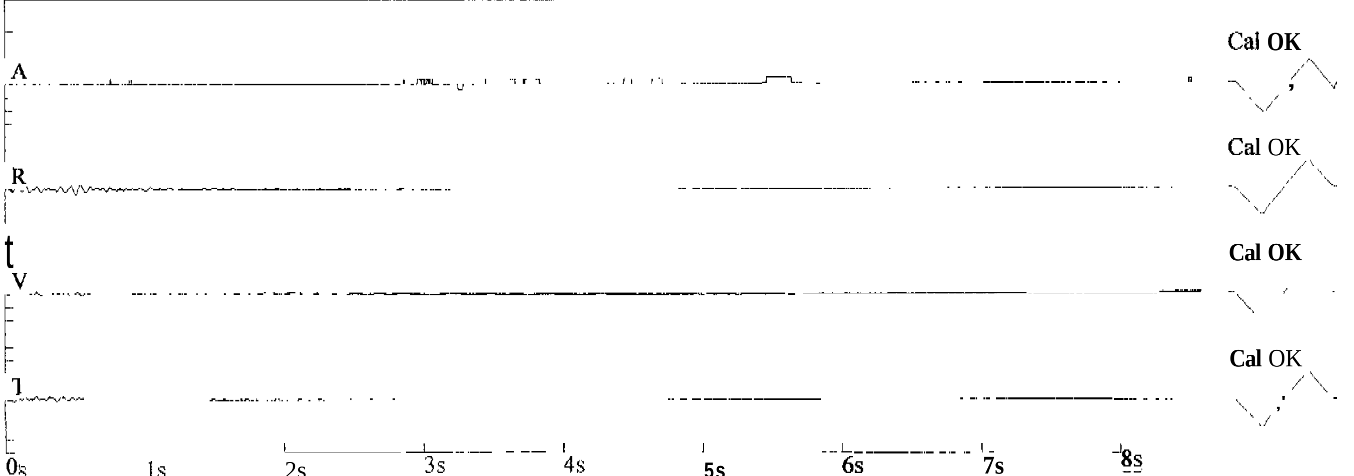
Acoustic (A) **2.25 Hz** | **Radial (R)** **18.94 Hz** | **Vertical (V)** **9.81 Hz** | **Transverse (T)** **27.06 Hz**



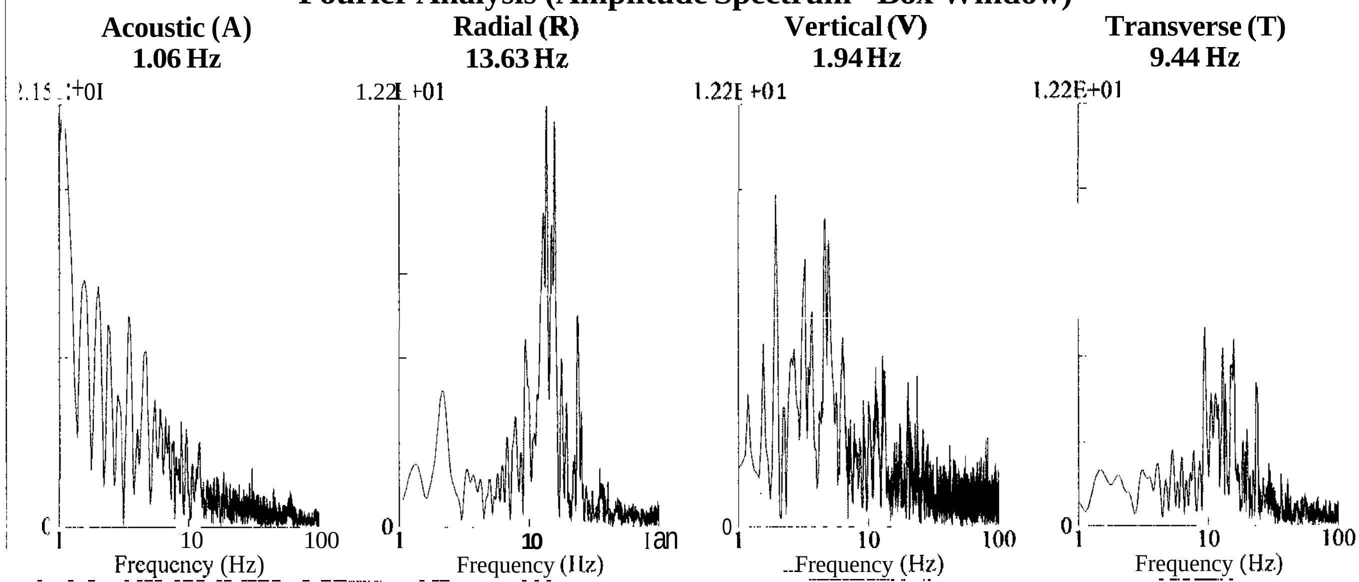
Sumner Well
5 in. (surface only)

File: 00804072.DTB Event Number: 072 Date: 11/20/2000 Time: 10:32
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 804

Amplitudes and Frequencies	Graph Information
Acoustic (A): 100 dB @ *0.0* Hz (0.02Mb 0.0003psi 0.0020kPa)	***Duration:*** 0.000 sec To: 8.500 sec
Radial ***(R):*** **0.02in/s 0.508mm/s @ 14.6Hz**	Acoustic *Scale:* 120dB **0.20Mb** (0.050Mb/div)
Vertical (V): **0.01**in/s 0.254mm/s @ 0.0Hz	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.005in/s **0.127mm/s** @ 0.0Hz	***Time*** Lines at: **1.00 sec intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)



Sumner Well
5 in. (surface only)

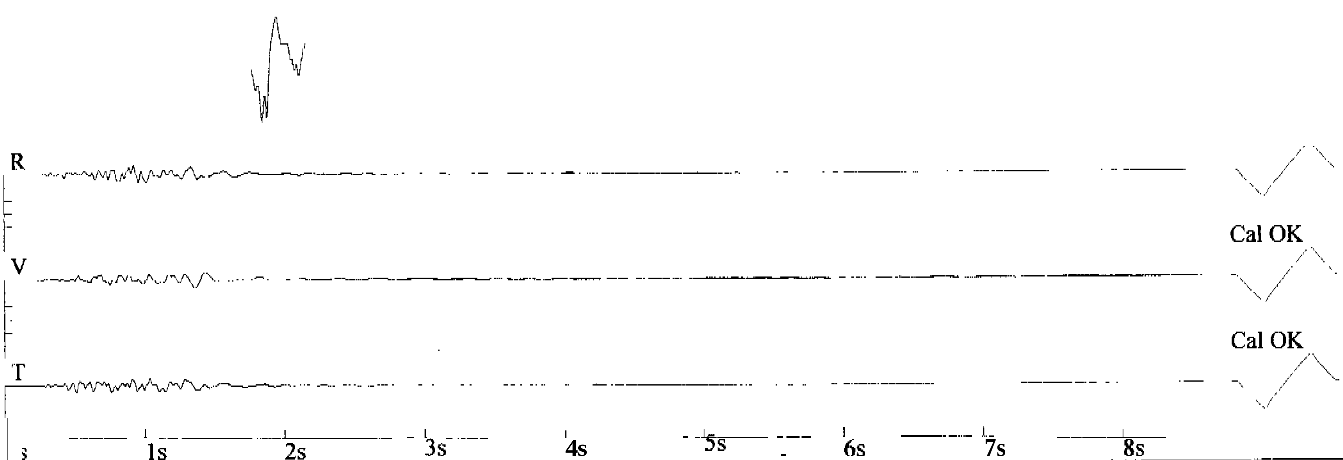
File: 00804075.DTB **Event Number:** 075 **Date:** 11/20/2000 **Time:** 16:09
Acoustic Trigger: 120 dB **Seismic Trigger:** 0.02in/s 0.508mm/s **Serial Number:** 804

Amplitudes and Frequencies

Acoustic (A): **120 dB @ 2.9 Hz**
(0.20Mb 0.0029psi 0.0200kPa)
***Radial (R):* 0.035in/s 0.889mm/s @ 16.0Hz**
Vertical (V): 0.03in/s 0.762mm/s @ 7.4Hz
Transverse (T): 0.03in/s 0.762mm/s @ 7.5Hz

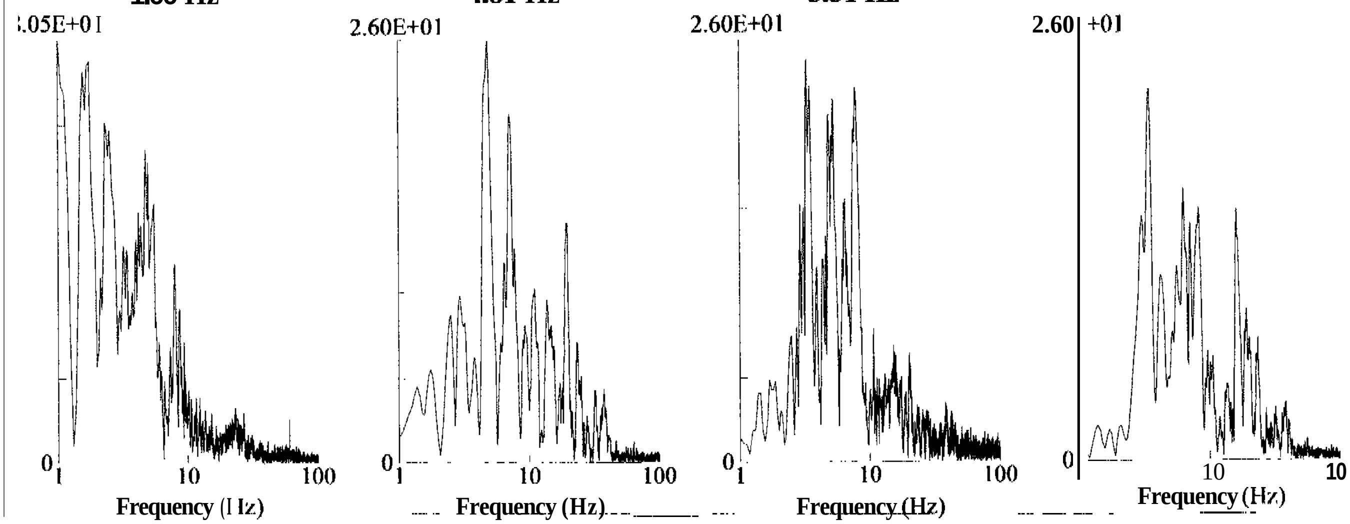
Graph Information

Duration: 0.000 sec **To: 8.500** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.00 Hz** | **Radial (R)** **4.81 Hz** | **Vertical (V)** **3.31 Hz** | **Transverse (T)** **3.44 Hz**



SPRING 2001

West Virginia
Dean Sr. surface

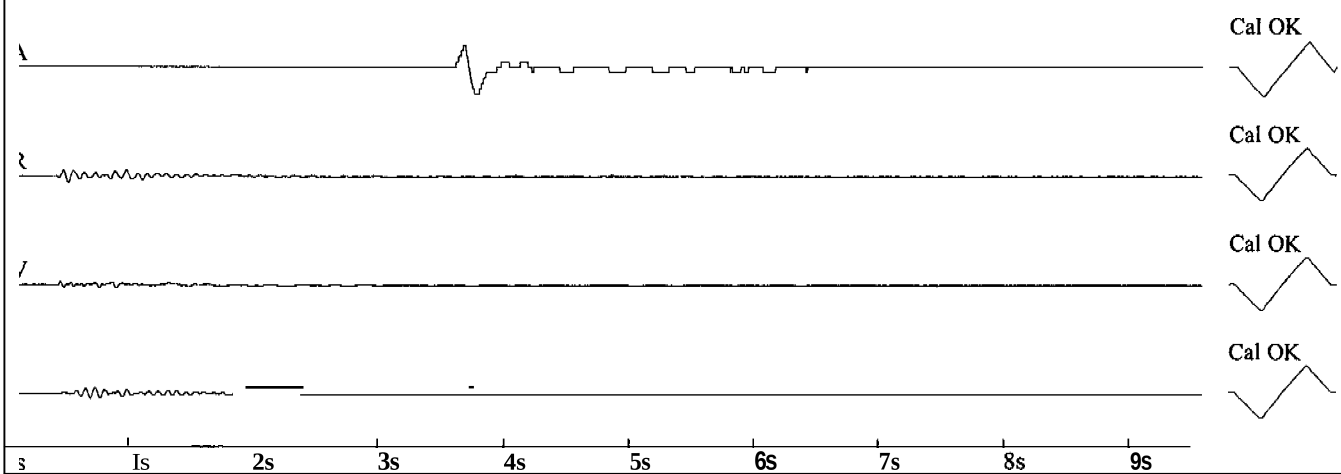
File: D1SAP001.DTB Event Number: 001 Date: 4/3/01 Time: 08:41
Acoustic Trigger: 114dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

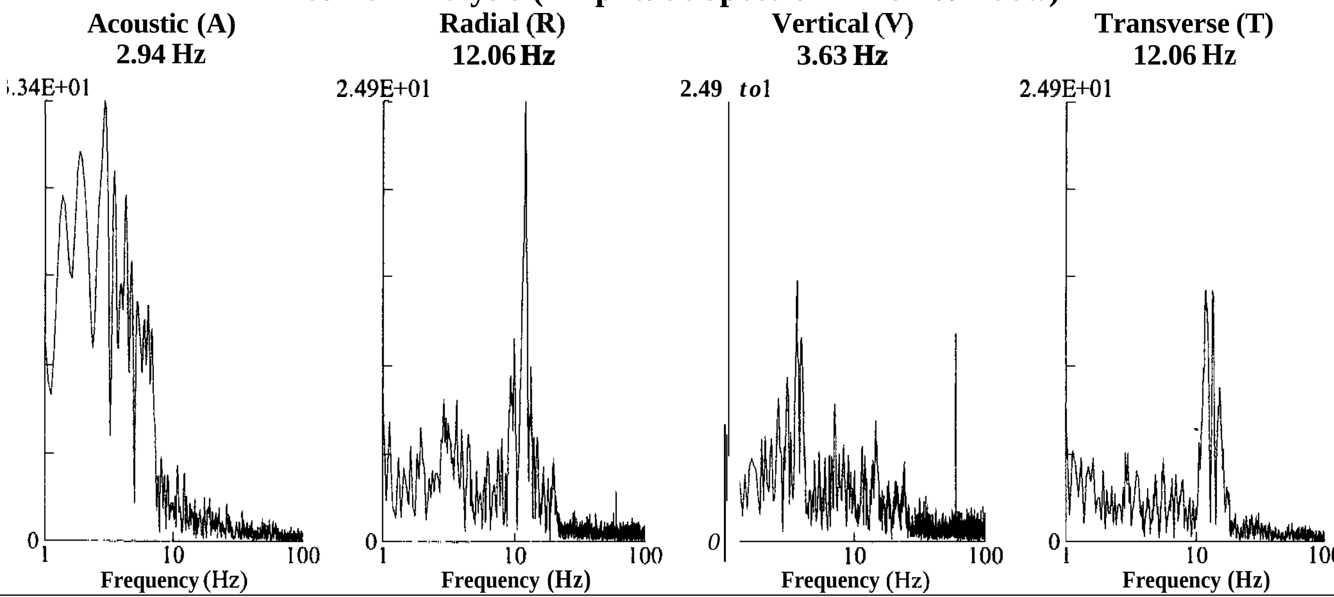
Acoustic (A): 114dB @ 2.3 **Hz**
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): **0.03in/s 0.762mm/s @ 12.1Hz**
vertical (V): 0.015in/s 0.381mm/s @ 16.0Hz
***Transverse** (T):* 0.025in/s 0.635mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: ***9.500*** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic ***Scale:***
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time ***Lines*** *at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 1.3 Hz
(0.06Mb 0.0009psi 0.0060kPa)

***Radial (R):* 0.03in/s 0.762mm/s @ 15.0Hz**

Vertical (V): 0.015in/s 0.381mm/s @ 24.3Hz

Transverse (T): 0.025in/s 0.635mm/s @ 15.0Hz

Calibration Date (yyyy/mm/dd): 2000/11/22

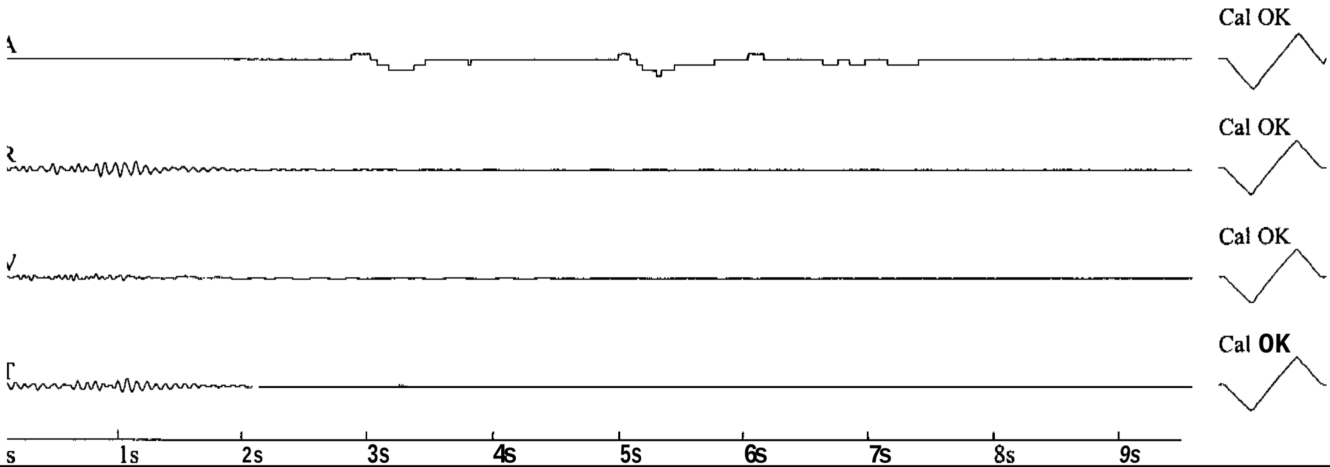
Graph Information

Duration: 0,000 sec **To:** 9.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

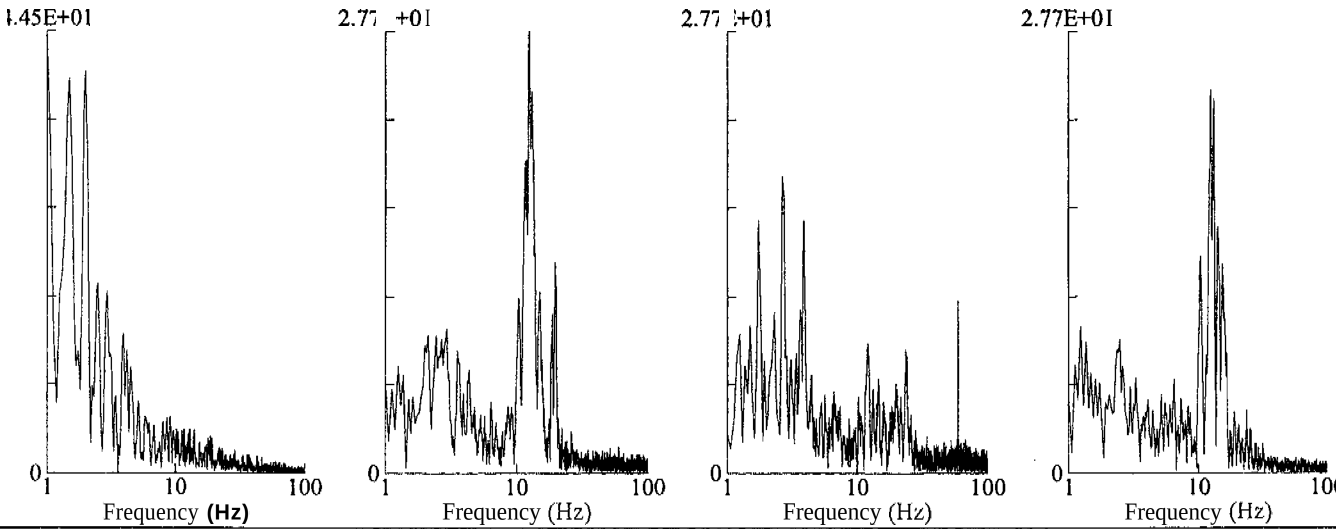
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: **1.00 sec intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) 1.00 Hz | **Radial (R)** 12.56 Hz | **Vertical (V)** 2.69 Hz | **Transverse (T)** 12.56 Hz



West Virginia
Dean Sr. shallow

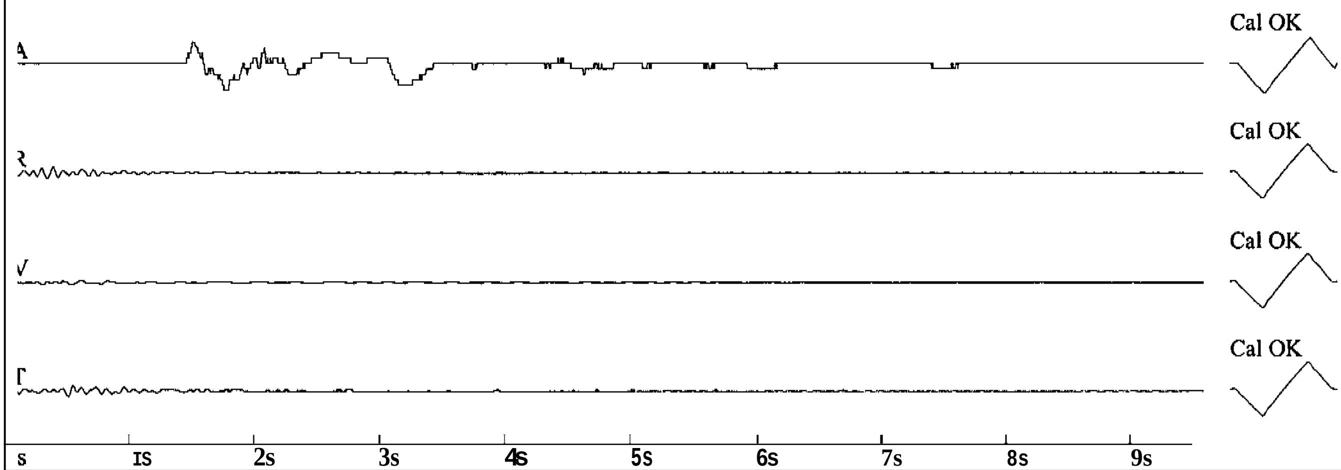
File: D1SAP003.DTB Event Number: 003 Date: **4/3/01** Time: 17:06
Acoustic Trigger: 114 dB **Seismic** Trigger. 0.025in/s **0.635mm/s** **Serial** Number: 1781

Amplitudes and Frequencies

Acoustic (A): **114** dB @ 2.1 **Hz**
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.015in/s 0.381mm/s @ 14.6Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.025in/s 0.635mm/s @ 10.8Hz**
Calibration ***Date (yyyy/mm/dd):*** 2000/11/22

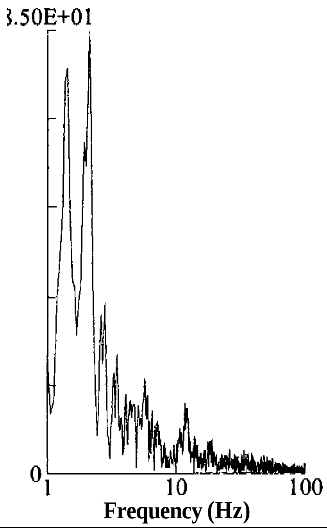
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

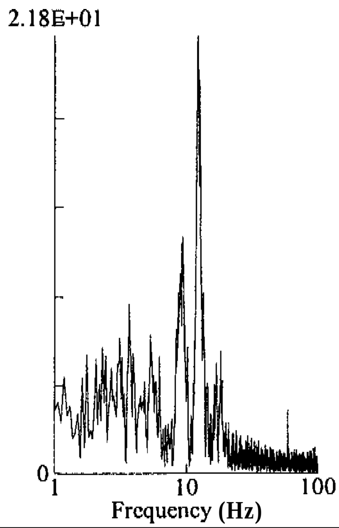


Fourier Analysis (Amplitude Spectrum - Box Window)

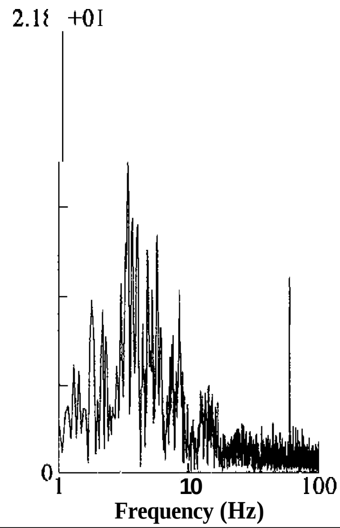
Acoustic (A)
2.13 Hz



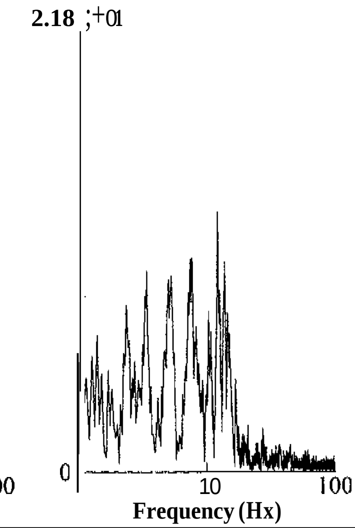
Radial (R)
12.31 Hz



Vertical (V)
3.44 Hz



Transverse (T)
12.25 Hz



West Virginia
Dean Sr. shallow

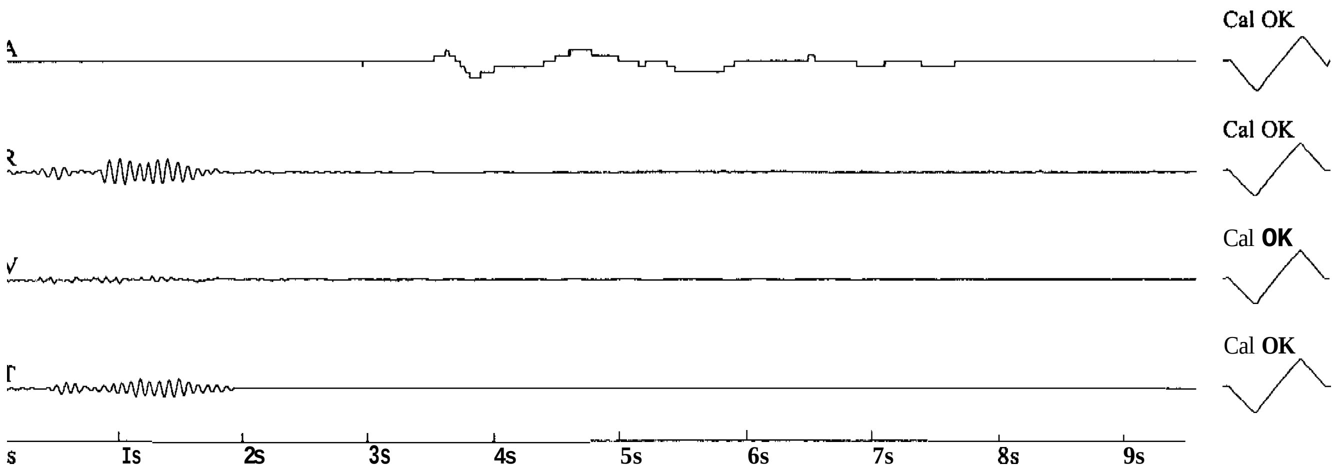
File: D1SAP004.DTB   Event Number: 004   Date: 4/4/01   Time: 11:20
Acoustic Trigger: 114 dB   **Seismic** Trigger: **0.025in/s 0.635mm/s**   Serial Number: 78

Amplitudes and Frequencies

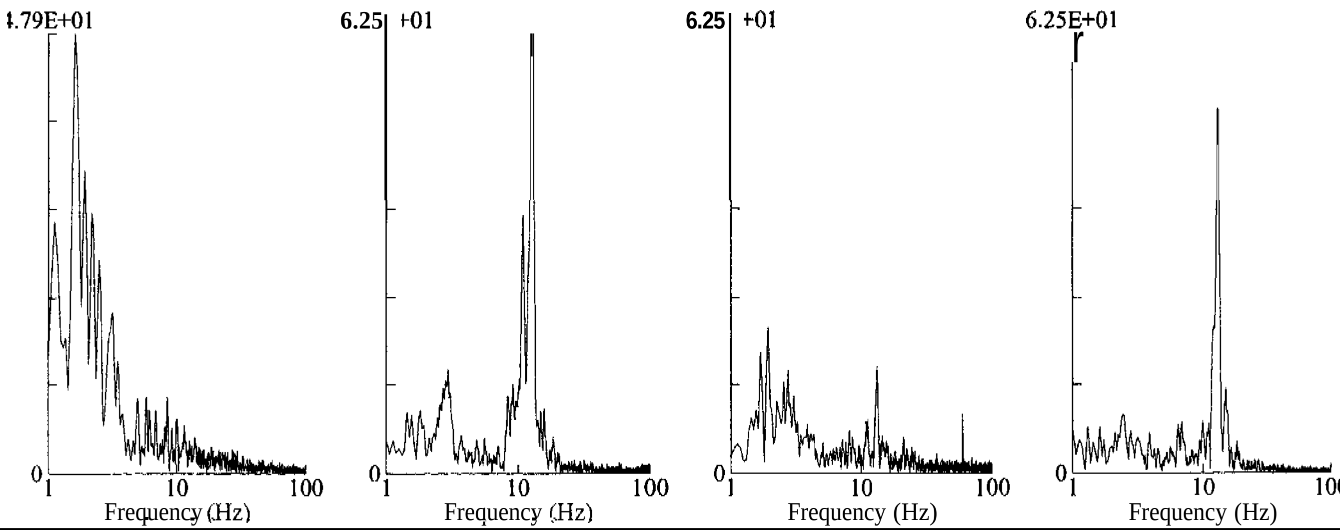
Acoustic (A): 110 dB @ 1.7 Hz
(0.06Mb 0.0009psi 0.0060kPa)
***Radial (R):* 0.05in/s 1.27mm/s @ 12.8Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 15.0Hz
Transverse (T): 0.035in/s 0.889mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec **To:** 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines ***at:*** **1.00sec** intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

File: D1SAP006.DTB   Event Number: 006   Date: 4/5/01   Time: 10:34
Acoustic Trigger: 114 **dB**   Seismic Trigger. 0.025in/s 0.635mm/s   **Serial** Number: 1781

Amplitudes and Frequencies

Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

***Radial (R):* 0.055in/s 1.397mm/s @ 16.0Hz**

Vertical (V): 0.025in/s 0.635mm/s @ 21.3Hz

Transverse (T): 0.045in/s 1.143mm/s @ 12.4Hz

Calibration Date (yyyy/mm/dd): 2000/11/22

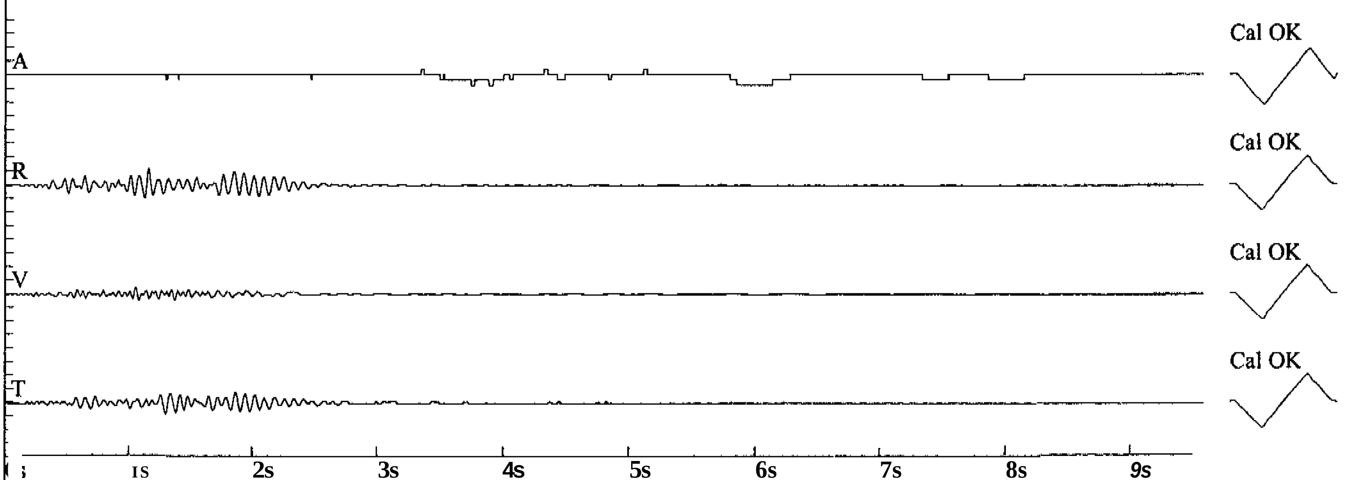
Graph Information

Duration: 0.000 sec To: 9.500 sec

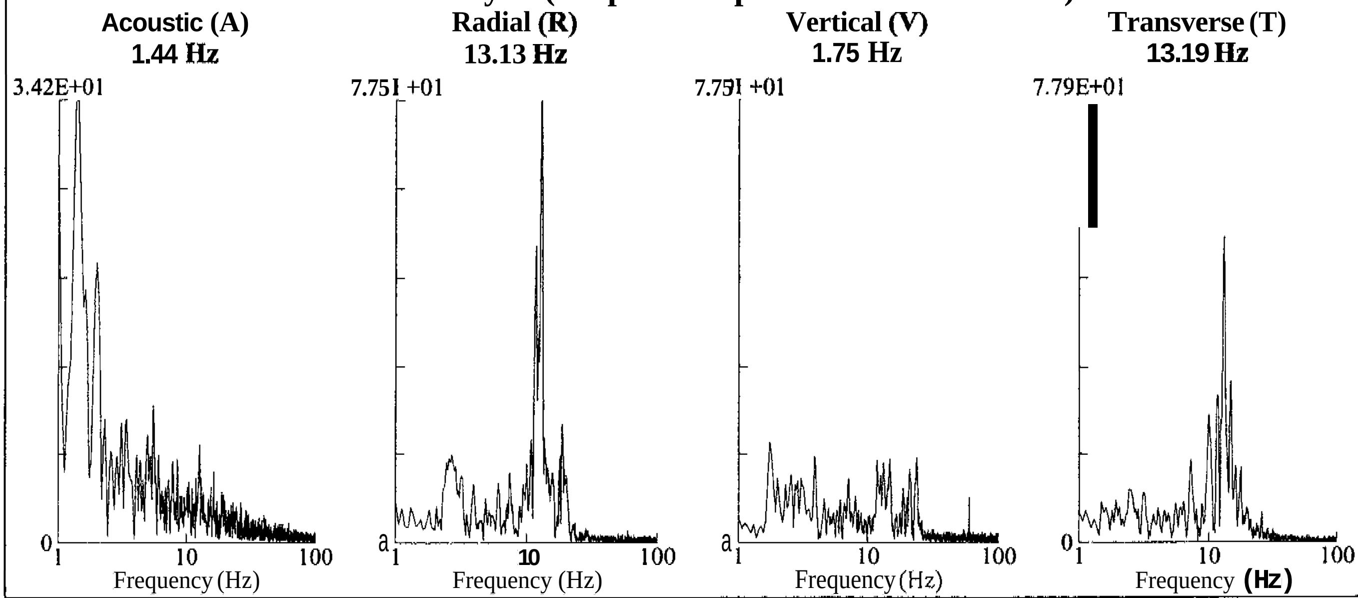
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

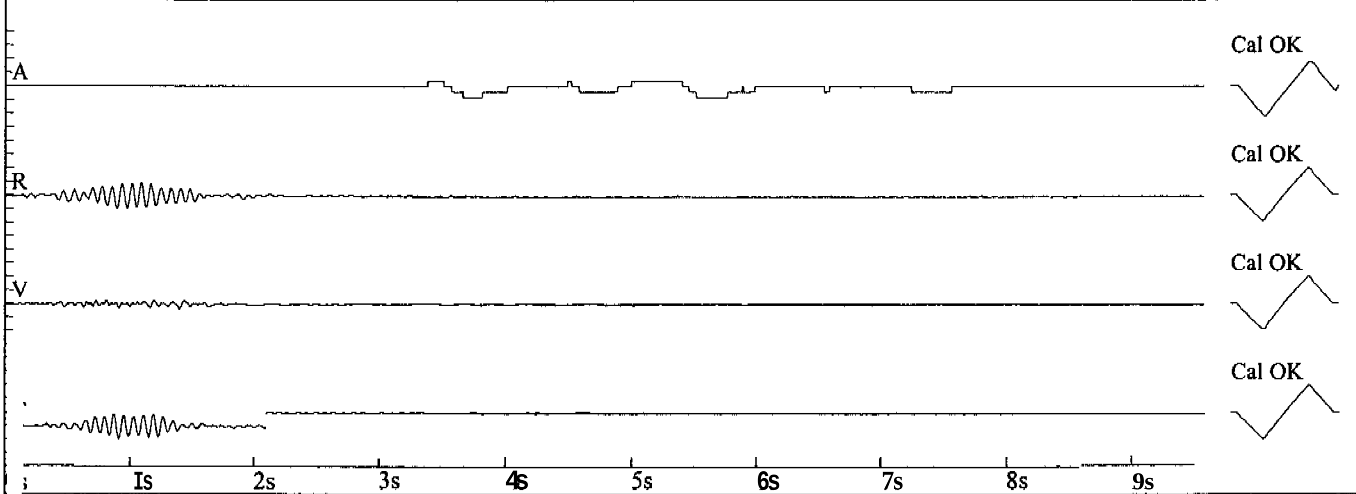
File: D1SAP007.DTB Event Number: **007** Date: 4/6/01 **Time:** 10:22
Acoustic Trigger: 114 dB **Seismic Trigger:** 0.025in/s 0.635mm/s **Serial** Number: 1781

Amplitudes and Frequencies

Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
***Radial (R):* 0.05in/s 1.27mm/s @ 12.1Hz**
Vertical (V): 0.02in/s 0.508mm/s @ 14.2Hz
***Transverse(T):* 0.05in/s 1.27mm/s @ 12.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

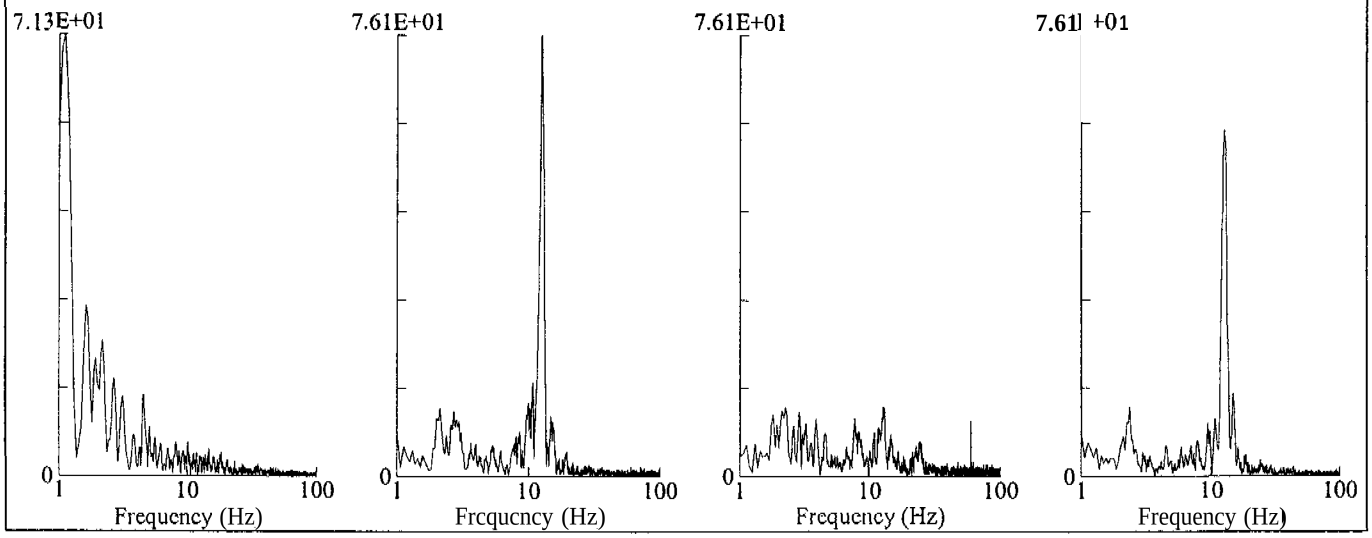
Graph Information

Duration: 0.000 sec To: **9.500** sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.13 Hz	12.69 Hz	12.81 Hz	12.69 Hz



West Virginia
Dean Sr. shallow

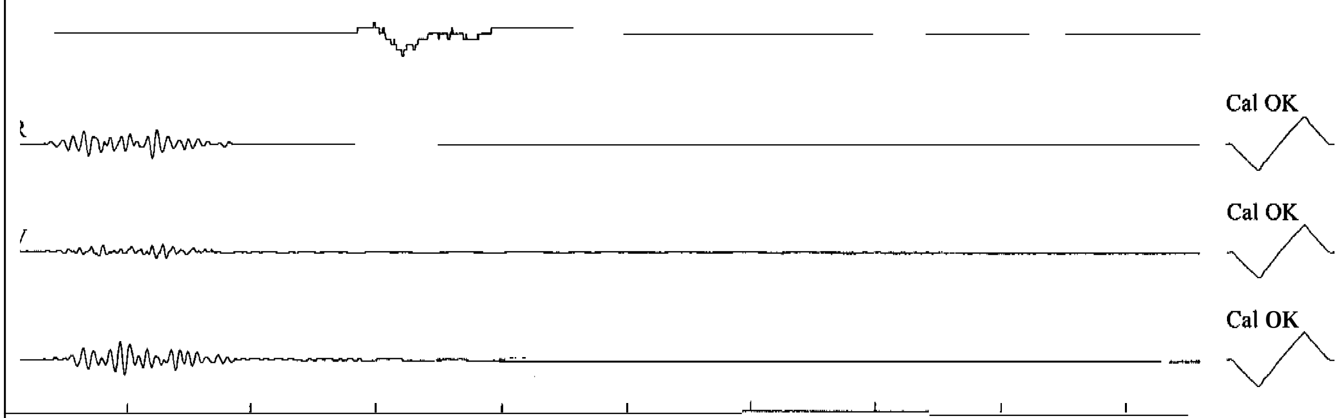
File: D1SAP009.DTB Event Number: 009 Date: 4/6/01 Time: 15:43
Acoustic Trigger: 114 **dB** **Seismic** Trigger: **0.025in/s 0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): **112** dB @ 1.9 Hz
(**0.08Mb** 0.0012psi 0.0080kPa)
Radial (R): 0.055in/s 1.397mm/s @ 13.1Hz
vertical (V): 0.03in/s 0.762mm/s @ 10.2Hz
***Transverse(T):* 0.06in/s 1.524mm/s @ 13.8Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

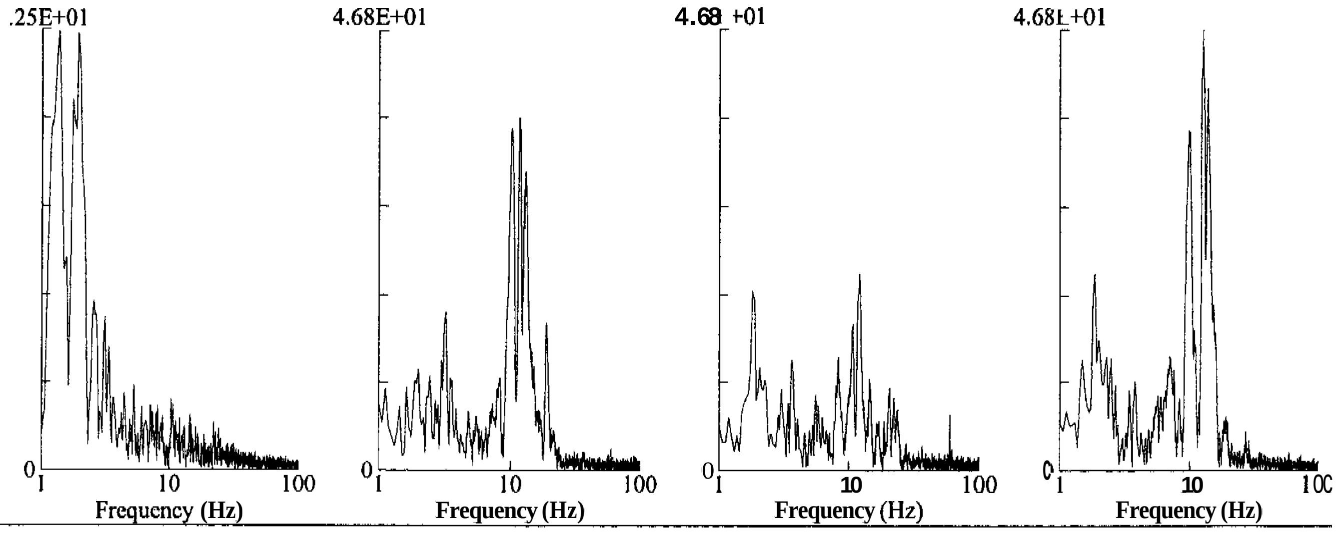
Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Time** Lines at:* 1.00 sec intervals



0 1s 2s 3s 4s 5s 6s 7s 8s 9s

Fourier Analysis (Amplitude Spectrum - Box Window)

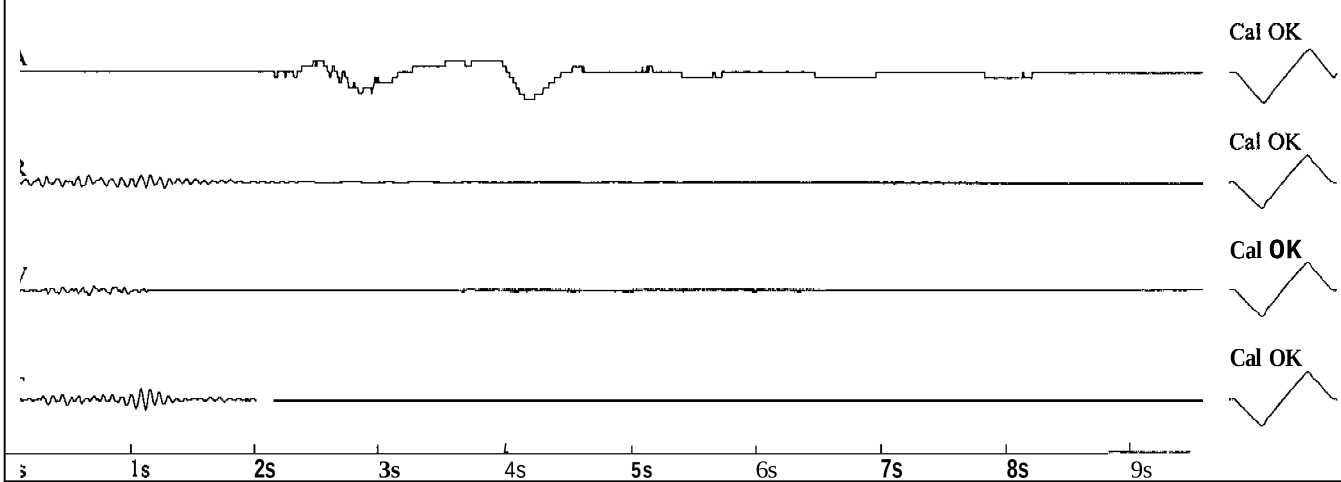
Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.38 Hz	**11.75 Hz**	**12.25 Hz**	**12.81 Hz**



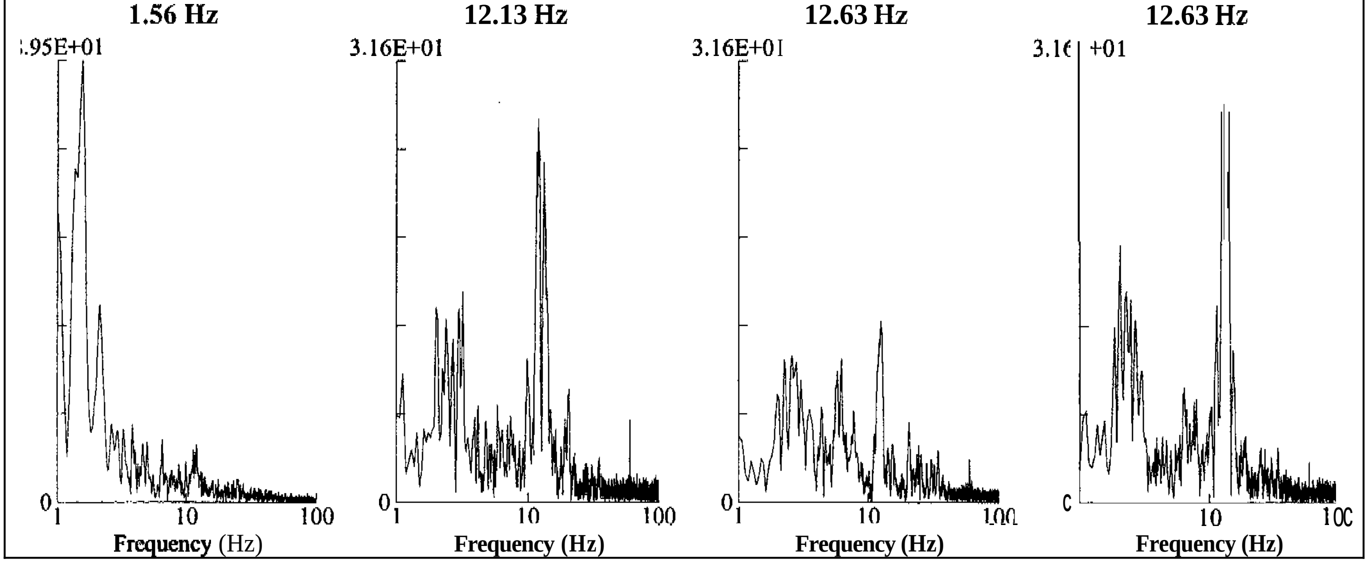
West Virginia
Dean Sr. shallow

File: D1SAP019.DTB Event **Number:** 019 Date: 4/9/01 Time: 12:41
Acoustic Trigger: 114 dB **Seismic** Trigger: 0.025in/s **0.635mm/s** **Serial** Number: 1781

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 114dB @ 1.4 Hz (0.10Mb 0.0015psi 0.0100kPa)	*Duration: 0.000* **sec** To: 9.500 sec
Radial (R): 0.025in/s 0.635mm/s @ 17.0Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 13.4Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) **5.08mm/s (1.270mm/s/div)**
***Transverse (T):* 0.04in/s 1.016mm/s @ 14.2Hz**	*Time Lines at:* 1.00 **sec** intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

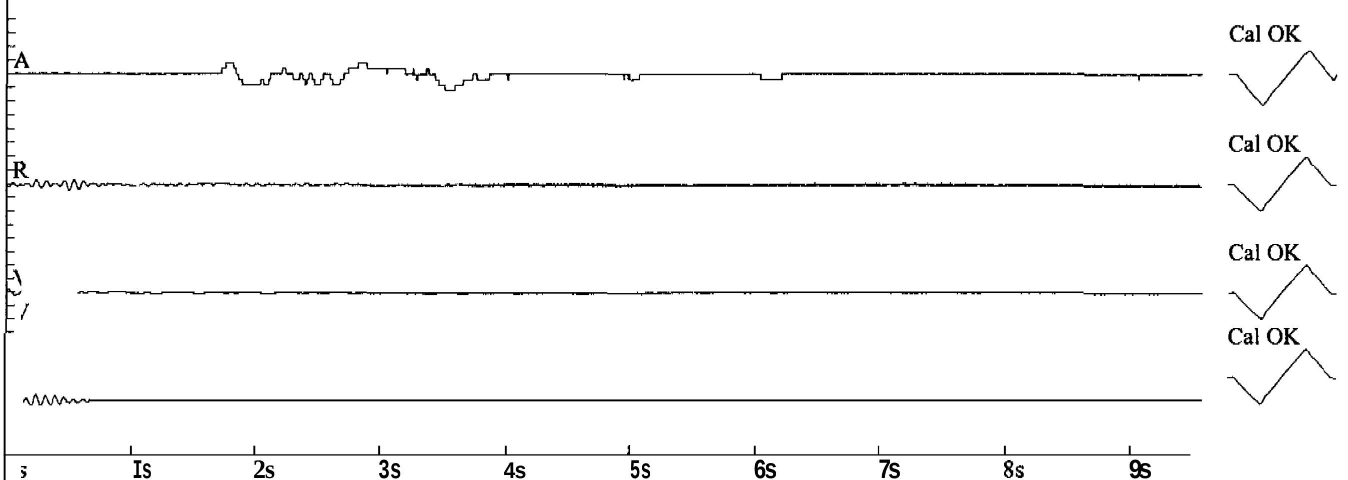
File: D1SAP020.DTB Event Number: 020 Date: 4/9/01 Time: 16:35
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s **Serial** Number: 1781

Amplitudes and Frequencies

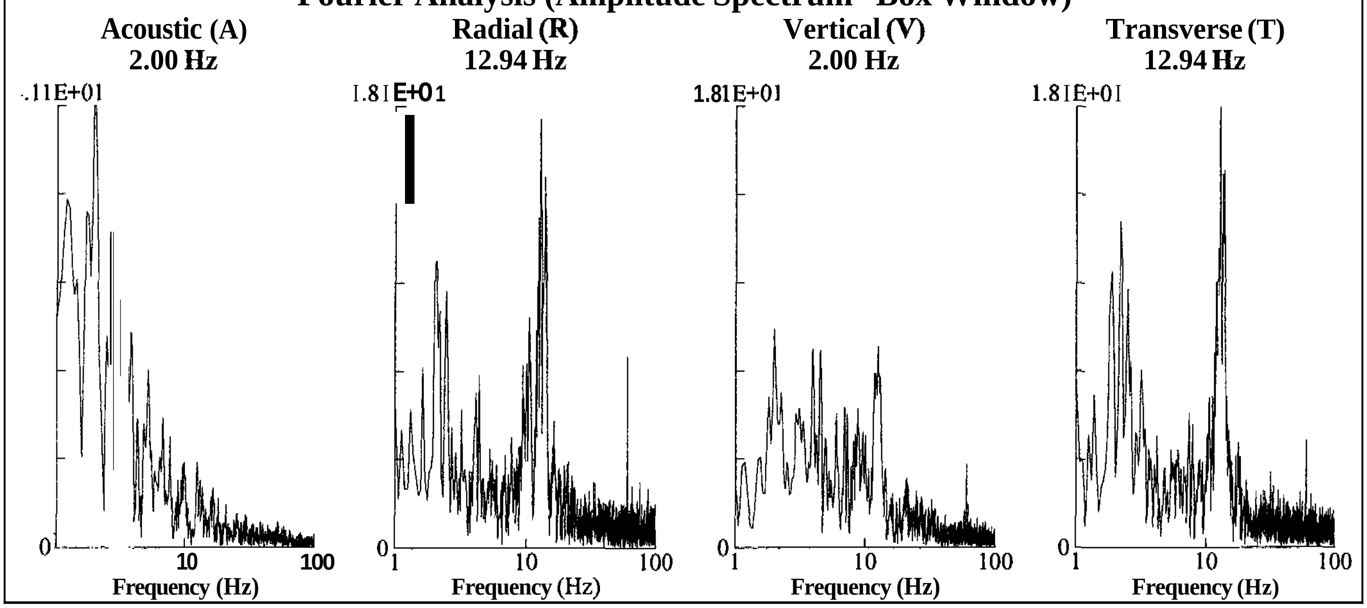
Acoustic (A): 110 dB @ **1.8 Hz**
(0.06Mb 0.0009psi 0.0060kPa)
***Radial (R):* 0.025in/s 0.635mm/s @ 12.8Hz**
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.01in/s **0.254mm/s** @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 **sec** To: 9.500 **sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s (1.270mm/s/div)**
Time Lines at: 1.00 sec intervals



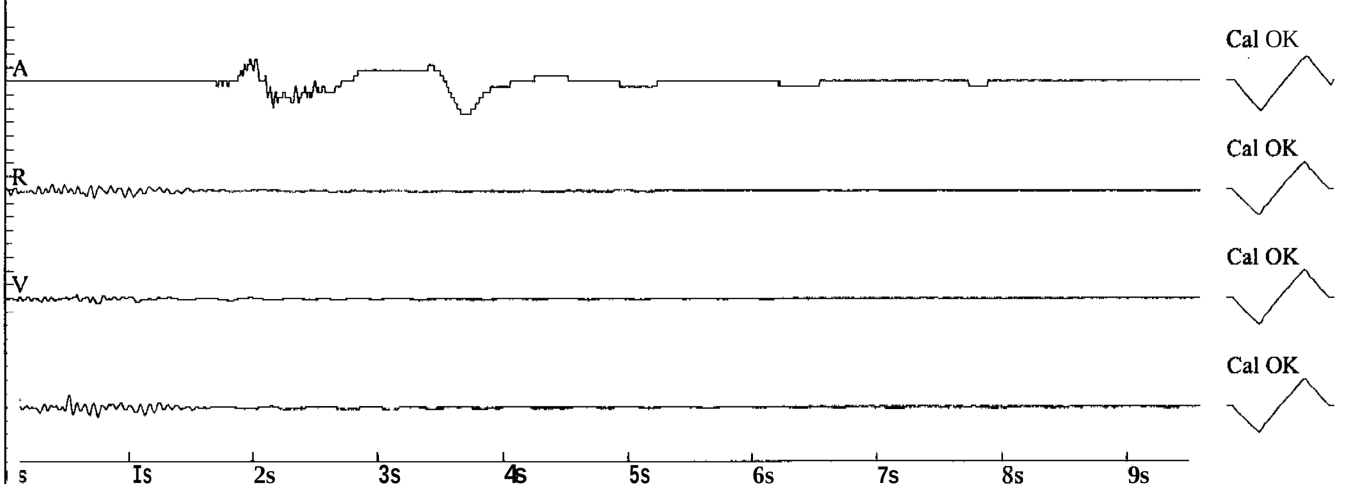
Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

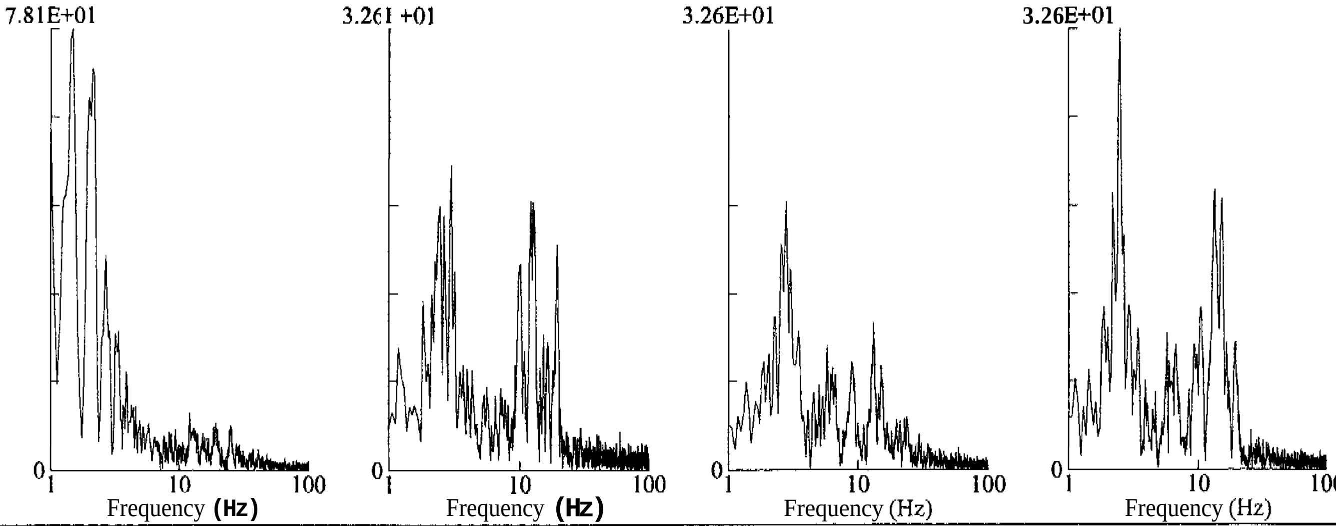
File: D1SAP021.DTB Event Number: 021 Date: 4/10/01 Time: 15:45
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies	Graph Information
Acoustic (A): 116dB @ 1.4 Hz (0.12Mb 0.0017psi 0.0120kPa)	*Duration: 0.000* sec To: *9.500* sec
Radial (R): 0.03in/s 0.762mm/s @ 15.0Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 9.3Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.045in/s 1.143mm/s @ 14.2Hz**	*Time Lines at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.50 Hz	**3.00 Hz**	**2.81 Hz**	**2.50 Hz**



West Virginia
Dean Sr. shallow

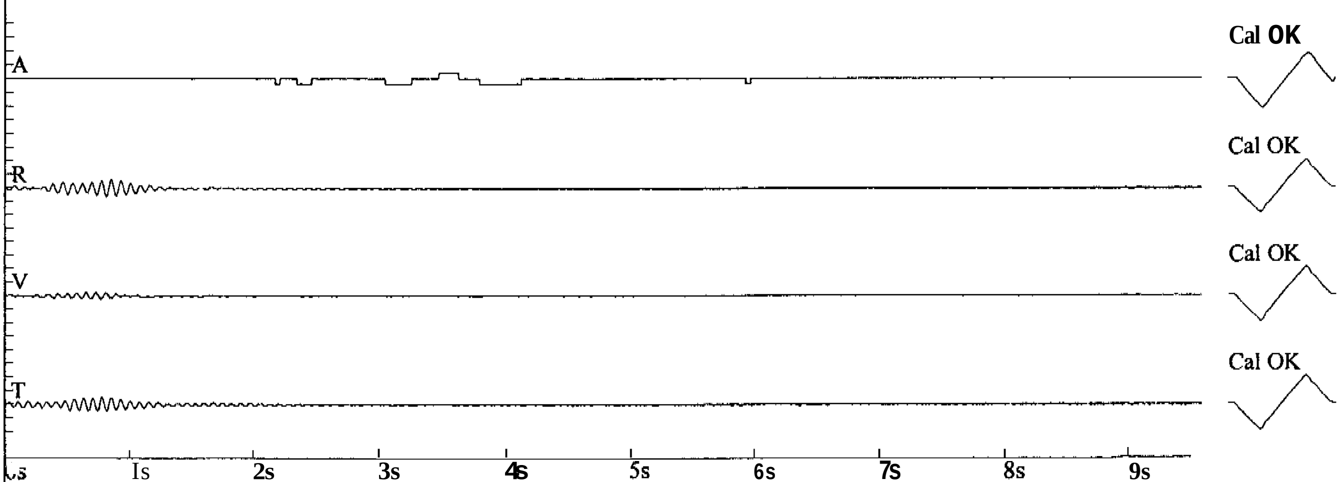
File: D1SAP022.DTB   Event Number: **022**   Date: 4/10/01   Time: 16:53
Acoustic Trigger: 114 **dB**   Seismic Trigger: 0.025in/s 0.635mm/s   **Serial** Number: 1781

Amplitudes and Frequencies

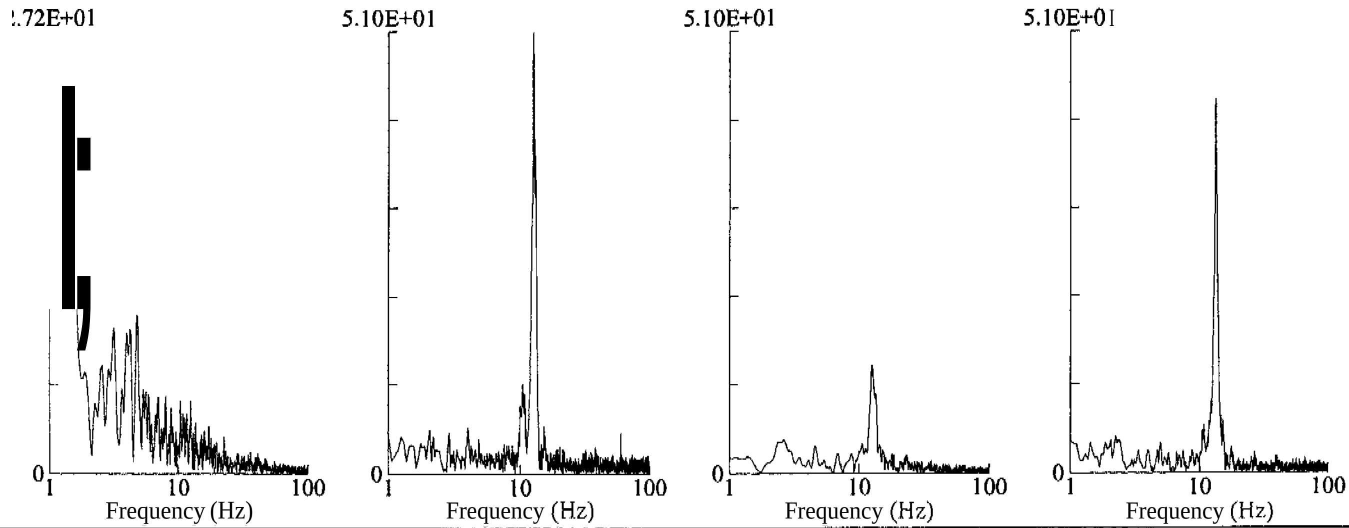
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
***Radial (R):* 0.035in/s 0.889mm/s @ 13.4Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 13.8Hz
Transverse (T): 0.025in/s 0.635mm/s @ 16.5Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

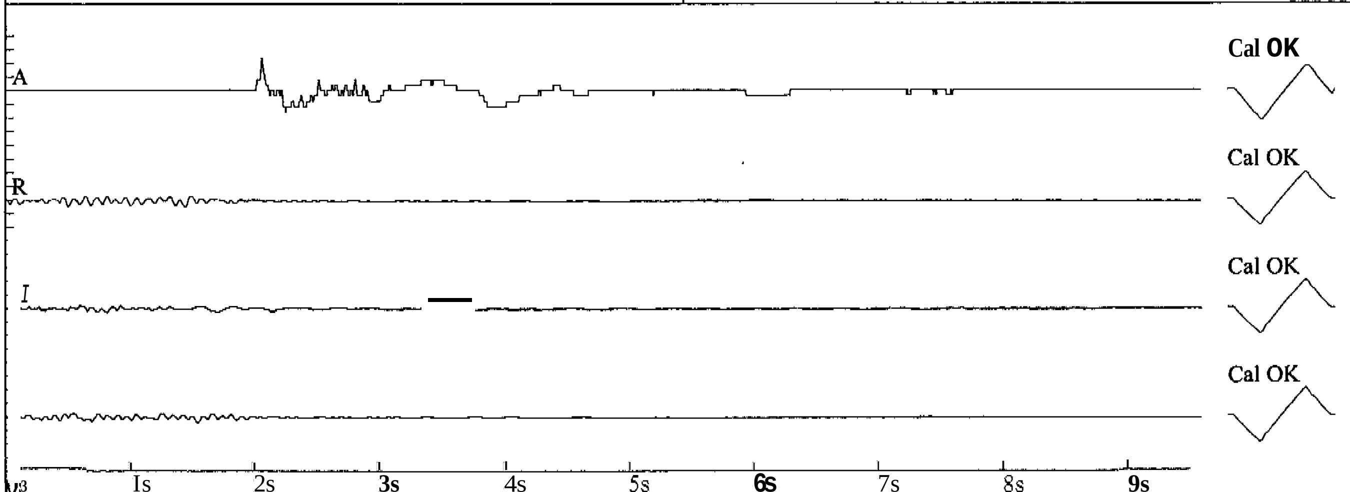
File: D1SAP040.DTB Event Number: 040 Date: 4/11/01 Time: 09:57
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): **116** dB @ ***5.6*** **Hz**
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): **0.025in/s 0.635mm/s @ 10.8Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 9.3Hz
Transverse (T): **0.025in/s 0.635mm/s @ 8.6Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

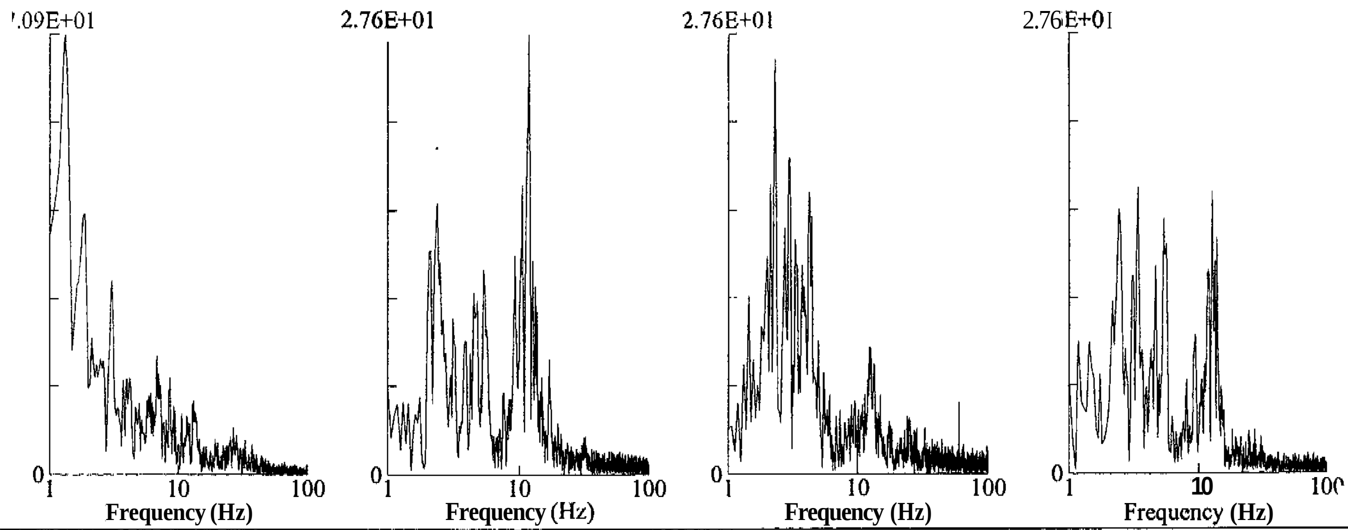
Graph Information

Duration: 0.000 **sec** To: *9.500* **sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (**1.270mm/s/div)**
Time Lines at: 1.00 **sec intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.31 Hz	**11.94 Hz**	**2.31 Hz**	**3.44 Hz**



West Virginia
Dean Sr. shallow

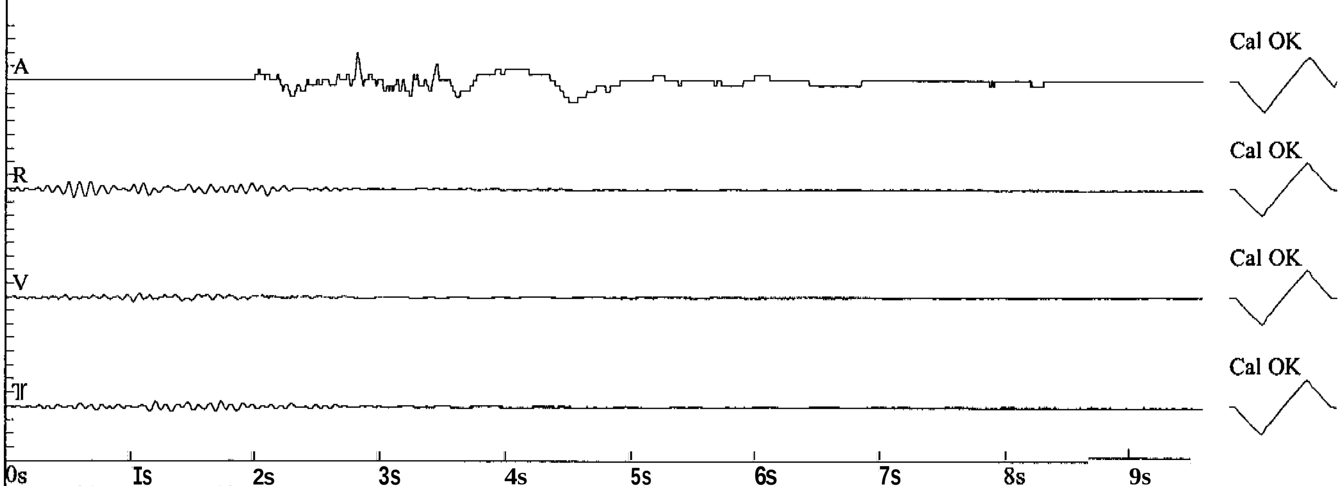
File: D1SAP042.DTB Event Number: 042 Date: 4/12/01 Time: 10:37
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** **Serial** Number: 1781

Amplitudes and Frequencies

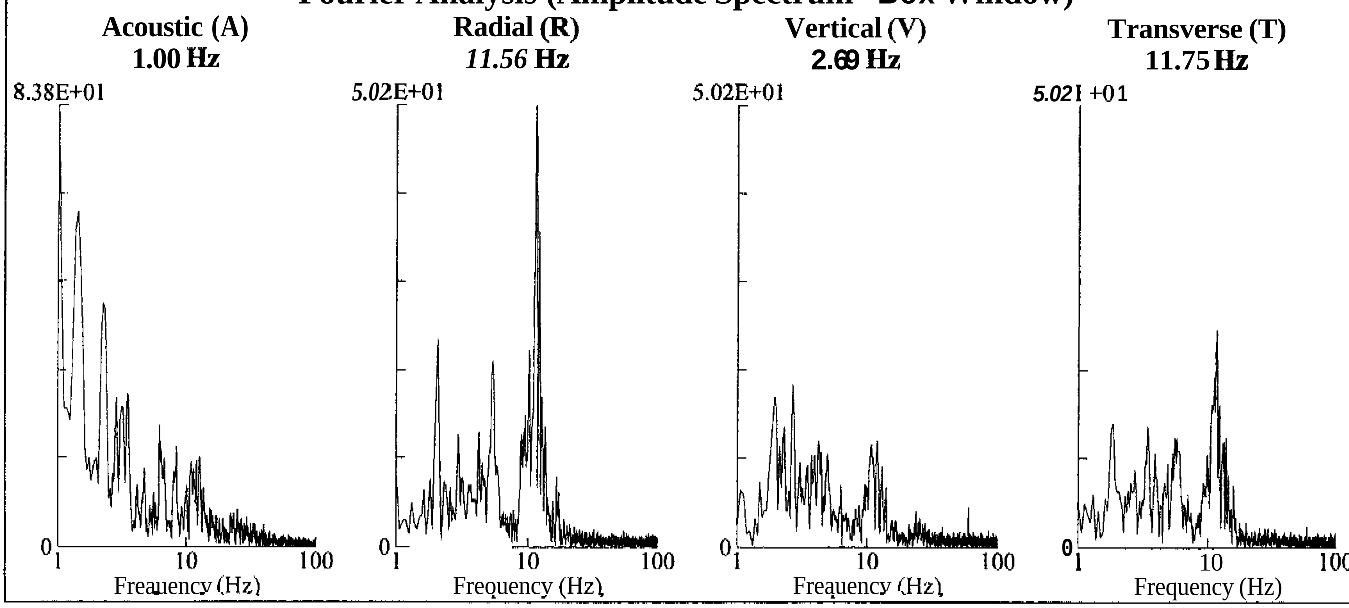
Acoustic (A): 114 dB @ 10.4 Hz
(0.10Mb 0.0015psi 0.0100kPa)
***Radial* (R): 0.035in/s 0.889mm/s @ 11.6Hz**
Vertical (V): 0.02in/s 0.508mm/s @ 12.1Hz
Transverse (T): 0.02in/s 0.508mm/s @ 11.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: 1.00 **sec** intervals



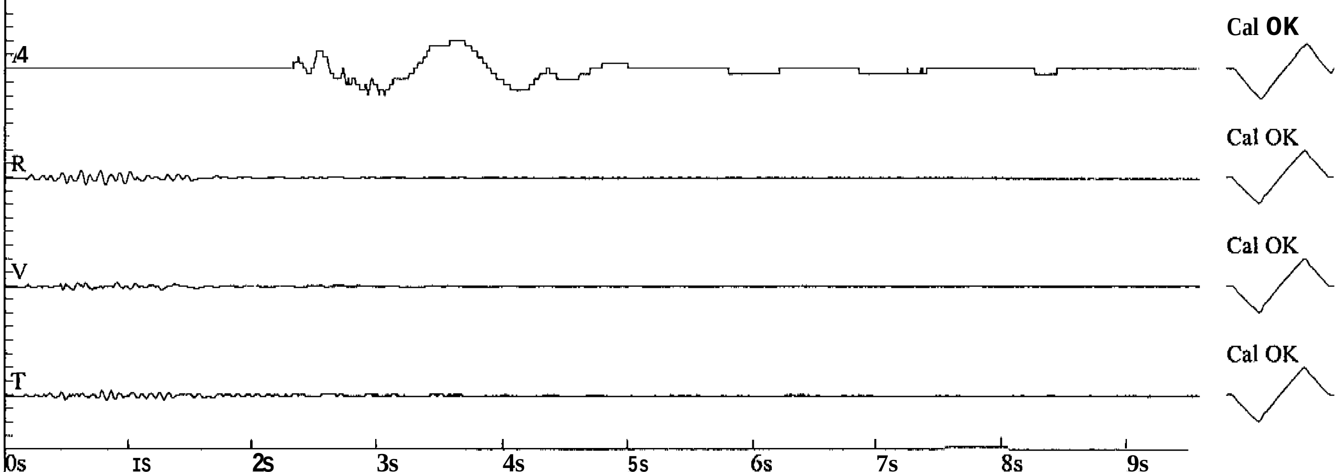
Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Sr. shallow

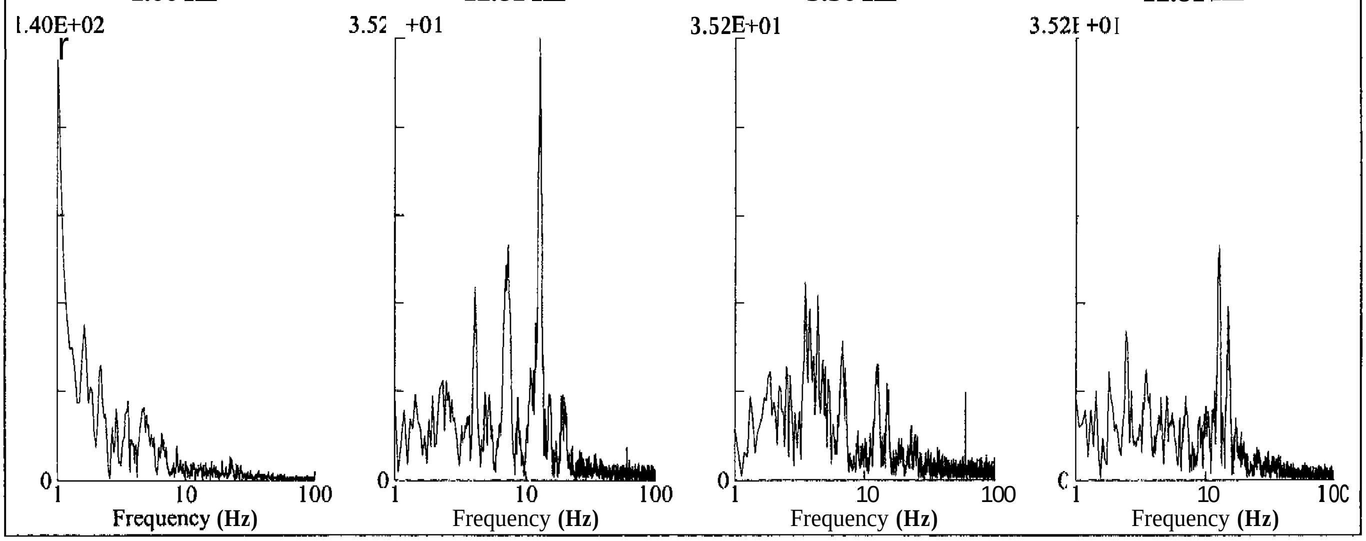
File: D1SAP043.DTB Event Number: 043 Date: 4/12/01 Time: 12:22
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies	Graph Information
Acoustic (A): **114** dB @ 1.1 Hz (0.10Mb 0.0015psi 0.0100kPa)	*Duration: 0.000* sec To: 9.500 sec
Radial ***(R)*:** **0.03in/s 0.762mm/s @ 14.2Hz**	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.015in/s 0.381mm/s @ 11.6Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.02in/s 0.508mm/s @ 13.8Hz	*Time Lines at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**12.81 Hz**	**3.50 Hz**	**12.81 Hz**



West Virginia
Dean Sr. shallow

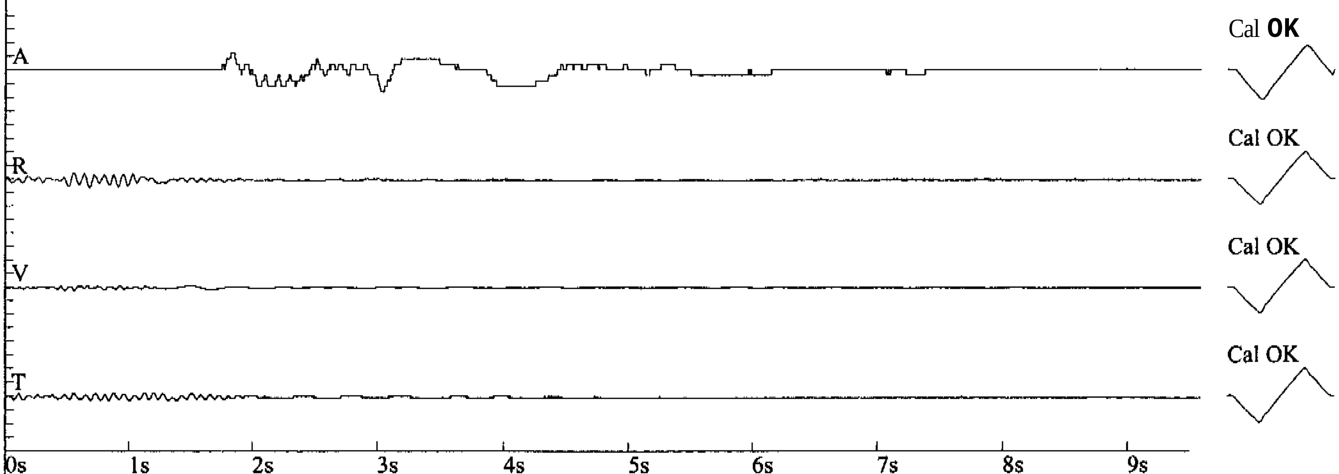
File: D1SAP046.DTB Event Number: 046 Date: 4/13/01 Time: 10:30
Acoustic Trigger: 114 **dB** Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): 112 dB @ 4.2 **Hz**
(0.08Mb 0.0012psi 0.0080kPa)
***Radial (R):* 0.035in/s 0.889mm/s @ 11.9Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 16.5Hz
Transverse (T): 0.015in/s 0.381mm/s @ 15.5Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

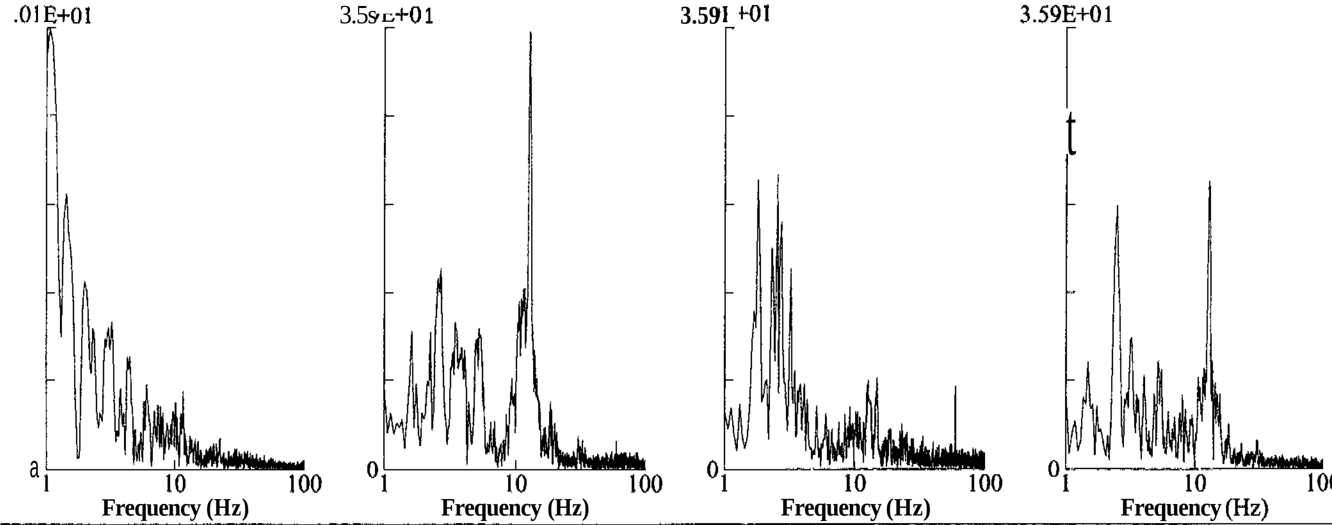
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB **0.20Mb** (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.06 Hz	**12.88 Hz**	**2.56 Hz**	**12.94 Hz**



West Virginia
Dear Sr. deep

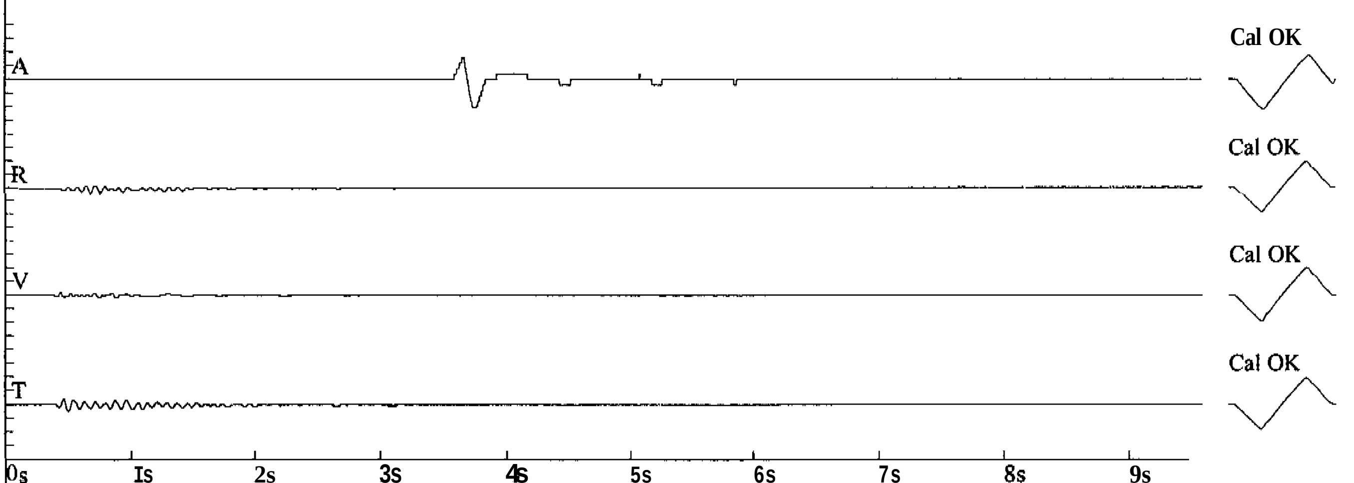
File: D1DAP003.DTB Event Number: 003 Date: 4/3/01 Time: 08:40
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

Acoustic (A): 114 dB @ 3.8 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.02in/s 0.508mm/s @ 16.0Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.025in/s 0.635mm/s @ 12.4Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

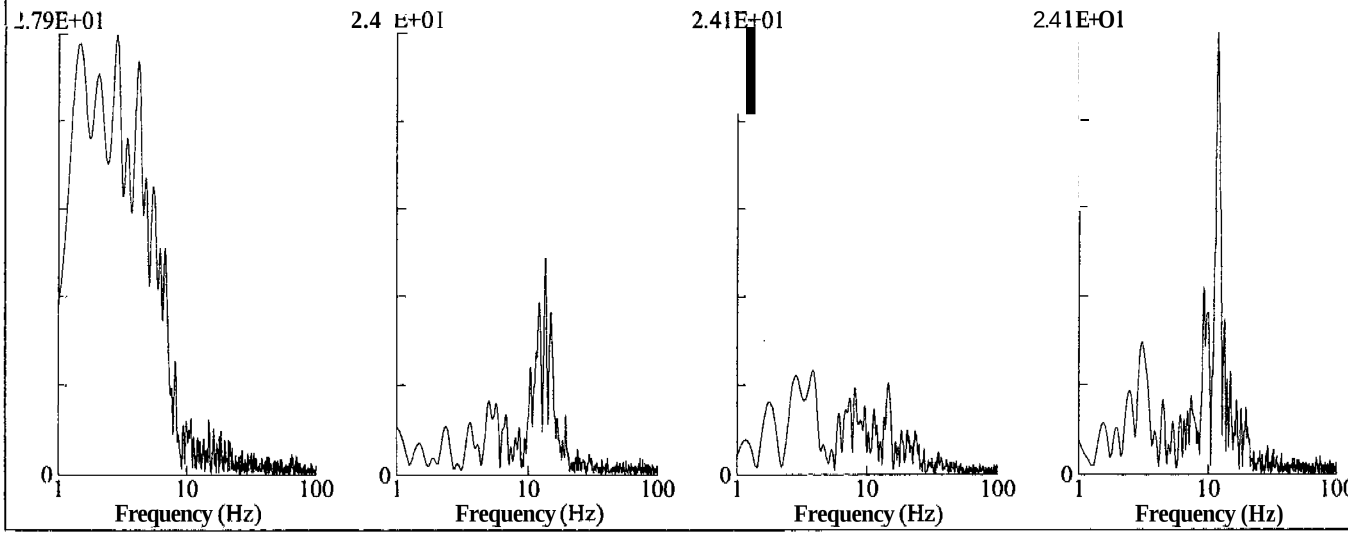
Graph Information

Duration: 0.000 sec **To:** 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
2.88 Hz	13.63 Hz	3.88 Hz	12.06 Hz



West Virginia
Dear Sr. deep

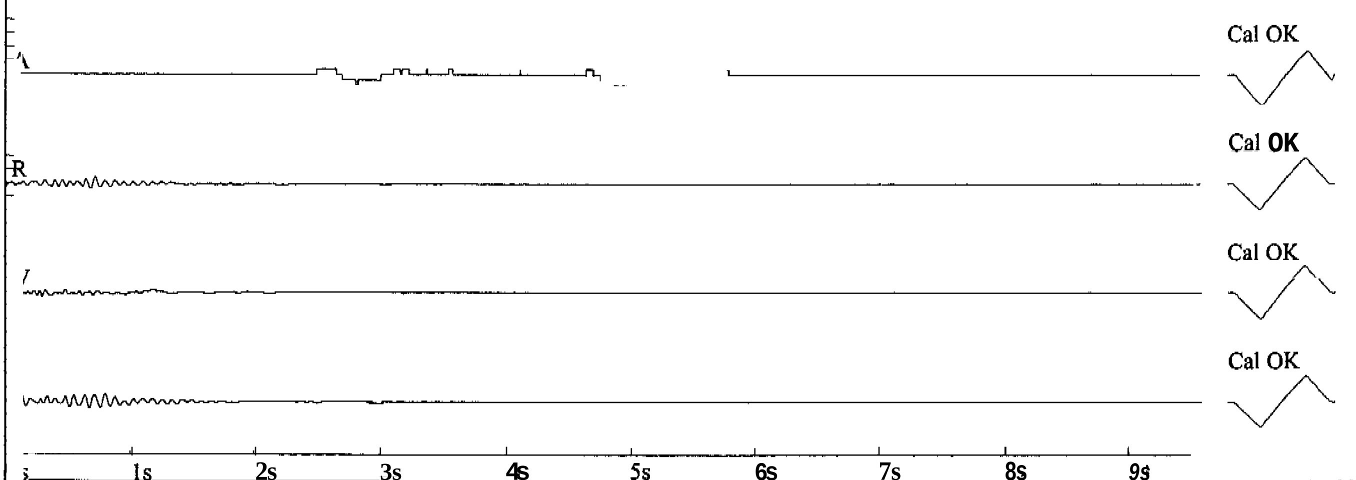
File: D1DAP004.DTB Event Number: 004 Date: 4/3/01 Time: 13:50
Acoustic Trigger: 114dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1782

Amplitudes and Frequencies

Acoustic (A): 106dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial ***(R):*** 0.025in/s 0.635mm/s @ 15.0Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.03in/s 0.762mm/s @ 15.0Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

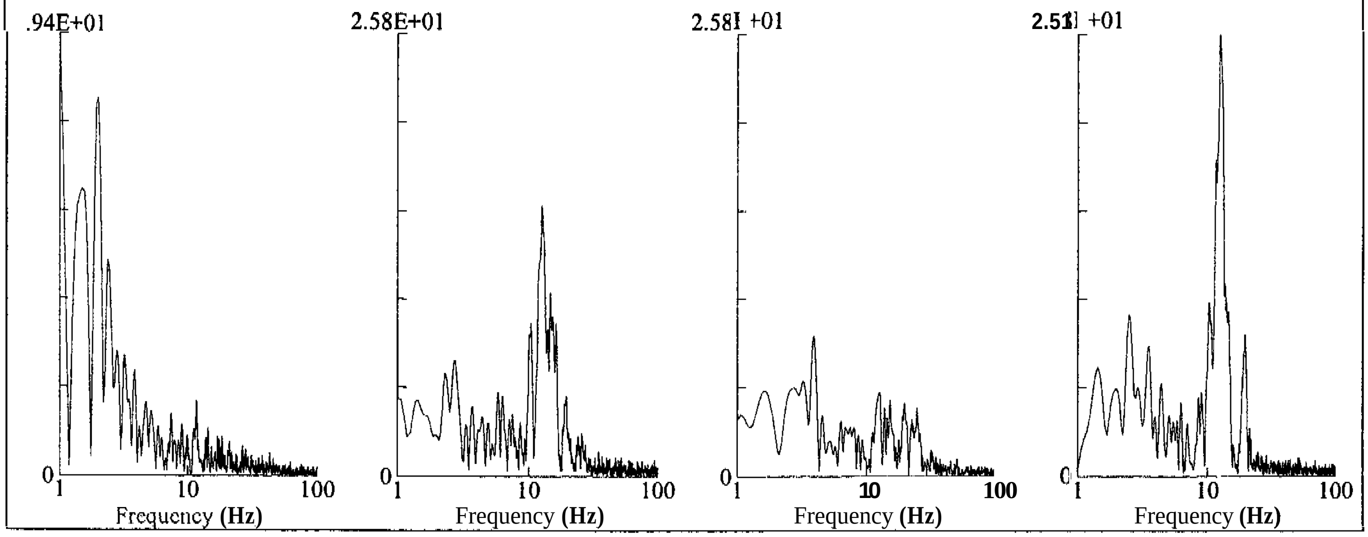
Graph Information

Duration: 0.000 sec **To:** *9.500* sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.00 Hz** | **Radial (R)** **12.75 Hz** | **Vertical (V)** **3.94 Hz** | **Transverse (T)** **12.56 Hz**



West Virginia
Dear Sr. deep

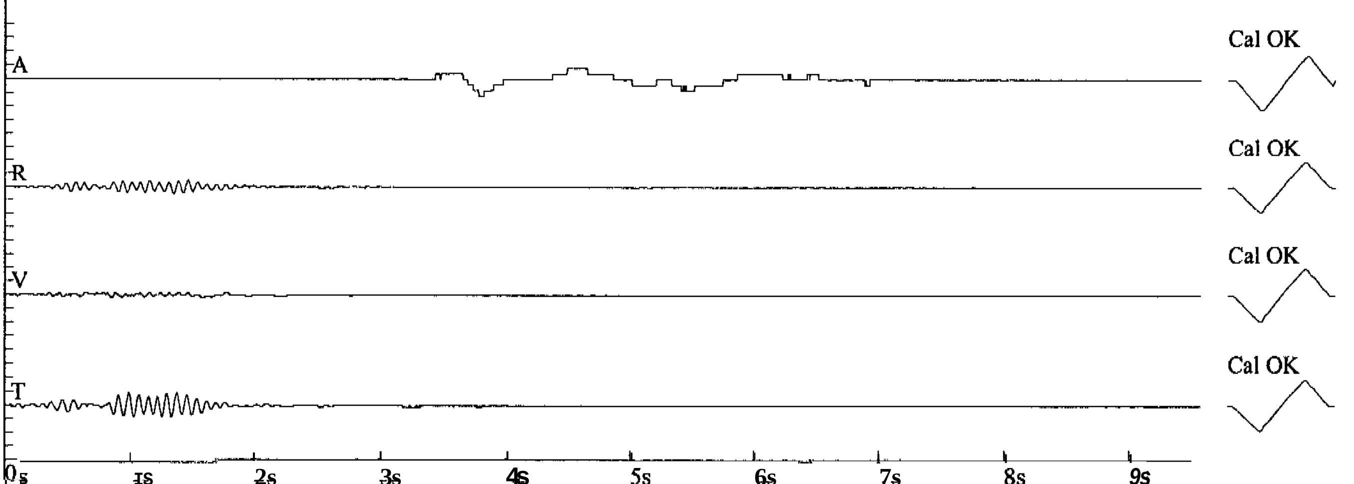
File: D1DAP005.DTB Event **Number:** 005 **Date:** 4/4/01 Time: 11:19
Acoustic **Trigger:** 114 dB Seismic **Trigger:** 0.025in/s 0.635mm/s **Serial Number:** 1782

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 2.1 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.03in/s 0.762mm/s @ 13.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 16.0Hz
***Transverse (T):* 0.045in/s 1.143mm/s @ 13.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

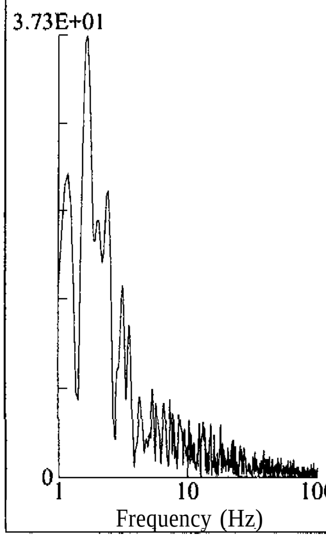
Graph Information

Duration: 0.000 **sec To:** 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals

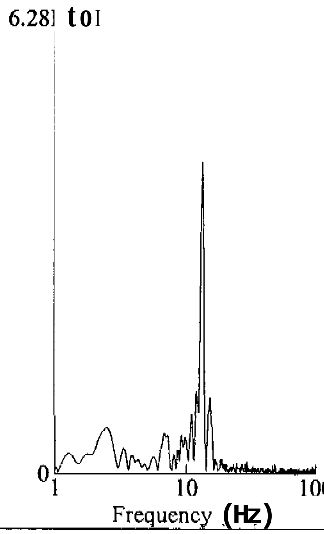


Fourier Analysis (Amplitude Spectrum - Box Window)

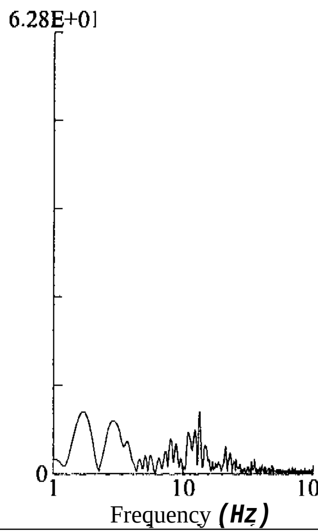
Acoustic (A)
1.69 Hz



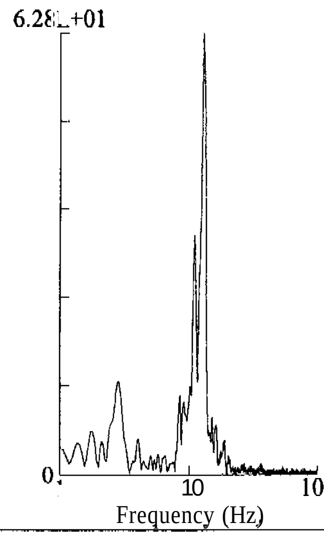
Radial (R)
13.31 Hz



Vertical (V)
1.69 Hz



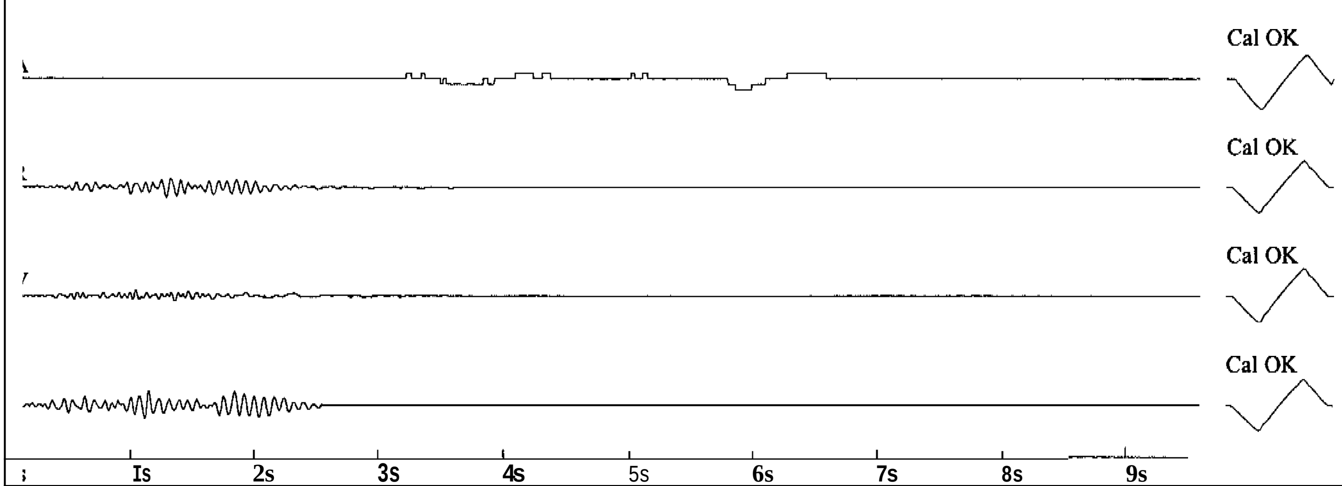
Transverse (T)
12.88 Hz



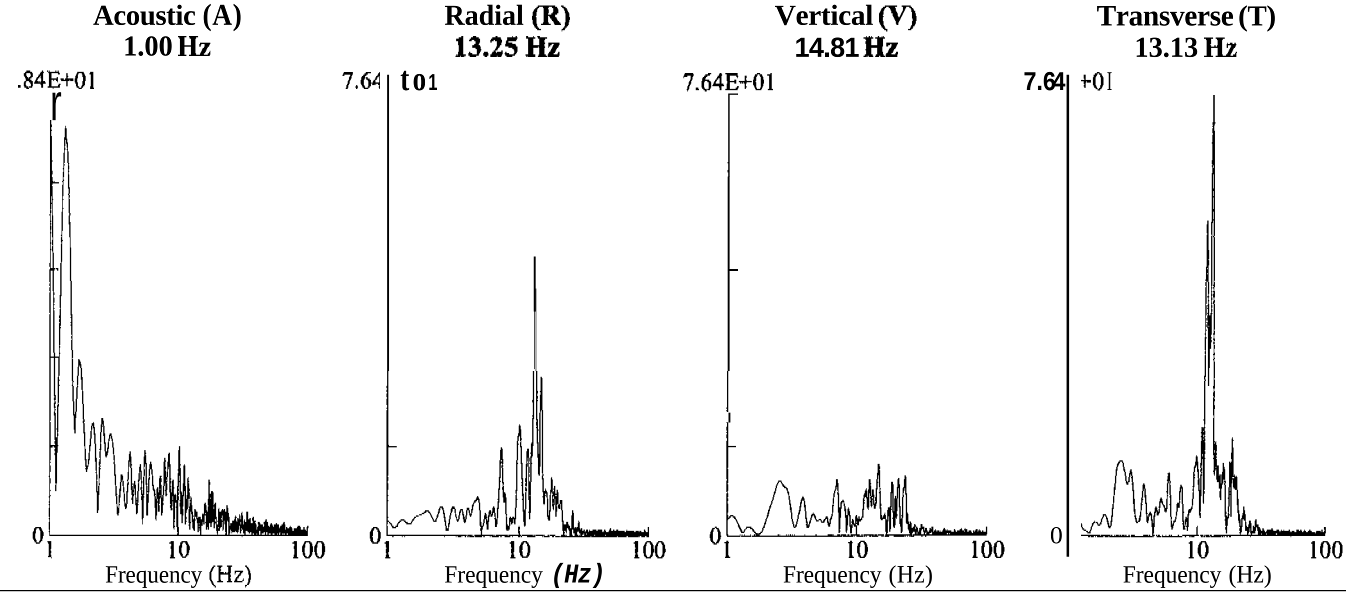
West Virginia
Dear Sr. deep

File: D1DAP006.DTB Event Number: 006 Date: 4/5/01 Time: 10:33
Acoustic **Trigger: 114** dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: **1782**

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 106 dB @ 0.0 Hz (0.04Mb 0.0006psi 0.0040kPa)	***Duration: 0.000*** **sec To: *9.500* sec**
Radial (R): 0.04in/s 1.016mm/s @ 13.8Hz	***Acoustic Scale:*** 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 21.3Hz	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.05in/s 1.27mm/s @ 15.0Hz**	***Time Lines** at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dear Sr. deep

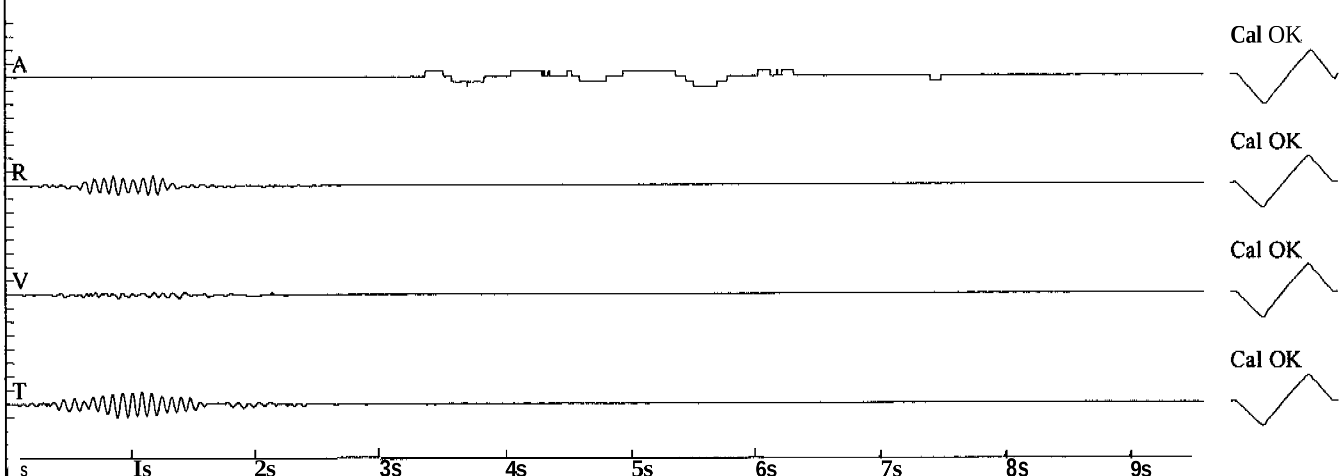
File: D1DAP007.DTB Event Number: 007 Date: 4/6/01 Time: **10:21**
Acoustic Trigger: **114** dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

Acoustic (A): **106** dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.035in/s 0.889mm/s @ 14.6Hz
Vertical (V): 0.015in/s 0.381mm/s @ 17.0Hz
***Transverse (T):* 0.05in/s 1.27mm/s @ 12.4Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

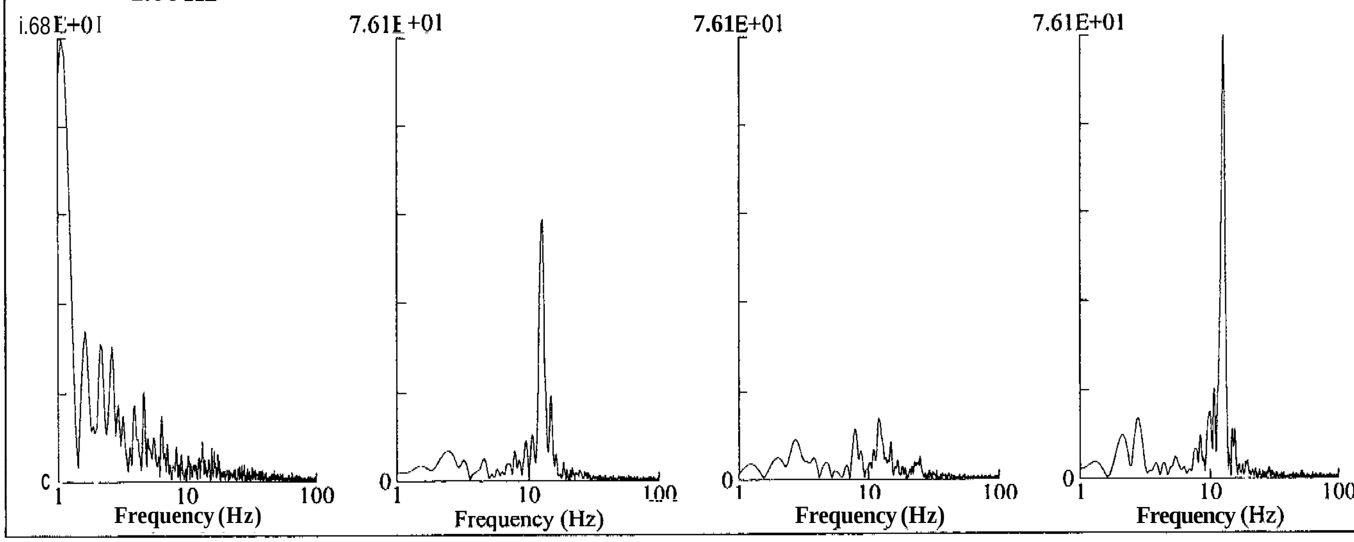
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.06 Hz	**12.75 Hz**	**12.06 Hz**	**12.75 Hz**



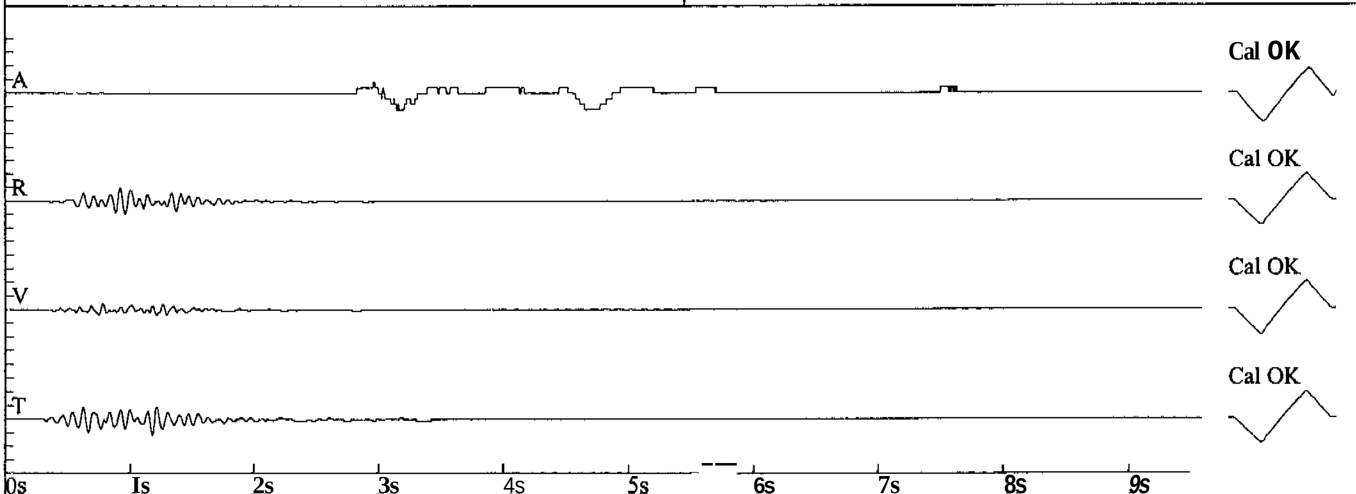
File: D1DAP008.DTB Event Number: 008 Date: 4/6/01 Time: 15:42
Acoustic Trigger: 114 **dB** Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1782

Amplitudes and Frequencies

Acoustic (A): 110 dB @ **2.7** Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.05in/s 1.27mm/s @ 13.4Hz
Vertical (V): 0.02in/s **0.508mm/s** @ 18.9Hz
Transverse ***(T):*** **0.06in/s 1.524mm/s @ 13.4Hz**
Calibration Date *(yyyy/mm/dd):* 2000/11/22

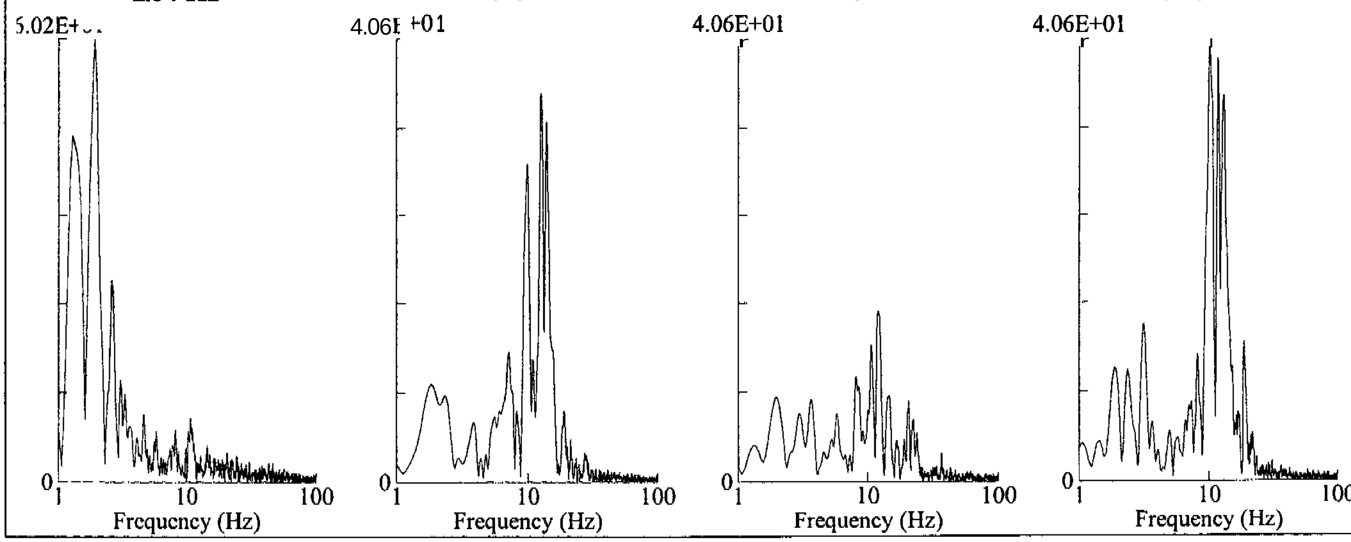
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.94 Hz** | **Radial (R)** **12.75 Hz** | **Vertical (V)** **12.13 Hz** | **Transverse (T)** **10.19 Hz**



West Virginia
Dear Sr. deep

File: D1DAP015.DTB **Event** Number: 015 Date: **4/9/0** **Time:** 12:40
Acoustic Trigger: 114 dB **Seismic Trigger:** 0.025in/s 0.635mm/s **Serial** Number: 1782

Amplitudes and Frequencies

Acoustic (A): **114** dB @ 1.5 Hz
(0.10Mb 0.0015psi 0.0100kPa)

Radial (R): **0.03in/s 0.762mm/s @ 15.5Hz**

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.025in/s 0.635mm/s @ 12.4Hz

Calibration Date *(yyyy/mm/dd):* 2000/11/22

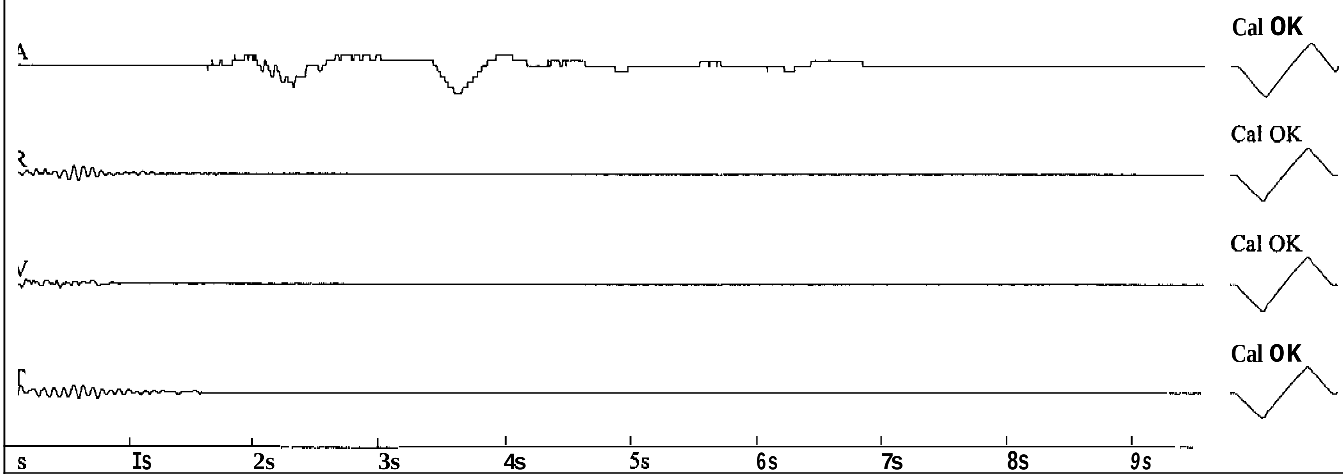
Graph Information

Duration: 0.000 sec To: 9.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

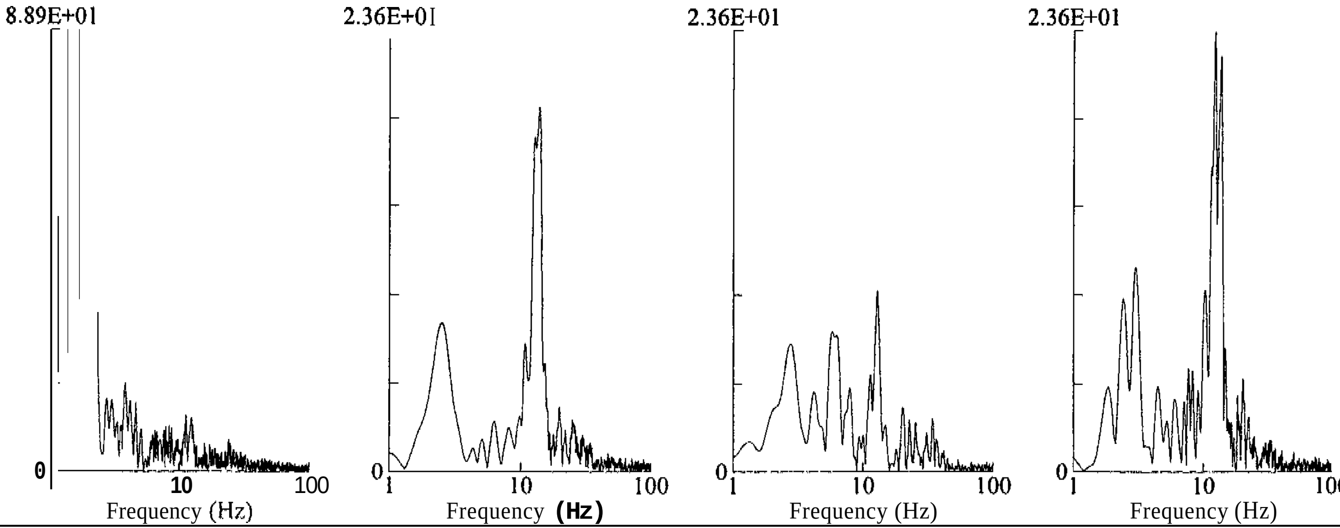
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time ***Lines at:*** 1.00 sec intervals



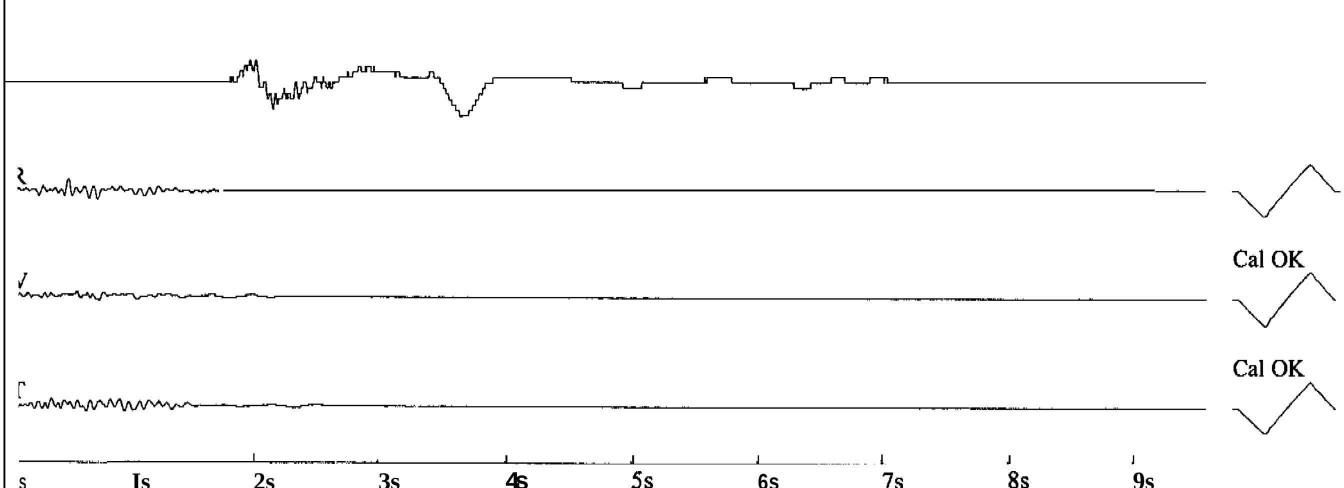
Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.50 Hz** | **Radial (R)** **14.00 Hz** | **Vertical (V)** **13.06 Hz** | **Transverse (T)** ***12.38*** **Hz**



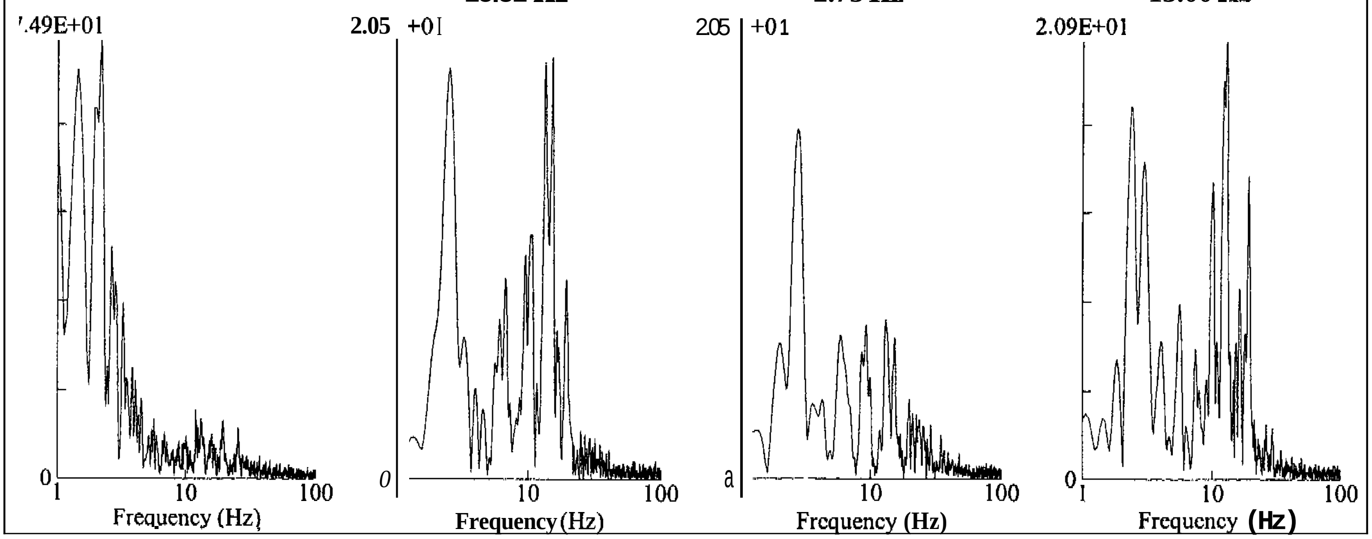
West Virginia
Dear Sr. deep

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 116dB @ 1.6Hz (0.12Mb 0.0017psi 0.0120kPa)	*Duration:* 0.000 sec To: 9.500 sec
***Radial (R):* 0.04in/s 1.016mm/s @ 13.8Hz**	***Acoustic Scale:*** 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 9.3Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.025in/s 0.635mm/s @ 12.8Hz	*Time Lines at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
2.19 Hz	**15.31 Hz**	**2.75 Hz**	**13.00 Hz**



West Virginia
Dear Sr. deep

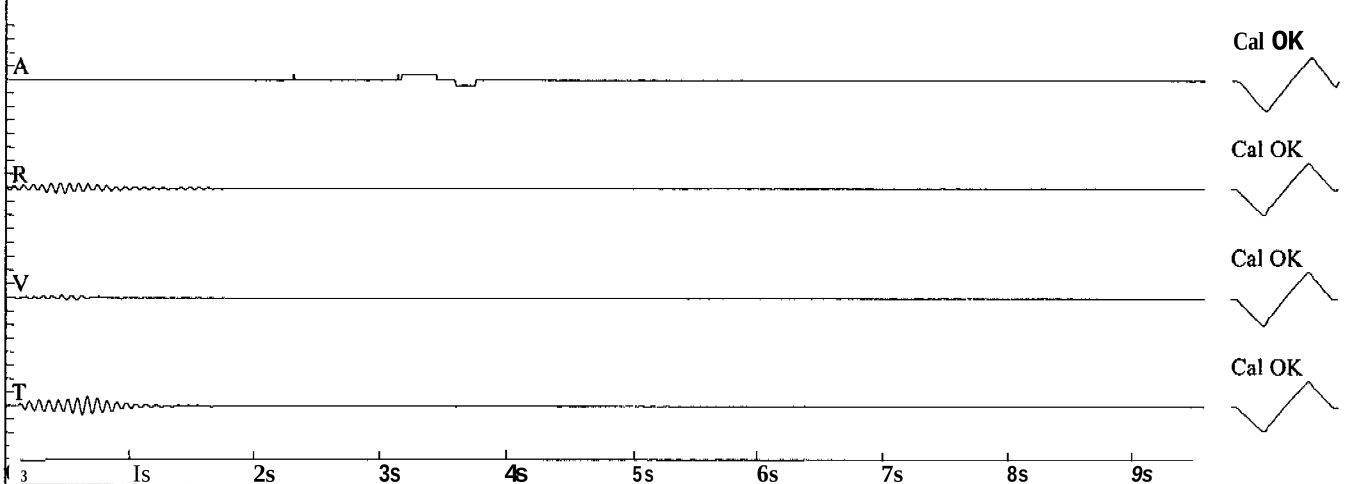
File: D1DAP017.DTB Event Number: 017 Date: 4/10/01 Time: 16:52
Acoustic Trigger: 114dB **Seismic Trigger:** 0.025in/s 0.635mm/s Serial Number: **1782**

Amplitudes and Frequencies

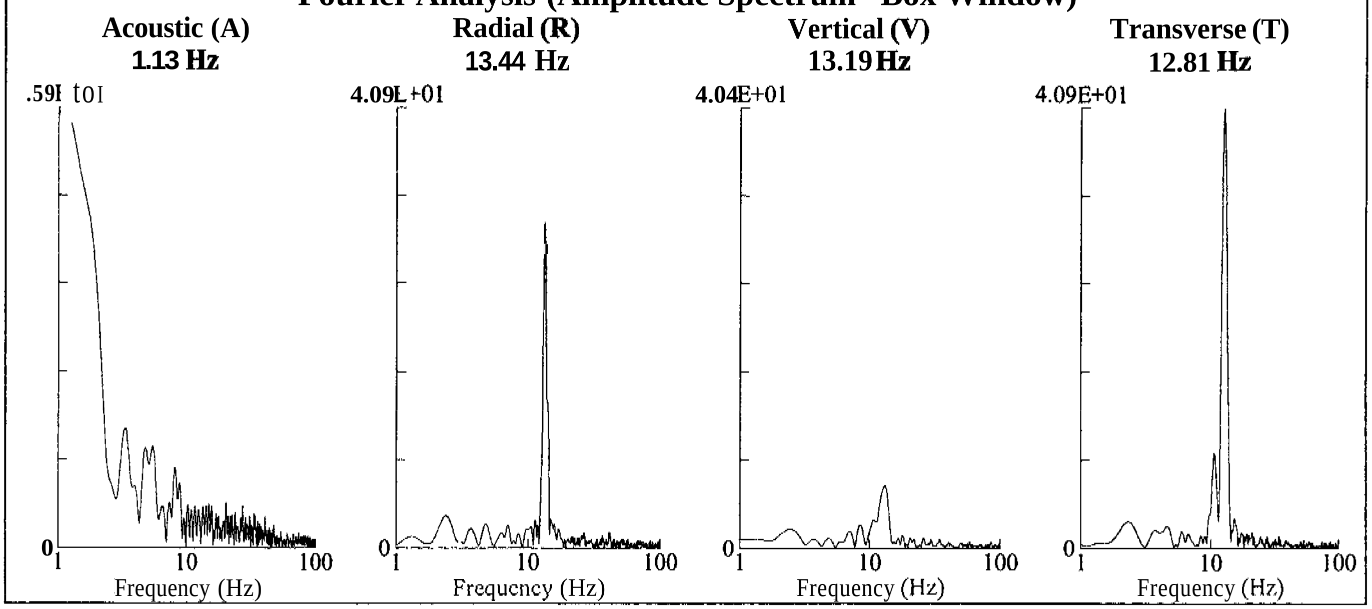
Acoustic (A): 100dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.02in/s 0.508mm/s @ 17.0Hz
Vertical *(V):* 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.035in/s 0.889mm/s @ 14.2Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic *Scale:*
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



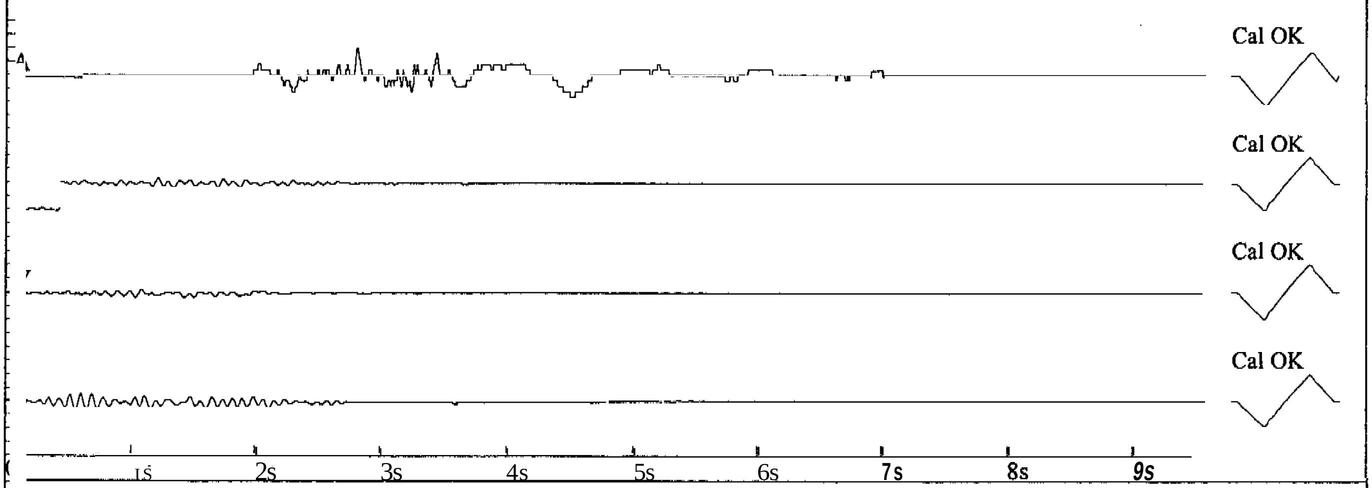
File: D1DAP026.DTB Event Number: **026** Date: 4/12/01 Time: 10:36
Acoustic **Trigger: 114** dB **Seismic** Trigger: 0.025in/s 0.635mm/s **Serial** Number: **1782**

Amplitudes and Frequencies

Acoustic (A): 114 dB @ 10.0 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial ***(R):*** 0.02in/s **0.508mm/s** @ 13.4Hz
Vertical (V): 0.015in/s **0.381mm/s** @ 12.8Hz
Transverse (T): **0.03in/s 0.762mm/s @ 13.8Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

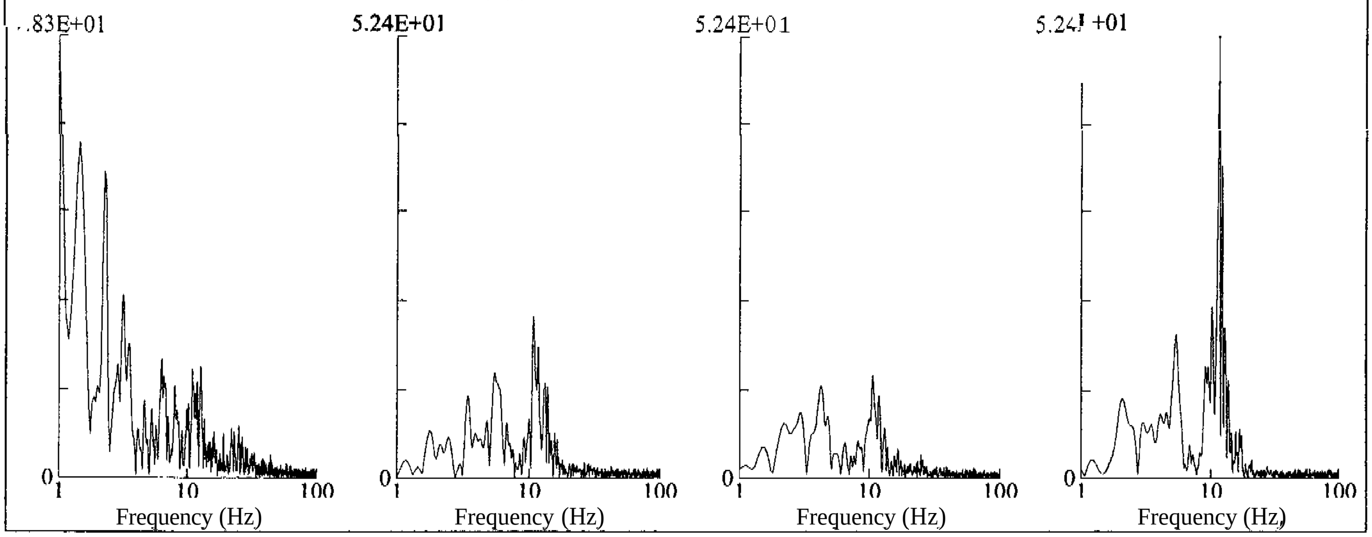
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: ***1.00*** **sec** intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

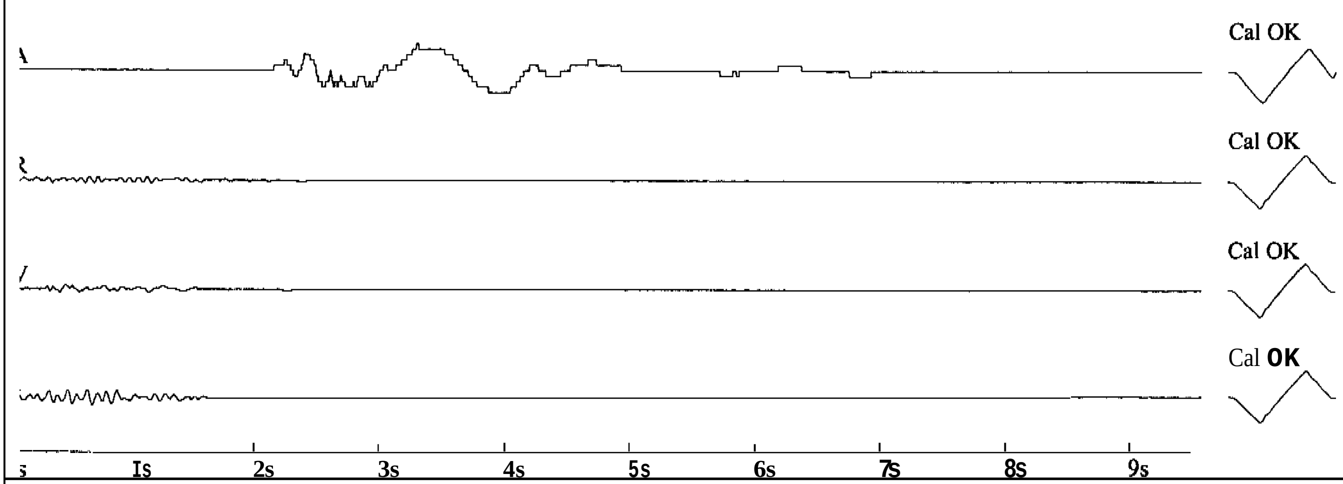
Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**10.88 Hz**	**10.69 Hz**	**11.63 Hz**



West Virginia
Dear Sr. deep

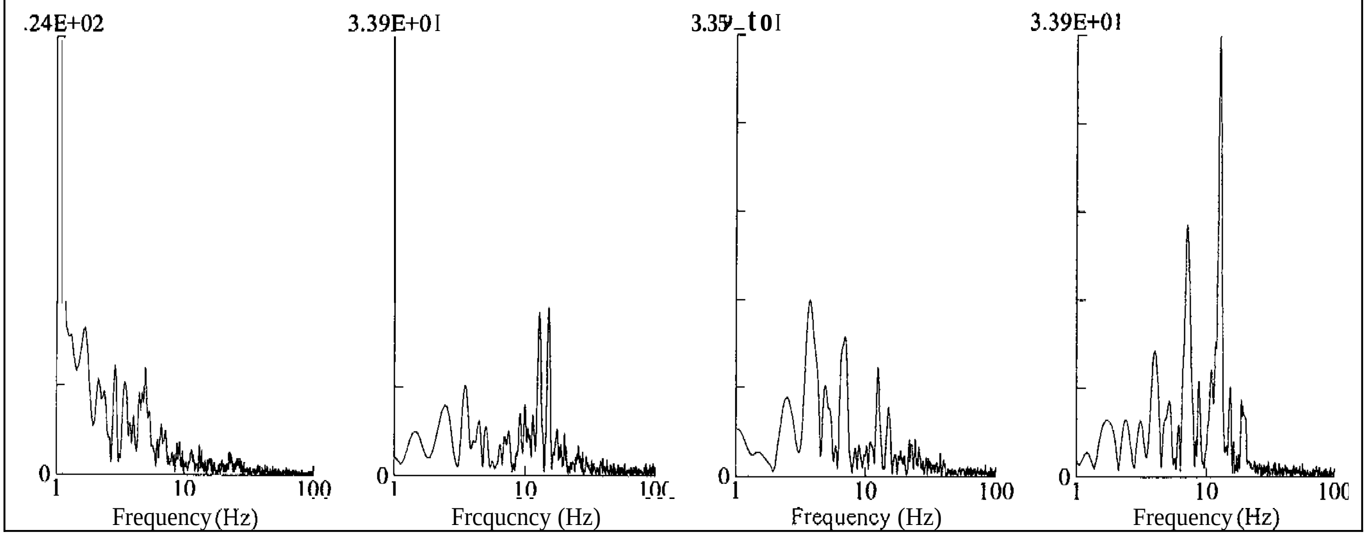
File: D1DAP027.DTB Event Number: 027 Date: 4/12/01 Time: 12:21
A ustic Trigger: 114dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number:

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 114dB @ 1.3Hz	***Duration:*** 0.000 sec To: 9.500 sec
(0.10Mb 0.0015psi 0.0100kPa)	Acoustic Scale:
Radial (R): 0.015in/s **0.381mm/s** @ 20.4Hz	120dB 0.20Mb (0.050Mb/div)
Vertical *(V)*: 0.015in/s 0.381mm/s @ 8.6Hz	***Seismic*** Scale:
***Transverse (T):* 0.03in/s 0.762mm/s @ 12.4Hz**	0.20in/s **(0.050in/s/div) 5.08mm/s** (1.270mm/s/div)
Calibration Date (yyyy/mm/dd): 2000/11/22	***Time Lines at:*** 1.00 **sec intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**15.13 Hz**	**3.75 Hz**	**12.75 Hz**



West Virginia
Dear Sr. deep

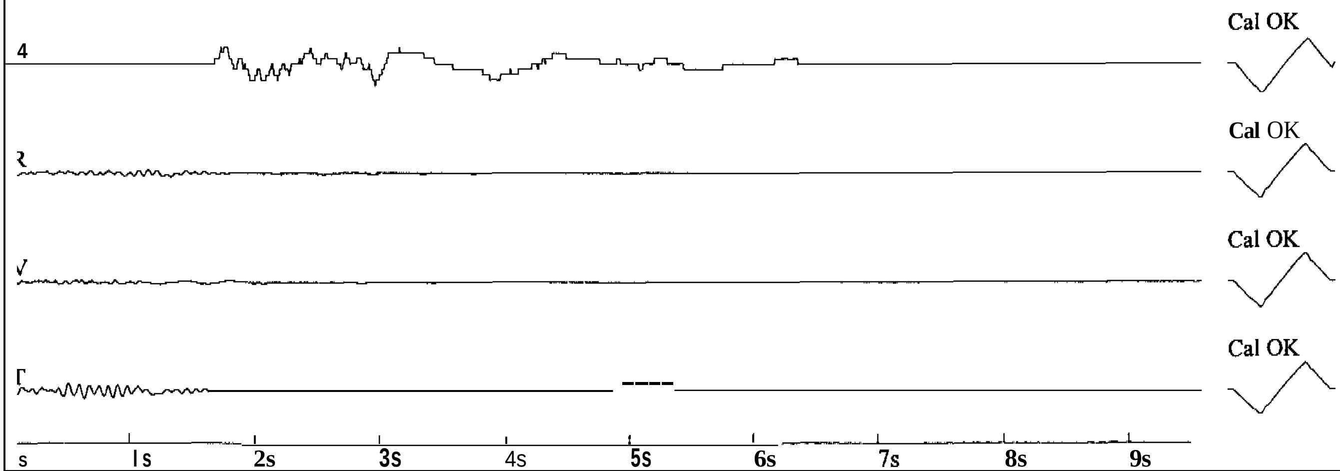
File: D1DAP028.DTB Event **Number:** 028 **Date:** 4/13/01 Time: 10:29
Acoustic Trigger: 114 dB Seismic **Trigger:** 0.025in/s 0.635mm/s **Serial** Number: **1782**

Amplitudes and Frequencies

Acoustic (A): 112 dB @ 5.0 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.015in/s 0.381mm/s @ 17.6Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): **0.03in/s 0.762mm/s @ 12.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

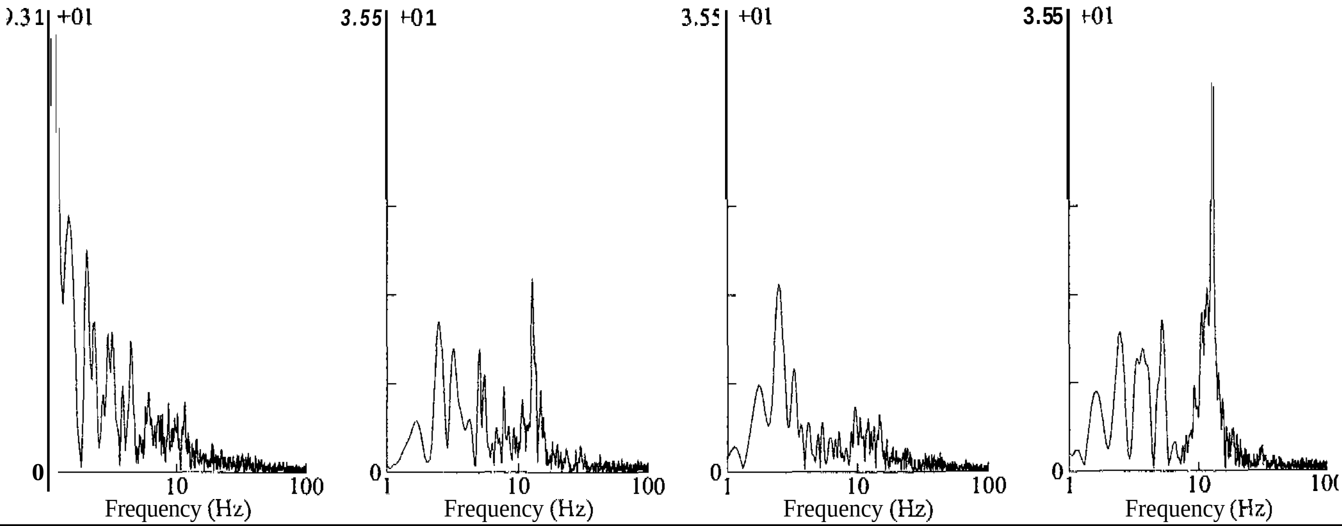
Graph Information

Duration: 0.000 sec **To:** 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

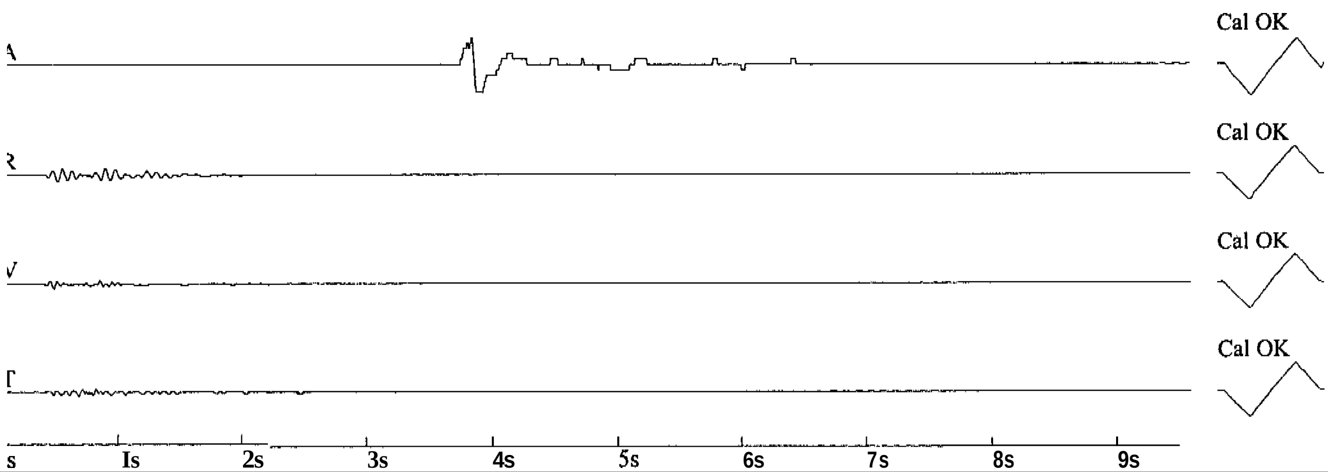
Acoustic (A) **1.13 Hz** | **Radial (R)** **13.00 Hz** | **Vertical (V)** **2.50 Hz** | **Transverse (T)** **12.94 Hz**



West Virginia
Dean Jr. surface

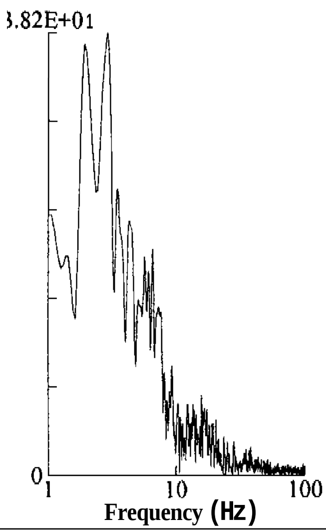
File: D2SAP005.DTB Event Number: 005 Date: 4/3/01 Time: 08:38
Acoustic Trigger: 114 dB **Seismic** Trigger: 0.025in/s **0.635mm/s** Serial Number: *779*

Amplitudes and Frequencies	Graph Information
Acoustic (A): **114** dB @ **5.4Hz** (0.10Mb 0.0015psi 0.0100kPa)	***Duration:*** *0.000* sec To: ***9.500*** sec
***Radial (R):* 0.025in/s 0.635mm/s @ 15.5Hz**	***Acoustic*** *Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.015in/s 0.381mm/s @ 20.4Hz	***Time Lines at:*** 1.00 sec intervals
Calibration Date *(yyyy/mm/dd):* 2000/11/22	

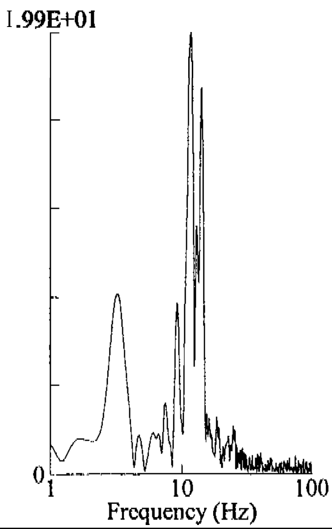


Fourier Analysis (Amplitude Spectrum - Box Window)

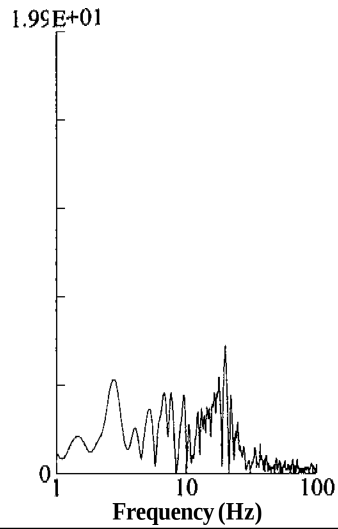
Acoustic (A)
2.94 Hz



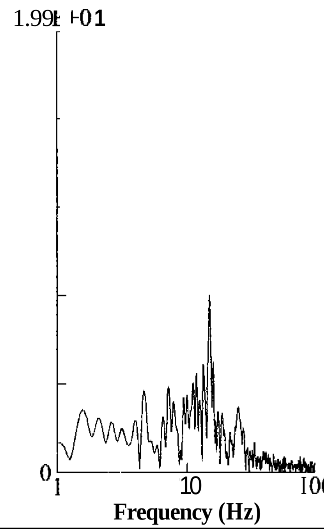
Radial (R)
11.94 Hz



Vertical (V)
20.13 Hz



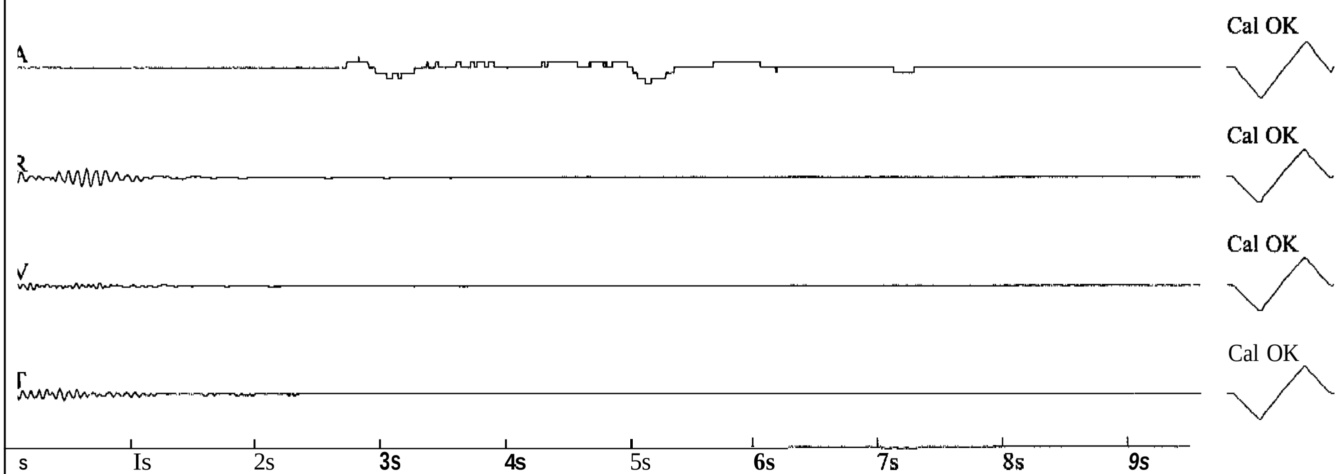
Transverse (T)
15.19 Hz



West Virginia
Dean Jr. surface

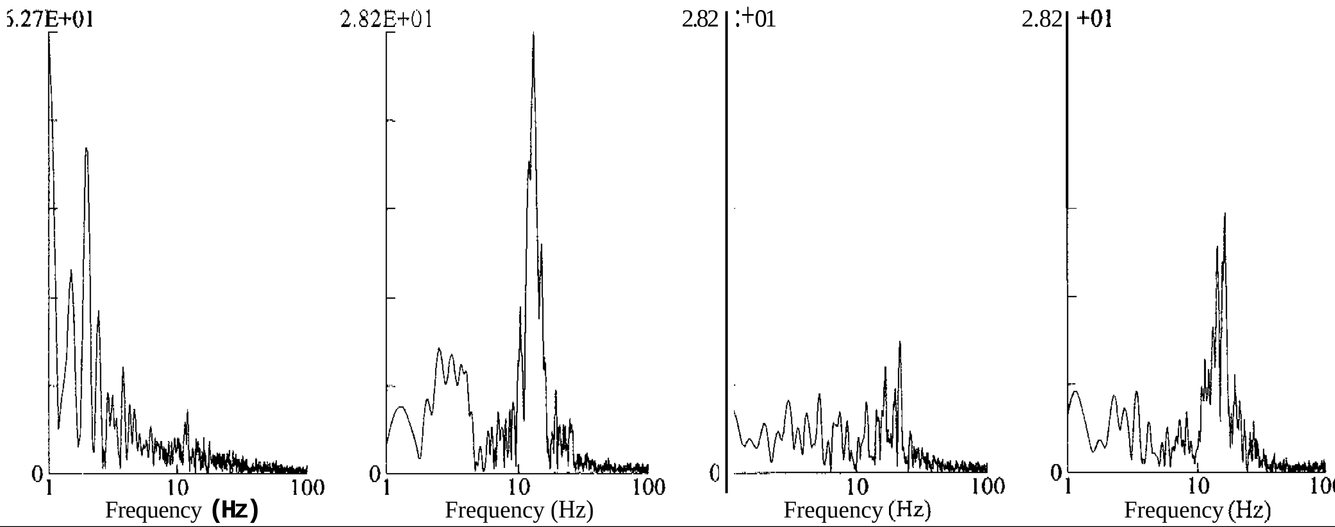
File: D2SAP007.DTB Event Number: 007 **Date: 4/3/01** Time: 13:48
Acoustic **Trigger:** 114 dB **Seismic** Trigger: 0.025in/s **0.635mm/s** **Serial Number:** 1779

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): **110** dB @ 1.6 **Hz** (0.06Mb 0.0009psi 0.0060kPa)	***Duration:*** 0.000 sec To: 9.500 sec
***Radial (R):* 0.035in/s 0.889mm/s @ 14.2Hz**	***Acoustic*** *Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V)*:* 0.01in/s **0.254mm/s** @ 0.0Hz	***Seismic*** *Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (**1.270mm/s/div**)
Transverse (T)*:* 0.015in/s **0.381mm/s** @ 22.2Hz	***Time*** *Lines at:* 1.**00 sec intervals**
Calibration Date *(yyyy/mm/dd):* 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	13.19 Hz	21.69 Hz	16.56 Hz



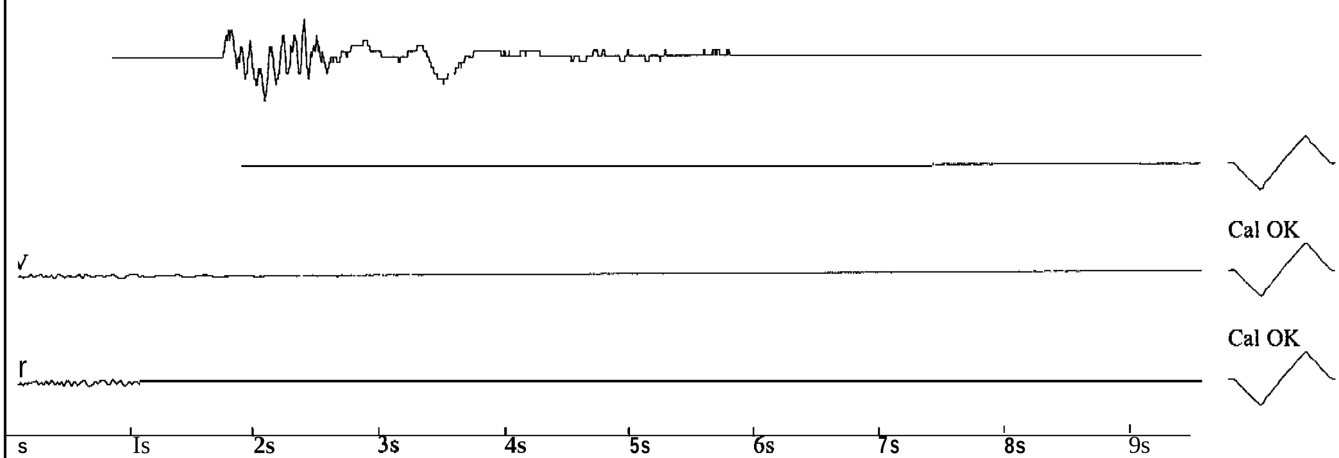
West Virginia
Dean Jr. surface

Amplitudes and Frequencies

Acoustic (A): 118 dB @ **3.8 Hz**
(0.16Mb 0.0023psi 0.0160kPa)
***Radial (R):* 0.025in/s 0.635mm/s @ 13.1Hz**
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.015in/s 0.381mm/s @ 8.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

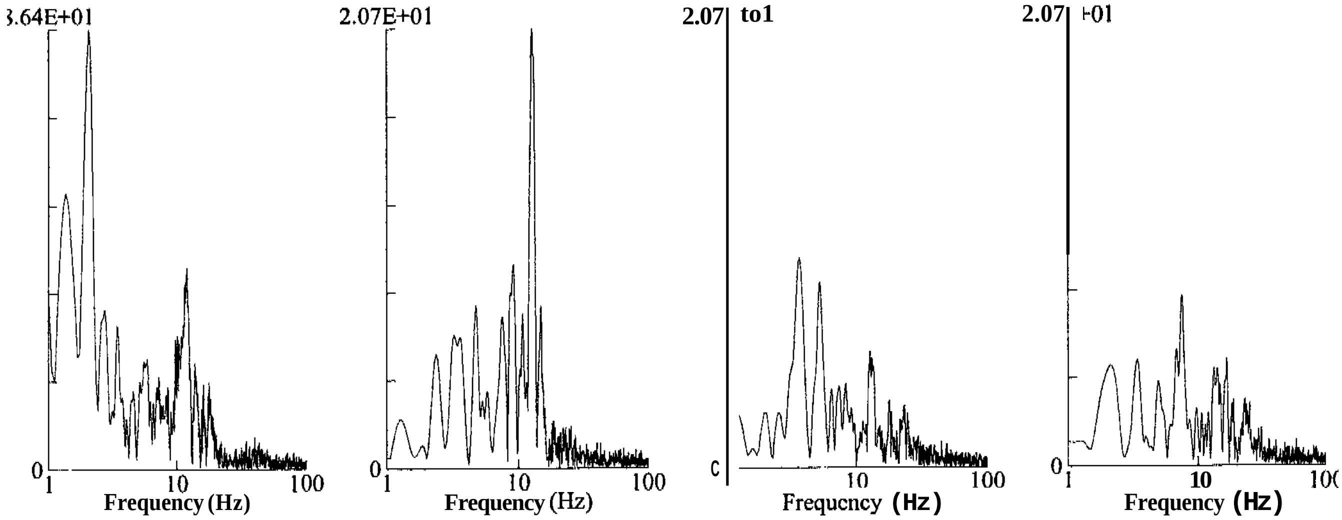
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **2.06 Hz** | **Radial (R)** **12.81 Hz** | **Vertical (V)** **3.63 Hz** | **Transverse (T)** **7.56 Hz**



West Virginia
Dean Jr. surface

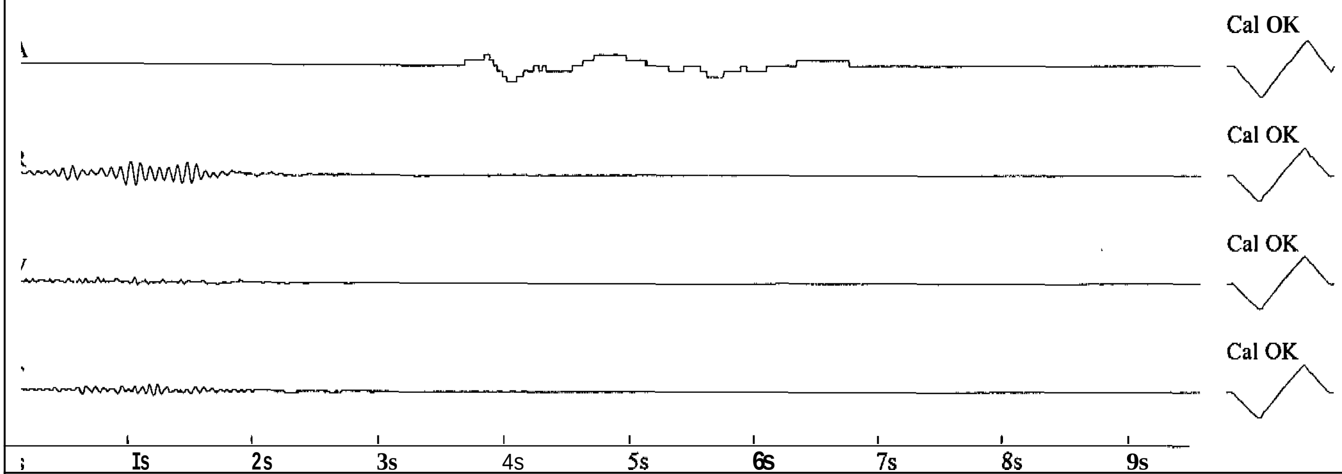
File: D2SAP010.DTB Event Number: 010 **Date:** 4/4/01 Time: 11:18
Acoustic Trigger: 114 dB **Seismic** Trigger: 0.025in/s 0.635mm/s Serial **Number: 1779**

Amplitudes and Frequencies

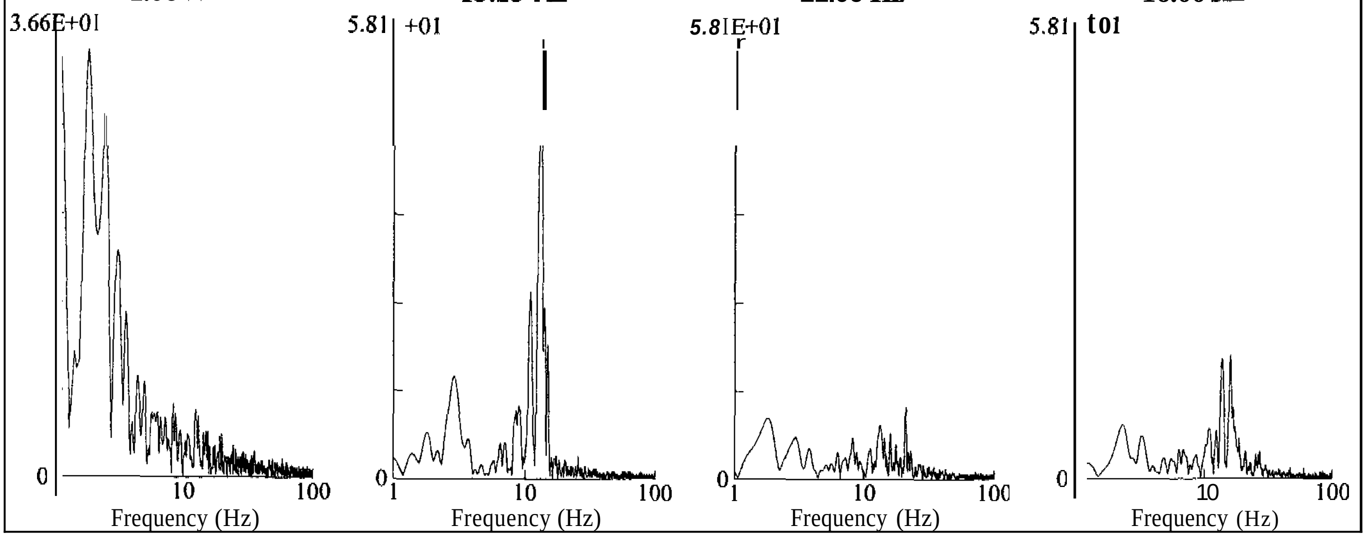
Acoustic (A): 110 dB @ **2.0** Hz
(0.06Mb 0.0009psi 0.0060kPa)
***Radial (R):* 0.045in/s 1.143mm/s @ 11.9Hz**
vertical (V): 0.015in/s 0.381mm/s @ 10.0Hz
Transverse (T): 0.02in/s 0.508mm/s @ 21.3Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Jr. surface

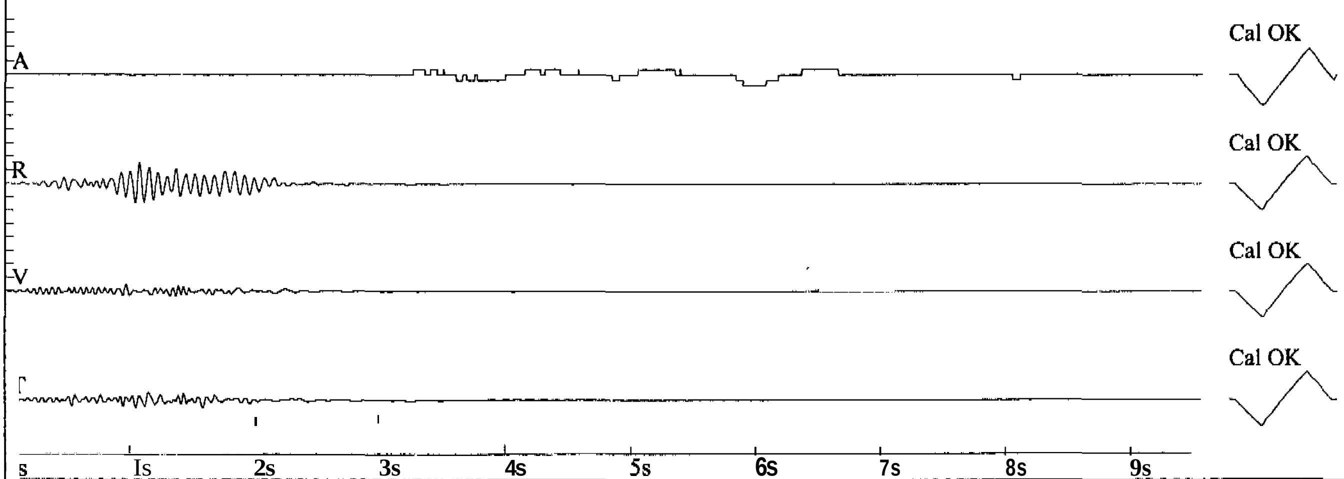
File: D2SAP011.DTB Event Number: 011 Date: 4/5/01 Time: 10:31
Acoustic Trigger: 114dB Seismic **Trigger:** 0.025in/s 0.635mm/s **Serial** Number: 1779

Amplitudes and Frequencies

Acoustic (A): 106dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
***Radial (R):* 0.08in/s 2.032mm/s @ 14.2Hz**
Vertical (V): 0.025in/s 0.635mm/s @ 18.2Hz
Transverse (T): 0.03in/s 0.762mm/s @ 17.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

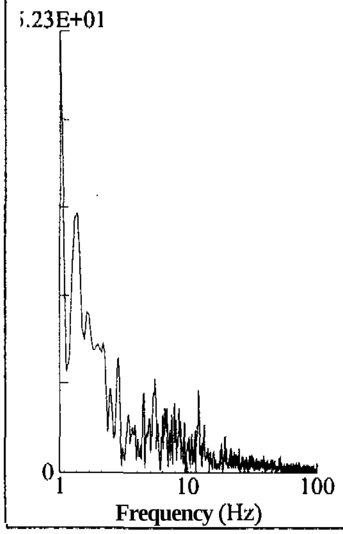
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Time Lines** at:* 1.00 sec **intervals**

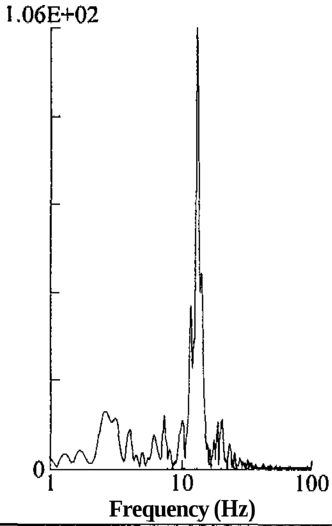


Fourier Analysis (Amplitude Spectrum - Box Window)

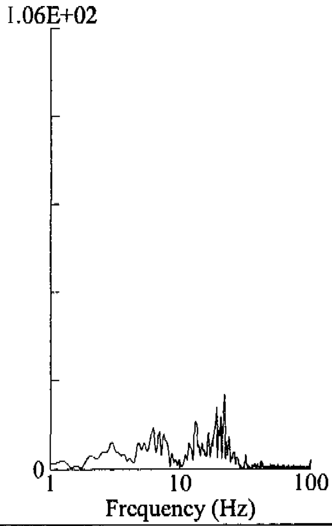
Acoustic (A)
1.00 Hz



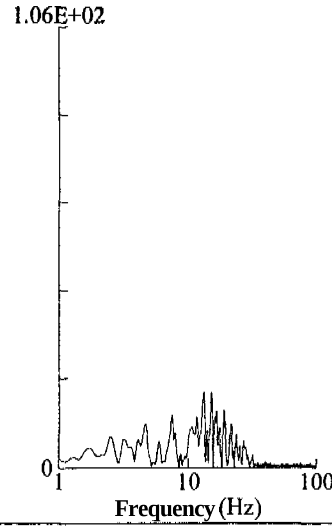
Radial (R)
13.06 Hz



Vertical (V)
21.81 Hz



Transverse (T)
13.19 Hz



West Virginia
Dean Jr. surface

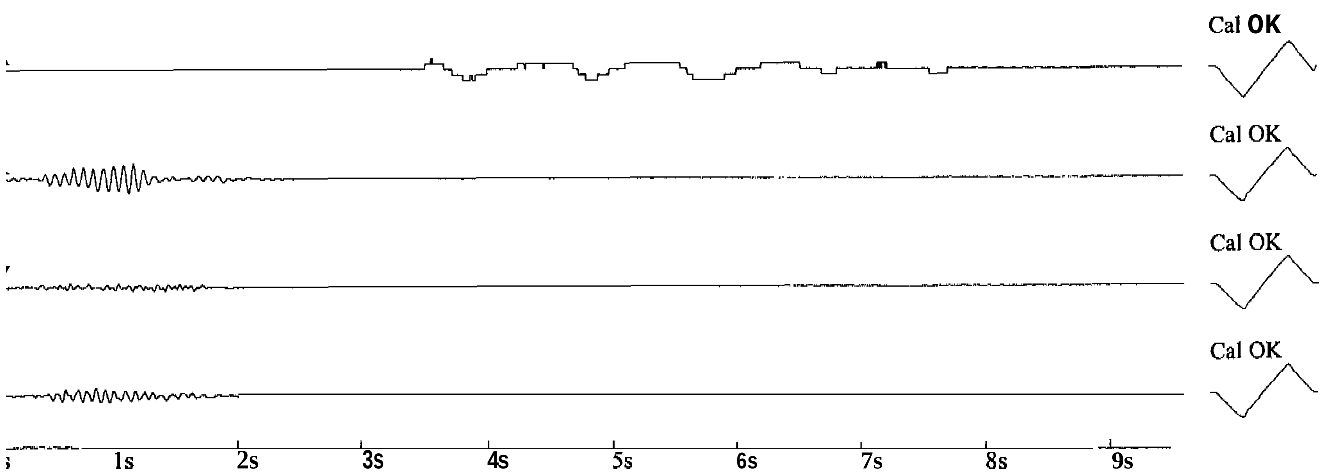
File: D2SAP012.DTB Event Number: 012 Date: 4/6/01 Time: **10:19**
Acoustic Trigger: 114 dB **Seismic Trigger:** 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

coustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
adial (R): **0.055in/s 1.397mm/s @ 13.8Hz**
ertical (V): 0.015in/s 0.381mm/s @ 24.3Hz
ransverse (T): 0.025in/s 0.635mm/s @ **15.0Hz**
alibration ***Date (yyyy/mm/dd):*** 2000111/22

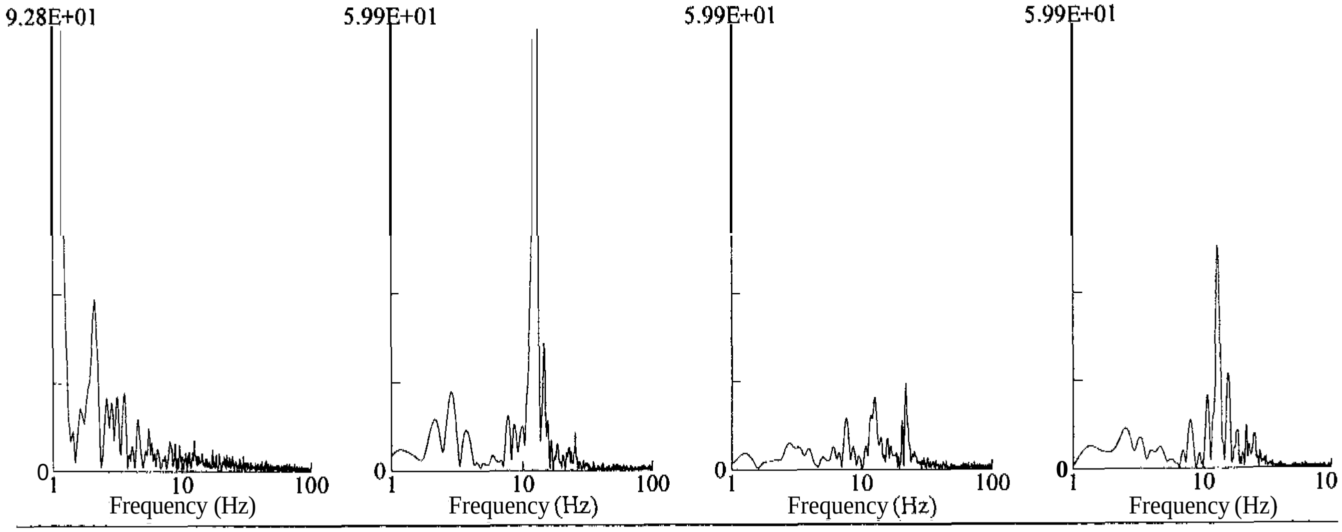
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

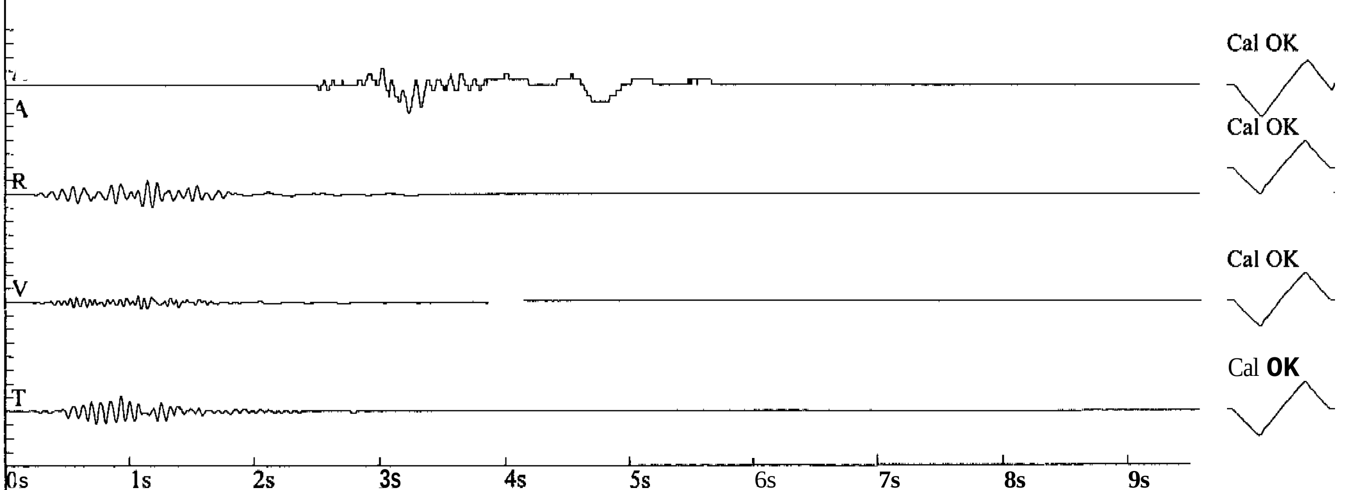
Acoustic (A) **1.06 Hz** | **Radial (R)** **12.88 Hz** | **Vertical (V)** **21.94 Hz** | **Transverse (T)** **12.94 Hz**



West Virginia
Dean Jr. surface

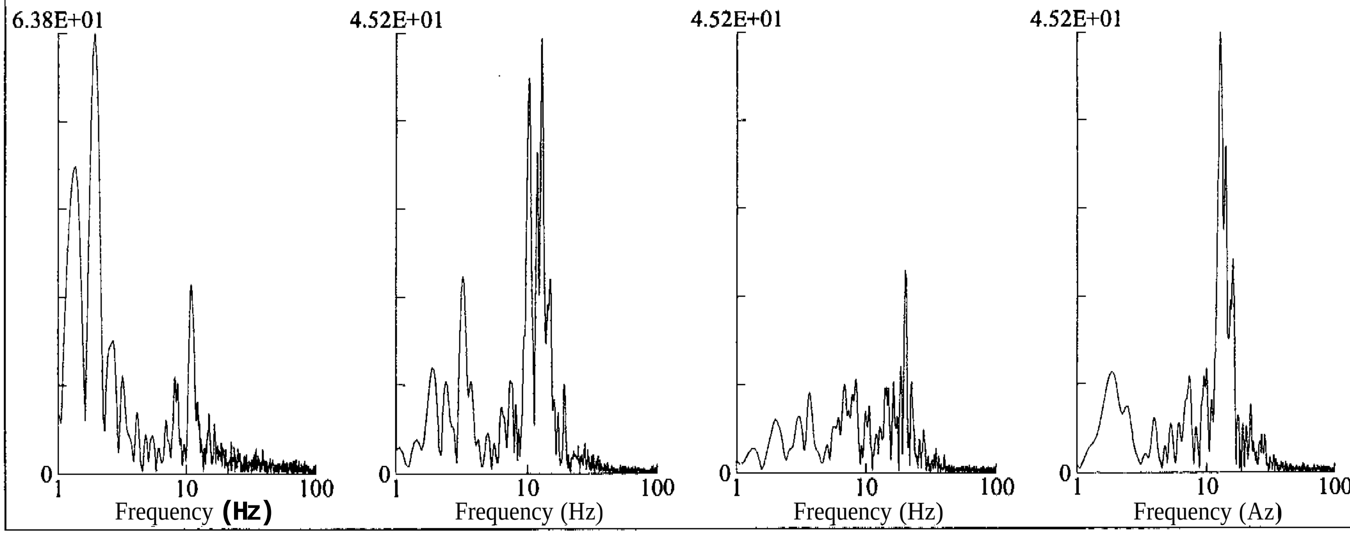
File: D2SAP013.DTB Event Number: 013 Date: 4/6/01 Time: 15:40
Acoustic Trigger: 114 **dB** Seismic Trigger: **0.025in/s 0.635mm/s** **Serial** Number: 1779

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 114dB @ 6.4 Hz (0.10Mb 0.0015psi 0.0100kPa)	*Duration:* 0.000 sec To: 9.500 sec
Radial (R): 0.05in/s 1.27mm/s @ 13.4Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.03in/s 0.762mm/s @ 19.6Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse *(T):* **0.055in/s 1.397mm/s @ 14.6Hz**	*Time Lines at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.94 Hz** | **Radial (R)** **12.94 Hz** | **Vertical (V)** **20.13 Hz** | **Transverse (T)** **12.81 Hz**



West Virginia
Dean Jr. surface

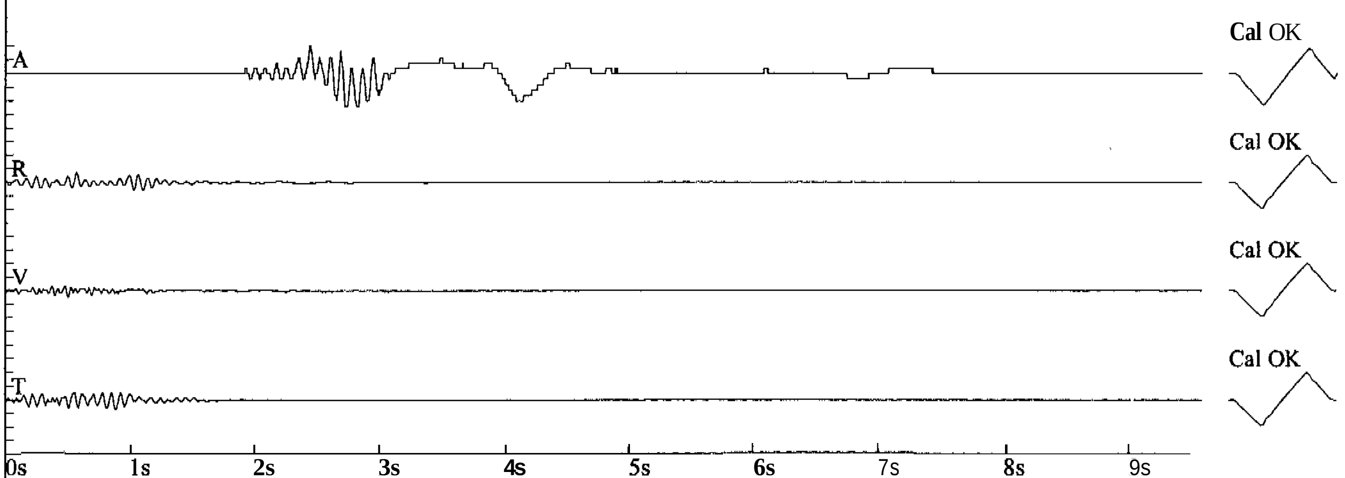
File: **D2SAP016.DTB** Event Number: 016 Date: 4/9/01 Time: 12:39
Acoustic Trigger: 114 **dB** **Seismic Trigger** 0.025in/s **0.635mm/s** Serial Number: 1779

Amplitudes and Frequencies

Acoustic (A): 116 **dB** @ 9.3 Hz
(0.12Mb 0.0017psi 0.0120kPa)
***Radial (R):* 0.035in/s 0.889mm/s @ 14.6Hz**
Vertical (V): 0.025in/s **0.635mm/s** @ 19.6Hz
***Transverse (T):* 0.035in/s 0.889mm/s @ 13.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

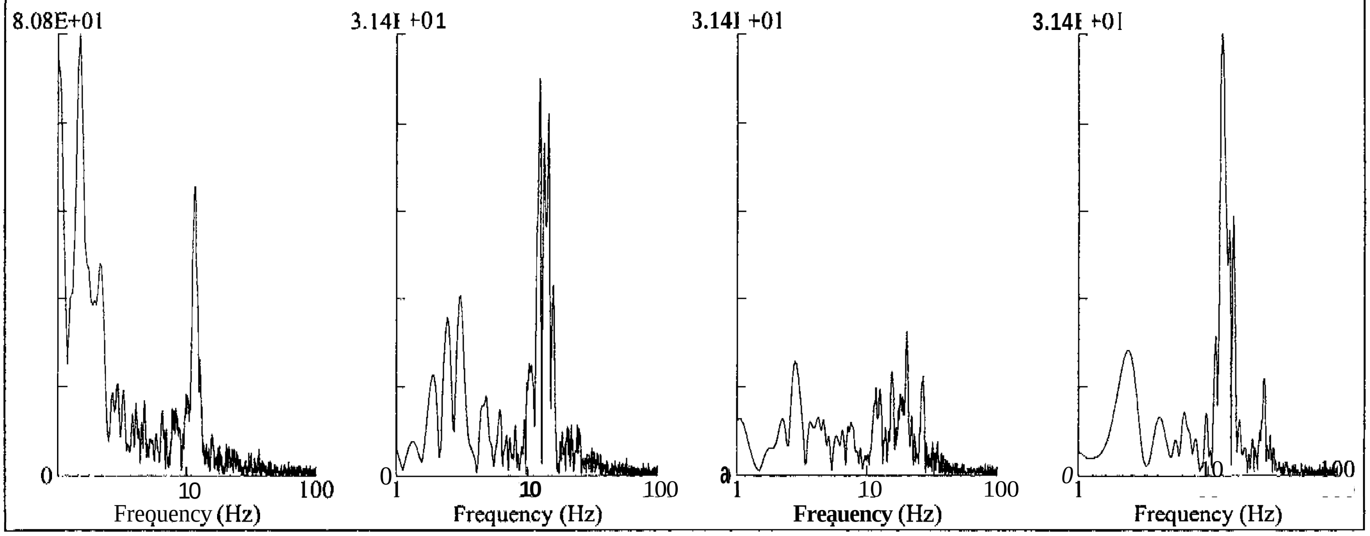
Graph Information

Duration: 0.000 sec *To:* ***9.500*** **sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s (1.270mm/s/div)**
Time Lines at: 1.00 **sec** intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.50 Hz	**12.38 Hz**	**20.38 Hz**	**12.88 Hz**



West Virginia
Dean Jr. surface

File: D2SAP018.DTB Event Number: 018 Date: 4/10/01 Time: 15:42
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1779

Amplitudes and Frequencies

Acoustic (A): 118 **dB** @ 6.4 **Hz**
(0.16Mb 0.0023psi 0.0160kPa)

Radial (R): 0.03in/s 0.762mm/s @ 10.8Hz

Vertical (V): 0.02in/s 0.508mm/s @ 17.0Hz

***Transverse (T):* 0.035in/s 0.889mm/s @ 18.2Hz**

Calibration Date *(yyyy/mm/dd):* 2000/11/22

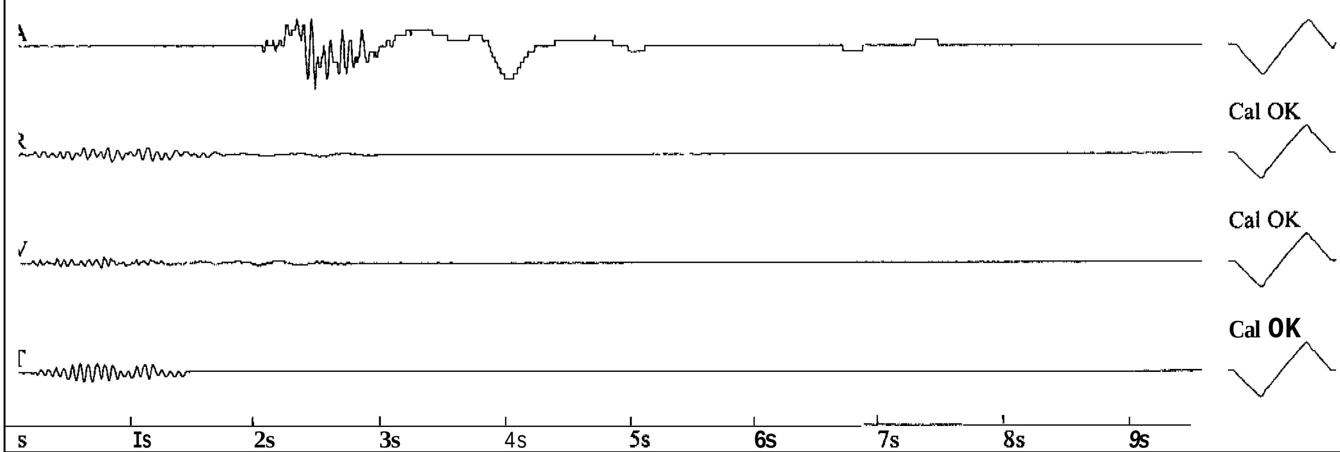
Graph Information

Duration: 0.000 sec To: 9.500 sec

Acoustic Scale:
120dB **0.20Mb** (0.050Mb/div)

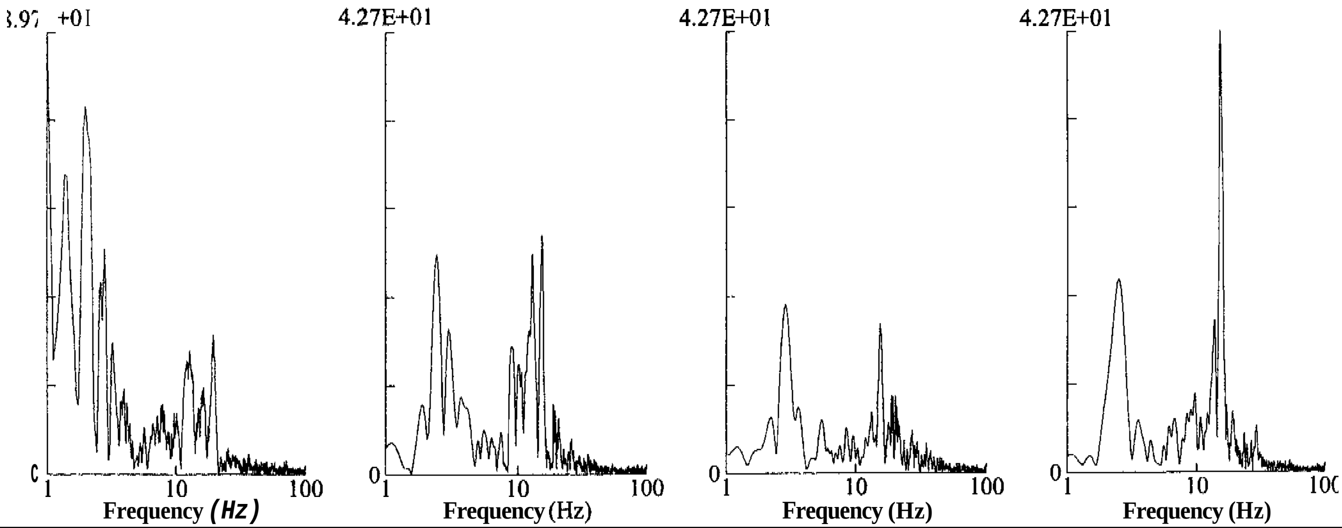
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**15.63 Hz**	**2.88 Hz**	**15.38 Hz**



West Virginia
Dean Jr. surface

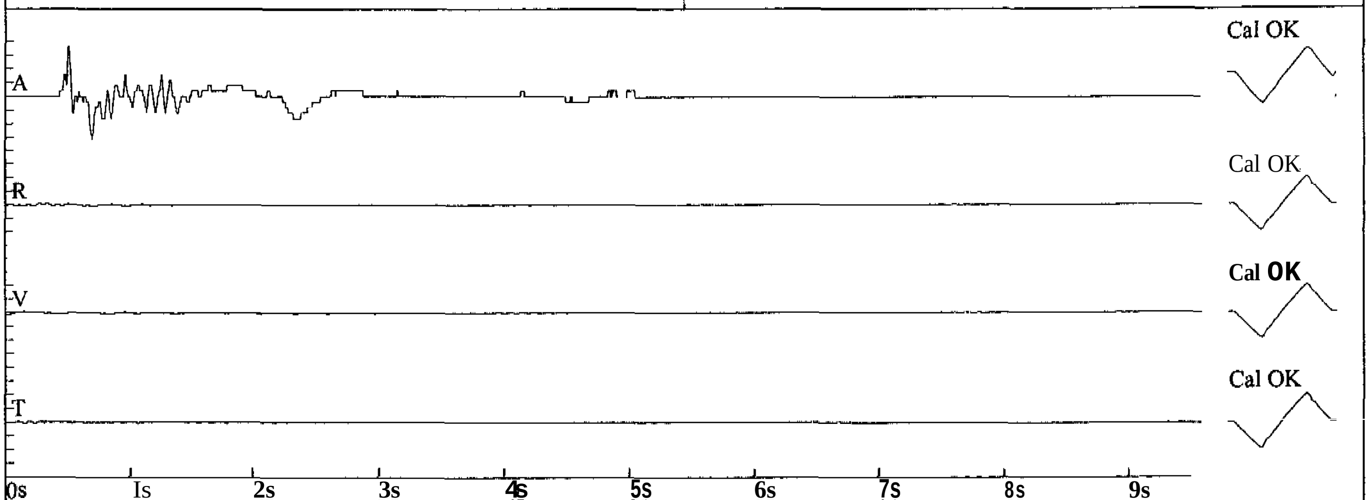
File: D2SAP024.DTB Event Number: **024** Date: 4/11/01 Time: 09:54
Acoustic Trigger: 114 dB **Seismic** Trigger: 0.025in/s 0.635mm/s **Serial** Number: **1779**

Amplitudes and Frequencies

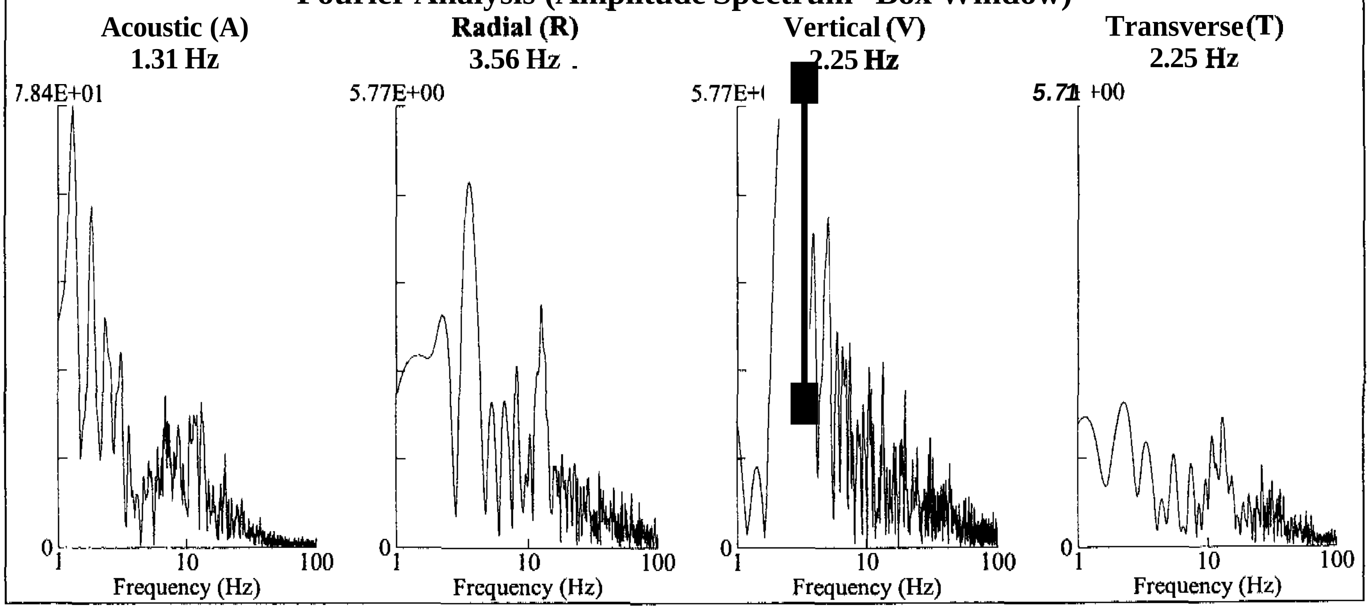
Acoustic (A): 119 dB @ 7.4 Hz
(0.18Mb 0.0026psi 0.0180kPa)
***Radial (R):* 0.005in/s 0.127mm/s @ 0.0Hz**
***Vertical(V):* 0.005in/s 0.127mm/s** @ 0.0Hz
***Transverse(T):* 0.005in/s 0.127mm/s @ 0.0Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

***Duration:* 0.000** sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
***Seismic** Scale:*
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Jr. surface

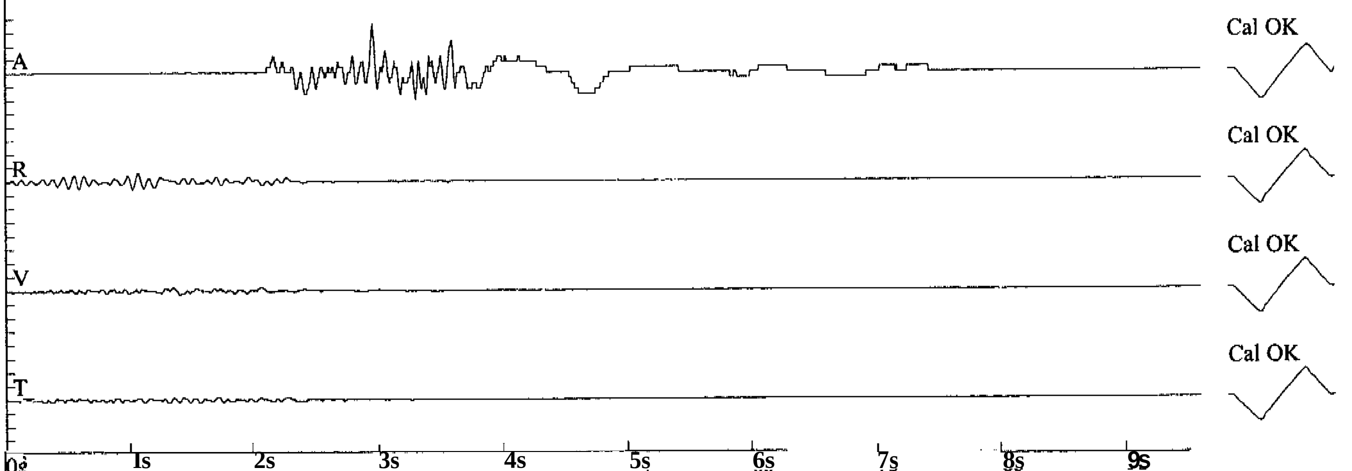
File: D2SAP025.DTB **Event Number:** 025 **Date:** 4/12/01 Time: 10:35
Acoustic Trigger: 114 dB **Seismic Trigger:** 0.025in/s 0.635mm/s **Serial Number:** 1779

Amplitudes and Frequencies

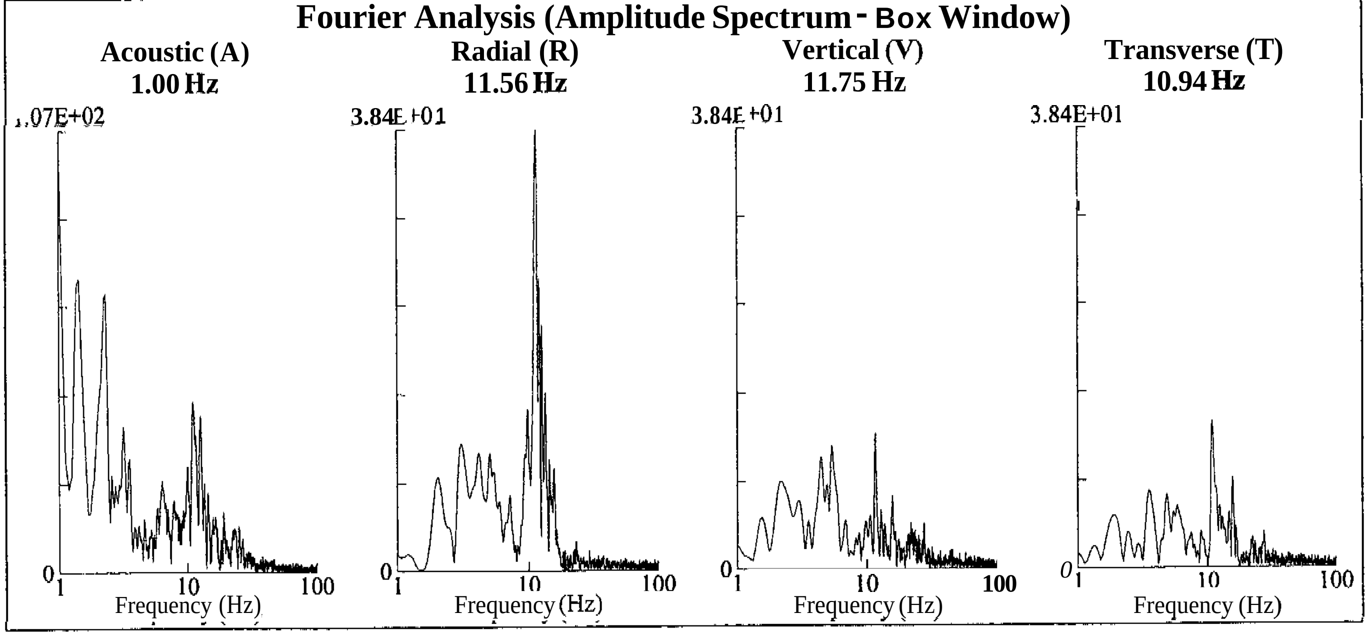
coustic (A): 119 dB @ **10.6 Hz**
(0.18Mb 0.0026psi 0.0180kPa)
***adial* (R): 0.03in/s 0.762mm/s @ 12.8Hz**
ertical (V): 0.015in/s 0.381mm/s @ 7.1Hz
ransverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
alibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



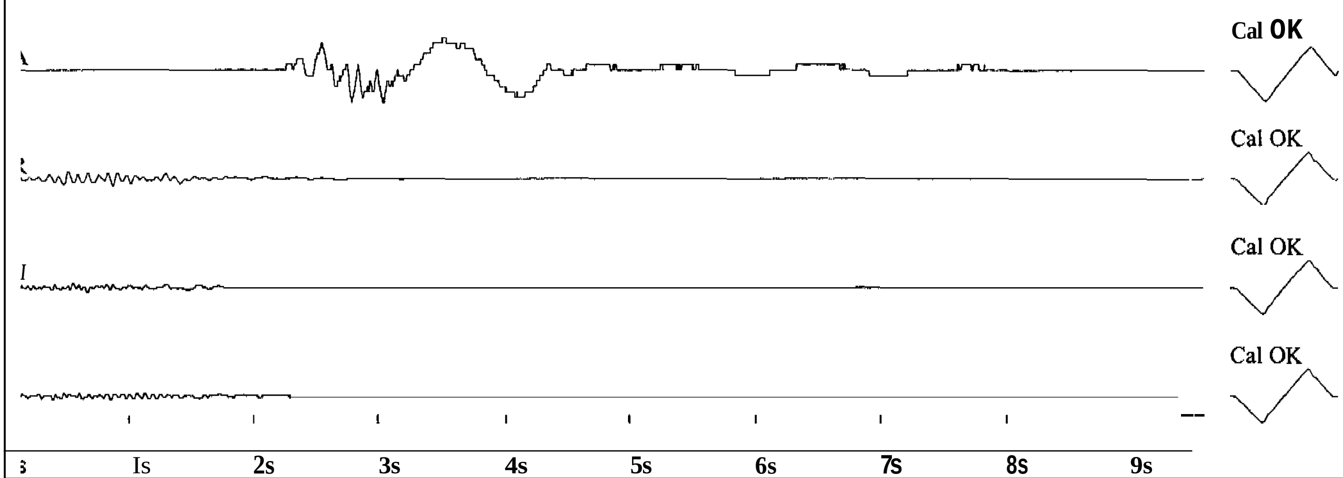
Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Jr. surface

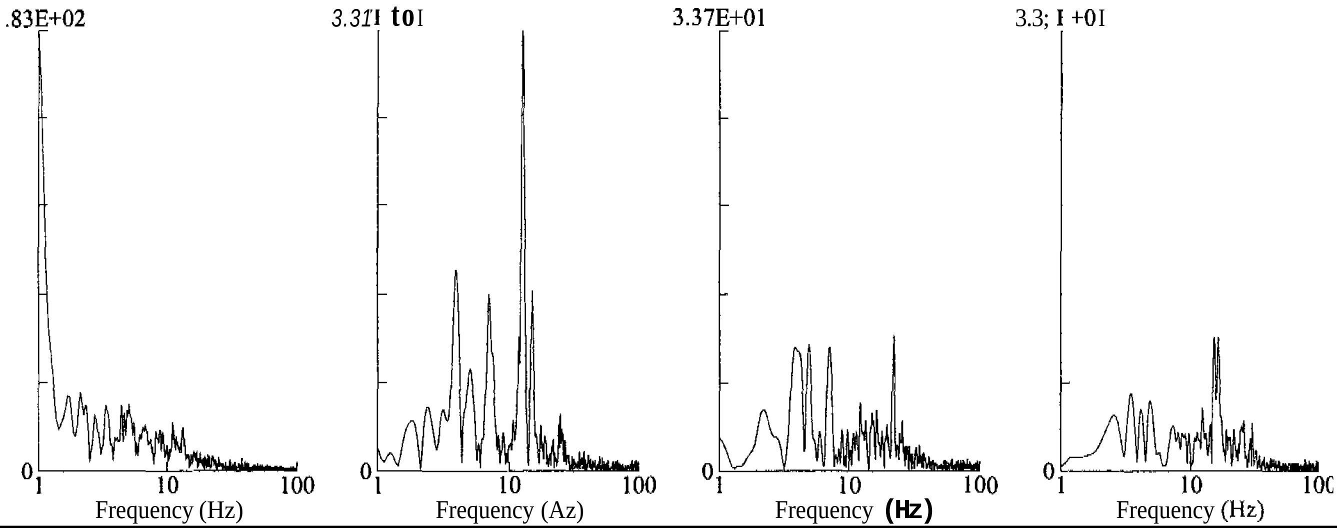
File: D2SAP026.DTB Event Number: 026 Date: 4/12/0 Time: 12:20
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies	Graph Information
Acoustic (A): 116 dB @ 1.1 Hz (0.12Mb 0.0017psi 0.0120kPa)	***Duration: 0.000*** **sec** To: 9,500 sec
Radial **(R): 0.03in/s 0.762mm/s @ 14.2Hz**	Acoustic ***Scale:*** 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 16.5Hz	***Seismic*** Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.015in/s 0.381mm/s @ 21.3Hz	***Time Lines*** *at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**12.69 Hz**	**22.13 Hz**	**16.56 Hz**



West Virginia
Dean Jr. surface

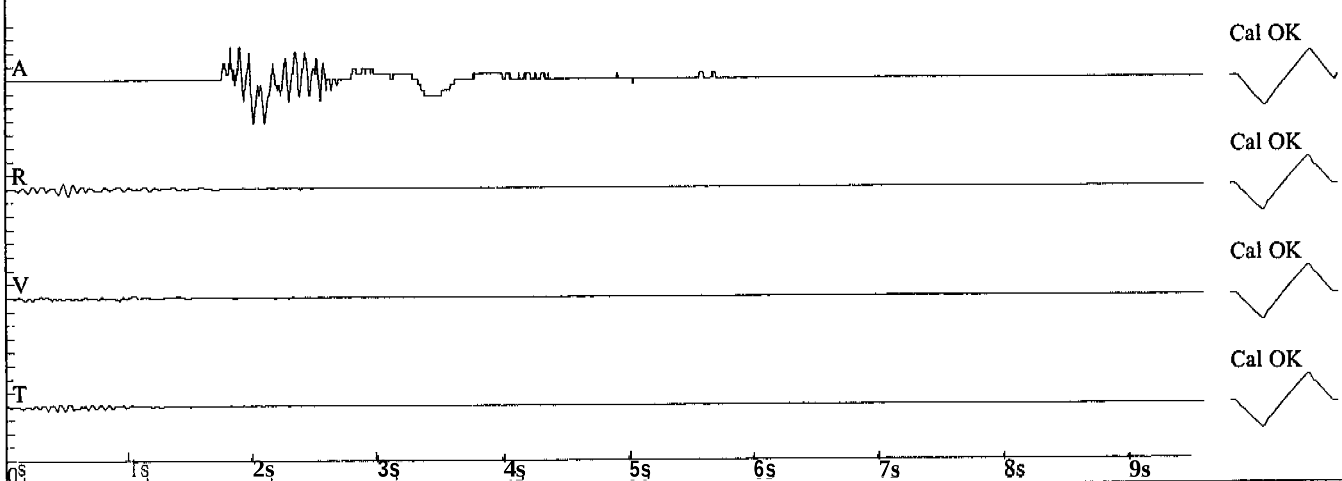
File: D2SAP027.DTB Event Number: **027** Date: **4/12/01** **Time:** 17:02
Acoustic **Trigger: 114** dB Seismic **Trigger:** 0.025in/s **0.635mm/s** **Serial** Number: 1779

Amplitudes and Frequencies

Acoustic (A): 118 dB @ 3.1 Hz
(0.16Mb 0.0023psi 0.0160kPa)
***Radial (R):* 0.025in/s 0.635mm/s @ 13.4Hz**
Vertical (V): 0.01in/s **0.254mm/s** @ 0.0Hz
Transverse (T): 0.01in/s **0.254mm/s** @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

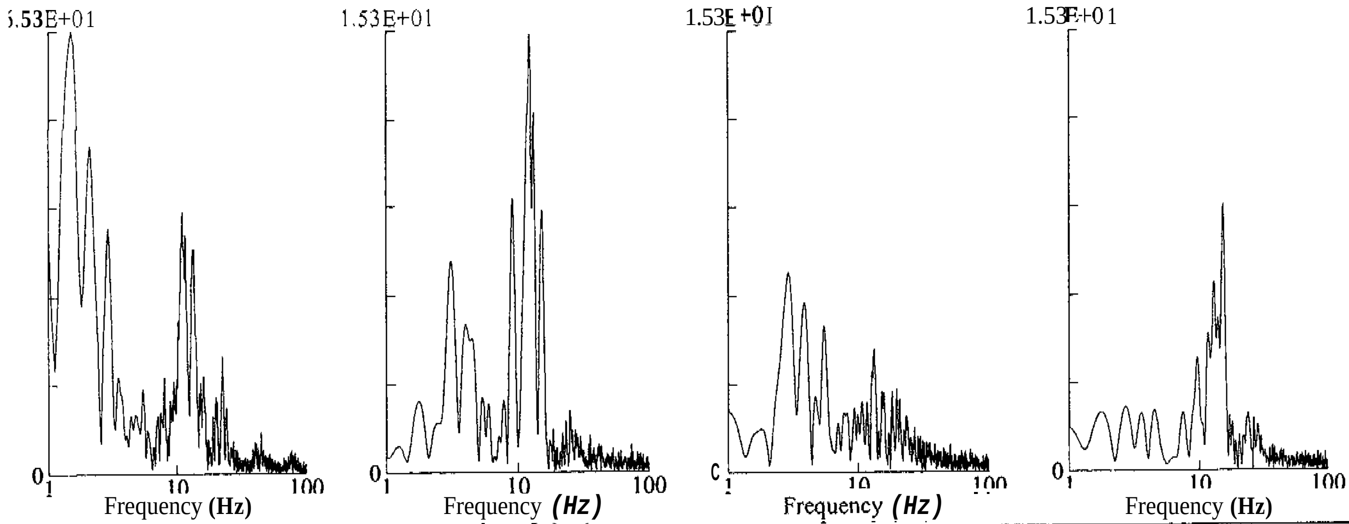
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB **0.20Mb** (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.50 Hz** — **Radial (R)** **12.38 Hz** — **Vertical (V)** **2.94 Hz** — **Transverse (T)** **15.50 Hz**



West Virginia
Dean Jr. surface

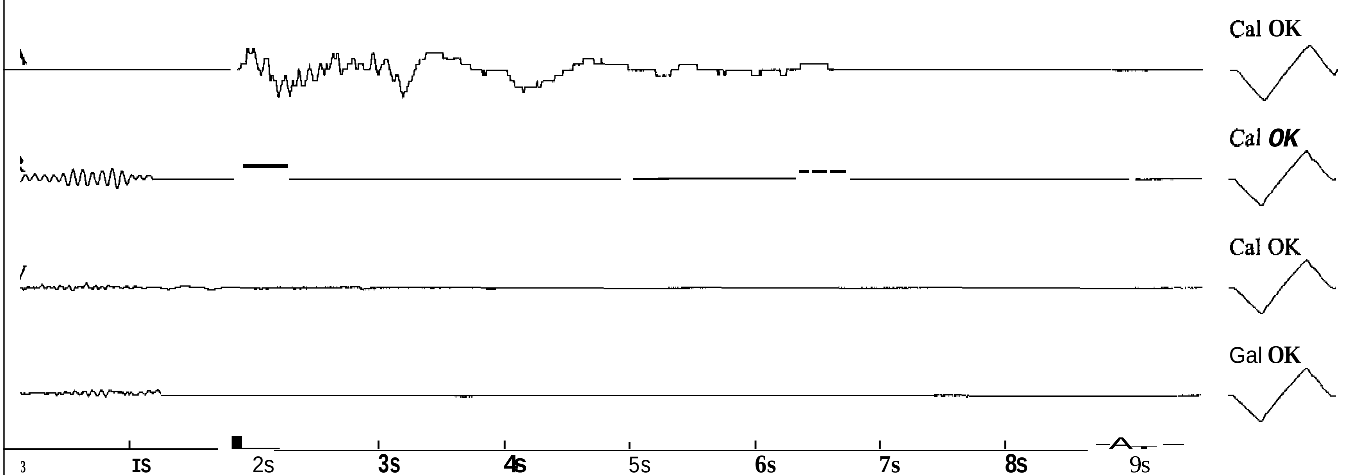
File: D2SAP030.DTB Event Number: 030 Date: 4/13/01 Time: 10:27
Acoustic Trigger: 114dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

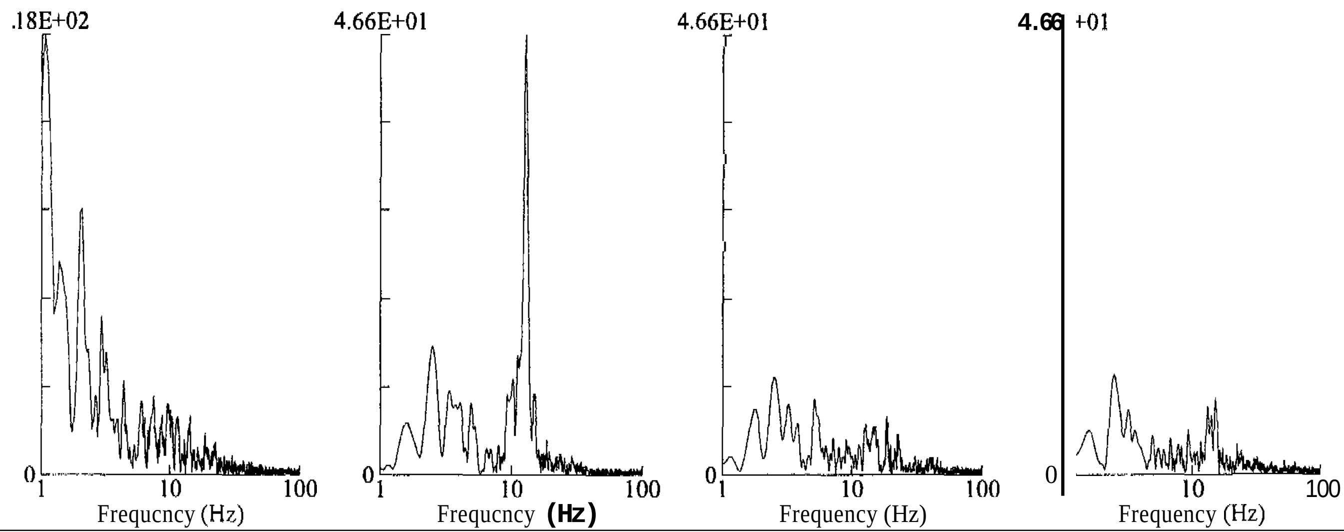
Acoustic (A): 114dB @ 2.5 Hz
(0.10Mb 0.0015psi 0.0100kPa)
***Radial (R):* 0.04in/s 1.016mm/s @ 12.8Hz**
Vertical (V): 0.015in/s 0.381mm/s @ 23.2Hz
Transverse (T): 0.015in/s 0.381mm/s @ 19.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic *Scale:*
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Jr. deep

File: D2WAP005.DTB **Event** Number: 005 **Date:** 4/3/01 Time: 17:03
Acoustic Trigger: 114 dB **Seismic** Trigger: 0.025in/s 0.635mm/s **Serial** Number: **1780**

Amplitudes and Frequencies

Acoustic (A): 117 dB @ 3.9 Hz
(0.14Mb 0.0020psi 0.0140kPa)

Radial **(R): 0.005in/s 0.127mm/s @ 0.0Hz**

vertical (V): **0.005in/s 0.127mm/s @ 0.0Hz**

Transverse (T): **0.005in/s 0.127mm/s @ 0.0Hz**

Calibration Date (yyyy/mm/dd): 2000/11/22

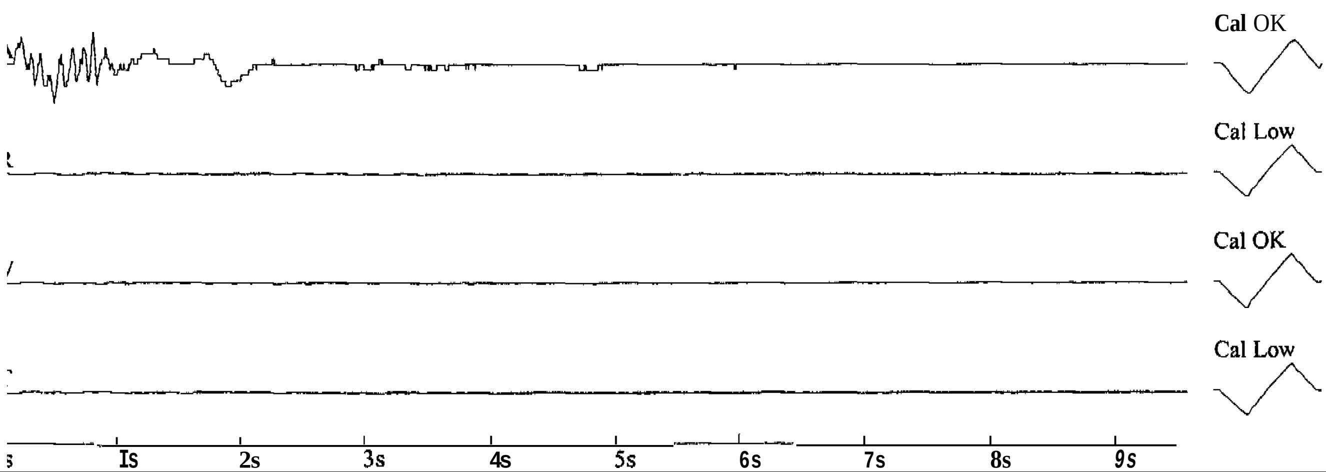
Graph Information

Duration: 0.000 sec To: *9.500* sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

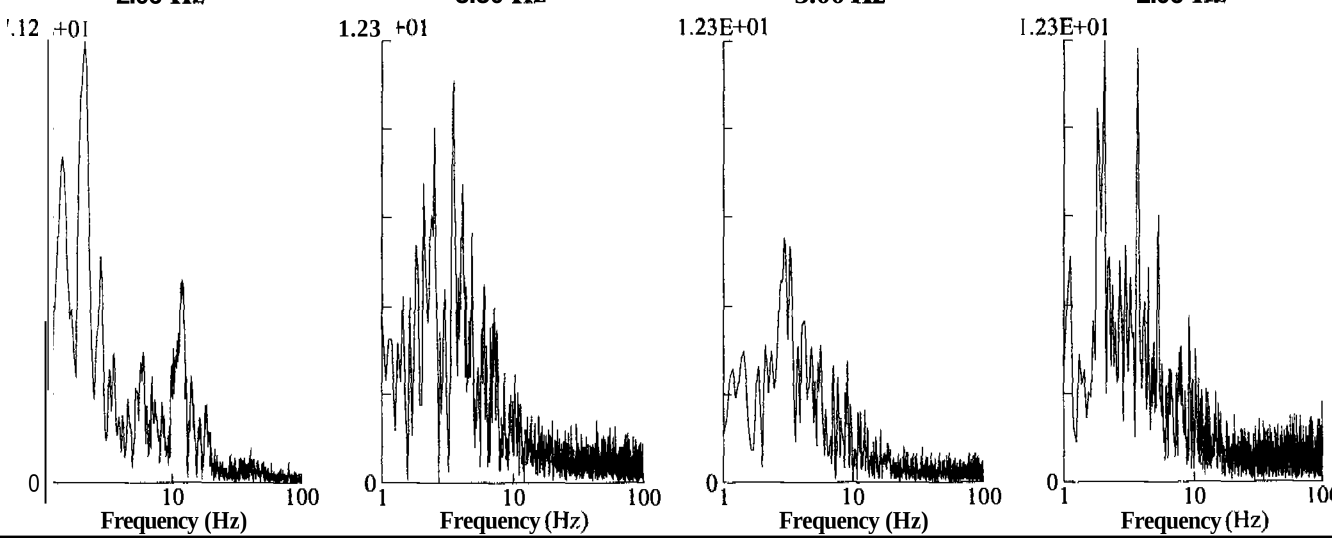
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
2.06 Hz	**3.50 Hz**	**3.00 Hz**	**2.06 Hz**



West Virginia
Dean Jr. deep

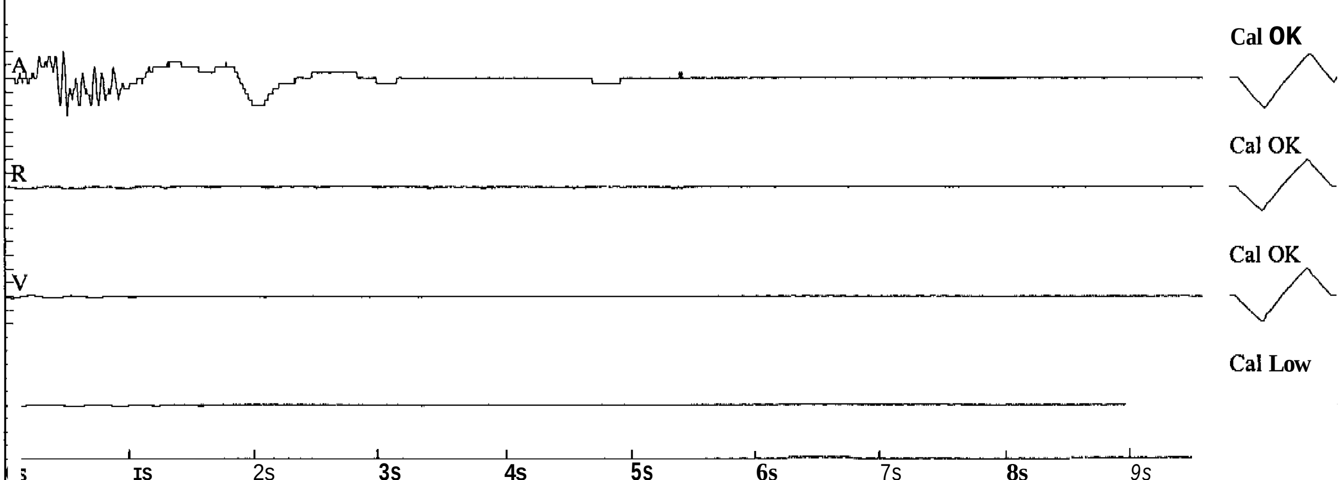
File: D2WAP011.DTB Event Number: 011 Date: 4/10/01 Time: 15:42
Acoustic Trigger: **114** dB Seismic Trigger **0.025in/s 0.635mm/s** Serial Number: 780

Amplitudes and Frequencies

Acoustic (A): 117 dB @ 6.4 **Hz**
(0.14Mb 0.0020psi 0.0140kPa)
Radial **(R): 0.005in/s 0.127mm/s @ 0.0Hz**
Vertical (V): **0.005in/s 0.127mm/s @ 0.0Hz**
Transverse (T): **0.005in/s 0.127mm/s @ 0.0Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

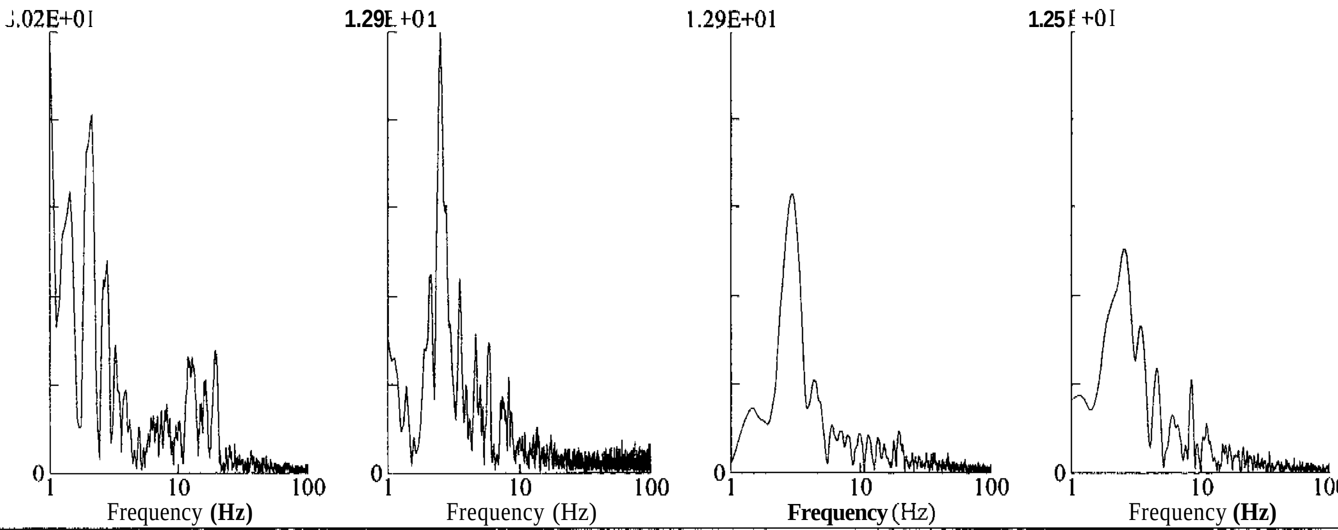
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.00 Hz** | **Radial (R)** **2.50 Hz** | **Vertical (V)** **3.00 Hz** | **Transverse (T)** **2.56 Hz**



West Virginia
Dean Jr. deep

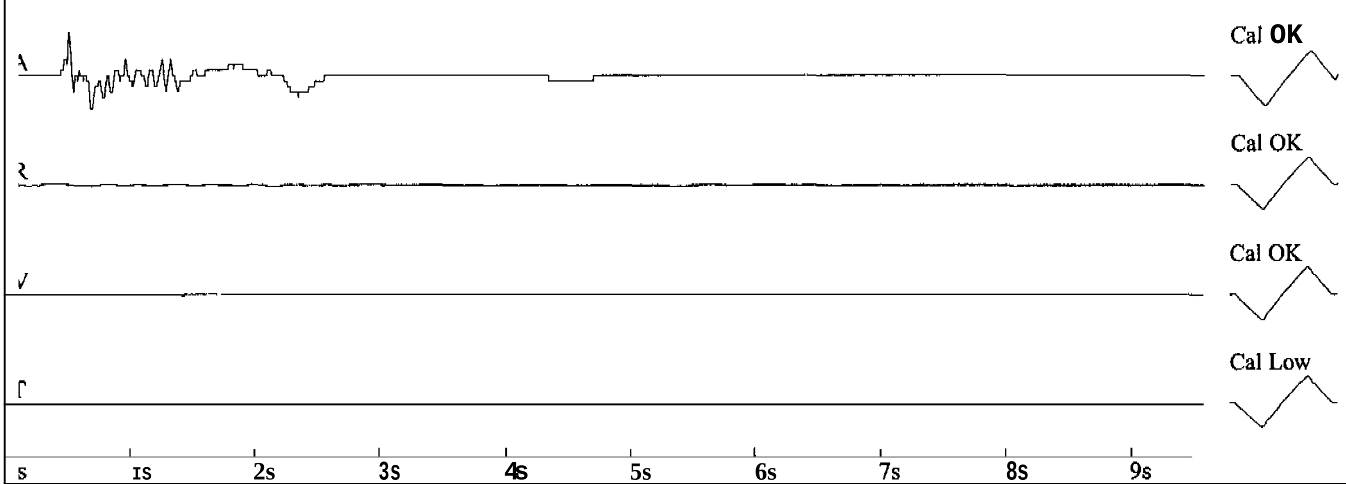
File: D2WAP032.DTB Event Number: 032 Date: 4/11/01 Time: 09:54
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

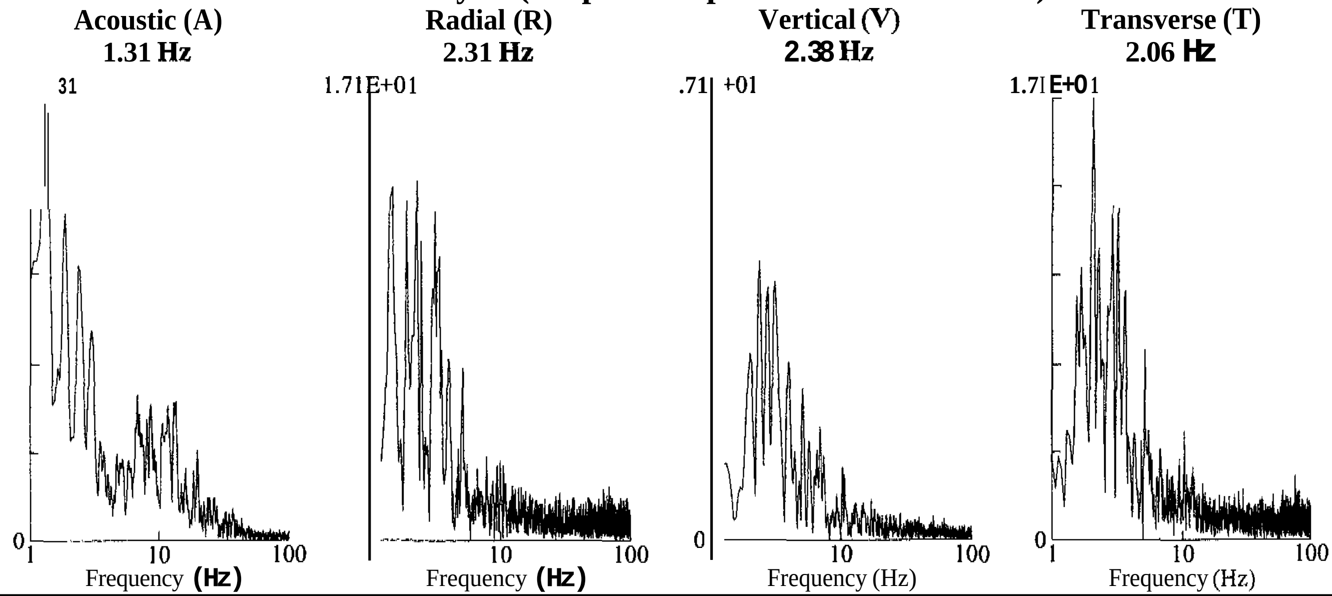
Acoustic (A): 118 dB @ 7.5 Hz
(0.16Mb 0.0023psi 0.0160kPa)
***Radial* (R): 0.005in/s 0.127mm/s @ 0.0Hz**
***Vertical (V):* 0.005in/s 0.127mm/s @ 0.0Hz**
***Transverse (T):* 0.005in/s 0.127mm/s @ 0.0Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic *Scale:*
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Dean Jr. deep

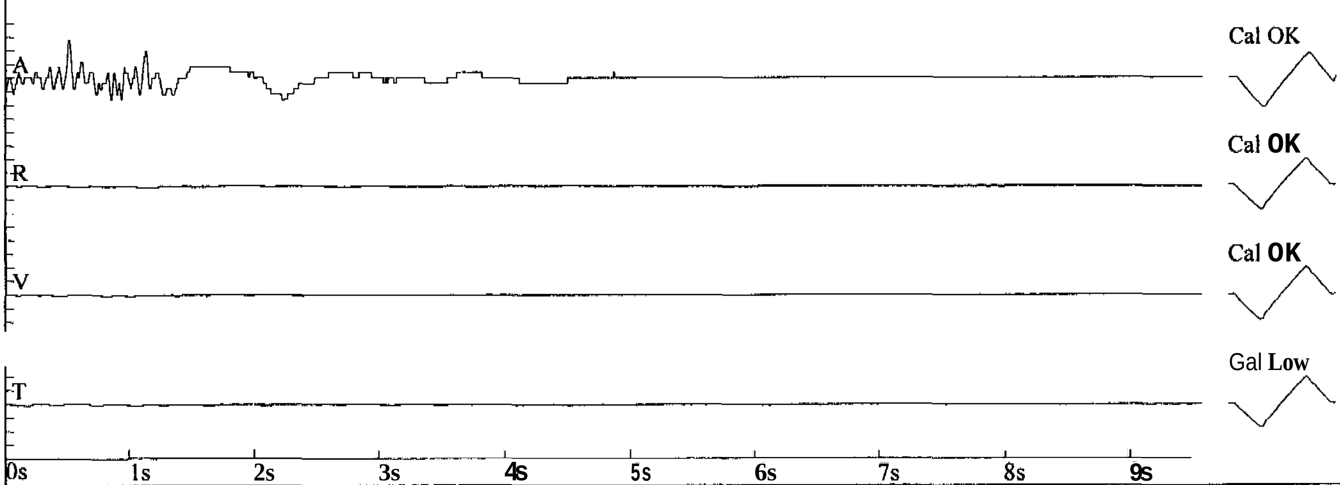
File: D2WAP033.DTB   Event Number: 033   Date: 4/12/01   Time: 10:34
Acoustic Trigger: 114 dB   **Seismic Trigger:** 0.025in/s 0.635mm/s   Serial Number: 1780

Amplitudes and Frequencies

Acoustic (A): 117 dB @ 11.1 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial **(R): 0.005in/s 0.127mm/s @ 0.0Hz**
Vertical (V): **0.005in/s 0.127mm/s @ 0.0Hz**
Transverse (T): **0.005in/s 0.127mm/s @ 0.0Hz**
Calibration Date *(yyyy/mm/dd):* 2000/11/22

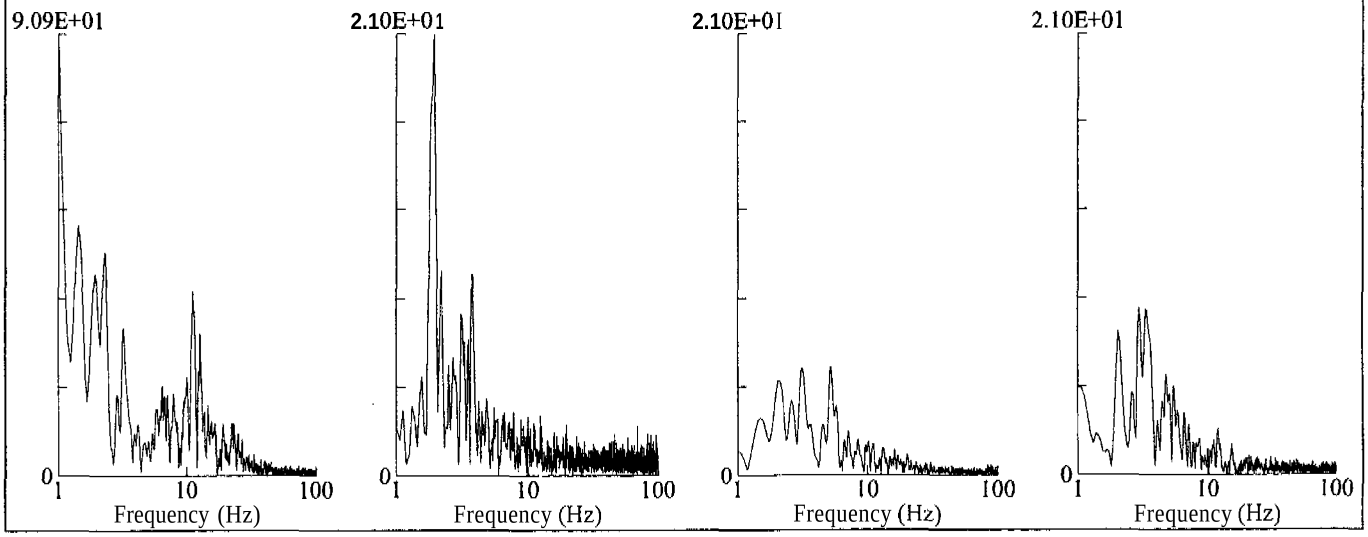
Graph Information

Duration: 0.000 sec To: **9.500**sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic ***Scale:***
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines *at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**1.94 Hz**	**5.25 Hz**	**3.00 Hz**



West Virginia
Dean Jr. deep

Amplitudes and Frequencies

Acoustic (A): 117 dB @ 3.1 Hz
(0.14Mb 0.0020psi 0.0140kPa)

***Radial (R):* 0.005in/s 0.127mm/s @ 0.0Hz**

***Vertical (V):* 0.005in/s 0.127mm/s @ 0.0Hz**

***Transverse (T):* 0.005in/s 0.127mm/s @ 0.0Hz**

Calibration Date (yyyy/mm/dd): 2000/11/22

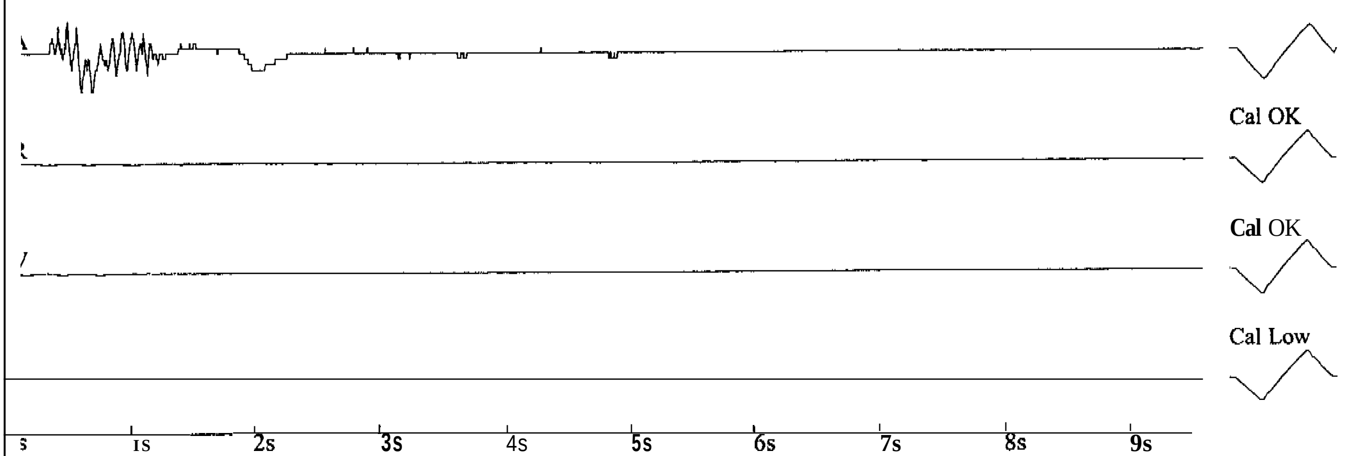
Graph Information

Duration: 0.000 sec To: 9.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec **intervals**



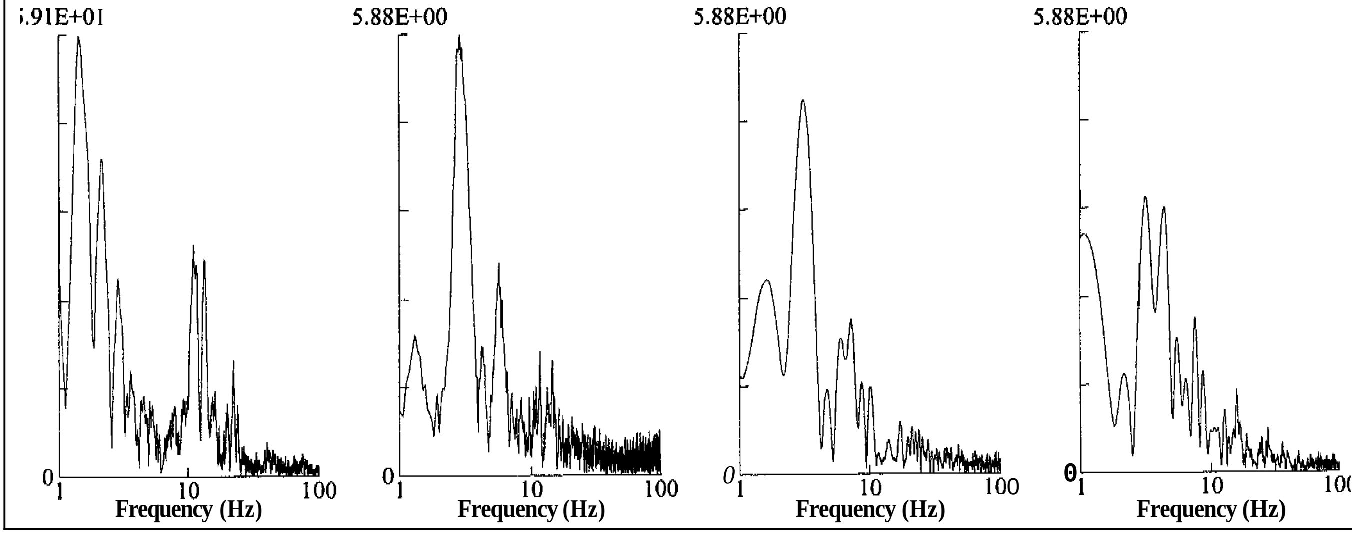
Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)
1.44 Hz

Radial (R)
2.88 Hz

Vertical (V)
3.13 Hz

Transverse (T)
3.19 Hz



West Virginia
Abbott 1 shallow

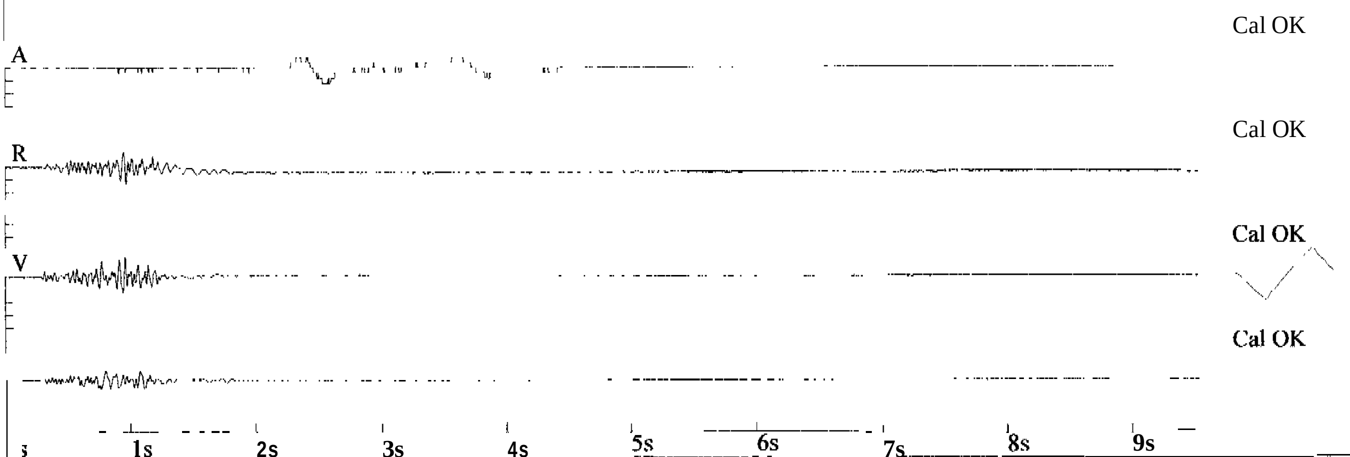
File: A1SAP016.DTB Event Number: 016 Date: 04/16/2001 Time: 16:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): 110 **dB** @ 1.8 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.065in/s 1.651mm/s @ 28.4Hz
***Vertical(V):* 0.075in/s 1.905mm/s @ 32.0Hz**
Transverse *(T):* 0.035in/s 0.889mm/s @ 12.8Hz
Calibration Dute (yyyy/mm/dd): 2000/11/22

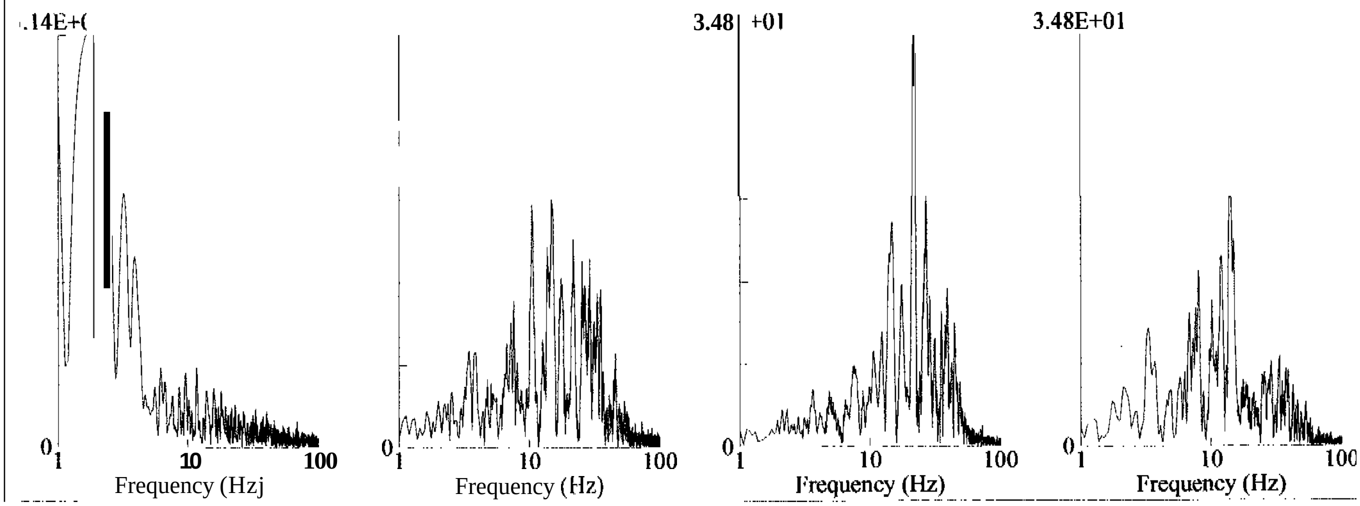
Graph Information

Duration: **0.000** sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.69 Hz** | **Radial (R)** | **Vertical (V)** **21.63 Hz** | **Transverse (T)** **14.00 Hz**



West Virginia
Abbott 1 deep

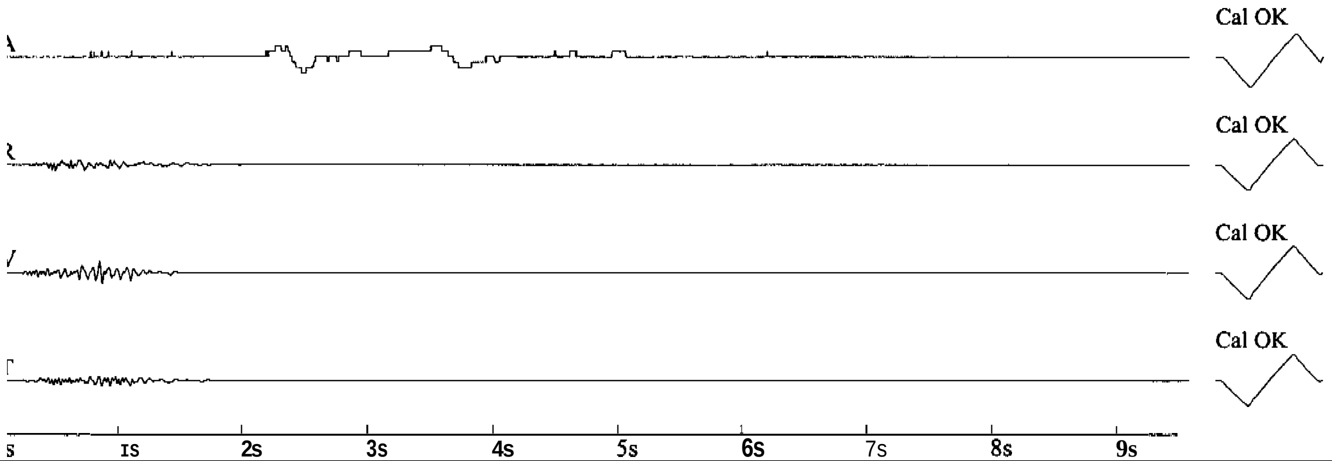
File: A1DAP004.DTB Event Number: 004 Date: 4/16/01 Time: 16:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

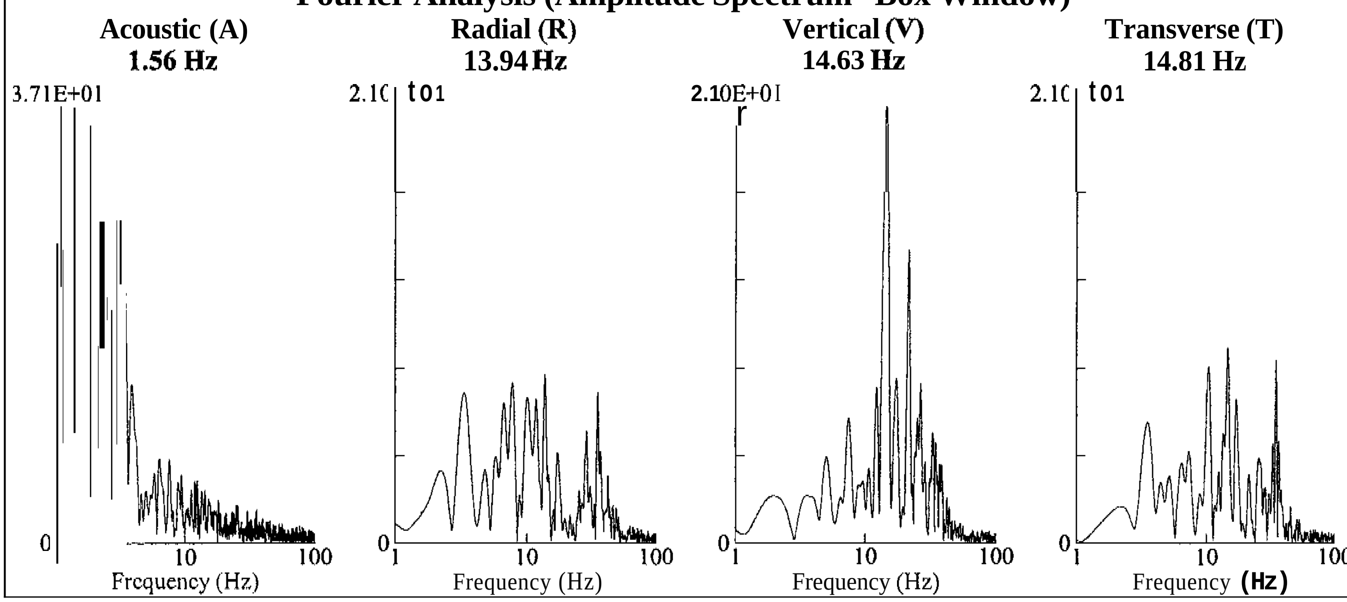
Acoustic (A): 110 dB @ 3.2 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 26.9Hz
Vertical *(V):* **0.04in/s 1.016mm/s @ 22.2Hz**
Transverse (T): 0.02in/s 0.508mm/s @ 25.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time *Lines at:* 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Abbott 1 shallow

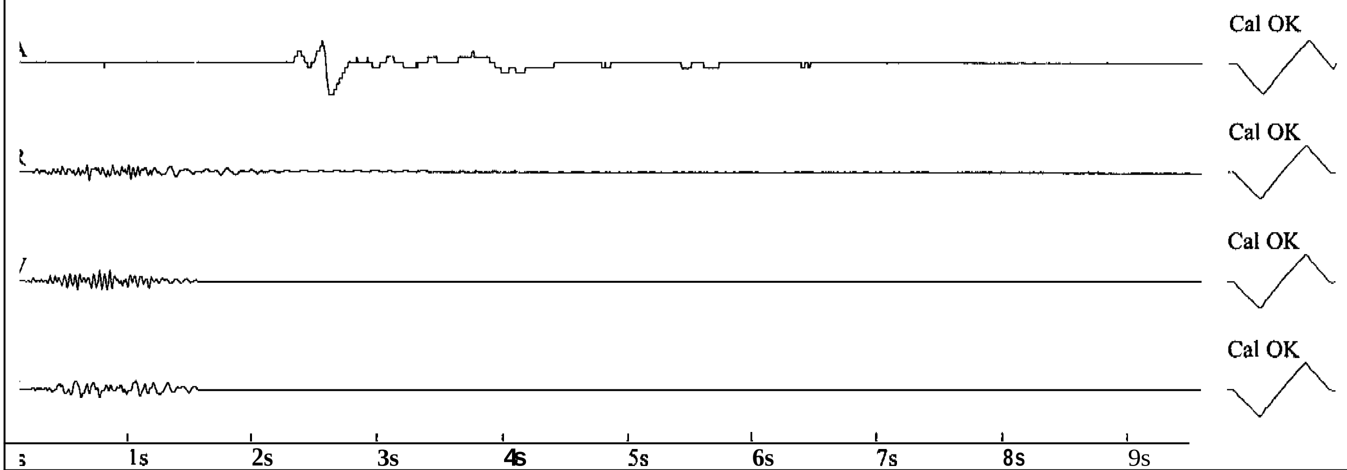
File: A1SAP026.DTB Event Number: 026 Date: 4/18/01 Time: 16:51
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in s 0.635mm/s Serial Number: 78

Amplitudes and Frequencies

Acoustic (A): **116 dB @ 2.8 Hz**
(0.12Mb 0.0017psi 0.0120kPa)
***Radial* (R): 0.035in/s 0.889mm/s @ 23.2Hz**
***Vertical (V):* 0.035in/s 0.889mm/s @ 26.9Hz**
***Transverse (T):* 0.035in/s 0.889mm/s @ 10.8Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

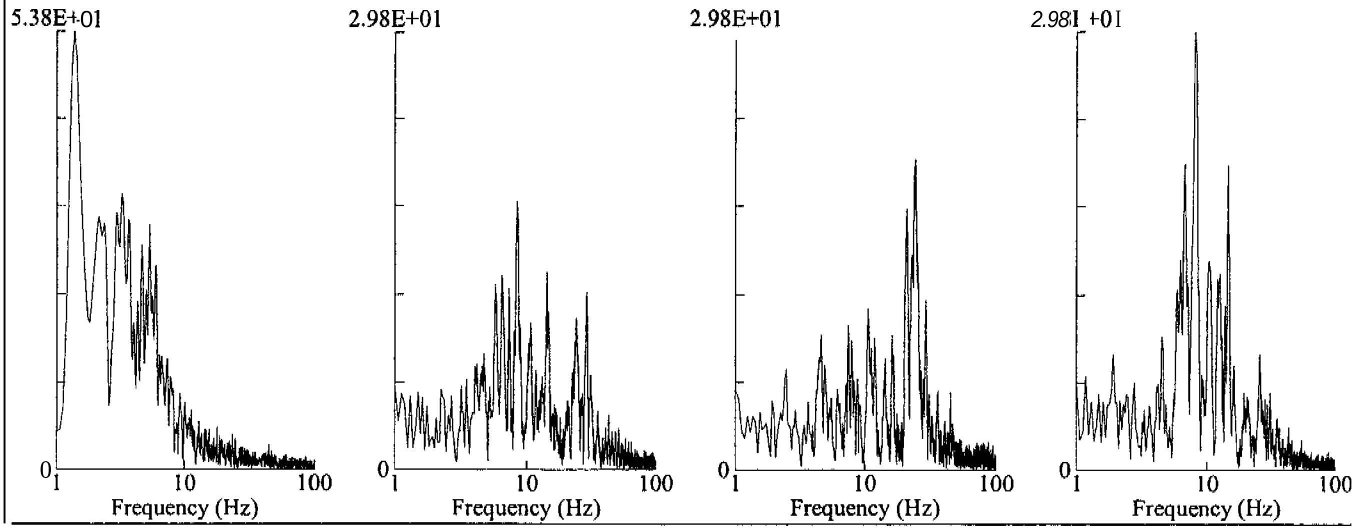
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic ***Scale:***
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

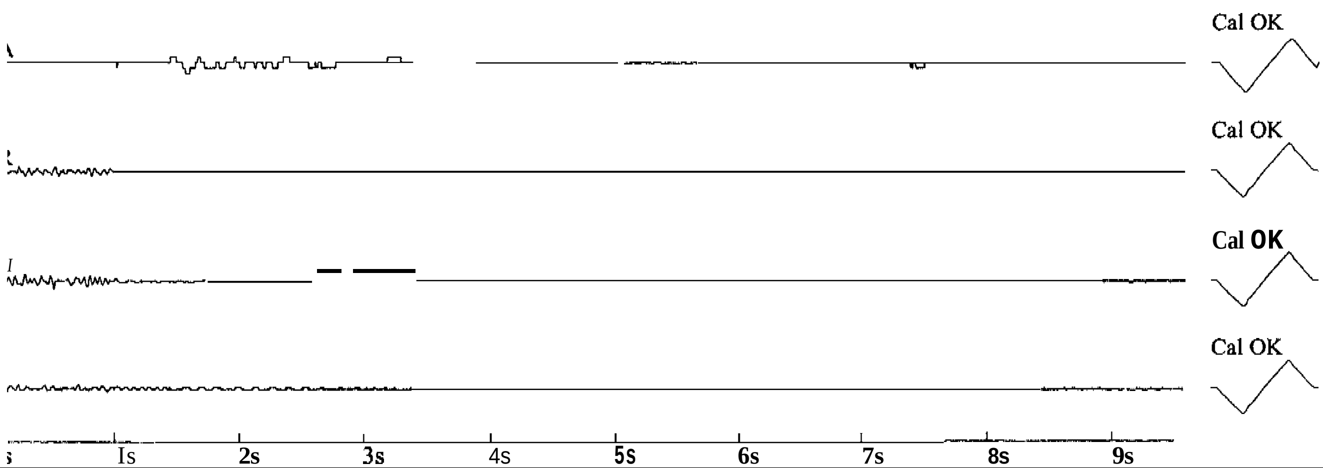
Acoustic (A) **1.38 Hz** | **Radial (R)** **8.56 Hz** | **Vertical (V)** **24.56 Hz** | **Transverse (T)** **8.13 Hz**



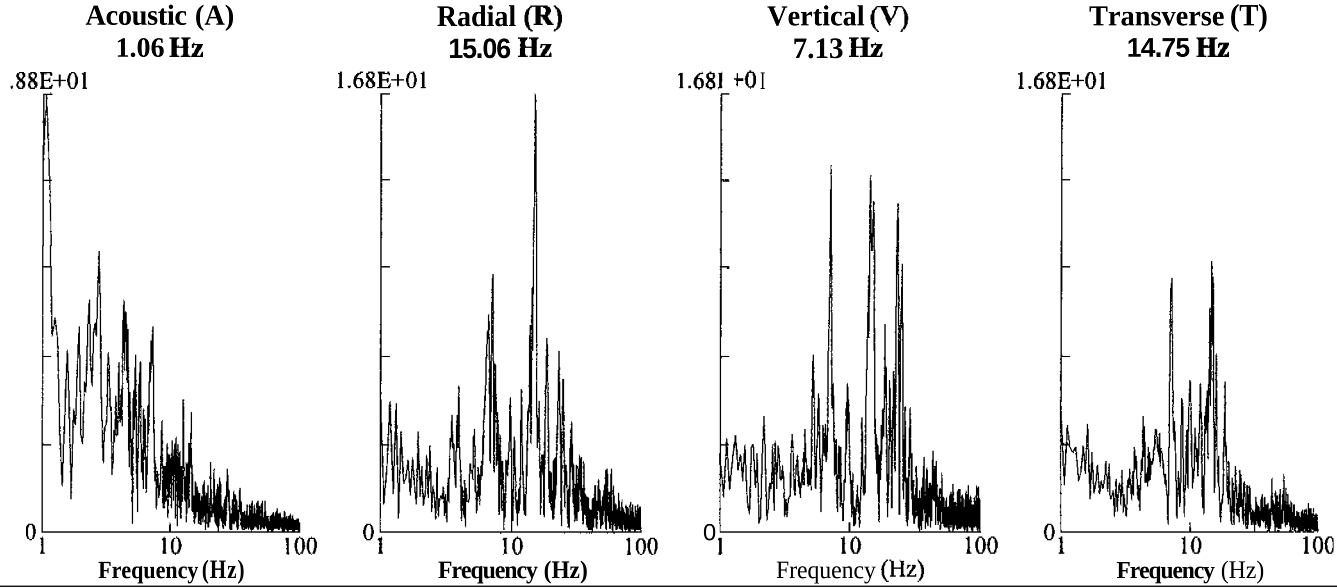
West Virginia
Abbott 1 shallow

File: A1SAP027.DTB Event **Number: 027** Date: **4/18/01** Time: **16:54**
Acoustic **Trigger: 114 dB** **Seismic** Trigger: **0.025in/s 0.635mm/s** Serial **Number: 1781**

Amplitudes and Frequencies	Graph Information
Acoustic (A): **106** dB @ 0.0 **Hz** (0.04Mb 0.0006psi 0.0040kPa)	***Duration: 0.000*** sec **To: *9.500*** sec
Radial (R): 0.02in/s 0.508mm/s @ 19.6Hz	***Acoustic Scale:*** 120dB 0.20Mb (0.050Mb/div)
***Vertical(V):* 0.03in/s 0.762mm/s @ 22.2Hz**	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): 0.015in/s 0.381mm/s @ 12.8Hz	*Time Lines at:* 1.00 sec intervals
Calibration Date (yyyy/mm/dd): 2000/11/22	



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Abbott 1 deep

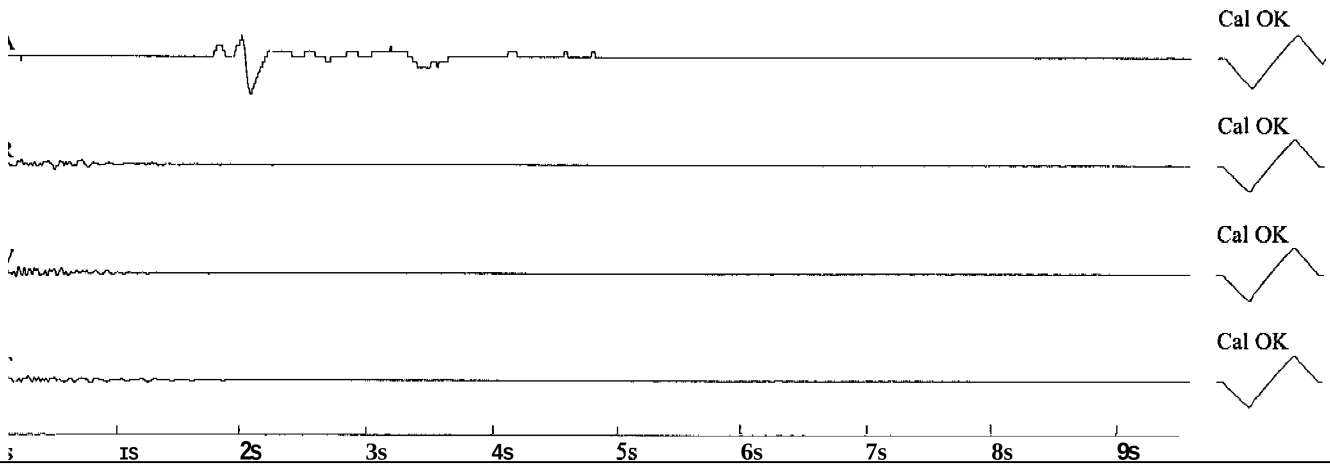
File: A1DAP006.DTB Event Number: 006 Date: 4/18/01 Time: 16:51
Acoustic Trigger: 114dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: **1782**

Amplitudes and Frequencies

Acoustic (A): **117** dB @ 3.3 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial ***(R):*** **0.025in/s 0.635mm/s @ 10.4Hz**
vertical *(V):* 0.015in/s 0.381mm/s @ 21.3Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration ***Date*** *(yyyy/mm/dd):* 2000/11/22

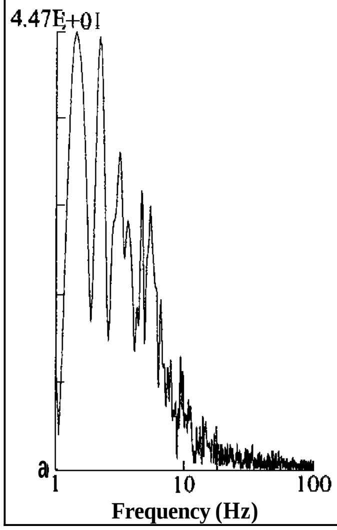
Graph Information

Duration: 0.000 sec **To:** ***9.500*** **sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s (1.270mm/s/div)**
Time Lines at: 1.00 sec intervals

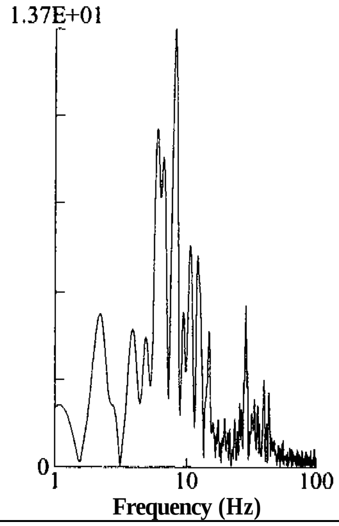


Fourier Analysis (Amplitude Spectrum - Box Window)

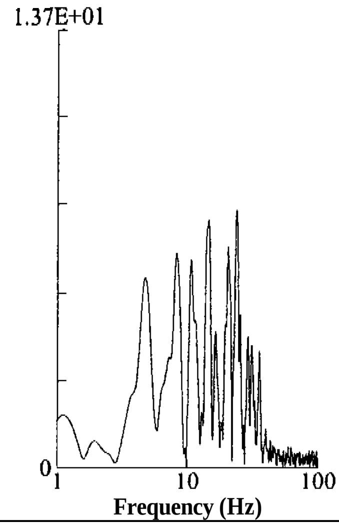
Acoustic (A)
1.44 Hz



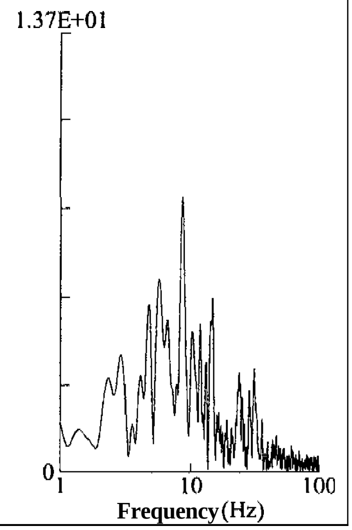
Radial (R)
8.25 Hz



Vertical (V)
24.13 Hz



Transverse (T)
8.56 Hz



West Virginia
Abbott 1 shallow

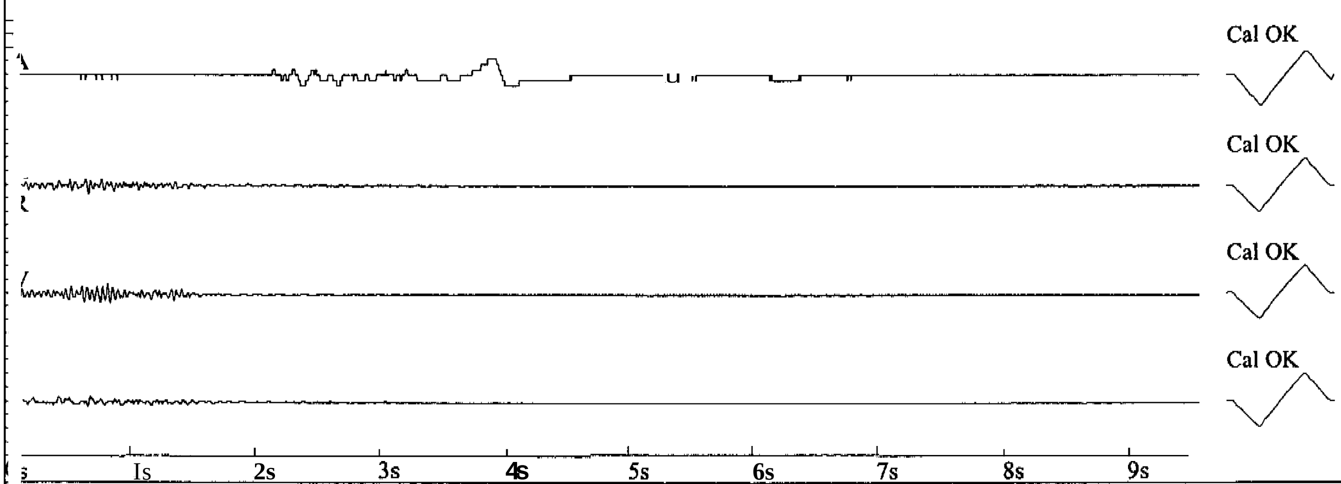
File: A1SAP028.DTB Event Number: 028 Date: 4/19/01 Time: 08:55
Acoustic Trigger: 114dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

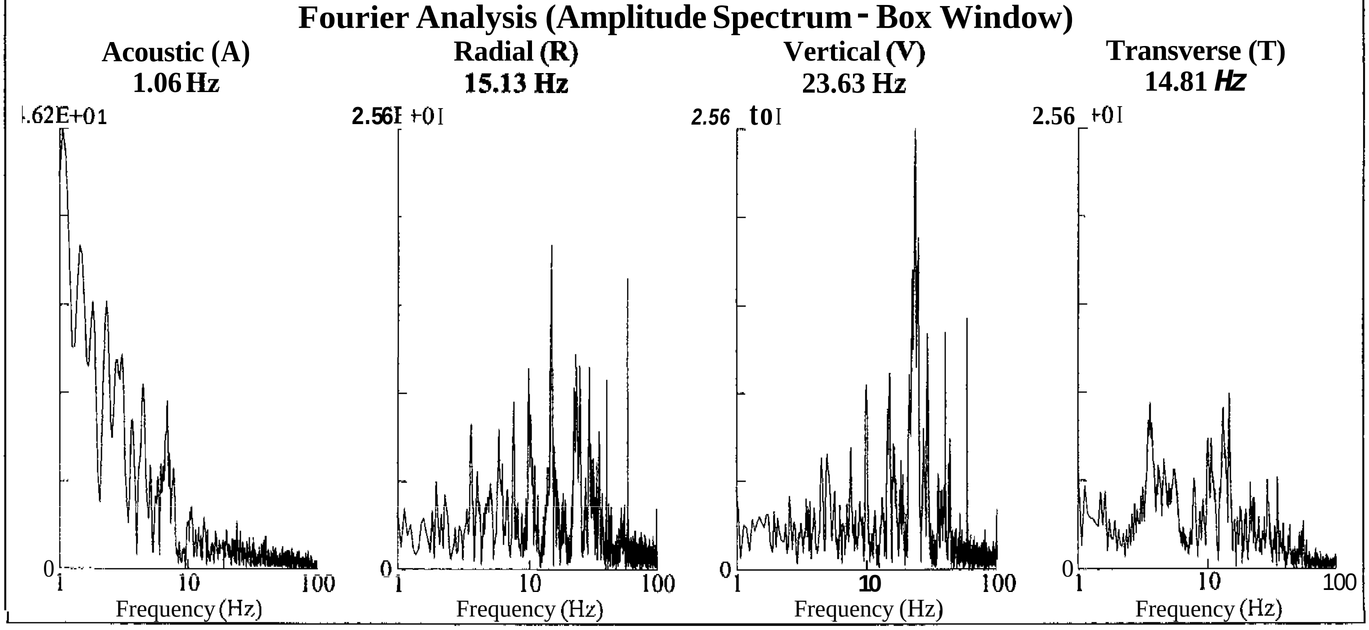
Acoustic (A): **110** dB @ 3.1 **Hz**
(0.06Mb 0.0009psi 0.0060kPa)
***Radial (R):* 0.035in/s 0.889mm/s @ 24.3Hz**
***Vertical (V):* 0.035in/s 0.889mm/s @ 28.4Hz**
Transverse (T): 0.02in/s 0.508mm/s @ 23.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 100 sec **intervals**



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia
Abbott 1 deep

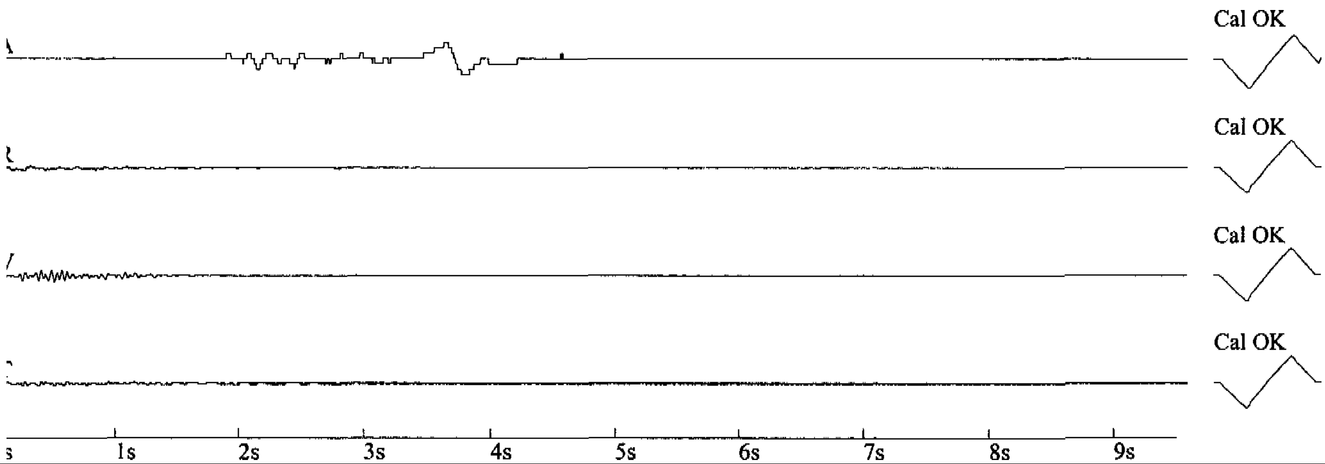
File: A1DAP007.DTB Event Number: 007 Date: 4/19/01 Time: 08:55
Acoustic Trigger: 114 **dB** Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1782

Amplitudes and Frequencies

Acoustic (A): 110dB @ ***5.5 Hz***
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.01in/s 0.254mm/s @ 0.0Hz
Vertical ***(V):*** **0.025in/s 0.635mm/s @ 22.2Hz**
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

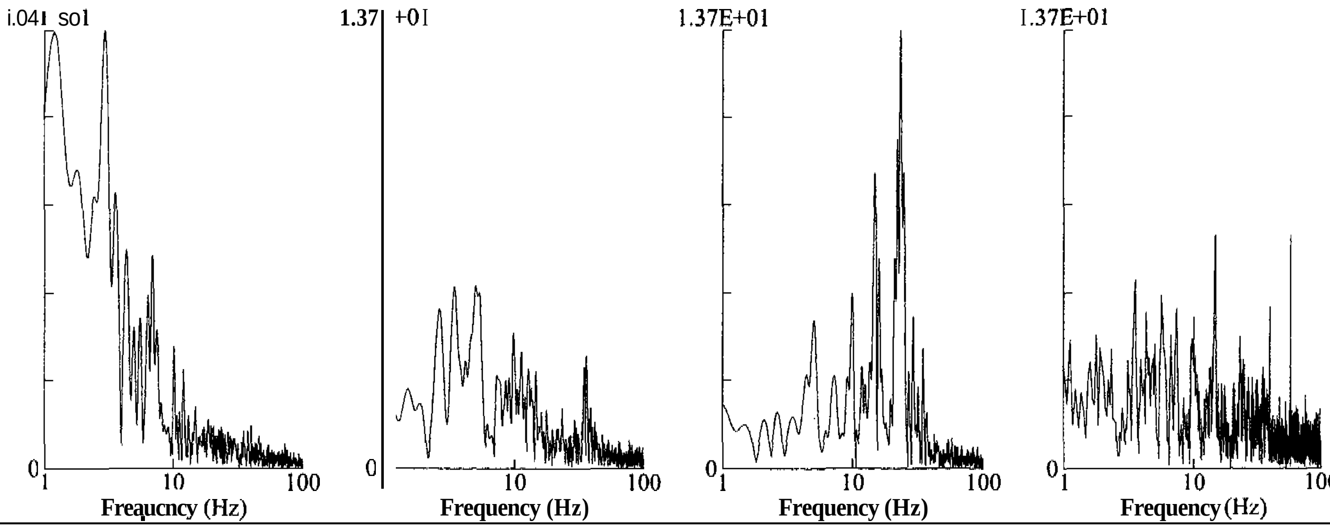
Graph Information

Duration: 0.000 sec To: **9.500**sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s** (1.270mm/s/div)
Time Lines ***at:*** 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **2.94 Hz** | **Radial (R)** **5.13 Hz** | **Vertical (V)** **23.56 Hz** | **Transverse (T)** **15.06 Hz**



West Virginia
Abbott 1 shallow

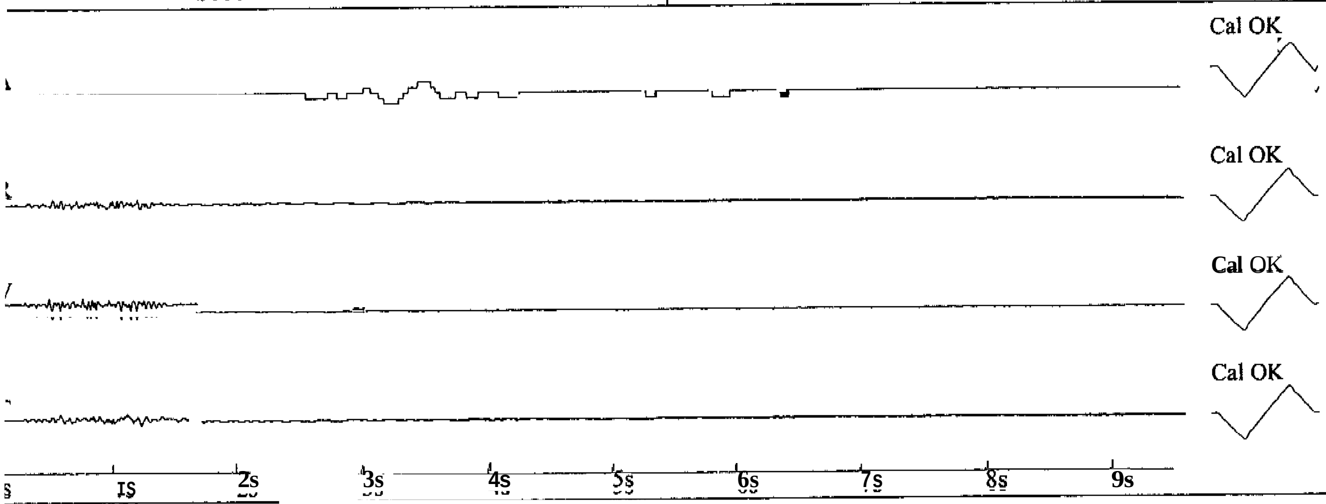
File: A1SAP033.DTB Event Number: 033 Date: 4/19/01 Time: 16:52
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s **0.635mm/s** Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): 106 dB @ ***0.0*** Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.02in/s 0.508mm/s @ 9.4Hz
***Vertical (V):* 0.025in/s 0.635mm/s @ 22.2Hz**
***Transverse (T):* 0.025in/s 0.635mm/s @ 12.4Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

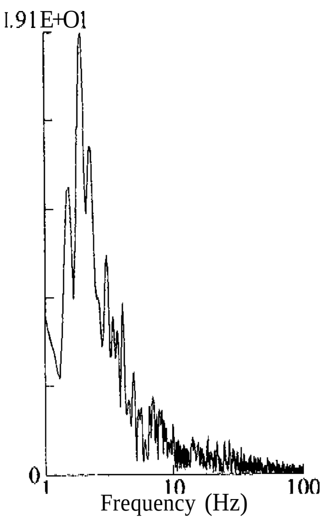
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic *Scale:*
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: **1.00** sec intervals

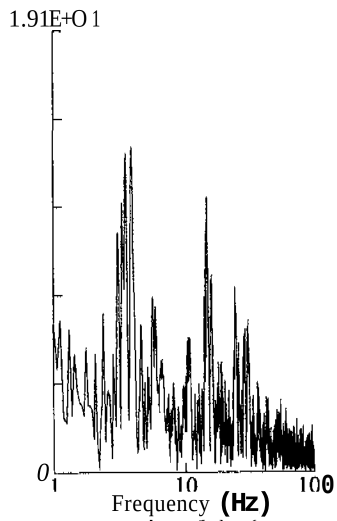


Fourier Analysis (Amplitude Spectrum - Box Window)

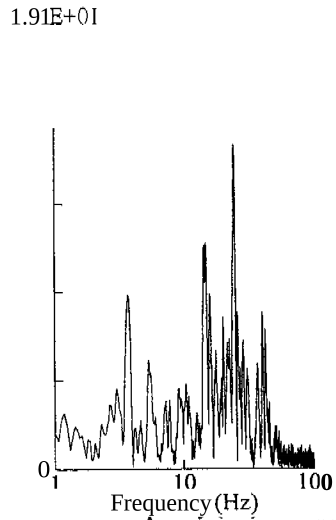
Acoustic (A)
1.94 Hz



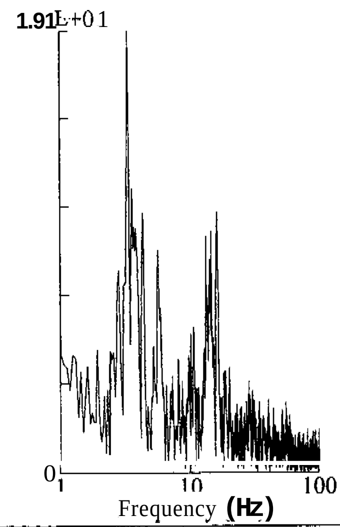
Radial (R)
3.94 Hz



Vertical (V)
24.75 Hz



Transverse (T)
3.31 Hz



West Virginia
Abbott 2 shallow

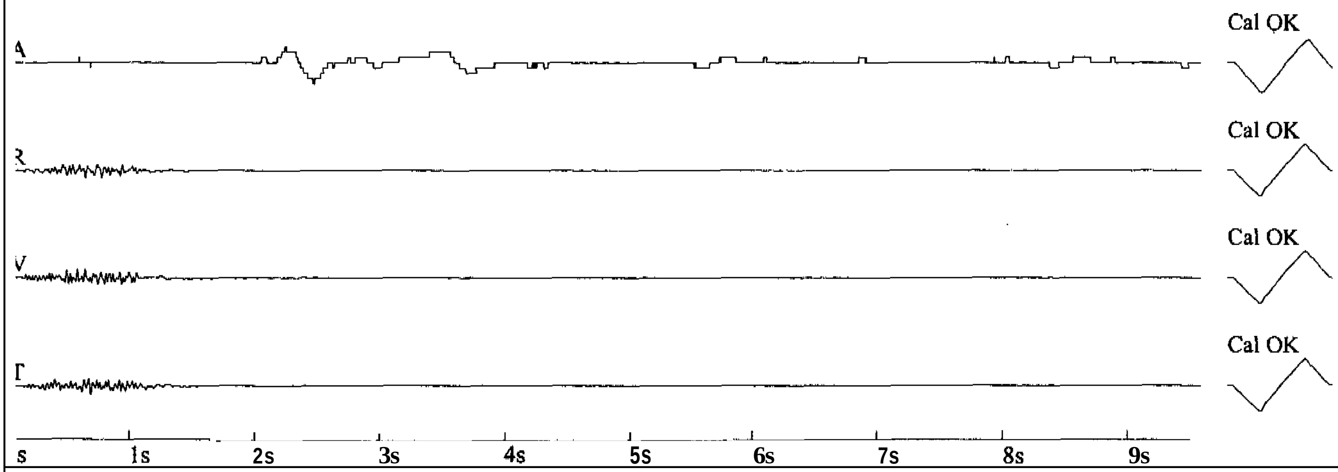
File: A2NS4020.DTB Event Number: 020 Date: 4/16/01 Time: 16:49
Acoustic Trigger: 114 dB Seismic **Trigger** 0.025in/s **0.635mm/s** **Serial Number:** 1779

Amplitudes and Frequencies

Acoustic (A): 112 dB @ 2.5 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Aadial (R): 0.03in/s 0.762mm/s @ 30.1Hz
Vertical (V): 0.03in/s 0.762mm/s @ 39.3Hz
***Transverse (T):* 0.035in/s 0.889mm/s @ 30.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

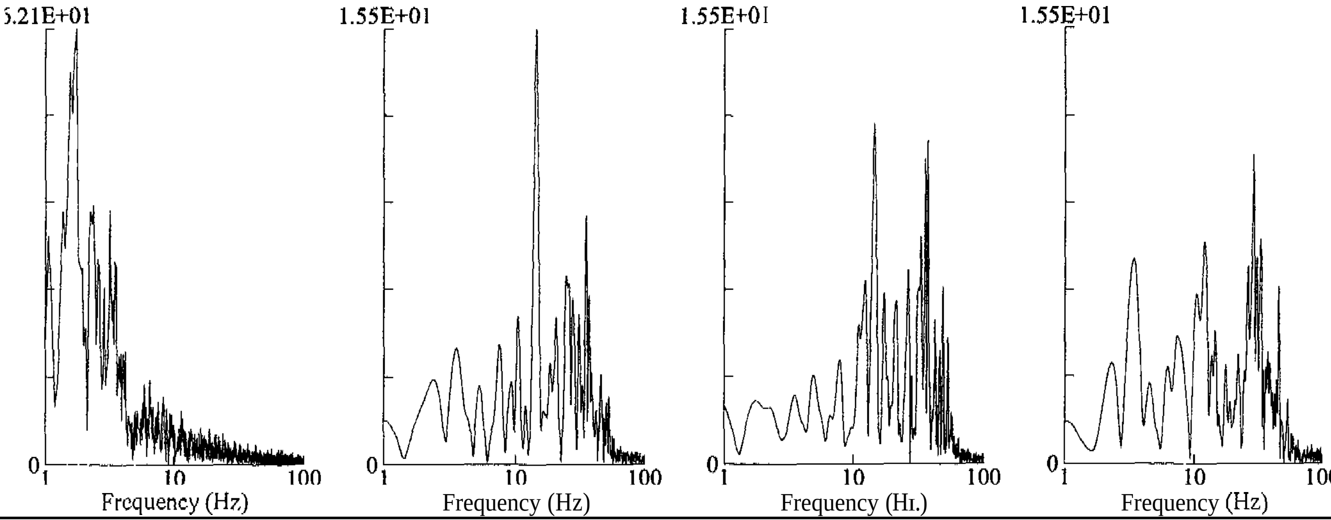
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic ***Scale:***
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.75 Hz**
Radial (R) **14.63 Hz**
Vertical (V) **14.50 Hz**
Transverse (T) **29.19 Hz**



West Virginia
Abbott 2 deep

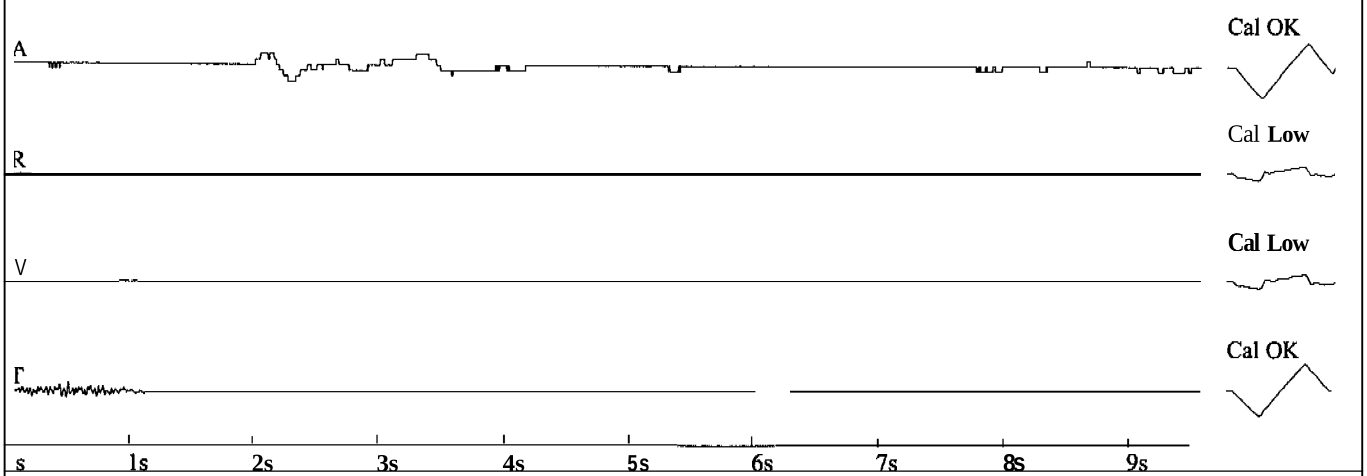
File: A2SP4017.DTB Event Number: 017 Date: 4/16/01 Time: 16:45
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 2.6 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial ***(R):*** 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.00in/s **0.00mm/s** @ 0.0Hz
Transverse ***(T):*** **0.03in/s 0.762mm/s @ 34.1Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

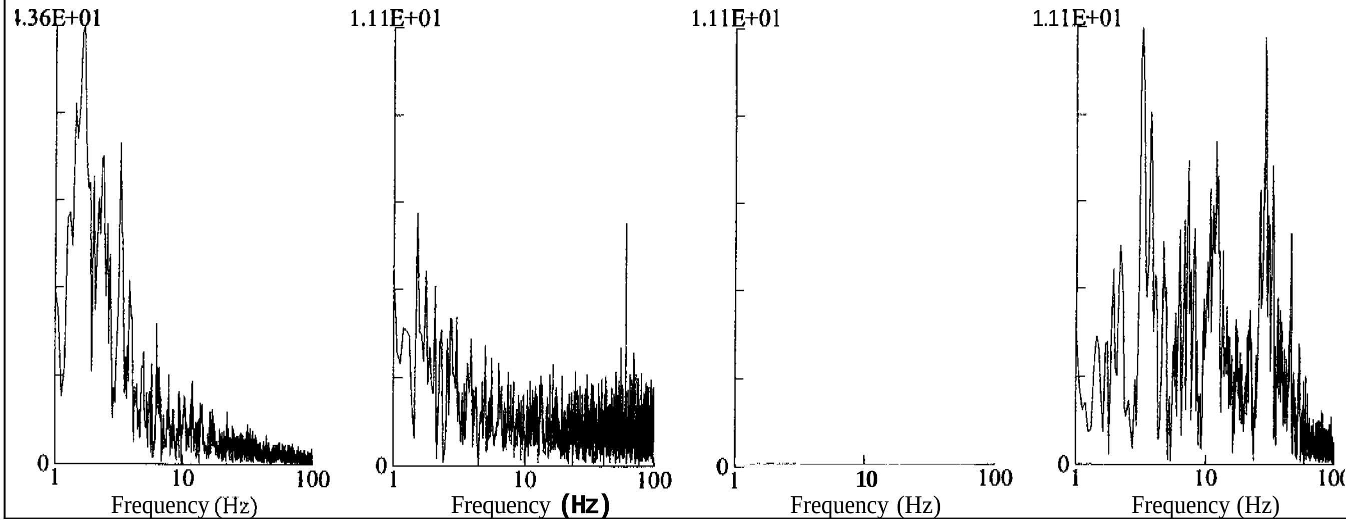
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.69 Hz** | **Radial (R)** **1.50 Hz** | **Vertical** **0.00 Hz** | **Transverse (T)** **3.25 Hz**



West Virginia
Abbott 2 shallow

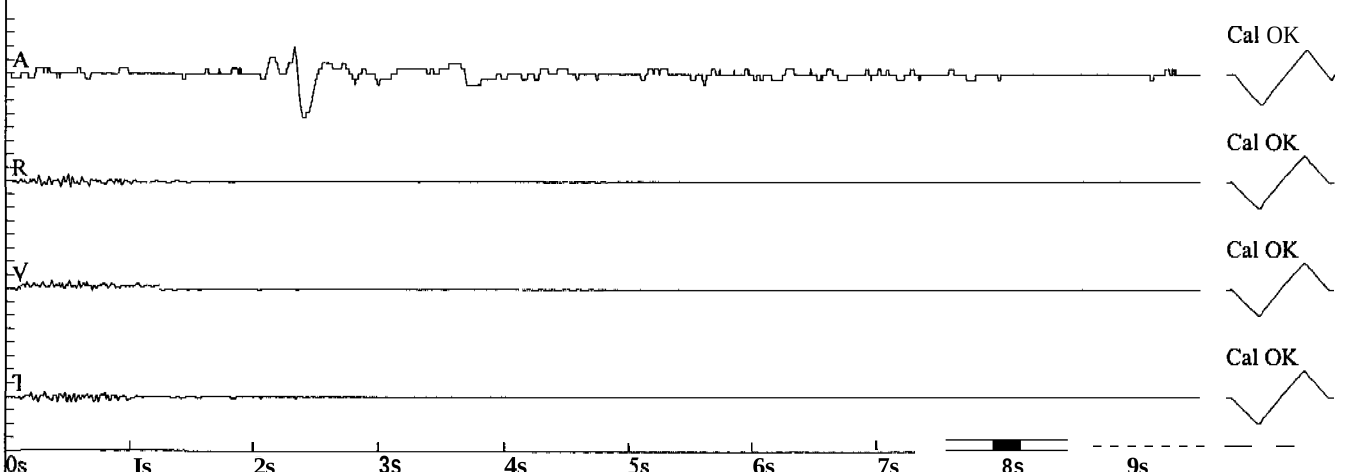
File: A2NS4072.DTB Event Number: 072 Date: 4/18/01 Time: 16:50
Acoustic Trigger: 114 dB S ismic Trigger 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

Acoustic (A): 118 dB @ 3.3 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial *(R)*: **0.025in/s 0.635mm/s @ 25.6Hz**
vertical (V): 0.02in/s **0.508mm/s** @ 28.4Hz
Transverse *(T):* 0.02in/s **0.508mm/s** @ 28.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

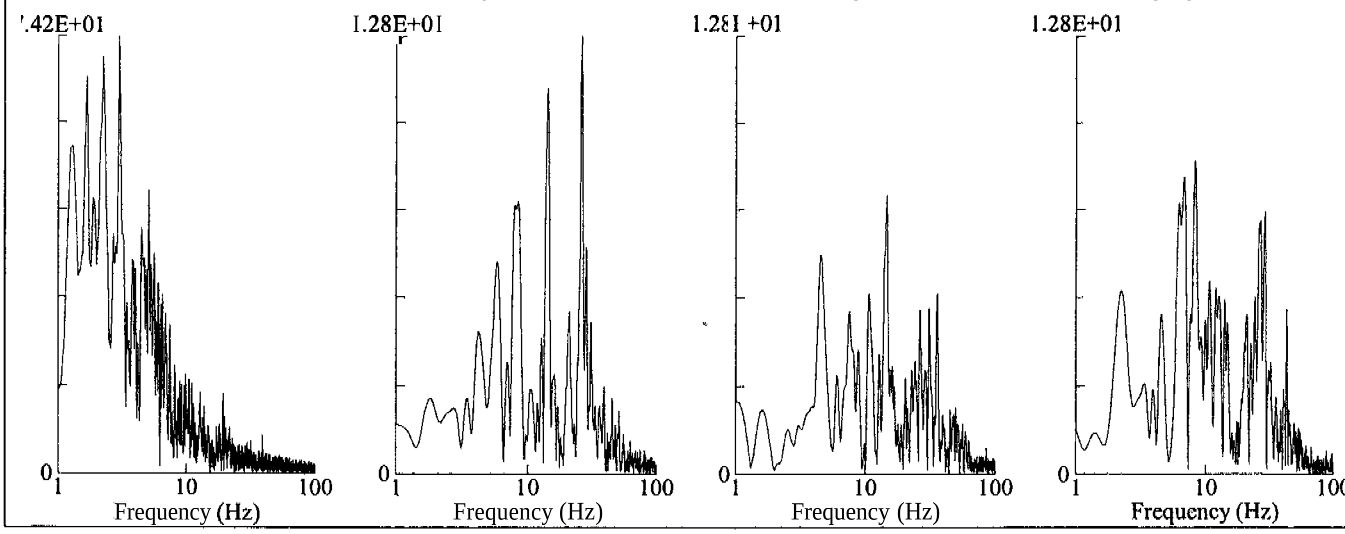
Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) **5.08mm/s (1.270mm/s/div)**
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **3.00 Hz** | **Radial (R)** **26.44 Hz** | **Vertical (V)** **14.75 Hz** | **Transverse (T)** **8.25 Hz**



FALL 2001

Kentucky
Sumner

Amplitudes and Frequencies

coustic (A): 125 dB @ 5.5 Hz
(0.34Mb 0.0049psi 0.0340kPa)

***R'adial(R):* 0.02in/s 0.508mm/s @ 14.2Hz**

***'ertical (V):* 0.02in/s 0.508mm/s @ 7.0Hz**

***'ransverse (T):* 0.02in/s 0.508mm/s @ 20.4Hz**

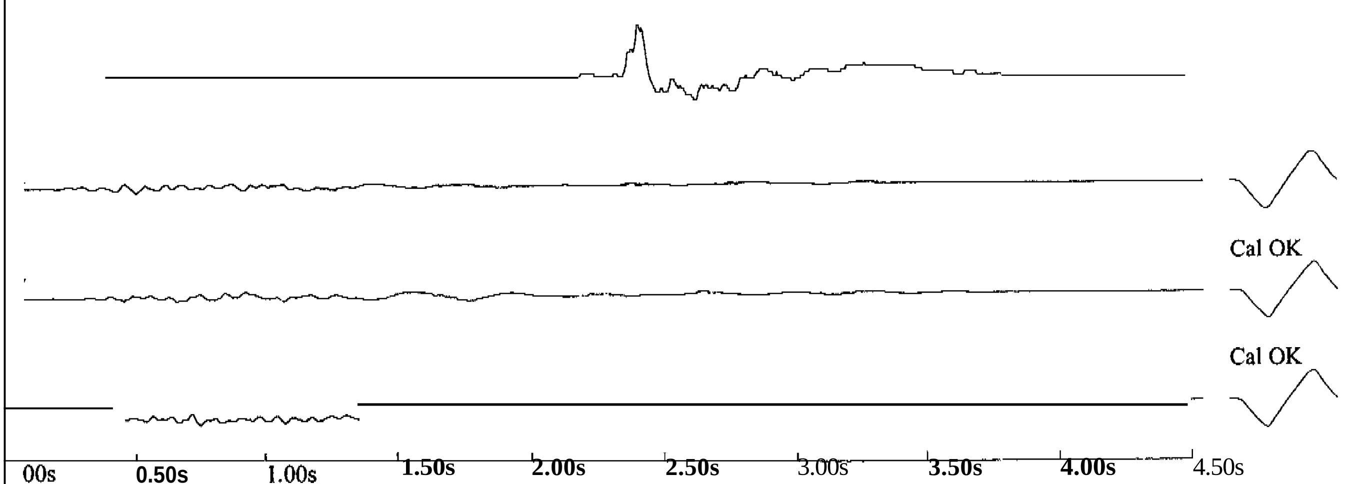
Graph Information

Duration: 0.000 sec To: 4.500 sec

Acoustic Scale:
125dB 0.36Mb (0.090Mb/div)

Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 0.50 sec intervals



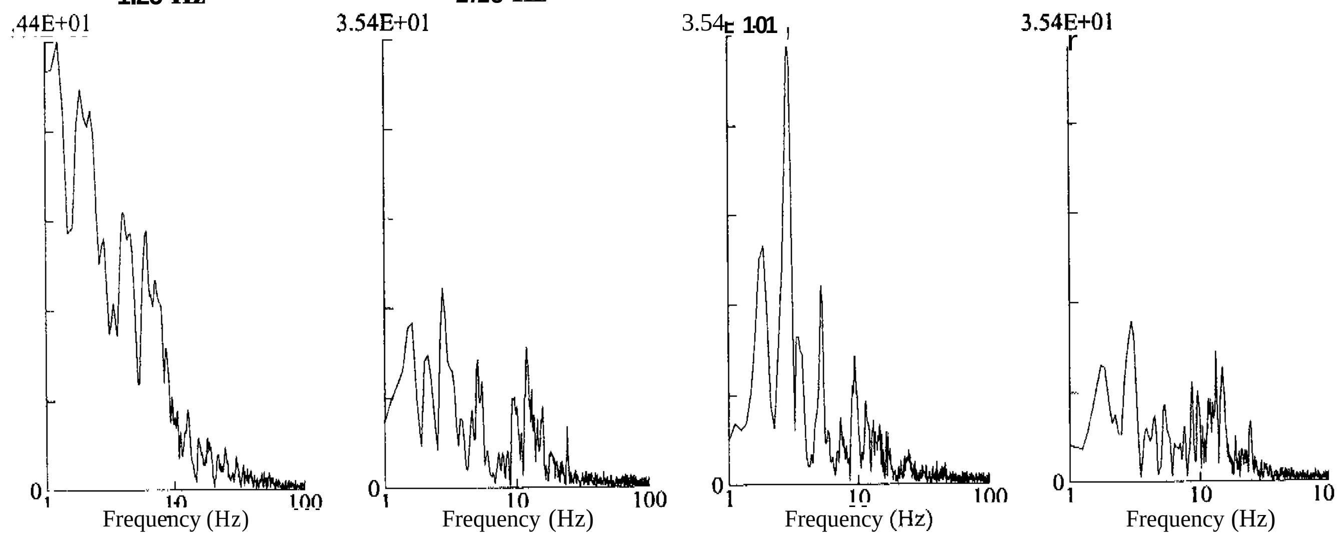
Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.25 Hz**

Radial (R) ***2.1s* Hz**

Vertical (V) **2.88 Hz**

Transverse (T) **3.00 Hz**



Kentucky
Sumner

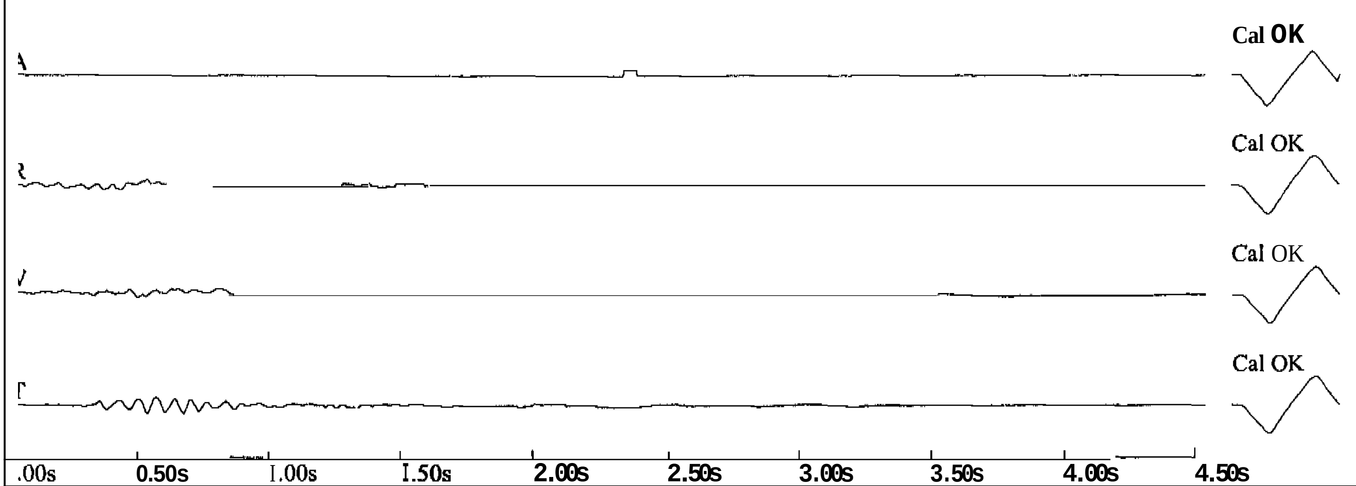
File: 608@@144.DTA Event Number: 144 Date: 9/24/01 Time: 13:53
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

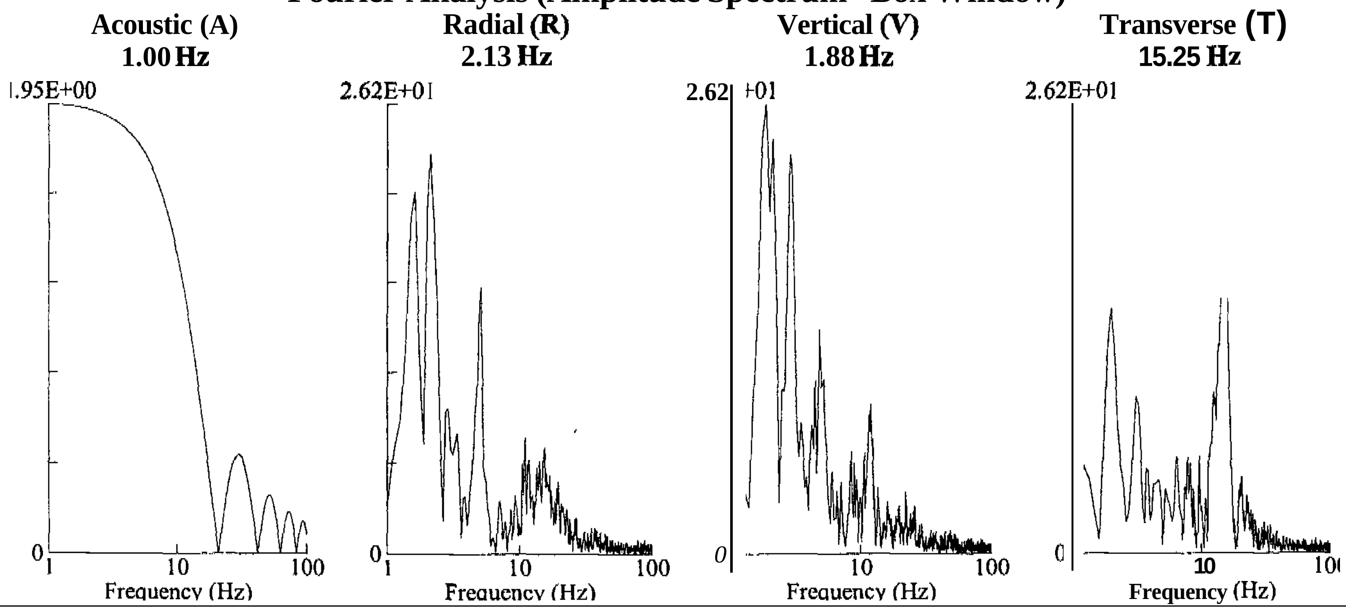
Acoustic (A): 100 dB @ **0.0 Hz**
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.02in/s 0.508mm/s @ 4.0Hz
Vertical (V): 0.02in/s 0.508mm/s @ 4.1Hz
***Transverse (T):* 0.03in/s 0.762mm/s @ 14.6Hz**

Graph Information

Duration: 0.000 sec To: **4.500**sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: **0.50** sec intervals

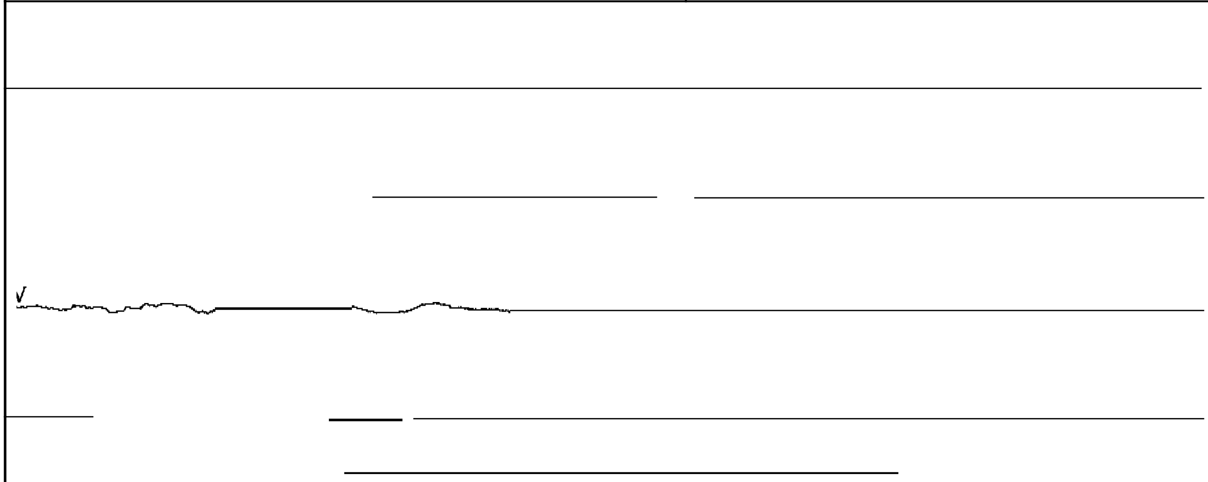


Fourier Analysis (Amplitude Spectrum - Box Window)

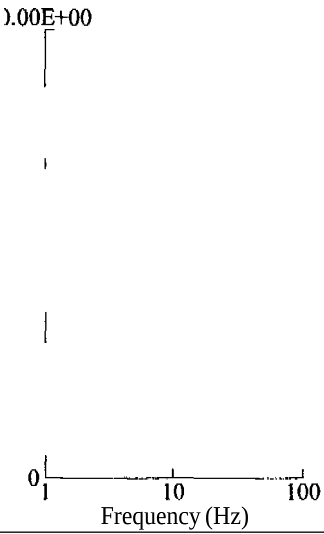


Kentucky
Sumner

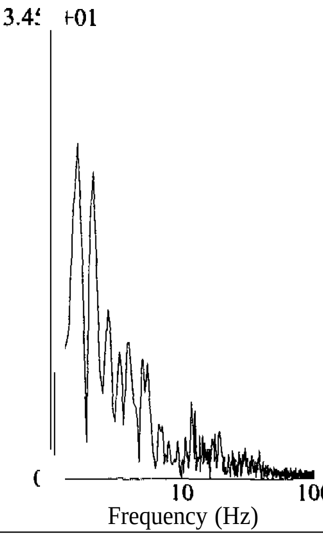
Amplitudes and Frequencies	**Graph Information**
Acoustic (A): <100 dB	*Duration: 0.000* sec To: 4.500 sec
Radial (R): 0.015in/s 0.381mm/s @ 6.8Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.02in/s 0.508mm/s @ 2.8Hz	*Seismic Scale:* 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse (T): **0.03in/s 0.762mm/s @ 11.6Hz**	*Time Lines at: 0.50* **sec intervals**



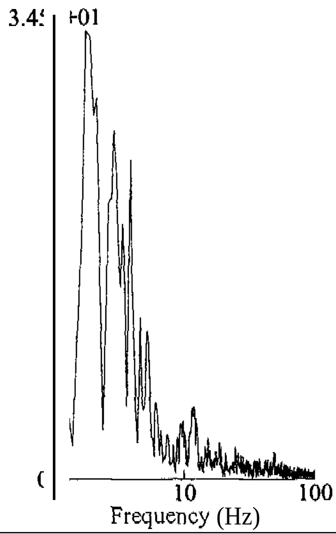
Acoustic (A)
0.00 Hz



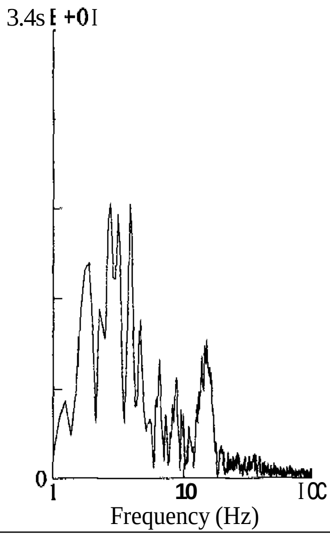
Radial (R)
1.63 Hz



Vertical (V)
1.75 Hz



Transverse (T)
2.75 Hz



Kentucky
Sumner

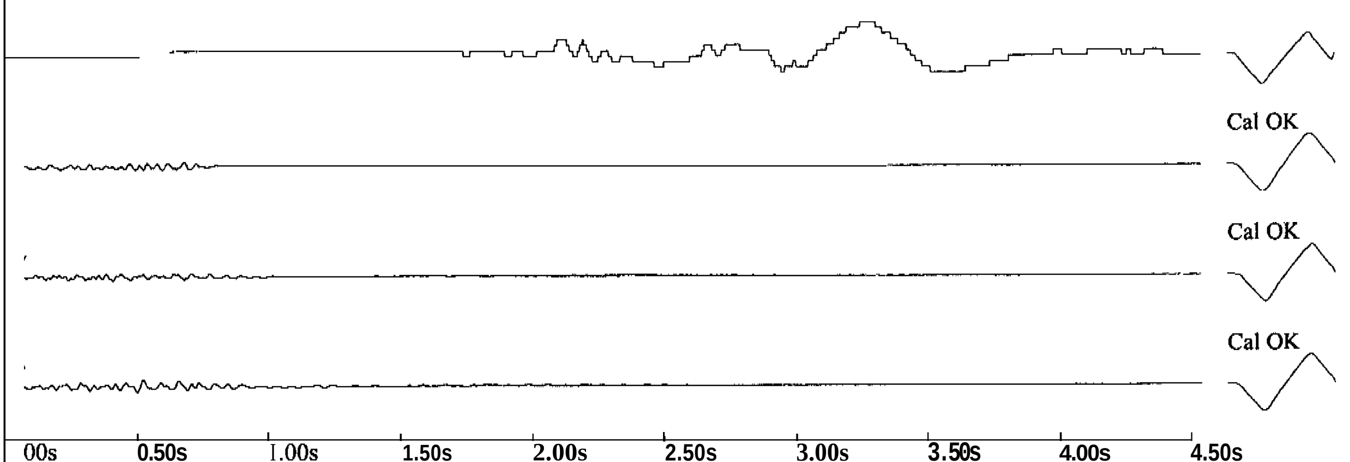
File: 608@@146.DTA Event Number: 146 Date: 9/25/01 Time: 15:44
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

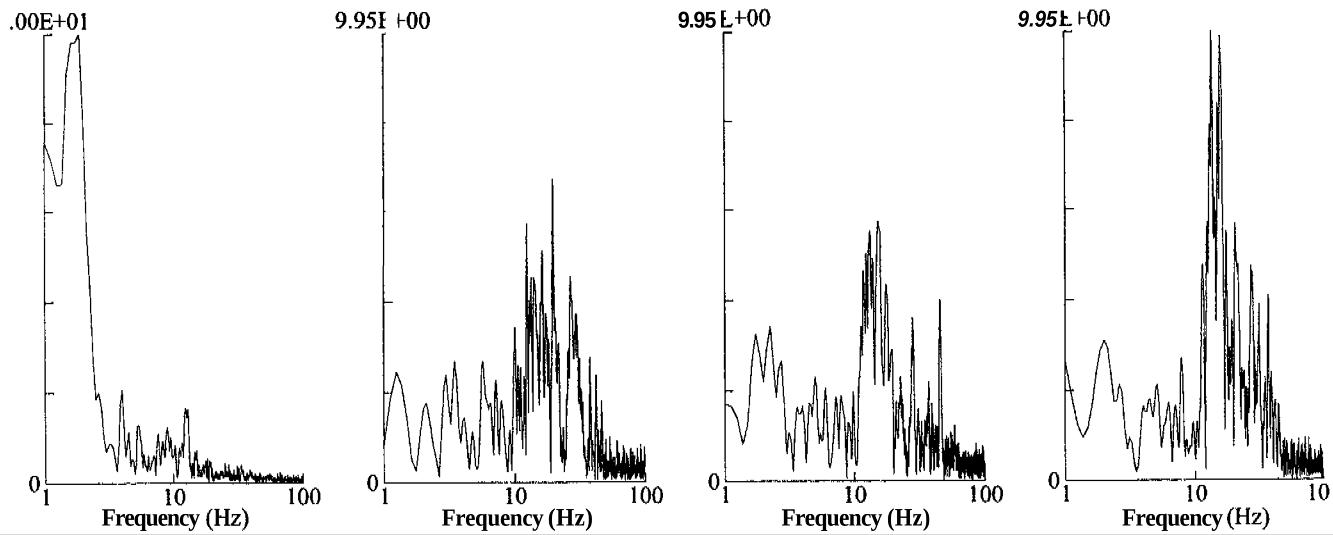
coustic (A): 116 dB @ 1.5 Hz
(0.12Mb 0.0017psi 0.0120kPa)
adial (R): 0.015in/s **0.381mm/s** @ 34.1Hz
'ertical (V): 0.01in/s **0.254mm/s** @ 0.0Hz
***'ransverse (T):* 0.025in/s 0.635mm/s @ 23.2Hz**

Graph Information

Duration: 0,000 sec To: **4.500 sec**
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



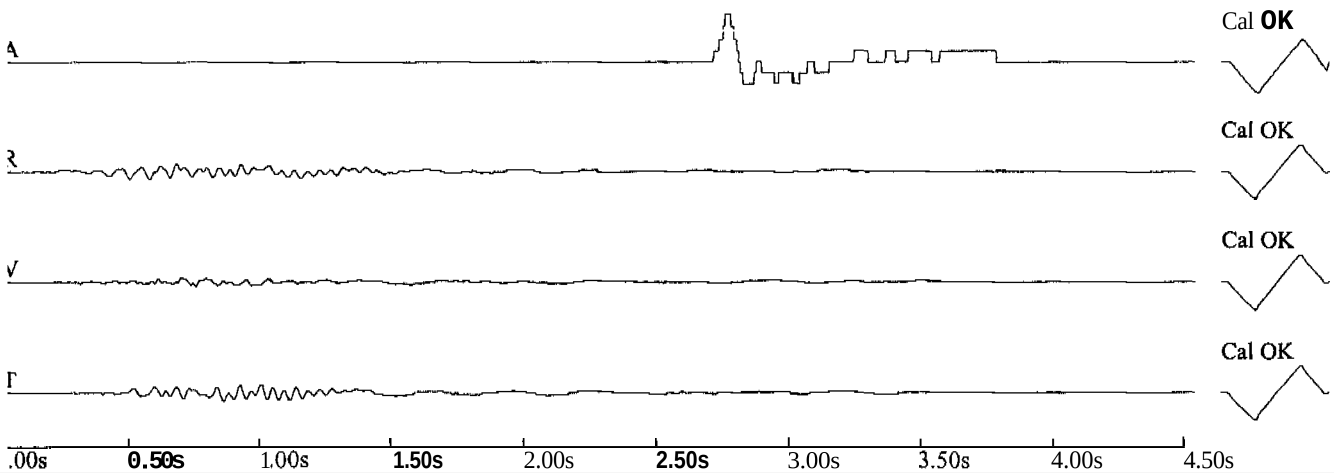
Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky
Hurley

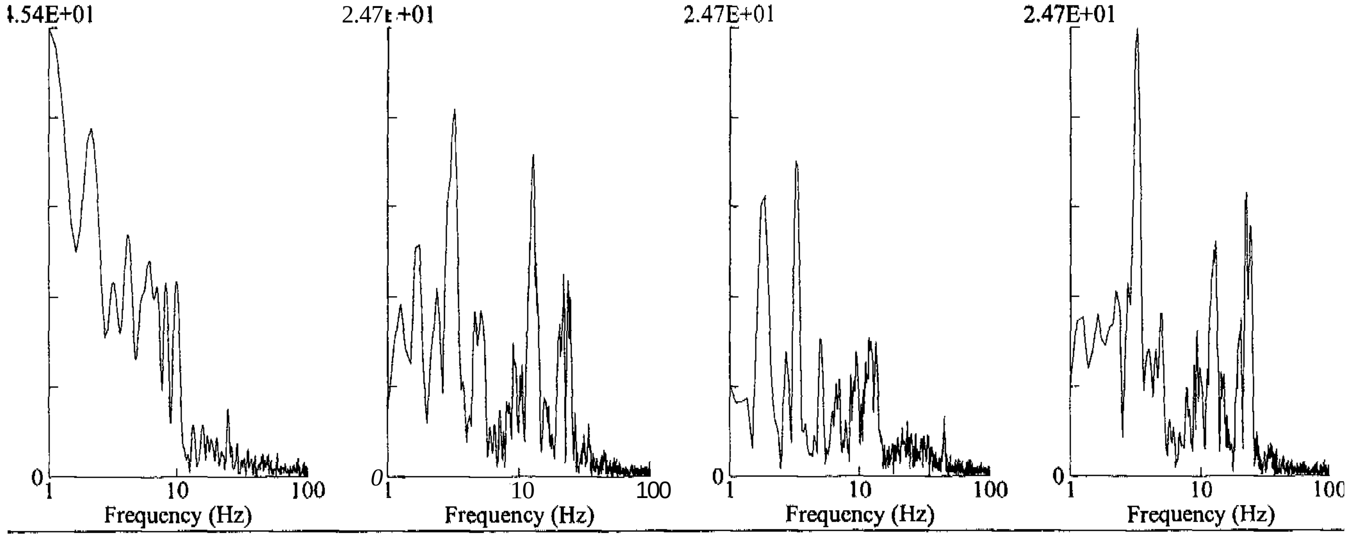
File: 813@@065.DTA Event Number: ***065*** Date: 9/21/01 Time: 15:20
Acoustic Trigger: 120 dB **Seismic Trigger: 0.02in/s 0.508mm/s** Serial Number: 813

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): 118 dB @ 6.7 Hz (0.16Mb 0.0023psi 0.0160kPa)	***Duration: 0.000*** **sec** To: 4.500 sec
Radial (R): **0.03in/s 0.762mm/s @ 9.4Hz**	***Acoustic Scale:*** 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.015in/s **0.381mm/s** @ 34.1Hz	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse(T): **0.03in/s 0.762mm/s @ 23.2Hz**	***Time Lines at: 0.50*** sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	3.25 Hz	3.25 Hz	3.25 Hz



Kentucky
Hurley

Amplitudes and Frequencies

Acoustic (A): **106 dB** @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

Radial **(R): 0.02in/s 0.508mm/s @ 16.5Hz**

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz

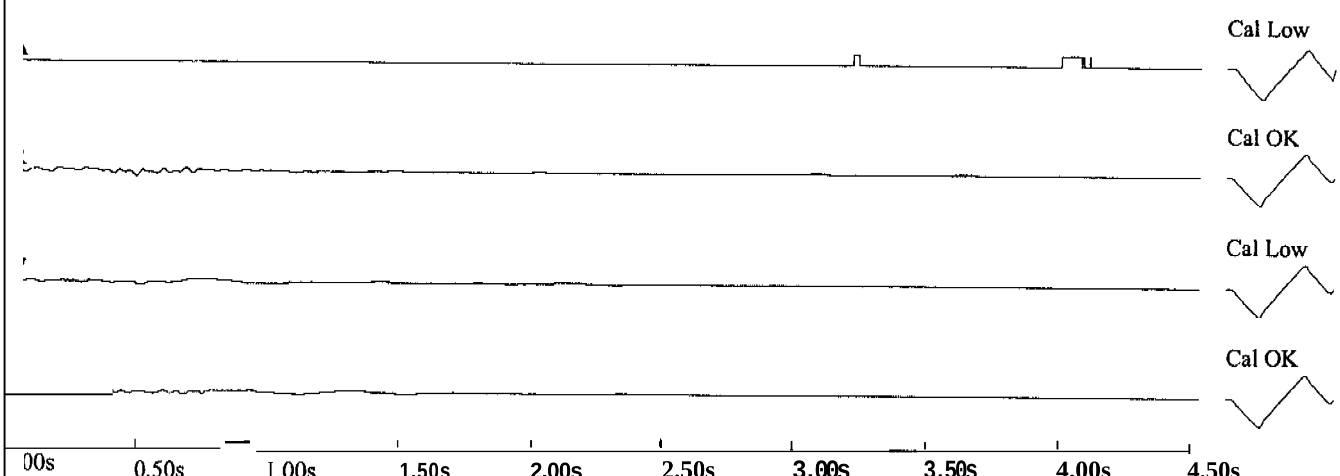
Graph Information

Duration: 0.000 sec To: 4.500 sec

Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)

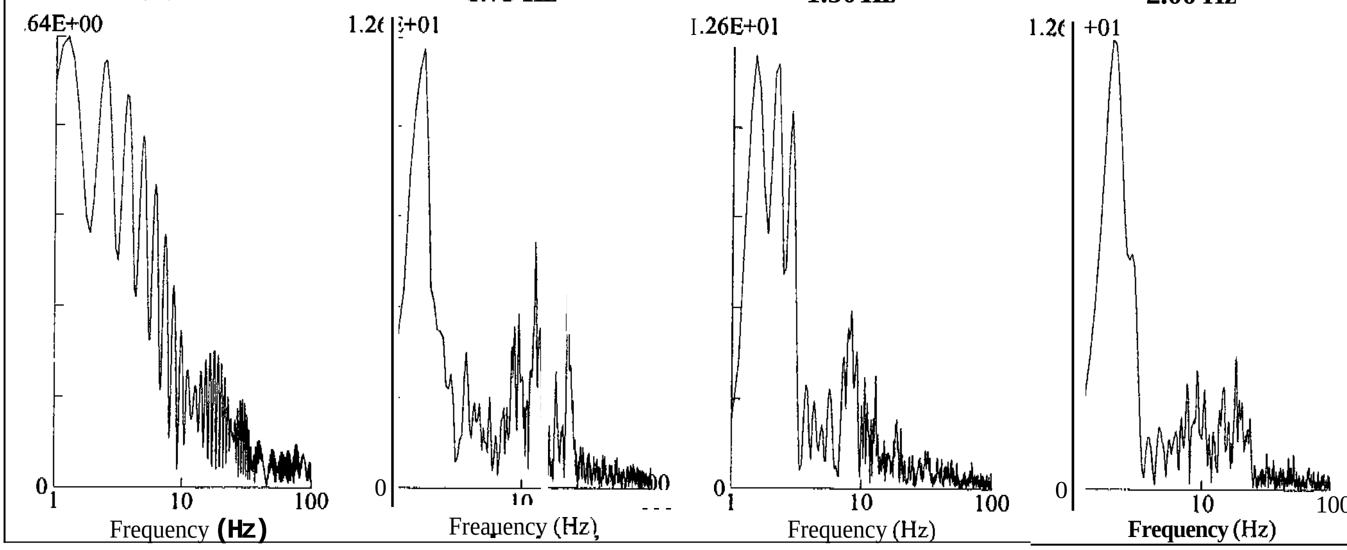
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A) **1.25 Hz** | **Radial (R)** **1.75 Hz** | **Vertical (V)** **1.50 Hz** | **Transverse (T)** **2.00 Hz**

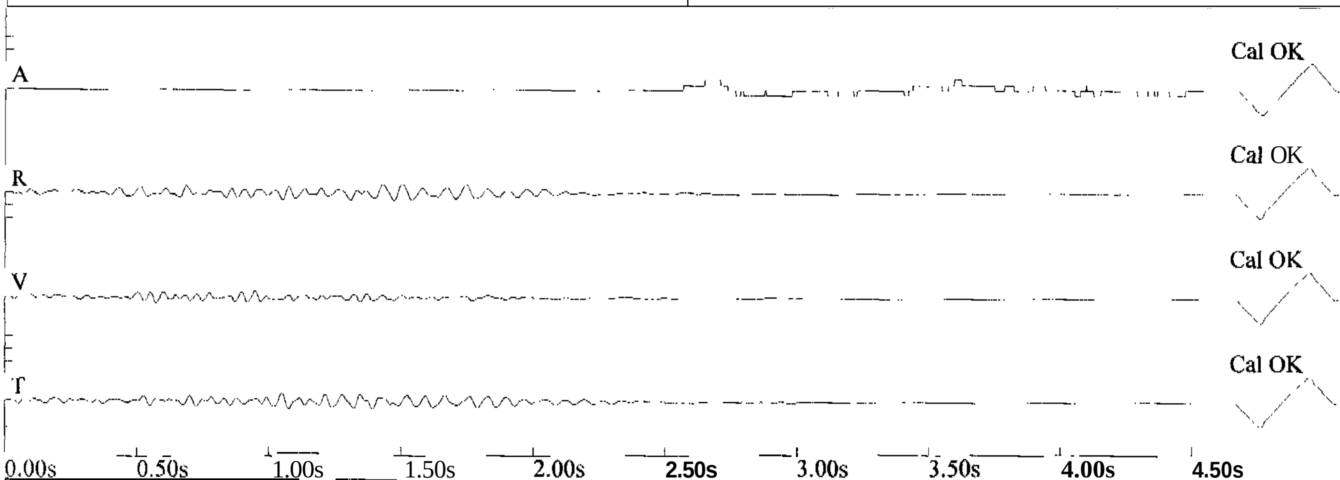


WINTER 2001

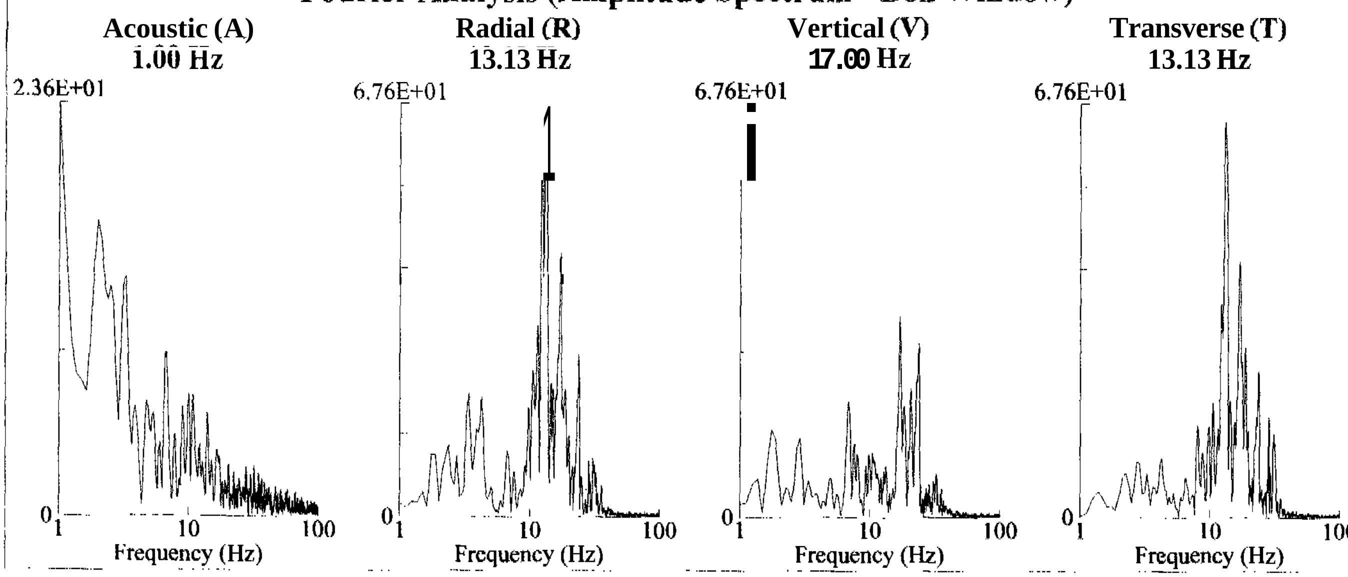
Dean Jr. Well - surface transducer

File: 01769224.DTB Event Number: 224 Date: 12/04/2001 Time: 16:44
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1769

Amplitudes and Frequencies	Graph Information
Acoustic (A): **106** dB @ 0.0 Hz (0.04Mb 0.0006psi 0.0040kPa)	***Duration:*** 0.000 sec **To:** 4.500 sec
***Radial* (R): 0.0325in/s 0.8255mm/s @ 13.4Hz**	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.025in/s 0.635mm/s @ 19.6Hz	***Seismic Scale:*** 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
***Transverse (T):* 0.0325in/s 0.8255mm/s @ 18.9Hz**	***Time Lines at:*** 0.50 sec intervals
Calibration Date (yyyy/mm/dd): 2000/09/22	



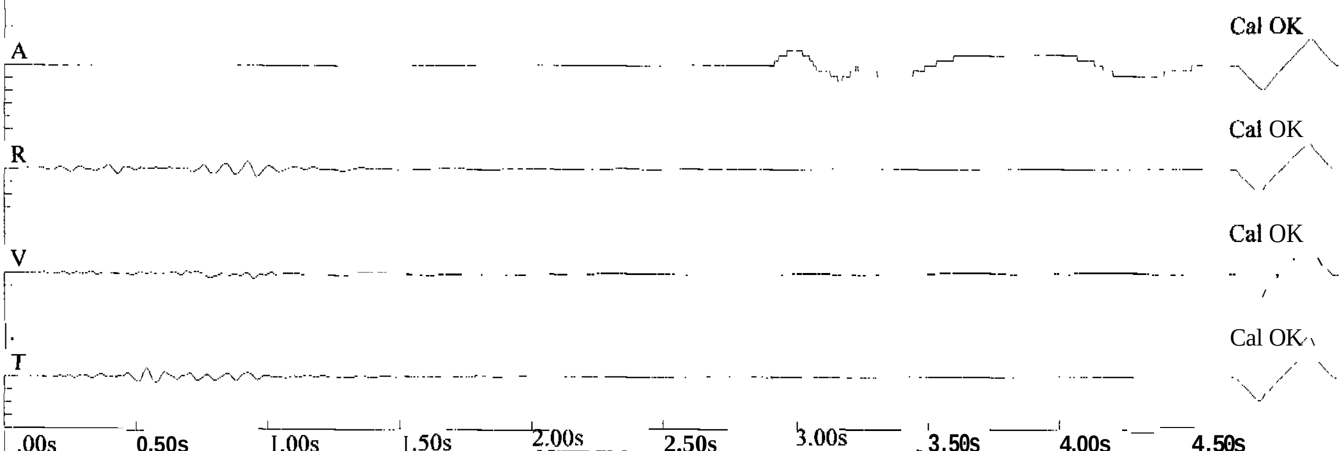
Fourier Analysis (Amplitude Spectrum - Box Window)



Dean Jr. Well - surface transducer

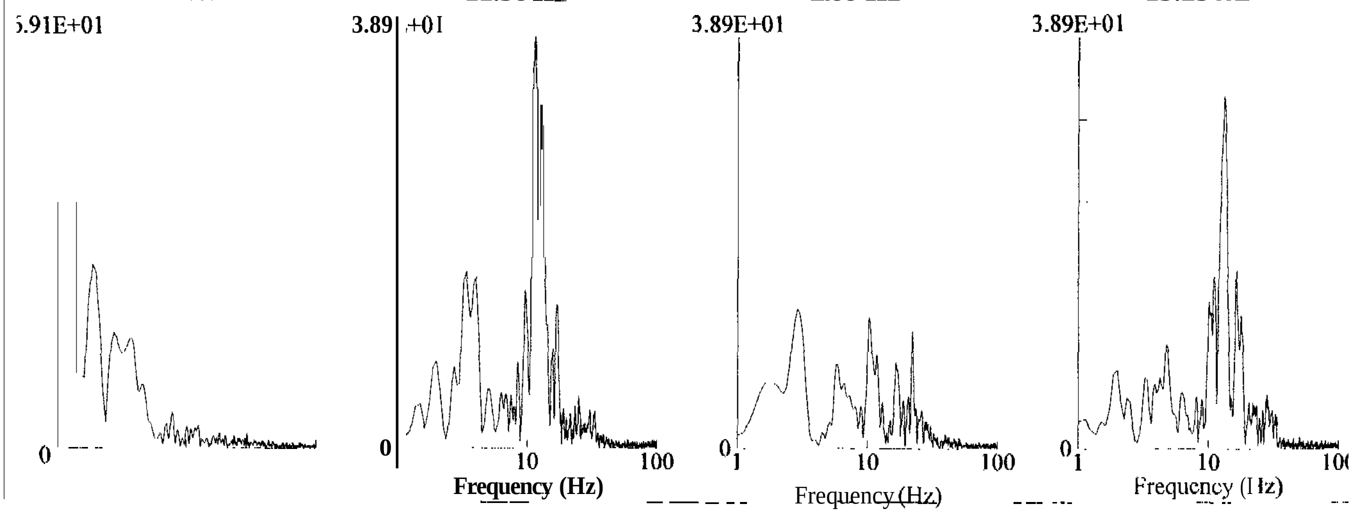
File: 01769229.DTB Event Number: 229 Date: 12/05/2001 Time: 16:46
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s **0.508mm/s** **Serial Number:** 1769

Amplitudes and Frequencies	**Graph Information**
Acoustic (A): **110 dB @ 3.8** Hz (0.06Mb 0.0009psi 0.0060kPa)	*Duration:* **0.000** sec To: **4.500** sec
Radial (R): 0.03in/s 0.762mm/s @ 12.1Hz	*Acoustic Scale:* 120dB 0.20Mb (0.050Mb/div)
Vertical (V): 0.0125in/s **0.3175mm/s** @ 17.0Hz	***Seismic*** Scale: 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Transverse ***(T):* 0.0325in/s 0.8255mm/s @ 15.5Hz**	***Time*** *Lines* at: 0.50 sec **intervals**
Calibration Date (yyyy/mm/dd): 2000/09/22	



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.00 Hz	**11.38 Hz**	**2.88 Hz**	**13.25 Hz**



Dean Jr. Well - surface transducer

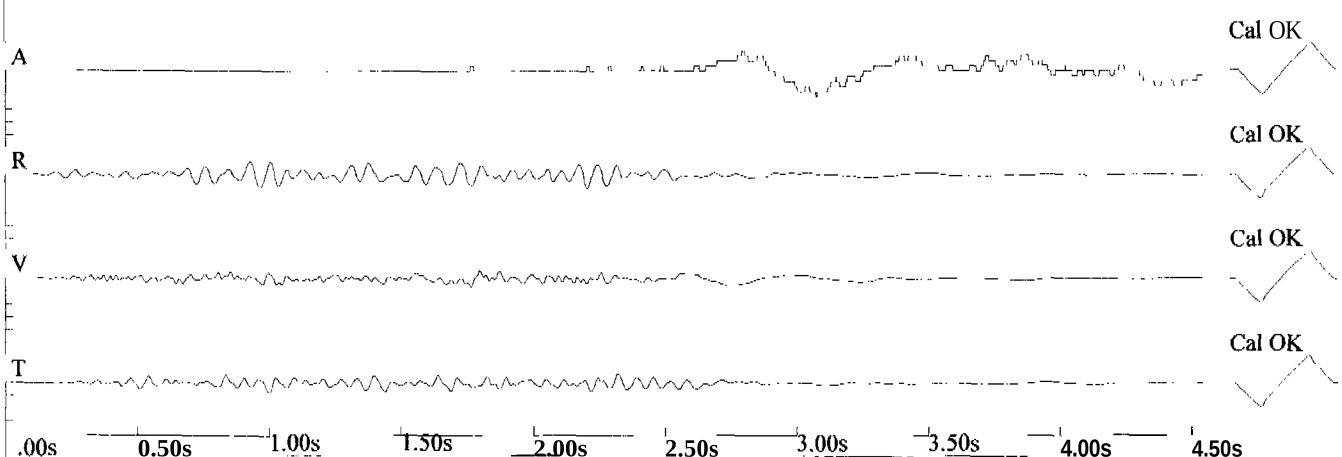
File: 01769230.DTB Event Number: 230 Date: 12/05/2001 Time: 16:50
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s **0.508mm/s** Serial Number: 1769

Amplitudes and Frequencies

Acoustic (A): 114 dB @ 1.6 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): **0.0525in/s 1.3335mm/s @ 16.0Hz**
Vertical (V): 0.0325in/s 0.8255mm/s @ 10.0Hz
Transverse (T): 0.0375in/s **0.9525mm/s** @ 14.6Hz
Calibration Dale (yyyy/mm/dd): 2000/09/22

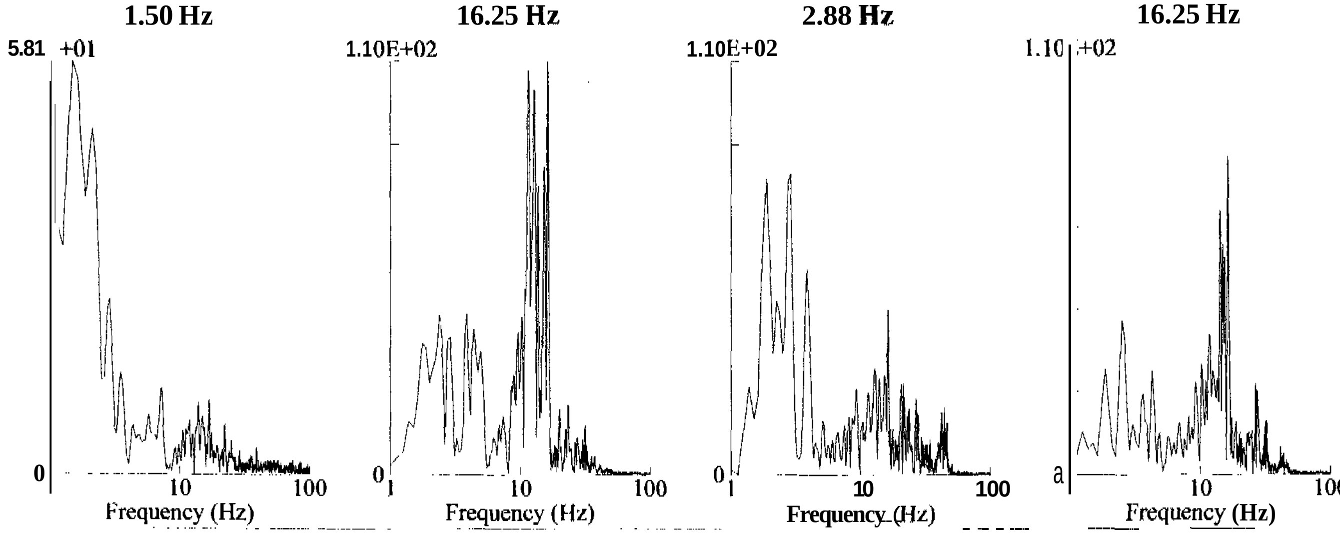
Graph Information

Duration: ***0.000*** sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)

Acoustic (A)	Radial (R)	Vertical (V)	Transverse (T)
1.50 Hz	**16.25 Hz**	**2.88 Hz**	**16.25 Hz**



Appendix B

Laboratory Analysis Results

iml

Inter•Mountain Laboratories, Inc

Phone (505) 326-4737 Fax (505)325-4182

2506 West Main Street, Farmington, NM 87401

Date: 11/29/00

Client: Daniel B. Stephens

Lab ID: 0300W04998 - 5000

Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

William Lipps
IML-Farmington, NM

iml Inter-Mountain Laboratories Inc

Phone (505) 326-4737 Fax (505)325-4182 2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: RATLIFFE 1
Lab ID: 0300W04998
Matrix: Water
Condition: Cool/Intact

Date Received: 11/10/00
Date Reported: 11/29/00
Date Sampled: 11/09/00
Time Sampled: 1115

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	448	mg/L		2	EPA 160.2	11/13/00	1455	FP
Solids - Total Suspended	4	mg/L		2	EPA160.2	11110100	1455	KA
Sulfate	109	mg/L		5	EPA300.0	11/29/00	0900	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	11/22/00	1447	WL
Iron	4.17	mg/L		0.02	EPA200.7	11/22/00	1447	WL
Manganese	0.36	mg/L		0.01	EPA200.7	11/22/00	1447	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-11 I- May, 1994.

Reviewed By: ____________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: BANKS 1

Lab ID: 0300W04999

Matrix: Water

Condition: Cool/Intact

Date Received: 11/10/00

Date Reported: 11/29/00

Date Sampled: 11/09/00

Time Sampled: 1355

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Analysis Init
General Parameters								
Solids - Total Dissolved	274	mg/L		2	EPA160.2	11/13/00	1455	FP
Solids - Total Suspended	3	mg/L		2	EPA 160.2	11/10/00	1455	KA
Sulfate	72	mg/L		5	EPA 300.0	11/29/00	0900	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	11/22/00	1450	WL
Iron	3.48	mg/L		0.02	EPA200.7	11/22/00	1450	WL
Manganese	0.44	mg/L		0.01	EPA200.7	11/22/00	1450	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: BOGGS 1
Lab ID: 0300W05000
Matrix: Water
Condition: Cool/Intact

Date Received: 11/10/00
Date Reported: 11/29/00
Date Sampled: 11/06/00
Time Sampled: 0930

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	1,740	mg/L		2	EPA 160.2	11/13/00	1455	FP
Solids - Total Suspended	19	mg/L		2	EPA 160.2	11/10/00	1455	KA
Sulfate	991	mg/L		5	EPA 300.0	11/29/00	0900	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	11/22/00	1459	WL
Iron	17.7	mg/L		0.02	EPA200.7	11/22/00	1459	WL
Manganese	1.10	mg/L		0.01	EPA 200.7	11/22/00	1459	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-11 I - May, 1994.

Reviewed By: ____________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Quality Control Report
Duplicate Analysis

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: BANKS 1
Lab ID: 0300W04999
Matrix: Water
Condition: Cool/Intact

Report Date: 11/29/00
Receipt Date: 11/10/00
Sample Date: 11/09/00
Time Sampled: 1355

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Units
Solids - Total Dissolved	274	272	1	2	mg/L
Solids - Total Suspended	3	10	7**	2	mg/L
Sulfate	72	72	0	5	mg/L
Aluminum	<0.05	<0.05	NC*	0.05	mg/L
Iron	3.48	3.34	4	0.02	mg/L
Manganese	0.44	0.42	5	0.01	mg/L

*NC - Non-Calculable RPD due to value(s) less than DL ** - Difference used for results < 5 X Detection Limit

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________________

iml Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name	Project Location
DESTA / OSM Well Study	Norton, Va

Sampler: (Signature)	Chain of Custody Tape No.
T. Ste[illegible]	NA

ANALYSES / PARAMETERS

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	(1L) SO4, TDS, TSS	(250 mL) Total Al, Fe, Mn			Remarks
Ratliffe 1	11/9/00	1115	W04998	Water	2	X	X			
Banks 1	11/9/00	1355	W04999	Water	2	X	X			
Boggs 1	11/6/00	0930	W05000	Water	2	X	X			

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[signature]	11/9/00	1515			
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by laboratory: (Signature)	Date	Time
			[signature]	11/10/00	9:20

Inter-Mountain Laboratories, Inc.

- ☐ 555 Absaraka, Sheridan, Wyoming 82801, Telephone (307)674-7506
- ☐ 1633 Terra Avenue, Sheridan, Wyoming 82801, Telephone (307)672-8945
- ☐ 1701 Phillips Circle, Gilette, Wyoming 82718, Telephone (307)682-8945
- ☒ 2506 West Main Street, Farmington, NM 87401, Telephone (505) 326-4737
- ☐ 11183 State Hwy. 30, College Station, TX 77845, Telephone (979) 776-8945

T0664

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

December 7,2000

Todd Stein
Daniel B. Stevens Consulting
6020 Academy Rd. NE, Suite 100
Albuquerque, NM 87109

Mr. Stein:

Enclosed please find the reports for the samples received by our laboratory for analysis on November 21,2000.

If you have any questions about the results of these analyses, please don't hesitate to call me at your convenience.

Thank you for choosing IML for your analytical needs!

Sincerely,

William Lipps
Assistant Lab Manager/IML-Farmington

Enclosure

xc: File

Inter-Mountain laboratories, Inc.
Phone (505)326-4737 Fax (505)325-4182
2506 West Main Street, Farmington, NM 87401

DANIEL B. STEVENS

Case Narrative

On November 21,2000, four water samples were submitted to Inter-Mountain Laboratories - Farmington for analysis, The parameters performed on the samples are indicated on the accompanying Chain of Custody.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the samples reported herein are found in: EPA: "Methods for Chemical Analvsis of Water and Wastes (MCAWW)" – EPA/600/4-79-020 – March 1983, "Methods for the Determination of Metals in Environmental Samples", Supplement I-600/R-94-111 – May, 1994.

If there are any questions regarding the information presented in this report package, please feel free to contact us at your convenience.

Sincerely,

William Lipps
Assistant Lab Manager/IML-Farmington

iml

Inter•Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client:	Daniel B. Stephens
Project:	Norton, VA
Sample ID:	Boggs 2
Lab ID:	0300W05150
Matrix:	Water
Condition:	Intact

Date Received:	11/21/00
Date Reported:	12/05/00
Date Sampled:	11/18/00
Time Sampled:	1515

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Analysis Init.
General Parameters								
Solids - Total Dissolved	1,710	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	9	mg/L		2	EPA160.2	11/17/00	0900	KA
Sulfate	955	mg/L		5	EPA 300.0	12/01/00	1339	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	€PA 200.7	12/05/00	1344	WL
Iron	0.03	mg/L		0.02	EPA200.7	12/05/00	1344	WL
Manganese	0.88	mg/L		0.01	EPA 200.7	12/05/00	1344	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May. 1994.

Reviewed By: ______________________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: Ratliff 2
Lab ID: 0300W05151
Matrix: Water
Condition: Intact

Date Received: 11/21/00
Date Reported: 12/05/00
Date Sampled: 11/18/00
Time Sampled: 1425

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Analysis Init.
General Parameters								
Solids - Total Dissolved	430	mg/L		10	EPA160.1	11/22/00	0930	FP
Solids - Total Suspended	14	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	108	mg/L		5	EPA300.0	12/01/00	1406	KA
Total Metals								
Aluminum	0.07	mg/L		0.05	EPA 200.7	12/05/00	1347	WL
iron	5.71	mg/L		0.02	EPA200.7	12/05/00	1347	WL
Manganese	0.42	mg/L		0.01	EPA200.7	12/05/00	1347	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

Inter-Mountain Laboratories, Inc.
Phone (505 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Client:	Daniel B. Stephens		
Project:	Norton, VA		
Sample ID:	Banks 2	Date Received:	11/21/00
Lab ID:	0300W05152	Date Reported:	12/05/00
Matrix:	Water	Date Sampled:	11/18/00
Condition:	Intact	Time Sampled:	1430

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	260	mg/L		10	EPA160.1	11/22/00	0930	FP
Solids - Total Suspended	21	mg/L		2	EPA160.2	11/17/00	0900	KA
Sulfate	72	mg/L		5	EPA300.0	12/01/00	1416	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/05/00	1350	WL
Iron	24.8	mg/L		0.02	EPA 200.7	12/05/00	1350	WL
Manganese	0.35	mg/L		0.01	EPA200.7	12/05/00	1350	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505)325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: Sumner 1
Lab ID: 0300W05153
Matrix: Water
Condition: Intact

Date Received: 11/21/00
Date Reported: 12/05/00
Date Sampled: 11/18/00
Time Sampled: 1605

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Analysis Init.
General Parameters								
Solids - Total Dissolved	250	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	7	mg/L		5	EPA 300.0	12/01/00	1425	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/05/00	1353	WL
Iron	20.8	mg/L		0.02	EPA200.7	12/05/00	1353	WL
Manganese	0.89	mg/L		0.01	EPA200.7	12/05/00	1353	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May. 1994.

Reviewed By: ____________________

Client/Project Name	Project Location		
DBS4A / OSM Well Study	Norton, Va		RS
Sampler: (Signature)	**Chain of Custody Tape No.**		
[illegible]	NA		

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	(1L) SO4, TDS, TSS	(125 mL) Total Al, Fe, Mn			Remarks
Boggs 2	11/18/00	1515		H2O	2	X	X			
Ratliff 2	11/18/00	1425		H2O	2	X	X			
Banks 2	11/18/00	1436		H2O	2	X	X			
Sumner 1	11/19/00	1605		H2O	2	X	X			

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[illegible signature]	11/19/00	2120			
Relinquished by: (Signature)	**Date**	**Time**	**Received by: (Signature)**	**Date**	**Time**
Relinquished by: (Signature)	**Date**	**Time**	**Received by laboratory: (Signature)**	**Date**	**Time**

Inter-Mountain Laboratories, Inc.

❒ 555 Absaraka
Sheridan, Wyoming 82801
Telephone (307) 674-7506

❒ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

❒ 1701 Phillips Circle
Gillette, Wyoming 82718
Telephone (307) 682-8945

❒ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

❒ 11183 State Hwy. 30
College Station, TX 77845
Telephone (979) 776-8945

70865

iml

Inter•Mountain Laboratories, Inc.

Phone (505) 326-1737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Date: 12/12/00

Client: Daniel B. Stephens

Lab ID: **0300W05218**

Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) **326-4737**.

William Lipps
IML-Farmington, NM

iml

Inter-Mountain Laboratories, Inc

Phone (505 324-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

dent: Daniel B. Stephens

Project: Norton, VA

Sample ID: Hurley #1

Lab ID: 0300W05218

Matrix: Water

Condition: Intact

Date Received: 11/22/00

Date Reported: 12112/00

Date Sampled: 11120100

Time Sampled: 1418

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	700	mglL		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	22	mglL		2	EPA 160.2	11/28/00	1200	KA
Sulfate	36	mglL		5	EPA300.0	12/05/00	1002	KA
Total Metals								
Aluminum	<0.05	mglL		0.05	EPA200.7	12/05/00	1416	WL
Iron	12.9	mg/L		0.02	EPA200.7	12/05/00	1416	WL
Manganese	1.51	mg/L		0.01	EPA200.7	12/05/00	1416	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________________

Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

lient/Project Name	Project Location	ANALYSES / PARAMETERS
DBS+A OSM Well Study	Norton, Va	
ampler: (Signature)	**Chain of Custody Tape No.**	
Mike Duine	NA	

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	(1L) SO_4, TDS, TSS	(1x250mL) Total Al, Fe, Mn			Remarks
Hurley 1	11/20	1418		H_2O	2	X	X			
[redacted]										

elinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Mike Duine	11/20/00	1953			
elinquished by: (Signature)	**Date**	**Time**	**Received by: (Signature)**	**Date**	**Time**
elinquished by: (Signature)	**Date**	**Time**	**Received by laboratory: (Signature)**	**Date**	**Time**
			Sharon Williams	11/22/00	12[illegible]

Inter-Mountain Laboratories, Inc.

- ☐ 555 Absaraka, Sheridan, Wyoming 82801, Telephone (307) 674-7506
- ☐ 1633 Terra Avenue, Sheridan, Wyoming 82801, Telephone (307) 672-8945
- ☐ 1701 Phillips Circle, Gillette, Wyoming 82718, Telephone (307) 682-8945
- ☒ 2506 West Main Street, Farmington, NM 87401, Telephone (505) 326-4737
- ☐ 11183 State Hwy. 30, College Station, TX 77845, Telephone (979) 776-8945

70737

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Date: 12/15/00

Client: Daniel B. Stephens

Lab ID: 0300W05257 - 60

Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

William Lipps
IML-Farmington, NM

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505)325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: Sumner-2
Lab ID: 0300W05257
Matrix: Water
Condition: Intact

Date Received: 11/28/00
Date Reported: 12/15/00
Date Sampled: 11/25/00
Time Sampled: 1800

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Analysis Init.
General Parameters								
Solids - Total Dissolved	250	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	103	mg/L		2	EPA160.2	12/01/00	1130	KA
Sulfate	5	mg/L		5	EPA300.0	12/06/00	1018	WL
Total Metals								
Aluminum	0.06	mg/L		0.05	EPA200.7	12/06/00	1356	WL
Iron	67.0	mg/L		0.02	EPA200.7	12/06/00	1356	WL
Manganese	3.86	mg/L		0.01	EPA200.7	12/06/00	1356	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________________

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325.4182
2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: Hurley-2
Lab ID: 0300W05258
Matrix: Water
Condition: Intact

Date Received: 11/28/00
Date Reported: 12/15/00
Date Sampled: 11/25/00
Time Sampled: 1900

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	650	mg/L		10	EPA160.1	11/29/00	1200	KA
Solids - Total Suspended	26	mg/L		2	EPAi60.2	12/01/00	1130	KA
Sulfate	37	mg/L		5	EPA300.0	12/06/00	1018	WL
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/06/00	1359	WL
Iron	14.7	mg/L		0.02	EPA 200.7	12/06/00	1359	WL
Manganese	I.46	mg/L		0.01	EPA 200.7	12/06/00	1359	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-1 II - May, 1994.

Reviewed By: ______________

iml

Inter•Mountain laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: Dean 1-1
Lab ID: 0300W05259
Matrix: Water
Condition: Intact

Date Received: 11/28/00
Date Reported: 12/15/00
Date Sampled: 11/26/00
Time Sampled: 1615

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	400	mg/L		10	EPA160.1	11/29/00	1200	KA
Solids - Total Suspended	75	mg/L		2	EPA160.2	12/01/00	1130	KA
Sulfate	145	mg/L		5	EPA300.0	12/06/00	1018	WL
Total Metals								
Aluminum	0.07	mg/L		0.05	EPA200.7	12/06/00	1402	WL
Iron	26.4	mg/L		0.02	EPA 200.7	12/06/00	1402	WL
Manganese	1.00	mg/L		0.01	EPA200.7	12/06/00	1402	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ________________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 2-1

Lab ID: 0300W05260

Matrix: Water

Condition: intact

Date Received: 11/28/00

Date Reported: 12115100

Date Sampled: 11/26/00

Time Sampled: 1620

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init
General Parameters								
Solids - Total Dissolved	320	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	7	mg/L		2	EPA 160.2	12/01/00	1130	KA
Sulfate	109	mg/L		5	EPA 300.0	12/06/00	1018	WL
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/06/00	1410	WL
Iron	4.62	mg/L		0.02	EPA200.7	12/06/00	1410	WL
Manganese	0.39	mg/L		0.01	EPA200.7	12/06/00	1410	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: [signature]

DANIEL B. STEPHEN'S& ASSOCIATES, INC.

Chain of Custody

To: Inter-Mountain Laboratories, Inc.

Date 11/26/00 Project No.

Client DBS&A OSM Well Study

Relinquished by Mike Devine 11/26/00 2153

Sent by: ☒ Fed Ex ☐ DHL ☐ Other

Purpose of Shipment Sample Analysis

Possible Contaminants

Item No.	Sample No.	Analysis to be Done	Sample Container	Comments
	Sumner-2	IL-SO4, TDS, TSS 1250mL Total Al, Fe, + Mn	2	Iced, 11/25/00 1800, Aq
	Harley-2	"	2	Iced, 11/25/00 1900, Aq
	Dean 1-1	"	2	Iced, 11/26/00, 1615, Aq
	Dean 2-1	"	2	Iced, 11/26/00 1620, Aq

Date Received 11-28-00 by S Williams @ 1110
Company Representative

Received the above articles in good condition

Except as noted

DBS&A Form No. 095 5/92

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326.4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Date: 12/20/00

Client: Daniel B. Stephens

Lab ID: 0300W05356 - 59

Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

William Lipps
IML-Farmington, NM

iml

Inter-Mountain Laboratories, Inc.

Phone (505)326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 1-2

Lab ID: 0300W05356

Matrix: Water

Condition: Intact

Date Received: 12/05/00

Date Reported: I2120100

Date Sampled: 12/04/00

Time Sampled: 1305

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	380	mg/L		10	EPA160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	144	mg/L		5	EPA300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/19/00	1437	WL
Iron	5.42	mg/L		0.02	EPA200.7	12/19/00	1437	WL
Manganese	0.85	mg/L		0.01	EPA 200.7	12/19/00	1437	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

iml Inter•Mountain laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Client:	Daniel B. Stephens		
Project:	Norton, VA		
Sample ID:	Dean 2-2	**Date Received:**	12/05/00
Lab ID:	0300W05357	**Date Reported:**	12/20/00
Matrix:	Water	**Date Sampled:**	12/04/00
Condition:	Intact	**Time Sampled:**	1324

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	280	mg/L		10	EPA160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	109	mg/L		5	EPA 300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/19/00	1445	WL
iron	1.84	mg/L		0.02	EPA200.7	12/19/00	1445	WL
Manganese	0.24	mg/L		0.01	EPA200.7	12/19/00	1445	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________________

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: Abbott 1-1
Lab ID: 0300W05358
Matrix: Water
Condition: Intact

Date Received: 12/05/00
Date Reported: 12120100
Date Sampled: 12/04/00
Time Sampled: 1240

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	180	mg/L		10	EPA 160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	7	mg/L		5	EPA300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/19/00	1448	WL
Iron	0.89	mg/L		0.02	EPA 200.7	12/19/00	1448	WL
Manganese	0.10	mg/L		0.01	EPA200.7	12/19/00	1448	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: Abbott 2-1
Lab ID: 0300W05359
Matrix: Water
Condition: Intact

Date Received: 12/05/00
Date Reported: 12/20/00
Date Sampled: 12/04/00
Time Sampled: 1245

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	160	mg/L		10	€PA 160.1	12/08/00	1600	FP
Solids - Total Suspended	58	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	15	mg/L		5	EPA300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	12/19/00	1451	WL
Iron	16.4	mg/L		0.02	EPA 200.7	12/19/00	1451	WL
Manganese	0.55	mg/L		0.01	EPA200.7	12/19/00	1451	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

DANIEL B. STEPHENS & ASSOCIATES, INC.

Chain of Custody

To: Inter-Mountain Laboratories, Inc

Date 12/4/00 Project No. 9290

Client DBS&A OSM Well Study

Relinquished by [signature] 12/4/00 1445

Sent by: ☒ Fed Ex ☐ DHL ☐ Other Fax - 1- 505 - 888 - 0258

Purpose of Shipment Lab Analysis

Possible Contaminants N/A

Item No.	Sample No.	Analysis to be Done	Sample Container	Comments
	Dean 1-2	1L - SO_4, TDS, TSS 1-250ml - Total Al, Fe, & Mn	1-1L 1-250 ml	Aq, 12/4/00 1305 W05356
	Dean 2-2	"	"	Aq, 12/4/00 1324 5357
	Abbott 1-1	"	"	Aq, 12/3/00 1240 5358
	Abbott 2-1	"	"	Aq, 12/3/00 1245 5359

Date Received 12/5/00 by Sharon Williams

Company Representative

Received the above articles in good condition

Except as *noted*

DBS&A Form No. 095 5/92

iml Inter•Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Date: 1/25/01

Client: Daniel B. Stephens

Lab ID: 0301W00307 - 08

Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

William Lipps
IML-Farmington, NM

Inter-Mountain Laboratories, Inc.
Phone (505) 326-4737 Fax (505) 325-4182
2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton, VA
Sample ID: ABBOTT 1-2
Lab ID: 0301W00307
Matrix: Water
Condition: Cool/Intact

Date Received: 01/11/01
Date Reported: 01/25/01
Date Sampled: 12/07/00
Time Sampled: 1813

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	140	mg/L		10	EPA 160.1	01/15/01	1000	FP
Solids - Total Suspended	6	mg/L		2	EPA 160.2	01/12/01	0820	KA
Sulfate	<5	mg/L		5	EPA 300.0	01/11/01	0941	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	01/25/01	1204	WL
Iron	0.34	mg/L		0.02	EPA200.7	01/25/01	1204	WL
Manganese	0.03	mg/L		0.01	EPA 200.7	01/25/01	1204	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ______________________

iml

Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: ABBOTT 2-2
Lab ID: 0301W00308
Matrix: Water
Condition: Cool/Intact

Date Received: 01/11/01
Date Reported: 01/25/01
Date Sampled: 12/07/00
Time Sampled: 1620

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Analysis Time	Init.
General Parameters								
Solids - Total Dissolved	130	mg/L		10	EPA160.1	01/15/01	1000	FP
Solids - Total Suspended	35	mg/L		2	EPA 160.2	01/12/01	0820	KA
Sulfate	12	mg/L		5	EPA 300.0	01/11/01	0941	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA200.7	01/25/01	1207	WL
Iron	5.16	mg/L		0.02	EPA200.7	01/25/01	1207	WL
Manganese	0.07	mg/L		0.01	EPA 200.7	01/25/01	1207	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: [signature]

iml

Inter-Mountain laboratories, Inc

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Quality Control Report
Duplicate Analysis

Client: Daniel B. Stephens
Project: Norton,VA
Sample ID: ABBOTT 2-2
Lab ID: 0301W00308
Matrix: Water
Condition: Cool/Intact

Report Date: 02/05/01
Receipt Date: 01/11/01
Sample Date: 12/07/00
Time Sampled: 1620

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Units
Solids - Total Dissolved	130	150	14	10	mg/L
Solids - Total Suspended	35	46	27	2	mg/L
Sulfate	12	12	0**	5	mg/L
Aluminum	<0.05	<0.05	NC*	0.05	mg/L
Iron	5.16	5.57	8	0.02	mg/L
Manganese	0.07	0.07	0	0.01	mg/L

*NC - Non-Calculable RPD due to value(s) less than DL ** - Difference used for results < 5 X Detection Limit

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: ____________

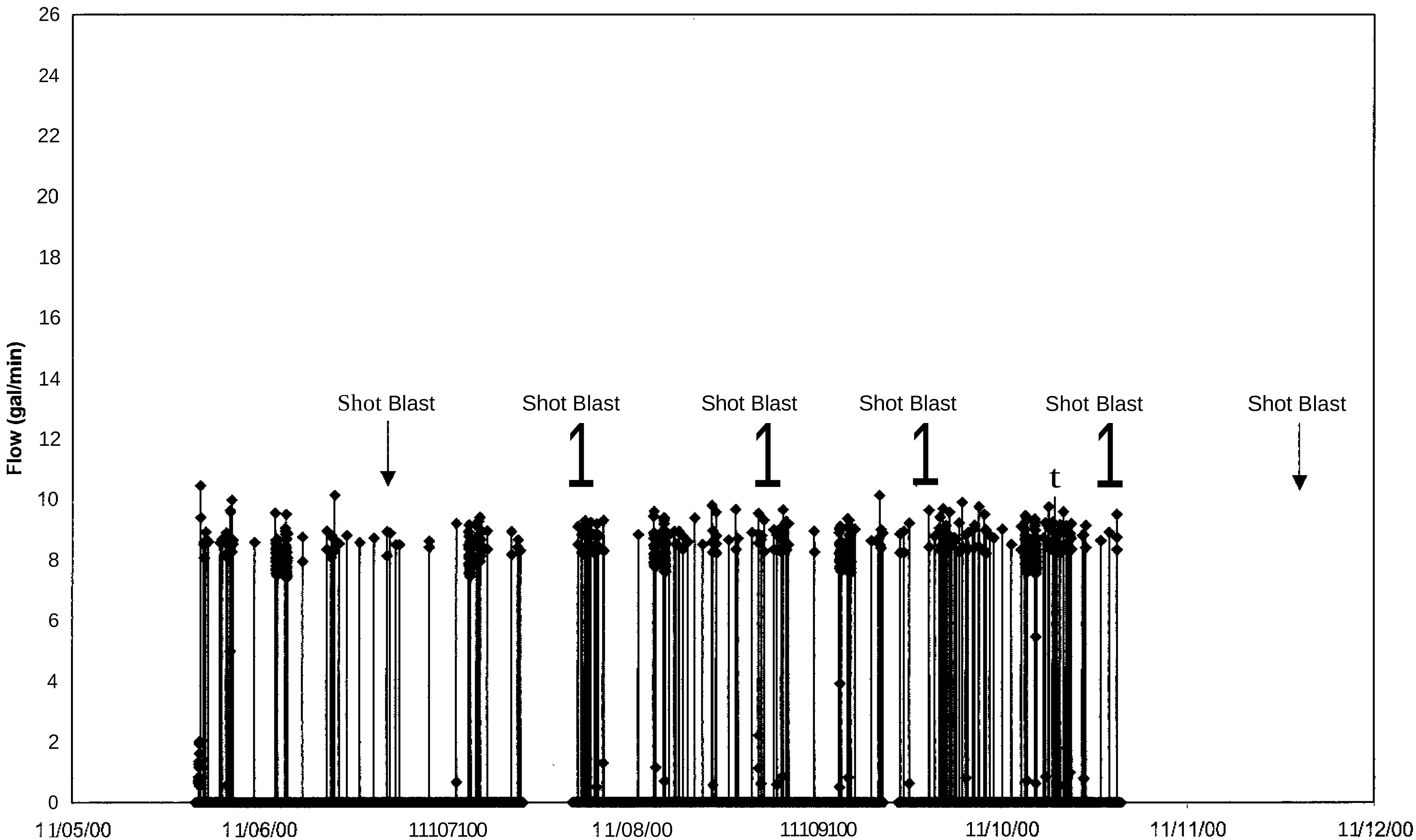
Appendix C

Graphs of Quarterly Monitoring Data

Appendix C1

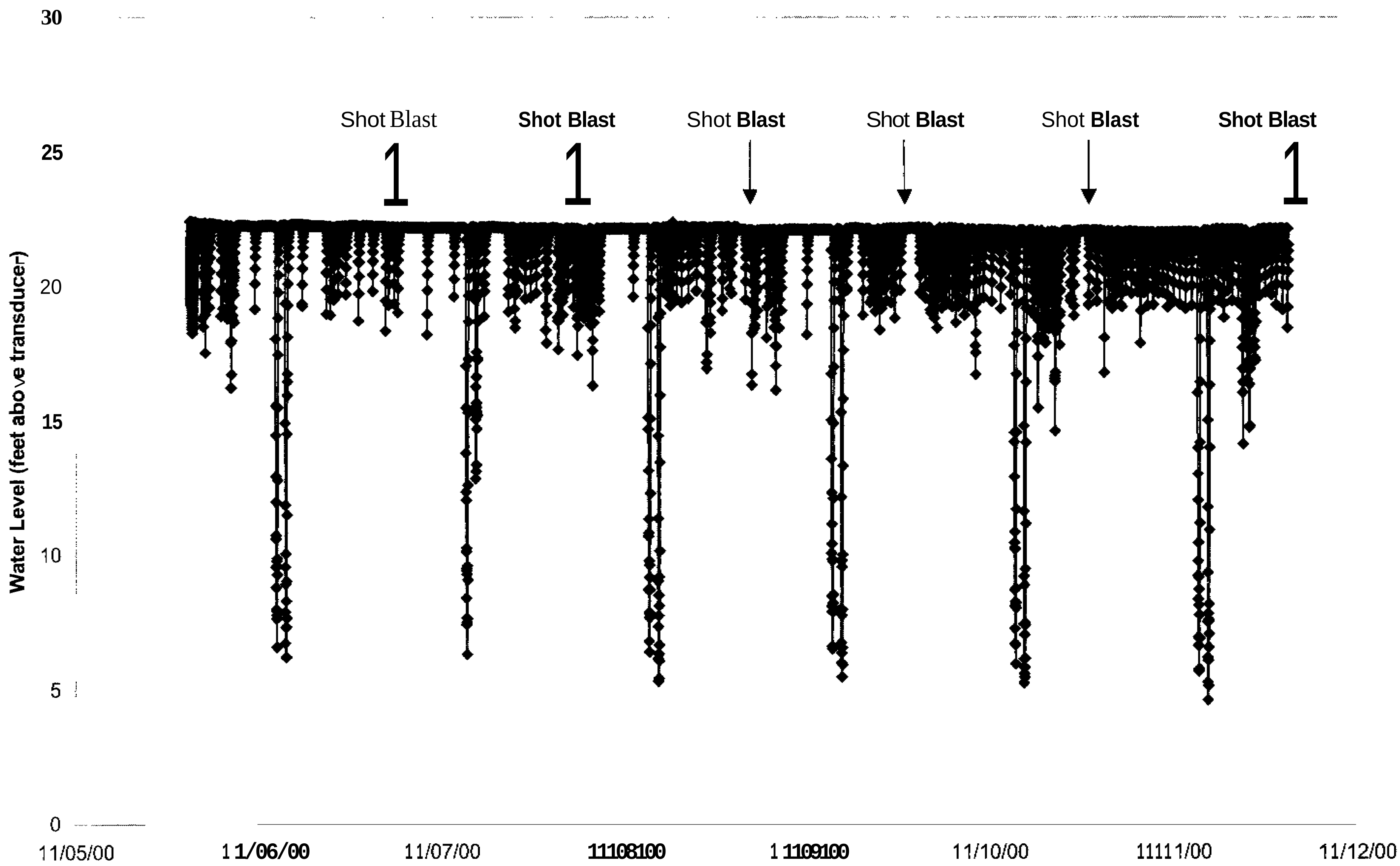
Fall-Winter 2000

Well Yield
Site VA-1 Well-I
Fall-Winter 2000

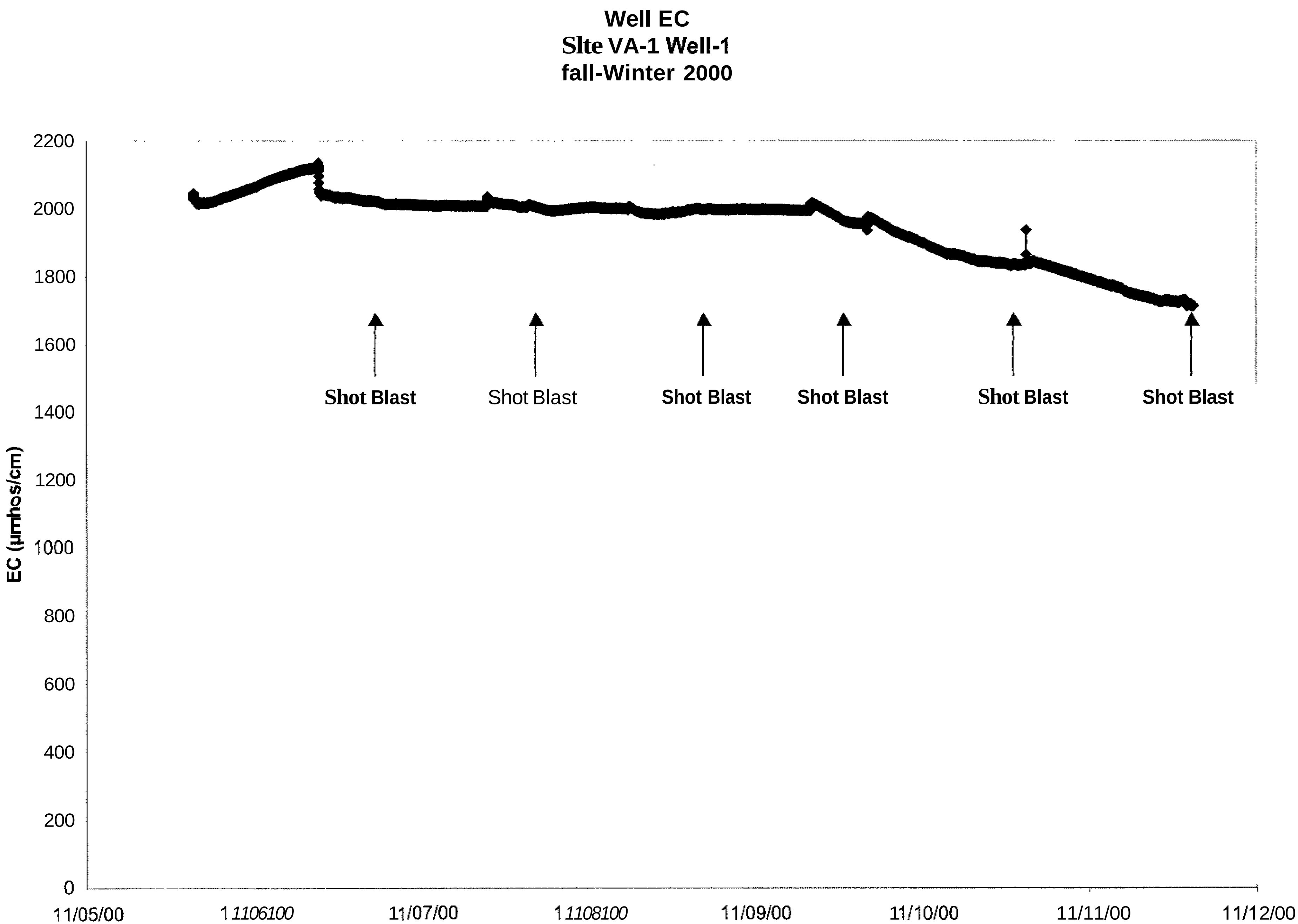


S:\projects\9290\sheets\boggsflow_nov00.xls Tab Ftow

Water Level
Site VA-1 Well-1
Fall-Winter 2000

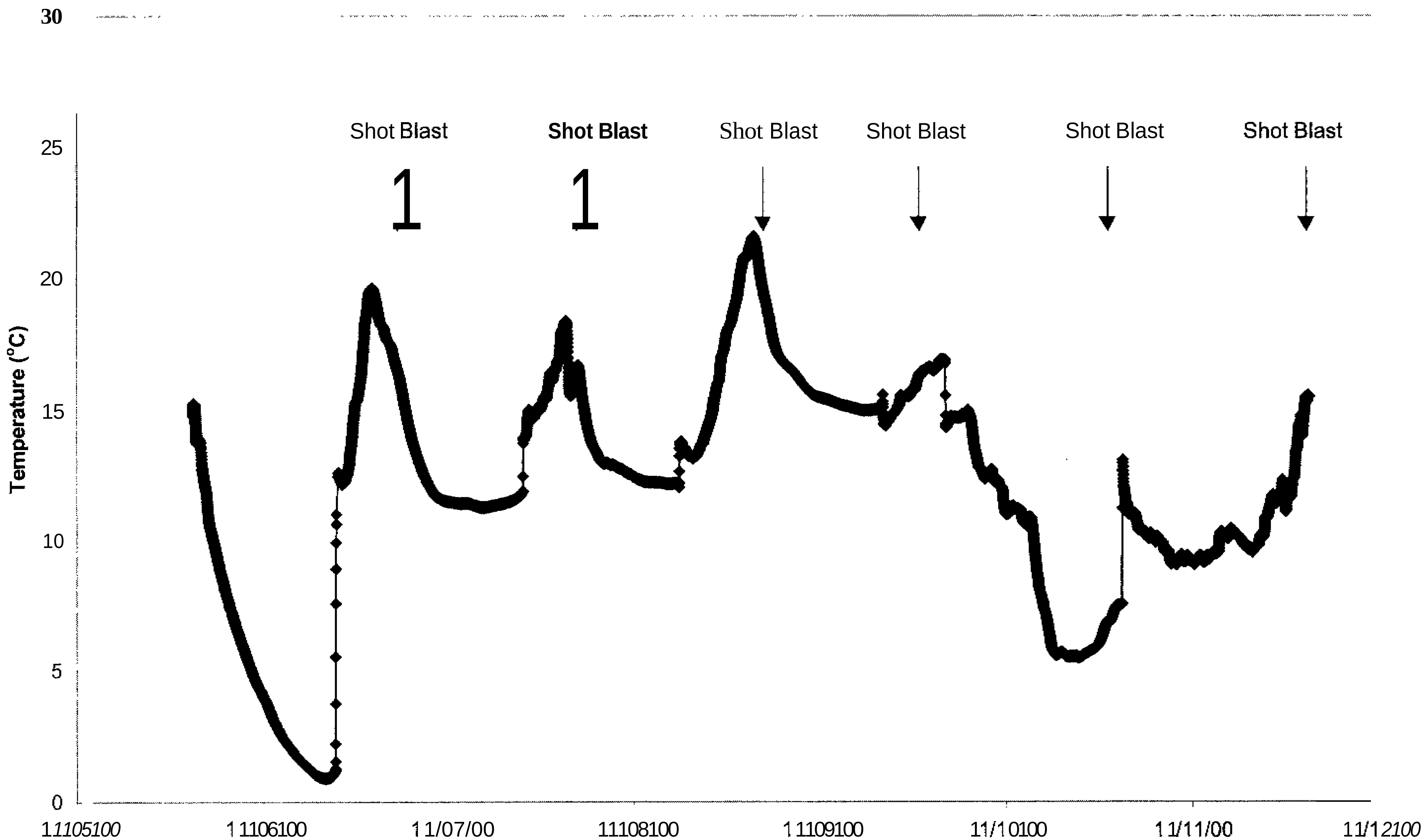


S:\projects\9290\sheets\Boggs\21x\Boggs21X_nov00.xls Tab **Stage**



S:\projects\9290\sheets\Boggs\21x\Boggs21X_nov00.xls Tab ec

Water Temperature
Site VA-1 Well-1
Fall-Winter 2000



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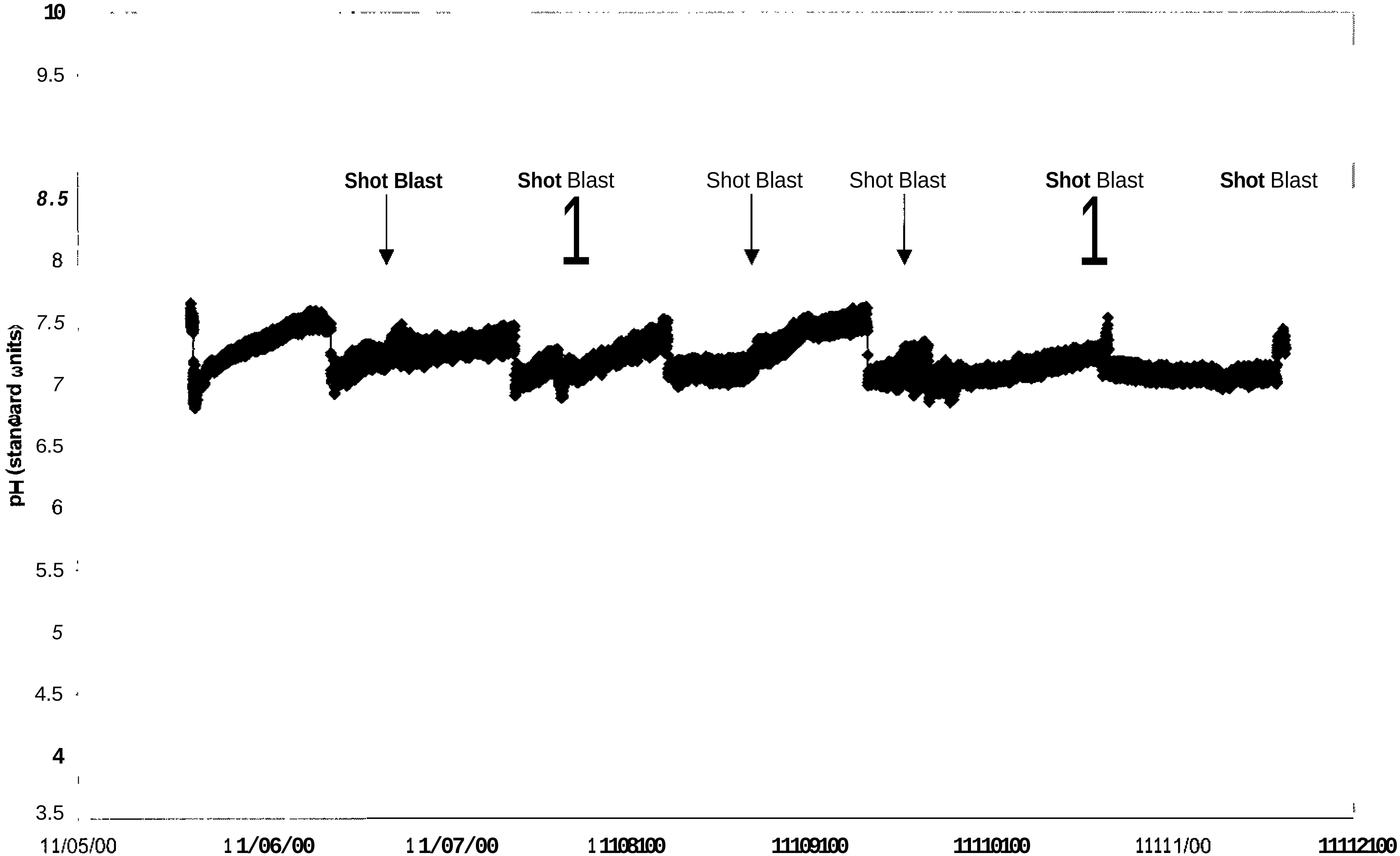
Water pH
Site VA-1 Well-1
Fall-Winter 2000



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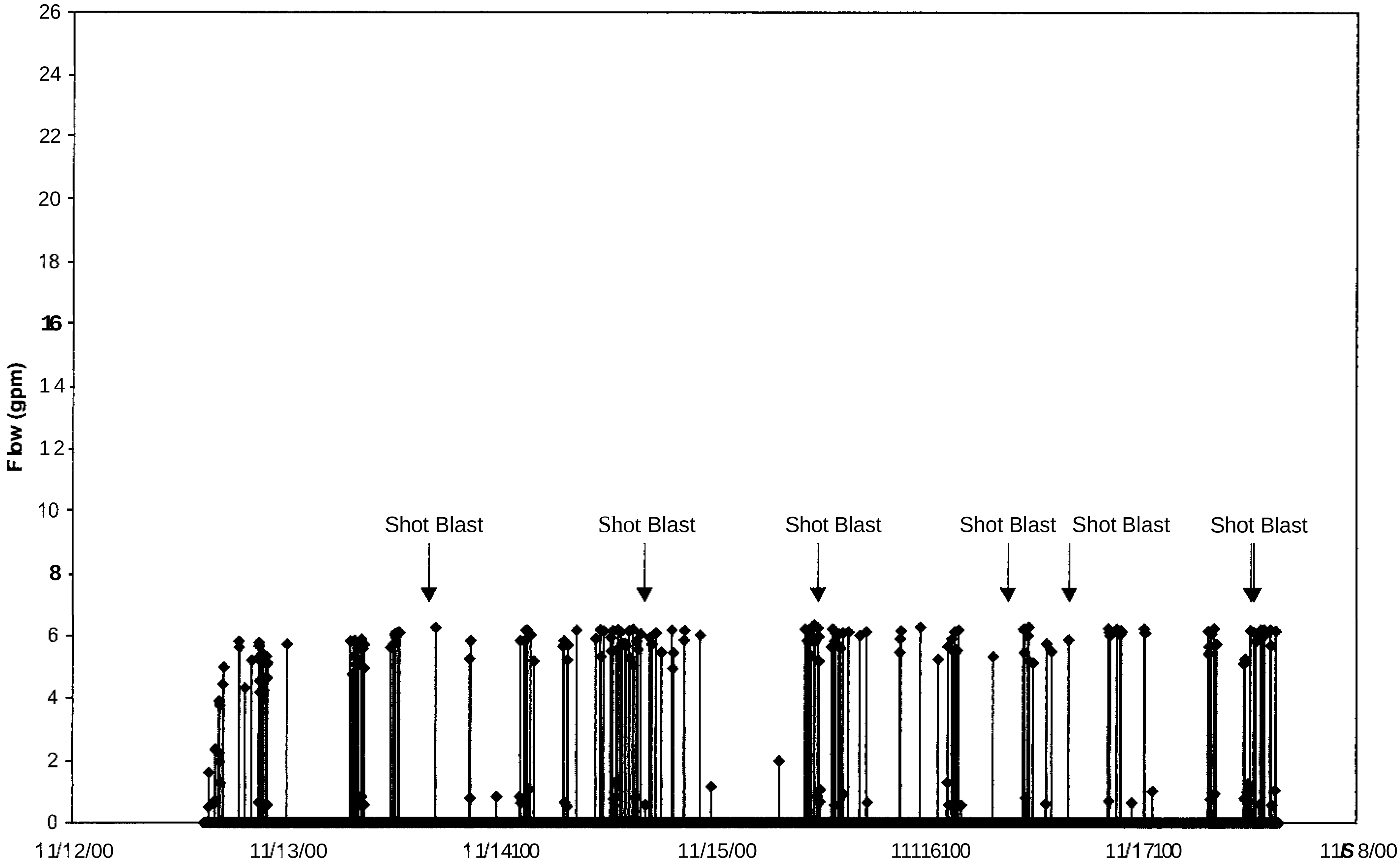
Well Yield
Site KY-I Well-I
Fall-Winter 2000



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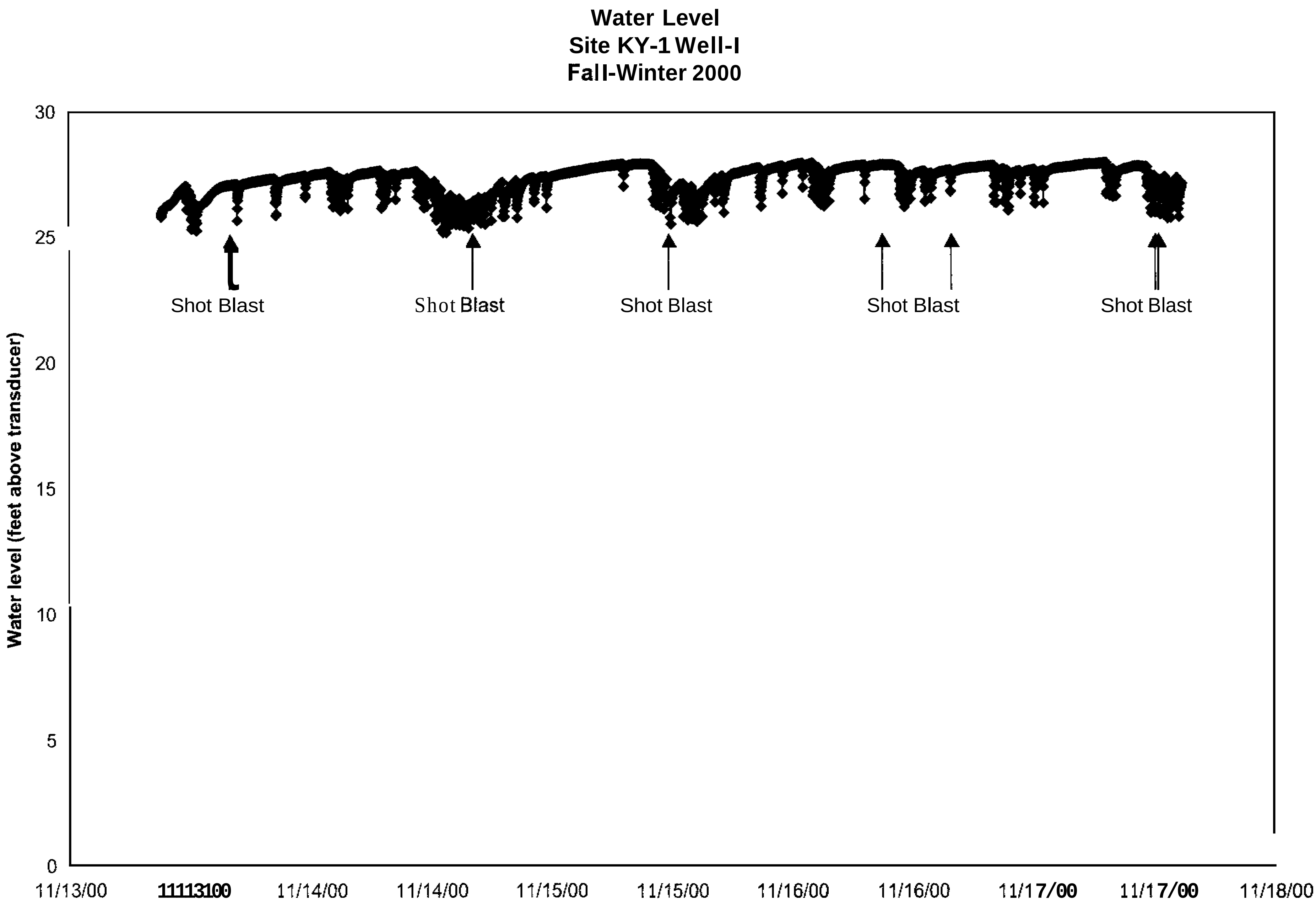
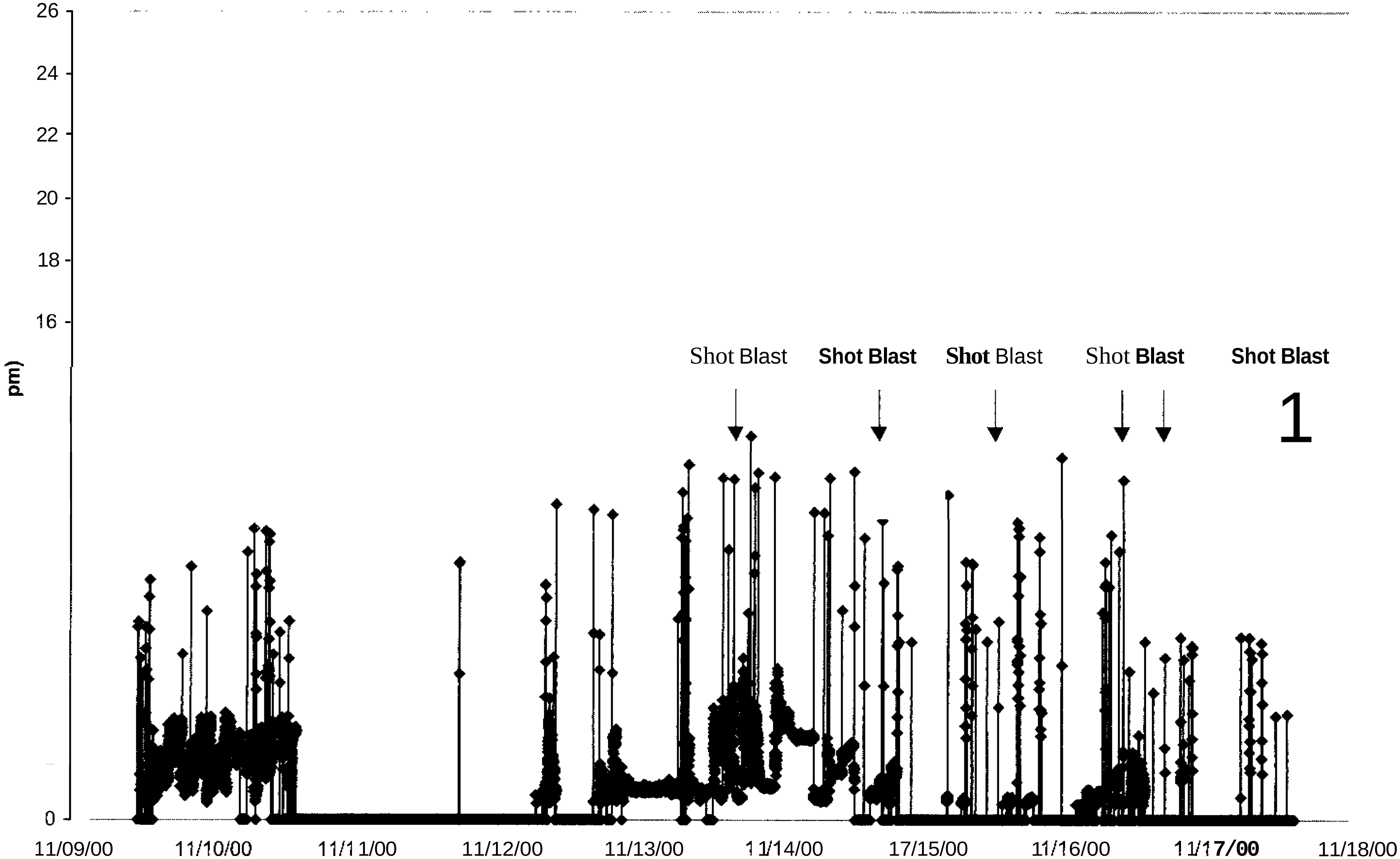
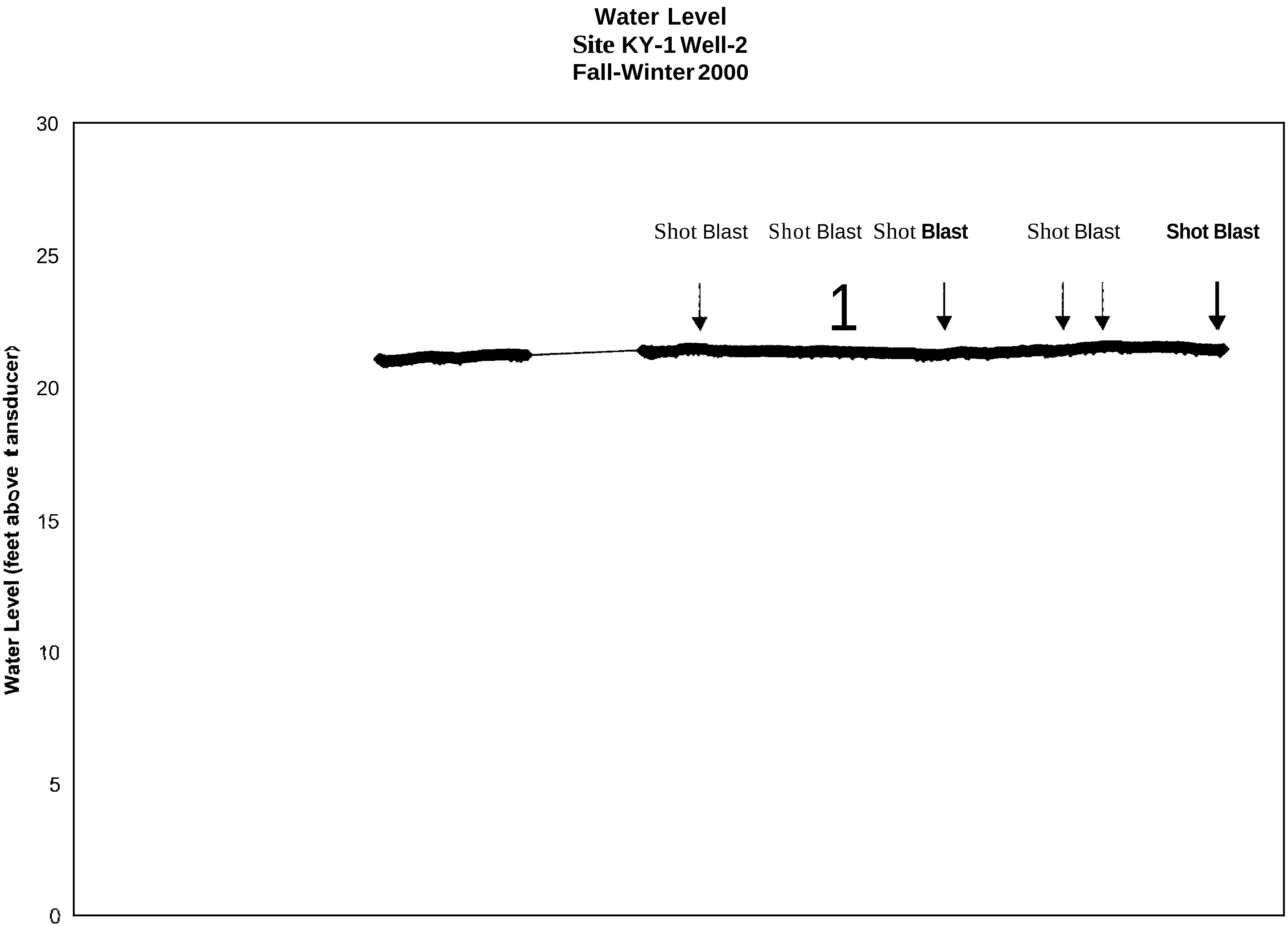


S:\projects\9290\sheets\banks\21x\BANKS21X_nov00.xls Tab Stage

Well Yield
Site KY-1 Well-2
Fall-Winter 2000

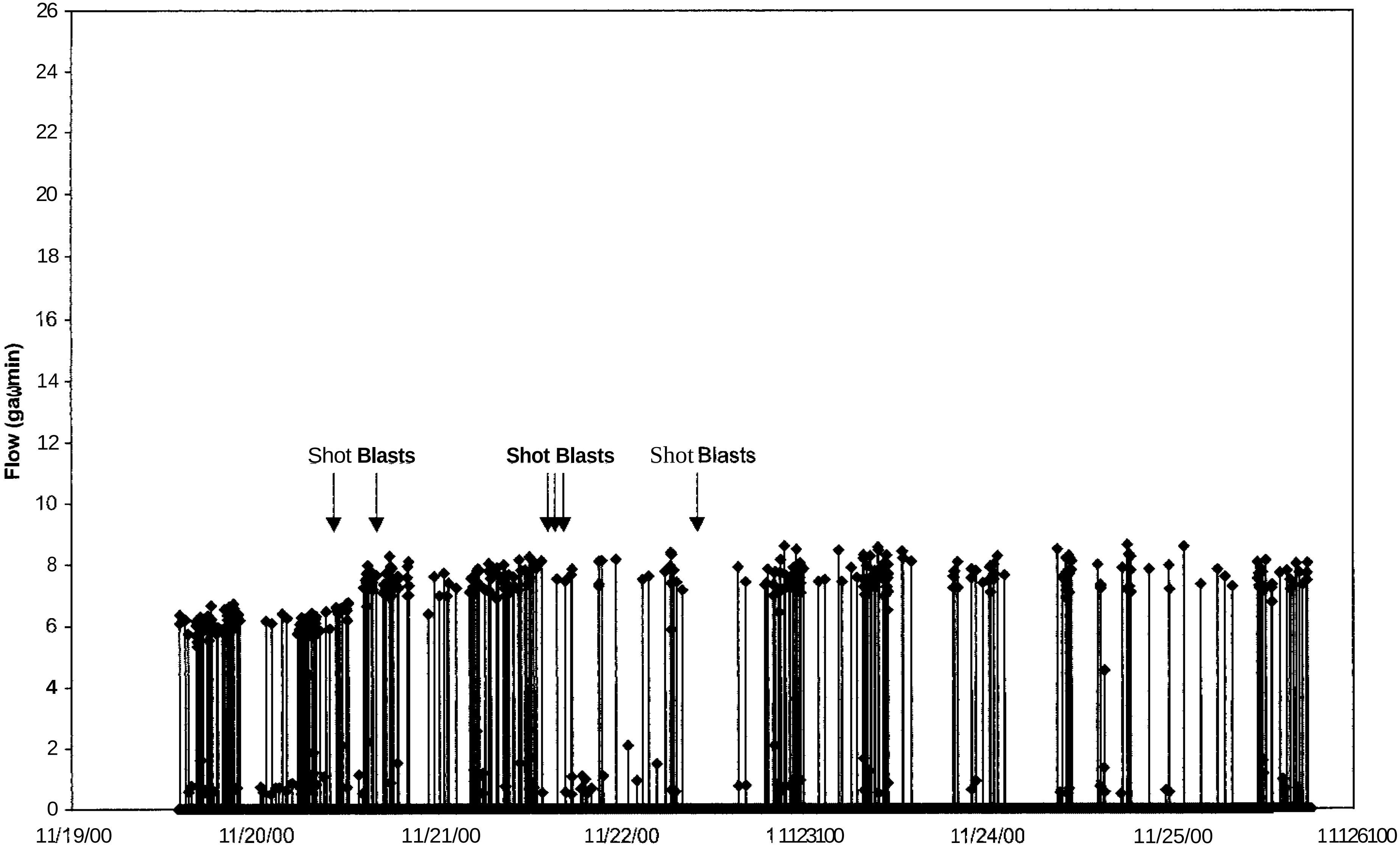


S:\projects\9290\sheets\ratliff\1010\ratliffflow.xls



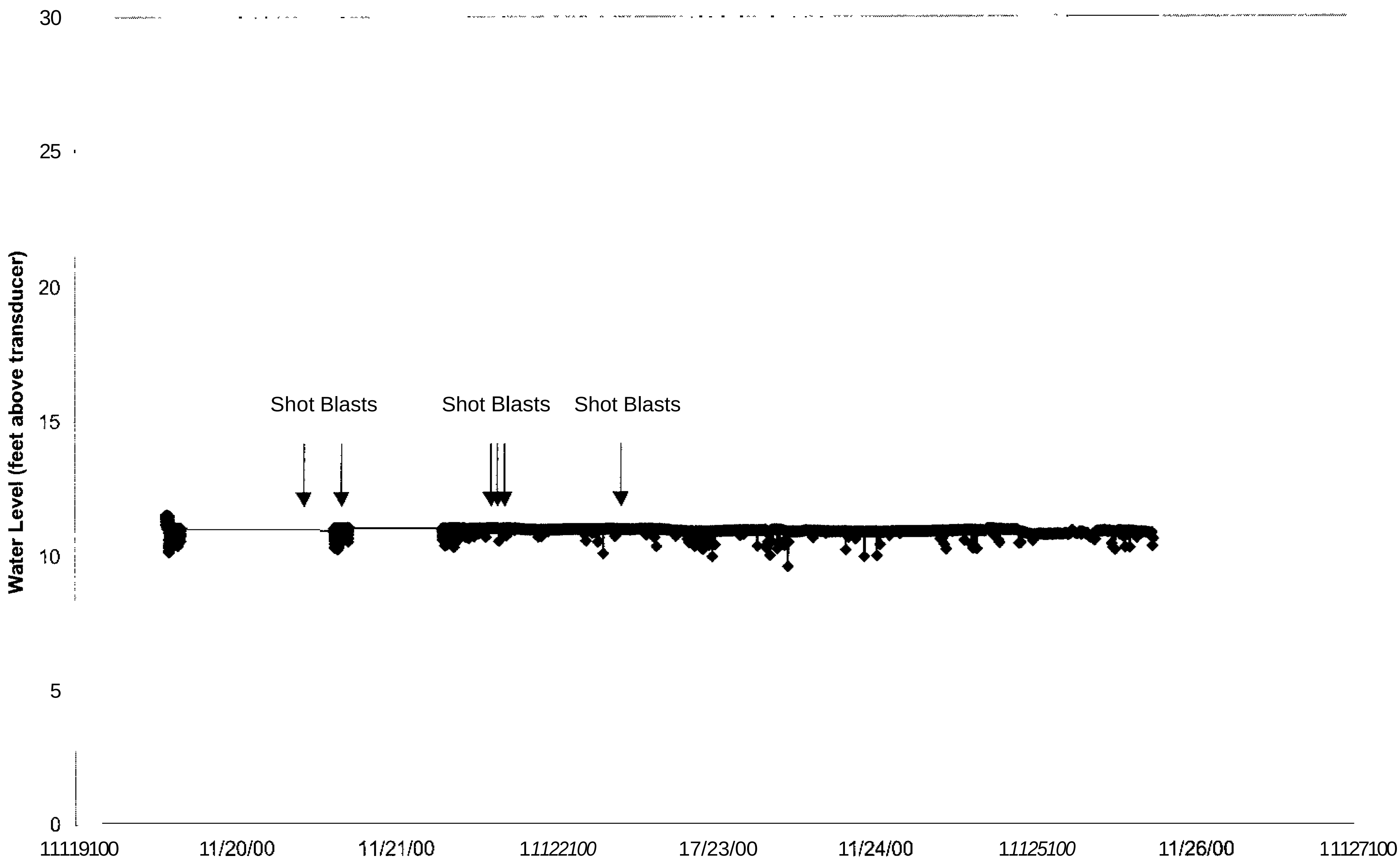
Water Level
Site KY-1 Well-2
Fall-Winter 2000
30
25
20
15
10
5
0
Water Level (feet above t ansducer)
Shot Blast
Shot Blast
Shot Blast
Shot Blast
Shot Blast
1

Well Yield
Site KY-2 Well-2
Fall-Winter 2000



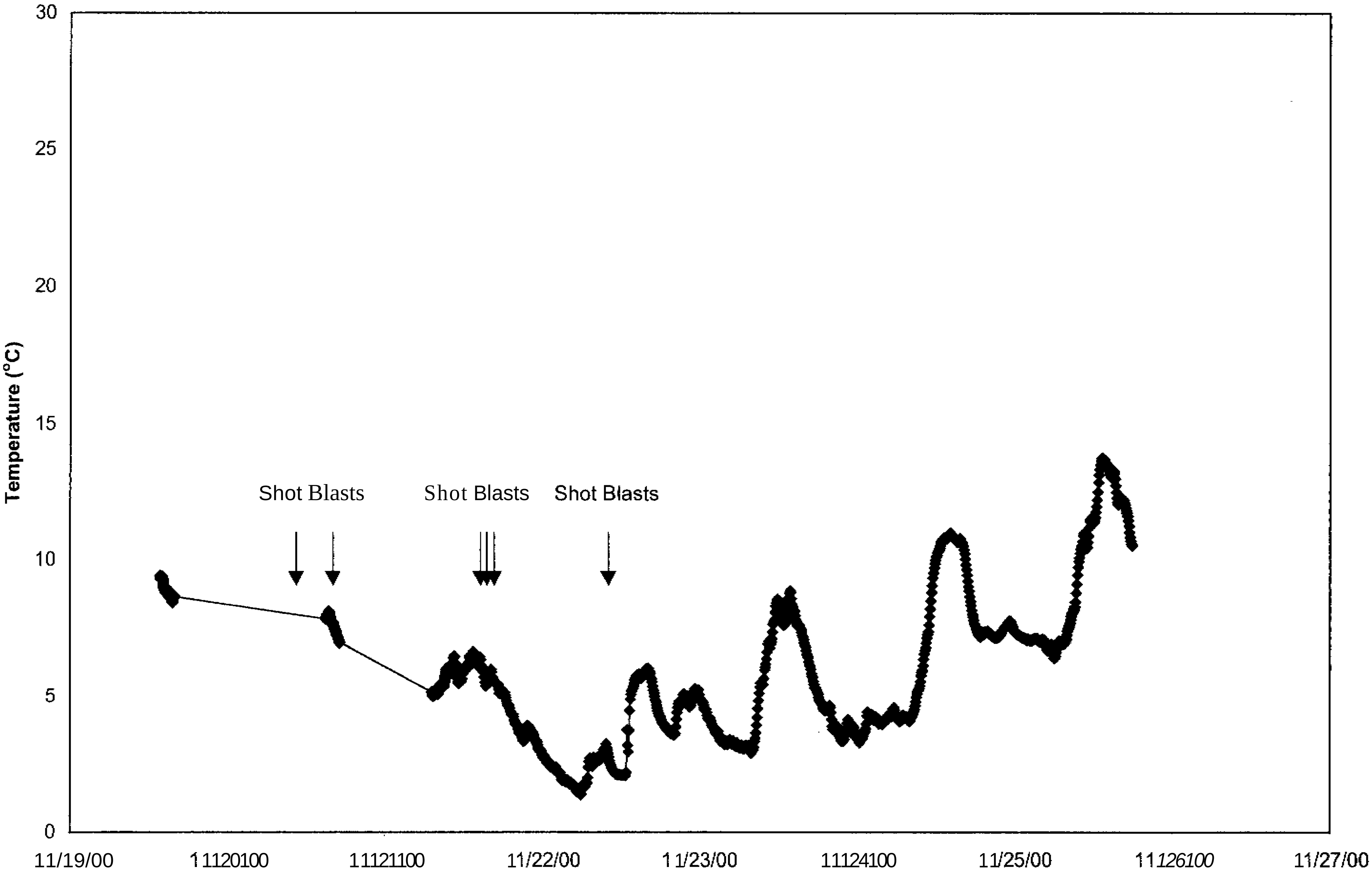
S:\projects\9290\sheets\sumner\1010\SumnerFlow.xls

Water Level
Site KY-2 Well-2
Fall-Winter 2000



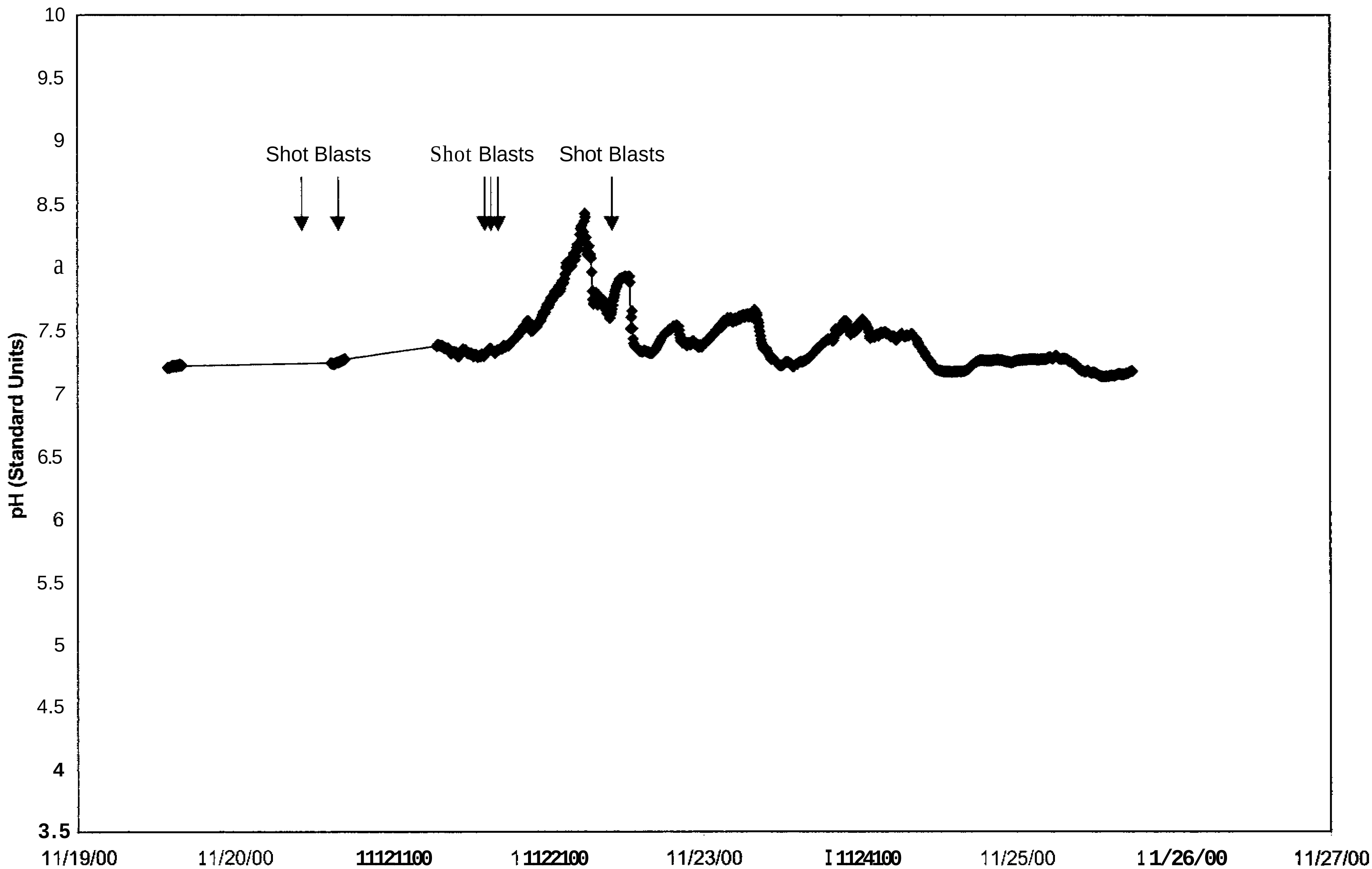
S:\projects\9290\sheets\Sumner\21x\SUMNER21X_nov00.xls Tab Stage

Water Temperature
Site KY-2 Well-2
Fall-Winter 2000



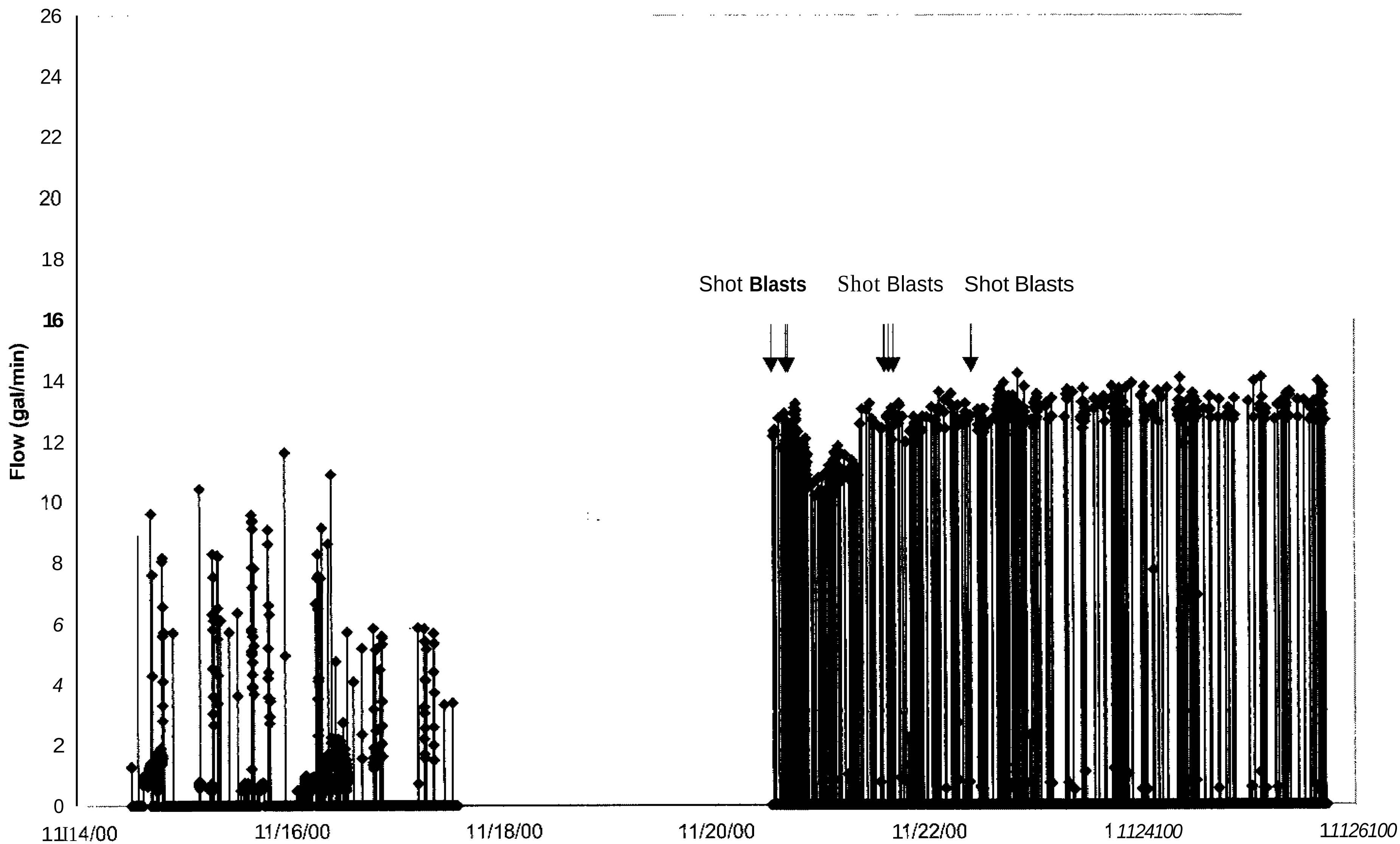
S:\projects\9290\sheets\Sumner\21x\SUMNER21X_nov00.xls Tab temp

Water pH
Site KY-2 Well-2
Fall-Winter 2000



S:\projects\9290\sheets\Sumner\21x\SUMNER21X_nov00.xls Tab PH

Well Yield
Site KY-2 Well-3
Fall-Winter 2000



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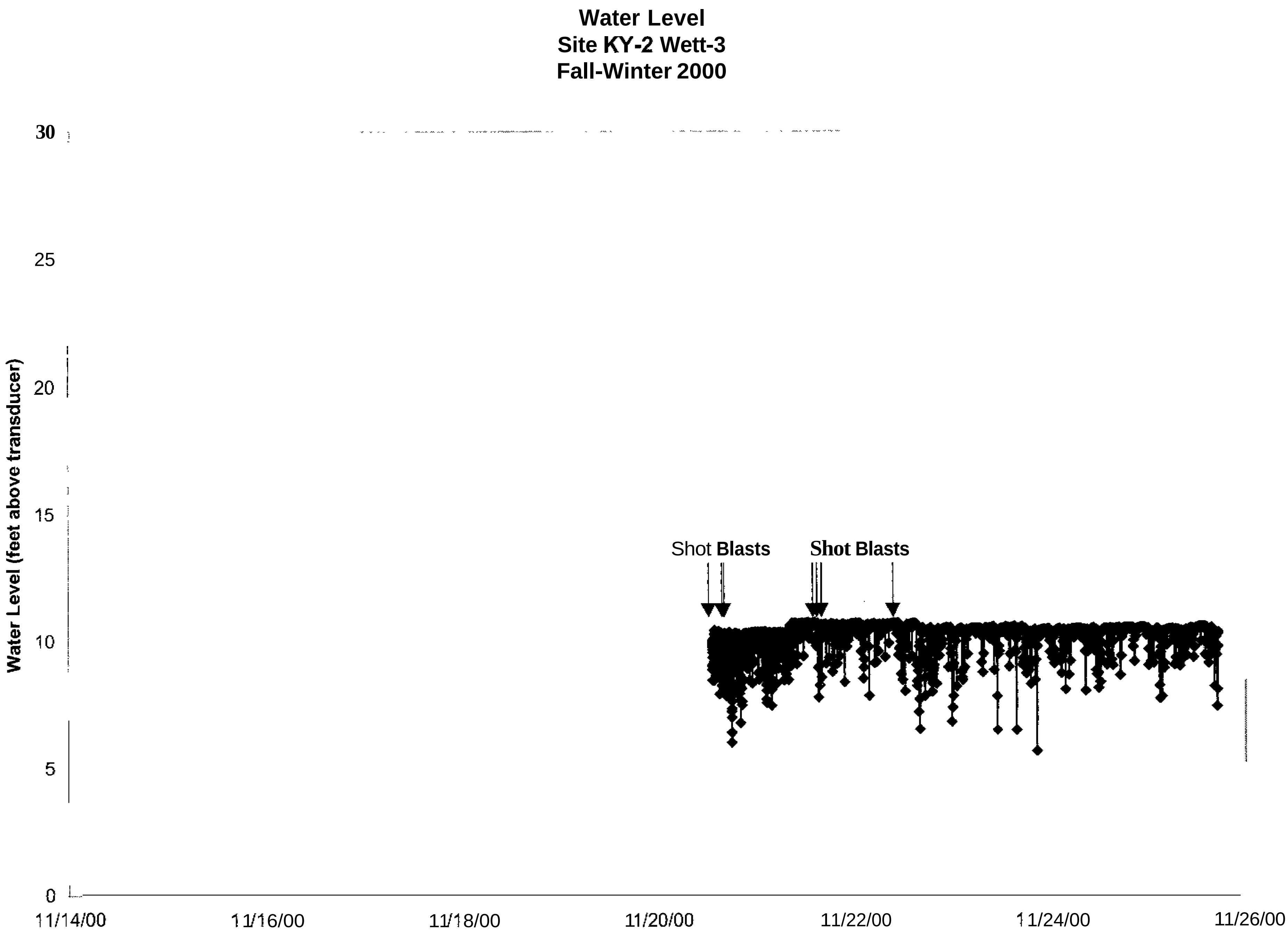
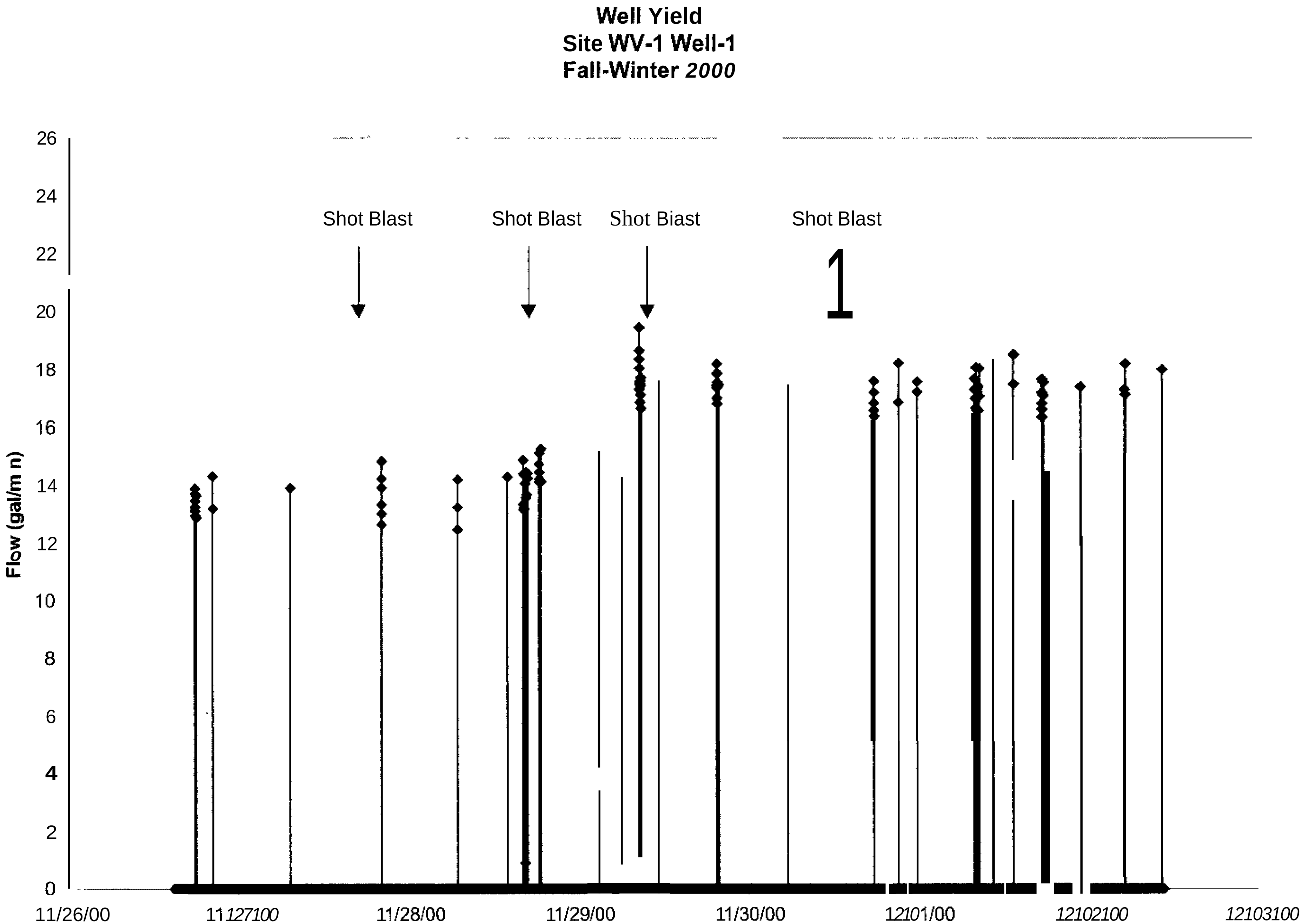


S:\Projects\9290\sheets\hurley\21x\Hurley\HURLEY21X_nov00.xls Tab **Stage**



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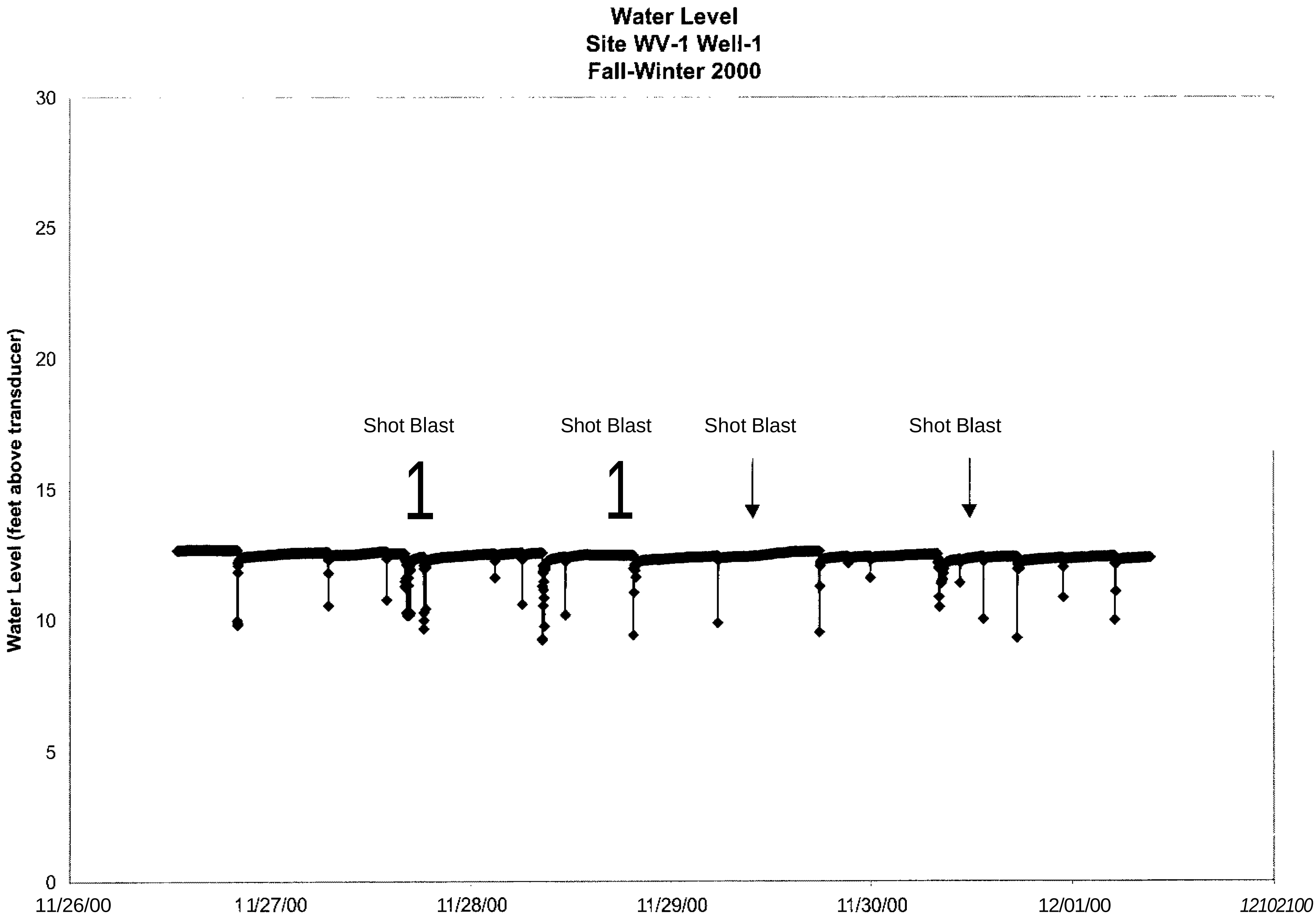
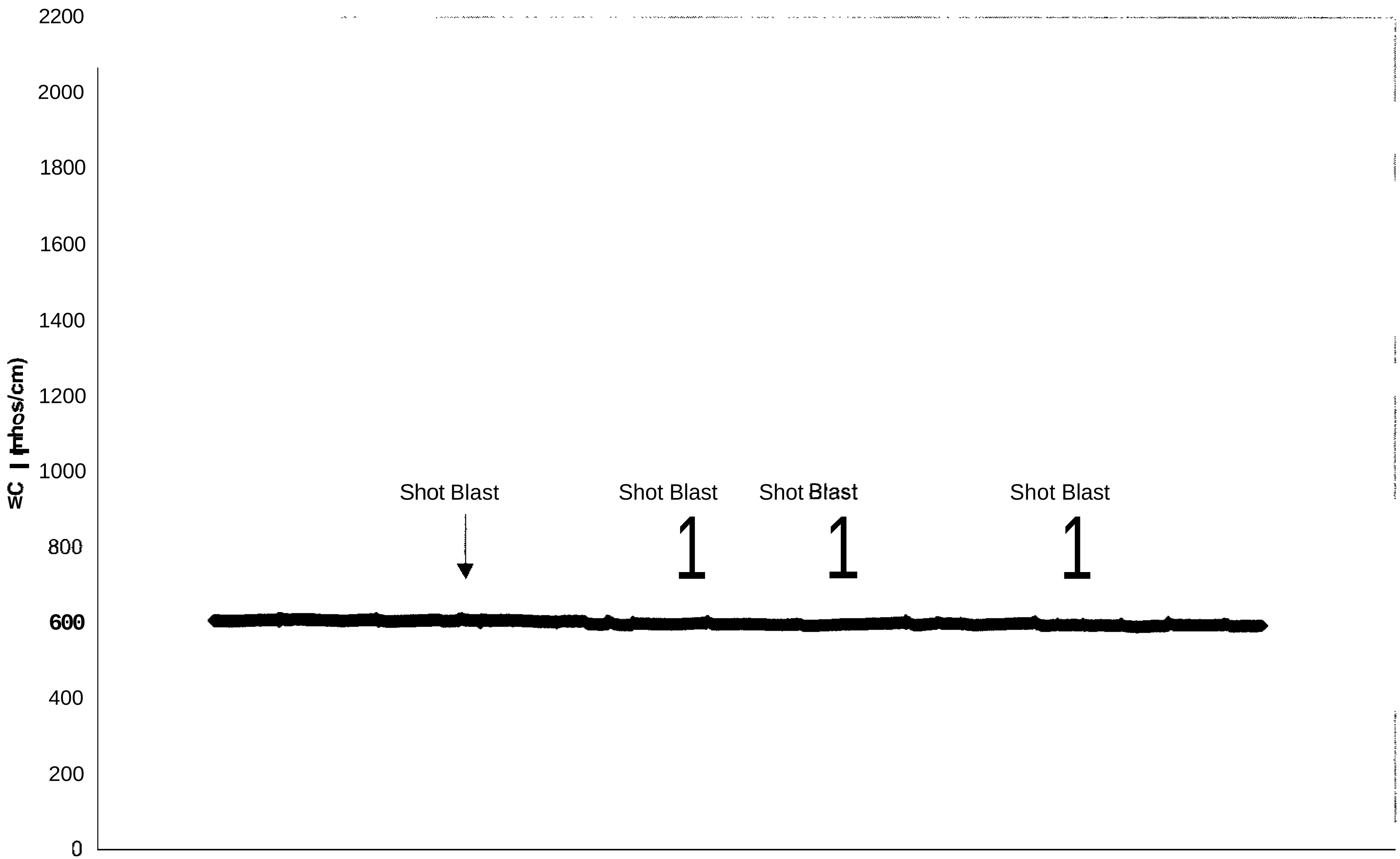


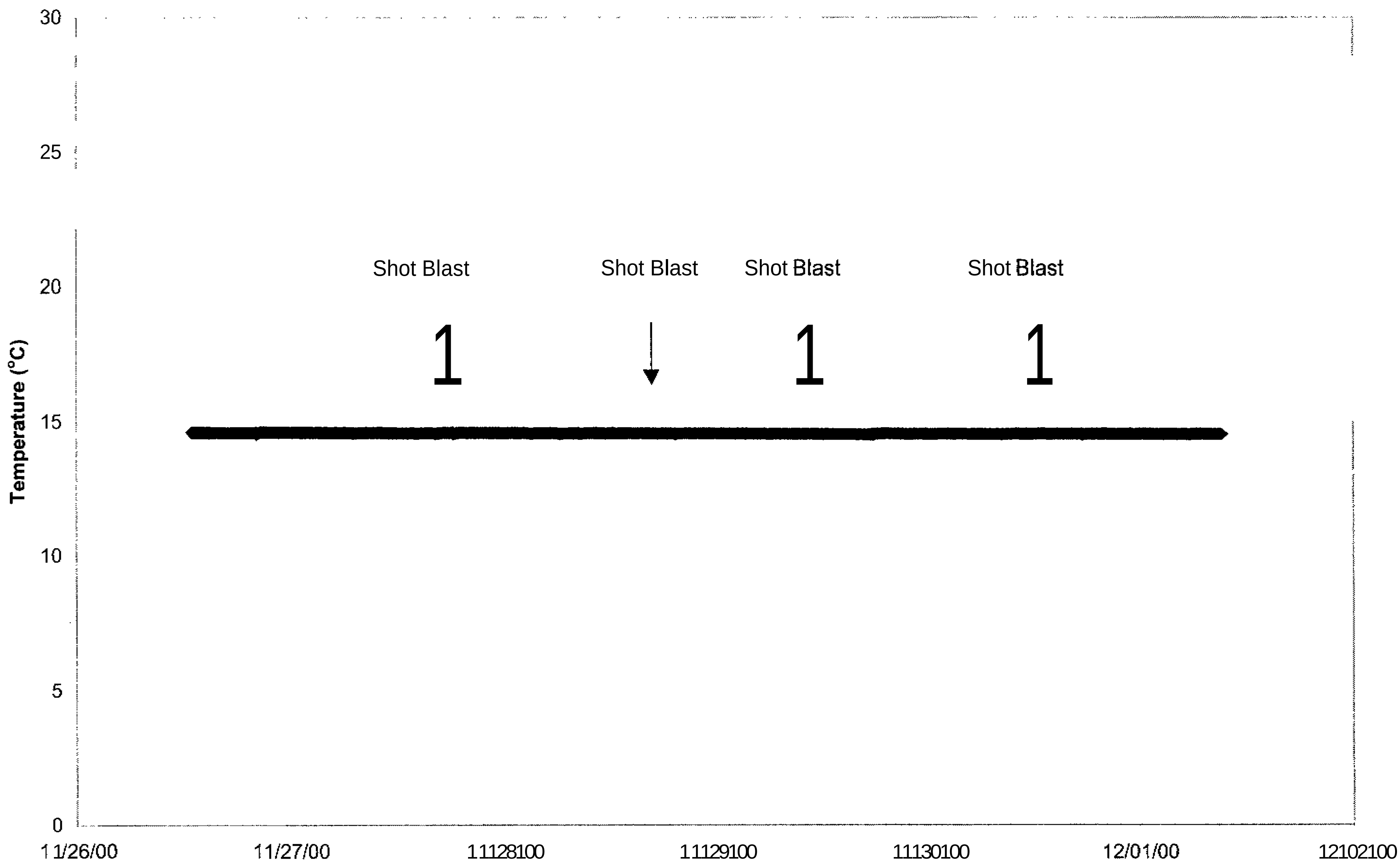
S:\projects\9290\sheets\Dean 1\21x\Dean121X_nov00.xls Tab Stage

Well EC
Site WV-1 Well-1
Fall-Winter 2000



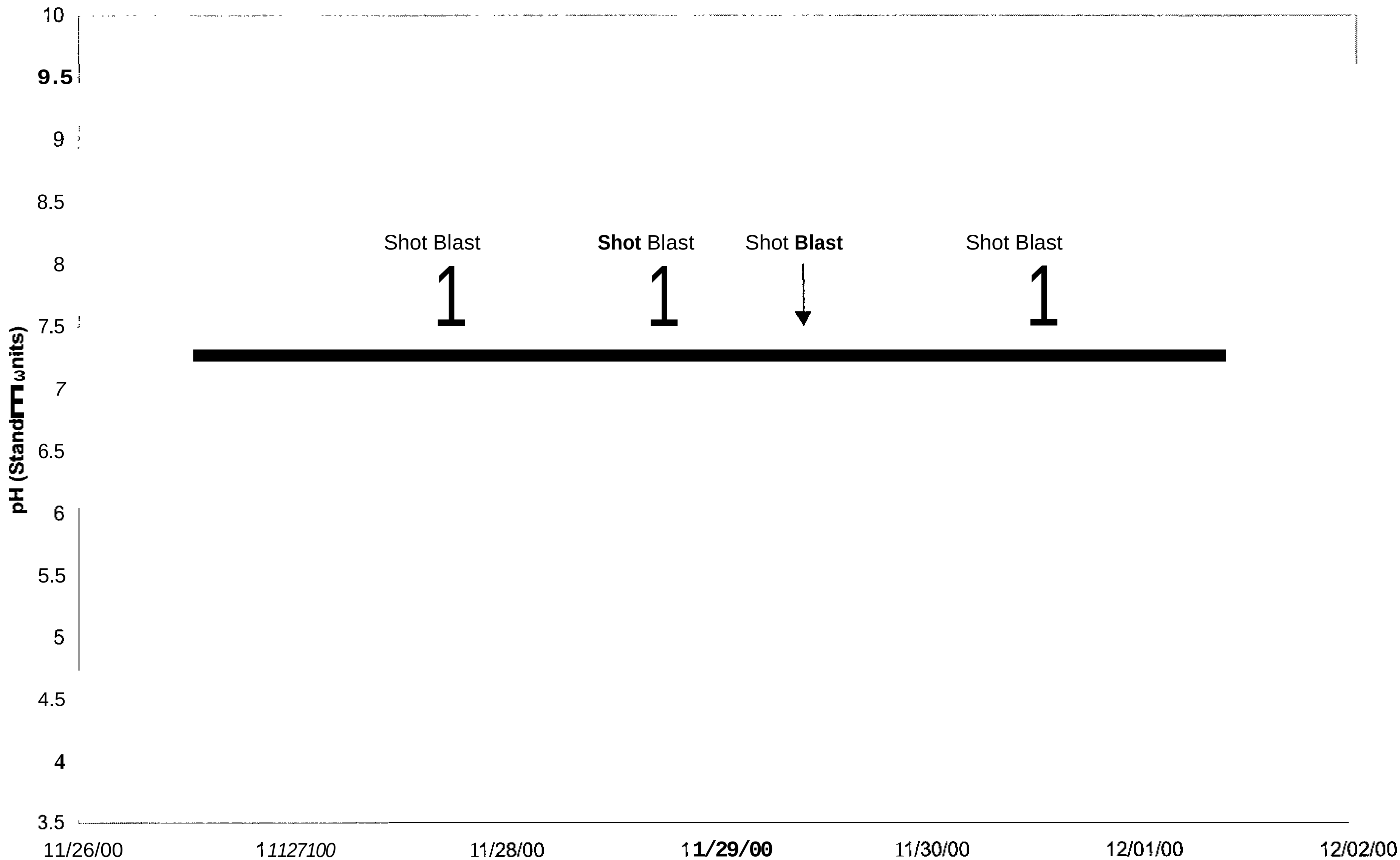
S:\projects\9290\sheets\Dean 1\21x\Dean121X_nov00.xls Tab EC

Water Temperature
Site WV-1 Well-1
Fall-Winter 2000



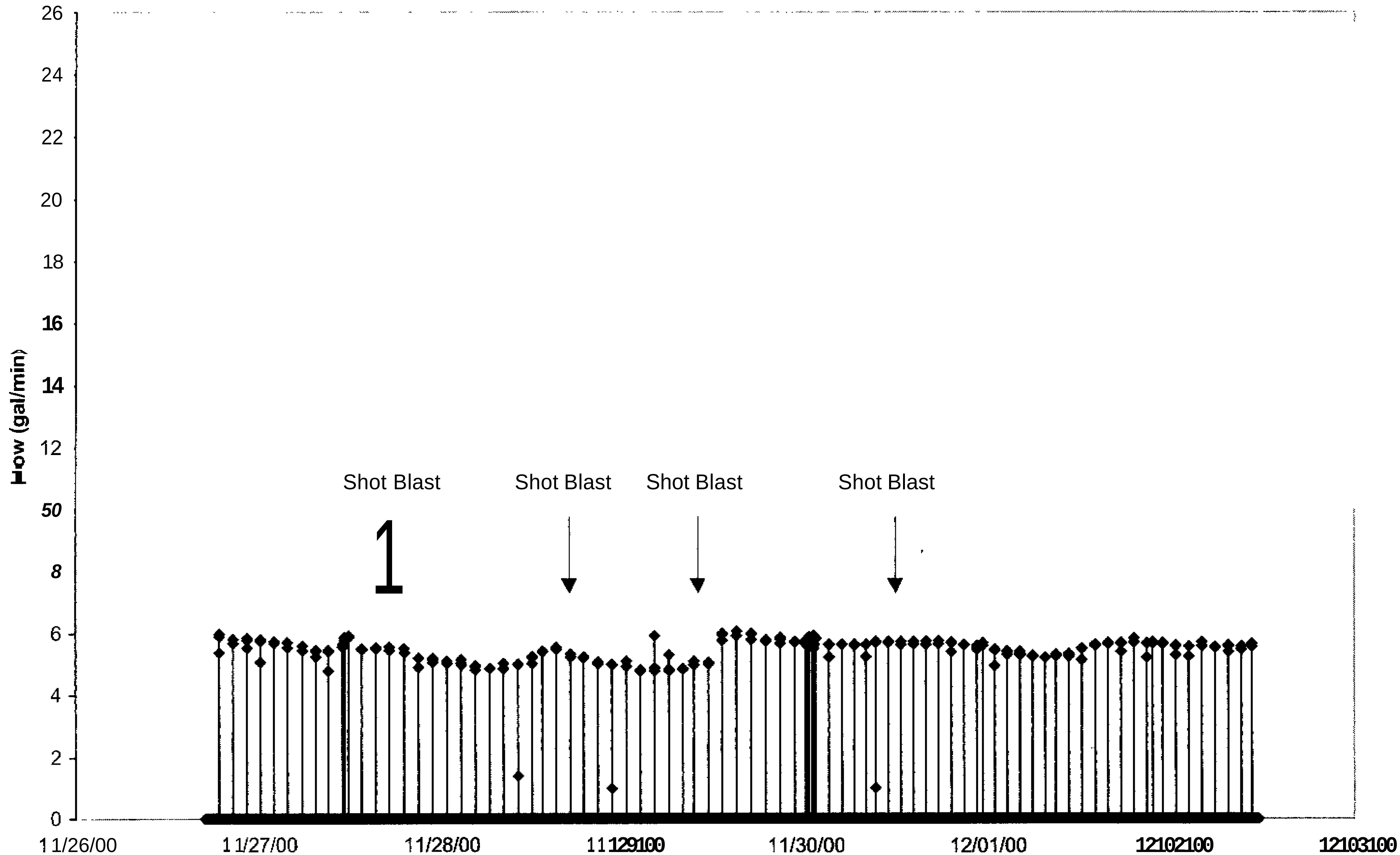
S:\projects\9290\sheets\Dean 1\21x\Dean121X_nov00.xls Tab temp

Water pH
Site WV-1 Well-I
Fall-Winter 2000



S:\projects\9290\sheets\Dean 1\21x\Dean121X_nov00.xls Tab PH

Well Yield
Site WV-1 Well-2
fall-Winter 2000



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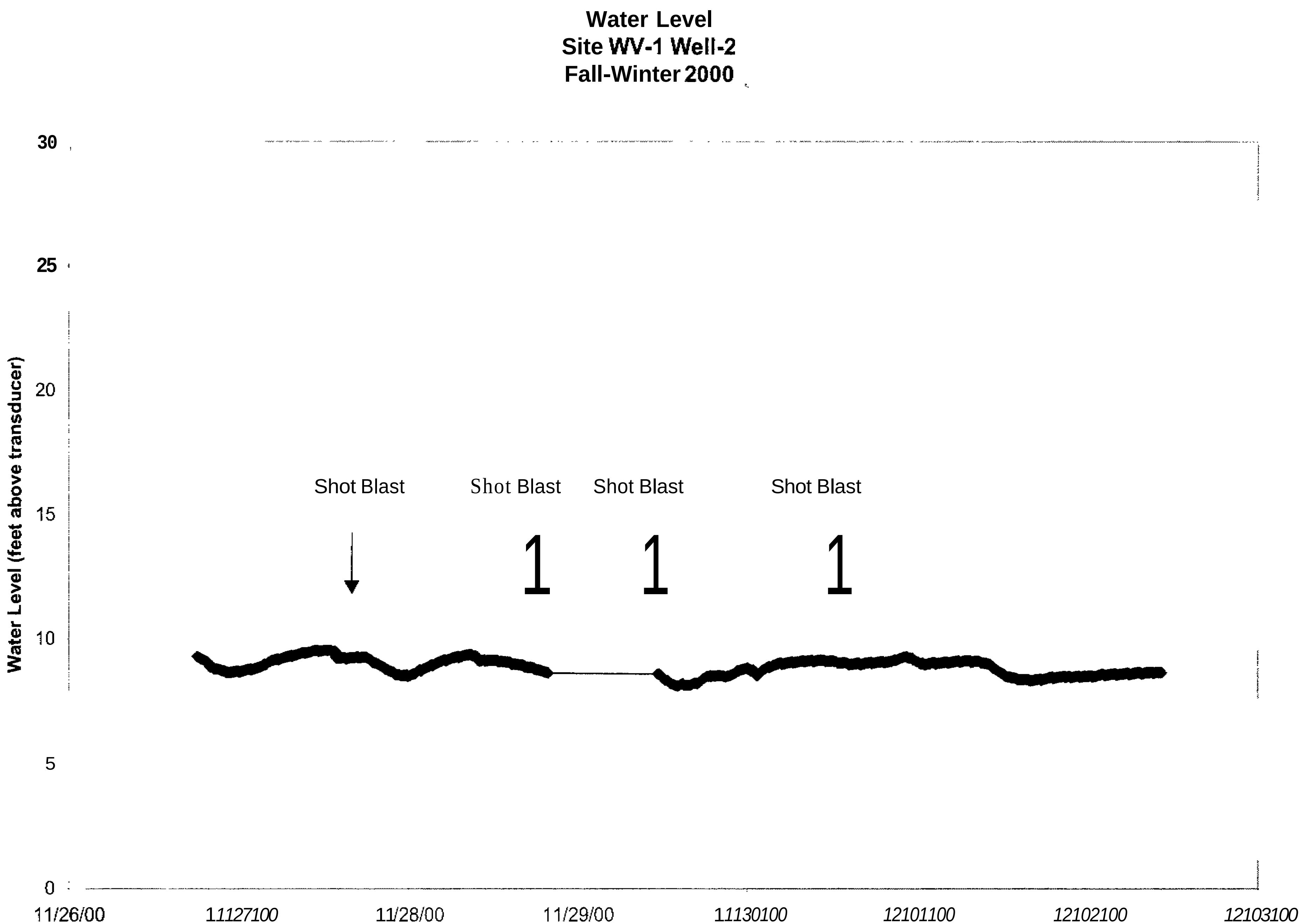
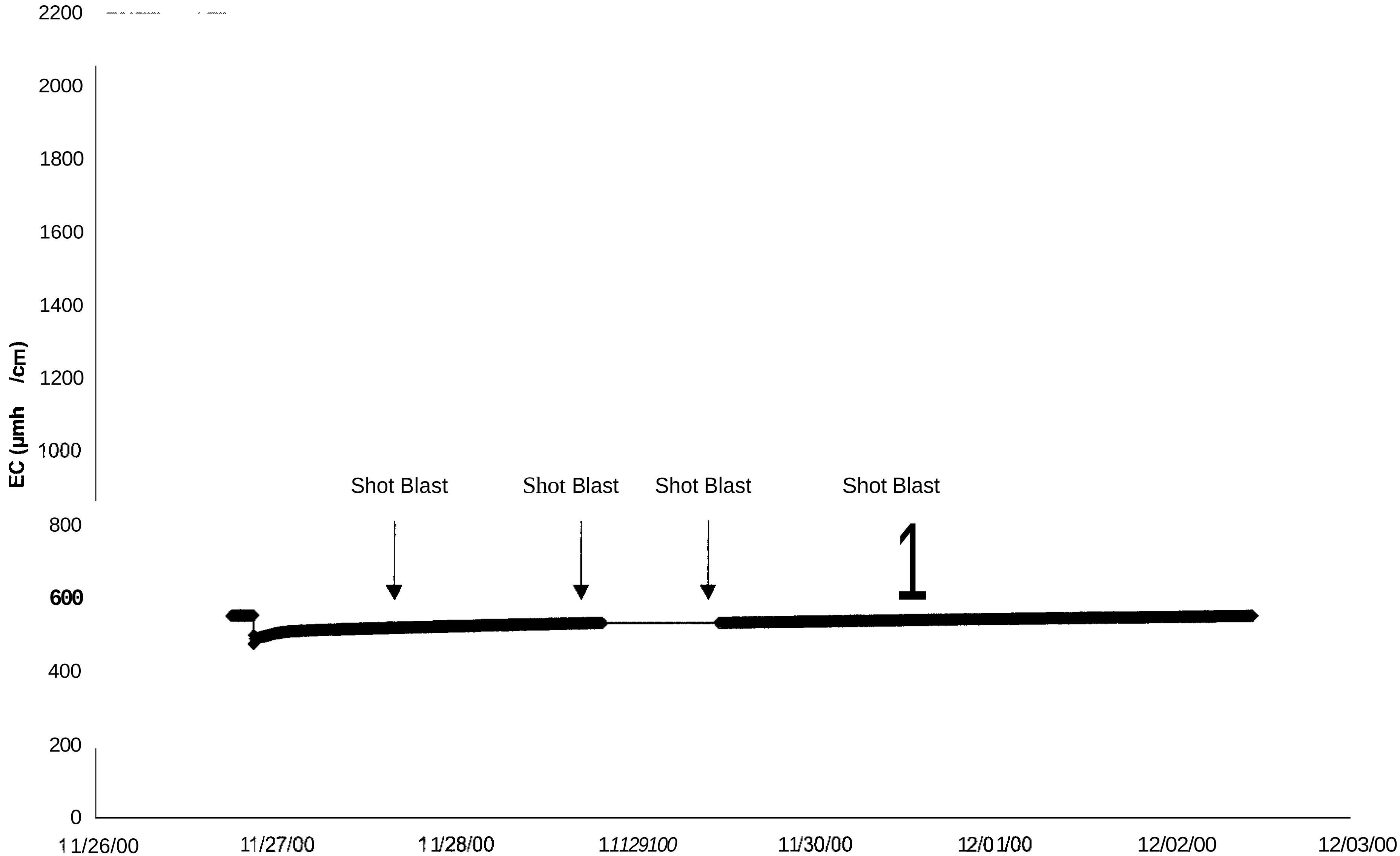


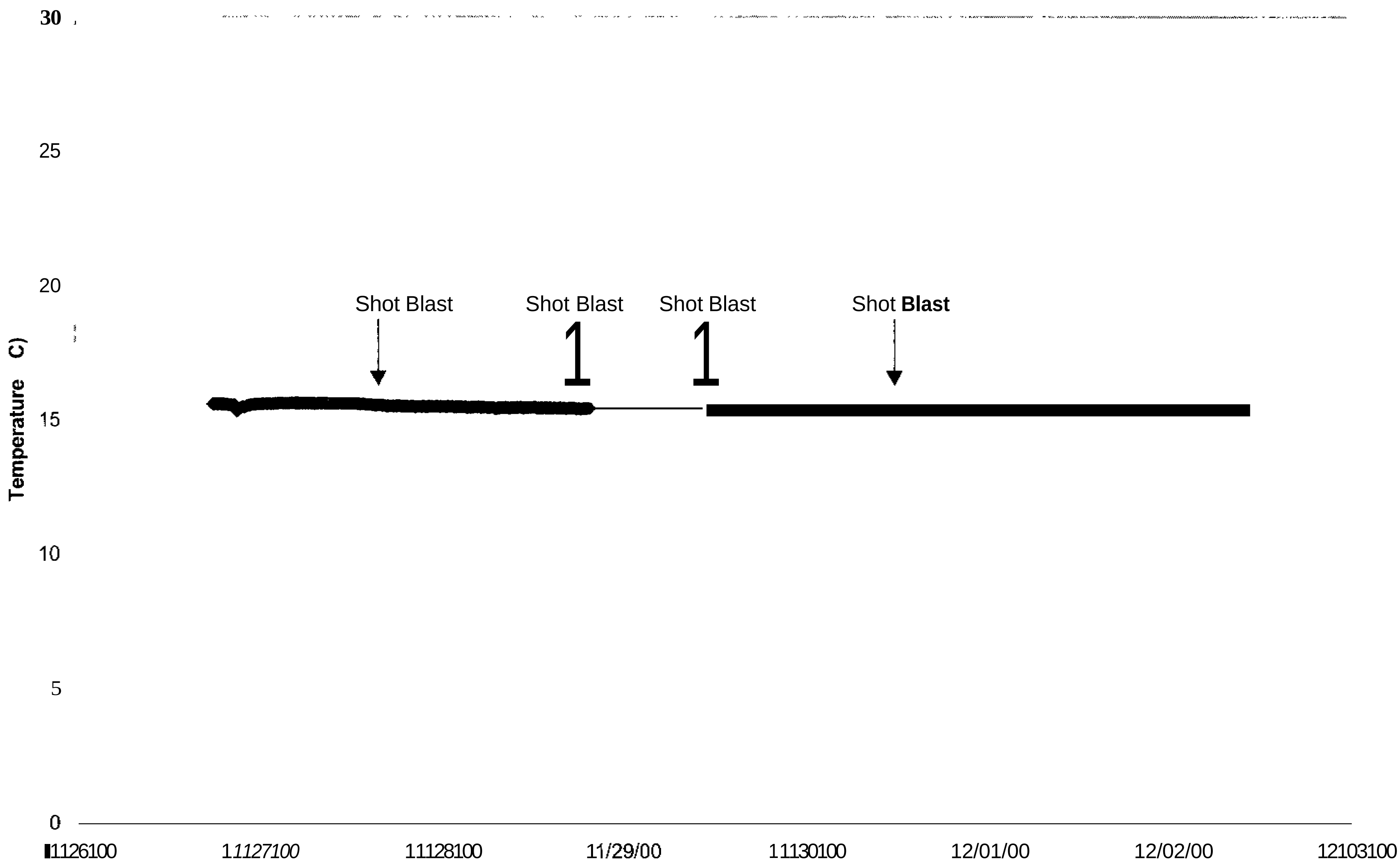
S:\projects\9290\sheets\Dean 2\21x\DEAN221X_nov00.xls Tab Stage

Well EC
Site WV-1 Site-2
Fall-Winter 2000



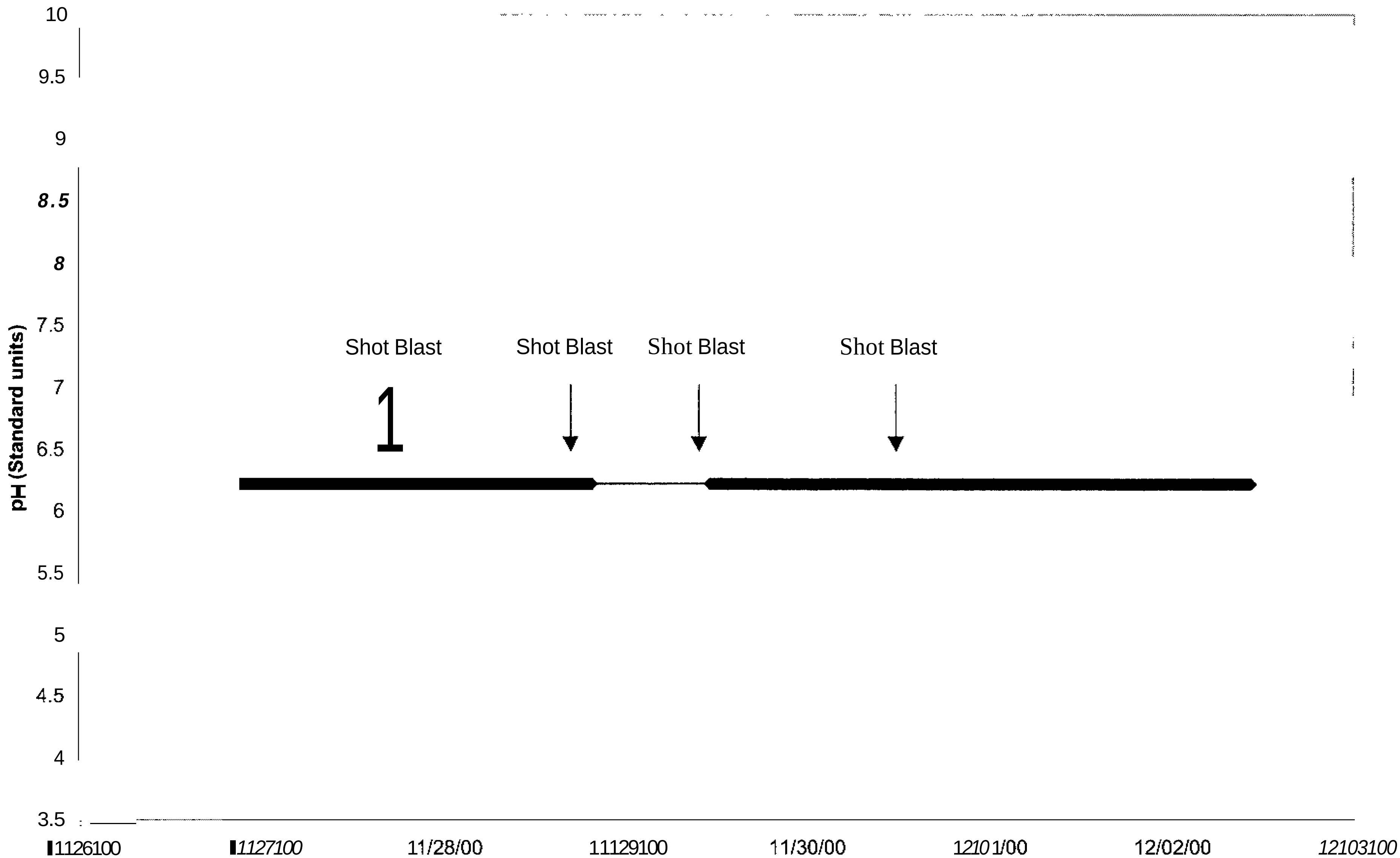
S:\projects\9290\sheets\Dean 2\22x\DEAN221X_nov00.xls Tab EC

Water Temperature
Site WV-1 Well-2
Fall-Winter 2000



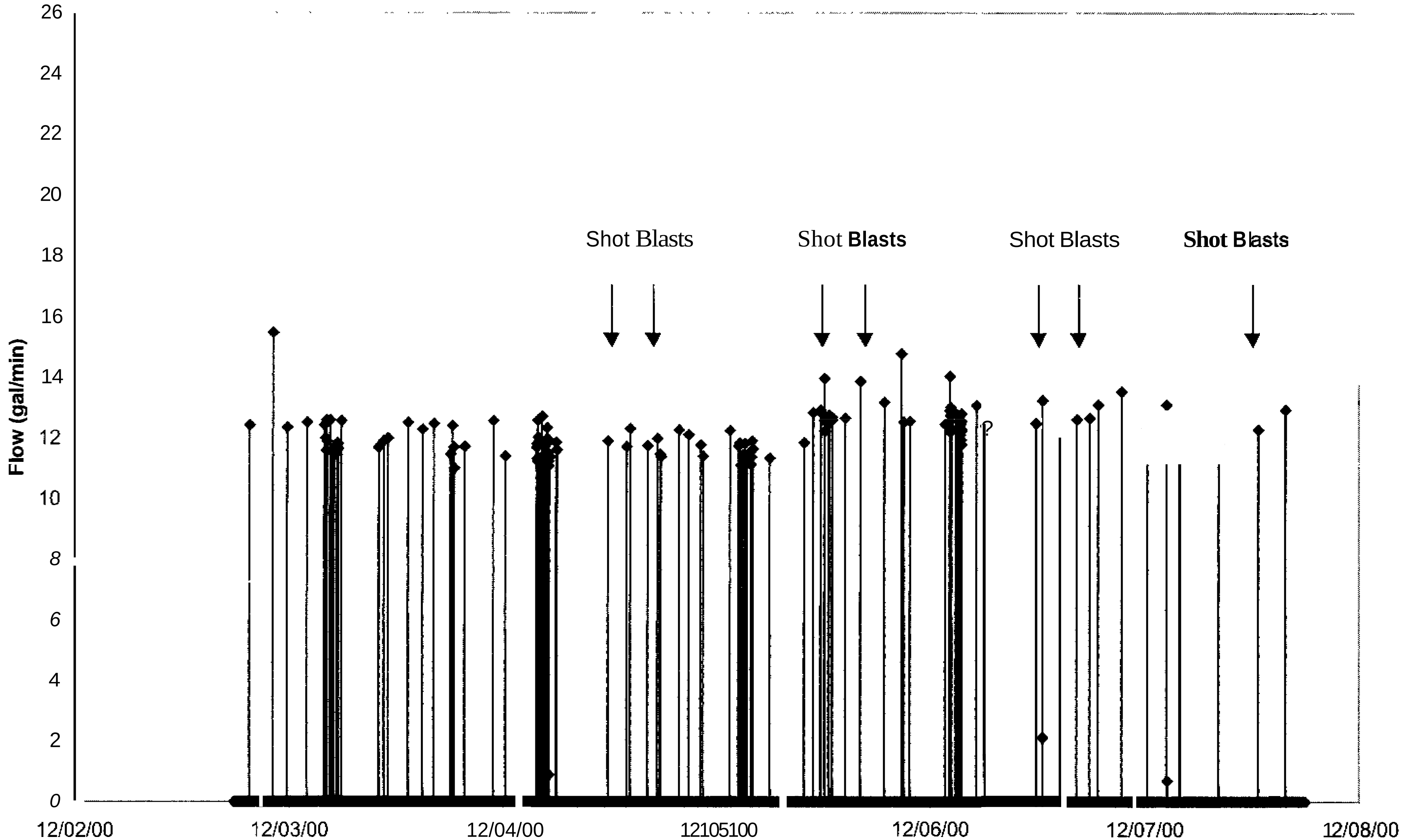
S:\projects\9290\sheets\Dean 2\21x\DEAN221X_nov00.xls Tab temp

Water pH
Site WV-1 Well-2
Fall-Winter 2000



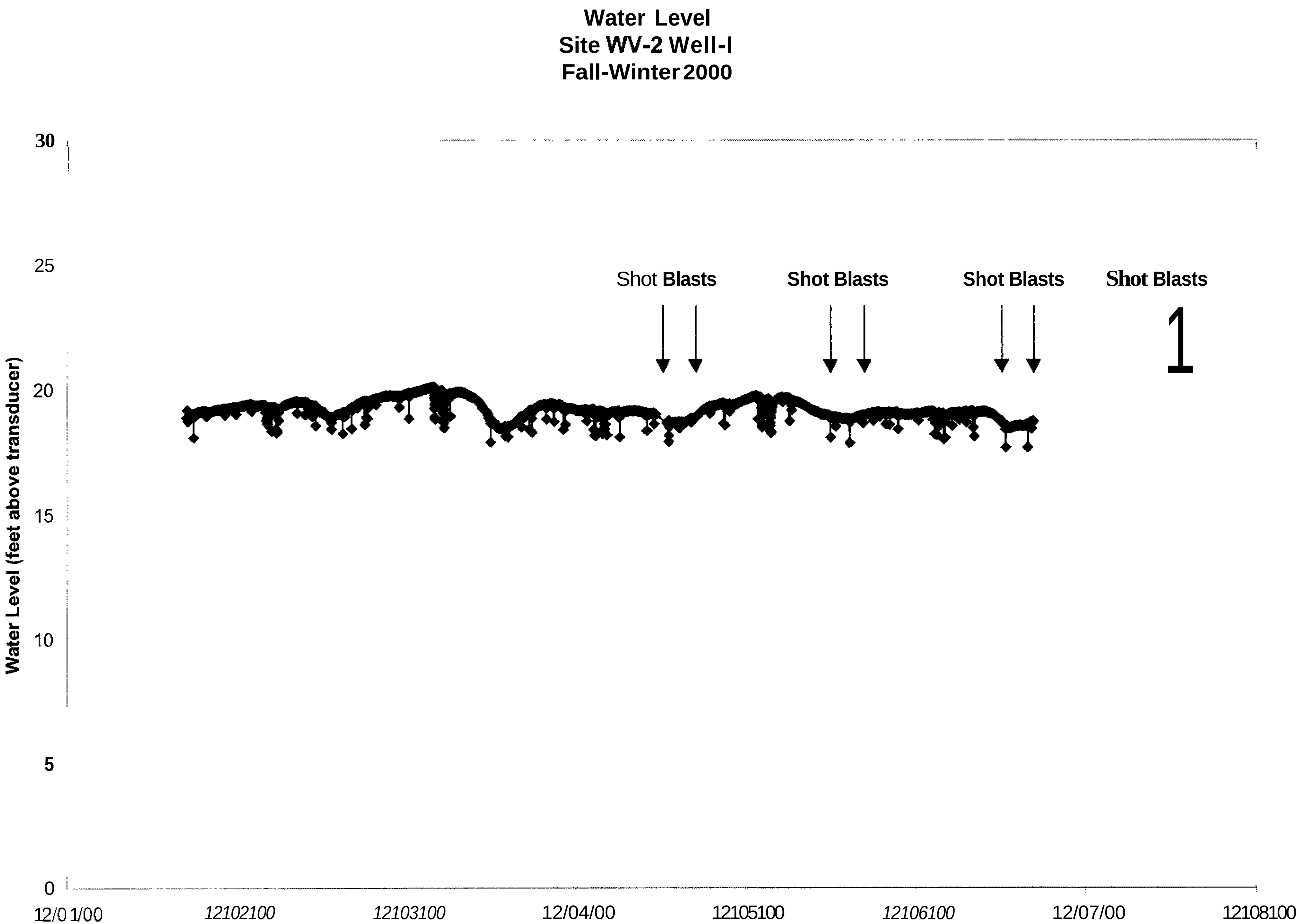
S:\projects\9290\sheets\Dean 2\21x\DEAN221X_nov00.xls Tab PH

Well Yield
Site WV-2 Well-1
Fall-Winter 2000

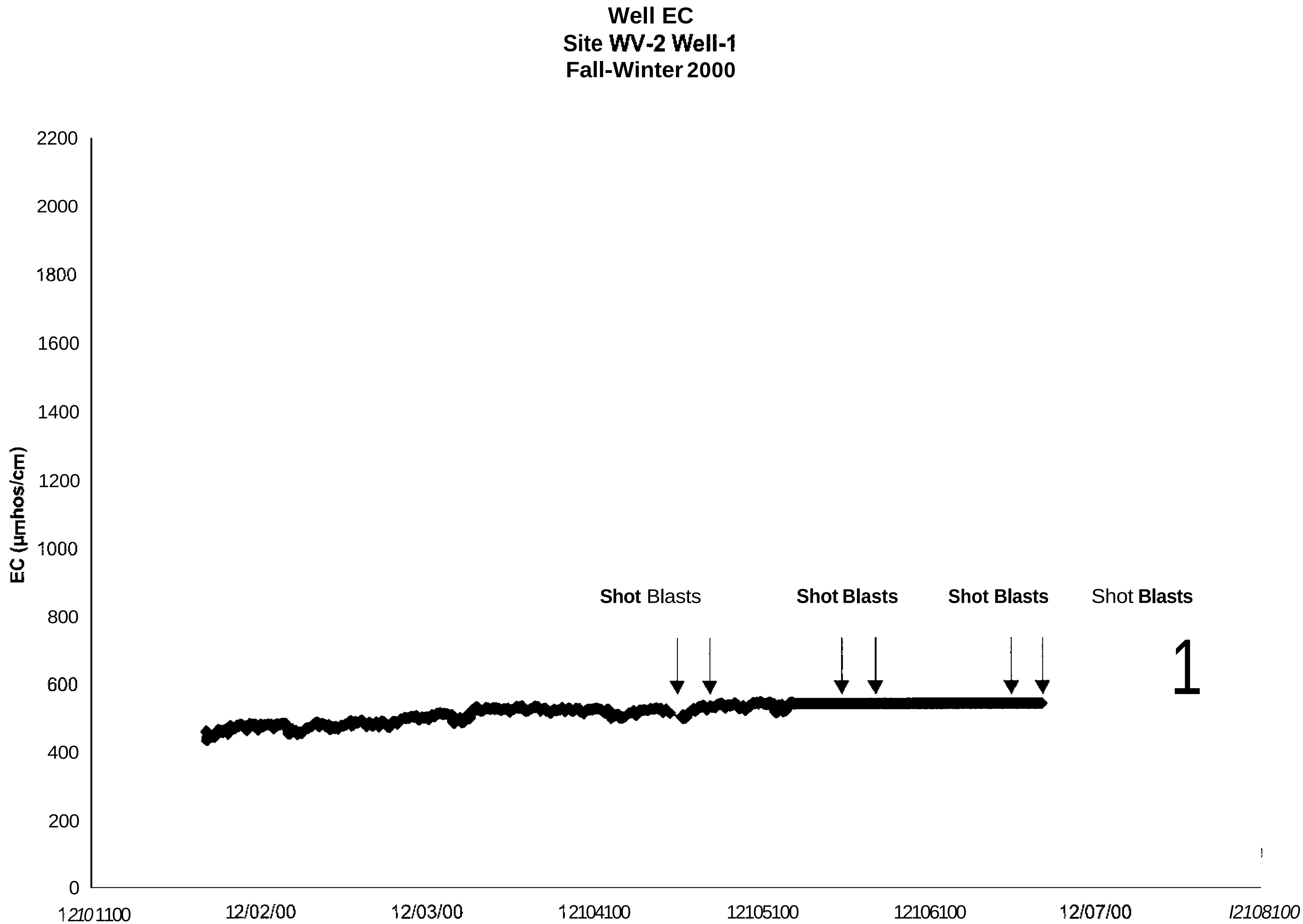


S:\projects\9290\sheets\abbot1\1010\Abbott1flow.xls

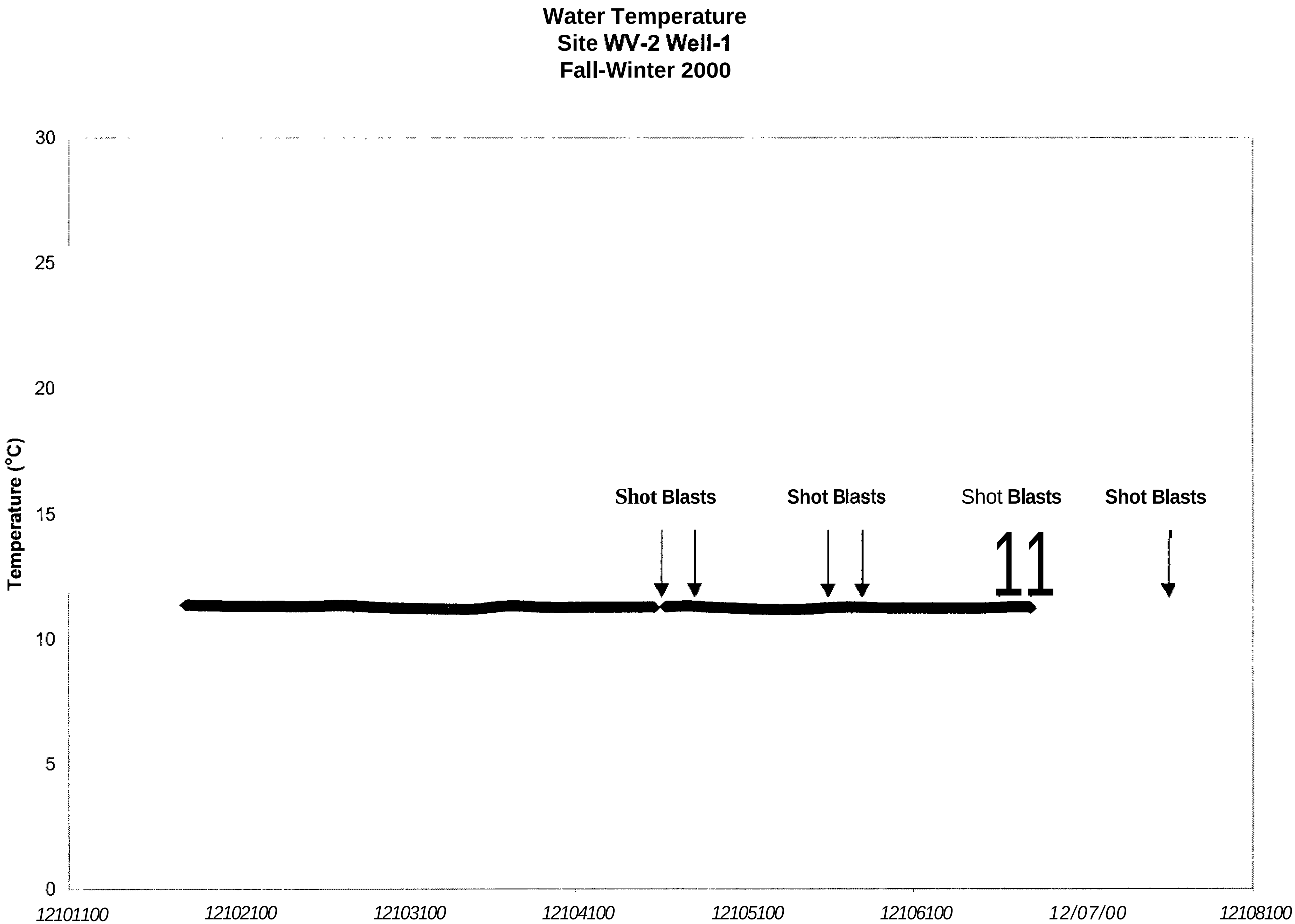
Note: 0.001 = 0



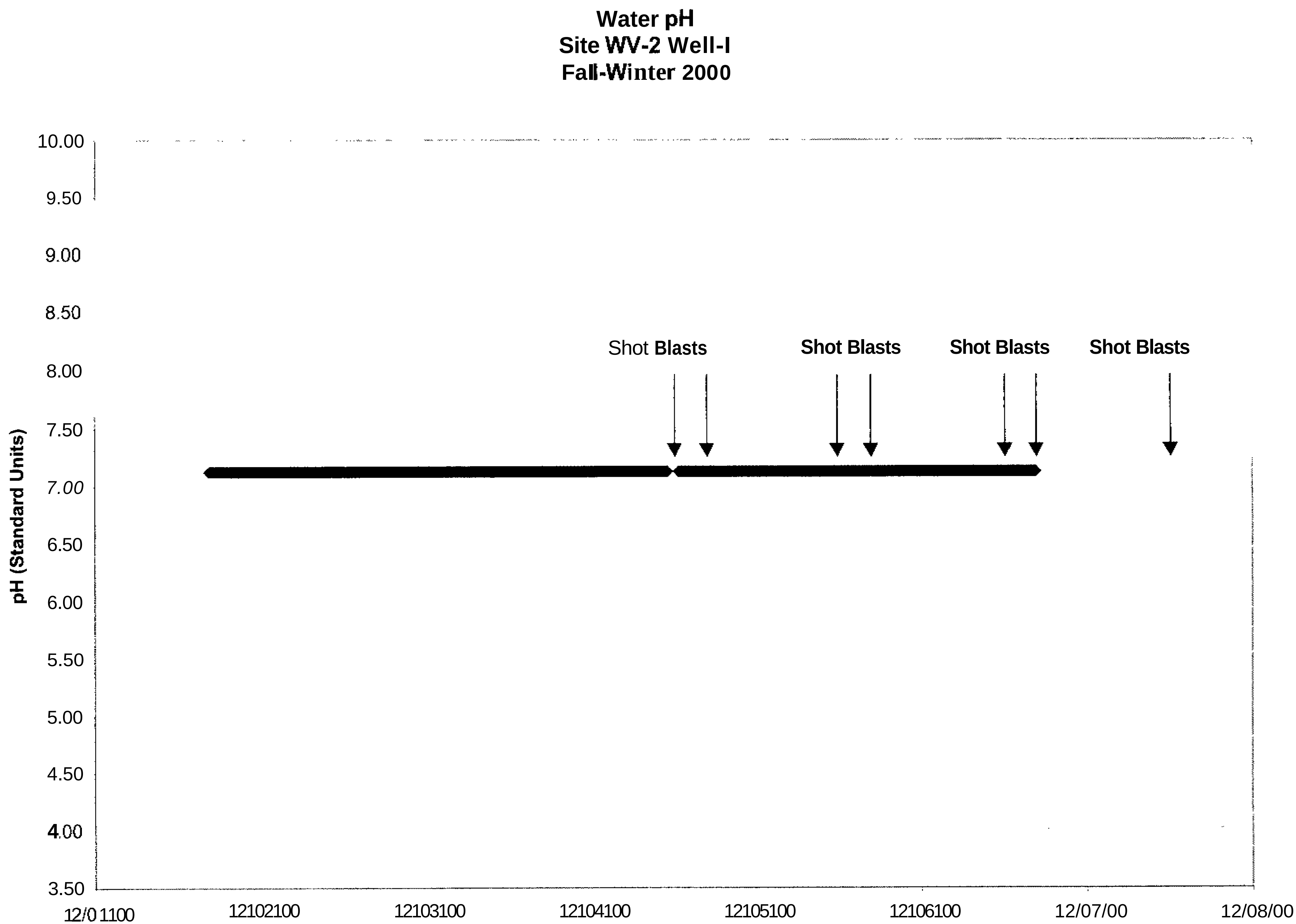
S:\projects\9290\sheets\abbot 1\21x\Abbott121X_dec00.xls Tab Stage



S:\projects\9290\sheets\abbot 1\21x\Abbott121X_dec00.xls Tab **EC**

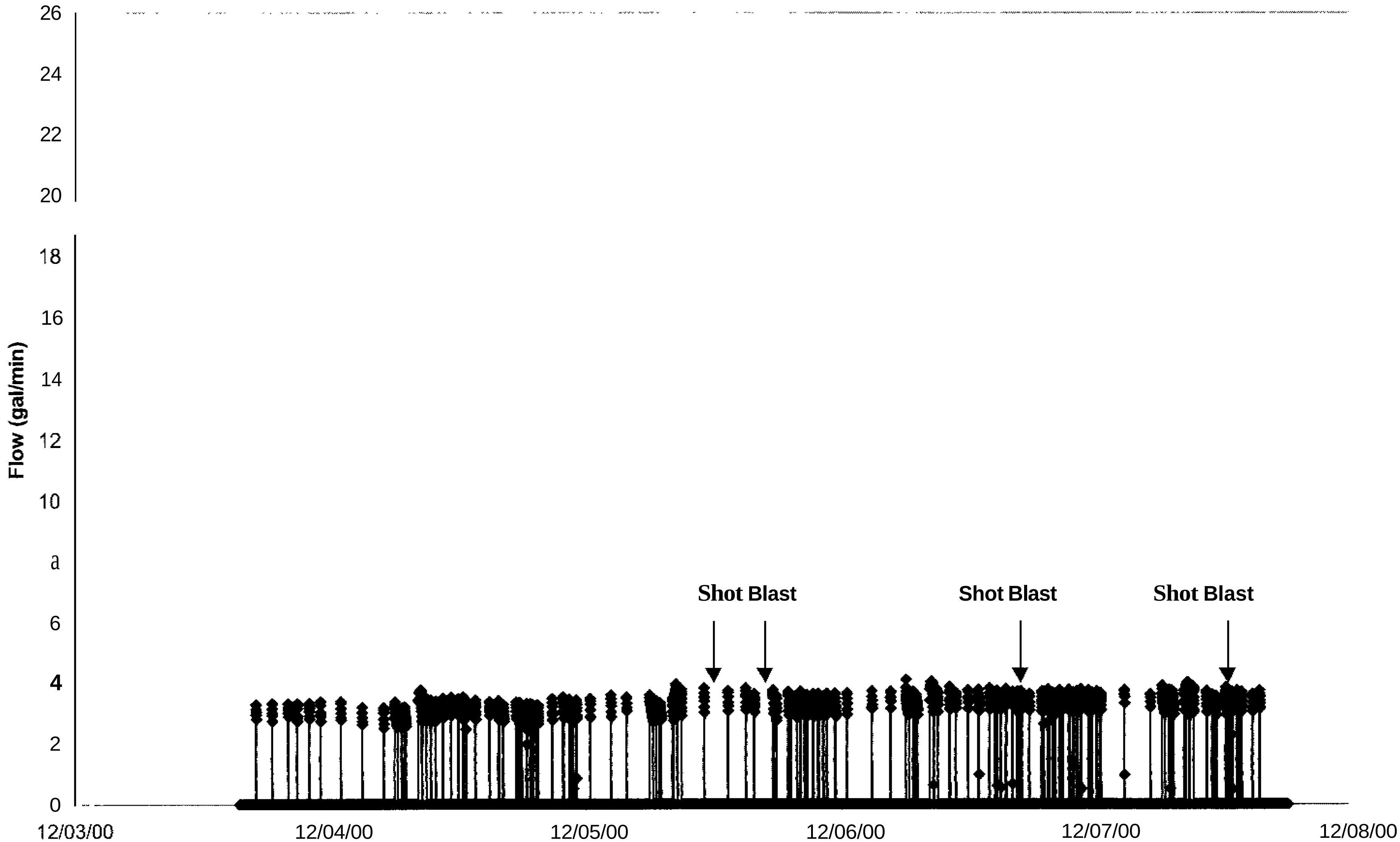


S:\projects\9290\sheets\abbot 1\21x\Abbott121X_dec00.xls Tab Temp



S:\projects\9290\sheets\abbot 1\21x\Abbott121X_dec00.xls Tab pH

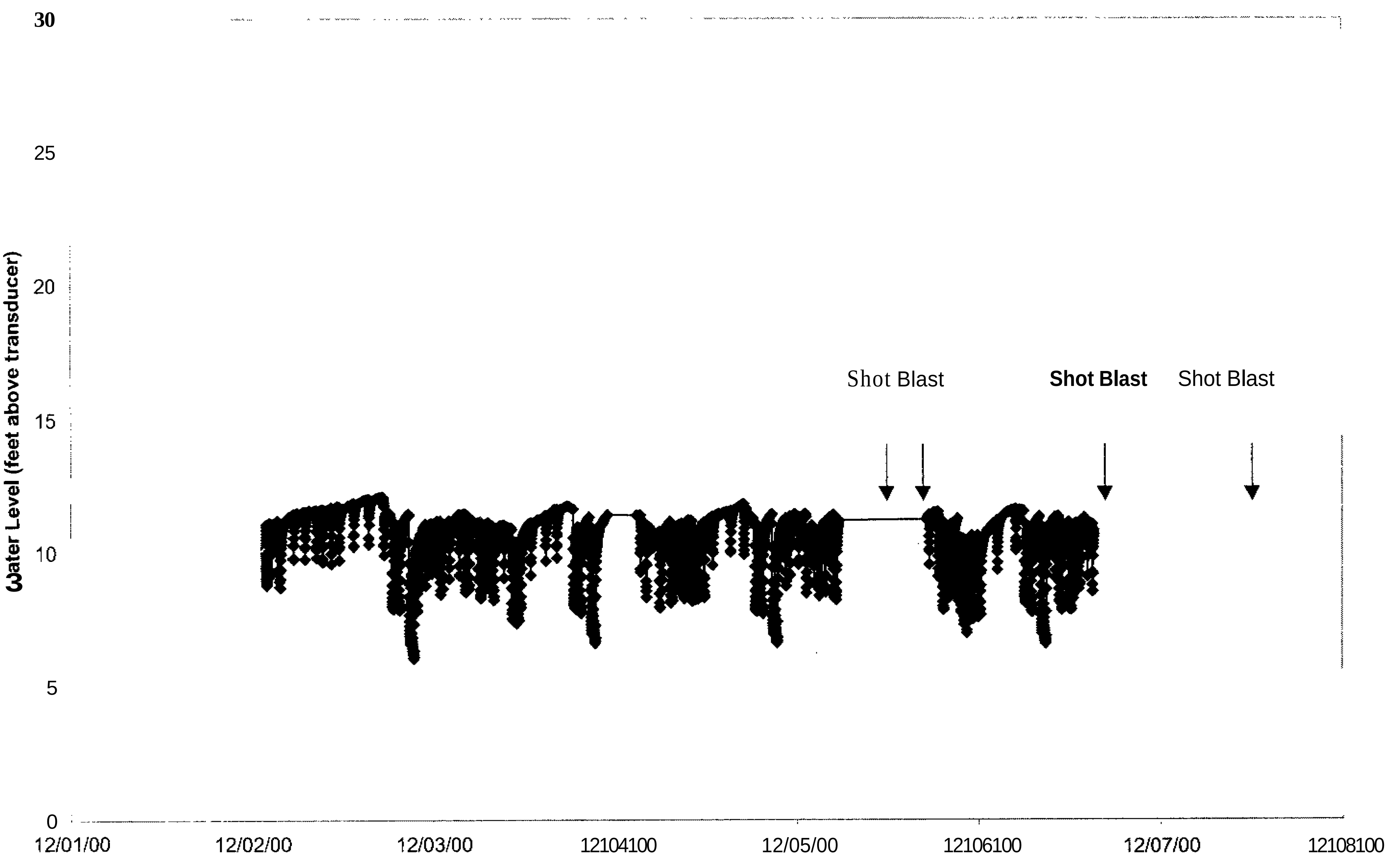
Well Yield
Site WV-2 Welt-2
Fall-Winter 2000



S:\projects\9290\sheets\abbott2\1010\abbott2flow.xls

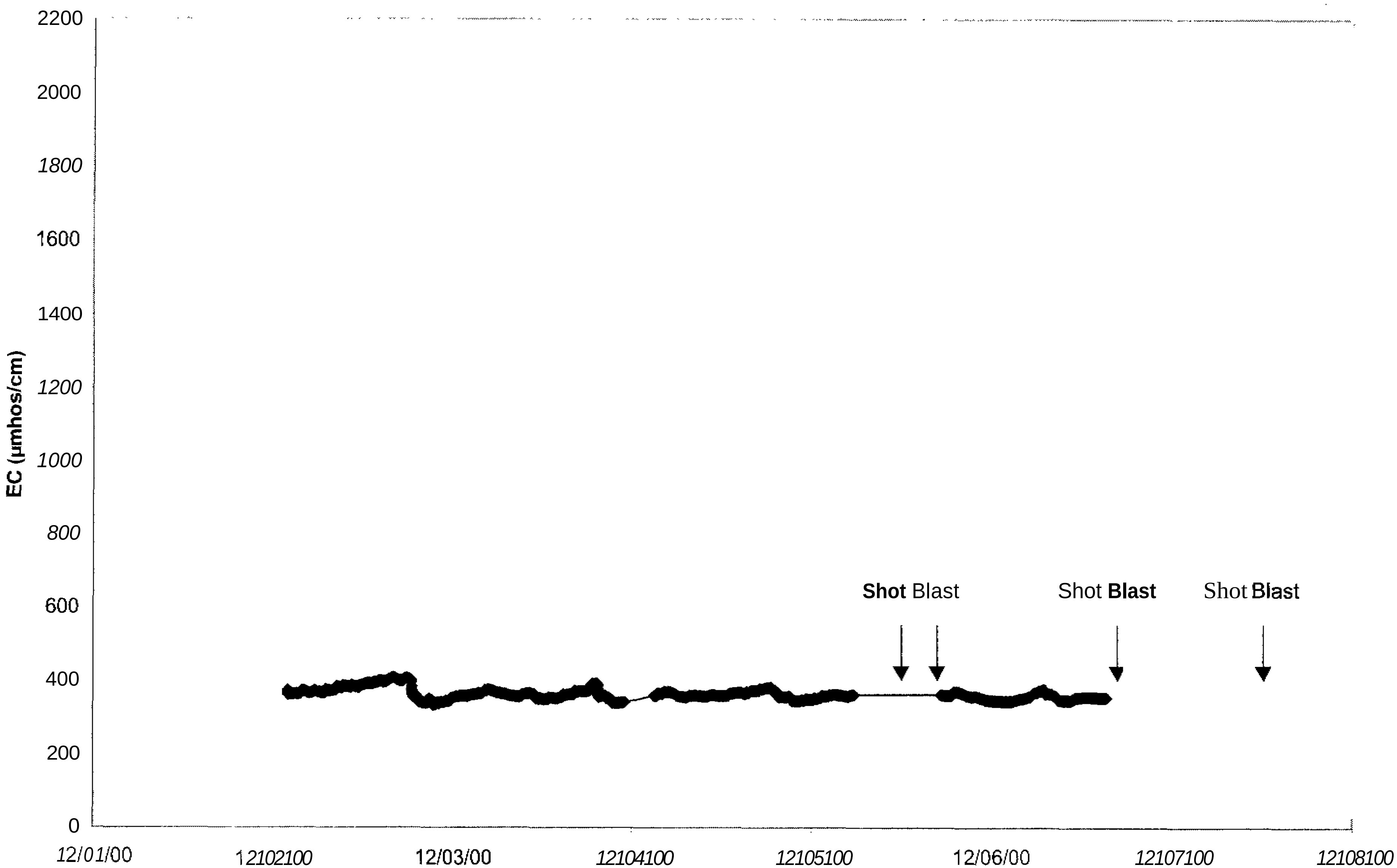
Note: 0.001=0

Water Level
Site WV-2 Well-2
Fall-Winter 2000



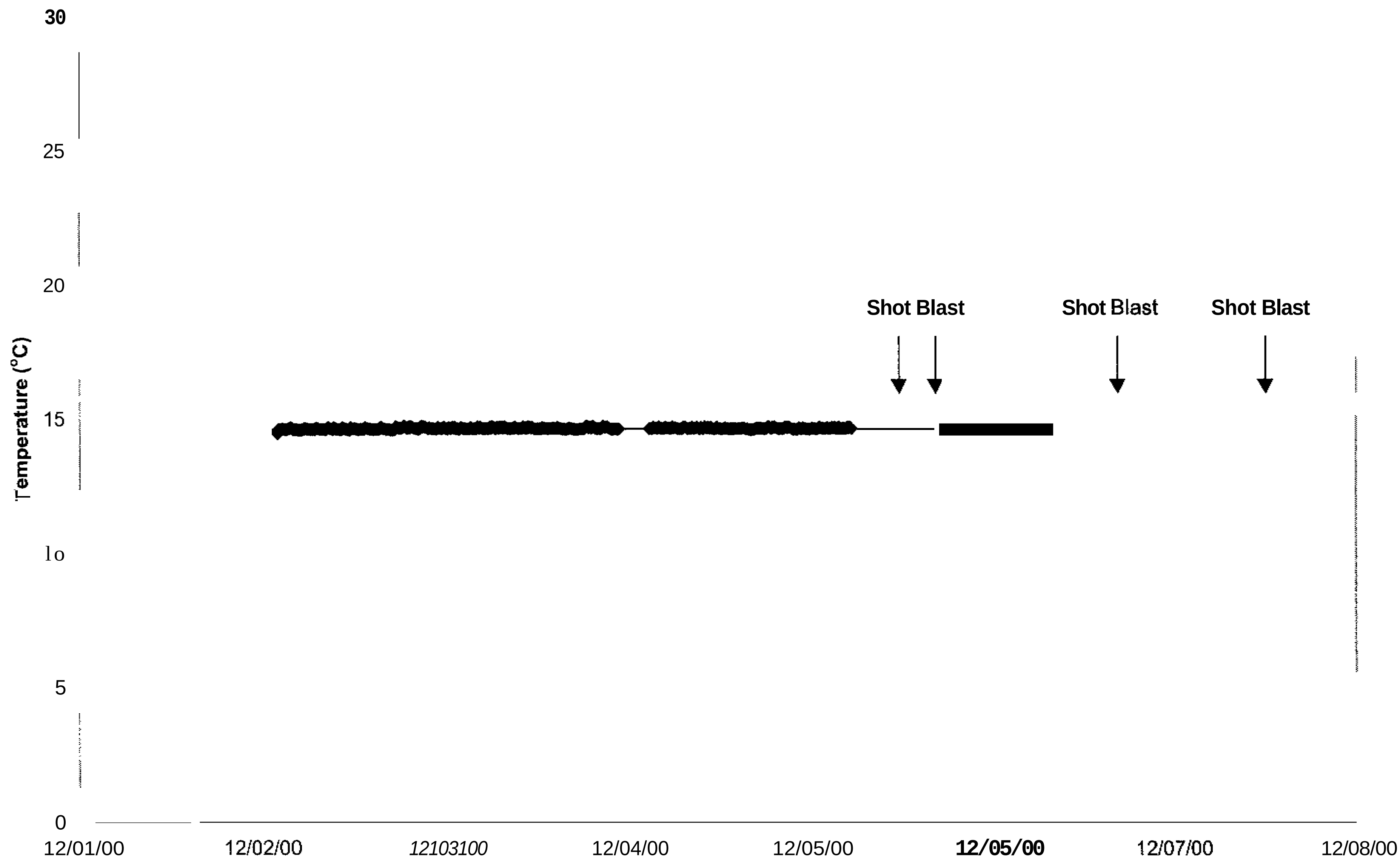
S:\projects\9290\sheets\Abbott 2\21x\Abbott221X_dec00.xls Tab Stage

Well EC
Site WV-2 Well-2
Fall-Winter 2000



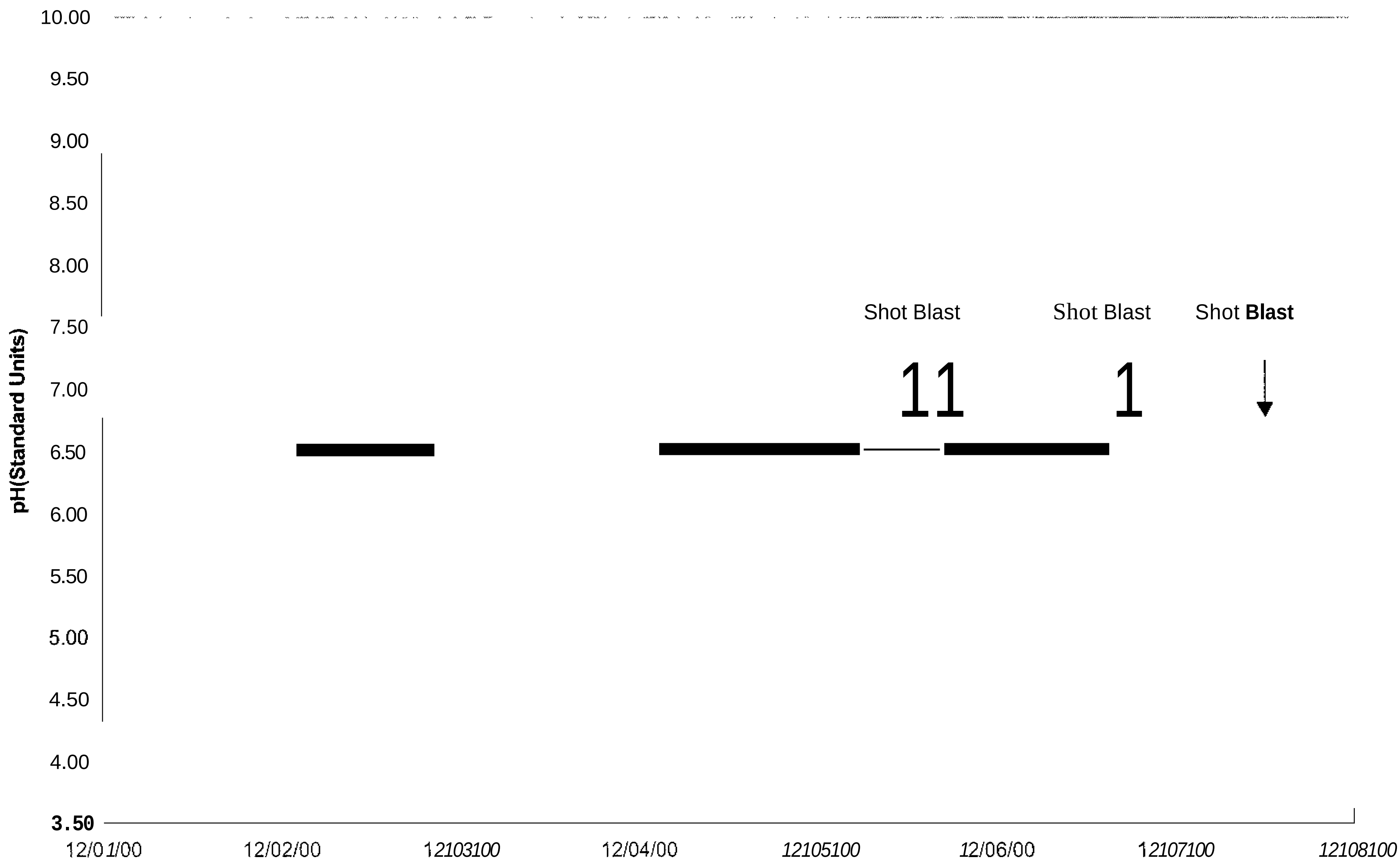
S:\projects\9290\sheets\Abbott 2\21x\Abbott221X_dec00.xls Tab EC

Water Temperature
Site WV-2 Well-2
Fall-Winter 2000



S:\projects\9290\sheets\Abbott 2\21x\Abbott221X_dec00.xls Tab temp

Water pH
Site WV-2 Well-2
Fall-Winter 2000

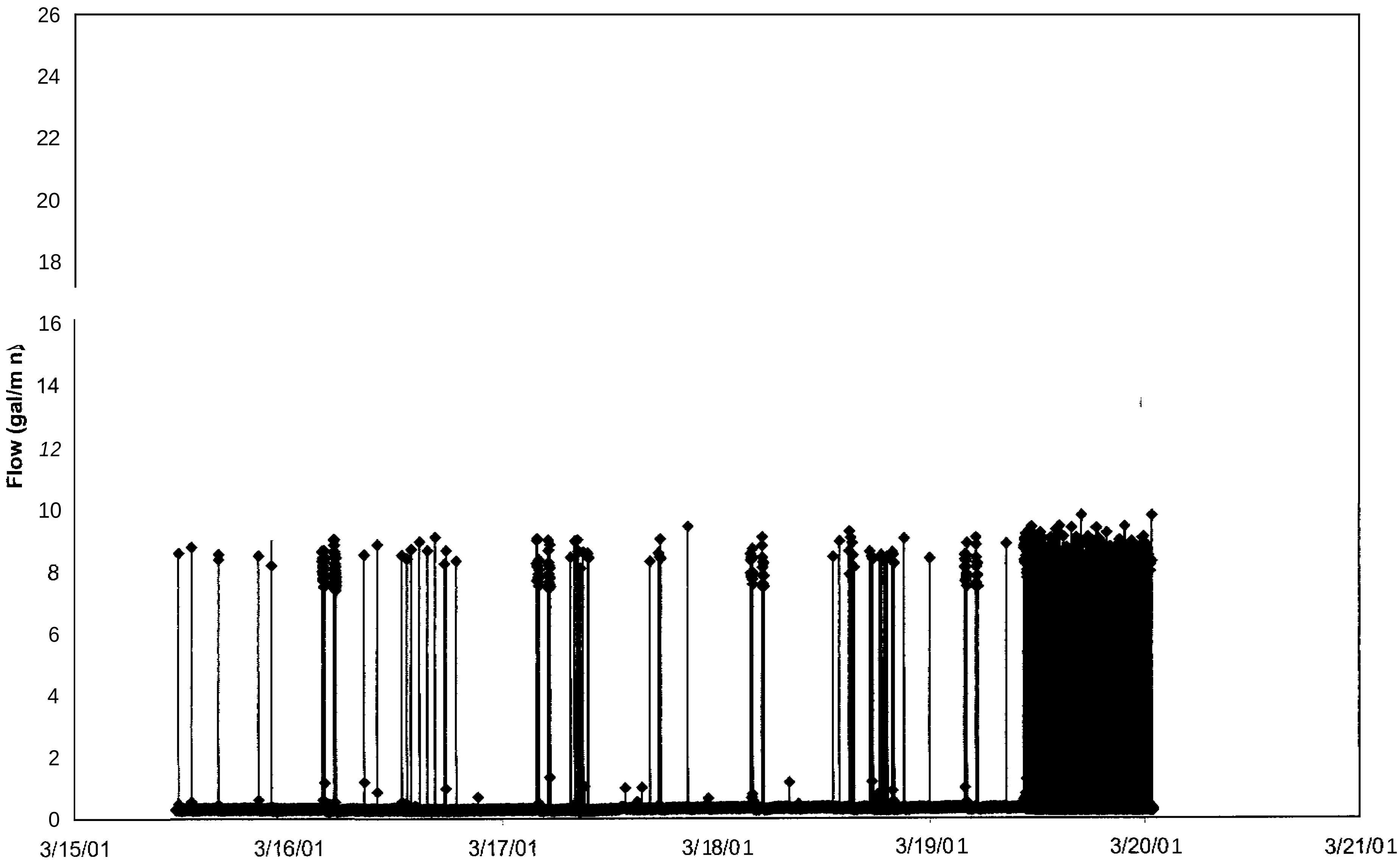


S:\projects\9290\sheets\Abbott 2\21x\Abbott221X_dec00.xls Tab PH

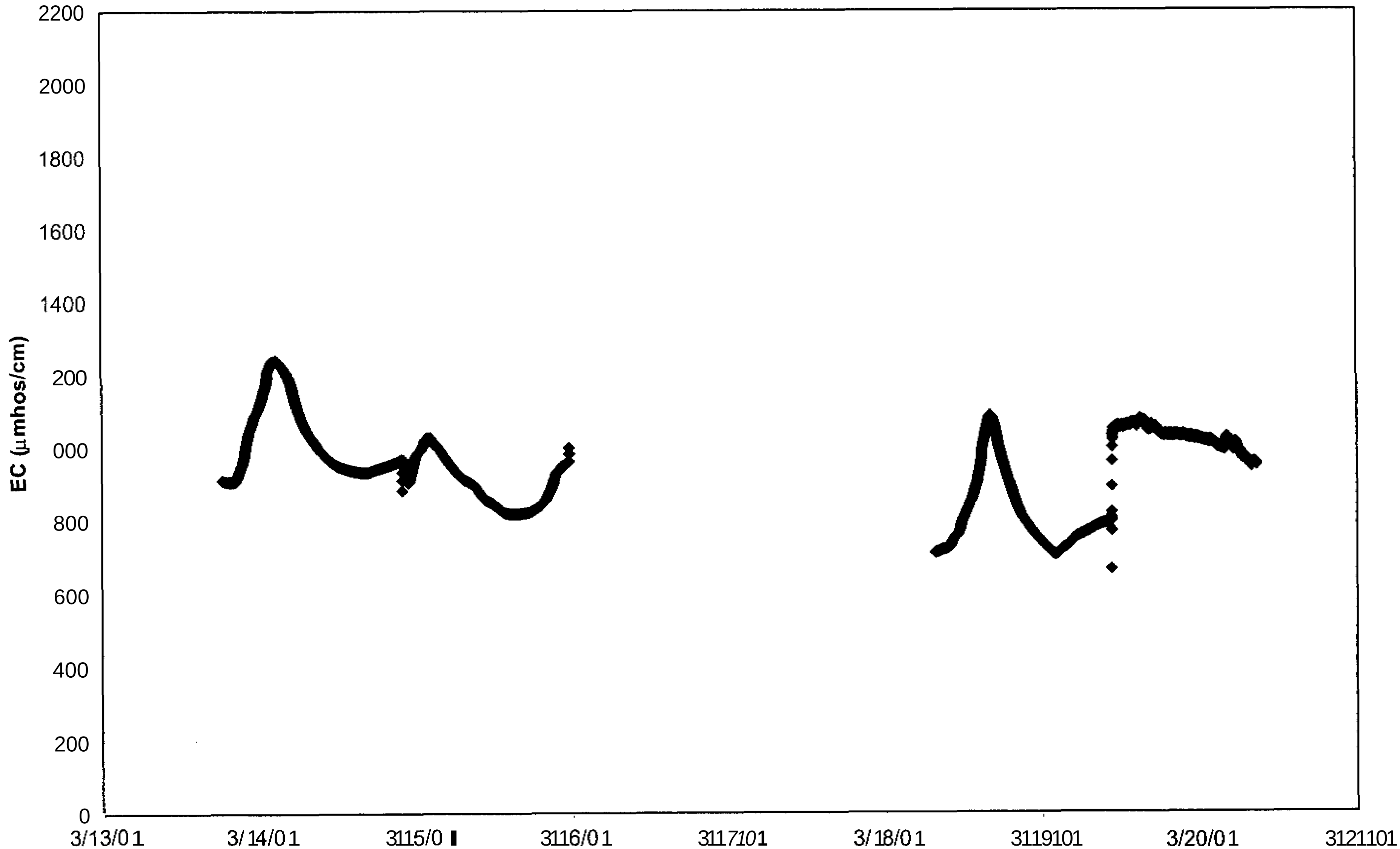
Appendix C2

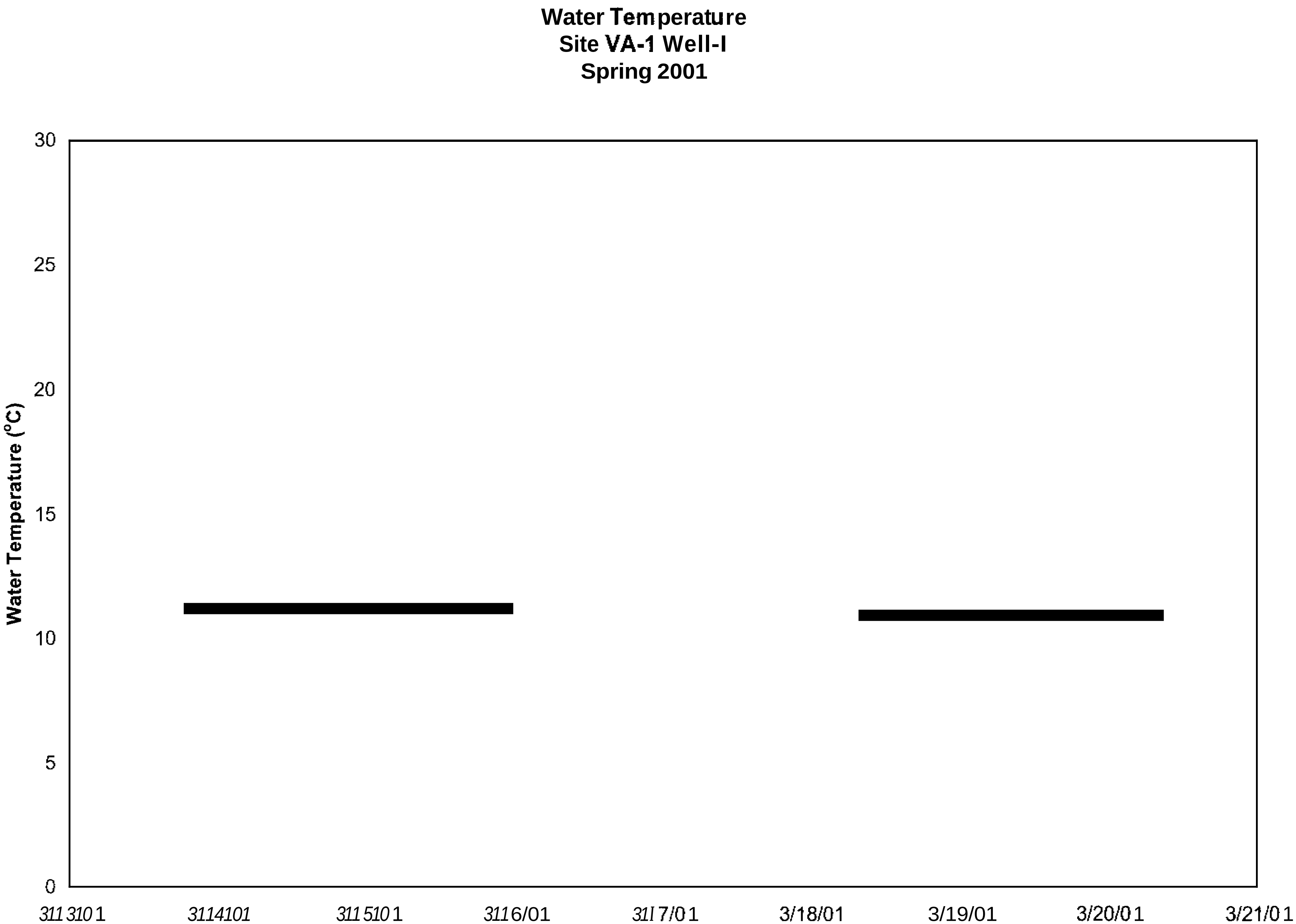
Spring 2001

Well Yield
Site VA-1 Well-1
Spring 2001



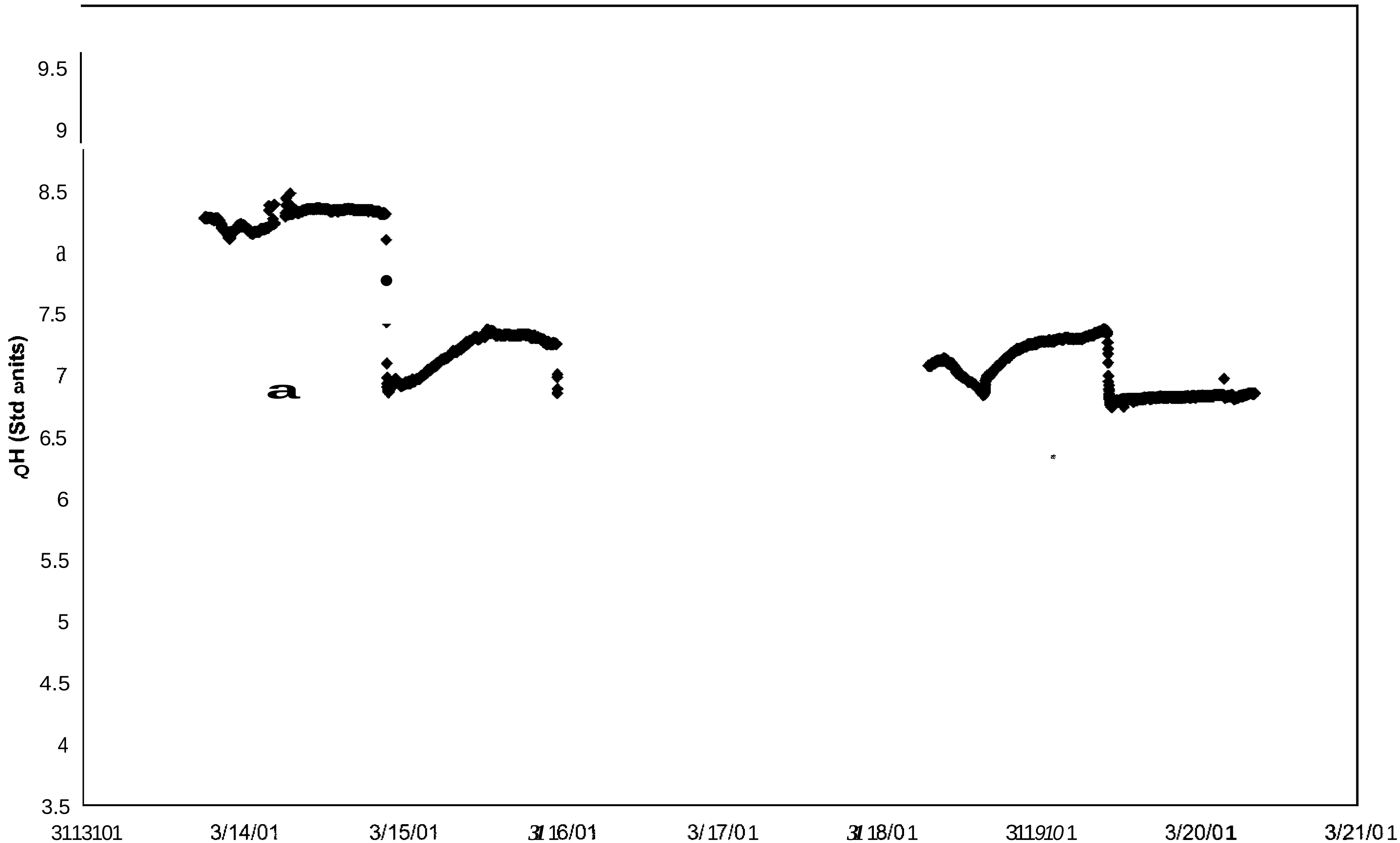
Well EC
Site VA-1 Well-I
Spring 2001



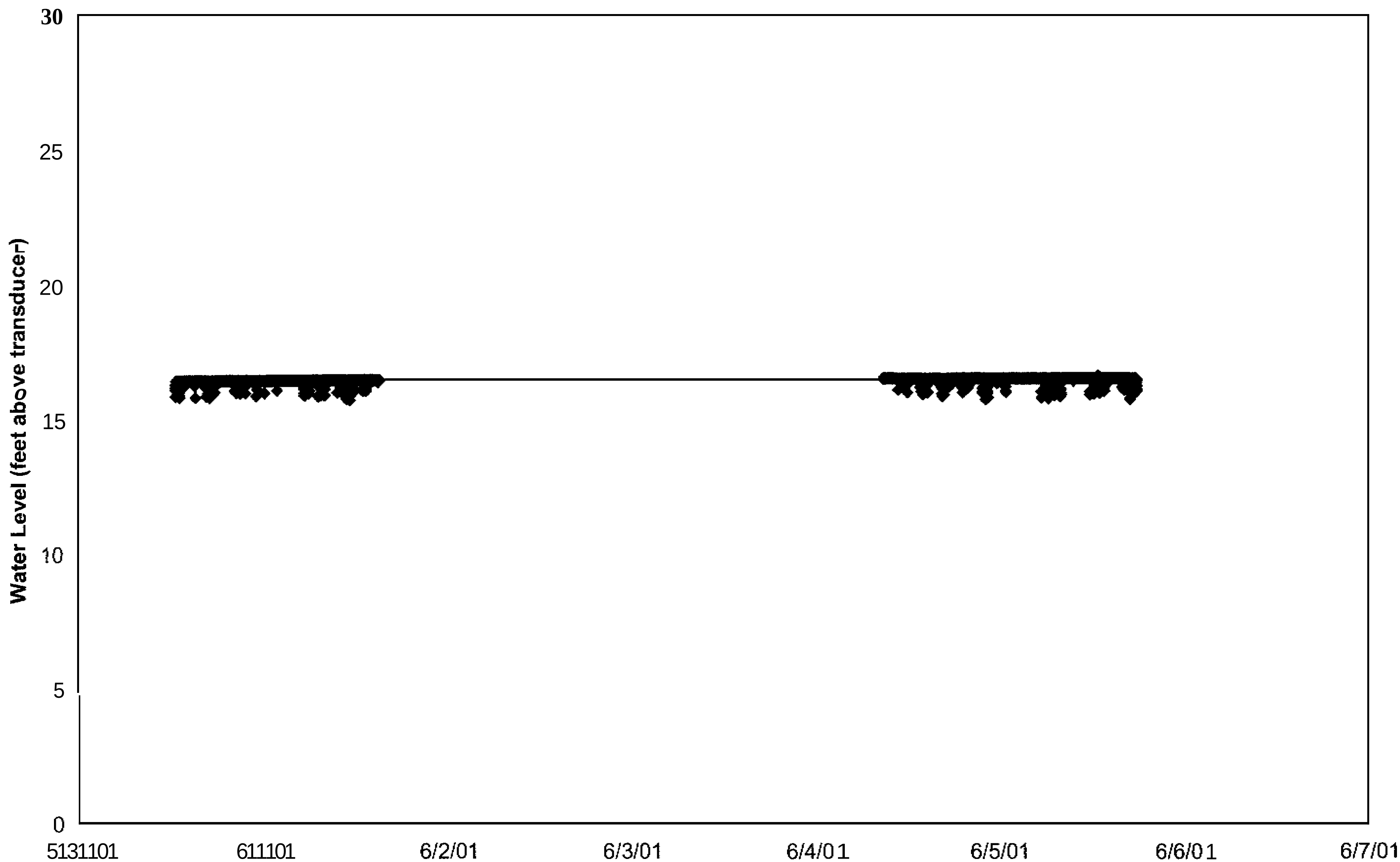


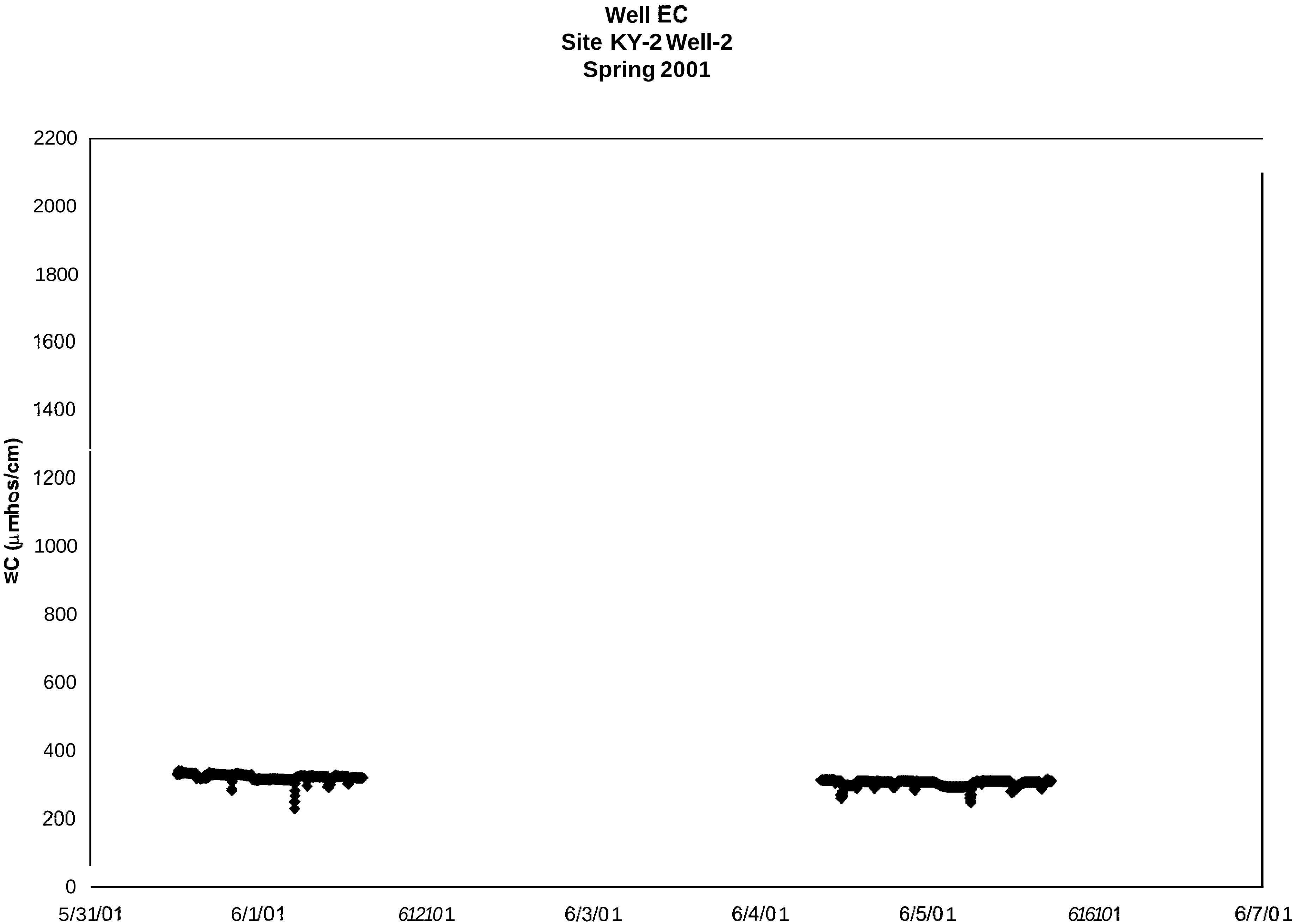
Water Temperature
Site VA-1 Well-I
Spring 2001
Water Temperature (°C)
30
25
20
15
10
5
0
311 310 1
3114101
311 510 1
3116/01
31I 7/01
3/18/01
3/19/01
3/20/01
3/21/01

Water pH
Site VA-1 Well-1
Spring 2001



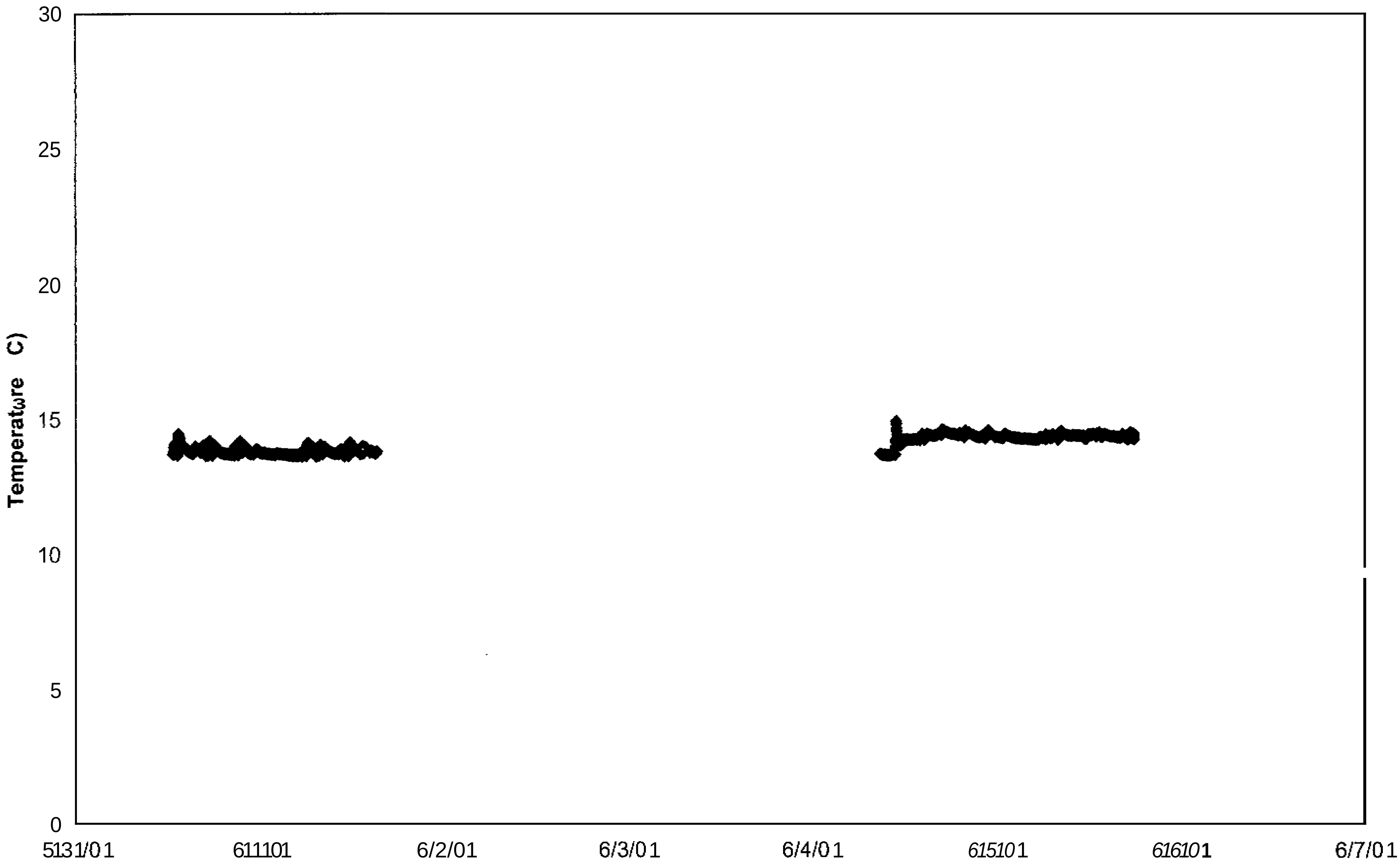
Water Level
Site KY-2 Well-2
Spring 2001



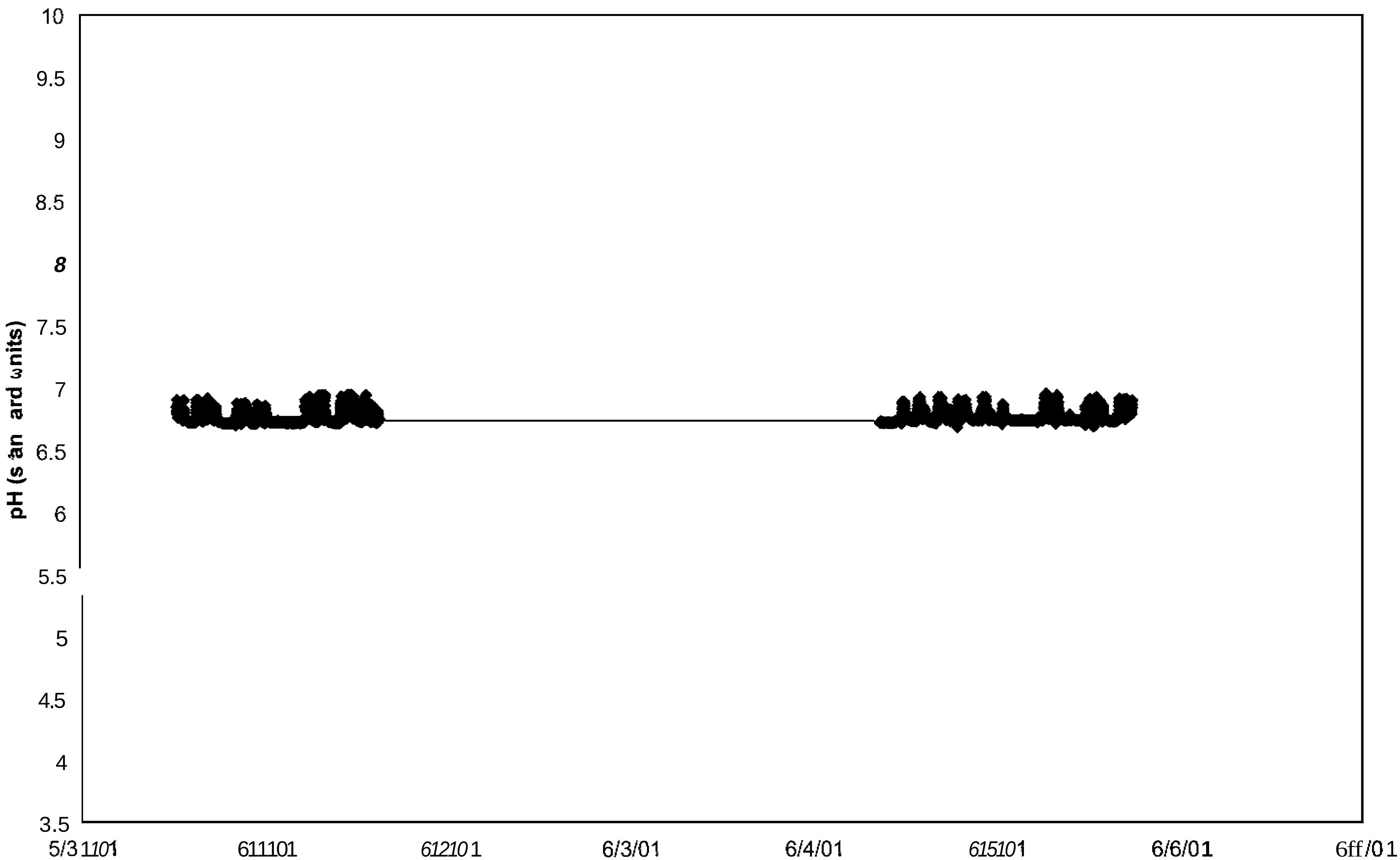


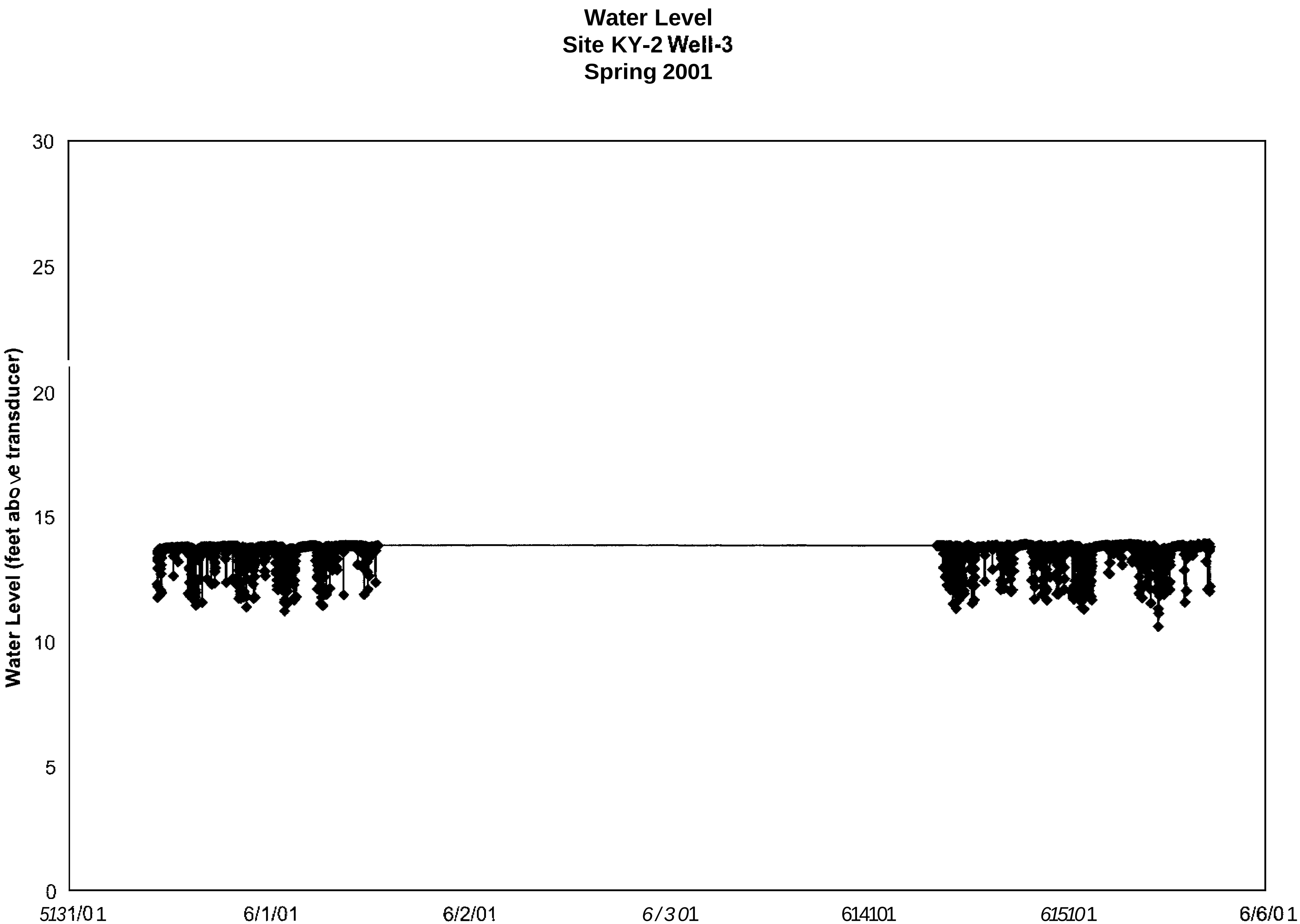
Well EC
Site KY-2 Well-2
Spring 2001
EC (µmhos/cm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5/31/01
6/1/01
6/2/01
6/3/01
6/4/01
6/5/01
6/6/01
6/7/01

Water Ternperature
Site KY-2 Well-2
Spring 2001

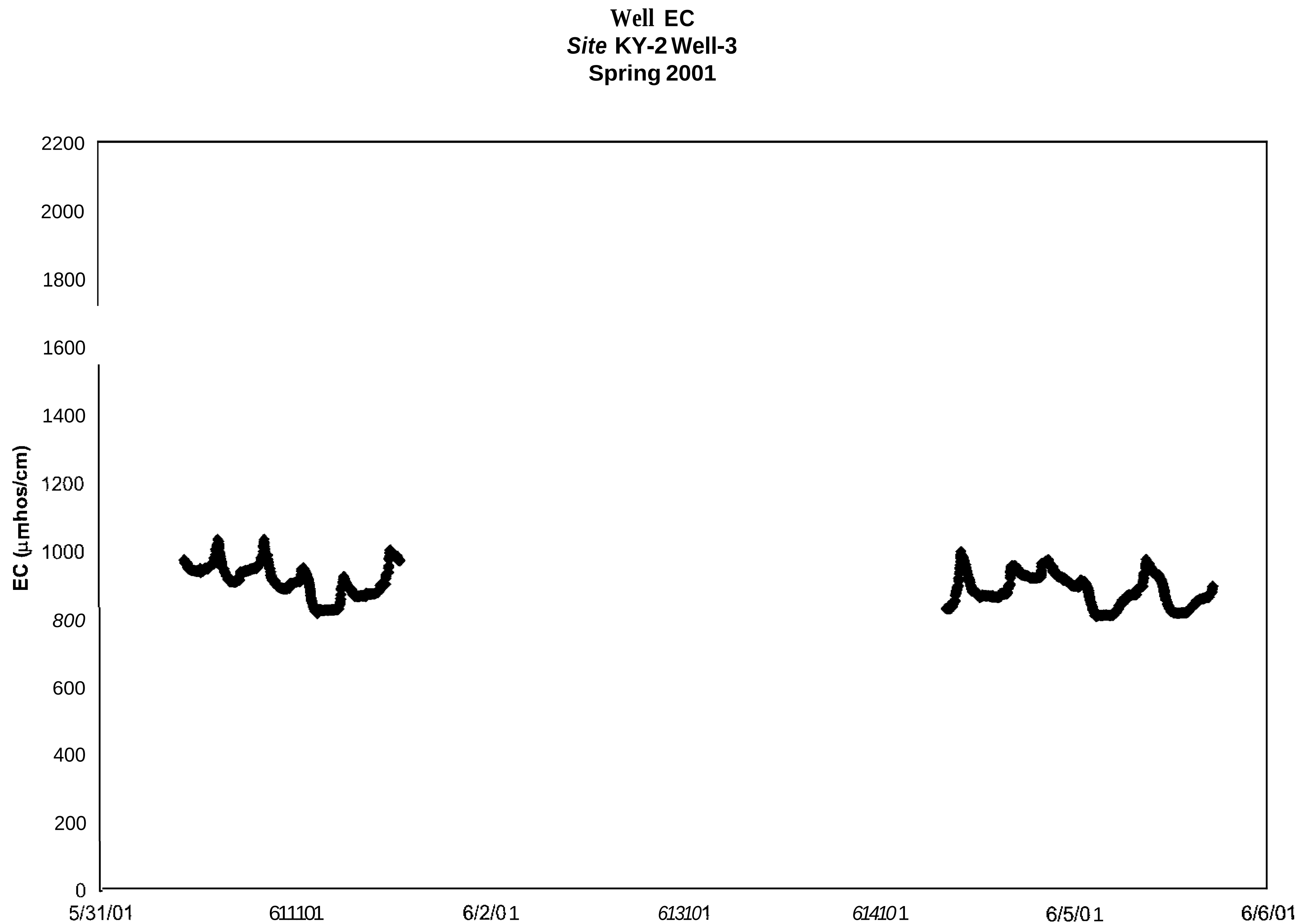


Water pH
Site KY-2 Well-2
Spring 2001

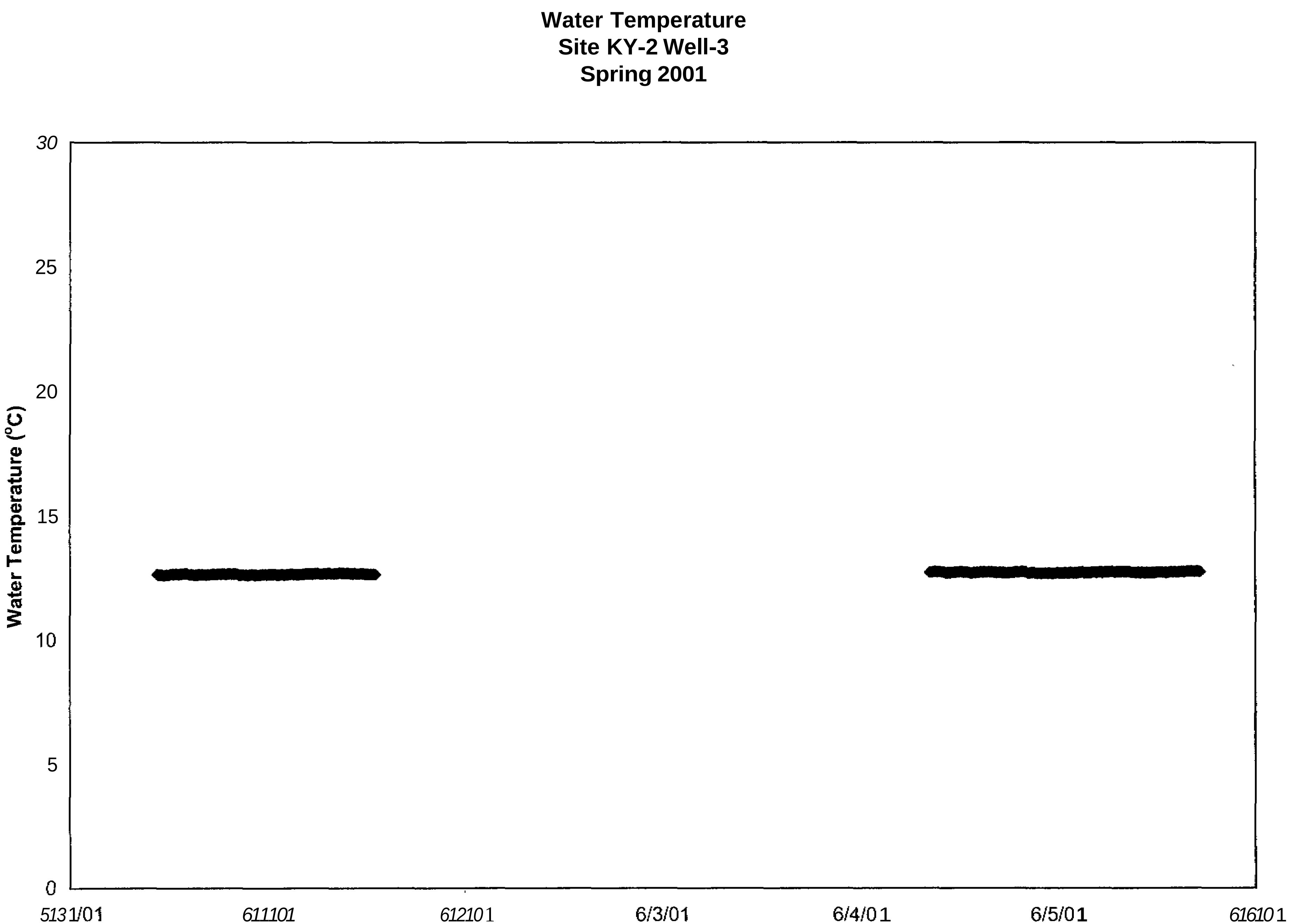




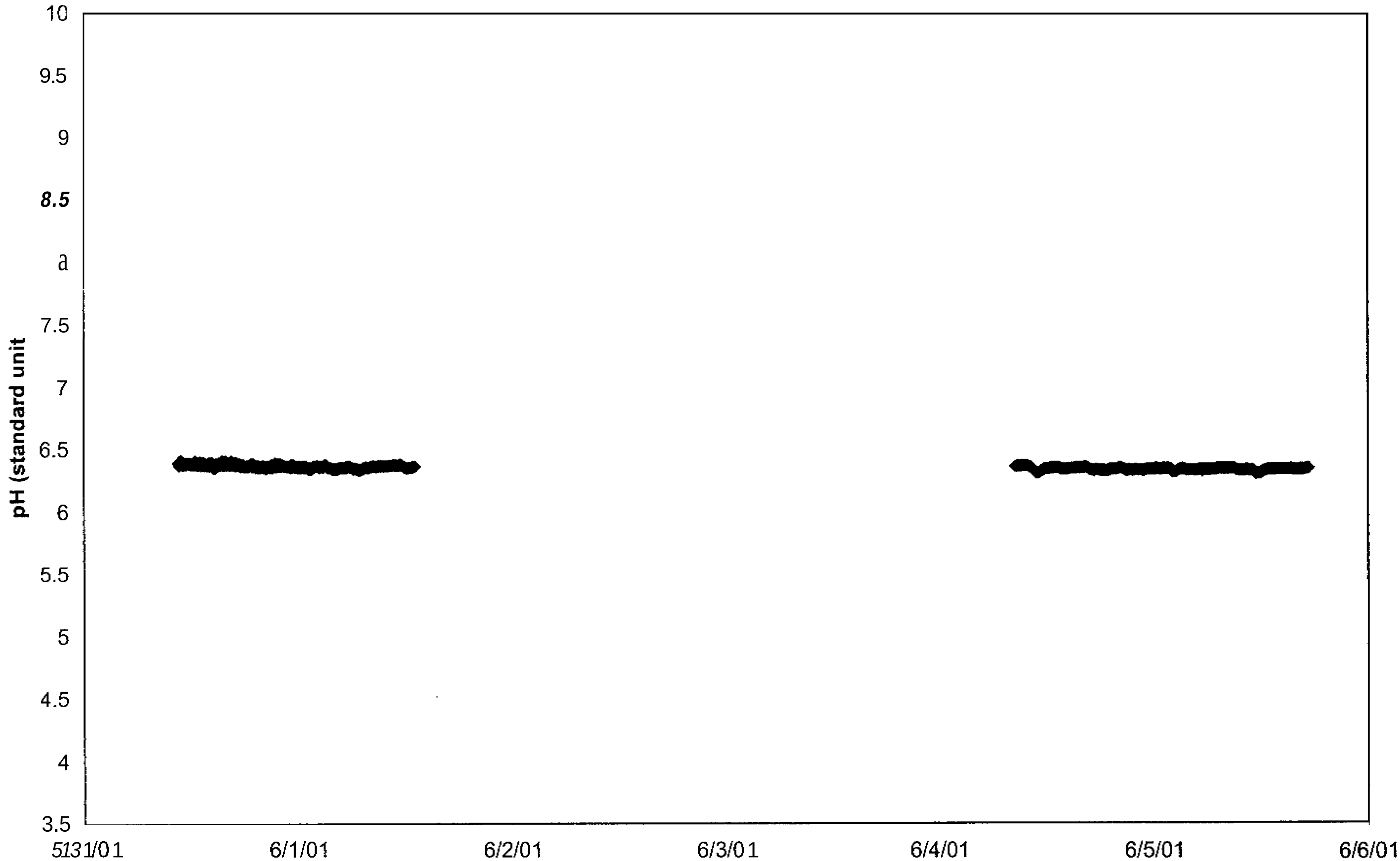
Water Level
Site KY-2 Well-3
Spring 2001
Water Level (feet above transducer)
30
25
20
15
10
5
0
5/31/01
6/1/01
6/2/01
6/3/01
6/4/01
6/5/01
6/6/01



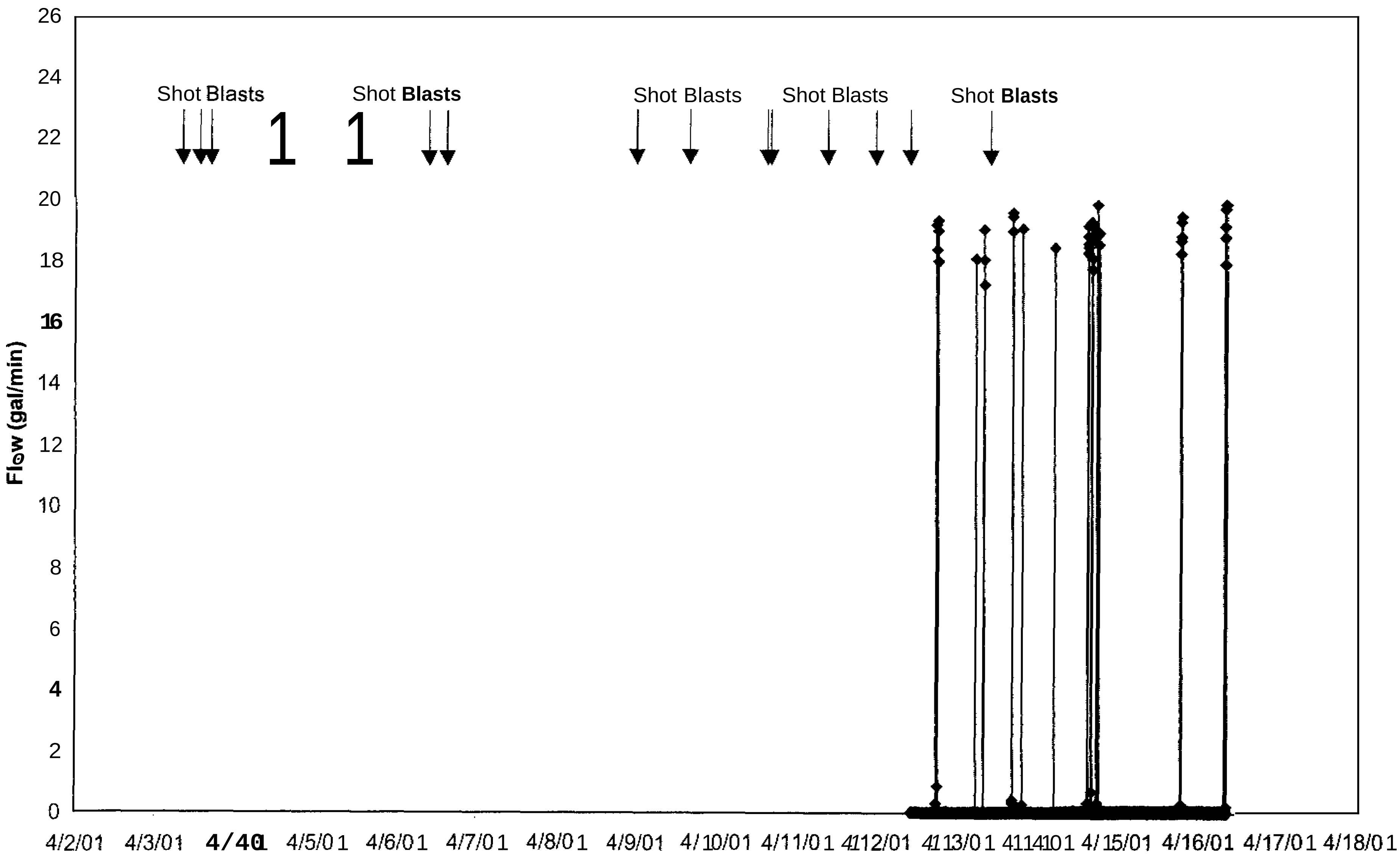
Well EC
Site KY-2 Well-3
Spring 2001
EC (µmhos/cm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5/31/01
611101
6/2/01
613101
614101
6/5/01
6/6/01

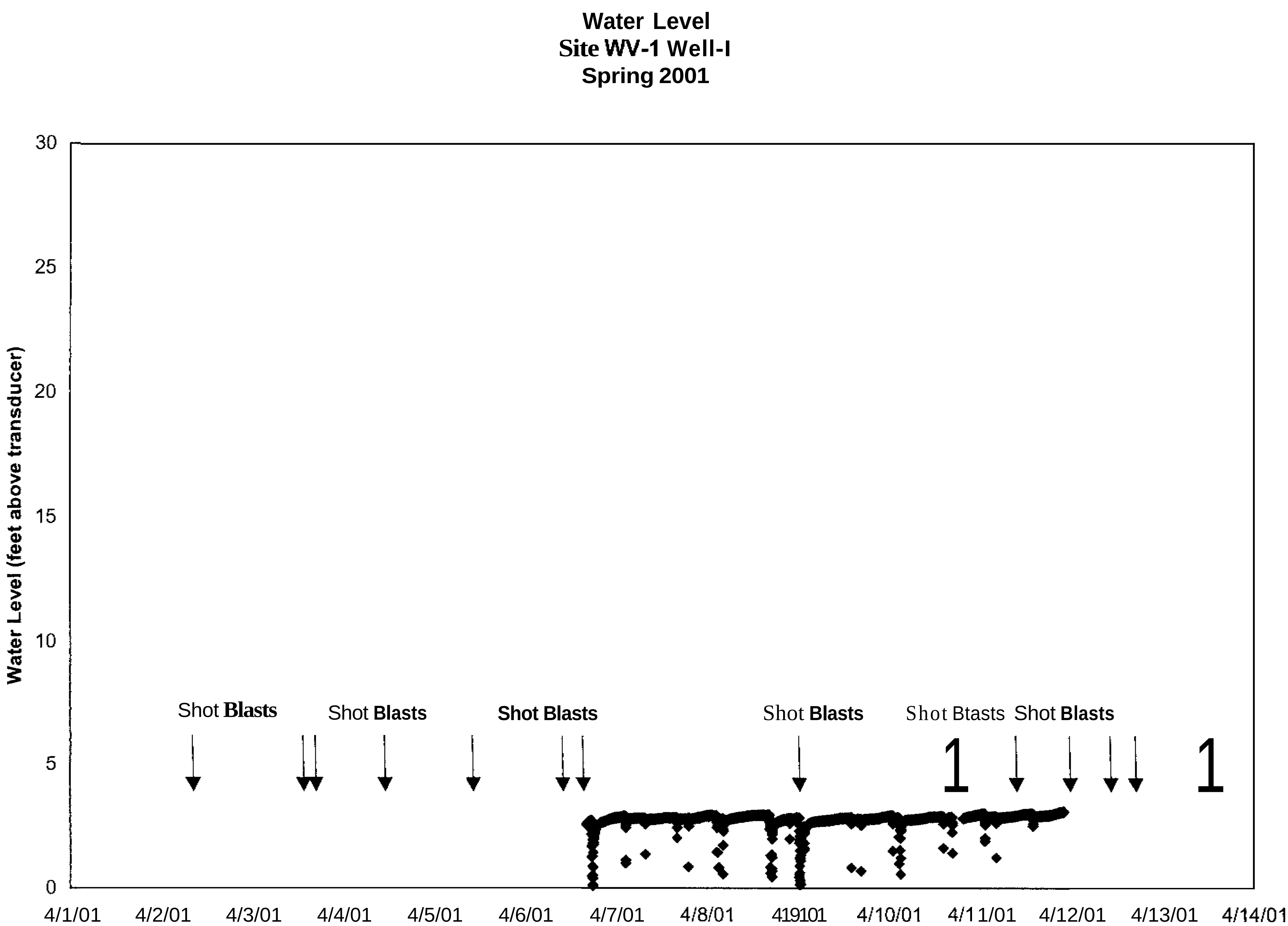

Water Temperature
Site KY-2 Well-3
Spring 2001
Water Temperature (°C)
30
25
20
15
10
5
0
5131/01
611101
612101
6/3/01
6/4/01
6/5/01
616101

Water pH
Site KY-2 Well-3
Spring 2001

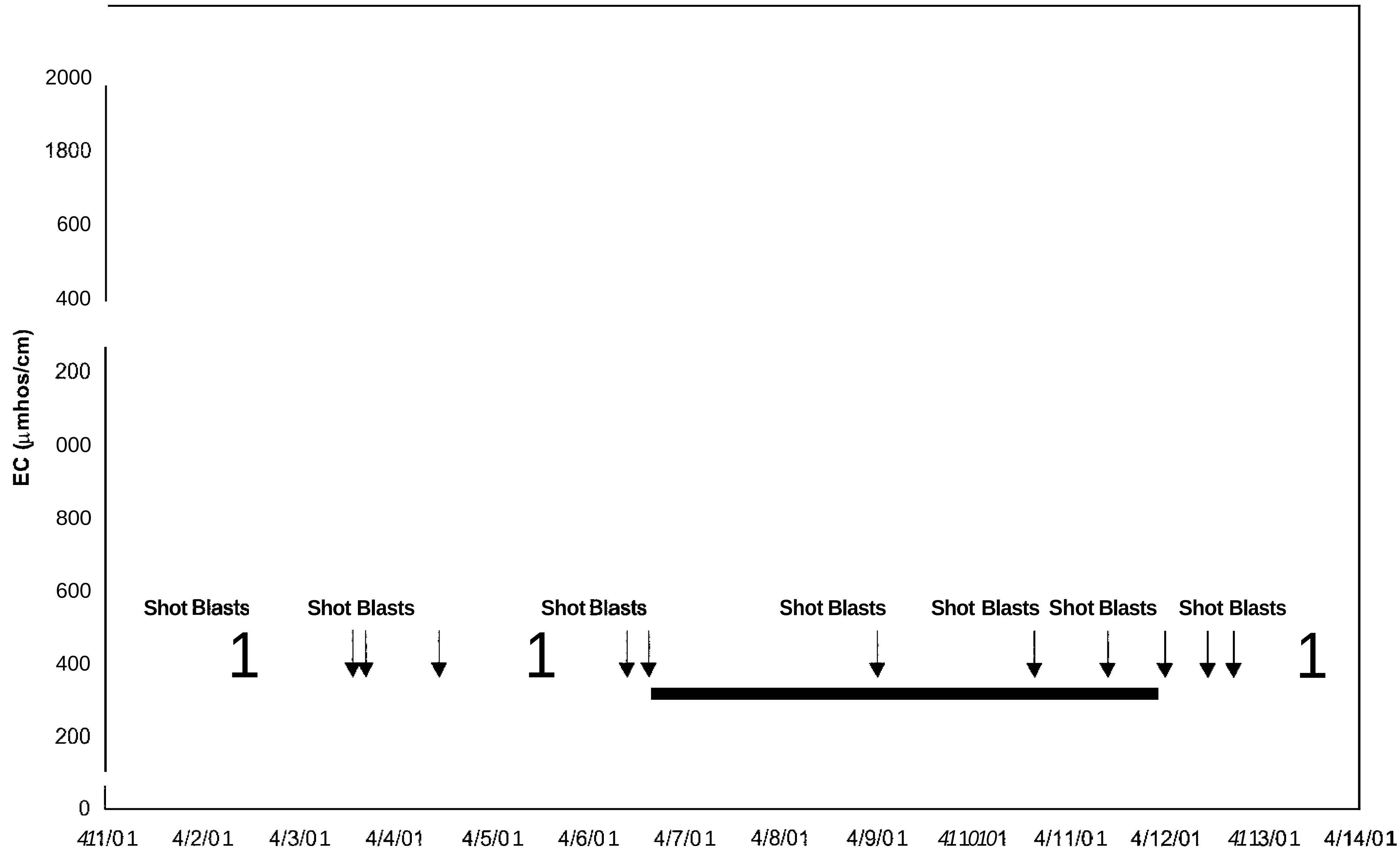


Well Yield
Site WV-1 Well-I
Spring 2001

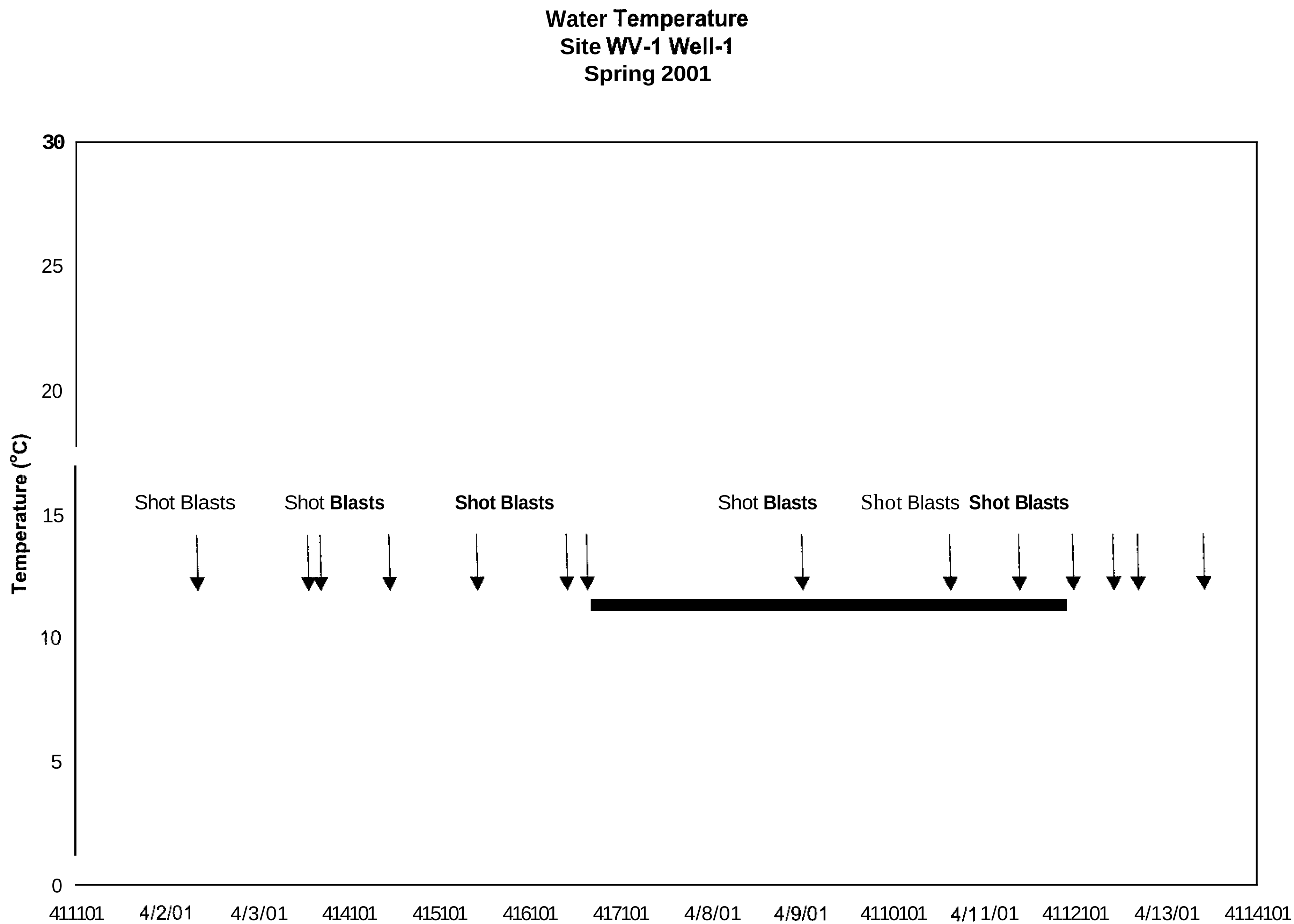




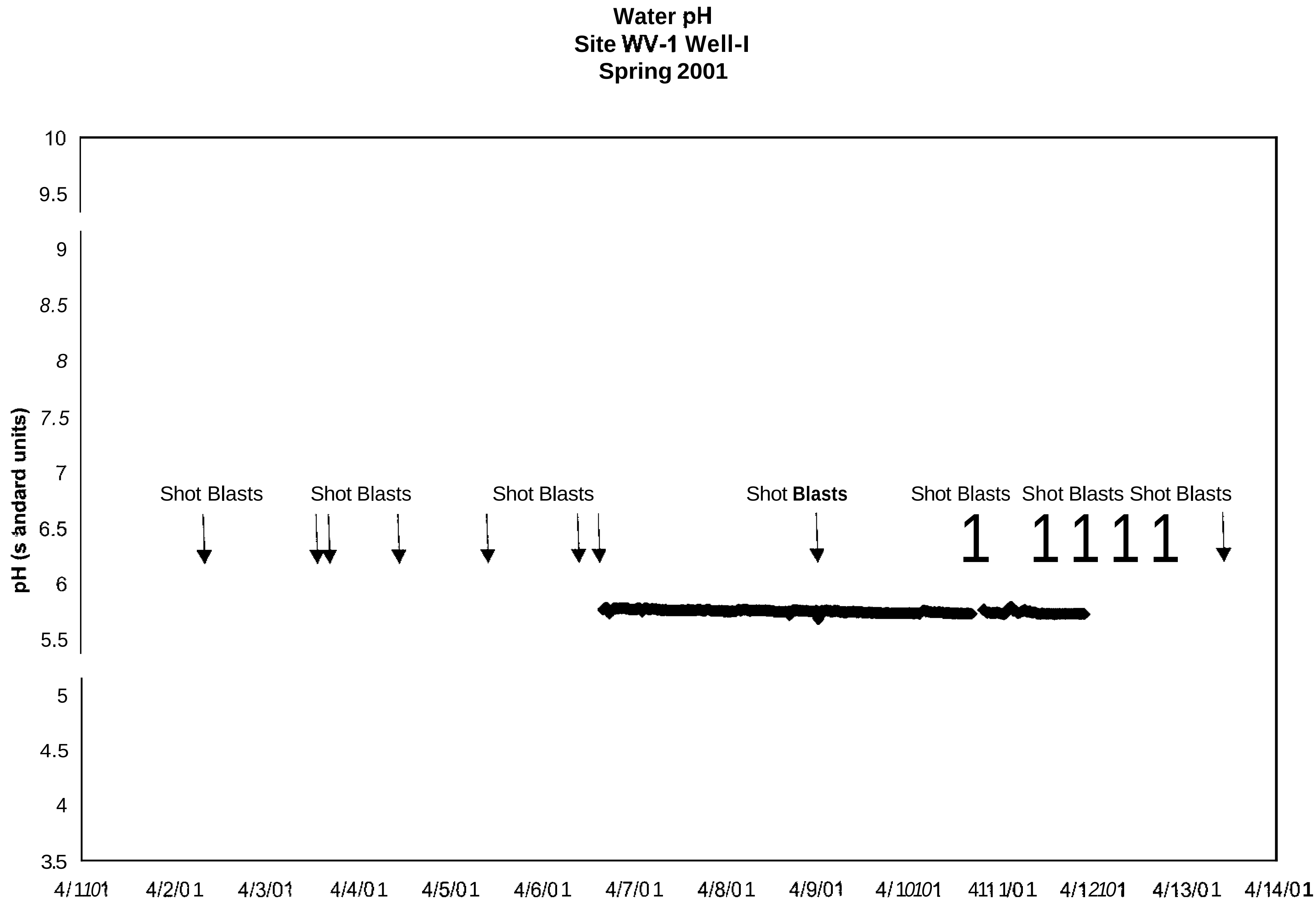
Water Level
Site WV-1 Well-I
Spring 2001
Water Level (feet above transducer)
30
25
20
15
10
5
0
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Btasts
Shot Blasts
4/1/01
4/2/01
4/3/01
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
4/9/01
4/10/01
4/11/01
4/12/01
4/13/01
4/14/01



2000
1800
600
400
200
000
800
600
400
200
0
EC (µmhos/cm)
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
1
1
1
4/2/01
4/3/01
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
4/9/01
4/11/01
4/12/01
4/14/01

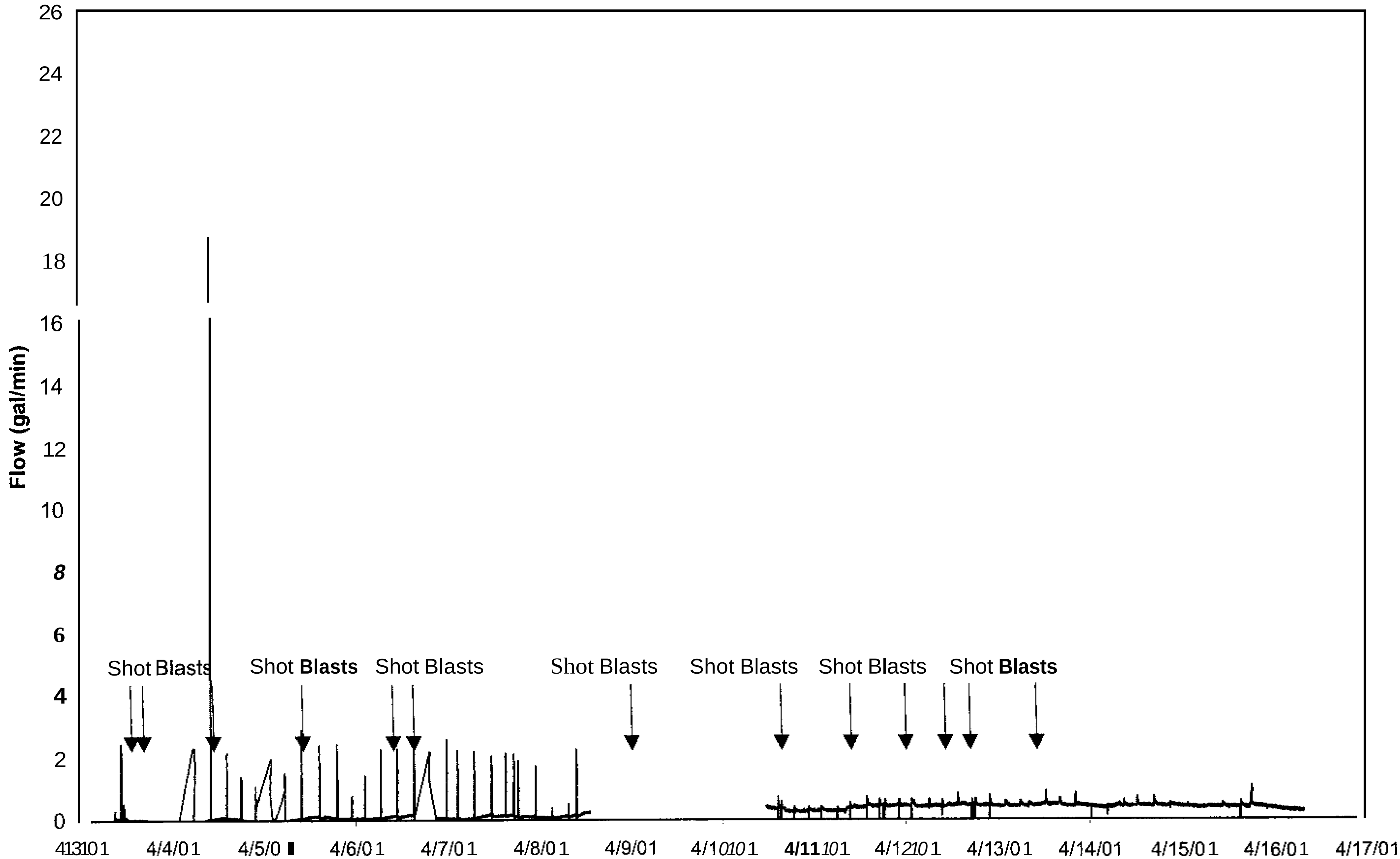


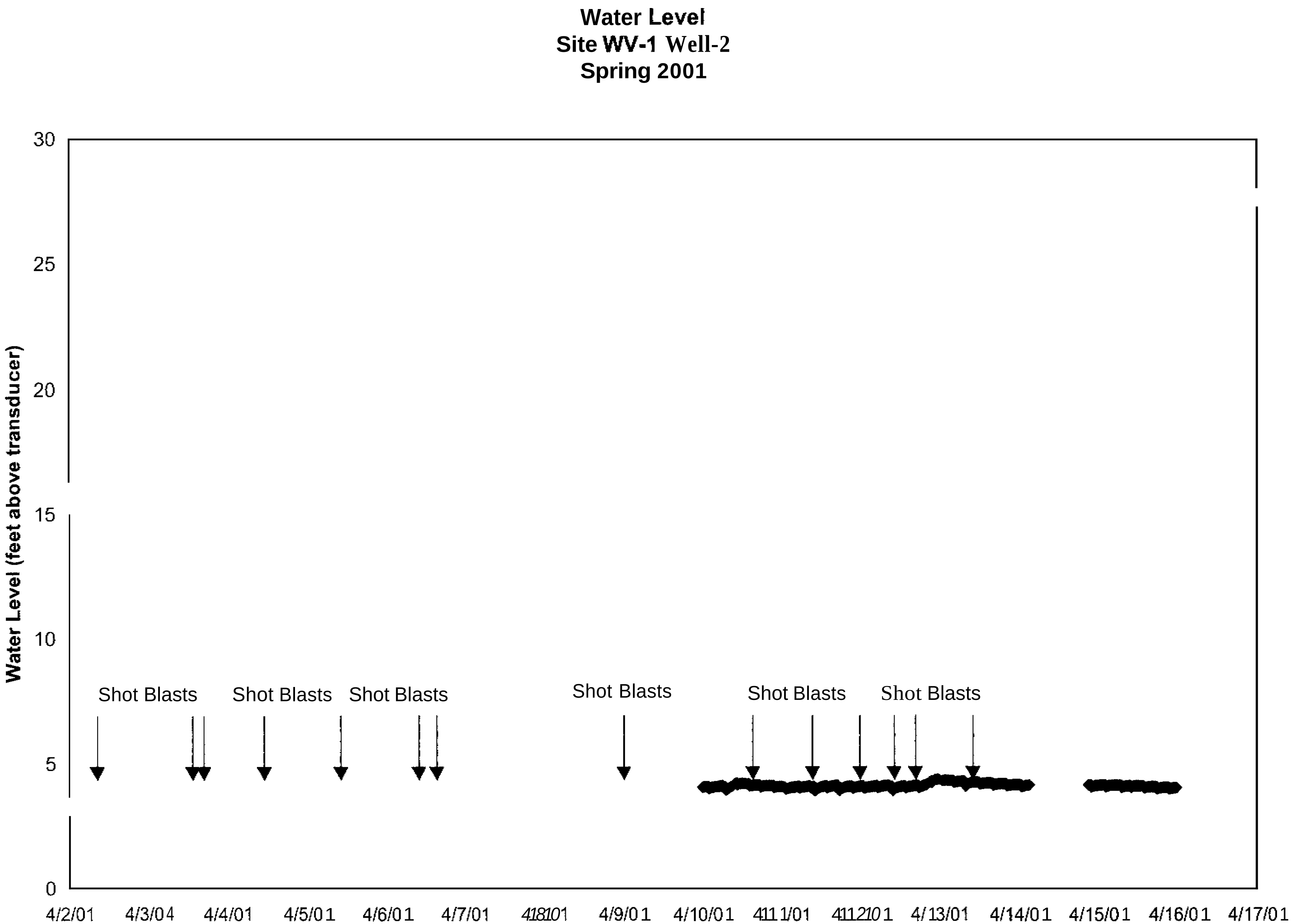
Water Temperature
Site WV-1 Well-1
Spring 2001
Temperature (°C)
0
5
10
15
20
25
30
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
411101
4/2/01
4/3/01
414101
415101
416101
417101
4/8/01
4/9/01
4110101
4/1 1/01
4112101
4/13/01
4114101



Water pH
Site WV-1 Well-I
Spring 2001
pH (standard units)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
4/1/01
4/2/01
4/3/01
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
4/9/01
4/10/01
4/11/01
4/12/01
4/13/01
4/14/01

Well Yield
Site WV-1 Well-2
Spring 2001




Water Level
Site WV-1 Well-2
Spring 2001
Water Level (feet above transducer)
30
25
20
15
10
5
0
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
4/2/01
4/3/04
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
4/9/01
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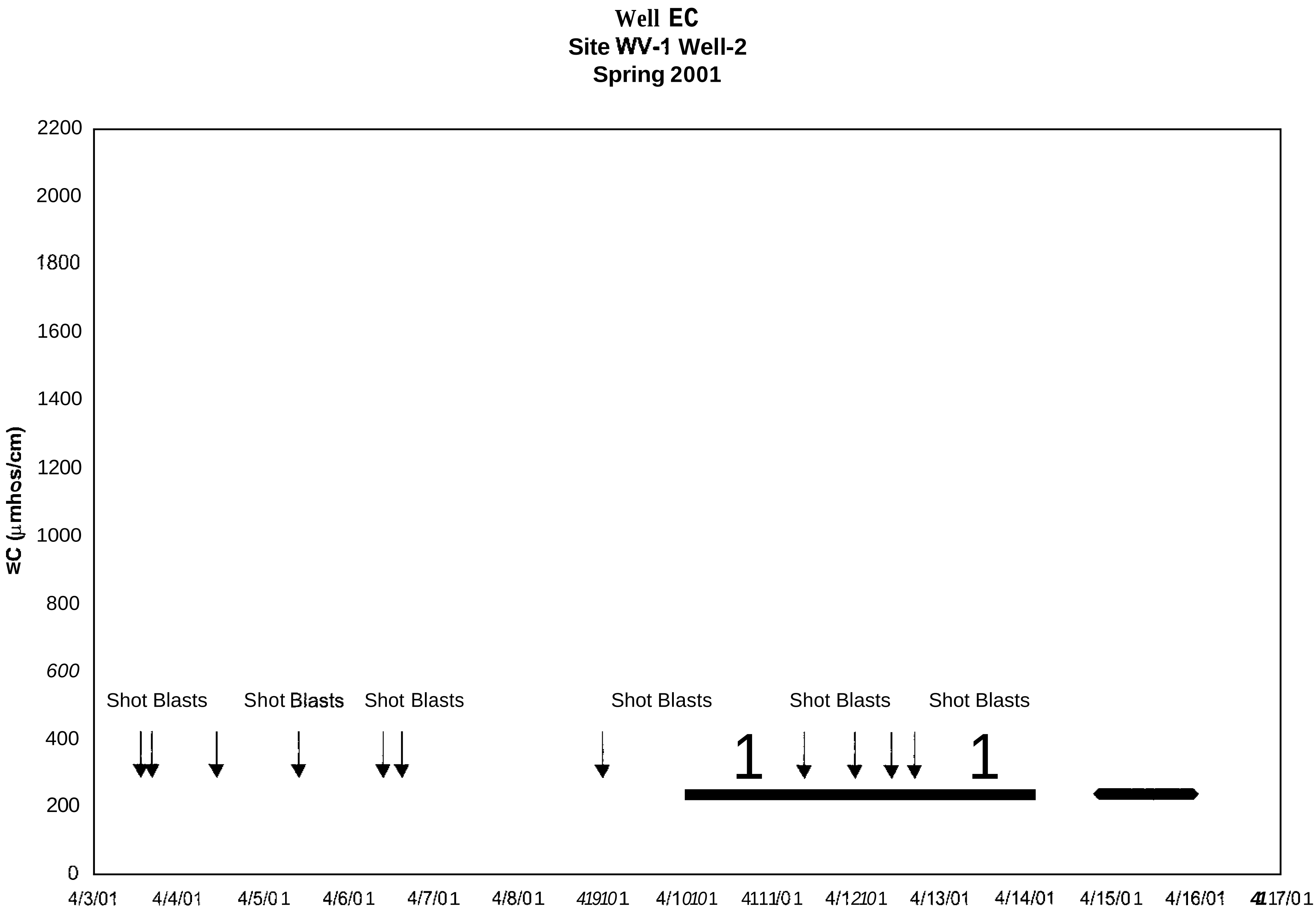
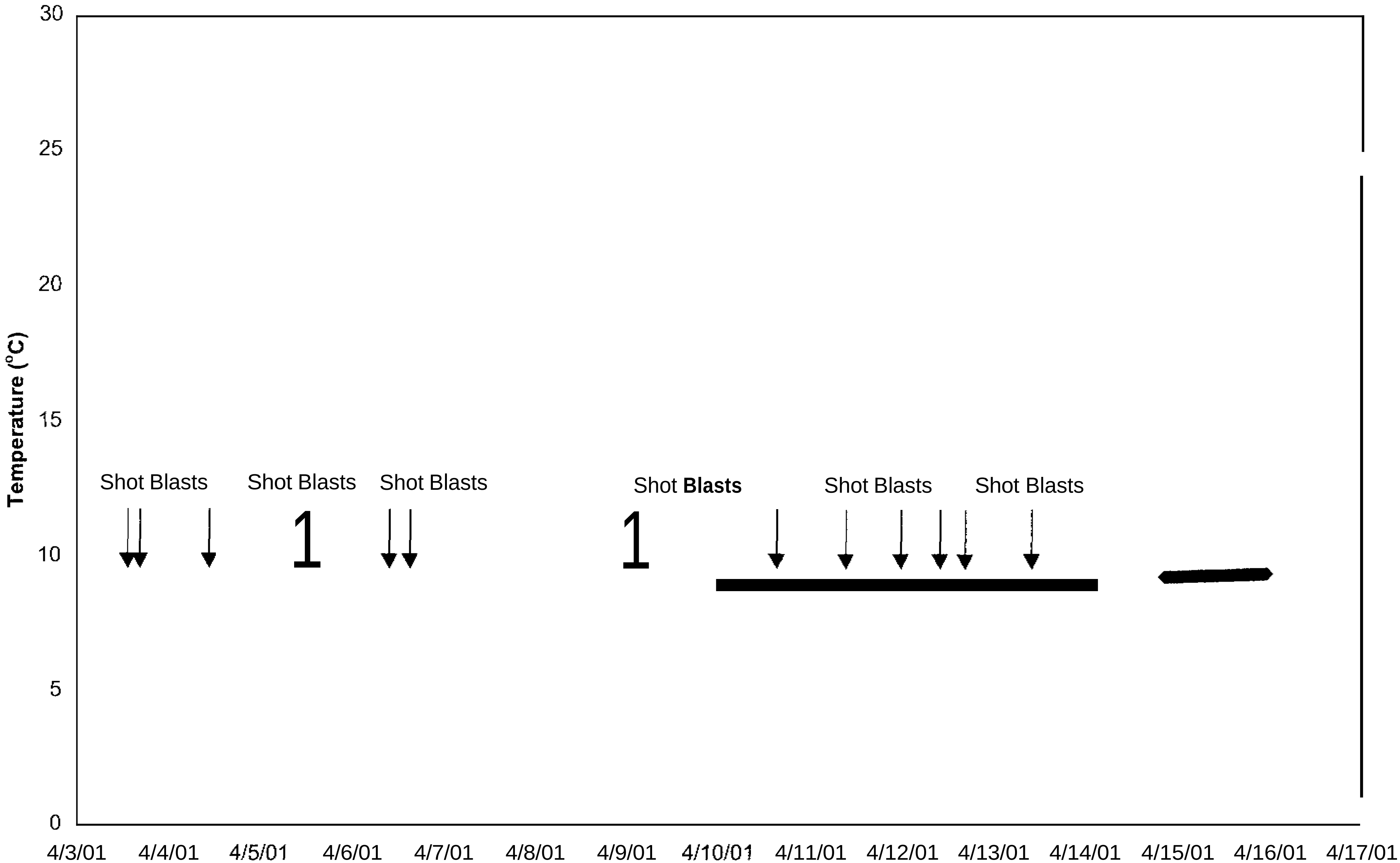
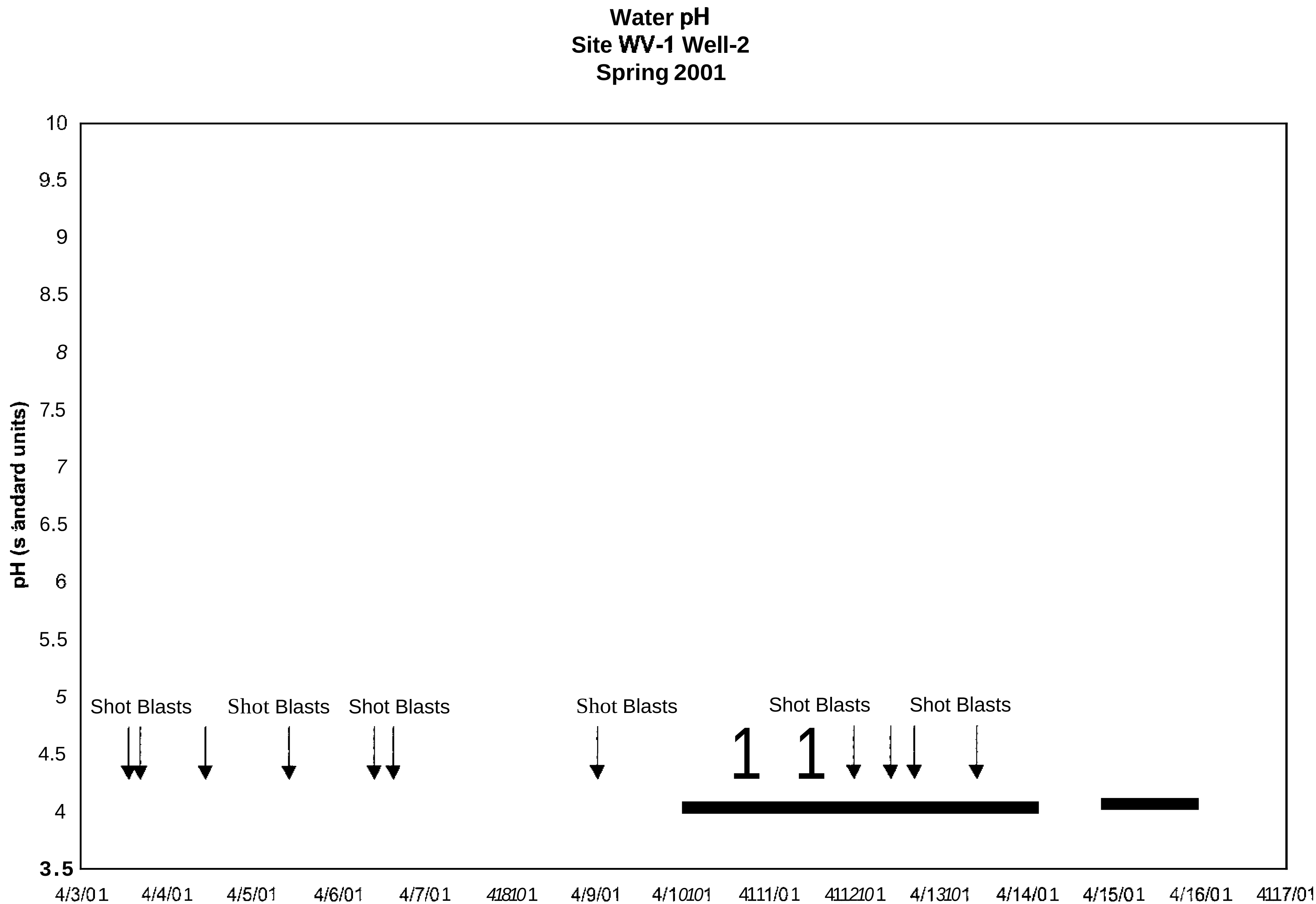
4/16/01
4/17/01


Well EC
Site WV-1 Well-2
Spring 2001
EC (µmhos/cm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
4/3/01
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
4/9/01
4/10/01
4/11/01
4/12/01
4/13/01
4/14/01
4/15/01
4/16/01
4/17/01

Water Temperature
Site WV-1 Well-2
Spring 2001




Water pH
Site WV-1 Well-2
Spring 2001
pH (standard units)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
Shot Blasts
4/3/01
4/4/01
4/5/01
4/6/01
4/7/01
4/8/01
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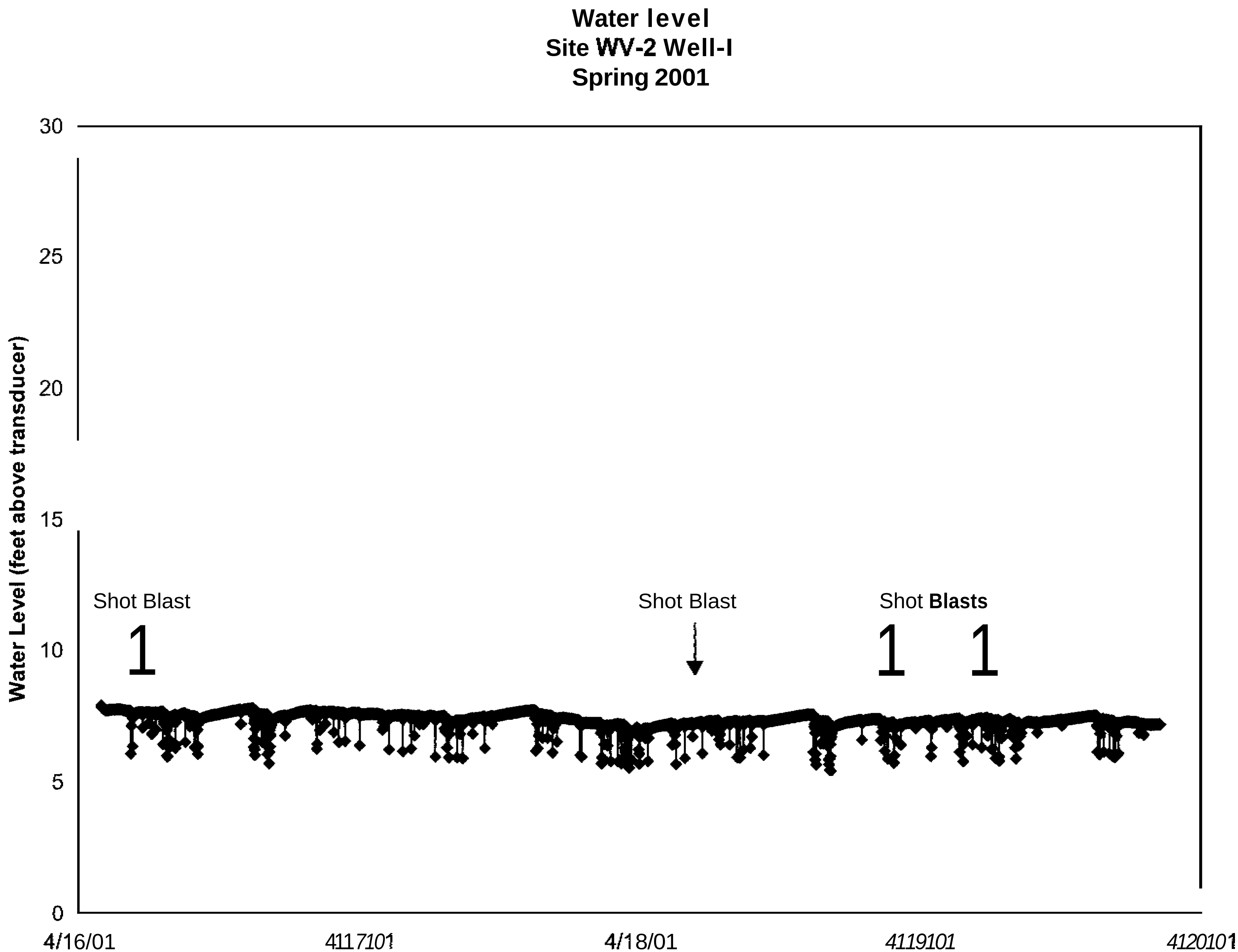
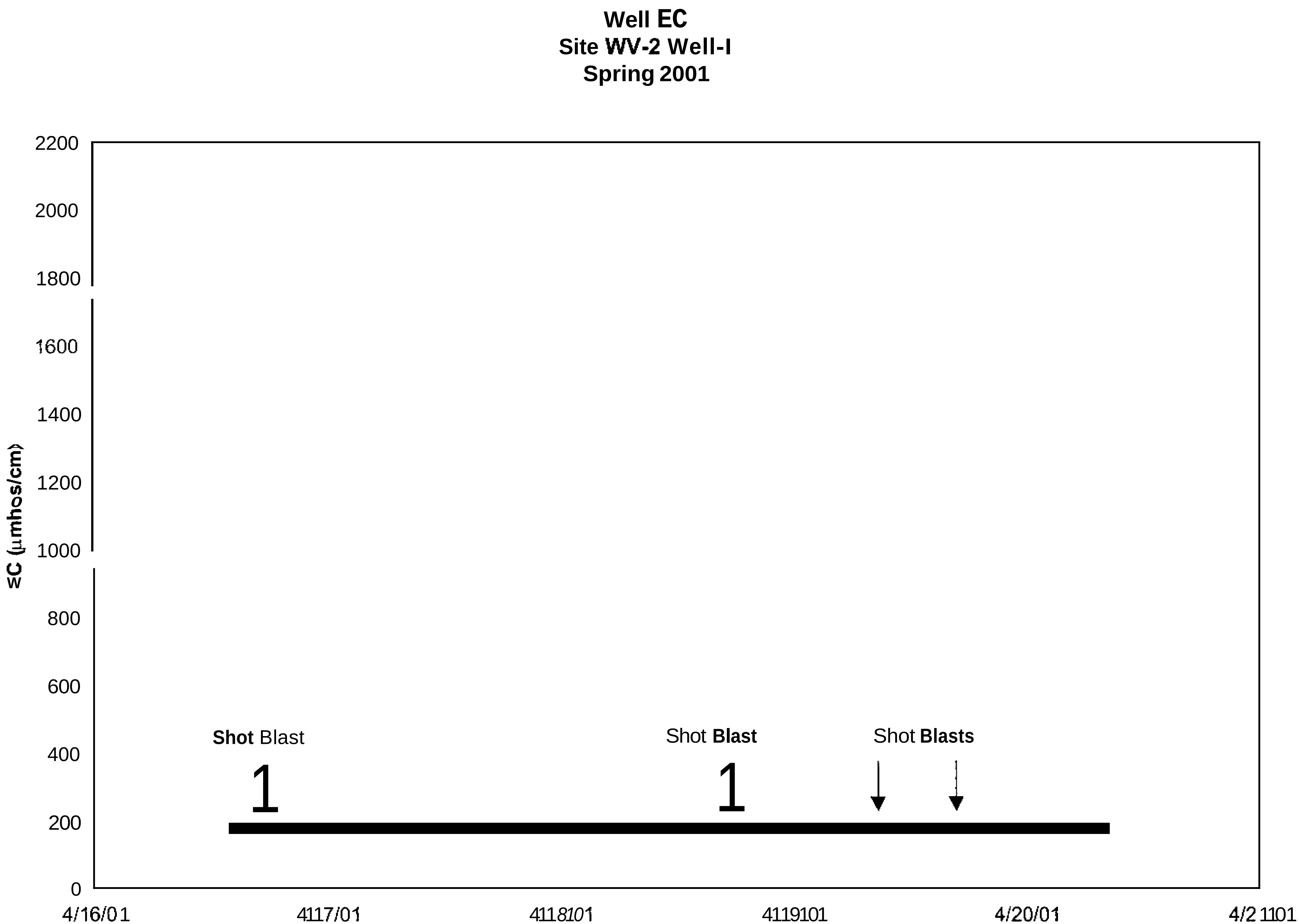
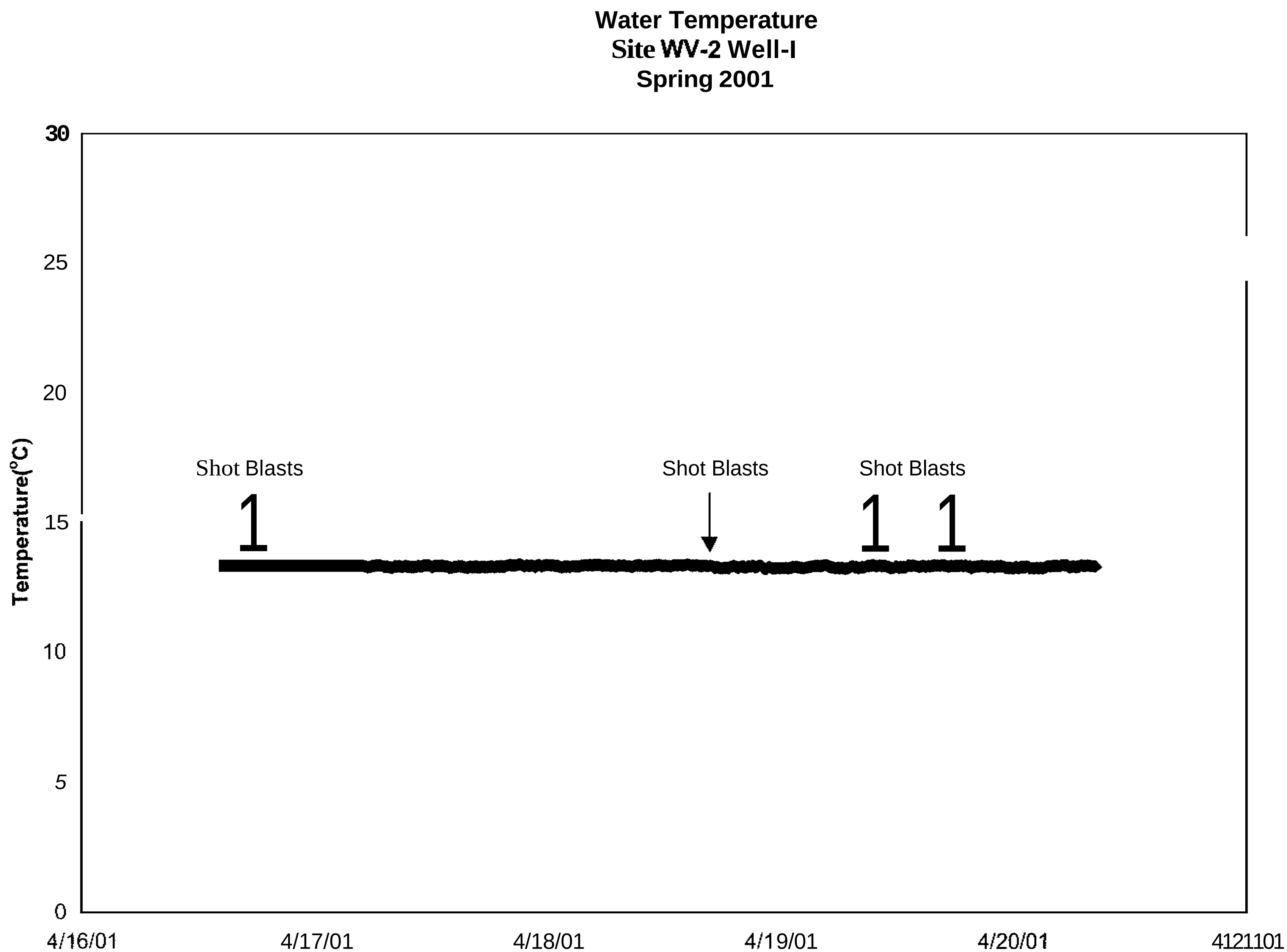
4/16/01
4/17/01



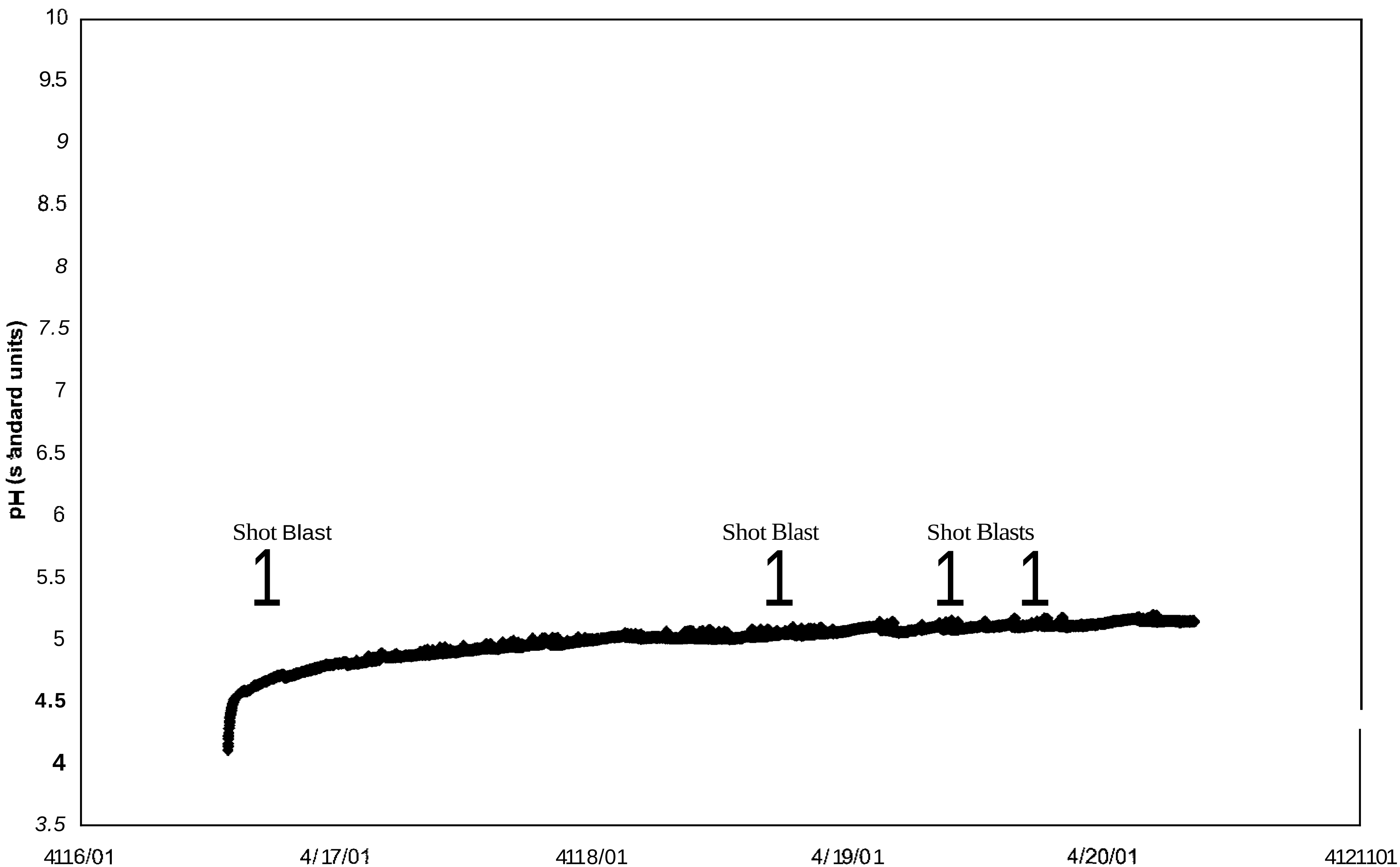
Water level
Site WV-2 Well-I
Spring 2001
Water Level (feet above transducer)
30
25
20
15
10
5
0
Shot Blast
Shot Blast
Shot Blasts
4/16/01
4117101
4/18/01
4119101
4120101



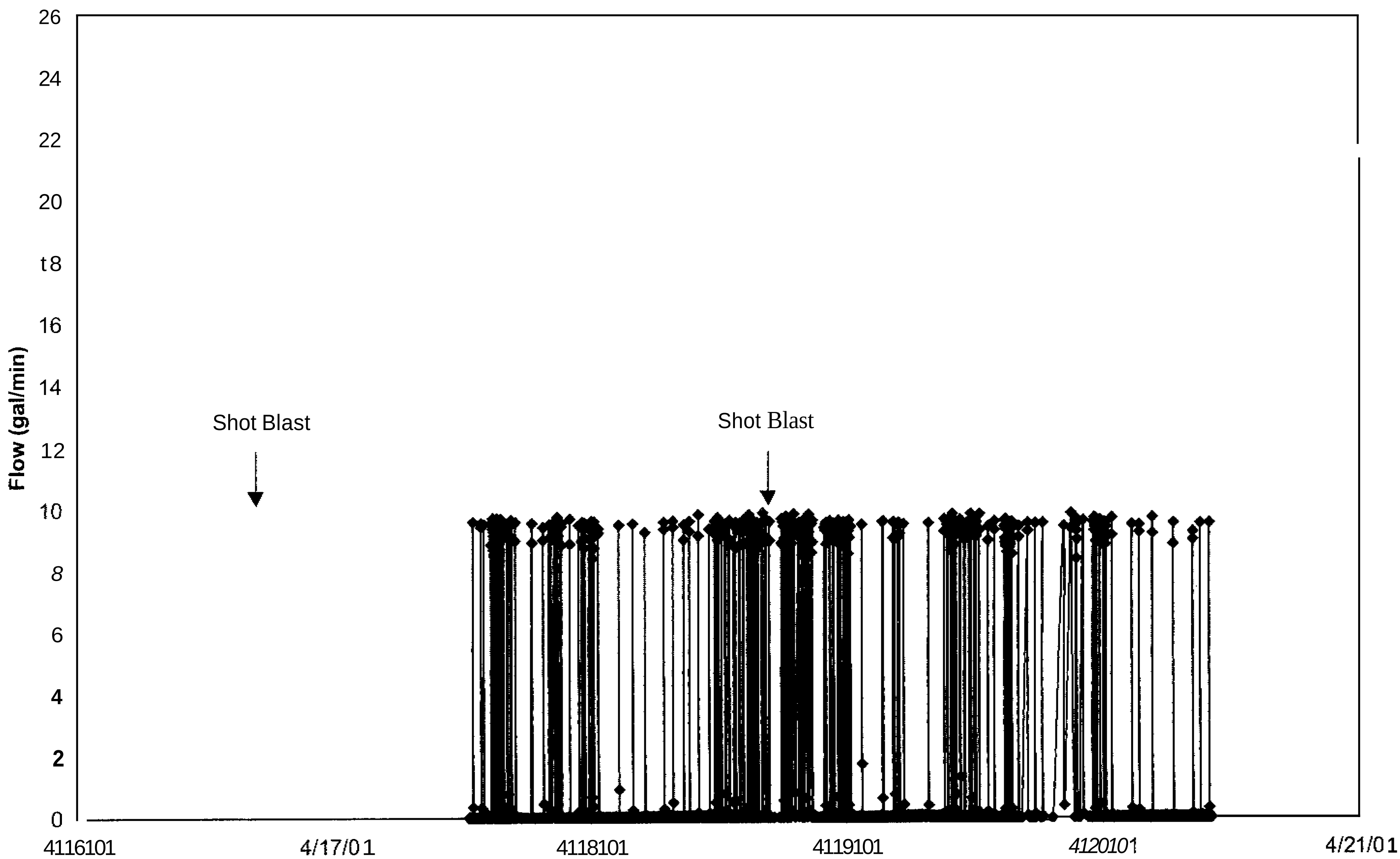
Well EC
Site WV-2 Well-I
Spring 2001
EC (µmhos/cm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Shot Blast
Shot Blast
Shot Blasts
4/16/01
4/17/01
4/18/01
4/19/01
4/20/01
4/21/01


Water Temperature
Site WV-2 Well-I
Spring 2001
Temperature(°C)
30
25
20
15
10
5
0
Shot Blasts
Shot Blasts
Shot Blasts
4/16/01
4/17/01
4/18/01
4/19/01
4/20/01
4121101

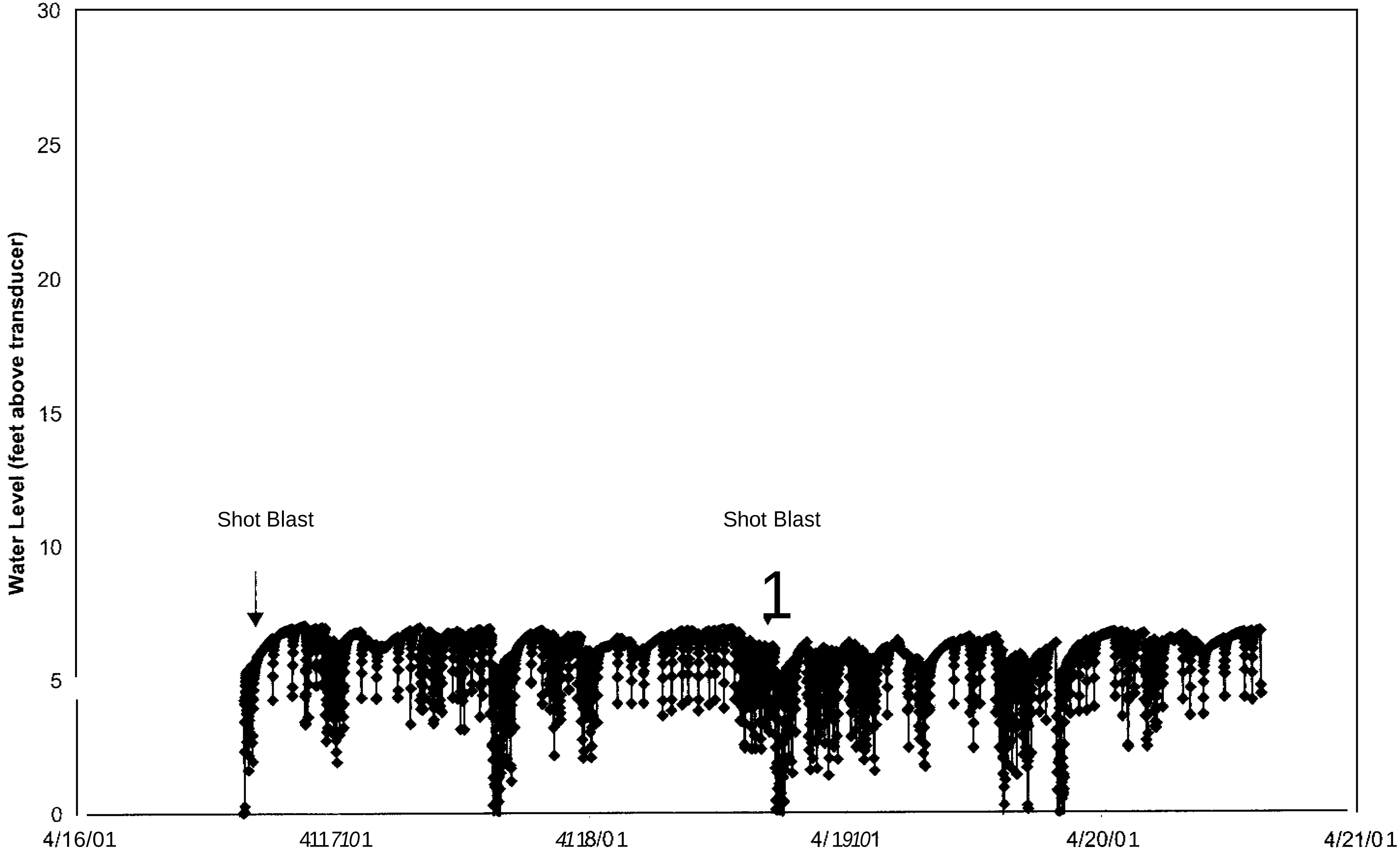
Water pH
Site WV-2 Well-1
Spring 2001

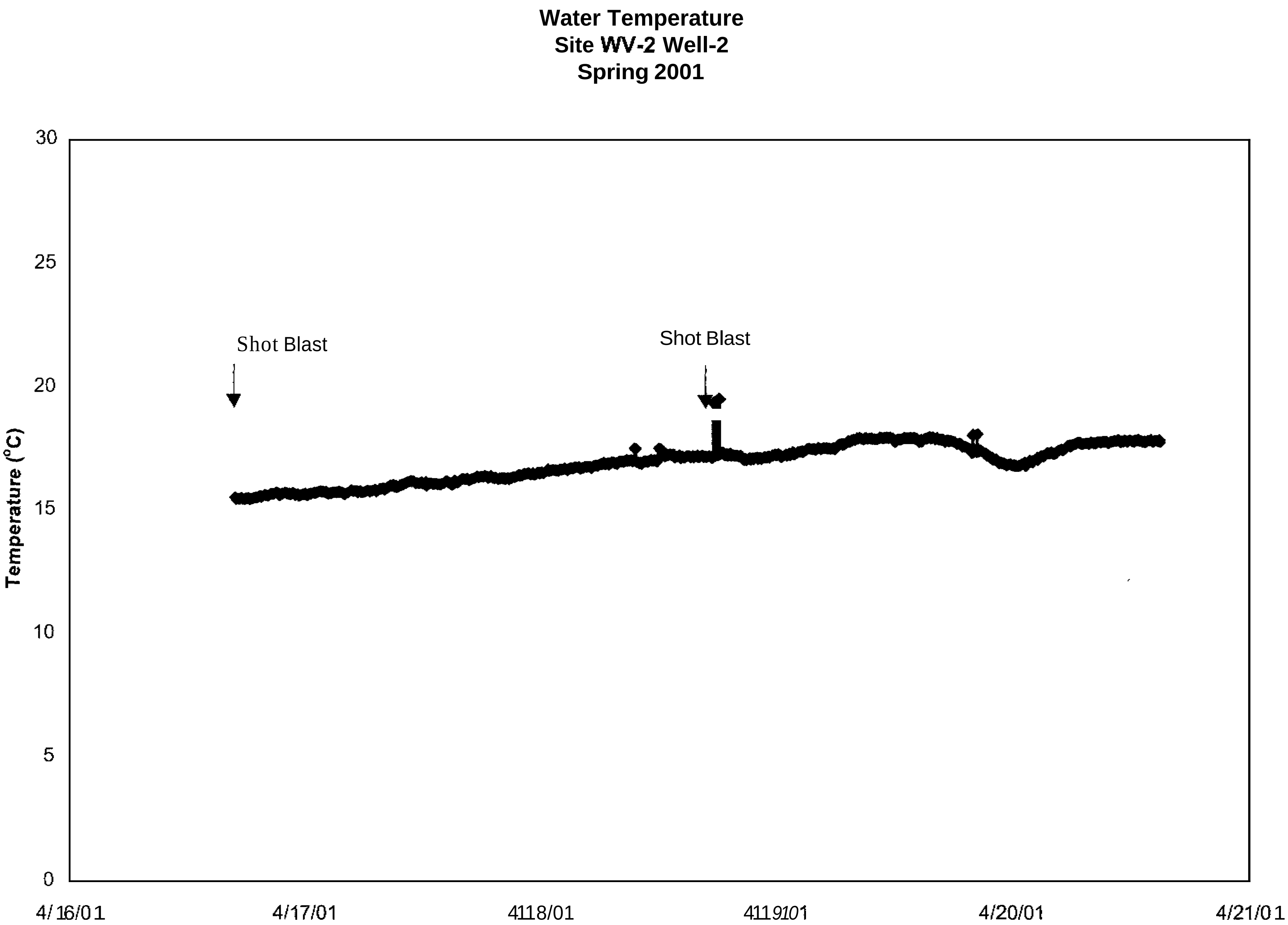


Well Yield
Site WV-2 Well-2
Spring 2001

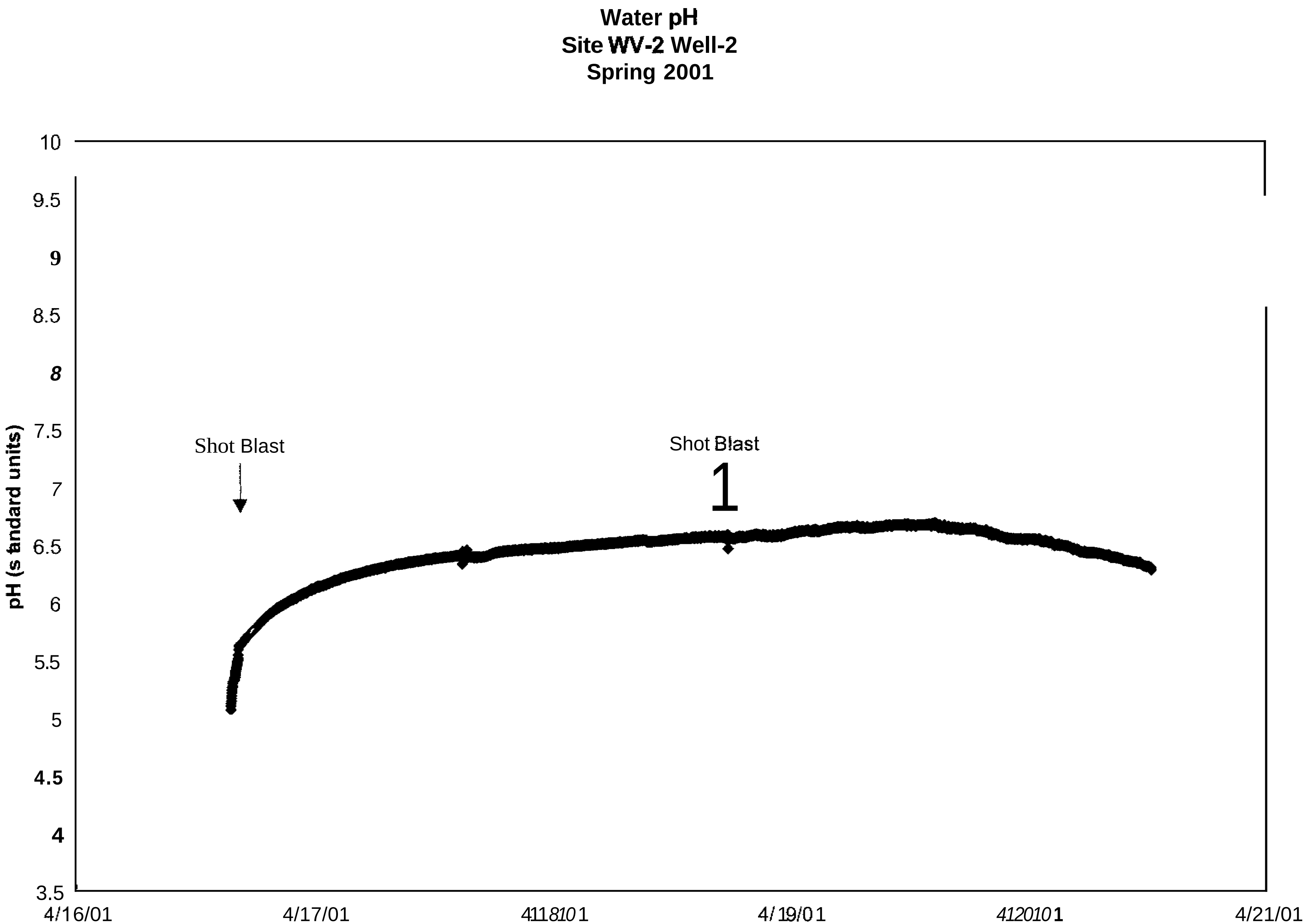


Water Level
Site WV-2 Well-2
Spring 2001





Water Temperature
Site WV-2 Well-2
Spring 2001
Shot Blast
Shot Blast
Temperature (°C)
30
25
20
15
10
5
0
4/ 16/0 1
4/17/01
4118/01
411910 1
4/20/01
4/21/0 1

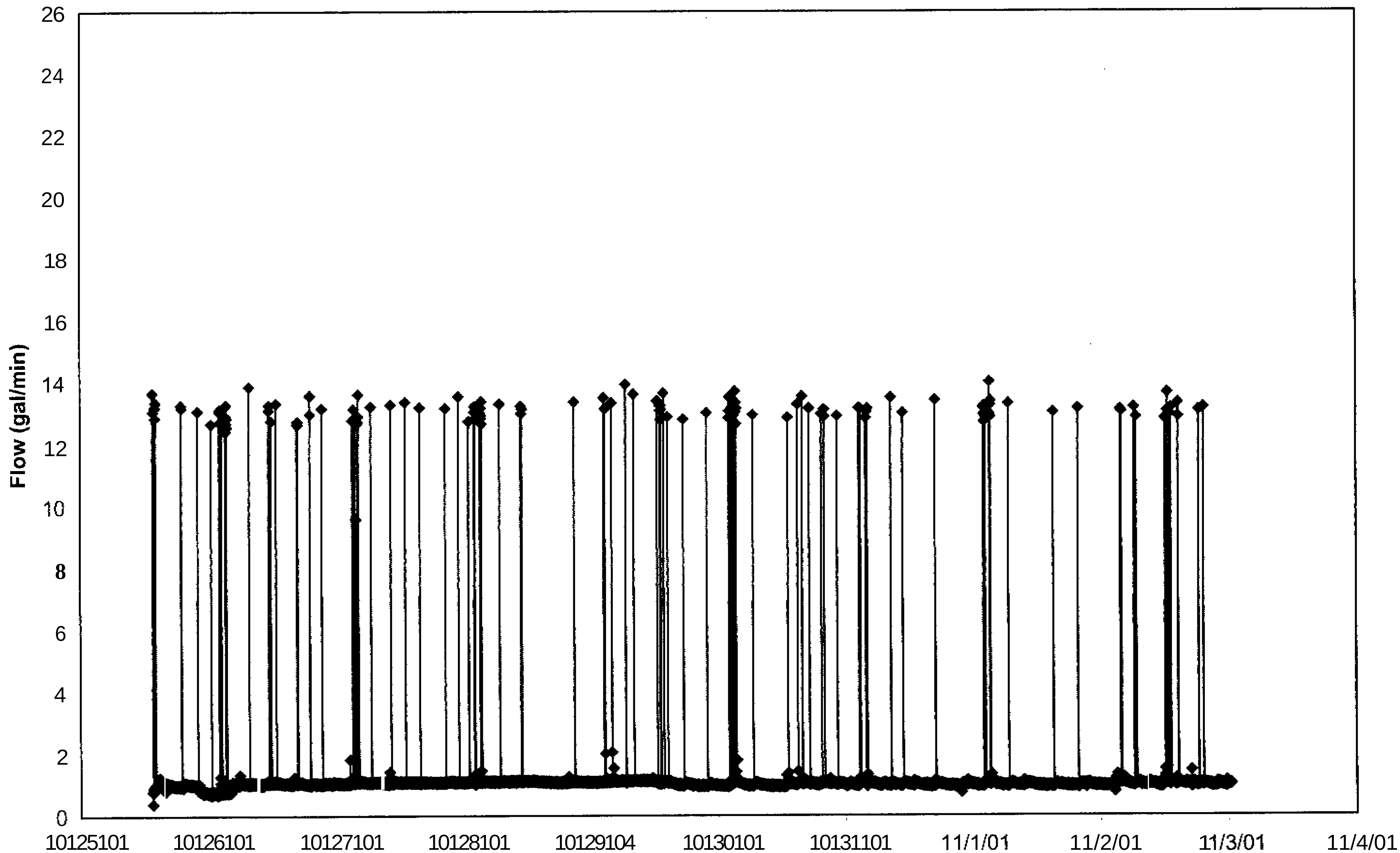


Water pH
Site WV-2 Well-2
Spring 2001
pH (standard units)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
Shot Blast
Shot Blast
4/16/01
4/17/01
4/18/01
4/19/01
4/20/01
4/21/01

Appendix C3

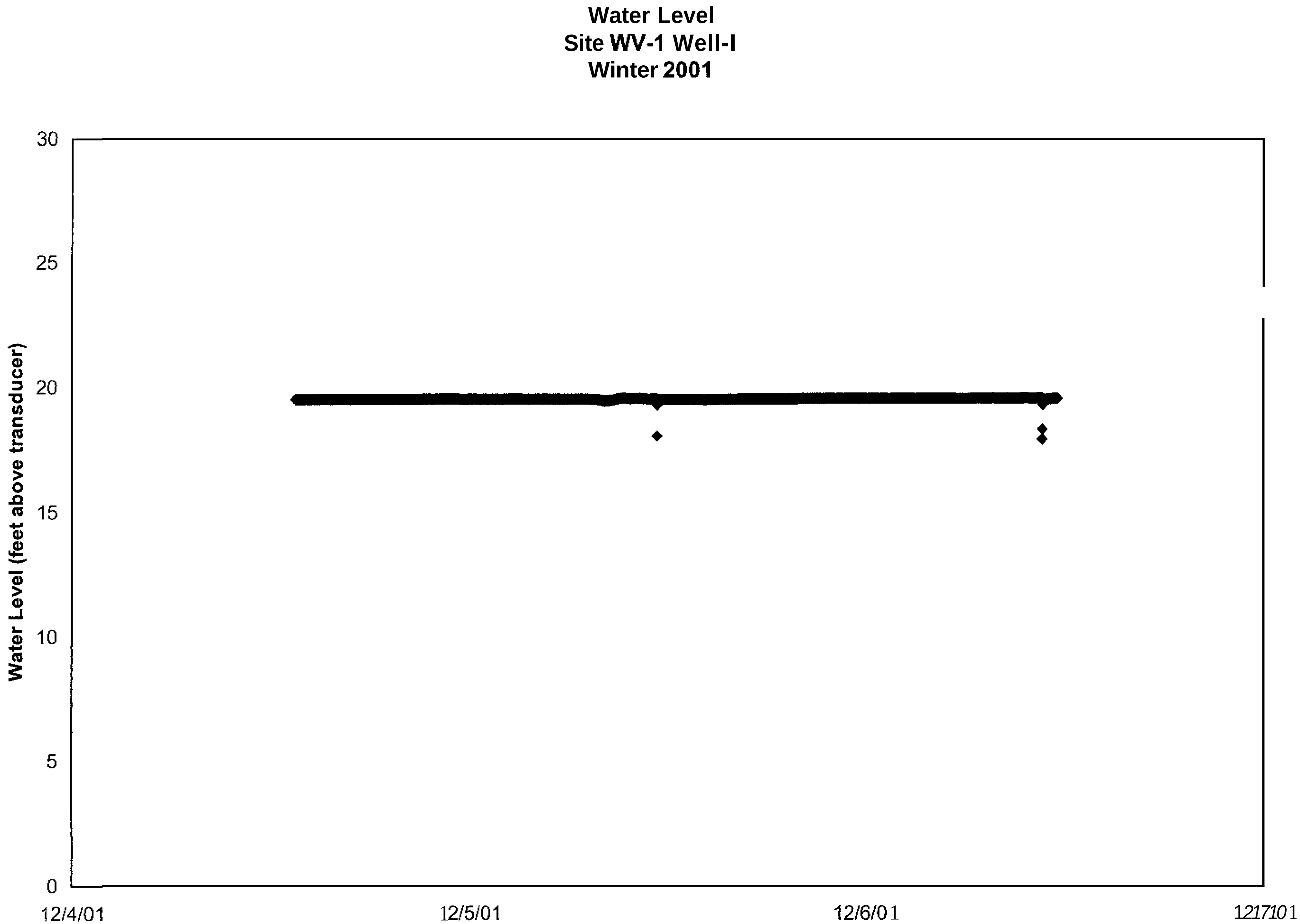
Fall 2001

Well Yield
Site WV-2 Well-1
Fall 2001

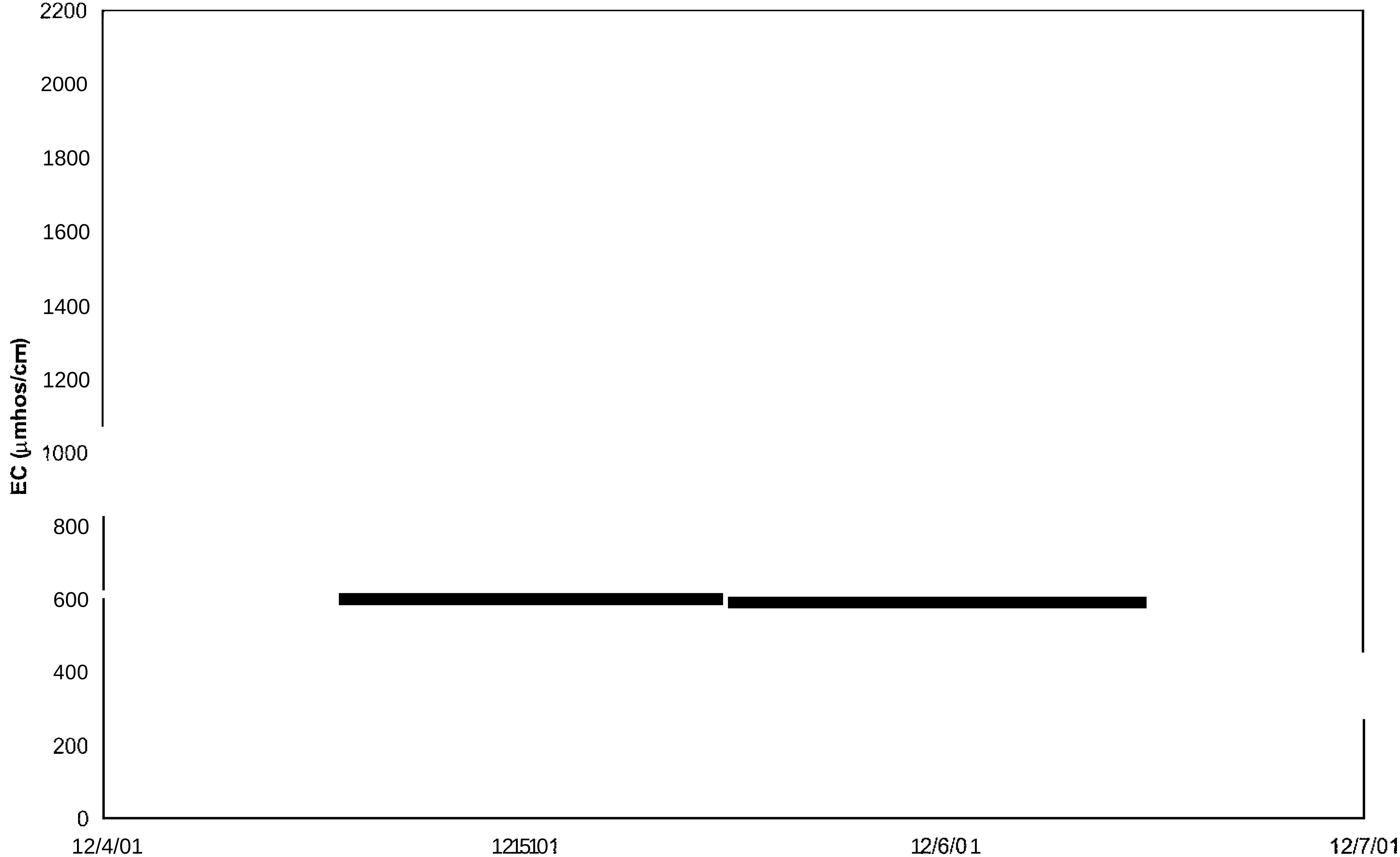


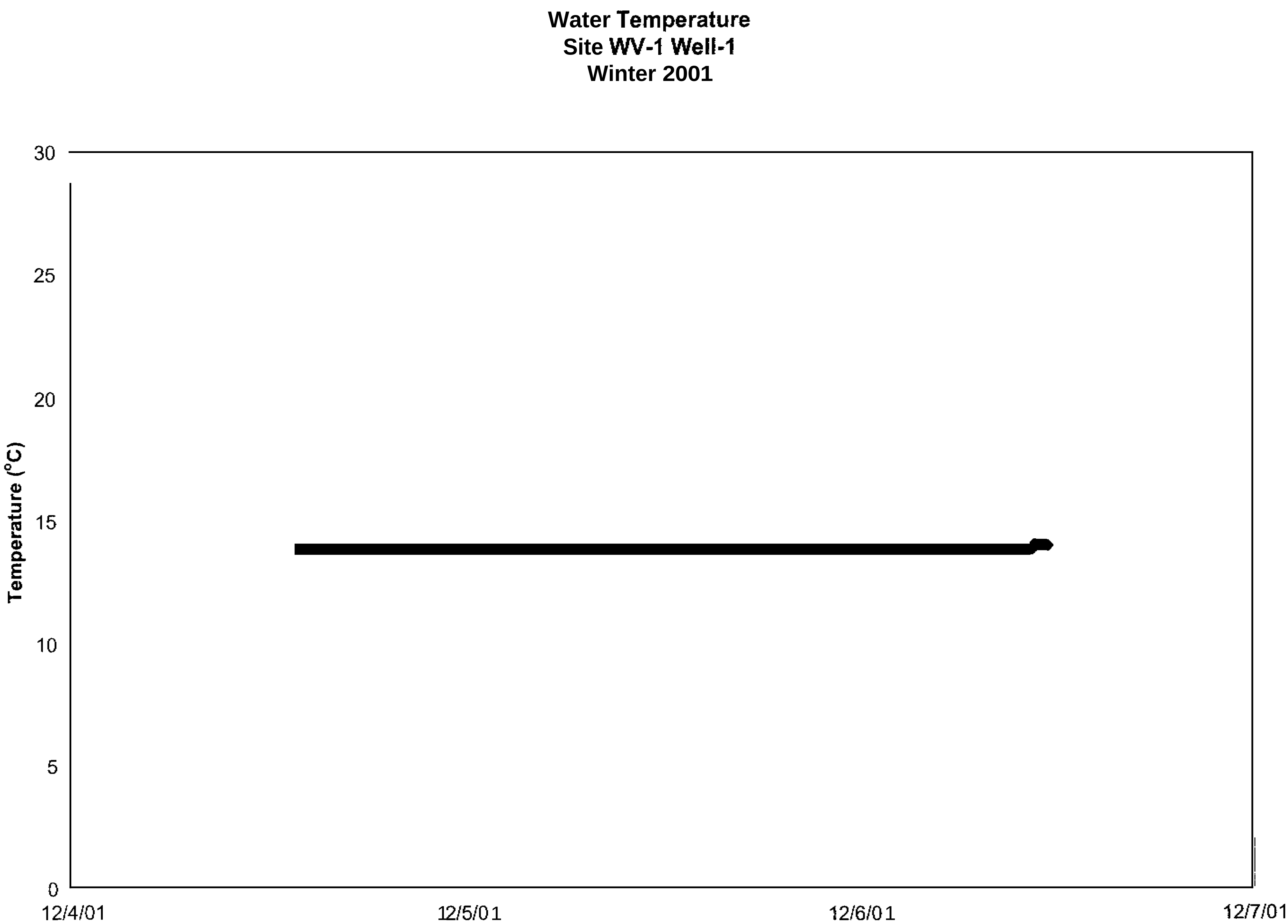
Appendix C4

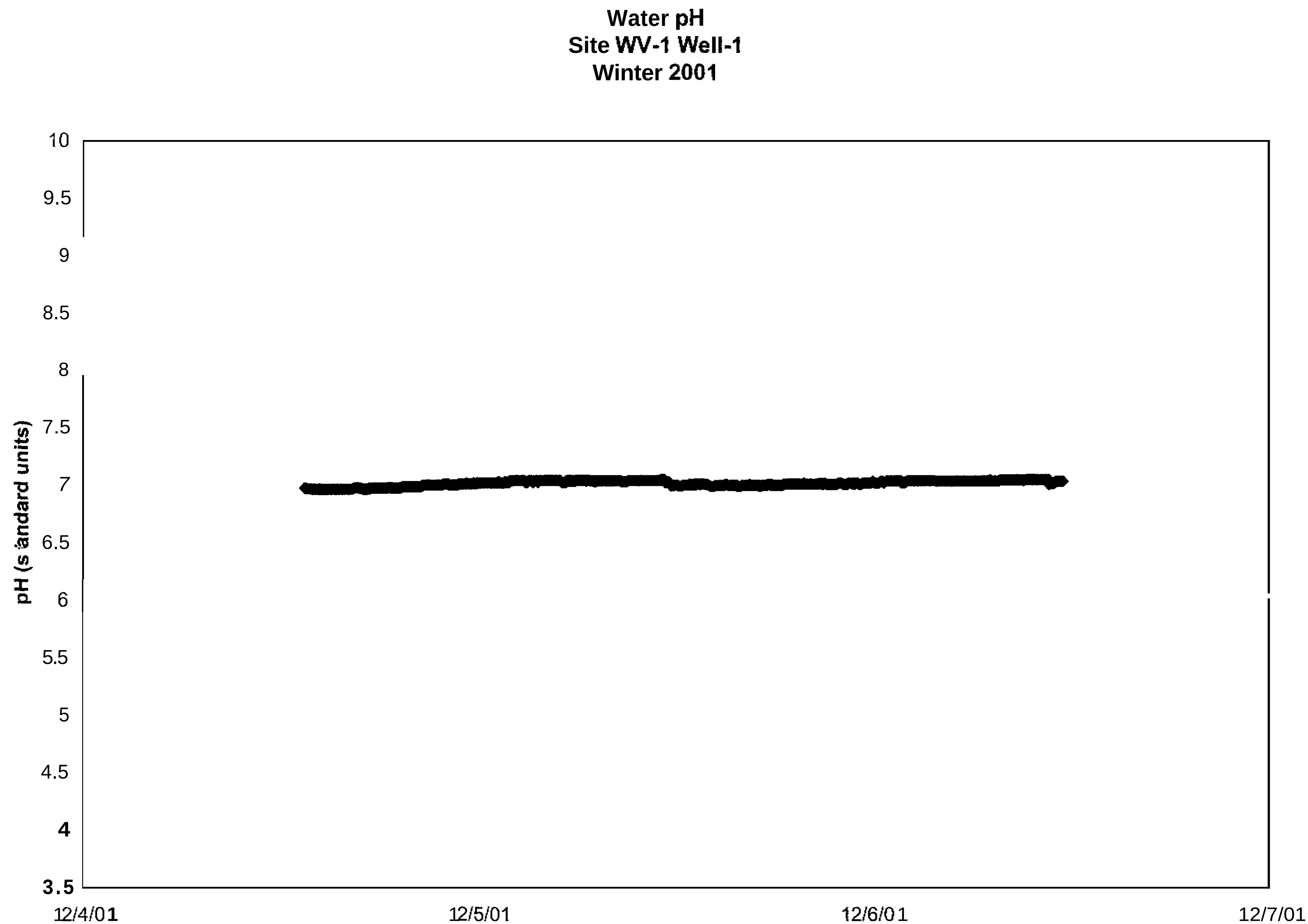
Winter 2001


Water Level
Site WV-1 Well-I
Winter 2001
Water Level (feet above transducer)
30
25
20
15
10
5
0
12/4/01
12/5/01
12/6/01
12/7/01

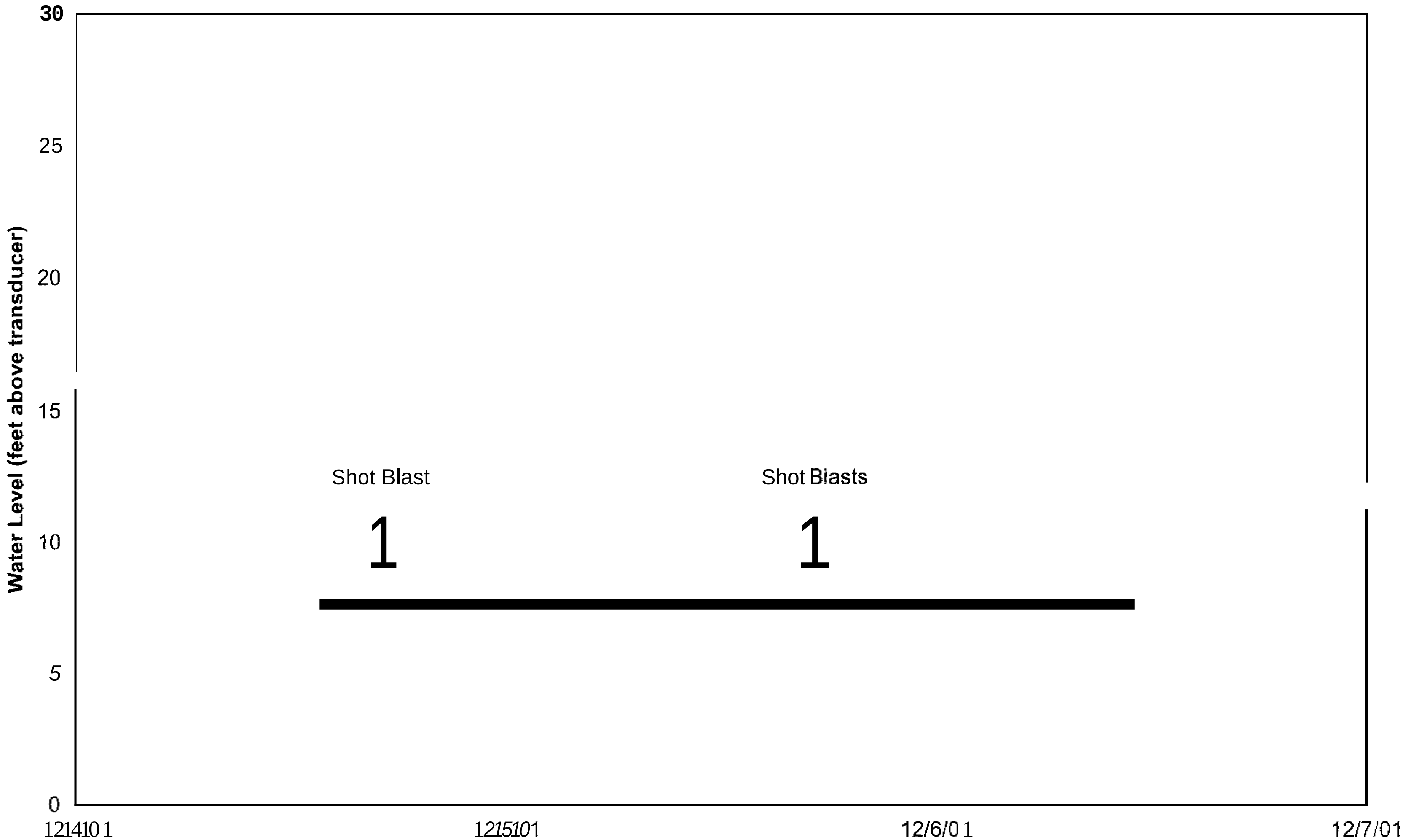
Well EC
Site WV-1 Well-1
Winter 2001

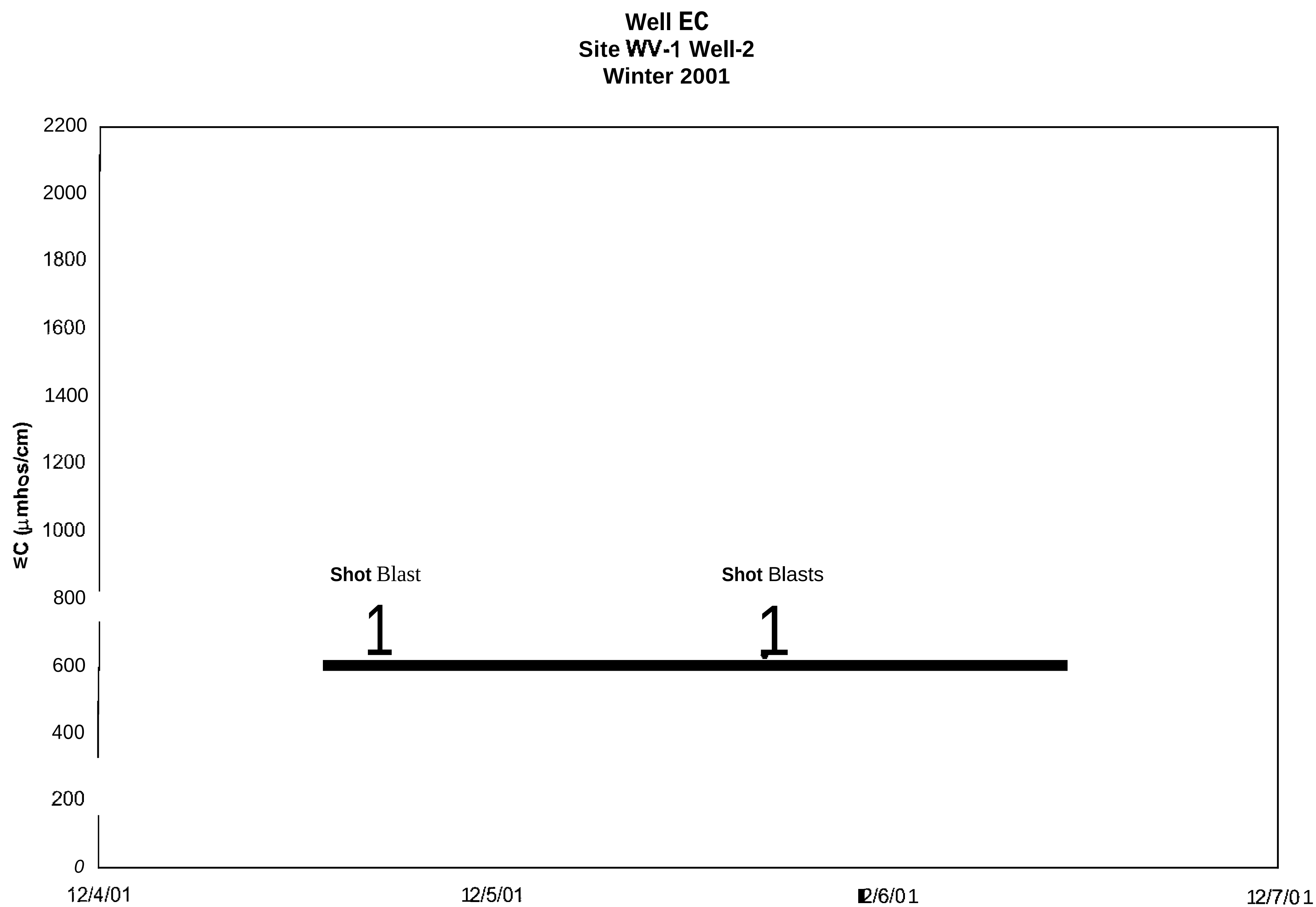



Water Temperature
Site WV-1 Well-1
Winter 2001
Temperature (°C)
30
25
20
15
10
5
0
12/4/01
12/5/01
12/6/01
12/7/01


Water pH
Site WV-1 Well-1
Winter 2001
pH (standard units)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
12/4/01
12/5/01
12/6/01
12/7/01

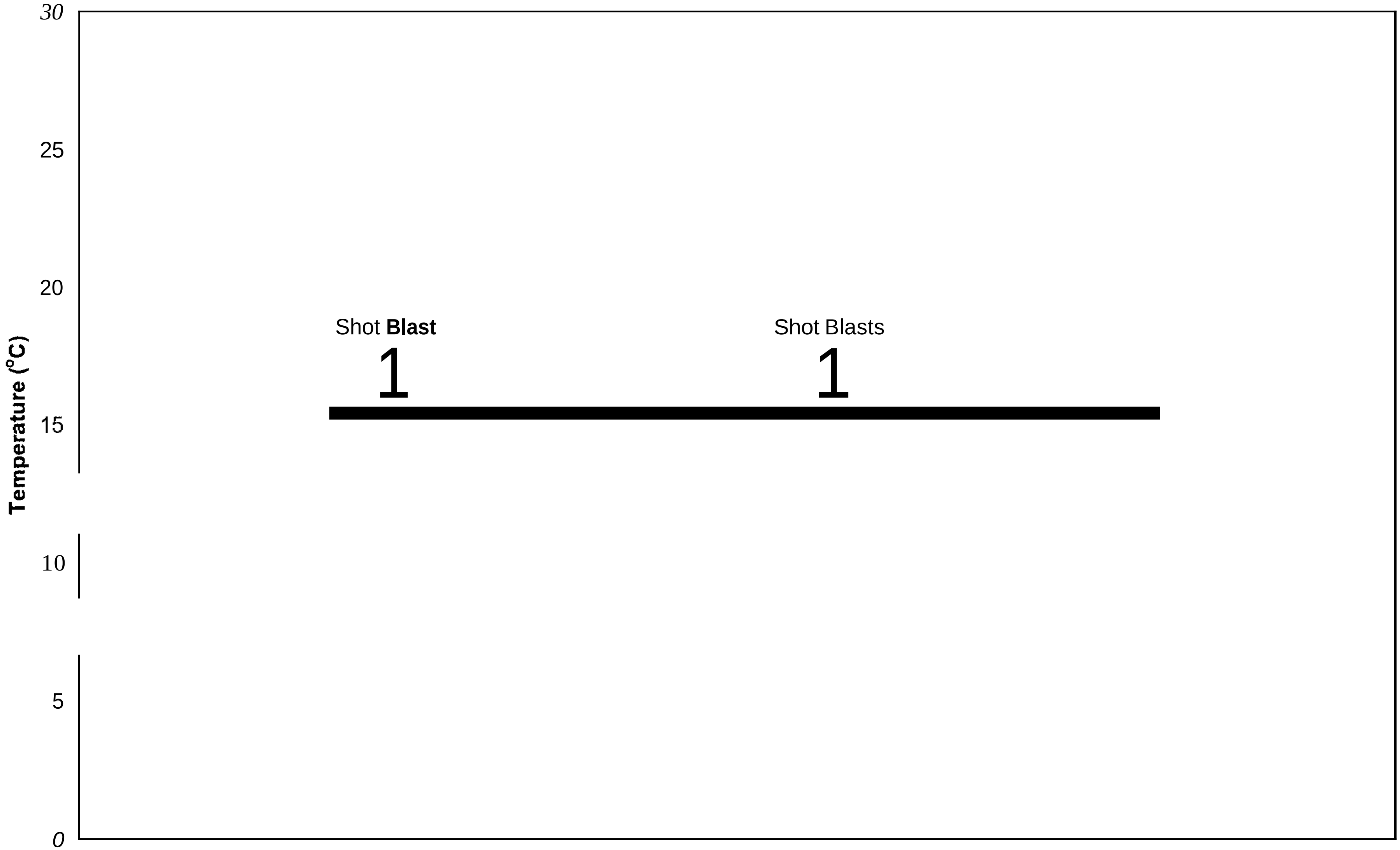
Water Level
Site WV-1 Well-2
Winter 2001



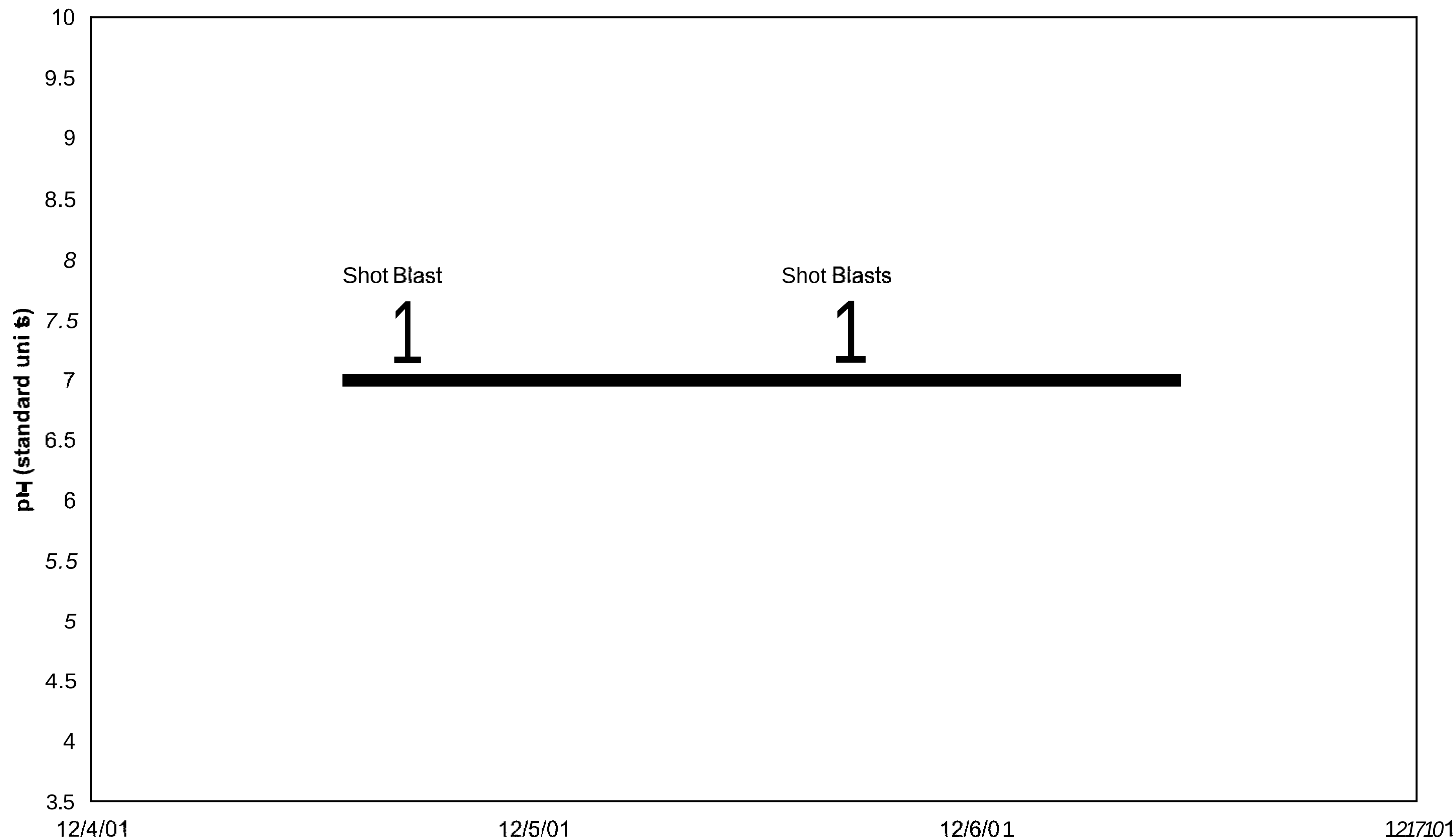


Well EC
Site WV-1 Well-2
Winter 2001
EC (µmhos/cm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Shot Blast
Shot Blasts
12/4/01
12/5/01
12/6/01
12/7/01

Water Temperature
Site WV-1 Well-2
Winter 2001



Water pH
Site WV-1 Well-2
Winter 2001



Workshop on Mountaintop Mining
Effects on Ground Water

Charleston, West Virginia
May 9, 2000

Background Information

About the Mountaintop Mining/Valley Fill Environmental Impact Statement

The U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (Corps), U.S. Office of Surface Mining (OSM), and U.S. Fish and Wildlife Service (FWS), in cooperation with the State of West Virginia, are preparing an Environmental Impact Statement (EIS) on a proposal to consider developing agency policies, guidance, and coordinated agency decision making processes to minimize, to the maximum extent practicable, the adverse environmental effects to waters of the United States and to fish and wildlife resources from mountaintop mining operations, and to environmental resources that could be affected by the size and location of fill material in valley fill sites. The draft EIS will be released for public comment during the summer of 2000. The final EIS is slated for completion by January 2001.

Early in 1998, the four Federal agencies now involved in the EIS formed a work group and agreed on a series of priority areas where more information and analysis would assist them in regulating the effects of valley fills associated with coal mining operations. Study plans were adopted and funded for undertaking valley fill inventories in West Virginia, Kentucky, and Virginia; for assessing the stability of valley fills; and for assessing the potential for downstream flooding from these mining operations. The agencies also placed priority on studying the impacts of valley fills on aquatic habitat; on surveying and evaluating mitigation practices being employed in West Virginia and neighboring Appalachian Coalfield States; and on evaluating how to better coordinate the Federal regulatory programs. These studies were underway or in the planning stages when the Bragg v. Roberston settlement agreement was reached in December 1998.

With the decision to prepare an EIS, the agencies brought the coordination of these technical studies under the scope of the EIS, and broadened state participation. The expanded network of agencies has now examined the studies initiated in 1998 and has modified those study plans to make them more useful for the EIS. Additional work plans responding specifically to the EIS mandate have also been drafted.

Team leaders have been selected among the participating agencies for each of the technical study areas, which are listed below. The team leaders worked with a team representative of the expertise of each agency to develop a work plan. The work plans reflect what the agencies believe should be studied, and are subject to revision as work progresses and new insights are gained.

EIS Technical Study Areas:
?? Future Mining
?? Fill Stability
?? Mining and Reclamation Technology
?? Flooding Potential
?? Fill Hydrology
?? Streams
?? Fisheries
?? Wetlands
?? Aquatic Ecosystem Enhancement
?? Terrestrial Ecology
?? Soil Quality and Forest Productivity
?? Socioeconomic
?? Mine Dust and Blasting Fumes
?? Landscape Ecology/Cumulative Effects

Background on Workshop on Mountaintop Mining Effects on Ground Water

Initially, the priority EIS Technical Study Areas all focused on impacts of mountaintop mining and valley fills on surface water and watershed resources and the EIS Steering Committee placed the issue of mountaintop mining/valley fill effects on ground-water resources outside the scope of this EIS. However, the EIS Steering Committee subsequently concluded that the National Environmental Protection Act requires that the issue of impacts on ground water be addressed in some way in order to properly complete the EIS. Therefore, the EIS Steering Committee directed the development of a forum to consider the state-of-knowledge on the potential impacts of mountaintop mining with valley fills on ground-water resources and determine if these potential impacts were of sufficient concern to warrant additional study within the scope of the EIS.

The workshop was managed for the EIS Steering Committee by Mr. Mike Robinson of the Office of Surface Mining. Technical program chair was Mr. Jim Eychaner of the U.S. Geological Survey (USGS) from Charleston, West Virginia. USGS provides objective scientific information to Department of Interior regulatory agencies. Workshop logistics, facilitation, and documentation were overseen by Mr. Carey Butler, an employee of WPI, which is a not-for-profit environmental consulting firm affiliated with Virginia Tech University.

The forum leaders gathered a planning committee that included representatives of the Office of Surface Mining, Region III of the Environmental Protection Agency, the USGS, the West Virginia Division of Environmental Protection, the West Virginia Mining and Reclamation Association, and the West Virginia Coal Association. The committee developed the concept for a one-day workshop with the following objectives:

Workshop Objectives

- Identify potential impacts of mountaintop mining on ground-water quality and quantity
- Review existing knowledge and ongoing research that applies to mountaintop mining effects on ground water. Identify knowledge gaps
- Review and assess the public comments concerning mountaintop mining impacts on ground water received during the EIS Scoping Process
- Identify potential technical and policy actions in light of workshop findings for further consideration during the EIS process

The committee invited a group of individuals knowledgeable on the subject of surface mining and ground water to debate the current science and develop recommendations on the issue for the EIS Steering Committee. Additionally, the workshop would consider the twelve public comments received during the EIS scoping process. The workshop was held on May 9, 2000 in the meeting room of the West Virginia Division of Environmental Protection in Nitro, West Virginia.

The workshop agenda, meeting participants, and the public comments received that concerned ground-water issues are included as attachments to this background paper.

Attachments:

Workshop Agenda
Meeting Participants
Public Comments

Workshop on Mountaintop Mining (MTM)
Effects on Groundwater (GW)

Charleston, WV
May 9, 2000

Workshop Objectives

1. Identify potential impacts of MTM on GW quality and quantity
2. Review existing knowledge and ongoing research that applies to MTM effects on GW. Identify knowledge gaps
3. Review and assess the public comments concerning MTM impacts on GW received during the EIS Scoping Process
4. Identify potential technical and policy actions in light of workshop findings for further consideration during the EIS process

Workshop Agenda

0800 Introduction and Workshop Objectives; Review of Public Comments

0815 Presentation on GW aspects of MTM (Jim Eychaner, USGS): Overview presentation to provide participants with a common understanding of issues under investigation. More detailed presentations will follow. All speakers will assume that participants have a general understanding of groundwater hydrology and MTM operations. Suggested topics include:

- Pre-mining GW hydrology and chemistry
- GW flow through rock fractures
- Blasting; magnitude, proximity, chemistry, immediate and delayed effects
- GW flow through unconsolidated material
- GW monitoring plans and data

0900 Open Discussion: Have we identified all the potential effects?

0915 Presentation on Mining Operator Requirements and Permit Applications (Tom Galya, WVDEP): Present the federal and state permit application requirements relevant to GW effects. Discuss how this information is typically obtained. Suggested topics include:

- Pre-mining baseline data and analysis
- GW monitoring plans and implementation
- Post-mining closure data and analysis (including time frame since closure)

1000 Open Discussion: Do we understand current operator requirements and limitations?

1015 Break

Detailed Topical Presentations- The following presenters will deliver a brief (10 to 15 minute) discourse on the topic including what is known, where uncertainty exists, the potential effects on GW quantity and quality, conceivable actions to reduce the uncertainty, and conceivable regulatory changes that would mitigate the effect. Each presentation will be followed by a brief discussion period for the group to add additional information or debate the science and recommendations

1030 Public Concerns of MTM Effect on GW (Rick Eades, WVCAG): Opportunity for selected participant(s) to comment on the public perspective concerning MTM effects on GW and opportunities to mitigate these effects.

1100 GW flow through rock fractures (Mark Kozar, USGS): Effect of MTM induced fracture on aquifer hydrology

1130 Blasting (Jay Hawkins, OSM): magnitude in MTM operations, unspent explosive material, fracture, effects on well integrity, transient effects on water quality, delayed effects

1200 Lunch

1300 GW flow through unconsolidated material (David Wunsch, KGS): GW flow through MTM backfill and valley fills, water quality and quantity

1330 GW Chemistry Effects (Bob Evans, OSM): effects of MTM disturbance on chemistry throughout the aquifer and watershed

1400 GW Monitoring (Bob Evans, OSM): Federal and state specific requirements (WV, KY, VA, TN) and their effectiveness

1430 Break

1445 Open Discussion on Regulatory Enhancements (Facilitator): What should be required by regulation to address the potential effects compared to what is currently required and what has been received in past applications. Where are the gaps in required data and analysis to make protective decisions on a permit application? Is all the required information necessary?

1530 Summarize Proceedings (Facilitator): Present summary recorded throughout day organized in the following format:

- Potential effect on GW quantity and/or quality
- Recommendations for additional study
- Recommendations for regulatory enhancement
- Comments

1600 Open Discussion on Recommendations (Facilitator)

1645 Final Comments and Next Steps

1700 Adjourn

Workshop Logistics

The workshop will be held in the training room of WVDEP office in Nitro, WV on May 9, 2000. Please be there sufficiently early so that we may start promptly at 0800.

A proceedings will be prepared to capture the presentations, conclusions, and recommendations of the workshop for the EIS Steering Committee and the public. Please provide any prepared remarks in MS Word or simple text format and any presentation material in MS Powerpoint or other electronic format.

POC for comments, concerns, or logistical needs: Carey R. Butler, PE, WPI, (304) 598-9383, x15, carey_butler@mt.wpi.org

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUNDWATER
MAY 9, 2000

	Perspective/ Affiliation	Phone	Email	Mailing Address

PARTICIPANTS

Rick Eades	WVCAG	(304) 346-5891	Wvcag@newwave.net	1324 Virginia St. East, Charleston,WV 25301
John C. Hemple	EEI Geophysical	(304) 338-6920	Johncave@aol.com	PO Box 47, Dailey, WV 26259
Tom Galya	WVDEP	(304) 759-0510	Tgalya@mail.dep.state.wv.us	10 McJunkin Road, Nitro,WV 25143
Nick Schaer	WVDEP	(304) 759-0510	Nschaer@mail.dep.state.wv.us	525 Tiller St., Logan WV 25601
Bob Evans	OSM	(412) 937-2895	Bevans@osmre.gov	3 Parkway Center, Pittsburgh, PA 15220
Jay Hawkins	OSM	(412) 937-2127	Jhawkins@osmre.gov	3 Parkway Center, Pittsburgh, PA 15220
Mark Kozar	USGS	(304) 347-5130 x228	Mdkozar@usgs.gov	11 Dunbar Steet, Charleston, WV 29301
Randy Orndorff	USGS	(703) 648-4316	Rorndorf@usgs.gov	926A National Center, Reston, VA 20192
Jim Eychaner	USGS	(304) 347-5130 x225	Eychaner@usgs.gov	11 Dunbar Steet, Charleston, WV 29301
Bruce Leavitt	Industry	(724) 228-7385	Bkleavit@bellatlantic.net	2776 S-Bridge Road, Washington, PA 15301
Ron Mullennex	Industry	(540) 322-5467	Ron.Mullennex@mma1.com	PO Box 848, Bluefield, WV 24605
Dave Johnson	KY SMRE	(502) 564-2340	Dave.Johnson@mail.state.ky.us	#2 Hudson Hollow, Frankfort, KY 40601
Pam Carew	KY SMRE	(502) 564-2340	Pamela.Carew@mail.state.ky.us	#2 Hudson Hollow, Frankfort, KY 40601
Lynn D. Haynes	VA DMME/DMLR	(540) 523-8179	ldh@mme.state.va.us	PO Drawer 900, Big Stone Gap, VA 24219
David Wunsch	KGS	(606) 257-5500	Wunsch@kgs.mm.uky.edu	228 MMRB,University of Kentucky, Lexington, KY 40506
Dawn Moore	WVGES	(304) 347-5130 x285	Damoore@usgs.gov	11 Dunbar Steet, Charleston, WV 29301

	Perspective/ Affiliation	Phone	Email	Mailing Address

FACILITATORS

Carey Butler	NETL/WPI	(304) 598-9383, x15	Carey_butler@mt.wpi.org	3606 Collins Ferry Road, Suite 202 Morgantown, WV 26505
Mike Waldon	WPI	(540) 557-6080	Mike_waldon@wpi.org	2000 Kraft Drive, Blacksburg,VA 24060
Sandy Vilar	WPI	(304) 598-9383, x10	Sandy_vilar@mt.wpi.org	3606 Collins Ferry Road, Suite 202, Morgantown, WV 26505

OBSERVERS

Dan Sweeney	EPA, Philadelphia	(215) 814-5731	Sweeney.dan@epa.gov	1650 Arch St., Philadelphia, PA 19013
Gary Bryant	EPA, Wheeling	(304) 234-0230	Bryant.gary@epamail.epa.gov	1060 Chapline St., Wheeling, WV 26003
Dave Vande Linde	WVDEP	(304) 759-0510	Dvandelinde@mail.dep.state.wv.us	10 McJunkin Road, Nitro, WV 25143
Rodney Woods	Corps	(513) 684-6212	Rodney.l.woods@lrdor.usace.army.mil	PO Box 1159, Cincinatti, OH 45201-1159
Mike Robinson	OSM	(412) 937-2882	Mrobinso@osmre.gov	3 Parkway Center, Pittsburgh, PA 15220
Dave Hartos	OSM	(412) 937-2909	Dhartos@osmre.gov	3 Parkway Center, Pittsburgh, PA 15220
Les Prether	OSM	(412) 937-2825	lprether@osmre.gov	3 Parkway Center, Pittsburgh, PA 15220
Cindy Tibbott	FWS	(814)234-4090 x226	Cindy_tibbott@fws.gov	315 S Allen St., State College, PA 16801
Ben Greene	WVMRA	(304) 346-5318	wvmra@wvmra.com	1624 Kanawha Blvd. E., Charleston, WV 25311
Bill Raney	WVCA	(304) 342-4153	braney@wvcoal.com	1301 Laidley Tower, Charleston, WV 25301
Jason Bostic	WVCA	(304) 342-4153	JdBostic@aol.com	1301 Laidley Tower, Charleston, WV 25301
Kenneth Johnson	Consol/Pitt	(412) 831-4524	kenjohnson@consolenergy.com	1800 Washington Road, Pittsburgh, PA 15241
George Gunn	OSM	(304) 347-7158	Ggunn@osmre.gov	1027-Virginia St. East, Charleston, WV 25301
Doug Growitz	OSM-HQ	(202) 208-2634	Dgrowitz@osmre.gov	1951 Constitution Ave. NW Rm 203, Washington, DC 20240

Public Comments from the EIS Scoping Process Concerning Groundwater

As a result of the public outreach efforts of the EIS scoping process, 641 different people provided comments at the public meetings and 95 comment letters were received. Comments desribed economic and social impact concerns; policy and regulatory review issues; EIS process questions; and a broad range of environmental impacts asociated with mountaintop mining/valley fill operations. The twelve comments that pertained to impacts on groundwater are presented below.

"Flattening a mountaintop and filling a valley will cause unknown changes to the hydrologic cycle. We don't know if valley fills cause increased flooding or increased drought. No one knows if a filled valley will recharge groundwater at the same rate than if its left with its original topography and plant cover."

"Entire aquifers have disappeared with the heavy mechanization of the coal industry. Our region once had wonderful and productive artesian wells, absolutely everywhere throughout the region."

"There has been no scientific study done addressing how this type of work effects the health of the aquifer. By eliminating these ephemeral and perennial streams, and their associated wetlands, there must be direct effects on the seasonal recharging of the aquifer."

"We were informed by a DEP geologist that our well water had a very high sodium content. The origin of the sodium was traced up to the mouth of Beech Fork which directly feeds from the coal prep plant and the mountaintop mine operation.... We would like to see further studies done to help determine the cause of this problem and hopefully keep it from happening in the future."

"From what I have seen in my 28 years of mining experience, the valley fills created due to surface mining makes the downstream more productive for aquatic life because the valley fills act as water reservoirs and provides a reliable stream of water downstream - without valley fill the stream might dry up in extremely dry weather."

"*Blasting methods utilized at MTR sites include the use of large amounts of ammonium nitrate and diesel fuel. There is scant data on the effects of these chemicals on springs, wells, or other water resources."*

"The drinking water hazard due to nitrates from the use of ammonium nitrate blasting should be studied and appropriate recommendations considered in the study report."

"Please pay particular attention to the fact that much of southern WV is already underlain by extensive deep mines, which may lead to a greater risk of blasting damage to groundwater flow and quality, over a larger region."

"Research is needed into the effects of MTR blasting on groundwater hydrology and quality...This problem is only exasperated by the fact that many of the MTR areas are underlain with extensive old mine works. In addition, this same region is peppered with thousands of active natural gas wells. Does MTR blasting have any negative effects on natural gas wells?"

"The Fish and Wildlife (Service) estimates that 31% of the Mud River headwaters are currently filled! How much is too much, what are the cumulative effects on water quality, aquifer recharge, and surface water flow."

"Does hazardous waste & petroleum product storage and/or spills effect ground or surface water?"

"The EIS should determine to what extent hazardous materials, tank farms, dumps, etc., may pollute ground or surface water."

Workshop on Mountaintop Mining Effects on Ground Water

Charleston, West Virginia
May 9, 2000

Workshop Proceedings

Welcome and Introductions

Mr. Mike Robinson, Chief, Program Support Division, Office of Surface Mining, Pittsburgh PA

Mr. Robinson, a member of the EIS Steering Committee, opened the workshop by welcoming the participants and thanking them for their participation and effort to prepare for the meeting. He provided the background of the EIS on Mountaintop Mining with Valley Fills and described how the EIS Steering Committee structured the EIS into Technical Study Areas. He also noted that initially, the potential impact of mountaintop mining and valley fill on ground water was not identified as a major concern and how ground water studies generally take a great deal of time and money to complete. He pointed out that the EIS Steering Committee knew that they had neither the necessary time nor funding to complete a major study on ground water issues and chose to focus their limited resources on the highest priority concerns. However, he noted that the EIS Steering Committee had subsequently concluded that the EIS could not be properly concluded without reviewing the issue of ground water impacts from surface mining operations. He asked for the workshop participants to combine their formidable knowledge and experience on the workshop subject and identify any technical needs that the EIS Steering Committee should consider for additional study or effort to adequately understand the potential impacts of mountaintop mining and valley fills on ground water resources.

Workshop Objectives

Mr. Carey Butler, WPI

Following Mr. Robinson's remarks, Mr. Butler took charge of the workshop and introduced the workshop objectives. These objectives are provided below:

1. Identify potential impacts of mountaintop mining with valley fills on ground water quality and quantity
2. Review existing knowledge and ongoing research that applies to mountaintop mining effects on ground water. Identify knowledge gaps

3. Review and assess the public comments concerning mountaintop mining impacts on ground water received during the EIS Scoping Process
4. Identify potential technical and policy actions in light of workshop findings for further consideration during the EIS process

Mr. Butler also presented his perspective on the key factors for a successful workshop. These included remaining focused on the technical issues and staying clear of value judgments. He expressed the opinion that rendering value judgments are in the domain of government officials and the public and that this group should provide the best technical basis for such judgments. He also asked, in the interest of a timely meeting, that the group to distinguish those technical issues that are vital to good decisions in the EIS process from the many interesting but non-essential issues of ground water science.

Mr. Butler presented a summarized listing of the twelve public comments for use by the workshop participants throughout the day. These are presented below:

Summary of Public Comments Regarding Ground water Issues
(the number of public comments in the summarized group appear in parentheses):

- Unknown changes to the hydrologic cycle (quantity) and water quality of the regional aquifer from filling headwater valleys (4)
- Loss of the aquifer resources due to mining (1)
- Valley fills provide a reliable source of water that enhances downstream productivity (1)
- Blasting shock and chemistry effects aquifer quality (2)
- Blasting shock in undermined areas effects aquifer quantity (2)
- Hazardous materials from mining operations effect ground water quality (2)

Ground-water Aspects of Mountaintop Mining

Mr. Jim Eychaner, U.S. Geological Survey (USGS)

Mr. Eychaner provided the keynote presentation to summarize the effects of mountaintop mining on ground water. He presentation is included as an appendix to this proceedings. In his presentation he outlined the effects in terms of ground water quantity or quality, transient or long-term effects, and immediate or delayed effects. His discussion covered four distinct ground water settings including fracture flow system before mining, intergranular flow system of spoil after mining, fracture flow system after mining and the transient effects of blasting.

He drew largely from the Kanawha-New River Basin Study Unit of the National Water Quality Assessment Program (NAWQA). The Kanawha-New River NAWQA Program studies the 12,223 square miles drained by the Kanawha-New River in the Appalachian Mountains of West Virginia, Virginia, and North Carolina. The Kanawha-New River is one of 59 hydrologic systems being studied by the NAWQA Program. The purpose of these studies is to describe the status and trends in the quality of ground- and surface-water resources and understand the natural and human factors that affect these resources.

He presented preliminary findings of the Kanawha-New River Study that included 30 wells on the Appalachian Plateau and another 28 wells near reclaimed surface mines. He noted that none of the reclaimed surface mines were near areas that have been subject to mining of the same scale of current mountaintop mining operations. He noted that a report was due to be published soon containing the results of the study and that information about the report could be found at the following URL:

http://wv.usgs.gov/nawqa

Mr. Eychaner also referenced the 1980 study by Berger and Associates that studied blasting effects on ground water from four sites in West Virginia, Pennsylvania, and Ohio. The study noted visible water quality changes immediately after blasting near test wells and that turbidity was the most common citizen complaint in the study. He also noted that turbidity samples collected in the study were only collected after 300 minutes of continuous pumping, which makes the results of limited value when considering residential well applications.

Mr. Eychaner led a workshop discussion on the potential effects of mountaintop mining with valley fills on ground water. During this discussion, Bruce Leavitt commented that researchers have been looking for many years at the hydrology of fill material in the context of acid mine drainage from surface mines. He continued that there should be essentially no difference with a mountaintop mining fill and that these studies should be useful to the EIS conclusion on ground water effects. Mr. Eychaner stated that where the water in the fill discharges from the fill is equivalent to a spring but the residence time in the fill is reduced when compared to the original undisturbed aquifer system.

Jay Hawkins responded to a question by John Hemple regarding seasonal patterns from fill material by suggesting the large storage capacity of a valley fill could reduce peak flow and maintain low-flow above pre-mining discharge levels. Mr. Eychaner remarked that the effect on drought flow is being studied for the EIS. He said that with the addition of fill, small stream low-flow levels are over an order of magnitude greater than before the fill is added and that these data have been provided to the EIS team although he had not seen it published anywhere. He continued that for a flood-flow study, they established stream discharge gauging stations downstream of fill sites and below control sites with no fills. The data were normalized by dividing discharge by drainage area upstream of the gauge site and found that peak discharge is reduced below the mined (and filled) sites.

Mining Operator Requirements and Permit Applications

Dr. Tom Galya, West Virginia Division of Environmental Protection

Dr. Galya presented the requirements for a state surface mining permit that are relevant to ground water effects. The outline of his presentation is provided below and the complete presentation is included as an appendix to this proceedings. Dr. Galya also provided a copy of the complete permit application requirements (MR-4) that are likewise included in the appendix.

SMCRA Permit Application

- Data, Maps, and Analysis is Provided by the Permittee
- Permit Area Geology Data
- Permit Area Hydrology Data
  - Baseline Ground Water
  - Baseline Surface Water
- PHC, HRP, and CHIA Assessments
- SMCRA and NPDES Compliance Monitoring
  - During Mining Ground Water Monitoring Plan
  - During Mining Surface Water Monitoring Plan
- Post-Mining Water Discharge Quality
- Post-Mining Closure
  - Phased Bond Release

NPDES Permit Application

- Ground Water Protection Plan

The areas of the application that require ground water relevant data are Section 1, Geologic Information, of the MR-4 Permit Application with specific information for:

- Drill Hole Data with stratigraphic data and acid-base accounting of seams and overburden
- Geologic Cross Sections
- Hydrogeologic Maps
- Geologic Description of the Permit and Adjacent Area, and
- Anticipated Impacts on Geology and Hydrology of the Permit Area

Section J of MR-4, Hydrologic Information, requires:

- Inventory of Ground-water Users
- Baseline Surface-water Chemistry Data
- Baseline Ground-water Chemistry Data
- Probable Hydrologic Consequences (PHC) of the Proposed Operation, and
- Hydrologic Reclamation Plan (HRP)

The state law requires the Director of the Division of Environmental Protection to prepare a Cumulative Hydrologic Impact Assessment (CHIA) to determine whether the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area.

Dr. Galya went on to describe the three phases of bond release after post-mining reclamation that require operators to provide data to validate that the mining operation has met the requirements of the permit application. Dr. Galya also described the Ground water Protection Rules for Coal Mining Operations contained in Title 38 Series 2F of the West Virginia Code. The law requires a Ground water Protection Plan to receive an NPDES Permit for the operation.

The discussion following the presentation several issues were raised. The first centered on the adequacy of guidance and the ability of mine permit applicants to submit sufficient baseline data of consistent quality for the state regulators to perform a consistent review and discern all the possible impacts in the CHIA. The group noted that in some cases, private well owners are unwilling to permit access to their ground water wells to obtain baseline data and Rick Eades suggested proposed a public education component to encourage their participation. Nick Schaer commented that the term "reasonably foreseeable use" is not well defined.

Representatives from Kentucky and Virginia noted that their regulations and experience are similar and suggested that they were also similar in Tennessee. Dave Johnson noted that Kentucky did a field study of 25 permit applications to determine if data in the applications were accurate. He said the results were varied and that they are now doing training of consultants and field personnel. He also noted that a problem in Kentucky is that a person reviewing a permit may not have experience in all the areas to conduct a thorough review of the application. Lynn Haynes said that a review team approach is used in Virginia. Nick Schaer commented that West Virginia processes about 50 permits each year. Bob Evans said that Tennessee uses a similar process but they usually require seasonal data rather than six months, which should better define the complete hydrogeological range.

Public Concerns of Mountaintop Mining on Ground Water

Rick Eades, West Virginia Citizen's Action Group

Mr. Eades talked from a written set of comments that are included in the appendix. He began his presentation by stating the opinion that "citizens are concerned that these (ground water) issues are not addressed, or inadequately addressed, in the largest study ever undertaken to determine environmental impacts from MTR (mountaintop removal) mining. Despite written and verbal requests to EIS overseers, citizens are unaware of meaningful studies to address these concerns." He then listed seven areas of concern that are outlined below. [Facilitator's note: as Mr. Eades written notes were not provided to the workshop participants during the meeting, it is not clear that all the concerns detailed in his notes were given adequate treatment during the workshop.]

- Valley fills (Insufficient effort to study the effects on ground water with monitoring wells during the EIS)
- Water supply wells proximal to blasting
- Permanent ground water storage loss in interburden/coal units
- Ground water loss or impacts below the lower-most bench (up to 600+ feet removed in some areas
- Guidance for determining the point of origin of intermittent streams (versus ephemeral)
- Ground water chemistry
- The basis hydrogeologic regime represents a high degree of complexity

Mr. Eades expressed the concern that citizen's are questioning the lack of commitment of resources, for example money for monitoring wells, to gain direct measurement to assess these potential environmental impacts. He continued by stating the use of indirect (anecdotal) evidence to characterize hydrogeologic impacts has the potential to miss real long-term effects of mountaintop mining. He concluded by stating that the citizen's he represents have a very low degree of confidence in the EIS to adequately characterize ground water impacts from mountaintop mining and would like to have as many resources devoted to ground water monitoring as have been allocated to study economic impacts.

In the discussion that followed, Bill Raney asked "what is the difference between mining now and mining in the 1980's." Mr. Eades replied that mined out areas are now in much thicker strata and cover larger areas, sequencing of blasts has evolved, and there is continual subsidence. John Hemple added the Berger and Associates study (on blasting near wells) is a start, but today's blasting areas are larger, and changes in blasting threaten to open previously sediment-blocked fractures.

There was a general discussion of drilling wells through spoil material. David Wunsch noted that he has done a lot of study in this area and creating stable deep wells in spoil material is very difficult. Rodney Woods expressed the opinion that it must be difficult to find a contractor who will take the risk of drilling such a well with the high potential for losing drill bits in deep spoil.

Effect of Mountaintop Mining Induced Fracture on Aquifer Hydrology

Mark Kozar, USGS

Mr. Kozar gave a presentation entitled, "Age of Ground water in the Kanawha-New and Allegheny-Monongahela River Basins." In this presentation, he gave the results of chlorofluorcarbon (CFC) dating of water samples taken from wells in these regions to determine water age. CFC dating is a result of the relatively recent appearance of CFC in the atmosphere and, therefore, the know time (1940's) in which this tracer was introduced into ground water recharge zones. He noted that the age of water in hilltop wells of the Kanawha-New River Basin averages about 19 years of age while water in hillside and valley wells averages 29 and 42 years, respectively. He went on to note that the younger age in of ground water in mined areas may indicate increased ground water flow velocities due to enhance permeability. He suggested that this factor should be reflected in ground water models and regulations designed to protect ground water in fractured bedrock aquifers of the region.

The group discussion that followed centered on whether or not longer ground water travel times would be realized. John Hemple asked if Mr. Kozar's conclusion means that removing the recharge area might lengthen the recharge time. David Wunsch stated that fractures are dynamic and many quickly become filled with mud. Bruce Leavitt commented that not all material is placed in the valley; much of the material is placed back on the bench in back stacks. Jay Hawkins mentioned that there are studies on the issue of recharge in mined areas that were conducted in Ohio.

Blasting in Mountaintop Mining

Jay Hawkins, Office of Surface Mining

Mr. Hawkins presented a report entitled, "Impacts of Blasting on Domestic Water Wells" that drew from both his personal research and the research of others. His complete presentation is included in the Appendix. Mr. Hawkins researched the effects of blasting from 1994 to 1995 when he worked for the Bureau of Mines. He reported the preliminary results of his study of a study in Clearfield County, Pennsylvania with similar topographic characteristics to a mountaintop mining operation in southern West Virginia but on a smaller scale. The study included instrumented logging of several nested wells to examine the effects of blasting on water levels and aquifer characteristics both in the horizon of the coal seam being mined and the next lower coal seam that represented the first yielding unit below the water-table aquifer.

According to Mr. Hawkins, the blasting ranged from 50 to 100 holes with approximately 60 feet of overburden initially at a range of about 900 feet from the wells. He reported that there was no observable ground-water fluctuations that could be attributed to the blasting with monitoring covering up to 20 minutes after the blasts. Mr. Hawkins also reported that in this study, there were no observable changes in the aquifer characteristics identified by the slug tests and constant-discharge well tests that were conducted before and after the blasting. He noted that eventually, pumping of the mine pit and encroachment of the highwall toward the wells dewatered the water-table aquifer.

Mr. Hawkins also discussed three other published studies how blasting affects domestic water wells including D.A. Roberson (1988), D.E. Siskind and J.W. Kopp (1987), and J.A. Kipp and J.S. Dinger (1991). His report on these studies is detailed in his presentation.

He concluded that depending on well construction, lithologic units encountered, and proximity to the blasting, some of the larger blasting shots could act as a catalyst for some well sloughing or collapse. However, he added, the well would have to be inherently weak to begin with and that smaller blasting shots are not likely to cause these effects. He also concluded that minor water fluctuations from blasting may cause short term turbidity increases but should not pose long-term water quality problems. He did allow that the issue of residual nitrates from blasting as a source of ground water contamination has not been adequately addressed and may need further study.

In the discussion that followed, John Hemple agreed that larger shots could trigger a well to slough and cited an anecdote of a well that became contaminated with fecal coliform after nearby blasting. Dave Johnson commented that, in his experience, most complaints are from people in valleys, while mining is occurring nearby at higher elevations. Mr. Hawkins listed four relevant questions regarding blasting as (1) the nitrates issue, (2) pre-blast well testing of yield, (3) water quality testing and a number of samples (6-12) taken over a year, and (4) regulated scaled distances and peak-particle velocities. He also commented that blasting should be avoided on days with temperature inversions as this would reduce the public perception of damage by eliminating the shock wave reflected off the inversion. Mike Robinson commented that the Office of Surface Mining does have a complaint group and is considering funding a study. Jim Eychaner stated that they normally see small nitrate values in domestic wells.

Ground-water Flow through Unconsolidated Materials

David Wunsch, Kentucky Geological Survey

Mr. Wunsch reported on a comprehensive study of ground water flow through unconsolidated materials that was conducted at the Star Fire Tract in eastern Kentucky. He stated that there is a higher conductivity for ground water in coal seams and cited a recent dissertation, which is being published by the Kentucky Geological Survey. He discussed a well design for use in fill material that has an increased probability of remaining intact as the fill material shifts and settle. He noted the following issues that should be considered, (1) comparing bench-scale studies with field observations, (2) spoil settlement, and (3) establishing GIS databases.

The complete report on the Star Fire Tract is available from the Kentucky Geological Survey using the hyperlink in the citation below:

Report of Investigations 6 (series 11), **Design, Construction, and Monitoring of the Ground-Water Resources of a Large Mine Spoil Area: Star Fire Tract, Eastern Kentucky,** by David R. Wunsch, James S. Dinger, and Page B. Taylor, 1992, 16 p.

Ground-water Chemistry Effects and Ground-water Monitoring

Bob Evans, Office of Surface Mining

Mr. Evans prepared presentations with great detail on each of these subjects but was allowed only ten minutes to quickly summarize his points so the group could move on to summarizing ground water issues raised during the workshop and developing recommendations.

Mr. Evans highlighted several actions that could be taken to reduce the uncertainty of operators and regulators on ground water issues in mining permits. These are summarized below:

- Conduct field studies of existing mining operations to relate site geochemistry to post-mining water quality
- Better establish the ground water flow paths through mine backfills and valley fills
- Enhance the experiential knowledge base of reviewers and permit preparers through standardization of testing methods, databases, field studies, etc.
- Establish post-mining water quality from backfills and valley fills to validate PHC predictions
- Develop electronic data submission/storage requirements for submission of geologic and hydrologic data.

Mr. Evans pointed out the crosswalk he prepared between federal regulations and the regulations of West Virginia, Virginia, and Kentucky for Ground water Baseline Requirements and Ground water Performance Monitoring Plans.

The workshop participants expressed their appreciation for the obvious hard work Mr. Evans had put into his presentations and asked that both presentations be included in the workshop proceedings. These presentations are included in the appendix.

Facilitated Open Discussion

Mr. Butler facilitated an open discussion of the group toward a set of recommendations regarding additional scientific study or regulatory enhancements necessary to identify and protect against the potential detrimental effects of mountaintop mining on ground water resources. He organized the discussion around five major technical areas that had been addressed during the day. They were:

1) Baseline Hydrology Assessment
2) Fracture Hydrology (long-term effects)
3) Blasting (short-term or transient effects)
4) Fill Hydrology
5) Aquifer Resource Issues

Mr. Butler then added bulleted sub-items that were discussed during the day and asked the group to add to or modify the bulleted lists until they were satisfied. Then for each technical area the group was asked to identify thoughts or suggestions that had been heard during the day that would contribute to either improved science or enhanced regulations regarding mountaintop mining and the potential effects on ground water. Finally, the group was asked to synthesize from those thoughts and ideas a specific list of essential recommendations for additional scientific study or regulatory modifications to address the uncertainties of mountaintop mining effects on ground water.

Under science issues, the group was asked to consider whether there was sufficient scientific knowledge to be sufficiently predictive regarding potential effects of mountaintop mining on ground water. Under regulatory issues, the group was asked to consider if existing permitting regulations required sufficient data of the right type and quality to render an adequate decision regarding the potential effects of mountaintop mining on ground water. Under each topic below, the area issues are listed under the main technical area heading followed by comments and recommendations (italicized) to address key areas of uncertainty in both Science and Regulation.

1) Baseline Hydrology Assessment

- Adequacy of Requirements
- Adequacy of Application Information
- Adequacy of Review

Science no comments or recommendations

Regulation

Standardization of Permit Review	*Electronic Data Submission*
Technical Audits- QA/QC	
Depth of well water, seasonality	*Policy for measured well yield determination*
Variability among states	
Sampling plans	

There was substantial discussion among the workshop participants on the value and meaning of well yield testing required by permit applicants. The group considered several issues including how many wells are needed, which is dependent on the methodology of geostatistics that is considered appropriate for the circumstances. The group also considered if it was adequate to simply measure water levels at a single moment or if more data were necessary to account for daily and seasonal patterns of consumption and recharge. Finally, the group discussed whether or not the state should require the applicant to drill wells as part of pre-application monitoring.

David Wunsch commented that we want the application and decision to be based on sound science and not just “feel good” application of the regulations. He noted that

Kentucky is developing a database of wells that are useful for monitoring. Tom Galya noted that decisions regarding how many wells to use and where they are located is determined at the pre-permit meeting. Dave Vande Linde stated that West Virginia is moving to a tiered review process where initial data is reviewed and decisions are made about additional monitoring or adding wells. Mr. Vande Linde also noted that West Virginia is implementing a random technical review of permits for quality assurance and quality control purposes.

The group endorsed two recommendations in the interest of improving the baseline hydrology assessment during the permitting process. First, the group recommended moving to an electronic data submission process as recommended by Bob Evans during his presentation. This will improve the standardization of permit application review and quality assurance audits. Second, the group recommended establishing a regulatory policy for measured flow in terms of obtaining accurate discharge and stream yield measurements.

Second, the group recommended establishing a regulatory policy for measured flow. Discharge reported for either pumped wells or streams typically has been an estimate with no supporting documentation, in contrast to chemical analyses that are supported by detailed QA plans. The group recommended that all flows reported to WV DEP be measured using an identified method appropriate to the situation.

2) Fracture Hydrology (long-term)

- Aquifer Dewatering
- Recharge

Science

USGS Work *Improved Conceptual Models*
Ohio Study
KY thesis

Regulation no comments or recommendations

The group recommended that the conceptual model for flow through fractured bedrock be improved by considering the greater age of ground water as presented by Mark Kozar earlier in the workshop. Jim Eychaner further commented that we need to improve the science, through observations that can lead to improved models, before we propose any changes to the regulations.

3) Blasting (ST/Transient)
- Well Integrity
- Water Quality

Science

Berger Study — *Nitrates*

Montana work — *New Study in PA*

Turbidity/Total Suspended Solids

Regulation

Monitoring Wells in Valleys

Max Peak Particle velocity

Pre-blasting survey (WV Law)

Under the topic of science, the group addressed the question of whether the Berger and Associates 1980 study is still adequate considering the increased magnitude of blasting operations in mountaintop mining. Jay Hawkins commented that vertical shock is not necessarily of concern because the mine operator tries not to break the coal bed when blasting. Mr. Hawkins also commented that he does not think nitrate contamination of ground water from blasting operations is a problem. However, he continued, this potential impact has not been well studied.

Tom Galya stated that analysis for Total Suspended Solids (TSS) is not currently required. Nick Schaer added that many labs perform the TSS protocol as part of other laboratory tests. Dr. Galya proposed that TSS be made part of the standardized suite of analyses and reports required with permit applications.

Jay Hawkins commented that a proper pre-blasting survey could help define the potential effects of a blasting operation and limit potential liability for all parties. Rick Eades stated that it is part of the law in West Virginia but, in actuality, these studies are very limited in scope.

The group endorsed recommendations for study on the issue of nitrates from blasting as a potential ground water contamination source, support for the potential new study on blasting effects at a mining site in Pennsylvania identified by Jay Hawkins, and adding TSS to the standard list of analyses for ground water samples. The group also endorsed including monitoring wells in valleys adjacent to mountaintop mining sites in the monitoring plan, review limiting maximum peak-particle velocity of blasting operations, and raising the regulatory rigor of pre-blasting surveys.

4) Fill Hydrology

- Recharge
- Well Dewatering
- Storage Capacity (seasonal)
- Equilibrium Chemistry (water quality)
- Monitoring

Science

Star Fire Tract	*Conclude Star Fire Tract residual studies*
ODEX drilling	
USGS work at monitored sites	E*nhancements to USGS work (chemistry)*

Regulation no comments or recommendations

The discussion under this topic considered the potential for significant differences between fills constructed from sandstone and shale overburden. Jim Eychaner suggested this was an area for additional study and that the improvements in science would be reflected in better permit reviews. The group identified two immediate opportunities for improving the science of fill hydrology. The first is to conclude many of the unfinished topical studies at the Star Fire Tract and the second is to enhance the current USGS study by increasing the chemical analyses that are being conducted.

5) Aquifer Resource

- Relative productivity of perched aquifers and fills
- Effect on regional ground water aquifer from filling headwater streams

Science

Ballard Site	*Recharge Mass Balance*

Regulation no comments or recommendations

The group identified the need for development of water budget (mass balance) estimates for both pre- and post-mining conditions. Rick Eades stated that the Ballard site study will include the performance of a recharge mass balance. Jay Hawkins commented that this information is generally well known but the studies have not been collected and integrated.

Reuben Gillispie (reubengillispie@wvdhhr.org) noted that the state does not specify a list of significant aquifers. Instead, a vague definition is applied on a case-by-case basis. Bob Evans said that if the aquifer is designated as a sole-source aquifer, then EPA will not allow any activity that threatens the aquifer. The CHIA, he said, requires you to determine if there will be damage to the aquifer off-site. Despite this discussion, the group did not endorse any recommendations regarding naming significant aquifers or the CHIA.

Workshop Conclusion

The workshop was concluded following the open discussion and development of recommendations. Recommendations will be forwarded to the EIS Steering Committee for consideration.

Attachments:

Workshop Agenda

Meeting Participants

Public Comments

Presentations:

Eychaner

Galya

Eades

Kozar

Hawkins

Wunsch

Evans (2) Ground Water Monitoring

Ground Water Geochemistry Effects

Effects of Mountaintop Coal Mining on Ground Water

Jim Eychaner

USGS

Charleston WV

Mountaintop Coal Mining

- Ground Water Issues
  - Water Quantity
  - Water Quality
- Timing of effects
  - Transient or Long-Term
  - Immediate or Delayed

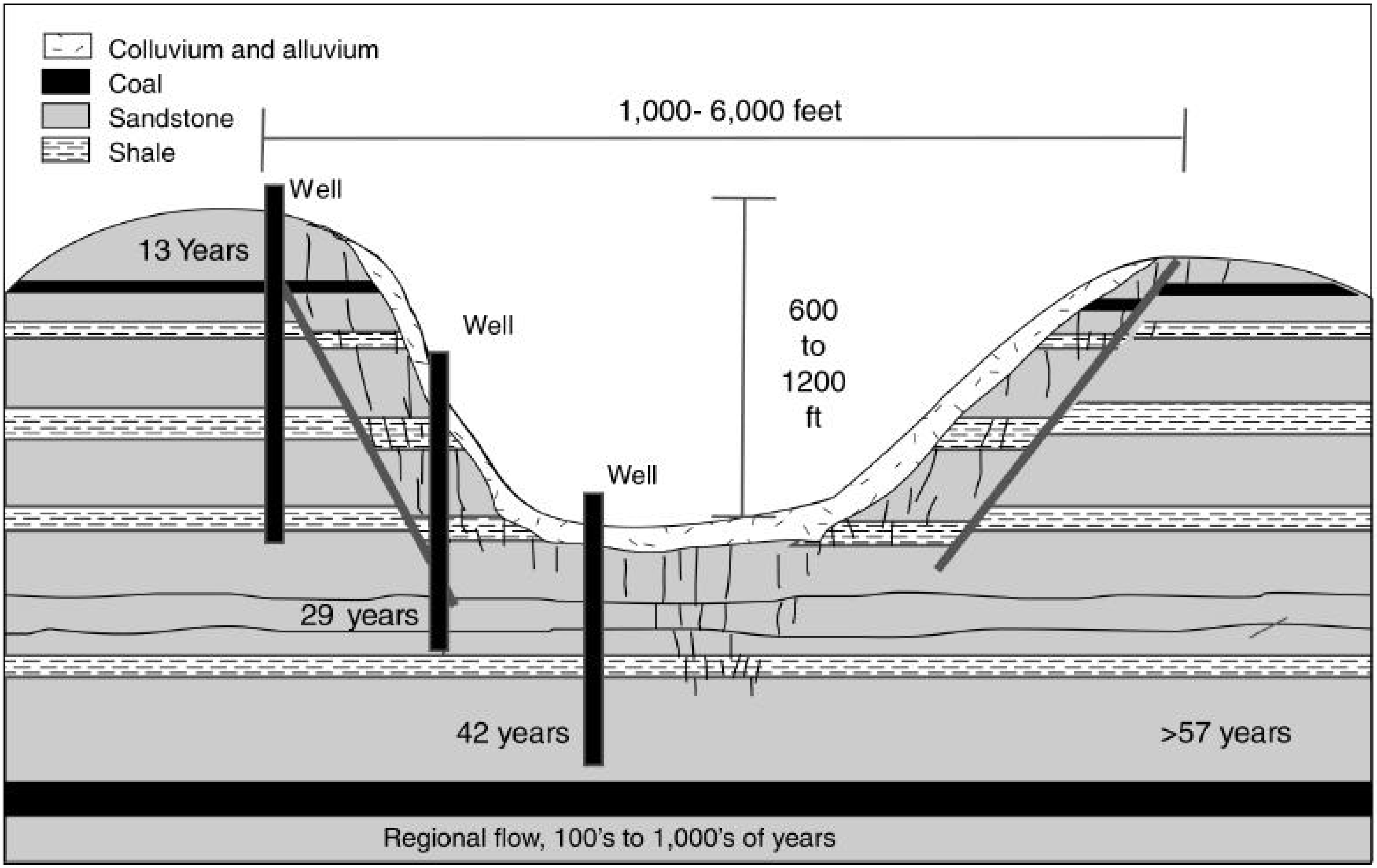
Ground Water Settings

- Fracture flow system before mining
- Granular flow system after mining
- Fracture flow system after mining
- Transition: Blasting

Before Mining

- Layered sandstone, shale, coal
  - Near horizontal
  - Well cemented (carbonate & silicate)
- Steep topography
  - Relief 600 - 1,200 ft
  - Ridge spacing 1,000 - 6,000 ft
- Dendritic drainage network

Geohydrology before mining



Fracture Network

- A blanket of fractures draped across the topography
  - Stress-relief fractures
  - High-angle joints and faults
  - Bedding-plane separations
  - Coal seams
- Permeability decreases with depth
- How do discrete fractures connect?

Ground-Water Flow

- Scale of aquifer segment
  - Ridge to valley
  - Along valley
  - Deep aquifers
- Seasonal recharge via soil, alluvium
- Apparent age of water
  - Hilltops 13 yr, Hillsides 29 yr, Valleys 42 yr
  - Effects of individual-fracture paths

Well characteristics

- 6 inch diam, 80-200 ft deep, 20-40 ft casing
- Half at base of slope close to stream
- Submersible or jet pump, 5-10 gpm
- Pump cycles every few minutes when used
- New wells have concrete pad, casing grout
- ?WL/?T < 7 ft/min or 1 ft/10 sec

Water Quality--Kanawha NAWQA

- Appalachian Plateau survey - 30 wells
  - Shallow domestic wells in good condition
  - Bacteria, major constituents, nutrients, trace elements, pesticides, volatiles, radon, CFC age
- Mining survey - 28 wells, not MTM
  - Reclaimed surface coal mines, similar wells
  - Major constituents, nutrients, trace elements, radon, CFC age

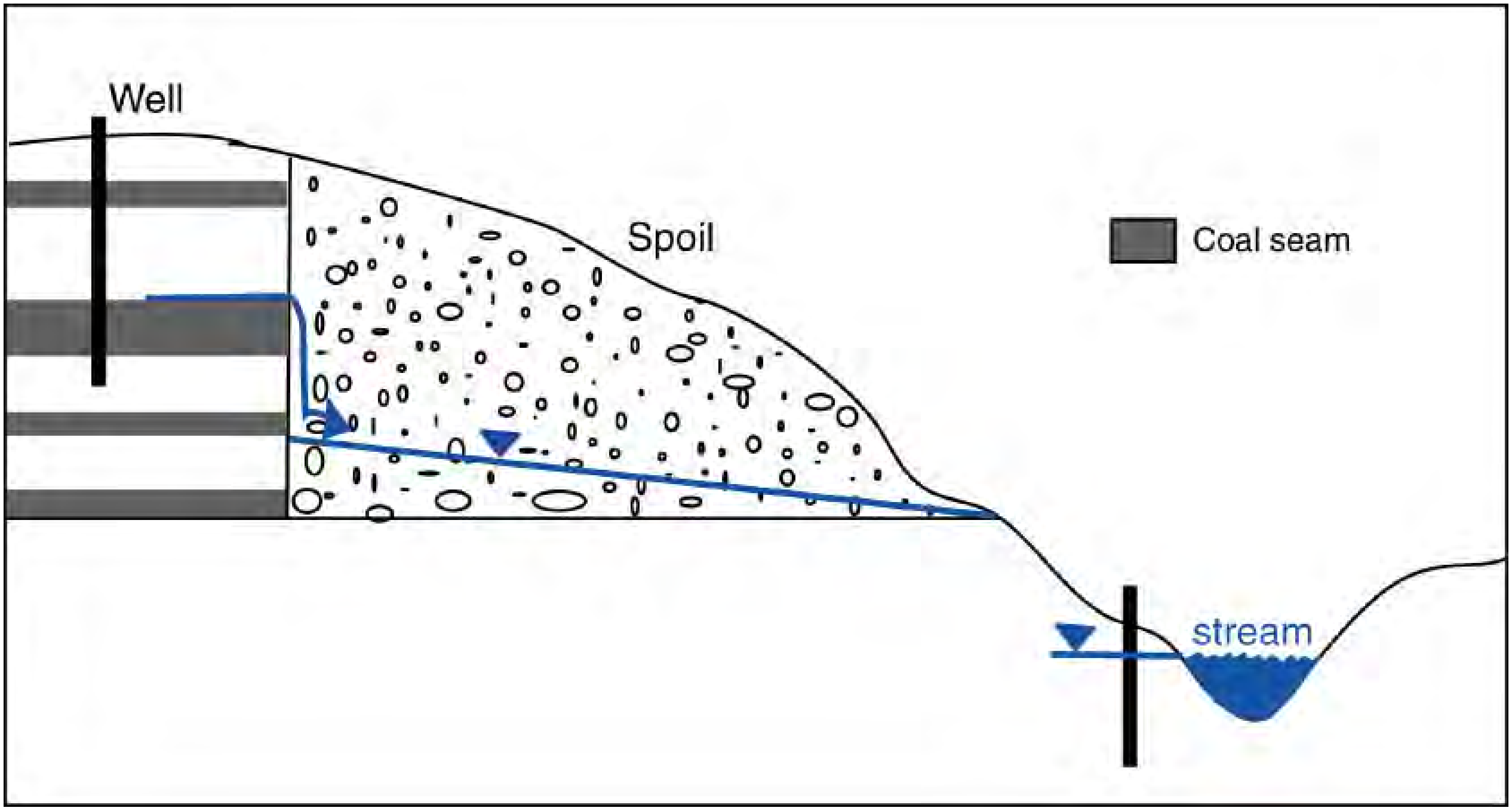
Appalachian Plateau, 30 wells

- More dilute $Ca(HCO_3)_2$ near ridges, tending to $NaHCO_3$ or Na_2SO_4 in valleys
- Fe exceeds SMCL in 40%, Mn in 57%
- Rn: median 300 pCi/L, >95% < 4000
- Total N: median 0.29 mg/L, 90% < 1.0
- Detected CS_2, $CHCl_3$, or benzene in 20-40%
- Fecal bacteria absent, Pesticides rare

Granular flow system

- In backcast or valley fills
- Permeability horizontal or angle of repose
- Coarse zones by design or chance
- Pyritic spoil high and dry in backcast

Geohydrology -- spoil on bench



Granular flow - hydraulics

- Thin saturated zone above coal pavement (backcast) or former valley (valley fill)
- Stable water table after a few years
- Recharge: increased infiltration, fractures
- Discharge: to streams, fractures
- Residence time decreased
- Permanent through-flowing system

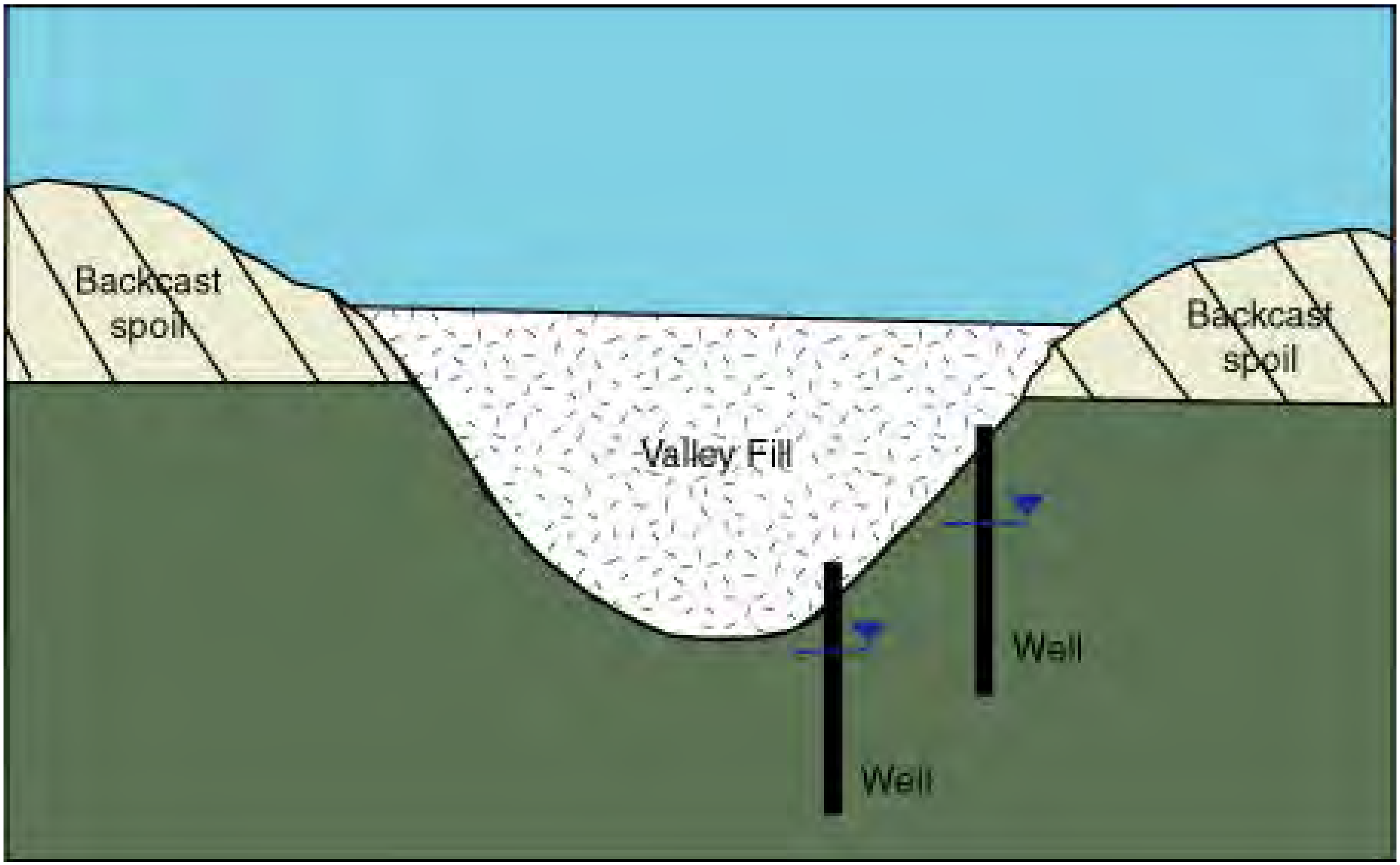
Granular flow - chemistry

- Geochemistry of new rock-water interactions -- What is on the flow path?
- TDS, SO4 increase, variable by site
- TDS gradually decreases as exposed minerals react
- Difficult to install wells

Fracture system after mining

- Fractures above highwall drain to new base
- Fractures below water table can recharge
- Progress of effects depends on
  - Specific fracture connections and flow paths
  - Residence time in each fracture
  - Geochemistry along each path

Geohydrology -- Valley Fill



Effects on existing wells

- Upslope wells can go dry
  - Water-level trend one way for days, weeks
  - Effects depend on distance
- Downslope, cross-slope well effects are more subtle
  - Multiyear lag possible

Berger & Associates (1980)

- Studied blasting effects on ground water
- Four study sites in WV, PA, OH
  - New observation wells
  - Repeated pump tests as mining approached
  - Periodic chemistry samples
- Specific capacity constant or increased

Near reclaimed mines - NAWQA

- 28 wells, complete reclamation 2-12 yr
- Effects seen within 2000 ft H, 150 ft deep
- Increased: SO_4, Fe, Mn, TDS, turbidity
- Decreased: pH, Rn
- Total N: median 0.38 mg/L, 86% < 1.0
- Apparent age unchanged, median 28 yr
- Mixed residence time on multiple paths

Blasting -- The Transition

- Effects result from vibration magnitude, frequency spectrum, and duration
- Objective: shatter rock to allow removal
  - Grid of shot holes, charged with ANFO
  - Optimize design on spacing, charge, delay
- Objective: minimize off-site effects
- Scale exceeds that of 1980

Transient effects on wells

- Water-level surge
  - Compression wave, f >1 hz, could produce surge ? A/A_0 * Height of water column
  - ?WL/?T > 1 ft/s possible
  - Surging could continue for the duration of the blast wave train
  - Compare pumping: ?WL/?T < 1 ft/10 sec
  - Effect observed in earthquakes

Transient effects (2)

- Turbidity transient possible
  - Visible water quality change immediately after blast shock felt by citizen
  - Is the science credible?
  - Most common citizen complaint in 1980 study
  - Turbidity samples in 1980 were collected only after 300 minutes of continuous pumping.

Principal Unknowns

- Pre-mining flow details
- Lag time, long-term chemistry near large fills (fracture system)
- Variability of flow in large fills of different construction
- Duration of chemical effects (granular)
- Transient water levels and turbidity

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

REQUIREMENTS FOR STATE PERMIT MINE APPLICATIONS RELEVANT TO GROUND WATER EFFECTS.

SMCRA PERMIT APPLICATION

O DATA, MAPS, AND ANALYSIS IS PROVIDED BY THE PERMITTEE

O PERMIT AREA GEOLOGY DATA

O PERMIT AREA HYDROLOGY DATA

- BASELINE GROUND WATER
- BASELINE SURFACE WATER

O PHC, HRP, AND CHIA ASSESSMENTS

O SMCRA AND NPDES COMPLIANCE MONITORING

- DURING MINING GROUND WATER MONITORING PLAN
- DURING MINING SURFACE WATER MONITORING PLAN

O POST- MINING WATER DISCHARGE QUALITY

O POST-MINING CLOSURE

- PHASE BOND RELEASE

NPDES PERMIT APPLICATION

O GROUND WATER PROTECTION PLAN

T.Galya, WVDEP, Nitro, WV
5/9/00

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

GEOLOGIC INFORMATION - SECTION I, MR-4 PERMIT FORM

SECTION I PROVIDES:

- DRILL HOLE DATA
  - STRATEGRAPHIC DATA - 38CSR2 §3.23.A.2
  - ACID-BASE ACCOUNTING OF SEAM AND OVERBURDEN DATA - 38CSR2 §3.23 and §3.23.f.1
- GEOLOGIC CROSS SECTIONS - 38CSR2 §3.23A and §3.23.f.4
- HYDROGEOLOGIC MAP - 38CSR2 §3.23.b
- GEOLOGIC DESCRIPTION OF THE PERMIT AND ADJACENT AREA
  - STRATRGRAPHY - 38CSR2 §3.23.a.2
  - STRUCTURE - 38CSR2 §3.23.b
- ANTICIPATED IMPACTS ON GEOLOGY AND HYDROLOGY OF THE PERMIT AREA - 38CSR2 §3.23.f.5

Section I: Geologic Information

NOTE: The geologic information being required shall address both the areal and structural geology and related information of both the proposed permit and adjacent areas down to and including the deeper of either the stratum immediately below the lowest coal seam to be mined, or any aquifer which may be adversely impacted below the lowest coal seam to be mined.

I-1. Provide the following information for all coal seam(s), rider(s), and/or refuse to be mined, processed, stockpiled, or affected by the proposed operation.

COAL, RIDER SEAM(S) AND/OR COAL REFUSE (USGS NAME)	THICKNESS (INCHES)	SULFUR FORMS (Yo)			
		ORGANIC	PYRITIC	SULFATE	TOTAL

NOTE: Acid-producing coal seams include but are not limited to the Waynesburg, Washington, Freeport, Sewickley, Redstone, Pittsburgh, Kittanning, Elk Lick, Peerless, No. 2 Gas, Upper Eagle, No. 5 Block, and Stockton Lewiston.

1-2. Is gravity discharge anticipated from a proposed underground mine or augering area?
☐ Yes ☐ No ☐ N/A

If yes, and coal seams are defined as acid-producing, provide site-specific data demonstrating that the seams to be mined are no acid-producing or iron-producing in the location of the proposed mine. *Identify as attachment I-2*

1-3. Is coal fly ash usage proposed?
☐ Yes ☐ No

If Yes, provide analysis to show its chemical properties. *Identify as attachment 1-3*

1-4. Is coal processing refuse disposal proposed?
☐ Yes ☐ No

If Yes, provide overburden analysis to show its chemical properties. *Use attachment I-11*

1-5. Are durable rockfills proposed?

☐ Yes ☐ No

If Yes, provide slake durability analysis. *Use attachment I-I 1*

1-6. Does the applicant request a waiver of the requirement to provide certain geologic information?

☐ Yes ☐ No

If Yes, address **A.** and B. below:

A. Check the type of waiver requested:

☐ Results of test borings as requested in I-1 1.

☐ Engineering properties of soft rock for underground mines as requested in I-12.

B. Provide the specific source of existing equivalent information available upon which the request for waiver is based. *Identify as attachment **I-6***

[-7. Provide certified geologic cross-sections which include the following: *Identify as attachment I-7*

A. Nature and depth of the various strata or overburden including geologic formation names and/or geologic members as described by the **U.S.** Geological Survey or other published geologic reports;

B. Presence of any known structural features such as faults, fractures, anticlines, synclines, and monoclines;

C. Depth of weathering identified during exploration and drilling;

D. Nature and thickness, in inches, of all coal or rider seams above and immediately below the proposed coal seam(s) to be mined;

E. Nature and thickness of the stratum immediately beneath the lowest coal seam to be mined;

F. Vertical distribution of aquifers and the name(s) of the stratum (or strata) in which the water is found. For each aquifer system, show the seasonal fluctuations in head and general water quality information. Also, provide appropriate cross-references to the detailed water quality information under the baseline ground water information section; and

G. Denote any potentially acid-producing materials, topsoiling, and durable materials.

MR-4, SECTION I, GEOLOGIC INFORMATION

1-7. PROVIDE CERTIFIED GEOLOGIC CROSS-SECTIONS WHICH INCLUDE THE FOLLOWING:

F. VERTICAL DISTRIBUTION OF AQUIFERS – 38CSR2 §3.23.c

- FOR EACH AQUIFER SYSTEM:
  - ➢ NAME(S) OF THE STRATUM (OR STRATA) IN WHICH WATER IS FOUND
    - SHOW THE SEASONAL FLUCTUATIONS IN HEAD – 38CSR2 §3.22.b.3 AND §3.23.c
    - GENERAL WATER QUALITY INFORMATION – 38CSR2 §3.22.b.1
    - PROVIDE APPROPRIATE CROSS-REFERENCES
- DETAILED BASELINE GROUND WATER QUALITY INFORMATION – 38CSR2 §3.22.b.2

I-8. Provide a certified geohydrologic map identifying the following:
NOTE: Proposal map can be utilized only if this additional information does not make the map difficult to read.

A. Locations (latitude and longitude) and elevations of all bore holes and sampling sites;

B. All mineral croplines and the strike and dip of the coal to be mined;

C. Existing or previous surface mining limits with their permit numbers;

D. Location and extent of known workings of any underground mines and auger mined areas, including mine openings to the surface. Label these openings as to whether they are currently discharging water or are known to have discharged water in the past;

E. Areal extent of aquifers with the name(s) of the stratum (or strata) in which the water is found and show the anticipated direction of water movement;

F. Location and depth of all oil and gas wells, and their Office of Oil and Gas permit numbers, for all wells which are within the proposed mining limits (surface or underground) and/or within 1000 feet of the proposed permit boundary;

G. Presence and attitude of any known structural features such as faults; axial traces of synclines, anticlines, and monoclines; and any recognized fracture patterns of lineament traces;

H. Location of geologic cross-section(s).

1-9. Provide a detailed geologic description of the permit and adjacent areas which include the following: *Identify as attachment I-9.*

A. Stratigraphic and lithologic descriptions of the area to be affected by mining;

B. Hydrogeologic setting including the areal and vertical distribution of all aquifers; seasonal differences in head; the name(s) of the stratum (or strata) in which the water is found; and the availability, movement, quality, and quantity of ground water flow in all aquifer units;

C. Structural geology of the coal seam and the strata to be affected by mining both in the permit and adjacent areas, including faults, folds, fracture and lineament traces, and regional and site specific strike and dip;

D. Geochemical character of all strata and coal to be disturbed by mining and the potential of this strata for generating acid, alkaline, or iron-laden drainage;

E. Depth and degree of weathering of area strata and the effects this weathering has on the physical and geochemical properties of the overburden proposed for disturbance;

F. Effects of fracturing and weathering on the extraction of coal and the hydrologic regime;

MR-4, SECTION I, GEOLOGIC INFORMATION

1-9. PROVIDE A DETAILED GEOLOGIC DESCRIPTION OF THE PERMIT AND ADJACENT AREAS WHICH INCLUDE THE FOLLOWING:

B. HYDROGEOLOGIC SETTING

- AREAL DISTRIBUTION OF ALL AQUIFERS – 38CSR2 §3.2c
- VERTICAL DISTRIBUTION OF ALL AQUIFERS – 38CSR2 §3.2c
- SEASONAL DIFFERENCES IN HYDROSTATIC HEAD – 38CSR2 §3.22.b.3
- THE NAME(S) OF THE STRATUM (OR STRATA) IN WHICH WATER IS FOUND
- AVAILABILITY OF GROUND WATER FLOW IN ALL AQUIFER UNITS – 38CSR2 §3.22.c.3
- HYDROGEOLOGY OF GROUND WATER FLOW IN ALL AQUIFER UNITS
  - ➢ QUALITY OF GROUND WATER FLOW – 38CSR2 §3.22.b.2
  - ➢ QUANTITY OF GROUND WATER FLOW – 38CSR2 §3.22.b.3

G. Anticipated impacts of all proposed and existing operations on the geology and hydrology of the area, including impacts resulting from multiple seam mining and subsidence;

H. For underground mining operations (including auger mining) indicate whether or not there is the potential for gravity discharge(s) and the anticipated quantity and quality of the discharge(s) from each potential discharge site. For non-gravity discharge situations, indicate the potential for seepage along the outcrop barrier and the potential hydraulic head which might result in the underground workings. Indicate if the potential discharge will require chemical treatment.

I-10. Complete Geologic Borehole Log for all test borings and coreholes in the proposed permit and adiacent area. ***Use attachment 1-10***

I-1 1. Provide a statement of results of the test borings or core samples for the proposed permit and adiacent areas. ***Use attachment I-11.***

1-12. Provide for room and pillar mining operations the thickness and analyzed engineering properties of clays or soft rock in the stratum immediately above and below each coal seam to be mined. ***Identify as attachment 1-12***

1-13. Will topsoil substitute be utilized?

☐ Yes ☐ No

If Yes, include analysis of original topsoil, topsoil substitute, and appropriate certifications. Demonstrate that the proposed substitute material is of sufficient quantity and equally suitable for sustaining vegetation as the existing topsoil and the resulting soil medium is the best available in the permit area to support vegetation. ***Identify us attachment 1-13***

GEOLOGIC BOREHOLE LOG

Attachment 1-10

Page ____ of ____

Company Name	Location: Quadrangle________ Latitude________	Hole Number
Surface Elevation	Longitude________	Driller________ Date Drilled________

SAMPLE NO.	DEPTH FROM SURFACE (feet)	THICKNESS OF STRATUM (feet)	LITHOLOGIC DESCRIPTION

OVERBURDEN SAMPLE ANALYSIS

Attachment I-11

Company Name________________________________ **Mine Name**________________________ **Page** ____ **of** ____

Sampling Point________
(Reference to Lithologic Log)

Laboratory Name________________________________

Sample I. D. No.	Elevation Top of Stratum (ft/msl)	Unit Thickness (Feet)	Material	Paste pH	Total Sulfur (%)	Pyritic Sulfur (%)	* Potential Acidity	* Neutralize Potential	* Net Excess or Deficiency	** Fizz Rate	*** Color	Slake Durability Index (SDI)

*Units in tons of $CaCO_3$ equivalent per 1000 tons of material

**Units: 0 = None, 1 = Slight, 2 = Moderate, 3 = Strong

***Munsell Color Chart

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

HYDROLOGIC INFORMATION-- SECTION J, MR-4 PERMIT FORM

<u>SECTION J PROVIDES</u>:

- INVENTORY OF GROUND WATER USERS – 38CSR2 §3.22.b.1
- BASELINE SURFACE WATER CHEMISTRY DATA - 38CSR2 §3.22.c
- BASELINE GROUND WATER CHEMISTRY DATA - 38CSR2 §3.22.b
- PHC (PROBABLE HYDROLOGIC CONSEQUENCES) OF PROPOSED OPERATION – 38CSR2 §3.22.b.4
- HRP (HYDROLOGIC RECLAMATION PLAN) - 38CSR2 §3.22.f AND §3.22.b.4

Section J: *Hydrologic Information*

J-1. Identify on the PROPOSAL MAP all surface water and ground water bodies on the proposed permit area, adjacent areas and areas over the proposed mineral extraction.

J-2. Provide a Ground Water Inventory on the proposed permit area. adjacent areas and areas over the proposed mineral extraction. *Use attachment J-2*

J-3. Provide Baseline Surface Water Quality and Quantity information for the proposed permit area, adjacent areas and areas over the proposed mineral extraction. ***Use attachments J-3A and B***

J-4. Provide Baseline Ground Water Quality and Quantity information for the proposed permit area, adjacent areas and areas over the proposed mineral extraction. *Use* ***attachment J-4A and*** *B*

J-5. Are there significant aquifers on the proposed permit area, adjacent areas and/or areas over the proposed mineral extraction?

☐ Yes ☐ No

If Yes, provide a description to include discharge rates or usage and depth to water under seasonal conditions. ***Identify as attachment J-5***

J-6. Provide a statement describing the **Probable Hydrologic Consequences (PHC)** of the proposed mining operation, with respect to the hydrologic balance, on the permit area, adjacent areas, and over the proposed mineral extraction. The statement must provide the following information: ***Identify as attachment J-6.***

WATER OUANTITY:

- Whether the proposed operation may result in water supply diminution or interruption for any ground or surface water source currently being used for domestic, agricultural, industrial, or any other legitimate purpose;
- Potential impact the proposed operation will have on flooding or streamflow alteration, including channel scouring and dewatering of streams;
- Whether the proposed operation will disturb aquifers that significantly insure water use;
- Potential effects of the proposed operation on ground and surface water availability.

WATER QUALITY:

- Whether the proposed operation may result in water supply contamination for any underground or surface water source currently being used for domestic, agricultural, industrial, or any other legitimate purpose;
- Whether acid or toxic forming materials are present which could result in the contamination of surface or ground water;
- Potential impact the proposed operation will have on sediment yield;
- Potential impacts resulting from increases in total hot acidity, total suspended solids, dissolved solids, and other important water quality parameters.

GRAVITY DISCHARGE/OUTCROP SEEPAGE:

- Potential for gravity discharge from the underground workings during and after mining, the potential impacts resulting from the complete failure of the outcrop barrier, and the formation of outcrop seepage faces. (Provide calculations)

1-7. Does the PHC indicate that a currently used or significant ground water resource is likely to be contaminated, diminished, or interrupted?

☐ Yes ☐ No

If Yes, provide the following information. ***Identifi as attachment J-7***

A. Identify the alternative water source(s) and provide a detailed description of any aquifer, developed or undeveloped, proposed as an alternative water source;

- If the alternative source(s) is developed , show the location on the proposal map using designation **AW-1, AW-2,** etc.
- If the alternative source(s) is undeveloped, provide proposed plans and specifications.

B. Provide water quality and quantity data demonstrating its suitability for the identified use(s).

J-8. Does the PHC indicate that a currently used or significant surface water resource is likely to be contaminated. diminished, or interrupted?

☐ Yes ☐ No

If Yes, provide the flood flows, base flows, and other characteristics to fully evaluate such probably hydrologic consequences as water availability and suitability for both the pre mining and postmining land use in order to plan remedial and reclamation activities. ***Identifi as attachment J-8***

J-9. Is a waiver of ground water monitoring requested?

☐ Yes

If Yes, identify each individual water-bearing stratum for which a waiver is requested and demonstrate by use of the PHC determination and other available baseline hydrologic and geologic information that the particular water-bearing stratum is not one which serves or may potentially serve as a significant aquifer or one which ensures the hydrologic balance within the cumulative impact area.

If No, provide letter(s) of permission to monitor domestic water supplies proposed as monitoring sites. ***Identifi as attachment J-9***

NOTE: The ground water and surface water monitoring plans are to be included in Section U of this application.

J-10. Provide copies of original laboratory data sheets for the surface water and ground water baseline monitoring sites. *Identify as attachment J-10*

J-11. Provide a hydrologic reclamation plan in the form of maps and/or narrative which describes the steps to be taken to minimize disturbances to the hydrologic balance within the permit and adjacent areas; to prevent material damage outside the permit area; to met applicable federal and state water quality laws and regulations; and to protect the rights of present water users. The plan shall include: *Identify as attachment J-11*

A. Preventive and remedial measures to avoid acid or toxic mine drainage;
B. Measures to assure the protection of the quality and quantity of surface and ground water systems;
C. Measures to be taken to prevent, to the extent possible, contributions of suspended solids;
D. Measures to control drainage and, if needed, a description of the water treatment facilities;
E. Measures to be taken to restore, enhance, protect, or replace the approximate premining recharge capacity (underground operations do not need to respond to this subpart);
F. Measures to be taken to prevent, control, or mitigate the adverse impacts of gravity, seepage, or pump discharges from underground mines and/or augering, if applicable; and
G. Restore, protect or replace the water supply of present water users in accordance with section 24 of the Act.
H. Preventive and remedial measures to prevent any other potential adverse hydrologic impacts identified in the PHC.

GROUND WATER INVENTORY

Attachment J-2

*D = DOMESTIC I = INDUSTRIAL P = POTABLE (Drinkable) O = OTHER

NAME	ADDRESS	WELL (*)	SPRING (*)

BASELINE SAMPLING SITE DESCRIPTION

SURFACE WATER

Attachment J-3A

SAMPLING SITE	DESCRIPTION	LATITUDE	LONGITUDE	ELEVATION

BASELINE SURFACE WATER ANALYSIS

Attachment J-3B

Company Name: ____________________

Mine Name: ____________________

Laboratory Name: ____________________

Sample I.D. No.	Date Sampled	pH	Flow cfs or gpm	Total Hot Acidity ppm $CaCO_3$	Mineral Acidity ppm $CaCO_3$	Total Alkalinity ppm $CaCO_3$	Total Fe ppm	Total Mn ppm	TSS ppm	TDS ppm	Spec. Cond. µmhos	SO_4 ppm	Al ppm	

BASELINE SAMPLING SITE DESCRIPTION

GROUND WATER

Attachment J-4A

SAMPLING SITE	DESCRIPTION	LATITUDE	LONGITUDE	ELEVATION	SOURCE/ AQUIFER

BASELINE GROUND WATER ANALYSIS

Attachment J-4B

Page _____ of _____

Company Name: ____

Mine Name: ____

Laboratory Name: ____

Sample I.D. No.	Date Sampled	pH	Flow gpm or depth to water (ft)	Total Hot Acidity ppm $CaCO_3$	Mineral Acidity ppm $CaCO_3$	Total Alkalinity ppm $CaCO_3$	Total Fe ppm	Total Mn ppm	TSS ppm	TDS ppm	Spec. Cond. µmhos	SO_4 ppm	Al ppm	Other

BASELINE SAMPLING SITE DESCRIPTION
GROUND WATER
Attachment J-4A

GW-1	Benlah Justice-Drilled Well-100'+ deep	37" 40' 35"	82° 08' 37"	950'	Sandstone
GW-2	James Smith	37" 40' 13"	82" 07' 01"	965'	Sandstone
GW-3	Wade Canada,Sr.-Drilled Well-102' deep	37" 41' 49"	82° 06' 36"	950'	Sandstone
GW-4	James Bailey-Drilled Well-83' deep	37" 41' 37"	82" 07' 37"	975'	Sandstone

BASELINE GROUND WATER ANALYSIS

Attachment J-4B

Page ___ of ___

Company Name: **White Flame Energy, Inc.**
Mine Name: **Surface Mine No. 9**
Laboratory: **J & M Monitoring, Inc.**

Sample I.D. No.	Date Sampled	pH	Flow gpm or depth to water (ft)	Total Hot Acidity ppm CaCO3	Mineral Acidity ppm CaCO3	Total Alkalinity ppm CaCO3	Total Fe ppm	Total Mn ppm	TSS ppm	TDS ppm	Spec. Cond. umhos	SO4 ppm	Al ppm	Other
GW-2	10/30/96	6.30	--	0.00	--	78.00	6.23	1.22	134.00	--	--	40.00	--	
GW-2	11/13/96	6.90	--	0.00	--	75.00	5.39	0.63	42.00	--	319.00	37.00	--	
GW-2	12/20/96	6.70	--	0.00	--	143.00	3.52	0.55	42.00	--	--	42.00	--	
GW-2	01/31/97	6.80	--	0.00	--	71.00	22.63	0.64	2.00	--	295.00	15.00	--	
GW-2	02/14/97	7.20	--	0.00	--	64.00	0.043	0.70	26.00	--	280.00	40.00	--	
GW-2	03/05/97	7.00	--	0.00	--	71.00	4.44	0.85	18.00	--	260.00	17.00	--	

26.39

Workshop on Mountaintop Mining effects on Ground water

CHIA- The Director shall perform a separate CHIA *(reference in CSR2 38 3.22d)* for the Cumulative Impact Area (CIA) of each permit application. The evaluation determines whether the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area.

A. Determine whether the hydrologic assessment of the CIA indicates that the addition of the impacts of the proposed operation to those of the other Anticipated Mining operations may cause material damage to the hydrologic balance outside the permit area.

B. Acknowledgment of hydrologic concerns in the PHC and HRP, and discuss rationale for inclusion of each concern addressing each significant ground water (aquifer) use.

C. Develop indicator parameters to monitor ground water quality and quantity in order to evaluate potential adverse effects upon significant aquifer uses.

D. Determine the material damage criteria that will be used to identify impacts to significant aquifer uses.

- Water quality
- Water quantity

E. Selection and establishment of Threshold impact assessment-monitoring sites in the CIA.

1. Selection of Threshold impact sites where impacts are to be assessed; sites located on CIA map.

Section U: Water Monitoring Plan

U-1. Provide a surface water monitoring plan to include the following: *Identify as attachment U-1*

A. Monitoring site locations;

B. Quality and quantity parameters; and

C. Sampling and reporting frequency.

(NOTE: Attached Surface Water Analysis Form is lo be completed and submitted to DEP as required).

U-2. Provide **a** ground water monitoring plan to include the following, if applicable: *Identify as attachment **U-2.***

A. Monitoring site locations;

B. Quality and quantity parameters; **and**

C. Sampling frequency.

(NOTE: Attached Ground Water Analysis Form is lo be completed and submitted lo DEP as required).

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

PHASE I BOND RELEASE

- RAW WATER DATA IS REQUIRED FOR ALL PHASE I RELEASES. MINIMUM, ONE (1) SAMPLE PER DRAINAGE AREA
- WHERE NO CHEMICAL TREATMENT HAS BEEN USED DURING THE LAST 12 MONTHS
  - RAW WATER NOT REQUIRED
- WHERE CHEMICAL TREATMENT HAS BEEN USED DURING THE LAST 12 MONTHS
  - **SIX** MONTHLY SAMPLES OF RAW WATER MUST BE COLLECTED AND ANALYZED SHOWING COMPLIANCE WITH THE EFFLUENT LIMITS SET FORTH IN THE NPDES PERMIT, AS WELL AS THE SMCRA REGRADING REQUIREMENTS
- WHERE CHEMICAL TREATMENT IS CURRENTLY BEING USED OR IS NEEDED TO MEET THE EFFLUENT LIMITS AT THE OUTLET
  - PHASE I RELEASE WILL NOT BE GRANTED
- PHASE I BOND RELEASE MAY BE GRANTED WITH CHEMICAL TREATMENT IF THE PERMITTEE COMPLIED WITH STIPULATIONS IN 38CSR2 §12.2.e OF THE REGULATIONS

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

PHASE II BOND RELEASE

- ALL ITEMS MUST BE ADDRESSED IN PHASE I PRIOR TO THE SUBMISSION FOR PHASE II BOND RELEASE
- A ONE YEAR HISTORY OF RAW WATER SAMPLES TAKEN AT INTERVALS SET FORTH IN THE NPDES AND MEETING APPLICABLE EFFLUENT LIMITS OF NPDES PERMIT.
- ALL SAMPLING MUST BE DONE FOR CONSECUTIVE PERIODS THROUGHOUT THE REQUIRED DURATION
- DMR'S SHOWING THE OUTLET MEETS EFFLUENT LIMITS ARE NOT ACCEPTABLE AS RAW WATER EVEN IF THERE IS NO CHEMICAL TREATMENT.
- PERMIT WILL BE REQUIRED TO ABANDON A STRUCTURE AND/OR TO OBTAIN PHASE II BOND RELEASE

WORKSHOP ON MOUNTAINTOP MINING EFFECTS ON GROUND WATER

PHASE III BOND RELEASE

- MUST HAVE ACTIVE NPDES PERMIT COVERING ARTICLE 3 SMCRA PERMIT THAT ACCURATELY REFLECTS THE CURRENT CONDITIONS

- MUST BE MODIFIED TO DELETE ANY OUTLETS WHERE ANY DRAINAGE STRUCTURE HAS BEEN REMOVED. IF ALL DRAINAGE STRUCTURES HAVE BEEN REMOVED, THEN AN APPROVED STORM WATER PERMIT IS NECESSARY.

- MUST BE FIVE YEARS AFTER LAST AUGMENTED SEEDING AND NOT LESS THAN TWO YEARS AFTER REMOVAL OR BREACHING OF ANY DRAINAGE STRUCTURE

  - THE EXCEPTION IS LIGHT INDUSTRY FOR THE POST MINING LAND USE

- RAW WATER FROM THE PERMITTED AREA MUST MEET THE EFFLUENT LIMITS SET IN THE NPDES PERMIT

  - RAW WATER DOES NOT SHOW ANY ADVERSE IMPACT TO THE HYDROLOGIC BALANCE

West Virginia
Surface Mining Reclamation
Regulations

West Virginia
Surface Coal Mining and Reclamation
Act

Office of Explosives and Blasting

Bureau of Environment

Division of Environmental Protection

1999

3.21.a. If the Director is unable to determine whether the proposed operation is located within the boundaries of any of the lands described in paragraph (1), subsection (d), section 22 of the Act, or closer than the limits provided in paragraph (4), subsection (d), section 22 of the Act, the Director shall transmit a copy of the relevant portions of the permit application to the appropriate Federal, State or local government agency for a determination or clarification of the relevant boundaries or distances. The agency shall make such determinations within thirty (30) days of receipt of the Director's request. The Director may extend the response period by thirty (30) days upon written request.

3.21.b. When the Director receives any request for determination of valid existing rights on lands within the area of jurisdiction of the National Park Service or the U. S. Fish and Wildlife Service, a notification shall be made to the appropriate agency, and they shall have thirty (30) days in which to respond. The Director may, upon written request, extend the response period by an additional thirty (30) days.

3.21.c. Where the proposed operation would include Federal lands within the boundaries of any national forest when the applicant seeks a determination that mining is permissible under paragraph (5), subsection (d), section 22 of the Act, the applicant shall submit a permit application to the field office of the Federal Office of Surface Mine Reclamation and Enforcement with a request that such determinations be made.

3.22. Hydrologic Information.

3.22.a. PHC. Each permit application shall, in addition to the requirements of the Act, contain a statement describing the probable hydrologic consequences (PHC) of the proposed mining operation, with respect to the hydrologic balance, on both the permit area and adjacent areas. The statement shall be based on base line information developed from sampling and analysis of surface and groundwater at monitoring sites established both on the permit area and adjacent areas. Sampling and analysis shall be performed in accordance with methods approved by the Office of Surface Mining Reclamation and Enforcement. The longitude, latitude and elevation shall be given for each of the monitoring sites. Mathematical modeling techniques may be used to aid in the development of the required information. The PHC determination shall include findings on: whether adverse impacts may occur to the hydrologic balance; whether acid-forming or toxic-forming materials are present that could result in the contamination of surface or ground-water, and whether the proposed operation may proximately result in contamination, diminution or interruption of an underground or surface source of water within the proposed permit or adjacent areas which is used for domestic, agricultural, industrial, or other legitimate purpose; and what impact the proposed operation will have on:

3.22.a.1. Sediment yield from the disturbed area;

3.22.a.2. Acidity, total suspended and dissolved solids, and other important water quality parameters;

3.22.a.3. Flooding or stream flow alteration;

3.22.a.4. Ground-water and surface-water availability; and

3.22.a.5. Other characteristics as required by the Director.

3.22.b. Base Line Ground Water Information. Each application for a permit shall contain:

3.22.b.1. The location, ownership, and use (if any) of known existing wells, springs, and other groundwater resources including discharges from other active or abandoned mines on the proposed permit area and adjacent areas in sufficient numbers to allow the applicant to make a reasonable approximation of the base line groundwater conditions and use;

3.22.b.2. Water quality analysis including, at a minimum, total dissolved solids, alkalinity, acidity, sulfates, specific conductance, pH, total iron and total manganese. Correlation data from other monitoring sites within the general area of the proposed mining operations may be accepted; provided, that a limited number of validation samples from the permit area may be required; provided further, that in areas where prior mining experience has shown acid production to be a possibility, or in acid producing seams in areas with no prior mining history, site specific water sampling and analysis data shall be required;

3.22.b.3. For significant aquifers, groundwater quantity descriptions including discharge rates or usage and depth to water under seasonal conditions in each water-bearing stratum above the coal seam and each potentially impacted stratum below the coal seam. Where deemed appropriate and feasible by the Director the operator may calculate water usage for water status discharge determinations; and

3.22.b.4. If the determination of the probable hydrologic consequences (PHC) indicates that a currently used or significant groundwater, resources is likely to be contaminated, diminished, or interrupted, additional information shall be provided as necessary to fully evaluate such probable hydrologic consequences as water availability and suitability for both the premining and postmining land use in order to plan remedial and reclamation activities such as alternative water sources.

3.22.c. Base Line Surface Water Information. Each application for a permit shall contain:

3.22.c.1. The name, location, ownership, and description of all surface water bodies on the permit area and adjacent areas;

3.22.c.2. Water quality descriptions including information on total suspended solids, total dissolved solids, specific conductance, pH, acidity, alkalinity, sulfates, total iron and total manganese sufficient to demonstrate seasonal variations; provided, that correlation data from other monitoring which does not include one or more of the above parameters may be accepted; provided further, that a limited number of validation samples may be required. In areas where prior mining experience has shown acid production to be a possibility, or in acid producing seams in areas with no prior mining history, site specific water sampling and analysis data shall be required;

3.22.c.3. Water quantity descriptions including information on seasonal flow rates, variation, and usage; and

3.22.c.4. If the determination of the probable hydrologic consequences (PHC) indicates that a currently used or significant surface water resource (including all lightly buffered streams) is likely to be contaminated, diminished, or interrupted, additional information shall be provided on the flood flows, base flows, and other characteristics or information as necessary to fully evaluate such probable hydrologic consequences as water availability and suitability for both the premining and postmining land use in order to plan remedial and reclamation activities such as alternative water sources.

3.22.d. The applicant shall submit with the application all available data and analysis described in subdivisions 3.22.b and 3.22.c of this subsection for use in preparing the cumulative hydrologic impact assessment (CHIA).

3.22.e. The Director shall perform a separate CHIA for the cumulative impact area of each permit application. This evaluation shall be sufficient to determine whether the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area.

3.22.f. Each permit application shall

contain a hydrologic reclamation plan. The plan shall be specific to the local hydrologic conditions. It shall contain in the form of maps and descriptions the steps to be taken during mining and reclamation through bond release to minimize disturbances to the hydrologic balance within the permit and adjacent areas; to prevent material damage outside the permit area; to meet applicable Federal and State water quality laws and regulations; and to protect the rights of present water users. The plan shall include the measures to be taken to:

3.22.f.1. Avoid acid or toxic drainage;

3.22.f.2. Prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow;

3.22.f.3. Provide water treatment facilities when needed:

3.22.f.4. Control drainage;

3.22.f.5. Restore, protect, or replace water supply of present water users in accordance with section 24 of the Act. The plan shall specifically address the potential adverse hydrologic consequences identified in the PHC determination and shall include preventive and remedial measures; and

3.22.f.6. Restore approximate premining recharge capacity provided that underground mining operations are exempt from this requirement

3.22.g. Each application for a permit shall contain a surface water monitoring plans based on the PHC determination and base line hydrologic and geologic information. These plans shall identify monitoring site locations, quantity and quality parameters, sampling frequency, and describe how the data will be used to determine the impact of the operation on the hydrologic balance both on the permit area and adjacent areas. Monitoring sites shall be located in the surface water bodies such as streams, lakes. and impoundments that are potentially impacted or into which water will be discharged at both upstream and downstream locations from the discharge. Monitoring parameters shall include but are not limited to total dissolved solids or specific conductance corrected at 25°C, total suspended solids, flow measurements, pH, acidity, alkalinity, total iron and total manganese. The selection of these parameters must be based on current and approved postmining land uses and all hydrologic balance protection objectives.

3.22.h. Each application for a permit shall contain a ground water monitoring plan for all significant groundwater resources provided that monitoring shall not be required if the applicant can demonstrate that the aquifer is not one which significantly ensures the hydrologic balance within the cumulative impact area as provided in subdivision 14.7.c of this rule. The decision of need will be based on the PHC determination and base line hydrologic and geologic information gathered both on and off the mine site. These plans shall identify monitoring site locations (latitude, longitude, and ground level elevations), quantity and quality parameters to be monitored, sampling frequency and duration, and describe how the data will be used to determine the impact of the operation on the hydrologic balance both an and off the mine site. Monitoring parameters shall include, but are not limited to, total dissolved solids or specific conductance corrected at 25°C, pH, acidity, alkalinity, total iron, total manganese, and water levels or discharge rates. The selection of these parameters must be based on current and approved postmining land uses and all hydrologic balance protection objectives.

3.22.i. If the PHC indicates that adverse impact may occur to the hydrologic balance or that acid forming or toxic forming material is present that may result in contamination of surface or groundwater supplies, then additional information supplemental to that required in subdivisions 3.22.b and 3.22.c. of this subsection shall be provided to evaluate such probable hydrologic consequences and to plan remedial and reclamation activities.

3.23. Geology. Each application for a permit shall contain the following geologic and related information:

3.23.a. Geologic cross sections, maps or plans of the proposed permit area and adjacent areas, prepared by or under the direction of and certified by a person approved by the Director. When required by the Director, test borings or core samplings shall be analyzed to determine the following information:

3.23.a.1. The locations (latitude and longitude) and elevations of all bore holes;

3.23.a.2. The nature and depth of the various strata or overburden including geologic formation names and/or geologic members;

3.23.a.3. The elevation location of subsurface wafer, if encountered, and its quality;

3.23.a.4. The nature and thickness of any coal or rider seams above the seam to be mined;

3.23.a.S. The nature of the stratum immediately beneath the coal seam to be mined;

3.23.a.6. All mineral crop lines and the strike and dip of the coal to be mined, within the area of land to be affected;

3.23.a.7. Exiiingorprevious surface mining limits; and

3.23.a.8. The location and extent of known workings of any underground mines, including mine openings to the surface,

3.23.b. Information concerning the areal and structural geology of both the proposed permit and adjacent areas, down to the deeper of either the stratum immediately below the lowest coal seam to be mined or any aquifer which may be adversely impacted below the lowest coal seam to be mined. Areal geology may include information such as mapped outcrop locations shown on a 7 ½ minute United State Geological Survey (U.S.G.S.) topographic map, aerial photographs and published geologic reports for the area of concern. Structural geology may include mapped lineament traces from aerial photography or topographic maps and any published structural geologic reports for the area of concern;

3.23.c. Areal and vertical distribution of aquifers with seasonal differences in head and the name(s) of the stratum (or strata) in which the water is found;

3.23.d. Location and depth of all oil and gas wells within the proposed permit area for both surface and underground mines;

3.23.e. For underground mining operations, indicate whether or not there will be a gravity discharge; and

3.23.f. A statement of the result of test borings or core samples from the permit and adjacent areas including:

3.23.f.l. The results of test borings including the lithologic logs of the drill holes displaying the physical properties and thickness of each stratum encountered which the applicant has made at the area to be covered by the permit, or other equivalent information and data in a form satisfactory to the Director including the structural geology, thickness of the coal seam to be mined, location of subsurface water, if encountered, and an analysis of the chemical and physical propenies. including but not limited to the sulfur content of any coal seam, the chemical analysis of potentially acid or toxic-forming sections of the overburden, and the chemical analysis of the stratum lying immediately underneath the coal to be mined: Provided, that information which pertains only to the analysis of the chemical and physical properties of the coal, except information regarding such mineral or elemental contents which are potentially toxic in the environment, shall be kept confidential and not a matter of public record;

3.23.f.2. Premining overburden sampling and analysis or previous experience and correlation data, shall be made a part of each permit application for all acid-producing seams. Overburden sampling and analysis is to be performed in accordance with standard procedures set forth in Environmental Protection Agency Manual No. 600/2-78-054 (Field and Laboratory Methods Applicable to Overburdens and Minesoils) or other methods approved by the Director,

3.23.f.3. For standard room and pillar mining operations, the thickness and engineering properties of clays or soft rock such as clay shale, if any, in the stratum immediately above and below each coal seam to be mined;

3.23.f.4. Cross sectional or areal maps illustrating faults, crop lines, dip/strike, synclines, anticlines and other known geologic structural features which have a bearing on the extraction of the coal and/or the hydrologic regime. The maps shall be accompanied by a detailed description of the illustrated data including a brief description of the degree of fracturing and weathering noted during the exploration drilling if it is believed to have a potential influence on the extraction of the coal and/or the hydrologic regime;

3.23.f.5. An explanation of the anticipated potential impacts of the proposed mining operation on the hydrology and geology of the area; and

3.23.f.6. An applicant may be granted a waiver for the requirements of paragraphs 3.23.f.1 and 3.23.f.3 of this subdivision only after the Director finds in writing that the collection and analysis of such data is unnecessary because other equivalent information exists and is available to the Director, provided, that in areas where mining history has shown acid production to be a possibility, or in acid producing seams in areas with no prior mining history. site specific overburden sampling and analysis data shall be required.

324. Protection of Adjacent Operations. Surface mining activities shall be designed to protect disturbed surface areas. including spoil disposal sites, so as not to endanger any present or future operations of either surface or underground mining activities.

3.25. Transfer, Assignment or Sale of Permit Rights and Obtaining Approval; Sale, Conveyance or Assumption of Control or Ownership of an Operation.

3.25.a The Director may grant written approval of the transfer, assignment or sale of a permit under the following terms and conditions:

3.2S.a.1. The applicant shall affirmatively demonstrate to the Director that a bond in the full amount of that required for the permit will be kept in full force and effect before. during, and after the transfer, assignment, or sale.

3.25.a.2. The application for transfer, assignment, or sale, shall set forth on forms prescribed by the Director, the information required in paragraphs 1. through 6., subsection a.. section 9; and paragraph 9. subsection a. of section 9, subsections d. and f. of section 9; paragraph 10., subsection a. of section 10; and paragraph 5. subsection b. of section 18 of the Act and subdivisions 3.1.a, 3.1.b, 3.1.c, 3.1.d, 3.1.i, 3.1.j, and 3.1.k of this rule.

3.25.a.3. The applicant for transfer, assignment or sale of a permit shall, upon filing of the application with the Director, give notice of the filing in a newspaper of general circulation in the locality of the operation. The notice shall be in the form of a legal advertisement containing information as set forth on forms provided by the Director, the name and address of the original permittee and the permit number and shall provide for a thirty (30) day comment period. Any person whose interests are or may be adversely affected,

WEST VIRGINIA

HYDROLOGIC PROTECTION

REGULATIONS

November 1,1998

Bureau of Environment
Divison of Environmental Protection

TITLE 38
LEGISLATIVE RULES
OFFICE OF MINING AND RECLAMATION
DMSION OF ENVIRONMENTAL PROTECTION

SERIES 2F
GROUNDWATERPROTECTIONRULES COAL MINING OPERATIONS

$38-2F-1. General.

1.1. Scope. -- These . rules establish a series of practices for the protection of groundwater which are to be followed by any person who conducts coal mining operations subject to the provisions of W. Va. Code §22-12-1 et seq. and subject to regulation under W. Va. Code §22-3, and/or under W.Va. Code §22-11, as it relates to coal mining operations.

1.2. Authority. -- W. Va. Code §22-12-5.

1.3. Filing Date. - May 13, 1994.

1.4. Effective Date. -- June 1, 1994.

§38-2F-2. Definitions. As used in these rules, unless used in a context that clearly requires a different meaning, the term:

2.1. Act means the West Virginia Groundwater Protection Act, W. Va. Code §22-12-1 et seq.

2.2. Coal Mining Operation means any facility or activity which falls within the definition of "surface mine," "surface mining," or "surface mining operations" set forth in W. Va. Code §22-3-(3)(u).

2.3. Contaminant means any material in a solid, liquid or gaseous state that has the potential to cause contamination.

2.4. Contamination means any man-made or man-induced alteration of the chemical, physical, biological, or radiological integrity of the groundwater, resulting from activities regulated under this rule, in excess of existing groundwater quality, unless that activity or site has: (1) been exempted pursuant to subsection 5(h) of the Act; (2) has been granted a deviation or variance from existing quality as provided for in the Act; or (3) is subject to an order, permit, or other regulatory action that requires restoration or maintenance of groundwater quality at a different concentration level.

2.5. Director means the Director of the Division of Environmental Protection or the Director's authorized designee.

2.6. Groundwater means the water occurring in the zone of saturation beneath the seasonal high water table, or any perched water zones.

2.7. Impoundment means an area which is a natural topographic depression, man-made excavation, or diked area that is designed or improved in such a manner so as to hold an accumulation of contaminated surface runoff, process wastewater, product, or sewage, or any other liquid substance that could contaminate groundwater.

2.8. Liner means a continuous layer of natural or man-made materials beneath and on the sides of an area which restricts the downward or lateral escape of contaminants.

2.9. Permit means any license, certification, registration, permit, or any other approval granted by an agency authorized to regulate coal mining facilities or activities which may have an impact on groundwater.

2.10. Practice means any action which is protective of groundwater.

2.11, Secondary Containment means utilizing dikes, berms, synthetic or natural liner systems, double-walled containment vessels, or any combination thereof to prevent contaminants from accidentally discharging into the environment.

2.12. Exempted coal mining operations means those operations subject to the exemption set forth in W. Va. Code, §22-12-5(h), and which are of an earth disturbing nature resulting from and directly related to coal extraction. Exempted coal mining operations include: coal and slurry impoundments; refuse areas and on-site haulways.

§38-2F-3. Groundwater Protection Plans and Practices for Coal Mining Operations.

3.1. Hydrologic and water quality protection practices established under the authority of W. Va. Code §22-11 or W. Va. Code §22-3 and the legislative rules promulgated thereunder, were enacted in part to protect groundwater and are hereby incorporated by reference into this rule.

3.2. All coal mining operations which are not subject to the exemption set forth in subsection (h), Section 5 of the Act, shall conduct groundwater protection practices, and prepare and implement groundwater protection plans, as set forth in this mle. All exempted coal mining operations must conduct groundwater protection practices consistent with W. Va. Code §22-11-1et seq, and W. Va. Code §22-3-1 et seq. Exempted operations are not subject to the existing quality or to the related provisions of subsections (f) and (g), Section 5 of the Act. Further, exempted operations are not subject to water quality standards promulgated by the Environmental Quality Board pursuant to the Act. Such operations shall nonetheless be designed, constructed, operated, maintained, and closed in such manner as to reasonably protect groundwater from contamination.

3.3. Groundwater Protection Plans.

3.3.a. Each groundwater protection plan shall at a minimum contain the following:

3.3.a.l. An inventory of all operations and activities that are not exempted operations and may reasonably be expected to contaminate groundwater, and an indication of the current existence of and the potential for groundwater contamination. These include, but are not limited to, evaluation of materials handling areas, loading and unloading areas, equipment cleaning, maintenance activities, pipelines carrying contaminants, sumps and tanks containing contaminants.

3.3.a.2. A description of new and/or existing controls or activities to protect groundwater from the identified potential contamination sources.

3.3.a.3. Schedules and procedures for employee training addressing the prevention of groundwater contamination.

3.3.a.4. Provisions for inspections to be conducted by the operator at least every six *(6)* months to ensure that all elements of the coal mining operation's groundwater protection program are in place, properly functioning, and appropriately managed.

3.3.a.5. Groundwater monitoring procedures as deemed appropriate for the facility and/or as required by the Director.

3.3a.6. A discussion of all information reasonably available to the facility/activity regarding existing groundwater quality at, or which may be affected by, the site.

3.3.b. Within one year of the effective date of these rules all existing non-exempt coal mining operations shall complete and implement a groundwater protection plan; provided, that the groundwater protection plan shall be included with any new permit application submitted under W. Va. Code §22-3 or W. Va. *Code* §22-11, ninety (90) days or later after the effective date of these. rules or with any permit renewal application submitted one (1) year or more after the effective date of these rules; provided, further, that the Director may waive the requirement for a groundwater protection plan for an operation which has been granted Phase II bond release in accordance with W. Va. Code §22-3, if he finds that such is not necessary for the purposes of the

Act.

3.3.c. The groundwater protection plan may be integrated with the statement of probable hydrologic consequences and the hydrologic reclamation plan required by W. Va. Code §22-3 and rules promulgated pursuant thereto.

3.3.d. A copy of the groundwater protection plan shall be kept on-site, or at the operator's nearest readily accessible office, and shall be made available for review by the Director upon request. A copy or copies of the plan shall be provided for Division review and/or files upon request by the Director.

3.3.e. The Director may require modification to groundwater protection plans to assure adequate proteaion of groundwater. Further, the Director may during review of a groundwater protection plan require such other information as he reasonably needs to evaluate the plan.

3.3.f. In addition to the basic groundwater protection plan requirements, each plan shall address the specific requirements set forth in subsections 5 and 6 of this section to the extent the operation includes such areas or features.

3.3.g. Adherence to a groundwater protection plan does not relieve the facility/activity of any obligation to comply with any other state, federal or local rule, regulation, law or act.

3.4. Groundwater Protection Practices for Non-Coal Loading and Unloading Areas; Distribution and Bulk Facilities.

3.4.a. Loading and unloading stations including but not limited to areas used to load and unload drums, trucks, and railcars shall have spill prevention and control facilities and procedures, as well as secondary containment if appropriate or if otherwise required. Spill containment and cleanup equipment shall be readily accessible.

3.4.b. Distribution facilities and bulk containers shall be designed/installed in such a manner so as to prevent spills and leaks from contaminating groundwater.

3.5. Groundwater Protection Practices for Pipelines, Ditches, Pumps, and Drums.

3.S.a. Pipelines conveying materials which have the potential to contaminate groundwater shall preferentially be installed above ground.

3.S.b. Ditches shall not be installed as primary conveyances for materials which have the potential to contaminate groundwater unless provided with appropriate liners.

3.5.c. Pumps and ancillary equipment (e.g., valves, flanges, filters, condensate lines and instrumentation) handling materials that have the potential to contaminate groundwater shall be selected and installed to prevent or contain any spills or leaks.

3.5.d. Drums, containing materials that have the potential to contaminate groundwater, shall be stored so that spills and leaks are contained. Measures shall be taken to control drum deterioration and/or damage due to handling.

3.6. Groundwater Protection Practices for Sumps and Tanks.

3.6.a. Above-ground storage tanks shall have secondary containment that is appropriate considering the potential to contaminate groundwater. Such secondary containment shall be adequately designed and constructed to contain the materials for a time sufficient to allow removal and disposal without additional contamination of groundwater, but in no case will that time be less than seventy-two (72) hours.

3.6.b. Underground tanks containing materials which have the potential to contaminate groundwater shall be designed, constructed, and operated utilizing leak detection or secondary containment, or other appropriate controls that are capable of preventing groundwater contamination

3.6.c. New tanks containing materials

that have the potential to contaminate groundwater may only be installed underground for overriding safety, legal, security, or fire protection concerns.

3.6.d. Sumps containing materials which have the potential to contaminate groundwater shall be designed, constructed, and operated utilizing leak detection or secondary containment, or other appropriate controls that are capable of preventing groundwater contamination.

3.6.e. Secondary containment is not required for sumps and tanks used only as secondary containment for other facilities.

§38-2F-4. Monitoring.

4.1. Pursuant to W. Va. Code §22-3 and W. Va. Code §22-11, the Director may require placement and maintenance of a reasonable number of groundwater monitoring stations (such as piezometers, monitoring wells, or springs) at coal mining operations in order to monitor for groundwater contamination and water levels. Existing facilities not currently monitoring groundwater shall do so if required by the Director.

4.2. In addition to the base line groundwater information required by CSR 38-2-3.22 and monitoring required by CSR 38-2-14.7, the Director may require such other base line data and monitoring as he determines appropriate to meet the requirements of these rules or the Act. A waiver of groundwater monitoring granted under CSR 38-2-14.7(c) may operate as a waiver for the purposes of these rules and the Act if, in addition to the demonstration required by CSR 38-2-14.7(c), the applicant demonstrates and the Director finds in writing that monitoring is not necessary for the purposes of the Act or these rules.

4.3. Groundwater monitoring stations shall be located and maintained, or drilled, constructed, and maintained in a manner that allows accurate determination of groundwater quality and levels, and prevents contamination of groundwater through the finished well hole or casing.

4.4. Groundwater monitoring stations shall be designed and installed in accordance with applicable rules promulgated pursuant to the Act.

4.5. All groundwater monitoring stations shall be accurately located, utilizing latitude and longitude, by surveying or other acceptable means, and the coordinates shall be included with all data collected.

4.6. Data Management - The Director may at his discretion require submittal of any or all groundwater monitoring data collected in association with a regulated activity, and may further specify an electronic format in which the data is to be submitted.

§38-2F-5. Fees.

5.1. Coal mining operations shall be subject to the fee schedule and fee payment requirements as set forth in CSR 47-55-1 et seq. Failure to remit fees when and as due is a violation of these rules.

§38-2F-6. Prohibitions.

6.1. It shall be unlawful for any person, unless an authorization has been issued by a groundwater regulatory agency, to deliberately allow crude oil, or any petroleum product derived from crude oil, or septage, or natural gas, or salt water, or any chemical mixture which may contaminate groundwater to escape from any well, pipeline, impoundment, storage tank, treatment unit, equipment, or storage container, or to deliberately allow such materials to flow onto or under the land surface in a manner that could contaminate groundwater.

Note: 47CSR11 requires all spills and accidental discharges to be reported by calling 1-800-642-3074.

§38-2F-7. Enforcement.

7.1. Any person who violates the Act or these rules shall be subject to applicable civil and criminal penalties, injunctive relief, enforcement orders, and procedures as set forth in section 10 of the Act.

7.2. The appeal and review procedures set forth in section 11 of the Act shall be applicable to actions arising under these rules.

7.3. Civil penalties for violations of these rules shall be assessed by the Director in accordance with CSR 47-56.

7.4. Violations by a coal operator, arising from acts or omissions subject solely to these rules or the Act, shall not be counted toward a pattern of violations or in determining the history of violations pursuant to W. Va. Code §22-3, and rules pursuant thereto.

§38-2F-8. Remediation.

8.1. For all non-exempt coal mining operations, The Director may conduct or order other persons to conduct remedial actions which are appropriate to the type and extent of contamination, and which are subject to applicable permit conditions and variances and deviations from existing water quality and water quality standards that are allowed under the Act. The Director encourages agreements for investigation and cleanups in appropriate cases.

8.2. The use of permanent solutions to the maximum extent practical to correct groundwater contamination is preferred.

8.3 Cleanup actions shall not rely primarily on dilution and dispersion of the substance if active remedial measures are technically and economically feasible, as determined by the Director. Natural attenuation of groundwater contamination may be an appropriate remediation response.

8.4 Adequate groundwater monitoring shall be conducted to demonstrate control and containment of the substance. The Director shall specify which parameters should be monitored in a remedial operation. The groundwater monitoring must continue until results assure adequate remedial action was taken.

8.5. In addition to any required remediation, the Director may order the facility or activity to mitigate or compensate for the loss of beneficial use of groundwater, or for any significant adverse impact to groundwater.

§38-2F-9. Applicability of Requirements.

9.1. The Director may, to the extent authorized by the Act, waive some or all of the requirements of this rule upon determining in writing that such requirements are not necessary to protect groundwater from contamination.

§38-2F-10. Appropriateness Study.

10.1. The Environmental Protection Advisory Council shall conduct a study and report back to the Joint Committee on Government and Finance on or before November 1, 1995. The study shall be an evaluation of the appropriateness and effectiveness of these rules and shall include any recommendations, modifications, or alternatives thereto.

CODE OF WEST VIRGINIA

Chapter 22 - Articles 1, 4, 11, 12, 13, and 14

Chapter 22B - Article 1

June 10,1994

Bureau of Environment

Division of Environmental Protection

concurrence of such designated agencies or political subdivisions, as appropriate, are hereby authorized to be groundwater regulatory agencies for purposes of regulating such facilities or activities to satisfy the requirements of this article. In addition, the department of agriculture is hereby authorized to be the groundwater regulatory agency for purposes of regulating the use or application of pesticides and fertilizers. Where the authority to regulate facilities or activities which may adversely impact groundwater is not otherwise assigned to the division of environmental protection, the department of agriculture, the bureau of public health or such other specifically designated agency pursuant to any other provision of this code, the division of environmental protection is hereby authorized to be the groundwater regulatory agency with respect to such unassigned facilities or activities. The division of environmental protection shall cooperate with the department of agriculture and the bureau of public health, as appropriate, m the regulation of such unassigned facilities or activities.

(c) Within one year of the effective date of this article, the department of agriculture, bureau of public health and division of environmental protection shall promulgate m accordance with the provisions of chapter twenty-nine-a of this code such legislative rules as may be necessary to implement the authority granted them by this article.

(d) Groundwater regulatory agencies shall develop groundwater protection practices to prevent groundwater contamination from facilities and activities within their respective jurisdictions consistent with this article. Such practices shall include, but not be limited to, criteria related to facility design, operational management, closure, remediation and monitoring. Such agencies shall issue such rules, permits, policies, directives or any other appropriate regulatory devices, as necessary, to implement the requirements of this article.

(e) Groundwater regulatory agencies shall rake such action as may be necessary to assure that facilities or activities within their respective jurisdictions maintain and protect groundwater at existing quality, where the existing quality is better than that required to maintain and protect the standards of purity and quality promulgated by the board to support the present and future beneficial uses of the state's groundwater.

(f) Where a person establishes to the director that (1) the measures necessary to preserve existing quality are not technically feasible or economically practical and (2) a change m groundwater quality is justified based upon economic or societal objectives, the director may allow for a deviation from such existing quality. Upon the director's finding of (1) and (2) above, the director may grant or deny such a deviation for a specific site, activity or facility or for a class of activities or facilities which have impacts which are substantially similar and exist m a defined geographic area. The director's reasons for granting or denying such a deviation shall be set forth in Writing and the. director has the exclusive authority to determine the terms and conditions of such a deviation. To insure that groundwater standards promulgated by the board are not violated and that the present and future beneficial uses of groundwater are maintained and protected, the director shall evaluate the cumulative impacts of all facilities and activities on the groundwater resources m question prior to any granting of such deviation from existing quality. The director shall consult with the department of agriculture and the bureau of public health as appropriate m the implementation of this subsection. The director shall, upon a written request for such information, provide notice of any deviations from existing quality granted pursuant to this subsection.

(g) Should the approval required in subsection (f) of this section be granted allowing for a deviation from existing quality, the groundwater regulatory agencies shall take such alternative action as may be necessary to assure that facilities and activities within their respective jurisdictions maintain and protect the standards of purity and quality promulgated by the board to support the present and future beneficial uses for that groundwater. In maintaining and protecting such standards of the board, such agencies shall establish preventative action limits which, once reached, shall require action to control a source of contamination to assure that such standards are not violated. The director shall provide guidelines to the groundwater regulatory agencies with respect to the establishment of such preventative action limits.

(h) Subsections (e), (f) and (g) of this section do not apply to coal extraction and earth disturbing activities directly involved in coal extraction that are subject to either or both article three or eleven of this chapter. Such activities are subject to all other provisions of this article.

(i) This article is not applicable to groundwater within areas of geologic formations which are site specific to:

(1) The production or storage zones of crude oil or natural gas and which are utilized for the exploration, development or production of crude oil or natural gas permitted pursuant to articles six, seven, eight, nine or ten of this chapter; and

(2) The injection zones of Class II or III wells permitted pursuant to the statutes and rules governing the underground injection control program.

Public Concerns of MTR Mining Effects on Groundwater

Presented by: Rick Eades, Hydrogeologist, WV Citizen Action Group
Presented to: EIS Steering Committee Workshop Participants
May 9, 2000

Key GW Issues - Citizens are concerned that these issues are not addressed, or inadequately addressed, in the largest study ever undertaken to determine environmental impacts from MTR mining. Despite written and verbal requests to EIS overseers, citizens are unaware of meaningful studies to address these concerns.

1. Valley fills (one of the most controversial aspects of MTR mining)
   a. No wells planned or in use to *measure* GW fluctuations, flow rates, or chemistry
   b. No cluster wells to *measure* communication of VF GW with aquifers beneath the valleys
   c. Settlement issues, sorting and *eventual discrete plugging and channeling of GW*; potential for time delayed slope stability issues at discrete discharge points
   d. *Residence rime* and chemistry variations, *seasonally*
   c. Potential "bypassing" of surface water monitoring points, by GW discharge from VFs via *subsurface pathways* (seasonal considerations and chemistry impacts on GW and streams)

2. Water supply wells proximal to blasting
   a. No studies using supply wells (or uniformly constructed monitoring wells) with continuous chart recorders for water level fluctuations; while simultaneously using seismographs *to correlate ground vibrations to measured GW fluctuations*; proximal to actual blasting (at various distances, and considering different stratigraphic settings)
   b. GW chemistry of wells in deeper strata possibly sourced from old deep mines, and *blasting induced subsidence effects on* turbidity, flow, GW storage, delayed responses of subsidence
   c. Domino effect of potentially less *recharge* through sealed fractures after blasting on lowermost bench (function of high volume dust, mechanical compaction); or conversely, GW quality and turbidity issues if dust is mobilized via blasting fracture planes (near term impacts)

3. **Permanent GW** 'storage loss in **interburden/coal units** (up *to* 600+ feet removed in some areas)
   a. No monitoring of multiple units throughout sequence to be mined, prior to MTR; *baseline on GW in various interburden units and coal seams, storage, estimated discharge* to streams on dry seasonal periods
   b. Concern over claims that no water is in storage (from dry blast hole drilling), given that blasting in higher units could have dewatered lower ones
   c. Without an estimate of this loss, the *future environmental impacts on stream flows* (derived from GW contributions in various basins) cannot be understood
   d. If diminished GW contribution to *streams* in dry seasonal periods, and thereby lower stream flow, existing waste loading rates could lead to *surface water degradation* {collateral damage to environment from decreased GW storage and discharge to *streams)*

4. GW loss or impacts below the lowermost bench
   a. Per blasting concerns above, *dewatering of lower strata* is a concern via induced or enhanced fractures
   b. *Blasting induced subsidence,* when time delayed could alter GW in lower coal seams, both in terms of availability and quality
   c. *Recharge may not be occurring,* if fine grained particulate or dust and equipment operation are scaling fractures

5. Guidance for determining the point of origin of intermittent streams (v. ephemeral)
   a. Given the Haden ruling on buffer zones, all parties need to develop usable methods for delineating the point within a valley where a stream changes from ephemeral to intermittent; the EIS isn't likely to *identify changes in these delineations* relative in the context of recent droughts
   b. MTR and removal of GW within interburden and coal seams could result in less GW discharge and *changing of the point of origin of intermittent streams* (see lack of baseline GW information above); also relative to un-mined basins in the downdip direction

6. CW chemistry
   a. *Application rates, and fate and transport* of chemicals and fertilizers used in reseeding areas (during contemporaneous reclamation and for post mining applications) need to be determined or estimated
   b. The potential esists for *spills or discharges* of various other chemicals of concern, iiicluding fuels, waste oils, degreasers, etc.; the fate of these in terms of GW is unclear

7. The basic hydrogeologic regime represents a high degree of complexity
   a. Any useful study of GW conditions should span *at least one hydrologic year*
   b. The *droughts of 1987, 1988, 1998, and 1999* have to be accounted for in some capacity
   c. The behavior of *VF material as a pseudo-aquifer* is a "wildcard" in the long term
   d. subsidence in lower stratigraphic zones may be enhanced by MTR mining; enhanced fractures could contribute to discrete zones of weakness (relative to heterogeneous materials, material strength/competency variations, fracture frequency and aperture); so that subsidence could be a *significant long term collateral impact* of MTR mining in terms of GW availability and quality.

Summary statements:

Citizens are concerned that the above items are not being *direcily* addressed in the EIS.

Citizens are questioning the lack of commitment of resources *(money for monitoring wells, etc.)* to gain direct measurement to assess these potential environmental impacts.

The impacts suggested above seem to represent *reasonable concerns.*

In instances where indirect evidence *(anecdotal data from stream measurements)* is being used to characterize hydrogeologic impacts, the potential to miss very real and very significant long-term effects of MTR on groundwater further concerns citizens.

In summary, *citizens have a very low degree of confidence in the EIS to adequately characterize groundwater impacts from* MTR *mining* – and wish as many dollars were devoted to groundwater monitoring as have been allocated to study economic impacts.

Age of Ground Water in the Kanawha-New and Allegheny-Monongahela River Basins

West Virginia District USGS-WRD

National Water Quality Assessment

Mark D. Kozar, Hydrologist

Introduction

- Wells were sampled for chlorofluorocarbons (CFC's) from the Appalachian Plateaus Physiographic Province within the Kanawha-New and Allegheny-Monongahela River Basins of West Virginia, Maryland, and Pennsylvania.
- Wells sampled were primarily domestic homeowner and small public supply wells.
- CFC data was used to compute the age of the ground water in the wells sampled.

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CFC Ground Water Age Dating

- Chlorofluorocarbons (CFC's) were developed in the 1930's.
- CFC production and use has steadily increased since they were developed.
- First detectable concentrations of CFC's in the atmosphere occurred around 1940.
- CFC's can be used to date ground water.

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Henry's Law

- $C_i = K_h \times P_i$ where
- C_i is concentration in equilibrium with air in pm/kg (picomoles per kilogram.
- K_h is the Henry's Law constant, and
- P_i is the partial pressure of a gas in air. P_i is expressed as a volume fraction in parts per trillion (pptv).

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Topics of Discussion

- How Old is Ground Water in the Kanawha-New and Allegheny-Monongahela River Basins?
- What Factors Affect the Age of Ground Water in the region?
- How does mining affect age of ground water in fractured bedrock aquifers?

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Age of Ground Water in the Kanawha-New River Basin

- Water from hilltop wells ranged from 11 to 19 years and averaged 13 years in age.
- Water from hillside wells ranged from 10 to 42 years and averaged 29 years in age.
- Water from valley wells ranged from 19 to >57 years and averaged 42 years in age.

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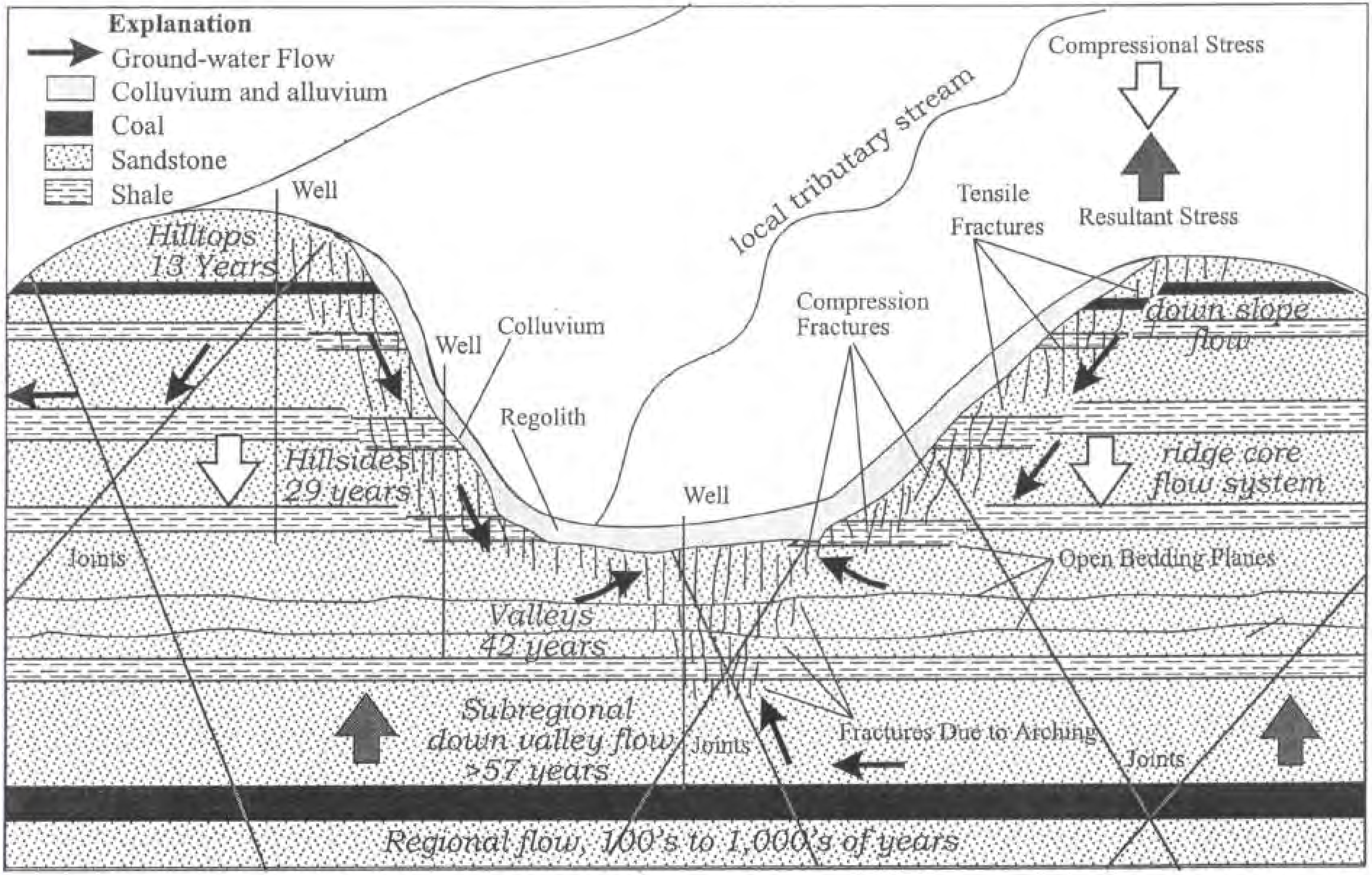

Figure 3. Revised conceptual model of ground-water flow in an Appalachian Plateaus fractured-bedrock aquifer including apparent age of ground water (Modified from Wyrick and Borchers, fig. 3.2-1, 1981 and Kozar, 1998).

Age of Ground Water in mined areas of the Kanawha-New River basin

- Hilltop wells could not be located for sampling as that portion of the hydrologic flow system typically is disturbed.
- Water from hillside wells ranged from 10 to 47 years and averaged 27 years in age.
- Water from valley wells ranged from 4 to >58 years and averaged 32 years in age.

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Age of Ground Water in mined areas of the Allegheny-Monongahela basin

- Water from hilltop wells could not be located in that portion of the hydrologic flow system which typically is disturbed.
- Water from hillside wells ranged from 11 to 57 years and averaged 30 years in age.
- Water from valley wells ranged from 13 to >57 years and averaged 29 years in age.

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Factors Affecting Age of Ground Water in the Region

- Topographic Setting (Water from valley wells is oldest, from hilltop wells is youngest, and from hillside wells is intermediate in age).
- No other factors including well depth, well yield, length of casing, water level, and distance from recharge area were found to be correlated with ground water age.

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Possible Factors Affecting Age of Ground Water in Mined Areas

- Lack of distinct topographic effects in the Allegheny-Monongahela basin may be due to lower relief and/or rolling topography.
- Surface mining may have altered normal ground-water flow patterns.
- Younger age of ground water in mined areas may be reflective of increased ground-water flow velocity due to enhanced permeability.

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What this Means

- Ground water in the region is much older than previously thought.
- Ground-water travel times within the region are therefore much longer than previously thought.
- Surface mining may alter natural ground-water flow processes resulting in increased ground-water flow velocitiy (younger age).

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Implications and Applications

- Conceptual models of ground water flow in fractured bedrock aquifers of the Appalachian Plateaus need to be revised based on the information revealed by CFC age dating.
- Regulations designed to protect ground water resources must address longer travel and residence times for ground water in fractured bedrock aquifers of the region.

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Future Considerations

- Additional data is needed to understand ground-water flow and age of ground water in deeper portions of the Appalachian Plateaus aquifers, especially in fractured bedrock below ridge tops.
- CFC data is also needed in areas of active surface and underground mining, especially in hilltop settings.

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Impacts of Blasting on Domestic Water Wells

Jay Hawkins
Workshop on Mountaintop Mining Effects on Groundwater
May 9,2000

Opening Statement:

I'm going to cover two areas of the impacts of blasting on domestic wells and associated aquifers. First, I will discuss my personal experiences with researching this problem. Second, I will review the studies of others on the subject. Then, I will summarize some thoughts and give some points for discussion.

I. My research. - I used to work at the U.S. Bureau of Mines researching ground and surface water problems related to surface and underground mining.

A. At the request of Mike Smith, District Mining Manager in the Hawk Run Office of the PADEP, I began looking at the blasting problem early in 1994. I shut the work down at the end of 1995 because of my departure from the Bureau. Many of you know that the Bureau was eliminated in 1996. During the short period of research, I did manage to instrument a few shots and conduct several aquifer tests, before, between, and after the blasts.

Incidentally, I have recently had discussions with the PADEP on the initiation of a new study on the impacts of blasting on ground water and wells.

My study site was in Clearfield Co. Pennsylvania (*Fig 1)*, a mountaintop job, similar topography to southern WV. Numerous well nests were completed across the site with 4 to 6 wells at each nest (*Fig 2)***.** Here are the well nests. The area that I will show data from is this nest here and the mining was initiated in this area.

B. Monitoring of Blasts was the first part of the study-

1. Wells were instrumented with pressure transducers wired to data loggers.

2. The wells initially instrumented included *(Fig 3)*

a. One well was completed similar to domestic water wells, i.e. an open borehole drilled to the top of the seat rock of the mined coal seam with 20 feet of casing installed at the top. This represented the water-table aquifer.

b. A second well was completed to the first coal seam below the one being mined (~60 feet). The well was cased all the way down with an open interval at the lower coal seam and the immediate roof rock. The remainder of the hole was properly grouted. This represented the first yielding unit below the water-table aquifer.

Figure 1

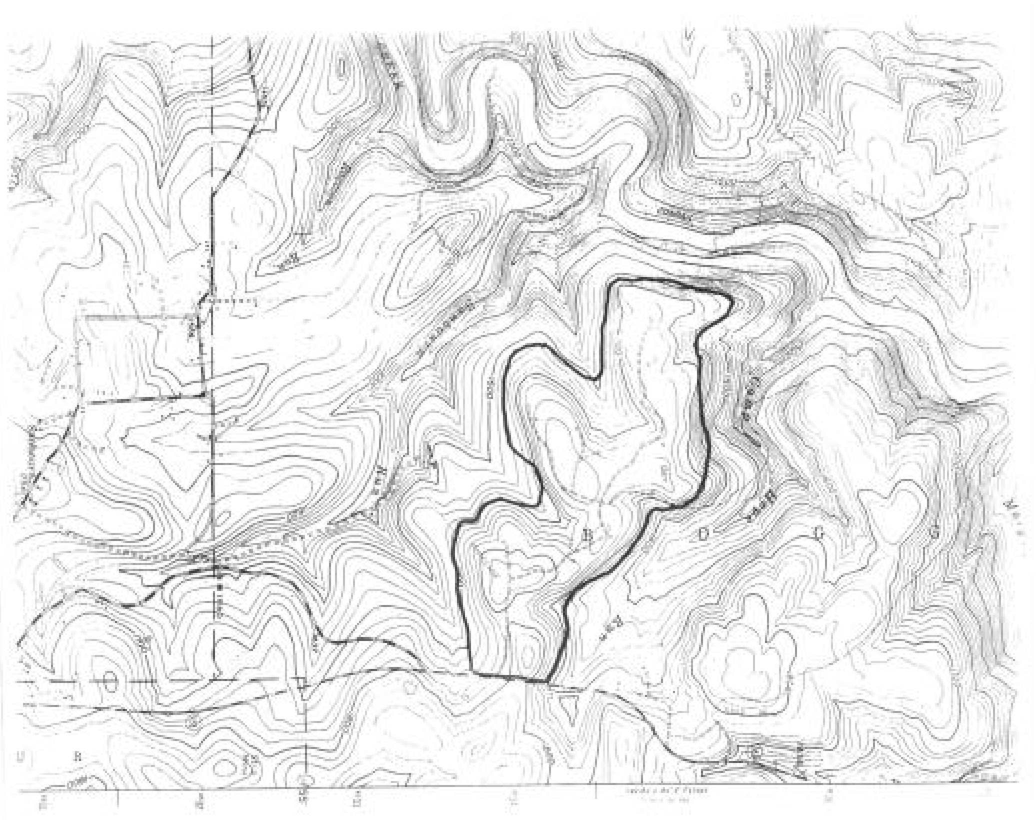
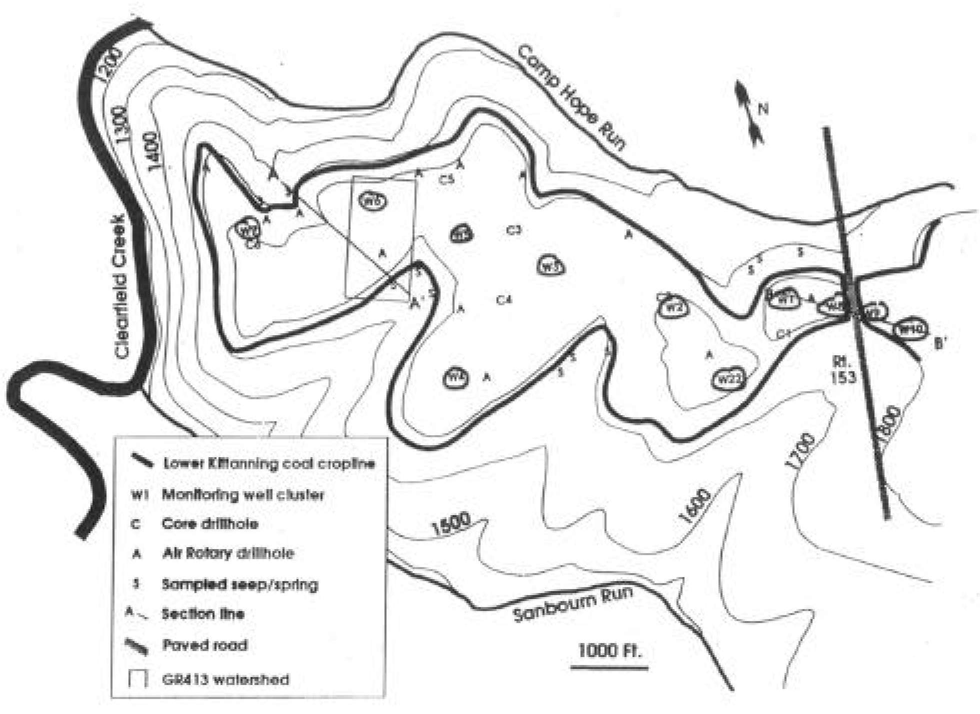


Figure 2



PEDA Kauffman Site Layout With Selected Borehole and Monitoring Well Locations.

3. The monitoring interval was every 15 seconds. Before, during, and for 15 to 20 minutes after the blast.

4. The shots ranged from 50 to 100 holes with approx. 60' of overburden.

5. The blasting was initially 900-1000 feet from the wells.

6. The graphs of the water level monitoring (figs. 4-6) show no noticeable ground-water level fluctuations that could be attributed to the blasting. The scale for observing changes was 1/100th of a foot. The blasting for the first 2 graphs occurred at about 15 minutes. The blasting occurred at about 5 to 7 minutes.

C. Aquifer testing was also conducted to determine impacts of blasts.

1. Types of tests: 1) Slug injection (falling-head test), 2) Slug withdraw, and Single well constant-discharge testing.

2. Conducted prior to the first shot, between shots, and after the shots. Some testing was performed after the pit was opened. But the well that was completed like a domestic well was eventually dewatered by the pumping at the open pit.

3. Results: No observable changes due to blasting were noted. However, expected seasonal variations are seen.

4. Other wells across the site and further away were also tested with similar results.

D. These results are very, very preliminary:

1. Blasting caused no noticeable water table fluctuations and the hydraulic conductivity was unchanged.

2. The pumping of the pit and encroachment of the highwall toward the wells dewatered the water table aquifer.

Results of Other Studies (published).

A. **D.A. Roberson (1988)** - Summarized two studies.

A study tested wells 150 feet from a blast. Scaled distance of 30 which is fairly high. Wells exhibited no quality or quantity impacts. Blast pressure surges ranged from 0.1 to 0.3 feet. (Montana). Not everything can be translated from this study to West Virginia, because the ground water hydrologic systems in Montana are radically different.

Conceptual Diagram of the Blasting Study

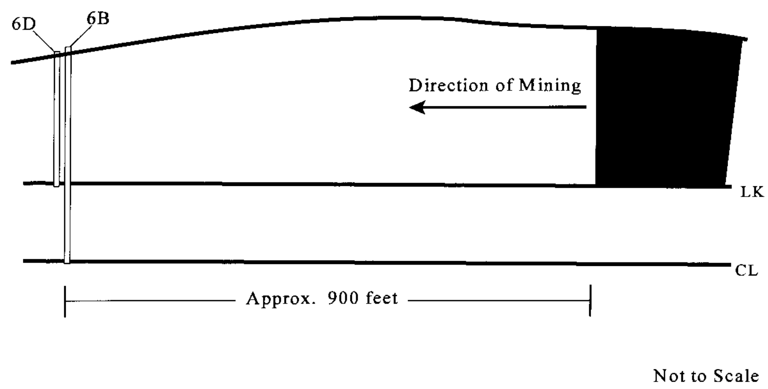


Figure 3

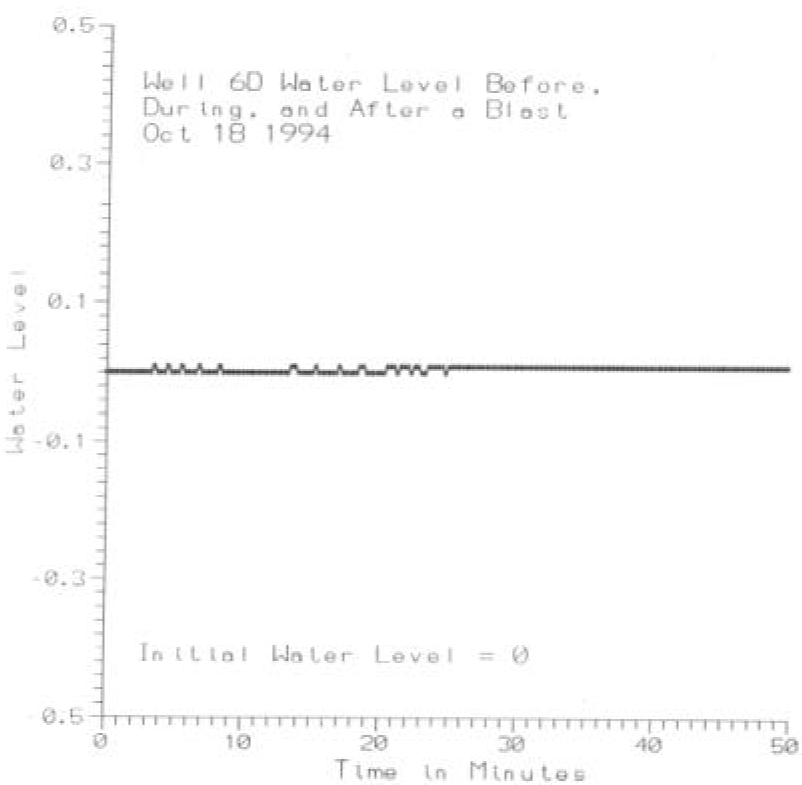


Figure 4

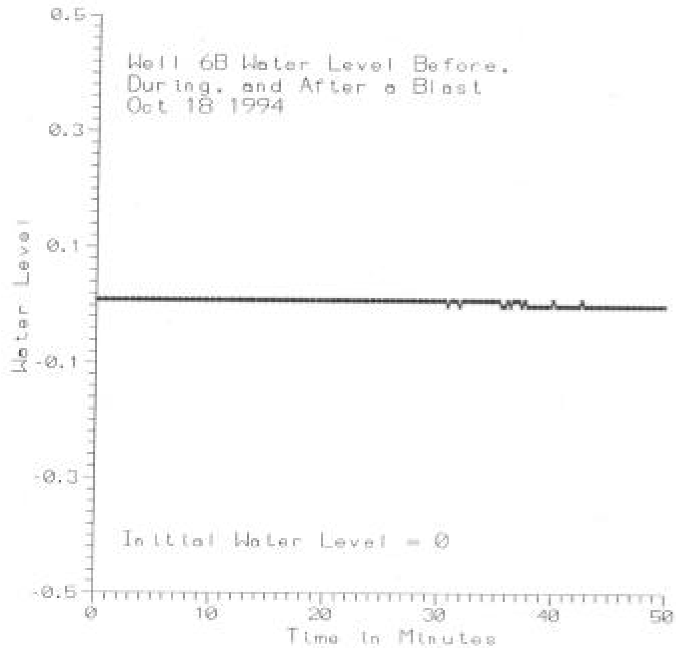


Figure 5

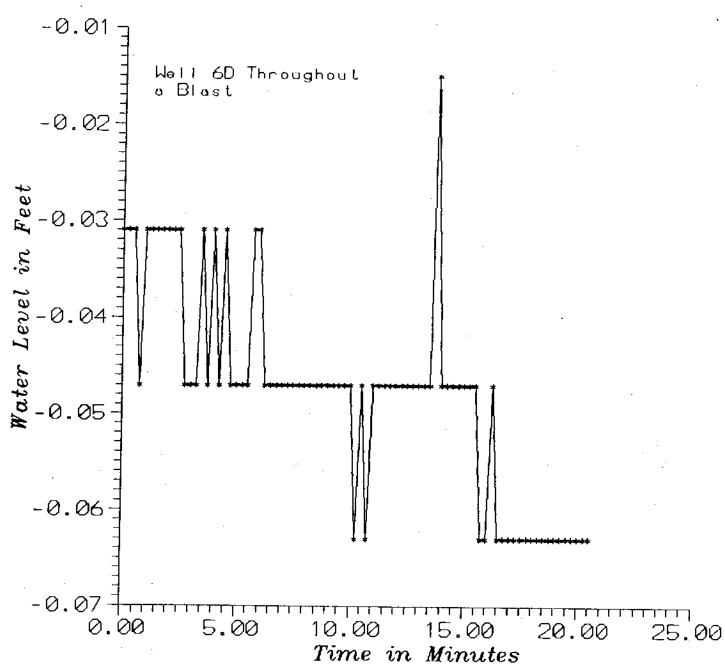


Figure 6

The other study (the Berger Study) observed ground-water impacts from manmade stress-release caused the rock mass removal during mining, but nothing from the blasting. The water quality and water levels were unaffected by the blasting. The “opening up” of the fractures lowered the ground-water levels by increasing the storage or porosity This work was conducted in West Virginia, Pennsylvania, and Ohio.

B. **D. E. Siskind and J. W. Kopp (1987)** - Based on the Berger work.

Looked at 36 case histories. Vibration levels up 2 in/s.

The well yield and aquifer storage improved as the mining neared the wells, because of the opening of the fractures from loss of lateral confinement, not blasting. This is similar to how stress-relief fractures form.

At one site the process was reversed after the mine was backfilled. They conjectured that the fractures closed back up or “fines” clogged the fractures. In my experience, it is doubtful the fractures clogged that quickly with fines. Ground water in the Appalachian Plateau moves very slowly and seldom carries anything but the finest suspended solids. It is more likely the fractures were recompressed.

They stated that blasting may cause some temporary (transient) turbidity similar to those events that cause turbidity without blasting.

Such as:

1. natural sloughing off inside of the well bore due to inherent rock instability. This can be accelerated by frequent over pumping. And is common to wells completed through considerable thickness of poorly consolidated and/or highly fractured claystones and shales.

2. significant rainfall events. The apertures of the shallow fractures that are intersected by a domestic well are commonly highly transmissive, thus will transmit substantial amounts of shallow flowing and rapidly recharging water. This water will commonly be turbid and can enter the well in high volumes. I have recorded water-level increases in the wells I was studying by over 50 feet in less than one hour from a large rainfall event. The lack of grouting of the near surface casing (~20 feet) commonly allows this to happen. Also, if the top of the well is not grouted properly surface water can enter along the side of the casing and flow down the annulus.

	Well 6D (simulated domestic water well)	
Testing Date	Hydraulic Conductivity (K) in m/s	Transmissivity (T) in m²/s
May 1994	4.74 x 10^{-6}	7.73 x 10^{-5}
----- Blast Occurred -----		
October 1994	3.28 x 10^{-8}	2.87 x 10^{-7}
----- Blast Occurred -----		
November 1994	3.59 x 10^{-6}	6.00 x 10^{-5}
August 1995	2.35 x 10^{-8}	1.76 x 10^{-7}

Table 1

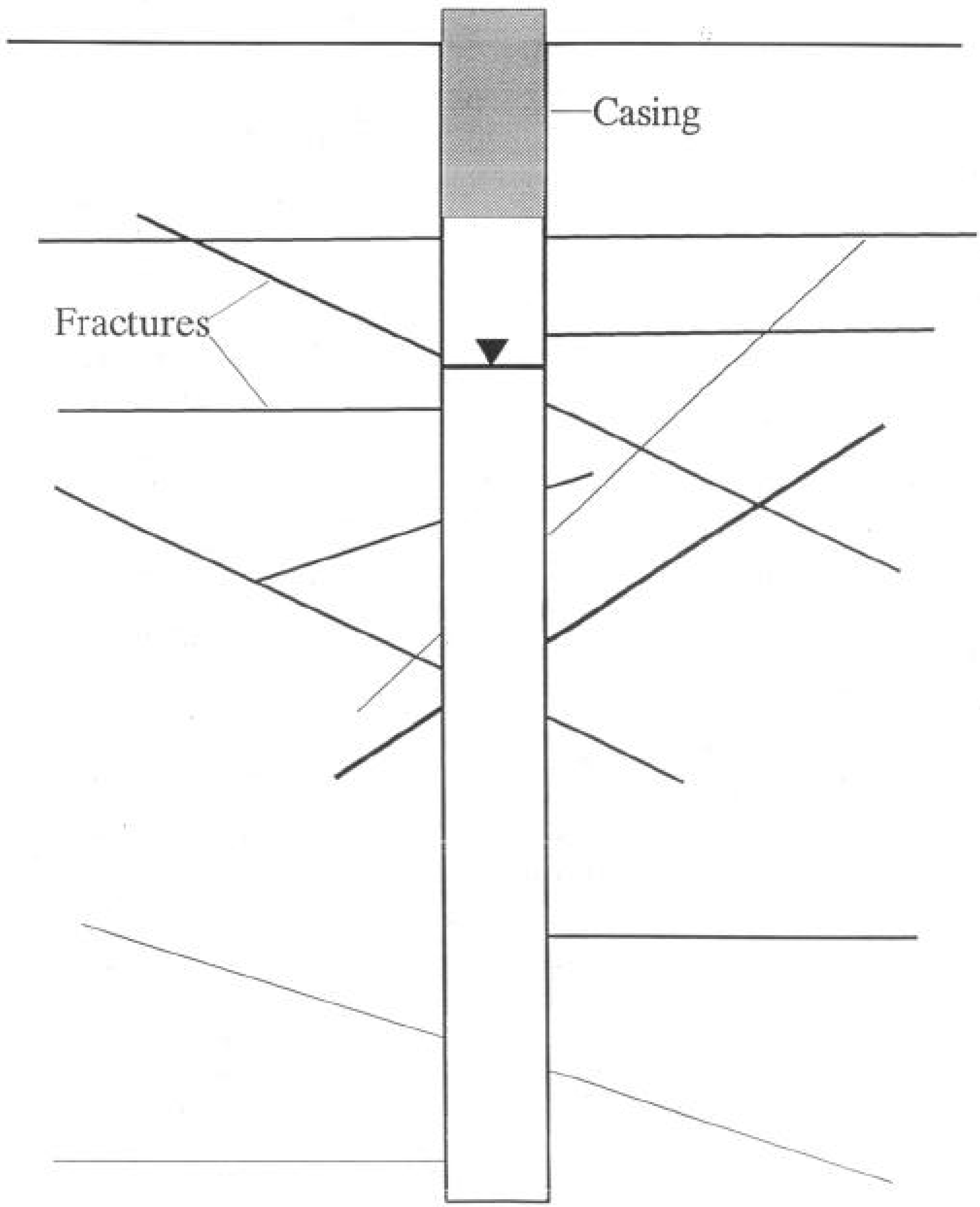


Figure 7

Siskind and Kopp (1987) recommended the use of well screens to prevent the sloughing of the well bore.

C. J.A. Kipp and J. S. Dinger (1991)

They recorded what they called “blasting shadows” in the shallow water table wells (70 and 71) and not in the deeper wells (80) accessing confined units *(fig 7*).

They said that “the shots were extremely strong”. They don’t say how close the blasting was to the wells.

Based on their graph the water level spikes ranged from about 0.2 feet to nearly 1.4 feet. Greater water level changes will be observed for the normal pumping of a domestic well or from infiltrating precipitation.

General Discussion:

1. Depending on the well construction, lithologic units encountered, and proximity to the blasting, I believe that some of the larger shots could act as a catalyst for some well sloughing or collapse**.** However, the well would have to be inherently weak to begin with. The small to moderate shots have not shown these to impact wells.

2. The minor water fluctuations attributed to blasting may cause a short term turbidity problem, but do not pose any long term problems. This fluctuation would not cause well collapse, as fluctuations from recharge and pumping occurs frequently.

3. Long term changes to the well yield are more likely due to the opening of fractures from loss of lateral confinement. Short term dewatering of wells is caused by the opening of the fractures creating additional storage. A longer term dewatering is caused by encroachment of the highwall and pumping of the pit water. The pit acts like a large pumping well.

4. I do not believe that long term water quality problems will be caused by blasting alone. With the possible exception of the introduction of residual nitrates, from the blasting materials, into the ground water system. The question arises what levels of nitrates are being seen in domestic wells hydrologically connected to a site? How long does it take before they are gone or return to baseline concentrations? I personally believe that natural attenuation will take care of most of the nitrites with in a short distance of the source over a short period of time.

5. Most of the long term impacts on water quality are due to the mining (the breakup of the rocks). The mechanisms of these changes (via pyrite oxidation) are well known. They increase the dissolved solids component especially sulfate, iron, manganese, aluminum, and sometimes sodium. Occasionally, other minor metals show up.

Where Do We Go From Here?

The nitrates question may need to be answered.
Perhaps pre-blast surveys of wells need to be conducted. This would include at least:

- Well testing. I recommend both a wet and dry season tests.
- Visual inspection with a borehole camera to determine the integrity of the well bore and the delivery system.

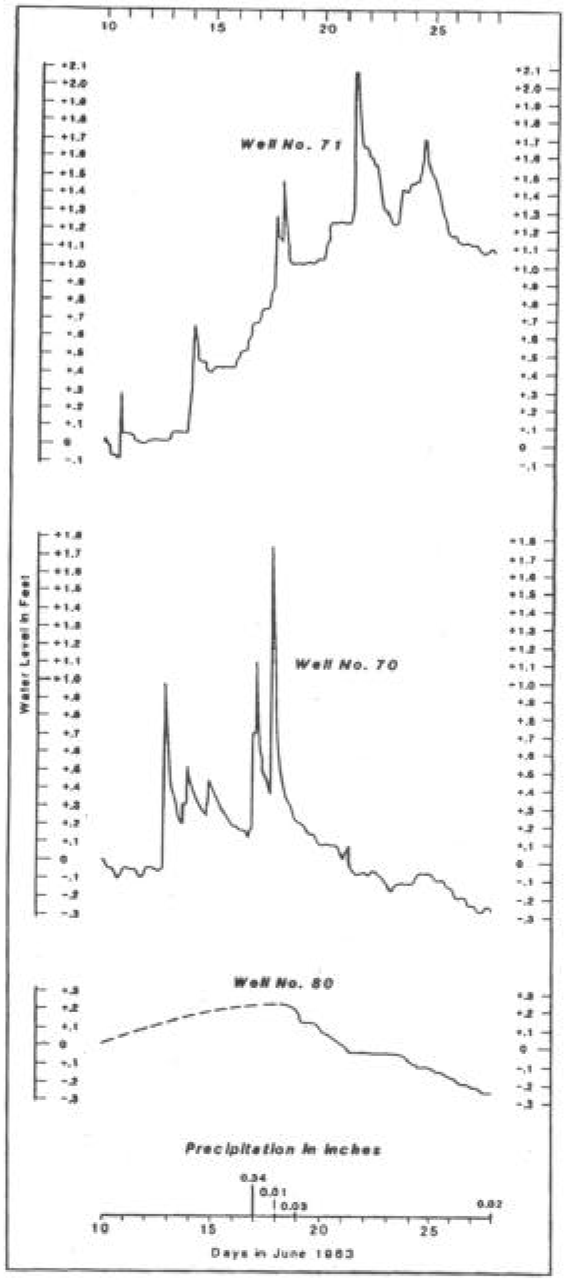
Water quality testing, 6 to 12 monthly samples. Both the wet and dry season need to be characterized.

Perhaps some maximum particle velocity or scaled distance needs to be established for well protection. For example, the Bureau of Mines stated particle velocities over 2.0 in/sec are likely to cause structure damage. Perhaps a scaled distance of 50 per shot delay, as suggested by the Bureau of Mines would work.

Restrict blasting on days with temperature inversions. The air blast tends to reflect off of the inversion and appear worse on these days.

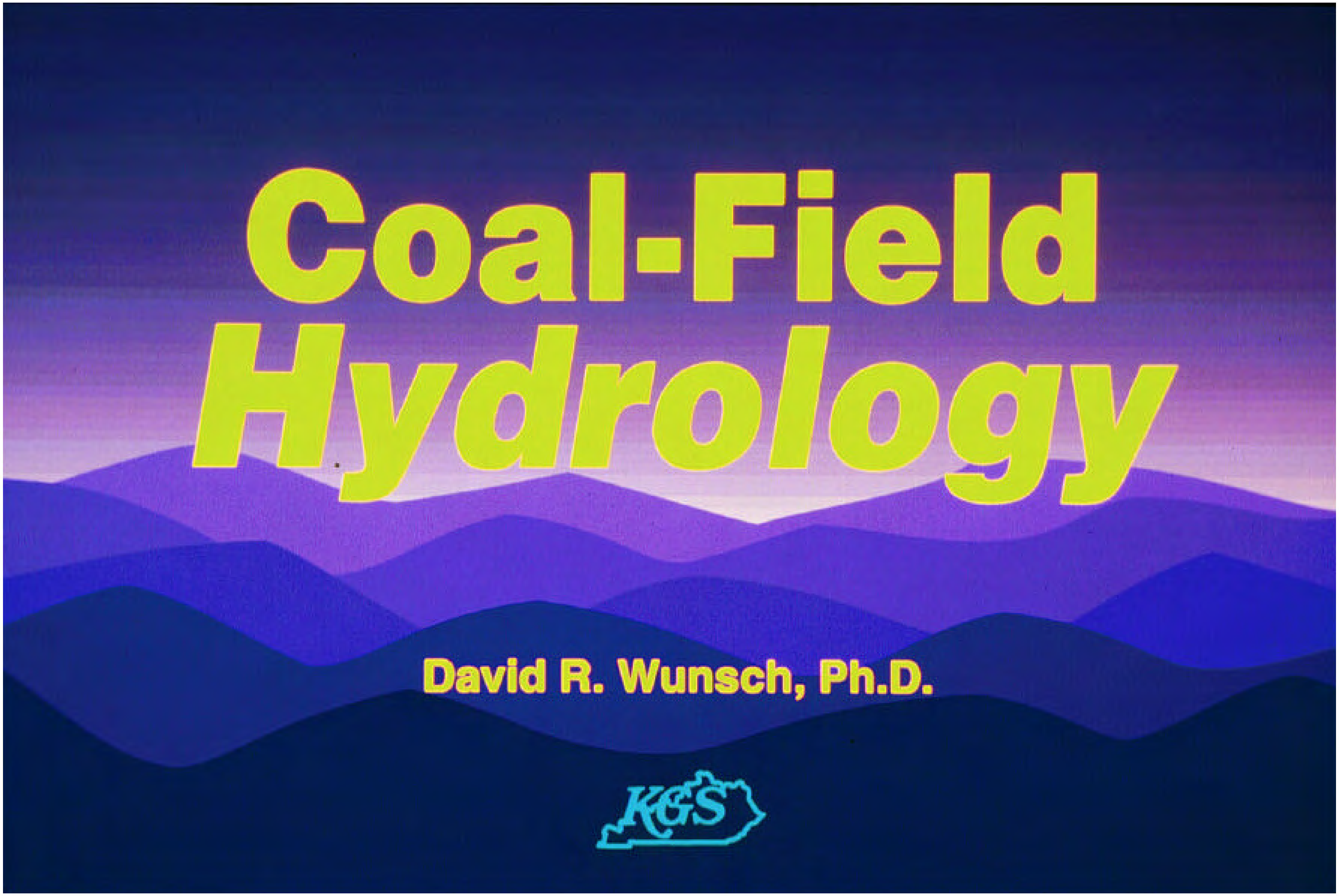
Some earthquakes have been shown to impact shallow ground-water flow in the Appalachian Plateau. An earthquake of 5.2 (which is fairly large) occurred in 1998 near Jamestown Pennsylvania. It is believed that it may have increased the hydraulic conductivity of certain units and dewatered some ridge top wells. However, an earthquake of this magnitude is much much larger than any shot for MTM would be. A rough equivalency for a magnitude 1.0 earthquake is 200,000 pounds of explosive per delay. A magnitude 5.0 earth quake is roughly 10,000 times greater than a 1.0 earthquake.

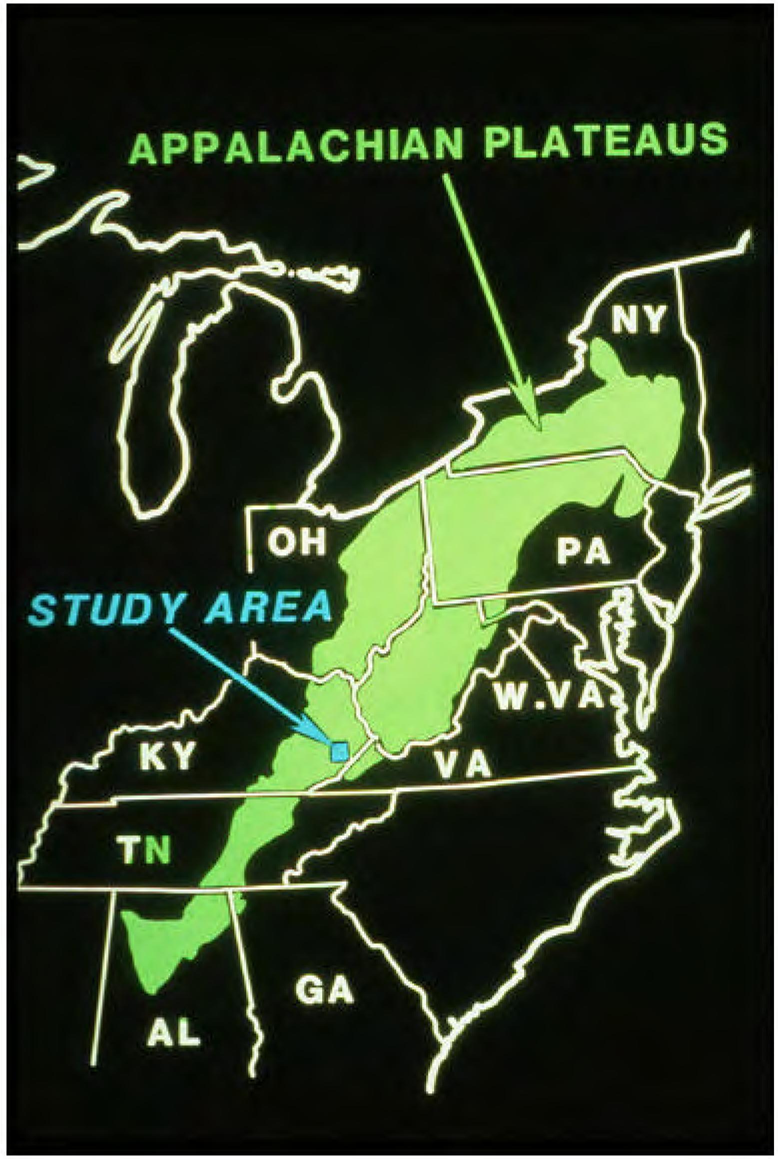
Figure 8

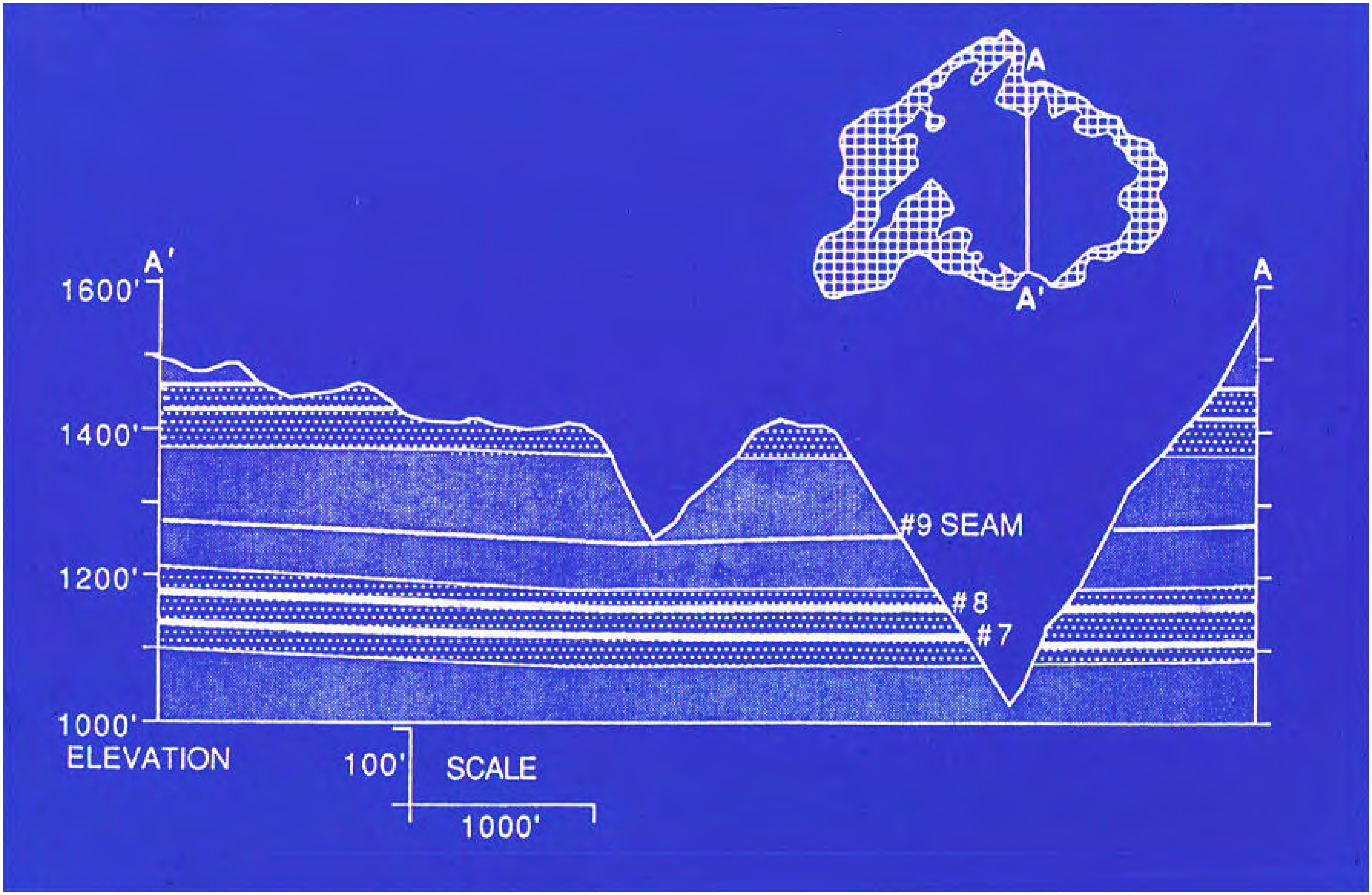


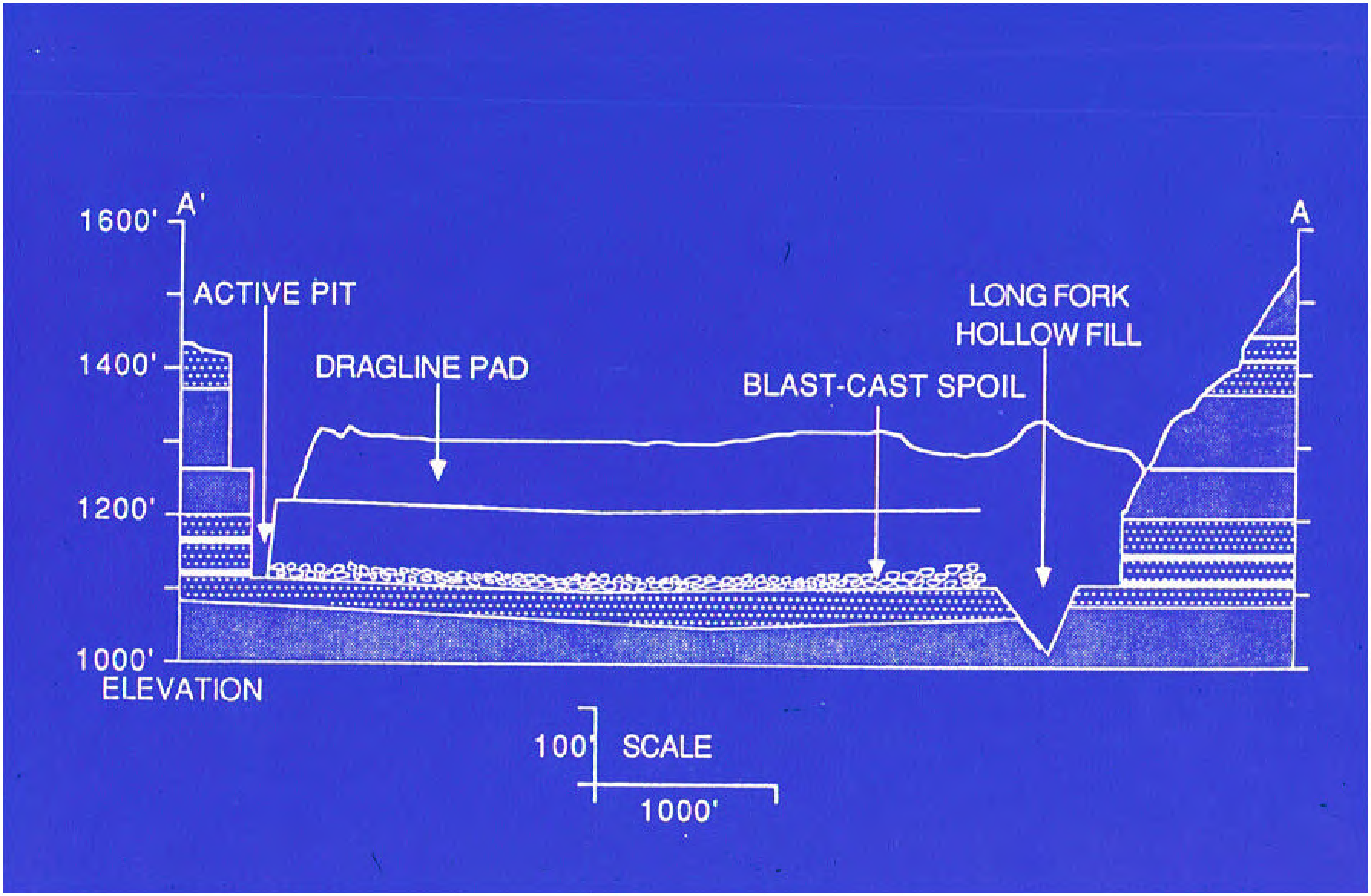
Hydrographs of wells 70,71 and 80 showing the effects of blasting.

After Kipp and Dinger (1991)

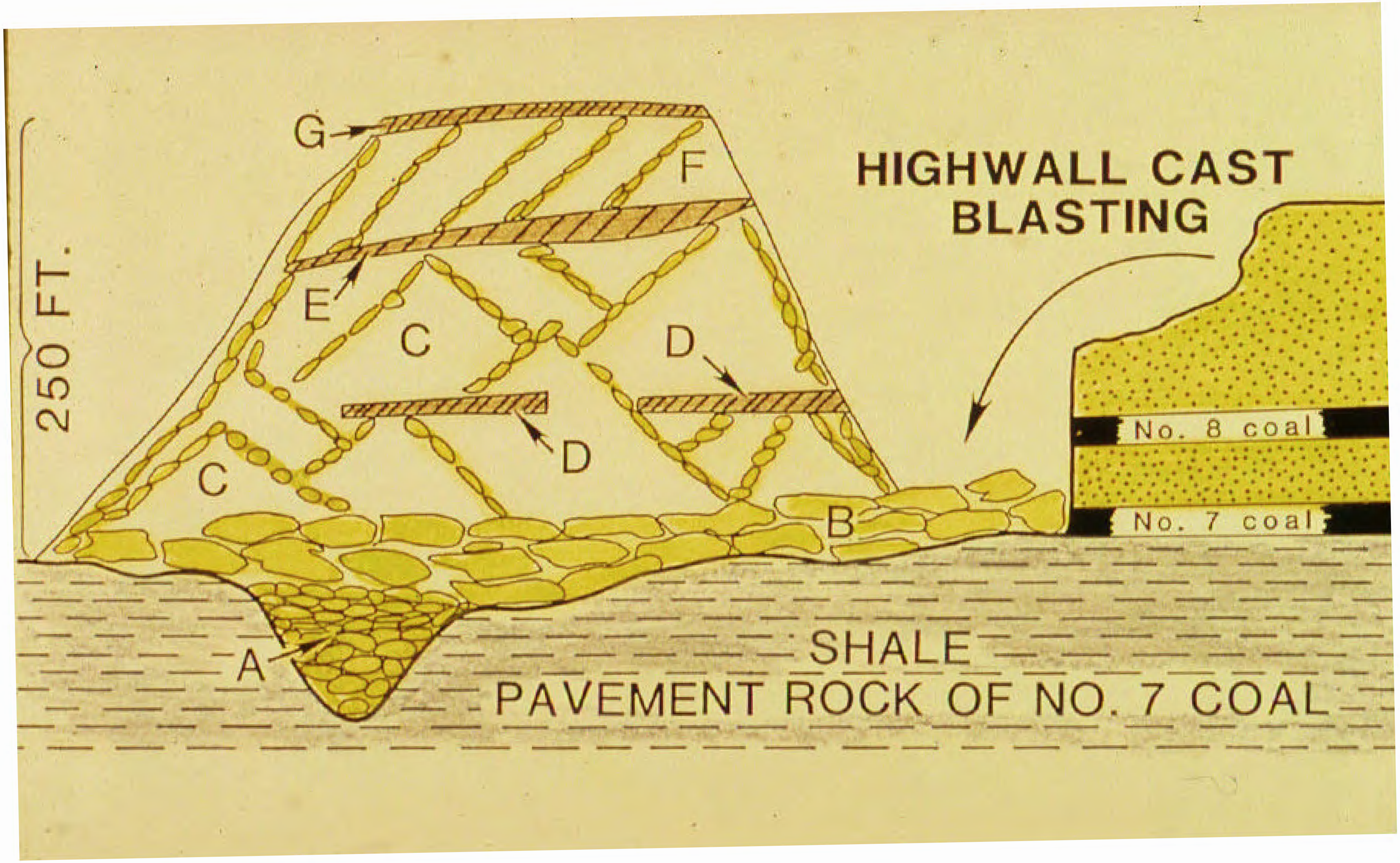

Coal-Field
Hydrology
David R. Wunsch, Ph.D.
KGS


APPALACHIAN PLATEAUS
NY
PA
OH
STUDY AREA
W.VA
KY
VA
TN
GA
AL

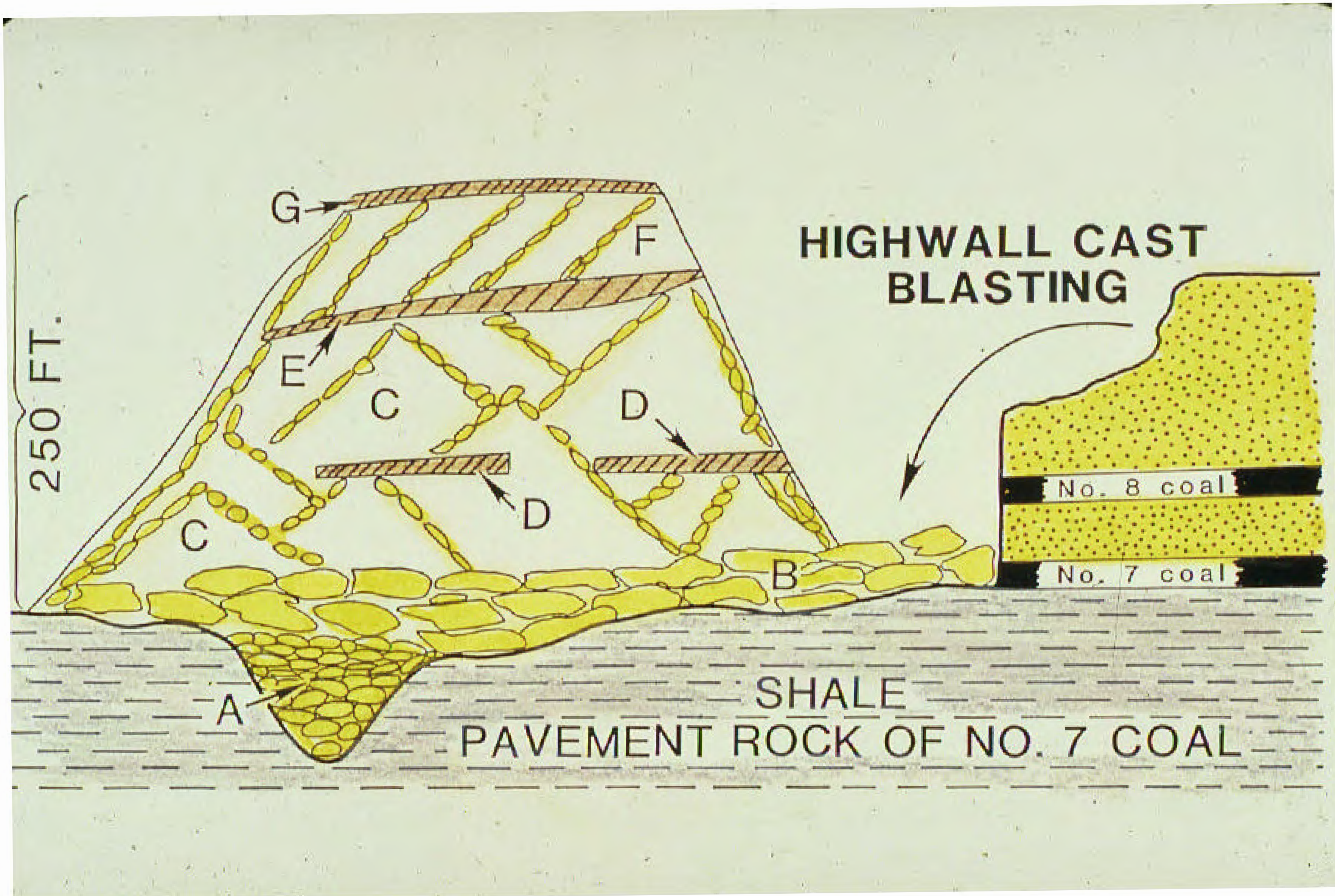

A
A'
A'
A
1600'
1400'
1200'
1000'
ELEVATION
#9 SEAM
#8
#7
100'
SCALE
1000'



A'
A
1600'
1400'
1200'
1000'
ELEVATION
ACTIVE PIT
DRAGLINE PAD
BLAST-CAST SPOIL
LONG FORK
HOLLOW FILL
100'
SCALE
1000'



HIGHWALL CAST
BLASTING
250 FT.
G
F
E
C
D
D
C
B
A
No. 8 coal
No. 7 coal
SHALE
PAVEMENT ROCK OF NO. 7 COAL



HIGHWALL CAST
BLASTING
250 FT.
G
F
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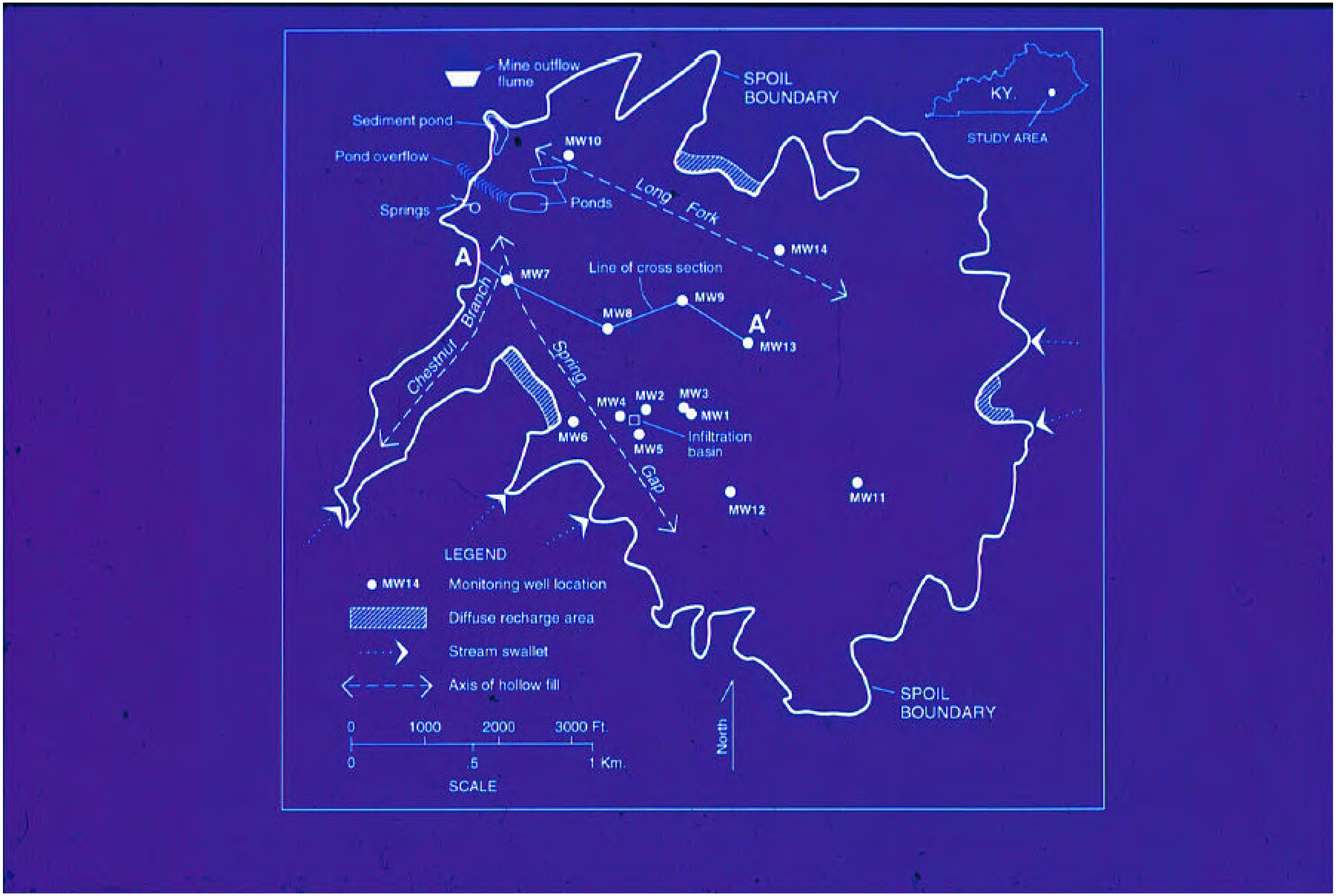
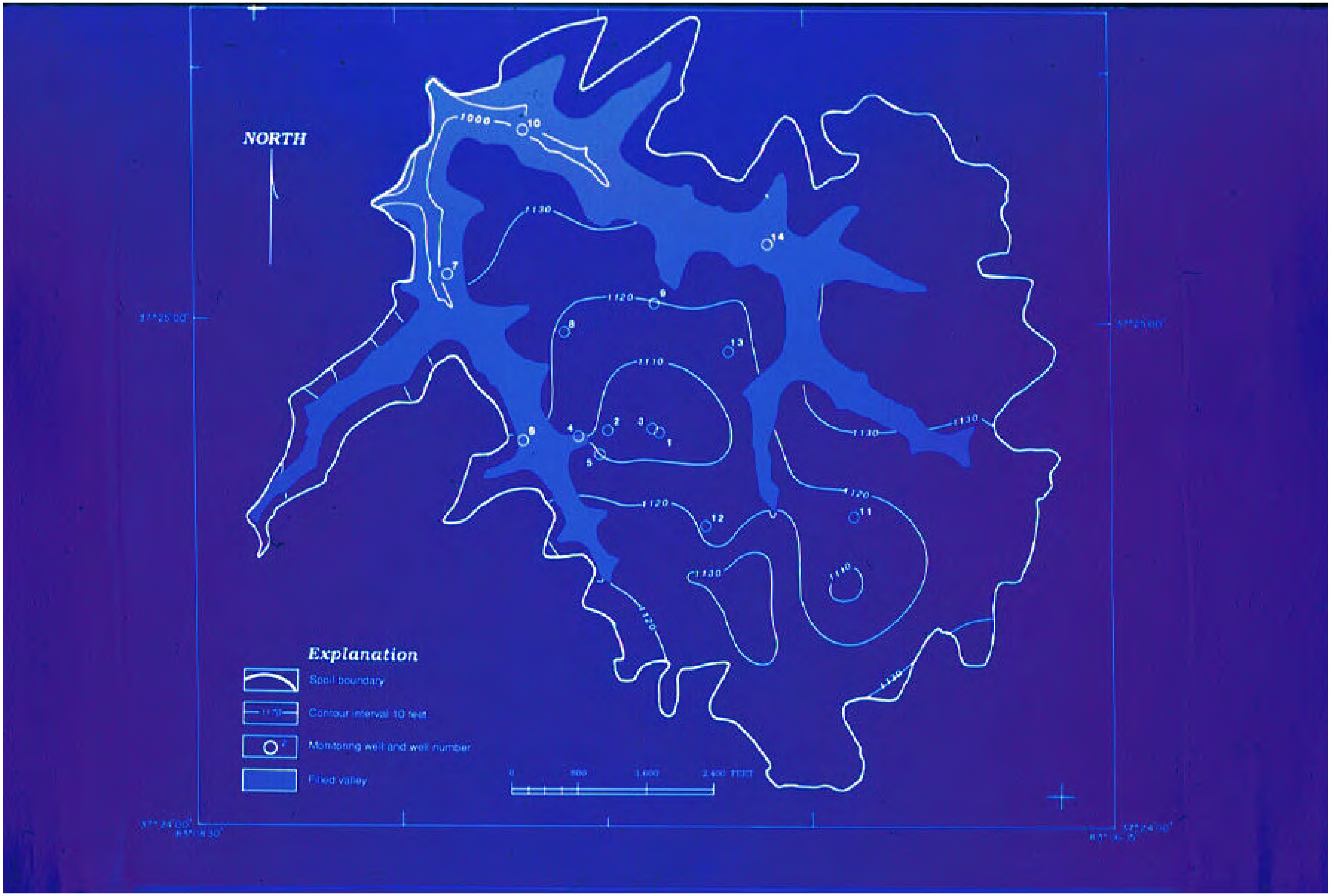
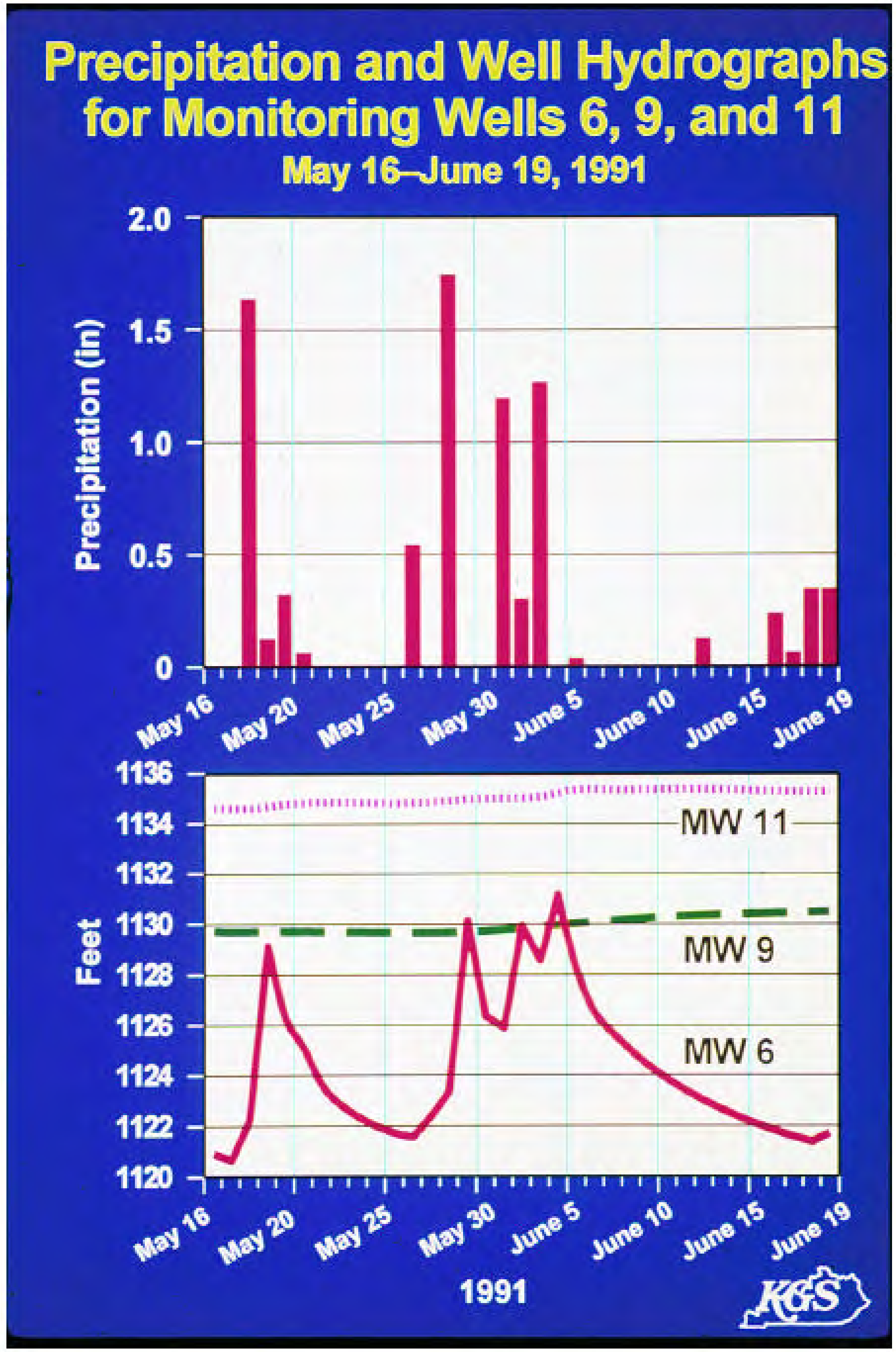
No. 8 coal
No. 7 coal
SHALE
PAVEMENT ROCK OF NO. 7 COAL

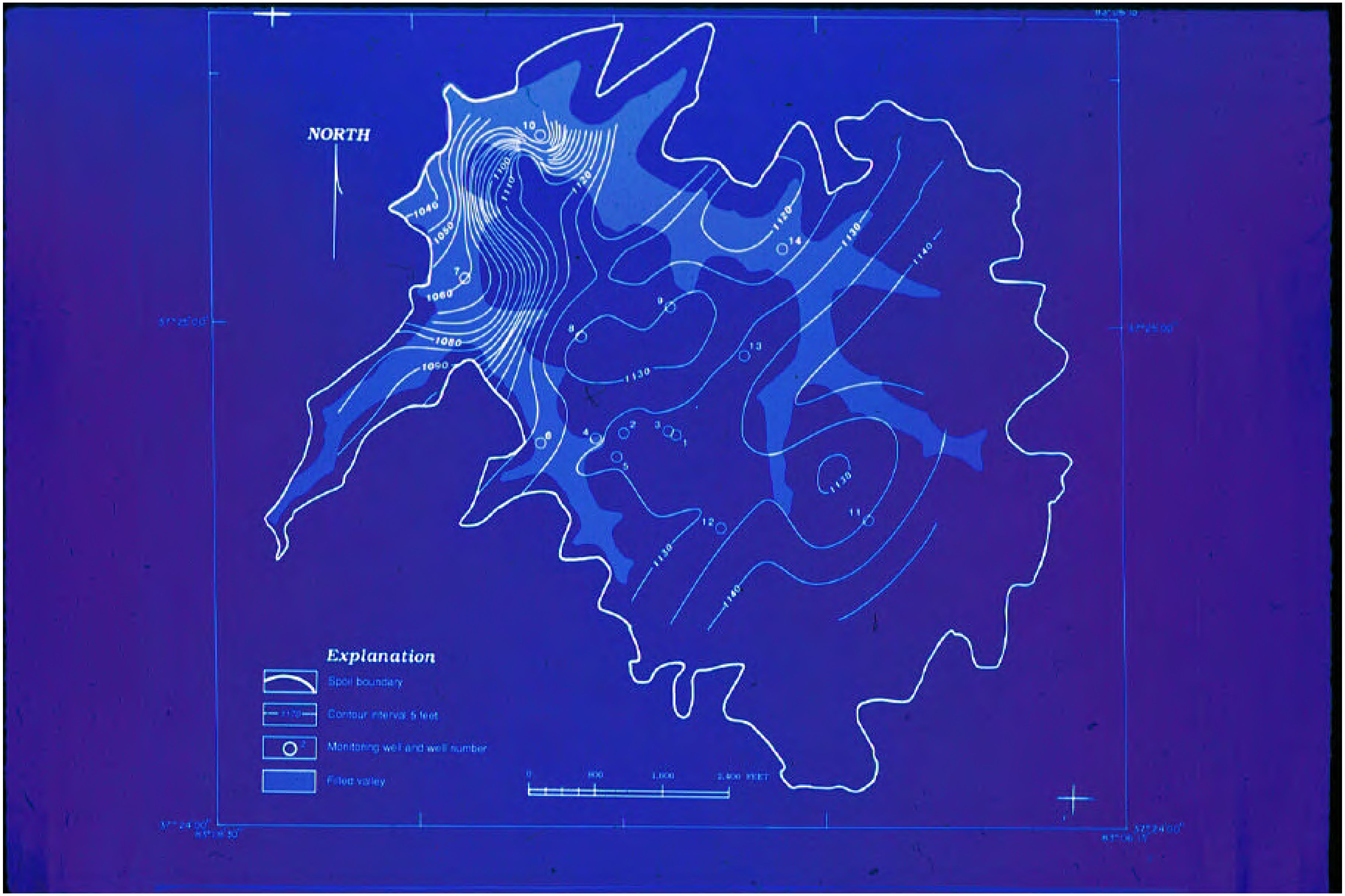

VOLVO

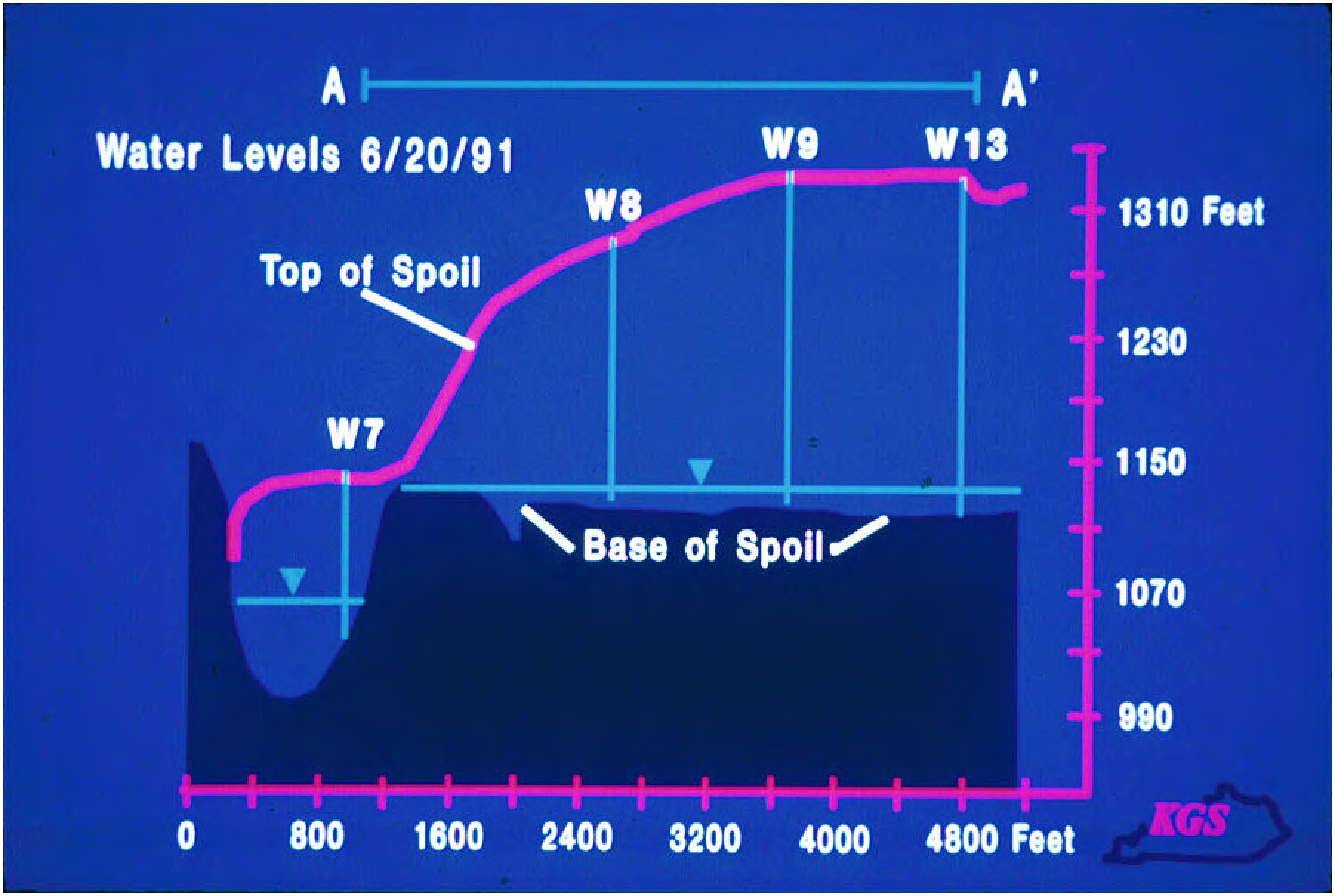


Mine outflow flume
SPOIL BOUNDARY
KY.
STUDY AREA
Sediment pond
MW10
Pond overflow
Ponds
Long Fork
Springs
MW14
A
MW7
Line of cross section
MW9
MW8
A′
MW13
Chestnut Branch
Spring
MW4
MW2
MW3
MW1
MW6
MW5
Infiltration basin
Gap
MW12
MW11
LEGEND
MW14 Monitoring well location
Diffuse recharge area
Stream swallet
Axis of hollow fill
0 1000 2000 3000 Ft.
0 .5 1 Km.
SCALE
North
SPOIL BOUNDARY


NORTH
Explanation
Spoil boundary
Contour interval 10 feet
Monitoring well and well number
Filled valley
0
800
1,600
2,400 FEET
1000
1130
1120
1110
1130
1120
10
14
7
9
8
13
6
4
2
3
1
5
12
11


Precipitation and Well Hydrographs for Monitoring Wells 6, 9, and 11
May 16–June 19, 1991
Precipitation (in)
2.0
1.5
1.0
0.5
0
May 16
May 20
May 25
May 30
June 5
June 10
June 15
June 19
Feet
1136
1134
1132
1130
1128
1126
1124
1122
1120
MW 11
MW 9
MW 6
May 16
May 20
May 25
May 30
June 5
June 10
June 15
June 19
1991
KGS


NORTH
Explanation
Spoil boundary
Contour interval 5 feet
Monitoring well and well number
Filled valley
0
1,000
FEET



A
A'
Water Levels 6/20/91
W7
W8
W9
W13
Top of Spoil
Base of Spoil
1310 Feet
1230
1150
1070
990
0
800
1600
2400
3200
4000
4800 Feet
KGS

Saturated Thickness in Monitoring Wells in June 1991

Wells Placed Over Hollow Fills			*Spoil-Interior Wells*		
Well ID	*Saturated Thickness*	*Water Elevation*	*Well ID*	*Saturated Thickness*	*Water Elevation*
			2	21.0	1,132.0
			3	10.1	1,131.6
			5	23.1	1,132.4
4	24.5	1,128.4	8	10.6	1,131.1
6	23.7	1,121.6	9	9.5	1,130.4
7	27.1	1,059.5	11	17.6	1,135.3
10	37.1	1,048.8	12	16.7	1,133.1
14	38.0	1,123.0	13	14.7	1,131.5
n=5 range=23.7–38.0 median=27.1 mean=30.1			n=8 range=9.5–23.1 median=15.7 mean=15.4		

KGS

Hydraulic Conductivity in Monitoring Wells, Measured by Slug Tests

Well No.	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/sec)
MW 4	7.0×10^{-5}	2.0×10^{-6}
MW 5	$>8.2 \times 10^{-4}$	$>2.7 \times 10^{-5}$
MW 7	2.0×10^{-5}	8.0×10^{-6}
MW 8	$>7.3 \times 10^{-4}$	$>2.4 \times 10^{-5}$
MW 9	4.0×10^{-5}	1.0×10^{-6}
MW 10	$>9.0 \times 10^{-4}$	$>2.9 \times 10^{-5}$
MW 12	4.0×10^{-4}	1.0×10^{-5}
MW 13	$>5.8 \times 10^{-4}$	$>1.9 \times 10^{-5}$
MW 14	2.0×10^{-4}	8.0×10^{-6}

KGS

HYDRAULIC CONDUCTIVITY OF MINE SPOIL (CM/S)

WUNSCH AND DINGER (1994)	2.0 x E-5 to >9.0 x E-4
OERTEL AND HOOD (1983)	4.6 x E-5 to 2.1 x E-2
HERRING AND SHANKS (1980)	4.6 x E-5 to 4.8 x E-2

KGS

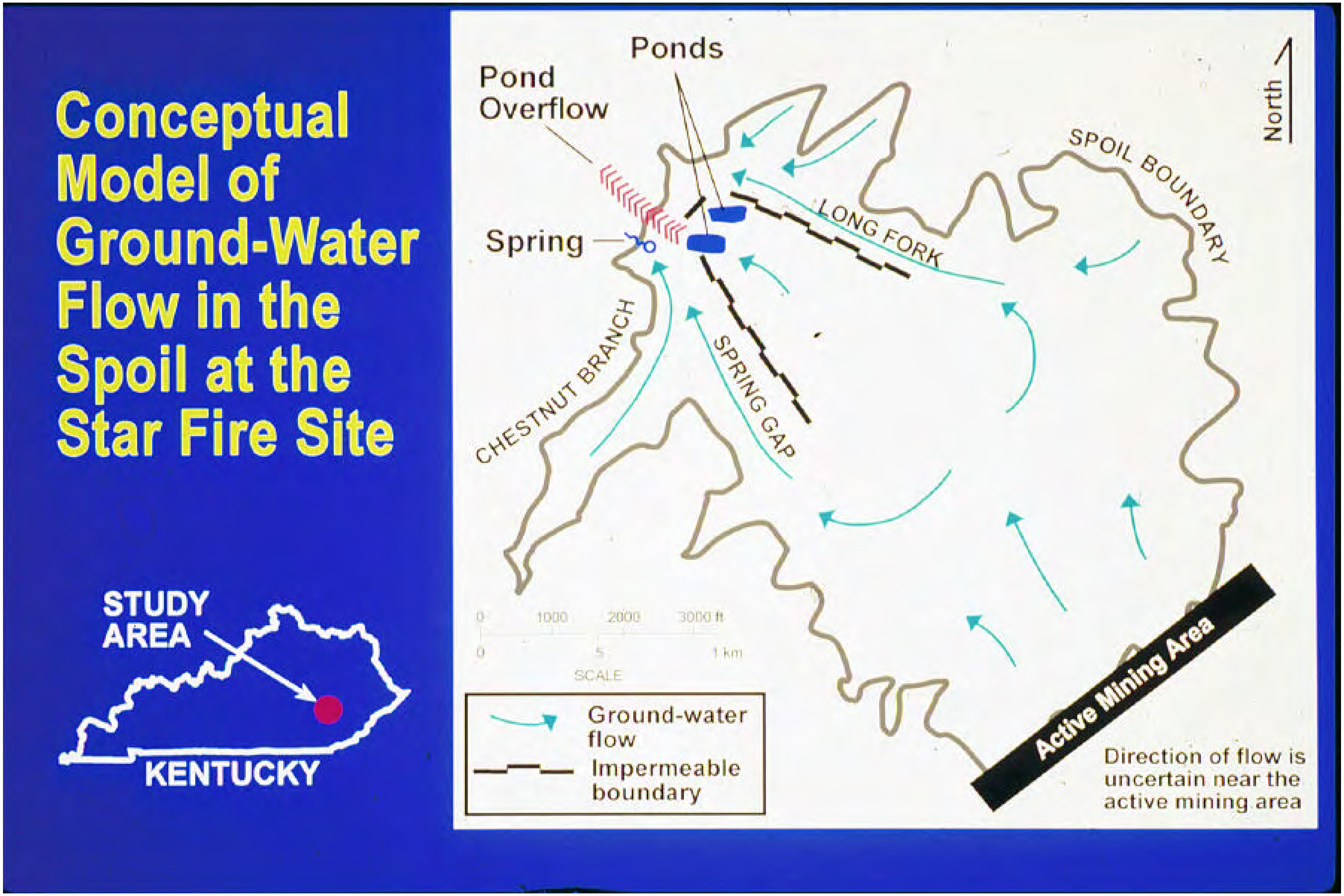
Mass-balance calculations:

$$Qt = Qpo + Qcb + (Qsp - Qcb) + Qlf$$

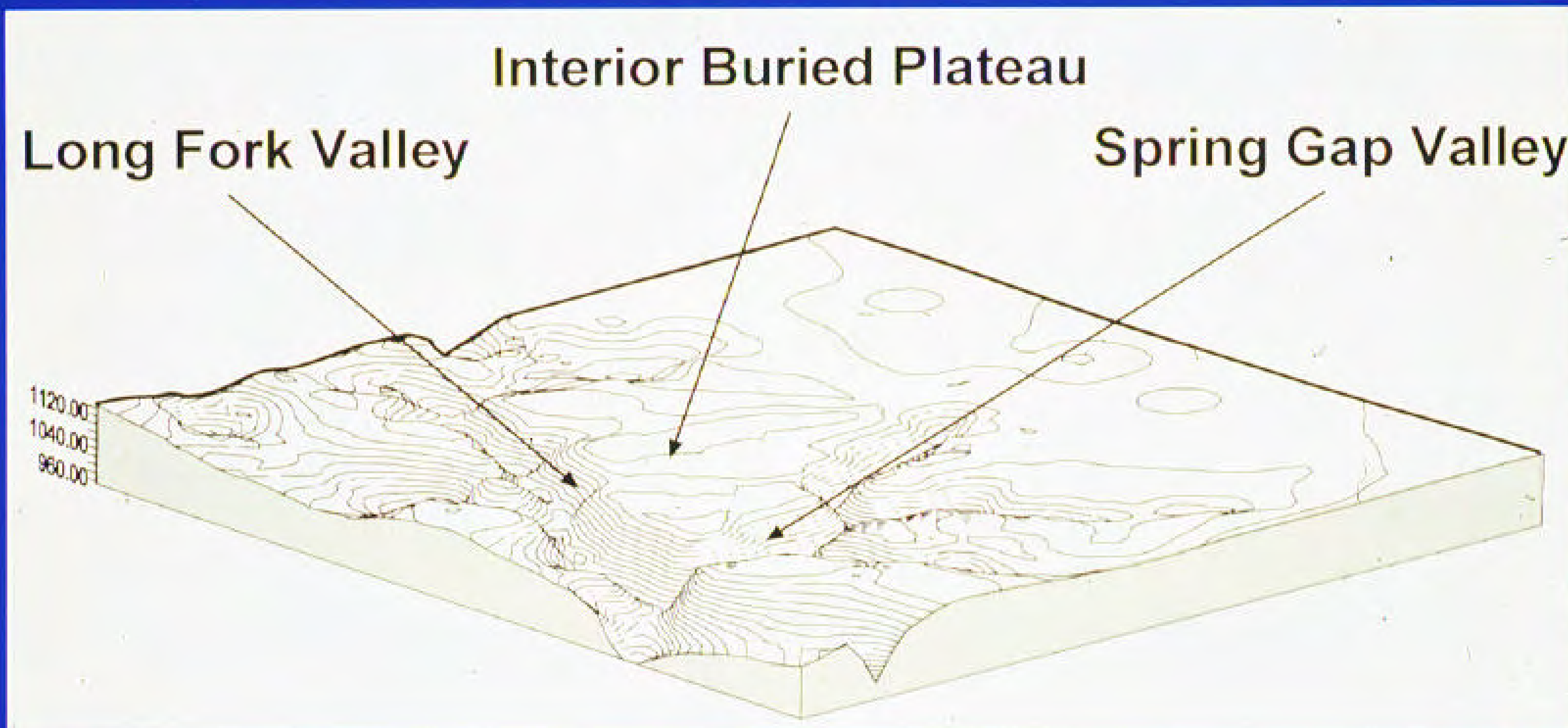
where:

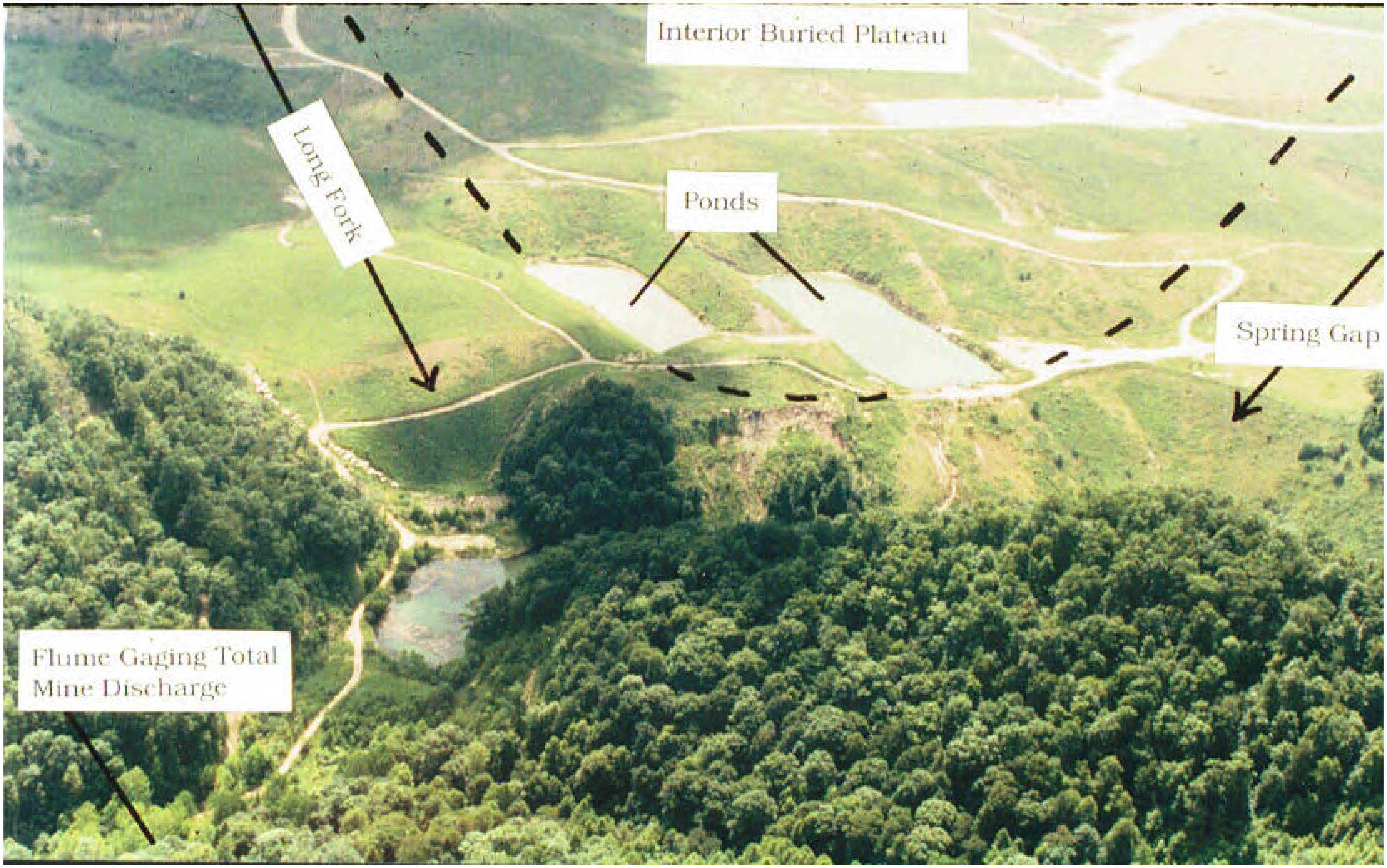
Qt = measured total mine discharge at Long Fork flume
Qpo = measured discharge of the pond overflow
Qcb = measured discharge from Chestnut Branch
Qsp = measured discharge at Spring Gap Spring
Qlf = calculated total mine discharge at Long Fork Spring

KGS


Conceptual Model of Ground-Water Flow in the Spoil at the Star Fire Site
STUDY AREA
KENTUCKY
Ponds
Pond Overflow
Spring
North
SPOIL BOUNDARY
LONG FORK
CHESTNUT BRANCH
SPRING GAP
0 1000 2000 3000 ft
0 .5 1 km
SCALE
Ground-water flow
Impermeable boundary
Active Mining Area
Direction of flow is uncertain near the active mining area

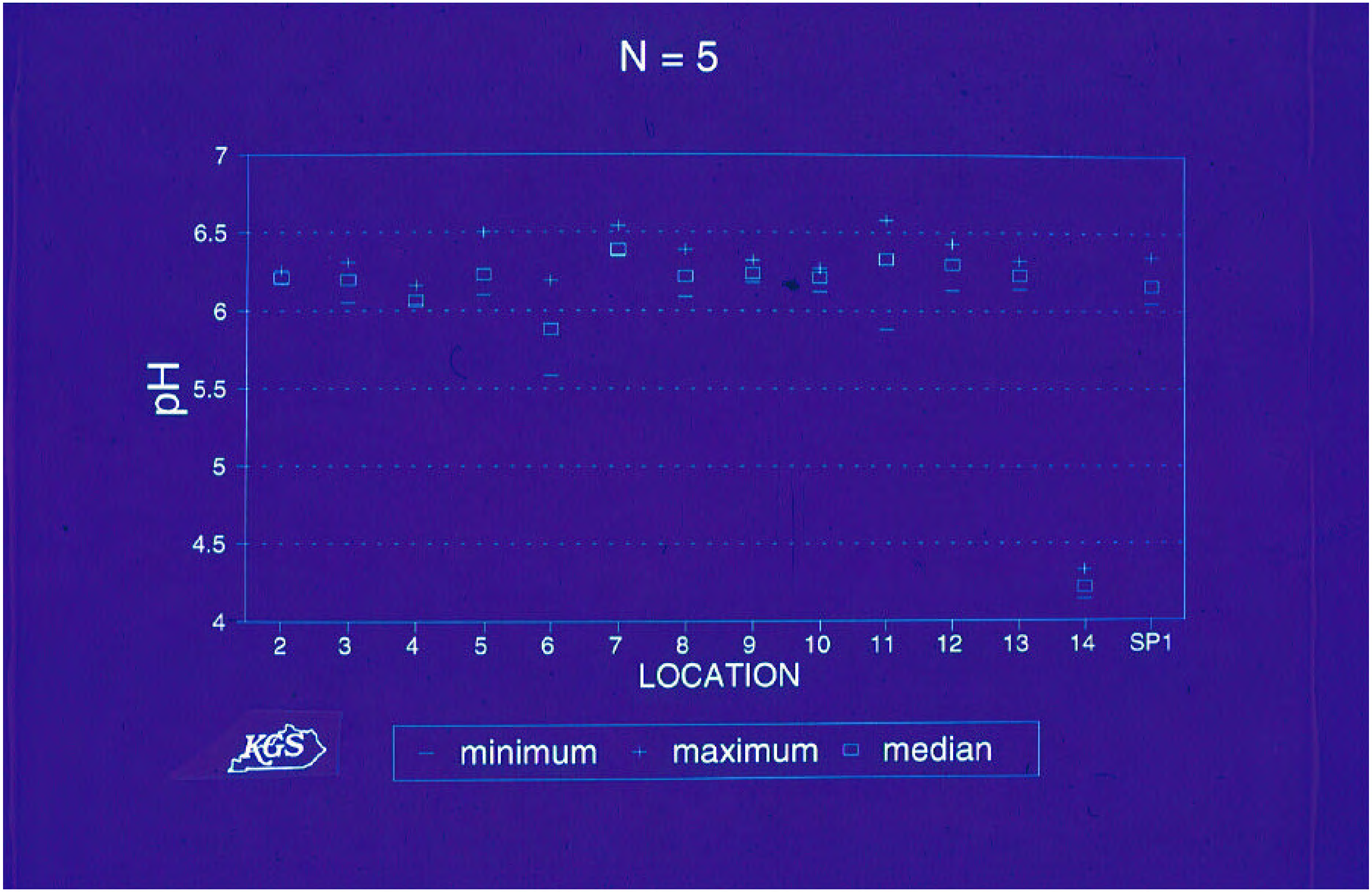
Digital Terrain Model Showing the Bedrock Topography Buried Beneath the Spoil



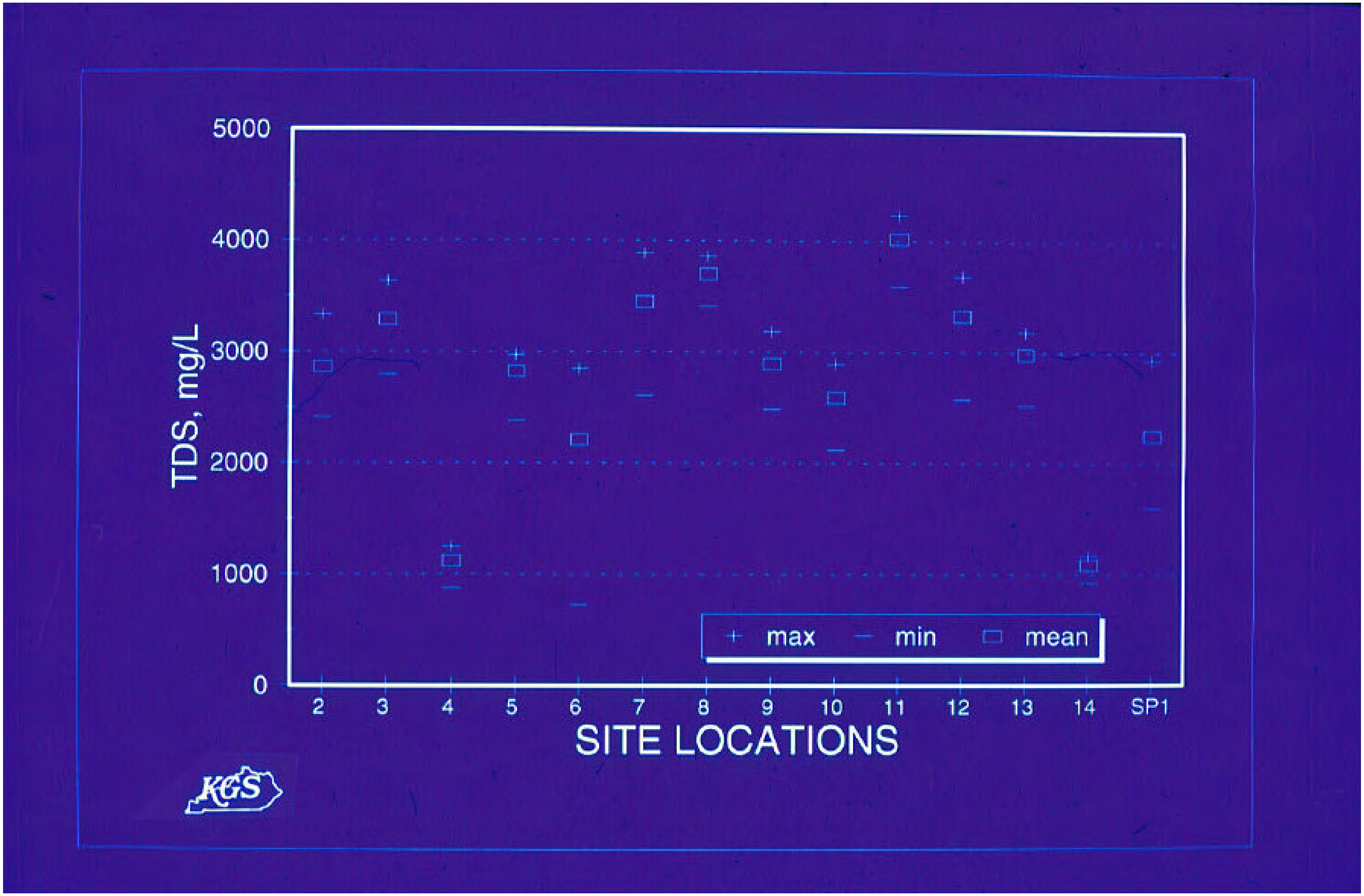

Interior Buried Plateau
Long Fork
Ponds
Spring Gap
Flume Gaging Total
Mine Discharge


Pond Overflow
Spring Discharge

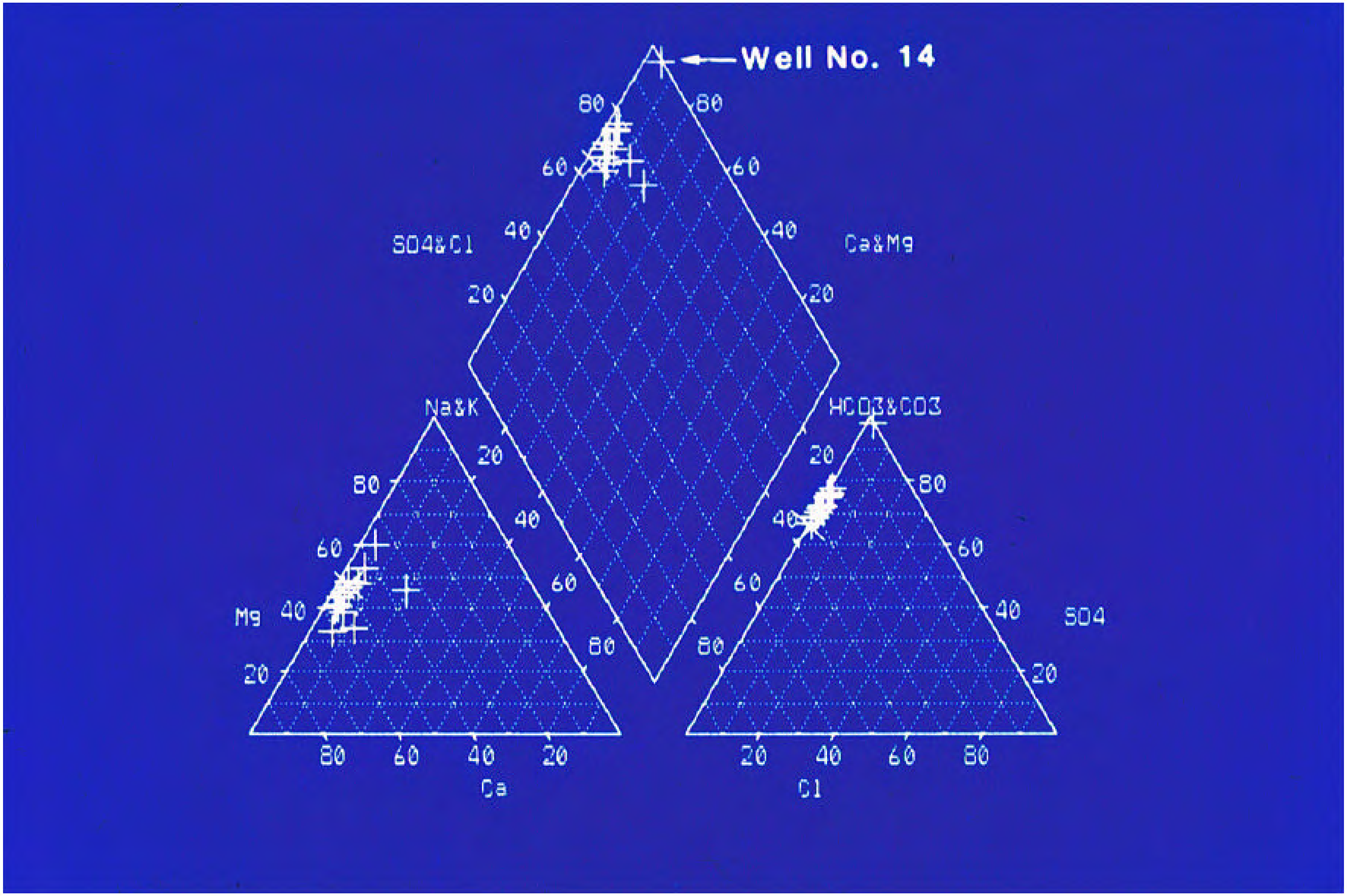

3500



N = 5
pH
7
6.5
6
5.5
5
4.5
4
2
3
4
5
6
7
8
9
10
11
12
13
14
SP1
LOCATION
KGS
minimum
maximum
median



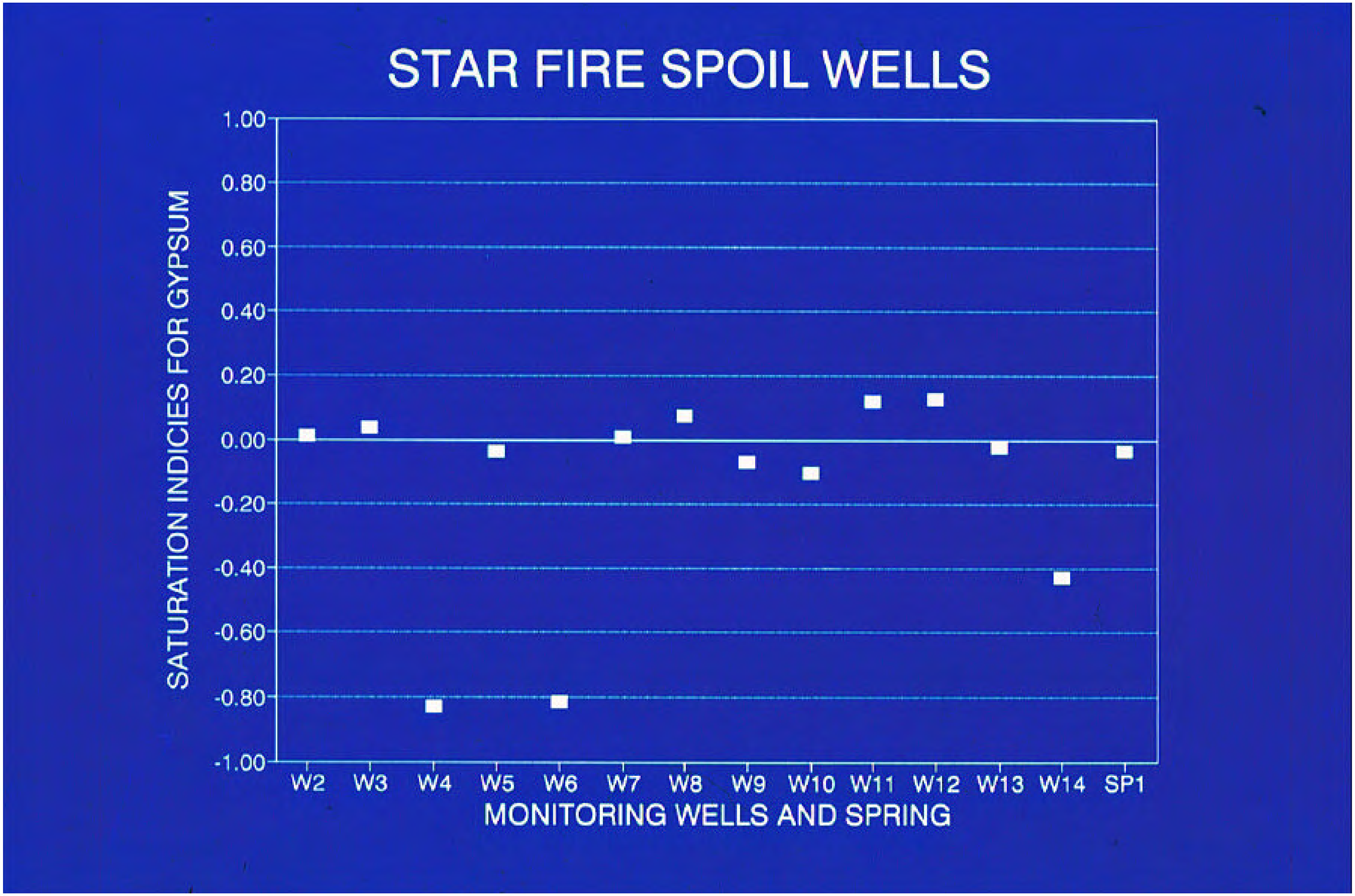
5000
4000
3000
2000
1000
0
TDS, mg/L
+ max
— min
□ mean
2
3
4
5
6
7
8
9
10
11
12
13
14
SP1
SITE LOCATIONS
KGS

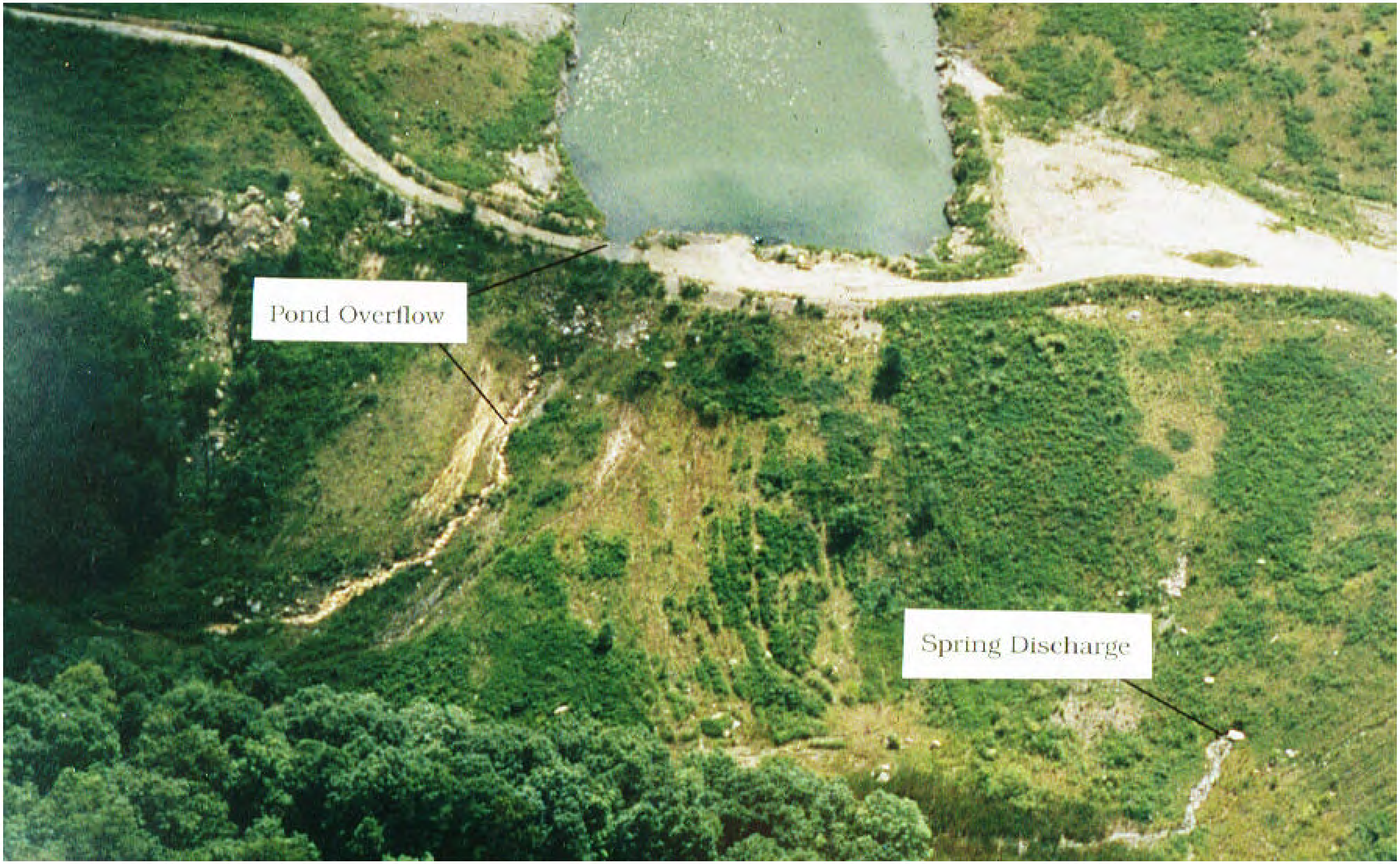


Well No. 14
SO4&Cl
Ca&Mg
Na&K
HCO3&CO3
Mg
Ca
Cl
SO4

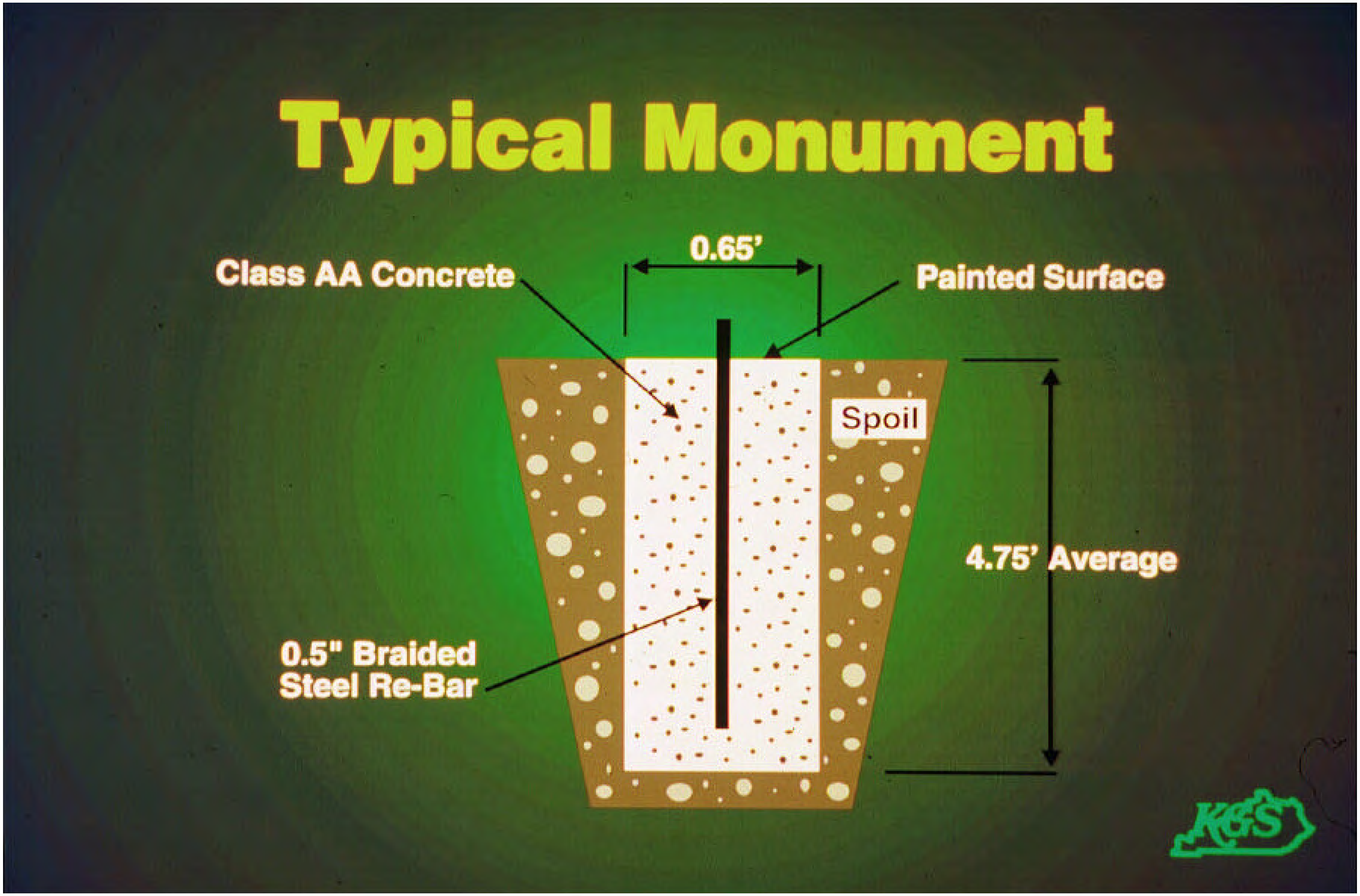
Table 6. Saturation indicies for selected minerals shown in log IAP/K using the model PHREEQE (Parkhurst and others,1980). IAP= ion activity product, K= equilibrium constant.

Well #:	Calcite	Dolomite	Gypsum	Chlorite
MW#2	-0.3618	-0.8095	0.0116	-10.9561
MW#3	-0.2230	-0.6151	0.0364	-10.8265
MW#4	-1.2823	-2.4945	-0.8279	-15.3130
MW#5	-0.2750	-0.6708	-0.0378	-10.2089
MW#6	-1.5691	-3.0704	-0.8140	-17.2109
MW#7	-0.2747	-0.3551	0.0095	-7.3621
MW#8	-0.0049	-0.1510	0.0754	-7.8246
MW#9	-0.2792	-0.5369	-0.0681	-9.2461
MW#10	-0.4647	-0.8510	-0.1012	-10.3842
MW#11	-0.5093	-0.9636	0.1195	-12.3585
MW#12	-0.2738	-0.7338	0.1251	-11.3047
MW#13	-0.4078	-0.8301	-0.0217	-9.9278
MW#14	-4.5345	-9.0036	-0.4288	-34.2911
SP 1	-2.4520	-4.9492	-0.0336	-11.5458

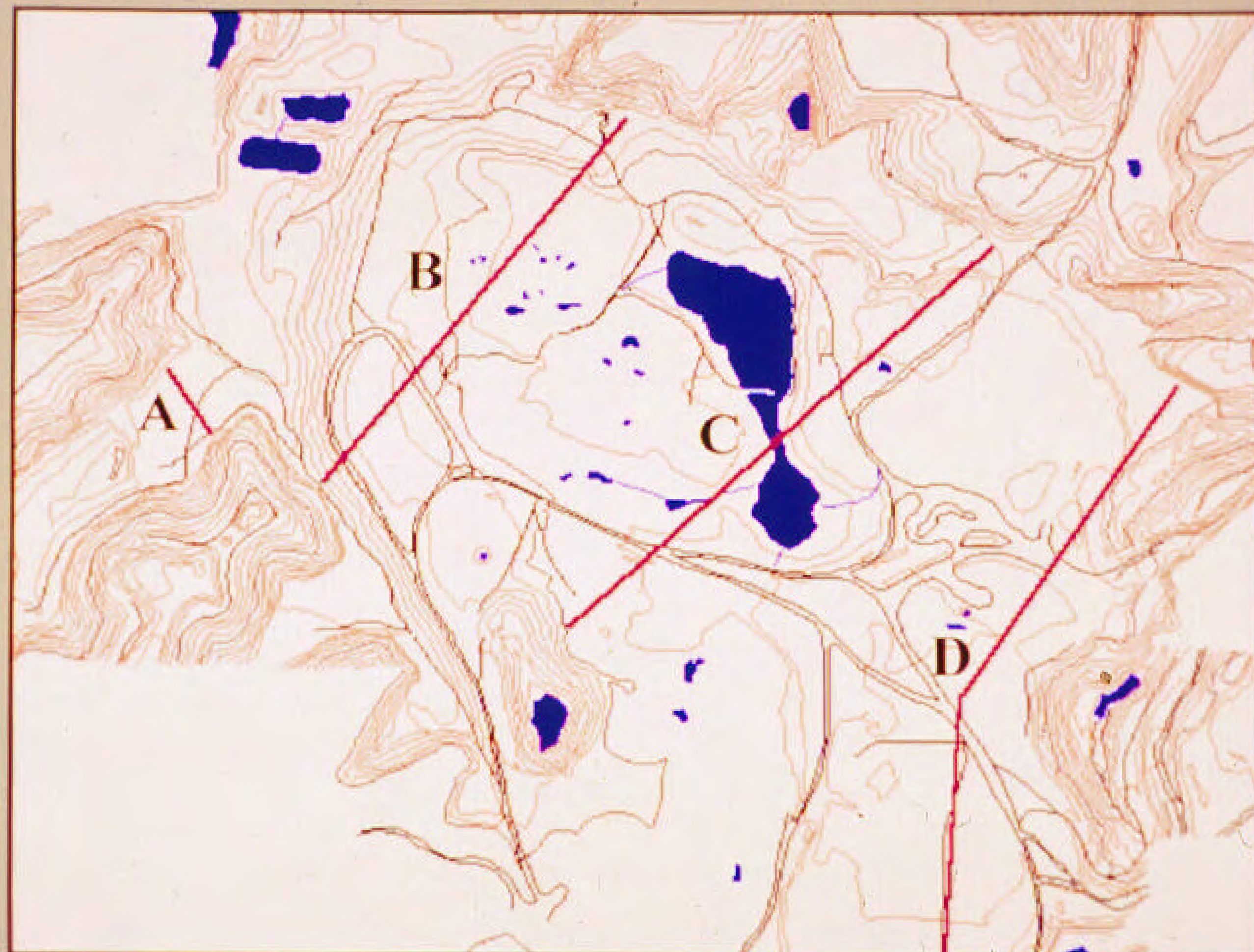

STAR FIRE SPOIL WELLS
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
SATURATION INDICIES FOR GYPSUM
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
W13
W14
SP1
MONITORING WELLS AND SPRING

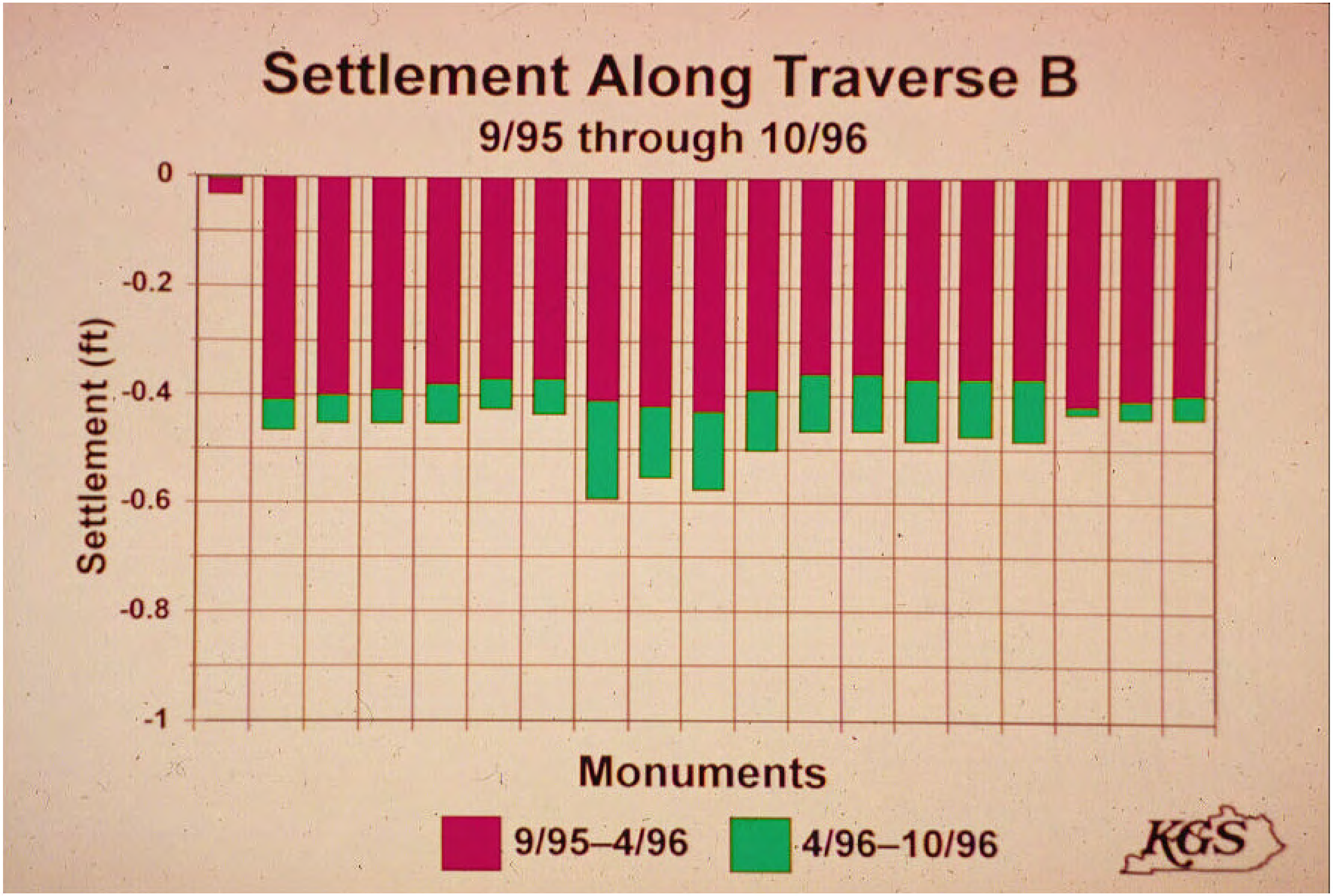

Pond Overflow
Spring Discharge

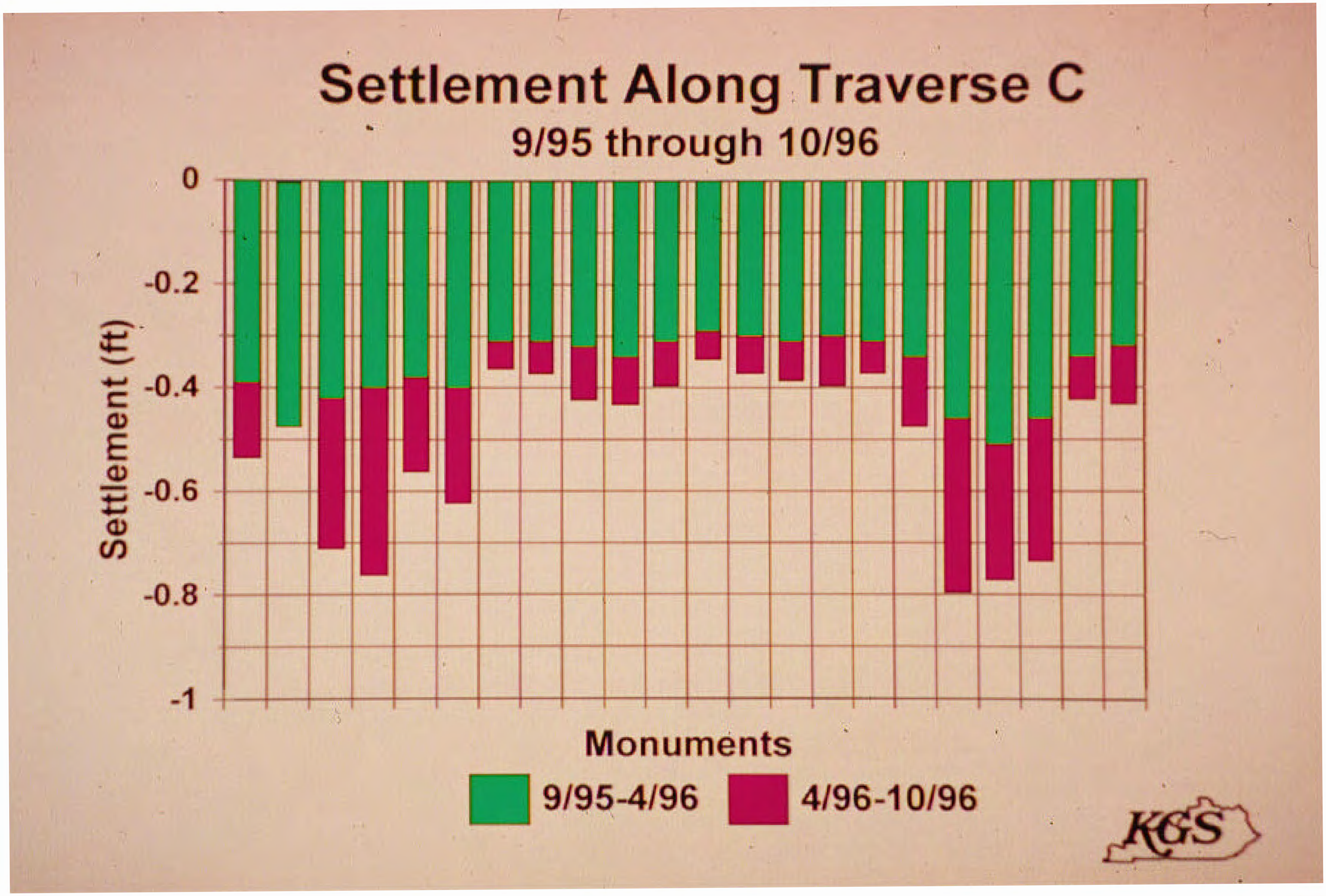

4


Typical Monument
0.65'
Class AA Concrete
Painted Surface
Spoil
4.75' Average
0.5" Braided
Steel Re-Bar
KGS

Star Fire Site




Settlement Along Traverse B
9/95 through 10/96
0
-0.2
-0.4
-0.6
-0.8
-1
Settlement (ft)
Monuments
9/95–4/96
4/96–10/96
KGS


Settlement Along Traverse C
9/95 through 10/96
0
-0.2
-0.4
-0.6
-0.8
-1
Settlement (ft)
Monuments
9/95-4/96
4/96-10/96
KGS

Hydrochemical Facies Model for Dissected, Coal-Bearing Strata in the Appalachian Coal Field

David R. Wunsch, Ph.D.
Kentucky Geological Survey

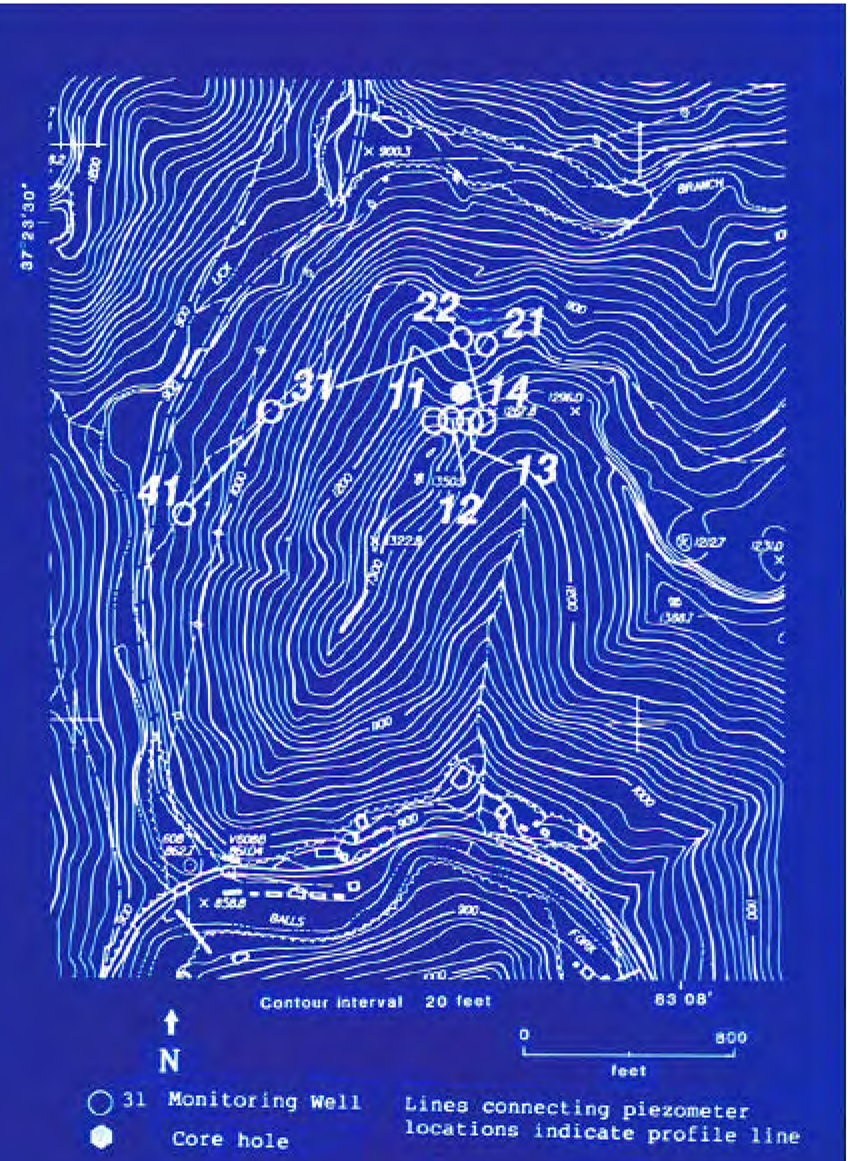
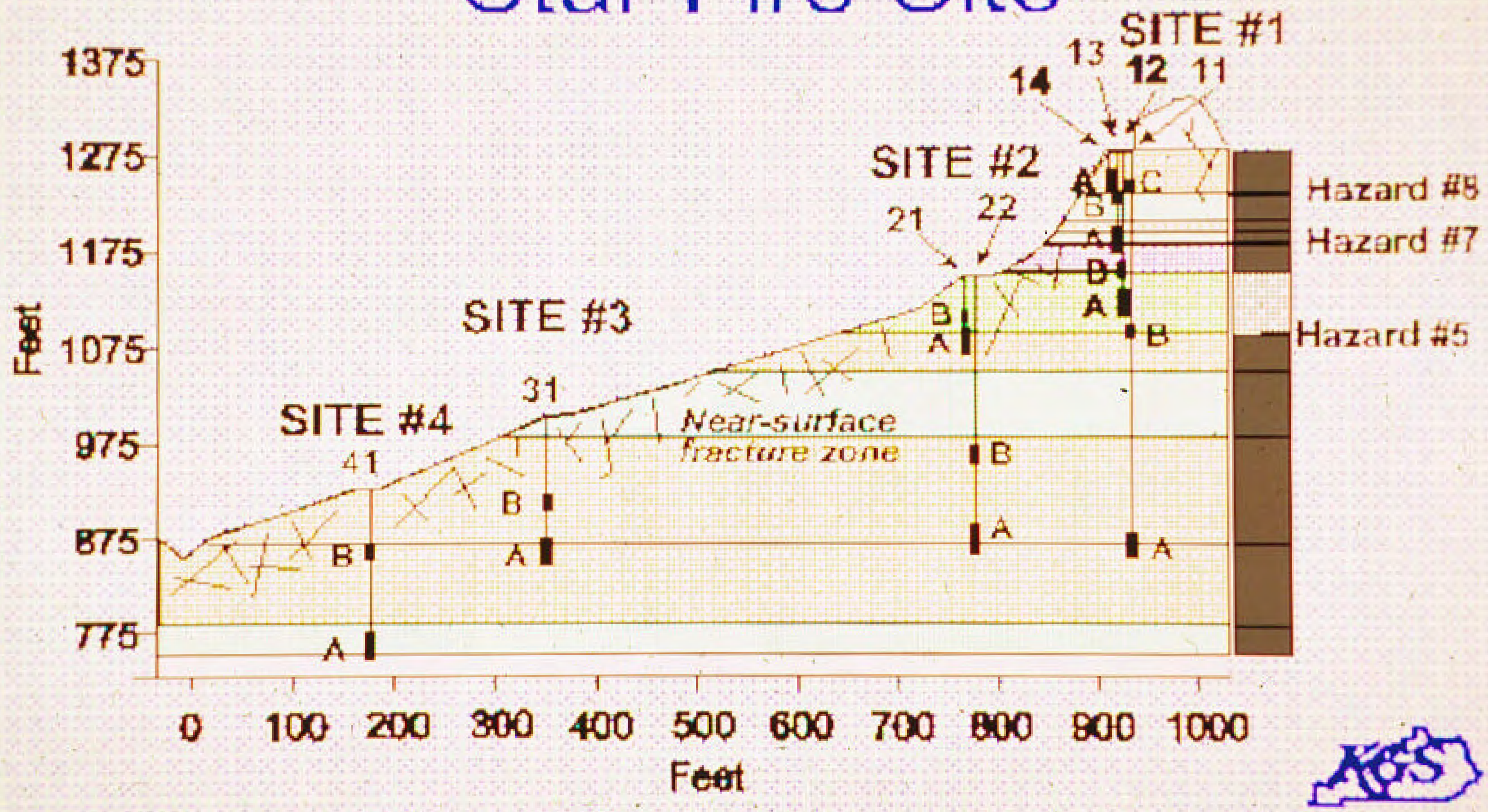
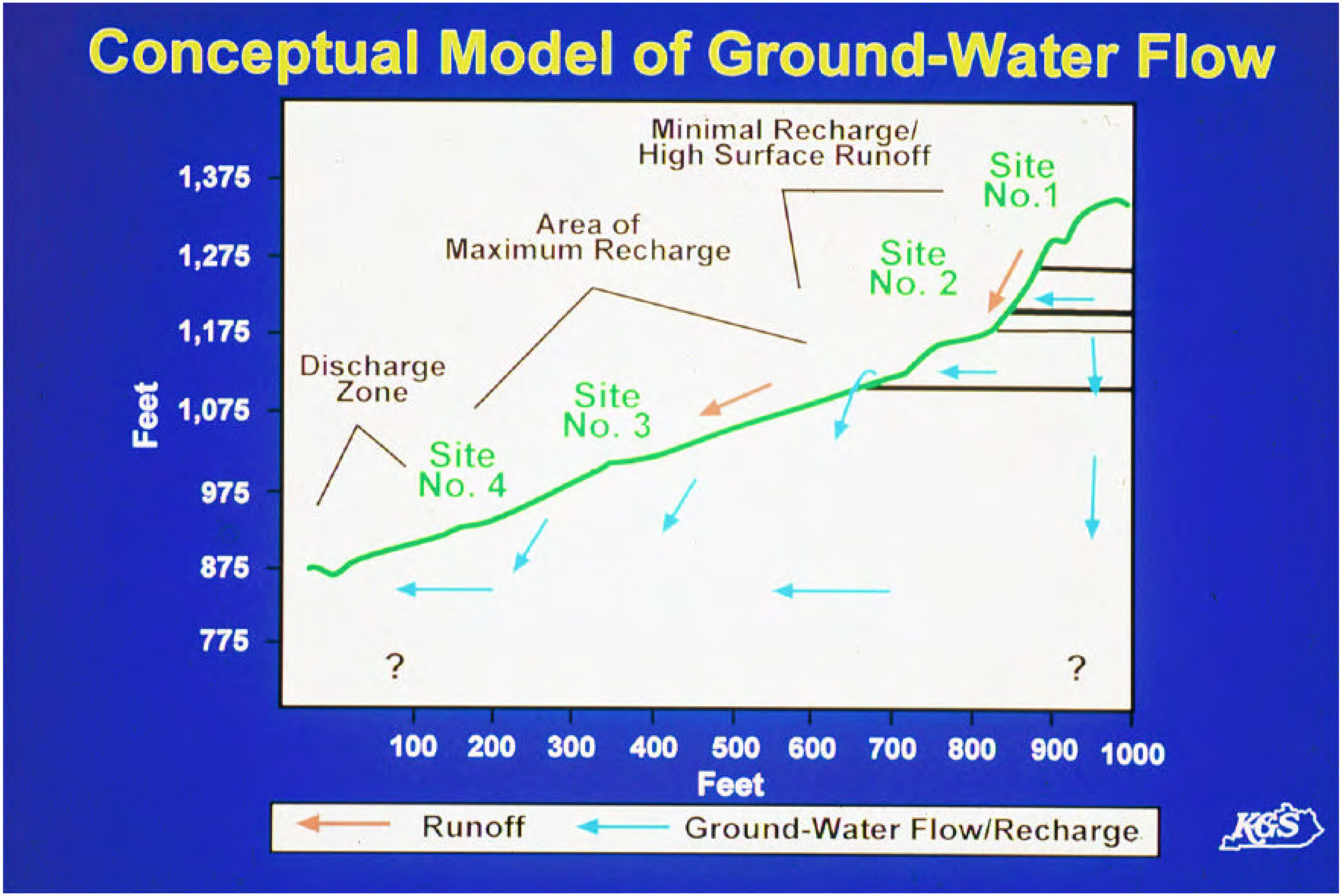


Figure 4. Location of piezometers at the study site.

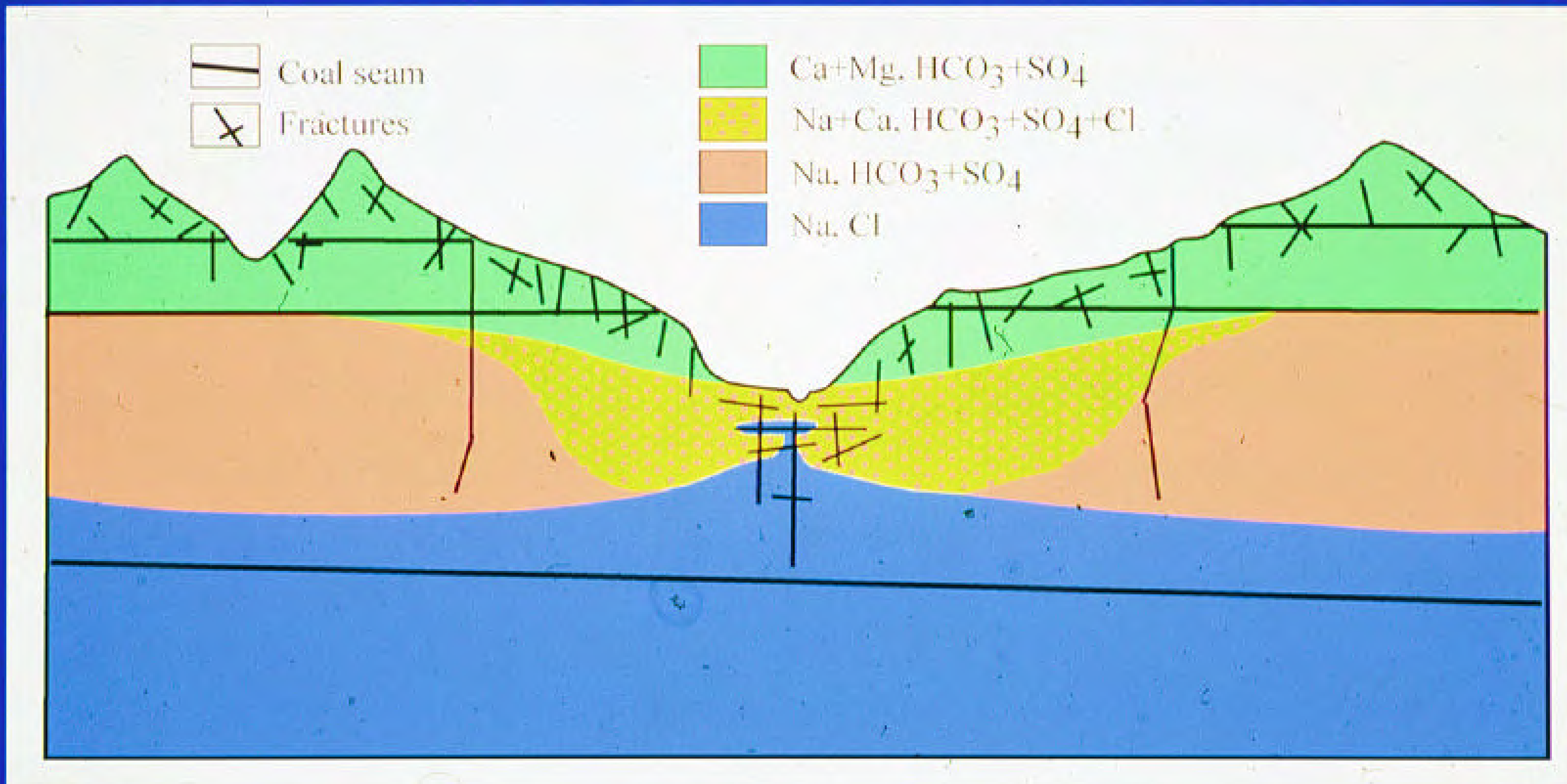
Star Fire Site





Conceptual Model of Ground-Water Flow
Minimal Recharge/
High Surface Runoff
Site
No.1
Area of
Maximum Recharge
Site
No. 2
Discharge
Zone
Site
No. 3
Site
No. 4
1,375
1,275
1,175
1,075
975
875
775
Feet
?
?
100
200
300
400
500
600
700
800
900
1000
Feet
Runoff
Ground-Water Flow/Recharge

Conceptual Model of Hydrochemical Facies



Ground Water Monitoring

Robert S. Evans, Hydrologist

Office of Surface Mining
Reclamation & Enforcement
Appalachian Regional Coordinating Center
3 Parkway Center
Pittsburgh, PA

May 9, 2000

Ground Water Baseline Monitoring Requirements

OSM / TN 30 CFR 780.21(b)(1) GROUND WATER BASELINE REQUIREMENTS			
Regulations	**KY 405 KAR**	**VA 4 VAC 25-130**	**WV Title 38 CSR 2**
Location and Ownership	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.b (1)
Seasonal Variation	8:030 - Section 14(3)	780.21(b)(1)	?
Usage of Ground Water in Permit and Adjacent Area	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.b (1)
Water Quality Parameters	8:030 - Section 14(3)	780.21(b)(1)	Section 3.22.b (2)
Approximate Rates of Discharge or Usage of Supplies	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.b (3)
Depth to Water in the Coal Seam and each water-bearing stratum above and potentially impacted stratum below	8:030 - Section 14(3)	780.21(b)(1)	Section 3.22.b (3)

Ground Water Performance Monitoring Regulations

OSM / TN 30 CFR 780.21(i) GROUND WATER PERFORMANCE MONITORING PLANS			
Regulations	KY 405 KAR	VA 4 VAC 25-130	WV Title 38 CSR 2
Based on PHC and analysis of all baseline hydrologic, geologic information	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.h
Monitoring of suitable parameters	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.h
Identify parameters to be monitored, sampling frequency, and site locations.	8:030 - Section 14(3)	780.21(b)(1)	Section 3.22.h
Describe how the data will be used to determine the impacts of the operation upon the hydrologic balance.	8:030 - Section 14(2)	780.21(b)(1)	Section 3.22.h
Monitoring must be submitted to the RA every 3 months for each monitoring location	8:030 - Section 14(3)	780.21(b)(1)	Section 3.22.h

Where Does Uncertainty Exist?

- Establishing natural variability in quality / quantity to use in impact determinations
- Establishing all parameters that may be affected
- Sample locations / sample collection / sample handling / sample analysis
- Variability in comfort levels of the reviewers
- Differences between States, e.g. representative wells/springs, spoil wells, etc.
- Differences in acid base accounting analysis, presentation, and interpretation

Potential Effects on Ground Water Quantity and Quality

- Inproper sample site locations could lead to late detection of impacts.
- Inproper sample collection, handling, and analysis can provide a poor basis for comparing the "during mining" to the "baseline" (ambient) conditions.
- Incomplete user surveys might not establish all parameters that may be affected.
- Differences in acid base accounting analysis, presentation, and interpretation can lead to inconsistencies in PHC predictions.

Conceivable Actions to Reduce the Uncertainty

- Enhance the experiential knowledge base of the reviewers and permit preparers through standardization of testing methods, databases, field studies, etc.
- Establish postmining water quality from backfills and valleyfills to validate PHC predictions.
- Develop electronic data submission / storage requirements for submission of geologic and hydrologic data.

Ground Water Geochemistry Effects

Robert S. Evans, Hydrologist

Office of Surface Mining
Reclamation & Enforcement
Appalachian Regional Coordinating Center
3 Parkway Center
Pittsburgh, PA

May 9, 2000

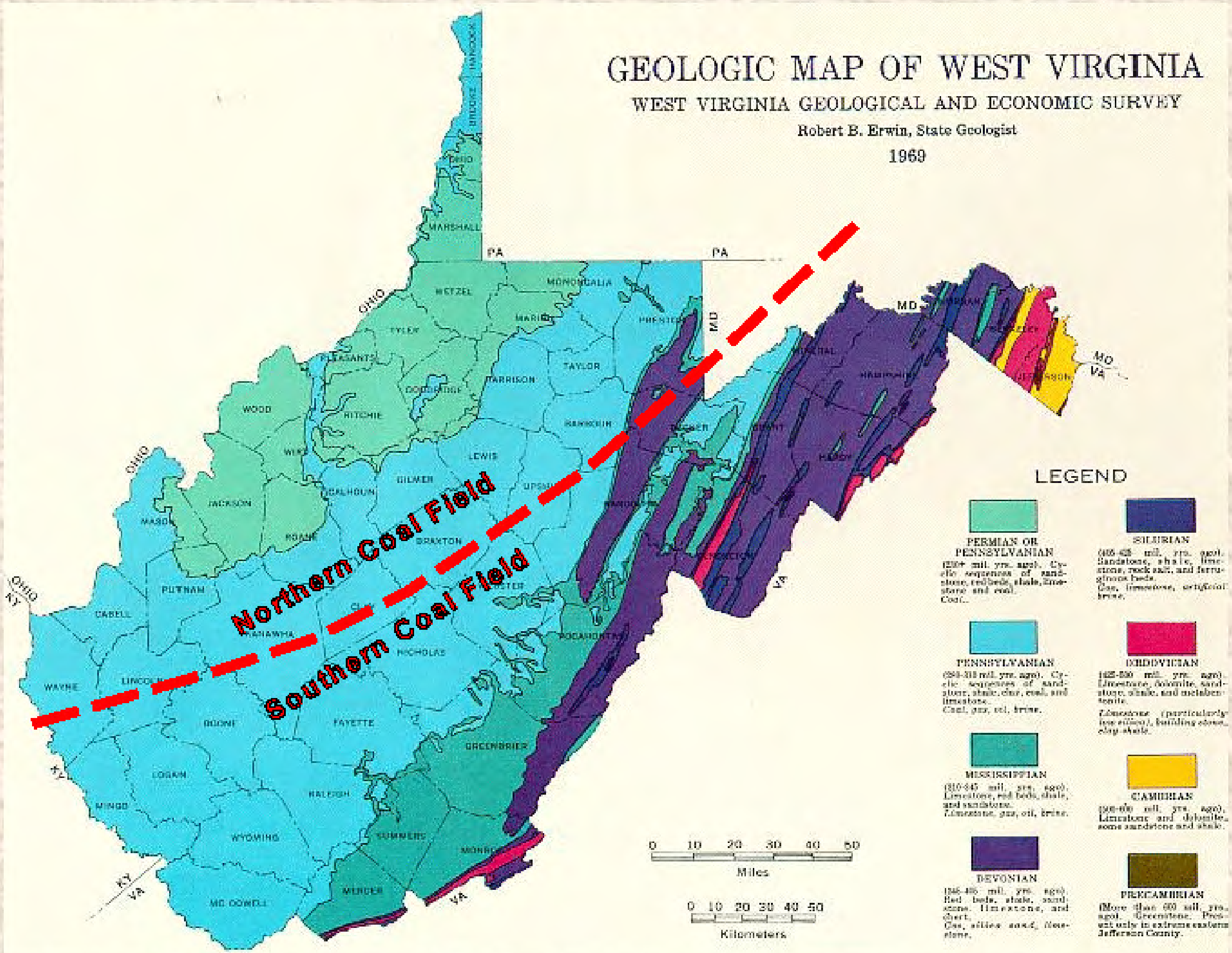
Techniques Used to Predict Postmining Water Quality

- **Acid Base Accounting**
  - Volume Weighted
  - Siderite Modified Testing
- **Recharge to the fill areas**
  - Quality and quantity of the ground water recharge to the fill areas
- **Adjacent Existing Mining Operations**
  - Water quality from backfills and valley fills
  - Requires demonstration that operations are similar in topography, geology, hydrology, mining methods and age, etc.

Overburden Geochemistry and Postmining Water Quality

- **WV broken into two coal coalfields based on coal quality**
  - Northern coalfield overall has higher potential acidity (sulfur) and frequently higher neutralization potential (more limestones).
  - Southern coalfield overall has lower potential acidity (sulfur) and lower neutralization potential (more sandstones).
  - Acid Base Accounting studies conducted in hydrologic and geologic conditions representative of the Northern coalfield and provides relationship between mining methods, overburden geochemistry, and post mining water quality.

West Virginia Coalfields



Characterization of Ground Water Quality Impacts

- Northern coalfields-generally understood that sites with higher sulfur levels that have acid discharges can have severe acid drainage problems unless substantial alkaline material exists on site.
- Southern coalfields-generally thought that sites with lower sulfur levels would likely have alkaline discharges; but without significant alkaline material can result in acidic discharges.
- Sulfates, total dissolved solids, specific conductance, and metals frequently increase as a result of mining.
- Recharge to stress relief systems frequently changed spoil water storage and discharges.

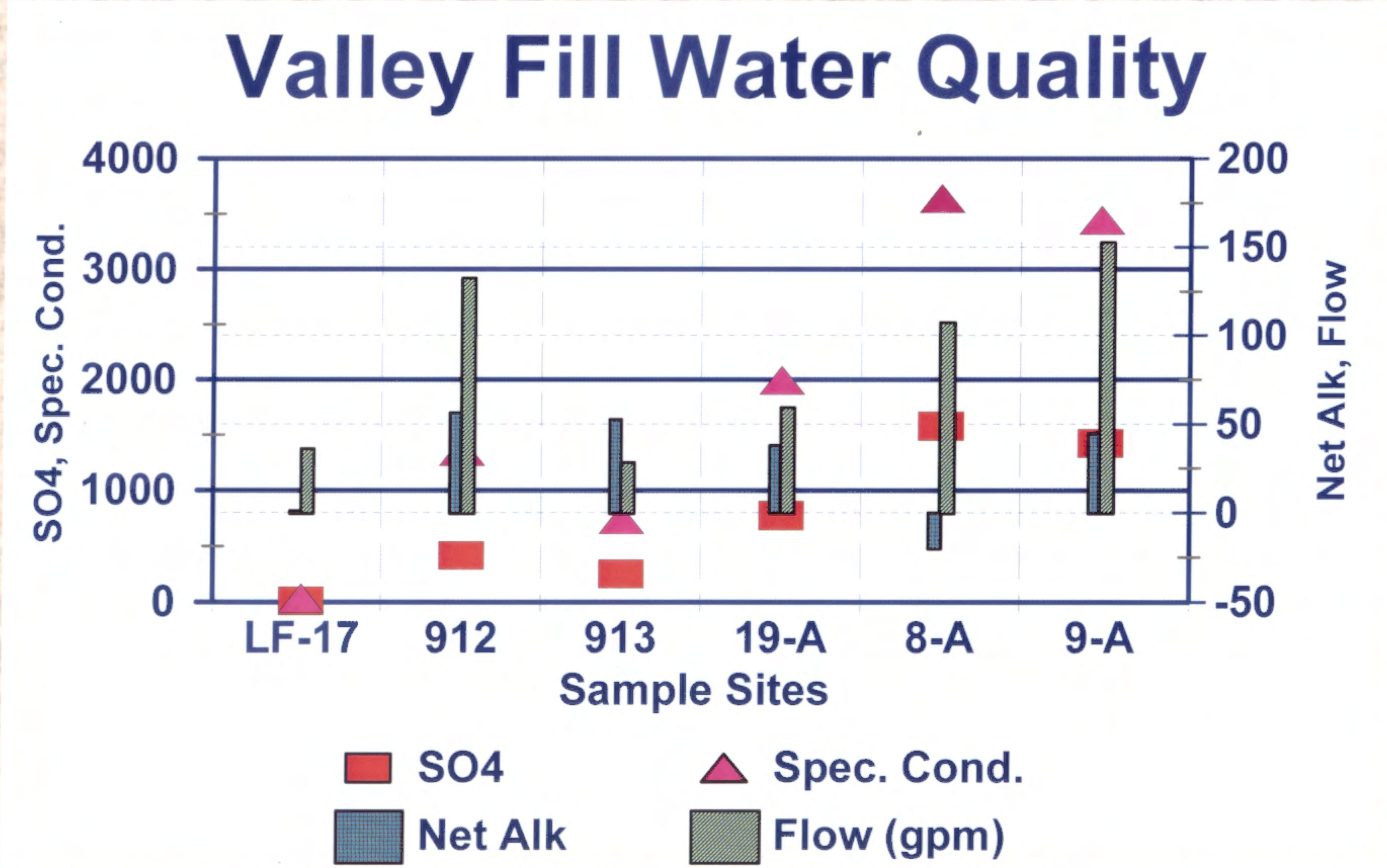
Ground Water Impacts-Watersheds

- Recharge of spoil water to streams frequently increase sulfate, total dissolved solids, specific conductance in receiving streams especially during low flow as a result of increased base flow.
- Metals may increase in the receiving stream but frequently decline after mining and reclamation are completed.

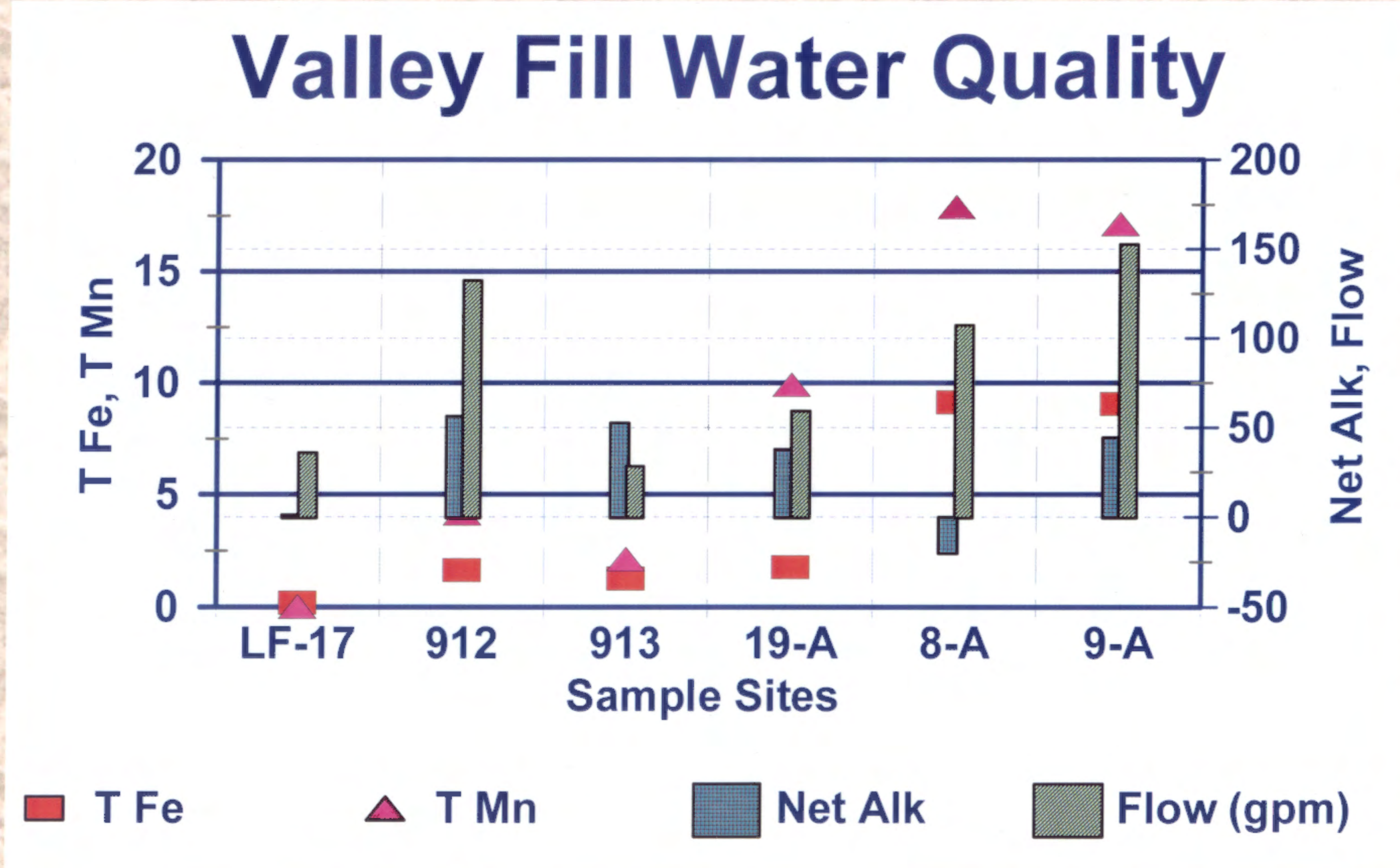
Conceivable Actions to Reduce the Uncertainty

- Field studies of existing mining operations to relate geochemistry to postmining water quality.
- Better establish the ground water flow paths through mine backfills and valley fills.

Example Ground Water Chemistry: Aquifers



Example Ground Water Chemistry: Aquifers



COMPARATIVE STUDY OF STRUCTURE RESPONSE TO COAL MINE BLASTING

Prepared for

Office of Surface Mining
Reclamation and Enforcement
Appalachian Regional Coordinating Center
Pittsburgh, Pennsylvania

Contract No. CTO-12103

Prepared by

C. T. Aimone-Martin
Aimone-Martin Associates, LLC

M. A. Martell
Aimone-Martin Associates, LLC

L. M. McKenna
Northwestern University

D. E. Siskind
DESA, Inc.

C. H. Dowding
Northwestern University

Contracting Officer's Technical Representative

Kenneth K. Eltschlager

February 2003

TABLE OF CONTENTS

ABSTRACT

Whole structure and mid-wall responses of 25 structures to surface coal mine blasting were characterized. Eighty-nine blasts were conducted at 11 mine sites throughout the U.S. to measure blast-generated dynamic response of atypical structures found in the proximity of surface coal mining. Atypical structures selected for this study include log-type, manufactured (single wide and double wide trailers), "mine camp"-type, adobe, and stone. Traditional acoustic microphones, tri-axial (ground) and single component (structure) velocity transducers were used to record airblast, ground motions, and structure response time histories with a common time base. The relative responses of selected "atypical" structures to blast vibrations and non-blasting causes of structural stress, including natural forces, environmental effects, and human habitation, are compared.

Data analyses for blast-induced motions were conducted to:

- compare vibration time histories in terms of velocity and calculated displacement within structures relative to ground excitations,
- evaluate the influence of air overpressures on structure response,
- evaluate response frequencies to determine natural frequencies and damping characteristics,
- determine structure response amplification of ground motions, and
- compute differential displacements of construction components and corner motions to estimate global or gross structure strains.

Corner and mid-wall motions from blasting were compared to motions induced by normal household activities and external forces such as wind. In addition, wall crack deformation responses to environmental changes, human-induced vibrations and blasting were measured in four of the structures in a parallel study.

Amplitudes of ground vibrations measured at structures ranged from 0.02 to 1.25 inches per second (in/sec). Scaled distances ranged from 22.9 to 340.0 ft/lb$^{1/2}$.

The amplifications of ground motions measured in upper structure corners varied by type of structure as well as for certain structures within each design type. Corner responses of log and wood-frame structures fell below values reported in U.S. Bureau of Mines RI 8507. For two structure designs (two-story log and two-story stone), amplifications greater than 4 were measured when excited by ground motions with predominant frequencies of 4 to 7 Hz.

Little difference in horizontal time histories between lower floor and ground motion responses were noted for all structure types with the exception of trailers without wood-frame add-ons. Single and double wide trailers produced wall base motions greater than exterior ground motions.

Trailer whole structure and mid-wall motions duplicated airblast time histories. Peak structure responses occurred within the airblast phase rather than within the ground motion phase, particularly when airblast exceeded 116 decibels. Mid-wall motions showed both high

frequency and low frequency characteristics for specific structures while trailer mid-walls tended to respond only at high frequencies. One-story camp and log structures and massive stone, concrete block and adobe structures did not respond to airblast.

Whole structure natural frequencies averaged 6.0 Hz. Mid-walls averaged 8.4 and 13.8 Hz in the transverse and radial walls, respectively. These values fell below those reported by the U.S. Bureau of Mines in RI 8507. Mid-wall motion frequencies duplicated low frequencies of the upper corner and also carried a high-frequency component. However, the range in data in this study corroborated U.S. Bureau of Mines findings.

Damping values fell well within the range reported in previous studies of 2 % to 10% of critical. Trailer transverse wall damping averaged 9.5% while log and trailer structures exhibited the highest whole structure (upper corner) radial damping of 9.7% and 9.6%, respectively. The least damped structure type was the two-story stone and measured 3.9% of critical.

Wall strains calculated from gross and mid-wall differential displacement were less than 20 μ-strains for wall bending. The maximum calculated in-plane tensile wall strain was 133.1 μ-strains and is well below cracking thresholds of 300 to 1000 μ-strains for plaster and wallboard.

Structure response to non-blasting events was measured. Human-induced whole structure responses up to 0.51 in/sec and mid-walls up to 2.14 in/sec were measured and are equivalent to ground vibration amplitudes of 0.28 in/sec for single wide trailers and 0.11 in/sec for double wide trailers and one-story adobe. Wind gusts generated air pressures that resulted in detectable levels of structure shaking and mid-wall responses in trailers up to 0.1 in/sec

Direct measurements of crack response were made for four structures. Addendum I is a report describing the measurement techniques and summarizing the long term (environmental) and transient (blast vibration) changes in crack width. Addendum II outlines protocols for implementing many of the measurement and analytical procedures described in this report.

INTRODUCTION

Explosives are used to break rock overlying a coal seam. The rock can be broken in place (conventional blasting) or broken and partially displaced into the adjacent pit (cast blasting). In any blast, the majority of energy is spent breaking rock. The balance of energy emanates from the site into the environment as either seismic or airblast energy. Once blasted, all the rock is moved to expose the coal for mining.

Ground vibrations and airblast leaving the mine eventually arrive at adjacent properties. The energy is then transmitted into the buildings. In turn the buildings respond or shake. If ground vibrations and /or airblast are strong enough, the building may be damaged. The Office of Surface Mining (OSM) and other regulatory agencies limit the amount of energy received at the building regardless of how blasting is being conducted at the mine.

Based on the research conducted to date, damage to buildings has never been observed below ground vibrations of 0.5 in/sec or airblasts of 140 decibels. Federal regulations allow limits up to a maximum vibration of 1.0 in/sec (between 301 to 5000 feet) and 134 decibels, respectively. At these limits, no damage is expected but we acknowledge that hairline cracking of plaster is possible under certain site or building conditions. The intent of the regulatory scheme, as outlined in the preamble to the federal rules and the development of a blasting plan, is for the coal mine permittee and the regulatory authority to tailor the allowable limits based on the site specific need to prevent damage to occupied dwellings. The regulatory authority is responsible for lowering the limits if necessary to prevent damage

People inside buildings can feel the structure shake and hear bric-a-brac rattle at ground vibrations and airblast as low as 0.04 in/s and 100 decibels, respectively. Citizens often begin noticing normal house changes, such as cracks in walls, and blame the changes on the vibrations they feel. To some, any type of environmental vibration is intrusive and disturbing. Since low level blasts will annoy some people, complaints are common.

The part of any residential structure most susceptible to blast induced vibrations is the superstructure or portion above ground level. Research over the years has defined the structure response characteristics of "typical" one and two story residential structures. OSM has built their regulations around this research since the majority of structures near coal mines are residential.

Occasionally, structures are found near the mine that do not fall into the "typical" category or may not have been included in the body of data on which the rules were founded. Such structures may include pre-fabricated houses, trailers, log homes, sub-code homes and adobe structures. This study measures the response characteristics of these "untypical" structures to blast induced ground vibration and airblast and compares motion characteristics to those of “typical” structures studied by the U.S. Bureau of Mines (U.S.B.M) and others in establishing the widely adopted safe level blast vibration criteria in the U.S. As such, field measurements and analyses were made to duplicate those conducted by past researchers. U.S.B.M. research primarily considered traditional wood frame housing. Therefore, it was the goal of this research to extend the understanding of similarities and differences in dynamic response between traditional wood-frame constructions and non-traditional type structures.

The motivation for this study began because of blast-related complaints from residences living near surface coal mines, despite an industry-wide adherence to safe blasting criteria prescribed for the coal mining industry. Limited investigations of blast complaints conducted by government officials revealed that certain structure types may respond to blasting vibrations in unique and unusual ways. Currently there is no uniform approach or guidelines available to investigate the uniqueness in structure response. Therefore this study was initiated to address two issues. The first was to characterize the response to blasting in various types of structures that are unlike those types that have been previously studied. The second was to develop a methodology to investigate and evaluate structures by placing traditional vibration instrumentation within structures in a manner to address uniqueness.

An important objective was to compare the responses of this study data to the data previously obtained by the U.S. Bureau of Mines as a measure of uniqueness for all structures studied. Finally, this study provided the opportunity for government personnel (GP) to take part in structure instrumentation and analysis of response data. This on-site training process is valuable to enhance understanding and confidence that GP require when investing blast-related complaints.

It is not the intent of this study to evaluate and compare the influence of blast design on ground motion and airblast excitations as a source of vibration response of structures. Furthermore, this study did not address wall cracking. No observations of crack extensions were made during structure response monitoring. Therefore, no conclusions have been made regarding the potential of specific ground motions and airbast excitations to induce cosmetic cracks in structures. Furthermore, there are no correlations of structure response with cracking potential.

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PROJECT APPROACH

Ground motion, airblast, and structural response data from surface coal mining blasting were collected at eleven mining sites. Structures instrumented in this study were selected to represent the range of structures found in the proximity of surface coal mining with focus on those not previously studied by the U.S. Bureau of Mines during structure response studies. These designs included pre-manufactured trailers, log, earth and stone, and mine "camp". Time-correlated measured responses include those of whole structure, mid-wall, and selected structural components. Responses include those from human activities, environmental effects, and surface mine blasting.

A crack response study, supported by Northwestern University, was conducted in parallel to the structure response study within structures possessing a representative hairline drywall, plaster or concrete block crack. Transient displacements of the crack from blasting were compared to static crack movement produced from long-term changes in environmental climate conditions. Results of this crack study are found as an Addendum I to this report and titled "Direct Measurement of Crack Response Study of Four OSM Study Structures". The monitoring of existing cracks within selected structures was neither part of the scope of work for this project nor was it required by the Office of Surface Mining. However, it was felt that a crack study, would provide another basis for understanding the manner in which structures respond to human habitation, environmental effects and blasting.

SITE AND STRUCTURE SELECTION

Eleven coal mining sites were selected by OSM based on recommendations of state personnel. These states included Virginia, Kentucky (two sites), West Virginia (two sites), Tennessee, Alabama, Ohio, Pennsylvania, New Mexico (representing Native American Indian lands), and Indiana. State blasting specialists nominated coal mines, based on structure uniqueness.

Criteria for the selection of structures had to satisfy study objectives and facilitate project tasks within limited time constraints and resources. These criteria included structure uniqueness, the proximity of the structures to the mine blasting site(s), willingness of home owners to cooperate on the project, and availability of a significant number and intensity (e.g. amplitudes of ground vibrations and airblast) of planned mine blasts to ensure measurable structure response, and the cooperation and assistance of the mine operators.

Specific selection criteria for structures included the following:

- Structure uniqueness

A minimum of one "atypical" structure was needed at each mine. At some sites, traditional wood-frame structures were selected based on availability and satisfaction of all other criteria. Incorporation of a limited number of traditional word-frame structures provided a basis of comparison responses with those of previous research and those of unique structures selected at the same mine site.

- Proximity to an active surface coal mining operation

To satisfy project objectives, sufficient blast-induced ground vibration and airblast energy was necessary to produce measurable vibrations and structure response. Therefore, the blast site distance to structures and the explosive charge weights (e.g. maximum charge weight detonated on one delay or within an eight millisecond, ms, delay interval) were important parameters to consider in site and structure selection. It was important that at least five blasts be detonated during the week monitoring to facilitate scheduling constraints and instrumentation requirements. Mine operations generating significant levels of ground vibrations (e.g., averaging 0.25 inches per second, or in/sec) and airblast (in excess of 115 dB) over a wide range of scaled distance factors were considered to be sufficient for the structure response study. Coordinating project logistics around five planned mine blasts one to two months ahead of site arrival provided challenges that were overcome by the cooperation of mine operators.

- Cooperation of the homeowner

Owners of structures that satisfied the criteria were provided written documentation describing the study. Home owners willing to participate were asked to sign a right of entry (required by OSM) and a release of claims (required by the contractor).

- Cooperation of the mine operator

Site scheduling was dependent on mine blasting activities near the homes. Mine operators were contacted by agency personnel and the contractor to coordinate study activities during specific weeks. Additionally, mine operators were requested to supply information on the location of blasts and proposed charge weights. In cases where five blasts were not possible during one week, an attempt was made to separate large blasts into smaller blasts or provide a few single hole detonations. In a few cases, less than five blasts were provided. However, redundancy in structure types among sites and greater numbers of blasts at other sites provided a sufficiently large data base to meet study objectives.

DESCRIPTION OF STRUCTURES

Structures were characterized and construction details were documented in a number of ways. Photographs were taken of each structure exterior and interior as well as the foundation (for non-slab foundations and where access was available). Specific attention was given to the type of foundation support. Laser-level surveys were conducted to establish floor elevations for all structures and room dimensions were measured with a laser rangefinder. This information was used to assess the overall condition of structures that might be a function of foundation support, distribution of structure load, as well as unusual structure loads or other construction details.

Appendix 1 provides detailed documentation of each structure. Included are scaled room layouts and photographs of various features. Room measurements were necessary to compute gross strains within structure walls.

Table 1 presents general construction details of all structures in this study. Structures are identified by state and location in the order in which they appear in Appendix I.

Structure designs include the following categories:

- pre-manufactured trailers constructed as single wide, double wide, and wood-frame add-on support by concrete masonry units (CMU, or cinder blocks),
- log structures – one and two story traditional natural log and two story prefabricated, manufactured log structures with vaulted ceiling living areas
- mine "camp dwellings" constructed of wood frames with diagonally sheathed walls and foundations of perimeter CMUs and interior log poles
- masonry and earth - construction includes CMU's, field stone and adobe, and traditional adobe
- traditional wood-frame structures - including one, two, and three story (cantilevered) designs

A brief description of each structure is given below. For clarity the following designations were used in identifying the structure category:

T – trailer	S – single-wide trailer
C – camp	SA – single-wide trailer with add-on
L – log	D – double wide trailer
E – masonry and earth	1S – one story
W – wood frame	2S – two story
	3S – three story

The designations following the structure category used to identify the states and mines (in alphabetical order) are:

AL - Alabama
IN - Indiana
KY1 – Kentucky site 1
KY2 – Kentucky site 2
NM – New Mexico
OH - Ohio
PA - Pennsylvania
TN - Tennessee
VA - Virginia
WV1 – West Virginia site 1
WV2 – West Virginia site 2

If two structures of the same category and design were selected, the following identifier was used:

A – first structure of category and design
B – second structure of same category and design

Pre-manufactured Trailer Structures

Pre-manufactured trailers ranged from small, single wide units 64 ft. long by 14 ft. wide to large double wide trailers 74 feet long by 28 feet wide. Single wide trailers with wood frame add-ons were 54 to 46 ft. in length and 24 to 26 ft. wide. All trailer interior walls, with the exception of one double wide, were constructed of wood fiberboard coated with a thin layer of plaster compound. All walls were covered with wallpaper or wood paneling.

One double wide trailer possessed a recently constructed wood frame and drywall interior wall separating the dining area from the kitchen parallel to the “marriage” wall (e.g. long trailer axis). This was the only trailer founded on a full basement.

All other trailers rested on piers of unmortared concrete blocks that were leveled with wood wedge shims. Pier support geometries for single wide and double wide trailers are shown in Figure 1. Some trailers were fastened to the ground using perimeter hurricane strapping shown in Figure 2. Concrete blocks were stacked singly or in pairs and placed beneath steel beams as shown. Wood shims were placed between the pier and trailer beams in all cases. Piers for one trailer were supported on poured concrete pads. The remaining trailer piers were founded directly on the soil.

A number of piers were tilted from a vertical line and not aligned normal to the steel beams. Tilting piers are shown in Appendix I for all trailers with the exception of TD-TN (Note, TD-PA is founded on a full basement). Tilting results from eccentric loading about the pier support.

TS-KY2 is a single wide trailer with interior paneled walls. The single CMUs were configured as shown in Figure 1 (a). No hurricane strapping was used.

TS-IN is a single wide trailer with a small room addition at the east end founded on a stack of single CMUs configured as shown in Figure 1 (a). Hurricane strapping was used and all interior walls were paneled.

TS-AL is a single wide trailer with hurricane strapping. Double concrete piers support beams as shown in Figure 1 (a). Interior walls were either paneled or papered.

TS-OH is a single wide trailer with loose hurricane strapping. The trailer was built into a hillside and supported by varying pier heights ranging from a single half-block to a double set of five blocks in the configuration shown in Figure 1 (a). Interior walls were either paneled with wood or covered with wallpaper.

TSA-VA is a single wide with a wood frame add-on along the entire back of the house. The original trailer section is supported with double CMU piers while the wood frame add-on is supported by a conventional CMU perimeter wall. A one by eight sill plate supports floor joints and does not support the trailer section cross members. All interior walls have wallpaper covering or were paneled. No hurricane strapping was used.

TSA-KY2 is a single wide with a wood frame add-on along the entire front of the structure. A CMU wall exists around the entire perimeter. Beneath the trailer section, it serves as a skirt. Beneath the addition, it supports the frame. All interior piers were double concrete blocks. The wood-frame section is not supported with a perimeter wall and supported only with double concrete blocks. The support configuration is generalized in Figure 1 (b). No hurricane strapping was used.

TD-WV2 is a two-year old double-wide trailer. The support configuration is generalized in Figure 1 (c) with one single width stack of CMUs placed along the "marriage" wall beam. The piers were founded on poured concrete pads. Standing water from a bathroom water leak was noted under the northwest corner of the trailer. No hurricane strapping was used and all walls were covered with vinyl wall covering.

TD-TN is a two-year old double wide trailer with hurricane strapping. Double CMU piers were used in the corners and along the "marriage" wall beam. Single CMU piers used for all other beams along the perimeter as shown in the configuration of Figure 1 (b). All interior walls have wallpaper covering.

TD-PA is a double wide trailer with a full basement constructed of CMUs. The center steel beam carrying the "marriage" wall was cut to accommodate the stairway into the basement from the laundry room. This main beam is supported by steel posts, spaced on12 foot centers along the trailer long axis. CM walls support cross-beams. All interior walls were wallpapered. The newly constructed wood-frame wall between the kitchen and the dining area is completed with drywall.

Mine Camp Structures

Mining camp houses ranged in age from 50 to 100 years old and construction widely varies. Exterior walls were constructed with two by fours placed at right angles to current wood frame construction practices. Shown in Figure 3, the four inch dimension of the studs is oriented parallel to the wall. Diagonal exterior boards complete the framing. Traditional camp houses in central Appalachia are supported on interior log poles, many of which are founded directly on bedrock. Others are supported on both logs and CMU piers. Floor joists rest on perimeter walls without sill plates and are randomly located rather than uniformly spaced. Other mine camp structures are supported on a mix of wood poles and concrete blocks or bricks. Perimeter foundations comprise a variety of fieldstone, CMUs, and poured concrete with rectangular wood post framing. A number of camp structures have been renovated by replacing stone foundations and adding modern wood-frame rooms.

C1S-AL is a one story mining camp structure approximately 55 years old. The frame construction rests on a CMU perimeter wall and interior piers of unmortared single concrete blocks or clay bricks. The interior walls of the house were paneled with a wood product. The living room has new sheet rock walls.

C1S-VA is a one-story structure built in 1945. The home is founded on bedrock using wood log posts. The exterior perimeter wall is constructed partly of field stones (front of the house) and cement block at the rear of the structure. Irregularly spaced floor joints do not form any particular pattern and rest directly on top of the perimeter concrete blocks with a sill plate formed of concrete. A number of log posts were found to be loose and not tied to the floor joists. All interior walls were paneled.

C2S-KY1A is a two-story camp home built in the early 1900's. Interior walls were plaster on lath covered with paneling throughout the house. Basement ceiling joists vary in spacing and were supported by log posts. Discontinuous two by eights were used to support the joists in many places. Basement walls were formed using field stone and mortar.

C2S-KY1B is a two-story camp home built in the 1950's with two additions. The rear addition forms the kitchen and a bathroom and a recent addition forms the living room. The older section of the structure is founded on a full basement while the additions are built upon a crawl space. The structure is supported with a perimeter concrete block wall and interior supports of many varieties. Interior supports include unmortared concrete block piers, wood posts, table legs, and a steel jack. Interior walls were newly constructed drywall or paneling.

Log Structures

The five log homes in this study were constructed of horizontally laid logs fitted together by one of the three techniques: the saddle lock-notch, notched and scribed, and butt-jointed. Figure 4 shows the three types of log fittings used to construct the homes. Four of the structures combine corner notching, either the saddle lock-notch or notched and scribed, and the log weight is used to form stable structures. The remaining house was built using butt-joints throughout the structure. At the structure corners, log ends were nailed perpendicular to each other. The butt-joint combined with the log weight formed a stable structure.

The logs with a saddle lock-notch were stacked such that they do not rest against each other except at the notch leaving a crack or "chink" of one inch or more visible between the logs. Chinks allow for warping and expanding. The chinks were filled or caulked with a plaster or mud material. Scribing a log is the terminology used to describe fitting the entire length of the log to match the shape of one log to another. Scribed logs were notched at each end and a tongue or groove is cut from notch-to-notch the length of the log. The tongue and groove serves as a means of tightly fitting the logs together. The butt-joint technique does not require notching to stabilize the logs. Two logs were joined by placing one log perpendicular to one end of the other log and nailing the two together. The normal stabilization method for butt-jointed logs involves drilling vertically through the stacked logs of a wall and driving rebar down through the drilled hole to stabilize the wall.

L1S-OH is a one story log cabin with a full CMU block wall basement. The structure is 40 years old. Walls comprise hand-crafted milled logs, approximately nine inches in diameter, were notched and scribed.

L1S-WV1 is a one-story primitive handcrafted log cabin constructed more than 100 years. The construction is called primitive because the bark was not removed from the logs. The original part of the structure was built from hand-hewn logs that were saddle lock-notched and horizontally stacked. The chink was caulked with a mud or plaster type material. The logs were approximately six inches in thickness with additional six inches of framing on the inside for a total wall thickness of 12 in. Interior walls have a plaster finish. The original cabin sits on concrete piers at the corners. A concrete block foundation was added under the front porch of the cabin and under an addition at the rear.

L2S-TN is a two-story handcrafted cabin built using a butt-joint technique for the wall construction and corners. The logs were railroad cross ties cut six inch by six inch square and joined end-to-end with length of a wall with a two by six board nailed along the top of the joined cross ties. The cabin walls stand only under the weight of the logs. No vertical structural supports or ties (e.g., rebar) were used to vertically tie logs together. The foundation comprises a CMU perimeter wall and interior block piers forming a two to three foot crawl space founded directly on bedrock.

L2S-OH is a modern mill-log custom home designed and built by the owner. It is approximately 2 years old with a full cinder block basement. The vaulted ceiling in the living and dining rooms were constructed with roof trusses and exposed beams and rafters. A partial second floor is designed over one-half of the structure.

L2S-WV2 is constructed from a log home kit with modern mill-logs, a vaulted ceiling with exposed breams, rafters and trusses. A partial second floor is constructed over one-half of the structure. The structure is founded on a crawl space with a cinder block perimeter wall and interior piers of concrete block. A single post supports a balcony and the roof beam overlooking the living area.

Masonry and Earth Structures

Masonry and earth structures include concrete block, stone, and adobe brick (stabilized from hardened soil blocks, baked in the sun) faced with stucco. Three structures falling in this category were located in New Mexico. Consistent with construction practices in the southwest, houses were founded on concrete slab or directly on the ground with stone perimeter beams supporting bearing walls.

E1S-NMA is a one-year old cinder block building founded on a reinforced eight-inch thick concrete slab.

E2S-NM is a two story stone (field rock with cement joint grout) structure built in 1880 with interior adobe walls. The stone exterior walls comprise two layers of sandstone block and mortar without wood framing or a bond beam to tie the exterior stone walls together. The mansard roof rafters rest on two, two by eight inch headers lying on top of the stone walls. There are no nailed connections between the roof and the structure wall. Interior walls on the first floor are covered with structural plaster. Exterior stone and interior adobe walls rest on a rock wall foundation.

E1S-NMB is a 17-year old single story traditional adobe structure. Exterior walls were covered with stucco while interior walls comprise exposed adobe bricks. The house is founded on a four inch concrete slab.

Wood-frame Structures

Wood-frame structures represent "typical" construction akin to structures previously selected by the U.S. Bureau of Mines. All wood-frame structures were founded on full basements.

W1S-IN is a one-story wood-frame structure with a full basement of CMU wall construction built in the 1950s.

W1S-PA is a newly constructed one-story wood-frame house with a full basement of CMUs.

W2S-IN is a house that was recently purchased by the mining company prior to mining through the property. It has a concrete block full basement and a partially completed attic. The structure age is unknown.

W3S-WV1 is a three-story structure founded on a concrete slab. The first story, constructed of CMUs, serves as a shop. The second and third stories were of wood-frame construction of perimeter dimensions four feet wider than the first floor.

INSTRUMENTATION

Whole structure and mid-wall responses were recorded with single axis velocity transducers attached to four-channel blasting seismographs manufactured by LARCOR, of Dallas, Texas. A connector interface box linked transducers to the seismograph, which allowed the air channel to be employed to record velocity. Three seismographs, one exterior (master) and two interior (slaves), were daisy-chained together to record ground and structure motions with a common time base. The master was set on trigger mode and the two slaves were set on manual mode. When triggered, the master unit sent a one-volt spike to the slave units to simultaneously start data recording. A tri-axial transducer buried in the ground and microphone recorded three components of ground motion and airblast at each structure exterior.

Interior transducer output was amplified by a factor of 2 (e.g., lowest detection level of 0.005 inches per second, in/sec All three seismographs were programmed to record 6 to 12 seconds of event time at a sample rate of 512 per second. The master unit was programmed to trigger at a ground particle velocity of 0.02 to 0.03 in/sec and the maximum range for all units varied from 2.5 to 10.0 in/sec depending on blast-to-structure distance and gain selected.

Polarity Testing of Velocity Geophones

Polarity was checked for each geophone prior to deploying instruments in the field. When evaluating differential motions between the ground and structures, it is important to document the polarity of the geophones. For instance, polarity for a vertical sensor normally produces a positive phase first motion. If the polarity of a structure-mounted vertical sensor is such that the first motion is negative while a ground motion sensor vertical component produces a positive first motion, it is likely that the structure sensor polarity is reversed.

Polarity becomes critical when measuring and comparing relative motions between the ground and upper portions of structures, particularly when differential displacements are to be calculated in order to estimate gross structure strains and in-plane wall strains. If sensors are mismatched, differential displacements may be over two times greater than displacements for a common polarity.

Sensor Locations within Structures

Typical instrumentation placements for many of the structures are shown in Figures 5 and 6. Horizontal sensor orientations for common polarity are found in Figure 7. The radial alignment of sensors placed in the ground and within structures was directed along the long axis of each structure. Efforts were made to place the ground R component in the same direction as positive (inward) wall and structure motions. Sometimes the position orientation of the radial ground sensor was placed in a direction opposite to that of the structure or mid-wall orientation. This opposite polarity was easily recognized and compensated during analysis.

Specific locations of exterior and interior geophones, and the seismograph unit serial number to which they were connected, are illustrated in the structure plans in Appendix II. Interior sensors S1 and S2 consisted of four single-component velocity transducers, three mounted to record horizontal motions and one mounted to record vertical motion. A sensor cluster (two horizontal and one vertical) was placed at the first floor structure corner base (S1) and a duplicate cluster (S2) was placed at the highest point of the same corner. Motions recorded at S1 and S2 were used to measure the whole structure response to blasting. Mid-wall response was measured using a third horizontal sensor, placed at or near the middle of each conjoined wall (shown as wall 1 and wall 2). At S1 and S2, the R sensor was aligned with the longest axis of the structure and T with the shortest axis, as shown in Figure 5 (b). The vertical, V, sensor was placed on either wall. Figure 6 shows a typical instrumentation set up for a one-story mining camp structure

Other instrumentation layouts, specific to a unique construction type, did not adhere to the typical layout shown in Figures 5 and 6. In most cases, the lower structure vertical response reflected the ground vertical vibrations. Therefore, in some structures the vertical component normally placed at the lower was placed on a ceiling or other more useful locations. Sometimes, motions between two or more construction components were monitored. Special layouts were used for double wide trailer TD-TN (where opposite sides of the “marriage” wall were instrumented), single wide trailers TS-AL and TS-OH (measuring torsional motions at opposite ends of the trailer), and between two different construction types in TSA-VA. Motions were also measured in log structures along the “great” wall at the end of a vaulted ceiling room by placing single transducers at the roof peak, L2S-TN, L2S-OH, and between the roof beam, rafters and center post, L2S-WV2. In two structures, the vertical motions of the ceiling were measure (E2S-NM, TS-IN) rather than wall vertical motions.

RESULTS

The focus of this study was to characterize the response of atypical structures to blasting vibrations and airblast generated from surface coal mines. The uniqueness of structure design was addressed by comparing vibration response characteristics with characteristics measured by the U.S. Bureau of Mines and others during previous studies using traditional design structures.

A total of 25 structures were selected for this study at 11 mine sites. Twenty-one structures represented non-traditional designs and four structures comprised traditional wood-frame construction. Ninety-nine mine blasts were conducted during response measurements and 2824 velocity time-histories were recorded and analyzed.

The results of this study are organized in two sections. The first section illustrates the characteristics in mine site blast vibration and airblast generation and attenuation. The second section provides the results of structure response, comparing the relative whole structure and mid-wall motions as well individual structure response relative to external ground vibrations and air overpressures. The response of structure motions relative to ground motions were evaluated in terms of amplification factor as defined by the U.S. Bureau of Mines (Siskind, et al, 1980a) and compared to amplification factors found for traditional structures. Fundamental (or natural) structure frequencies and damping characteristics were evaluated for structures only when significant ground motion and air overpressure intensities were generated. Maximum gross structure and wall strains were calculated based on whole structure differential displacements and mid-wall displacements integrated from velocity time histories. Lastly, the influence of airblast on certain airblast-sensitive structure designs was evaluated.

In each evaluation, data processing and analysis procedures are explained. Data are summarized in table format and selected data are plotted in figures for comparisons. All sensor records are available in electronic format

Summary tables for all sites are given in Appendix III. Data in these tables include the following:

- Blast date and time
- Maximum charge weight per delay and blast-to-structure distance
- Calculated scaled distance (square- and cube-root)
- Ground motion and airblast measurements
  - maximum velocity for each of the three components of ground motions
    - (T, transverse, V, vertical and R, radial)

peak particle velocity (PPV, in in/sec), the highest of three components
peak frequency (Hz) for three components (zero-crossing frequency)
Fast Fourier Transform (FFT) predominant frequency (Hz) for three components
airblast, in decibels (dB)

- Whole structure response, single components
  - maximum velocity (in/sec), peak (zero crossing) frequency (Hz), and FFT frequency (Hz) for the R, V, and T components at either
    - S1 (lower corner) and S2 (upper corner)
    - S1 (lower corner) and S2 (upper peak or highest point in the structure)
    - S1 (lower wall) and S2 (upper wall) for interior or exterior walls
    - a variety of locations throughout the structure for conjoined components
- Mid-wall response, single components
  - maximum velocity (in/sec), peak (zero crossing) frequency (Hz) and FFT frequency (Hz) for the radial (R) and transverse (T) walls

Mine Site Characteristics

Table 2 summarizes the ranges in values for blast-to-structure distances, maximum charge weight per delay and square root scaled distance factors. The total number of mine blasts and number of structures instrumented per site are given. Scaled distance factors ranged from 23 $ft/lbs^{1/2}$ in New Mexico to 340 $ft/lbs^{1/2}$ at Kentucky site 2. Blast-to-structure distances ranged from 570 ft. in Ohio to 9219 ft. in Indiana. The maximum charge weight detonated per delay among all sites was 13,047 lbs. in New Mexico while the smallest of 126 lbs. was used in Indiana and West Virginia site 1.

Ground Vibrations and Airblast Measurements

Ground Vibration Attenuation Plots

Attenuation plots of peak particle velocity versus square root scaled distance (SRSD) are shown in Figure 8 for all blast data. Figures 9 and 10 are attenuation plots for surface coal mine sites by state. Best-fit lines (50-percentiles) through site data with a sufficient range in scaled distance and a statistically significant data set to allow trend analysis are shown in Figure 9. Included in Figures 9 through 10 is the best-fit line given in Report of Investigation (RI) 8507 by the U.S. Bureau of Mines (Siskind, et al. 1980a) for the maximum horizontal component of ground motion for all coal mine data. Equations and correlation coefficients (R^2) for these lines are found in Table 3. The equations were fit to the PPV. Data for sites included in Figure 10 were not correlated. This is because either data represented a narrow range in blast-to-structure distances and charge weights, the data was highly scattered, or a limited number of blasts were conducted to produce a significant data set for correlation purposes.

Central Appalachia data in Figure 10 show a clustered set of similar scaled distances in Virginia and in West Virginia at site 2. Blasting at the remaining sites was conducted at various scaled distances in a number of different compass directions from structures. As such, data trends are not apparent and a narrow spread in ground motion values was recorded below 0.1 in/sec (98.5% of the data fell below 0.1 in/sec).

Interestingly, the New Mexico site generated data for both unconfined (casting) and highly confined (pre-split) as shown in Figure 9. The data fell with two distinct groups and the effects of greater confinement provided by pre-splitting blasting techniques resulted in far higher ground motion amplitudes compared to those produced from casting blast at a given scaled distance. Charge weights per delay for pre-splitting averaged 300 lbs/delay and for casting blasts, charge weights averaged 13,000 lbs/delay.

Equations describing the attenuation of ground motions, shown in Table 3, are compared with those provided by the U.S. Bureau of Mines for surface coal mines (Siskind, et al., 1980a). Site-specific data presented in the current study show a good degree of data correlation for the Alabama, Indiana, and New Mexico sites and scaled distance slope exponents (-b) ranging from –1.34 in Indiana to –2.22 in Alabama. The intercept or source term, ‘a’, varies from 64 in Indiana for highwall blasts with high relief (e.g. long delay periods along the face) to 5448 in New Mexico for highly confined pre-split blasts. The source term is a good indicator of explosive energy coupling at the blast site. Average values for data parameters ‘a’ and ‘b’ are slightly higher than values reported for coal mine data by the U.S. Bureau of Mines summarized in RI 8507, where ‘b’ is –1.52 and ‘a’ equal to 119 for all components of ground motion. This difference may indicate the presence of higher attenuating geologies at the current study sites in comparison with the U.S.B.M. sites.

Airblast

Airblast overpressure attenuation is given in Figure 11 for cube root scaled distance (CRSD) showing 50-percentile best-fit lines. Table 4 summarizes the best-fit equations in comparison with equations given by the U.S. Bureau of Mines (Siskind, et al, 1980b). The U.S. Bureau of Mines equation for highwalls shows a source term ‘a’ of 0.146 and ‘b’ equal to –0.823, R^2 of 0.77. The data for all sites compare favorably with past U.S. Bureau of Mines data.

Frequency Content of Ground Motions

Measuring Frequencies

Previous research has produced frequency-based velocity data without a clear definition of frequency or methods used to calculate frequencies. Frequency components of a vibration are equally important as the particle velocities. When the intent is to evaluate damage potential, the entire time history, or all frequency component, is an important factor to consider.

Frequency is most reliably computed by applying the Fourier frequency function, or FFT (Fast Fourier Transform), to transform the ground motion time histories (time domain) into the frequency domain. In this manner, the distribution of frequency content can be compared based on relative intensities of ground motion at specific frequencies, and predominant frequencies can be easily identified.

In contrast, the “zero-crossing” method has been widely adopted by industry for determining and reporting a single frequency value at the peak velocity of ground motions measured in three directions (R, T, and V), or the PPV. Current industry practices employ this "zero-crossing" frequency at the PPV to determine compliance with frequency-based limits (referred to henceforth as the peak frequency). A problem arises when the peak frequency occurs in a complex vibration time history containing a variety of frequencies and amplitudes. If the peak velocity occurs early in the time history within the high frequency components (e.g. above 20 to 30 Hz), the zero-crossing method may result in a frequency well above the natural frequency range of residential structures, even if the entire time history contains a strong low-frequency component. This peak frequency may not represent the frequency at which the maximum vibration energy is transferred into the structure. Most seismograph analysis software provides a means to plot the "zero-crossing" frequency for every peak contained within the time history. In this respect, the vibration energy contained over all frequencies can be evaluated with respect to potential structure response.

Measured Vibration Amplitudes and Frequencies

Peak particle velocity (PPV) data versus frequency are plotted in Figures 12 and 13. The upper bounds are shown for safe level blasting criteria recommendations reported in U.S. Bureau of Mines RI 8507 (Siskind, et al, 1980a) and Office of Surface Mining (1983). Frequency in Figure 12 is the peak frequency at the PPV while in Figure13, it is the predominant frequency calculated from the power spectrum of the Fast Fourier Transform (FFT).

Table 5 summarizes site-specific differences in frequency ranges calculated by the "zero-crossing" (Z.C.) and FFT methods. In all cases, with the exception of Tennessee, Z.C. frequencies at the PPV are higher at the upper end of the range compared with the FFT method. The change in the highest frequency within the range is most dramatic at five sites (Kentucky 1, New Mexico, Alabama, Kentucky-2, and Indiana) with upper Z.C. frequencies from 18 to 34 Hz and upper FFT frequencies less than 20 Hz. The remaining sites did not show such a large difference. The Tennessee site FFT frequencies actually increased over the Z.C. frequency. This increase is probably because the structure foundations rests directly on bedrock and measured ground motions were recorded within the thin, overlying soil layer where high frequencies were preserved.

Since the FFT method accounts for the entire wave train, it is preferred for structure response analysis. FFT is closely related to response spectra of ground motions and are employed to calculate structural natural frequencies and damping from structure motions.

Summary of Findings

These observations serve to illustrate a number of important points as follows:

- Different site characteristics, particularly structure site geology and blast-to-structure distance, produced different frequency content. Structure distances ranged from 570 ft. to 6280 ft. from the blasting. Certain structures such as those in Tennessee were founded directly on bedrock while others (in New Mexico) were founded on thick soils. Sites with different foundation materials produced a spread in ground motion frequencies while sites with similar geology produced a concentration of data within a narrow frequency range.

- At all but one mine site, FFT frequencies fell below "zero-crossing" frequencies and within the natural frequencies of structures for walls (12 to 20 Hz) and superstructures (5 to 10 Hz) reported by Dowding (1996)

- The Z.C. method employed to calculate frequencies were generally above those computed using the FFT method when only the peak velocities were analyzed.

- Frequencies calculated using the FFT method is a better indicator of the natural frequency of a specific site.

- Airblast attenuation was similar to that observed by the U.S. Bureau of Mines.

- Peak particle velocities for Appalachian coal mines were consistently below mean values predicated by the U.S. Bureau of Mines in RI 8507 for all coal mines with the exception of Pennsylvania. This is because mining in Appalachia is conducted at elevations higher than those of structures and well behind slope berms. As a result, PPV values are highly attenuated.

- Pre-split blasting consistently shows PPV values well above the mean for coal mining in RI 8507.

Structure Response

The measured response of structures to blasting vibrations and airblast are important to assess damage potential to individual components of the building. The amount of structure shaking is a function of the amplitude and frequency content of external ground velocity and airblast overpressure and the natural frequency and damping characteristics of the structure. Horizontal components of ground velocities are often amplified in structures while the highest structure velocities are measured when the ground frequency occurs at or within the structure's natural frequencies. The amplification of structure response relative to external ground vibrations is an important factor when assessing blast damage potential.

Two modes of structure vibrations occur during blasting and are referred to as mid-wall and whole structure responses. Mid-wall response is the motion of individual components such as wall, floors and ceilings, where motions are perpendicular to the plane of the building component. Mid-walls generally respond at high frequencies and tend to rattle windows and loose objects attached to walls. Resulting bending strains tend to be the greatest when the walls respond at their natural frequencies.

Whole structure response is vibration of the entire structure frame, measured at an outside corner, resulting in distortions, or racking, in walls. At low frequencies and high amplitudes of ground motions, whole structure deflections produce wall shear strains that, in turn, may be potentially damaging. Structure deflections are measured in terms of differential displacements between the upper and low (ground) corners in structures.

Time History Comparisons: Structure Response Relative to Ground Motions and Air Overpressures

Structural response (SR) to ground velocity and air pressure (airblast) are shown for (S2) upper structure corner locations or wall peaks, in rooms with vaulted ceilings and (S1) lower structure corners, at the base of the first floor wall, and mid-walls in Appendix IV. Ground velocities (GV) and air pressure (AP) are shown for comparisons. Peak values for velocities and airblast are provided. Superimposing excitation and structure response waveforms provides a visual means of evaluating the energy transferred into the structures over time. It further allows visual evaluation of structure or mid-wall free response after passage of the ground and air pressure pulses. Horizontal components of velocity were selected for comparisons. The maximum structure velocity in either the radial or transverse component is shown in Appendix IV figures, depending on the peak occurring within the structure.

Vertical components were only evaluated for manufactured (trailers) structures where structure response vertical motions were amplified. For all other structure designs, negligible differences among the lower and upper structure responses relative to ground vertical motions could be detected. Vertical structure motions within most structures duplicated ground vertical components in frequency, amplitude, and phase.

All vibrations are plotted in terms of velocity, in inches per second (in/sec). Vertical scales are not given and may vary between figures. However, among waveforms being compared in any one figure, constant vertical scales are used. Air pressure (AP) vertical scales are consistent among all plots.

Waveform time histories are expanded in time to illustrate similarities or differences in amplitudes, frequencies, and phases. Phase refers to the positive and negative pulse shapes forming the sinusoidal characteristics of a waveform. Vibrations of structures that are well-coupled to the ground may show good time history in-phase match with ground motions. However, when ground motion exhibit frequencies close to the natural frequency of the structure, structure vibrations are amplified and exhibit a near 90-degrees phase shift from the forcing or excitation motions

Structure designs used for comparisons include manufactured (trailers), log, camp, earth, stone, and masonry. Responses of standard wood-frame structures are not shown as responses do not show uniqueness beyond what other structure studies show.

Figure IV-1 compares ground motions with those at the structure base (S1). Figure IV-2 shows comparisons between S1 and S2, the upper structure response. In Figures IV-3 through IV-6, ground and S2 motions are compared relative to air pressure time histories. Air pressure time histories are plotted with mid-wall and S2 structure responses in Figures IV-7 through IV-10 to show the airblast effects of whole structure and wall responses.

Ground motion versus lower structure response: Lower structure horizontal responses (S1) are generally equal to or lower in amplitude than the same component of ground motion for all structure design with the exception of trailers. Trailer structure base motions for single wide and double wide trailers shown in Figure IV-1(a) can exceed those of the ground except in the case of trailers with wood-frame add-ons (TSA-KY2). This is observed also for camp structures to a less extent in Figure IV-1(d). One-story traditional log structure base response given in Figure IV-1(b) and earth, stone, and masonry structures shown in Figure IV-1(c) often fell well below motions in the ground.

Vertical components of ground and S1 velocities are superimposed in Figure IV-1(e) to show the amplification of vertical motions in single and double wide trailers. Vertical trailer responses are amplified because trailers are not coupled to the ground and are free to bounce. Furthermore, the tendency of trailers to rotate around the long axis (radial direction) in the transverse directions can often translate a portion of this response in the vertical direction, resulting in higher vertical response than would be predicted by ground motions. This type of structure response is unique to trailers and was not measured in other structure designs

Lower structure response versus upper structure response: Differential horizontal motions, or the difference between upper structure response, S2, and lower structure response, S1, induce whole structure strains in walls from racking distortions. Computing differential displacements, by first integrating the velocity time histories and subtracting S1 from S2 over time, allows the best estimation of strains.

A visual comparison of relative horizontal motions between the upper (S2) and lower (S1) walls of structures is shown in Figure IV-2. A good agreement of velocity time histories for most structure designs exists with the exception of log structures, shown in Figure IV-2 (b), and the two-story camp structure (C2S-KY1A) in Figure IV-2(d). All trailer motions showed good phase agreement (e.g. time history peaks and troughs matched in frequency). Motions in adobe (E1S-NMB) and concrete block (E1S-NMA) structures given in Figure IV-2 (c) show good phase agreement and amplification of S1 motions in the upper structure (at S2). The two-story stone structure (E2S-NM) did not show good phase matching.

Log structures, regardless of design, do not show similar upper and lower structure responses. Motions do not match in peaks while two-story designs show amplification of the upper response that is absent in one-story designs. This is to be expected because log structures are not constructed with a frame and the upper and lower horizontal log members move independently.

Ground and air pressure time histories relative to upper structure response: Upper structure (S2) response relative to ground motions and air pressure (or the pressure equivalent of airblast) are shown in Figures IV-3 through IV-6. Structures used to illustrate air pressure effects were subjected to airblast levels at or above 116 decibels (dB) (with the exception of camp structure C2S-KY1A). Single wide trailer responses (Figure IV-3) are less sensitive to ground vibrations than to airblast pressures. The airblast phase of structure response shows higher S2 amplitudes than for the ground motions phase for trailers TS-KY2, TS-IN, and TSA-KY2 with a wood-frame add-on. Airblast influence is not as apparent in double wide trailer TD-WV2 because the instruments used to measure whole structure response were placed along the interior center (marriage) wall. Note that the ground and S2 responses are approximately 90-degrees out of phase (where structure peaks lag behind peak in the ground motion) indicating that the deformation response of the structure is at a maximum.

Airblast excitation of whole structure response is apparent in the two-story log structures shown in Figure IV-4 (L2S-WV2 and L2S-TN) and is not as noticeable in one-story log, camp, earth, and masonry structures. The two-story stone structure E2S-NM, shown in Figure IV-5, was responding at the natural frequency by the time that the air pressure arrived and shows not additional response. This is evidence again by the phase shift in S2 response relative to the ground motion.

Mid-wall and upper structure response to air pressure: Mid-wall and upper structure (S2) motions shown in Figures IV-7 through IV-10 are compared with airblast arrival. Mid-wall motions show both high frequency and low frequency characteristics for log, camp, earth, stone, and masonry structures while trailer mid-walls responded only at high frequencies. Of the log structures for which mid-walls were measured, only L2S-OH mid-wall duplicated the low frequency peak S2 response. This is because the wall measured was the "great wall' in the living room with a vaulted ceiling containing a massive stone chimney. Therefore, the mid-wall and upper peaks tended to move as one unit. This response was also observed in the two-story stone structure E2S-NM in Figure IV-9. The absence of high frequency components in the upper story mid-wall shows the strong influence of the whole structure motions on the massive stone mid-wall, indicating that the mid-wall moved in concert with the structure and not independently.

The one-story log structure L1S-WV1 did not show detectable mid-wall response to airblast (Figure IV-8). Similarly, the influence of air pressures is not significant for earth, stone and masonry mid-walls given in Figure IV-9. One-story adobe and concrete block structures also showed a correspondence in motions between upper structure and mid-walls. However E1S-NMB responded with both high and low frequencies.

Trailer mid-wall response is similar to the low frequency whole structure response with high frequencies superimposed. The large difference in exterior wall mid-wall response from S2 response for TD-WV2 given in Figure IV-7 is because S2 was measured on an interior wall and mid-wall response is shown for an exterior wall.

The mid-wall response of the one-story camp structure in Figure IV-10 is typical of motions for loose surface covering such as wood paneling in a thin-walled structure. In this case the mid-wall shows a large amplification over the upper structure response because of the loosely nailed paneling on this exterior wall to which the motion sensor was attached. The mid-wall response therefore is not necessarily true mid-wall response but rather the response of the material covering the wall. It is indicative, however, of rattling of objects on or adjacent to walls.

Summary of findings

- Lower corner horizontal responses for single wide and double wide trailers and camp structures exceeded ground velocities for similar components Single wide trailer with wood frame add-ons do not show this behavior.

- The lower horizontal corner response in log, earth, and masonry structures are equal or less than external ground motions.

- Trailers exhibited amplification of vertical ground velocities. Vertical structure response was less than external vertical vibration for all other structure designs.

- Upper (S2) and lower (S1) corners move in phase for trailers and one story camp, earth, stone, and masonry construction. Log structure corner motions are highly random and out of phase because they lack the frame support provided in other structure designs. Two story stone and camp structures show similar characteristics to log designs.

- The influence of airblast on whole structure response, for airblast of 116 dB and above, is clearly measured for trailers and two-story log structures. Earth, masonry and camp designs do not clearly show structure response to airblast.

- Mid-walls respond at high frequencies relative to whole structure responses. However, for log, camp, earth, stone, and masonry structures, mid-walls carried additional low frequencies associated with whole structure responses. Mid-walls did not respond to airblast in one-story log, earth, masonry, and two-story stone structures. Airblast effects are readily measured in mid-wall of all trailers, with both high and low frequency (whole structure) components, and camp structures.

- Loose construction components and wall covering, such as paneling, can create high mid-wall motions that are not associated with structure response.

Correlating Structure Response to Ground Motions and Air Pressures

Whole structure (S2) and mid-wall responses were plotted against PPV and maximum airblast overpressure to compare the relative influences on structure response. Depending on structure design, the maximum structure responses will fall within the ground motion phase or airblast phase of structure response. For instance, trailer are sensitive to airblast and many of the peak velocities contained within the mid-wall time histories occur simultaneously with the airblast arrival (airblast phase) rather than during the passage of the ground motion wave (ground phase). Other structures show a greater sensitivity to ground motions and relatively little response to air pressures.

Maximum velocities within the upper structure (corner or peak measured at S2) and mid-wall time histories were plotted against the respective excitation driving the peak (e.g. peak air pressure or peak ground motion). Only horizontal components in the transverse, T, or radial, R, directions are considered.

Best-fit equations of structure response versus PPV for each structure design are presented in Table 6 to be consistent with RI 8507. Earlier discussions showed the importance of the entire excitation wave train. Thus these equations should not be used to predict structure response motion.

All equations were forced through the origin with a y-intercept value of ‘0’. A positive y-intercept at x = 0 is meaningless as it is not possible to measure a structure response without a positive driving force. A negative y-intercept is feasible in the case where a threshold force is necessary to measure a response. Although comparing this threshold among structures may be of interest, it was not a necessary component of response and therefore not measured. For comparisons with U.S. Bureau of Mines structure response equations given in RI 8507, positive y-intercepts were necessary to compute in some cases, but are not shown in Table 6.

Structure response to ground vibrations: Ground motion-induced peak structure responses are compared in Figures 14 and 15 for whole structures and mid-walls. Upper corner peak motions in Figure 14 show that only two structure designs (one-story log and earth, stone, and masonry) were subjected to peak ground motions greater than 0.40 in/sec. By comparing the data in Figure 14 with Figure 35 in RI 8507, it is apparent that atypical structure responses fall with the range of U.S. Bureau of Mines data.

However, the response of the two-story stone structure within a narrow range of ground motions from 0.21 to 0.45 in/sec shows amplifications above those exhibited by other structures within the same PPV range. The stone structure response can be explained by two factors. The unusual construction does not include an upper bond beam along the top of the walls. As such, the stone structure is free to respond without typical wall constraints. The second factor is that the ground frequency matched the natural frequency of the structure (about 4 Hz).

Mid-wall responses are shown for all structures in Figure 15. The mid-wall response of the stone structure is well above other structure designs. This is because the mid-walls did not move independently of the whole structure and amplified the 4 Hz ground vibrations. Mid-wall horizontal motions fall within the range of mid-wall responses reported in RI 8507 Figure 33.

Trailers are unique in that they have large ratios of transverse to radial wall dimensions. Figure 16 shows that the mid-wall responses in all trailers fall within two trends. Trailers tend to “rock’ along the long axis and whole structure responses are far larger in the transverse direction than in the radial direction. As stated previously, mid-walls carry the same motion carried by the whole structure. Hence, transverse mid-walls in trailers respond to this higher transverse motion.

Best-fit lines for one and two-story whole structure horizontal corner responses are given in Figure 17. Equations in Table 6 for these lines (given for all structures) show a large difference in slopes averaged for all structures. The one-story slope coefficient of 0.63 agrees with U.S. Bureau of Mines data fit for one-story wood frame structures (0.56 slope). Although the two-story slope of 1.43 falls above the 0.55 slope reported in RI 8507 for coal mine data, two-story whole structure responses fall within U.S. Bureau of Mines measurements when quarry and iron mine data are included.

Structure response to airblast overpressures: Airblast induced whole structure and mid-wall responses are shown in Figures 18 and 19. Earth, stone, and masonry structures did not respond to airblast over the ranges measured. All peak structure responses occurred strictly in the ground motion phase. Log structures exhibited little whole structure responses and no air-blast induced mid-wall responses.

The greatest airblast sensitivity existed in trailers for both mid-wall and whole structure responses. The large population of airblast-induced data for trailers indicates that the majority of the peak structure responses tended to fall within the airblast phase as opposed to the ground motion phase. Wood-frame and camp structures exhibited some sensitivity to airblast relative to ground motion. A comparison of mid-wall motions shows approximately 1.3, 1.8 and 2.9 times greater air-induced motions relative to ground-induced motions among trailers, wood-frame, and camp structure, respectively.

The unusual trailer and wood frame response to airblast (shown grouped within the ellipse in Figure 18) were recorded during an 11.6 Hz airblast pulse. The airblast frequency precisely matched the detonation time equal to the 67 ms front row delays plus the arrival time between holes spaced 21 feet apart, adding a 19 ms inter-hole travel time (21 ft. divided by the speed of sound in air around 1100 ft.). The inverse of 0.086 ms pulse beat is a strong 11.6 Hz that matched the power spectrum peak. This unusual airblast frequency is shown in Figure IV-7 for structure TS-IN and the response of the mid-walls and, to some degree, the whole structure, is evident.

Whole structure (racking) airblast responses in this study were very close to previous U.S. Bureau of Mines studies and recent measurements by Siskind (2002). The envelope of maximum response shown in Figure 18 is 77 in/sec/psi for well-confined blasts and 155 in/sec/psi for unusually high frequency airblasts. Historical U.S. Bureau of Mines and values provided by Siskind (2002) for equivalent type airblasts were 42 and 135 in/sec/psi, respectively. With the high variability of airblast characteristics and hence responses, these results can be considered equivalent and normal.

Airblast and vibration guidelines can be compared. The racking response maximum value of 155 in/sec/psi and regulatory limits of 132 dB for a 2-Hertz system (0.0129 psi), gives a maximum structure response of 2.06 in/sec. This is consistent with the U.S. Bureau of Mine's worst case vibration criteria of 0.50 in/sec and 4.0 amplification factor, which yields a maximum structure response of 2.0 in/sec. The maximum air-blast induced structure response measured in this study was 0.52 in./sec.

In contrast to whole structure response, mid-wall responses to airblast shown in Figure 19 are higher than historical values, specifically for the trailer type structures. This study's worst case envelope for mid-wall responses was 442 in/sec/psi. The historical U.S. Bureau of Mines value was about 319 in/sec/psi, but did not include trailers. This study's results, exclusive of trailers, found a maximum of 266 in/sec/psi that is fairly close to the U.S. Bureau of Mine's value.

Summary of findings

- Whole structure and mid-wall peak responses induced by ground motions for all structures fell within data provided in U.S. Bureau of Mines RI 8507.

- Ground motion-induced whole structure response for one-story structures agrees with U.S. Bureau of Mines data fit for one-story wood frame structures. Two-story structure response falls above structure response reported in RI 8507 for coal mine data and within U.S. Bureau of Mines measurements when quarry and iron mine data are included.

- Earth, stone, and masonry structures did not response to airblast pressures while log structures produced measurable mid-wall responses and low whole structure responses.

- Trailers showed the highest whole structure and mid-wall responses to airblast with envelopes of 155 in/sec/psi and 442 in/sec/psi., respectively. Envelopes for other structure are 77 in/sec/psi and 266 in/sec/psi. These envelopes agree with historical U.S. Bureau of Mines data for non-trailer structures and are within normal ranges.

Fundamental Frequency Analysis: Natural Frequencies and Structure Damping

The natural frequency of each structure design was estimated using three methods. The first two methods were used to compute the natural frequencies during free response, when ground motions arrested, and during ground motion activity, when structure response peaks were 90-degrees out of phase with the ground motion peaks. The third method employed FFT analysis to calculate the predominant frequency of motion in structures when there was no free response. Calculating predominant frequencies using FFT analysis to estimate structure frequency response is desirable because blasting seismograph software easily accommodates this analysis. Isolating and computing natural frequencies over the response portion of structures that truly represents free response is often time consuming and requires experience. Therefore, a comparison of free response natural frequencies to FFT predominant frequencies is given herein to determine if using FFT analysis provides a good measure of structure free response.

Natural Frequency of Structures

Natural frequencies in structures can be observed either during free vibrations, when ground motions have ended, or during ground motions, producing a near-perfect sinusoid response, symmetrical about the time history x-axis and containing one single frequency. In the later case, structure vibration peaks will show a 90-degree phase angle shift from the ground motion (excitation) peaks, as described by Crum (1997) and predicted by theory (Harris, 2001). Examples of waveform time histories showing natural frequencies produced in the second floor upper corner and mid-wall during ground motions are given in Figures 20 (a) and (b). The ground motions are 90-degrees out of phase within the mid-wall and upper structure motions beyond the time marked by the vertical dashed lines. Just beyond this time the natural frequency can be measured. It should be pointed out that only two structures, TD-WV2 and E2S-NM, exhibited natural frequency response during ground motion activity.

Figure 20 (c) illustrates free response of an upper corner once ground motions have arrested and before arrival of the airblast. The structure response in this region, between 3.5 sec. and 6 sec., is 4.0 Hz. True free response measurements are often difficult to detect and analyze in the absence of ground motions and before the arrival of the airblast pulse. If the airblast arrives before ground motions arrest, free response may not be detected. The majority of structures exhibited this form of free response for natural frequency measurements. However, a sufficient number of structure responses in which ground motions could be isolated from airblast influence to obtain reliable free response measurements.

Table 7 shows the natural frequencies computed during the response phase shift from ground motions for E2S-NM (two-story stone structure) and TD-WV2 (double wide trailer). The 4.0 Hz stone structure radial and transverse mid-wall sensors were located on the first and second floors, respectively. The transverse S2 sensor placed in the 7.0 Hz double wide trailer was located along the marriage (center) wall and the radial sensor was placed on the outside wall, center at the structure peak. Both mid-walls were placed on outside walls. Within each structure, the frequency responses in mid-walls and the whole structure were identical, indicating that mid-walls do not respond independently but rather with the upper structure. Table 8 summarizes structure free response frequencies, calculated using the FFT of the time history after the ground motion has arrested. Data from structure response given in Table 3 from U.S.B.M RI 8507 for wood-frame structures are provide for comparison. Whole structure free response data for all structure and all sites compare well with U.S.B.M. data. Mid-wall response data may not compare because the U.S.B.M placed mid-wall sensors on the wall facing the blasts to capture air pressure effects. Therefore orientations could not be verified and mid-wall response data are averaged for both T and R directions.

Structure Response Based on Ground Motion FFT Analysis

Appendix V contains plots of relative amplitude from FFT analysis for S2 and MW as well as predominant frequencies of structure response compared to the dominant FFT frequencies of ground motions. Data are grouped by responses for radial, R, and transverse, T, walls to demonstrate that R and T frequencies are different for most structures.

Plotting structure response FFT frequencies based on relative amplitude from spectral analysis is a good means of identifying specific structures that respond at a unique and consistent frequency, regardless of ground motion amplitude and airblast levels. This further serves to illustrate how structures may amplify ground motions if the predominant ground frequency is close to the natural frequencies of the whole structure or mid-walls.

Figure V-1 through V-4 show relative amplitudes plotted against FFT predominant frequency at the upper structure (S2) and mid-walls (MW) for T and R walls. These peaks do not necessarily correlate with the averages given in Table 8 for all structures within each category as they represent the strong, dominating frequency for a single structure within the design category. For instance, in Figure V-1 (a), the single, strong peak at 3.8 Hz represents the predominant upper structure motion in TS-OH while all other single-wide trailers responded at higher frequencies. Whole structure double-wide trailer responses (TD-WV2 and TD-PA) shown in Figure V-1 (b) are centered at 7.2 Hz. Trailers with wood-frame add-ons responded at 4.4 Hz and 7.7 Hz.

Other dominating T frequencies are observed for all log structures, between 6.1 and 6.4 Hz, for designs with vaulted ceilings at 8.3 Hz, and earth, stone, and masonry structures, centered at 4.0 Hz. Camp and wood-frame structures show various amplitudes at a variety of frequencies that are not centered on one value.

Radial structure and wall motions show some predominance at 6.6 Hz for single-wide trailer TS-OH. Earth, stone, and masonry and log structures show central R frequencies similar to those in the T direction while camp and wood-frame structure show some focus between 6 to 7 Hz.

In Figures V-5 through V-8, T and R upper structure frequency responses are plotted against ground motions in terms of peak FFT frequencies. Data in Figure V-5 and V-7 indicate that single-wide and double-wide trailer structure frequencies do not correlate with ground motion frequencies for the same component. Response frequencies vary for whole structure and mid-walls. Wood-frame add-on trailers and log structures show a uniform behavior in response frequencies over a wide range of ground motion frequencies. Mid-walls tend to respond at frequencies higher than the upper structure. This is also observed for T walls for wood-frames structures in Figure V-6 (d).

Therefore, regardless of ground motions frequencies, structure frequencies were low and structures tended to respond at their natural frequencies. Trailers are an exception where structure frequencies highly varied.

Verification of Spectral Analysis Ability of Seismic Data Analysis Software

When using FFT methods to calculate frequency content, a question always arises regarding the computation schemes used in computing the power spectrum. The ability of computations to resolve the peak or predominant frequency in a spectral plot is a function of the number of data in the time history (record length) and sample rate (number of data points). The longer the record length, the more data are contained in the time history, and the frequency intervals become smaller. When only a small segment of the waveform (e.g. containing the natural frequency) is used in the FFT analysis, frequency intervals may become large, on the order of 0.5 to 1 Hz. Resolving the dominant frequency within $\pm$ 0.2 Hz may not be possible and the true peak may be missed.

Spectral plots using two softwares are compared in Figure 21 for the upper corner transverse response for TS-OH given in (a). Spectral plots using Seismograph Data Analysis 2000 v. 6.2.3 from White Industrial Seismology, Inc., and NUVIB (Huang, 1994) for various record length segments shown in Figure 21 (a) are given in Figures 21 (b) through 21 (d). Although the frequency intervals are not the same for each record length selected, the predominant frequencies calculated by each methods are in good agreement as follows:

	Predominant frequency in Hz	
	White software	NUVIB
Entire waveform	3.75	3.72
Segment 1	4.00	4.00
Segment 2	3.75	3.72

Damping of Structure Motion

Structure damping near the natural frequency or during free responses was computed. Damping is the structure's resistance to movement and causes the structure to return to its resting position in a harmonic sinusoid. The harmonic vibration peaks decay in a well-defined exponential function from a maximum value, P_1, according to the following:

$$\beta = \frac{1}{2\pi m} \ln \frac{P_1}{P_{m+1}} \qquad (100\%) \tag{1}$$

where β is the damping coefficient, P_1 and P_{m+1} are the successively peak amplitudes where $P_1 > P_{m+1}$ and P_1 is usually taken as the peak "free" response after the ground vibration has ceased. P_{m+1} is any peak following P_1, "m" cycles later in time. The damping coefficient is defined as the percentage of critical damping, where perfect damping is 100%. A perfectly damped system (such as a well-coupled geophone) is one that responds exactly the same as the driving force. On the other hand, at 0% damping, a structure would resonate and never stop vibrating. Values for successive damped peaks in the time history used to calculate β are illustrated in Figure 20 as P1 and P2.

Damping in structures is low as it takes many oscillations for a structure to complete moving. Dowding (1985) reports damping for residential structures in the range of 2 % to 10% of critical.

Damping terms were computed for structures that exhibited response peaks out of phase from ground motions, shown in Table 7, and for structures that exhibited free response after ground motions arrested, summarized in Table 9. Based on the data in Table 9, trailer transverse mid-walls showed the greatest damping (9.5% of critical). Log and trailer structures exhibited high damping in the radial structure peaks (9.7% and 9.6%, respectively). The least damped structure type was the earth, stone, and masonry structures with a 3.9% average damping term (the CMU block structure, E1S-NMA, did not show free response and therefore damping could not be computed). High damping in trailer and log structures can be explained by the unconstrained nature of construction components that do not effectively transmit frequencies. CMU piers supporting trailers are not mortared while logs are not nailed together to form a solid, supporting mass. Structure response amplitude may be high in such structures, but they quickly dampen due to the lack of structure bonding.

Summary of Findings

- Whole structure and mid-wall natural frequencies were determined for free response motions. Whole structures averaged 6.0 Hz and mid-wall averaged ranged from 8.4 to 13.8 Hz. U.S. Bureau of Mines whole structure natural frequencies range 7.1 to 7.8 Hz and mid-walls averaged 16.4 Hz.

- Average damping for all structure was 7.8% for whole structure vibrations and ranged 7.3 % to 6.2 % for mid-walls. Average damaging values found by the U.S. Bureau of Mines ranged 4.4 % to 5% for whole structures and 1.8 % to 2.3 % for mid-walls.

- FFT methods are the best way to predict dominant frequencies.

- Structures tended to response at their natural frequencies with the exception of trailers. Structure vibration frequencies in trailers are highly varied and often respond at frequencies higher than their natural frequency.

- Log and trailer structures are more highly damped because of their lack of structure bonding.

Amplification Factors

Time-correlated amplifications of ground motions within structures were computed in terms of an amplification factor (AF) defined by Siskind et al. (1980) and explained by Crum (1997). AF is defined as

$$AF = \frac{S2_{peak}}{V} \qquad (2)$$

where $S2_{peak}$ is the maximum velocity of the upper structure and V is the velocity of the ground motion for the same component at the corresponding moment of time or immediately preceding the time at the peak S2 motion. AF values were also computed using peak mid-wall responses relative to V in the ground.

Whole structure and mid-wall amplifications were determined from superimposed velocity time histories as shown in Figure 22 for the upper structure relative to ground velocity.

Plots of AF for whole structure responses are plotted for predominant FFT ground motion frequencies in Figures 23 through 27. For ground motion FFT frequencies greater than 7.1 Hz, the mean AF is 1.7 with a maximum of 3.3. At 7.1 Hz and below, the mean AF is 2.2 with a maximum of 5.0. Amplification factors greater than 3 were associated with ground motion frequencies between 4.0 and 7.1 Hz.

In U.S.B.M RI 8507, typical whole structure amplification factors are reported to be 1.5 with 4.0 being the highest value. The greatest values occurred at ground motion frequencies between 5 and 12 Hz. The U.S.B.M. study did not include sites with ground motion frequencies less than 5 Hz and included ground motions up to 85 Hz. In the current study, the average site ground motion frequency was 9.6 Hz with 28% of the sites exhibiting ground motion dominant frequencies of 5 Hz or less. It is reasonable to conclude that the U.S.B.M. data did not include AF greater than 4 because ground motion frequencies did not fall within the lower ranges of structure natural frequencies included in the current study.

Amplification plots by structure show that the two-story stone and two-story camp structures show the highest average amplification factors because structure natural frequencies matched those of the ground. The 4-Hz stone structure (E2S-NM) was subjected to six blasts with an average ground motion frequency of 4 Hz. One single two-story camp structure, with a natural frequency response of 6.1 Hz, was subjected to five blasts with ground motions averaging 6.4 Hz.

Summary of Findings

- Time correlated amplification factors (AF) ranged from 0.4 to 5. The U.S. Bureau of Mines calculated AF from 1.5 and 4.0.
- The highest AF values were observed for the two-story stone and two-story camp structures where the ground vibration frequencies matched the natural frequency of the structures. Log and one-story earth and masonry structures exhibited the lowest values of AF. Amplification factors in trailer were 4.0 and less.
- The highest amplification factors occurred when ground motion predominant frequencies matched structure natural frequencies.

Relative Displacements and Calculated Strains

Previous studies involving crack observations during blasting have shown that a strong correlation exists between peak particle velocity and blast-induced threshold wall damage (Nicholls, et al., 1971; Siskind, et al., 1980; Stagg, et al., 1984). Studies that included dynamic strain gage instruments mounted on walls have produced limited insight to threshold strains that cause wall cracking. This is because changes in crack lengths and widths for blasting events are similar for time periods when no blasting took place. Furthermore, it is not possible to anticipate the wall locations that cracking will take place such that strain gages can be strategically placed.

Only two studies are notable. Wiss and Nicholls (1974) measured failure strains in gypsum wallboard during blasting and found new cracks formed during a maximum dynamic wall strain of 1010 μ-strains. Critical tensile failure strains in gypsum wallboard are given in RI 8507 by Siskind, et al., 1980. Openings along butt joints and new cracks appeared during blasting events at failure strains in excess of 300 to 400 μ-strains. Strains associated with mortar joint cracking during blasting were measured in excess of 300 μ-strains (Edwards and Northwood, 1960; Northwood, et al., 1963).

Differential structure displacement time histories were computed by integrating velocity traces and used to compute the maximum differential whole structure strains. Peak or maximum differential displacements, $\Delta\delta_{max}$, between the upper and lower structure motions were used to determine global wall shear strains, γ, and maximum wall bending strains, ε. A schematic showing displacement and global shear strain is given in Figure 28. Note that the sensors mounted on the radial walls (the wall of the shortest overall structure lateral dimensions) measure gross structure motions in the transverse direction. Similarly, the transverse sensors measure motions in the radial walls.

Maximum differential displacements were computed by subtracting time-correlated displacement time histories measured at S1 (lower structure corner) from S2 time histories (upper structure corner). Since the polarity of the transducers was known, the resultant displacements were automatically accounted. Thus the relative displacement was obtained by simple subtraction. However only the absolute values are reported.

The maximum global structure shear strain of the wall, γ, is computed using the peak or maximum differential displacement divided by the wall height as follows

$$\gamma = \frac{\Delta\delta_{max}}{L} \qquad (3)$$

where L is the wall height in inches and $\Delta\delta_{max}$ is in inches. Therefore γ is given as μ-in./in. or μ-strains.

The in-plane tensile wall strain, ε_L, is related to the gross structure shear strain for the same wall being affected by the motions. The maximum in-plane strain, $\varepsilon_{L(max)}$, is aligned along a 45 degree diagonal as shown in Figure 28, where $\theta = 45°$ is the direction of the maximum strain. The solution for in-plane tensile strains can be found in basic mechanics textbooks and $\varepsilon_{L(max)}$ is given as

$$\varepsilon_{L(max)} = \gamma_{max} \sin\theta \cos\theta \qquad (4)$$

which reduces to

$$\varepsilon_{L(max)} = (0.5)\,\gamma_{max}$$

when $\theta = 45°$ and $\varepsilon_{L(max)}$ is one-half of the gross structure strain, γ. Global or overall in-plane tensile strains are critical to threshold wall cracking potential.

Maximum wall bending strain, ε, given by Dowding (1985)

$$\varepsilon = \frac{6d\Delta\delta'_{\max}}{L^2} \tag{5}$$

for a fixed-fixed response system, where d is the wall thickness divided by two, in inches, and ε is given as μ-in./in. or μ-strains. For a fixed-free structure, bending strain is computed as

$$\varepsilon = \frac{3d\Delta\delta'_{\max}}{L^2} \tag{6}$$

where $\Delta\delta'_{max}$ is now the maximum resultant wall displacement (assumed to be located at the mid-wall) calculated as

$$\Delta\delta'_{\max} = S_{mw} - \left(\frac{S_2 + S_1}{2}\right) \tag{7}$$

where S_{mw} is the peak mid-wall displacement and S2 and S1 are the time-correlated upper and lower corner displacements.

Calculated in-plane tensile strains and wall bending strains are summarized by structure design in Table 11. Average and maximum values are reported. Figures 29 (a) and (b) show examples of differential displacements (in terms of absolute values) calculations for the E2S-NM two-story stone structure in the radial and transverse directions, respectively. These displacements, given in inches, represent the average measurements for this structure during the study. Velocity time histories at the upper (S2) and lower (S1) structure corners were integrated and the resulting displacement time histories are subtracted (S2 - S1) to obtain the differential wall shear displacements. The absolute value of S2 – S1 is shown to readily display the maximum value of $\Delta\delta_{max}$.

Maximum calculated in-plane tensile strains and maximum calculated wall bending strains are shown in Figures 30 and 31 plotted against maximum ground motion for the same component. The largest in-plane tensile strains shown in Figure 30 were calculated from time-correlated differential displacements in the second story of the stone structure (E2S-NM). Motions in the radial direction resulted in a maximum calculated in-plane tensile strain of 113.1 μ-strain in the transverse wall. The second story transverse wall produced a maximum calculated bending strain of 46.6 μ-strain, assuming a fixed-free model of bending and is shown in Figure 31 at a PPV of 0.46 in/sec. The fixed-free model for structure E2S-NM is justified based on the absence of a top plate or beams affixed to the stone exterior walls to render the upper structure rigid. Calculated strains in the stone structure are below levels measured during previous research on mortar joint cracking during blasting.

One- and two-story log structures carry large strains due to their natural flexibility supplied by the individual wood members. Radial motions produced transverse wall peak strains of 95.5 and 66.6 μ-strain for one- and two-story log structures, respectively. Mid-wall strains were relative small for two-story structures and among the highest for one-story designs. Depending on the quality of wood, failure strains for logs can range from 7000 to 20,000 μ-strain

(USDA, 1999). Therefore, calculated strains produced by blasting during this study are far below those strain levels that could possibly cause cracks in log walls.

Calculated strains produced in trailers, camp, wood-frame, concrete block, and adobe structures were as high as 12.5 μ-strains for gross structure shear (for which the highest was computed for wood frame types) and less than 9.2 μ-strains for all bending wall strains. Strains calculated for the one-story cinder block structure for radial and transverse in-plane strains fell below those calculated for wood frame structures. Cinder block wall strains are well below critical failure strains.

Summary of Findings

- Peak in-plane tensile strains calculated from whole structure differential displacements were 113.1 μ-strain in the two story stone structure. A value of 95.5 μ-strain was computed for a one-story log structure. For all other structures, whole structure wall strains were less then 40 μ-strain.

- Peak calculated mid-wall bending strains were the greatest in the two-story stone structure with a value of 46.4 μ-strains. Bending strains for all other structures were less than 26 μ-strain.

- In some structures, ground velocities may compare to structure response at S1. Therefore, ground velocities may be used to evaluate response in structures expect in the case of trailers where S1 does not match ground velocities.

Non-blasting Sources of Structure Vibrations

Household Activities

Structure responses to non-blasting events are shown in Table 12 for seven structures. A comparison of non-blasting event responses are shown in Table 13 compared with the maximum whole (upper) structure and mid-wall velocities recorded during blasting. It was not difficult to generate structure motions during normal household activities within trailers and wood frame structures. Structure responses from household activities were equal to those produced during blasting in the single wide trailer, TS-IN.

The more massive masonry and earth structures did not significantly respond during non-blasting influences. Therefore, responses shown in Table 12 are very low in amplitudes. Log and camp structures were not included in these tests.

Wind

Table 14 summarizes whole structure and mid-wall maximum velocities and strains for three trailers that responded to significant wind gusts traveling between 12 and 32 miles/hour. The maximum upper structure (S2) velocity and calculated whole structure strains (γ_{max}) are given for the T and R components or walls. Note that the upper structure response for the given component drives the shear strains in the opposing wall as previously described. For instance, the 0.055 in/sec maximum velocity recorded at S2 in the T direction produced an estimated 3.5 μ-strains of shear in the radial wall.

Upper structure transverse (S2) and mid-wall responses (both T and R walls) for air pressures (AP) from blasting and wind gusts are compared in Figure 32 for single wide trailer TS-KY2. Wind gusts are not efficient driving forces compared with blasting to excite significant structure responses. However wind gusts can generate air pressures that result in detectable levels of structure shaking and mid-wall responses up to 0.1 in/sec.

Summary of Findings

- Whole structure trailers motions from household activities were measured equal to motions induced from blasting. Mid-wall responses were general equal to or less than the responses from blasting. Structure responses from household activities in earth, stone and masonry structures were far lower and in some cases barely detectable in comparison with blasting responses.

- Trailer structure responses to wind gusts produced whole structure motions that were generally one-half of the motions generated during blasting.

CONCLUSIONS

1. Predominant frequencies of the ground motion time histories, as estimated from the power spectrum computed using FFT methods, tended to produce frequencies below those computed using the zero-crossing method computed at the PPV. The upper end of the frequency range using the zero-crossing at the PPV was 16 to 32 Hz compared to a 7 to 20 Hz from the power spectrum. In all cases except one site, FFT frequencies fell below zero-crossing frequencies. The exception was the Tennessee site in which structure were founded directly on bedrock.

2. Fourier transforms are preferable in structure response analysis to determine predominant excitation frequencies as the entire waveform is involved in the process.

3. Structure response relative to ground motions and airblast was evaluated by comparing horizontal time histories among the ground, lower structure (S1), upper structure (S2), and the mid-walls. Little difference between lower floor response and ground motions were noted for all structure types with the exception of trailers in the vertical direction. Single and double wide trailers produced wall base motions greater than exterior ground motions. In the case of trailers, wall base motions should to be instrumented in order to compute differential wall displacements. For other structure designs for which the foundations are coupled to the ground, exterior ground motions may be used to estimate lower structure horizontal responses.

4. Whole structure motions, as indicated by the best-fit slope of upper structure response versus PPV, were the highest in the two story stone (3.22) and camp (2.70) structures. Trailers, one-

story wood frame, and log structures responded similarly with slopes of 1.29, 1.30, and 1.54, respectively. Other one story structures (log, earth and masonry) exhibited structure responses less than ground motions.

5. The greatest mid-wall responses, as indicated by the best-fit slope of mid-wall response versus PPV, were measured in log structures possessing "great walls" (2.98) and camp structures (2.58). Responses were similar for trailers (2.09) and wood frame (2.09) mid-walls

6. The influence of airblast over 116 decibels on the upper structure (S2) and mid-wall responses were observed for trailers. Whole structure and mid-wall motions duplicated airblast time histories and peak structure responses occurred within the airblast phase rather than within the ground motion phase. Mid-wall motions show both high frequency and low frequency characteristics for specific structures while trailer mid-walls tended to respond only at high frequencies. Upper (second story) mid-walls and upper structure corners move as one unit in most two story structures studied. In a number of cases, mid-wall responses duplicate airblast waveform signatures. Structure types that clearly did not show a response after the air pressure pulse arrival include one-story camp, log structures, and massive stone, concrete block and adobe structures.

7. Average values for natural frequencies of mid-walls and whole structures in both the radial and transverse directions fell below those reported by the U.S. Bureau of Mines in RI 8507. An average of 18 Hz for mid-wall (no specific component) is reported in RI 8507. Dowding (1996) reported mid-wall frequencies between 12 – 20 Hz. Whole structure natural frequencies are reported to range 5 to 10 Hz. Data in this study corroborate these whole structure findings.

8. Damping characteristics during free response were evaluated for all structures. The greatest damping in mid-walls was found for the transverse direction in trailers equal to 9.5% of critical. Log and trailer structures exhibited the highest whole structure radial damping of 9.7% and 9.6%, respectively. The least damped structure type was the two-story stone that responded with an average damping of 3.9%. Values for damping fall well within those reported in the range of 2 % to 10% of critical by Dowding (1985).

9. Amplification factors varied by type of structure as well as for certain structures within each design type. These observations may be compared with those from U.S. Bureau of Mines RI 8507 where the maximum values were 4 for structure corners. Corner responses of log and wood-frame structures fell below RI 8507 values. Out of this study of 25 atypical structures chosen for their unusual character, only two structure designs displayed amplifications greater than 4. These included the two story stone and two story camp structures with upper structure motions amplified by 5.0 and 4.6, respectively. These values can be attributed to the fact that these structures were vibrated at or near their natural frequencies of 4 to 7 Hz.

10. In-plane tensile wall strains calculated from gross structure differential displacements were below cracking thresholds of 300 to 1000 μ-strains for plaster and wallboard. Calculated wall bending strains were less than 20 μ-strains. Bending is generally not a concern for damage potential to structures. Whole structure strains are most important when assessing structure response.

11. Peak structure velocities induced in these atypical structures by occupant-induced motions were found to vary among structures by type and distance between the source and measuring transducer. Habitation excitations that generated structure responses were primarily door and window closings. Those structures with low-mass walls (e.g., trailers) responded more than did structures with more massive walls to similar activities.

RECOMMENDATIONS

1. Time histories collected during this study of 25 atypical structures should be electronically archived for future access and analysis. They represent an unusually rich source of data that included ground motions as well as structural and crack responses.

2. The crack measurements presented in Addendum I to this study involved monitoring crack displacements, demonstrating that inexpensive techniques can be used to measure both long-term (environmental or weather-induced) and transient (blast induced) changes in crack widths, when conditions allow, to supplement traditional structure response techniques.

3. For atypical structures, time-correlated ground motion and structure velocity responses could be measured with systems similar to those employed in this study if conducted as outlined in Addendum II. Whole structure response motions should be measured at the top and bottom wall corners of uniform construction. Mid-wall response as well as crack deformations can be measured as additional options.

REFERENCES

Crum, S.V., 1997, House Responses from Blast-Induced Low Frequency Ground Vibrations and Inspections for Related Interior Cracking, U.S. Department of Interior, Office of Surface Mining Report, Contract No. 143868-PO96-12616.

Dowding, C.H., 1996, *Construction Vibrations*, Prentice Hall.

Edwards, A. T., T. D. Northwood, 1960, Experimental Studies of the Effects of Blasting on Structures, *The Engineer*, v. 210.

Huang, F., 1994, NUVIB (Northwestern University Vibration Analysis Software), ver. 1.01, Department of Civil Engineering, Northwestern University, Evanston, IL.

Nicholls, H.R., C.F. Johnson, and W. I. Duvall, 1971, Blasting Vibrations and Their Effects on Structure, U.S. Bureau of Mines Bull. 656.

Harris, C. M., 2001, Harris' Shock and Vibration Handbook, McGraw-Hill.

Northwood, T. D., R. Crawford, and A. T. Edwards, 1963, Blasting Vibration and Building Damage, *The Engineer*, v. 15, No. 5601.

Siskind, D.E, 2002, personal communication.

Siskind, D.E., M. S. Stagg, J. W. Kopp, and C. H. Dowding, 1980a, Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting, U.S. Bureau of Mines RI 8507.

Siskind, D.E., V. J. Statura, M. S. Stagg, and J. W. Kopp, 1980b, Structure Response and Damage Produced by Airblast from Surface Mining, U.S. Bureau of Mines RI 8485.

Stagg, M.S., D.E. Siskind, M. G. Stevens, and C. H. Dowding, 1984, Effects of Repeated Blasting on a Wood-Frame House, U.S. Bureau of Mines RI 8896.

U.S. Department of Agriculture, 1999, Wood Handbook – Wood as an Engineering Material. General Tech. Rep FLP-GTR-113. Madison, WI. U.S.D.A. Forest Service, Forest Products Laboratory.

Wiss, J.F. and H.R. Nicholls, 1974, A Study of Damage to a Residential Structure from Blast Vibrations, ASCE, New York.

Table 1 Summary of construction types

Category	Structure type	Site	Designation	Structure	Wall height (in)	Wall thickness (in)	Overall house dimensions (ft x ft)	Maximum differential elevation (in)
pre-manufactured trailers	single wide	KY2	TS-KY2	no strapping	94	4	65 x 14	3.9
		IN	TS-IN	strapping	90	4	64 x 14	3.8
		AL	TS-AL	strapping	94	6	72 x 16	2.8
		OH	TS-OH	strapping	94	6	73 x 15	3.5
	single wide add-on	VA	TSA-VA	add-on	94	5	54 x 14	3.3
				original trailer	82	4	54 x 12	
		KY2	TSA-KY2	add-on	94	4	56 x 12	8.2
				original trailer	94	4	56 x 12	
	double wide	VW2	TD-WV2	center wall	94	6	64 x 28	2.4
		TN	TD-TN	center wall	104	4	74 x 28	1.8
		PA	TD-PA	basement	117	8	48 x 24	3.8
				first floor	84	4		
mine camp	single-story	AL	C1S-AL	first floor	86	8	50 x 27	4.0
		VA	C1S-VA	first floor	82	2	34 x 28	7.4
	two-story	KY1	C2S-KY1A	first floor	92	4	28 x 28	5.1
				second floor	92	4		
		KY1	C2S-KY1B	first floor	94	5.5	48 x 29	3.3
				second floor	94	5.5	29 x 16	
log	one-story	OH	L1S-OH	basement	91.6	9	38 x 23.5	3.7
				first floor	90.4	9		
		VW1	L1S-WV1	historic log cabin	78	12	24 x 26	5.9
	two-story	TN	L2S-TN	first floor	111.5	6.75	29 x 25	3.5
				second floor loft	93.5	6.75		
		OH	L2S-OH	first floor	great-wall 282 in. mid-wall at 144 in. from base	7	37 x 25	2.0
				second floor	82	7		
		WV2	L2S-WV2	west wall	94	8	46 x 30	2.7
				center post	286	8		
				second floor loft	82	8		
earth, stone, and masonry	one story cinder block	NM	E1S-NMA	ground floor	120	8	60 x 40	1.7
	two-story historic stone	NM	E2S-NM	first floor	108	24	37 x 30	5.0
				second floor	90	15		
	one-story adobe	NM	E1S-NMB	first floor	114	10	70 x 32	3.1
wood-frame	one-story	IN	W1S-IN	basement	92.4	8	40 x 22	3.7
				first floor	96	6		
		PA	W1S-PA	first floor	102	6	66.5 x 35	3.2
	two-story	IN	W2S-IN	basement	90	8	35 x 30	Nm
				first floor	96	6		
	three-story cantilever	WV1	W3S-VW1	garage	101	8	42 x 16	1.9
				first floor	94	5	42 x 20	
				second floor	52	5	42 x 20	

Nm – not measured

Table 2 Site information

Site	Number of Structures	Number of Blasts	Blast-to-Structure Distance (ft)	Charge Weight per Delay (lbs)	Square-Root Scaled Distance Factor ($ft/lbs^{1/2}$)
Alabama	2	4	852-1520	280-550	36-86
Indiana	3	16	816-9219	126-1712	44-223
Kentucky – 1	2	7	1830-5140	404-1044	60-184
Kentucky – 2	2	7	1510-4600	183-808	68-340
New Mexico	3	6	2095-5565	300-13047	23-278
Ohio	3	23	570-6280	284-4130	25-268
Pennsylvania	2	4	1390-1510	612-486	58-68
Tennessee	2	3	1225-6110	885-2809	34-149
Virginia	2	6	1212-1390	313-361	64-77
West Virginia – 1	2	5	4640-2240	126-2076	78-215
West Virginia – 2	2	8	1610-2670	415-973	76-118

Table 3 Ground motion attenuation equations from Figure 9

Site	Equation $[a\,(D/W^{1/2})^{-b}]$	Correlation Coefficient (R^2)
Alabama	$958\,(D/W^{1/2})^{-2.22}$	0.97
Indiana	$64\,(D/W^{1/2})^{-1.34}$	0.91
Ohio	$231\,(D/W^{1/2})^{-1.67}$	0.75
New Mexico – casting	$256\,(D/W^{1/2})^{-1.93}$	0.98
New Mexico – pre-split	$5448\,(D/W^{1/2})^{-2.03}$	0.90
U.S Bureau of Mines coal mine data*	$133\,(D/W^{1/2})^{-1.50}$ (maximum horizontal) $119\,(D/W^{1/2})^{-1.52}$ (all components)	

* U.S. Bureau of Mines RI 8507 (Siskind, et al, 1980a)

Table 4 Airblast overpressure attenuation equations

Site	Equation $[a\,(D/W^{1/3})^{-b}]$	Correlation Coefficient (R^2)
All sites	$0.35\,(D/W^{1/3})^{-0.95}$	0.45
Coal mine data for highwalls *	$0.146\,(D/W^{1/3})^{-0.823}$	0.77
Coal mine data for coal parting *	$49.6\,(D/W^{1/3})^{-1.62}$	0.50

* U.S. Bureau of Mines RI 8485 (Siskind, et al, 1980b)

Table 5 Comparisons of two methods used to determine frequencies: zero-crossing and FFT methods

Site	Range of Frequencies (Hz)	
	Measured at the PPV using zero-crossing method	Calculated using FFT method
Sites with the great change in frequency between the two methods		
Kentucky – 1	9 – 22	6 – 7
New Mexico	4 – 18	4 – 8
Alabama	10 - 34	8 – 17
Kentucky – 2	18 - 30	15 – 19
Indiana	3 - 28	2 – 19
Sites with little change in frequency between the two methods		
Ohio	4 - 24	3 – 18
Pennsylvania	8 - 22	7 – 20
Virginia	7 - 23	6 – 20
West Virginia – 1	11 - 16	11 – 14
West Virginia – 2	7 - 19	6 – 16
Tennessee	10 - 32	12 – 35

Table 6 Best fit equations relating structure response in terms of whole structure and mid-wall motions to ground motions and air overpressures for different structure designs

Driving force	Response	Structure design	Stories or component	Best fit equation slope (a)	Correlation Coefficient (R^2)
peak particle velocity ground motion PPV	whole structure WSR = a * PPV	trailers	1	0.66	0.64
		log	1	0.45	0.91
			2	1.54	0.84
		earth, stone, and masonry	1	0.91	0.76
			2	3.22	0.42
		wood-frame and camp	1	1.30	0.88
			2	2.70	0.73
		all structures	1	0.63	0.45
			2	1.43 (1)	0.75
	mid-wall MWR = a * PPV	trailers	R	1.32	0.86
			T	2.09	0.73
		log	R	1.90	0.80
			T	2.98	0.94
		camp	R	2.58	0.87
			T	2.25	0.98
		wood-frame	R	1.83	0.92
			T	2.08	0.67
		earth, stone, and masonry	R	1.52	0.90
			T	1.24 (1)	0.83
airblast overpressure AP	whole structure WSR = a * AP	trailers	1	28.9	0.51
	mid-wall MWR = a * AP	trailers	R	206.1	0.52
			T	155.4	0.55
		camp	R	120.0	0.67
			T	131.0	0.95
		wood-frame	R	175.0	0.74
			T	213.6	0.70

(1) excluding the historic stone structure response

Table 7 Natural frequencies and damping coefficients calculated when ground motions occur at a 90 degrees phase shift from structure response

Structure	Shot Date (time)	PPV	Airblast	Transverse				Radial			
				whole structure		mid-wall		whole structure		mid-wall	
				natural frequency	damping coefficient	natural frequency	damping coefficient	natural frequency	damping coefficient	natural frequency	damping coefficient
		(in/sec)	(dB)	(Hz)	(%)	(Hz)	(%)	(Hz)	(%)	(Hz)	(%)
E2S-NM	6/22/01 (14:16)	0.258	131	4	6.31	4	4.88	4	2.33	4	3.55
	7/17/01 (12:52)	0.46	119	na	na	4	4.91	na	na	4	6.93
	7/23/01 (11:23)	0.23	110	4	3.09	4	5.89	na	na	4	4.58
	7/26/01 (11:05)	0.253	106	4	7.73	4	7.28	4	5.36	4	2.90
	7/26/01 (14:55)	0.21	122	4	4.58	4	3.55	4	3.55	4	6.45
	Average			**4**	**5.43**	**4**	**5.30**	**4**	**3.75**	**4**	**4.88**
TD-WV2	12/04/01 (12:22)	0.095	112	7	3.64	7	3.00	7	3.55	Na	Na
	12/05/01 (16:54)	0.060	116	7	4.89	7	3.55	7	6.45		
	12/06/01 (16:52)	0.085	117	7	1.8	7	5.43	7	11.06		
	average			**7**	**3.44**	**7**	**3.99**	**7**	**7.02**		

Na – not applicable as response is not detected

Table 8 Average and range (minimum to maximum) of natural frequencies computed during free response after ground motions have arrested

Design	Transverse (Hz)		Radial (Hz)	
	whole structure	mid-wall	whole structure	mid-wall
Trailer	6.9 (3.5 – 13.5)	9.5 (4.3 – 29.3)	6.3 (4.3 – 6.8)	19.9 (6 – 29)
Log	6.5 (6 – 8)	15.8 (8 – 24)	6.4 (5 – 7.5)	13.8 (6 – 27.5)
Earth, stone, and masonry	4.4 (4 – 4.8)	4.3 (3.8 – 4.8)	4.3 (4 – 4.5)	4.3 (3.8 – 4..5)
Camp	5.3 (3 – 7.5)	3.4 (3 – 3.8)	6.9 (6.5 – 7.5)	6.9 (6.5 – 7.5)
Wood-frame	7.6 (3 – 13)	8.9 (4 – 13.5)	Nd	23.9 (22 – 25.5)
Average for all structures	6.1	8.4	6.0	13.8
U.S.B.M. RI 8507 (Table 3)	7.1 (4 – 10)		7.8 (4 – 11)	16.4 (8.3 – 36)(1)

(1) The U.S.B.M. instrumented only the mid-wall facing the blast to measure air pressure effects

Table 9 Average damping coefficients for free response computed in Table 7

Design	Transverse (% of critical)		Radial (% of critical)	
	whole structure	mid-wall	whole structure	mid-wall
Trailer	8.9	9.5	9.6	8.7
Log	8.5	8.5	9.7	6.8
Earth, stone, and masonry(1)	3.9	6.4	6.6	8.7
Camp	9.2	6.2	5.5	8.2
Wood-frame	8.2	5.8	Nd	8.5
Average for all sites	7.7	7.3	7.9	8.2
U.S.B.M. RI 8507 (Table 3)	5.0	2.3	4.4	1.8

Nd – not detected
(1) excluding CMU block structure

Table 10 Amplification factors

Design	Description	Time-correlated Amplification Factors	
		average	minimum-maximum
Trailers	Single-wide	1.0	1.0 – 3.6
	Double-wide	2.4	1.1 – 4.0
	Add-on	1.9	0.4 – 3.3
Log	One story	1.4	0.4 – 3.0
	Two story	2.1	0.9 – 3.0
Earth, stone, and masonry	One story	1.1	0.6 – 1.6
	Two story	3.5	1.7 – 5.0
Camp	One story	2.1	1.5 – 3.5
	Two story	3.3	1.5 – 4.6
Wood-frame	One story	1.7	1.0 – 2.5
	Two story	1.3	1.1 – 1.5
	Three story	1.6	1.3 – 1.9

Table 11 Blast-induced strains for the radial, R, and transverse, T, walls

Design		In-plane tensile strains[1] (μ-strains)		Wall bending strains (μ-strains)	
		Average (maximum)		Average (maximum)	
		R	T	R	T
Trailer	single wide	5.0 (23.5)	6.7 (38.3)	1.5 (11.5)	2.9 (25.7)
	double wide	3.5 (33.2)	8.9 (23.4)	9.2 (18.9)	1.8 (16.0)
	add-on	8.0 (30.0)	4.9 (10.1)	0.9 (3.9)	6.0 (11.1)
Log	one-story	2.7 (41.7)	4.8 (95.5)	10.5 (13.3)	8.9 (15.5)
	two-story	3.0 (24.5)	4.1 (66.6)	0.2 (1.6)	Na
Earth, stone, and masonry	cinder block	7.4 (10.4)	11.6 (13.4)	Na	3.6 (11.7)
	adobe	4.2 (4.9)	3.9 (7.3)	8.8 (12.1)	5.1 (9.0)
	2-story stone	49.0 (98.9)	55.1 (113.1)	5.2 (18.3)[2]	18.9 (46.6)[3]
Camp	one-story	11.6 (27.4)	9.5 (18.7)	4.5 (8.0)	5.4 (9.2)
	two-story	2.9 (6.6)	1.7 (13.2)	0.03 (1.4)	0.1 (0.3)
Wood-frame	one-story	11.0 (39.4)	12.5 (33.7)	5.2 (13.0)	3.1 (9.6)
	two-story	2.0 (15.2)	2.7 (13.7)	Na	7.5 (13.0)[3]

(1) Note that the wall being strained is 90-degrees from the motion sensor recording velocity (e.g., the radial sensor records motion of the transverse walls while the transverse sensor records motion of the radial wall)

(2) first floor

(3) second floor

Na – no sensor used in this location

Table 12 Structure responses to non-blasting activities

Structure Design	Designation	Activity	Maximum velocity (in/sec) upper structure response R	upper structure response T	mid-wall response R	mid-wall response T
single wide trailer	TS-IN	shut north bedroom door	0.10	0.06	0.98	0.29
		child running	0.04	0.02	0.07	0.13
		close north window	0.51	0.40	1.08	0.42
		shut room closet door	0.10	0.50	0.78	0.74
		children playing in family room	0.07	0.04	0.14	0.10
		shut family room outside door	0.05	0.07	0.70	0.22
Double wide trailer	TD-PA	shut west bedroom door	0.05	0.03	0.17	0.34
		slam west bedroom door	0.16	0.10	0.49	1.46
		shut west bathroom door	0.20	0.30	0.50	2.14
		shut exterior kitchen door	0.06	0.12	0.23	0.34
		close west bedroom window	0.15	0.15	0.16	0.74
		jump in bedroom	0.02	0.05	0.16	0.42
		chair fall back in dining room	0.05	0.04	0.06	0.09
one-story wood frame	W1S-IN	shut front door	0.065	0.10	1.58	0.14
		walk in living room	0.02	0.01	0.38	0.17
		child bouncing a ball in living room	0.03	0.05	0.38	0.10
two-story wood frame	W2S-IN	jump in living room	0.03	0.06	Na	Na
		running down stairs	0.04	0.03		
		drop sofa end in living room	0.03	0.05		
		close kitchen window	0.01	0.06		
one-story earth, stone, and masonry	E1S-NMA	shut garage door	0.01	0.02	Na	0.03
	E1S-NMB	shut patio door	0.05	0.12	0.08	0.07
		bump wall with shoulder	0.02	0.04	0.02	0.15
		bump wall with a broom	0.01	0.02	0.01	0.14
two-story earth, stone, and masonry	E2S-NM	Backhoe dropping flagstone near house	0.05	0.04	Na	0.03
			0.03	0.04		0.06
			0.02	0.02		0.03
			0.02	0.02		0.03

Na – no mid-wall sensors mounted

Table 13 Comparison of structure responses for household activities with blasting

Structure designation	Structure response velocity (in/sec)							
	Maximum from household activities				Maximum from blasting activities			
	whole structure		mid-walls		whole structure		mid-walls	
	R	T	R	T	R	T	R	T
TS-IN	0.51	0.40	1.08	0.42	0.52	0.41	1.24	0.64
TD-PA	0.20	0.30	0.50	2.14	0.19	0.20	1.08	0.535
W1S-IN	0.065	0.10	1.58	0.14	0.82	0.55	0.16	0.15
W2S-IN	0.03	0.06	Na	Na	0.24	0.25	Na	Na
E1S-NMA	0.01	0.02	Na	0.03	0.66	0.31	Na	0.78
E1S-NMB	0.05	0.12	0.08	0.07	0.15	0.22	0.27	0.305
E2S-NM	0.05	0.04	Na	0.03	1.52	1.24	0.63	2.64

Na – sensor not mounted in location

Table 14 Velocities and calculated strains in trailers produced by wind for wind speeds ranging from 12 to 32 miles/hour

<table>
<tr><th rowspan="2">Structure Design</th><th rowspan="2">Designation</th><th rowspan="2">Component or wall</th><th>Maximum upper structure response</th><th>Whole structure transverse shear strain</th><th>Maximum mid-wall response</th><th>Mid-wall bending strains</th></tr>
<tr><th>(in/sec)</th><th>(μ-strains)</th><th>(in/sec)</th><th>(μ-strains)</th></tr>
<tr><td rowspan="6">Single wide trailer</td><td rowspan="4">TS-KY2</td><td>T</td><td>0.055</td><td>1.5</td><td>0.090</td><td>1.1</td></tr>
<tr><td>R</td><td>0.035</td><td>3.5</td><td>0.055</td><td>1.2</td></tr>
<tr><td>T</td><td>0.040</td><td>1.2</td><td>0.060</td><td>0.7</td></tr>
<tr><td>R</td><td>0.025</td><td>3.4</td><td>0.060</td><td>0.8</td></tr>
<tr><td rowspan="2">TS-AL</td><td>R</td><td>0.010</td><td>Na</td><td>0.030</td><td>1.8</td></tr>
<tr><td>T</td><td>0.030</td><td>Na</td><td>Na</td><td>1.6</td></tr>
<tr><td rowspan="2">Double wide trailer</td><td rowspan="2">TD-PA</td><td>R</td><td>0.005</td><td>1.1</td><td>0.010</td><td>0.6</td></tr>
<tr><td>T</td><td>0.010</td><td>1.0</td><td>0.025</td><td>0.3</td></tr>
</table>

Na – strain could not be computed as sensors were not placed in lower corners or not on radial mid-walls

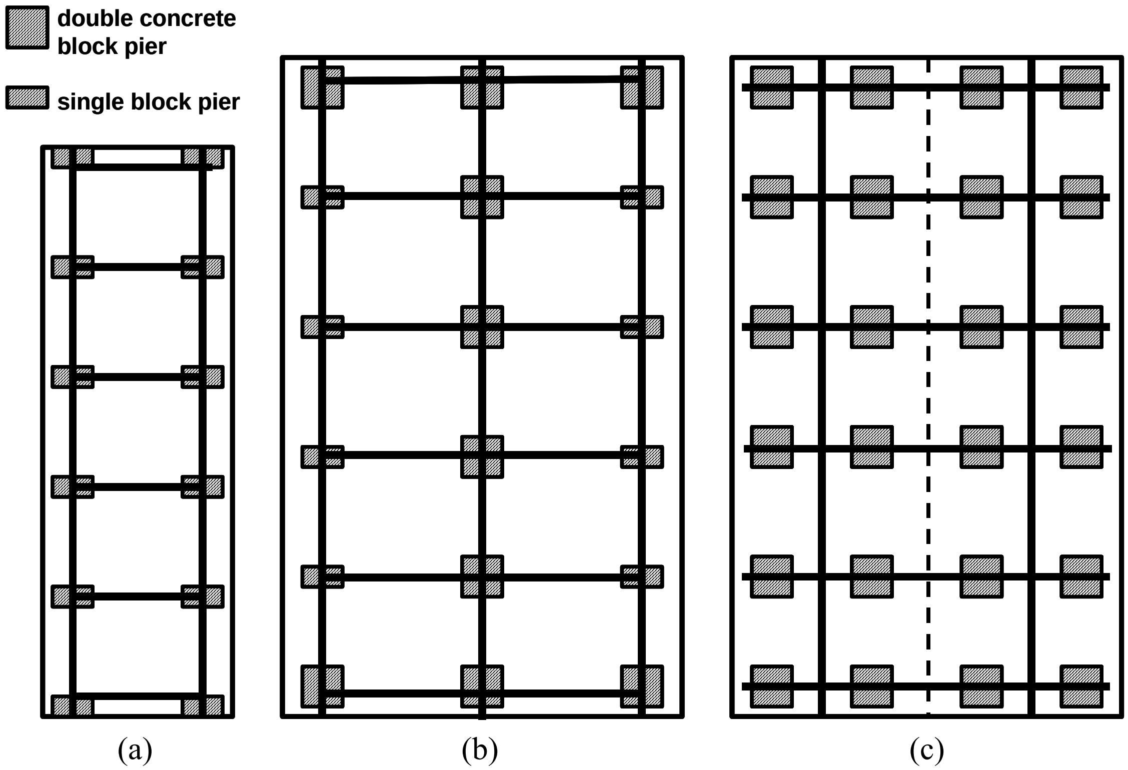


Figure 1 Three generalized trailer pier support system layouts (a) for single wide trailers using single stacked CMUs, and double wide trailer supports (b) using single and double CMUs beneath three axis beams (c) four rows of double CMUs

Figure 2 Hurricane straps required by building code in states in which trailer were selected for the study in Ohio, Tennessee, Alabama, and Indiana

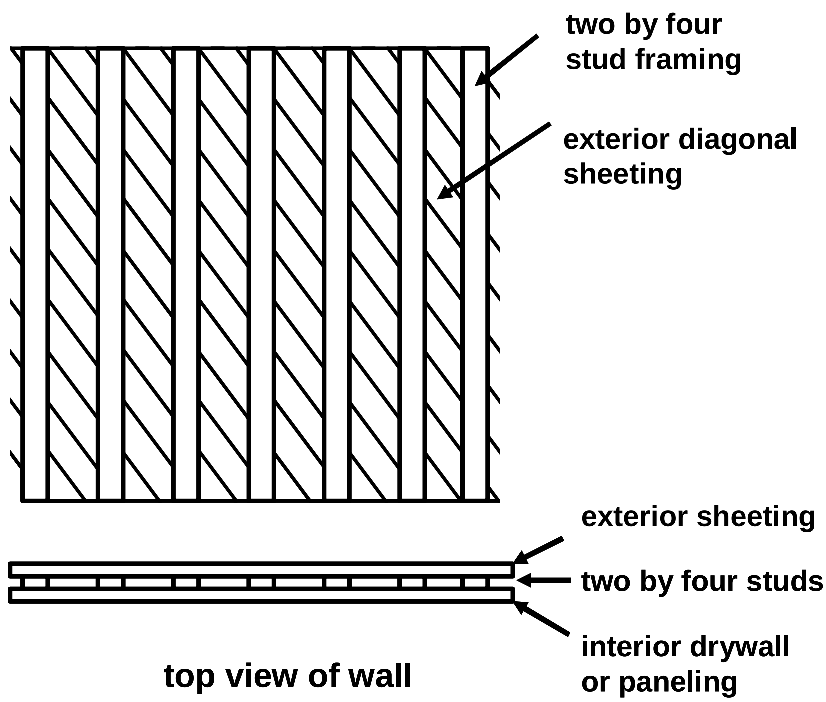
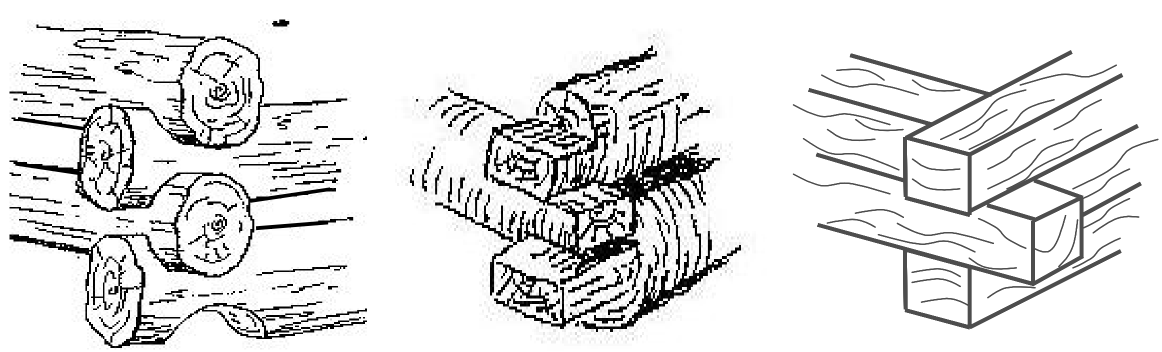
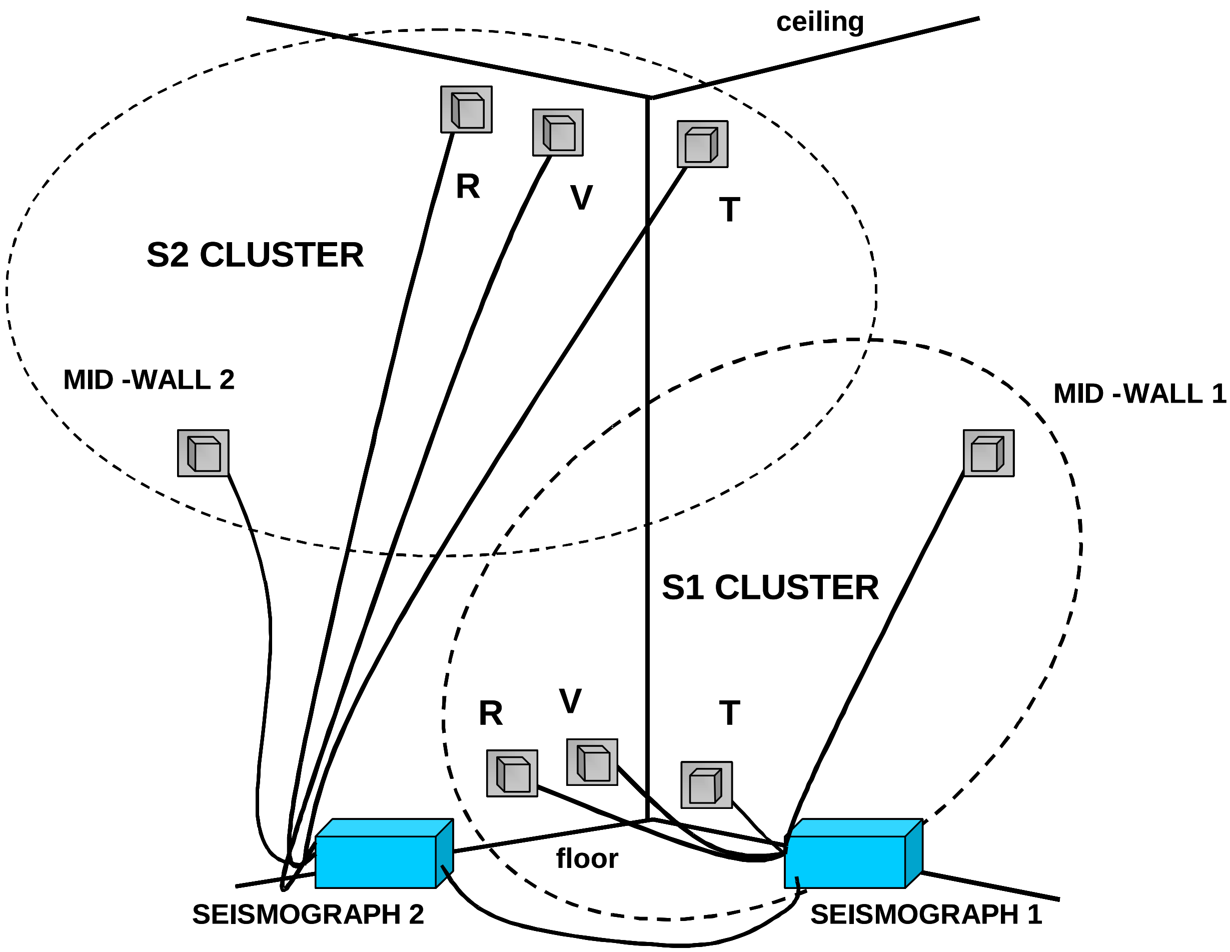


Figure 3 Details of mining camp wall structure

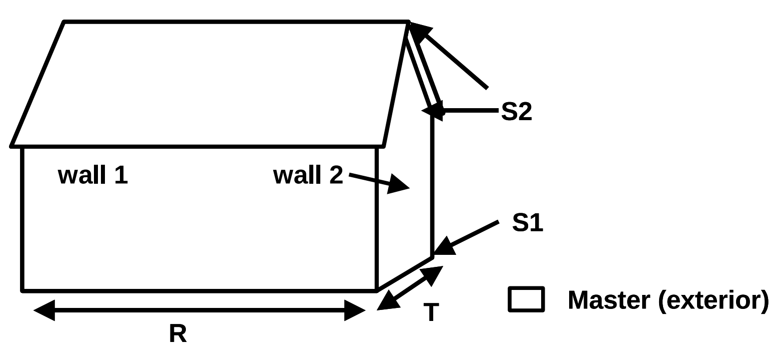


(a) (b) (c)

Figure 4 Three types of log fitting (a) saddle lock-notched with spacing between the logs for chinking, (b) notched and scribed, and (c) butt-jointed.

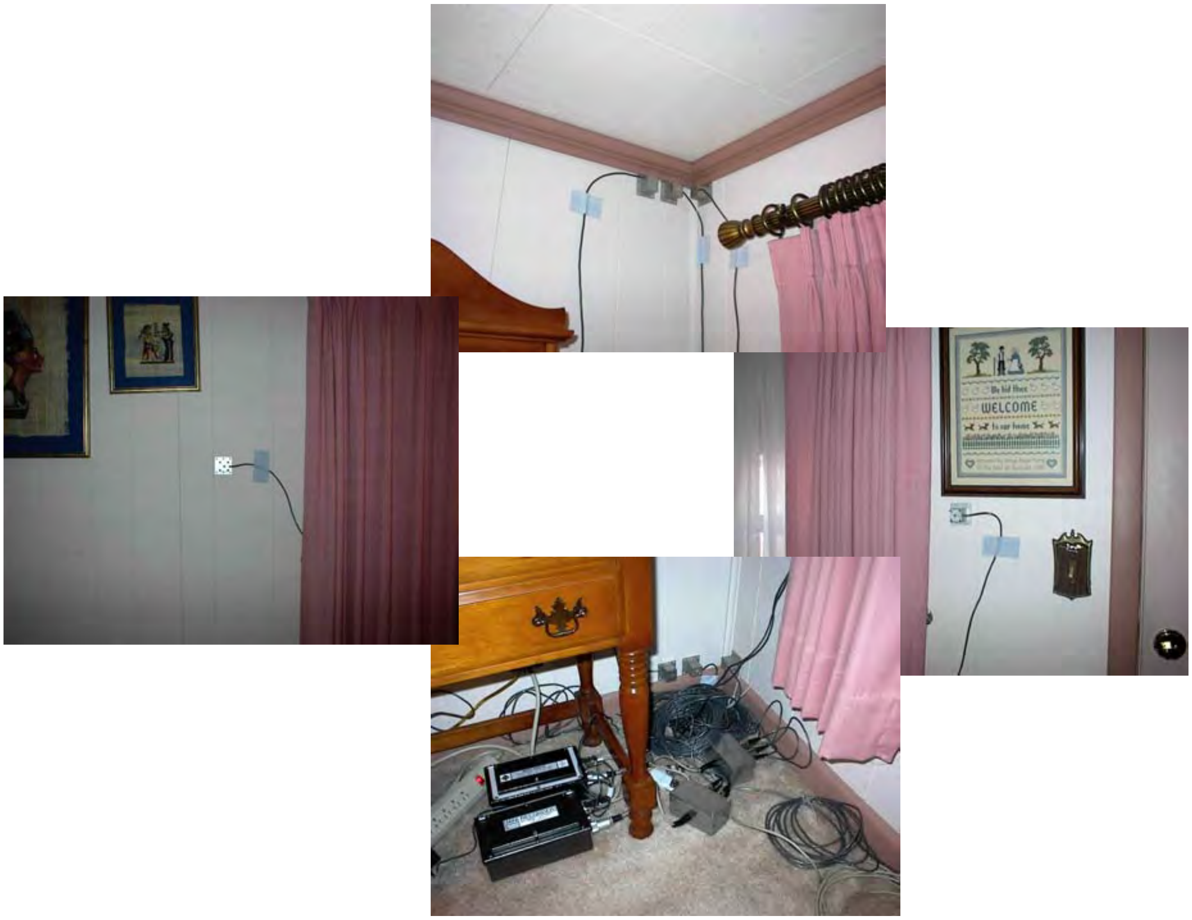


(a)

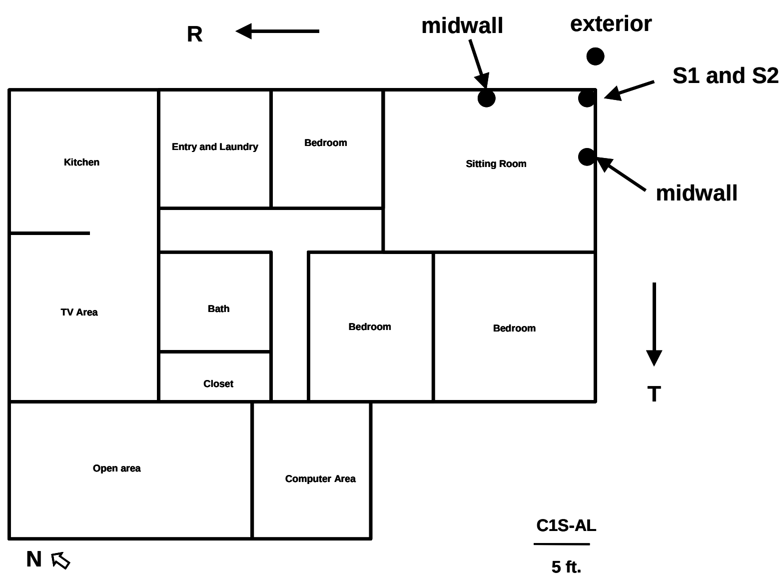


(b)

Figure 5 Typical instrument layout showing (a) S1 and S2 interior velocity sensors used to measure whole structure and mid-wall vibrations (b) location of exterior master seismograph showing orientations of the radial (R) and transverse (T) components



(a)



(b)

Figure 6 Instrumentation layout for mining camp structure C1S-AL

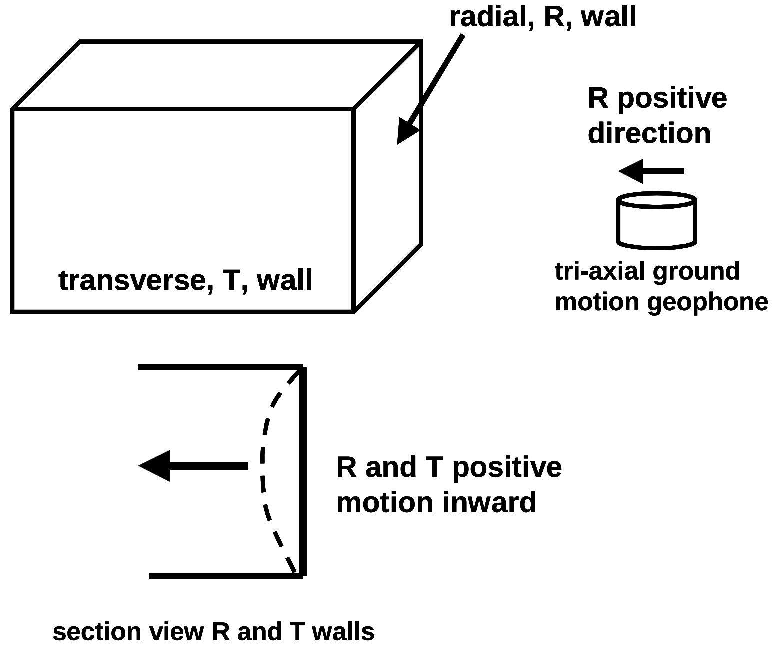


Figure 7 Convention used for radial, R, and transverse, T, geophone orientations

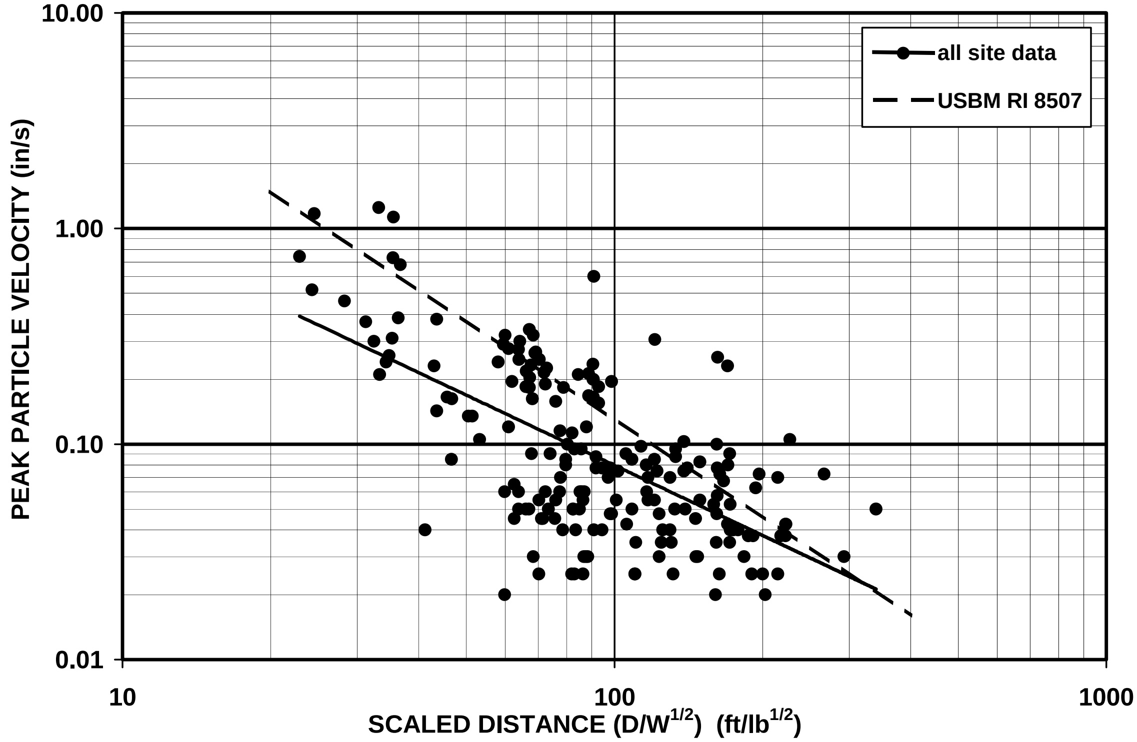


Figure 8 Attenuation plot of maximum ground vibrations for all data

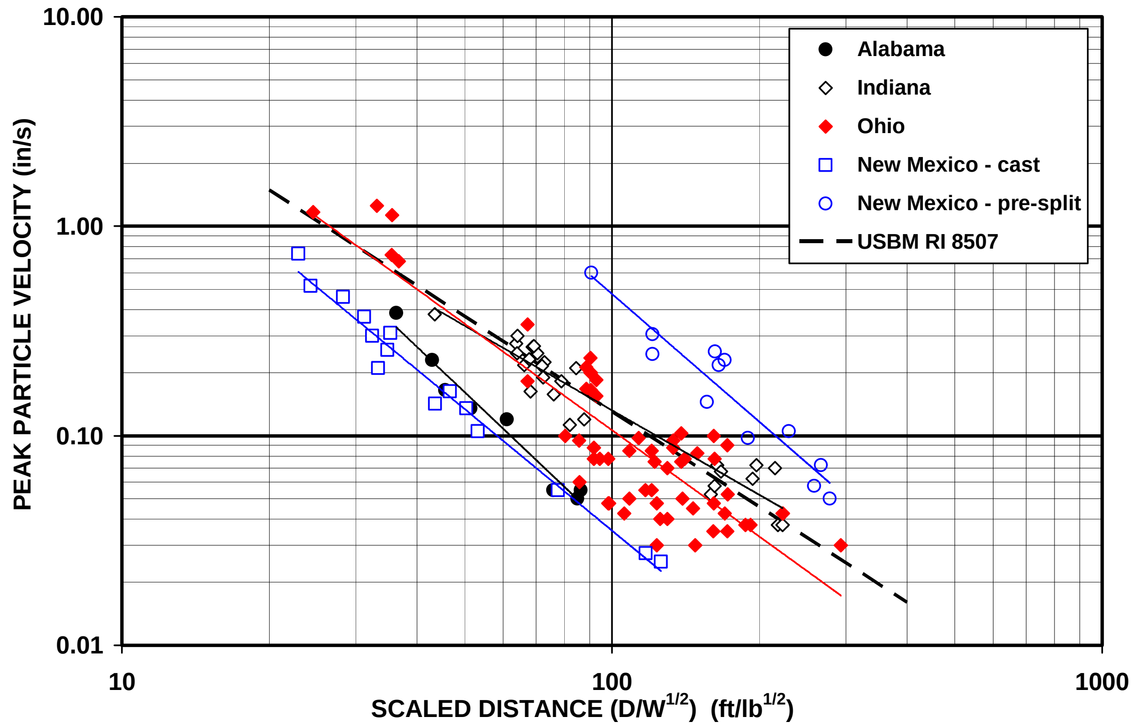


Figure 9 Attenuation plots of maximum ground vibrations separated by site (regression equations shown in Table 3)

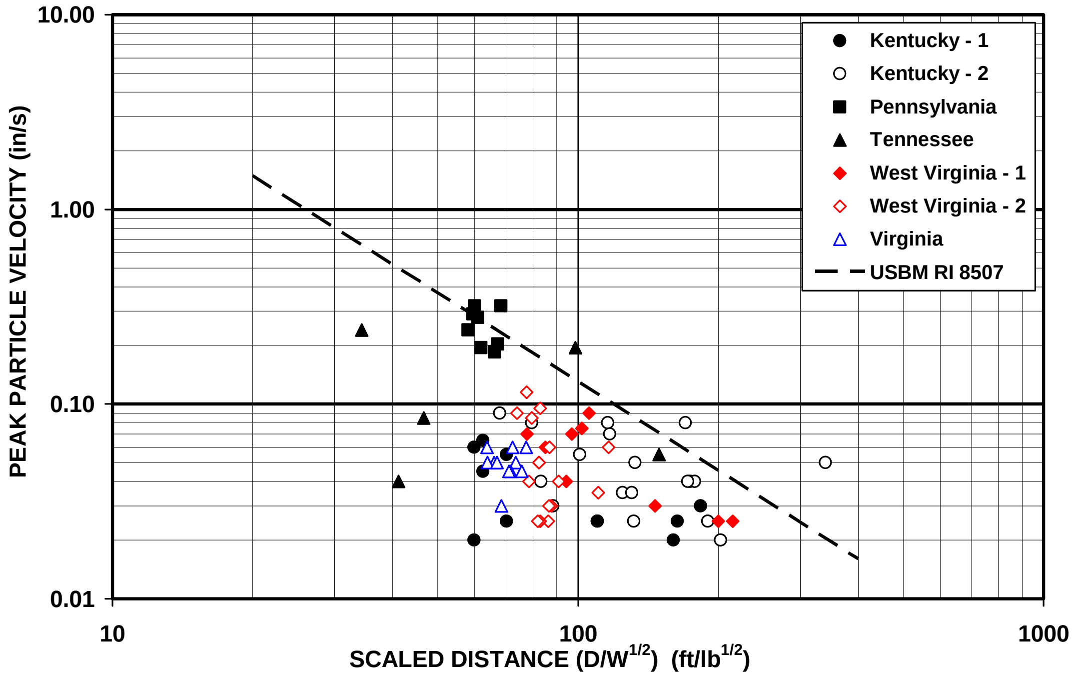


Figure 10 Maximum ground vibrations for clustered and uncorrelated data

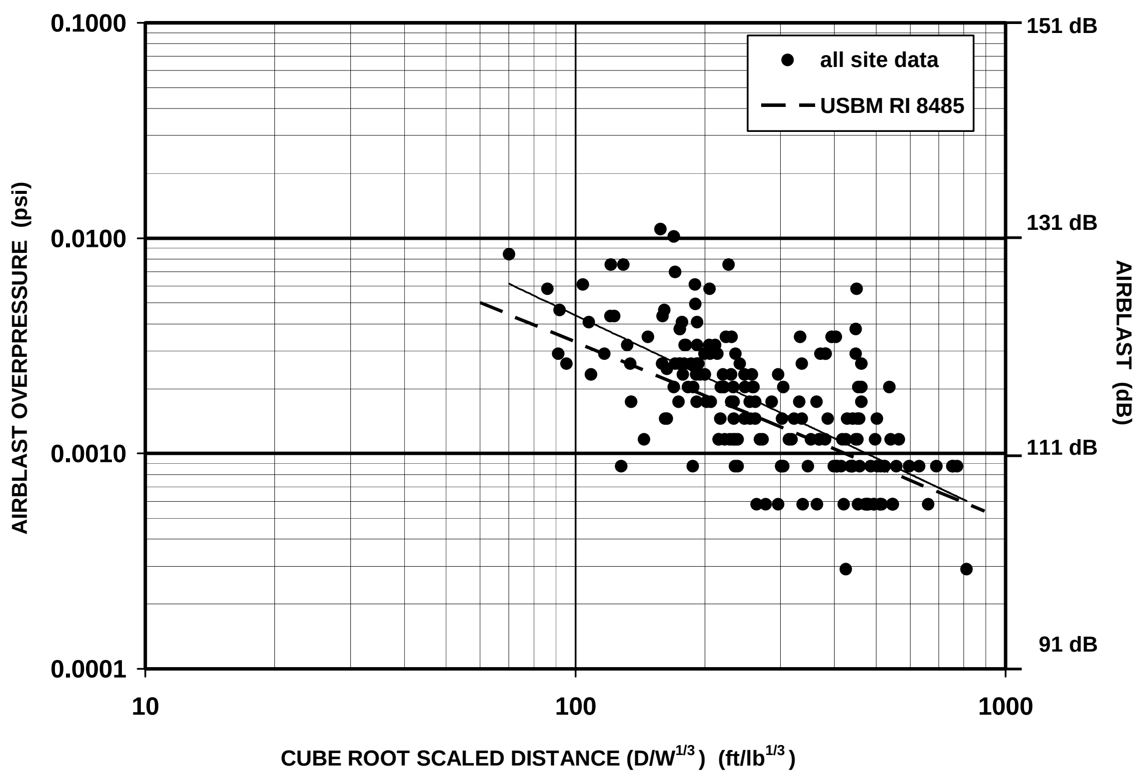


Figure 11 Airblast overpressure attenuation for all data (airblast in dB = 20 log [overpressure in psi] + 170.8)

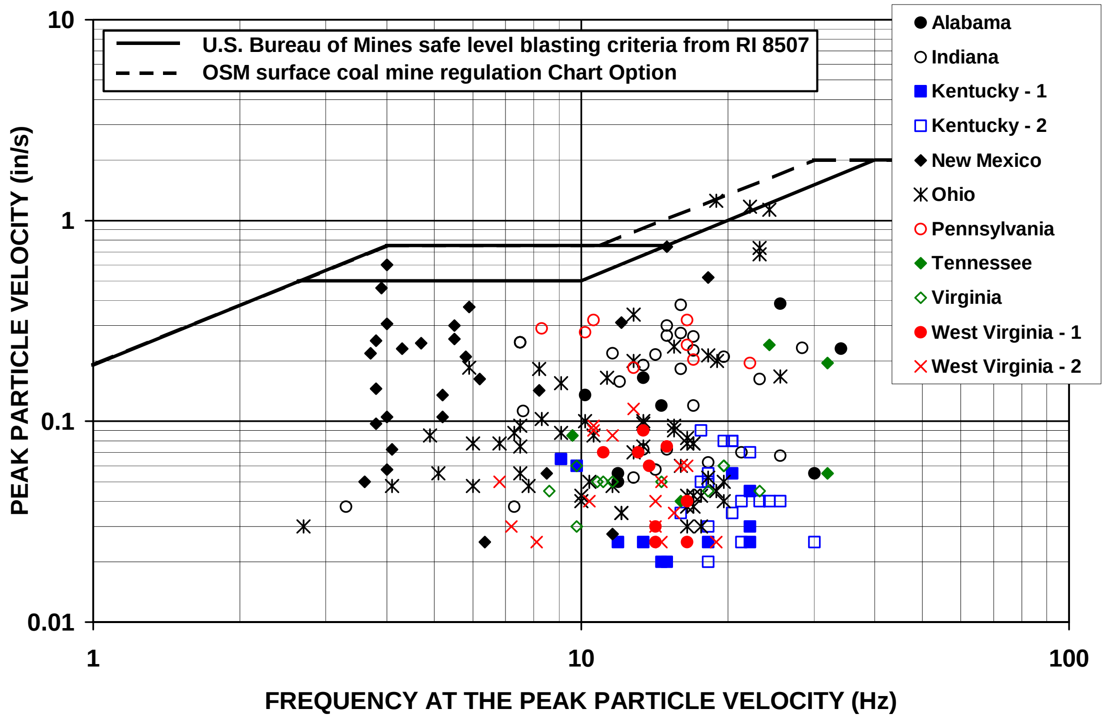


Figure 12 Peak particle velocity (PPV) versus frequency at the PPV

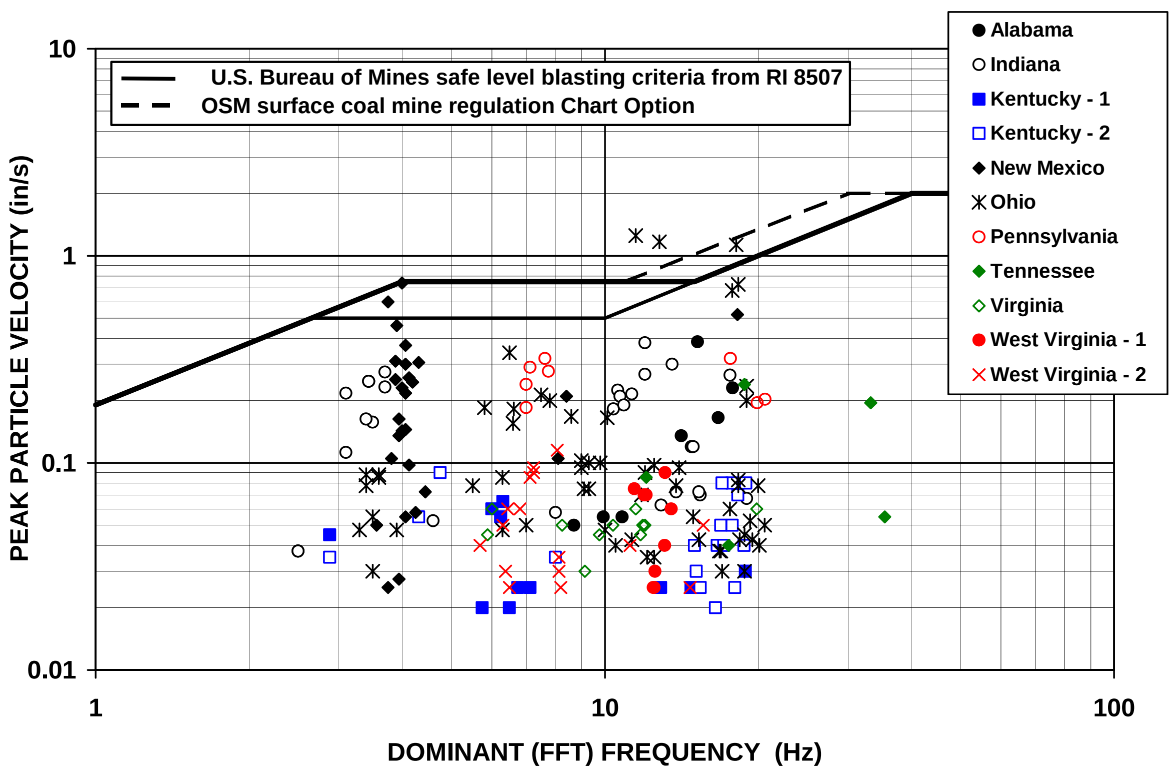


Figure 13 Peak particle velocity (PPV) versus predominant frequency using FFT methods

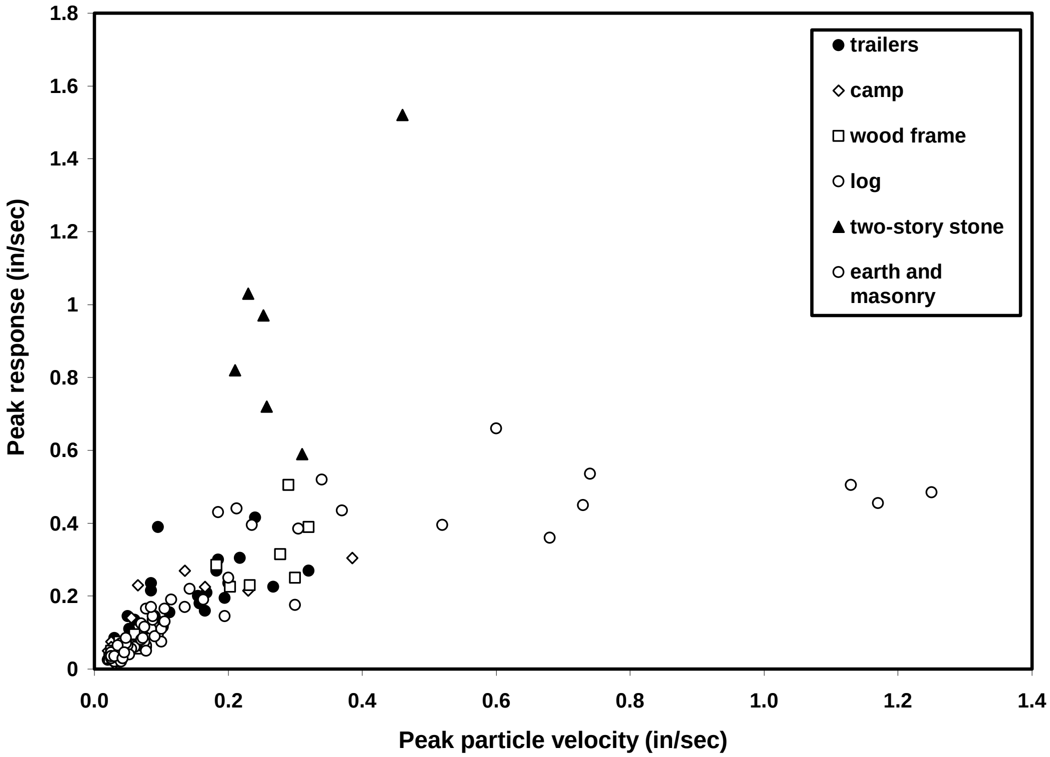


Figure 14 Ground motion-induced whole structure response

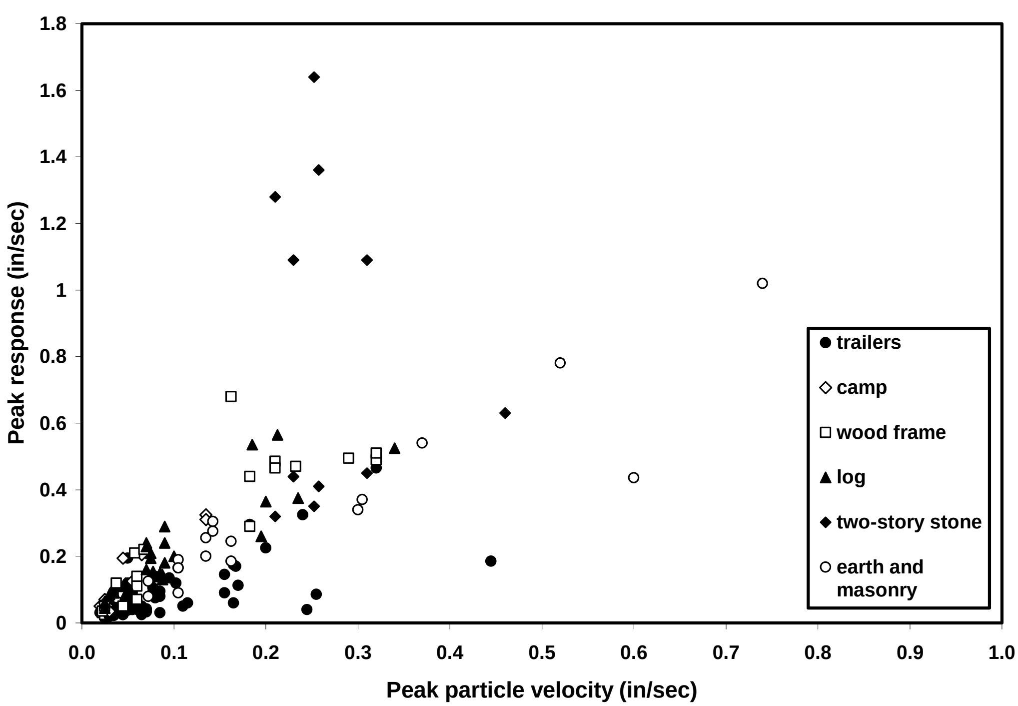


Figure 15 Ground motion-induced mid-wall response

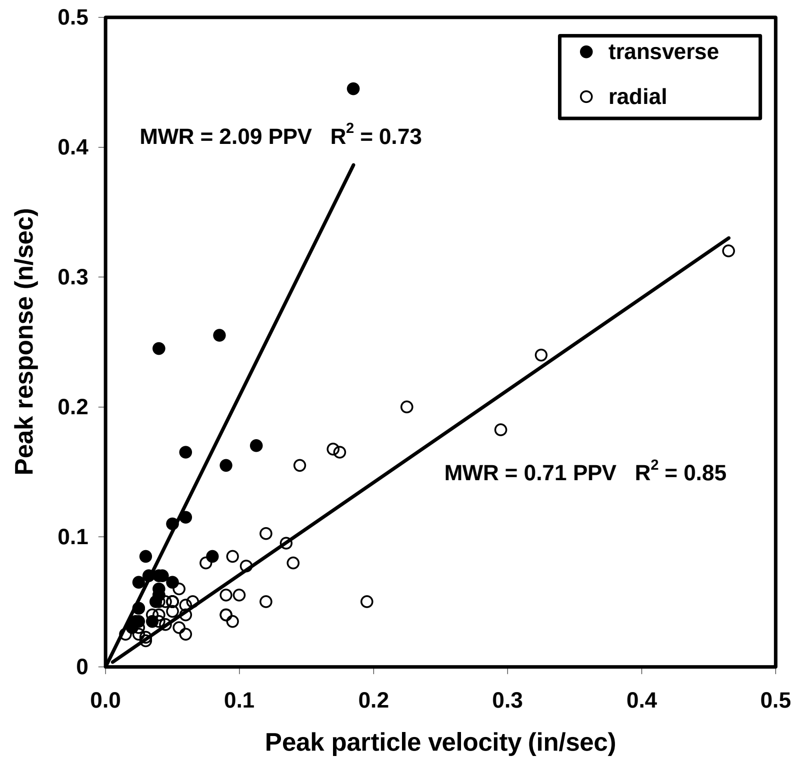


Figure 16 Ground motion-induced mid-wall responses for trailers

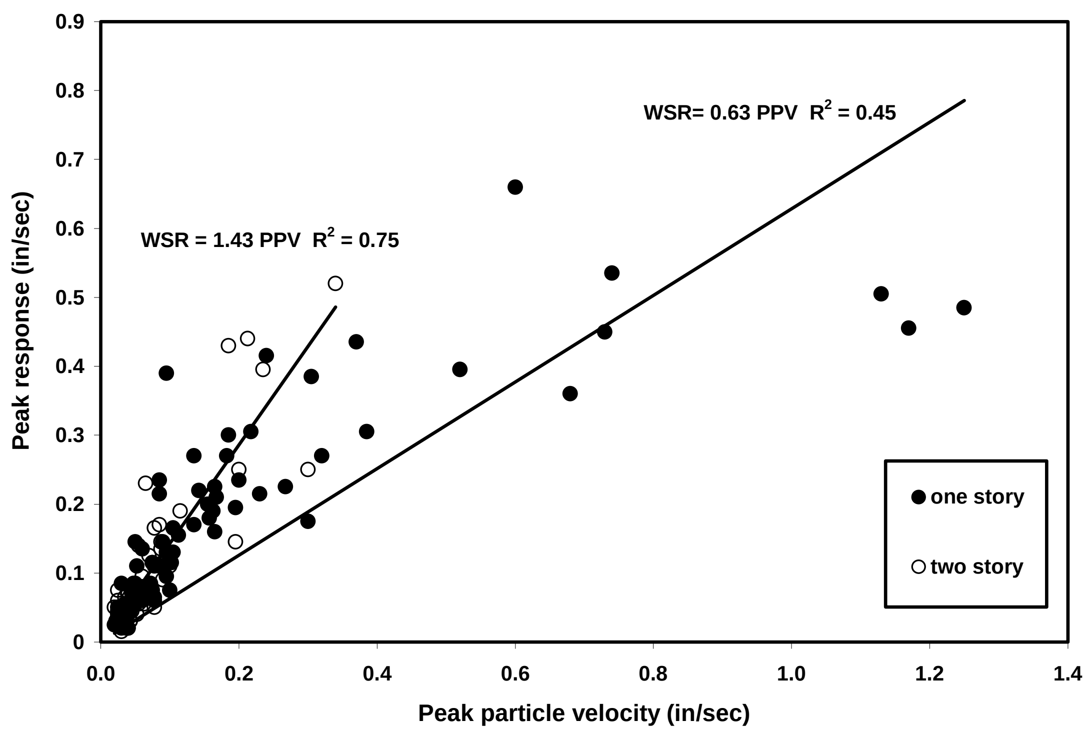


Figure 17 Ground motion-induced whole structure response for one and two story structures

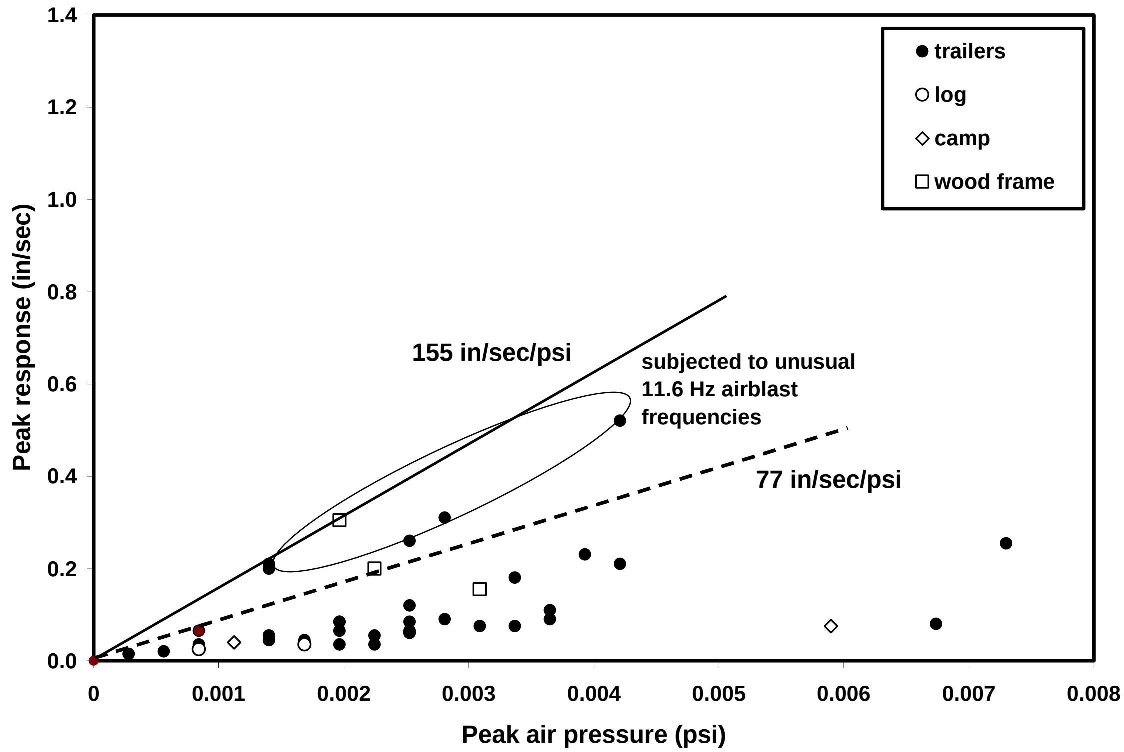


Figure 18 Airblast-induced whole structure response

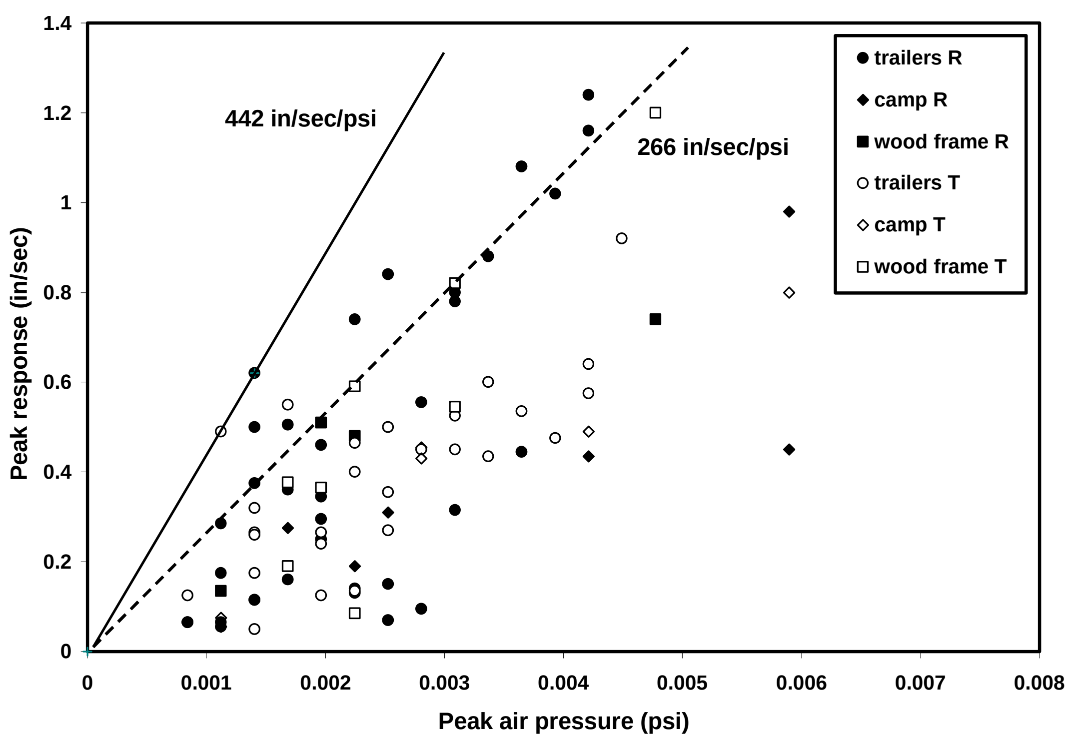
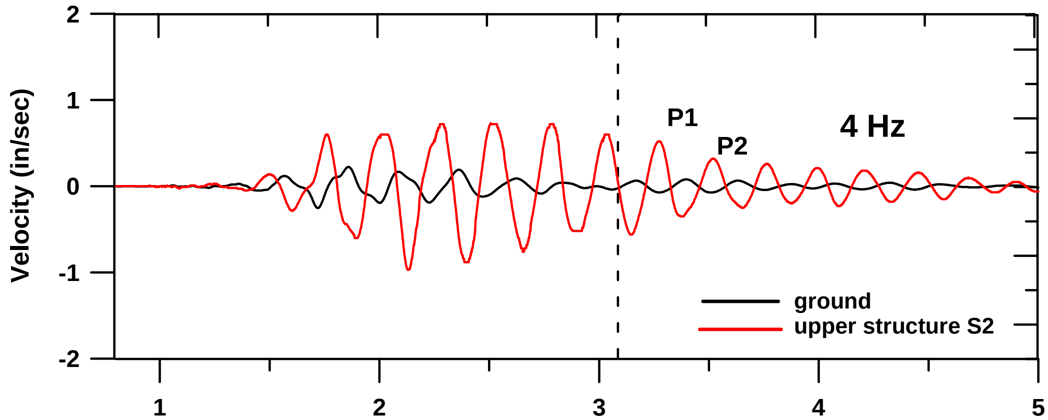
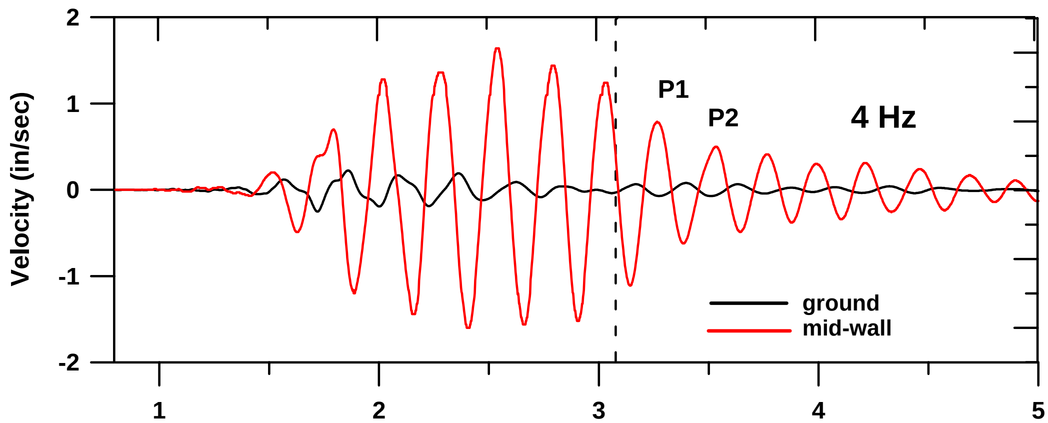


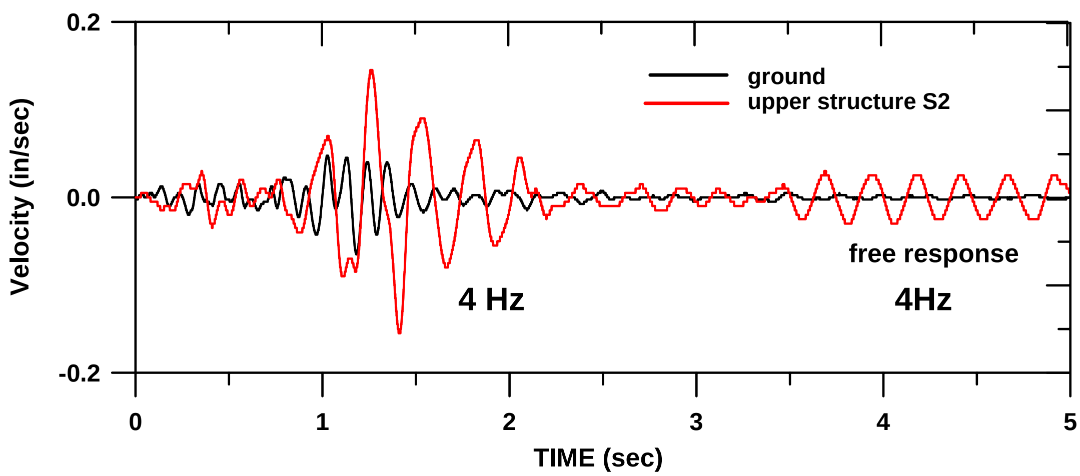
Figure 19 Airblast-induced mid-wall response



(a)



(b)



(c)

Figure 20 Natural frequency response for stone structure E2S-NM (a) whole structure and (b) mid-wall horizontal structure response compared with ground motions; (c) whole structure free response in trailer structure TS-OH prior to airblast arrival at 4.7 seconds.

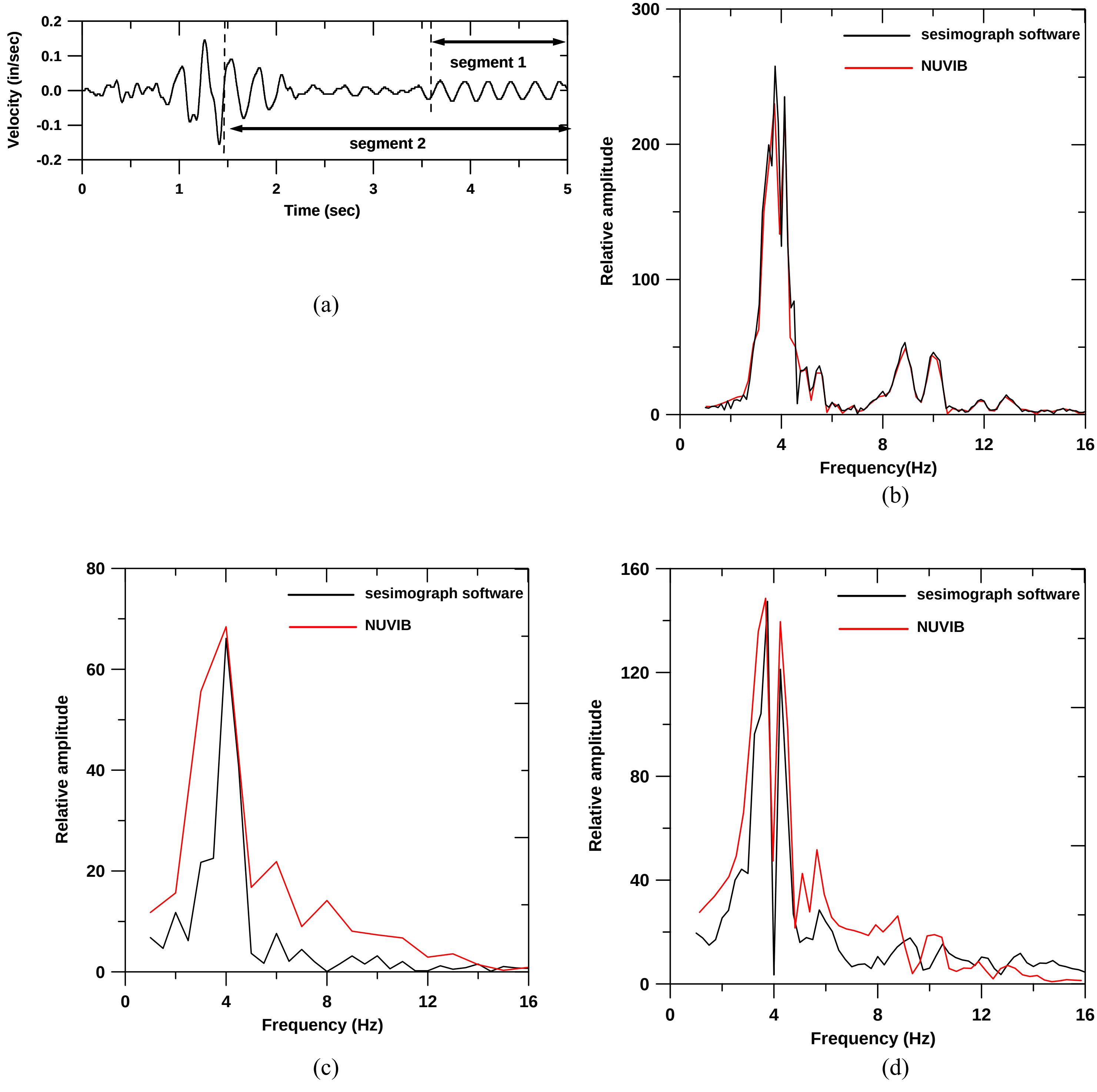


Figure 21 Upper corner transverse response FFT plots for trailer TS-OH response shown in (a), comparing the FFT power spectrum using two different software for (b) the entire time history, (c) segment 1 free response only, and (d) segment 2.

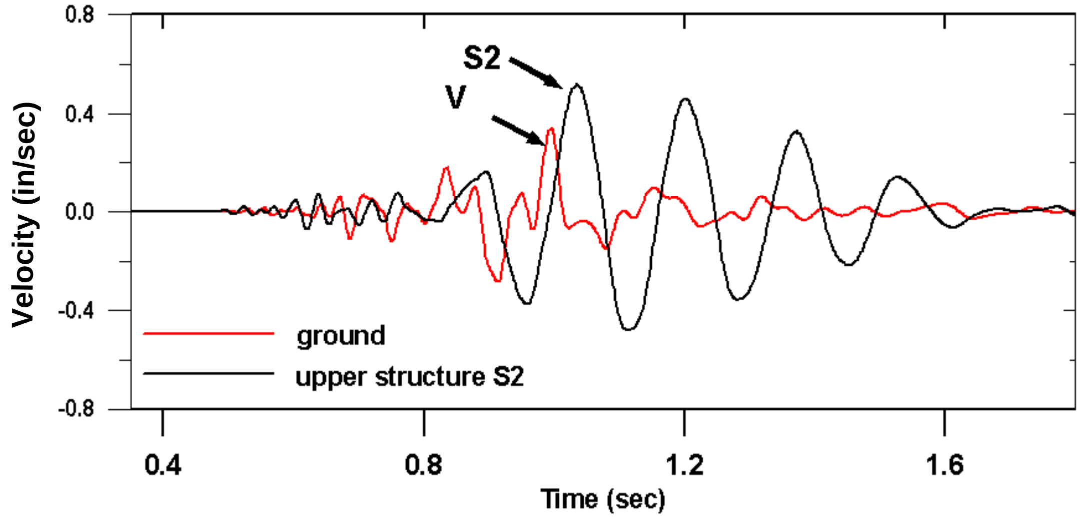


Figure 22 Selection of peaks S2 and V for calculating amplification factors AF

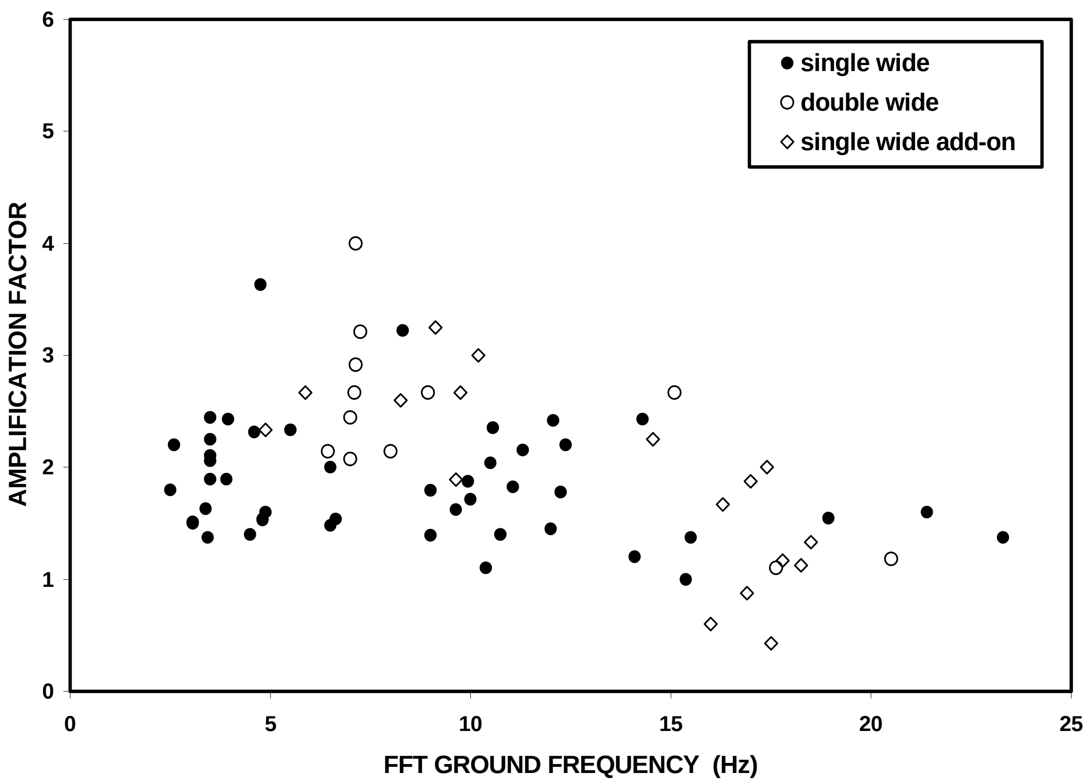


Figure 23 Amplification factor versus FFT ground frequency for all trailers

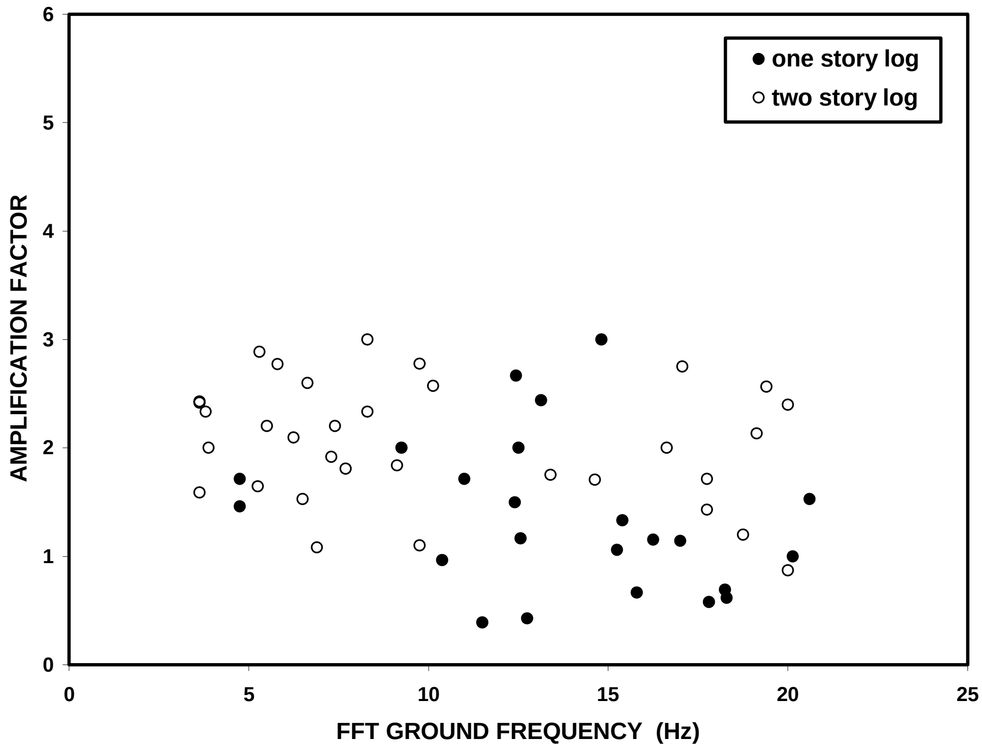


Figure 24 Amplification factor versus FFT ground frequency for all log structures

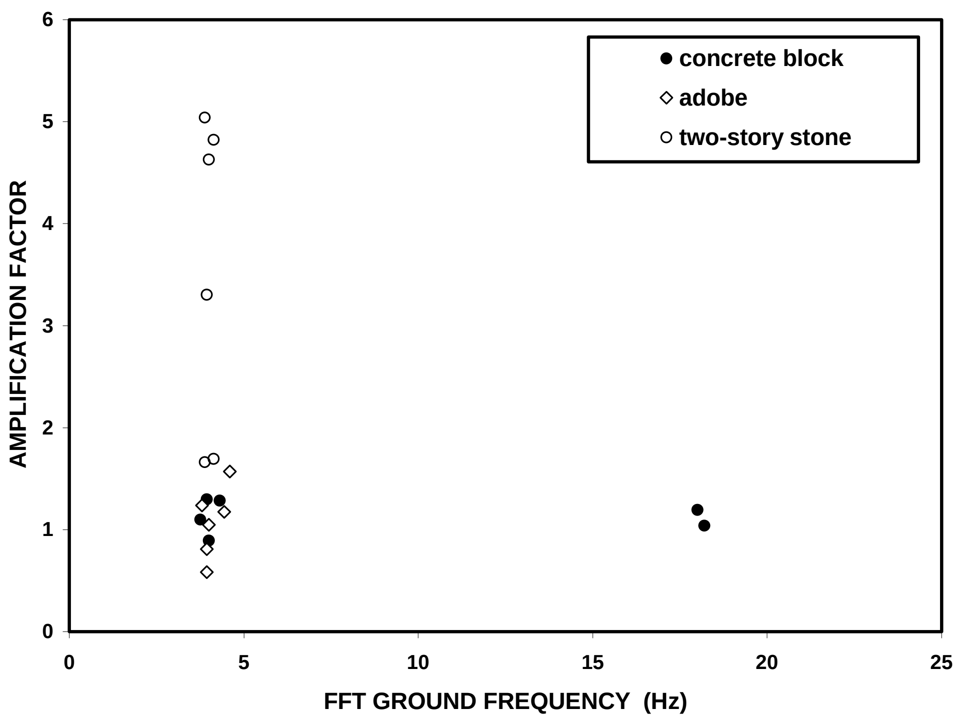


Figure 25 Amplification factor versus FFT ground frequency for all earth and masonry structures

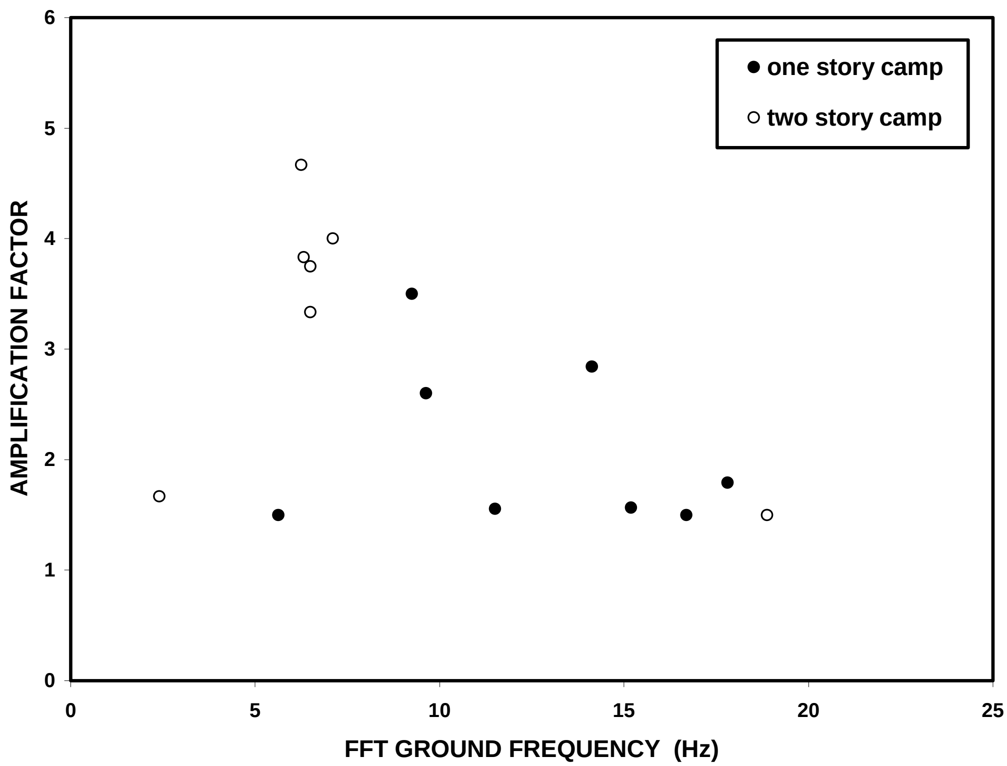


Figure 26 Amplification factor versus FFT ground frequency for all camp structures

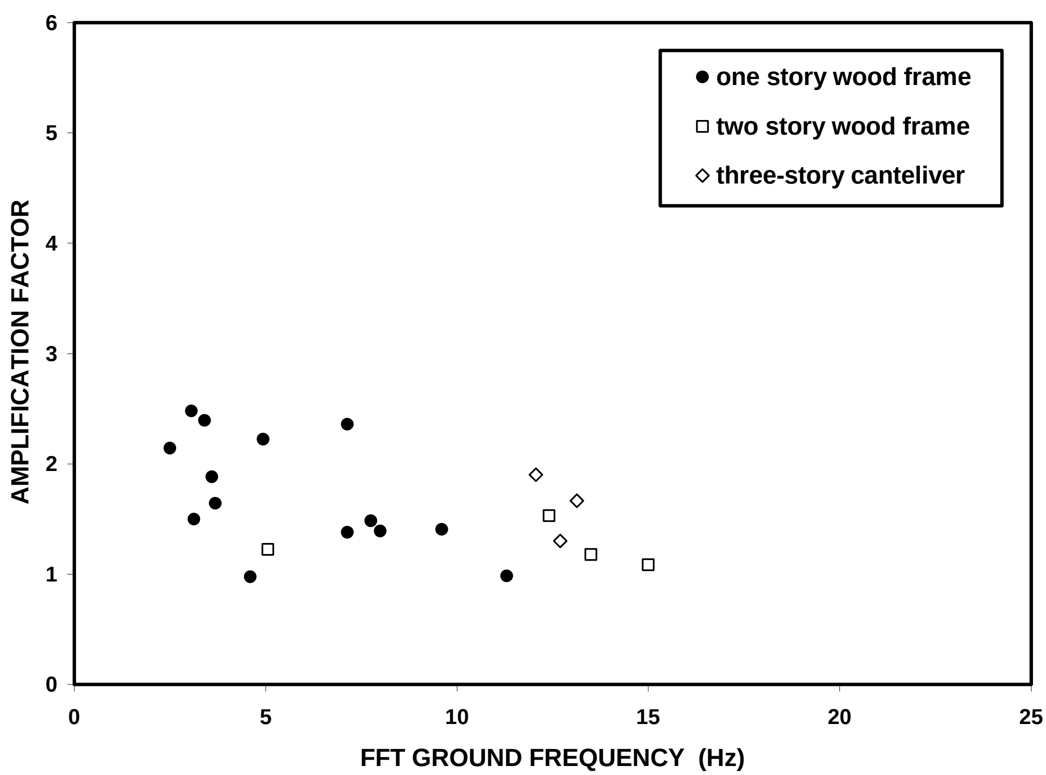


Figure 27 Amplification factor versus FFT ground frequency for all wood-frame structures

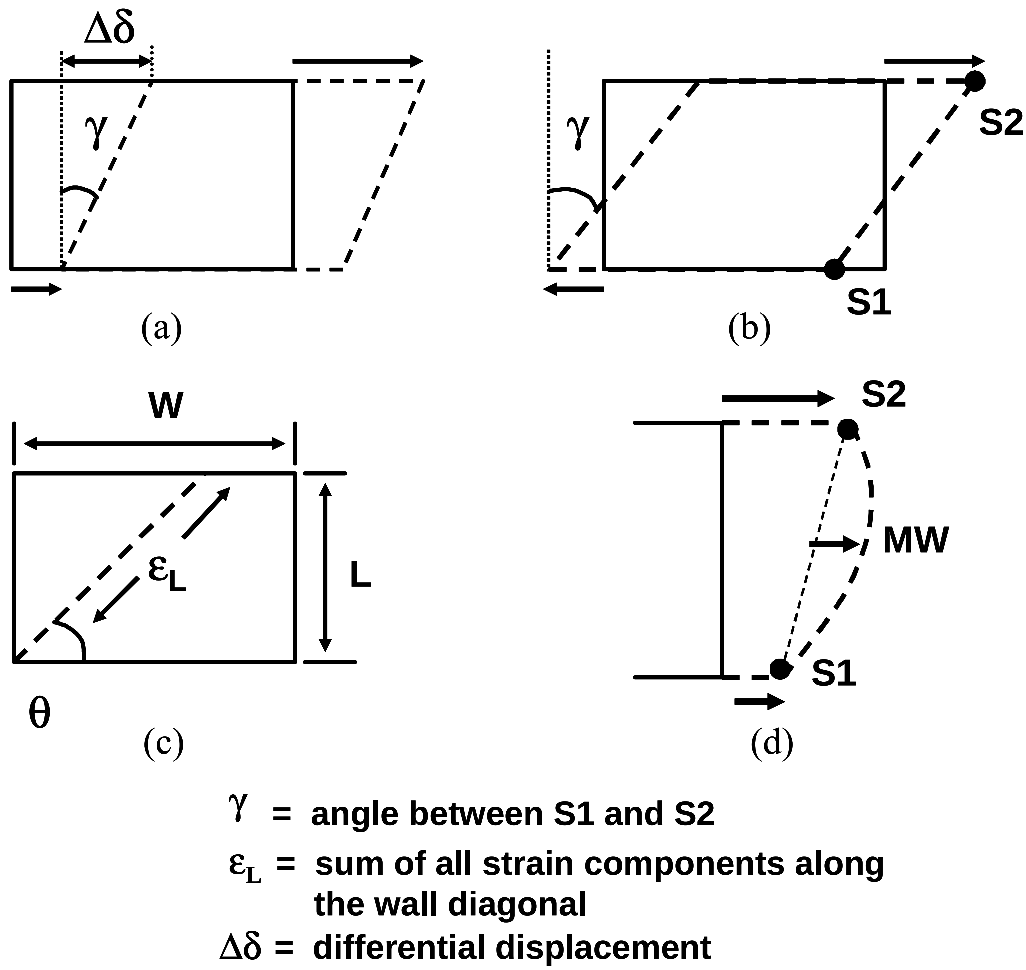
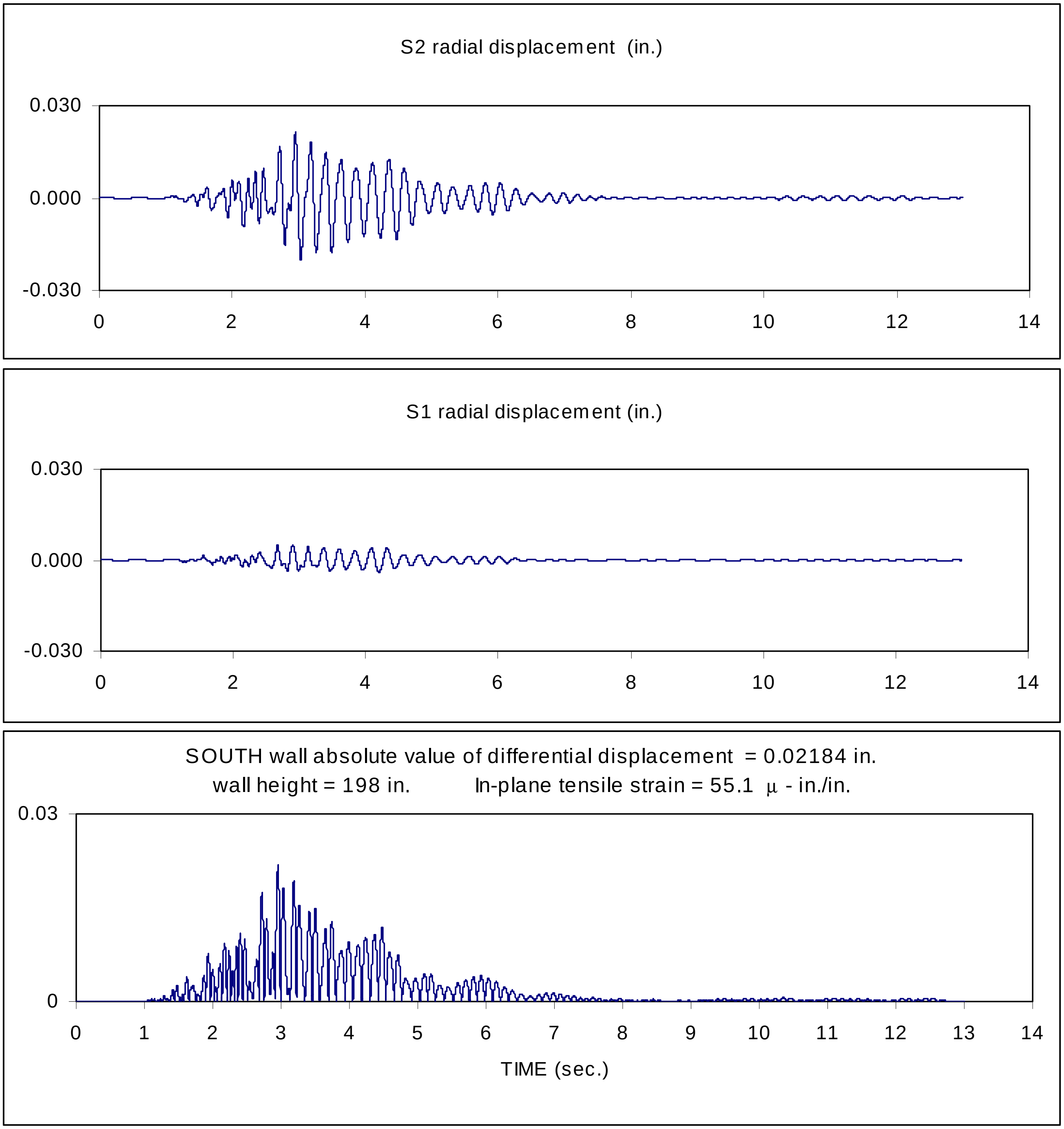
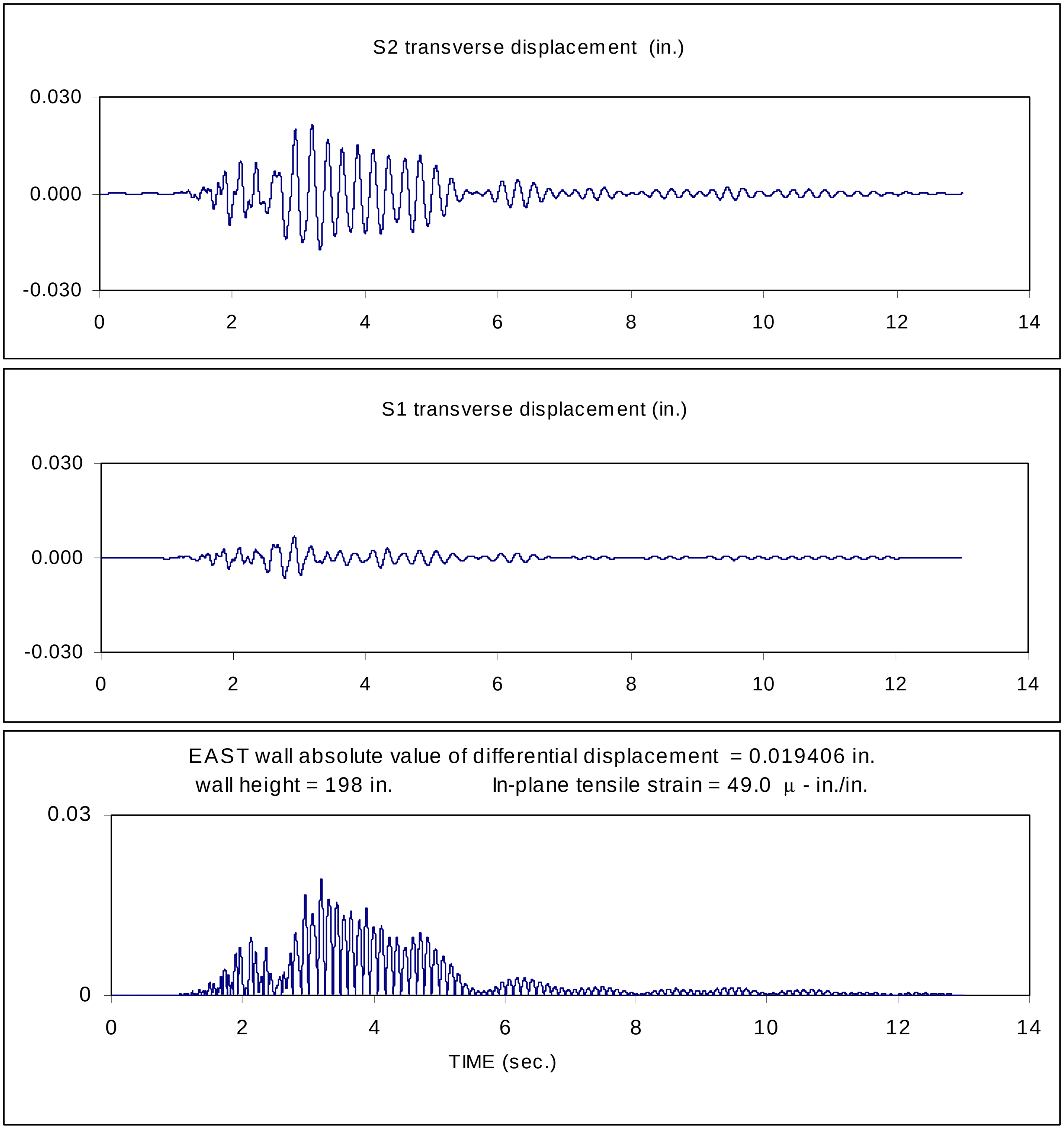


Figure 28 Global structure strains for (a) in-phase and (b) out-of-phase structure motions; in-plane tensile wall strains are defined in (c), and wall bending strains are shown in (d)



(a)

Figure 29 (a) Example calculations for whole structure differential displacement (absolute values) time history for the radial direction (transverse wall) of structure E2S-NM



(b)

Figure 29 (b) Example calculations for whole structure differential displacement (absolute values) time history for the transverse direction (radial wall) of structure E2S-NM

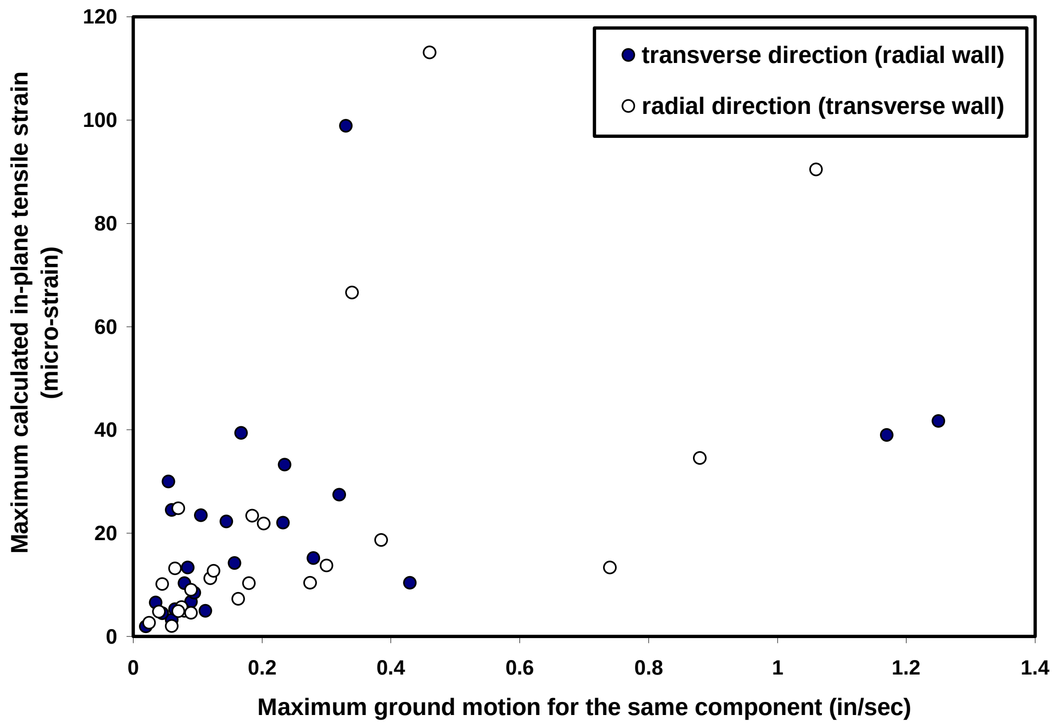


Figure 30 Calculated in-plane tensile strains versus peak particle velocity

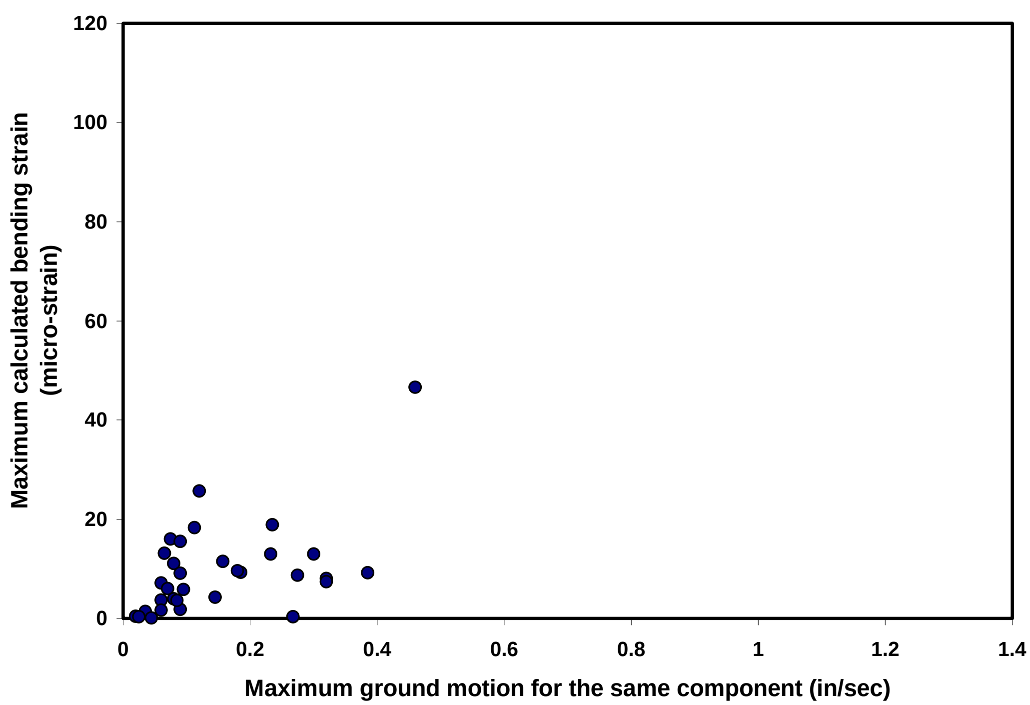
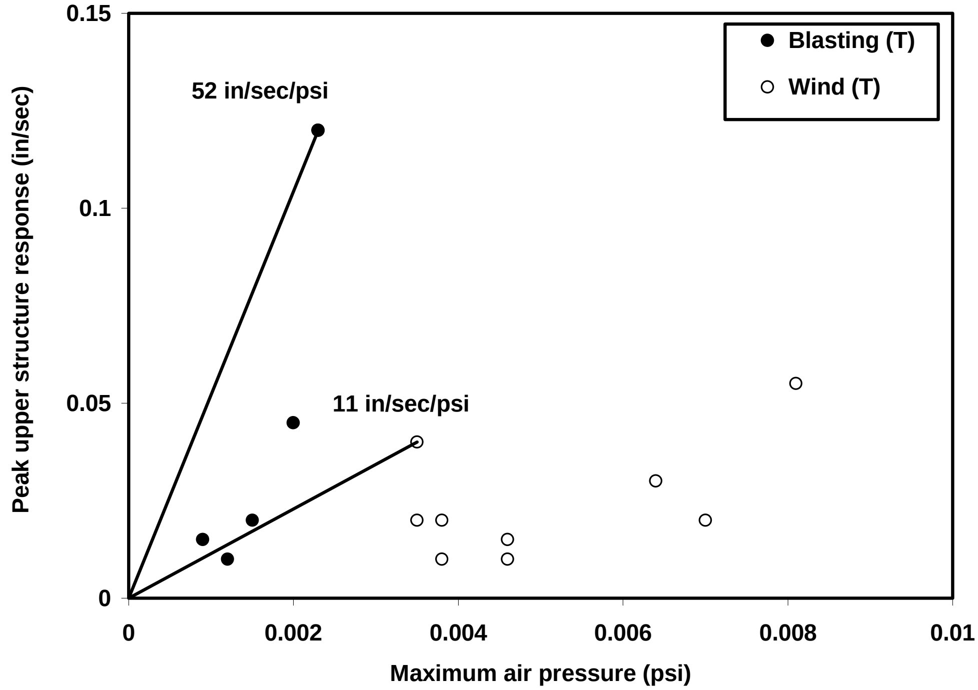
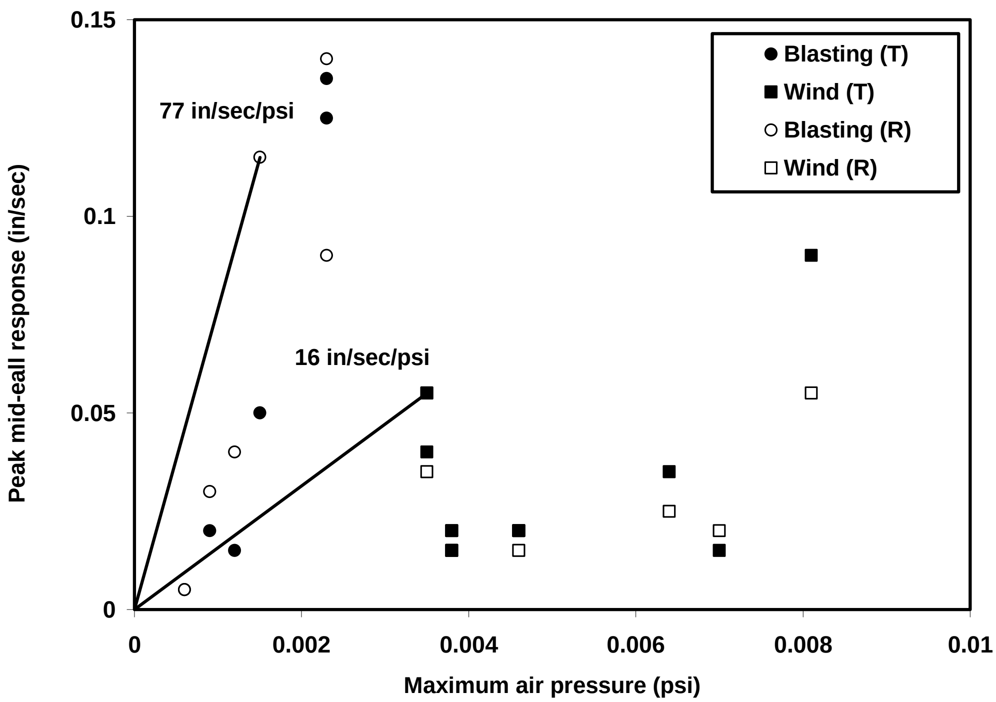


Figure 31 Calculated wall bending strains versus the corresponding peak particle velocity for all horizontal components



(a)

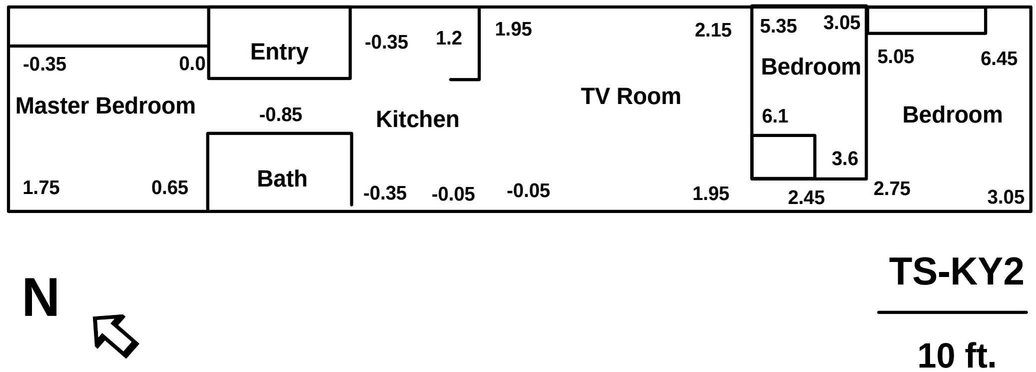


(b)

Figure 32 Structure response versus maximum air pressure measured during blasting and wind gusts for single wide trailer TS-KY2 (a) upper structure (S2) and (b) mid-wall responses

APPENDIX I

Structure Layouts and Photographs

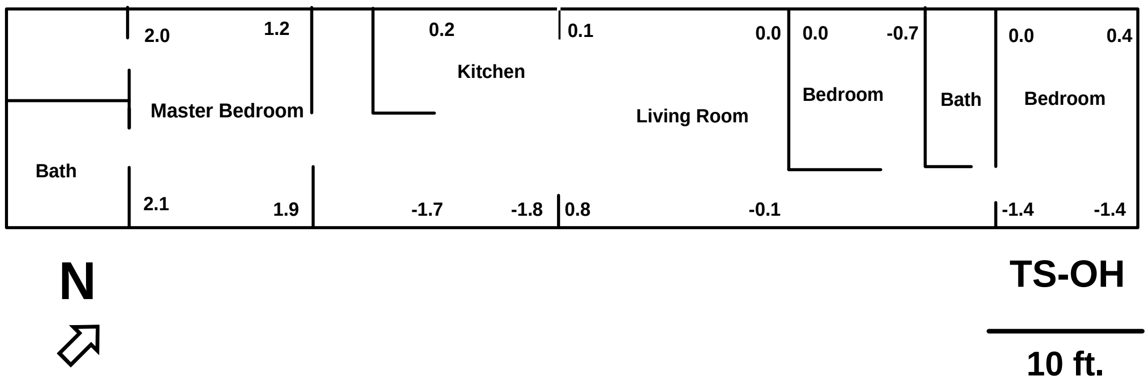


-0.35
0.0
Master Bedroom
1.75
0.65
Entry
-0.85
Bath
-0.35
1.2
Kitchen
-0.35
-0.05
1.95
2.15
TV Room
-0.05
1.95
5.35
3.05
Bedroom
6.1
3.6
2.45
5.05
6.45
Bedroom
2.75
3.05
N
TS-KY2
10 ft.

TS-KY2 single wide trailer

TS-IN single wide trailer

TS-AL single wide trailer

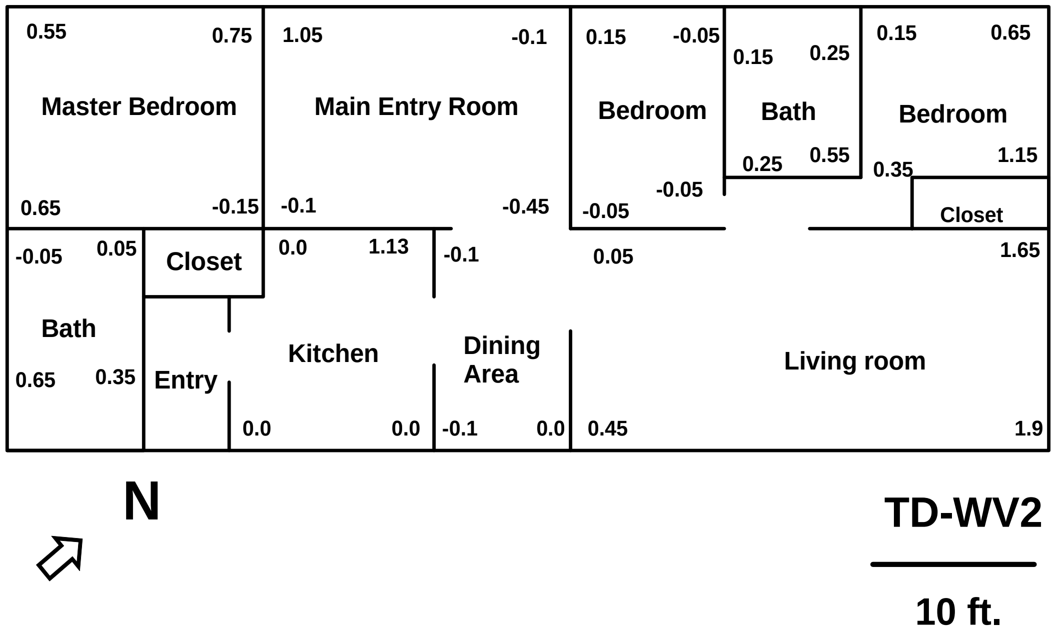

2.0
1.2
0.2
0.1
0.0
0.0
-0.7
0.0
0.4
Kitchen
Master Bedroom
Living Room
Bedroom
Bath
Bedroom
Bath
2.1
1.9
-1.7
-1.8
0.8
-0.1
-1.4
-1.4
N
TS-OH
10 ft.

TS-OH
wide

single
trailer

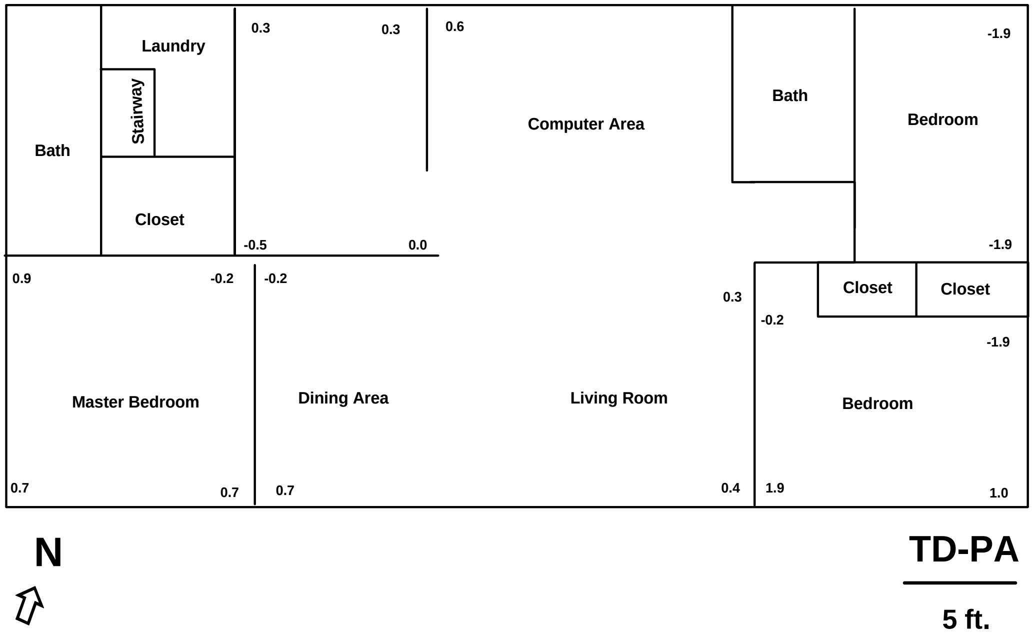
TSA-VA single wide add-on

TSA-KY2 single wide add-on

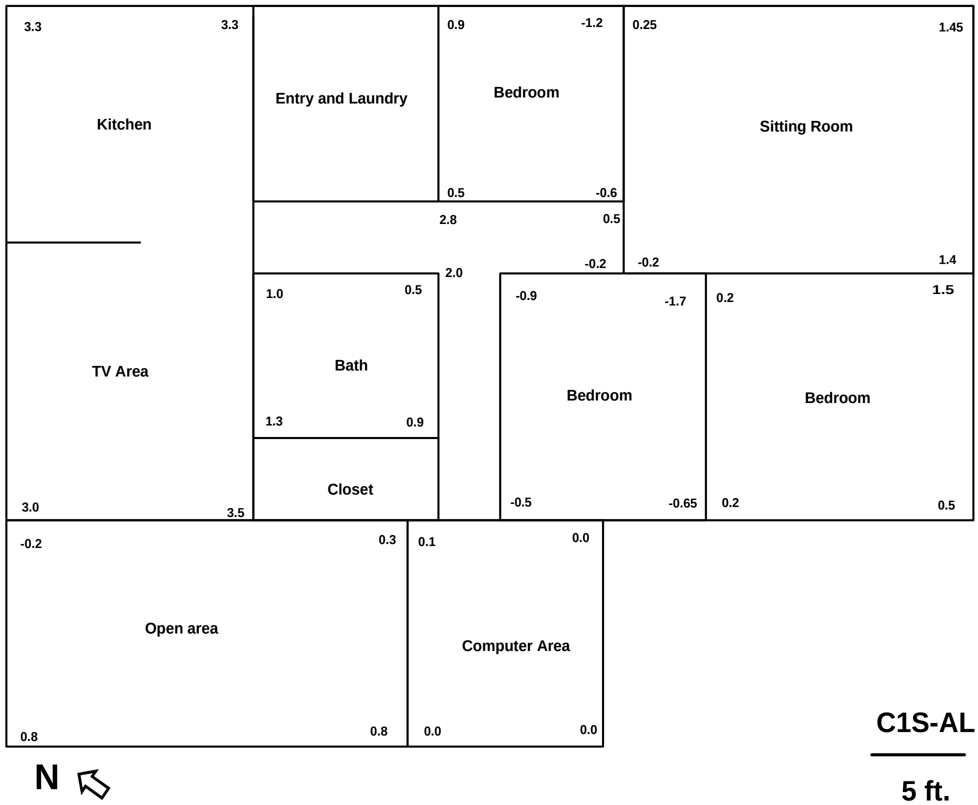


TD-WV2 double wide trailer

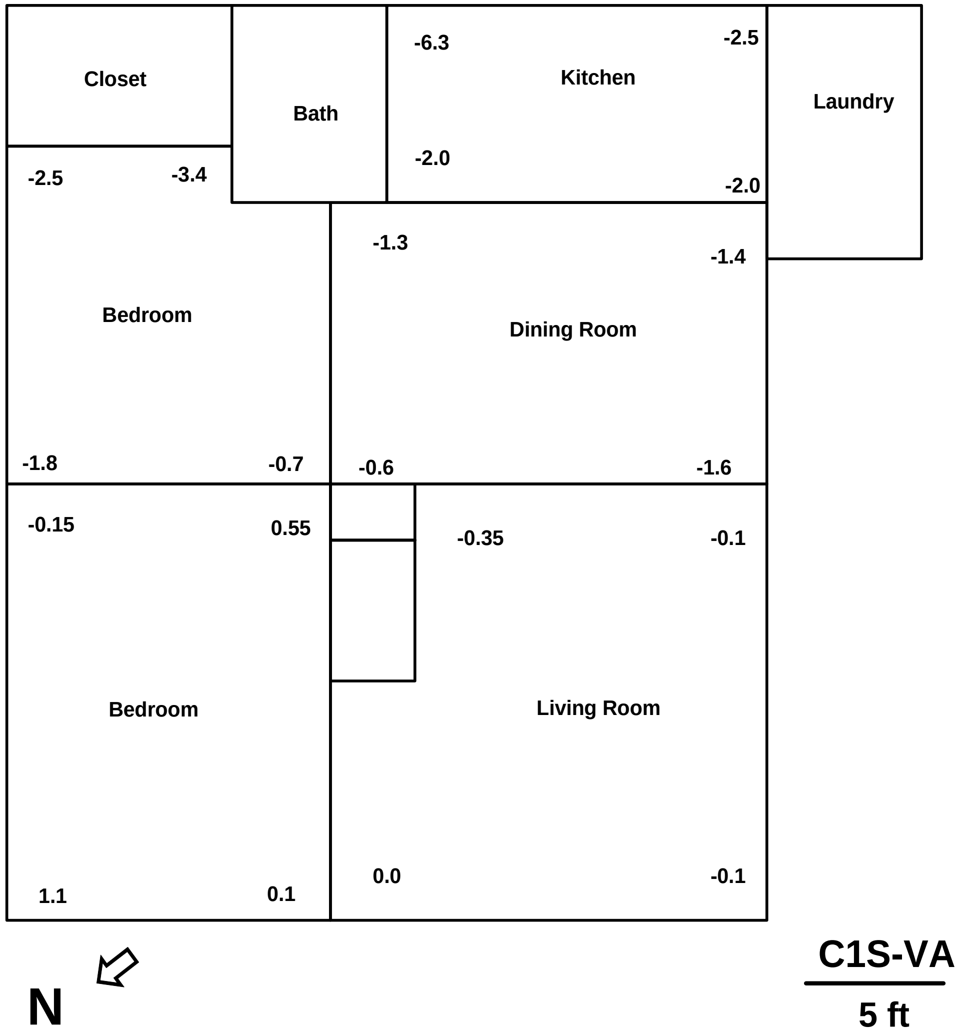
TD-TN double wide trailer



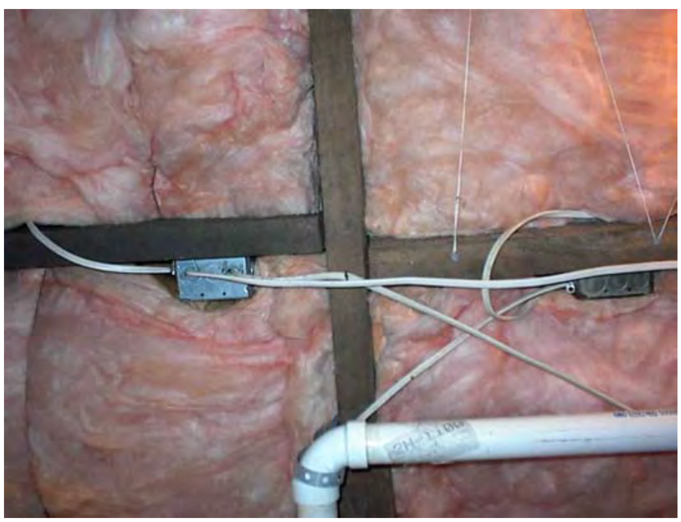
PD-PA double wide trailer with full basement



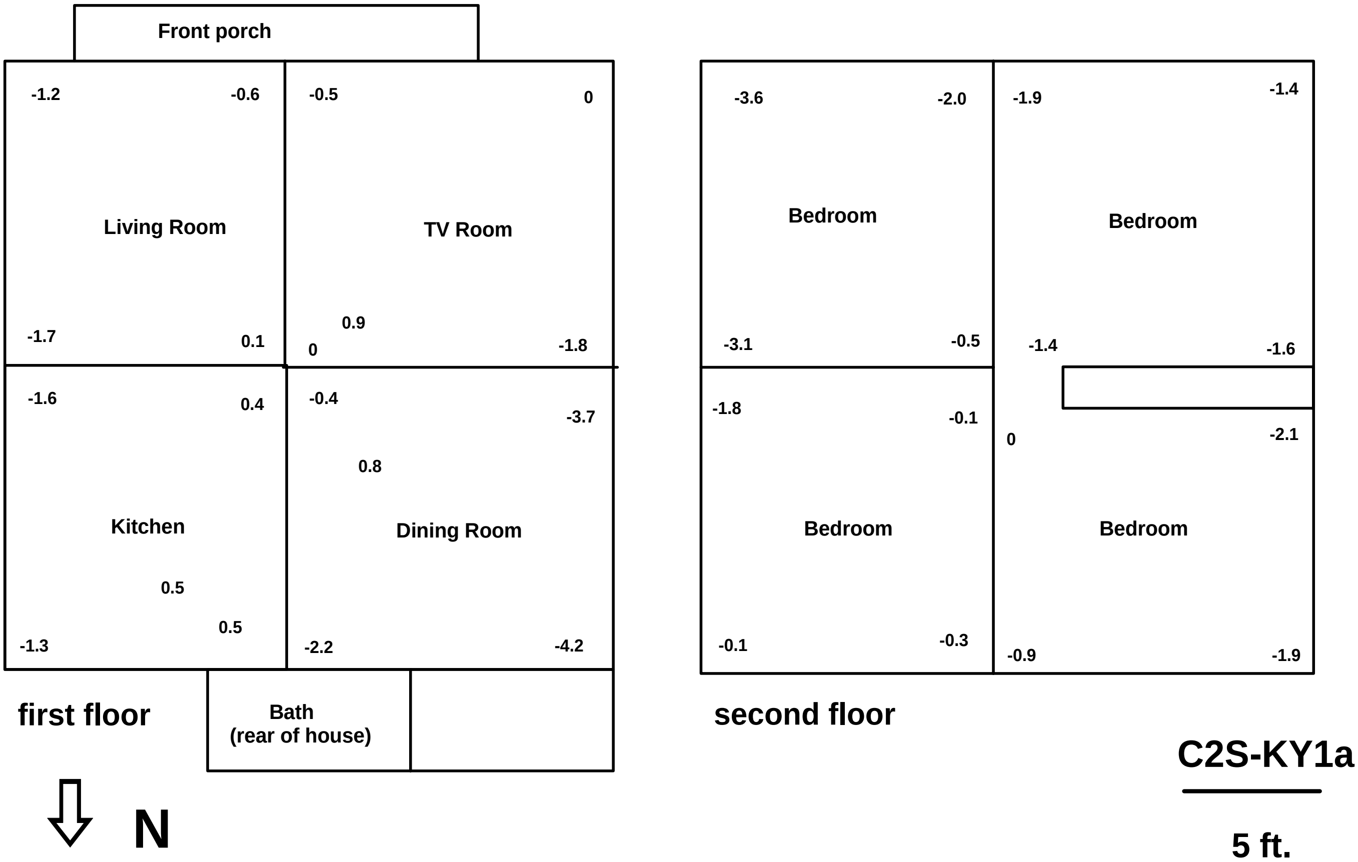
C1S-AL camp house



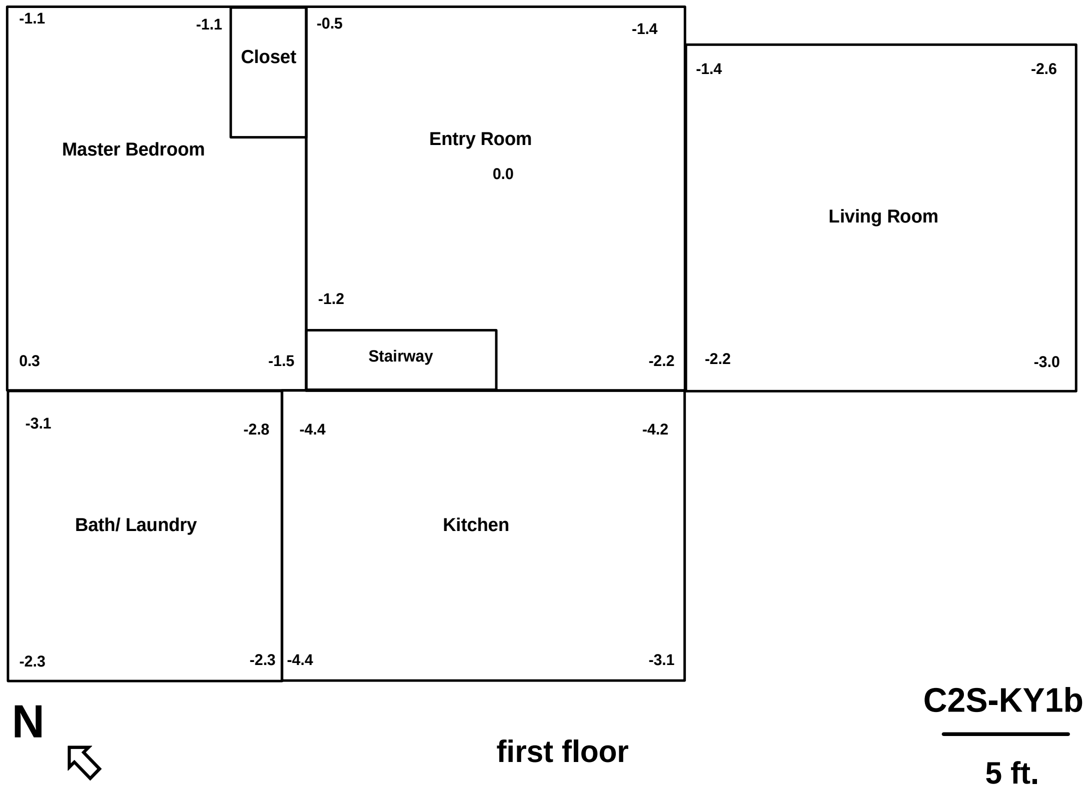

C1S-VA camp house

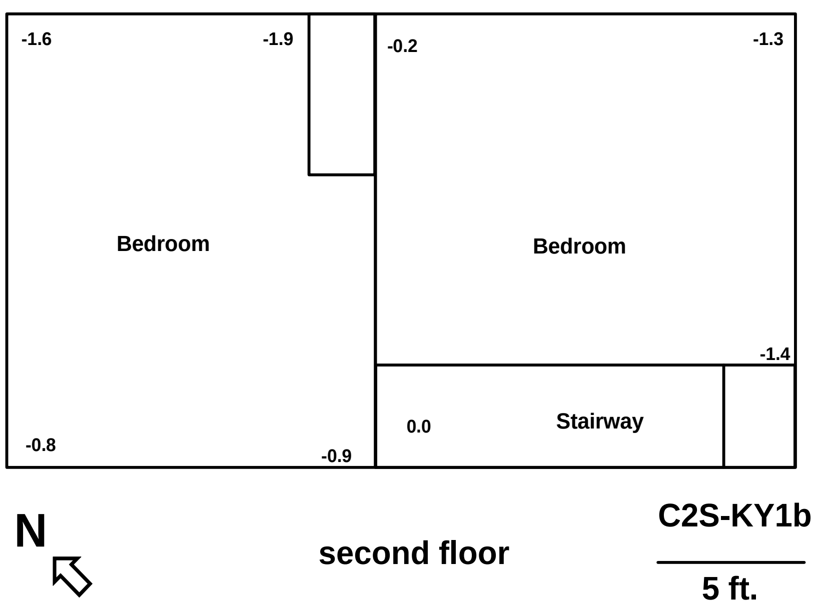


C1S-VA (cont.) camp house



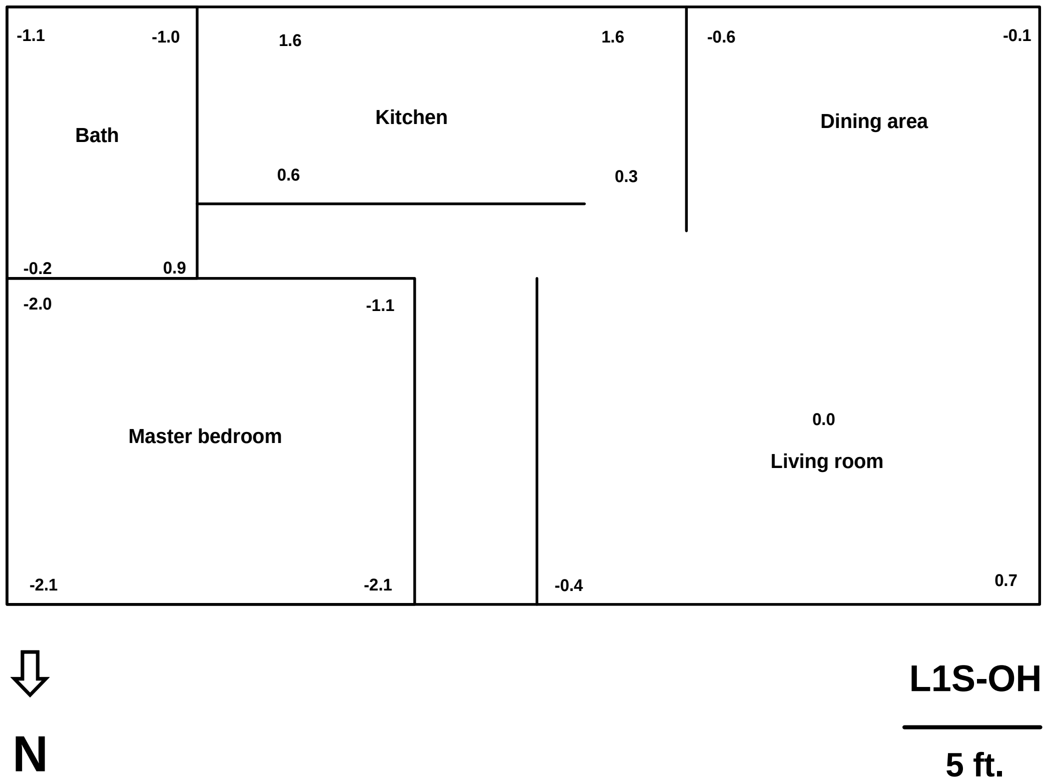
C2S-KYA Two story camp house

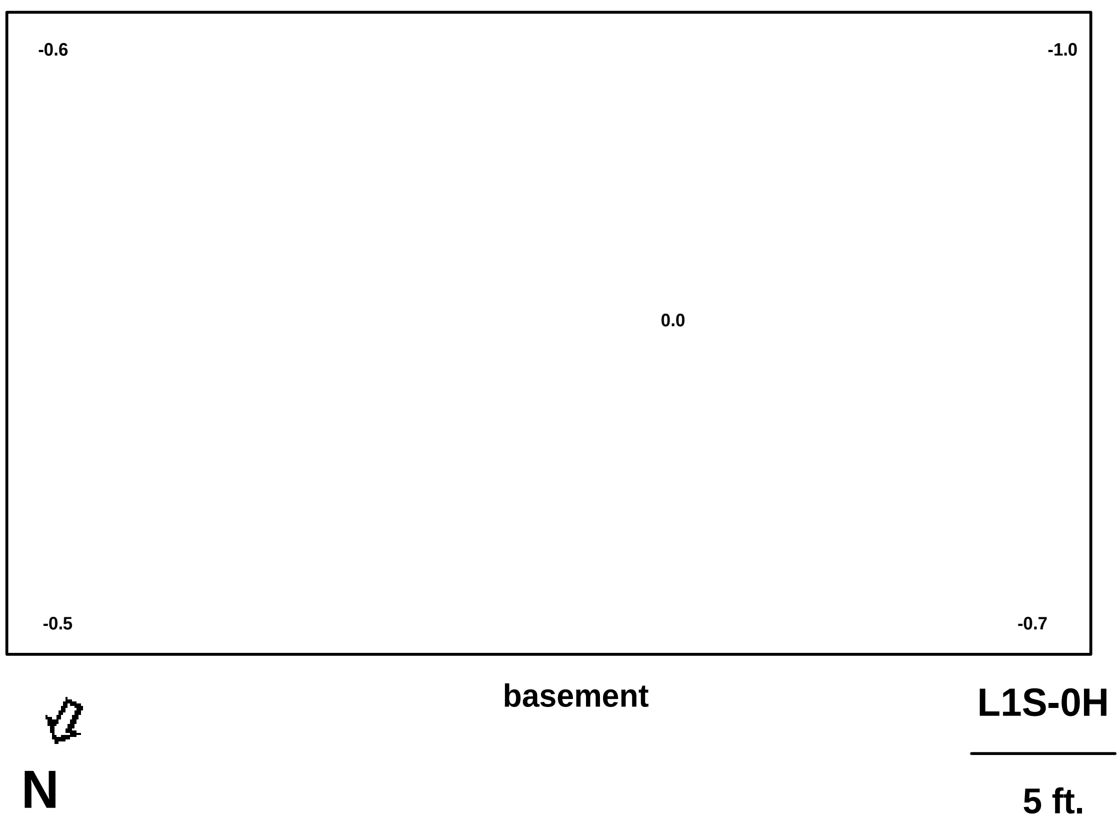




C2S-KY1B Two story camp house

C2S-KY1B Two story camp house

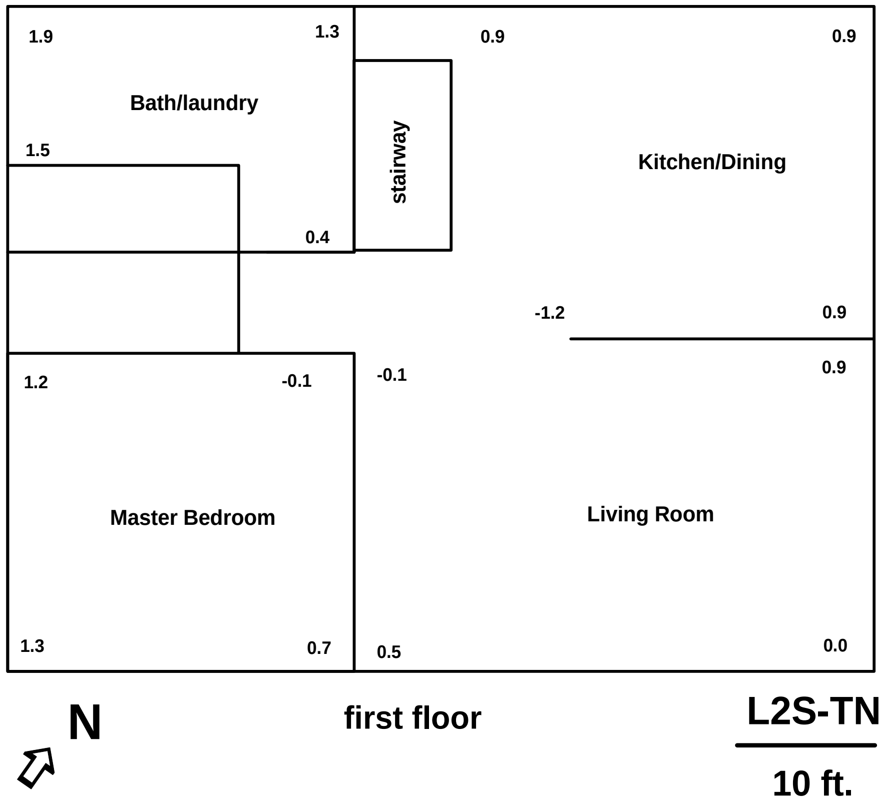


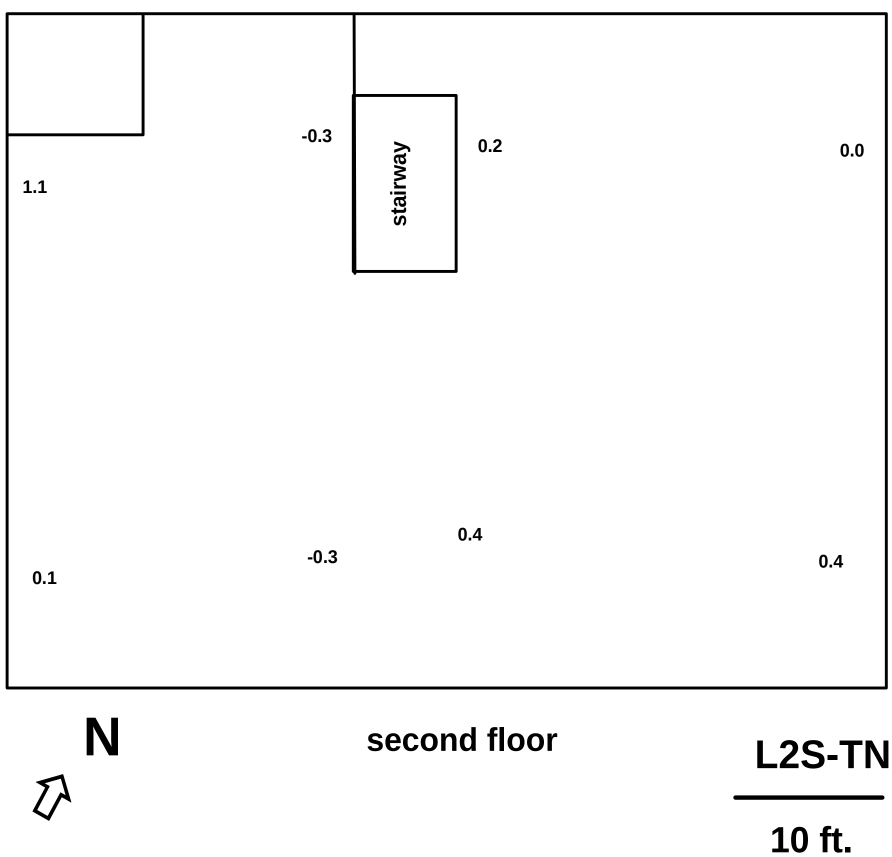


L1S-OH Traditional log house

L1S-OH (cont.) Traditional log house

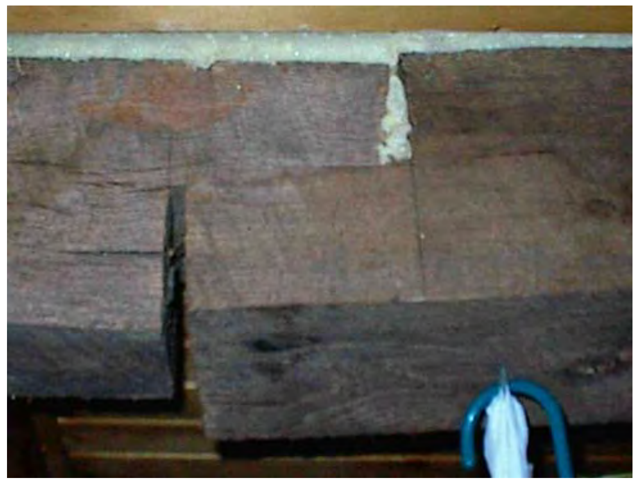
LS1-WV1 Historic log structure





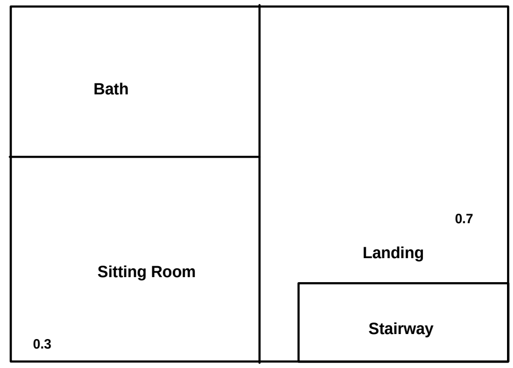
L2S-TN Two-story log house



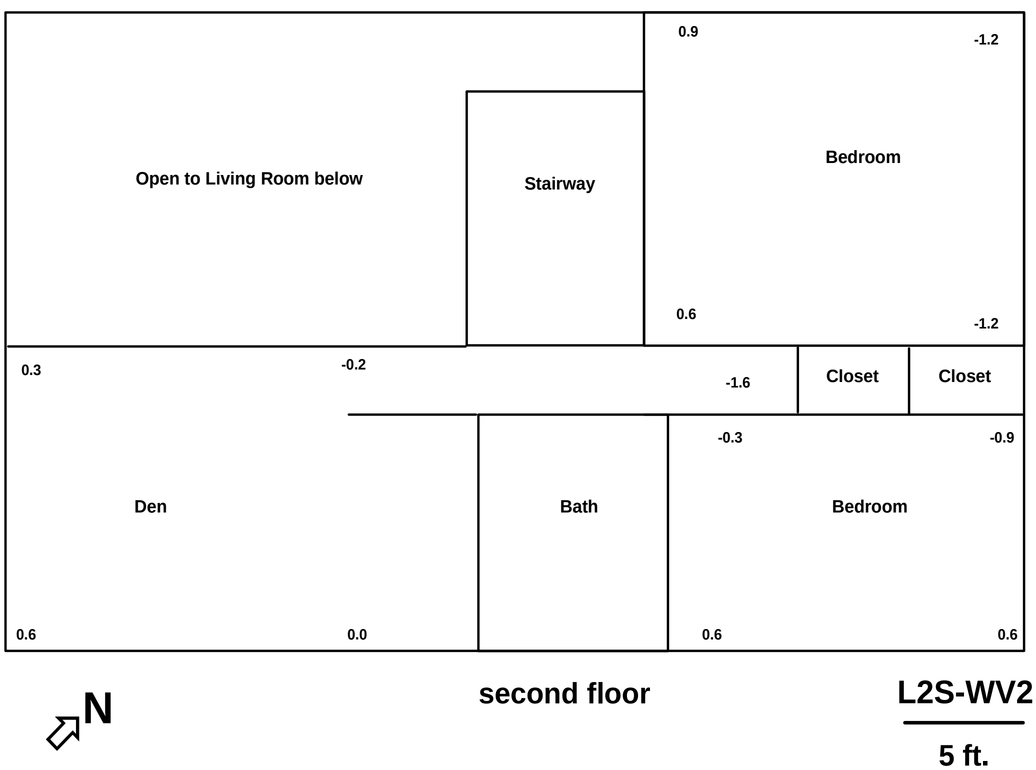
L2S-TN (cont.) Two-story log house

first floor



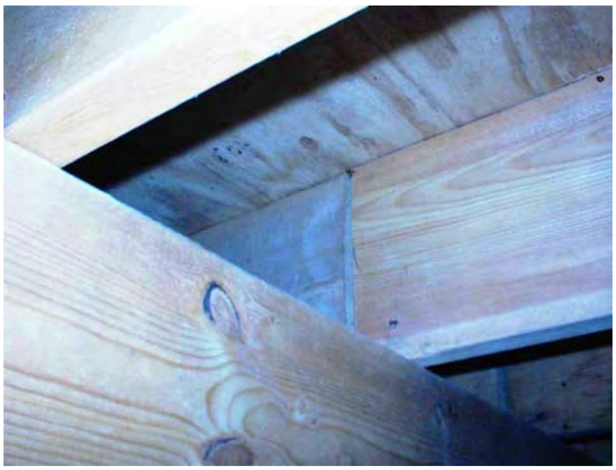
second floor

L2S-OH Two-story log house

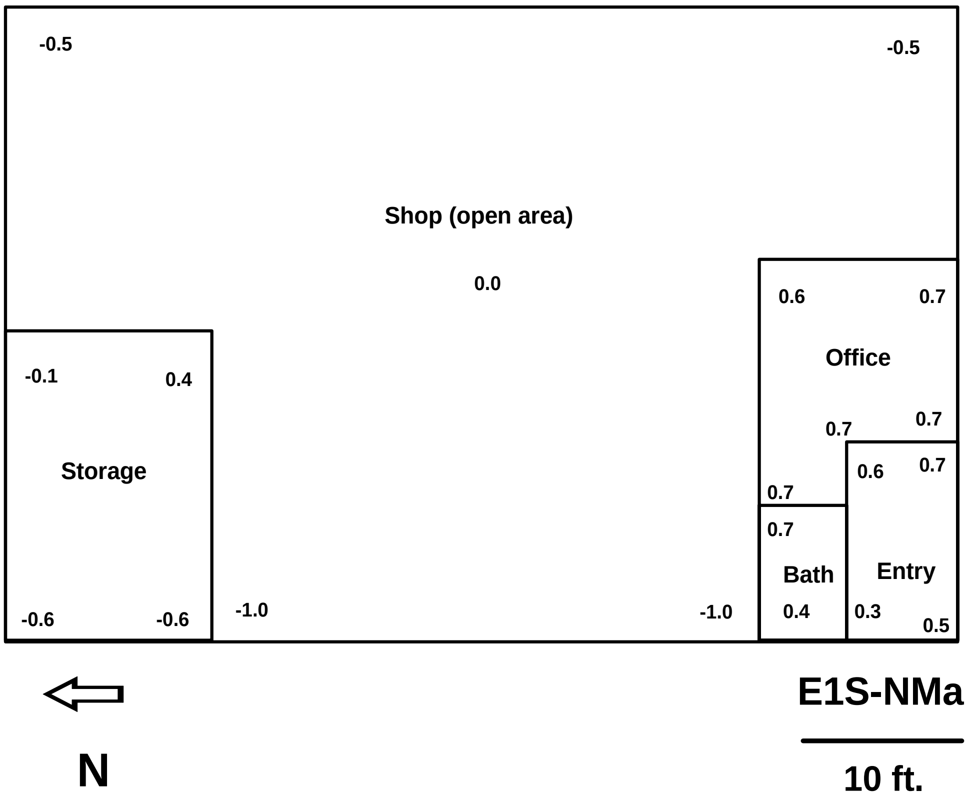


L2S-WV2 Two-story log house

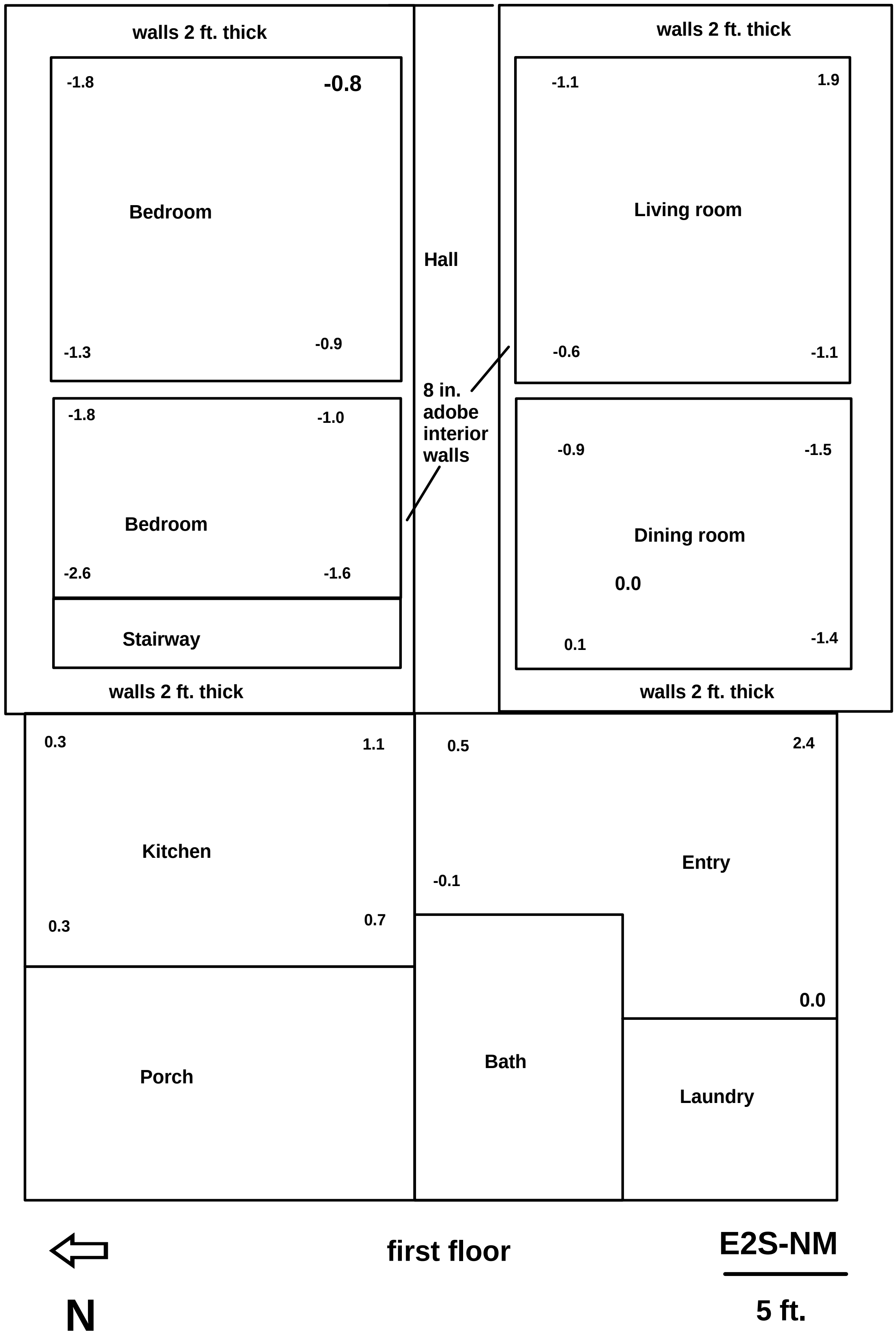




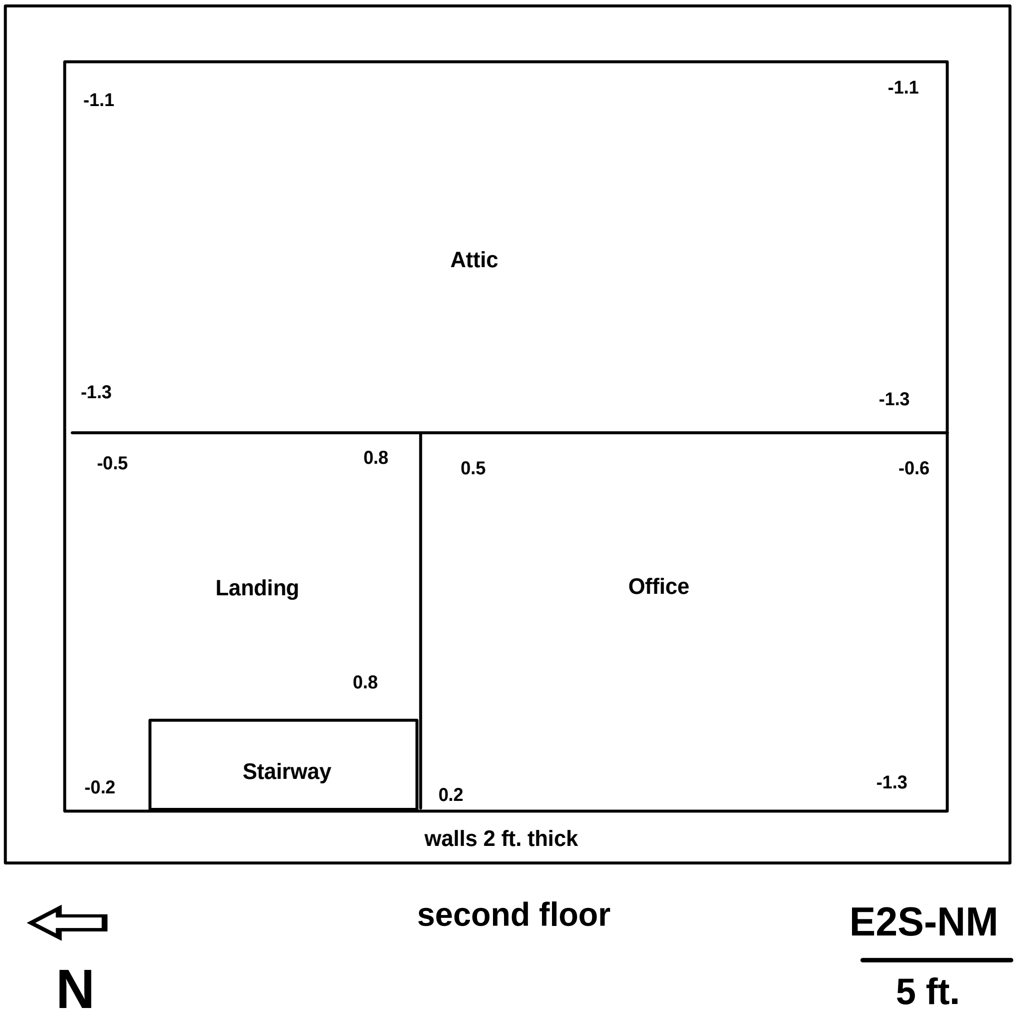

L2S-WV2 Two-story log house



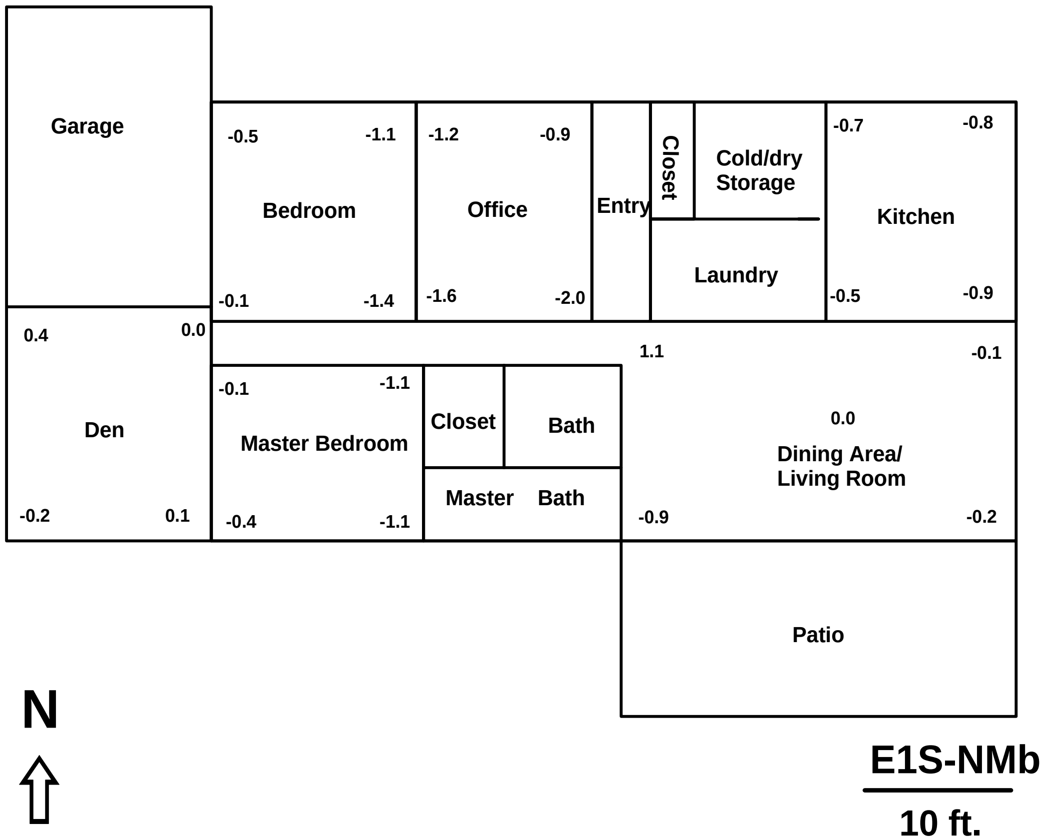
E1S-NMA Concrete block structure



E2S-NM Two-story stone house

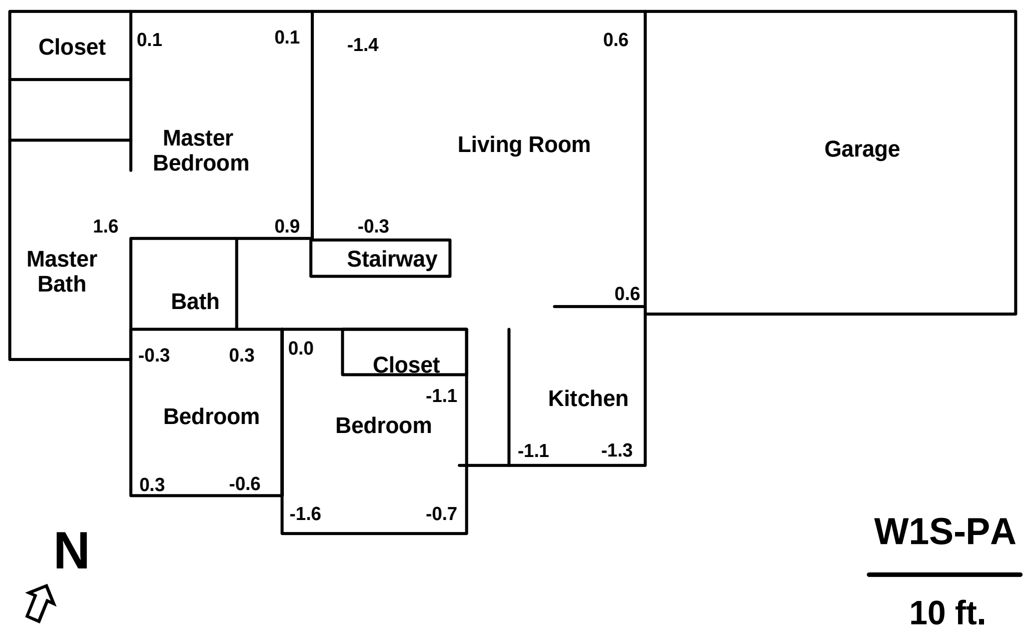


E2S-NM (cont.) Two-story stone house

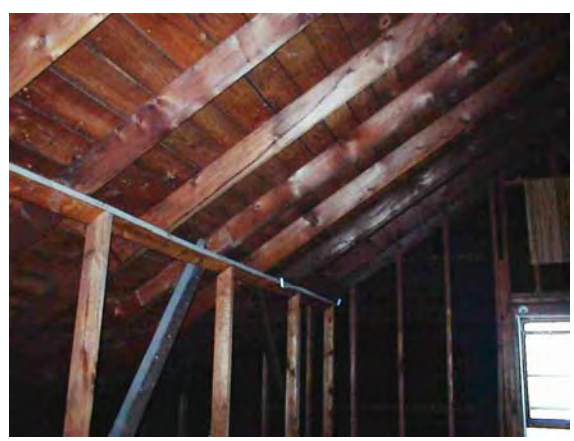


E1S-NMB Traditional adobe house

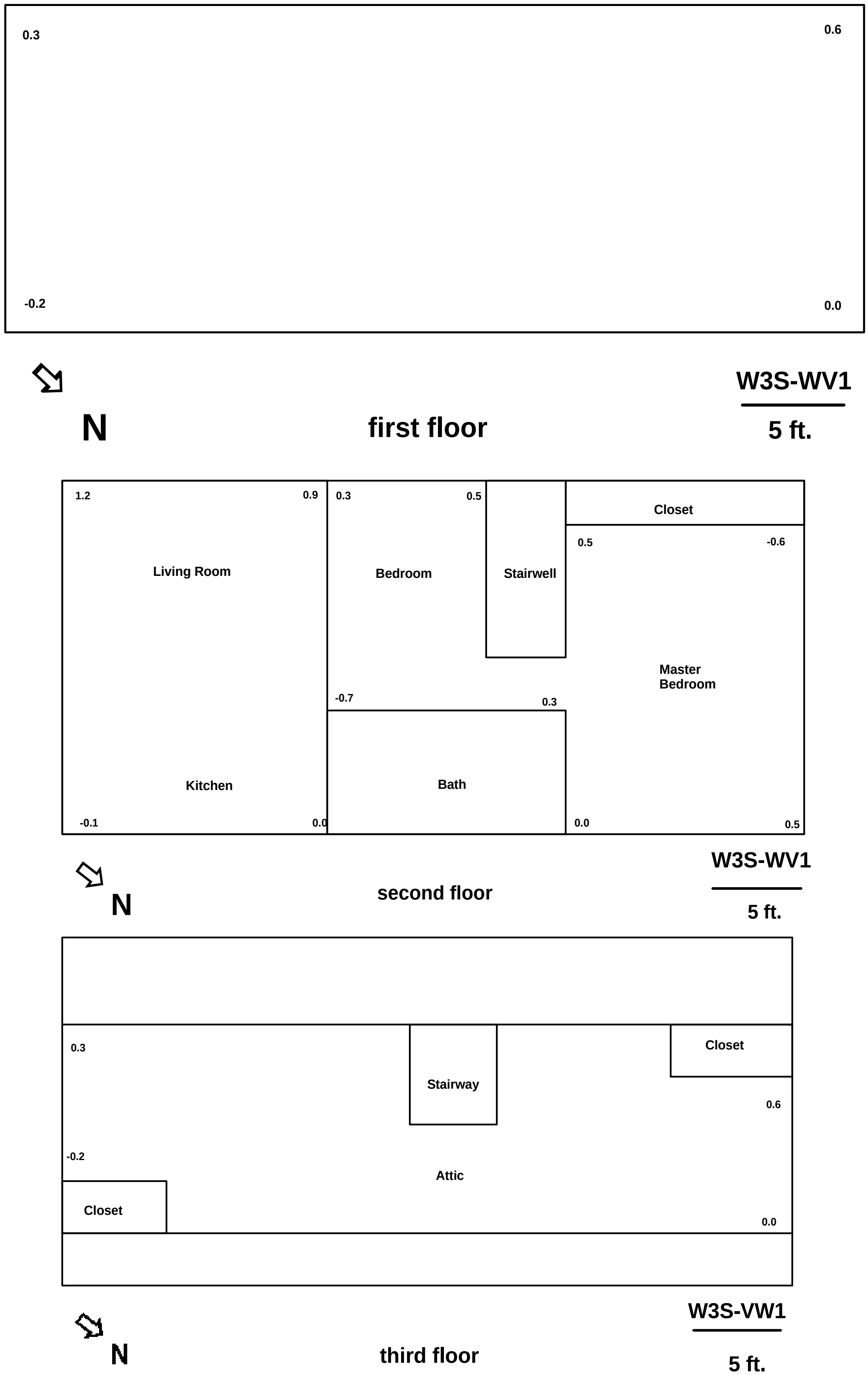
W1S-IN Wood-frame house



W1S-PA Wood-frame house under construction



W2S-IN Wood-frame house

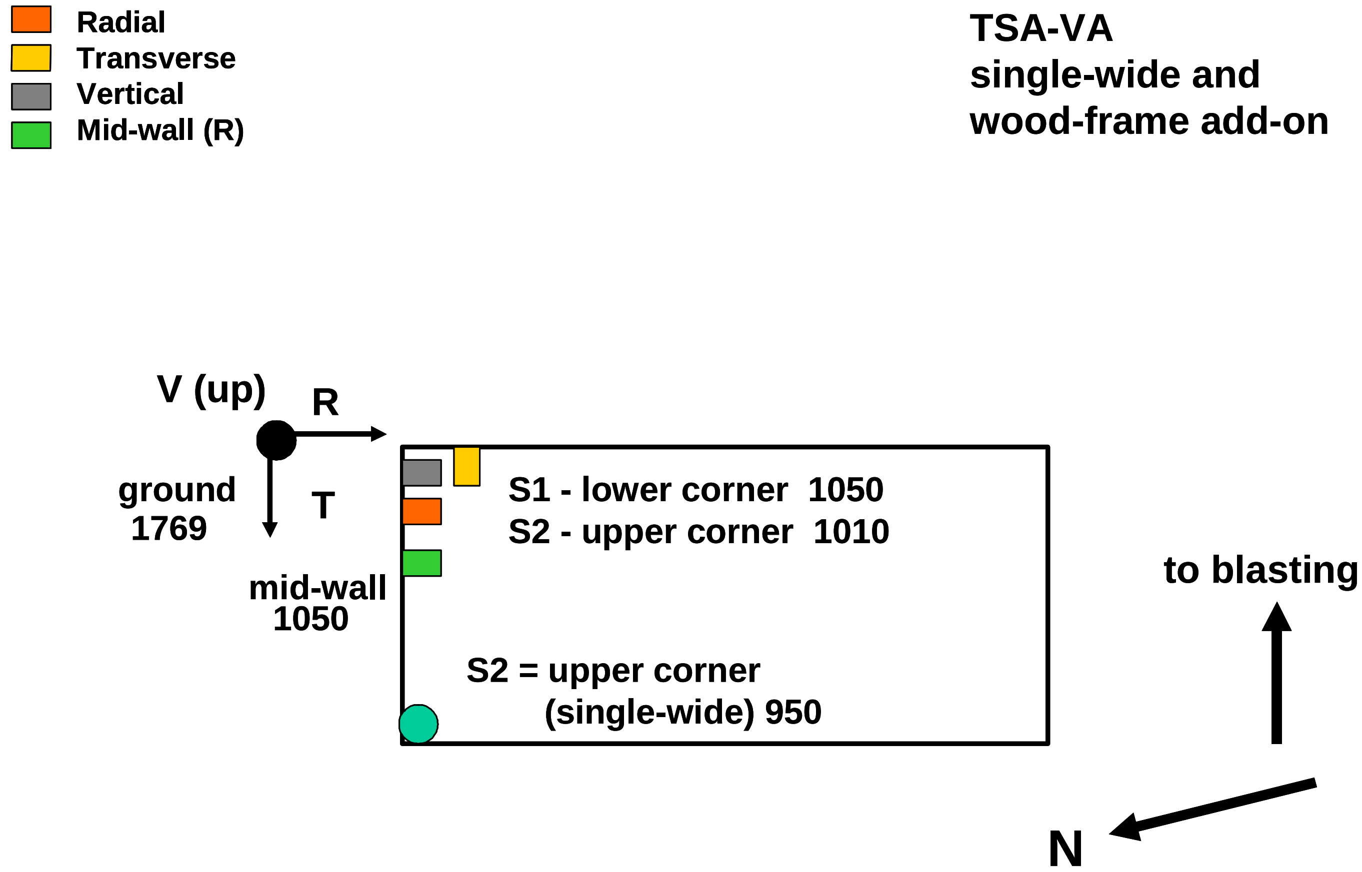


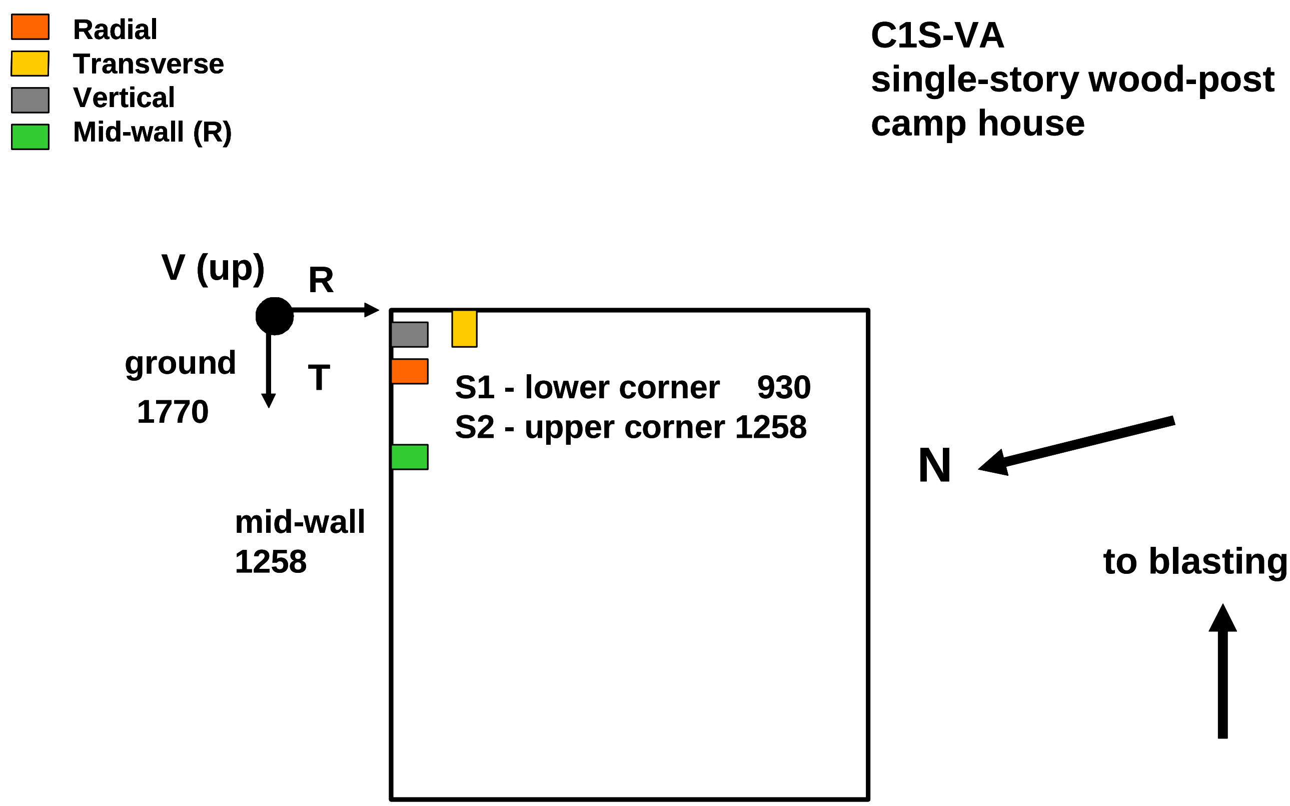
W3S-WV1 Three-story cantilever house

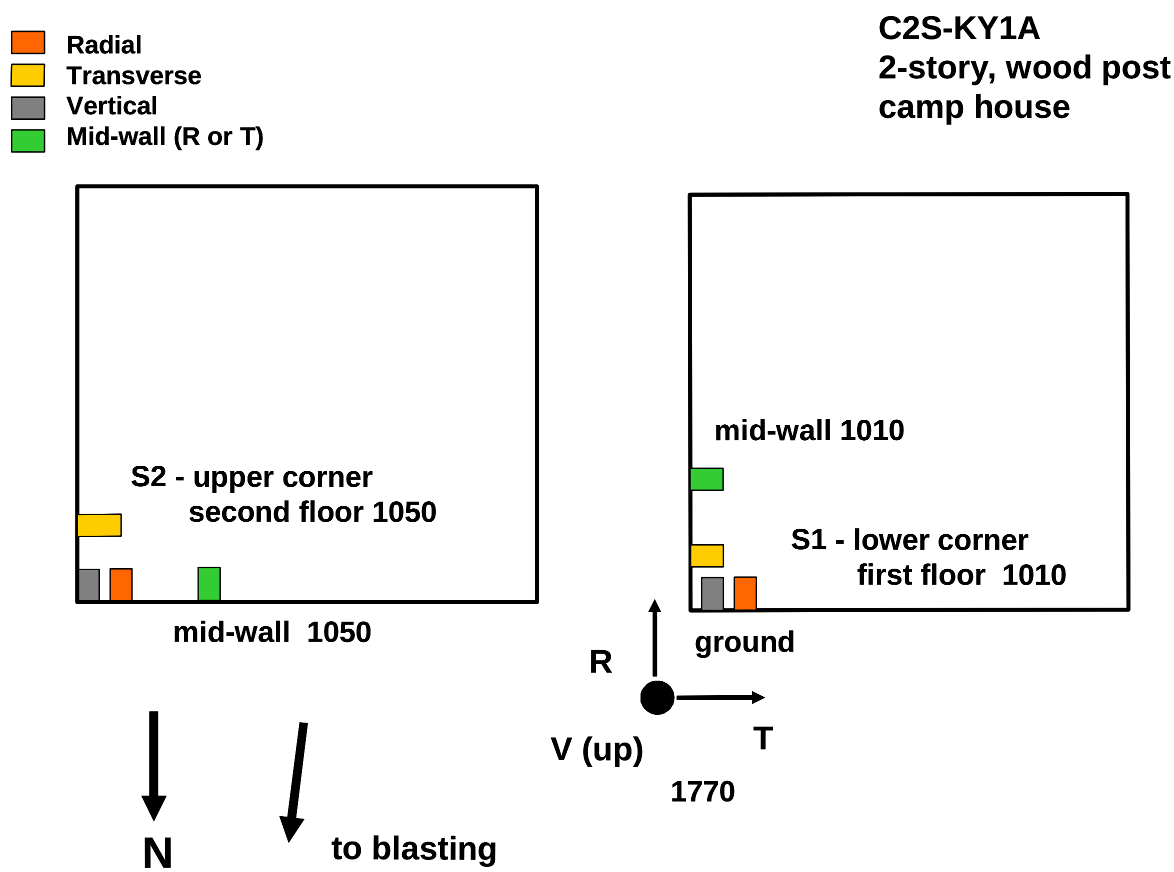
W3S-WV1 (cont.) Three-story cantilever house

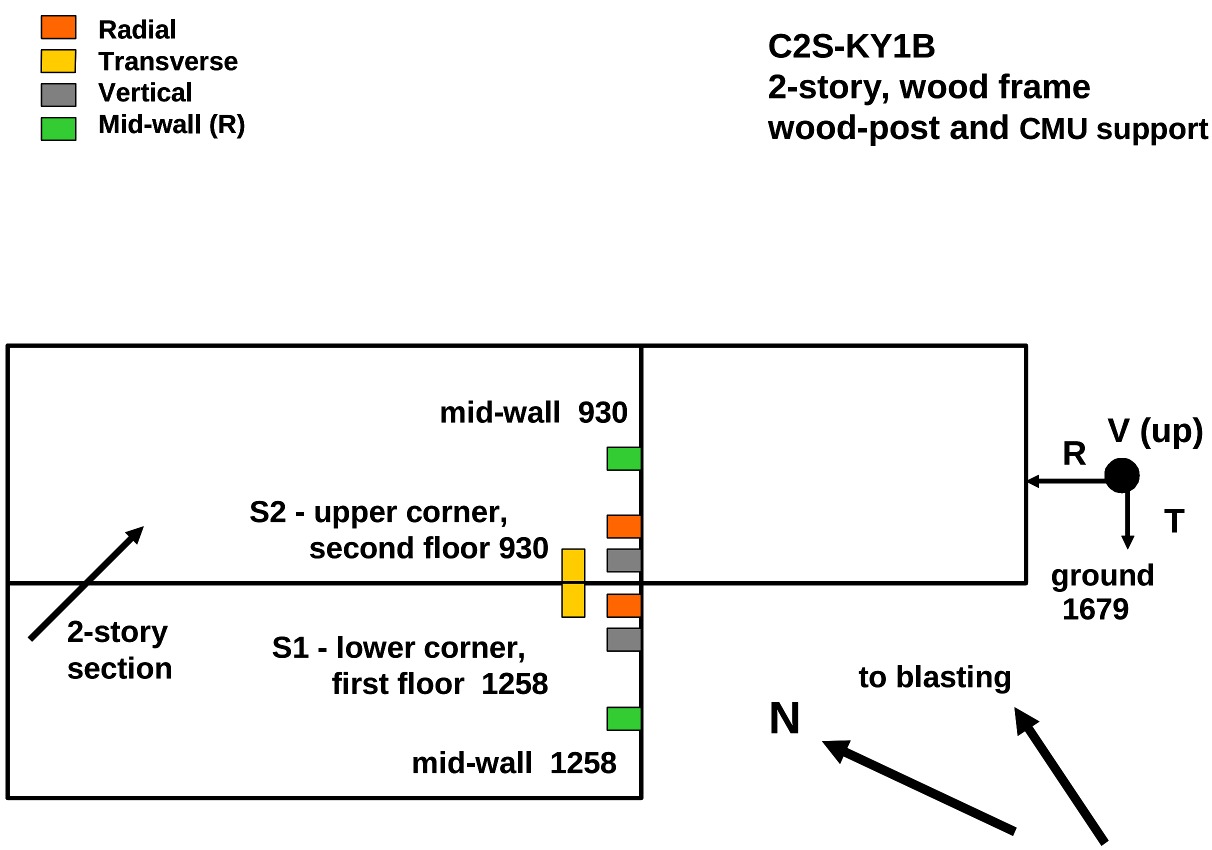
APPENDIX II

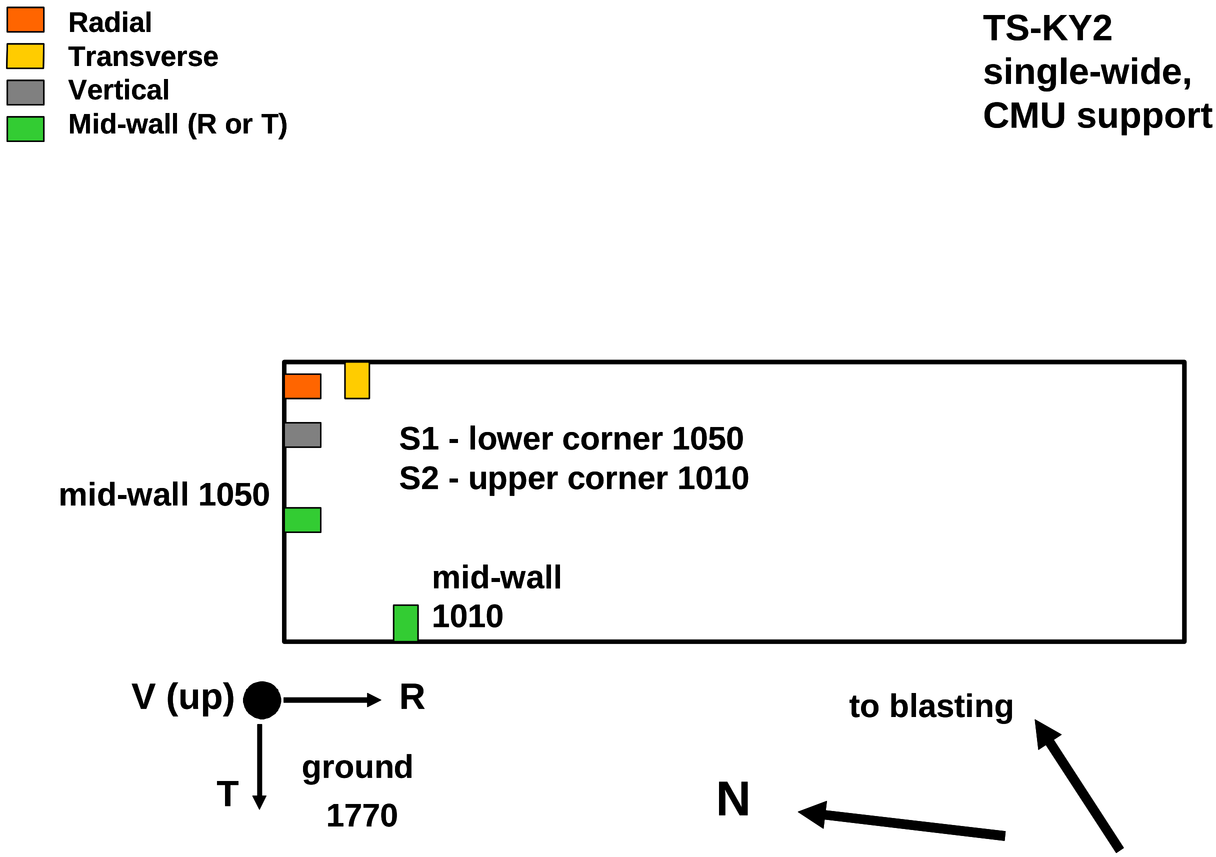
Instrumentation Locations

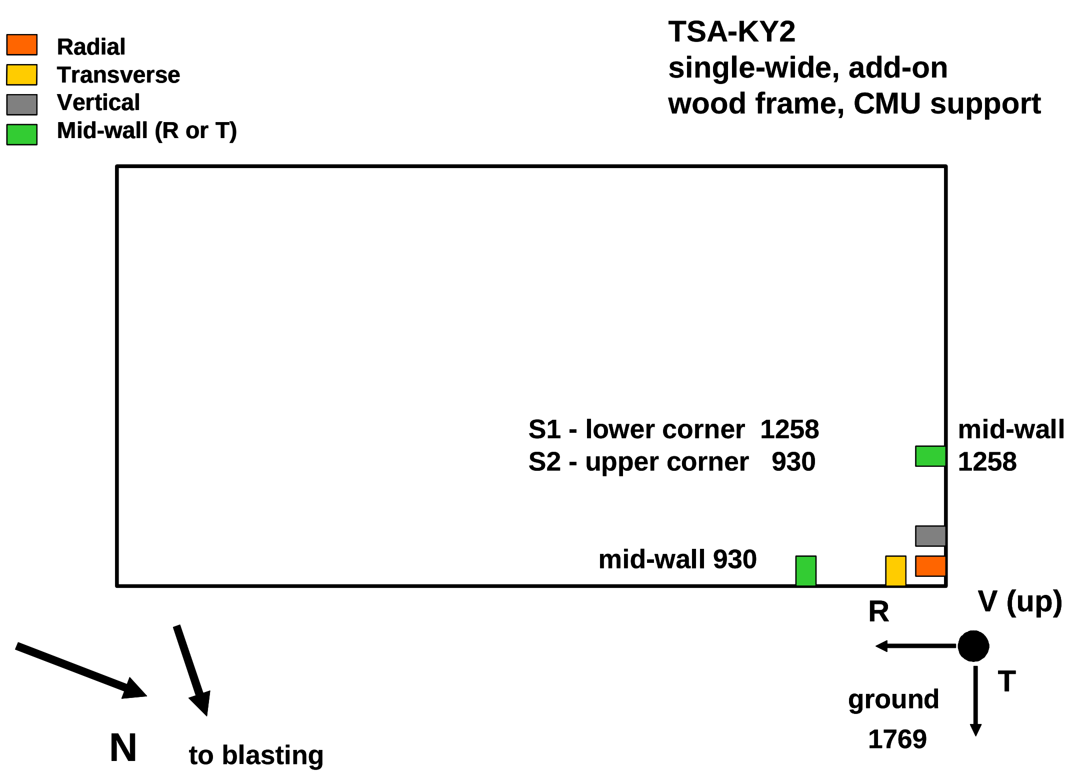

Radial
Transverse
Vertical
Mid-wall (R)
TSA-VA
single-wide and
wood-frame add-on
V (up)
R
ground
1769
T
mid-wall
1050
S1 - lower corner 1050
S2 - upper corner 1010
S2 = upper corner
(single-wide) 950
to blasting
N

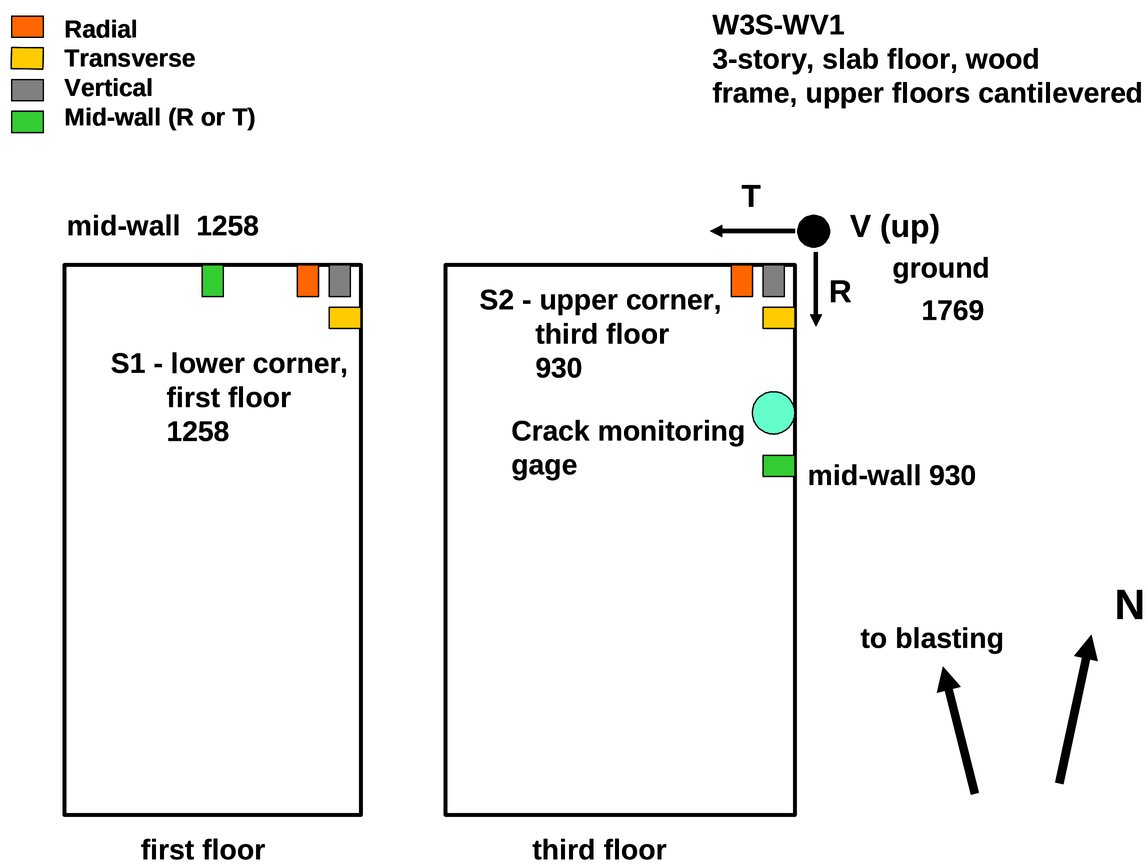

Radial
Transverse
Vertical
Mid-wall (R)
C1S-VA
single-story wood-post
camp house
V (up)
R
ground
1770
T
mid-wall
1258
S1 - lower corner 930
S2 - upper corner 1258
N
to blasting

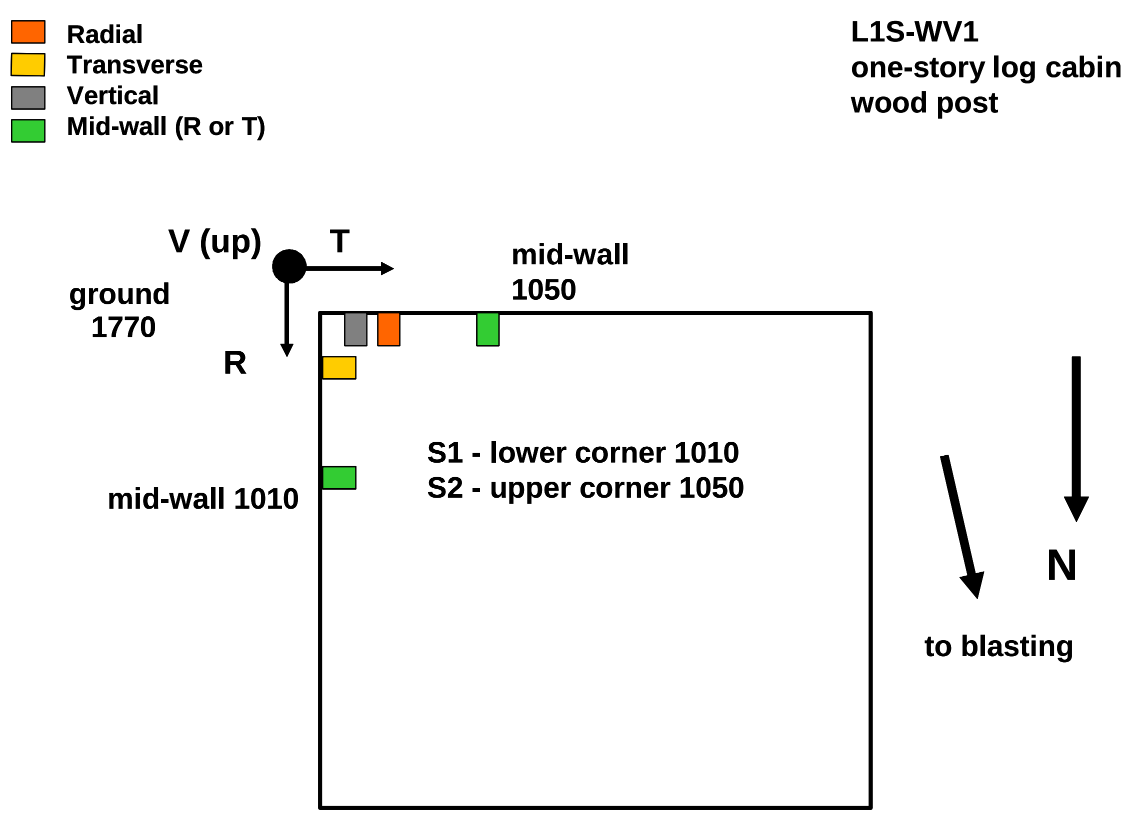

Radial
Transverse
Vertical
Mid-wall (R or T)
C2S-KY1A
2-story, wood post
camp house
S2 - upper corner
second floor 1050
mid-wall 1050
mid-wall 1010
S1 - lower corner
first floor 1010
ground
R
V (up)
T
1770
N
to blasting

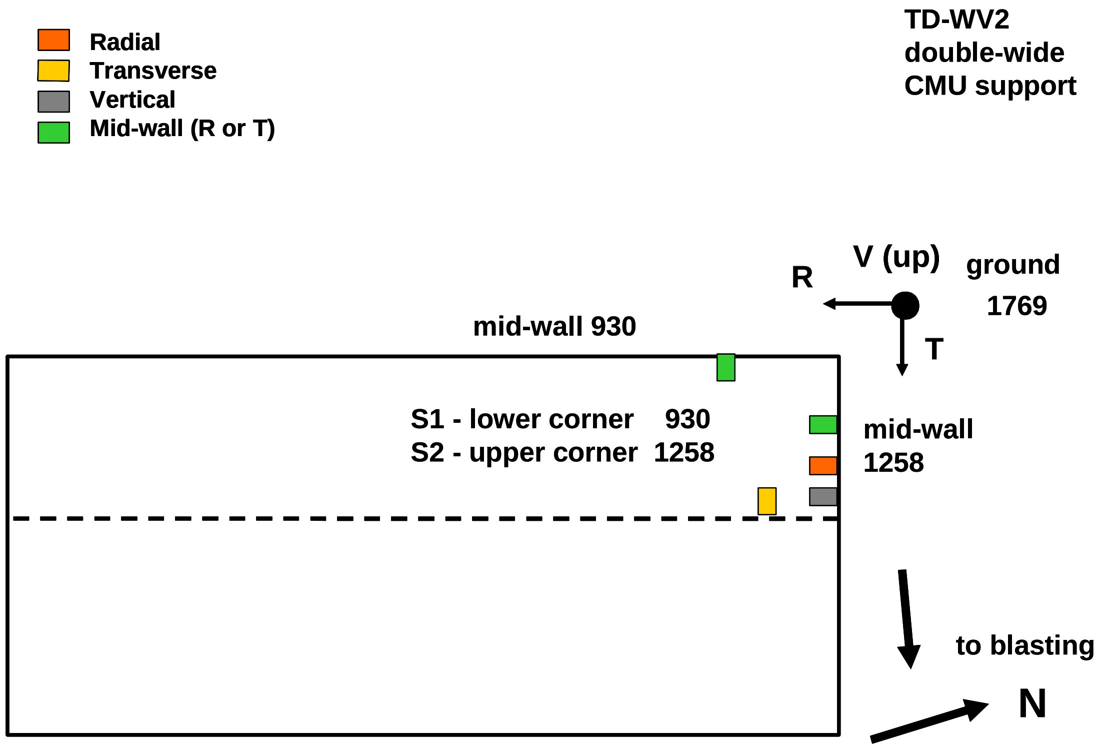

Radial
Transverse
Vertical
Mid-wall (R)
C2S-KY1B
2-story, wood frame
wood-post and CMU support
mid-wall 930
S2 - upper corner,
second floor 930
2-story
section
S1 - lower corner,
first floor 1258
mid-wall 1258
R
V (up)
T
ground
1679
to blasting
N

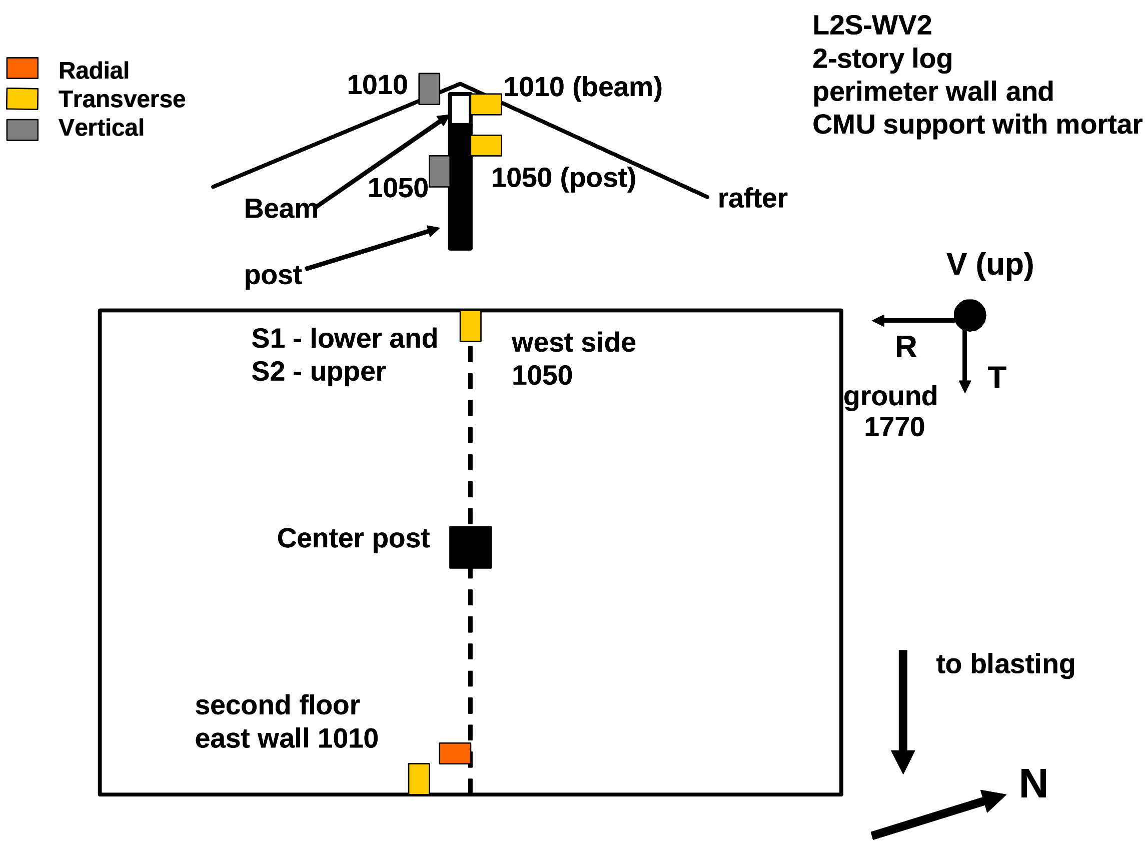

Radial
Transverse
Vertical
Mid-wall (R or T)
TS-KY2
single-wide,
CMU support
S1 - lower corner 1050
S2 - upper corner 1010
mid-wall 1050
mid-wall
1010
V (up)
R
T
ground
1770
to blasting
N

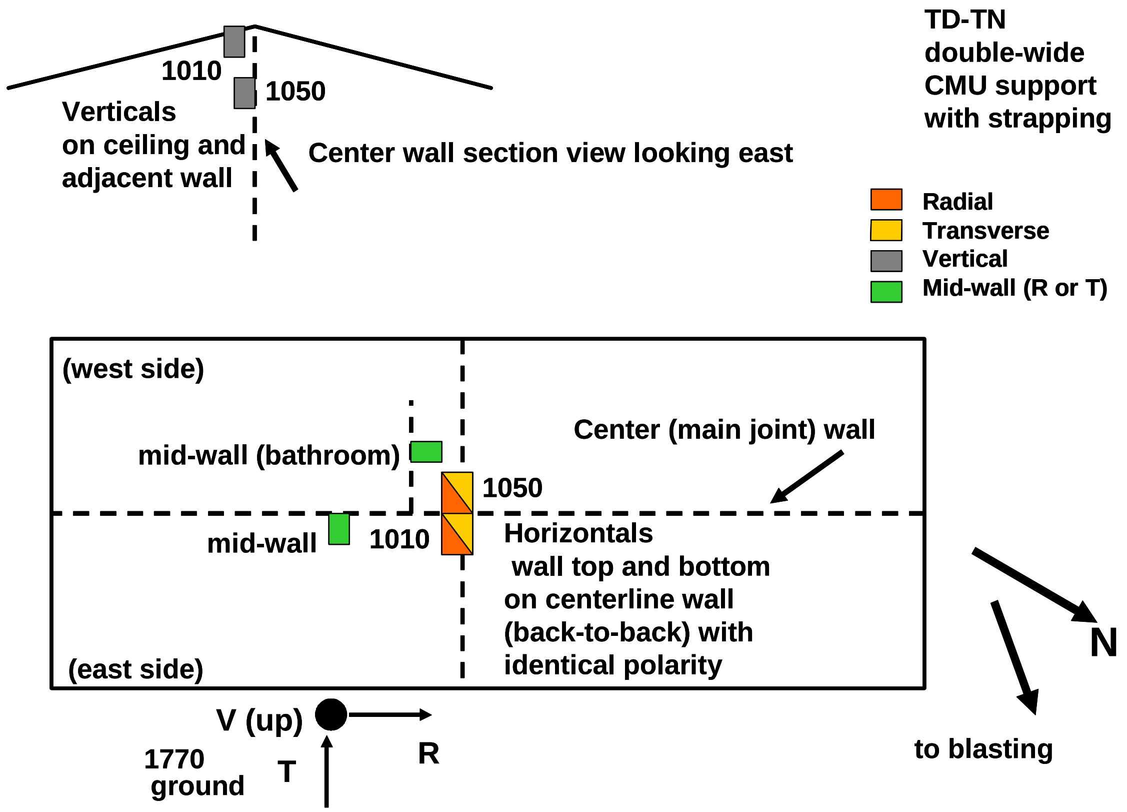

Radial
Transverse
Vertical
Mid-wall (R or T)
TSA-KY2
single-wide, add-on
wood frame, CMU support
S1 - lower corner 1258
S2 - upper corner 930
mid-wall
1258
mid-wall 930
R
V (up)
T
ground
1769
N
to blasting

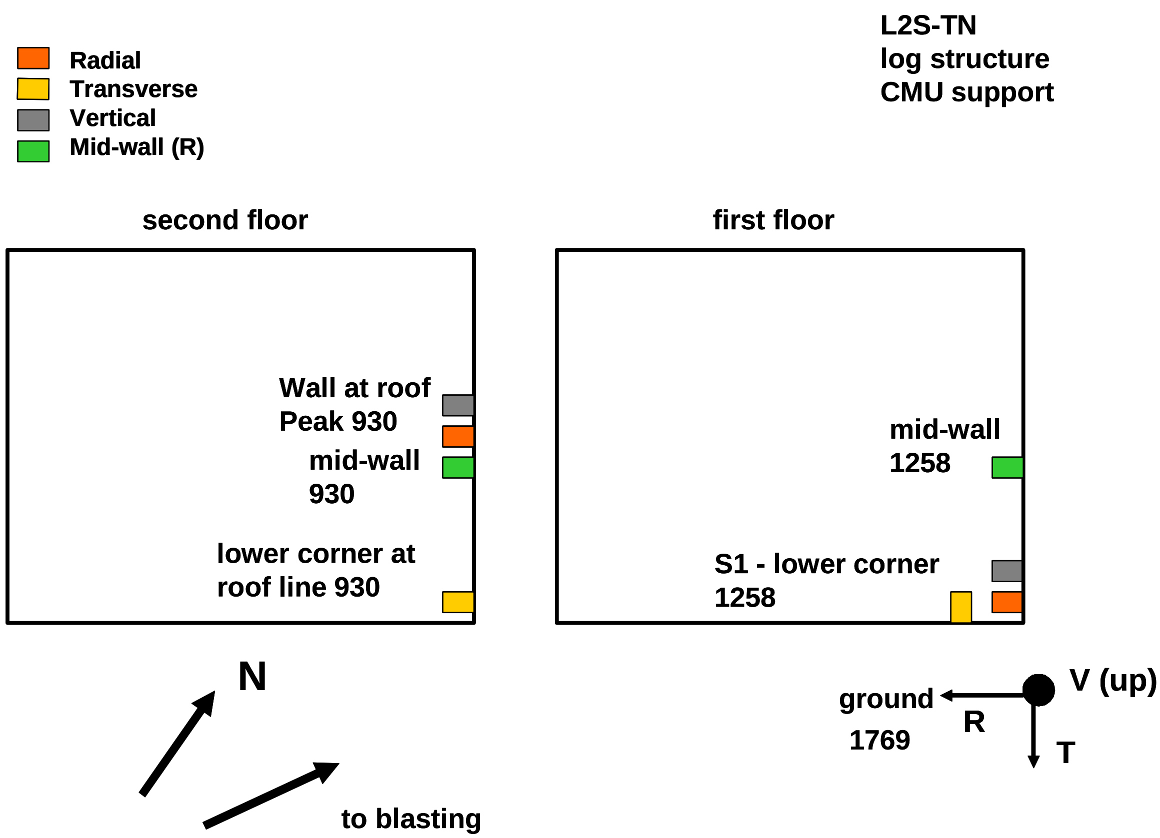

Radial
Transverse
Vertical
Mid-wall (R or T)
W3S-WV1
3-story, slab floor, wood
frame, upper floors cantilevered
mid-wall 1258
T
V (up)
R
ground
1769
S1 - lower corner,
first floor
1258
S2 - upper corner,
third floor
930
Crack monitoring
gage
mid-wall 930
to blasting
N
first floor
third floor

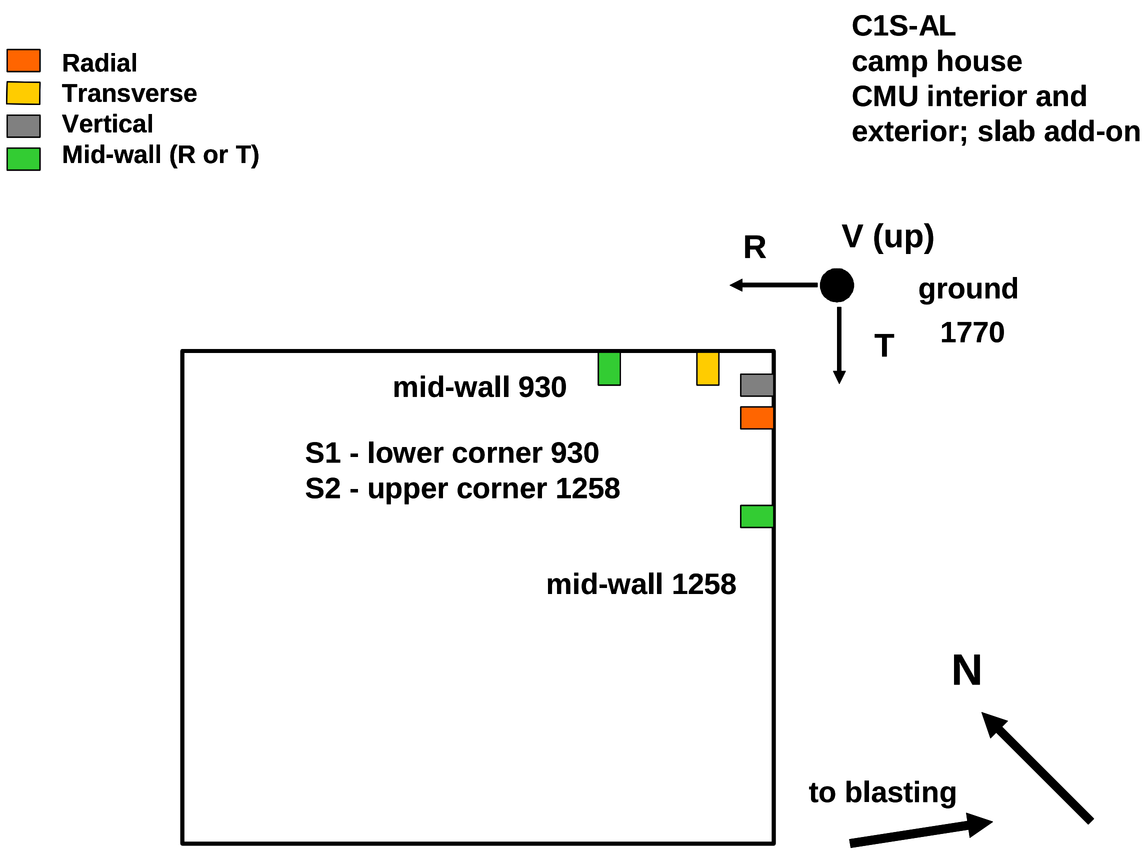

Radial
Transverse
Vertical
Mid-wall (R or T)
L1S-WV1
one-story log cabin
wood post
V (up)
T
ground
1770
R
mid-wall
1050
S1 - lower corner 1010
S2 - upper corner 1050
mid-wall 1010
N
to blasting


Radial
Transverse
Vertical
Mid-wall (R or T)
TD-WV2
double-wide
CMU support
V (up)
R
T
ground
1769
mid-wall 930
S1 - lower corner 930
S2 - upper corner 1258
mid-wall
1258
to blasting
N

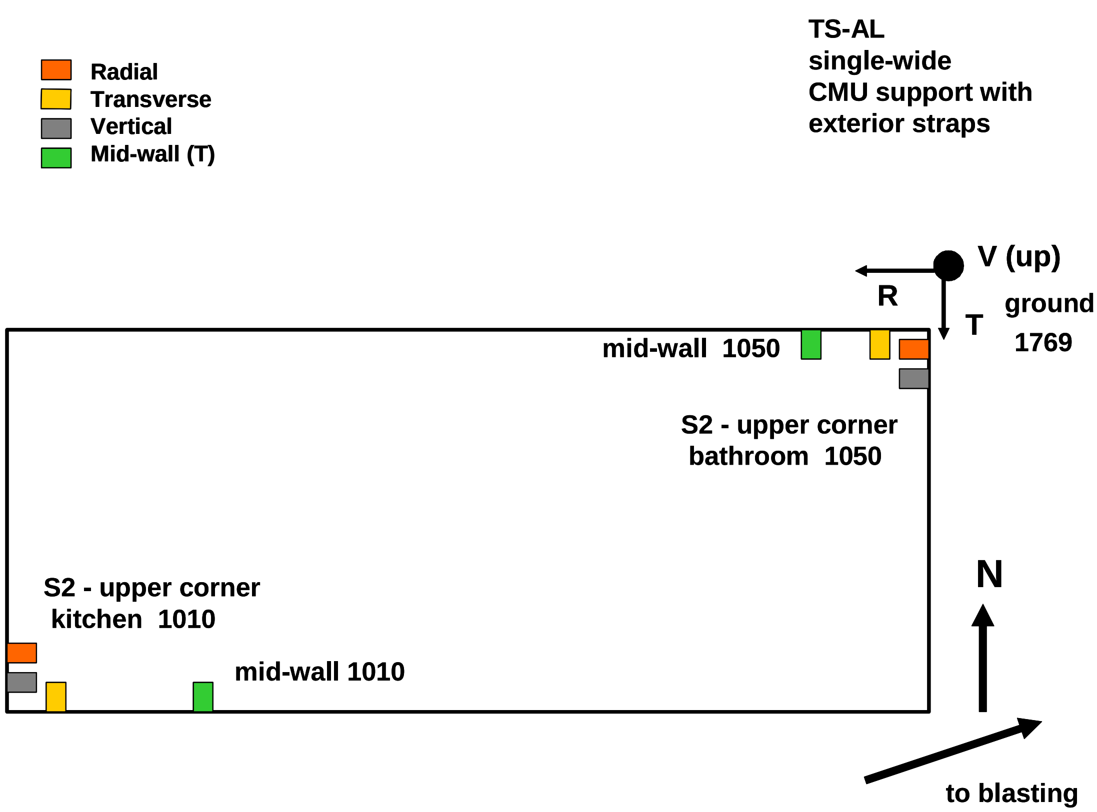

L2S-WV2
2-story log
perimeter wall and
CMU support with mortar
Radial
Transverse
Vertical
1010
1010 (beam)
1050
1050 (post)
Beam
rafter
post
V (up)
R
T
ground
1770
S1 - lower and
S2 - upper
west side
1050
Center post
second floor
east wall 1010
to blasting
N


TD-TN
double-wide
CMU support
with strapping
1010
1050
Verticals
on ceiling and
adjacent wall
Center wall section view looking east
Radial
Transverse
Vertical
Mid-wall (R or T)
(west side)
mid-wall (bathroom)
Center (main joint) wall
1050
mid-wall
1010
Horizontals
wall top and bottom
on centerline wall
(back-to-back) with
identical polarity
(east side)
N
to blasting
V (up)
R
1770
ground
T


L2S-TN
log structure
CMU support
Radial
Transverse
Vertical
Mid-wall (R)
second floor
first floor
Wall at roof
Peak 930
mid-wall
930
lower corner at
roof line 930
mid-wall
1258
S1 - lower corner
1258
N
to blasting
ground
1769
R
V (up)
T

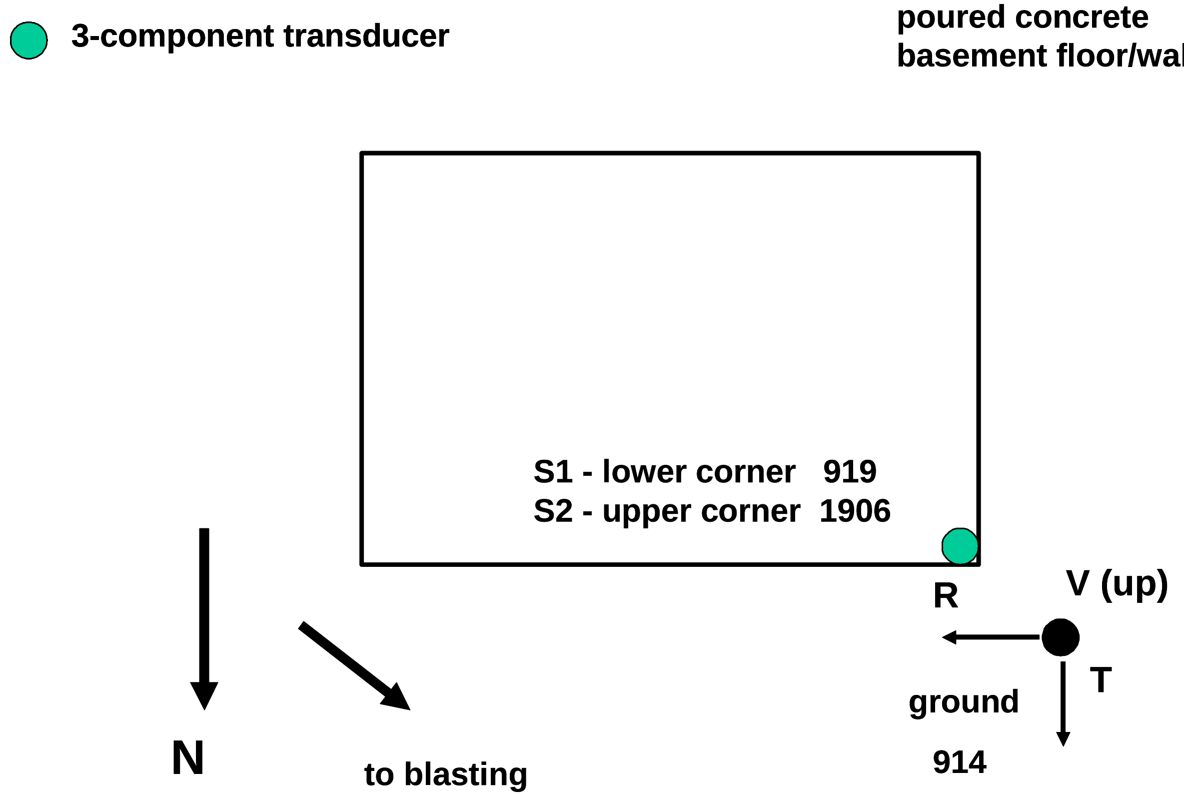


Radial
Transverse
Vertical
Mid-wall (R or T)
C1S-AL
camp house
CMU interior and
exterior; slab add-on
R
V (up)
ground
T
1770
mid-wall 930
S1 - lower corner 930
S2 - upper corner 1258
mid-wall 1258
N
to blasting

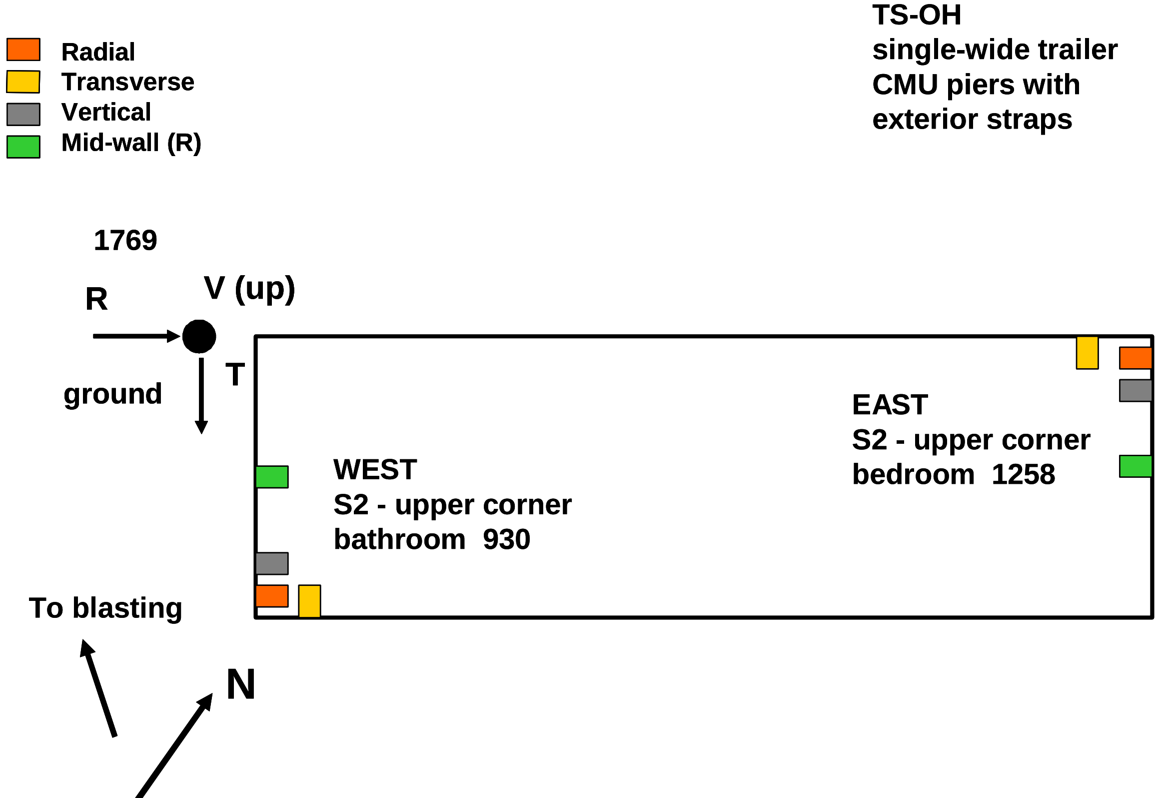


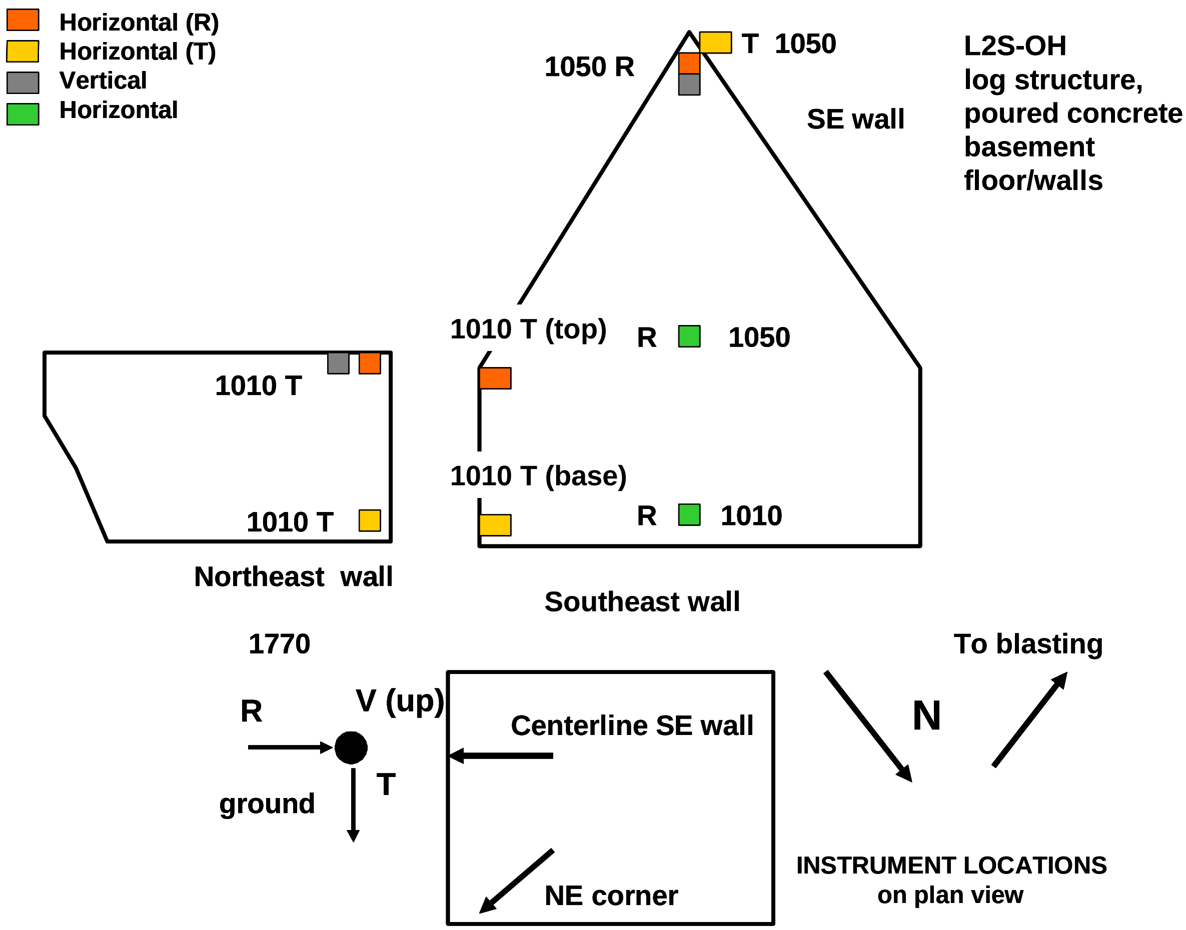
Radial
Transverse
Vertical
Mid-wall (T)
TS-AL
single-wide
CMU support with
exterior straps
V (up)
R
ground
T
1769
mid-wall 1050
S2 - upper corner
bathroom 1050
S2 - upper corner
kitchen 1010
mid-wall 1010
N
to blasting

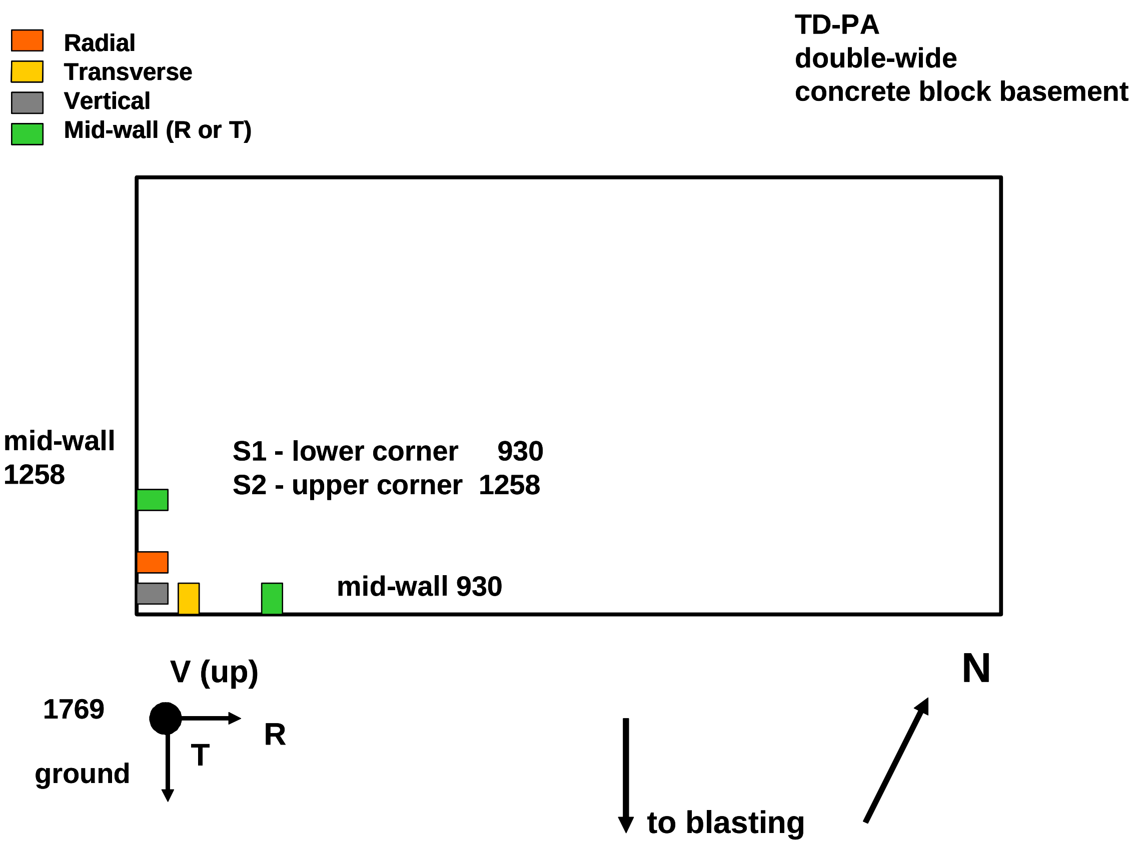
L1S-OH
log structure,
poured concrete
basement floor/walls

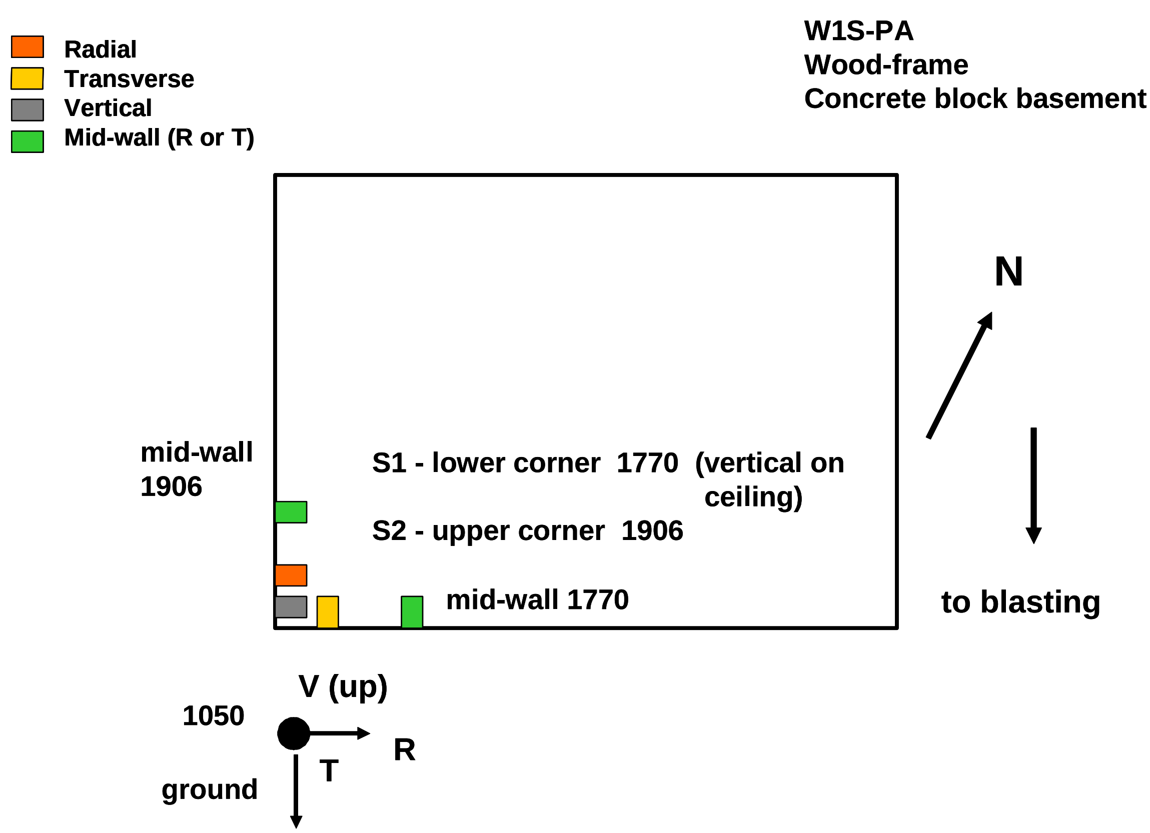


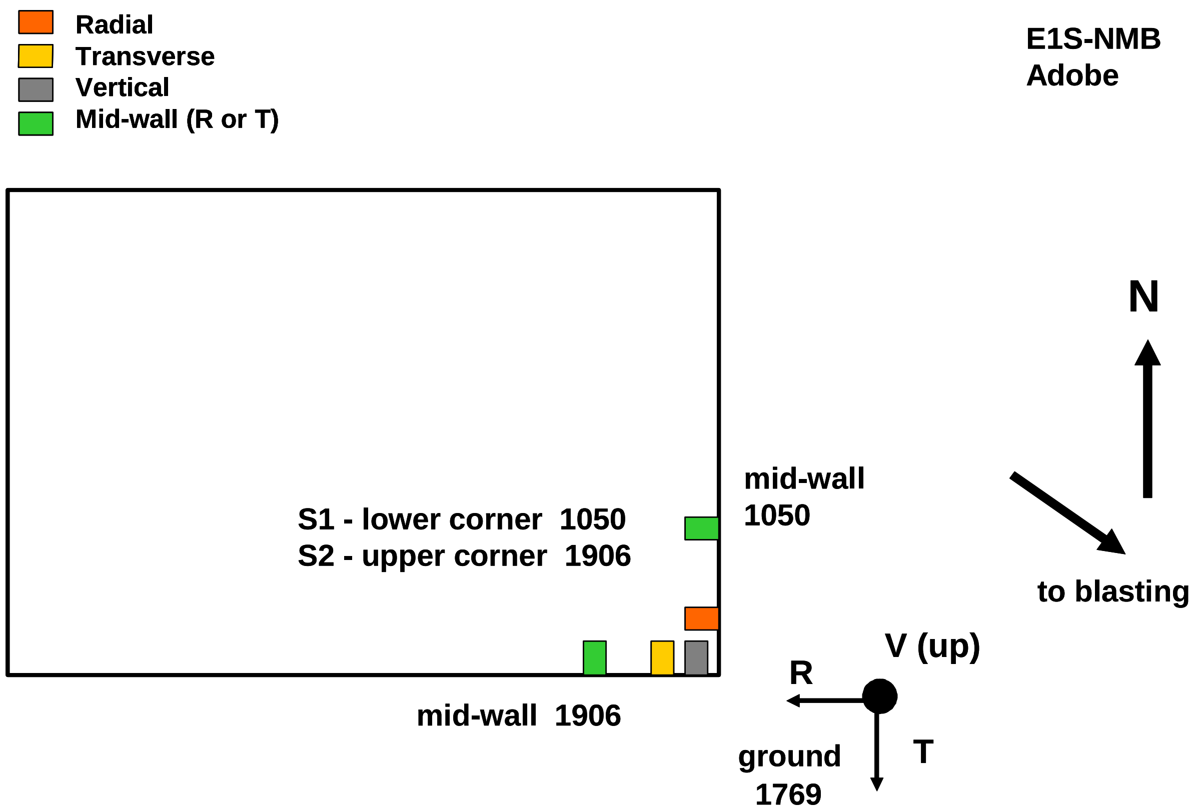
TS-OH
single-wide trailer
CMU piers with
exterior straps



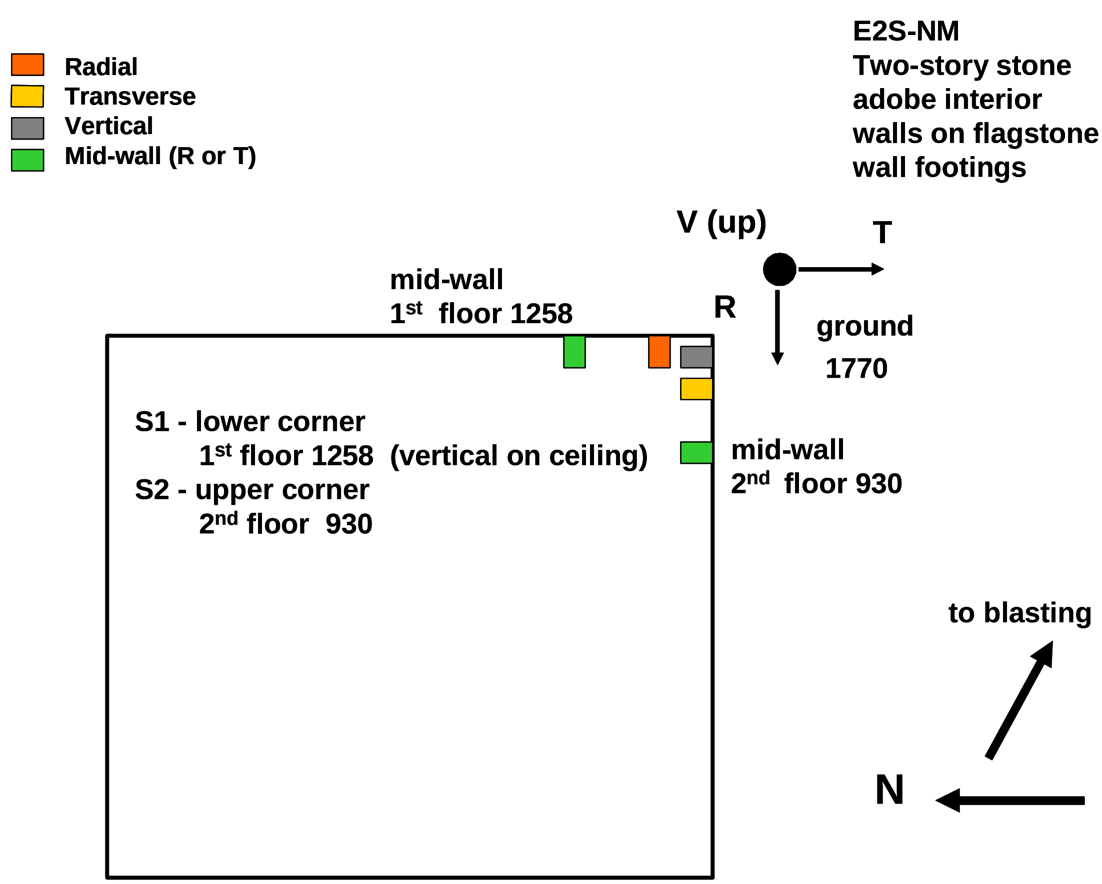

Horizontal (R)
Horizontal (T)
Vertical
Horizontal
1050 R
T 1050
SE wall
L2S-OH
log structure,
poured concrete
basement
floor/walls
1010 T (top)
R
1050
1010 T
1010 T (base)
R
1010
1010 T
Northeast wall
Southeast wall
1770
R
V (up)
ground
T
Centerline SE wall
NE corner
To blasting
N
INSTRUMENT LOCATIONS
on plan view


Radial
Transverse
Vertical
Mid-wall (R or T)
TD-PA
double-wide
concrete block basement
mid-wall
1258
S1 - lower corner 930
S2 - upper corner 1258
mid-wall 930
V (up)
1769
R
T
ground
N
to blasting


Radial
Transverse
Vertical
Mid-wall (R or T)
W1S-PA
Wood-frame
Concrete block basement
N
mid-wall
1906
S1 - lower corner 1770 (vertical on ceiling)
S2 - upper corner 1906
mid-wall 1770
to blasting
V (up)
1050
R
T
ground



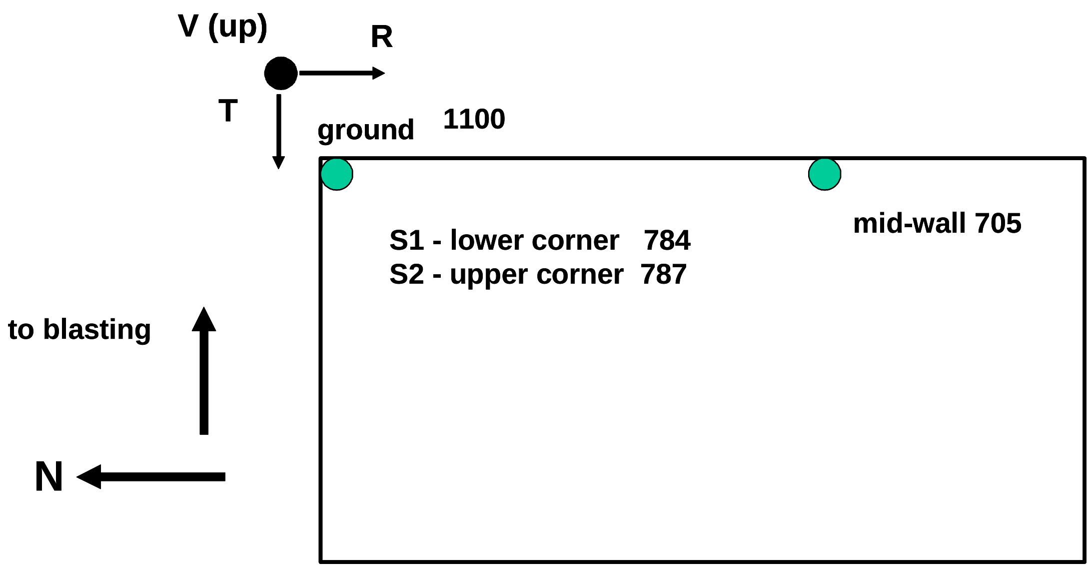
Radial
Transverse
Vertical
Mid-wall (R or T)
E1S-NMB
Adobe
N
mid-wall
1050
S1 - lower corner 1050
S2 - upper corner 1906
to blasting
V (up)
R
T
mid-wall 1906
ground
1769



Radial
Transverse
Vertical
Mid-wall (R or T)
E2S-NM
Two-story stone
adobe interior
walls on flagstone
wall footings
V (up)
T
mid-wall
1st floor 1258
R
ground
1770
S1 - lower corner
1st floor 1258 (vertical on ceiling)
S2 - upper corner
2nd floor 930
mid-wall
2nd floor 930
to blasting
N

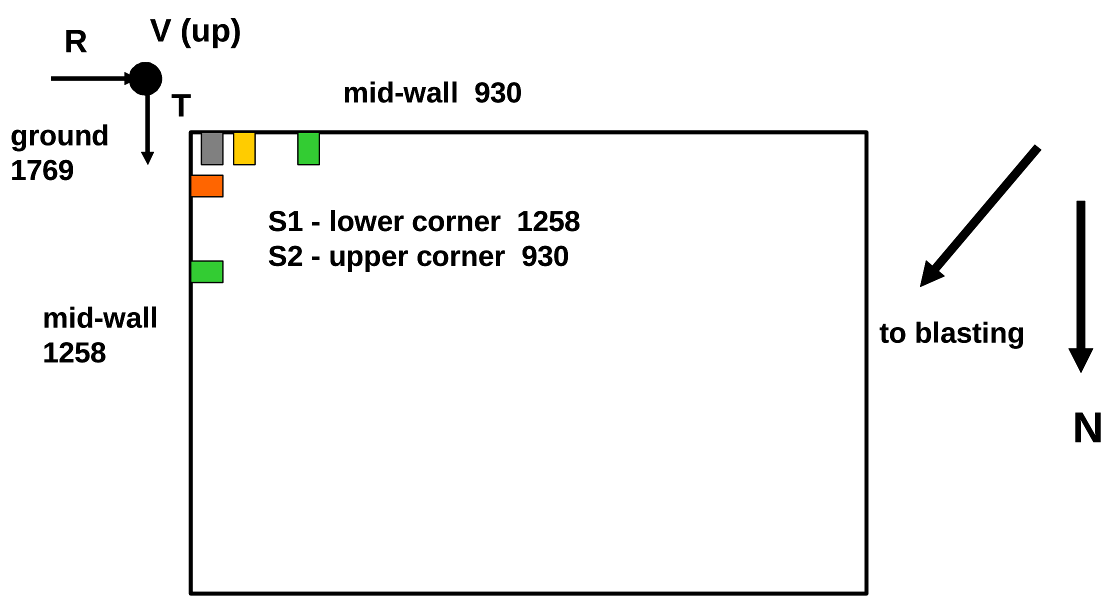
3-component transducer

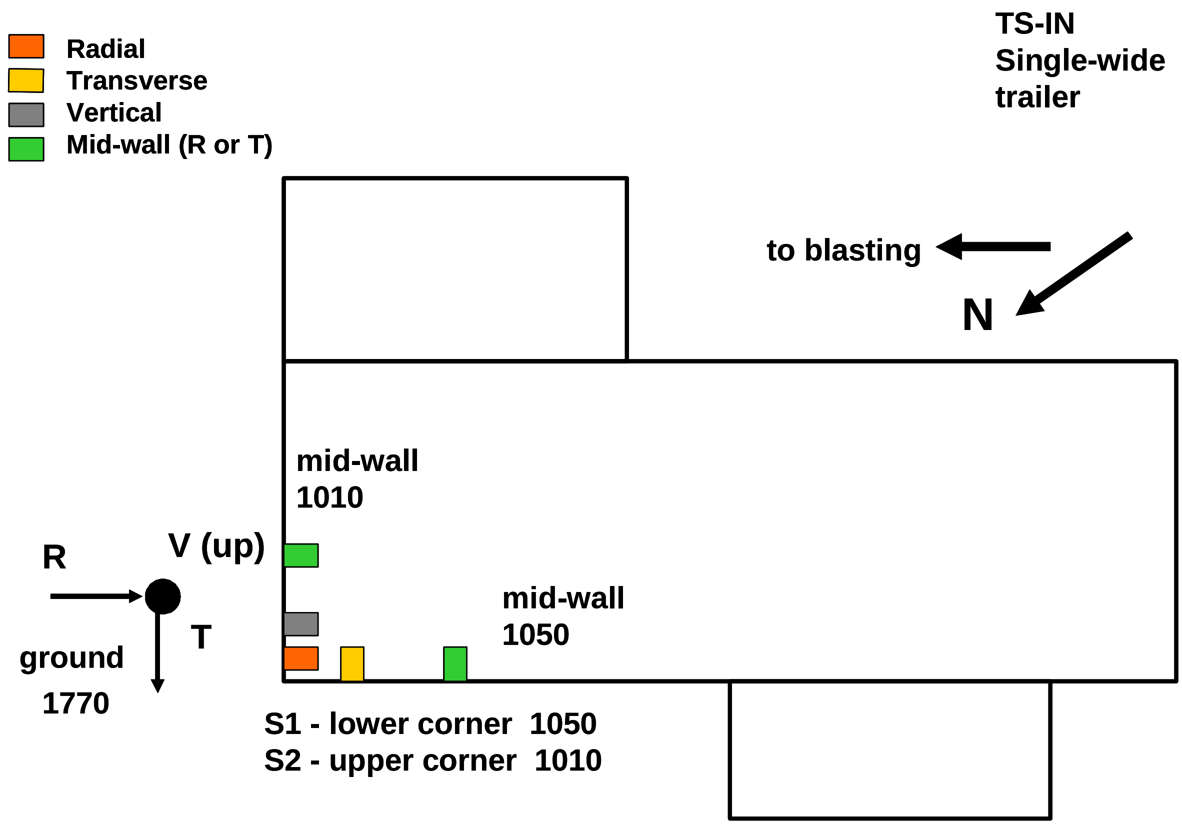
E1S-NMA
Concrete Block
on 6 in. slab

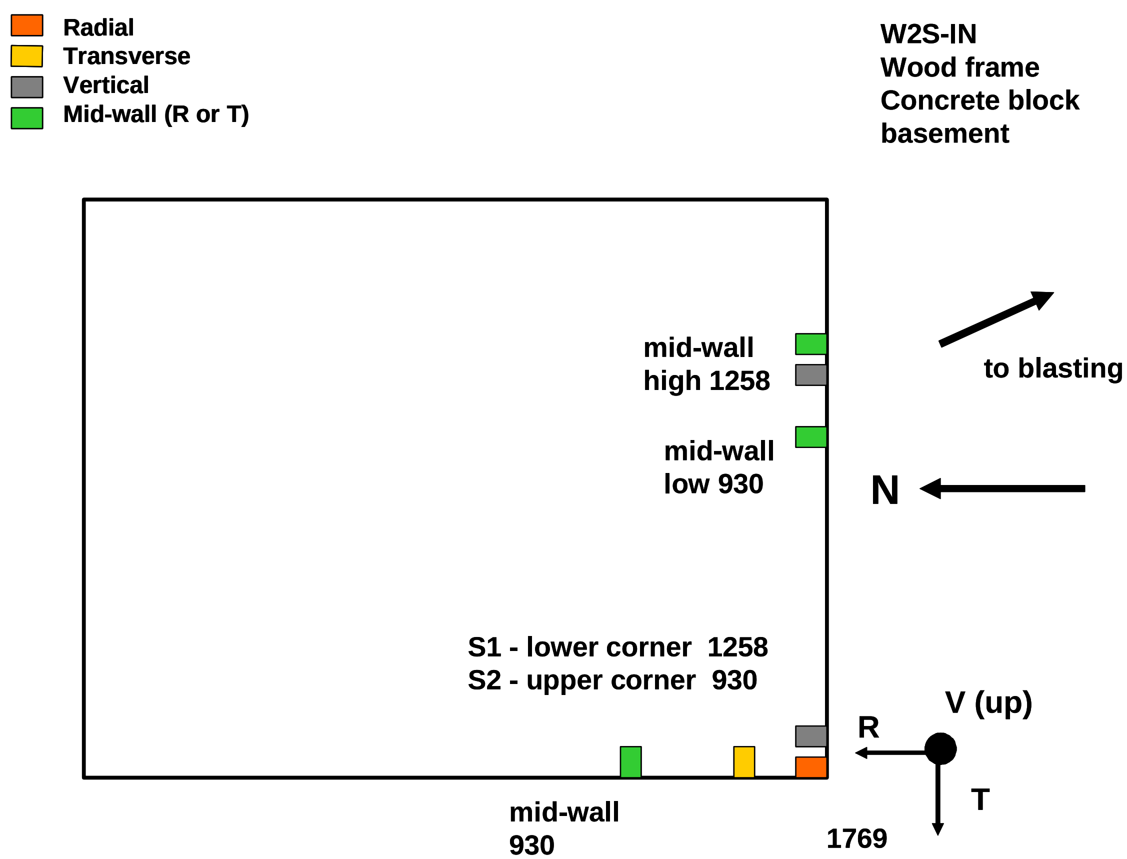


Radial
Transverse
Vertical
Mid-wall (R or T)

W1S-IN
Wood-frame
Concrete block basement




Radial
Transverse
Vertical
Mid-wall (R or T)
TS-IN
Single-wide
trailer
to blasting
N
mid-wall
1010
R
V (up)
T
ground
1770
mid-wall
1050
S1 - lower corner 1050
S2 - upper corner 1010


Radial
Transverse
Vertical
Mid-wall (R or T)
W2S-IN
Wood frame
Concrete block
basement
mid-wall
high 1258
to blasting
mid-wall
low 930
N
S1 - lower corner 1258
S2 - upper corner 930
V (up)
R
T
mid-wall
930
1769

APPENDIX III

Blast Data, Ground Vibrations, Airblast, and Structure Vibration Response Summaries by Site

Alabama																			
Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	($ft/lb^{1/2}$)	($ft/lb^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	12/19/00	1769	NE corner	ground	1430	550	61.0	174.9	0.12	0.105	26.9	15.5	0.115	32	42.6	0.12	14.6	14.8	122
	14:32	1010	SW top	kitchen top corner						0.305	17.6	13.4	0.18	18.2	13.9	0.115	15.5	15.1	
		1010	S wall	mid-wall												0.445	18.9	15.8	
		1050	NE top	bathroom top corner						0.16	10	5.6	0.2	14.6	15.2	0.12	12.1	7.8	
		1050	N wall	mid-wall												1.68	20.4	21.3	
	12/20/00	1769	NE corner	ground	1445	280	86.4	221.3	0.055	0.055	30.1	10.8	0.045	34.1	11.63	0.05	19.6	14.3	117
	15:29	1010	SW top	kitchen top corner						0.245	11.9	11.9	0.16	12.8	11.56	0.085	10.8	10.8	
		1010	S wall	mid-wall												0.250	12.1	11.9	
		1050	NE top	bathroom top corner						105	8.1	5.6	0.1	18.9	11.31	0.075	10	10.9	
		1050	N wall	mid-wall												0.45	18.9	5.6	
TS-AL	12/22/00	1769	NE corner	ground	1480	380	75.9	204.7	0.055	0.055	11.9	9.9	0.055	13.8	15.44	0.035	15.5	16.8	121
	11:00	1010	SW top	kitchen top corner						0.25	11.3	12.0	0.14	14.6	12	0.1	12.8	8.9	
		1010	S wall	mid-wall												0.315	14.6	11.9	
		1050	NE top	bathroom top corner						0.075	8.2	5.9	0.1	16.5	15.4	0.075	11.6	8.9	
		1050	N wall	mid-wall												0.78	18.2	18.6	
	12/22/00	1769	NE corner	ground	1520	320	85.0	222.7	0.05	0.05	11.9	8.7	0.045	11.3	8.31	0.05	11.1	8.3	112
	14:50	1010	SW top	kitchen top corner						0.115	9.1	8.4	0.08	16.5	8.56	0.145	8.3	8.5	
		1010	S wall	mid-wall												0.195	10.2	16.4	
		1050	NE top	bathroom top corner						0.075	8.3	5.6	0.12	11.9	8.63	0.16	8.2	8.4	
		1050	N wall	mid-wall												0.44	20.4	23.9	
	12/19/00	1770	NE corner	ground	852	550	36.3	104.2	0.385	0.32	14.6	14.4	0.315	30.1	20.44	0.385	25.6	15.2	126
	14:32	930	NE corner base	S1						0.36	15.5	14.4	0.28	34.1	20.8	0.485	46.5	8.9	
		930	N wall	midwall						0.8	20.4	17.4							
		1258	NE corner top	S2						0.265	12.4	8.3	0.28	32	20.8	0.305	11.6	9.1	
		1258	E wall	midwall												0.98	21.3	14.9	
	12/20/00	1770	NE corner	ground	860	280	51.4	131.7	0.23	0.19	22.2	17.8	0.175	39.3	42.38	0.23	34.1	17.8	120
	15:29	930	NE corner base	S1						0.17	39.3	14.8	0.14	16.5	11.1	0.17	36.5	17.9	
		930	N wall	midwall						0.43	12.4	10.9							
		1258	NE corner top	S2						0.205	12.1	10.9	0.14	21.3	10.94	0.215	16	10.7	
		1258	E wall	midwall												0.455	13.4	14.4	
C1S-AL	12/22/00	1770	NE corner	ground	890	380	45.7	123.1	0.165	0.14	30.1	14.8	0.16	18.9	15.4	0.165	13.4	16.7	124
	11:00	930	NE corner base	S1						0.145	36.5	14.9	0.16	32	15.6	0.19	26.9	9.9	
		930	N wall	midwall						0.49	25.6	16.8							
		1258	NE corner top	S2						0.145	16.5	8.8	0.16	13.4	15.9	0.225	11.3	10.0	
		1258	E wall	midwall												0.435	23.2	15.5	
	12/22/00	1770	NE corner	ground	920	320	51.4	134.8	0.135	0.105	11.6	13.8	0.1	14.6	8.44	0.135	10.2	14.1	116
	14:50	930	NE corner base	S1						0.115	10.6	13.6	0.120	16.5	8.5	0.145	10	8.3	
		930	N wall	midwall						0.31	11.3	8.9							
		1258	NE corner top	S2						0.175	8.5	9.0	0.12	12.4	8.63	0.27	9.8	9.3	
		1258	E wall	midwall												0.325	10.6	14.4	

Indiana																			
Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	($ft/lb^{1/2}$)	($ft/lb^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	08/18/01	1770	E side	ground	1968	781	70.4	214.2	0.2475	0.2475	7.5	3.4	0.2025	18.2	3.5	0.2025	6.7	3.6	120
	12:55	1050	N corner	S1(V-celing)						0.295	4	3.9	0.79	16	16	0.23	6.2	3.6	
		1050	NW wall	mid-wall												0.45	3.9	3.9	
		1010	N corner	S2						0.31	4	3.9	0.36	25.6	17	0.275	7.1	3.6	
		1010	NE wall	mid-wall						0.555	17	3.6							
	08/18/01	1770	E side	ground	1355	451	63.8	177.1	0.275	0.1575	18.2	3.9	0.14	25.6	10.8	0.275	16	3.7	123
	17:33	1050	N corner	S1(V-celing)						0.165	11.6	6.7	1.12	15	15.6	0.155	10.2	3.7	
		1050	NW wall	mid-wall												0.475	8.5	6.7	
		1010	N corner	S2						0.23	8	6.7	0.42	19.6	17.8	0.205	11.1	13	
		1010	NE wall	mid-wall						1.02	25.6	21.6							
	08/19/01	1770	E side	ground	1837	584	76.0	220.2	0.1575	0.15	9.1	3.1	0.083	15	9	0.1575	12	3.5	118
	13:27	1050	N corner	S1(V-celing)						0.14	6.5	3.1	0.74	12.8	9.7	0.1	4.3	10.7	
		1050	NW wall	mid-wall												0.465	25.6	26.4	
		1010	N corner	S2						0.18	8.2	3.1	0.2	18.2	17.8	0.18	11.1	10.8	
		1010	NE wall	mid-wall						0.74	21.3	21.2							
	08/19/01	1770	E side	ground	3379	451	159.1	441.5	0.0525	0.05	12.8	13.2	0.05	21.3	21.3	0.0525	12.8	4.6	114
	16:23	1050	N corner	S1(V-celing)						0.06	15	8.8	0.69	16	13.44	0.075	11.1	4.6	
		1050	NW wall	mid-wall												0.175	28.4	8.8	
		1010	N corner	S2						0.07	10.6	8.8	0.1	16	13.8	0.11	11.6	13.6	
		1010	NE wall	mid-wall						0.375	21.3	19.3							
	08/19/01	1770	E side	ground	9025	1712	218.1	756.3	0.0375	0.0375	7.3	2.5	0.025	18.2	8.5	0.0325	4.1	4.1	110
	17:27	1050	N corner	S1(V-celing)						0.04	7.5	4.3	0.16	16	14	0.035	4.5	4.3	
		1050	NW wall	mid-wall												0.05	7.7	4.2	
		1010	N corner	S2						0.045	3.2	4.2	0.04	17	17.6	0.04	4.2	4.3	
		1010	NE wall	mid-wall						0.065	19.6	20.6							
	08/20/01	1770	E side	ground	unknown	unknown			0.0225	0.0225	4.8	3.1	0.01	41	3.2	0.02	4.1	2.9	<100
	9:30	1050	N corner	S1(V-celing)						0.03	4.8	3.1	0.02		16.4	0.02	3.9	2.9	
	distant mine	1050	NW wall	mid-wall												0.035	4.9	3.1	
		1010	N corner	S2						0.03	4.7	3.1	0.02		3.1	0.025	3.5	2.9	
		1010	NE wall	mid-wall						0.03	5.5	2.9							
	08/20/01	1770	E side	ground	3480	451	163.9	454.7	0.0725	0.0725	13.4	13.8	0.0725	18.2	18.9	0.0575	13.4	18.9	117
	12:30	1050	N corner	S1(V-celing)						0.095	15	10.6	0.52	13.4	15.4	0.065	11.1	10.4	
		1050	NW wall	mid-wall												0.24	25.6	10.5	
		1010	N corner	S2						0.115	11.6	10.5	0.09	21.3	19	0.085	11.6	12.7	
		1010	NE wall	mid-wall						0.345	23.2	20.9							
	08/20/01	1770	E side	ground	unknown	unknown			0.025	0.025	5.4	4.9	0.005		4.9	0.015	5.6	4.9	<100
	12:44	1050	N corner	S1						0.035	5.6	4.8	0.01		15.5	0.01		4.9	
	distant mine	1050	NW wall	mid-wall												0.045	5.4	4.9	
		1010	N corner	S2						0.04	5.4	4.9	0.01		4.9	0.01		5.1	
		1010	NE wall	mid-wall												0.015	9.8	4.9	
	08/20/01	1770	E side	ground	844	150	68.9	159.1	0.265	0.1975	12.1	10.5	0.245	36.5	32.9	0.265	17	17.6	119
	16:05	1050	N corner	S1						0.165	10.2	4.7	0.71	16	15.1	0.185	10.6	10.6	
		1050	NW wall	mid-wall												0.5	36.5	4.7	
		1010	N corner	S2						0.26	12.1	4.7	0.35	18.2	10.6	0.255	11.1	10.6	
		1010	NE wall	mid-wall						0.84	23.2	19.2							
	08/21/01	1770	E side	ground	991	240	64.0	159.8	0.215	0.1375	19.6	11.1	0.1325	21.3	8.81	0.215	13.4	11.9	124
	9:52	1050	N corner	S1						0.175	11.6	11.6	1.23	15	11.9	0.15	10.6	12.3	
		1050	NW wall	mid-wall												0.575	28.4	26	
		1010	N corner	S2						0.21	16	11.7	0.33	21.3	20.44	0.2	14.2	12.3	
		1010	NE wall	mid-wall						1.16	25.6	26.4							
TS-IN	08/21/01	1770	E side	ground	2146	1051	66.2	211.6	0.2175	0.2175	11.6	3.1	0.125	13.4	12.4	0.2125	12.8	3.5	121
	17:37	1050	N corner	S1						0.215	4.7	3.3	0.94	15	15.6	0.215	11.1	3.7	
		1050	NW wall	mid-wall												0.45	28.4	3.31	
		1010	N corner	S2						0.24	5.9	3.3	0.33	15	13.38	0.306	13.4	13	
		1010	NE wall	mid-wall						0.8	18.2	12.9							
	08/22/01	1770	E side	ground	unknown	unknown			0.025	0.025	5.7	4.5	0.0075	5.3	4.7	0.0225	4.8	4.63	<100
	15:00	1050	N corner	S1(V-celing)						0.03	5.1	4.4	0.02			0.015	5.3	4.6	
	distant mine	1050	NW wall	mid-wall												0.035	5.6	4.5	
		1010	N corner	S2						0.035	5.5	4.5	0.01			0.01	4.7	4.6	
		1010	NE wall	mid-wall						0.035	5.5	4.6							
	08/22/01	1770	E side	ground	2660	1051	82.1	262.2	0.1125	0.1125	7.6	3.1	0.08	14.2	16.3	0.095	13.4	2.9	116
	17:30	1050	N corner	S1(V-celing)						0.095	9.8	3.1	0.54	15	16	0.1	6.9	2.9	
		1050	NW wall	mid-wall						0.17	11.6	10.4							
		1010	N corner	S2						0.155	12.1	10.4	0.15	13.4	16.3	0.12	12.1	10.4	
		1010	NE wall	mid-wall						0.505	18.2	21.2							
	08/23/01	1770	E side	ground	unknown	unknown			0.0325	0.0325	4	4.8	0.01	4.6	4.69	0.0275	4.5	4.9	100
	12:58	1050	N corner	S1(V-celing)						0.045	4.5	4.8	0.04	28.4	18.3	0.025	4.6	4.9	
	distant mine	1050	NW wall	mid-wall												0.07	5.1	4.8	
		1010	N corner	S2						0.05	4.9	4.8	0.02		4.8	0.025	5.6	4.9	
		1010	NE wall	mid-wall						0.045	18.2	4.9							
	08/23/01	1770	E side	ground	1202	301	69.3	179.7	0.2675	0.165	11.6	10.1	0.1775	12.8	40.3	0.2675	15	12	121
	13:00	1050	N corner	S1(V-celing)						0.15	16	12.3	1.01	13.4	16.2	0.135	10.6	10.3	
		1050	NW wall	mid-wall												0.525	32	43	
		1010	N corner	S2						0.195	12.1	12.3	0.33	15	20	0.225	10.6	10.3	
		1010	NE wall	mid-wall						0.78	25.6	20.0							
	08/23/01	1770	E side	ground	920	447	43.5	120.6	0.38	0.37	12.1	12.0	0.2775	21.3	7.8	0.38	16	12.1	124
	17:40	1050	N corner	S1(V-celing)						0.34	13.4	5.9	1.28	12.8	16.3	0.33	10.6	12	
		1050	NW wall	mid-wall												0.64	18	5.9	
		1010	N corner	S2						0.405	8.8	5.9	0.61	17	12.2	0.52	11.1	12.2	
		1010	NE wall	mid-wall						1.24	18.2	19.4							
	08/24/01	1770	E side	ground	1595	330.5	87.7	231.1	0.1275	0.095	12.8	3.5	0.1275	51.2	40.31	0.12	17	14.9	122
	12:12	1050	N corner	S1(V-celing)						0.11	13.4	3.5	0.95	15	10.9	0.11	14.2	10.4	
		1050	NW wall	mid-wall						0.435	32	21.7							
		1010	N corner	S2						0.18	10.6	10.6	0.3	17	14.2	0.17	15	10.4	
		1010	NE wall	mid-wall												0.88	23.2	32.4	
	08/24/01	1770	E side	ground	816	125.5	72.8	163.2	0.225	0.2075	12.8	10.6	0.1625	36.5	10.4	0.225	17	10.6	114
	15:48	1050	N corner	S1(V-celing)						0.105	13.4	10.8	0.64	15	15.2	0.145	11.6	9.8	
		1050	NW wall	mid-wall						0.32	21.3	39.5							
		1010	N corner	S2						0.135	12.8	11.0	0.26	15	22.3	0.2	13.4	9.81	
		1010	NE wall	mid-wall												0.62	25.6	27.1	
	08/24/01	1770	E side	ground	unknown	unknown			0.0425	0.0425	4.2	4.8	0.04	5.2	4.9	0.0375	4.9	4.9	nd
	16:50	1050	N corner	S1(V-celing)						0.06	4.6	4.8	0.02			0.035	5.2	4.9	
	distant mine	1050	NW wall	mid-wall						0.07	4.6	4.8							
		1010	N corner	S2						0.065	4.8	4.8	0.02			0.04	5	5	
		1010	NE wall	mid-wall												0.05	5.5	4.9	
	08/24/01	1770	E side	ground	816	128.5	72.0	162.0	0.215	0.215	14.2	12.2	0.1525	16	11.4	0.215	14.2	11.3	114
	17:58	1050	N corner	S1(V-celing)						0.14	9.8	11.3	0.49	13.4	13.2	0.145	12.1	11.8	
		1050	NW wall	mid-wall						0.26	16	11.3							
		1010	N corner	S2						0.16	8.5	11.4	0.18		9.3	0.21	12.1	12	
		1010	NE wall	mid-wall												0.5	18.2	12	

Indiana (cont.)																			
	08/18/01	1769	SE corner	ground	1439	451	67.8	188.0	0.2325	0.2325	28.4	3.7	0.16	36.5	6.63	0.18	28.4	3.8	117
	17:33	1258	SE corner	S2 lower corner						0.26	28.4	3.7	0.18	32	34.9	0.13	6.2	6.4	
		1258	E wall	mid-wall												0.51	13.4	6.4	
		930	SE corner	S2						0.23	6.4	**6.6**	0.18	36.5	34.8	0.205	6.7	6.44	
		930	S wall	mid-wall						0.47	18.2	16.8							
	08/19/01	1769	SE corner	ground	1906	584	78.9	228.5	0.1825	0.1825	16	10.4	0.09	32	10.2	0.1325	6.9	**3.1**	112
	13:27	1258	SE corner	S2 lower corner						0.205	25.6	10.4	0.12	32	10.2	0.135	12.1	3.31	
		1258	E wall	mid-wall												0.44	8	9.3	
		930	SE corner	S2						0.145	6.4	3.6	0.13	32	10.2	0.285	8.8	9.9	
		930	S wall	mid-wall						0.29	14.2	10.9							
	08/19/01	1769	SE corner	ground	3438	451	161.9	449.2	0.0575	0.055	25.6	4.3	0.0325	25.6	13.9	0.0575	14.2	8	
	16:43	1258	SE corner	S2 lower corner						0.06	19.6	7.2	0.04	15	7.4	0.04	7.3	7.1	
		1258	E wall	mid-wall												0.135	15	7.2	
		930	SE corner	S2						0.075	8.8	7.2	0.04	18.2	7.4	0.08	8.8	7.2	
		930	S wall	mid-wall						0.21	18.2	7.2							
	08/19/01	1769	SE corner	ground	9219	1712	222.8	772.6	0.0375	0.0375	3.3	2.5	0.015	8.5	2.31	0.02	15	4.1	110
	17:27	1258	SE corner	S2 lower corner						0.055	3.6	2.5	0.03	9.8	8.4	0.025	7.5	4.1	
		1258	E wall	mid-wall												0.075	10.6	8.4	
		930	SE corner	S2						0.075	4.7	4.1	0.02		8.4	0.055	9.4	8.4	
		930	S wall	mid-wall						0.12	12.8	15.9							
	08/20/01	1769	SE corner	ground	unknown	unknown			0.0225	0.0225	4.4	3.1	0.01	5.2	5.7	0.0075	5.2	2.9	<100
	9:30	1258	SE corner	S2 lower corner						0.03	4	3.1	0.01		3	0.025	3.8	2.9	
	distant mine	1258	E wall	mid-wall												0.03	3.6	2.9	
		930	SE corner	S2						0.03	4.6	3.1	0.01		3.1	0.025	4.9	2.9	
		930	S wall	mid-wall						0.035	4.5	3.1							
W1S-IN	08/20/01	1770	SE corner	ground	3540	451	166.7	462.6	0.0675	0.0675	25.6	19.0	0.035	15	13.8	0.05	13.4	23.5	116
	12:33	1258	SE corner	S1(V-celing)						0.08	12.8	3.5	0.06	9.1	10.4	0.035	3.4	2.8	
		1258	E wall	mid-wall												0.19	12.1	10.8	
		930	SE corner	S2						0.08	9.4	6.9	0.05	21.3	10.4	0.06	9.8	10.4	
		930	S wall	mid-wall						0.22	17	10.4							
	08/20/01	1770	SE corner	ground	unknown	unknown			0.025	0.025	5	4.9	0.01	6	5.2	0.0075	5.3	4.8	100
	12:41	1258	SE corner	S1(V-celing)						0.04	5	5.0	0.01		4.8	0.02	4.6	4.9	
	distant mine	1258	E wall	mid-wall												0.025	6	4.9	
		930	SE corner	S2						0.05	5.4	4.9	0.01		5	0.025	5.8	4.9	
		930	S wall	mid-wall						0.05	12.8	4.9							
	08/20/01	1770	SE corner	ground	1035	150	84.5	195.1	0.21	0.2025	25.6	11.4	0.12	16	7.8	0.21	19.6	10.7	118
	16:02	1258	SE corner	S1(V-celing)						0.225	14.2	11.4	0.13	14.2	22.3	0.125	9.4	4.6	
		1258	E wall	mid-wall												0.485	14.2	10.8	
		930	SE corner	S2						0.165	7.1	5.0	0.13	25.6	22.3	0.2	9.8	10.7	
		930	S wall	mid-wall						0.465	16	22.4							
	08/21/01	1770	SE corner	ground	1122	240	72.4	180.9	0.19	0.19	13.4	10.9	0.125	42.6	10.1	0.175	21.3	11.3	121
	9:48	1258	SE corner	S1(V-celing)						0.255	19.6	10.9	0.12	17	10.7	0.1	8.5	7.2	
		1258	E wall	mid-wall												0.82	12.8	11.1	
		930	SE corner	S2						0.15	7.5	3.2	0.12	23.3	10.7	0.155	8.8	7.2	
		930	S wall	mid-wall						0.545	15	15.4							
	08/21/01	1770	SE corner	ground	2209	1051	68.1	217.8	0.1625	0.1625	23.2	3.4	0.105	6.2	9.8	0.1425	12.1	3.8	117
	17:33	1258	SE corner	S1(V-celing)						0.285	25.6	3.4	0.13	25.6	12.4	0.115	2.8	3.8	
		1258	E wall	mid-wall												0.365	12.8	10.8	
		930	SE corner	S2						0.305	6.7	3.4	0.14	25.6	12.4	0.2	8	3.8	
		930	S wall	mid-wall						0.68	14.2	15.8							
	08/22/01	1769	SW corner	ground	2081	1051	64.2	205.2	0.3	0.28	17	13.5	0.225	32	30.1	0.3	15	13.56	126
	17:30	1258	SW corner	S1(V-crack)						0.18	8.8	5.6	0.23	36.5	21.5	0.14	11.6	13.4	
		1258	S wall	at crack												0.23	16	13.6	
		930	SW corner	S2						0.25	9.8	5.6	0.2	32	13.4	0.24	12.1	13.4	
		930	W wall	mid-wall						0.84	17	13.3							
	08/23/01	1769	SW corner	ground	3730	301	215.0	557.6	0.07	0.0575	14.2	12.4	0.0425	32	28	0.07	21.3	15.4	110
	13:00	1258	SW corner	S1(V-crack)						0.045	12.1	12.4	0.06	36.5	43	0.04	16	13	
		1258	S wall	at crack												0.06	16	14.8	
		930	SW corner	S2-second floor						0.065	13.4	7.3	0.03	28.4	12.4	0.05	11.1	7.9	
W2S-IN		930	S wall	base wall kit												0.045	25.6	14.8	
	08/23/01	1769	SW corner	ground	4163	447	196.9	545.6	0.0725	0.06	15	15.0	0.045	28.4	25.8	0.0725	15	15.3	106
	17:30	1258	SW corner	S1(V-crack)						0.045	11.1	15.0	0.06	25.6	14	0.045	14.2	14	
		1258	S wall	at crack												0.045	28.4	25.8	
		930	SW corner	S2-second floor						0.065	12.1	7.3	0.05	28.4	25.8	0.05	16	7.6	
		930	S wall	base wall kit												0.055	12.8	15.3	
	08/24/01	1769	SW corner	ground	3358	300.5	193.7	502.3	0.0625	0.045	23.2	5.1	0.045	36.5	29.2	0.0625	18.2	12.9	114
	12:10	1258	SW corner	S1(V-crack)						0.055	10.6	5.1	0.06	36.5	31.3	0.045	12.1	12.8	
		1258	S wall	at crack												0.06	23.2	7.6	
		930	SW corner	S2-second floor						0.055	19.6	5.1	0.05	36.5	29.1	0.05	10.2	7.6	
		930	S wall	base wall kit												0.065	18.2	12.8	

Kentucky Site 1																			
Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	($ft/lb^{1/2}$)	($ft/lb^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	11/13/2000	1770	NE corner	ground	4800	684	183.5	546.0	0.030	0.020	23.2	21.3	0.015	28.4	21.4	0.030	22.2	18.9	106
	16:04	1010	NE corner	S1						0.015	17.6	3.8	0.040		19.2	0.020	17.6	29.3	
		1010	E wall	mid-wall						0.035	16.5	19.6							
		1050	NE corner	S2						0.015	6.4	3.8	0.020		21.6	0.015	20.4	6.5	
		1050	N wall	mid-wall												0.045	21.3	19.0	
	11/14/2000	1770	NE corner	ground															
	11/15/2000	1770	NE corner	ground	2020	828	70.2	215.6	0.025	0.020	19.6	3.0	0.020	20.40	2.5	0.025	18.20	12.9	112
	11:48	1010	NE corner	S1						0.025	13.4	3.0	0.040		29.2	0.025	12.80	4.3	
		1010	E wall	mid-wall						0.075	10.2	10.9							
		1050	NE corner	S2						0.030	8.5	3.9	0.040		9.8	0.045	5.50	4.4	
		1050	N wall	mid-wall												0.055	8.3	4.4	
	11/16/2000	1770	NE corner	ground			NOT	TRIGGERED											
	9:07																		
C2S-KY1A	11/16/2000	1770	NE corner	ground	2240	414	110.1	301.2	0.025	0.015	24.3	14.8	0.015	25.6	2.9	0.025	22.2	2.4	110
	16:00	1010	NE corner	S1						0.025	15.0	3.6	0.040		3.6	0.015	18.2	4.4	
		1010	E wall	mid-wall						0.060	14.6	3.7							
		1050	NE corner	S2						0.025	4.5	3.7	0.020		14.8	0.025	4.9	4.5	
		1050	N wall	mid-wall												0.040	6.6	4.5	
	11/17/2000	1770	NE corner	ground			NOT	TRIGGERED											
	signature																		
	holes																		
	12:15																		
	11/17/2000	1770	NE corner	ground	2020	1044	62.5	132.0	0.045	0.045	23.2	1.8	0.045	22.2	2.9	0.040	19.6	2.0	121
	12:34	1010	NE corner	S1			NOT	TRIGGERED											
		1010	E wall	mid-wall			NOT	TRIGGERED											
		1050	NE corner	S2			NOT	TRIGGERED											
		1050	N wall	mid-wall			NOT	TRIGGERED											
	11/13/2000	1769	SE corner	ground			NOT	TRIGGERED											
	11/14/2000	804	SE corner	ground	5000	936	163.4	512.3	0.025	0.025	13.4	6.8	0.015			0.020	8.3	6.5	106
	16:20	1258	SE corner	S1						0.025	13.1	9.6	0.020			0.020	17	6.4	
		1258	E wall	mid-wall												0.070	13.8	9.4	
		930	SE corner	S2						0.060	9.1	6.0	0.020			0.075	7.3	6.8	
		930	E wall	mid-wall												0.070	8.1	6.8	
	11/15/2000	1769	SE corner	ground	2020	828	70.2	215.6	0.055	0.025	7.0	6.4	0.025	11.9	2.5	0.055	20.4	6.3	112
	11:50	1258	SE corner	S1						0.030	14.6	7.8	0.040			0.050	6	6.3	
		1258	E wall	mid-wall												0.170	8.8	6.3	
		930	SE corner	S2						0.090	7.0	6.3	0.040		13.3	0.140	7.1	6.3	
		930	E wall	mid-wall												0.125	7.5	6.3	
	11/16/2000	1769	SE corner	ground	5140	1026	160.5	510.8	0.020	0.010		10.5	0.005			0.020	15	6.5	106
	9:07	1258	SE corner	S1						0.015	11.6	9.6	0.020		13.0	0.015	13.8	6.5	
		1258	E wall	mid-wall												0.060	13.4	11.0	
		930	SE corner	S2						0.050	8.3	6.1	0.020		13.1	0.050	8	6.8	
C2S-KY1B		930	E wall	mid-wall												0.050	7.3	6.8	
	11/16/2000	1769	SE corner	ground	2240	414	110.1	301.2	0.025	0.020	11.9	7.4	0.015	13.1	10.1	0.025	11.9	7.1	110
	16:00	1258	SE corner	S1						0.020	5.0	7.4	0.020			0.025	7.5	7.0	
		1258	E wall	mid-wall												0.080	10.4	10.9	
		930	SE corner	S2						0.045	8.5	7.2	0.020		14.3	0.060	8	7.5	
		930	E wall	mid-wall												0.050	12.4	7.5	
	11/17/2000	1769	SE corner	ground	1830	936	59.8	187.5	0.020	0.015	11.3	9.8	0.015	16.5	11.0	0.020	14.6	5.8	110
	signature	1258	SE corner	S1			NOT	TRIGGERED											
	holes	1258	E wall	mid-wall			NOT	TRIGGERED											
	12:15	930	SE corner	S2			NOT	TRIGGERED											
		930	E wall	mid-wall			NOT	TRIGGERED											
	11/17/2000	1769	SE corner	ground	2020	1044	62.5	199.6	0.065	0.035	11.6	6.2	0.025	11.3	2.4	0.065	9.1	6.3	120
	12:34	1258	SE corner	S1						0.035	10.8	6.3	0.040			0.060	5.6	6.3	
		1258	E wall	mid-wall												0.130	7.5	6.4	
		930	SE corner	S2						0.090	6.6	6.3	0.040		6.4	0.230	6.5	6.4	
		930	E wall	mid-wall												0.205	6.3	6.4	

Kentuckey Site 2																			
Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	($ft/lb^{1/2}$)	($ft/lb^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	11/20/2000	1770	NW corner	ground	2570	183	190.2	453.9	0.025	0.010		15.4	0.010		2.13	0.025	30.1	15.38	106
	9:20a	1050	NE corner	S1						0.020	21.3	15.63	0.020			0.015	24.3	15.3	
		1050	N wall	mid-wall												0.060	24.3	18.4	
		1010	NE corner	S2						0.020	25.6	18.1	0.020			0.025	16.5	14	
		1010	W wall	mid-wall						0.045	28.4	31							
	11/20/2000	1770	NW corner	ground	1510	495	67.9	191.3	0.090	0.090	17.6	4.8	0.055	18.2	4.88	0.060	9.1	3.38	118
	16:09p	1050	NE corner	S1						0.085	7.3	7	0.080	8.2	7.9	0.065	7.8	7	
		1050	N wall	mid-wall												0.140	19.6	26.8	
		1010	NE corner	S2						0.145	7.2	7	0.100	7.6	7.9	0.085	8	7	
		1010	W wall	mid-wall						0.155	6	7							
	11/21/2000	1770	NW corner	ground	1670	274	100.9	257.6	0.055	0.040	25.6	23.3	0.035	16	18	0.055	18.2	4.31	118
	14:40	1050	NE corner	S1						0.065	8.2	7.44	0.060	27	7.63	0.040	12.8	3.94	
		1050	N wall	mid-wall												0.100	21.3	17.3	
		1010	NE corner	S2						0.120	7.8	7.7	0.080	13.8	8?	0.055	12.8	18.13	
		1010	W wall	mid-wall						0.135	7.8	7.7							
	11/21/2000	1770	NW corner	ground	1810	211	124.6	304.6	0.035	0.015	26.90	5.50	0.030	13.40	6.75	0.035	16.00	8.00	117
	15:35	1050	NE corner	S1						0.030	13.40	7.44	0.040		6.90	0.030	13.10	12.30	
TS-KY2		1050	N wall	mid-wall												0.46	26.9	28.9	
		1010	NE corner	S2						0.050	12.10	7.44	0.040		8?	0.045	13.80	?	
		1010	W wall	mid-wall						0.125	24.3	29.3							
	11/21/2000	1770	NW corner	ground	3710	807	130.6	399.4	0.035	0.020	16.5	2.6	0.020	14.2	2.5	0.035	20.4	2.88	110
	16:43	1050	NE corner	S1						0.020	15	2.6	0.020		14.4	0.020	18.9	2.13	
		1050	N wall	mid-wall												0.095	21.3	18.6	
		1010	NE corner	S2						0.025	13.1	2.6	0.040			0.055	18.9	17.7	
		1010	W wall	mid-wall						0.035	20.4	2.56							
	11/21/2000	1770	NW corner	ground	2520	209	174.3	425.4	0.040	0.035	21.3	21.4	0.025	22.2	4.13	0.040	25.6	15	112
	16:46	1050	NE corner	S1						0.030	25.6	14.8	0.020		15.1	0.025	25.6	15	
		1050	N wall	mid-wall												0.090	24.3	14.9	
		1010	NE corner	S2						0.040	20.4	15.1	0.040			0.035	17.6	15	
		1010	W wall	mid-wall						0.070	25.6	13.1							
	11/22/2000	1770	NW corner	ground	2300	678	88.3	262.4	0.030	0.030	18.2	15.13	0.020	16.5	3.5	0.025	9.6	14.1	114
	10:14	1050	NE corner	S1						0.015	22.2	15	0.020		15.63	0.015	13.1	6.75	
		1050	N wall	mid-wall												0.115	23.2	24.7	
		1010	NE corner	S2						0.020	22.2	9.13	0.040		9.25	0.030	14.2	19.3	
		1010	W wall	mid-wall						0.050	11.1	9.31							
	11/20/2000	1769	NE corner	ground	2410	183	178.2	425.2	0.040	0.030	20.4	18.5	0.010		14.8	0.040	21.3	16.63	100
	9.:19	1258	NE corner	S1						0.020	4.4	4.38	0.020			0.015	17	6.25	
		1258	N wall	mid-wall												0.035	14.2	12.4	
		930	NE corner	S2						0.020	5.3	4.4	0.020		8.4	0.010		6.25	
		930	E wall	mid-wall						0.055	18.9	4.4							
	11/20/2000	1769	NE corner	ground	4600	183	340.0	811.6	0.050	0.040	18.200	17.5	0.010		16.7	0.050	18.2	17.8	100
	10:33	1258	NE corner	S1						0.025	15.000	4.5	0.050	14.2	13.13	0.020	17.6	6.44	
		1258	N wall	mid-wall												0.050	14.2	13.13	
		930	NE corner	S2						0.020	6.2	4.5	0.040		16.6	0.015	17.6	6.44	
		930	E wall	mid-wall						0.065	17	16							
	11/20/2000	1769	NE corner	ground	3100	234	202.7	504.0	0.020	0.015	21.3	20.9	0.010		3.2	0.020	18.2	16.5	110
	12:25	1258	NE corner	S1						0.025	4.600	4.25	0.020			0.015	13.1	4.13	
		1258	N wall	mid-wall												0.030	13.8	12	
		930	NE corner	S2						0.025	4.6	4.25	0.020			0.015	13.1	4.13	
		930	E wall	mid-wall						0.030	13.8	12							
	11/20/2000	1769	NE corner	ground	2180	274	131.7	336.3	0.025	0.025	21.3	18	0.015	9.6	4.5	0.015	19.6	16.13	119
	13:05	1258	NE corner	S1						0.050	3.8	4.38	0.040		4.38	0.020	4.8	4.4	
		1258	N wall	mid-wall												0.150	7.4	10.63	
		930	NE corner	S2						0.075	3.7	4.38	0.020		4.5	0.020	7.5	5.88	
		930	E wall	mid-wall						0.270	18.2	4.38							
	11/20/2000	1769	NE corner	ground	1770	495	79.6	224.2	0.080	0.080	23.2	17	0.030	21.3	7.75	0.080	19.6	18.9	122
	16:10	1258	NE corner	S1						0.155	5.2	4.9	0.040		7.7	0.065	8.2	6.6	
		1258	N wall	mid-wall												0.140	8.2	6.6	
		930	NE corner	S2						0.205	5	4.94	0.040		7.75	0.090	6.3	6.63	
		930	E wall	mid-wall						0.600	20.4	22.75							
	11/20/2000	1769	NE corner	ground	2500	211	172.1	420.7	0.040	0.030	25.4	17.4	0.010		14.8	0.040	24.3	17.13	106
	16:47	1258	NE corner	S1						0.025	12.4	4.600	0.020			0.015	19.6	4.6	
TS1-KY2		1258	N wall	mid-wall												0.040	14.2	12.75	
		930	NE corner	S2						0.035	5.2	4.44	0.020		14.5	0.010		6.25	
		930	E wall	mid-wall						0.055	17.6	4.44							
	11/21/2000	1769	NE corner	ground	1920	274	116.0	296.2	0.080	0.080	20.4	17.8	0.030	17.6	17.8	0.050	22.2	17.8	118
	14:39	1258	NE corner	S1						0.105	4.6	4.31	0.040		4.2	0.025	7.7	4.38	
		1258	N wall	mid-wall												0.130	10.2	8.56	
		930	NE corner	S2						0.150	4.7	4.31	0.020		4	0.030	14.2	4.4	
		930	E wall	mid-wall												0.400	16.4	4.3	
	11/21/2000	1769	NE corner	ground	1700	211	117.0	286.1	0.070	0.070	22.2	18.25	0.030	28.4	8.38	0.060	18.2	16.75	116
	15:36	1258	NE corner	S1						0.130	4.6	4.44	0.060	18.9	4.44	0.055	6.8	4.5	
		1258	N wall	mid-wall												0.360	10.6	5.94	
		930	NE corner	S2						0.180	4.6	4.44	0.040		4.44	0.065	7.5	6.5	
		930	E wall	mid-wall												0.550	16	4.44	
	11/21/2000	1769	NE corner	ground	3770	808	132.6	405.7	0.050	0.050	22.2	17.7	0.010		2.5	0.050	17.6	16.9	110
	16:42	1258	NE corner	S1						0.045	4.9	4.3	0.040		2.56	0.030	9.4	6.7	
		1258	N wall	mid-wall												0.065	6.8	6.7	
		930	NE corner	S2						0.065	4.1	4.31	0.020			0.035	13.4	6.7	
		930	E wall	mid-wall						0.125	10.6	4.31							
	11/21/2000	1769	NE corner	ground	2460	209	170.2	415.3	0.080	0.050	18.9	16	0.030	21	15.6	0.080	21.4	17	110
	16:44	1258	NE corner	S1						0.025	4.5	4.5	0.040			0.025	20.4	15.13	
		1258	N wall	mid-wall												0.075	13.4	12.5	
		930	NE corner	S2						0.035	4.4	4.5	0.020		15.6	0.020	13.4	6.44	
		930	E wall	mid-wall						0.085	16.5	4.5							
	11/22/2000	1769	NE corner	ground	2170	678	83.3	247.5	0.040	0.020		14.56	0.020		14.9	0.040	23.2	18.8	114
	10:14	1258	NE corner	S1						0.110	4.6	4.31	0.040		4.3	0.030	8.6	6.75	
		1258	N wall	mid-wall												0.115	9.4	6.7	
		930	NE corner	S2						0.150	4.2	4.4	0.020		4.44	0.030	10.2	6.75	
		930	E wall	mid-wall					0.052	0.265	13.4	4.31							

New Mexico

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	(ft/lb$^{1/2}$)	(ft/lb$^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	06/22/01	1769	SE corner	ground	5333	13047	46.7	227.3	0.1625	0.1125	4.7	3.9	0.0875	5.8	6.56	0.163	6.2	3.9	128
	14:20	1050	SE corner	S1						0.11	4.8	3.9	0.09	3.94	6.5	0.13	5.5	3.9	
	cast	1050	E wall	mid-wall												0.245	4.6	3.9	
		1906	SE corner	S2						0.135	4.8	3.9	0.09	9.4	3.94	0.19	5.9	3.9	
		1906	S wall	mid-wall						0.185	9.4	3.9							
	6/26/2001	1769	SE corner	ground	5186	1708	125.5	434.9	0.0125	0.0125	12.1	3.8	0.01	18.2	7.44	0.013	8.8	3.8	112
	3:57	1050	SE corner	S1						0.01		3.8	0.01		7.5	0.01		3.7	
	cast	1050	E wall	mid-wall												0.025	16	16.7	
		1906	SE corner	S2						0.02	6.5	3.8	0.01		7.44	0.015	9.8	3.8	
		1906	S wall	mid-wall						0.045	18.2	11.2							
	6/28/2001	1769	SE corner	ground	4816	300	278.1	720.8	0.05	0.05	3.6	3.6	0.025	3.1	3.38	0.043	4	4.6	100
	3:03	1050	SE corner	S1						0.06	4.4	4.2	0.05	4.5	4.38	0.05	4.1	4.1	
	pre-split	1050	E wall	mid-wall												0.08	5.3	4.1	
		1906	SE corner	S2						0.075	4.3	4.2	0.05	4.8	3.63	0.06	4.8	4.1	
		1906	S wall	mid-wall						0.075	4.4	4.1							
	7/3/2001	1769	SE corner	ground	4478	300	258.5	670.2	0.05	0.05	3.6	3.6	0.05	3.1	3.38	0.085	4	4.6	100
	1:48	1050	SE corner	S1						0.055	3.8	3.5	0.02		3.13	0.045	4.4	4.3	
	pre-split	1050	E wall	mid-wall												0.055	4.4	4.3	
		1906	SE corner	S2						0.06	4	3.6	0.02		3.25	0.055	4.3	4.0	
		1906	S wall	mid-wall						0.06	4	3.5							
	07/05/01	1769	SE corner	ground	4941	9591	50.5	233.3	0.135	0.135	5.2	3.9	0.103	6	5.2	0.133	10.6	3.8	117
	3:04	1050	SE corner	S1						0.11	5	3.9	0.09	6.5	8.3	0.105	5.3	3.8	
	cast	1050	E wall	mid-wall												0.255	10.6	8.1	
E1S-NMB		1906	SE corner	S2						0.17	6.2	3.9	0.11	7.1	8.3	0.165	7.1	3.8	
		1906	S wall	mid-wall						0.2	8.8	3.9							
	07/17/01	1769	SE corner	ground	4606	11183	43.6	206.6	0.1425	0.1425	8.2	4.0	0.1	6.4	7.25	0.123	4.4	3.8	116
	12:51	1050	SE corner	S1						0.105	5.9	4.0	0.11	10.6	7.25	0.115	3.9	3.8	
	cast	1050	E wall	mid-wall												0.275	7.3	3.8	
		1906	SE corner	S2						0.22	7.7	7.3	0.14	9.8	7.25	0.15	5	3.8	
		1906	S wall	mid-wall						0.305	8.2	7.3							
	07/23/01	1769	SE corner	ground	4621	300	266.8	691.6	0.0725	0.0575	4.8	4.6	0.0475	4.7	4.56	0.073	4.1	4.4	110
	11:22	1050	SE corner	S1						0.065	4.1	4.6	0.06	5.3	3.13	0.07	3.8	3.6	
	pre-split	1050	E wall	mid-wall												0.125	5.1	3.6	
		1906	SE corner	S2						0.08	5	4.6	0.06	5.6	4.75	0.085	4.3	3.6	
		1906	S wall	mid-wall						0.08	7.3	4.6							
	07/26/01	1769	SE corner	ground	5565	600	227.2	661.2	0.105	0.07	3.8	3.7	0.035	5.4	4	0.105	4	3.8	106
	11:04	1050	SE corner	S1						0.075	3.69	4.0	0.03	6.5	3.7	0.105	4	3.8	
	pre-split	1050	E wall	mid-wall												0.165	5.2	3.9	
		1906	SE corner	S2						0.09	4.1	3.7	0.04	6.9	4.1	0.13	4.1	3.8	
		1906	S wall	mid-wall						0.09	4.1	3.7							
	07/26/01	1769	SE corner	ground	4593	7455	53.2	235.8	0.105	0.105	5.2	8.1	0.070	19.6	8	0.073	8.5	4.4	120
	2:55	1050	SE corner	S1						0.09	5.6	8.2	0.08	8.2	8	0.055	5.8	4.5	
	cast	1050	E wall	mid-wall												0.19	11.1	8.2	
		1906	SE corner	S2						0.165	6.7	8.3	0.1	9.8	8	0.075	5.1	4.5	
		1906	S wall	mid-wall						0.165	7.3	8.3							
	06/22/01	1770	SE corner	ground	3978	13047	34.8	169.5	0.2575	0.1875	7.1	3.9	0.1725	8	7.4	0.258	5.5	4.1	131
	14:20	1258	SE corner	S1(V-celing)						0.19	4.5	4.0	0.47	11.1	9.2	0.22	5.1	4.1	
		1258	E wall	mid-wall						0.39	19.6	12.9				0.41	8.2	4.1	
		930	SE corner	S2						0.61	4.4	4.0	0.25	8	4.13	0.72	5.9	4.1	
		930	S wall	mid-wall						1.36	4.3	4.0							
	07/05/01	1770	SE corner	ground	3458	9591	35.3	163.3	0.31	0.3	8.2	3.7	0.1375	10.2	6.94	0.31	12.1	3.9	117
	3:04	1258	SE corner	S1(V-celing)						0.24	4.5	3.7	0.46	15	17.6	0.26	11.1	3.9	
		1258	E wall	mid-wall												0.45	11.6	3.9	
		930	SE corner	S2						0.57	4.6	3.7	0.22	9.1	17.9	0.59	5	3.9	
		930	S wall	mid-wall						1.09	4.9	3.9							
	07/17/01	1770	SE corner	ground	2991	11183	28.3	134.2	0.46	0.33	6.5	3.9	0.225	7.7	3.94	0.46	3.9	3.9	119
	12:51	1258	SE corner	S1(V-celing)						0.35	5.3	3.9	0.5	9.4	3.9	0.38	4.1	3.9	
		1258	E wall	mid-wall												0.63	4.5	3.9	
		930	SE corner	S2						1.24	4.2	3.9	0.31	12.1	3.94	1.52	4.8	3.9	
E2S-NM		930	S wall	mid-wall						2.64	4.1	3.9							
	07/23/01	1770	SE corner	ground	2943	300	169.9	440.5	0.23	0.15	3.3	3.8	0.1725	5.2	4	0.23	4.3	4.0	110
	11:22	1258	SE corner	S1(V-celing)						0.19	3.5	3.8	0.21	6.2	4	0.26	3.7	4.0	
		1258	E wall	mid-wall												0.44	4.4	4.0	
		930	SE corner	S2						0.48	4.5	3.8	0.24	5.8	7.13	1.03	4.3	4.0	
		930	S wall	mid-wall						1.09	4.4	3.8							
	06/26/01	1770	SE corner	ground	3975	300	229.5	594.9	0.2525	0.2525	3.8	3.9	0.1425	5.8	7.2	0.183	4	3.9	106
	11:04	1258	SE corner	S1(V-celing)						0.26	3.8	3.9	0.23	6.9	3.94	0.21	4.4	4.0	
		1258	E wall	mid-wall												0.35	5	4.0	
		930	SE corner	S2						0.97	4.5	3.9	0.16	7.1	7.2	0.71	4.4	4.0	
		930	S wall	mid-wall						1.64	3.9	3.9							
	06/26/01	1770	SE corner	ground	2876	7455	33.3	147.7	0.21	0.21	5.8	8.4	0.1075	11.1	.8.1	0.188	7.5	4.1	122
	2:55	1258	SE corner	S1(V-celing)						0.23	5.3	4.1	0.24	7.3	8.44	0.16	7.5	4.1	
		1258	E wall	mid-wall												0.32	6.7	4.2	
		930	SE corner	S2						0.59	4.6	4.3	0.18	13.4	8.4	0.82	6.2	4.2	
		930	S wall	mid-wall						1.28	4.5	4.3							

New Mexico (cont.)

ESNMM	062201	100	NE corner	ground	38.75	130.47	32.2	155.6	0.3	0.23	9.1	3.9	NR			0.3	5.5	4.1	13.2
	1420	78	SE corner	S1						0.145	4.2	4.0	0.05	8.8	11.8	0.025	4.6	4.1	
		787	SE corner	S2						0.175	9.1	3.9	NR			NR			
		75	E wall	mid-wall						0.34	7.1	9.9	0.055	11.6	9	0.21	4.5	4.1	
	070601	100	NE corner	ground	28.0	130.47	25.4	128.7	0.7	0.085	15	10.0	0.15	13.4	18	0.37	5.9	4.1	11.2
	314	78	SE corner	S1						0.31	12.8	3.8	0.09	14.2	17.9	0.31	5.3	4.1	
		787	SE corner	S2						0.145	13.4	3.8	NR			NR			
		75	E wall	mid-wall						0.34	12.8	18.1	0.22	12.1	17.8	0.285	5.3	4.1	
	071701	100	NE corner	ground	24.3	110.83	22.9	108.7	0.74	0.45	11.6	12.6	0.265	13.4	18.3	0.74	15	4.0	11.8
	1251	78	SE corner	S1						0.28	10.2	3.8	0.115	14.2	18	0.175	5.1	4.0	
		787	SE corner	S2						0.32	15	3.8	0.185	14.2	18	0.355	3.5	4.0	
		75	E wall	mid-wall						1.02	13.4	18.0	0.155	15	12.5	0.145	13.4	4.0	
	072301	100	NE corner	ground	28.5	130	120.0	318.5	0.185	0.23	8	4.4	0.1	4.7	4.4	0.385	4	4.3	11.2
	1122	78	SE corner	S1						0.265	4.1	4.1	0.13	8	8.6	0.33	4	4.3	
		787	SE corner	S2						0.235	4.2	4.1	0.135	8	8.6	0.385	4.1	4.3	
		75	E wall	mid-wall						0.37	7.3	4.1	0.135	7.3	4.3	0.33	4.1	4.3	
	082601	100	NE corner	ground	31.4	130	185.5	470.5	0.6	0.3	4.1	3.8	0.14	9.1	4.9	0.6	4	3.8	10.5
	1114	78	SE corner	S1						0.265	4.6	4.1	0.145	8.8	8.75	0.375	4	3.8	
		787	SE corner	S2						0.31	5.3	4.1	0.155	7.7	8.75	0.66	4	3.8	
		75	E wall	mid-wall						0.145	3.7	4.1	0.205	7.3	8.2	0.365	4	3.8	
	082801	100	NE corner	ground	28.5	74.5	28.3	107.6	0.2	0.33	16	4.1	0.31	17	18.4	0.51	18.2	18.2	12.3
	1255	78	SE corner	S1						0.275	12.8	4.1	0.195	17	18	0.335	6	4.0	
		787	SE corner	S2						0.085	12.8	4.1	0.38	16	18	0.285	11.6	4.0	
		75	E wall	mid-wall						0.78	15	18.3	0.19	14.2	8.4	0.31	5.9	4.0	

Ohio

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance		Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	($ft/lb^{1/2}$)	($ft/lb^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
L1S-OH	03/15/01	914	NW corner	ground	5120	748	187.2	565.3	0.0375	0.0375	17	16.9	0.0125	8.3	1.9	0.03	15.5	15.8	112
	12:32	919	NW base	living room						0.015	15.5	17.0	0.0175	11.3	8.5	0.015	17.6	15.5	
		1906	NW top	living room						0.02	12.8	8.5	0.035	13.4	8.5	0.02	13.4	8.1	
	03/16/01	914	NW corner	ground	570	539	24.6	70.2	1.17	1.17	22.2	12.8	0.56	24.3	25.3	1.06	17	12.8	129
	14:42	919	NW base	living room						0.51	23.2	12.8	0.41	30.1	25.5	0.57	30.1	24.9	
		1906	NW top	living room						0.455	21.3	8.5	0.68	36.5	25.8	0.455	7	7.3	
	03/19/01	914	NW corner	ground	580	306	33.2	86.2	1.25	1.25	18.9	11.5	0.38	26.9	25.1	0.88	18.2	13.5	126
	11:53	919	NW base	living room						0.54	18.2	11.0	0.41	22.2	12.5	0.48	14.2	12.0	
		1906	NW top	living room						0.485	8.9	7.8	0.565	30.1	12.5	0.385	8.6	8.3	
	03/19/01	914	NW corner	ground	600	286	35.5	91.2	0.73	0.73	23.2	18.3	0.26	21.3	14.8	0.49	16.5	14.5	120
	15:42	919	NW base	living room						0.225	25.6	7.8	0.175	18.9	18.8	0.2425	17.6	14.0	
		1906	NW top	living room						0.45	7.6	8.0	0.225	34.1	25.5	0.32	7.7	8.3	
	03/20/01	914	NW corner	ground	610	294	35.6	91.9	1.13	1.13	24.3	18.3	0.32	28.4	17.8	0.72	20.4	14.3	124
	13:03	919	NW base	living room						0.41	24.3	26.8	0.2675	18.9	27.0	0.36	25.4	26.8	
		1906	NW top	living room						0.505	8	8.3	0.385	18.2	13.3	0.31	17.6	8.5	
	03/20/01	914	NW corner	ground	640	304	36.7	95.4	0.68	0.68	23.2	17.8	0.245	25.6	17.8	0.68	18.9	10.4	119
	15:45	919	NW base	living room						0.263	23.2	23.0	0.175	22.2	17.8	0.38	22.2	10.0	
		1906	NW top	living room						0.36	9.4	6.9	0.275	17.6	27.5	0.17	8.6	8.4	
	03/21/01	914	NW corner	ground	4900	2694	94.4	353.1	0.078	0.078	16.5	13.8	0.0375	17.6	12.9	0.055	14.2	11.0	112
	16:02	919	NW base	living room						0.0375	11.3	13.6	0.035	12.4	12.6	0.04	11.3	6.9	
		1906	NW top	living room						0.06	8.6	8.4	0.06	14.2	14.0	0.06	9.4	8.0	
	03/22/01	914	NW corner	ground	4900	3254	85.9	331.6	0.06	0.06	16	17.6	0.035	13.5	17.4	0.0525	14.6	4.8	116
	16:16	919	NW base	living room						0.0225	14.2	4.9	0.025	12.8	8.4	0.0325	12.8	4.8	
		1906	NW top	living room						0.04	11.1	8.1	0.04	10.8	8.5	0.06	7.1	8.1	
	03/23/01	914	NW corner	ground	4300	504	191.5	541.5	0.0375	0.0375	16.5	16.8	0.0075	18.2	10.5	0.0175	14.6	15.4	112
	16:06	919	NW base	living room						0.015	15	17.0	0.0175	12.1	11.0	0.015	14.6	15.0	
		1906	NW top	living room						0.015	14.6	8.4	0.035	15.4	14.2	0.02	10.4	8.4	
	03/23/01	914	NW corner	ground	5000	3408	85.6	333.2	0.095	0.095	15.5	14.1	0.0325	9.3	5.5	0.075	13.8	4.8	122
	16:23	919	NW base	living room						0.05	12.4	3.1	0.06	11.1	8.8	0.0475	8.5	4.8	
		1906	NW top	living room						0.055	8.6	8.3	0.095	12.8	8.3	0.095	7.5	8.1	
	03/24/01	914	NW corner	ground	5100	2026	113.3	404.1	0.0975	0.0975	13.4	12.5	0.03	12.8	4.0	0.0625	12.1	1.3	122
	14:02	919	NW base	living room						0.055	12.8	12.6	0.0475	10.8	12.4	0.0375	11.9	3.4	
		1906	NW top	living room						0.06	10.2	8.5	0.1	12.8	12.6	0.07	7.6	9.1	
	03/26/01	914	NW corner	ground		NO	TRIGGER												
	14:41	919	NW base	living room															
	03/26/01	914	NW corner	ground		NO	TRIGGER												
	16:10	919	NW base	living room															
	03/27/01	914	NW corner	ground	4020	832	139.4	428.4	0.05		19.6	20.6	0.0225	23.2	20.1	0.0425	17.6	13.8	114
	14:36	919	NW base	living room							17.6	13.5	0.0275	10.6	11.3	0.0175	13.4	11.4	
		1906	NW top	living room						0.05	10.2	8.3	0.04	10.6	8.3	0.045	9.8	8.3	
	03/27/01	914	NW corner	ground	5160	4130	80.3	322.5	0.1	0.015	13.4	9.3	0.0325	11.1	10.0	0.065	13.1	16.3	114
	16:02	919	NW base	living room						0.065	12.4	9.3	0.0475	10.4	9.9	0.035	4.7	3.3	
		1906	NW top	living room						0.1	8.9	8.5	0.095	12.8	9.3	0.075	8.8	8.3	
	03/28/01	914	NW corner	ground	3970	546	169.9	486.7	0.0425	0.0525	16.5	11.4	0.025	19.6	7.8	0.0225	13.8	15.4	112
	14:32	919	NW base	living room						0.065	17	11.5	0.0275	11.9	8.1	0.015	20.4	14.8	
		1906	NW top	living room						0.0425	bad data								
	03/28/01	914	NW corner	ground	5300	2056	116.9	417.9	0.055	0.0175	10	9.3	0.03	8	8.6	0.055	5.1	14.8	112
	16:23	919	NW base	living room							10.2	9.3	0.04	8.2	9.0	0.035	5.5	4.8	
		1906	NW top	living room						0.0475	bad data								
	03/29/01	914	NW corner	ground	3900	696	147.8	441.0	0.03	0.035	16.5	17.0	0.0075	21.3	2.0	0.015	17.6	15.9	110
	14:32	919	NW base	living room							15.5	11.5	0.01	15	8.3	0.0075	32	16.0	
		1906	NW top	living room						0.03	12.1	8.0	0.02	16.5	16.0	0.015	13.8	9.3	
	03/29/01	914	NW corner	ground	5540	2056	122.2	436.8	0.075	0.0125	13.4	9.3	0.02	14.2	8.6	0.045	11.1	8.3	110
	16:08	919	NW base	living room						0.02	13.1	9.3	0.0325	11.2	9.3	0.04	10.8	8.3	
		1906	NW top	living room						0.075	8.2	8.0	0.06	11.9	8.5	0.09	8.6	8.3	
	03/30/01	914	NW corner	ground		NO	TRIGGER			0.0425									
	14:38	919	NW base	living room						0.115									
	3/31/2001	914	NW corner	ground		NO	TRIGGER												
	14:38	919	NW base	living room															
	4/2/2001	914	NW corner	ground	5420	2618	105.9	394.3	0.0425		14.6	15.8	0.0175	9.4	4.0	0.0425	10	15.3	122
	13:40	919	NW base	living room							11.9	7.8	0.0175	12.1	7.8	0.03	5.6	3.9	
		1906	NW top	living room						0.0325	cannot read								
	04/02/01	914	NW corner	ground	4790	1030	149.3	475.4	0.0825	0.02	16.5	18.3	0.02	28.4	17.8	0.0575	13.8	15.3	106
	15:54	919	NW base	living room						read	14.6	12.0	0.03	15	14.5	0.03	13.4	15.0	
		1906	NW top	living room						0.0825	12.4	10.3	0.055	15.5	14.5	0.045	10.4	8.3	
	04/03/01	914	NW corner	ground	3650	848	125.3	386.5	0.04	0.0325	19.6	20.1	0.0325	28.4	19.8	0.0275	18.2	17.3	114
	13:36	919	NW base	living room						0.035	14.2	17.4	0.0225	25.6	19.8	0.0175	24.3	19.0	
		1906	NW top	living room						0.04	12.4	8.3	0.025	26.9	19.8	0.02	13.8	8.3	
	04/03/01	914	NW corner	ground	4790	1161	140.6	456.8	0.0775	0.0125	17	18.3	0.035	25.6	10.4	0.0775	12.1	10.4	114
	15:04	919	NW base	living room						0.02									
		1906	NW top	living room						0.0775	10.8	10.4	0.075	12.1	10.8	0.065	9.3	8.0	

Ohio (cont.)

	03/16/01	1770	So. Corner	ground	1860	539	80.1	229.0	0.34	0.06	5.5	4.5	0.2525	28.4	7.8	0.34	12.8	6.5	121
	14:43	1010	NE wall	R=upper (T) A=V T=lower						0.165	20.4	4.5	0.3	25.6	26.5	0.29	5.5	6.0	
		1010	SE wall	V=base (R)												0.24	7.3	5.3	
		1050	SE wall	R=upper A=V T=rafter						0.33	5.8	6.0	0.21	30.1	27.0	0.52	6	6.3	
		1050	SE wall	V=midwall (R)												0.525	5.8	6.3	
	03/19/01	1770	So. Corner	ground	1830	306	104.6	272.1	0.213	0.213	18.2	7.5	0.2	24.3	26.0	0.21	15	5.3	116
	11:53	1010	NE wall	R=upper (T) A=V T=lower						0.16	7.7	7.6	0.23	25.6	28.0	0.205	6.4	6.0	
		1010	SE wall	V=base (R)												0.235	7.7	5.0	
		1050	SE wall	R=upper A=V T=rafter						0.23	7.7	7.4	0.14	28.4	17.4	0.44	6	5.8	
		1050	SE wall	V=midwall (R)												0.565	7.8	5.8	
	03/19/01	1770	So. Corner	ground	1830	286	108.2	278.3	0.185	0.173	12.8	9.4	0.0875	24.3	22.9	0.185	5.9	5.8	110
	15:42	1010	NE wall	R=upper (T) A=V T=lower						0.11	8.5	9.4	0.1	6.7	6.0	0.15	7.5	6.0	
		1010	SE wall	V=base (R)												0.245	6	6.0	
		1050	SE wall	R=upper A=V T=rafter						0.21	7	6.0	0.07	25.6	6.5	0.43	6.6	6.3	
		1050	SE wall	V=midwall (R)												0.535	8	6.0	
	03/20/01	1770	So. Corner	ground	1790	294	104.4	269.7	0.235	0.1675	16.5	7.6	0.1275	30.1	21.4	0.235	15.5	19.1	114
	13:03	1010	NE wall	R=upper (T) A=V T=lower						0.145	8.3	7.6	0.13	21.3	7.6	0.21	6.9	7.6	
		1010	SE wall	V=base (R)												0.165	8.1	5.4	
		1050	SE wall	R=upper A=V T=rafter						0.29	7.4	7.6	0.13	21.3	21.8	0.395	6.6	6.0	
		1050	SE wall	V=midwall (R)												0.375	5.8	6.0	
	03/20/01	1770	So. Corner	ground	1800	304	103.2	268.2	0.2	0.165	16	9.6	0.105	21.3	17.6	0.2	18.9	19.4	110
	15:45	1010	NE wall	R=upper (T) A=V T=lower						0.105	19.6	9.7	0.13	11.3	6.0	0.14	5.7	5.8	
		1010	SE wall	V=base (R)												0.115	9.4	11.0	
		1050	SE wall	R=upper A=V T=rafter						0.19	6.4	5.7	0.09	21.3	17.6	0.25	7	6.3	
		1050	SE wall	V=midwall (R)												0.365	9.8	11.3	
	03/21/01	1770	So. Corner	ground	5180	2694	99.8	373.3	0.085	0.085	10.6	6.3	0.045	18.9	25.8	0.08	15.5	11.0	110
	16:02	1010	NE wall	R=upper (T) A=V T=lower						0.045	8.9	5.9	0.05	25.6	6.3	0.09	6.3	6.0	
		1010	SE wall	V=base (R)												0.07	14.2	6.5	
		1050	SE wall	R=upper A=V T=rafter						0.11	5.8	6.3	0.04	25.6	12.4	0.105	5	6.5	
		1050	SE wall	V=midwall (R)												0.14	9.4	6.5	
	03/22/01	1770	So. Corner	ground	5180	3254	90.8	350.5	0.0475	0.0475	6	5.3	0.025	6.8	17.5	0.0475	14.2	18.8	112
	16:16	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.07	6.9	5.3	0.03	16.5	17.4	0.045	6.8	5.0	
		1050	SE wall	V=midwall (R)												0.12	11.6	11.8	
	03/23/01	1770	So. Corner	ground	4550	504	202.7	572.9	0.0425	0.0025	18.9	17.8	0.0175	19.6	13.5	0.0425	17.6	18.4	110
	16:06	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.03	13.8	5.9	0.02	NM	18.9	0.015	20.4	6.7	
		1050	SE wall	V=midwall (R)												0.055	17	15.9	
	03/23/01	1770	So. Corner	ground	5280	3408	90.4	351.8	0.0775	0.0775	6	5.5	0.0325	23.2	5.1	0.07	12.4	2.9	120
	16:23	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.165	6.1	5.5	0.04	20.1	5.2	0.085	5.3	6.4	
		1050	SE wall	V=midwall (R)												0.155	11.1	6.4	
	03/24/01	1770	So. Corner	ground	5410	2026	120.2	428.6	0.07	0.0575	9.8	9.8	0.04	13.8	3.9	0.07	12.8	11.8	117
	14:02	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.125	15.5	6.2	0.04	13.4	17.5	0.07	8	6.6	
		1050	SE wall	V=midwall (R)												0.16	11.9	11.4	
	03/26/01	1770	So. Corner	ground	4510	284	267.6	687.4	0.03	0.0175	14.2	17.8	0.015	22.2	13.1	0.03	17.6	18.8	110
	14:41	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.03	10.4	6.6	0.01	NM	NM	0.02	13.4	6.3	
		1050	SE wall	V=midwall (R)												0.035	17	16.0	
	03/26/01	1770	So. Corner	ground	5550	1360	150.5	502.1	0.035	0.0275	8.5	6.6	0.025	4.4	3.5	0.035	12.1	12.0	117
	16:10	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
L2S-OH		1050	SE wall	R=upper A=V T=rafter						0.065	7	6.6	0.02	NM	3.4	0.04	7.5	6.7	
		1050	SE wall	V=midwall (R)												0.09	11.1	6.7	
	03/27/01	1770	So. Corner	ground	4190	832	145.3	446.5	0.0775	0.0575	16.5	20.0	0.03	19.6	20.0	0.07775	17	20.0	112
	14:36	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.035	11.6	6.2	0.02	NM	20.0	0.05	9.6	7.8	
		1050	SE wall	V=midwall (R)												0.11	12.1	11.2	
	03/27/01	1770	So. Corner	ground	5470	4130	85.1	341.9	0.0875	0.0875	9.1	3.6	0.04	11.9	9.5	0.0675	8.3	3.4	112
	16:02	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.135	4	5.8	0.04	11.6	9.4	0.1	8.6	3.3	
		1050	SE wall	V=midwall (R)												0.145	10.2	11.3	
	03/28/01	1770	So. Corner	ground		NO	TRIGGER												
	14:32	1010	NE wall	R=upper (T) A=V T=lower															
	3/28/2001	1770	So. Corner	ground	5600	2056	123.5	441.5	0.0875	0.0875	7.3	3.6	0.0275	10.8	9.5	0.05	8.5	3.4	106
	16:23	1010	NE wall	R=upper (T) A=V T=lower						ND	NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.145	7	5.8	0.06	14.2	9.5	0.095	6.9	6.4	
		1050	SE wall	V=midwall (R)												0.13	10.8	6.4	
	03/29/01	1770	So. Corner	ground	4040	696	153.1	456.9	0.0525	0.0285	18.9	16.6	0.025	14.2	16.5	0.0525	18.2	19.3	110
	14:32	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.04	10.8	6.3	0.03	17.6	16.6	0.035	12.8	6.1	
		1050	SE wall	V=midwall (R)												0.1	14.6	15.9	
	03/29/01	1770	So. Corner	ground	5840	2056	128.8	460.4	0.075	0.075	7.5	9.1	0.02	13.8	9.5	0.0725	9.6	12.0	106
	16:08	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.115	5.5	6.1	0.03	10.8	9.5	0.08	8.2	6.4	
		1050	SE wall	V=midwall (R)												0.14	11.3	11.8	
	03/30/01	1770	So. Corner	ground	3750	366	196.0	525.3	0.0425	0.02	20.4	20.0	0.02	22.2	26.8	0.0425	17	1935.0	110
	14:38	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.03	13.4	6.1	0.02	nm	18.5	0.02	8.5	7.2	
		1050	SE wall	V=midwall (R)												0.045	14.2	12.0	
	03/31/01	1770	So. Corner	ground	5670	2394	115.9	424.9	0.0475	0.0475	4.1	3.9	0.0125	19.6	7.6	0.03	11.6	4.9	112
	14:38	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.085	6.4	6.1	0.01	NM	NM	0.05	7	4.9	
		1050	SE wall	V=midwall (R)												0.085	9.8	4.9	
	04/02/01	1770	So. Corner	ground	5790	2618	113.2	421.2	0.085	0.085	4.9	3.6	0.0225	5.3	3.8	0.0675	11.1	3.5	120
	13:40	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.17	5.5	6.2	0.03	13.1	6.7	0.07	5.9	6.5	
		1050	SE wall	V=midwall (R)												0.15	11.3	11.5	
	04/02/01	1770	So. Corner	ground	5050	1030	157.4	501.2	0.09	0.0725	13.8	10.1	0.035	26.9	26.0	0.09	15.5	12.0	106
	15:54	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.09	7.3	5.9	0.03	30.1	14.4	0.06	8.3	5.4	
		1050	SE wall	V=midwall (R)												0.18	12.8	12.0	
	04/03/01	1770	So. Corner	ground	3770	848	129.5	399.2	0.045	0.045	18.2	17.0	0.025	15	17.3	0.045	18.9	18.8	114
	13:36	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.04	11.9	6.0	0.03	23.2	17.3	0.045	11.3	6.3	
		1050	SE wall	V=midwall (R)												0.11	15	14.4	
	04/03/01	1770	So. Corner	ground	5040	1161	147.9	480.7	0.1	0.1	10.2	9.8	0.03	26.9	12.9	0.0925	14.6	12.0	110
	15:04	1010	NE wall	R=upper (T) A=V T=lower							NO	DATA							
		1010	SE wall	V=base (R)												ND			
		1050	SE wall	R=upper A=V T=rafter						0.11	10	5.9	0.04	16	13.0	0.07	9.3	6.6	
		1050	SE wall	V=midwall (R)												0.2	12.4	12.0	

Ohio (cont.)																			
	03/16/01	1769	NW corner	ground	1560	539	67.2	192.1	0.1825	0.1825	8.2	6.5	0.1775	39.3	5.5	0.1725	36.5	4.3	123
	14:43	930	NW corner	R, A(V), T						0.14	5.3	4.1	0.3	8.8	9.1	0.15	5	6.1	4
		930	west midwall	V												0.29	22.2	6.1	
		1258	SE corner	R, A(V), T						0.27	5.6	5.1	0.16	12.8	5.3	0.16	5.2	6.1	
		1258	east midwall	V												0.295	8.6	6.1	
	03/19/01	1769	NW corner	ground	1550	306	88.6	230.5	0.1675	0.16	10.4	10.8	0.14	30.1	28.0	0.1675	25.6	8.6	118
	11:53	930	NW corner	R, A(V), T						0.28	4.3	3.7	0.33	10.4	9.3	0.2	6	6.4	
		930	west midwall	V												0.29	17.6	6.4	
		1258	SE corner	R, A(V), T						0.21	4.1	5.0	0.17	11.6	14.3	0.155	6.4	6.4	
		1258	east midwall	V												0.17	6.1	6.4	
	03/19/01	1769	NW corner	ground	1570	286	92.8	238.7	0.155	0.155	9.1	6.6	0.055	25.6	5.9	0.1525	10.8	7.8	112
	15:42	930	NW corner	R, A(V), T						0.145	6.7	4.0	0.32	9.3	9.3	0.165	7.2	6.0	
		930	west midwall	V												0.18	7.6	6.0	
		1258	SE corner	R, A(V), T						0.2	6.3	5.3	0.28	8.5	6.8	0.135	7.1	6.0	
		1258	east midwall	V												0.145	7.7	6.0	
	03/20/01	1769	NW corner	ground	1550	294	90.4	233.5	0.2	0.145	8.3	9.6	0.1125	42.6	8.9	0.2	12.8	8.0	116
	13:03	930	NW corner	R, A(V), T						0.175	7.1	4.0	0.45	8.8	9.5	0.235	6.4	6.7	
		930	west midwall	V												0.225	6.1	6.6	
		1258	SE corner	R, A(V), T						0.235	6.3	5.1	0.26	8.1	7.9	0.205	6.6	6.7	
		1258	east midwall	V												0.225	6	8.0	
	03/20/01	1769	NW corner	ground	1580	304	90.6	235.4	0.165	0.145	10.4	10.4	0.065	51.2	6.5	0.165	11.3	10.1	112
	15:45	930	NW corner	R, A(V), T						0.135	4.5	3.7	0.26	9.3	10.0	0.21	7.2	6.4	
		930	west midwall	V												0.225	24.3	6.4	
		1258	SE corner	R, A(V), T						0.16	5.9	5.1	0.17	8.1	6.4	0.16	7.4	6.4	
		1258	east midwall	V												0.175	7.4	6.4	
	03/21/01	1769	NW corner	ground	5630	2694	108.5	405.7	0.05	0.05	10.4	7.0	0.025	12.4	6.5	0.0375	11.1	6.5	110
	16:02	930	NW corner	R, A(V), T						0.075	5.8	4.0	0.14	11.3	6.5	0.065	7	6.5	
		930	west midwall	V												0.075	6.6	6.5	
		1258	SE corner	R, A(V), T						0.085	5.8	5.4	0.07	7.8	6.4	0.065	7	6.5	
		1258	east midwall	V												0.065	7.1	6.5	
	03/22/01	1769	NW corner	ground		NO	TRIGGER												
	16:16	930	NW corner	R, A(V), T															
	03/23/01	1769	NW corner	ground		NO	TRIGGER												
	16:06	930	NW corner	R, A(V), T															
	03/23/01	1769	NW corner	ground	5730	3408	98.2	381.8	0.0475	0.0475	7.8	3.3	0.025	12.4	4.1	0.045	2.8	3.4	120
	16:23	930	NW corner	R, A(V), T						0.135	3.5	3.6	0.07	11.3	6.6	0.08	5.1	6.6	
		930	west midwall	V												0.14	18.9	6.6	
		1258	SE corner	R, A(V), T						0.135	5.8	5.3	0.09	10.2	5.3	0.08	5.2	6.6	
		1258	east midwall	V												0.095	17.6	6.6	
	03/24/01	1769	NW corner	ground	5840	2026	129.7	462.7	0.04	0.0375	11.3	10.0	0.02	4.1	3.8	0.04	10	10.5	119
	14:02	930	NW corner	R, A(V), T						0.11	3.8	3.8	0.12	11.6	10.1	0.06	7	6.6	
		930	west midwall	V												0.09	14.2	6.6	
		1258	SE corner	R, A(V), T						0.155	8.6	5.4	0.08	10.4	8.8	0.045	7.2	6.6	
		1258	east midwall	V												0.07	13.1	6.6	
	03/26/01	1769	NW corner	ground		NO	TRIGGER												
	14:41	930	NW corner	R, A(V), T															
TS-OH	03/26/01	1769	NW corner	ground		NO	TRIGGER												
	16:10	930	NW corner	R, A(V), T															
	03/27/01	1769	NW corner	ground		NO	TRIGGER												
	14:36	930	NW corner	R, A(V), T															
	03/27/01	1769	NW corner	ground	5900	4130	91.8	368.8	0.0775	0.06	8.2	10.0	0.02	11.6	9.1	0.0775	6.8	3.4	112
	16:02	930	NW corner	R, A(V), T						0.175	4.3	3.6	0.09	11.1	10.0	0.095	7.6	3.4	
		930	west midwall	V												0.1	7.1	3.4	
		1258	SE corner	R, A(V), T						0.075	5.6	3.3	0.07	10.8	9.1	0.11	6.5	3.4	
		1258	east midwall	V												0.105	7	3.4	
	03/28/01	1769	NW corner	ground		NO	TRIGGER												
	14:32	930	NW corner	R, A(V), T															
	03/28/01	1769	NW corner	ground	6040	2056	133.2	476.2	0.095	0.065	8.3	8.9	0.0175	12.1	8.9	0.095	7.5	9.0	106
	16:23	930	NW corner	R, A(V), T						0.155	4	3.8	0.08	10.8	9.9	0.13	6.8	9.0	
		930	west midwall	V												0.125	6.6	8.9	
		1258	SE corner	R, A(V), T						0.075	5.2	5.4	0.1	8.9	9.1	0.13	6.6	9.0	
		1258	east midwall	V												0.135	6.7	8.9	
	03/29/01	1769	NW corner	ground		NO	TRIGGER												
	14:32	930	NW corner	R, A(V), T															
	03/29/01	1769	NW corner	ground	6280	2056	138.5	495.1	0.103	0.053	8.8	8.9	0.018	16	9.0	0.103	8.3	9.0	106
	16:08	930	NW corner	R, A(V), T						0.110	4.5	3.8	0.090	9.8	9.5	0.130	7.2	8.9	
		930	west midwall	V												0.135	7.2	9.0	
		1258	SE corner	R, A(V), T						0.035	3.7	3.3	0.090	10.2	9.0	0.115	7.4	8.9	
		1258	east midwall	V												0.120	7.3	8.9	
	03/30/01	1769	NW corner	ground		NO	TRIGGER												
	14:38	930	NW corner	R, A(V), T															
	3/31/2001	1769	NW corner	ground	6040	2394	123.4	452.7	0.030	0.023	8.5	3.9	0.008	6.8	4.0	0.030	2.7	3.5	114
	14:38	930	NW corner	R, A(V), T						0.08	3.7	3.8	0.03	13.4	11.4	0.055	6.8	6.6	
		930	west midwall	V												0.055	6.3	6.6	
		1258	SE corner	R, A(V), T						0.06	5.4	5.6	0.04	14.2	6.6	0.055	6.8	6.7	
		1258	east midwall	V												0.055	7.3	6.7	
	04/02/01	1769	NW corner	ground	6170	2618	120.6	448.9	0.055	0.0375	5.3	3.5	0.0125	14.6	3.9	0.055	7.5	3.5	122
	13:40	930	NW corner	R, A(V), T						0.155	3.9	3.9	0.08	8.6	3.9	0.090	7	6.7	
		930	west midwall	V												0.110	6	3.6	
		1258	SE corner	R, A(V), T						0.22	7.7	5.3	0.13	10	7.6	0.090	6.8	3.6	
		1258	east midwall	V												0.090	6.9	3.7	
	04/02/01	1769	NW corner	ground	5510	1030	171.7	546.9	0.035	0.035	12.1	12.5	0.015	18.9	12.4	0.030	11.3	12.3	106
	15:54	930	NW corner	R, A(V), T						0.035	9.6	4.1	0.09	12.1	10.1	0.040	9.3	6.6	
		930	west midwall	V												0.050	13.1	6.6	
		1258	SE corner	R, A(V), T						0.04	11.3	5.6	0.08	12.4	14.9	0.040	8.1	6.4	
		1258	east midwall	V												0.040	8.2	6.6	
	04/03/01	1769	NW corner	ground			NO TRIGGER												
	13:36	930	NW corner	R, A(V), T															
	04/03/01	1769	NW corner	ground	5500	1161	161.4	524.5	0.0475	0.0475	11.6	10.0	0.0175	12.8	12.5	0.04	10.8	12.4	110
	15:04	930	NW corner	R, A(V), T						0.06	9.3	3.9	0.16	10.8	10.1	0.06	7.2	6.4	
		930	west midwall	V												0.06	21.3	6.4	
		1258	SE corner	R, A(V), T						0.06	11.1	5.5	0.09	12.4	12.7	0.055	6.7	6.5	
		1258	east midwall	V												0.06	7.3	6.5	

Pennsylvania

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	$(ft/lb^{1/2})$	$(ft/lb^{1/3})$	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	05/22/01	1769	SW corner	ground	1437	612	58.1	169.6	0.24	0.14	11.6	7.4	0.065	11.6	7.5	0.24	16.5	7	117
	10:37	930	SW corner	S1						0.105	7	7.0	0.34	15.5	7.5	0.31	12.4	7	
		930	S wall	mid-wall						0.265	21.3	7.5							
		1258	SW corner	S2						0.2	8.6	7.5	0.34	15	7.5	0.415	15	7.1	
		1258	W wall	mid-wall												0.98	9.4	13.13	
	05/22/01	1769	SW corner	ground	1458	486	66.1	185.8	0.235	0.235	11.6	8.0	0.095	14.2	7.5	0.185	12.8	7	119
	12:16	930	SW corner	S1						0.125	6.7	7.1	0.46	14.2	7.38	0.215	14.2	7.13	
		930	S wall	mid-wall						0.445	7.3	7.3							
		1258	SW corner	S2						0.3	8.8	7.3	0.46	13.8	7.4	0.3	8	7.25	
		1258	W wall	mid-wall												0.9	10.4	13	
TD-PA	05/23/01	1769	SW corner	ground	1483	612	59.9	175.0	0.32	0.165	16.5	7.3	0.07	11.2	6.5	0.32	16.5	17.6	119
	2:15	930	SW corner	S1						0.135	6.2	7.3	0.34	15	16.5 & 7.4	0.33	13.8	17.25 & 6.3	
		930	S wall	mid-wall						0.355	18.9	7.3							
		1258	SW corner	S2						0.21	5.8	7.4	0.35	14.6	16.5 & 7.4	0.27	8.5	7.3	
		1258	W wall	mid-wall												0.465	8	13	
	05/24/01	1769	SW corner	ground	1390	504	61.9	175.0	0.195	0.165	18.9	20.5	0.115	46.5	20.13	0.195	22.2	19.9	122
	10:41	930	SW corner	S1						0.09	11.6	6.8	0.32	14.2	8.25	0.215	16.5	19.8	
		930	S wall	mid-wall						0.535	19.6	19.8							
		1258	SW corner	S2						0.195	9.4	7.0	0.32	13.8	8.25	0.185	9.3	9.25	
		1258	W wall	mid-wall												1.08	14.6	13	
	05/22/01	1050	SW corner	ground	1472	612	59.5	173.7	0.29	NR			0.0725	9.8	7.5	0.29	8.3	7.13	116
	10:37	1770	SW corner	S1(V-celing)						0.14	17.6	9.6	0.53	18.9	17.5	0.24	7.7	7.4	
		1770	S wall	mid-wall						0.39	19.6	12.9							
		1906	SW corner	S2						0.165	6.4	7.1	0.14	11.1	7.13	0.505	7.6	6.6	
		1906	W wall	mid-wall												0.495	7.2	6.63 & 22.3	
	05/22/01	1050	SW corner	ground	1507	486	68.4	192.1	0.32	0.32	10.6	7.6	0.0875	19.6	7.4	0.268	7.7	7.13	119
	12:16	1770	SW corner	S1(V-celing)						0.23	10	7.5	0.42	18.9	20.3	0.17	4.9	7.13	
		1770	S wall	mid-wall						0.51	17.6	26.8 (12.8 & 7.5)							
		1906	SW corner	S2						0.3	7.8	7.6	0.11	19.6	7.9	0.39	7.4	6.4	
		1906	W wall	mid-wall												0.49	13.8	6.13 & 24.9	
W1S-PA	05/23/01	1050	SW corner	ground	1507	612	60.9	177.9	0.2775	0.1375	7	8.4	0.0875	1.9	6.5	0.278	10.2	7.8	118
	2:15	1770	SW corner	S1(V-celing)						0.12	7.4	7.0	0.54	21.3	18.5	0.23	6.4	7.63	
		1770	S wall	mid-wall						0.59	16.5	26.1 & 10.8							
		1906	SW corner	S2						0.165	6.7	7.1	0.08	5.8	6.4	0.315	8.2	6.3	
		1906	W wall	mid-wall												0.48	23.2	6.3	
	05/24/01	1050	SW corner	ground	1510	504	67.3	190.1	0.203	0.1675	7.7	8.1	0.095	30.1	20	0.203	17	20.6	125
	10:41	1770	SW corner	S1(V-celing)						0.13	8.5	6.5	0.56	18.2	20.3	0.16	14.6	20.9	
		1770	S wall	mid-wall						1.2	17	12.8							
		1906	SW corner	S2						0.19	10.4	6.5	0.09	7.2	14.3	0.255	7.2	6.5	
		1906	W wall	mid-wall												0.74	19.6	20.3	

1010 machine on 4 X divide values by 2

1770 machine on 1X mult values by 2

Tennessee

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	(ft/lb$^{1/2}$)	(ft/lb$^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	12/12/2000	1770	E side	ground	1910	1676	46.7	161.2	0.085	0.085	9.6	12.1	0.085	11.9	11.25	0.07	18.2	12.6	124
	12:21	1010	east side center	see note						0.11	11.9	6.6	0.16	12.8	13.13	0.235	9.6	6.6	
		1010	center wall- east	mid-wall						0.92	6.7	13.3							
		1050	west side center	see notes						0.12	11.9	6.6	0.12	12.8	12.5	0.15	8	6.6	
		1050	bath wall-radial	mid-wall												0.095	18.9	7.8	
	12/12/2000	1770	E side	ground	1225	885	41.2	127.9	0.04	0.04	16	17.5	0.035	11.1	10.88	0.02		4.1	110
	17:00	1010	east side center	see note						0.06	17	17.5	0.06	12.8	12.81	0.05	18.9	6.9	
TD-TN	3-holes	1010	center wall- east	mid-wall						0.245	15.5	14.4							
		1050	west side center	see notes						0.055	16	17.6	0.06	12.8	19.75	0.055	13.1	6.9	
		1050	bath wall-radial	mid-wall												0.06	12.8	19.8	
	12/15/2000	1770	E side	ground	1820	2809	34.3	129.3	0.24	0.24	24.3	18.8	0.135	15.5	12.88	0.18	11.1	3.8	128
	12:05	1010	east side center	see note						0.195	18.9	6.5	0.28	15	12	0.28	8.2	6.6	
		1010	center wall- east	mid-wall						2.56	13.8	14.1							
		1050	west side center	see notes						0.205	16.5	6.6	0.28	16	12	0.21	14.2	6.6	
		1050	bath wall-radial	mid-wall												0.325	17.6	5.8	
	12/12/2000	1769	NE corner	ground	6110	1676	149.2	515.7	0.055	0.055	32	35.4	0.02	22.2	17.25	0.025	34.1	17.1	106
	12:19	1258	NE corner	first floor corner						0.04	18.2	23.0	0.04		17.38	0.035	24.3	6.9	
		1258	midwall	first floor north wall												0.07	22.2	7.2	
		930	N wall peak	second floor near roof peak						0.05	7.8	7.2	0.04		17.25	0.55	7.3	7.2	
		930	midwall	north wall						mid-wall	not	measured							
L2S-TN	12/12/2000	1769	NW corner	ground			NOT	TRIGGERED											
	17:00																		
	12/15/2000	1769	NE corner	ground	5230	2809	98.7	371.6	0.195	0.195	32	33.3	0.105	23.2	11.1	0.125	26.9	14.6	120
	12:05	1258	NE corner	first floor corner						0.105	18.2	20.8	0.14	21.3	24.5	0.145	18.9	19.3	
		1258	midwall	first floor north wall												0.26	17.6	7.1	
		930	N wall peak	second floor near roof peak						0.105	18.2	7.1	0.18	21.3	24.75	0.145	8.5	7.1	
		930	midwall	north wall												0.72	21.3	19.8	

Virginia

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	(ft/lb$^{1/2}$)	(ft/lb$^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	11/06/00	1769	NE corner	ground	1213	337	66.1	174.6	0.050	0.050	11.9	4.88	0.050	11.6	12	0.035	12.1	8.25	119
	15:58	1050	NE corner	S1						0.040	7.2	6.75	0.080	12.8	12	0.040	8.3	8	
		1050	N wall	mid-wall												0.145	18.2	20.13	
		1010	NE corner	S2						0.070	8.3	6.75	0.080	10.8	12	0.070	10.8	9.25	
		950	NW corner	S2						0.080	8.9	6.75	0.060	13.4	11.75	0.080	10.6	9.25	
	11/07/00	1769	NE corner	ground	1300	361	68.4	182.9	0.030	0.030	9.8	9.13	0.015	8.6	8.5	0.020	9.6	8	117
	15:41	1050	NE corner	S1						0.030	7.40	7.50	0.040		7.63	0.025	9.40	8.13	
		1050	N wall	mid-wall												0.125	18.90	9.25	
		1010	NE corner	S2						0.080	7.50	7.50	0.040		7.63	0.045	8.80	9.25	
		950	NW corner	S2						0.085	7.80	7.50	0.040	8.60	7.88	0.070	8.90	9.25	
	11/08/00	1769	NE corner	ground	1213	361	63.8	170.7	0.050	0.045	9.10	9.63	0.050	14.60	11.88	0.045	10.80	8.88	119
	15:46	1050	NE corner	S1						0.045	7.20	7.00	0.080	12.40	11.88	0.050	11.10	8.88	
		1050	N wall	mid-wall												0.135	18.90	21.63	
		1010	NE corner	S2						0.110	8.10	7.00	0.100	11.30	11.88	0.065	9.30	9.00	
		950	NW corner	S2						0.135	8.5	6.94	0.060	12.8	8.94	0.065	8.9	8.94	
TSA-VA	11/09/00	1769	NE corner	ground	1300	313	73.5	191.8	0.050	0.045	6.8	9.13	0.045	6.8	8.5	0.050	10.8	8.25	119
	11:56	1050	NE corner	S1						0.050	6.1	7.13	0.080	8.2	8.25	0.045	15.5	8.13	
		1050	N wall	mid-wall												0.245	18.2	8.25	
		1010	NE corner	S2						0.080	6.8	7.5	0.080	7.2	8.25	0.085	8.3	8.13	
		950	NW corner	S2 (3-component)						0.105	6.4	7.5	0.085	8	8.38	0.100	8.3	8.19	
	11/10/00	1769	NE corner	ground	1273	361	67.0	179.1	0.050	0.045	9.4	9.75	0.050	11.1	10.38	0.030	13.1	7.75	119
	12:21	1050	NE corner	S1						0.040	8.3	7	0.080	15.5	10.38	0.050	14.2	7.13	
		1050	N wall	mid-wall												0.190	17	21.13	
		1010	NE corner	S2						0.120	9.8	7.13	0.100	11.1	10.38	0.075	8.2	9.63	
		950	NW corner	S2 (3-component)						0.130	7.3	7.13	0.075	10.6	7.13	0.090	9.1	9.63	
	11/11/00	1769	NE corner	ground	1212	361	63.8	170.6	0.060	0.055	12.8	5.88	0.060	9.8	6	0.045	9.4	6.25	128
	13:49	1050	NE corner	S1						0.060	8.1	6	0.080	11.6	6.13	0.055	8.5	6.13	
		1050	N wall	mid-wall												0.375	7.7	21.25	
		1010	NE corner	S2						0.090	7.7	7.38	0.080	10	6.13	0.090	7.8	6.13	
		950	NW corner	S2 (3-component)						0.100	6.8	7.38	0.075	9.8	6.38	0.105	7.8	6.38	
	11/06/00	1770	NE corner	ground	1390	337	75.7	200.1	0.045	0.045	23.2	9.75	0.035	14.2	5.38	0.035	23.2	10.31	118
	15:58	930	NE corner	S1						nm			nm			nm			
		1513	NE corner	S1 (3-component)						0.040	14.6	4.75	0.045	19.6	23	0.035	10.6	10.25	
		1258	NE corner	S2						0.070	10.8	10.31	0.060	24.3	23	0.070	7.8	10.13	
		1258	N wall	mid-wall												0.190	9.8	10.31	
		1514	NE corner	S2 (3-component)						0.060	8.6	10.25	0.050	24.3	23	0.060	9.1	10.25	
	11/07/00	1770	NE corner	ground			NOT	TRIGGERED											
	11/08/00	1770	NE corner	ground	1360	361	71.6	191.4	0.045	0.045	8.6	11.75	0.035	16.5	5.5	0.040	17.6	5.63	116
	15:46	930	NE corner	S1						0.040	8.000	5.63	0.060	22.2	5.63	0.045	17	4.88	
		1513	NE corner	S1 (3-component)						0.040	7.4	5.25	0.055	14.2	5.63	0.040	8.2	5.63	
		1258	NE corner	S2						0.060	7.7	5.69	0.060	17.6	5.63	0.060	8.6	7.06	
		1258	N wall	mid-wall												0.195	9.6	7.13	
		1514	NE corner	S2 (3-component)						0.060	7.8	7.13	0.055	13.8	5.63	0.055	8.2	5.63	
	11/09/00	1770	NE corner	ground	1370	313	77.4	202.2	0.060	0.060	19.6	19.88	0.045	14.6	7.88	0.035	19.6	2	116
C1S-VA	11:56	930	NE corner	S1						0.025	15.5	2	0.040		8.13	0.055	22.2	22.38	
		1513	NE corner	S1 (3-component)						0.035	5.8	7.63	0.050	12.4	7.88	0.035	18.2	10.38	
		1258	NE corner	S2						0.035	16.5	7	0.060	14.2	8.88	0.070	8.3	7.63	
		1258	N wall	mid-wall												0.275	11.1	12.63	
		1514	NE corner	S2 (3-component)						0.065	15.5	7.63	0.050	13.4	7.88	0.040	14.6	7	
	11/10/00	1770	NE corner	ground	1375	361	72.4	193.5	0.060	0.060	19.6	11.5	0.035	21.3	5.5	0.040	22.2	9.63	119
	12:21	930	NE corner	S1						0.035	10.6	10.38	0.040		25.25	0.050	15.5	5.5	
		1513	NE corner	S1 (3-component)						0.045	16	5.5	0.040	20.4	11.75	0.040	9.3	10.5	
		1258	NE corner	S2						0.060	10	10.5	0.060	21.3	5.63	0.065	7.7	10.38	
		1258	N wall	mid-wall												0.310	7.8	10.5	
		1514	NE corner	S2 (3-component)	1375	361	72.4	193.5		0.600	7.8	10.38	0.045	22.2	5.5	0.065	9.6	10.5	
	11/11/00	1770	NE corner	ground					0.045	0.045	18.2	5.88	0.045	7.1	5.88	0.045	9.6	5.75	126
	13:49	930	NE corner	S1						0.055	9.1	5.880	0.060	19.6	6	0.070	14.6	5.88	
		1258	NE corner	S2						0.090	8.5	5.88	0.060	8.8	5.88	0.090	7.2	6.13	
		1258	N wall	mid-wall												0.450	9.6	10.63	
		1514	NE corner	S2 (3-component)						0.080	7.5	6	0.060	9.3	5.88	0.085	7.6	5.88	

West Virginia Site 1																				
Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	(ft/lb$^{1/2}$)	(ft/lb$^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	11/27/2000	1769	NE corner	ground	2500	1037	77.6	247.6	0.07	0.045	11.9	15.2	0.045	11.3	11.8	0.07	11.1	12.1	117
	16:59	1258	NE corner	S1						0.04	10.6	15.4	0.06	15	11.9	0.06	12.1	12.1	
		1258	N wall	mid-wall												0.11	15.5	12.1	
		930	NE corner	S2						0.065	4.5	4.4	0.18	14.2	13.0	0.095	10.4	7.3	
		930	E wall	mid-wall												0.085	4.6	4.4	
	11/28/2000	1769	NE corner	ground		NOT	TRIGGERED												
	17:02																		
	11/29/2000	1769	NE corner	ground	4300	2076	94.4	337.9	0.04	0.04	17.6	13.2	0.01		13.3	0.04	16.5	13.1	106
	9:56	1258	NE corner	S1						0.03	20.4	13.2	0.02		13.0	0.045	13.8	13.1	
W3S-VW1		1258	N wall	mid-wall												0.09	16.5	15.4	
		930	NE corner	S2						0.04	6.7	4.2	0.12	16.5	13.3	0.05	16.5	7.1	
		930	E wall	mid-wall												0.05	8.9	4.2	
	11/29/2000	1769	NE corner	ground		NOT	TRIGGERED												
	17:00																		
	11/30/2000	1769	NE corner	ground	3880	2076	85.2	304.9	0.06	0.06	13.8	13.5	0.04	21.3	13.6	0.05	15.5	12.7	110
	11:57	1258	NE corner	S1						0.055	11.9	13.6	0.06	19.6	13.6	0.05	12.1	12.6	
		1258	N wall	mid-wall												0.14	16	12.7	
		930	NE corner	S2						0.05	7.1	4.3	0.16	15	13.4	0.065	13.1	12.6	
		930	E wall	mid-wall												0.07	8.3	4.3	
	11/27/2000	1770	SE corner	ground	3400	1037	105.6	336.7	0.09	0.065	13.1	11.6	0.055	17	18.5	0.09	13.4	13.1	114
	16:58	1010	SE corner	S1						0.095	13.1	13.1	0.1	22.2	18.4	0.08	11.9	11.7	
		1010	E wall	mid-wall						0.29	16	15.7							
		1050	SE corner	S2						0.08	14.6	13.1	0.1	23.2	18.4	0.11	10.8	7.6	
		1050	S wall	mid-wall												0.24	16.5	13.1	
	11/28/2000	1770	SE corner	ground	2410	126	214.7	481.5	0.025	0.02	18.2	12.0	0.01		2.7	0.025	16.5	12.4	106
	17:02	1010	SE corner	S1						0.025	15.5	12.8	0.045	11.6	5.9	0.025	10.4	12.3	
		1010	E wall	mid-wall						0.045	11.6	11.6							
		1050	SE corner	S2						0.03	17	7.8	0.02		12.8	0.03	9.4	7.9	
		1050	S wall	mid-wall												0.06	17	15.6	
	11/29/2000	1770	SE corner	ground	4640	2076	101.8	364.7	0.075	0.075	15	11.4	0.035	18.2	2.1	0.04	20.4	14.8	106
	9:56	1010	SE corner	S1						0.045	18.2	14.8	0.08	19.6	14.8	0.09	17.6	11.5	
		1010	E wall	mid-wall						0.195	17	19.0							
		1050	SE corner	S2						0.07	18.2	19.2	0.06	23.2	14.6	0.075	8.1	7.8	
		1050	S wall	mid-wall												0.21	18.2	19.1	
L1S-WV1	11/29/2000	1770	SE corner	ground	2240	234	146.4	364.2	0.03	0.025	16	12.3	0.02	11.9	2.6	0.03	14.2	12.6	116
	17:02	1010	SE corner	S1						0.035	13.4	12.6	0.040		7.9	0..03	14.6	12.3	
		1010	E wall	mid-wall						0.085	16.5	13.3							
		1050	SE corner	S2						0.045	10.6	7.8	0.02		7.9	0.05	8.5	7.6	
		1050	S wall	mid-wall												0.075	17	13.2	
	11/30/2000	1770	SE corner	ground	4420	2076	97.0	347.4	0.07	0.07	13.1	11.9	0.05	18.2	18.3	0.05	13.1	12.4	110
	11:55	1010	SE corner	S1						0.06	17	12.4	0.1	20.4	18.3	0.075	17.6	11.9	
		1010	E wall	mid-wall						0.23	14.2	14.7							
		1050	SE corner	S2						0.065	17	12.6	0.08	24.3	18.3	0.08	10.4	8.1	
		1050	S wall	mid-wall												0.24	17.6	19.5	
	12/1/2000	1770	SE corner	ground	2400	144	200.0	458.6	0.025	0.02	15.5	11.8	0.1		3.8	0.025	14.2	12.5	110
	17:06	1010	SE corner	S1						0.025	15.5	12.6	0.02		8.1	0.025	16	7.7	
		1010	E wall	mid-wall						0.06	17	13.6							
		1050	SE corner	S2						0.025	18.2	8.1	0.065	17.6	19.4	0.03	9.6	7.8	
		1050	S wall	mid-wall												0.065	17.6	19.4	

West Virginia Site 2

Structure	Shot Date and Time	Unit	Structure Location	Placement of Transducer(s)	Distance	Charge Weight/Delay	Scaled Distance	Scaled Distance	Peak Particle Velocity	T	Peak Frequency	FFT Frequency	V	Peak Frequency	FFT Frequency	R	Peak Frequency	FFT Frequency	Airblast
					(ft)	(lb)	(ft/lb$^{1/2}$)	(ft/lb$^{1/3}$)	(in/sec)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(in/s)	(Hz)	(Hz)	(dB)
	12/4/2000	1769	NW corner	ground	1870	481	85.3	239.2	0.095	0.095	10.6	7.3	0.085	13.1	7.25	0.09	12.4	7.3	112
	12:23	930	N end-middle	S1						0.305	8.9	7.3	0.12	16.5	7.19	0.085	7.6	7.3	
		930	W wall	mid-wall						0.49	8.6	7.3							
		1258	N end-middle	S2						0.39	7.5	7.3	0.14	15	7.25	0.135	9.1	7.2	
		1258	N wall	mid-wall												0.285	21.3	25.0	
	12/4/2000	1769	NW corner	ground	2410	415	118.3	323.7	0.06	0.055	23.2	6.9	0.05	25.6	14.4	0.06	16.5	6.4	112
	5:01	930	N end-middle	S1						0.075	16.5	7.1	0.08	20.4	14.3	0.04	16	6.4	
		930	W wall	mid-wall						0.115	15	7.1							
		1258	N end-middle	S2						0.065	6	7.1	0.08	23.2	15.9	0.08	11.9	11.2	
		1258	N wall	mid-wall												0.175	24.3	24.4	
	12/5/2000	1769	NW corner	ground	2600	973	83.4	263.0	0.05	0.04	14.6	8.9	0.035	15.5	8.5	0.05	6.8	6.3	117
	12:05	930	N end-middle	S1						0.08	11.9	6.8	0.06	22.2	14.1	0.045	9.4	6.3	
		930	W wall	mid-wall						0.11	13.8	6.8							
		1258	N end-middle	S2						0.085	8.9	6.8	0.08	18.9	14.25	0.065	7.4	6.3	
		1258	N wall	mid-wall												0.12	16.5	6.3	
	12/5/2000	1769	NW corner	ground	2230	625	89.2	261.4	0.06	0.06	13.8	7.0	0.045	17	15.56	0.06	16	6.8	116
	16:54	930	N end-middle	S1						0.11	11.9	7.1	0.1	18.2	15.7	0.06	11.3	6.8	
		930	W wall	mid-wall						0.165	11.6	7.1							
		1258	N end-middle	S2						0.135	7.6	7.1	0.1	14.2	15.3	0.095	11.9	11.6	
		1258	N wall	mid-wall												0.16	24.3	7.1	
TD-WV2	12/5/2000	1769	NW corner	ground	2670	901	89.0	277.1	0.03	0.025	20.4	7.1	0.015	21.3	15.06	0.03	7.2	6.4	112
	16:55	930	N end-middle	S1						0.06	7.3	7.4	0.02		14.7	0.025	8.1	6.3	
		930	W wall	mid-wall						0.085	7	7.4							
		1258	N end-middle	S2						0.085	6.9	7.4	0.04		15.1	0.03	5.8	6.4	
		1258	N wall	mid-wall												0.055	22.2	6.5	
	12/6/2000	1769	NW corner	ground	2630	901	87.6	272.9	0.025	0.025	15.5	15.1	0.015	17	15	0.025	8.1	6.5	112
	12:22	930	N end-middle	S1						0.04	12.8	7.3	0.04		14.8	0.025	10.8	9.5	
		930	W wall	mid-wall						0.065	11.9	7.3							
		1258	N end-middle	S2						0.05	12.1	7.3	0.04		15.2	0.045	11.6	11.3	
		1258	N wall	mid-wall												0.065	23.2	11.3	
	12/6/2000	1769	NW corner	ground	1730	452	81.4	225.9	0.085	0.085	11.6	7.1	0.065	18.2	14.9	0.075	7.4	7.2	117
	16:52	930	N end-middle	S1						0.175	7.4	7.2	0.12	16	15	0.08	13.4	7.1	
		930	W wall	mid-wall						0.255	8.8	7.2							
		1258	N end-middle	S2						0.215	7.4	7.2	0.14	16	15	0.1	8.1	7.2	
		1258	N wall	mid-wall												0.295	22.2	24.3	
	12/7/2000	1769	NW corner	ground	2600	793	92.3	281.5	0.04	0.02	21.3	7.1	0.02	14.6	13.2	0.04	10.4	5.7	106
	12:13	930	N end-middle	S1						0.04	12.4	7.1	0.04		13	0.035	11.1	11.4	
		930	W wall	mid-wall						0.06	13.1	7.1							
		1258	N end-middle	S2						0.05	8.9	7.1	0.06	13.4	11.8	0.055	10.8	11.5	
		1258	N wall	mid-wall												0.09	21.3	11.5	
	12/4/2000	1770	NW corner	ground	1720	481	78.4	220.0	0.115	0.11	10.6	7.7	0.085	17.6	14.8	0.115	12.8	8.1	112
	12:23	1010	all horizotnal	upper corner/beam						0.155	8.9	7.4	0.115	13.1	8.13	0.19	11.9	7.5	
		1010	air channel	vertical on rafter									0.14	17.6	18.63				
		1050	all horizotnal	west wall/first floor						0.23	19.6	7.4	0.145	7.2	7.44	0.08	16.5	11.6	
		1050	air channel	vertical on post									0.145	7.2	7.44				
	12/4/2000	1770	NW corner	ground	2310	415	113.4	310.3	0.035	0.03	13.1	7.4	0.035	18.9	15.63	0.035	15.5	8.1	114
	5:01	1010	all horizotnal	upper corner/beam						0.055	20.4	6.4	0.04	22.2	6.06	0.055	19.6	6.4	
		1010	air channel	vertical on rafter									0.06	25.6	19.6				
		1050	all horizotnal	west wall/first floor						0.08	24.3	6.5	0.05	12.4	6.5	0.035	24.3	21.4	
		1050	air channel	vertical on post									0.04		19.56				
	12/5/2000	1770	NW corner	ground	2500	973	80.1	252.9	0.04	0.03	12.1	8.3	0.04	14.2	11.2	0.035	11.6	8.1	117
	12:05	1010	all horizotnal	upper corner/beam						0.055	13.1	5.2	0.055	5.8	6.63	0.07	16.5	6.5	
		1010	air channel	vertical on rafter									0.06	16	10.8				
		1050	all horizotnal	west wall/first floor						0.075	15	6.6	0.065	10.8	10.94	0.045	17	10.8	
		1050	air channel	vertical on post									0.04		10.81				
	12/5/2000	1770	NW corner	ground	2110	625	84.4	247.3	0.05	0.025	14.2	6.9	0.05	14.6	15.6	0.045	15	8.3	119
	4:54	1010	all horizotnal	upper corner/beam						0.06	6.8	6.3	0.065	6.6	6.75	0.065	6.4	6.3	
		1010	air channel	vertical on rafter									0.04		6.75				
		1050	all horizotnal	west wall/first floor						0.085	6.4	6.3	0.065	8	6.25	0.04	22.2	13.1	
		1050	air channel	vertical on post									0.04		6.8				
L2S-WV2	12/5/2000	1770	NW corner	ground	2550	901	85.0	264.6	0.025	0.015	30.1	8.3	0.025	18.9	14.7	0.02	18.9	8.4	117
	4:55	1010	all horizotnal	upper corner/beam						0.04	9.6	6.3	0.045	7.2	6.5	0.045	13.4	7.0	
		1010	air channel	vertical on rafter									0.04		11.8				
		1050	all horizotnal	west wall/first floor						0.055	19.6	7.1	0.03	23.2	7.06	0.02	22.2	11.9	
		1050	air channel	vertical on post									0.02		11.8				
	12/6/2000	1770	NW corner	ground	2510	901	83.6	260.5	0.025	0.02	13.1	13.4	0.025	18.2	15.1	0.025	14.6	8.2	114
	12:22	1010	all horizotnal	upper corner/beam						0.04	11.6	6.3	0.04	6.6	6.5	0.035	11.9	6.3	
		1010	air channel	vertical on rafter									0.04		14				
		1050	all horizotnal	west wall/first floor						0.045	10.6	6.3	0.04	11.6	6.25	0.025	19.6	12.3	
		1050	air channel	vertical on post									0.02		14				
	12/6/2000	1770	NW corner	ground	1610	452	75.7	210.2	0.09	0.09	10.6	7.3	0.075	15.5	15.31	0.065	15.5	8.6	120
	4:52	1010	all horizotnal	upper corner/beam						0.11	11.3	7.2	0.09	6.4	6.44	0.115	12.1	7.3	
		1010	air channel	vertical on rafter									0.08	20.4	8.2				
		1050	all horizotnal	west wall/first floor						0.135	18.2	7.2	0.115	12.4	7.2	0.06	24.3	12.5	
		1050	air channel	vertical on post									0.06	32	8.3				
	12/7/2000	1770	NW corner	ground	2480	793	88.1	268.5	0.03	0.02	25.6	3.8	0.025	14.6	13	0.03	14.2	8.1	106
	12:13	1010	all horizotnal	upper corner/beam						0.035	4.3	3.8	0.045	6	5.7	0.035	4	3.8	
		1010	air channel	vertical on rafter									0.04		11.4				
		1050	all horizotnal	west wall/first floor						0.045	28.4	3.8	0.035	5.8	10.94	0.025	5.3	12.8	
		1050	air channel	vertical on post									0.02		11				

APPENDIX IV

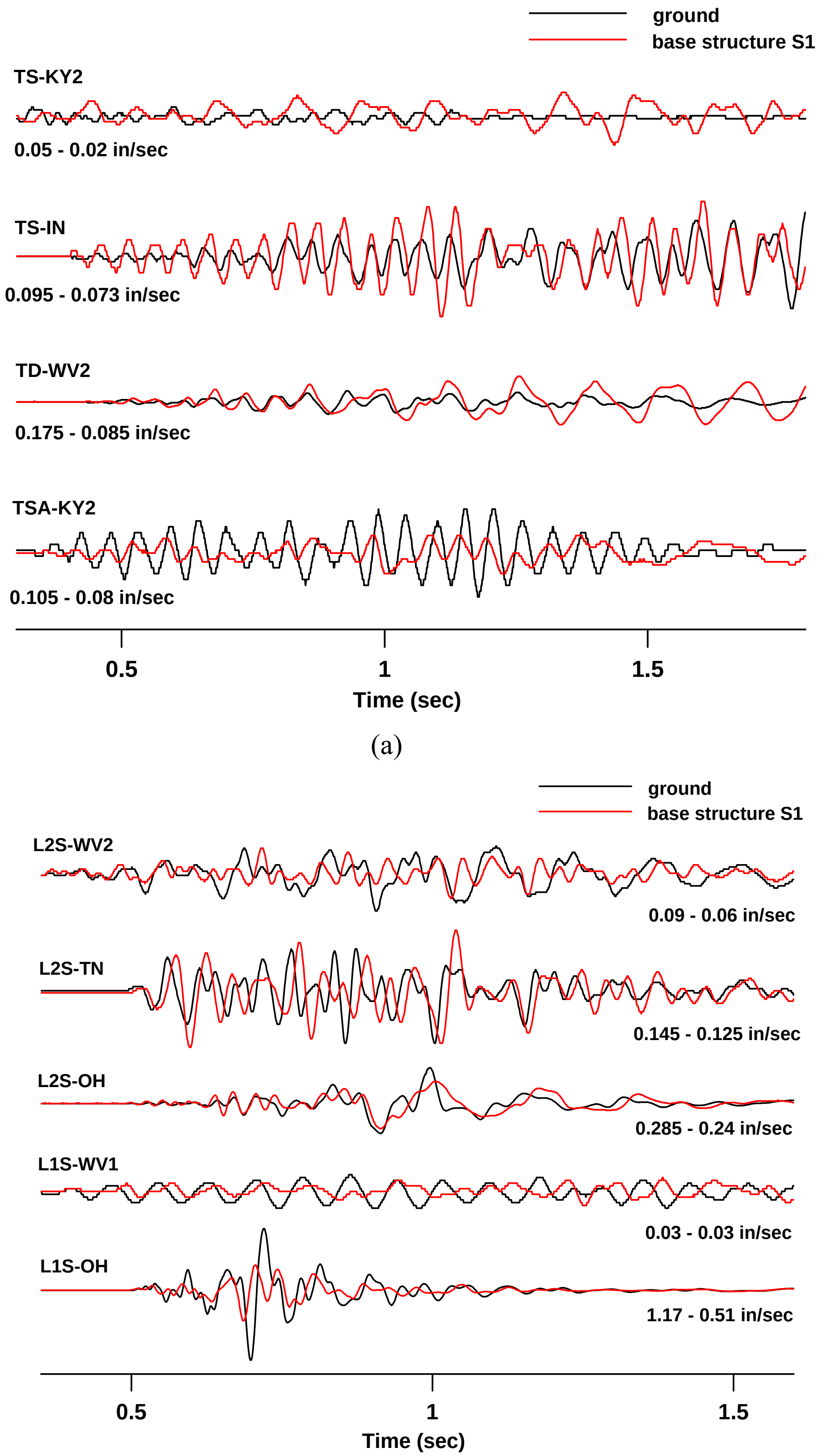
Typical Waveform Time Histories

Appendix IV contains typical ground motion, airblast, and time-correlated structure response time histories. Data for specific shots were selected based on the largest airblast and significant ground motion amplitudes resulting the in highest structures responses. These are considered to be representative "worst case" shot records in this study.

Peak velocities are provided for each waveform. In the case of superimposed waveforms, the range in velocities provided refers to the peak velocity for each waveform. For clarification, the reader is directed to Appendix III.

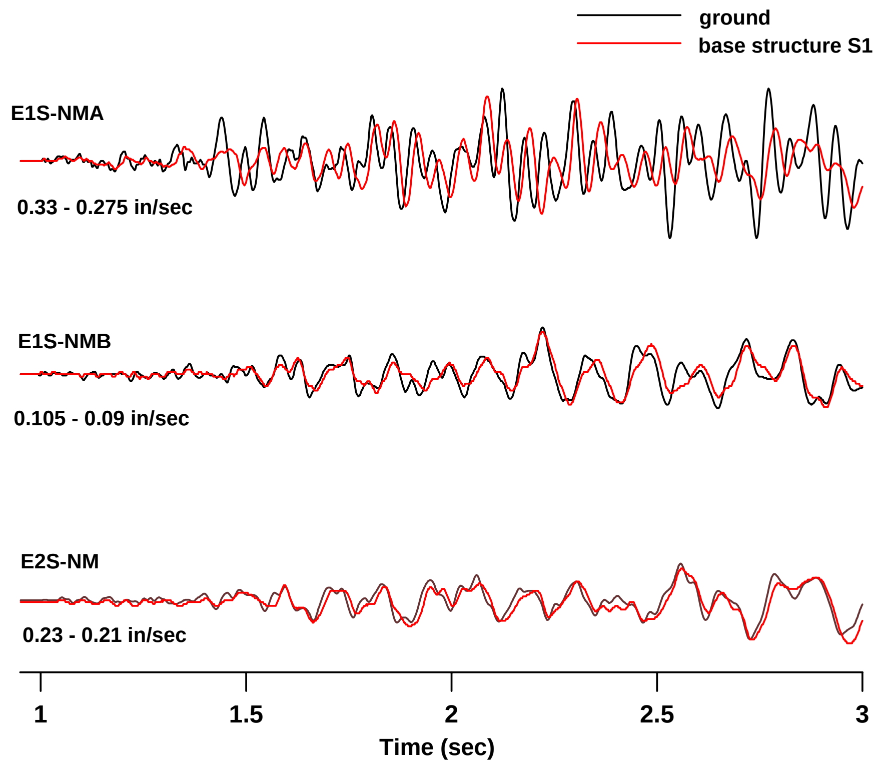
The following table summarized the structure designation, shot data and time for selected time histories:

Structure Design	Designation	Shot date	Shot time
Trailer	TS-KY2	11/21/00	15:35
	TS-IN	8/20/01	12:30
	TD-WV2	12/06/00	16:52
	TSA-KY	11/21/00	14:39
	TS-OH	3/28/00	16:23
Log	L2S-WV2	12/06/00	16:52
	L2S-TN	12/15/00	12:05
	L2S-OH	3/16/01	14:43
	L1S-WV1	11/29/00	17:02
	L1S-OH	3/16/01	14:42
Earth and masonry	E1S-NMA	7/26/01	14:55
	E1S-NMB	7/26/01	14:55
	E2S-NM	7/26/01	14:55
Camp	C1S-VA	11/11/00	13:49
	C2S-KYIA	11/15/00	11:48

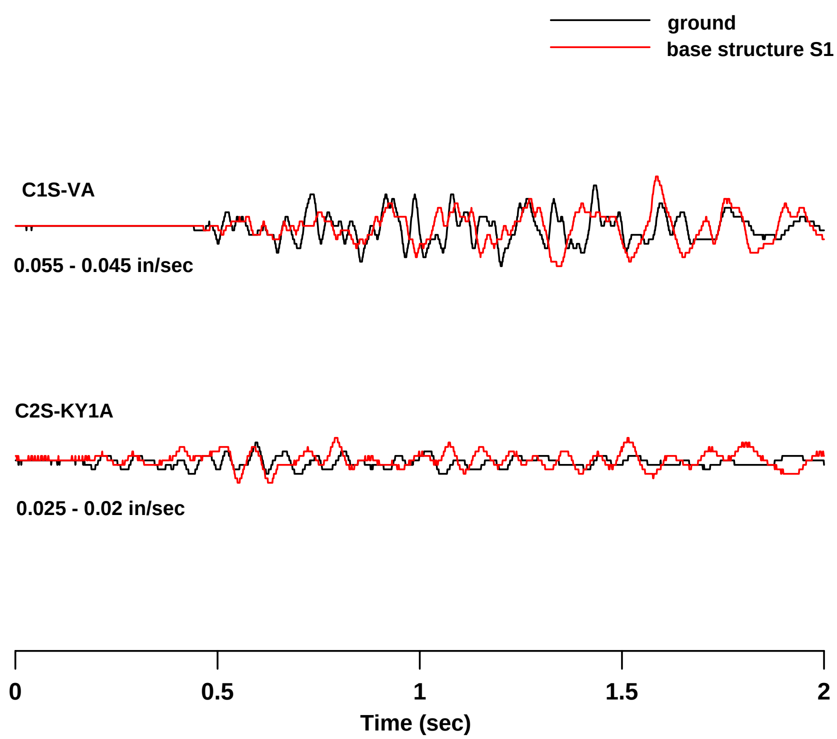


(b)

Figure IV-1 Horizontal components of ground motion and lower structure for (a) manufactured and (b) log structures

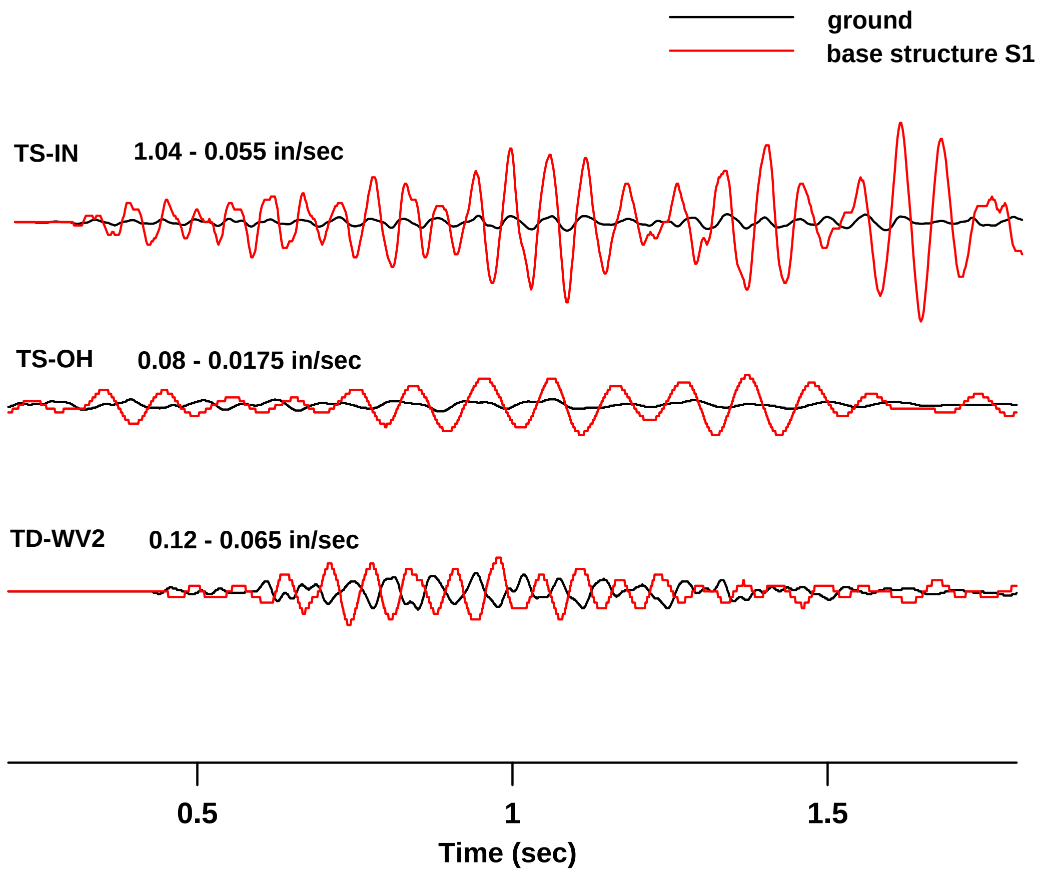


(c)



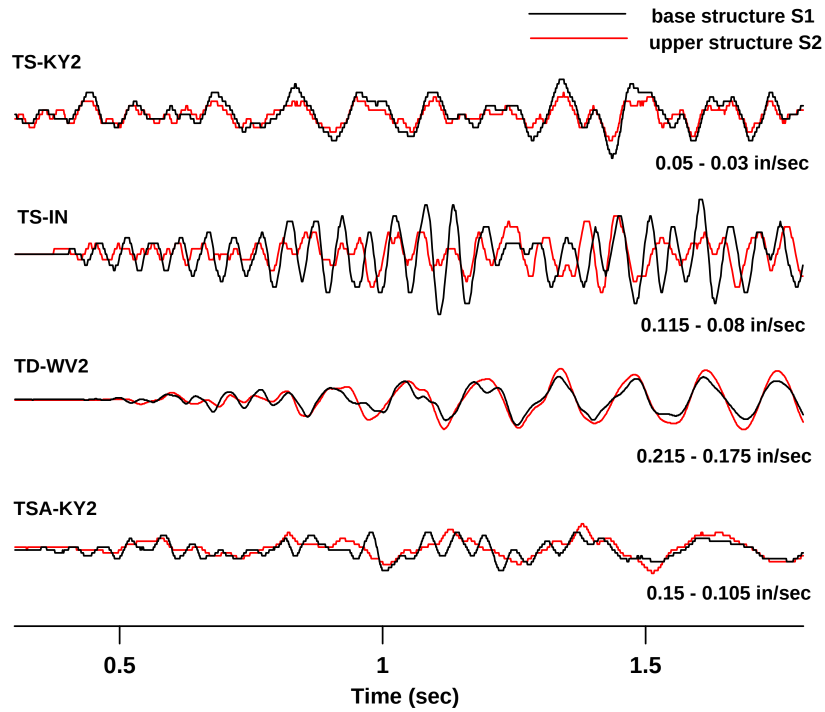
(d)

Figure IV-1 (cont.) Horizontal components of ground motion and lower structure for (c) earth and masonry and (d) camp structures

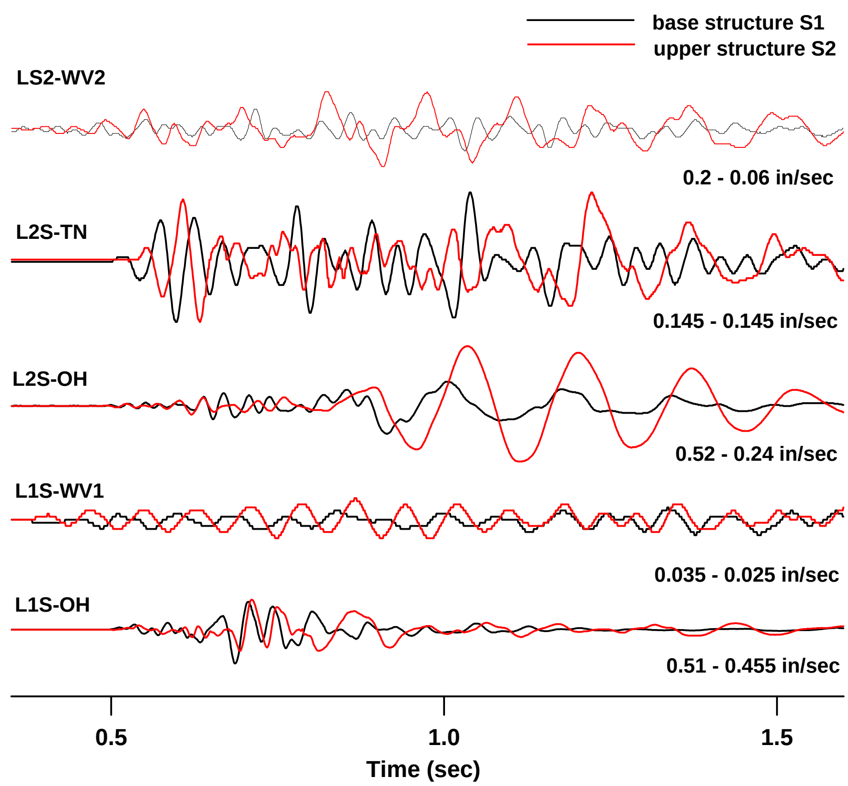


(e)

Figure IV-1 (cont.) Vertical components of ground motion and lower structure for (e) single and double wide trailers

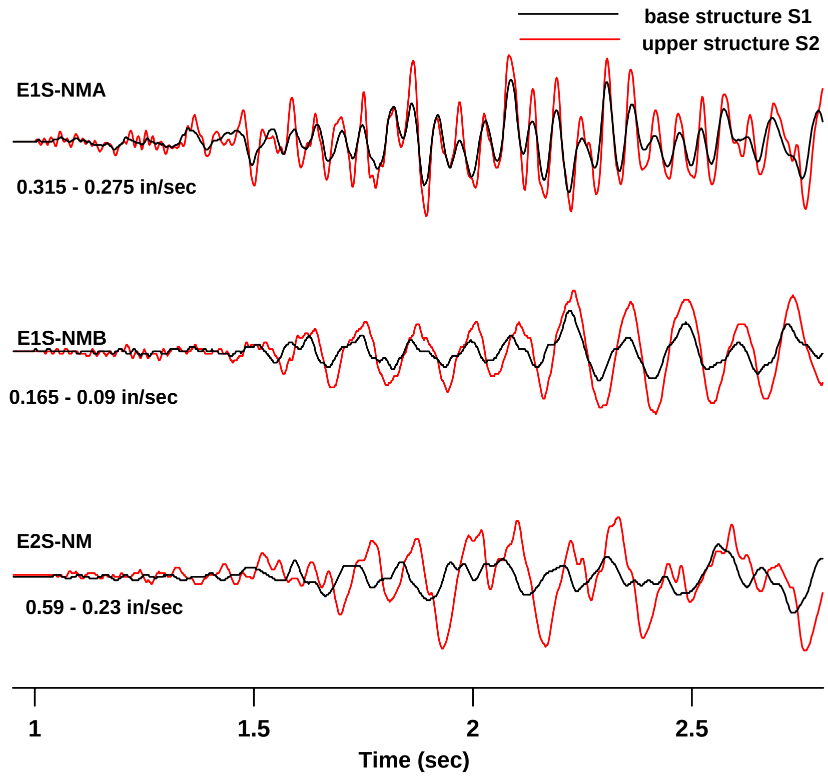


(a)

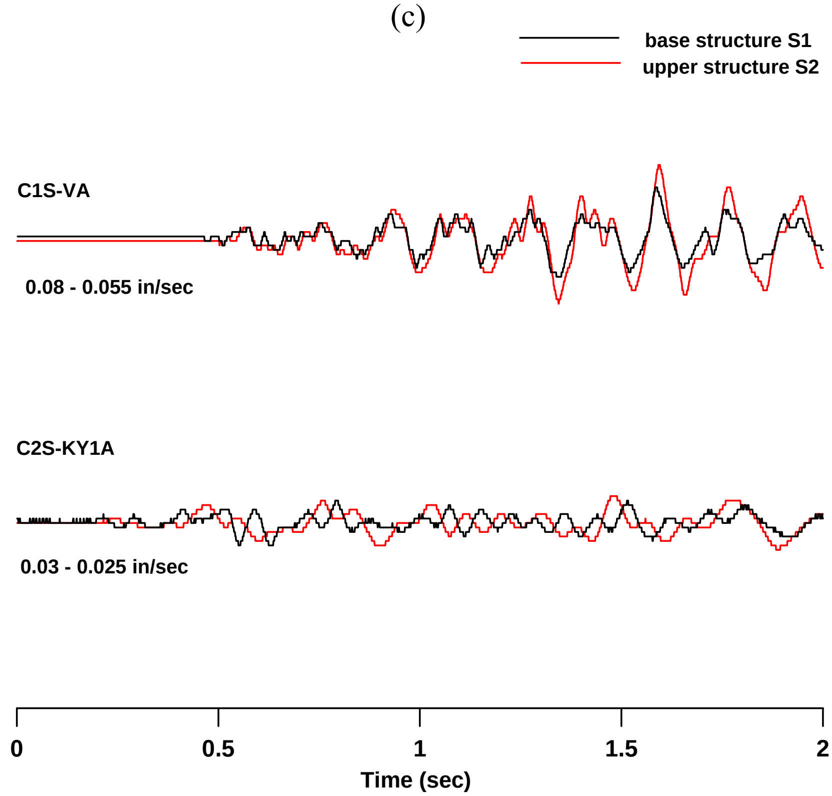


(b)

Figure IV-2 Horizontal components of lower and upper structure response for (a) manufactured and (b) log structures



(c)



(d)

Figure IV-2 Horizontal components of lower and upper structure response for (c)) earth and masonry and (d) camp structures

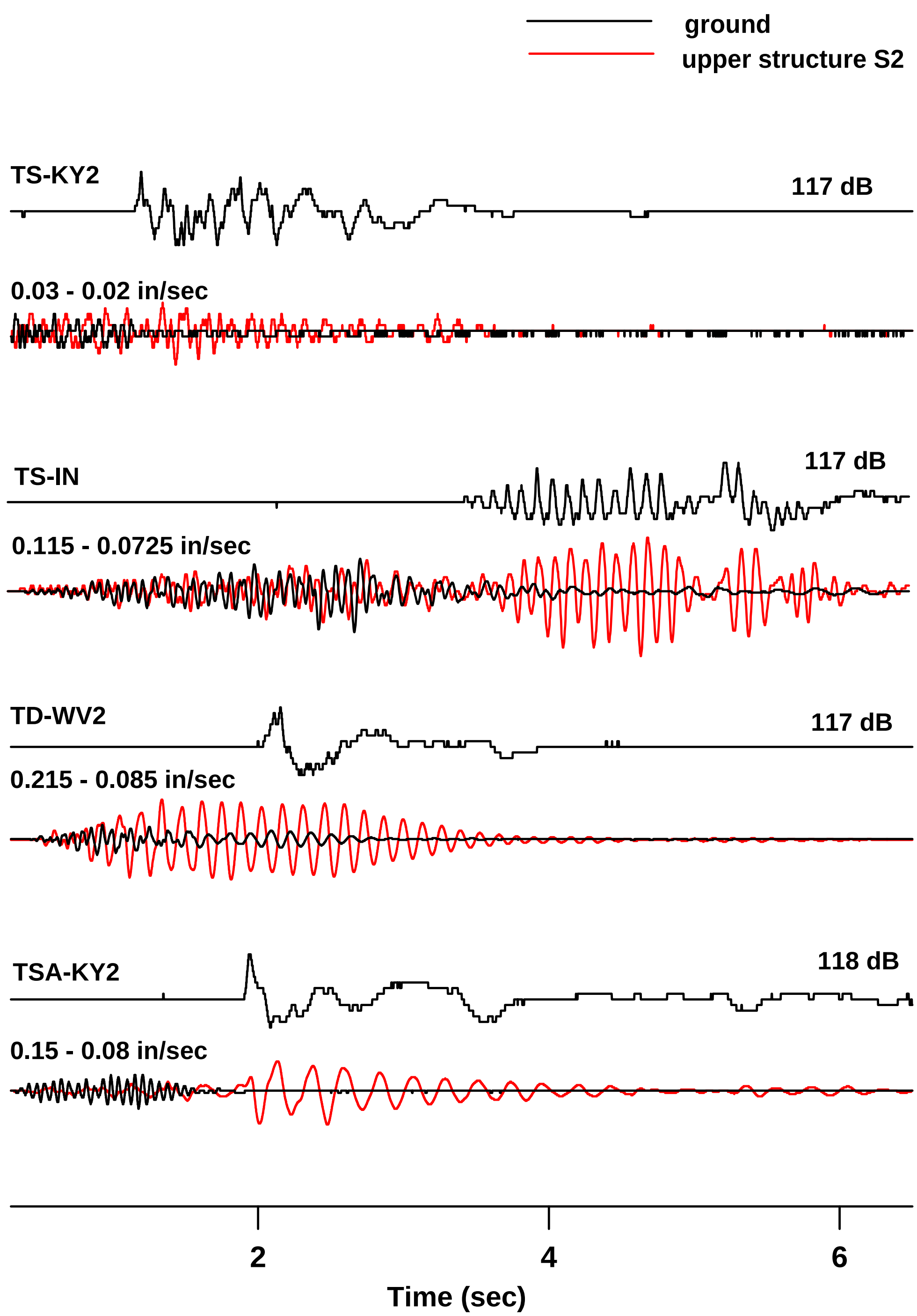


Figure IV-3 Horizontal components of ground motions and upper structure response and air overpressures for manufactured structures

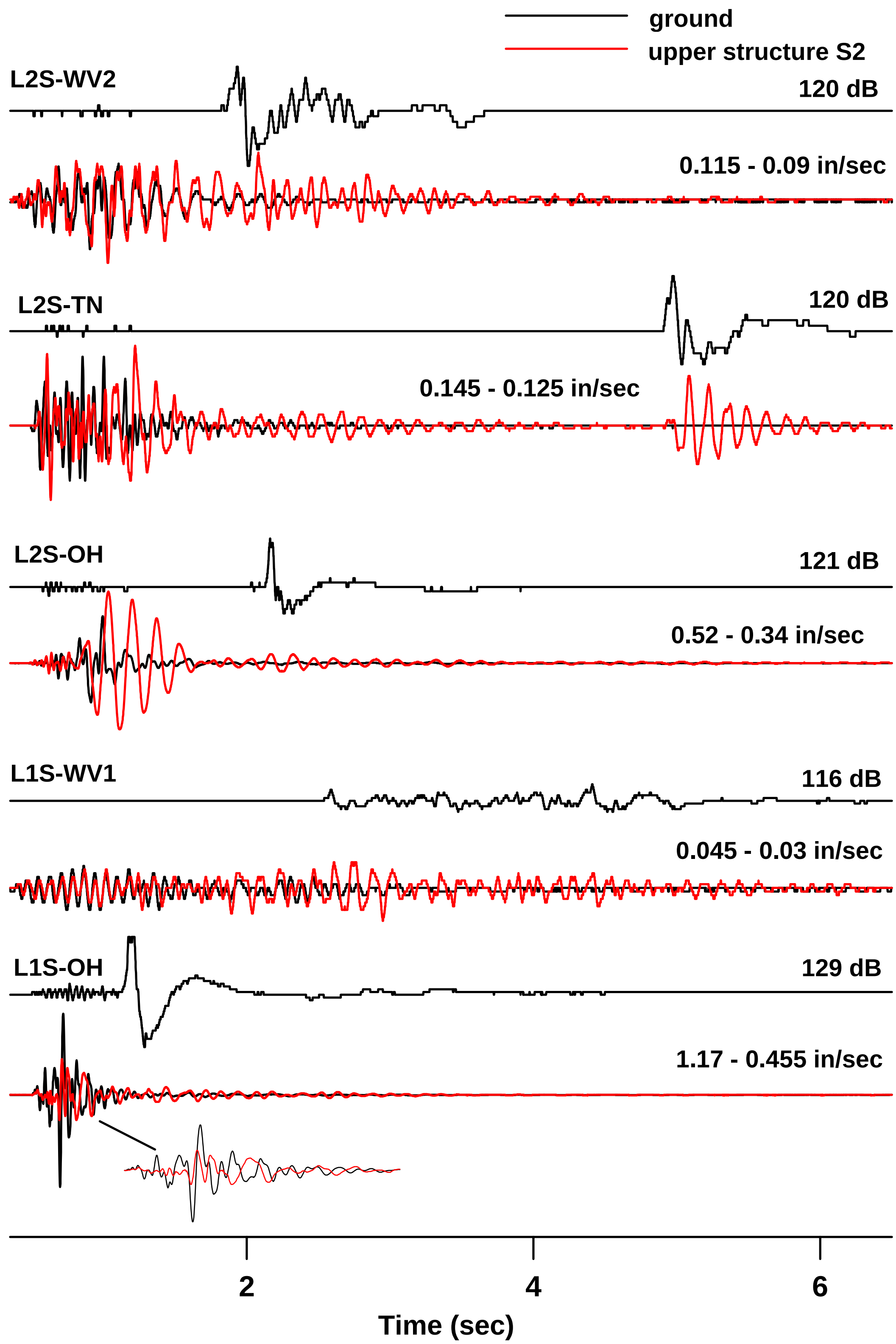


Figure IV-4 Horizontal components of ground motions and upper structure response and air overpressures for log structures

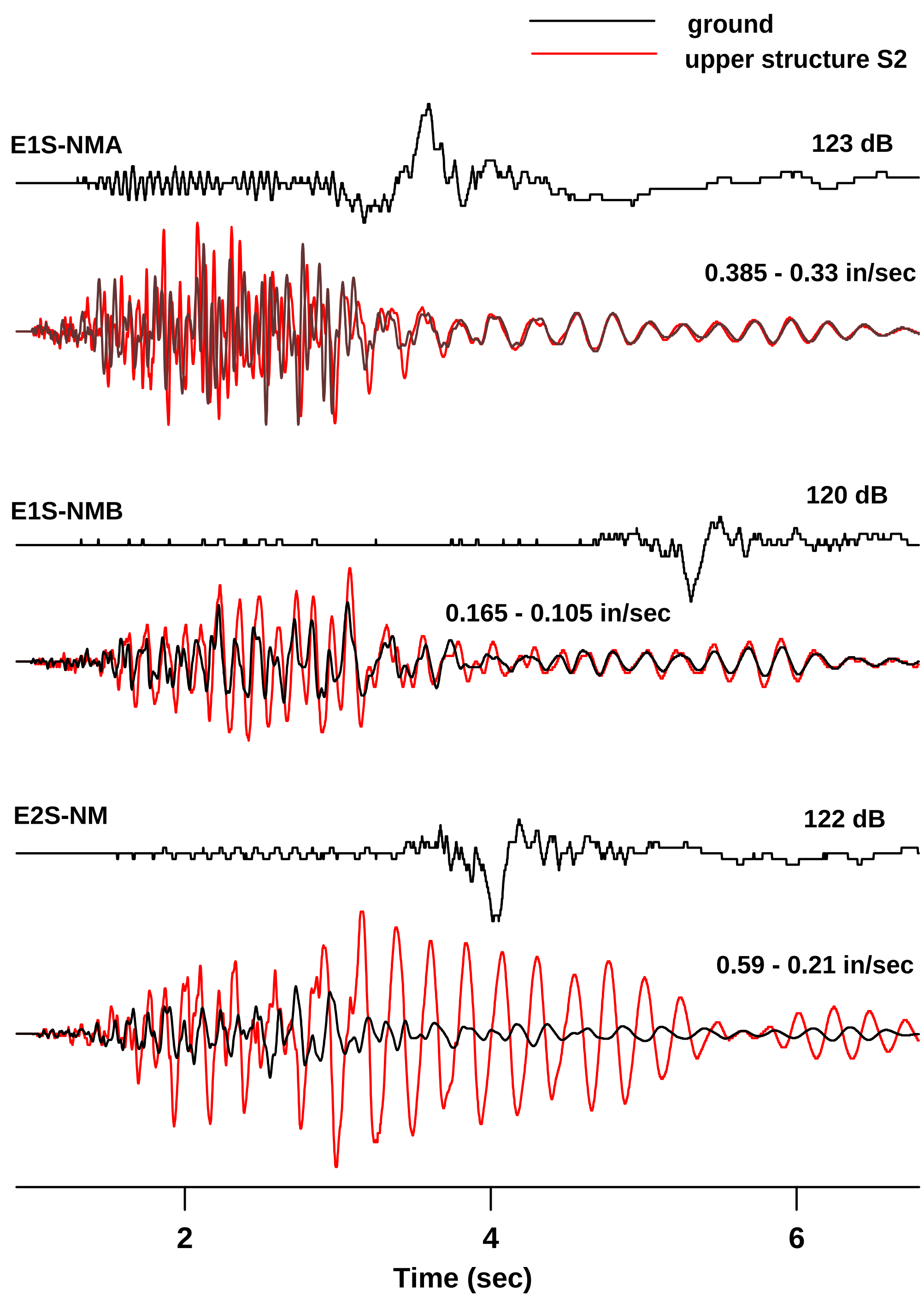


Figure IV-5 Horizontal components of ground motions and upper structure response and air overpressures for earth, masonry, and stone structures

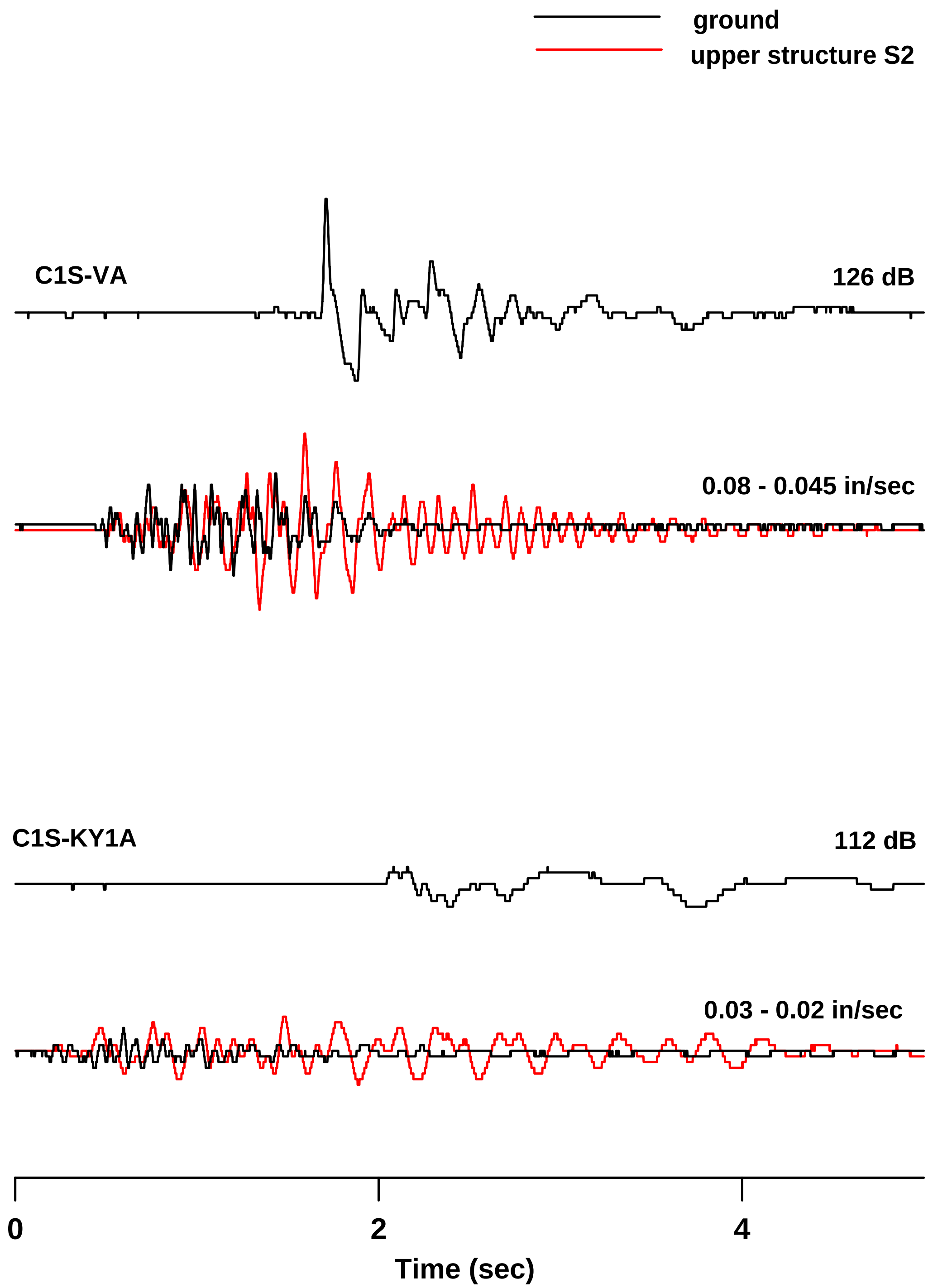


Figure IV-6 Horizontal components of ground motions and upper structure response and air overpressures for camp structures

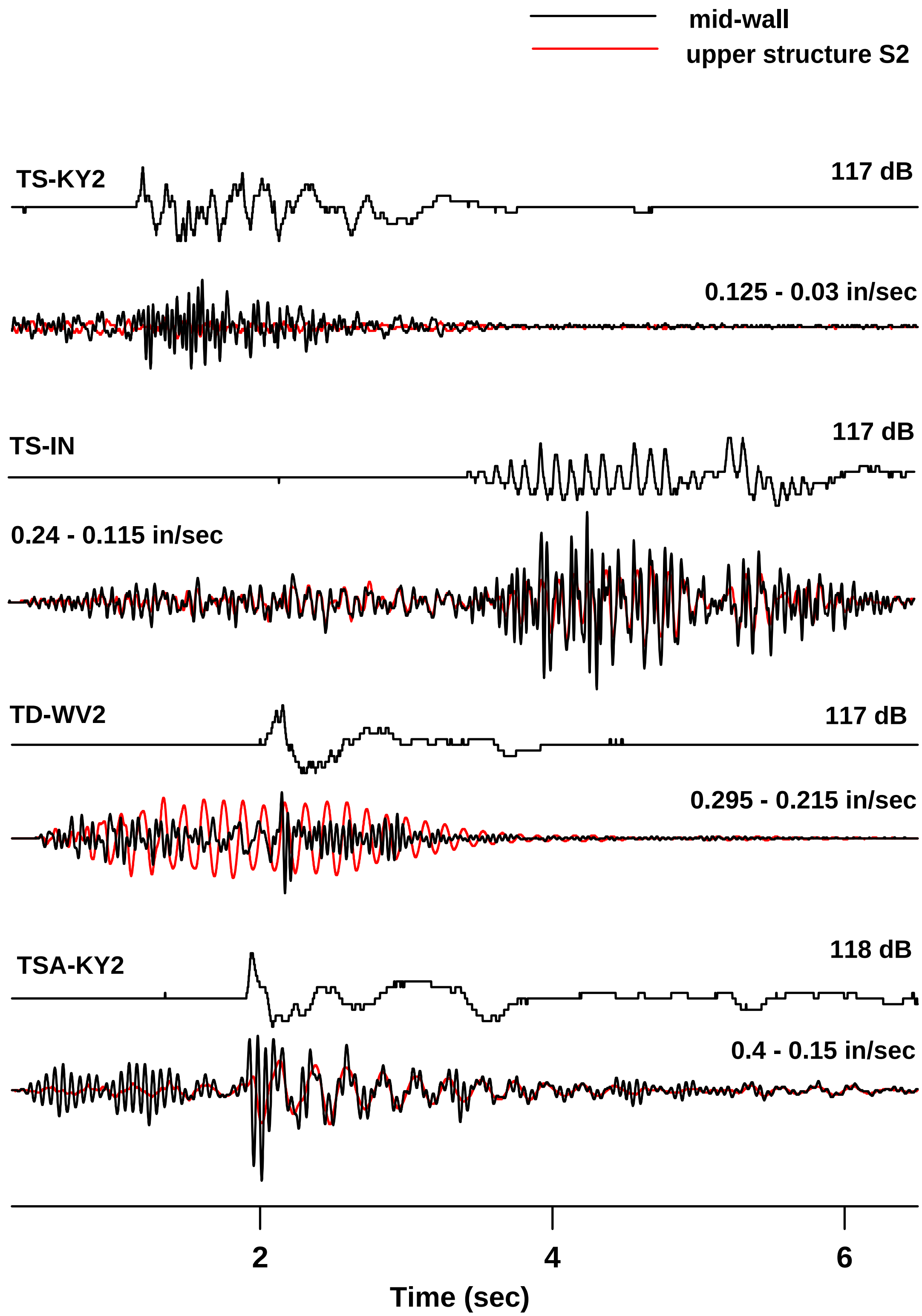


Figure IV-7 Horizontal components of upper structure and mid-wall responses and air overpressures for manufactured structures

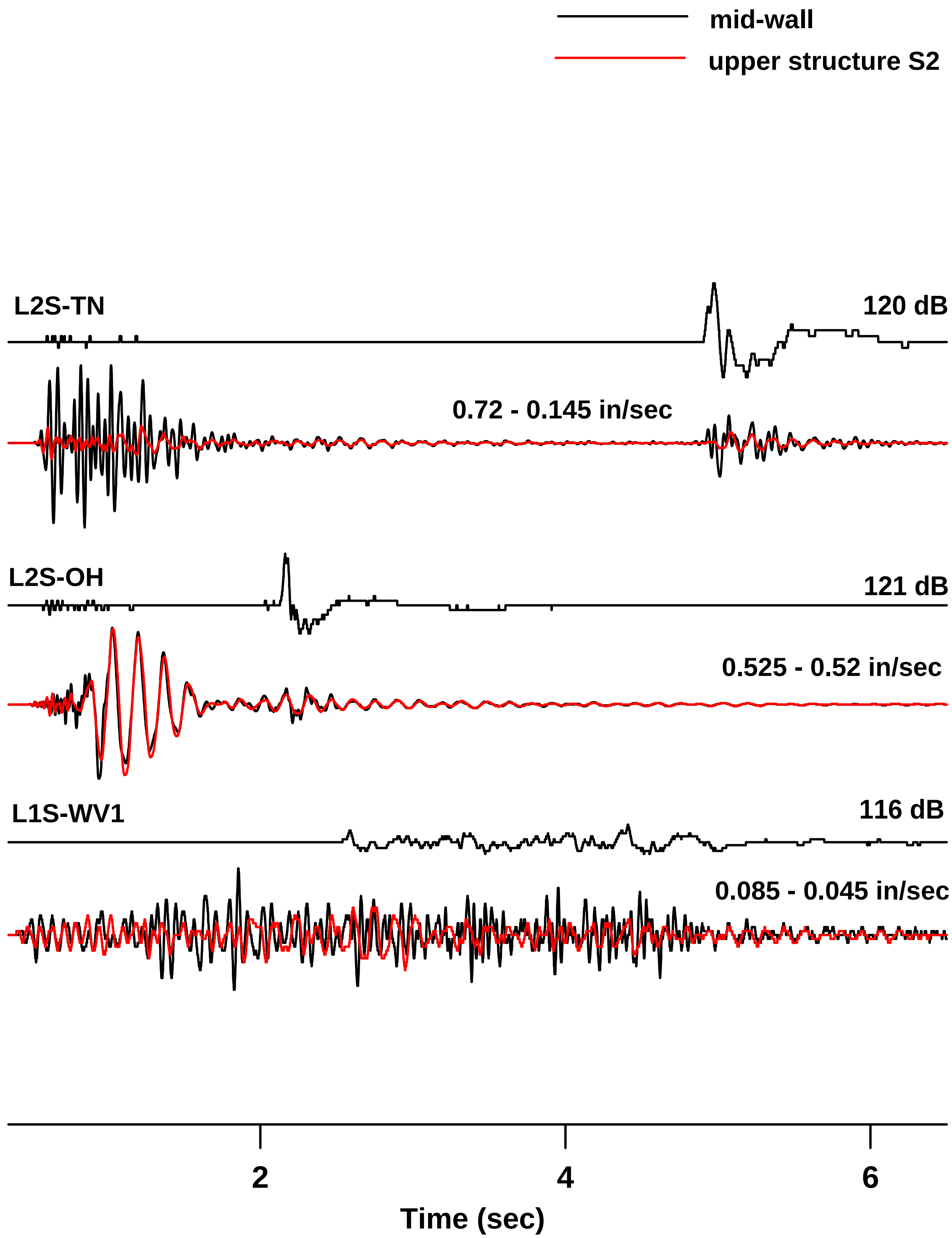


Figure IV-8 Horizontal components of upper structure and mid-wall responses and air overpressures for log structures

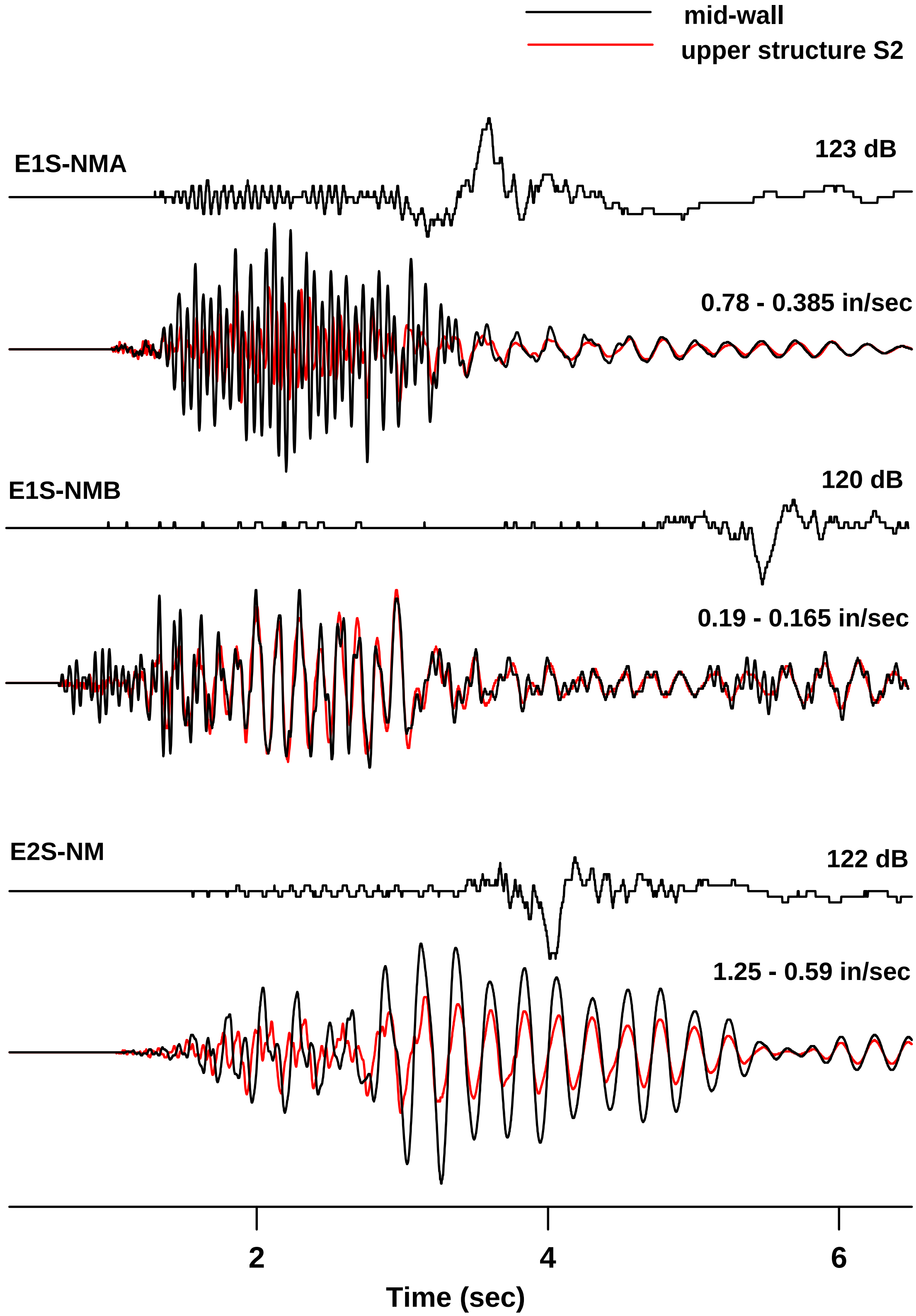


Figure IV-9 Horizontal components of upper structure and mid-wall responses and air overpressures for earth and masonry structures

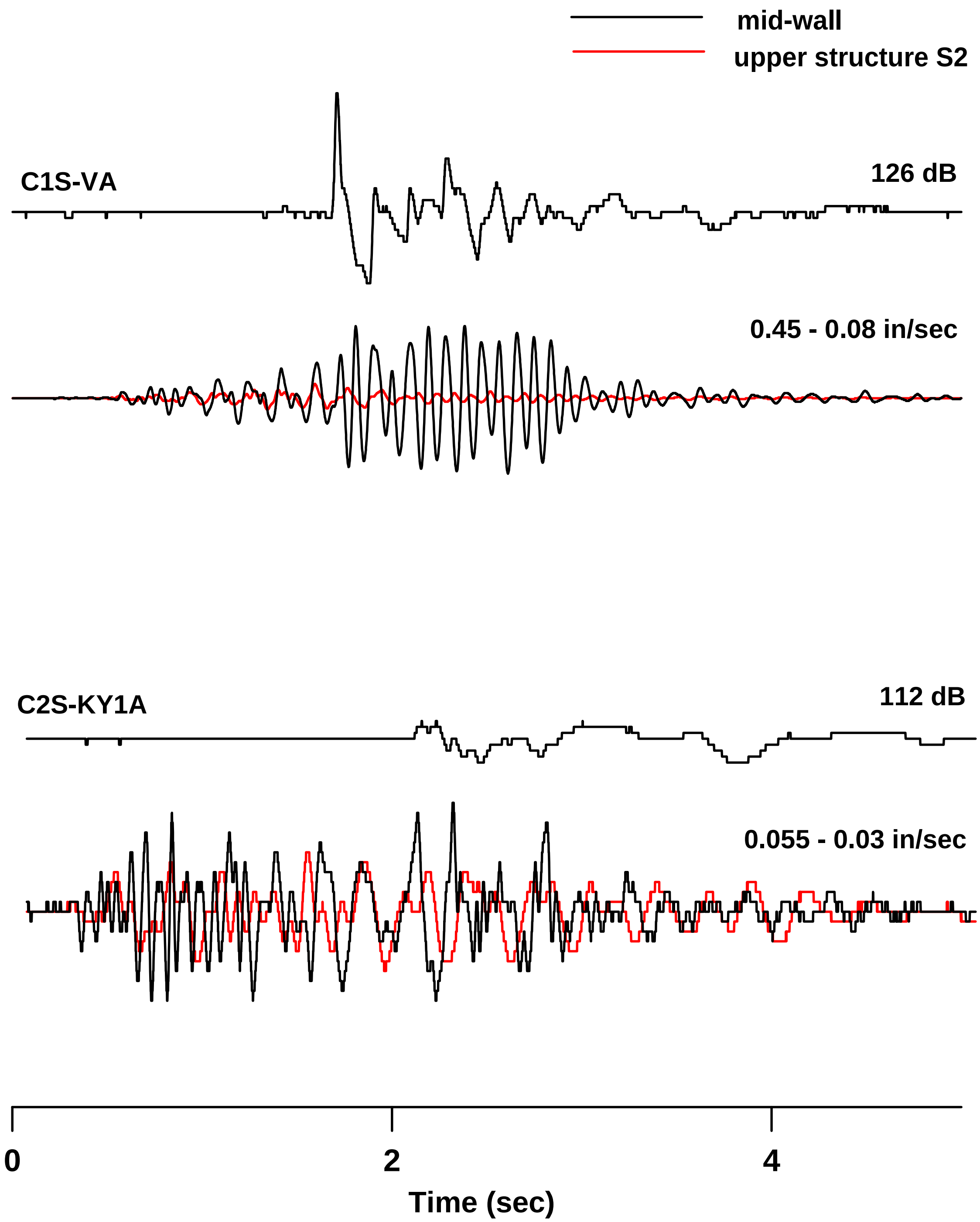
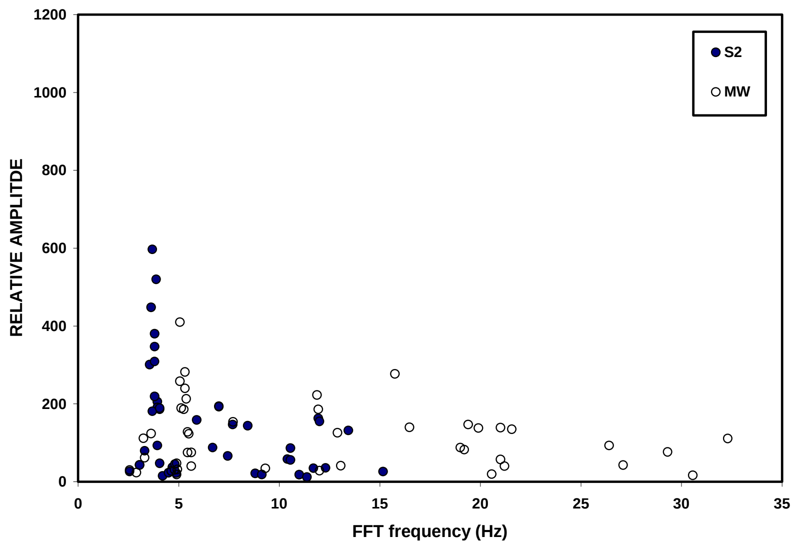


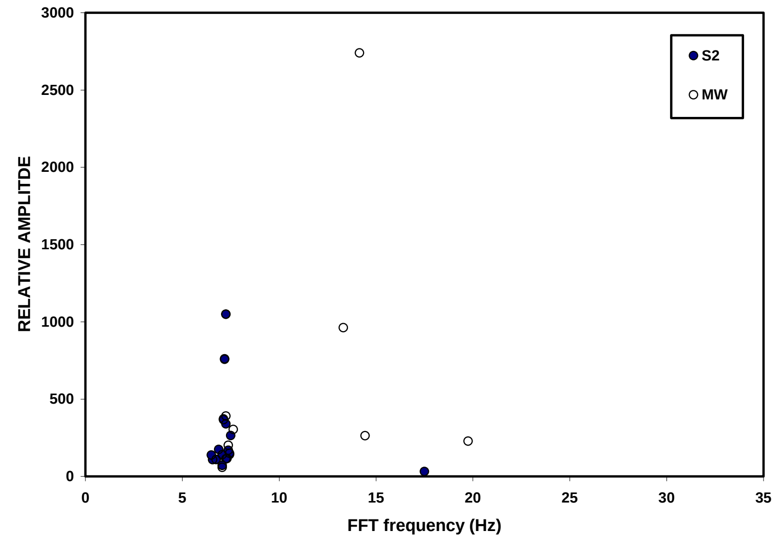
Figure IV-10 Horizontal components of upper structure and mid-wall responses and air overpressures for camp structures

APPENDIX V

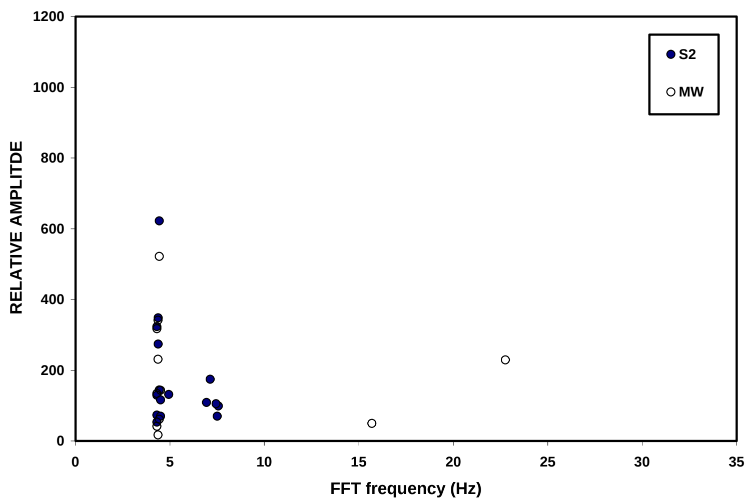
FFT Frequency Correlation Plots



(a)

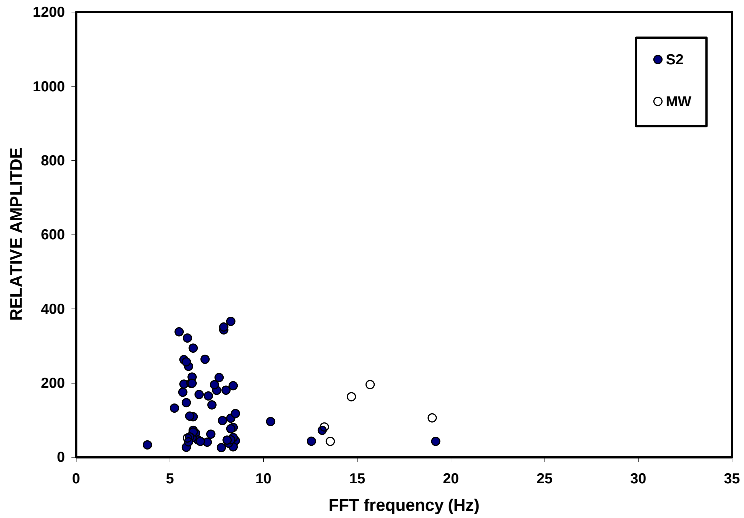


(b)

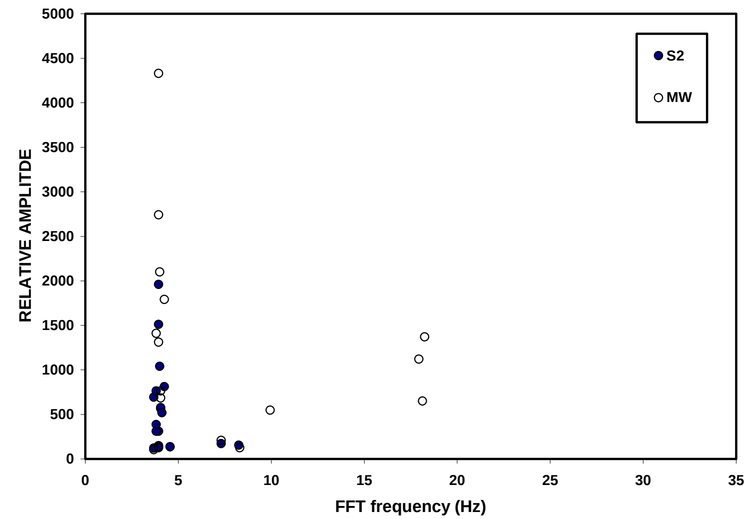


(c)

Figure V-1 Trailer responses for (a) single-wide, (b) double-wide and (c) wood frame add-on structures in the transverse direction



(a)



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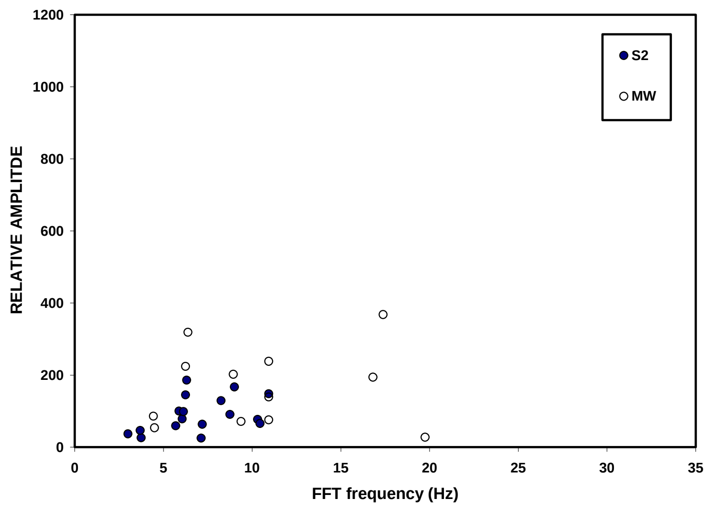

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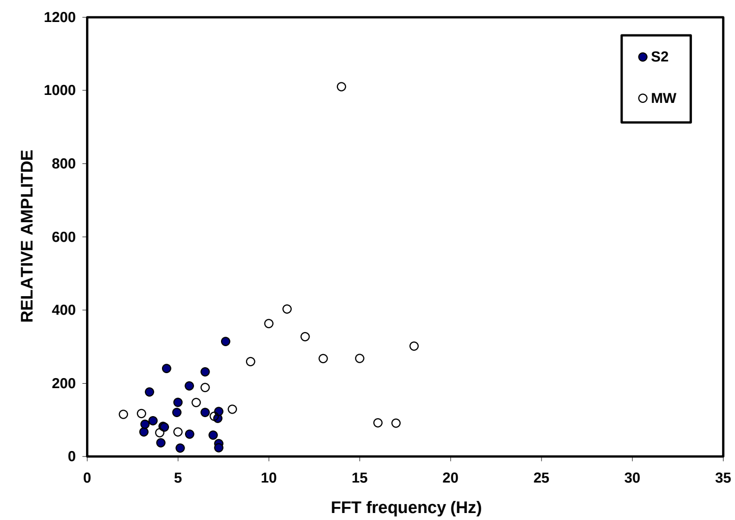
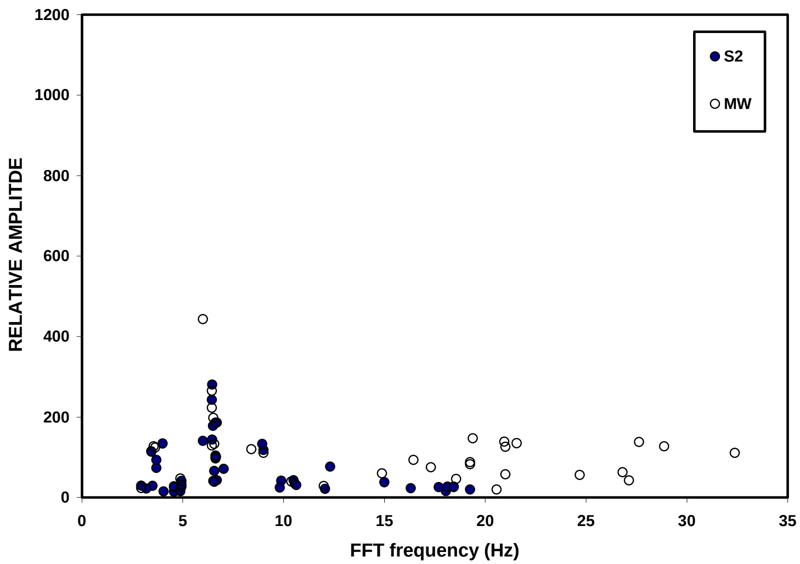
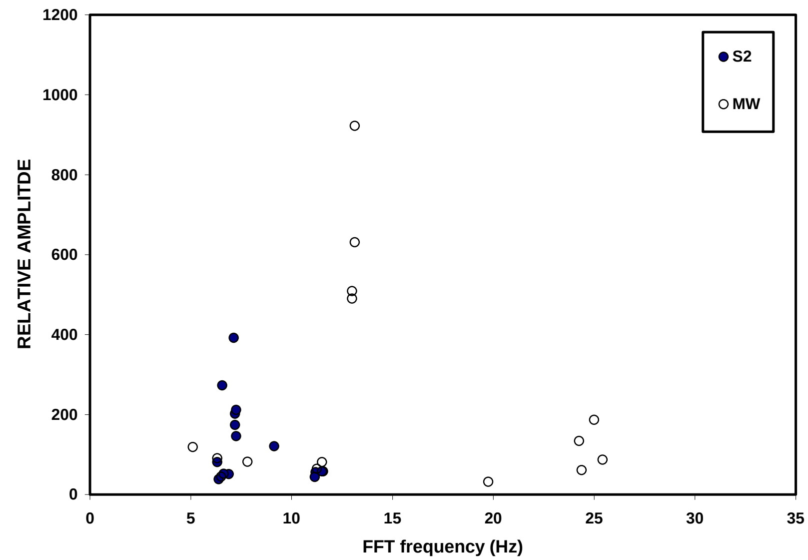


(d)

Figure V-2 Transverse structure response for (a) log (b) earth and masonry, (c) camp, and (d) wood-frame structures



(a)



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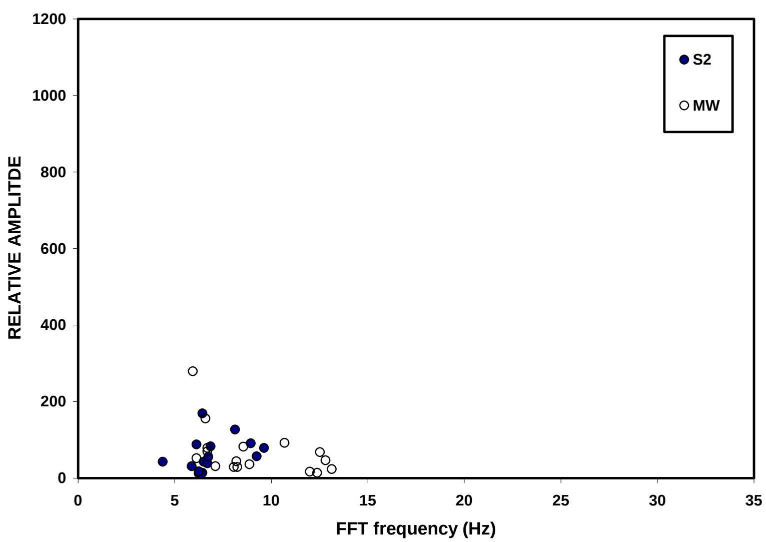


(c)

Figure V-3 Trailer responses for (a) single-wide, (b) double-wide and (c) wood frame add-on structures in the radial direction

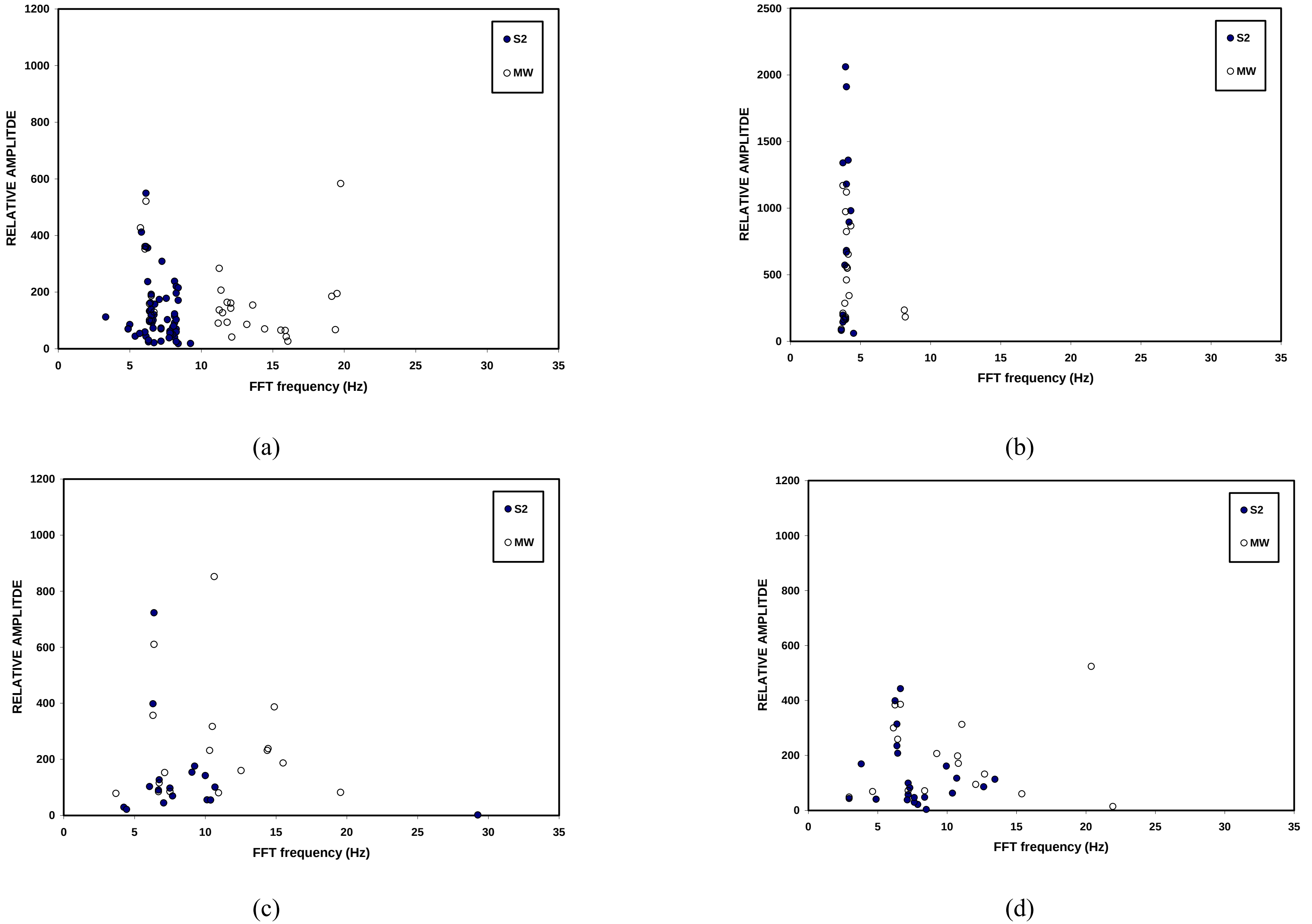
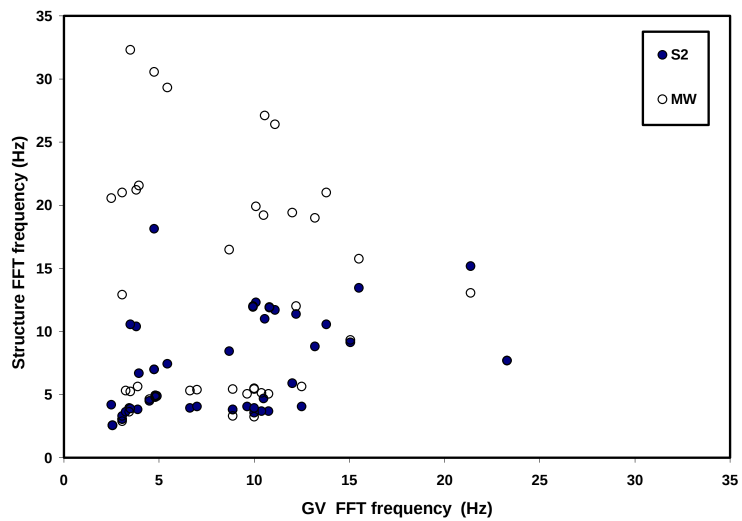
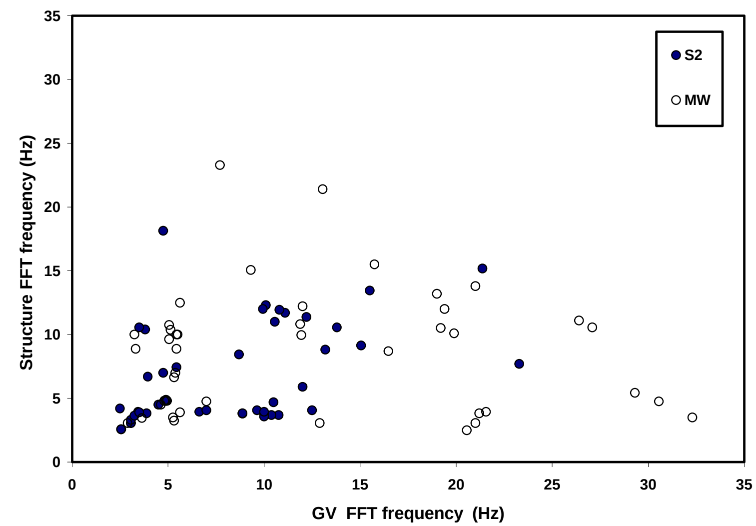


Figure V-4 Radial structure response for (a) log (b) earth and masonry, (c) camp, and (d) wood-frame structures



(a)



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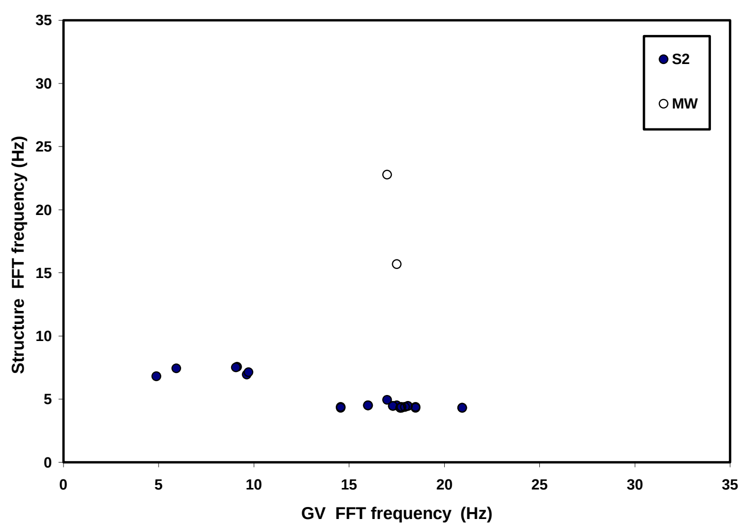
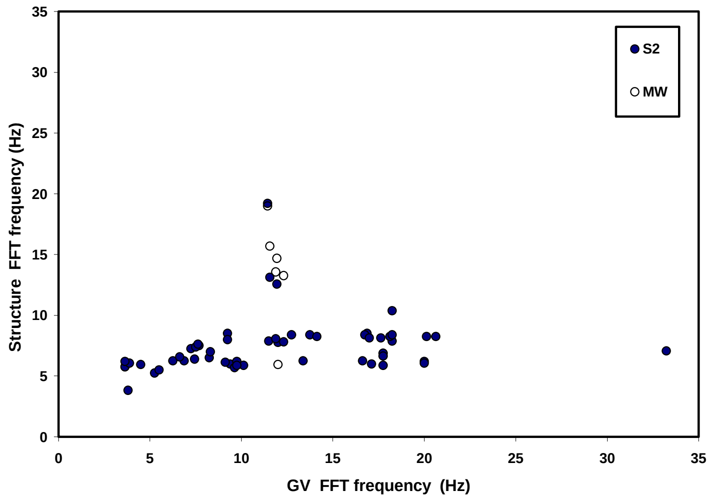
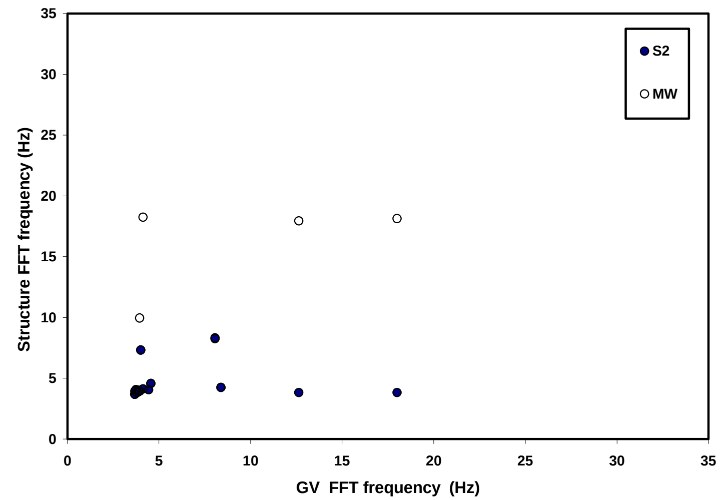


(c)

Figure V-5 Trailer responses for (a) single-wide, (b) double-wide and (c) wood frame add-on structures for the transverse component



(a)



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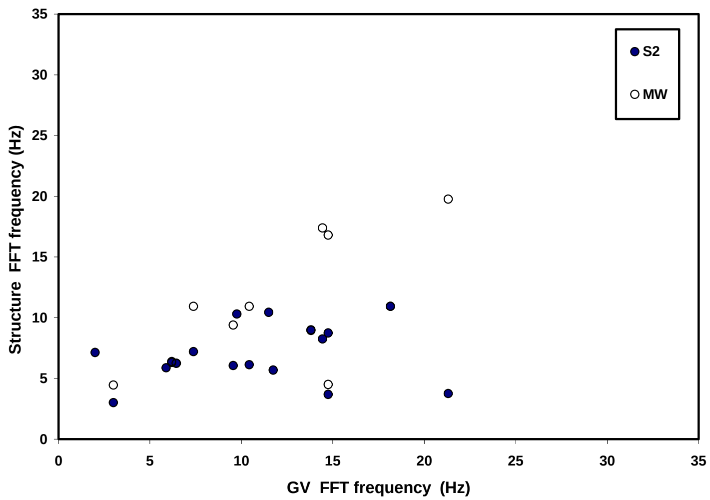

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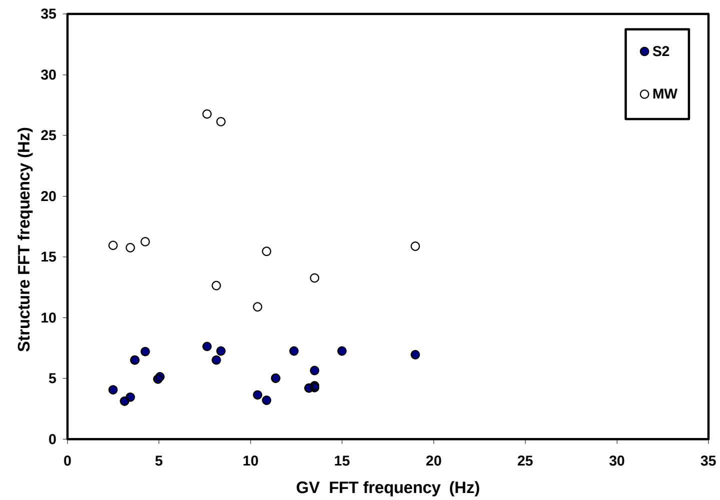
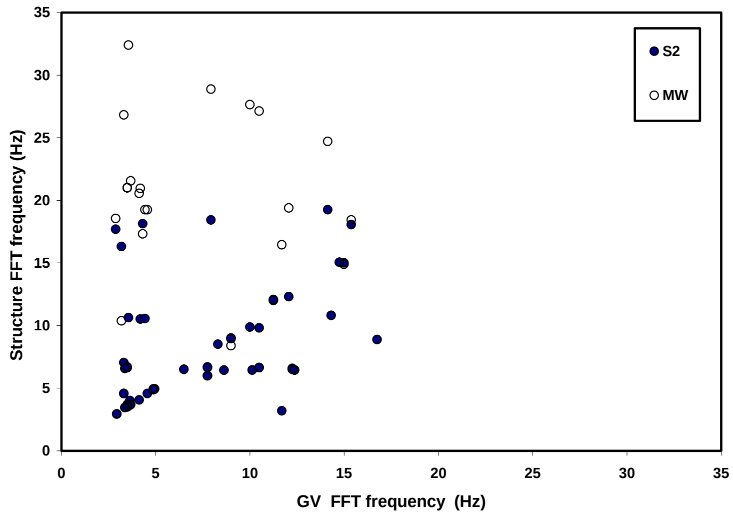
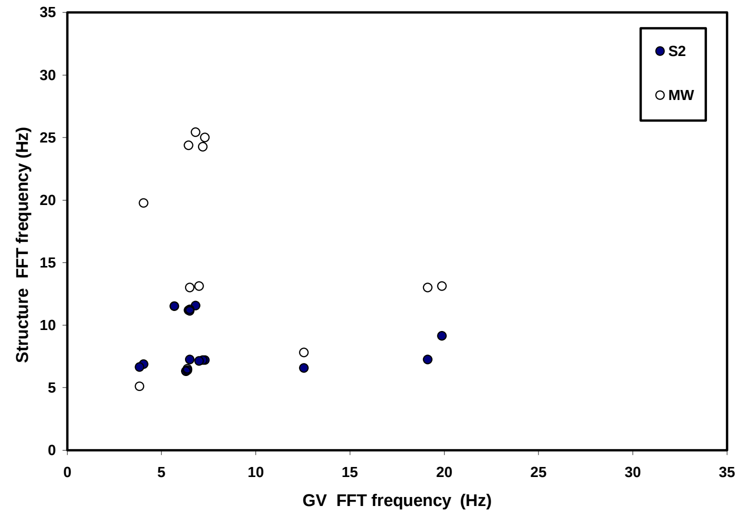


(d)

Figure V-6 Transverse structure response for (a) log (b) earth and masonry, (c) camp, and (d) wood-frame structures



(a)



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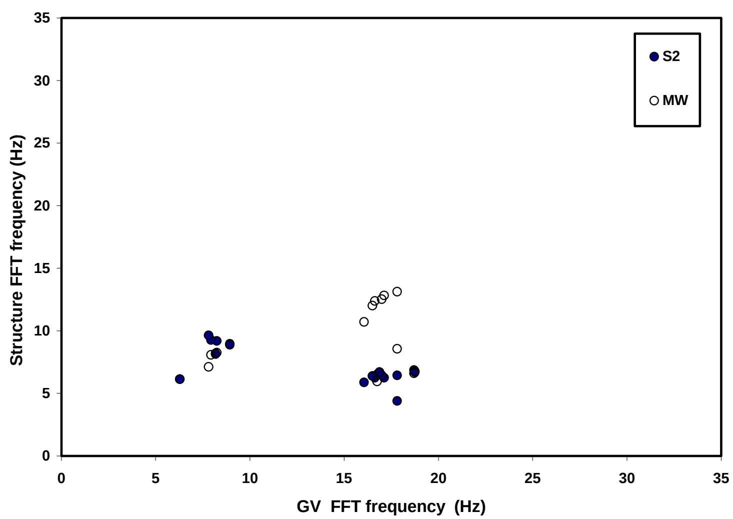
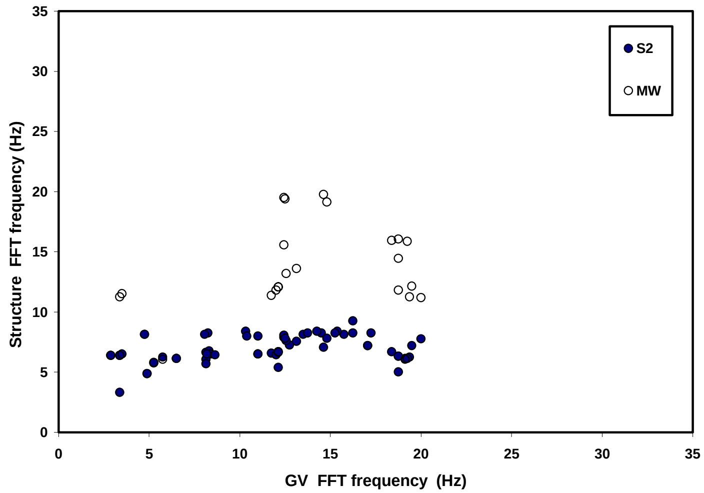


(c)

Figure V-7 Trailer responses for (a) single-wide, (b) double-wide and (c) wood frame add-on structures for the radial component



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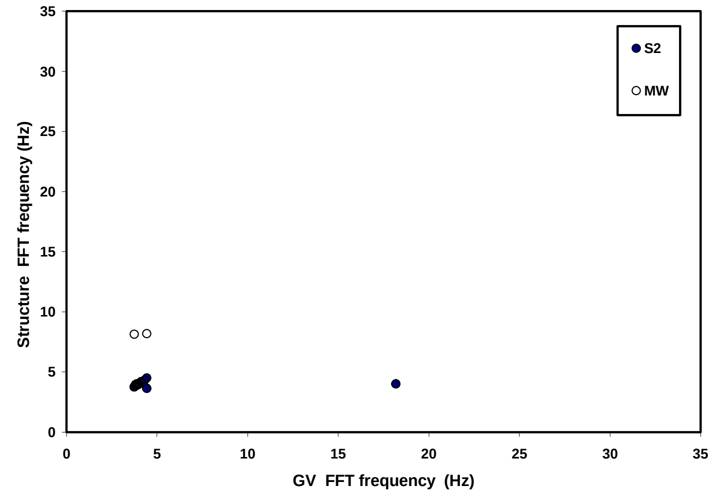

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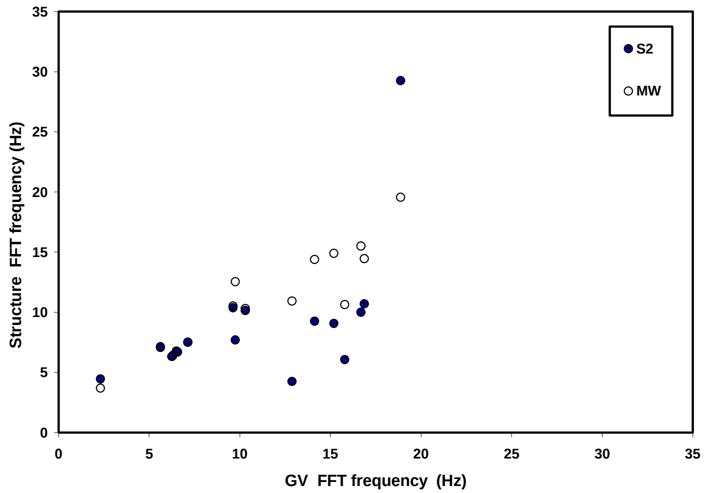

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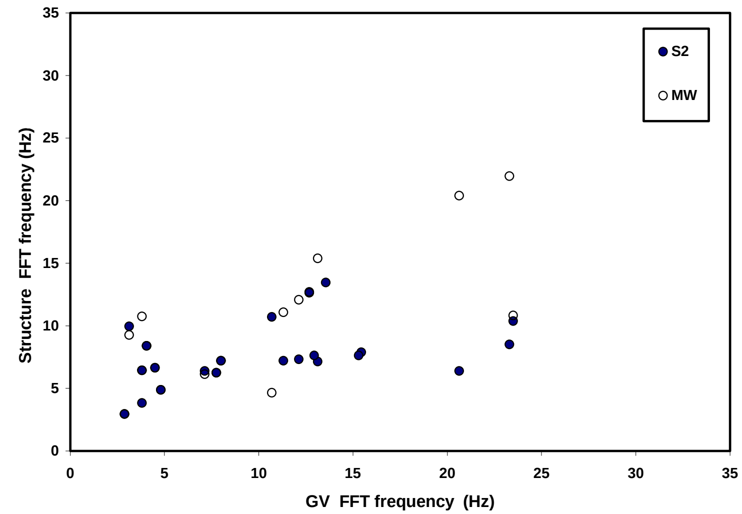


(d)

Figure V-8 Radial structure response for (a) log (b) earth and masonry, (c) camp, and (d) wood-frame structures

RESOURCE TECHNOLOGIES CORPORATION
P.O. Box 242, State College, Pa 16804-0242 Phone: 814 237-4009 Fax: 237-1769
248 East Calder Way, Suite 302

Effect of Various Valley Fill Restrictions on the Quantity of Coal Potentially Available for Mining

Introduction

Phase One of the Environmental Mountain Top Removal/Valley Fill (MTR/VF) Impact Technical Study was designed to estimate the effect of various valley fill restrictions on the quantity of coal potentially available to conduct mountain top removal operations and other types of mining throughout the state of West Virginia. The study also correlated the results in West Virginia to surface mining areas in Kentucky and Virginia. The estimations are based on a Geographic Information System (GIS) model developed by Resource Technologies Corporation (RTC) using MapInfo Professional and Vertical Mapper by Marconi that relies upon the following GIS data sets:

- Regional coal information maintained in the GIS including:
  - Coal Seam Elevation
  - Coal Seam Thickness
- Topographic information from the United States Geological Survey's National Elevation Data set (NED).
- Drainage basin polygons developed by RTC and the West Virginia University, Department of Resource Management (250, 150,75, and 35-acre basin coverage).

For this phase of the study, mountain top removal operations are defined as:

- Surface mining operations designed to mine multiple seams of coal by mining cross ridge: removing all seams of coal overlying a base seam. The base seam is exposed (outcrops) above drainage along the sides of the mountain. Stratigraphically higher seams of coal overlay the base seam. These seams may also outcrop along the sides of the mountain.
- By mining an entire area, across a ridge line, from coal outcrop to coal outcrop, the mountain top technique results in the:
  - Complete removal of a mountain top or portion of a mountain top.
  - Exploitation of all or nearly all seams of coal overlying and including the base seam within the mining area.
  - Generation of significant quantities of unconsolidated spoil that must be either returned to the mined area as backfill or placed in adjoining valleys as valley fill.

To assist in defining the technique, various advantages and disadvantages of the technique are summarized as follows:

- Mountain top mining is typically used to allow economic recovery of thin coal that is marginally mineable using other methods.

- By mining multiple seams simultaneously, the operations are designed to minimize stripping ratios and thus reduce extraction costs. Seams that are individually uneconomic to recover (too thin or underlying too much overburden) may be economically captured by mountain top removal operations.

- Multiple seam mining enables the operator to blend various coals to create marketable fuel products. This permits the economic recovery of some coal that may be individually uneconomic to exploit.

- Mountain top mining is also used to permit more efficient handling of overburden. Initial overburden is cast into hollows or valleys, creating room for effective mining at the seam level. Subsequent overburden can then be more efficiently handled and back-stacked on mined out portions of the mountain.

- The technique creates large valley fills and destroys the original contours and integrity of the original mountain structure above the base seam.

Phase One of the Economic Impact Technical Study was originally designed to estimate the effect of various valley-fill restrictions on the amount of coal potentially available to conduct mountaintop removal operations throughout the state of West Virginia. The estimations were based on a Geographic Information System (GIS) model developed by Resource Technologies Corporation (RTC) . The production of the Phase output, The steering committee determined that a further effort should undertaken to provide more specific output and to use more defined input data. As detailed in the paragraphs below the steering committee identified six issues to be addressed in the expanded effort. In addition, the steering committee desired to use the GIS output for examination of geospacial environmental concerns. This report and the associated data files are result of the expanded effort.

Specific Issues and Procedures Requirements identified by the Steering Committee:

The application of the model and a review of its output permitted the technical staff and steering committee to reconsider and refocus model requirements and expectations:

1. There are additional new data sets available which not available when the modeling effort was planned and executed. The use of these data may affect the conclusions. These data sets include:

    a. Digital elevation data sets with increased accuracy
    b. Polygons showing areas of deep mine depletion
    c. Polygons showing areas of surface mine depletion
    d. Polygons showing area of surface disturbance
    e. Polygons showing existing permitted valley fills
    f. Polygons showing existing Mountaintop Removal sites
    g. Polygons showing proposed Mountaintop Removal sites
    h. Geologic data from Kentucky and Virginia
    i. Revised coal outcrop, elevation and thickness from RTC efforts

2. There is a need to apply the procedure consistently to all "potential" mining types and coal sources including:

   a. Contour strip, highwall auger, conventional auger, and deep mining coals within the study area but not selected as potential mountain top sites

   b. Contour strip, highwall auger, conventional auger, and deep mining coals within the mountaintop areas that may become available for mining as mountain top sites are reduced or eliminated by increasing valley fill restrictions

   c. Contour strip coal that could augment mountain top recovery from seams below the base seam of the MTR site but still are above drainage. Coal to be exploited only to the extent that there is "excess fill space" available in each restrictive scenario.

3. There is a need to apply the procduere or account for the procedure on coals which may become available from Kentucky and Virginia.

Based on recent discussions with the EIS steering committee (Office of Surface Mining and West Virginia DEP) a number of issues are to be addressed by rerunning the GIS model using revised procedures and accessing new data. The new runs will permit estimating on a smaller region basis, more accurate allocation of past depletion, a more equal treatment of Kentucky and Virginia coal, and more consistent input concerning alternative coal sources: auger, contour strip, highwall, and deep mining. The following paragraphs address each issue independently:

Issue #1: **Receipt of recently available new data indicates that the earlier procedure used by RTC may overestimate the quantity of remaining coal resources that could potentially be exploited via mountain top removal procedures. This issue has yet to be proven.** The committee requires RTC to develop a procedure to consider the now available site-specific estimates of coal depletion. This effort is intended to better assess the impact of identifiable previous mining on Mining Resource and Related Valley Fill Area (MRRVF) coal resource estimations. Specifically, the procedure is to use site-specific historic mining information (coal depletion) for mines occurring since 1980 (deep mines) and since 1982 (surface mines) rather than the regional allocation of depletion by seam currently used. OSMRE, EPA, WVGES, and WVU have provided polygon data concerning the post 1980 mining information. Regional allocation of pre-1980/1982 mining will still be applied to the tonnage estimates.

Originally, regional allocation of coal depletion was chosen because of the absence of accurate statewide historic mining location information. "Mining Resource Areas" were selected assuming a virgin coal situation. Possible future coal production was reduced by subtracting a prorated portion of the regional historic production from the future coal production estimates. (This was completed by seam by county using Division of Labor and Industry annual reports. Seam names were normalized to standard US Bureau of Mines Bituminous numerical seam codes.)

By postulating virgin coal, it was assumed that the errors of commission would equal the errors of omission; that is, there would be just as many over-estimates as under estimates and on a statewide or regional basis the overall estimate would be acceptable. It was decided that this procedure would 1) remove any bias in the selection of potential "Mining Sites" and 2) allow the model to select potential "Mining Sites" based on unbiased stripping ratios. This bias was perceived to stem from the imperfect nature of the known historic mine maps. Using "virgin" coal allowed for the selection of all possible sites. Regional depletion allowed for the reduction in coal to be produced. Given the data available at the time, the committee agreed to this procedure. It must also be noted that the original intention of the effort was to model the likely proportionate loss of coal related to fill restrictions and not the prediction of actual sites and tonnages of coal to be produced.

Since the project was initiated, OSMRE has reviewed and accepted polygonal GIS data (WVGES) depicting depletion of sections of certain seams of coal (Coalburg, Stockton, Five Block) from deep mining activities in the MTR region. OSMRE has also accepted maps of surface mine permits dated from 1980 to date and polygons depicting surface disturbance related to mining from current USGS topographic maps. The committee requires that RTC use these data to further improve estimates of the available coal tonnages delineated by the RTC GIS model. This revised procedure will require rerunning the model following the depletion of specific seams of coal as identified by the new information:

a. Polygons of active surface mining permits and prior disturbed areas will be used to remove specific sites from consideration prior to model site selection by stripping ratio. It will assumed that currently active, permitted mine sites will be handled by some form of exception or "grand fathering" as related to some form of fill restrictions. Tonnage related to these specific sites can be reintroduced to the economic model based on legal and economic assumptions not related to the GIS.

b. Polygons of deep mining depletion will be used to remove specific **seam segments** from the data-set prior to model site selection by stripping ratio.

c. Pre 1980 deep-mined coal will be subtracted from the tonnage results following site selection – the same procedure used to date. Pre 1982 surface mined coal will be subtracted from the tonnage results following site selection – the same procedure used to date.

d. All previous selection procedures concerning Mountaintop Mining Sites (stripping ratios, above drainage, crop to crop coal, minimum tonnage, etc.) will still be implemented.

Note that the polygons of surface mines and disturbed areas do not identify specific seams mined. It will be assumed that the disturbance removed the top seams and as a result the site is removed as a potential MTR location – the site will fail by the stripping ratio test. There is no accurate way to ascertain the specific seam exploited at these sites nor is there a method to quantify the amount of coal removed at these locations.

Issue #2: **Given the recent availability of new data the original procedure used by RTC may overestimate the quantity of remaining fill sites.** Like issue #1, this issue has yet to be proven. Similar to the coal portion of the model, the model assumed universal availability of valley sites for fills. As was discussed in the preliminary report, there was no measure available other than site-specific analysis to ascertain which among valleys "technically" available would be practically available. The existing model makes no such differentiation. OSM now has available polygon coverage of existing fill sites (post 1982 polygons and pre 1982 point of base of toe). The committee requires that RTC use these data to remove valleys from the universe of fill sites available.

For the previous effort, RTC used the most recent DEM (30 meters) topographic data available to estimate overburden quantity and fill capacity. Presumably the DEM data captures topographic modifications caused by all but the most recent fills and overburden removal operations. Therefore, the RTC fill and overburden calculations may only be out of date at these recent locations. However, an examination of the polygon data provided by OSMRE shows that many of the existing fills are less than 50 acres. These small fills may not be accounted for in the DEM data. Additionally, OSMRE requires that RTC use the newer WNED data for the topographic base. This is the topographic base now being used by other researchers concerned with the project.

To satisfy the committee's request, RTC proposes that the elevation base used for the model be compared to the fill inventory. If there are significant changes warranted, RTC will use the polygon map to modify the DEM model used to calculate overburden generated and fill space available.

Issue #3: **The model should provide tonnage estimates of coal and the effect on likely production of surface mineable coal not included in the identified mountaintop resource areas.** It is necessary to identify additional tons, acres, and fill for coal that has not heretofore been included in the analysis. This would permit the research team to develop a "consistent" picture of the effect of fill restrictions across mining types and regions. The effort is needed since there appears to be no way to correlate the results of the MTR resource areas to non-MTR (contour only) areas. The areas that do not contain MTR sites are topographically and structurally different than those that do contain MTR sites. For example, the topography may be less steep, the hollows may be less deep, the drainage patterns may be different, and the coal may have greater or lessor dip. Analysis of these areas and comparison of the results to the MTR resource areas would prove useful to the economic and ecologic impact estimations.

To complete this effort, RTC will use outcrop maps and WNEDs to estimate virgin coal amenable to 12:1 contour (surface coal) and mining. The coal will be depleted by 1) polygons of mining activity and 2) regional depletion algorithms(same as currently used on MTR resource areas). Fill polygons will be constructed for surface contour operations. The model will be used to analyze the loss of resources related to increasing fill restrictions related to constrained drainage basin sizes. The model will identify potential non-mountaintop "mineable" coal resources as follows:

- Contour Mining: minimum 12 inch thickness, 80% recovery, maximum 12:1 overburden/coal ratio (bcy/recoverable tons), maximum above seam slope of 33 degrees (no stable backfill possible), and a minimum recoverable clean tons for operation of 500,000.

- Highwall Mining: on selected stable contour benches wider than 120 feet, minimum of 42 inch thickness, 33% recovery, and a minimum recoverable clean tons for operation of 250,000.

- Conventional Auger: on selected stable contour benches averaging 120 feet, minimum 24 inch thickness, 33% recovery, and a minimum recoverable clean tons for operation of 100,000.

- Underground Mining: an in-place reserve block exceeding 3,000,000 tons (main seam), minimum 36 inch thickness, 40-60% mining recovery, 35% prep loss, and a minimum recoverable clean tons for operation of 750,000, multiple seams at least 100 vertical feet separation. The deep tonnage estimates are seen as "residual" to the MTM Contour, and Highwall, and Auger coal estimates.

Issue #4: **Capture surface mineable coal <u>below</u> the "base seam" of the MTR resource areas.** As discussed by the committee, it would be useful to identify additional tons, acres, and fill for coal which was not captured by the MTR exploitation. This effort would assume "maximization" of fill space utilization at each MTR site. Coal would be added to potential production to the extent the fill could handle overburden (spoil) generated by exploiting additional coal. Coal would be added to the remaining production as coal is sterilized through the scenarios as by using outcrop maps and DEMS to estimate virgin coal amenable to 12:1 mining. The coal tonnage would be depleted as follows by: 1) assessing polygons of mining activity and 2) by the regional depletion algorithms(same as currently used on MTR resource areas). The model will be used to "integrate" the below-base seam coal into each scenario.

Issue #5: **Capture surface mineable coal which could be alternatively mined at the MTR resource areas if MTR is no longer amenable as an extraction technique.** The preliminary modeling and data production for this has been completed under the existing contract. The model will inventory alternative potential production from coal removed from the inventory of potential mountain sites by the regulatory scenarios as follows:

- Contour Mining: minimum 12 inch thickness, 80% recovery, maximum 12:1 overburden/coal ratio (bcy/recoverable tons), maximum above seam slope of 33 degrees (no stable backfill possible), and a minimum recoverable clean tons for operation of 500,000.

- Highwall Mining: on selected stable contour benches wider than 120 feet, minimum of 42 inch thickness, 33% recovery, and a minimum recoverable clean tons for operation of 250,000.

- Conventional Auger: on selected stable contour benches averaging 120 feet, minimum 24 inch thickness, 33% recovery, and a minimum recoverable clean tons for operation of 100,000.

- Underground Mining: an in-place reserve block exceeding 3,000,000 tons (main seam), minimum 36 inch thickness, 40-60% mining recovery, 35% prep loss, and a minimum recoverable clean tons for operation of 750,000, multiple seams at least 100 vertical feet separation.

Issue #6: **Apply West Virginia results to Eastern Kentucky and northwestern Virginia coal fields.** Two options are available:

- Apply some statistical or geostatistical measure to estimate Kentucky and Virginia from West Virginia research.

- Map Kentucky and Virginia Coal fields and apply the same modeling procedure used in West Virginia to the Kentucky and Virginia situation.

Concerning the first option: A statistical measure based on tons per acre, fills per basin, fills per ton, topographic province, drainage basin characteristics, (average slopes, streams per square mile, etc.) or other characteristic(s) may be useful and efficient to compare/correlate West Virginia results to the other states.

The WVU, Hill and Assoc. and RTC team strongly believes that mapping the KY and VA resources could prove expensive and time consuming. The technical team is therefore proposing instead, that topographic, hydrologic, structural, geomorphologic, and/or coal geology correlations (between regions of West Virginia and similar regions in the adjoining states) be used to estimate the effects of drainage basis restrictions on coal production in these states. This will allow the modeling to take advantage of the extensive research completed in West Virginia and maintain some control of budget and schedule. The project team will use all available information to analyze and compare regions and subregions in West Virginia to find correlations between regional topography, regulatory changes and changes in predicted coal production. These correlations will be used to predict similar changes in similar provinces in Kentucky and Virginia.

Concerning the second option, OSMRE now has available incomplete KYGS Geologic data concerning specific eastern seams. The data is for five primary eastern Kentucky coal seams. In a two phase process:

1) RTC can examine this data to determine compatibility with the model. The data will also be examined to determine the depth of coverage and the ultimate utility to the model process. To estimate the total tonnage of coal available and to select sites by cumulative stripping ratio criteria, RTC will be required to estimate the depth and thickness of the "less important" seams as they relate to the mapped primary seams. Stratigraphic interval and thickness will have to be estimated from available information. (Much of the effort required to construct the West Virginia coal GIS data base was expended on the interval and thickness estimation from divergent sources of data. In the case of the West Virginia data, the EIS project has benefitted from this effort without contributing to its cost.)

2) If the data are compatible and useful, RTC can then estimate the time and cost necessary to process the model in a similar fashion to the procedures used in West Virginia.

An initial task would be a trial effort which may or may not result in a complete mapping/modeling effort.

OSM may be able to produce VA Geologic data concerning specific Virginia seams. Like the Kentucky situation, if this data is available, RTC will examine it to determine compatibility with the model. Like the Kentucky data, the Va data could also be examined to determine the depth of coverage and the ultimate utility to the model process. If the data is compatible and useful RTC can then estimate the time and cost necessary to process the model.

This second option is really a two phase effort in itself. The first phase of which could take 3 to 4 weeks. Following the initial study RTC would report to the Project manager concerning the usefulness of proceeding with the Kentucky and Virginia mapping effort and would propose a budget and time frame. This effort could prove expensive and long.

Recommendation concerning Issue# 6: Based on conversations and planning efforts involving the research team, option 1 (Issue #6 (a) is the option being proposed for this effort. The effort will involve team members from RTC, OSMRE, WVDEP, WVU, EPA, and Hill and Associates. RTC will act as host and moderator of the effort. RTC will produce a brief report covering the results of the investigation and the recommendations. Following acceptance of the report by the committee and project manager, RTC will implement the estimating procedures and provide the output by county and HUC region to Hill and Associates and WVU.

Based on recent discussions with OSM and WV DEP personnel, the following process[1] will be tested, presented to the panel and used as appropriate:

1) Empirical data will be collected as follows:

a) The volume of excess spoil generated per unit weight of coal surface mined can be calculated for West Virginia, Kentucky, and Virginia using existing fill inventories and related historic coal production by mine. This approach uses empirical data to compare the amount of excess spoil generated per ton of coal surface mined in sections or topographic/mining provinces of West Virginia to that mined in Kentucky and in Virginia. Surface mine production statistics are maintained by mine by the each state's Property and Severance Tax Departments and the Office of Surface Mining and Reclamation and Enforcement. OSM has developed an GIS inventory of "as-built" fill polygons. The GIS information includes the permit number for each fil polygon. The procedure will develop an empirical base to relate fill to coal by region and by state. The development of the "base" must also address the varying state requirements which were applied to the fill construction and mining process as well as the changing fill structure requirements over time. This data may also be used to estimate differences in economic stripping ratio.

b) General topographic information such as average slope, number of mountain peaks per unit area, number of streams per unit area, tons of surface mineable coal per unit area, etc. will be examined.

c) The GIS will be exercised to use this information to demarcate the "boundaries" of topographic/mining/fill regions.

[1] Paraphrased from efforts written by M. Robinson, OSM. and reviewed during December 5, 2001, 8:30 am phone conversation including: J. Kern, D.Van DeLinde, Paul Rothman, G.Blaylock, Dave Hartos, and Thomas Mastrorocco.

2) The quantity of spoil produced per unit area is related to the tonnage of coal produced per unit area. Unit are si related to the topography of overlying overburden. The quantity of coal relates to the aggregate volume of multiple coal seams likely to be recovered by surface mining methods. The amount of spoil returned to the mined area is affected by operational techniques and topography. Assuming similar operational techniques, the amount of spoil material returned to the mined area is greater in less steep areas than in steep areas. The excess spoil per unit area produced in West Virginia or sections of West Virginia will be compared to excess spoil per unit area ratio in Virginia and Kentucky (or multiple regions in Kentucky). The empirical fill data developed above will used to test and adjust these correlations.

Adjustments to the detailed analysis of production-reduction in West Virginia can then be made by applying a ratio of Kentucky/Virginia excess spoil per unit area numbers to West Virginia excess spoil per unit area numbers.

For example: If the excess spoil per unit number in West Virginia is 10,000 cubic yards per acre and 8,000 yards per acre in Kentucky, the production-reduction percentage in West Virginia is reduced by 80 percent in Kentucky. And so, if under the 150-acre limit scenario, the production-reduction is 26 percent in West Virginia, Kentucky's production-reduction number for the 150-acre scenario is 26 percent times 80 percent, which equals to 20.8 percent. These percentages will be adjusted based on the empirical information, particularly the fill inventory. The process may follow the following procedure:

1. For the MTM/VF polygons identified by RTC, calculate the affective average aggregate coal thickness (or volume or tonnage) per unit area under the unconstrained scenario.

2. For the MTM/VF study area in West Virginia, calculate the average slope. If warranted, in lieu of the entire West Virginia study area calculate the average slope for the MTM polygons and adjacent area.

3. The average slope calculated in step 2 represents the base slope. It will be assumed that the ratio of bulked spoil returned versus bulked spoil not returned used by RTC in West Virginia (i.e. the 65 / 35 ratio) depends on base slope. Adjustments to this ratio based on lesser or greater slopes, if warranted will be applied to Kentucky (or regions in Kentucky) using a similar method. Mining experts should be consulted to determine what constitutes a reasonable adjustment.

4. Based on OSM's review of AOC and excess spoil placement in Virginia, a combination of topography and on-bench storage allows 85 percent of the bulked spoil material to returned on the mine site or existing benches. And so, in lieu of doing a detailed slope analysis, an 85/15 ratio should be used.

5. Using KYGS and VPI, information, the average aggregate thickness of coal (coal volume or tonnage) per unit area will be calculated for cumulative MTM polygons in Kentucky and Virginia. In the case of Kentucky, the average aggregate thickness can be done regionally if slope regions are identified.

Summary of Data Sources

Coal Data (Issue #1)

Seamless, statewide GIS coverages for each named seam in the state have been developed by RTC under contract with the State of West Virginia, Department of Tax and Revenue. Seamless digital GIS coverage means the coal is mapped in a single projection as a continuous layer, regardless of political boundaries.

Sixty-one named seams are maintained, the thirty-one seams in southern West Virginia available for mountain top removal mining are used in this study. Statewide seam name correlations were developed using the West Virginia Geologic Survey (Blake) revised stratigraphic nomenclature. Each seam is portrayed by four statewide seamless 30-meter grid coverages: elevation, thickness, sulfur and BTU. Relating the coal elevation coverages with statewide NED coverages creates overburden and outcrop grids. More than 300,000 data points are used to develop the coal grid coverages. These coverages are updated annually. Updates include new data collected by the Department of Tax and revue from tax returns and tax appeals and geologic map revisions produced by the West Virginia Geologic and Economic Survey. Permission for the use of these data for the purpose of conducting this study was obtained from the West Virginia Department of Tax and Revenue.

Sources for the data points include:

- United States Geological Survey
- West Virginia Geologic and Economic Survey Coal Elevation and Outcrop Quadrangle Maps
- West Virginia Mine Map Index
- County geologic reports
- Coal mine permit documents (West Virginia Department of Environmental Protection)
- Coal property owner and coal mine operator annual tax returns including drill core logs, geologic maps, and mine plans
- U.S. Department of Energy, Energy Information Agency reports identifying coal sources
- Other public and private data sources

Average resolution of the coal occurrence data points is five miles. Data can be significantly denser for some seams in some regions and less dense for other seams in other areas of the state. Specific elevation attributes are included in approximately 24,000 of the points. Elevation is inferred from another 40,000 ± points (i.e., surface mine locations, drift mine entries, 1/9 quad sampling from WVGES structure/contour geological maps).

The elevation points were used to interpolate the statewide elevation grid for each individual coal seam. Limits or bounds of the interpolation were developed for each seam by known mapped features such as the Eastern Front of coal occurrence. The elevations of seams represented with only sparse data were developed from known intervals with underlying and overlying seams with dense data points: reference datum seams. Nearest neighbor and inverse distance weighting were used to develop the grid coverages within the interpolation bounds.

Subtracting the coal elevation from the surface NED grid created coal occurrence and overburden grids. Negative cells (cells where the interpolated coal is above the surface elevation) are converted to null value. The result is a series of grids showing the outcrop pattern of the coal along the basic topographic patterns of the state. The coal occurrence is used to remove interpolated data cells from the thickness and coal characteristic grids. In 1998, an initial series of seam occurrence, thickness, and quality maps were produced. Various geologists and coal operators familiar with coal operations throughout the state reviewed the maps. Interpolation bounds were modified and new data points were added based on these reviews. This data was used to revise the map output. The revised set of maps was subjected to public scrutiny by way of their use for tax assessment purposes. As a result, where appropriate, interpolation bounds have been modified and new data points have been added to again revise and correct the map output. This is an annual correction process and has been completed twice.

Surface Elevation Data

Elevation data for the entire Mountain Top/Valley Fill study area was purchased from the EROS Data Center. The National Elevation Data set is designed to provide national elevation data in a seamless form with a consistent datum, elevation unit, and projection.

Drainage Basin Polygons (Issue #2)

RTC and the West Virginia University, Department of Agriculture and Resource Economics, using ArcInfo and the NED of the study area, developed various size drainage polygons. The drainage basin polygons represent the disturbed area due to mining within a watershed. Starting with the NED grid, a succession of ArcGrid functions were used to create grids that lead to the watershed polygons:

> *Flowdirection:* Creates a flow direction grid that represents which direction water would flow out of each NED cell.
>
> *Flowaccumulation:* Creates a grid that counts how many cells are 'upstream' of each cell using the Flowdirection grid. Each cell is assigned the value of the number of cells upstream.
>
> Convert to point coverage: Create a point coverage of cells from the Flowaccumulation grid that has the value within the size range of the watershed of interest. For example, to create the 150 acre drainage basins, if the cells of the NED were one square acre, then all the cells that have a Flowaccumulation value of 150 would be converted to a point. These points represent the outlet of a 150-acre watershed. For the MTR process a range of values had to be used because not every watershed had exactly the correct number of cells. A range of 100-200 acres was used for the 150-acre scenario.
>
> *Watershed:* Creates a watershed boundary polygon starting at the point coverage and draws the boundary based on the flow direction grid.

For example, the 150-acre drainage coverage created for the West Virginia Study Area contained 22,174 polygons varying in size from 99.96 acres to 199.96 acres with a mean of 141.17 acres. A portion of this coverage is shown in Figure 1. In Figure 1, the individual drainage basins are shown as they overlay the natural topography with red being a ridge top and blue being a streambed. As shown in the figure, the basins vary somewhat in size and define watersheds.

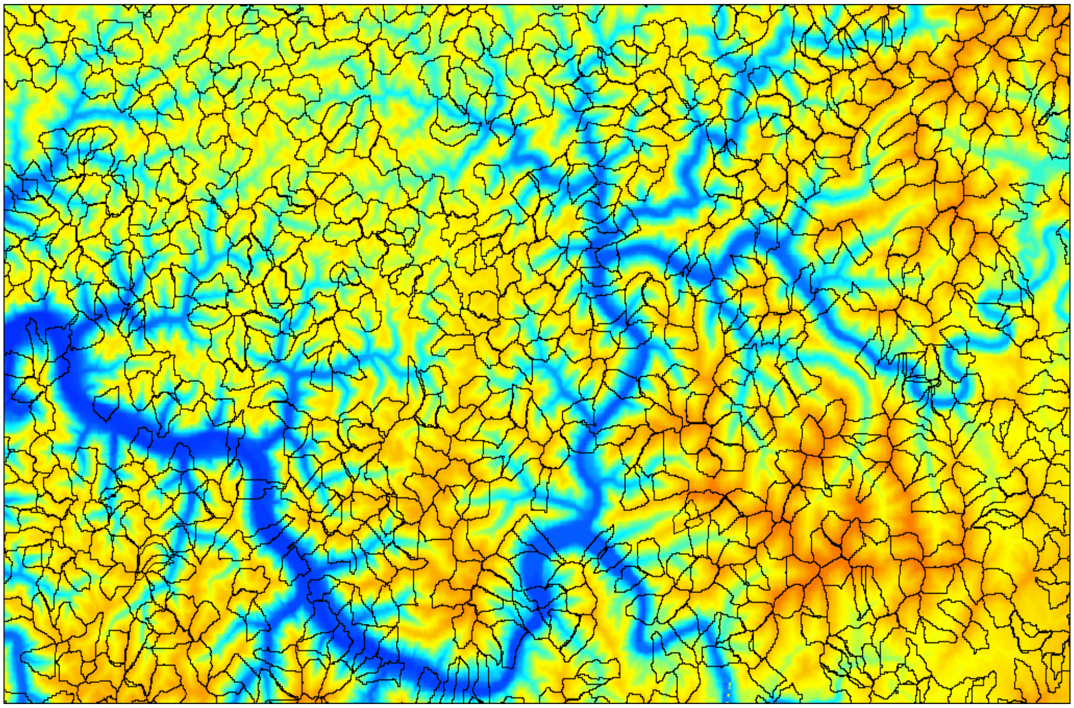


Figure 1: 150 acre disturbed area coverage over NED.

Summary of Procedures

Mine Site Identification (Issue #1)

To more efficiently allocate computer processing time, subsets of the statewide coal coverages were created. These subset grids (thickness and elevation for each seam at each potential mountain top mining site) included only coal that occurred above drainage.

Converting the grid extent of the coal into polygons created a set of outcrop polygons. A polygon represents the extent of each individual block of coal, as shown in Figure 2. The process resulted in the creation of more than 2232 irregular shaped polygons involving 31 seams in the MTR/VF section of the state. Polygons ranged in size from less than one acre to more than 30,000 acres. Polygons less than 5 acres were eliminated as too small to be included in the study.

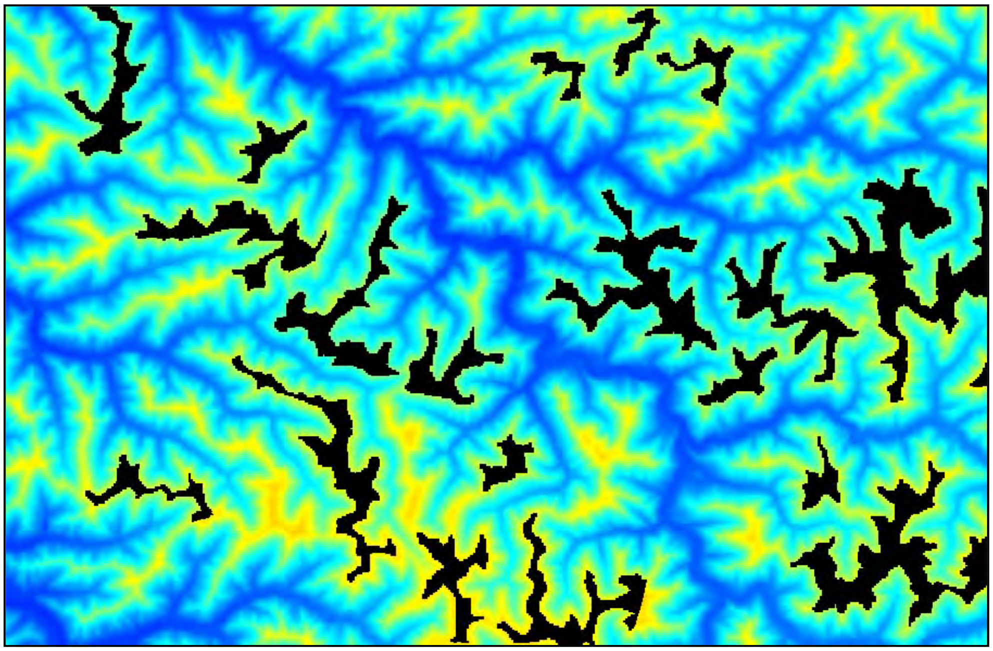


Figure 2: Coal Seam Polygons (Black)

Using the GIS, thickness grids and overburden grids for each seam were sampled by the polygons. Coal volume and overburden volume for each coal polygon were calculated. Coal volume was calculated from the thickness grids as cubic meter inches and converted to tons. Overburden volume was calculated as the total cubic meter feet of material overlying the top of the coal, excluding overlying coal volume, to the surface and converted to cubic yards. Because the overburden grids were developed from the NED and the elevation maps, the shape of the mine site was taken into account.

Concentric polygons were identified, as shown in Figure 3. Each polygon represents an individual seam at a higher elevation at a multi seam location. Before any environmental or further economic considerations were applied, a total of 647 polygon sets were created. The number of seams in each set varied from one to 7. The polygons and related data for each concentric set were stacked in order of elevation with lowest being the bottom of the stack. Two checks were completed at this point: 1) were the seams in stratigraphic sequence, and 2) did the size of the polygon decrease with elevation (as the higher seams were identified up the mountain). The lowest seam polygon was designated as the site identifier. Concentric seams were identified by the base seam and a sequence number suffix.

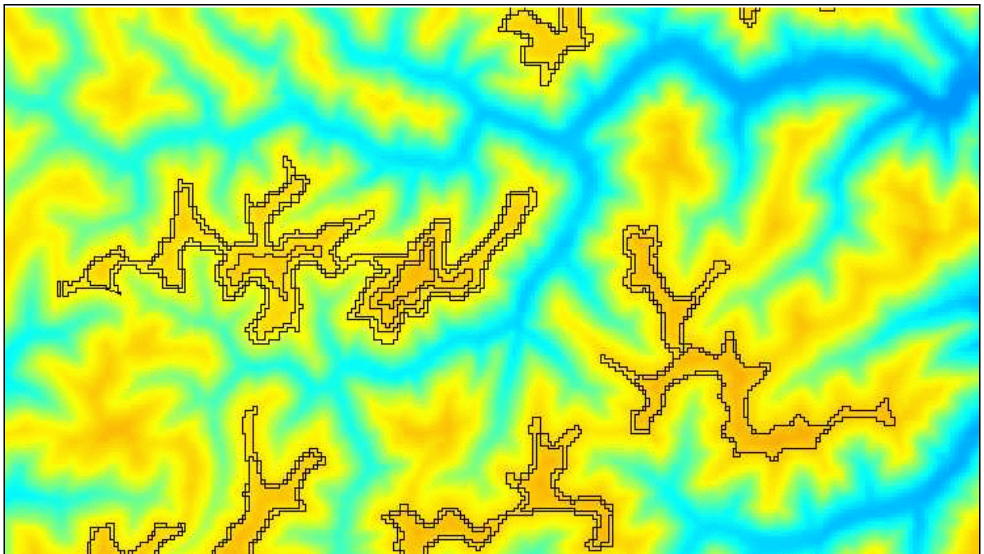


Figure 3: Concentric Coal Outcrop Polygons

Cumulative overburden was calculated for each coal polygon in each set. The calculations were developed from the highest seam to the lowest seam in each set. Cumulative and individual stripping ratios were calculated from the same data sets. A stripping ratio is calculated by dividing cubic yards of overburden by tons of recoverable coal. Recoverable coal is calculated at 70% of in-place coal. Thus, a data set was created for each mountain top area. An example of the calculations is shown in Table 1.

Table 1: Example of Calculations of Coal Tons and Stripping Ratios

Seam	Area (ac)	Elev. (ft)	Thick. (in)	Tons	Cumulative Tons	Cumulative Overburden	Stripping Ratio
Surface		1,675					
Seam 6	250	1,560	36	945,000	945,000	45,173,000	48 :1
Seam 5	400	1525	24	1,008,000	1,953,000	66,469,000	34 :1
Seam 4	1200	1500	20	2,520,000	4,473,000	111,642,000	25 :1
Seam 3	1500	1450	52	8,190,000	12,663,000	222,155,000	18 :1
Seam 2	1700	1400	68	12,138,000	24,801,000	343,747,000	14 :1
Seam 1	2000	1300	30	6,300,000	31,101,000	658,347,000	21 :1
*All data used on this table is for illustrative purposes only							

This table demonstrates the concept of 'Best in Stack.' Notice how the stripping ratio, it is a cumulative stripping ratio, changes as more seams are added to the mountain top mine. The Seam 1 has a stripping ration of 21:1 while the next seam up has a stripping ration of 14:1. Using Seam 1 as the base seam would fail this site because the stripping ratio is too high. For this reason the Seam 2 is used as the base seam; it has enough tons of coal and it has an acceptable stripping ratio.

The GIS model was used to identify sets that could technically support mountain top removal coal mining operations. The selection of sites was based on the following assumptions:

- A site must encompass a minimum of 600,000 short tons of recoverable clean coal from a recovery rate of 70%. No maximum limit was set.
- The delineated site must have a stripping ratio (cubic yards of overburden/interburden spoil to tons of recoverable coal) below:
  - Statewide: 15:1
  - McDowell, Raleigh, and Wyoming Counties: 20:1

- All identified coal blocks are above the mean regional base drainage level.
- All identified base seam coal exceeds 12 inches in thickness.
- All sites must contain at least two seams.
- Coal located within incorporated towns is not considered as mineable.
- Polygons representing mining since 1981 removed from mineable coal.
- After identification of potential sites, the calculated tonnage of mineable coal is depleted via a 100-year historic production by seam. This reduction for previous "un-locatable" mining is allocated by county, prorated by the proportion of acres of the seam contained in the site to the acres of the same seam in the county. The mined tonnage is doubled to account for sterilization and under-reporting.
- Counties are used as units to accumulate coal and basin statistics.

Mountain top areas satisfying the above criteria were selected. A total of 510 mountain top area polygon stacks were identified (Figure 4). The polygons representing the model mountain top areas were compared to the location of existing or pending mountain top mines. Model polygons captured or surrounded more than 90% of the identified existing permitted mountain top mines.

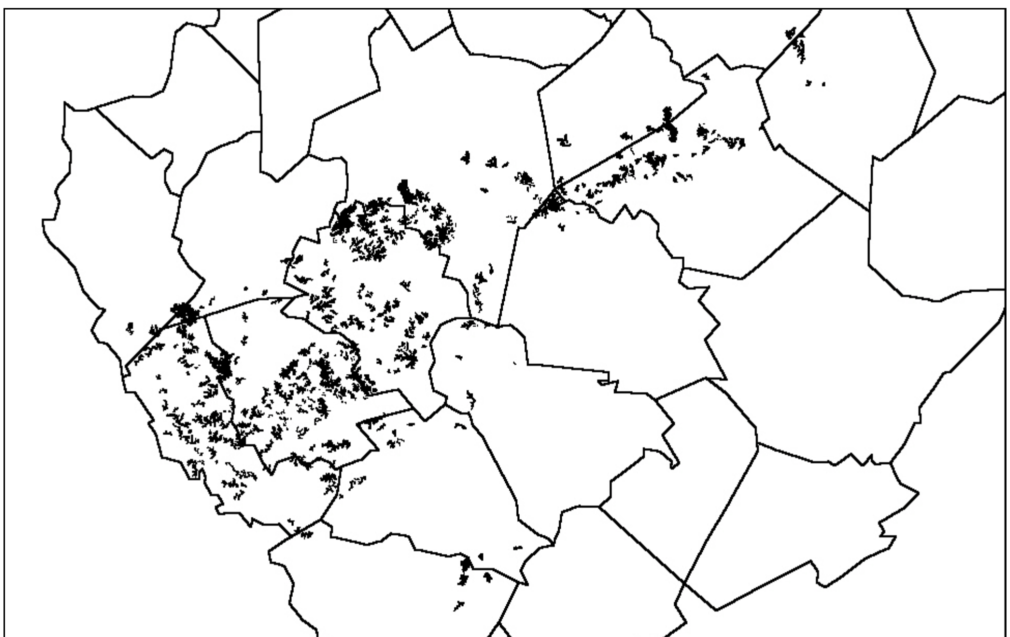


Figure 4: Mine sites in the Mountain Top Area

Valley Fills (Issue #2)

The valley fills are an integral part of the MTR process. The above steps were used to identify possible MTR sites based on technical mine selection criteria (an unconstrained environmental scenario). The valley fill analysis introduces environmental constraints on the site selection process. Four scenarios were analyzed: 250 acre disturbed areas, 150 acre disturbed areas, 75 acre disturbed areas, and 35 acre disturbed areas. The disturbed area encompasses both the mine and the fill area. A MTR site passes when there is enough volume available in the potential fill sites surrounding a mine site to accommodate the excess spoil generated from the mining operation per scenario. Excess spoil is the spoil that is not back filled on the mine site. To calculate excess fill the original overburden is expanded by 25% to represent swell. Sixty-five percent of the swollen spoil is back filled and 35% needs to be deposited in valley-fills. The process used to find the available volume in the fills surrounding a mine site is described below.

A buffer of 3,000 feet was constructed around the base polygon. This buffer represents a limitation on fill haulage distance. Adjacent 250, 150, 75, and 35 acre disturbed area polygons (produced by the process described above) were selected for each mountain top buffer area. To be selected the polygons had to touch the mountain top area.

The GIS was used to split-off those portions of the drainage polygons outside of the 3,000 foot buffers, portions overlapping the mountain top mine polygon, and portions across major highways. Polygons containing incorporated towns, federal and state parks, schools and cemeteries were eliminated from the data set as well.

Each fill was assigned an elevation of the associated base seam plus 50 feet. This elevation was used to replicate the back stacking of fill over the mined out area. The GIS was used to calculate the volume of fill space available between the land surface and the elevation of the polygon. In addition, the length, height, lowest elevation, and the slope of the ground surface were obtained for each fill polygon. The volume of each polygon was modified to account for the 27-degree slope of the fill toe (Figure 5).

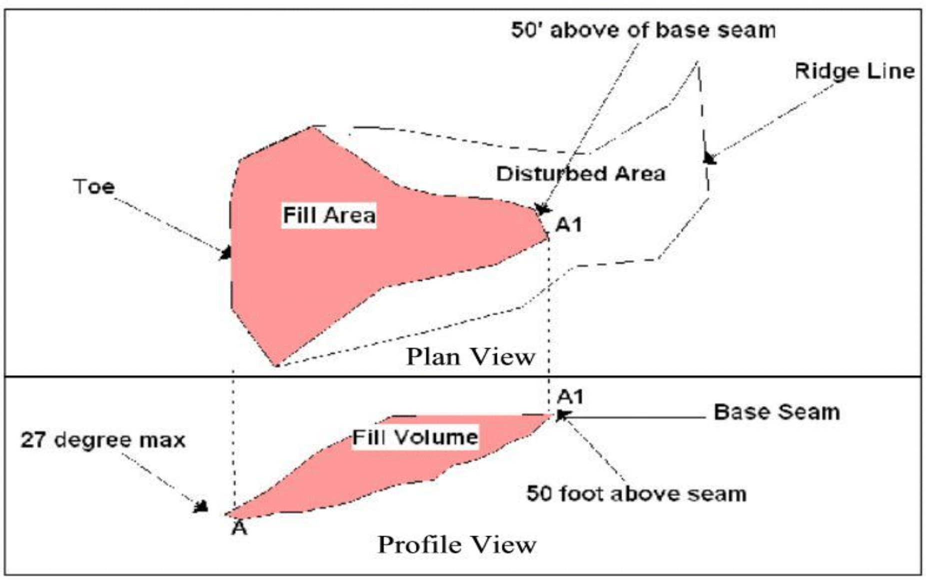


Figure 5: Fill Geometry

The volume in the fills surrounding a mine site was summed to produce the total spoil accommodation space for the mine. This value was compared to the estimate of valley fill to be generated by exploiting the coal. If the available fill space (volume in cubic yards available in valleys to receive fill) exceeded the valley fill to be generated by the potential mine, the site was identified as capable of supporting mountain top removal operation. If the site failed, the database for the mountain top area was reprocessed using the next higher seam as a base, enlarging the available fill spaces, raising the fill elevation (and thus the available volume), and decreasing the quantity of coal and fill to be stored. In most cases, retreating to the next higher seam was not an option, since the only way to obtain a suitable overall stripping ratio was usually to include the basal coal seam. This process was completed for each mine site at each scenario.

Figure 6 shows a MTR/VF mining site. The dark grey area within the red lines represents the entire area of potential mining activity. The dotted purple polygons represent potential fill areas selected to meet the 250-acreage limitation. (Note that not ALL potential or available fill space is required to satisfy the excess spoil demands.)

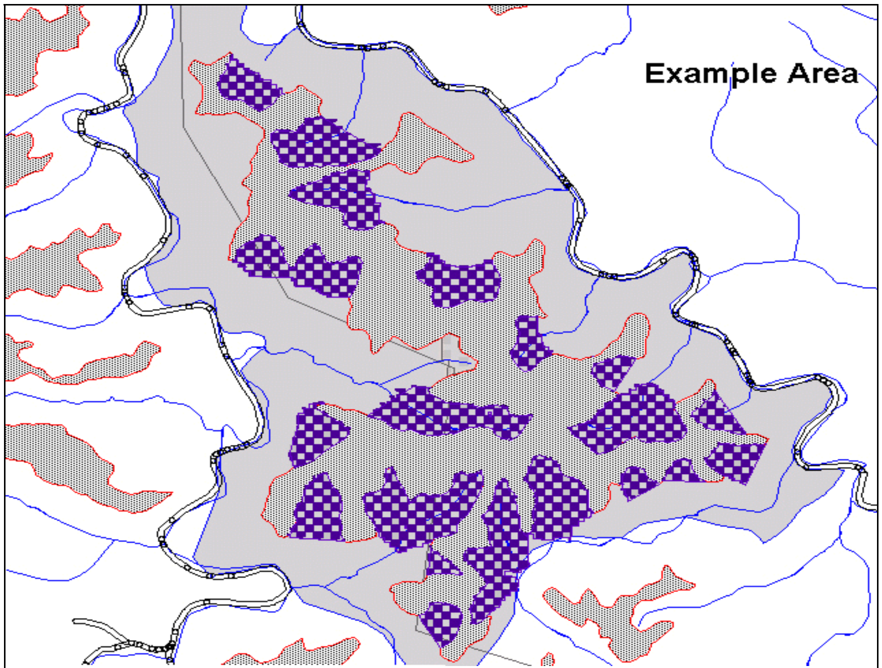


Figure 6: A mining area with fills

Table 2 summarizes the change in relative fill space availability as the drainage basin limitations become more restrictive. Figure 7 displays the mine site and the 21 fill sites.

Table 2: Summary of changes in fills space availability as shown in the Example Site**.**

Fill Site # (clockwise from top in Figure 6)	Maximum Fill area in acres per scenario			
	250	150	75	35
1	62	62	26	13
2	118	118	59	28
3	102	102	41	19
4	97	97	38	17
5	44	44	13	8
6	30	30	6	6
7	150	150	75	35
8	38	38	10	8
9	51	51	17	11

Fill Site # (clockwise from top in Figure 6)	Maximum Fill area in acres per scenario			
	250	150	75	35
10	18	18	2	2
11	24	24	4	4
12	123	123	52	24
13	132	132	56	26
14	41	41	11	8
15	17	17	2	2
16	122	122	46	21
17	84	84	38	18
18	71	71	33	16
19	121	121	46	21
20	71	71	33	16
21	133	133	58	27
Total	1,899	1,799	741	365
Average	86	82	34	17

Figure 7: Change in fills between scenarios

Table 2 and Figure 7 show that as the drainage basin limitation becomes more severe, the available fill space is constrained. In the 250-acre scenario, there are 21 potential fill sites available. These sites offer nearly 1,900 acres of potential fill area. In this scenario, the largest site can provide approximately 150 acres of fill space; the smallest potential fill site has 18 acres of space. The 35-acre scenario, in contrast, still shows 21 potential fill sites, however, they provide only 365 acres of potential fill space, with the largest at 35 acres and the smallest at two acres.

The following images (Figures 8 - 11) show another mountain top removal possibility. In this case, where the fills are drawn to scale the number of fill sites changes as the environmental scenario changes. In the more severe cases there are more fill sites available, but less total volume. At the 250 acre scenario, one large fill my encompass two or three hallows, while at the 35 acre scenario each hollow will have a separate fill.

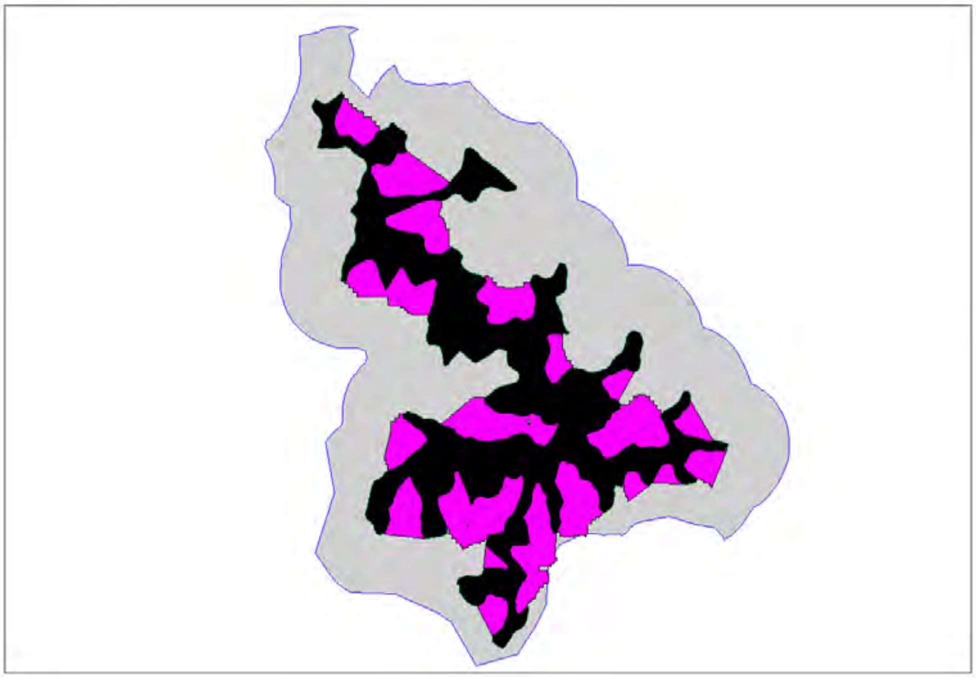


Figure 8: 250 acre scenario with 21 possible fill sites.

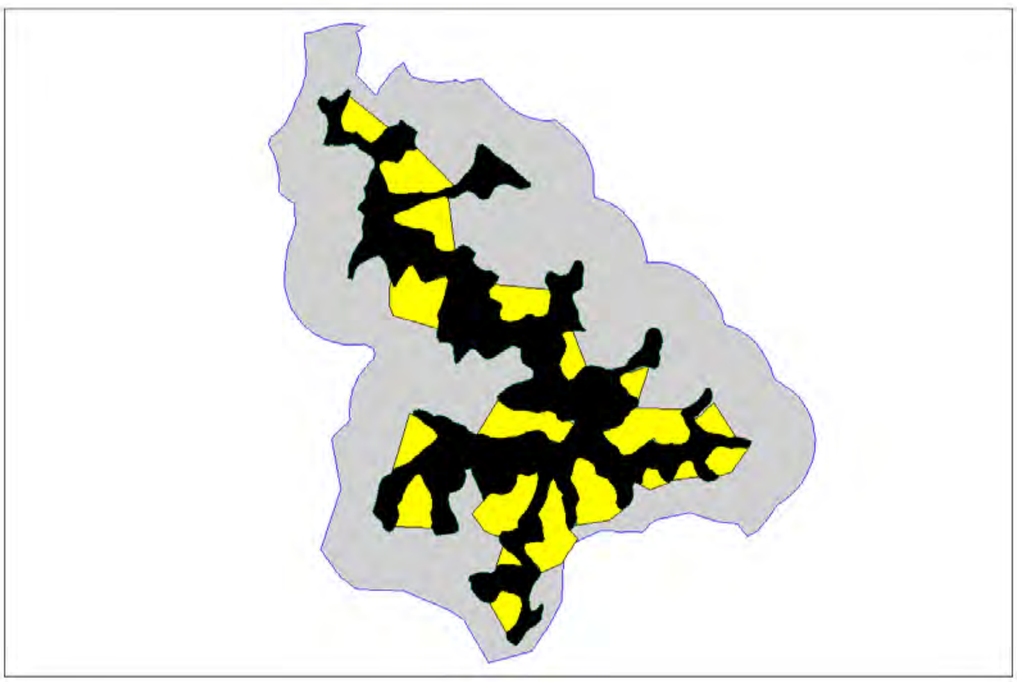


Figure 9: 150 acre scenario with 21 possible fill sites.

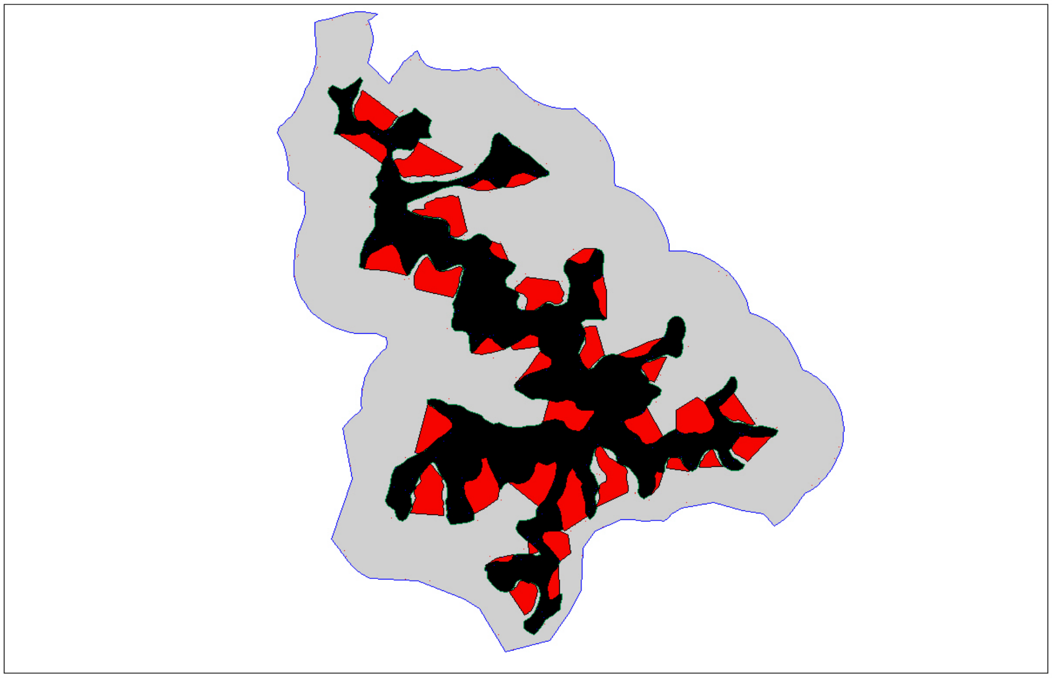


Figure 10: 75 acre scenario with 37 possible fill sites.

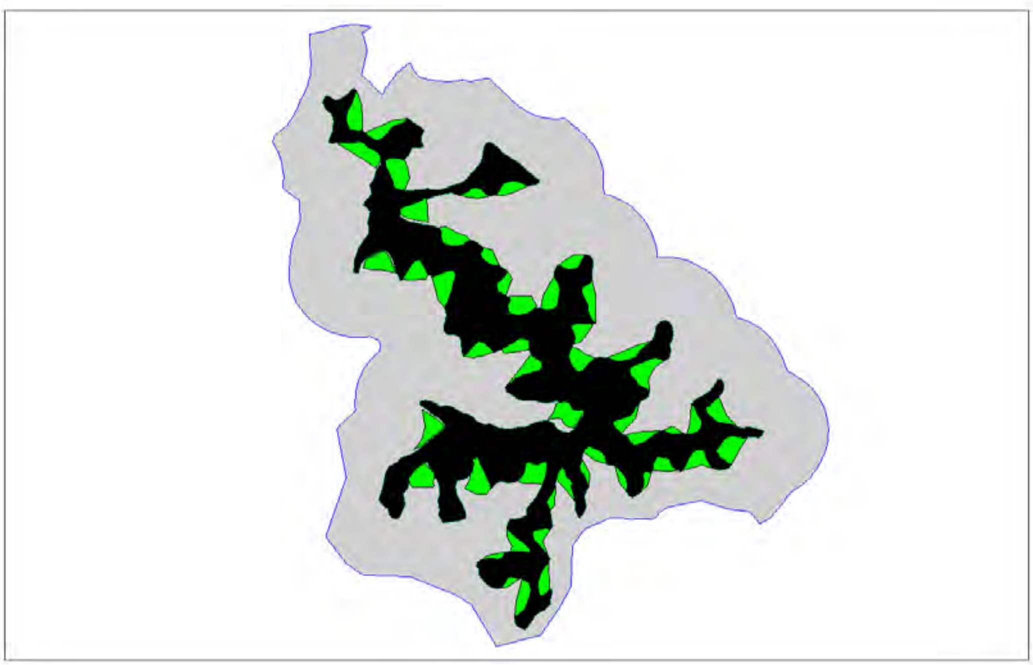


Figure 11: 35 acre scenario with 49 possible fill sites.

Summary of Results

The quantity of available fill volume is calculated for all potential mountain top mining areas identified in West Virginia. Available fill volume is used to determine the viability of each selected mining operation, i.e., if there is sufficient space to receive the valley fill generated by the model mine then the tonnage of coal available at the site is counted in the regional totals. This calculation is made for each selected mountain top mining area for each scenario. The procedure provides an estimate of coal obtainable at each mountain top mining site and thus the entire state. Previous production and current permitted production was subtracted from the coal available from each seam after the calculation of stripping ratios. There are no existing digital maps to accurately deplete all historic coal resources at specific sites before 1981. Therefore, the stripping ratios were calculated based on estimated tonnages of virgin coal. Tonnages for each seam were reduced for final reporting by depleting a prorated share of all known historic production within the municipal district and all existing permitted production by specific site through 1999.

As shown below in Figure 12 and Table 3, the addition of drainage basin size limitations for land disturbance significantly affects the total quantity of coal which may potentially be produced by mountain top removal operations.

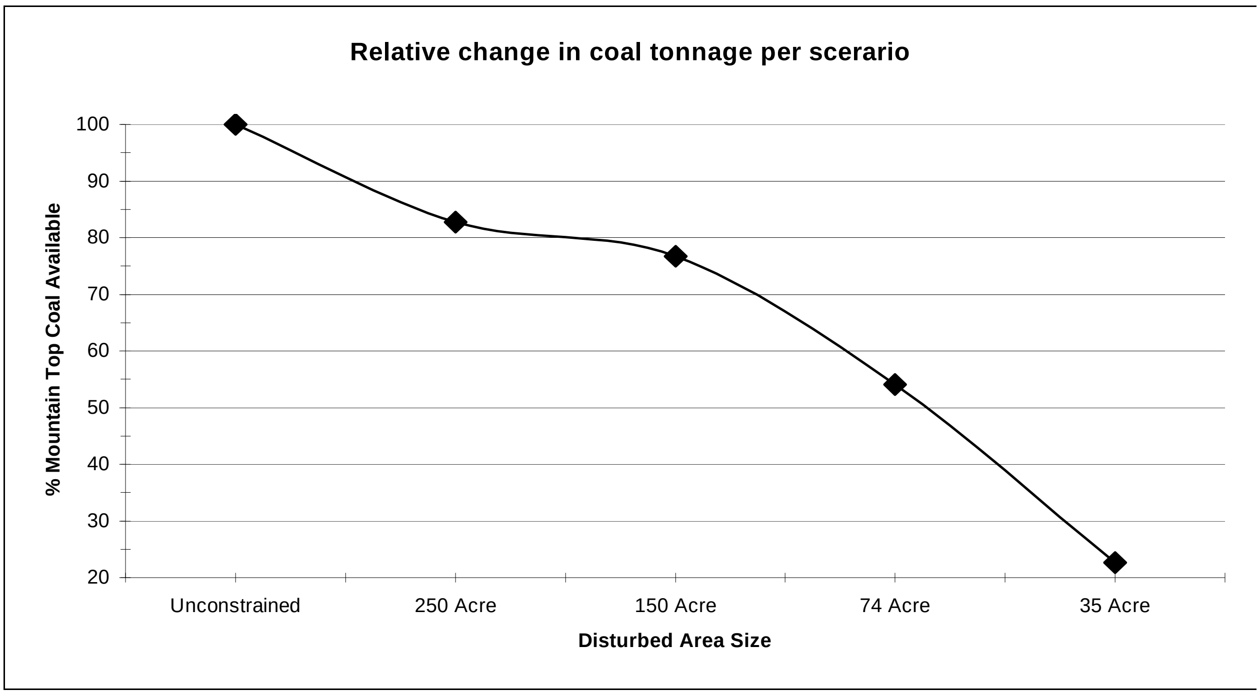


Figure 12: Potential Coal Available

Table 3: Overview of Effect of Basin Constraint					
	Unconstrained	**250 Acre**	**150 Acre**	**75 Acre**	**35 Acre**
Total Tons	1,111,223,494	919,512,131	852,829,517	600,324,203	252,053,489
% Change from Unconstrained		-17.25%	-23.25%	-45.98%	-77.32%

As shown above, imposing size limitations even at 250-acre drainage basin size reduces available coal by nearly 20%. Potential tonnage is further reduced at the 75-acre drainage basin limitation.

This is because a significant portion of a 75-acre drainage basin is included in the mine itself and thus is not available for fill. In addition, as the fill space size is reduced (the potential fill site is moved up the valley toward the mine site), the height of the toe is reduced. The space available is shallower and no longer capable of storing large quantities of fill. However, at the 75-acre level some new small hollows with some capacity for fill are now available. These hollows were the lateral sides of the larger fill area developed for the 150 and 250-acre scenarios.

As shown in Table 3, available tonnage is severely limited at the 35-acre level. More significantly than in the 75-acre scenario. A large portion of a 35-acre drainage basin is included within the mine itself and thus is not available for fill. In addition, the remaining space available tends to be very shallow and not capable of storing significant quantities of fill.

It must be emphasized that the GIS model includes all available fill sites, regardless of ownership or other environmental and cultural conflicts. Many of the sites would not necessarily be chosen in the real world mine planning process. This factor tends to create an overestimation of the sites and thus the tonnage available. It is thought that this factor becomes more significant as the drainage basin constraint is made more severe. In the 35-acre case, nearly all available space is being used to sustain the residual production. In the 250 and 150-acre scenarios, less than 10% of the available space is actually used for valley fill.

The Office of Surface Mining Reclamation and Enforcement (OSMRE) commissioned a study with selected mine operators to assess the impact of drainage basin limitations on potential coal production at specific mine sites. This effort resulted in similar predictions of coal loss at the all restriction levels. Although the results were similar there are some distinct differences between the methods:

- The GIS model selects all possible sites to deposit fill. Some of these sites may be inappropriate for numerous reasons unidentified in the GIS database. These fill sites may not have been selected during the empirical study. In the large drainage basin scenarios, there is generally enough excess fill capacity available in numerous sites that differences in selection criteria are not a factor. At the smaller drainage basin level, additional fill sites identified through the GIS (and discounted in the empirical study) may offer enough space to satisfy the fill requirements.

- The GIS uses all potential fill sites, regardless of size. Numerous small fill sites may divide enough available space to keep marginal mine sites in the study.

- The GIS treats all potential fill sites equally, regardless of distance from the actual spoil production. The GIS criterion is that the fill sites are within 3,000 feet of the mine site. The GIS mine site may be thousands of acres; fill generation may actually occur significantly further than 3,000 feet from the GIS fill site. In the empirical study, the mine sites are most likely smaller subsets of the GIS mountain top mine areas. As a result, the empirical study mine sites may not be contiguous or have large enough fill sites to be feasible. This factor can only be exacerbated at the 35-acre basin level.

- The empirical study can be seen as starting from the same topographic and coal base as the GIS study. Because the study is based on real world conditions such as land ownership, mine planning requirements, coal transport requirements, etc., the empirical study can only add constraints to the selection and percent use constraints. The empirical study by definition cannot add potential fill sites to the selection process. Because the GIS study is based on decreasing the size of fills to fit into drainage basin constructs, the addition of criteria can only exacerbate the coal loss.

These factors do not invalidate the GIS study. The portion of the study was designed to examine the statewide effect of fill space limitations on the quantity of coal available for mining. The GIS study was not designed to provide site specific mine planning. Site-specific mine planning will always reduce the results of a GIS study of this scope. The GIS study does provide solid evidence concerning the trend of coal reduction resulting from the environmental limitation.

A data file, by potential mountain top site, listing: tons, sulfur, volatility and Btu by seam and county name was provided to Hill and Associates for econometric modeling purposes and is included in the Appendix I. Each polygon is a separate record in the data file. The sites are located in 14 counties and involve 31 different named coal seams. Gannet Flemming, another contractor to the EPA on the MTR/VF project received map layers of each scenario for their analysis. Their analysis relies on the amount of area that is disturbed by the MTR process. Mine site, fill site and alternative mining (discussed below) polygons were included.

Fill Site Optimization (Issue #2)

After an examination of the results, it was observed that for most passing MTR sites there was an overabundance of fill volume: more fill space than spoil. Another section of the Environmetnal Impact Statement for MTR/VF relies on the map footprints of the mine sites and fills. An overabundance of fill sites would lead to a larger disturbed area than necessary. For this reason RTC used two separate methods to optimize the fill space (Table 4). The first method used the biggest fills first. The second method placed fill in the head of each fill and moved out until the excess spoil was accommodated. Polygons for these two scenarios were delivered to Gannet Flemming for use in their analysis.

Biggest to Smallest

The biggest to smallest method utilizes the fills with the largest volume capacity first until all spoil is accommodated. This scenario simulated dumping spoil into the biggest fills around a mine site until all of the spoil is deposited. This means some of the smaller fills around the mine site were not used if they were not needed.

Use a Little of each Fill

The many little fills method places spoil in each available fill, moving concentrically outward until all spoil is accommodated. In this scenario spoil was deposited equally in each fill around the mine site. This simulates placing a spoil in the headwaters of each fill.

Table 4: Fill Optimization Results

	Original Fill Acres	Biggest to Smallest Acres	Many Little Acres

35 Acre Scenario	43,270	15,076	27,013
75 Acre Scenario	105,862	38,693	60,173
150 Acre Scenario	187,882	64,291	86,434
250 Acre Scenario	247,764	74,111	103,749

Notice that both methods lead to a much smaller disturbed area than using all possible fills. Surprisingly, the biggest to smallest method is considerably smaller than the many little acres. This is because the many little acre method used fill space near the mine site where there is little volume. The biggest to smallest method used the entire original fill, so it went further out into the valley for more volume.

Alternative Mining Sources (Issue #3, Issue #4, Issue #5)

The entire mountain top region was analyzed with respect to strip mining, auger mining and deep mining. These types of mining augment the total amount of coal that can be mined in each mountain top scenario. When a mountain top mine fails, alternative mining sources are implemented. The tonnage for each type of alternative mining changes with each scenario because the alternative mining methods are implemented in areas where a mountain top site cannot be used. For example, there is more coal mined with alternative methods in the 35-acre scenario than in the 250-acre scenario. This is because alterative mining methods were used at MTR sites that were included in the 250 acres scenario but failed in the 35-acre scenario.

<u>Strip Mining</u>

The GIS was used to identify possible strip (contour) mining locations throughout the entire state for the 31 coal seams investigated. Criteria included 12 inch coal thickness, a 12:1 stripping ratio, maximum surface slope of 33 degrees, 80% recovery and 500,000 in-place tons. After discussions with the steering committee's coal industry representative, Barry Doss, strip mine sites within 200 feet horizontally and 100 feet vertically were combined. This leads to more sites reaching the 500,000 ton criteria. The result is 'snakes' around mountain sides (Figure 13).

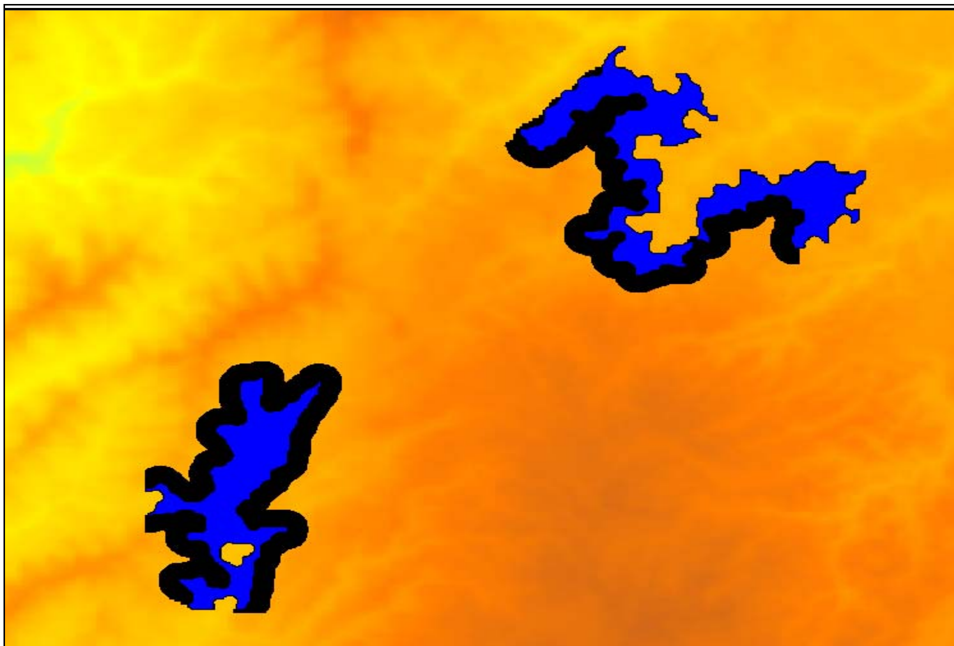


Figure 13: Strip (Blue) and Auger (Black) Mining

Auger Mining

Auger mining was analyzed everywhere where a viable strip operation was identified (the strip mine is used as the bench for the auger mining). Highwall mining and conventional auger mining was combined into one step as per discussions with Barry Doss. To mimic auger mining the GIS was used to calculate the tonnage of coal 600 feet into the mountain at a 35% recovery rate. The site had to have at least 250 ,000 clean recoverable tons and be 24 inches thick (Figure 13).

Deep Mining

The GIS also was used to simulate deep mining the entire state (Figure 14). A deep mine site had be below 200 feet of overburden, above the regional groundwater table, have coal at least 36 inches thick, and 750,000 clean tons at a recovery rate of 40% and prep loss at 35%. Previous deep mining polygons from the OSMRE were removed for the possible identified deep mines. Seams had to have 100 ft of interburden between them to be mined. For example, if seam 1 was 75 feet above seam 2 and seam 2 was 75 feet above seam 3, seams 1 and were mined, but seam 2 was not mined.

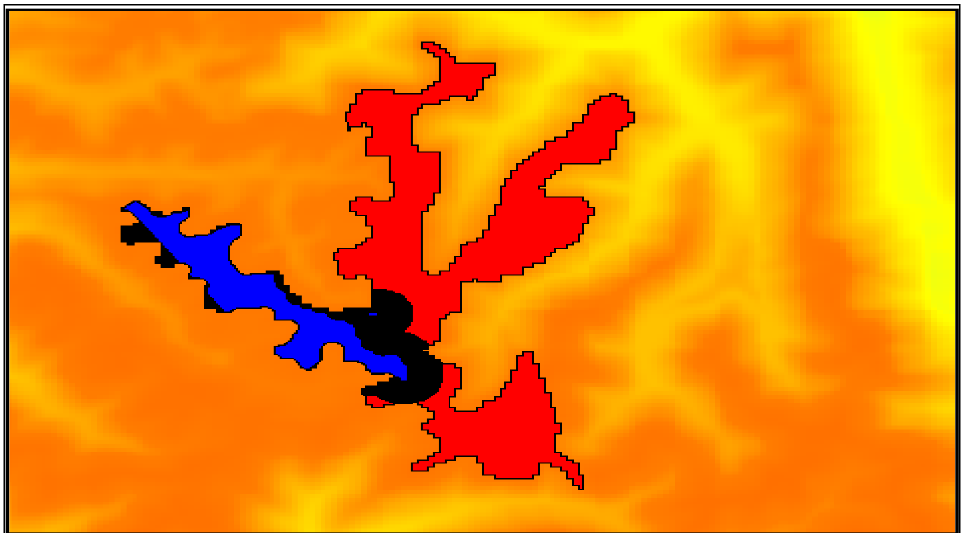


Figure 14: Deep mine (Red) with strip and auger mining

Figure 15 and Table 5 show the total tons available when using all mining types.

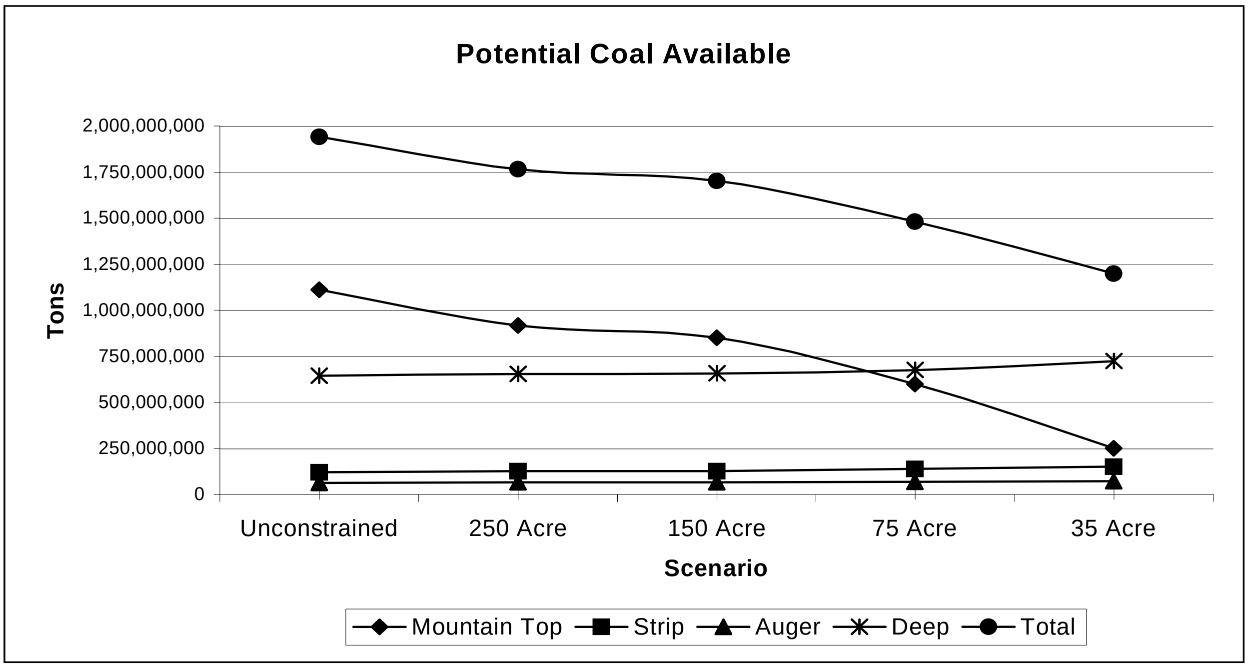


Figure 15: Tons per Mining Type

Table 5: Coal available (Tons)					
	Mountain Top	**Strip**	**Auger**	**Deep**	**Total**
Unconstrained	1,111,223,494	121,992,908	64,368,028	644,800,391	1,942,384,821
250 Acre	919,512,131	126,112,714	66,179,035	654,725,113	1,766,528,993
150 Acre	852,829,517	126,112,714	66,179,035	656,815,960	1,701,937,226
75 Acre	600,324,203	138,018,552	68,994,421	674,484,688	1,481,821,865
35 Acre	252,053,489	150,609,016	74,098,458	724,357,250	1,201,118,213

Correlation between West Virginia, Kentucky and Virginia (Issue #6)

The relative effects of the environmental restrictions on coal mining in West Virginia were applied to Kentucky and Virginia on a countywide basis. Because an extensive coal database was not available in Kentucky or Virginia the GIS analysis was not appropriate. Similar attributes had to be found between the counties of all three states to apply the results from West Virginia to the other two states. Attributes investigated included number of mountain tops, average slope of the topography, variance of slope, number of streams, and stream segment length. The reasoning behind this analysis is that counties with comparable features would have similar results with respect to MTR/VF environmental restrictions. For example, a county in Kentucky with the same number of mountain tops as a county in West Virginia may be expected to lose the same percentage of mineable coal between environmental scenarios.

To find the appropriate attribute to use as the link between the states, a correlation between the physical landscape of West Virginia and the MTR/VF results had to found. After many attempts to find an empirical relationship, the best relationship found that explains coal reduction between environmental scenarios is Landscape Slope Variance Coefficient. Landscape Slope Variance Coefficient represents the amount of change in the slope of the mountains per county. This factor had the highest positive correlation with respect to the MTR/VF scenario results. This implies that counties in Kentucky and Virginia with similar slope variance coefficients as counties in West Virginia would have the same relative changes in MTR/VF results as West Virginia.

Conclusions

As environmental constraints become more restrictive the amount of mountain top mining coal is severely limited. Strip, auger and deep mining can augment mountain top losses due to regulations, but only on a limited basis; the mountain top mining methods dominates the potential coal tonnage available in West Virginia. The results of the relative changes in mountain top mining in West Virginia due to regulations may be applied to Kentucky and Virginia on a countywide basis.

Appendix I: Results reported to Hill and Associates

Final Report

Contract No. 68-R3-01-04
Sponsoring Agency: U.S. Environmental Protection Agency
Project: Economic Impact of Mountain Top Mining and Valley Fills Environmental Impact Statement
Contractor: Hill & Associates, Inc.
OMB Clearance No. for Progress Reports: 2030-0005

Date: December 12, 2001

I. Background

This work was performed to provide assistance required by the U.S. EPA Region III to support the development of a Programmatic Environmental Impact Statement to assess the impacts of mountaintop mining and valley fill practices in sub-regions of West Virginia, eastern Kentucky and Virginia, as defined by the EIS Steering Committee.

In December 1998, Federal agencies and environmentalists agreed to a partial settlement of a lawsuit by the West Virginia Highlands Conservancy and several coal field residents against the WV Department of Environmental Protection (WVDEP) and the U.S. Army Corps of Engineers. Under the agreement, the EPA, the Office of Surface Mining, the Corps of Engineers, and the U.S. Fish and Wildlife Service, in conjunction with WVDEP, agreed to develop a Programmatic Environmental Impact Statement to assess the impacts of mountaintop mining and valley fill (MTM/VF) practices in Appalachian coal fields and to evaluate a range of changes to regulatory requirements and practices.

This work is part of a three-phase study to evaluate the economic impacts of regulatory changes for the mining industry. Phase 1 examines the impact of proposed regulatory changes on the amount of mineable coal reserves. Phase 2 uses these results to estimate the market impacts on coal prices, coal production, electricity generation and electricity pricing. Phase 3 addresses the total direct and indirect impact on the economies of the three eastern states included in the study.

Work on Phase 1, under a separate EPA contract, was performed by Resources Technology Corporation (RTC) of State College, Pennsylvania, to calculate coal reserves in West Virginia and the impacts of any regulatory restrictions on the amount of coal mineable with mountaintop mining and valley fill techniques. After completion of their West Virginia analysis, RTC extended their effort to include the coal reserves in eastern Kentucky and in Virginia and above-drainage reserves outside of mountaintop mineable sites. The portion of RTC's results which pertained to mountaintop ***mining*** sites became input to the effort by Hill & Associates, Inc. (H&A) of Annapolis, Maryland, which is the subject of this Final Report for the Phase 2 work. H&A analyzed the implications of those regulatory restrictions on the markets for coal mined in West Virginia, eastern Kentucky and Virginia, as well as the implications on coal and electricity prices.

II. Methodology

In this study, H&A used its proprietary database of coal mine operations and costs, its integrated Coal Forecasting System and National Power Model, data produced by RTC as described above, and its professional expertise in coal and energy markets to conduct the analysis of regulatory impacts on the selected coal markets and energy prices. H&A produced a baseline forecast with its models for each year in the period 2001-2010. This same time period then was again forecasted for each scenario of potential MTM/VF regulation. It is important to note that this current work includes the impacts of only one variable, the restriction of valley fill watershed size. Any other potential changes to the economics of surface mining in the study area are not included in this study.

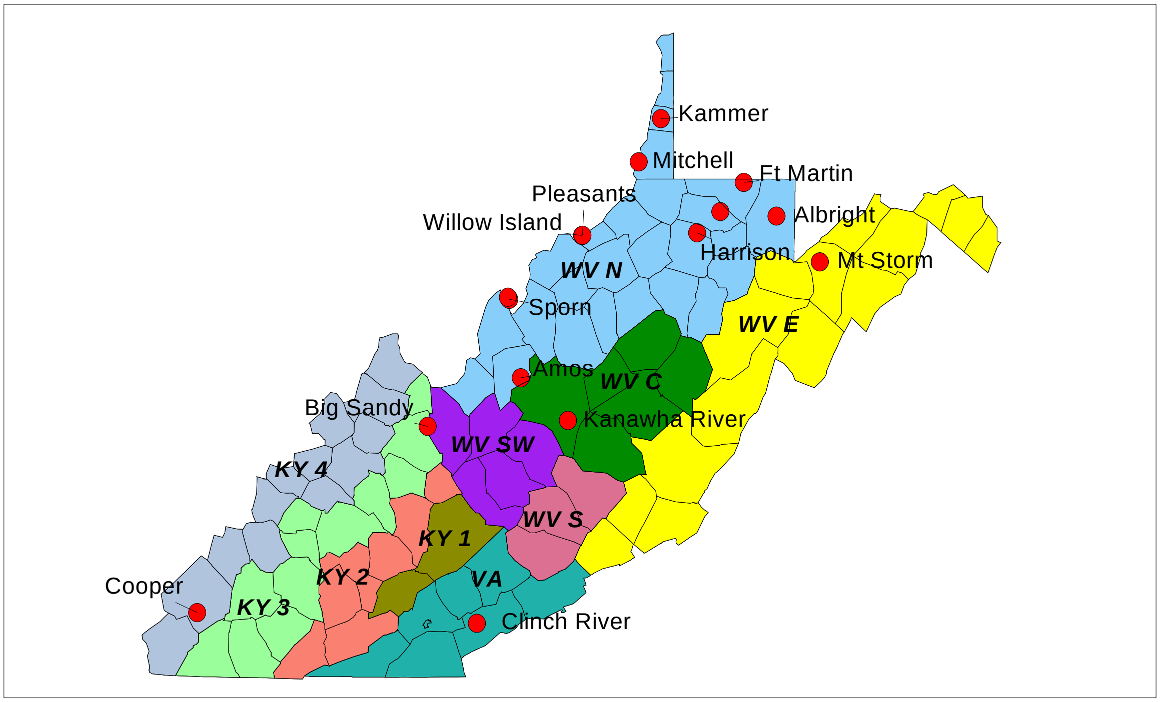
II.A. Assumptions

The baseline forecast was under an assumption of pre-lawsuit status quo with regard to Central Appalachian mining regulations. However, changes in utility plant air emission regulations were allowed to occur according to the scenario approved by the EIS Steering Committee. These changes include the implementation of National Ambient Air Quality Standards for ground-level ozone and for fine particulate matter. Specifically, the modeling assumed the following post-1998 structure of air emission environmental regulation of electric power plants:

- Title IV Phase II SO_2 and NO_x standards starting in 2000
- EPA 19-state (formerly 22-state before court relief granted for MO, WI and GA) NO_x SIP Call effective in 2005 (assuming further delay beyond 2004)
- NAAQS fine particulate standards represented as 50% reduction in SO_2 from Phase II levels beginning in 2008
- No CO_2 limits during the time frame of this study

Holding this year-by-year pattern of air emission regulations consistently the same across mining scenarios, H&A conducted an assessment, across four alternate mining regulatory scenarios, of changes from the base case in supply conditions in five mining sub-regions of West Virginia, four sub-regions of eastern Kentucky, and one region representing Virginia. Those sub-regions are shown in the figure below:

Figure 1 – Sub-Regions of the Study (With Power Plants)



The four alternate scenarios in addition to the Base Case are:

- Limiting valley fills to 250 acres watershed size
- Limiting valley fills to 150 acres watershed size
- Limiting valley fills to 75 acres watershed size
- Limiting valley fills to 35 acres watershed size

Using the supply changes provided by RTC from Phase 1, H&A then modeled the coal and electricity market implications of the four alternate regulatory scenarios using its integrated Coal Forecasting System and National Power Model.

RTC provided H&A with a database, which contained an estimate of recoverable coal reserves for each potential mountaintop removal site in West Virginia. In situations where a given site was mineable across a county boundary, the amount of coal in each county was calculated separately. RTC also provided an estimate of how much these reserves would be reduced for each of the four restricted mining scenarios.

In order to apply these numbers from RTC to H&A's existing database of coal production, reserves and mining costs, we calculated the percentage reduction for each mining case on a county by county basis. We then adjusted the reserves and production figures in our supply database downward by the same percentages, on a county by county basis in West Virginia. H&A did not interview individual coal producers to ascertain their estimates of reserve reductions on specific properties. The following table shows the calculated reduction percentages by West Virginia county. It shows the remaining fraction of each county's surface reserves after portions are rendered unmineable by the proposed MTM/VF restrictions.

Table 1 – West Virginia County Reduction Impact

		Remaining Fraction of Surface Reserves (Not Rendered Unmineable by MTM/VF)			
COUNTY	STATE	250 Acre	150 Acre	75 Acre	35 Acre
BARBOUR	WV	1.000	1.000	1.000	1.000
BOONE	WV	0.995	0.922	0.703	0.277
BRAXTON	WV	1.000	1.000	1.000	1.000
CLAY	WV	1.000	1.000	1.000	0.602
FAYETTE	WV	1.000	1.000	1.000	0.118
GREENBRIER	WV	1.000	1.000	1.000	1.000
KANAWHA	WV	0.913	0.913	0.415	0.119
LINCOLN	WV	0.128	0.128	0.111	0.075
LOGAN	WV	0.766	0.554	0.272	0.088
MCDOWELL	WV	1.000	1.000	0.850	0.360
MERCER	WV	1.000	1.000	1.000	1.000
MINGO	WV	0.786	0.781	0.505	0.218
NICHOLAS	WV	0.994	0.976	0.801	0.390
POCAHONTAS	WV	1.000	1.000	1.000	1.000
RALEIGH	WV	0.380	0.380	0.380	0.182
RANDOLPH	WV	1.000	1.000	1.000	1.000
SUMMERS	WV	1.000	1.000	1.000	1.000
UPSHUR	WV	1.000	1.000	1.000	1.000
WAYNE	WV	0.332	0.332	0.332	0.247
WEBSTER	WV	1.000	1.000	1.000	0.797
WYOMING	WV	0.633	0.663	0.633	0.073

For the purpose of this study, it was assumed that deep-mineable coal reserves were not affected by the hypothetical mining restrictions. However, in practice, deep mines in the study region typically feed raw production to a preparation plant for cleaning, and the reject material is often deposited in a nearby valley. The EIS Steering Committee instructed that coal refuse disposal associated with deep mining is not a part of this study.

RTC did not have the same detailed mapping capability in Kentucky and Virginia as it did in West Virginia. Therefore, RTC compared the topography in the coal producing counties of those states to the counties in West Virginia and supplied H&A with a table of comparable counties. H&A used these comparisons and made the same production/reserve reductions for counties with similar slope characteristics. The following table shows the coal producing counties in Virginia and Kentucky and the counties in West Virginia with similar topographic characteristics.

Table 2 – Similar Eastern Kentucky and Virginia Counties

County	State	Similar WV County
Bell	KY	Braxton
Breathitt	KY	Webster
Clay	KY	Wayne
Dickenson	VA	Webster
Floyd	KY	Clay
Harlan	KY	McDowell
Jackson	KY	Raleigh
Johnson	KY	Wayne
Knott	KY	Boone
Knox	KY	Fayette
Laurel	KY	Raleigh
Lawrence	KY	Wayne
Lee	KY	Raleigh
Leslie	KY	Boone
Letcher	KY	McDowell
Magoffin	KY	Kanawha
Martin	KY	Lincoln
McCreary	KY	Raleigh
Morgan	KY	Wayne
Owsley	KY	Nicholas
Perry	KY	Clay
Pike	KY	Mingo
Pulaski	KY	Raleigh
Rockcastle	KY	Fayette
Whitely	KY	Raleigh
Buchanan	VA	Boone
Lee	VA	Raleigh
Russell	VA	Nicholas
Scott	VA	Fayette
Tazewell	VA	Nicholas
Wise	VA	Nicholas

At the sites where RTC determined that mountaintop mining would not be feasible in the four restricted cases, RTC also calculated the tonnage of coal reserves that could be recovered by three other methods including: continuous-miner deep mine, contour strip, auger/highwall miner. These reserves were "added back" to the supply database as possible new mines. The hypothetical opening of these mines was delayed two years to account for engineering and permitting.

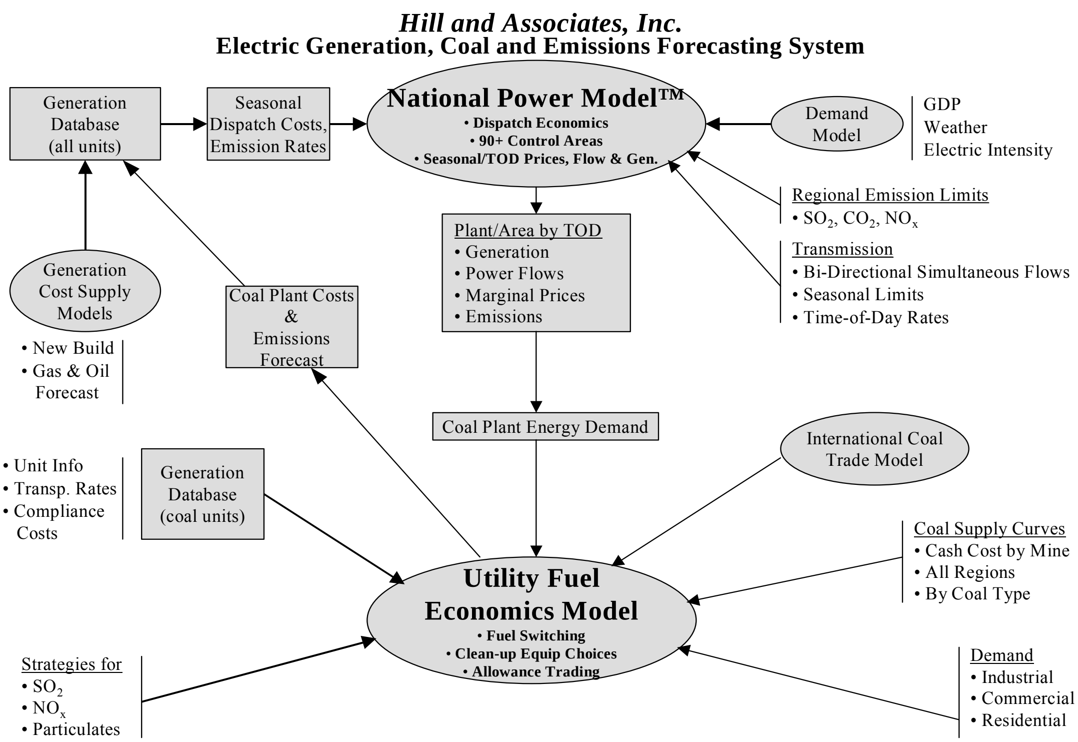
The mining cash operating costs on a per ton basis for active mines in our original database were held constant as the production and reserve values were reduced for each scenario. For the reserves that could be recovered by other methods, we assigned the average costs for active mines for each type of mining in each county.

In order to compare mining regulatory scenarios on both a risk-adjusted basis as well as an unadjusted basis, H&A ran two separate versions of the Base Case. One Base Case version used a "standard" 10% Return on Investment (ROI) criterion for investment in new coal mining capacity, while the other Base Case version used the same 15% ROI criterion that the MTM/VF regulation-affected scenarios used to reflect higher capital investment risk under a more aggressive regulatory environment.

II.B. The Models

The flow diagram in Figure 2 summarizes the actual modeling system that H&A uses to develop coal demand, supply and price projections, along with the electricity generation and electricity pricing associated with these coal projections.

Figure 2



This system is a combination of two primary models, the Utility Fuel Economics Model (UFEM) and the National Power Model (NPM). The UFEM determines optimal fuel choices as well as optimal environmental clean-up equipment selection at each utility coal-fired plant in the nation, while the NPM determines optimal dispatch of all electric generating plants (both coal and non-coal) on the electric grid.

By looping back and forth between these two models in a circular fashion for each year under a specific set of environmental rules, an overall converged optimization is reached in which the fuel and clean-up choices at each coal plant are dependent, in part, upon the plant's amount of dispatch while that dispatch is simultaneously determined, in part, by the costs and emissions from those fuel-related choices. The primary usefulness of this modeling approach for this current project lies in the fact that all U.S. plants are considered simultaneously in competition with each other both for their coal supply and for their competitive dispatch on the electric grid. The summation of individual plant fuel demands results in a total of coal demand for each specific region's coal.

Additionally, since we have each plant's most likely decision on the installation of environmental clean-up equipment (and have used an estimate of the costs associated with installing and operating such equipment in obtaining that likely decision), the final converged optimization result contains the plant-by-plant building blocks from which we can sum each sub-region's total of capital expenditures by utilities for environmental clean-up equipment. Those totals by sub-region are reported by year as results from this study.

During specific runs of the modeling system, as the National Power Model dispatches all the plants in the U.S. simultaneously by time-of-day and season, the coal-fired plants are competing against each other and against other generating plants such as gas-fired, nuclear, hydro, etc. Depending upon which environmental limits are in effect in each area of the country for the year being modeled, more or less power will be required from individual coal-fired plants, and these requirements are then translated into specific types of coal demand in the Utility Fuel Economics Model. The aggregated total tonnages for each coal type then become the basis for that scenario's coal forecast. To this electric utility basis are added independent projections of industrial steam coal use and exports of steam coal. The resultant totals by coal type determine the market clearing price for each coal as prices "float" against each other from their respective cost-supply curves.

II.C. <u>Mining Cost-Supply Curves</u>

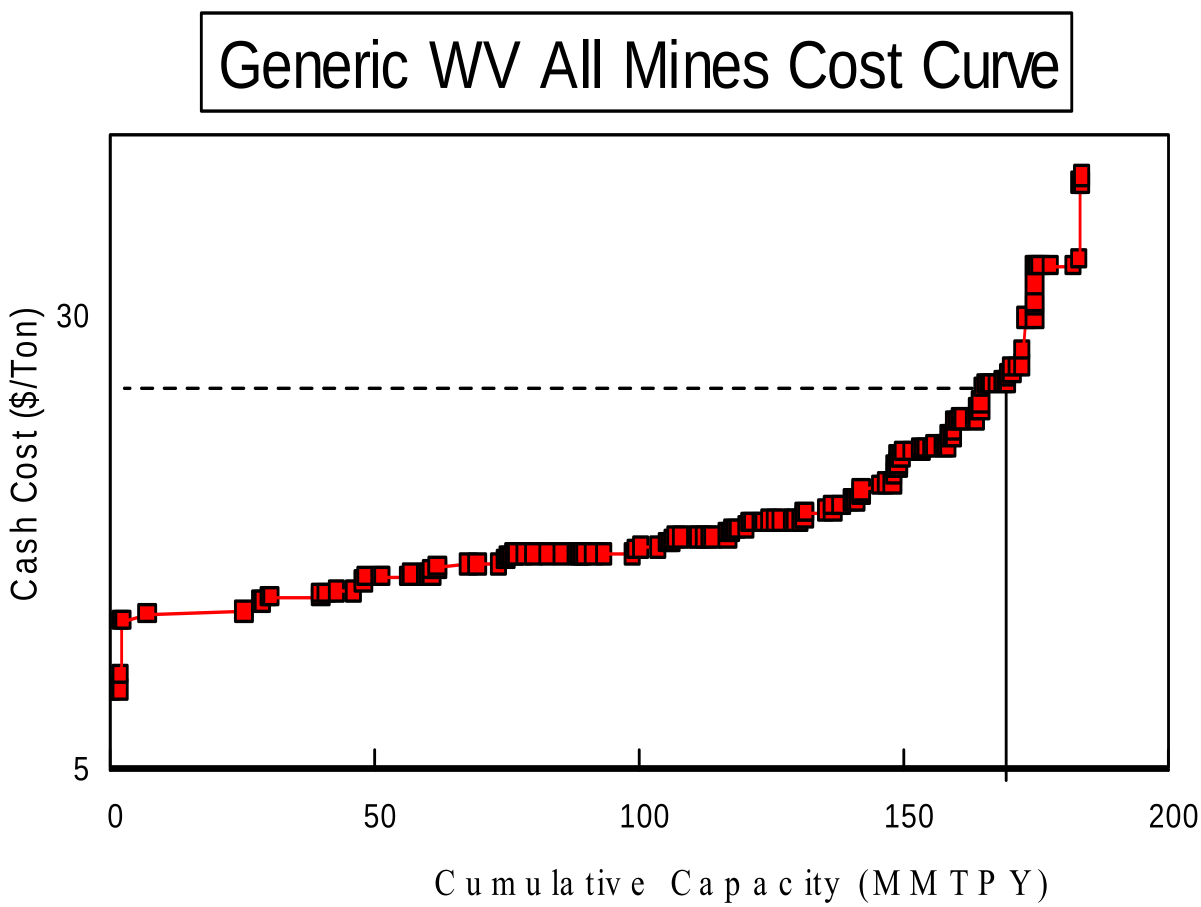
Inside the UFEM model, the supply curves relating mining costs to production capacity were built up from mine-by-mine estimates of cash operating costs for all currently operating mines in the country. The cash operating costs used in the model's supply curves are defined as including the following components: labor, materials and supplies, trucking to the prep plant or load-out, preparation costs (including loading), Black Lung/Reclamation taxes, mine overhead charge, division overhead charge, pension contribution, property tax, severance tax, and royalties.

Much of the information on costs, qualities and reserves was taken from the detailed county-by-county studies of coal supply that Hill & Associates, Inc. has been publishing for more than 15 years. Within our proprietary database, costs for all active mines were estimated by entering mine specific data into computer models developed by Hill & Associates. MSHA databases provided information on active mines, production, employees and manhours worked, from which we calculated productivity. This base was supplemented with information from mine interviews concerning work schedules, equipment, percentage of washed coal and trucking distances. In instances where trucking distances were not obtained by interviews, the distance was measured between the mine and the preparation plant via the most logical road using a computer-mapping program. Costs for potential mines on undeveloped properties were estimated by looking at costs of comparable active operations located nearby.

In the current version of the UFEM model, we have more than 100 separate sub-types of coal including 12 in West Virginia, 9 in eastern Kentucky and 5 in Virginia. For example, southern West Virginia mid-Btu near-compliance coal originating on the CSX railroad is a unique coal type with its own cost-supply curve separate from that same coal originating on the Norfolk Southern railroad.

Although Hill & Associates considers their individual mining cost curves (by specific type of coal) to be highly proprietary, we include in Figure 3 below a composite generalized curve for West Virginia for purposes of understanding in this report. The figure will be referenced in the methodology discussion that follows.

Figure 3



Each step on each mining cost-supply curve represents one mine with its own individual characteristics. It is this fact that allows us to incorporate the results of Phase 1 of the overall EIS study (the work by Resources Technology Corporation) into the H&A modeling system to differentiate between the separate MTM/VF regulatory scenarios. In particular, although RTC's results are not property-specific, the relative amount of coal made unmineable (or shifted to a higher-cost mining technique with less recovery) in each county under each MTM/VF scenario can be reduced to a percentage impact for that county.

Since we know the location of each mine and its characteristics, we can take each surface mine in a county and apply the county's percentage reduction impact to that mine's capacity and reserves (including, where appropriate, adding back a smaller higher-cost step into the mining cost-supply curve from which that mine was taken if the MTM/VF reduction could partially be replaced with another type of mining). Spreading the county's aggregated reduction percentage across all surface mines in the county does not exactly match what would happen in the real world where a true mountain top mining project might be more heavily affected while a small contour mining operation might escape totally unaffected. However, for the purposes of determining coal price and tonnage impacts on multi-county sub-regions of the affected states, it is believed that this methodology provides virtually identical results to what would be obtained if we had exact property-specific match-ups from Phase 1 of the overall EIS study. Although modeling, by its nature, establishes some industry-typical behavior patterns and decision rules, we would expect in the real world that some mines would be better prepared than others to adapt to any new regulations.

It is important to note that both the current production capacity and the reserves were reduced in this study by the appropriate county's reduction percentage. This implies a *de facto* assumption that any MTM/VF restrictions would be applied with no "grandfather" provisions exempting existing operations. In other words, existing operations that would violate the scenario's interpretation of MTM/VF rules would have their production capacity (in the modeling) immediately reduced, as well as having their reserves reduced for supporting future production. A methodology of reducing only reserves and leaving existing capacity intact (effectively grandfathering existing operations) could have been used, but one methodology or the other was required to be chosen for a single study, and the EIS Steering Committee chose the one equally affecting both reserves and existing capacity. The real world impact of the mining restrictions during the first year might be muted somewhat, compared to our modeling results, due to the fact that some operations have established fills and pre-stripped some amount of overburden for future mining.

The mine-by-mine nature of the steps on the model's mining cost curves serves a second purpose in this project. After the converged optimization is achieved between the UFEM and NPM models for any given year for a specific scenario, the final total amount of coal taken from each supply curve is used to determine which steps (or individual mines) produced coal in that model run, and which did not. As an output function, then, the supply curves are "broken apart" after the run, and the mines actually producing are summed by their type of mining (surface versus deep) and their sub-region of location. Thus, the tonnage results included later in this report are obtained by this summation (across several cost-supply curves) of the mines from a particular sub-region that actually produced coal in that year's model run for that scenario.

Since each coal type represented by a mining cost-supply curve has its own final market clearing price after the model run is done, a weighted average price calculation can be performed for each sub-region's coal production during the summation procedure described above. It is important to note that the modeling approach used in this study yields short-term market clearing prices for new business at the margin, and it does not include any averaging into the results of older long-term contracts which may be "out of market."

In addition, since we know the very specific type of mining such as longwall mining or continuous miner sections for each step (or individual mine) on the cost-supply curve, we can use our knowledge of typical manning tables for each type of mine to estimate the direct coal mining employment in each sub-region during the summation process described above for mines that actually operated during the model convergence runs. Future manning levels at coal mines were estimated by using the active production and productivity rates as reported by MSHA for surface and deep mines in the study area. The total number of production employees at active surface and deep mines was divided by the actual tonnage produced to determine ratios. These were then used as multipliers and were applied to the tons of production that were predicted by the model for the future years.

The values shown in the tables represent production employees only and do not include prep plant and mine office personnel. On the average, surface mines increase employment by 3.9 percent for the non-production tasks, including mine office staff, prep plant and "yard workers." For deep mines, the average is 10.5 percent. The overall average is 8.2 percent for deep and surface mining. In addition, some state labor statistics for "coal industry employment" include non-mining personnel involved in transportation, marketing and support services. None of these categories are included in the direct production employees reported in the results of this study.

II.D. Electricity Input/Output

On the electricity side, the NPM model works in a similar fashion with electric dispatch cost curves instead of mining cost curves. However, while the UFEM's mining cost curves stay relatively static during the modeling of any one year in a scenario (they do change across years as described later), the NPM's dispatch cost curves are very fluid during one year's looping between the models, changing with each loop as the coal-fired plants enter the electricity model with sometimes significantly different costs and emission rates due to their fuel and clean-up choices in each loop. Figure 1 above shows not only the sub-region definitions, but also the major coal-fired utility plants within each region. The electricity outputs from the NPM model include not only the megawatt-hours from coal-fired plants, but also the generation from all generators in the sub-region.

Wholesale electricity prices reported as output from the NPM model are really the "lambda" costs for each control area (basically, each utility) in the model. This lambda cost is defined as the dispatch cost of the very last plant that dispatched (i.e. the highest-cost plant that actually ran in that time-of-day period) within that control area. If the highest-cost power actually used for that time period happens to be wheeled power imported from a neighboring utility, then that cost of imported power is the lambda cost reported out as "wholesale electricity price" for that time-of-day and season for that control area.

Since the study sub-regions were defined around coal production, it turns out that some of them have no generating facilities in the sub-region. For this reason, some sub-regions will show electricity "results" in later sections of this report that stay uniformly at zero. Obviously, there still exists a price for electricity for those regions (although not a megawatt-hours of production number). However, we opt to report the "raw" weighted averages of electricity price from generators for the Phase 2 results, leaving it to the expertise of Phase 3 modelers to impute an electricity price from surrounding areas for those that show zero.

II.E. <u>New Capacity Additions</u>

Finally, we turn now to the methodology by which new capacity, both for coal mining and for electric generation, is added in the modeling. With regard to coal productive capacity, each cost step on the mining cost-supply curves has a "tons per year" new capacity number associated with it, as well as an amount of "additional" reserves that are associated with that new capacity (where that new capacity would be based on newly developed reserves). For many lower-cost steps, one or the other of these amounts (or both) have a zero value in the model because we believe that no new capacity can be built at that cost level or no new reserves are available to be developed at that level.

The real meaning behind those "new" mining capacity numbers (and associated reserves, in some cases) is important. In a few instances, this new capacity is actually associated with the specific mine whose cash operating cost was the basis for building that step into the curve. For those instances, our estimate is that the particular mine in question has the appropriate coal reserves available and the ability to expand their production at the same cost level at which they are now operating.

More often, this new capacity is <u>not</u> associated with that mine but rather represents the "step-out" capacity (at a cost increase) for another mine that is lower on the cost-supply curve. In other words, the lower-cost existing mine may have the opportunity to purchase or lease adjacent reserves that are not as geologically favorable for economic mining as those of their existing operation (or the step-out reserves may require longer haulage to a preparation plant at increased cost, for example). For this reason, the mining cost-supply curve has this higher cost step with zero <u>initial</u> capacity, but non-zero latent <u>expansion</u> capacity, lying "on top of" the step for the other, higher-cost existing mine which just happens to have the same cash operating cost as would be incurred with these other reserves.

In the UFEM model, the market clearing price for any coal is determined by the relationship between the final converged demand for that coal and the cost-supply curve for that coal. Referring to Figure 3 above, this is demonstrated by the vertical solid line (representing a hypothetical 170 million ton demand against the “generic WV all mines cost curve”) which intersects the curve and generates the horizontal dotted line that goes to the left and hits the Y-axis at a “market clearing” coal price of something under $30 per ton.

This market clearing price is reported from the model as the coal’s price except in instances where there is extreme shortage of the coal in question. If the competitive balance point for demand is so large compared to available capacity that it is effectively beyond the right-hand edge of the cost curve, then there is no “intersection” of demand with the curve. In that case, the reported price is set at a “net-back” value representing the highest value that some potential purchaser would actually be willing to pay (if more of that coal were available) in order to avoid some other costs such as installing a scrubber or purchasing another coal at high delivered cost. A real-world example of this netback phenomenon occurred in mid-2001 when Powder River Basin coal, whose cash operating cost does not exceed, say, $4.00 per ton, was selling in the marketplace for $12.00-$14.00 per ton. The coal was truly “worth” that to some buyers who could avoid paying $50.00 per ton for eastern coal in the very tight market.

For any point (or mine) on the curve to the left of the solid vertical “demand” line in Figure 3, the vertical distance down from the dotted line to the point (or mine) measures the cash “margin” that is available to that mine at that market clearing price. (We avoid the word “profit” here since the capital investment in the original mine is being ignored, and we are dealing only with cash operating costs.) For instance, referring to Figure 3 above, the mines falling between 160 and 170 mmtpy on the X-axis are just barely below the dotted line and may be making a cash “margin” of only $1-$2 per ton to cover their capital investment plus true profit. On the other hand, all of the mines below, say, 100 mmtpy will be experiencing a cash “margin” of several times that amount. For any particular mine, this larger cash “margin” may not only cover capital recovery (depending on the investment cost in that mine), but may be generating a Return on Investment (ROI) in excess of 10%. It is important to remember that Figure 3 is an illustrative generic curve and that the actual curves used in the modeling are much more definitive by type of coal instead of simply “all WV.”

Now all of the pieces start coming together with regard to the addition of new capacity into the mining cost curves. During the running of the UFEM model for any given year in a scenario, a check is made of this cash “margin” for every point on every curve. When the margin is sufficient to meet or exceed the criterion ROI for the expansion capital investment in that particular scenario, then that step’s latent “new capacity” is brought into the curve at that specific cost level, effectively expanding the horizontal span, or capacity, of that step.

However, the model imposes an overriding limit in each area (the "Area Limit") to avoid the situation where a price spike could trigger more capacity investment (in the model) than could be realistically accommodated in the real world. The model starts at the lower end of the curve (where cash "margin" is the greatest for any equilibrium price) and brings on the economically justified new capacity additions until the overriding "Area Limit" is reached. After that point, cost steps are not allowed to expand (in this particular year), even though the criterion ROI would be exceeded for that mine to expand. It is important to note that the overriding limit frequently is not reached even with fairly high prices because there is little expansion capability at the lower cost levels on the left side of the curve – Most of the undeveloped capacity occurs at higher cost levels.

In the modeling, we assumed that the initial year in which valley fill restrictions are first imposed (2002 in these scenarios) would be a "regrouping" year in which coal producers would concentrate on adjusting to the new rules at their existing operations and would not invest in ROI-driven capacity expansion for new operations inside the study area. Our primary rationale was that producers would take a "wait and see" attitude to let things "settle down" under new rules before they replaced their lost capacity. A secondary rationale was that at least a portion of any new replacement capacity would need to go through the design, engineering, permitting and construction procurement process, and all of this takes time.

One additional wrinkle in the methodology reflects the fact that there exists a very real "lag time" between the perceived need for new capacity investment and the point in time where that capacity is actually available. That lag time may be on the order of 1-3 years, but is somewhat offset by anticipation among the producer community (i.e. plans and permits may be preliminarily started with an eye toward rising prices). For this reason, the model uses a one-year delay in bringing on new capacity. In other words, the cash "margin" test described above actually uses the equilibrium price from <u>last year's</u> converged solution to bring on the new capacity instead of the price emerging out of this year's solution.

The bottom line is that, in the model, there is a "balancing act" occurring which mirrors what happens in the real world. In this balancing act, any "shortening" of a mine curve (due to exhaustion of reserves at individual mines, for example, or due to MTM/VF reductions to capacity) will likely lead to somewhat higher prices as demand hits "higher" on a shorter curve. These higher prices, in turn, cause more steps on the cost curve to "see" an acceptable ROI, leading to capacity expansion for that step <u>if</u> any is available. The concept of this "balancing act" is important to understanding some of the results presented later in this report.

There are two other secondary methods by which capacity is added into the mine curves within the model. First, one of the inputs to the model is an assumption of future productivity growth for each of the more than 100 types of coal. In these runs, a productivity gain of 3% per year, somewhat lower than the historic average due to tougher mining conditions, was assumed for all of the Central Appalachian area. This is important to capacity since, at a mine producing 1.0 million tons per year (mmtpy) and experiencing a 10% gain in tons per man-hour, the mine either could produce 1.1 mmtpy with the same workforce after the gain or could lay off approximately 9% of its workforce (1/110% = 91%) and produce the same 1.0 mmtpy with fewer workers. In the first case, we have a productivity-induced capacity increase. One of the model inputs involves our projection of what proportion of productivity gain goes toward capacity increase versus workforce reduction and, although the calculations are somewhat complicated, it works out that less than half of the productivity gain is going toward capacity in the model runs.

Second, there is a well-established pattern in the coalfields of mines that are running at their maximum capacity making small capacity gains (usually through equipment upgrades) even if the true ROI economics are not there to justify this "smaller than major expansion" level of capital investment. Accordingly, we have a test in the model that determines if a step was 100% used in the previous year and has at least 7 years of reserve life remaining. If both of these conditions are met, then the mine capacity is very slightly "stretched" for that step on the order of 1%-2% to reflect this real-world phenomenon.

Both of these secondary capacity effects (productivity and "stretch") are allowed to occur before the economic "margin" test is made for bringing on major new expansion capital at a mine. The net effect is that a small amount of the "major capital" capacity expansion may be forestalled by the lesser amount of "creep" in capacity that occurs due to productivity gains and the "stretch" described above.

Since a major purpose of the study is to provide information for projecting economic differences between the separate scenarios modeled, we would like to know how much more or less capital is invested in new mining capacity for each scenario. We accomplish this by carefully tracking the exact type of mining for each new capacity addition brought on at each step on the mine cost curves. We then apply our estimate of capital investment per annual ton of new capacity (for that specific type of mining) to the total expansion tonnage of that type brought on in the model run. Our capital estimates are based on interviews with equipment manufacturers and coal producers as well as on published information regarding capital expenditures for new coal mines. Finally, we sum up these capital dollars across the different mining types and report the result by year by sub-region for each MTM/VF scenario.

On the electricity side, the NPM model brings on new baseload capacity in a manner very similar to the "margin" test procedure described for the UFEM model above. That is, since the NPM model is driven by dispatch bid costs (the major component of which is fuel cost for a coal-fired plant), a test is made against that dispatch bid cost. Whenever the wholesale price of electricity in a control area (most generally, a single utility) as measured by lambda cost exceeds the anticipated dispatch bid cost for a new gas-fired combined cycle ("new CC") plant by a large enough "margin" to generate a criterion 10% ROI, then a new CC plant is built in that control area.

New peaking capacity is brought on automatically in the NPM model to satisfy a classical "reserve margin" calculation for each control area. In the model runs, we used a 10% reserve margin criterion which is somewhat lower than the historic regulated 15% required by many public utility commissions but is obviously higher than levels that currently exist in some portions of the country

Because new coal-fired plants were not considered a serious option over the past several years, the model has been set up to "automatically" bring on only gas-fired new capacity. However, in recent times the consideration of new coal-fired capacity (either expansion or grass-roots) has resurfaced. For this reason, in model runs for clients over the past year or so (until we build a module for actually making economic trade-offs between gas-fired and coal-fired new capacity), we simply add by hand a selected few coal plants in the model in control areas where new coal plants would be most likely. We spread these new coal additions across the next decade timed to the model's signals that new capacity is needed. Those coal-fired by-hand additions are entered in the appropriate year before the model does its calculations of the need for the model-generated new gas-fired capacity. One of those hand-entered coal-fired facilities shows up in year 2009 in the VA sub-region in the results of new generating capacity shown later in this report.

III. Results

For both versions of the base case and for each of the four alternate mining regulatory scenarios (six cases in total), this study has generated model outputs for each year of the 2001-2010 period. These outputs form the basis for H&A's projections under each scenario for each year for the following variables:

- Coal tonnage
- Direct coal employment
- Mine capacity capital expenditures
- Average coal price, fob mine
- Megawatt-Hours of generation
- Average wholesale price (lambda costs) of electricity
- Environmental clean-up equipment capital expenditures for utilities
- Electricity capacity investments by type (construction, equipment, etc.)
- Major coal mine operating costs by category
- Average U.S. wholesale price (lambda costs) of electricity

Except for the U.S. wholesale price of electricity and the major coal mine operating costs by category, all of these variable outputs are provided by study sub-region.

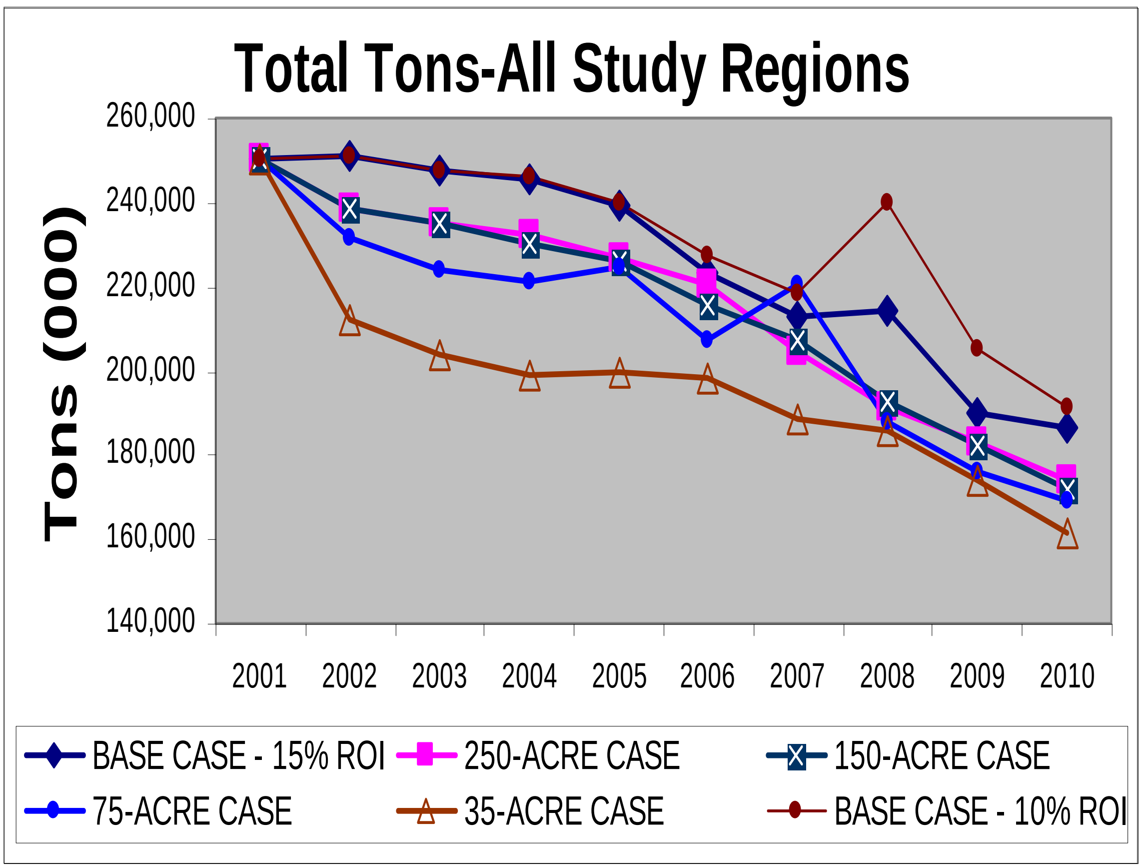
Although much of the detail by sub-region is primarily needed for EIS Phase 3 modeling (outside of this study) of total direct and indirect economic impact on the economies of the states being studied, those detailed results are presented in their entirety for the reader in the Appendices to this report. The Appendices are organized in the same order as the list immediately above. (Appendix A contains coal tonnage information, Appendix B coal employment numbers, etc.) All coal-production related parameters are reported by surface mining versus deep mining within each sub-region.

The remainder of this section of the report will focus on highlighting selected results, especially at a more aggregated level where appropriate, and providing descriptive and interpretive analysis of their meaning in the context of overall impacts of potential MTM/VF restrictions.

III.A. Coal Tonnage

Figure 4 presents a graph of the projected total coal tonnage by year from all of the MTM/VF directly-affected regions covered in this study. The numbers behind this graph are presented in the bottom section of Table A-1 in Appendix A.

Figure 4



There are several issues that arise from considering this graph. First, the general downward trend of total tonnage from the study region under all cases is a result we see across many modeling projects for different clients inside Hill & Associates. It is a reflection of the continuing economic and environmental adjustment of the coal marketplace that has been occurring over the past few years in which Powder River Basin (PRB) coal from Wyoming has been gaining in market share while Appalachian coals in general have had declining market share. This is exacerbated toward the end of the 10-year study period by the fact that significant blocks of higher-quality Central Appalachian reserves are starting to be exhausted. The better-quality coals in this region are slowly but surely being mined out.

It is not the purpose of this MTM/VF study to delve into the general trend of PRB coal supplanting Appalachian coal – there are several good studies from government sources and from consultants covering that topic. Rather, it is sufficient here to note the trend and the fact that it will, of course, have a general bearing on this study since a higher level of demand over the decade of study would necessarily place more strain on the coal supply system from the area that may be restricted to some degree by MTM/VF regulations.

Second, consider the two versions of the Base Case (the top two lines through most of the graph). For the years 2002-2005 the 15% ROI Base Case and the 10% ROI Base Case fall virtually on top of each other so that there appears to be only one line and, in fact, there is only a miniscule difference between the graphs for those years. The reason for this congruence between the two cases in the first few years lies in the somewhat complicated real-world "balancing act" (discussed in the "Methodology" section above) in which capacity is both leaving and entering the mining cost-supply curve simultaneously. By examining the detailed model working files for each of the runs represented by a single point on the graph above, we have determined that for years 2001-2004, the entire region is expanding as fast as it can under the "Area Limits" which are determined by the amount of new expansion that an area of the coalfields can absorb in one year, given the labor force, transportation capabilities, etc. of the area.

During this early period, there is enough expansion capacity in the "lower" area of the curve(s) that the "Area Limit" is reached before either the 15% ROI or the 10% ROI limiting factor becomes controlling. In other words, all of the steps that are expanding until we reach the "Area Limit" are above 15% ROI, so that both the 10% and the 15% ROI criteria are met. Thus, both ROI cases experience the same capacity expansion and virtually identical model results.

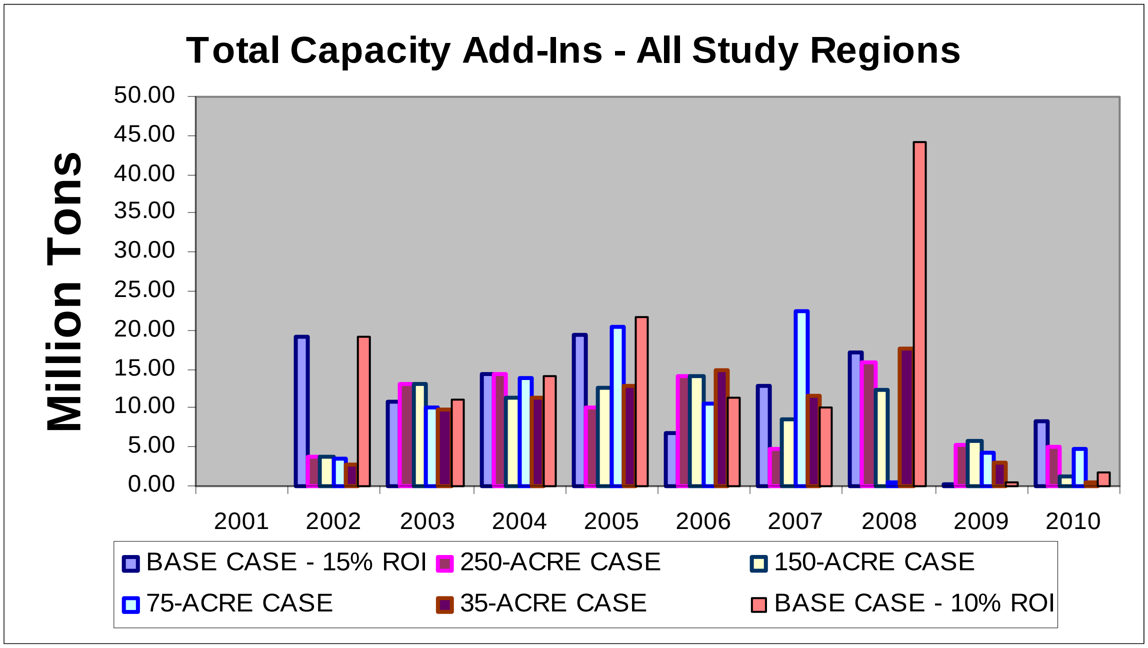
Then, in 2005 enough of the low-cost steps have exhausted their low-cost reserves so that the "Area Limit" starts falling first between the 15% ROI threshold and the 10% ROI threshold and eventually higher than the 10% threshold. From this point forward, two things happen. First, we start seeing significantly more productive capacity available in the case where new investment needs only a 10% ROI. Since this tends to "flatten" the cost curve and "stretch" it to the right (imagine this happening to Figure 3), the market clearing price for coal will tend to be lower in the 10% ROI case as compared to the 15% ROI case, and the tonnage actually produced at this lower price will be somewhat higher in the 10% case.

The second thing that happens as the "Area Limit" begins falling above one or both of the ROI limiting factors is that the actual cost curves in the 10% and 15% cases will start diverging from each other in shape and level as more production is drawn from one than the other and more capacity is added (at different spots on the curve) to one versus the other. This second factor is important because a particular expansion that was economic under the 10% rule but not under the 15% rule is still available for expansion in a later year on the 15% curve as economics change over time. Thus, we frequently see some degree of "catching up" by the disadvantaged case in our model runs. This phenomenon does show up in Figure 4 above as we see the difference between the two versions of the Base Case going as high as 25 million tons in 2008 but then shrinking (the "catching up" phenomenon) down to roughly 5 million tons in 2010.

A very interesting indirect effect of possible MTM/VF restrictions becomes apparent as we consider the 25 million ton differential between the two versions of the Base Case in 2008. Remember that the setup assumptions included a likely EPA-mandated cut of 50% in Clean Air Act Phase 2 sulfur emission levels for year 2008, driven by the National Ambient Air Quality Standard for fine (2.5 micron) particulate matter. The indirect effect of the MTM/VF restrictions is that, to the extent that this aggressive changing of the mining rules does cause the coal mining investment community to perceive higher levels of investment risk and require a higher ROI, then the modeling results indicate that the production responsiveness of this high-quality portion of the coal industry (Central Appalachia produces almost all of the compliance coal from the eastern U.S.) is fairly severely dampened by the higher risk perception.

In other words, under "standard" investment perceptions in the Appalachian coalfields, the cut in allowed sulfur emissions along with the associated increase in demand for higher-quality, low-sulfur coals would ordinarily cause a surge in new capacity investment and associated economic development in Central Appalachia. However, given the three-way interplay between Appalachian coal mining costs, Powder River Basin coal mining costs and the utilities' costs of installing new scrubbers, it turns out that this stimulus toward new mining capacity in Central Appalachia is highly vulnerable to perceptions of investment risk. This is illustrated in the 2008 portion of the bar graph shown below in Figure 5.

Figure 5



This bar chart presents the tonnage version of the capacity additions which are reflected in dollar investment numbers in the formal study output deliverable in Appendix C, Table C-1. The left bar of each year's set is the 15% ROI Base Case, and the bar to the far right of each year's set is the 10% ROI Base Case. In support of the discussion above, we see for 2008 that in the case where only a 10% ROI is required for new coal mining investment, approximately 2½ times as much new capacity is installed. The numbers in Appendix C in Table C-1 indicate that the capital required for these two tonnage bars are roughly $320 million and $800 million, respectively (constant 2001$).

An additional point to note from Figure 5 is the substantial differentiation in year 2002 between the Base Case(s) on the one hand (about 19 million tons of new capacity) and the MTM/VF-affected cases (3-4 million tons) on the other hand. This is a direct result of the assumption, discussed in Section II.E above, of a "regrouping" by coal producers in the initial year of imposition of MTM/VF restrictions. In other words, during this initial year "regrouping" period, no ROI-driven major capital expansions are occurring in the MTM/VF-affected cases, and the 3-4 million tons of increased capacity comes totally from the productivity and "stretch" increments described in Section II.E above.

To some extent, the non-expansion in 2002 in the MTM/VF-affected cases may be causing somewhat higher expansion in later years (higher than what would have happened in the same case in those later years without the early-year reluctance to invest). Experience in running the H&A models has shown that a constraint such as this one-year "regrouping" non-expansion often results in a "pent-up" pressure which is released when the constraint is released. The exception to this rule is the situation where a constraint of this type persists long enough for the competitive sources of supply (other coal fields) to over-expand and drive down overall prices on a sustained basis. However, this takes a few years to accomplish.

Turning now to the actual MTM/VF restricted cases in the tonnage production graph of Figure 4 near the start of this "Results" section, we see that all of the regulation-affected cases fall fairly uniformly below the Base Case(s), with the exception of the 75-Acre Case which will be discussed as a special situation later in this section. The fairly immediate separation between the curves in year 2002 is a function of three factors: (1) the assumption that any valley fill restrictions in a scenario are imposed instantaneously in 2002, (2) the "no grandfathering of existing operations" assumption discussed in Section II.C above, and (3) the one-year "regrouping" period during which no new ROI-driven capacity expansions occur as producers adjust to the new rules (as discussed in Section II.E above). Changing any one of these assumptions could have an impact on the timing and amount of separation between the curves, but the size of such an impact is uncertain without re-running the models because of the complicated interaction between "shortening" of the mine cost curves, price increases, ROI-driven capacity expansion, exhaustion of reserves at certain individual mines and competitive response from other coal fields such as the Powder River Basin and the Illinois Basin.

Table 3 below presents a brief synopsis (excluding the 75-Acre Case) of the general impact of the various levels of MTM/VF restriction as compared to the Base Case(s).

Table 3
Summary of Tonnage Impacts
(Excluding 75-Acre Case)

Time Period	Case	Total Study Region Annual Tonnage Loss vs. Base Case
2001 - 2005	250-Acre/150-Acre Cases	12 – 13 million tons (5% of Total Produc.)
	35-Acre Case	40 – 45 million tons (20% of Total Produc.)
2006 - 2007	250-Acre Case	3 - 8 million tons (2%-3% of Total Produc.)
	150-Acre Case	8 - 12 million tons (3%-5% of Total Produc.)
	35-Acre Case	25 – 30 million tons (10%-15% of Total Produc.)
2008	250-Acre/150-Acre Cases	12 – 48 million tons, depending on which Base Case (5%-20% of Total Produc.)
	35-Acre Case	16 – 55 million tons, depending on which Base Case (7%-23% of Total Produc.)
2009 - 2010	250-Acre/150-Acre Cases	8 - 20 million tons (4%-10% of Total Produc.)
	35-Acre Case	17 –30 million tons (8%-15% of Total Produc.)

One of the more interesting results, easily observable in Figure 4, is that the 250-Acre and 150-Acre Cases fall virtually on top of each other except for a little separation in the 2006-2007 period. For this reason, the table above presents both of these cases as one entity for the other time periods. The primary reason for these congruent results is the similarity in the amount of reserve diminution for these two cases in the RTC results from Phase 1 of the EIS support work.

Until Phase 3 of the EIS support studies is completed, we cannot answer just how substantial is the impact of the tonnage loss shown in Table 3. However, by way of benchmark comparison, the lower end of this market loss (5%-10%) is about the impact on the nation-wide coal market that the Ozone/Fine Particle rules of the National Ambient Air Quality Standards are projected to have. The upper end of the above market loss (40%-50%) is the projected nation-wide coal market loss if Kyoto-based "Global Warming" CO_2 limits are imposed in the U.S.

Referring back to Figure 4, we see that the 75-Acre Case does not seem to fall cleanly into this neat hierarchical pattern (at least not in selected years). What happened – Why does this case bounce around so erratically?

The answer again involves this somewhat complicated real-world "balancing act" (discussed in the "Methodology" section above) in which capacity is both leaving and entering the mining cost-supply curve simultaneously. It was mentioned earlier that some of the reserves in Central Appalachia are becoming low enough that they will start being exhausted within the 10-year study period. In one respect, we might consider the 35-Acre Case, in which substantial reserves have been rendered unmineable, as simply accelerating that situation so that the graph of the 35-Acre Case in Figure 4 immediately starts out (in 2002) already on that lower track that the other cases eventually reach near the end of the study period. On this lower track, there simply are not enough expansion reserves available at low enough cost levels (either because they were initially sterilized in the 35-Acre Case by MTM/VF regulations or because they are exhausted through production in the other cases) to keep the total market tonnage up above 200 million annual tons.

Now consider the 75-Acre Case which falls on the "knife-edge" between the upper track and the lower track discussed above. The amount of reserves made unmineable in the 75-Acre Case is not so large as to immediately throw it into the same situation as the 35-Acre Case where, from the very beginning, there are not enough expansion reserves to keep up. Rather, there are just enough expansion reserves to respond to price signals exceeding the ROI investment criterion, but these reserves (as well as the non-expansion reserves supporting existing capacity) have been cut very thin by the MTM/VF rules. Thus, many steps on the mining cost curve(s) have their reserves exhausting fast and furiously after the first two or three years. As so many reserves exhaust rapidly, strong price signals are sent for expansion; so strong, in fact, that quite a lot of new capacity surges in, and the tonnage curve actually bends upward momentarily.

However, both the expansion reserves and the reserves supporting existing capacity are again so thin due to the MTM/VF regulations that they continue to exhaust at a fast and furious pace, driving productive capacity down again. As the cycle repeats, strong price signals spur another big surge in expansion which turns the production tonnage curve upward again, only to have it sag the next year as thin reserves race toward exhaustion. Finally, there is enough exhaustion that the case becomes very similar to the 35-Acre Case where there simply are not enough expansion reserves to keep up, even for one year.

In summary, this is analogous to an attempt to fill a wooden trough with water by pouring in large bucketfuls, but there are many small holes in the sides of the wooden trough. With each bucketful poured in, we can momentarily raise the trough's water level, but it quickly runs back out of the holes. After a while, the reservoir from which we are drawing the bucketfuls becomes lower and lower, so that eventually we can only draw half-bucketfuls or quarter-bucketfuls. At the end of the day, we simply cannot overcome the outflow but can only slow down the continuing drop in water level.

There are two ways to look at this type of "knife-edge" effect. One way is to dismiss it as a modeling phenomenon and say that if we had chosen a slightly different ROI threshold for this case or had used 80 acres as the criterion instead of 75 acres, then we might very easily have fallen on one side or the other of the "knife-edge." The other approach (and the one we prefer) is to recognize that the model is telling us something. There is, in fact, a zone in here somewhere (that we have bracketed with the span of scenarios) where the market signals can get somewhat erratic because there is just enough resource in the producer segment of the coal industry to respond to price signals, albeit inadequately.

III.B. Coal Prices

Having discussed price signals at some length, let's turn our attention to the actual price outputs from the models that correspond to the tonnage results. Figures 6a and 6b below presents the weighted average prices for the coal totals of Figure 4. Again, it is important to note that these are short-term market clearing prices for new business and do not include any older "out of market" contract prices.

Figure 6a

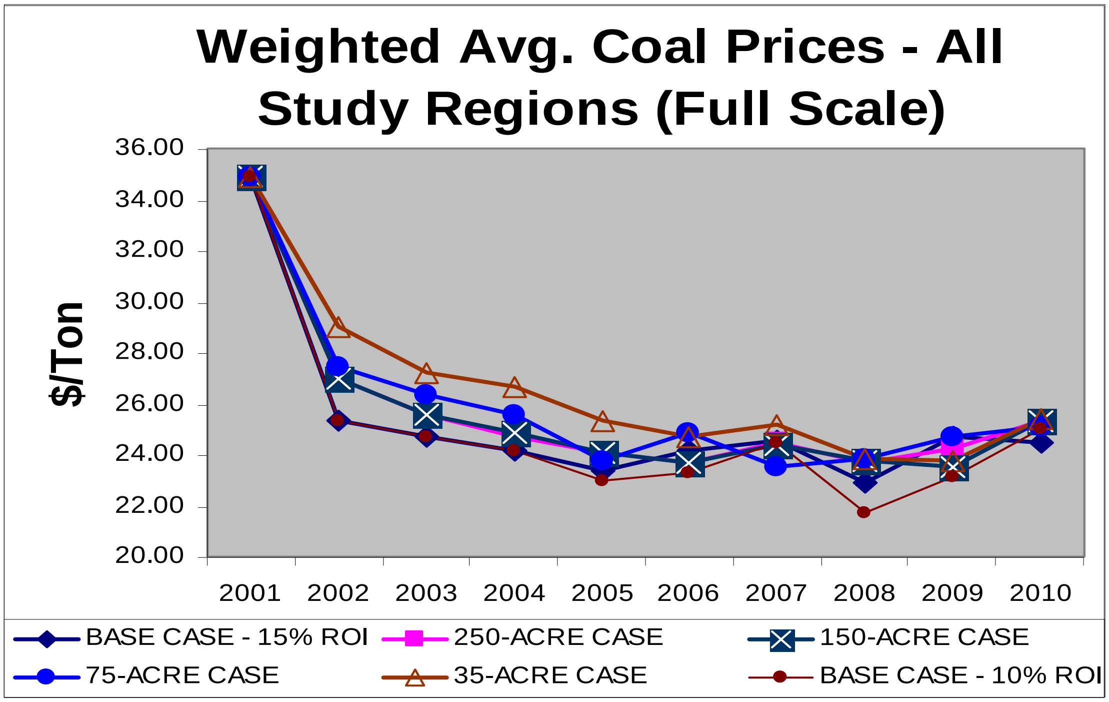
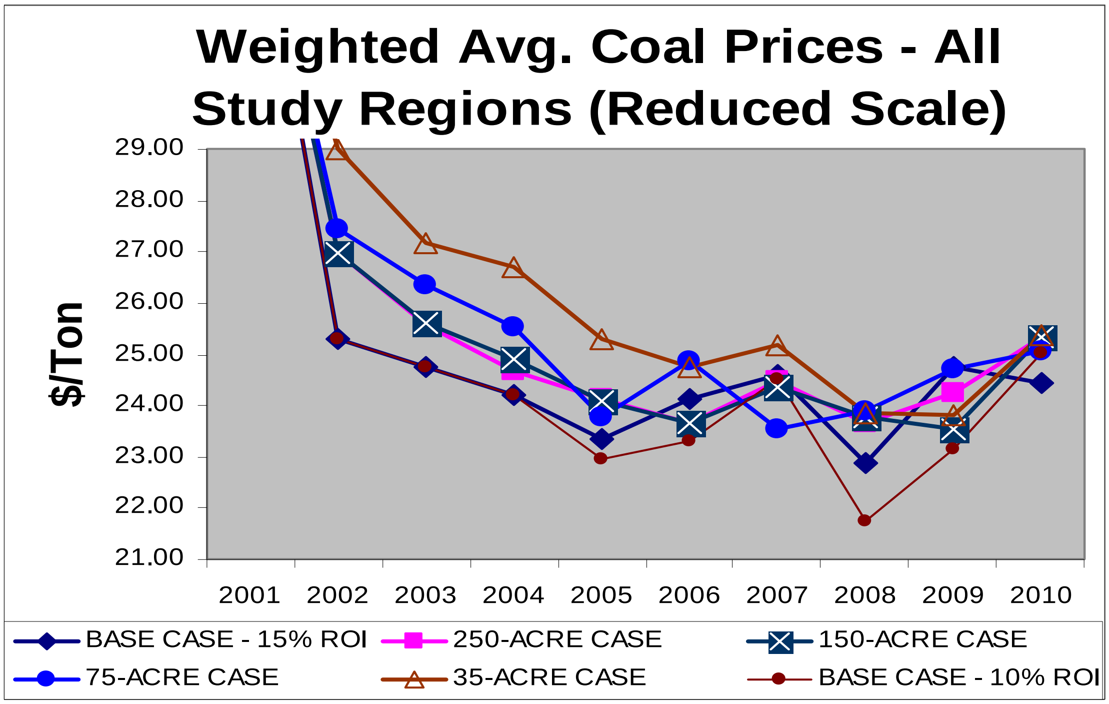


Figure 6a is presented on a scale of \$20 to \$36 per ton in order to show that the fall from the "once-in-a-quarter-century" market of 2001 is likely to be two to three times as large as the price differentials between the various MTM/VF scenarios. However, it should be noted that the reason for the large initial drop on the graph is due to the fact that the mid-2001 market was operating near the far right-hand edge of the cost curves. Referring back to Figure 3 from the "Methodology" section of this report, we can see that if we are very near the right-hand edge of the curve, then we can experience prices that are quite high. However, since the curve is so steep here, even a small increase in capacity lower on the curve (as producers attempt to produce more to take advantage of high prices) can "stretch" the curve to the right enough to cause a dramatically large drop in market clearing price. In other words, on a steep curve it does not take much horizontal movement to slide down a long way vertically.

On the other hand, the price differentials between the MTM/VF scenarios are occurring down on the flatter portion of the Figure 3 curve and represent perhaps more significant tonnage impacts. We see this on a gross scale by considering that the tonnage differences discussed above between scenarios is often on the order of 15-50 million annual tons, and this magnitude of tonnage is associated with price differentials in the \$2.50-\$3.50 per ton range. This means that we are operating on a less steep portion of the curve where large horizontal capacity movements correspond to lesser vertical movements in cost.

In order to focus on the subject of this study, Figure 6b is presented as identical to Figure 6a except that the scale is limited to $21 to $29 per ton to more easily visualize the roughly $2.50-$3.50 differences between scenario results.

Figure 6b



As we would expect, the prices shown in Figure 6b are almost exactly the inverse of the tonnage graph of Figure 4. That is, the lowest prices generally occur for the least restricted Base Case(s) where the tonnages from Figure 4 are higher. However, as the "catching up" phenomenon occurs (see earlier discussion), we would expect to see some crossing over of the prices as the relative shortness of supply for the more restricted cases eventually sends some pretty strong price signals. In fact, we see a very clear trend that the largest coal price differentials between scenarios occur immediately after the implementation of MTM/VF restrictions, and then these differences attenuate over time as the "catching up" phenomenon occurs. As discussed earlier, the 2008 "bump" in the graph is a measure of the coal marketplace response to the PM2.5-driven cut in SO_2 limits.

It is significant to note that despite (1) continuing productivity gains, which serve both to lower individual points on the Figure 3 cost curve and also to stretch the entire curve to the right, and (2) lower overall tonnages in later years, which means demand crosses farther to the left on the Figure 3 cost curve, we still see prices in Figure 6b holding relatively flat in the second five years of the study period. This is an indication of fairly strong prices (compared, say, to other areas of the coalfields) due to shortness of supply, even in the Base Case(s) which experience some reserve exhaustion near the end of the 10-year study period.

Finally, as we would expect, the 10% ROI Base Case prices are lower than the 15% ROI Base Case prices since there is more capacity expansion and therefore more supply in the supply/demand balance in the 10% case.

III.C. Coal Mining Employment

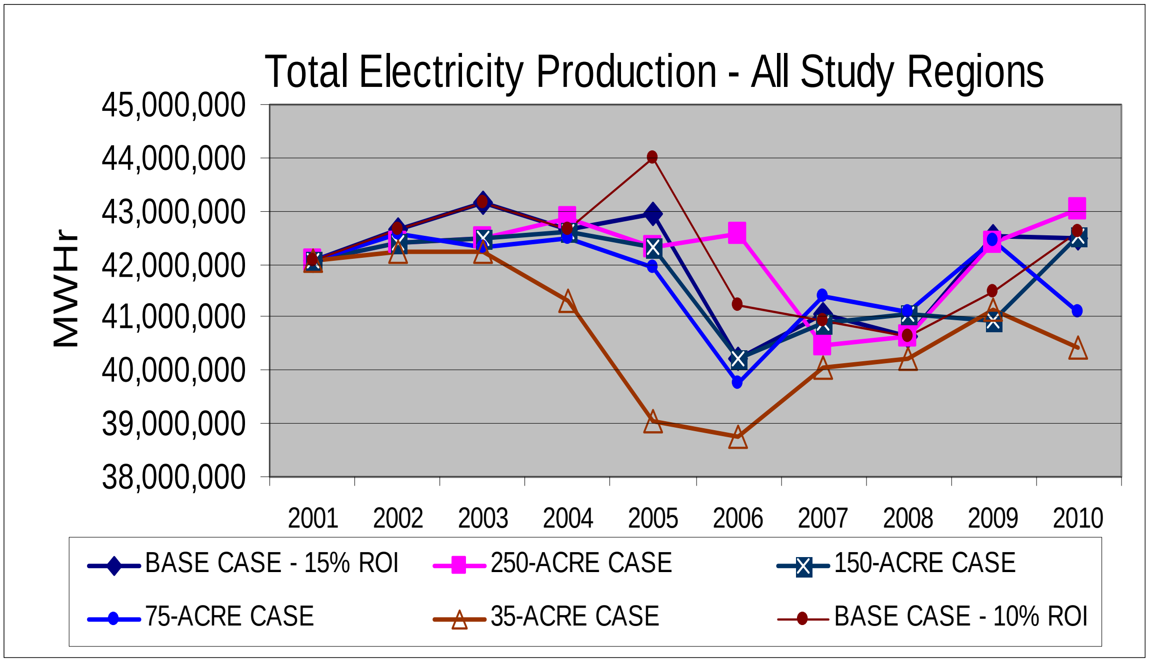
Before we leave the coal side of the results discussion, a couple of comments about the direct coal employment tables in Appendix B are appropriate. First, these "direct" employment numbers are very narrowly defined as really directly "in the mine" employees and would need a scale-up factor of perhaps 2.0 to match up with the officially reported state "coal mining employment" numbers. For example, we are showing an all-region total of 17,845 "direct" employees for 2001 in Appendix B, but Hill & Associates' own monthly short-term coal outlook lists official state coal mining employment numbers for July 2001 of approximately 3,900 for northern West Virginia, 12,100 for southern West Virginia, 12,500 for eastern Kentucky and 5,600 for Virginia. This total of more than 34,000 "official" coal mining employees for one summer month is roughly twice our modeling estimate of "direct" coal mining employees average for the year.

Second, although the last year of the study period shows a maximum "direct" employment loss of a little over 1,000 employees, the loss of employment in some mid-years can exceed 3,500 employees (e.g. comparing the 75-Acre Case with the 10% ROI Base Case for year 2008).

III.D. Electricity Generation Within the Study Region

Turning now to the electricity results from the integrated coal and electricity modeling system, Figure 7 below presents the electricity produced from the total study region under each scenario. The numbers behind this graph are presented in the bottom section of Table E-1 in Appendix E.

Figure 7



Two things are immediately apparent from Figure 7. First, there is a very loose general correlation with the coal results, in that the less restricted cases (the Base Cases and the 250-Acre Case) with their generally lower coal prices tend to be the ones showing higher electricity production, while the more restricted cases such as the 35-Acre Case with higher coal prices show lower electricity generation. Second, the electricity results are definitely NOT an exact mirror image of the coal results.

Upon reflection, this second point is not at all surprising. The coalfields included in the study region do, of course, supply the electric generating plants sitting on top of the coal, but they also supply many other electric generating stations outside of the study region. The issue of who wins and who loses the dispatch wars on the electric grid is an extremely complicated one and is one of the primary reasons why we run an integrated coal and electricity modeling system. There are many thresholds at individual generating stations where a change in coal prices for a certain quality of coal can result in the decision to install a scrubber, for example, and burn high-sulfur Pennsylvania or Ohio coal.

Particular differences between the electricity production graph of Figure 7 and the coal production graph of Figure 4 include the following:

- Unlike the coal results, the electricity results do not show the largest spread between scenarios immediately after the MTM/VF rules are implemented. Rather, the largest spread of electric generation across scenarios occurs after four or five years.

- The biggest sensitivity for electric generation appears to occur in response to the 19-State SIP Call for NO_x in 2005, while the coal tonnage maximum sensitivity seems to be oriented around the PM2.5-driven SO_2 cuts in 2008.

- While the absolute magnitude of coal tonnage impacts can be as high as 20%-25% of total production (see Table 3 above) and more typically runs a spread of 8%-15% difference between the most-restrictive and least-restrictive cases in most years; the electric generation spreads are more in the 2%-6% range in most years, going only to a maximum of about 11% of total production in 2005.

- The 250-Acre and 150-Acre Cases do not fall on top of each other in the electricity graph. Rather, the 250-Acre Case shows substantially higher electricity generation inside the study region than the 150-Acre Case for some of the mid-years and late-years.

- There appears to be significantly more cross-over between the scenarios in the electricity results. That is, the scenarios do not line up monotonically from least restrictive to most restrictive as they seem to do for coal tonnage (except for the 75-Acre Case in the coal results).

In summary, while we have both coal production and electricity production that can shift "just over the border" outside the study region and therefore not be included in the results reported here, there are generally wide quality differences between Pennsylvania/Ohio coal, for example, and Central Appalachian coal that limit the amount of direct substitution without equipment or allowance costs. Thus, the coal results tend to be more directly related to the severity of MTM/VF restriction. On the other hand, electricity as a product is so extraordinarily homogeneous that the shifting of power generation across the study region's border is a significant factor that disrupts the direct relationship between coal supply reduction and electric generation within the study region.

III.E. Electricity Prices

Figures 8a and 8b presents the model output electricity prices associated with the generation discussed above. The numbers behind the graph are shown in the bottom section of Table F-1 in Appendix F.

Figure 8a

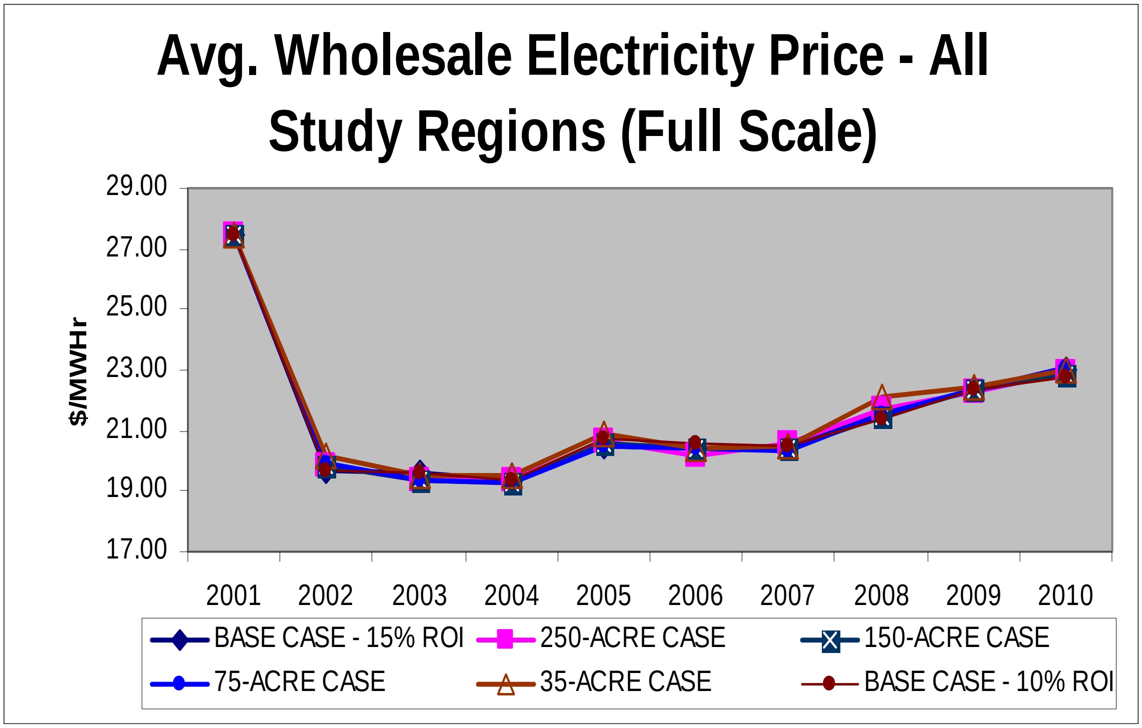
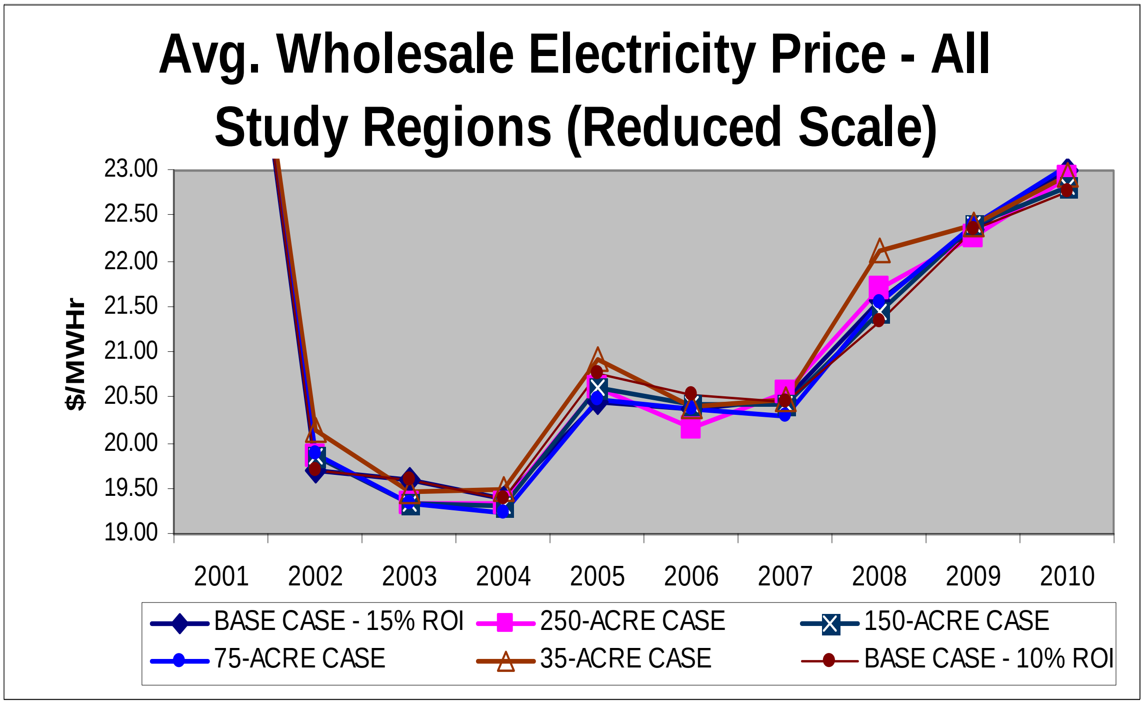


Figure 8a is presented on a scale of $17.00 to $29.00 dollars (constant 2001$) per megawatt-hour. This illustrates that the size of the electricity price drop that will accompany the expected coal market "bust" following the current "once-in-a-quarter-century" market boom is several times larger than the electricity price sensitivity to the MTM/VF scenarios.

In order to focus on the topic of this study, Figure 8b is identical to Figure 8a except that the scale is reduced to $19.00 to $23.00 per megawatt-hour.

Figure 8b



Even on this scale, it is evident that the electricity prices are quite insensitive to the MTM/VF restrictions, showing differences of only 1%-2%, or 3% at the maximum. This is a simple mechanical function since the models solve for the market clearing price (lambda cost) of electricity for each "control area" (most generally, a single utility). This mirrors the real world in which only one lambda cost exists at any one time in a competitive section of the transmission grid. Since this lambda cost is defined as the dispatch bid (assumed to be actual variable dispatch cost in the model) of the very last, or highest-cost, generator to be dispatched in any time period, that generator may or may not be affected by the price of coal from the MTM/VF study region. In fact, that last generator may be a gas-fired plant in some time periods.

Thus, while we may be calculating a weighted average of AEP and APS prices for the WV_N (northern West Virginia) sub-region, for example, each of those utilities span areas and generators outside of the study area as well as inside. Accordingly, the effects of MTM/VF restrictions are greatly diluted as we consider the wholesale price of electricity on the competitive transmission grid.

It is important to note that wholesale electricity prices, as modeled by lambda costs, may not be reflective of retail electricity prices, especially in a regulated electric utility environment. In particular, consider the hypothetical situation where a gas-fired plant is the "last" plant dispatched, and its dispatch cost is determining the price of electricity. Theoretically, we might raise the cost of many coal-fired plants lower on the dispatch cost curve and thereby substantially reduce the profitability of those coal plants (and perhaps the total utility) operating against the electricity price still being established by the gas-fired plant. The model would still yield the same lambda cost of the "last" generator, but the utility might very well file for a regulated rate increase due to higher average costs and reduced overall profitability of its entire portfolio of generators.

The overall U.S. average wholesale electricity price (lambda cost) for each scenario, needed by the anticipated model to be used in EIS support Phase 3, is listed in Table J-1 in Appendix J.

III.F. Capital Expenditures at Electric Plants

Table G-1 in Appendix G shows that, in general, there is no significant difference across MTM/VF scenarios in capital expenditures for environmental clean-up equipment at coal-fired generating plants. The one exception is in year 2004 when all of the MTM/VF restricted scenarios spend about \$15 million (constant 2001\$) more than the level of \$18-\$19 million in the Base Case(s).

Detailed examination of the plant-level model output reveals that this additional \$15 million dollars is due to the fact that one large plant grouping in the model, Units 1-3 at AEP's John E. Amos Plant, only partially scrubs (about 55%) in the Base Case(s) in 2004. In other words, at the coal prices in the Base Case(s), the best economics are to install scrubbing on only 55% of that unit grouping, and the remainder remains unscrubbed. However, at the coal prices of each of the MTM/VF restricted cases, the best economics are to install 100% scrubbing at this unit grouping at the correspondingly higher capital cost.

Turning to capital expenditures for new generating capacity, we see from Tables H-1 in Appendix H that the models call for new capacity only in the Virginia sub-region of the study area. Summation across the years reveals that the total capital investment (constant 2001\$) across the entire 10-year period is about \$1,160 million for New Combined-Cycle gas-fired baseload units, plus about \$300 million for New Gas-Turbine peaking units and around \$700 million for a new coal-fired generating station. This \$2.2 billion capital investment adds about 3400 MW of baseload capacity and roughly 1200 MW of peaking capacity.

Finally, the model anticipated to be used in EIS support Phase 3 requires a one-time breakdown of major coal mine operating costs by category. Those numbers are presented in Table I-1 in Appendix I.

APPENDICES

Table A-1

Total Tons - Surface and Deep Mines Combined

ProductionTons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	37,850	37,112	36,823	33,002	31,176	33,170	33,894	41,195	33,984	29,059
BASE CASE - 15% ROI	37,850	37,112	36,823	33,002	31,422	32,007	33,767	35,551	31,630	26,355
250-ACRE CASE	37,850	36,193	36,774	33,701	31,964	30,886	29,025	29,686	31,040	25,977
150-ACRE CASE	37,850	36,235	36,764	33,661	31,855	30,769	28,803	29,498	30,731	26,092
75-ACRE CASE	37,850	35,210	34,894	31,764	29,911	26,389	26,460	25,917	27,287	23,130
35-ACRE CASE	37,850	33,392	27,389	25,152	24,414	24,519	22,649	26,140	27,617	23,034
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 2										
BASE CASE - 10% ROI	49,100	46,844	46,224	46,608	40,984	32,500	36,086	34,865	28,029	23,534
BASE CASE - 15% ROI	49,100	46,844	46,074	46,599	41,518	33,638	35,576	35,765	27,881	27,768
250-ACRE CASE	49,100	42,903	42,522	42,398	43,787	34,633	31,040	33,043	27,504	23,835
150-ACRE CASE	49,100	42,903	42,482	43,177	43,426	34,093	30,769	31,944	25,817	23,319
75-ACRE CASE	49,100	42,746	42,880	43,419	42,577	36,946	32,564	30,616	24,684	26,238
35-ACRE CASE	49,100	41,361	40,668	42,055	43,418	36,341	33,160	29,975	23,527	21,542
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 3										
BASE CASE - 10% ROI	1,690	1,575	1,407	1,406	1,114	844	1,020	665	1,077	1,106
BASE CASE - 15% ROI	1,690	1,575	1,407	1,406	1,114	1,035	1,023	993	1,104	1,106
250-ACRE CASE	1,690	1,708	1,552	1,357	1,084	825	999	1,003	1,134	1,136
150-ACRE CASE	1,690	1,708	1,552	1,531	1,064	995	1,003	1,114	1,136	1,207
75-ACRE CASE	1,690	1,708	1,675	1,562	1,073	1,005	993	1,124	1,146	1,186
35-ACRE CASE	1,690	1,668	1,672	1,429	1,098	1,108	1,132	1,072	912	982
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 4										
BASE CASE - 10% ROI	90	120	50	0	0	0	0	0	0	40
BASE CASE - 15% ROI	90	120	50	0	0	0	0	0	40	41
250-ACRE CASE	90	81	90	0	0	0	0	0	40	41
150-ACRE CASE	90	81	80	0	0	0	0	0	40	41
75-ACRE CASE	90	81	30	0	0	0	0	0	40	41
35-ACRE CASE	90	51	41	41	0	0	40	0	40	41
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV C										
BASE CASE - 10% ROI	31,460	29,662	30,302	30,078	28,493	33,809	23,213	23,099	12,488	13,676
BASE CASE - 15% ROI	31,460	29,662	30,447	30,018	26,772	32,447	21,555	16,371	13,869	18,263
250-ACRE CASE	31,460	30,761	30,520	27,994	23,996	28,024	32,083	16,982	15,033	11,166
150-ACRE CASE	31,460	30,761	30,520	29,272	23,946	28,024	32,093	17,705	14,478	10,831
75-ACRE CASE	31,460	28,545	25,300	24,905	23,585	27,747	31,807	19,847	13,850	10,130
35-ACRE CASE	31,460	22,375	22,724	22,994	22,210	23,031	10,814	11,092	8,837	8,495
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV E										
BASE CASE - 10% ROI	890	658	679	699	648	739	761	782	1,004	1,026
BASE CASE - 15% ROI	890	658	679	699	720	740	761	782	1,004	1,026
250-ACRE CASE	890	864	679	699	720	740	761	782	1,004	1,026
150-ACRE CASE	890	864	679	699	720	740	761	782	943	1,025
75-ACRE CASE	890	864	823	699	720	740	761	782	1,004	1,026
35-ACRE CASE	890	864	884	843	713	724	734	745	895	844

Table A-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	35,080	39,019	42,631	44,639	46,765	48,120	47,144	46,330	41,430	42,893
BASE CASE - 15% ROI	35,080	39,019	42,631	44,639	46,765	48,241	47,147	44,586	40,898	41,454
250-ACRE CASE	35,080	35,767	38,943	43,151	45,479	47,120	46,842	43,016	42,515	41,380
150-ACRE CASE	35,080	35,667	38,943	43,222	45,479	47,120	46,842	43,016	42,495	41,379
75-ACRE CASE	35,080	35,308	38,945	43,244	47,417	49,297	49,118	44,566	43,851	42,943
35-ACRE CASE	35,080	34,958	38,965	43,244	47,581	50,099	50,098	47,175	45,025	39,467

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	5,750	5,413	4,431	1,849	1,477	1,117	1,127	1,064	544	554
BASE CASE - 15% ROI	5,750	5,413	4,431	1,849	1,477	1,117	1,127	1,064	544	554
250-ACRE CASE	5,750	5,238	3,211	1,159	838	788	788	685	185	185
150-ACRE CASE	5,750	5,308	3,251	1,159	838	788	788	365	185	185
75-ACRE CASE	5,750	5,238	3,703	1,882	1,530	1,190	1,221	1,252	1,283	1,314
35-ACRE CASE	5,750	4,499	3,417	1,233	553	513	529	539	550	560

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	61,190	62,379	55,381	58,943	66,136	53,564	50,552	69,764	65,887	57,483
BASE CASE - 15% ROI	61,190	62,379	55,381	58,923	66,682	50,323	46,895	56,022	50,730	46,768
250-ACRE CASE	61,190	58,800	53,326	51,634	51,662	54,304	38,060	42,529	42,354	46,852
150-ACRE CASE	61,190	58,790	53,216	47,398	51,052	50,086	41,243	44,652	44,252	45,551
75-ACRE CASE	61,190	55,018	47,253	43,721	51,096	40,508	52,699	39,828	41,437	41,014
35-ACRE CASE	61,190	45,891	40,083	32,996	33,663	40,485	45,606	45,100	45,194	44,152

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	134,370	137,131	133,423	136,208	143,518	137,349	122,798	141,038	121,352	115,633
BASE CASE - 15% ROI	134,370	137,131	133,568	136,128	142,415	132,868	117,484	118,824	107,044	108,066
250-ACRE CASE	134,370	131,429	126,678	124,638	122,695	130,977	118,534	103,993	101,090	100,608
150-ACRE CASE	134,370	131,389	126,608	121,749	122,035	126,758	121,727	106,520	102,353	98,971
75-ACRE CASE	134,370	124,971	116,024	114,451	124,348	119,482	135,606	106,274	101,424	96,426
35-ACRE CASE	134,370	108,586	106,074	101,311	104,720	114,852	107,781	104,651	100,500	93,519

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	88,730	85,651	84,503	81,016	73,273	66,513	71,000	76,725	63,090	53,739
BASE CASE - 15% ROI	88,730	85,651	84,353	81,008	74,053	66,680	70,367	72,310	60,655	55,270
250-ACRE CASE	88,730	80,885	80,938	77,456	76,835	66,343	61,064	63,732	59,718	50,989
150-ACRE CASE	88,730	80,927	80,878	78,369	76,345	65,857	60,576	62,556	57,723	50,658
75-ACRE CASE	88,730	79,745	79,479	76,745	73,561	64,340	60,017	57,656	53,157	50,595
35-ACRE CASE	88,730	76,472	69,769	68,677	68,930	61,967	56,981	57,186	52,095	45,599

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	27,200	28,032	29,777	28,625	22,886	23,265	24,662	22,212	21,061	22,254
BASE CASE - 15% ROI	27,200	28,032	29,777	28,516	23,013	23,929	25,132	23,123	22,491	23,071
250-ACRE CASE	27,200	26,463	27,643	29,980	27,182	23,020	24,702	23,818	22,174	22,729
150-ACRE CASE	27,200	26,463	27,643	30,031	27,390	23,027	24,768	23,772	21,961	22,116
75-ACRE CASE	27,200	26,802	28,498	30,141	26,690	23,551	25,090	24,269	21,735	22,367
35-ACRE CASE	27,200	26,775	27,722	29,178	26,032	21,416	24,089	23,788	21,300	22,086

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	250,300	250,814	247,703	245,849	239,677	227,127	218,460	239,975	205,504	191,626
BASE CASE - 15% ROI	250,300	250,814	247,698	245,651	239,481	223,477	212,983	214,257	190,191	186,407
250-ACRE CASE	250,300	238,777	235,258	232,074	226,711	220,340	204,300	191,543	182,983	174,326
150-ACRE CASE	250,300	238,779	235,128	230,150	225,770	215,642	207,071	192,847	182,038	171,744
75-ACRE CASE	250,300	231,518	224,000	221,338	224,598	207,374	220,713	188,199	176,315	169,388
35-ACRE CASE	250,300	211,833	203,565	199,165	199,682	198,235	188,852	185,625	173,895	161,203

Table A-2

Total Tons - Surface Mines Only
ProductionTons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	17,410	19,041	18,258	14,578	13,329	13,415	13,735	14,421	11,951	9,717
BASE CASE - 15% ROI	17,410	19,041	18,258	14,578	14,078	13,659	13,740	12,587	10,910	9,103
250-ACRE CASE	17,410	16,935	17,523	14,972	13,457	13,230	11,498	9,649	8,275	7,339
150-ACRE CASE	17,410	16,925	17,513	14,932	13,348	13,195	11,398	9,591	8,226	7,299
75-ACRE CASE	17,410	15,865	15,378	13,034	10,100	7,720	6,821	6,104	4,996	3,830
35-ACRE CASE	17,410	13,370	7,502	5,915	4,087	3,366	3,143	2,486	1,575	1,689

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 2										
BASE CASE - 10% ROI	19,470	19,130	16,819	13,982	12,010	11,897	12,575	10,314	11,194	10,361
BASE CASE - 15% ROI	19,470	19,130	16,819	13,982	13,544	12,698	12,080	13,024	11,277	10,283
250-ACRE CASE	19,470	15,784	14,819	12,796	12,664	10,218	9,427	8,397	7,663	7,606
150-ACRE CASE	19,470	15,784	14,779	13,370	12,235	9,677	8,967	8,217	7,493	7,536
75-ACRE CASE	19,470	15,576	14,336	12,935	9,617	9,746	8,535	8,187	8,435	8,031
35-ACRE CASE	19,470	13,370	11,405	8,824	7,876	7,002	6,456	6,349	6,456	7,157

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 3										
BASE CASE - 10% ROI	1,020	819	644	634	331	50	201	30	312	338
BASE CASE - 15% ROI	1,020	819	644	634	331	221	205	205	336	338
250-ACRE CASE	1,020	952	788	603	300	30	201	205	336	338
150-ACRE CASE	1,020	952	788	778	300	201	205	316	338	409
75-ACRE CASE	1,020	952	901	778	300	201	205	316	338	409
35-ACRE CASE	1,020	912	898	635	294	294	314	254	144	214

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 4										
BASE CASE - 10% ROI	80	120	50	0	0	0	0	0	0	40
BASE CASE - 15% ROI	80	120	50	0	0	0	0	0	40	41
250-ACRE CASE	80	81	90	0	0	0	0	0	40	41
150-ACRE CASE	80	81	80	0	0	0	0	0	40	41
75-ACRE CASE	80	81	30	0	0	0	0	0	40	41
35-ACRE CASE	80	51	41	41	0	0	40	0	40	41

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV C										
BASE CASE - 10% ROI	23,230	22,290	22,580	21,868	22,748	28,961	18,704	16,971	7,305	8,548
BASE CASE - 15% ROI	23,230	22,290	22,726	21,868	21,088	27,432	16,575	12,646	11,090	15,559
250-ACRE CASE	23,230	23,585	23,035	20,478	16,634	23,282	27,092	13,313	11,903	8,232
150-ACRE CASE	23,230	23,585	23,035	21,273	16,584	23,282	27,093	13,651	11,450	7,876
75-ACRE CASE	23,230	21,369	17,753	16,854	16,223	22,461	26,814	15,742	10,375	7,185
35-ACRE CASE	23,230	15,196	15,177	14,943	14,243	17,675	5,666	4,219	4,045	3,522

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV E										
BASE CASE - 10% ROI	630	391	401	411	350	431	442	453	664	677
BASE CASE - 15% ROI	630	391	401	411	422	432	442	453	664	677
250-ACRE CASE	630	596	401	411	422	432	442	453	664	677
150-ACRE CASE	630	596	401	411	422	432	442	453	604	676
75-ACRE CASE	630	596	545	411	422	432	442	453	664	677
35-ACRE CASE	630	596	607	555	415	415	415	415	555	495

Table A-2 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	1,480	1,175	517	144	72	133	275	216	377	470
BASE CASE - 15% ROI	1,480	1,175	517	144	72	254	277	216	448	471
250-ACRE CASE	1,480	1,293	296	215	134	134	275	215	235	466
150-ACRE CASE	1,480	1,193	296	286	134	134	275	215	215	465
75-ACRE CASE	1,480	833	298	308	93	274	134	214	277	468
35-ACRE CASE	1,480	483	318	308	256	276	277	256	215	466

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	1,210	1,223	1,078	328	339	349	359	370	380	390
BASE CASE - 15% ROI	1,210	1,223	1,078	328	339	349	359	370	380	390
250-ACRE CASE	1,210	1,048	191	21	21	21	21	21	21	21
150-ACRE CASE	1,210	1,118	231	21	21	21	21	21	21	21
75-ACRE CASE	1,210	1,048	338	328	339	349	359	370	380	390
35-ACRE CASE	1,210	308	318	328	339	349	359	370	380	390

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	27,730	30,668	27,159	29,650	32,438	17,345	12,020	23,483	24,205	20,778
BASE CASE - 15% ROI	27,730	30,668	27,159	29,650	32,787	17,362	12,031	17,377	17,141	15,495
250-ACRE CASE	27,730	26,780	24,962	24,608	23,805	21,123	6,377	9,971	10,121	10,806
150-ACRE CASE	27,730	26,770	24,852	20,372	23,145	16,903	6,372	9,161	9,046	8,883
75-ACRE CASE	27,730	22,392	18,259	16,047	20,425	6,085	9,631	8,604	7,259	5,092
35-ACRE CASE	27,730	13,177	10,665	4,472	1,859	2,067	4,241	3,648	2,784	1,944

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	54,280	55,747	51,736	52,401	55,947	47,218	31,801	41,492	32,931	30,863
BASE CASE - 15% ROI	54,280	55,747	51,882	52,401	54,708	45,828	29,684	31,061	29,723	32,592
250-ACRE CASE	54,280	53,303	48,885	45,734	41,015	44,992	34,207	23,971	22,944	20,201
150-ACRE CASE	54,280	53,263	48,815	42,362	40,305	40,772	34,202	23,500	21,335	17,921
75-ACRE CASE	54,280	46,239	37,193	33,949	37,501	29,601	37,380	25,381	18,954	13,812
35-ACRE CASE	54,280	29,761	27,086	20,606	17,112	20,782	10,958	8,908	7,979	6,816

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	37,980	39,110	35,770	29,193	25,669	25,362	26,512	24,765	23,457	20,456
BASE CASE - 15% ROI	37,980	39,110	35,770	29,193	27,952	26,578	26,025	25,815	22,563	19,765
250-ACRE CASE	37,980	33,752	33,220	28,371	26,421	23,478	21,127	18,251	16,314	15,325
150-ACRE CASE	37,980	33,742	33,160	29,080	25,883	23,074	20,570	18,123	16,097	15,284
75-ACRE CASE	37,980	32,474	30,645	26,746	20,018	17,667	15,560	14,606	13,809	12,311
35-ACRE CASE	37,980	27,702	19,847	15,415	12,257	10,662	9,954	9,089	8,215	9,101

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	8,330	7,737	7,855	7,412	7,287	7,101	7,551	5,947	7,039	7,446
BASE CASE - 15% ROI	8,330	7,737	7,855	7,412	7,390	7,616	7,642	6,562	7,649	7,185
250-ACRE CASE	8,330	8,043	7,851	7,964	7,488	7,451	7,375	6,436	6,912	6,856
150-ACRE CASE	8,330	8,043	7,851	7,954	7,406	7,160	7,122	6,396	6,729	6,670
75-ACRE CASE	8,330	8,341	8,150	7,731	6,453	7,109	6,424	6,201	5,410	4,753
35-ACRE CASE	8,330	8,007	7,333	6,421	5,246	4,391	4,166	3,472	3,381	3,285

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	100,590	102,594	95,362	89,006	88,903	79,681	65,864	72,204	63,427	58,765
BASE CASE - 15% ROI	100,590	102,594	95,507	89,006	90,050	80,022	63,350	63,438	59,935	59,542
250-ACRE CASE	100,590	95,098	89,956	82,068	74,924	75,920	62,709	48,658	46,170	42,382
150-ACRE CASE	100,590	95,048	89,826	79,395	73,594	71,005	61,894	48,019	44,161	39,875
75-ACRE CASE	100,590	87,054	75,988	68,426	63,972	54,377	59,364	46,188	38,173	30,876
35-ACRE CASE	100,590	65,470	54,266	42,442	34,615	35,835	25,078	21,469	19,576	19,202

Table A-3

Total Tons - Deep Mines Only
ProductionTons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	20,440	18,071	18,565	18,425	17,848	19,755	20,159	26,774	22,032	19,342
BASE CASE - 15% ROI	20,440	18,071	18,565	18,425	17,344	18,349	20,027	22,965	20,720	17,252
250-ACRE CASE	20,440	19,258	19,251	18,729	18,507	17,656	17,527	20,037	22,765	18,637
150-ACRE CASE	20,440	19,310	19,251	18,729	18,507	17,574	17,405	19,908	22,505	18,793
75-ACRE CASE	20,440	19,345	19,516	18,731	19,811	18,670	19,639	19,813	22,292	19,300
35-ACRE CASE	20,440	20,022	19,887	19,237	20,328	21,154	19,506	23,654	26,042	21,345
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 2										
BASE CASE - 10% ROI	29,630	27,714	29,405	32,626	28,974	20,603	23,511	24,552	16,835	13,172
BASE CASE - 15% ROI	29,630	27,714	29,255	32,617	27,973	20,940	23,497	22,741	16,604	17,486
250-ACRE CASE	29,630	27,119	27,703	29,602	31,123	24,415	21,613	24,646	19,841	16,229
150-ACRE CASE	29,630	27,119	27,703	29,807	31,191	24,416	21,803	23,727	18,324	15,783
75-ACRE CASE	29,630	27,170	28,544	30,485	32,960	27,200	24,030	22,429	16,249	18,208
35-ACRE CASE	29,630	27,991	29,263	33,231	35,542	29,339	26,704	23,626	17,070	14,385
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 3										
BASE CASE - 10% ROI	670	756	762	773	783	793	818	634	765	768
BASE CASE - 15% ROI	670	756	762	773	783	813	819	788	768	768
250-ACRE CASE	670	757	763	753	784	794	798	798	798	798
150-ACRE CASE	670	757	763	753	763	794	798	798	798	798
75-ACRE CASE	670	757	773	784	773	803	788	808	808	778
35-ACRE CASE	670	757	773	794	803	813	818	818	768	768
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 4										
BASE CASE - 10% ROI	10	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	10	0	0	0	0	0	0	0	0	0
250-ACRE CASE	10	0	0	0	0	0	0	0	0	0
150-ACRE CASE	10	0	0	0	0	0	0	0	0	0
75-ACRE CASE	10	0	0	0	0	0	0	0	0	0
35-ACRE CASE	10	0	0	0	0	0	0	0	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV C										
BASE CASE - 10% ROI	8,230	7,372	7,721	8,210	5,744	4,848	4,509	6,128	5,184	5,128
BASE CASE - 15% ROI	8,230	7,372	7,721	8,150	5,684	5,015	4,980	3,726	2,779	2,704
250-ACRE CASE	8,230	7,176	7,484	7,516	7,362	4,741	4,990	3,670	3,130	2,934
150-ACRE CASE	8,230	7,176	7,484	7,999	7,362	4,741	5,000	4,054	3,028	2,955
75-ACRE CASE	8,230	7,176	7,547	8,051	7,362	5,286	4,993	4,104	3,475	2,945
35-ACRE CASE	8,230	7,178	7,547	8,051	7,967	5,357	5,148	6,873	4,792	4,974
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV E										
BASE CASE - 10% ROI	260	267	278	288	298	308	319	329	339	349
BASE CASE - 15% ROI	260	267	278	288	298	308	319	329	339	349
250-ACRE CASE	260	267	278	288	298	308	319	329	339	349
150-ACRE CASE	260	267	278	288	298	308	319	329	339	349
75-ACRE CASE	260	267	278	288	298	308	319	329	339	349
35-ACRE CASE	260	267	278	288	298	308	319	329	340	349

Table A-3 (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV N										
BASE CASE - 10% ROI	33,600	37,844	42,114	44,496	46,693	47,987	46,869	46,114	41,053	42,423
BASE CASE - 15% ROI	33,600	37,844	42,114	44,496	46,693	47,987	46,869	44,370	40,451	40,983
250-ACRE CASE	33,600	34,474	38,647	42,936	45,345	46,987	46,567	42,801	42,281	40,914
150-ACRE CASE	33,600	34,474	38,647	42,936	45,345	46,987	46,567	42,801	42,281	40,914
75-ACRE CASE	33,600	34,474	38,647	42,936	47,325	49,022	48,984	44,352	43,574	42,475
35-ACRE CASE	33,600	34,474	38,647	42,936	47,325	49,822	49,822	46,919	44,810	39,001

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV S										
BASE CASE - 10% ROI	4,540	4,189	3,353	1,521	1,138	768	768	694	164	164
BASE CASE - 15% ROI	4,540	4,189	3,353	1,521	1,138	768	768	694	164	164
250-ACRE CASE	4,540	4,189	3,020	1,139	818	768	768	664	164	164
150-ACRE CASE	4,540	4,189	3,020	1,139	818	768	768	344	164	164
75-ACRE CASE	4,540	4,189	3,365	1,553	1,191	841	862	883	903	924
35-ACRE CASE	4,540	4,191	3,099	905	214	164	170	170	170	170

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV SW										
BASE CASE - 10% ROI	33,460	31,711	28,221	29,293	33,698	36,219	38,532	46,281	41,681	36,705
BASE CASE - 15% ROI	33,460	31,711	28,221	29,273	33,894	32,961	34,864	38,644	33,589	31,274
250-ACRE CASE	33,460	32,020	28,364	27,026	27,857	33,181	31,683	32,558	32,232	36,046
150-ACRE CASE	33,460	32,020	28,364	27,026	27,907	33,182	34,872	35,492	35,206	36,668
75-ACRE CASE	33,460	32,625	28,995	27,674	30,671	34,423	43,068	31,225	34,179	35,922
35-ACRE CASE	33,460	32,713	29,418	28,525	31,804	38,418	41,365	41,452	42,409	42,209

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All WV										
BASE CASE - 10% ROI	80,090	81,384	81,687	83,807	87,571	90,131	90,997	99,546	88,421	84,770
BASE CASE - 15% ROI	80,090	81,384	81,687	83,727	87,707	87,040	87,800	87,763	77,321	75,474
250-ACRE CASE	80,090	78,127	77,793	78,905	81,680	85,985	84,327	80,022	78,147	80,407
150-ACRE CASE	80,090	78,127	77,793	79,387	81,730	85,987	87,526	83,020	81,018	81,050
75-ACRE CASE	80,090	78,732	78,831	80,502	86,847	89,881	98,226	80,893	82,470	82,614
35-ACRE CASE	80,090	78,825	78,988	80,704	87,608	94,070	96,824	95,743	92,520	86,703

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All E. KY										
BASE CASE - 10% ROI	50,750	46,541	48,733	51,823	47,604	41,151	44,488	51,960	39,633	33,283
BASE CASE - 15% ROI	50,750	46,541	48,583	51,814	46,101	40,102	44,342	46,494	38,092	35,505
250-ACRE CASE	50,750	47,133	47,718	49,085	50,414	42,865	39,938	45,480	43,404	35,664
150-ACRE CASE	50,750	47,185	47,718	49,290	50,462	42,783	40,006	44,432	41,626	35,374
75-ACRE CASE	50,750	47,271	48,833	49,999	53,543	46,673	44,457	43,050	39,348	38,285
35-ACRE CASE	50,750	48,769	49,922	53,262	56,673	51,305	47,027	48,098	43,880	36,498

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
VA										
BASE CASE - 10% ROI	18,870	20,295	21,922	21,213	15,599	16,165	17,112	16,265	14,022	14,808
BASE CASE - 15% ROI	18,870	20,295	21,922	21,104	15,624	16,314	17,491	16,561	14,842	15,886
250-ACRE CASE	18,870	18,419	19,792	22,016	19,695	15,569	17,328	17,382	15,262	15,873
150-ACRE CASE	18,870	18,419	19,792	22,078	19,985	15,867	17,646	17,376	15,232	15,446
75-ACRE CASE	18,870	18,461	20,347	22,411	20,237	16,442	18,667	18,068	16,325	17,613
35-ACRE CASE	18,870	18,768	20,389	22,757	20,786	17,025	19,923	20,315	17,919	18,800

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All Regions										
BASE CASE - 10% ROI	149,710	148,220	152,341	156,843	150,775	147,447	152,596	167,771	142,077	132,861
BASE CASE - 15% ROI	149,710	148,220	152,191	156,645	149,431	143,455	149,633	150,819	130,256	126,865
250-ACRE CASE	149,710	143,679	145,302	150,005	151,788	144,420	141,592	142,885	136,813	131,945
150-ACRE CASE	149,710	143,731	145,302	150,755	152,177	144,637	145,177	144,828	137,877	131,869
75-ACRE CASE	149,710	144,464	148,012	152,912	160,627	152,996	161,349	142,011	138,143	138,512
35-ACRE CASE	149,710	146,363	149,300	156,723	165,067	162,400	163,774	164,156	154,319	142,001

Table B-1

Direct Coal Employment - (Number of Employees)
Base Case - 10% ROI

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1608	1652	1640	1588	1758	1794	2383	1961	1716
KY_1	Surface	972	975	942	844	775	780	799	839	694	562
KY_1 Total		**2791**	**2583**	**2595**	**2484**	**2363**	**2538**	**2593**	**3222**	**2655**	**2278**
KY_2	Deep	2609	2467	2617	2904	2579	1834	2092	2185	1498	1167
KY_2	Surface	1102	1044	941	790	676	669	693	544	629	585
KY_2 Total		**3711**	**3511**	**3558**	**3693**	**3255**	**2503**	**2786**	**2729**	**2127**	**1752**
KY_3	Deep	60	67	68	69	70	71	73	56	68	68
KY_3	Surface	60	48	38	37	20	3	12	2	18	20
KY_3 Total		**120**	**116**	**106**	**106**	**89**	**74**	**85**	**58**	**87**	**88**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	8	3	0	0	0	0	0	0	2
KY_4 Total		**6**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
WV_C	Deep	724	656	687	731	511	431	393	543	453	447
WV_C	Surface	1322	1266	1284	1244	1314	1686	1091	990	420	493
WV_C Total		**2046**	**1922**	**1971**	**1974**	**1825**	**2118**	**1484**	**1533**	**872**	**940**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	17	17	18	14	19	19	20	32	32
WV_E Total		**55**	**41**	**42**	**44**	**41**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2701	2996	3162	3311	3405	3346	3328	2975	3069
WV_N	Surface	69	51	24	8	4	8	16	13	22	28
WV_N Total		**2479**	**2752**	**3020**	**3169**	**3316**	**3413**	**3362**	**3341**	**2997**	**3097**
WV_S	Deep	404	373	298	135	101	68	68	62	15	15
WV_S	Surface	71	72	64	19	20	21	21	22	22	23
WV_S Total		**475**	**445**	**362**	**155**	**121**	**89**	**90**	**84**	**37**	**38**
WV_SW	Deep	2732	2612	2374	2449	2805	3045	3339	4059	3709	3253
WV_SW	Surface	1405	1497	1404	1567	1758	954	669	1231	1273	1127
WV_SW Total		**4137**	**4109**	**3778**	**4017**	**4563**	**3999**	**4008**	**5291**	**4983**	**4380**
ALLEKY	Deep	4489	4142	4337	4612	4237	3662	3959	4624	3527	2951
ALLEKY	Surface	2139	2075	1925	1671	1470	1452	1504	1385	1341	1169
ALL E. KY Total		**6627**	**6217**	**6262**	**6283**	**5707**	**5114**	**5463**	**6009**	**4869**	**4120**
ALLWV	Deep	6293	6366	6380	6503	6756	6977	7175	8022	7182	6815
ALLWV	Surface	2899	2903	2793	2856	3110	2688	1817	2275	1769	1703
ALLWV Total		**9192**	**9269**	**9173**	**9359**	**9866**	**9665**	**8991**	**10297**	**8951**	**8518**
ALLVA	Deep	1538	1658	1795	1728	1225	1271	1351	1267	1063	1102
ALLVA	Surface	488	455	463	437	430	419	446	351	415	439
VA Total		**2026**	**2113**	**2259**	**2166**	**1654**	**1690**	**1796**	**1618**	**1478**	**1541**
ALLREG	Deep	12319	12166	12513	12843	12217	11910	12485	13914	11772	10868
ALLREG	Surface	5526	5434	5181	4965	5010	4559	3766	4011	3526	3311
ALLREG Total		**17845**	**17600**	**17694**	**17808**	**17227**	**16469**	**16251**	**17925**	**15298**	**14179**

Table B-2

Direct Coal Employment - (Number of Employees)
Base Case - 15% ROI

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1608	1652	1640	1544	1633	1782	2044	1844	1535
KY_1	Surface	972	975	942	844	819	794	799	731	632	526
KY_1 Total		**2791**	**2583**	**2595**	**2484**	**2363**	**2427**	**2582**	**2775**	**2476**	**2061**
KY_2	Deep	2609	2467	2604	2903	2490	1864	2091	2024	1478	1556
KY_2	Surface	1102	1044	941	790	767	716	664	704	634	580
KY_2 Total		**3711**	**3511**	**3545**	**3693**	**3256**	**2580**	**2755**	**2728**	**2112**	**2136**
KY_3	Deep	60	67	68	69	70	72	73	70	68	68
KY_3	Surface	60	48	38	37	20	13	12	12	20	20
KY_3 Total		**120**	**116**	**106**	**106**	**89**	**85**	**85**	**82**	**88**	**88**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	8	3	0	0	0	0	0	2	2
KY_4 Total		**6**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	656	687	725	506	438	434	329	238	231
WV_C	Surface	1322	1266	1292	1244	1216	1596	966	735	643	907
WV_C Total		**2046**	**1922**	**1980**	**1969**	**1722**	**2034**	**1400**	**1063**	**881**	**1138**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	17	17	18	18	19	19	20	32	32
WV_E Total		**55**	**41**	**42**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2701	2996	3162	3311	3405	3346	3191	2903	2941
WV_N	Surface	69	51	24	8	4	15	16	13	26	28
WV_N Total		**2479**	**2752**	**3020**	**3169**	**3316**	**3420**	**3362**	**3204**	**2930**	**2968**
WV_S	Deep	404	373	298	135	101	68	68	62	15	15
WV_S	Surface	71	72	64	19	20	21	21	22	22	23
WV_S Total		**475**	**445**	**362**	**155**	**121**	**89**	**90**	**84**	**37**	**38**
WV_SW	Deep	2732	2612	2374	2448	2823	2755	3013	3379	2982	2776
WV_SW	Surface	1405	1497	1404	1567	1779	955	669	908	894	848
WV_SW Total		**4137**	**4109**	**3778**	**4015**	**4601**	**3710**	**3682**	**4288**	**3877**	**3624**
ALLEKY	Deep	4489	4142	4324	4611	4103	3569	3946	4138	3390	3160
ALLEKY	Surface	2139	2075	1925	1671	1605	1524	1475	1447	1288	1128
ALL E. KY Total		**6627**	**6217**	**6249**	**6283**	**5708**	**5093**	**5422**	**5585**	**4679**	**4288**
ALLWV	Deep	6293	6366	6380	6495	6768	6693	6890	6990	6169	5994
ALLWV	Surface	2899	2903	2802	2856	3037	2606	1692	1697	1618	1838
ALLWV Total		**9192**	**9269**	**9182**	**9352**	**9805**	**9299**	**8582**	**8687**	**7787**	**7832**
ALLVA	Deep	1538	1658	1795	1719	1227	1284	1384	1294	1136	1224
ALLVA	Surface	488	455	463	437	436	449	451	387	451	424
ALLVA Total		**2026**	**2113**	**2259**	**2156**	**1663**	**1733**	**1835**	**1681**	**1587**	**1648**
ALLREG	Deep	12319	12166	12499	12825	12098	11547	12221	12422	10695	10378
ALLREG	Surface	5526	5434	5190	4965	5078	4579	3618	3531	3358	3390
ALLREG Total		**17845**	**17600**	**17689**	**17790**	**17176**	**16125**	**15838**	**15952**	**14052**	**13767**

Table B-3

Direct Coal Employment - (Number of Employees)
250-Acre Case

Region	Mining Ty	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1714	1713	1667	1647	1571	1560	1783	2026	1659
KY_1	Surface	972	944	895	840	779	770	667	558	482	433
KY_1 Total		**2791**	**2657**	**2608**	**2507**	**2427**	**2341**	**2227**	**2342**	**2508**	**2092**
KY_2	Deep	2609	2414	2466	2635	2770	2173	1924	2193	1766	1444
KY_2	Surface	1102	887	829	747	743	603	556	495	452	449
KY_2 Total		**3711**	**3300**	**3295**	**3382**	**3513**	**2776**	**2480**	**2689**	**2218**	**1893**
KY_3	Deep	60	67	68	67	70	71	71	71	71	71
KY_3	Surface	60	56	47	36	18	2	12	12	20	20
KY_3 Total		**120**	**124**	**114**	**103**	**87**	**72**	**83**	**83**	**91**	**91**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	5	6	0	0	0	0	0	2	2
KY_4 Total		**6**	**5**	**6**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	630	658	669	655	422	435	324	275	251
WV_C	Surface	1322	1343	1311	1175	965	1358	1589	785	702	485
WV_C Total		**2046**	**1973**	**1969**	**1844**	**1621**	**1780**	**2024**	**1108**	**977**	**736**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	17	18	18	19	19	20	32	32
WV_E Total		**55**	**53**	**42**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2471	2759	3054	3222	3337	3310	3069	3019	2921
WV_N	Surface	69	59	16	11	8	8	16	13	14	27
WV_N Total		**2479**	**2530**	**2775**	**3065**	**3230**	**3345**	**3326**	**3081**	**3033**	**2949**
WV_S	Deep	404	373	269	101	73	68	68	59	15	15
WV_S	Surface	71	62	11	1	1	1	1	1	1	1
WV_S Total		**475**	**435**	**280**	**103**	**74**	**70**	**70**	**60**	**16**	**16**
WV_SW	Deep	2732	2633	2381	2261	2321	2764	2682	2836	2865	3202
WV_SW	Surface	1405	1347	1265	1277	1282	1138	342	534	543	596
WV_SW Total		**4137**	**3980**	**3646**	**3537**	**3603**	**3902**	**3023**	**3370**	**3408**	**3798**
ALLEKY	Deep	4489	4195	4247	4369	4487	3815	3554	4048	3863	3174
ALLEKY	Surface	2139	1891	1776	1623	1540	1374	1235	1066	956	904
ALL E. KY Total		**6627**	**6086**	**6023**	**5991**	**6027**	**5189**	**4790**	**5114**	**4819**	**4078**
ALLWV	Deep	6293	6130	6091	6111	6297	6620	6523	6317	6203	6421
ALLWV	Surface	2899	2840	2621	2481	2275	2524	1968	1352	1292	1142
ALLWV Total		**9192**	**8970**	**8712**	**8592**	**8572**	**9144**	**8491**	**7669**	**7495**	**7563**
ALLVA	Deep	1538	1491	1606	1796	1586	1214	1366	1363	1169	1219
ALLVA	Surface	488	473	463	470	442	440	435	380	408	404
ALLVA Total		**2026**	**1964**	**2069**	**2266**	**2027**	**1654**	**1801**	**1743**	**1577**	**1623**
ALLREG	Deep	12319	11816	11944	12276	12370	11649	11444	11727	11236	10813
ALLREG	Surface	5526	5205	4861	4574	4257	4338	3638	2798	2656	2451
ALLREG Total		**17845**	**17021**	**16804**	**16849**	**16627**	**15986**	**15082**	**14525**	**13891**	**13264**

Table B-4

Direct Coal Employment - (Number of Employees)
150-Acre Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1719	1713	1667	1647	1564	1549	1772	2003	1673
KY_1	Surface	972	943	895	839	773	767	661	555	480	431
KY_1 Total		**2791**	**2661**	**2608**	**2506**	**2420**	**2332**	**2210**	**2327**	**2482**	**2103**
KY_2	Deep	2609	2414	2466	2653	2776	2173	1940	2112	1631	1405
KY_2	Surface	1102	887	829	782	718	571	529	485	442	445
KY_2 Total		**3711**	**3300**	**3294**	**3435**	**3494**	**2744**	**2469**	**2596**	**2073**	**1849**
KY_3	Deep	60	67	68	67	68	71	71	71	71	71
KY_3	Surface	60	56	47	46	18	12	12	19	20	24
KY_3 Total		**120**	**124**	**114**	**113**	**86**	**83**	**83**	**90**	**91**	**95**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	5	5	0	0	0	0	0	2	2
KY_4 Total		**6**	**5**	**5**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	630	658	704	655	422	436	351	268	253
WV_C	Surface	1322	1343	1311	1222	963	1358	1589	805	675	464
WV_C Total		**2046**	**1973**	**1969**	**1925**	**1619**	**1780**	**2025**	**1156**	**943**	**717**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	17	18	18	19	19	20	28	32
WV_E Total		**55**	**53**	**42**	**44**	**45**	**46**	**47**	**49**	**58**	**63**
WV_N	Deep	2410	2471	2759	3054	3222	3337	3310	3069	3019	2921
WV_N	Surface	69	55	16	15	8	8	16	13	13	27
WV_N Total		**2479**	**2526**	**2775**	**3069**	**3230**	**3345**	**3326**	**3081**	**3031**	**2949**
WV_S	Deep	404	373	269	101	73	68	68	31	15	15
WV_S	Surface	71	66	14	1	1	1	1	1	1	1
WV_S Total		**475**	**439**	**282**	**103**	**74**	**70**	**70**	**32**	**16**	**16**
WV_SW	Deep	2732	2633	2381	2261	2325	2764	2965	3097	3133	3254
WV_SW	Surface	1405	1347	1261	1067	1248	910	342	491	489	488
WV_SW Total		**4137**	**3980**	**3641**	**3327**	**3573**	**3675**	**3307**	**3588**	**3622**	**3741**
ALLEKY	Deep	4489	4199	4247	4387	4491	3808	3561	3954	3705	3148
ALLEKY	Surface	2139	1891	1775	1667	1509	1350	1203	1058	944	902
ALL E. KY Total		**6627**	**6090**	**6022**	**6054**	**6000**	**5158**	**4763**	**5013**	**4649**	**4050**
ALLWV	Deep	6293	6130	6091	6145	6302	6620	6808	6577	6465	6473
ALLWV	Surface	2899	2840	2619	2323	2239	2296	1967	1329	1206	1013
ALLWV Total		**9192**	**8970**	**8710**	**8468**	**8540**	**8916**	**8775**	**7906**	**7670**	**7486**
ALLVA	Deep	1538	1491	1606	1802	1608	1237	1391	1362	1166	1181
ALLVA	Surface	488	473	463	469	437	422	420	377	397	394
ALLVA Total		**2026**	**1964**	**2069**	**2271**	**2045**	**1660**	**1811**	**1739**	**1563**	**1574**
ALLREG	Deep	12319	11821	11944	12334	12401	11665	11759	11894	11336	10802
ALLREG	Surface	5526	5204	4857	4459	4185	4069	3590	2764	2547	2308
ALLREG Total		**17845**	**17025**	**16801**	**16793**	**16586**	**15733**	**15349**	**14658**	**13882**	**13110**

Table B-5

Direct Coal Employment - (Number of Employees)
75-Acre Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1722	1737	1667	1763	1662	1748	1763	1984	1718
KY_1	Surface	972	881	820	753	583	449	402	360	295	226
KY_1 Total		**2791**	**2602**	**2557**	**2420**	**2346**	**2111**	**2150**	**2123**	**2279**	**1944**
KY_2	Deep	2609	2418	2540	2713	2933	2421	2139	1996	1446	1620
KY_2	Surface	1102	878	816	760	566	575	504	483	498	474
KY_2 Total		**3711**	**3296**	**3357**	**3473**	**3500**	**2996**	**2642**	**2479**	**1944**	**2094**
KY_3	Deep	60	67	69	70	69	71	70	72	72	69
KY_3	Surface	60	56	53	46	18	12	12	19	20	24
KY_3 Total		**120**	**124**	**122**	**116**	**87**	**83**	**82**	**91**	**92**	**93**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	5	2	0	0	0	0	0	2	2
KY_4 Total		**6**	**5**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	630	663	707	655	461	437	356	299	252
WV_C	Surface	1322	1223	1029	977	934	1299	1563	918	601	412
WV_C Total		**2046**	**1853**	**1692**	**1684**	**1590**	**1760**	**2000**	**1273**	**900**	**664**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	26	18	18	19	19	20	32	32
WV_E Total		**55**	**53**	**51**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2471	2759	3054	3356	3476	3476	3162	3093	3012
WV_N	Surface	69	42	16	16	5	16	8	13	16	28
WV_N Total		**2479**	**2513**	**2775**	**3071**	**3362**	**3492**	**3484**	**3174**	**3109**	**3040**
WV_S	Deep	404	373	299	138	106	75	77	79	80	82
WV_S	Surface	71	62	20	19	20	21	21	22	22	23
WV_S Total		**475**	**435**	**319**	**158**	**126**	**95**	**98**	**100**	**103**	**105**
WV_SW	Deep	2732	2681	2431	2318	2578	2875	3639	2779	3029	3184
WV_SW	Surface	1405	1134	936	866	1098	326	525	465	385	267
WV_SW Total		**4137**	**3815**	**3367**	**3183**	**3676**	**3201**	**4165**	**3244**	**3414**	**3451**
ALLEKY	Deep	4489	4207	4346	4450	4765	4154	3957	3831	3502	3407
ALLEKY	Surface	2139	1820	1691	1559	1167	1036	918	862	815	726
ALL E. KY Total		**6627**	**6027**	**6038**	**6009**	**5933**	**5190**	**4875**	**4693**	**4317**	**4134**
ALLWV	Deep	6293	6179	6176	6243	6722	6914	7658	6404	6531	6561
ALLWV	Surface	2899	2490	2027	1896	2077	1681	2137	1436	1056	763
ALLWV Total		**9192**	**8669**	**8204**	**8139**	**8798**	**8595**	**9795**	**7840**	**7588**	**7324**
ALLVA	Deep	1538	1495	1655	1832	1630	1288	1478	1420	1260	1370
ALLVA	Surface	488	492	481	456	381	419	379	366	319	280
ALLVA Total		**2026**	**1987**	**2136**	**2288**	**2011**	**1708**	**1857**	**1786**	**1579**	**1650**
ALLREG	Deep	12319	11880	12178	12525	13118	12356	13093	11656	11293	11338
ALLREG	Surface	5526	4802	4200	3911	3625	3136	3434	2664	2190	1769
ALLREG Total		**17845**	**16683**	**16377**	**16436**	**16742**	**15492**	**16527**	**14319**	**13483**	**13108**

Table B-6

Direct Coal Employment - (Number of Employees)
35-Acre Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1782	1770	1712	1809	1883	1736	2105	2318	1900
KY_1	Surface	972	751	435	349	241	199	185	147	93	100
KY_1 Total		**2791**	**2533**	**2205**	**2061**	**2050**	**2081**	**1921**	**2252**	**2411**	**1999**
KY_2	Deep	2609	2491	2604	2958	3163	2611	2377	2103	1519	1280
KY_2	Surface	1102	773	668	521	465	413	381	375	381	422
KY_2 Total		**3711**	**3264**	**3273**	**3478**	**3628**	**3024**	**2758**	**2477**	**1900**	**1703**
KY_3	Deep	60	67	69	71	72	72	73	73	68	68
KY_3	Surface	60	54	53	37	17	17	19	15	8	13
KY_3 Total		**120**	**121**	**122**	**108**	**89**	**90**	**91**	**88**	**77**	**81**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	3	2	2	0	0	2	0	2	2
KY_4 Total		**6**	**3**	**2**	**2**	**0**	**0**	**2**	**0**	**2**	**2**
WV_C	Deep	724	630	663	707	700	467	448	608	423	431
WV_C	Surface	1322	889	888	874	828	1035	332	249	239	208
WV_C Total		**2046**	**1519**	**1551**	**1582**	**1528**	**1502**	**780**	**857**	**662**	**639**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	30	26	18	18	18	18	26	25
WV_E Total		**55**	**53**	**54**	**52**	**45**	**45**	**46**	**47**	**56**	**56**
WV_N	Deep	2410	2471	2759	3054	3356	3530	3534	3350	3188	2791
WV_N	Surface	69	28	18	16	15	16	16	15	13	27
WV_N Total		**2479**	**2499**	**2776**	**3071**	**3372**	**3547**	**3550**	**3366**	**3201**	**2819**
WV_S	Deep	404	373	276	81	19	15	15	15	15	15
WV_S	Surface	71	18	19	19	20	21	21	22	22	23
WV_S Total		**475**	**391**	**295**	**100**	**39**	**35**	**36**	**36**	**37**	**38**
WV_SW	Deep	2732	2688	2468	2385	2669	3194	3521	3688	3766	3743
WV_SW	Surface	1405	713	573	227	99	122	240	186	138	92
WV_SW Total		**4137**	**3401**	**3041**	**2612**	**2768**	**3316**	**3761**	**3874**	**3904**	**3836**
ALLEKY	Deep	4489	4340	4443	4740	5044	4566	4185	4281	3905	3248
ALLEKY	Surface	2139	1580	1159	909	723	629	587	536	485	537
ALL E. KY Total		**6627**	**5921**	**5602**	**5650**	**5767**	**5195**	**4773**	**4817**	**4390**	**3785**
ALLWV	Deep	6293	6186	6190	6253	6771	7233	7546	7690	7422	7011
ALLWV	Surface	2899	1677	1527	1164	981	1211	628	490	438	376
ALLWV Total		**9192**	**7863**	**7717**	**7416**	**7751**	**8445**	**8174**	**8180**	**7860**	**7387**
ALLVA	Deep	1538	1522	1659	1862	1679	1337	1587	1613	1395	1468
ALLVA	Surface	488	472	433	379	309	259	246	205	199	194
ALLVA Total		**2026**	**1994**	**2092**	**2241**	**1989**	**1596**	**1832**	**1818**	**1595**	**1662**
ALLREG	Deep	12319	12048	12292	12855	13494	13136	13318	13584	12723	11728
ALLREG	Surface	5526	3730	3118	2452	2013	2100	1461	1231	1122	1107
ALLREG Total		**17845**	**15778**	**15410**	**15307**	**15507**	**15236**	**14779**	**14815**	**13844**	**12834**

Table C-1

Mine Capacity Capital Expenditures
Million Dollars

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	0.00	33.33	13.01	0.18	11.34	17.59	1.05	178.48	0.00	0.00
BASE CASE - 15% ROI	0.00	33.33	13.01	0.18	0.17	0.43	31.01	70.50	0.00	0.00
250-ACRE CASE	0.00	5.09	27.10	0.00	3.77	0.00	0.00	51.85	47.09	0.00
150-ACRE CASE	0.00	4.95	27.03	0.00	3.77	0.00	0.00	51.70	49.09	0.00
75-ACRE CASE	0.00	2.72	16.12	0.00	31.42	0.00	31.30	1.63	31.66	0.00
35-ACRE CASE	0.00	2.49	9.42	0.00	25.60	16.45	0.00	99.52	40.68	0.33
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 2										
BASE CASE - 10% ROI	0.00	67.08	45.89	68.35	0.70	0.70	39.17	79.52	0.00	0.00
BASE CASE - 15% ROI	0.00	67.08	42.89	71.18	0.70	0.70	53.53	21.67	0.00	21.12
250-ACRE CASE	0.00	12.60	34.51	54.21	38.50	0.00	0.00	68.61	0.00	0.00
150-ACRE CASE	0.00	12.60	34.30	54.21	39.96	0.00	0.00	31.92	0.00	0.00
75-ACRE CASE	0.00	12.30	33.19	54.52	80.17	0.00	0.00	0.00	1.08	39.18
35-ACRE CASE	0.00	12.29	31.83	79.48	59.95	0.00	0.00	0.00	1.50	0.00
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 3										
BASE CASE - 10% ROI	0.00	0.79	0.11	0.21	0.20	0.21	0.10	0.05	0.00	0.14
BASE CASE - 15% ROI	0.00	0.79	0.11	0.21	0.20	0.21	0.10	0.00	0.00	0.04
250-ACRE CASE	0.00	0.39	0.13	0.21	0.20	0.21	0.08	0.05	0.00	0.04
150-ACRE CASE	0.00	0.39	0.13	0.21	0.20	0.21	0.14	0.00	0.03	0.01
75-ACRE CASE	0.00	0.39	0.33	0.21	0.19	0.20	0.14	0.00	0.03	0.01
35-ACRE CASE	0.00	0.34	0.33	0.41	0.19	0.20	0.10	0.00	0.00	0.00
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 4										
BASE CASE - 10% ROI	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BASE CASE - 15% ROI	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
250-ACRE CASE	0.00	0.02	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.01
150-ACRE CASE	0.00	0.02	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.01
75-ACRE CASE	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
35-ACRE CASE	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV C										
BASE CASE - 10% ROI	0.00	8.37	11.56	14.41	88.19	83.51	0.18	68.97	0.42	0.40
BASE CASE - 15% ROI	0.00	8.37	11.56	13.29	65.01	70.13	0.43	0.43	0.42	62.96
250-ACRE CASE	0.00	7.17	12.15	14.47	4.65	96.36	40.28	0.27	0.26	0.49
150-ACRE CASE	0.00	7.17	12.15	14.47	5.13	96.42	40.28	0.27	0.52	0.48
75-ACRE CASE	0.00	6.69	12.04	10.45	12.14	70.47	66.64	0.69	0.68	0.66
35-ACRE CASE	0.00	0.66	7.55	10.27	0.97	53.47	0.52	43.08	0.52	0.48
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV E										
BASE CASE - 10% ROI	0.00	0.42	0.38	0.38	0.38	0.38	0.40	0.38	0.38	0.40
BASE CASE - 15% ROI	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40
250-ACRE CASE	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40
150-ACRE CASE	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
75-ACRE CASE	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40
35-ACRE CASE	0.00	0.42	0.38	0.38	0.27	0.20	0.21	0.21	0.21	0.22

Table C-1 (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV N										
BASE CASE - 10% ROI	0.00	145.99	144.44	78.27	77.52	37.61	22.30	43.74	0.00	46.66
BASE CASE - 15% ROI	0.00	145.99	144.44	78.27	77.52	37.61	22.33	14.31	0.00	16.93
250-ACRE CASE	0.00	30.85	141.15	145.22	79.27	52.32	1.60	20.54	7.07	3.92
150-ACRE CASE	0.00	30.85	141.15	145.22	79.27	52.32	1.60	20.54	7.07	3.92
75-ACRE CASE	0.00	30.85	141.15	145.22	148.57	54.27	9.75	0.48	9.25	5.89
35-ACRE CASE	0.00	30.85	141.15	145.22	148.57	82.27	10.32	19.76	0.00	0.03

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV S										
BASE CASE - 10% ROI	0.00	0.19	0.00	0.00	0.14	0.14	0.14	0.14	0.14	0.14
BASE CASE - 15% ROI	0.00	0.19	0.00	0.00	0.14	0.14	0.14	0.14	0.14	0.14
250-ACRE CASE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150-ACRE CASE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75-ACRE CASE	0.00	0.00	0.00	0.00	0.14	0.14	0.55	0.55	0.55	0.55
35-ACRE CASE	0.00	0.00	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.14

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV SW										
BASE CASE - 10% ROI	0.00	55.12	12.82	102.78	219.00	61.61	126.88	416.55	1.61	1.35
BASE CASE - 15% ROI	0.00	55.12	12.82	102.38	218.00	5.09	124.58	199.99	0.41	14.99
250-ACRE CASE	0.00	11.35	27.14	49.37	75.72	128.16	11.14	146.14	49.47	83.45
150-ACRE CASE	0.00	11.35	26.45	13.86	105.64	128.05	81.88	123.36	54.70	14.43
75-ACRE CASE	0.00	9.84	3.65	48.59	147.83	88.42	241.63	0.32	39.85	34.75
35-ACRE CASE	0.00	8.70	15.00	6.80	82.94	188.29	148.55	179.12	12.82	0.17

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All WV										
BASE CASE - 10% ROI	0.00	210.09	169.20	195.84	385.23	183.25	149.90	529.78	2.55	48.95
BASE CASE - 15% ROI	0.00	210.09	169.20	194.32	361.05	113.35	147.86	215.25	1.35	95.42
250-ACRE CASE	0.00	49.79	180.82	209.44	160.02	277.22	53.40	167.33	57.18	88.26
150-ACRE CASE	0.00	49.79	180.13	173.93	190.42	277.17	124.14	144.55	62.67	19.21
75-ACRE CASE	0.00	47.80	157.22	204.64	309.06	213.68	318.95	2.42	50.71	42.25
35-ACRE CASE	0.00	40.63	164.23	162.81	232.89	324.37	159.74	242.31	13.69	1.04

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All E. KY										
BASE CASE - 10% ROI	0.00	101.94	59.01	68.74	12.24	18.50	40.32	258.05	0.00	0.14
BASE CASE - 15% ROI	0.00	101.94	56.01	71.57	1.07	1.34	84.64	92.17	0.00	21.17
250-ACRE CASE	0.00	18.10	62.19	54.42	42.47	0.21	0.08	120.51	47.09	0.05
150-ACRE CASE	0.00	17.96	61.82	54.42	43.93	0.21	0.14	83.62	49.12	0.02
75-ACRE CASE	0.00	15.43	49.64	54.73	111.78	0.20	31.44	1.63	32.77	39.20
35-ACRE CASE	0.00	15.14	41.58	79.89	85.74	16.65	0.10	99.53	42.18	0.34

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
VA										
BASE CASE - 10% ROI	0.00	67.73	40.88	8.33	6.82	7.06	12.51	13.15	8.05	7.90
BASE CASE - 15% ROI	0.00	67.73	40.88	8.33	6.82	7.05	24.56	13.15	8.53	24.27
250-ACRE CASE	0.00	19.34	44.45	53.69	6.97	7.18	30.75	13.50	8.05	9.58
150-ACRE CASE	0.00	19.34	44.45	53.55	12.57	7.33	31.31	7.90	8.02	8.26
75-ACRE CASE	0.00	19.35	45.70	52.59	12.57	7.33	59.92	8.05	8.26	23.08
35-ACRE CASE	0.00	16.77	43.94	53.49	12.57	12.93	63.21	14.30	8.40	14.67

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All Regions										
BASE CASE - 10% ROI	0.00	379.76	269.09	272.91	404.29	208.81	202.73	800.98	10.60	56.99
BASE CASE - 15% ROI	0.00	379.76	266.09	274.22	368.94	121.74	257.06	320.57	9.88	140.86
250-ACRE CASE	0.00	87.23	287.46	317.55	209.46	284.61	84.23	301.34	112.32	97.89
150-ACRE CASE	0.00	87.09	286.40	281.90	246.92	284.71	155.59	236.07	119.81	27.49
75-ACRE CASE	0.00	82.58	252.56	311.96	433.41	221.21	410.31	12.10	91.74	104.53
35-ACRE CASE	0.00	72.54	249.75	296.19	331.20	353.95	223.05	356.14	64.27	16.05

Table D-1

Average Coal Prices
(Constant 2001 Dollars per Ton, Fob Mine)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	35.22	25.49	25.06	24.73	23.57	23.78	25.24	22.47	23.79	25.77
BASE CASE - 15% ROI	35.22	25.49	25.05	24.74	24.02	24.76	25.27	23.68	25.53	25.11
250-ACRE CASE	35.22	27.22	25.87	25.31	24.81	24.39	25.14	24.52	25.08	26.45
150-ACRE CASE	35.22	27.22	25.88	25.51	24.80	24.37	25.02	24.60	24.63	26.53
75-ACRE CASE	35.22	27.63	26.70	26.14	24.38	25.64	24.29	24.74	25.89	26.54
35-ACRE CASE	35.22	29.23	27.73	27.37	26.20	25.72	26.36	24.99	25.12	26.71
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 2										
BASE CASE - 10% ROI	35.02	25.27	24.70	24.13	23.02	23.54	24.77	22.30	23.81	25.50
BASE CASE - 15% ROI	35.02	25.27	24.70	24.15	23.44	24.49	24.79	23.38	25.37	24.64
250-ACRE CASE	35.02	27.00	25.44	24.67	24.14	23.86	24.83	24.15	24.80	26.17
150-ACRE CASE	35.02	27.00	25.44	24.83	24.13	23.87	24.68	24.30	24.58	26.24
75-ACRE CASE	35.02	27.36	26.21	25.40	23.79	25.17	23.97	24.45	25.71	26.07
35-ACRE CASE	35.02	28.87	27.25	26.74	25.61	25.20	25.81	24.71	25.11	26.47
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 3										
BASE CASE - 10% ROI	34.27	24.31	23.73	24.18	21.44	23.62	22.95	19.44	21.69	23.40
BASE CASE - 15% ROI	34.27	24.31	24.82	22.89	21.84	22.69	23.07	23.25	23.39	22.70
250-ACRE CASE	34.27	26.19	24.65	23.49	22.73	21.85	23.05	21.62	23.07	24.00
150-ACRE CASE	34.27	26.19	24.65	23.74	22.69	22.18	22.88	23.94	22.20	24.01
75-ACRE CASE	34.27	26.63	25.44	25.20	22.27	24.65	22.03	23.98	23.88	23.81
35-ACRE CASE	34.27	28.39	26.47	25.53	24.12	23.54	24.07	22.23	22.00	26.08
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 4										
BASE CASE - 10% ROI	34.88	25.17	24.30	0.00	0.00	0.00	0.00	0.00	0.00	25.57
BASE CASE - 15% ROI	34.88	25.17	24.29	0.00	0.00	0.00	0.00	0.00	25.46	24.58
250-ACRE CASE	34.88	26.85	25.01	0.00	0.00	0.00	0.00	0.00	24.75	26.03
150-ACRE CASE	34.88	26.85	25.02	0.00	0.00	0.00	0.00	0.00	24.53	26.17
75-ACRE CASE	34.88	27.16	25.78	0.00	0.00	0.00	0.00	0.00	25.63	26.08
35-ACRE CASE	34.88	28.54	26.85	26.07	0.00	0.00	25.35	0.00	25.19	26.50
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV C										
BASE CASE - 10% ROI	34.75	25.38	25.10	24.56	23.58	23.51	24.78	21.23	22.59	24.54
BASE CASE - 15% ROI	34.75	25.38	25.09	24.57	23.95	24.49	24.94	22.42	24.09	23.77
250-ACRE CASE	34.75	26.96	25.97	25.19	24.73	24.16	24.72	23.32	23.70	25.03
150-ACRE CASE	34.75	26.96	25.97	25.46	24.70	24.13	24.63	23.44	23.20	25.04
75-ACRE CASE	34.75	27.54	26.91	26.22	24.37	25.56	23.75	23.53	24.29	24.96
35-ACRE CASE	34.75	29.27	27.79	27.29	25.82	25.32	25.81	23.81	23.69	25.29
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV E										
BASE CASE - 10% ROI	35.77	26.11	24.81	23.40	22.24	22.54	23.24	22.52	24.10	25.99
BASE CASE - 15% ROI	35.77	26.11	24.81	23.40	22.48	22.97	23.17	23.06	24.97	25.72
250-ACRE CASE	35.77	27.61	25.57	23.62	23.04	22.58	23.13	23.38	23.60	26.21
150-ACRE CASE	35.77	27.62	25.58	23.87	23.07	22.57	23.17	23.48	23.29	25.87
75-ACRE CASE	35.77	27.95	26.01	24.37	22.97	23.30	22.28	23.38	23.87	25.44
35-ACRE CASE	35.77	29.50	26.58	25.40	23.85	23.22	23.53	23.26	23.22	26.42

Table D-1 (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV N										
BASE CASE - 10% ROI	34.91	24.92	23.33	22.66	21.78	22.03	22.71	21.42	22.95	24.46
BASE CASE - 15% ROI	34.91	24.92	23.33	22.66	22.03	22.44	22.64	21.96	23.80	24.21
250-ACRE CASE	34.91	26.55	24.38	22.86	22.56	22.14	22.68	22.29	22.70	24.88
150-ACRE CASE	34.91	26.56	24.39	23.10	22.60	22.15	22.73	22.38	22.40	24.46
75-ACRE CASE	34.91	26.79	24.81	23.71	22.42	22.67	21.82	22.25	22.79	23.85
35-ACRE CASE	34.91	28.22	25.28	24.65	23.08	22.54	22.99	22.20	22.30	24.40

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV S										
BASE CASE - 10% ROI	34.22	24.84	24.70	24.50	23.13	23.37	24.91	21.28	22.54	24.55
BASE CASE - 15% ROI	34.22	24.84	24.69	24.50	23.56	24.30	24.87	22.49	24.24	23.88
250-ACRE CASE	34.22	26.39	24.99	24.50	23.86	23.51	24.49	23.23	23.70	24.52
150-ACRE CASE	34.22	26.41	25.03	24.75	23.82	23.47	24.41	23.16	23.18	24.63
75-ACRE CASE	34.22	26.91	25.78	25.75	23.97	25.41	23.97	23.65	24.35	24.94
35-ACRE CASE	34.22	28.15	26.72	27.21	26.12	25.55	26.16	24.05	23.94	25.24

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV SW										
BASE CASE - 10% ROI	34.09	24.68	24.39	23.98	22.57	22.90	24.31	21.03	22.32	24.29
BASE CASE - 15% ROI	34.09	24.68	24.39	23.99	22.99	23.88	24.48	22.27	24.05	23.65
250-ACRE CASE	34.09	26.31	25.21	24.46	23.82	23.32	24.34	23.21	23.86	24.84
150-ACRE CASE	34.09	26.31	25.21	24.69	23.77	23.34	24.10	23.32	23.33	24.93
75-ACRE CASE	34.09	26.84	26.01	25.38	23.41	24.88	23.31	23.55	24.40	24.85
35-ACRE CASE	34.09	28.39	26.89	26.75	25.34	24.79	25.21	23.82	23.76	25.03

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All WV										
BASE CASE - 10% ROI	34.48	24.91	24.23	23.68	22.52	22.75	23.78	21.20	22.58	24.40
BASE CASE - 15% ROI	34.48	24.91	24.22	23.68	22.86	23.50	23.82	22.18	23.97	23.91
250-ACRE CASE	34.48	26.54	25.13	24.07	23.53	23.07	23.78	22.85	23.35	24.89
150-ACRE CASE	34.48	26.54	25.14	24.31	23.51	23.07	23.71	22.96	22.92	24.76
75-ACRE CASE	34.48	26.99	25.80	24.93	23.22	24.12	22.87	23.00	23.68	24.43
35-ACRE CASE	34.48	28.51	26.49	25.97	24.41	23.91	24.23	23.09	23.09	24.80

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All E. KY										
BASE CASE - 10% ROI	35.09	25.35	24.84	24.38	23.23	23.66	24.97	22.37	23.77	25.60
BASE CASE - 15% ROI	35.09	25.35	24.85	24.37	23.66	24.59	25.00	23.53	25.42	24.82
250-ACRE CASE	35.09	27.08	25.62	24.93	24.40	24.08	24.95	24.28	24.92	26.26
150-ACRE CASE	35.09	27.08	25.62	25.10	24.39	24.08	24.81	24.43	24.56	26.33
75-ACRE CASE	35.09	27.47	26.41	25.70	24.01	25.35	24.08	24.57	25.76	26.23
35-ACRE CASE	35.09	29.02	27.42	26.95	25.79	25.38	25.99	24.79	25.06	26.58

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
VA										
BASE CASE - 10% ROI	36.44	27.17	26.64	26.09	25.00	25.40	26.75	23.23	24.64	26.73
BASE CASE - 15% ROI	36.44	27.17	26.64	26.10	25.43	26.31	26.95	24.48	26.56	26.14
250-ACRE CASE	36.44	28.92	27.52	26.53	25.89	25.77	26.78	25.48	26.38	25.15
150-ACRE CASE	36.44	28.92	27.53	26.78	25.85	25.74	26.56	25.61	23.76	25.66
75-ACRE CASE	36.44	29.56	28.28	27.39	25.62	27.24	25.66	26.08	27.01	25.11
35-ACRE CASE	36.44	31.03	29.21	28.52	27.69	27.31	27.60	24.88	24.05	25.31

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All Regions										
BASE CASE - 10% ROI	34.91	25.31	24.73	24.19	22.97	23.29	24.50	21.76	23.15	25.01
BASE CASE - 15% ROI	34.91	25.31	24.73	24.19	23.35	24.13	24.58	22.88	24.74	24.45
250-ACRE CASE	34.91	26.99	25.58	24.67	24.11	23.66	24.49	23.65	24.23	25.33
150-ACRE CASE	34.91	26.99	25.59	24.90	24.09	23.66	24.37	23.77	23.54	25.34
75-ACRE CASE	34.91	27.45	26.33	25.53	23.76	24.86	23.52	23.88	24.72	25.06
35-ACRE CASE	34.91	29.01	27.18	26.68	25.31	24.73	25.19	23.84	23.80	25.38

Table E-1

Megawatt-Hours of Generation

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 2										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 3										
BASE CASE - 10% ROI	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634
BASE CASE - 15% ROI	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634
250-ACRE CASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634
150-ACRE CASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634
75-ACRE CASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634
35-ACRE CASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 4										
BASE CASE - 10% ROI	323,925	374,160	424,395	474,629	423,534	447,754	461,457	0	0	0
BASE CASE - 15% ROI	323,925	374,160	424,395	474,629	423,534	447,754	461,457	0	0	0
250-ACRE CASE	323,925	374,160	424,395	474,629	423,534	447,754	0	0	0	0
150-ACRE CASE	323,925	374,160	424,395	474,629	423,534	447,754	461,457	0	0	0
75-ACRE CASE	323,925	374,160	424,395	416,285	423,534	438,972	472,038	0	0	0
35-ACRE CASE	323,925	300,289	424,395	403,319	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV C										
BASE CASE - 10% ROI	675,656	711,542	680,236	587,926	590,798	34,223	34,223	34,223	34,223	34,223
BASE CASE - 15% ROI	675,656	711,542	680,236	587,926	573,229	34,223	34,223	34,223	34,223	34,223
250-ACRE CASE	675,656	711,542	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223
150-ACRE CASE	675,656	711,542	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223
75-ACRE CASE	675,656	711,542	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223
35-ACRE CASE	675,656	610,306	599,116	570,163	34,223	34,223	34,223	34,223	34,223	34,223

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV E										
BASE CASE - 10% ROI	3,055,270	3,084,117	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070
BASE CASE - 15% ROI	3,055,270	3,084,117	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070
250-ACRE CASE	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070
150-ACRE CASE	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070
75-ACRE CASE	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070
35-ACRE CASE	3,055,270	3,089,979	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV N										
BASE CASE - 10% ROI	21,530,733	21,835,448	21,669,331	21,550,402	21,846,927	20,397,537	19,737,796	18,842,834	18,764,416	18,701,353
BASE CASE - 15% ROI	21,530,733	21,835,448	21,669,331	21,547,871	21,851,469	19,403,986	19,742,119	18,830,782	18,829,724	18,830,612
250-ACRE CASE	21,530,733	21,594,004	21,512,683	21,502,314	21,741,207	21,775,492	19,708,842	18,834,237	18,834,237	18,705,238
150-ACRE CASE	21,530,733	21,593,990	21,512,683	21,502,314	21,725,959	19,391,344	19,700,787	18,836,945	18,837,703	18,707,946
75-ACRE CASE	21,530,733	21,765,769	21,468,335	21,358,253	21,377,274	19,334,547	19,780,646	18,832,432	18,744,684	16,775,490
35-ACRE CASE	21,530,733	21,413,446	21,478,832	20,370,008	19,297,988	18,765,704	19,188,656	18,419,165	18,419,283	16,444,314

Table E-1 (cont.)

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	25,261,659	25,631,107	25,462,530	25,245,799	25,573,727	23,596,293	22,966,089	22,071,127	21,992,709	21,929,646
BASE CASE - 15% ROI	25,261,659	25,631,107	25,462,530	25,243,268	25,560,700	22,602,742	22,970,412	22,059,075	22,058,017	22,058,905
250-ACRE CASE	25,261,659	25,394,548	25,224,762	25,197,711	24,911,432	24,974,248	22,937,135	22,062,530	22,062,530	21,933,531
150-ACRE CASE	25,261,659	25,394,534	25,224,762	25,197,711	24,896,184	22,590,100	22,929,080	22,065,238	22,065,996	21,936,239
75-ACRE CASE	25,261,659	25,566,313	25,180,414	25,053,650	24,547,499	22,533,303	23,008,939	22,060,725	21,972,977	20,003,783
35-ACRE CASE	25,261,659	25,113,731	25,190,911	24,047,642	22,468,213	21,964,460	22,416,949	21,647,458	21,647,576	19,672,607

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,616,851	2,121,634	2,121,634	2,121,634
BASE CASE - 15% ROI	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,616,851	2,121,634	2,121,634	2,121,634
250-ACRE CASE	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,155,394	2,121,634	2,121,634	2,121,634
150-ACRE CASE	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,616,851	2,121,634	2,121,634	2,121,634
75-ACRE CASE	2,447,360	2,502,997	2,558,633	2,555,925	2,568,575	2,589,415	2,627,432	2,121,634	2,121,634	2,121,634
35-ACRE CASE	2,447,360	2,429,126	2,558,633	2,542,959	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634

All VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	14339034	14505891	15134866	14777414	15868486	15023574	15363931	16455296	17368707	18552755
BASE CASE - 15% ROI	14339034	14505891	15134866	14778080	14833424	15023532	15472500	16455296	18355939	18294427
250-ACRE CASE	14339034	14516621	14684765	15029789	14835977	15015167	15364766	16458321	18215708	18979464
150-ACRE CASE	14339034	14516621	14684765	14803602	14835977	15027638	15366843	16891178	16761105	18482256
75-ACRE CASE	14339034	14516621	14560432	14861643	14835977	14626314	15745919	16909042	18358965	18979464
35-ACRE CASE	14339034	14675818	14478391	14723506	14444301	14626314	15484538	16458935	17360325	18656337

Total Study	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	42,048,053	42,639,995	43,156,029	42,637,482	44,010,788	41,218,064	40,946,871	40,648,057	41,483,050	42,604,035
BASE CASE - 15% ROI	42,048,053	42,639,995	43,156,029	42,635,617	42,962,699	40,224,471	41,059,763	40,636,005	42,535,590	42,474,966
250-ACRE CASE	42,048,053	42,414,166	42,468,160	42,841,769	42,315,984	42,587,612	40,457,295	40,642,485	42,399,872	43,034,629
150-ACRE CASE	42,048,053	42,414,152	42,468,160	42,615,582	42,300,736	40,215,935	40,912,774	41,078,050	40,948,735	42,540,129
75-ACRE CASE	42,048,053	42,585,931	42,299,479	42,471,218	41,952,051	39,749,032	41,382,290	41,091,401	42,453,576	41,104,881
35-ACRE CASE	42,048,053	42,218,675	42,227,935	41,314,107	39,057,555	38,741,217	40,056,881	40,228,027	41,129,535	40,450,578

Table F-1

Weighted Average Wholesale Electricity Price (Lambda Cost)
(Constant 2001 Dollars per MWHr)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 2										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 3										
BASE CASE - 10% ROI	25.86	18.17	17.68	17.67	18.69	19.14	18.71	20.34	20.78	21.49
BASE CASE - 15% ROI	25.86	18.17	17.68	17.68	18.62	18.59	18.69	20.64	20.82	21.98
250-ACRE CASE	25.86	18.42	17.47	17.60	18.83	18.36	18.86	20.71	20.90	21.73
150-ACRE CASE	25.86	18.42	17.47	17.58	18.81	18.79	18.62	20.59	21.00	21.58
75-ACRE CASE	25.86	18.46	17.47	17.42	18.61	18.58	18.43	20.74	20.84	21.86
35-ACRE CASE	25.86	18.75	17.62	17.73	18.97	18.45	18.54	20.65	20.83	21.72

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 4										
BASE CASE - 10% ROI	24.21	18.17	17.64	17.67	17.65	18.14	17.73	0.00	0.00	0.00
BASE CASE - 15% ROI	24.21	18.17	17.64	17.68	17.61	17.59	17.74	0.00	0.00	0.00
250-ACRE CASE	24.21	18.42	17.43	17.59	17.80	17.39	0.00	0.00	0.00	0.00
150-ACRE CASE	24.21	18.42	17.43	17.58	17.79	17.79	17.69	0.00	0.00	0.00
75-ACRE CASE	24.21	18.46	17.43	17.42	17.67	17.58	17.51	0.00	0.00	0.00
35-ACRE CASE	24.21	18.75	17.61	17.71	0.00	0.00	0.00	0.00	0.00	0.00

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV C										
BASE CASE - 10% ROI	25.87	18.17	17.68	17.67	18.69	19.15	18.71	20.34	20.78	21.49
BASE CASE - 15% ROI	25.87	18.17	17.68	17.68	18.62	18.59	18.69	20.64	20.82	21.98
250-ACRE CASE	25.87	18.42	17.46	17.60	18.83	18.36	18.86	20.71	20.90	21.73
150-ACRE CASE	25.87	18.42	17.46	17.58	18.81	18.79	18.62	20.59	21.00	21.58
75-ACRE CASE	25.87	18.46	17.46	17.42	18.61	18.58	18.43	20.74	20.84	21.86
35-ACRE CASE	25.87	18.75	17.62	17.73	18.97	18.45	18.54	20.65	20.83	21.72

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WV E										
BASE CASE - 10% ROI	28.40	20.32	20.75	20.19	22.02	21.48	21.48	22.13	22.99	23.05
BASE CASE - 15% ROI	28.40	20.32	20.75	20.19	21.42	21.48	21.52	22.42	22.73	23.08
250-ACRE CASE	28.40	20.32	20.50	20.18	21.43	21.48	21.48	22.61	22.74	23.07
150-ACRE CASE	28.40	20.32	20.50	20.15	21.42	21.48	21.48	22.26	23.02	23.04
75-ACRE CASE	28.40	20.32	20.51	20.21	21.42	21.48	21.48	22.34	22.94	23.07
35-ACRE CASE	28.40	20.46	20.58	20.24	21.58	21.48	21.52	22.53	22.93	23.06

Table F-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	26.79	19.44	18.97	18.98	20.00	19.90	19.75	20.60	21.80	22.52
BASE CASE - 15% ROI	26.79	19.44	18.97	18.99	19.93	19.63	19.73	20.75	21.97	22.94
250-ACRE CASE	26.79	19.70	18.75	18.91	20.14	19.37	19.82	20.83	21.82	22.73
150-ACRE CASE	26.79	19.70	18.75	18.89	20.12	19.75	19.67	20.66	21.90	22.58
75-ACRE CASE	26.79	19.72	18.75	18.72	19.94	19.62	19.53	20.78	21.85	22.98
35-ACRE CASE	26.79	20.02	18.91	19.10	20.45	19.59	19.66	21.79	21.98	22.81

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	26.96	19.51	19.15	19.10	20.22	20.11	19.99	20.82	21.97	22.60
BASE CASE - 15% ROI	26.96	19.51	19.15	19.11	20.08	19.89	19.98	20.99	22.08	22.96
250-ACRE CASE	26.96	19.74	18.94	19.04	20.30	19.64	20.05	21.09	21.95	22.78
150-ACRE CASE	26.96	19.74	18.94	19.01	20.28	19.99	19.92	20.89	22.06	22.65
75-ACRE CASE	26.96	19.76	18.94	18.87	20.13	19.88	19.80	21.01	22.01	22.99
35-ACRE CASE	26.96	20.04	19.09	19.21	20.61	19.86	19.92	21.90	22.12	22.85

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	25.64	18.17	17.67	17.67	18.52	18.97	18.54	20.34	20.78	21.49
BASE CASE - 15% ROI	25.64	18.17	17.67	17.68	18.45	18.42	18.52	20.64	20.82	21.98
250-ACRE CASE	25.64	18.42	17.46	17.60	18.66	18.19	18.86	20.71	20.90	21.73
150-ACRE CASE	25.64	18.42	17.46	17.58	18.64	18.62	18.46	20.59	21.00	21.58
75-ACRE CASE	25.64	18.46	17.46	17.42	18.46	18.41	18.26	20.74	20.84	21.86
35-ACRE CASE	25.64	18.75	17.62	17.73	18.97	18.45	18.54	20.65	20.83	21.72

All VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	29	20	21	20	22	21	22	22	23	23
BASE CASE - 15% ROI	29	20	21	20	21	21	22	22	23	23
250-ACRE CASE	28.66	20.36	20.39	20.12	21.47	21.41	21.55	22.67	22.82	23.23
150-ACRE CASE	28.66	20.36	20.39	20.1	21.46	21.44	21.49	22.27	22.99	23.14
75-ACRE CASE	28.66	20.37	20.4	20.15	21.44	21.51	21.4	22.37	23.03	23.26
35-ACRE CASE	28.66	20.53	20.5	20.23	21.69	21.5	21.57	22.59	22.97	23.21

Total Study Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	27.46	19.71	19.59	19.38	20.76	20.54	20.46	21.35	22.35	22.76
BASE CASE - 15% ROI	27.46	19.71	19.59	19.38	20.45	20.37	20.49	21.58	22.34	23.01
250-ACRE CASE	27.46	19.87	19.35	19.33	20.61	20.17	20.56	21.71	22.27	22.93
150-ACRE CASE	27.46	19.87	19.35	19.30	20.60	20.44	20.42	21.44	22.39	22.81
75-ACRE CASE	27.46	19.89	19.35	19.23	20.49	20.38	20.31	21.55	22.39	23.06
35-ACRE CASE	27.46	20.14	19.48	19.49	20.92	20.40	20.49	22.11	22.41	22.96

Table G-1

Utilities' Environmental Clean-Up Capital Expenditures
(Constant 2001 Dollars)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY 1										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 2										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 3										
BASE CASE - 10% ROI	0	0	0	0	6,720,191	0	0	16,877,843	0	0
BASE CASE - 15% ROI	0	0	0	0	6,720,191	0	0	16,877,843	0	0
250-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
150-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
75-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
35-ACRE CASE	0	0	0	0	6,371,246	0	0	16,877,843	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
KY 4										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV C										
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WV E										
BASE CASE - 10% ROI	0	0	0	0	7,410,199	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	7,410,199	0	0	0	0	0
250-ACRE CASE	0	0	0	0	7,410,199	0	0	0	0	0
150-ACRE CASE	0	0	0	0	7,410,199	0	0	0	0	0
75-ACRE CASE	0	0	0	0	7,452,999	0	0	0	0	0
35-ACRE CASE	0	0	0	0	7,915,047	0	0	0	0	0

Table G-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	209,349	0	0	18,675,821	21,263,721	0	0	43,012,286	0	0
BASE CASE - 15% ROI	209,349	0	0	19,812,967	21,604,468	0	0	43,012,286	0	0
250-ACRE CASE	209,349	0	0	34,476,811	27,818,454	0	0	43,012,286	0	0
150-ACRE CASE	209,349	0	0	33,304,565	27,434,487	0	0	43,012,286	0	0
75-ACRE CASE	209,349	0	0	35,224,441	27,517,336	0	0	43,012,286	0	0
35-ACRE CASE	209,349	0	0	36,333,508	18,898,112	0	0	43,012,286	0	0

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	0	0	0	0	0	0
BASE CASE - 15% ROI	0	0	0	0	0	0	0	0	0	0
250-ACRE CASE	0	0	0	0	0	0	0	0	0	0
150-ACRE CASE	0	0	0	0	0	0	0	0	0	0
75-ACRE CASE	0	0	0	0	0	0	0	0	0	0
35-ACRE CASE	0	0	0	0	0	0	0	0	0	0

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	209,349	0	0	18,675,821	28,673,921	0	0	43,012,286	0	0
BASE CASE - 15% ROI	209,349	0	0	19,812,967	29,014,668	0	0	43,012,286	0	0
250-ACRE CASE	209,349	0	0	34,476,811	35,228,653	0	0	43,012,286	0	0
150-ACRE CASE	209,349	0	0	33,304,565	34,844,687	0	0	43,012,286	0	0
75-ACRE CASE	209,349	0	0	35,224,441	34,970,336	0	0	43,012,286	0	0
35-ACRE CASE	209,349	0	0	36,333,508	26,813,158	0	0	43,012,286	0	0

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	6,720,191	0	0	16,877,843	0	0
BASE CASE - 15% ROI	0	0	0	0	6,720,191	0	0	16,877,843	0	0
250-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
150-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
75-ACRE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0
35-ACRE CASE	0	0	0	0	6,371,246	0	0	16,877,843	0	0

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	0	0	0	0	5,784,523	0	0	28,658,885	0	0
BASE CASE - 15% ROI	0	0	0	0	5,458,247	110,240	3,594	11,802,724	0	0
250-ACRE CASE	0	0	0	0	5,581,295	0	111,617	28,658,885	0	0
150-ACRE CASE	0	0	0	0	5,581,295	0	111,617	15,501,091	0	0
75-ACRE CASE	0	0	0	0	5,354,984	110,134	3,594	29,000,638	0	0
35-ACRE CASE	0	0	0	121,153	4,563,160	7,455	0	21,586,819	0	0

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASE CASE - 10% ROI	209,349	0	0	18,675,821	41,178,634	0	0	88,549,014	0	0
BASE CASE - 15% ROI	209,349	0	0	19,812,967	41,193,105	110,240	3,594	71,692,853	0	0
250-ACRE CASE	209,349	0	0	34,476,811	47,530,138	0	111,617	88,549,014	0	0
150-ACRE CASE	209,349	0	0	33,304,565	47,146,172	0	111,617	75,391,220	0	0
75-ACRE CASE	209,349	0	0	35,224,441	47,045,510	110,134	3,594	88,890,767	0	0
35-ACRE CASE	209,349	0	0	36,454,660	37,747,564	7,455	0	81,476,948	0	0

Table H-1

Electricity Capacity Capital Investments by Type
(Constant 2001 Dollars)

		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
		MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $
BASE CASE - 10% ROI																					
VA	CC	0	0	0	0	288	115,392,000	365	146,052,000	364	145,548,000	384	153,592,000	394	157,736,000	591	236,376,000	0	0	561	224,284,000
VA	GT	0	0	1,183	295,707,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0
BASE CASE - 15% ROI																					
VA	CC	0	0	0	0	288	115,392,000	365	146,052,000	364	145,548,000	384	153,592,000	394	157,736,000	541	216,376,000		0	561	224,284,000
VA	GT	0	0	1,182	295,457,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0
250-ACRE																					
VA	CC	0	0	0	0	291	116,512,000	365	145,992,000	364	145,552,000	384	153,592,000	394	157,736,000	541	216,376,000		0	561	224,284,000
VA	GT	0	0	1,179	294,792,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0
150-ACRE																					
VA	CC	0	0	0	0	291	116,512,000	365	145,992,000	364	145,552,000	384	153,592,000	394	157,736,000	541	216,376,000		0	561	224,284,000
VA	GT	0	0	1,179	294,792,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0
75-ACRE																					
VA	CC	0	0	0	0	291	116,512,000	365	145,992,000	364	145,552,000	384	153,592,000	393	157,336,000	541	216,376,000		0	561	224,284,000
VA	GT	0	0	1,179	294,792,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0
35-ACRE																					
VA	CC	0	0	0	0	292	116,736,000	365	145,984,000	364	145,552,000	384	153,592,000	394	157,736,000	530	212,148,000		0	564	225,796,000
VA	GT	0	0	1,179	294,657,500	0	0	0	0	0	0	0	0	0	0	0	0	7	1,745,000	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0

Table I-1

Major Coal Mine Direct Operating Costs by Category
For Entire Study Area

	Deep Mines $/Ton	Surface Mines $/Ton
Labor	$6.24	$4.30
Materials/Supply	$3.79	$8.36
Trucking	$1.12	$1.58
Coal Washing	$2.90	$0.40

Table J-1

Average U.S. Wholesale Electricity Price (Lambda Cost)
(Constant 2001 Dollars per MWHr)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Base - 10% ROI	37.25	22.54	22.44	22.32	23.11	22.22	22.32	23.15	23.51	24.00
Base - 15% ROI	37.25	22.54	22.44	22.32	23.06	22.19	22.33	23.30	23.65	24.12
250-Acre	37.25	22.63	22.33	22.24	23.09	22.12	22.36	23.40	23.66	24.12
150-Acre	37.25	22.63	22.33	22.25	23.10	22.19	22.28	23.34	23.64	24.06
75-Acre	37.25	22.64	22.34	22.26	23.07	22.17	22.12	23.41	23.64	24.12
35-Acre	37.25	22.78	22.40	22.27	23.27	22.20	22.30	23.36	23.58	24.15

Final Report

Contract No. CT212142
Sponsoring Agency: U.S. Department of the Interior, Office of Surface Mining
Project: Coordinated Review of Mountaintop Mining/Valley Fill EIS Economics Studies
Contractor: Hill & Associates, Inc.

Date: January 13, 2003

I. Background

The purpose of this study is to provide support, through funding by the Office of Surface Mining (OSM), for the multi-agency Mountaintop Mining/Valley Fill Environmental Impact Statement (MTM/VF EIS) Steering Committee in performing a coordinated review of prior economics studies done during the development of the MTM/VF EIS. Early in 2002 the Steering Committee determined that the prior work done for Phase I of the economic impacts studies had problems which resulted in substantial limitations on its use in further analysis. Since that work was used as input for the coal and electricity markets modeling of Phase II, the results of this economic modeling were deemed questionable.

This current study seeks to answer the question ***"In what direction and by approximately what magnitude would the economic modeling results of Phase II change if a different set of Phase I inputs, drawn from on-the-ground, real-world mining experience to date, were used?"*** Since it is specifically defined as a true sensitivity study, this current work is carefully designed to change nothing from the previous work except the modeling inputs that were considered to have problems from the previous Phase I work. Since it was not known exactly how these inputs would be changed until partially through the project, all work was done with step-by-step close review and coordination by the OSM Contracting Officer's Technical Representative (COTR), with EIS Steering Committee concurrence at certain key decision points.

It is important to note that this work was commissioned solely as a sensitivity study. It does not attempt to cover all of the scenarios of the previous work. Nor does it provide all of the market interpretations in the earlier study. Rather, it is designed to point directions and very rough magnitudes of output change resulting from input change.

As with the previous work, all coal tons (and related parameters) in this report are steam coal tons (arising from the modeling of the steam coal markets) and do not include about 40 million annual tons of metallurgical coal produced in the region. Since the vast majority of these met coal tons are produced by underground mining, which is assumed unaffected in this study, the various impacts of valley fill restrictions on coal tonnage are the same without including the met coal tonnage.

Although this report is intended to effectively communicate the sensitivity results on a stand-alone basis, it is expected that most readers will have read the earlier report (see draft MTM/VF EIS, Appendix G), dated December 12, 2001, (under EPA Contract No. 68-R3-01-04) which is the comparison basis for the sensitivity work. In particular, this current report does not attempt to capture all of the explanatory detail concerning the Hill & Associates market models that was included in the earlier report. However, where necessary to interpret the new results from the sensitivity model runs, the same previous mining cost curve logic will be used and even extended in this report.

Since this study is presenting sensitivity results compared to previous work, it will be necessary frequently to refer to that earlier work. Throughout the remainder of this report, the words "old," "previous," and "earlier" when applied to computer model runs or their results will indicate that we are talking about the work done during 2001 under EPA Contract Number 68-R3-01-04 and included in the report dated December 12, 2001.

II. Methodology

Work under this contract was broken into four segments:

A. During the initial segment of work, a "kickoff" meeting was held in Charleston, West Virginia, on October 17, 2002, to present to stakeholder representatives an overview of the previous economic impact work and the limitations of the analyses and results. Representatives from the environmental community, the coal mining industry, academia and various governmental agencies were in attendance. Although feedback was solicited at this meeting, a combination of confidentiality considerations and complexity of the presented material resulted in a lack of detailed quantitative suggestions for adjusting the modeling input parameters for any subsequent modeling.

B. In anticipation of this lack of detailed feedback in a large group setting instantaneously after being exposed to the analytical methodology, the second segment of work involved follow-up meetings with various stakeholder representatives. Reflecting the diversity of attendees at the original "kickoff" meeting, we held follow-up discussions with members of the environmental community, representatives from academia, governmental agency personnel, and technical representatives from the coal mining industry. In the case of coal mining industry representatives, these follow-up meetings were held one company at a time under strict confidentiality agreements since it was necessary to discuss extremely detailed mining costs, which are among the most competitively sensitive pieces of information in the industry. Results from these follow-up meetings are reported later in this report on a non-confidential aggregated basis.

C. The third segment of work involved the actual re-running of the economic market models using the same setup as the 2001 earlier project except for the more real-world oriented front-end input related to indications of reserve, capacity and cost impacts of valley fill limitations derived from stakeholder discussions. Stakeholder information was synthesized and interpreted base upon Hill & Associates professional experience to create new input assumptions as described further in this report. The resultant new modeling outputs, and their comparison to the earlier results, form the heart of the "Results" section of this report.

D. The final work segment of this contract involved interpretation and presentation of the sensitivity results in this report format.

II.A. Modeling Scenarios

Due to time and budget limitations, the sensitivity modeling was limited to 20 single-year convergences of the Hill & Associates modeling system. (The reader is referred to the earlier report in Appendix G of the MTM/VF EIS for a full discussion of how these models work.) Originally, this contract effort envisioned two selected scenarios, each containing ten consecutive years parallel to selected scenarios from the previous work. Each of the 10-year scenarios would test different sets of changes in the input parameters, with those sets of changes designed from the Hill & Associates synthesis of stakeholder input.

However, the MTM/VF EIS agencies decided that the 20 single-year model convergences (which must be run consecutively, in a calendar sense, because the models accumulate effects such as clean-up equipment installation and mine reserve depletion from one year to the next) would be best spread over three scenarios as follows:

Scenario #1: A 10-year model run (2002 – 2011) with valley fills limited to 75-acre watershed size. All parameters remained the same as earlier 75-acre runs except for the specific reserve, capacity and cost input changes for surface mines to replace the previous Phase I parameters.

Scenario #2: A 5-year model run (2002 – 2006) with valley fills limited to 250-acre watershed size. Again, all parameters remained the same as earlier 250-acre runs except for the specific reserve, capacity and cost input changes for surface mines to replace the previous Phase I parameters.

Scenario #3: Another 250-acre watershed size 5-year run (2002 – 2006), but with the valley fill restrictions phased in over the first three years instead of occurring instantaneously in the first year. Also, the required discounted cash flow return on investment (ROI) necessary to cause new mining capacity to be built was raised from 15% to 20% to reflect the growing reluctance to invest under the changing valley fill/watershed rules. Thus, this third scenario has two additional sensitivities included: the phase-in of valley fill restrictions and the "reluctance-to-invest" higher required ROI.

The rationale behind the definition of these scenarios, along with the specifics of the input parameter changes, is included in the "Results" section below.

However, it is important to carefully note at this point that ALL of these model runs continue to assume that deep-minable coal reserves will be totally unaffected by the valley fill restrictions. Hill & Associates was specifically instructed by the EIS Steering Committee not to include any impacts on existing deep mining (i.e., it is "grandfathered") or on future new deep mining. This "simplifying assumption" was deemed necessary in order to make the economic studies portion of the EIS consistent with the other portions of the overall EIS, which do not include any deep mining impacts. Hill & Associates was asked to include the statement in this report that the EIS agencies note that this [assumption of no deep mining impacts] is not a statement of policy, but merely an assumption to clearly isolate the effects of surface mining restrictions.

Despite this rationale for the assumption, we must point out that this methodology of assuming absolutely no impact on deep mining DOES have a significant impact on the modeling results and their interpretation. Overall regional economic impacts will depend largely on loss of total coal production plus the related employment loss. Since deep mined tonnage is a larger portion of total production in Central Appalachia than is surface production, any impacts on deep mined tonnage may affect the total of production even more than impacts on surface tonnage. Furthermore, since deep mining is more labor intensive than surface mining, ignoring deep impacts has even a larger impact on employment results than on tonnage. Thus, the apparent impacts of the new fill placement restrictions (under an assumption of no deep mining impacts) appear less significant than they would if this larger, more labor-intensive segment of total production were assumed to be affected in these model runs.

While we are mentioning items that are not included in this analysis, we note that this work does NOT analyze or interpret results of the injunction to preclude issuing CWA Section 404 permits for valley fills imposed on the U.S. Army Corps of Engineers Huntington District by the Federal District Court in West Virginia which, at the time of this writing, has effectively stopped the issuance of CWA Section 404 permits for valley fills (Rivenburgh v. Kentuckians for the Commonwealth, also known as "Haden II"). Nor does this current work consider or include "stream mitigation" costs that may be imposed by the U.S. Army Corps of Engineers in order to attain Clean Water Act Section 404 (CWA 404) authorization. Both the injunction and CWA 404 mitigation costs would likely have a significant effect on coal mining viability in the study area. However, it is beyond the scope of this contract to consider these input variables.

The method of presenting and interpreting the scenario results will be to graph them, along with the corresponding scenario results from the previous work on the same axes, and then to note the differences between the graphs as reflecting the sensitivity to changing the input parameters. In other words, the original 75-acre modeling results will be plotted alongside the new 75-acre results, and we can see the amount of change caused by the revised inputs.

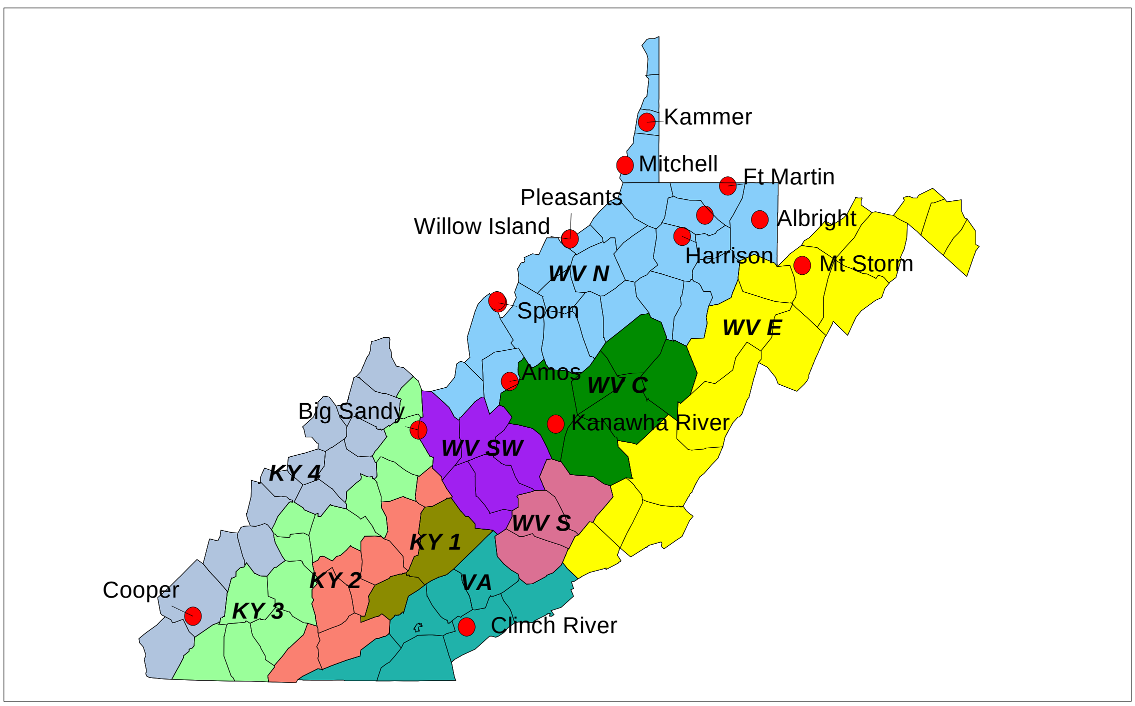
In all cases, the original baseline forecast at 15% required ROI, which matches all scenarios except Scenario #3 above, is also included on the graphs. This Base Case was specified by the EIS Steering Committee to represent pre-restriction conditions for Central Appalachian surface coal mining. Thus, the report allows comparison of production changes from the Base Case for "Old" and "New" modeling runs (e.g., "Old" 75-acre tonnage loss versus "New" 75-acre tonnage loss, or "Old" 250-acre to "New" phased in 250-acre).

III. Results

Since the new model runs do, in fact, produce all of the detailed data output for each year as did the previous model runs from the earlier work in 2001, similar detailed Appendices are contained in this report. Obviously, where a scenario stops after 5 years, the appropriate appendix table will simply have blanks for the second 5 years of the 10-year general project time horizon.

Figure 1 presents the mining sub-regions of the study area. The detailed data results in the Appendices are organized around these sub-region definitions, with totals at the bottom of each table. As the map shows, there are five mining sub-regions in West Virginia, four in eastern Kentucky and one in Virginia.

Figure 1 – Sub-Regions of the Study (With Power Plants)



However, despite the inclusion of this sub-regional detailed output in the Appendices, the remainder of the commentary in this report will focus on the much more generalized sensitivity directions and rough magnitude of output changes (due to the changed inputs) for the total study area.

III.A. Findings from Individual Stakeholder Meetings

Shortly after the initial "kickoff" meeting of this project, a team of technical specialists from Hill & Associates made separate visits to individual coal mining companies to research actual "on-the-ground" impacts experienced and projected due to valley fill restrictions. Coal producers representing approximately 60% of the affected surface mine tonnage in southern West Virginia and eastern Kentucky were visited.

Since these meetings were to be held under strict confidentiality agreements, some concern was expressed at the initial "kickoff" meeting in Charleston, WV, regarding whether bias might exist in the quantitative information that would be conveyed in these meetings. As a design safeguard against any possible bias, the Hill & Associates team adopted the following three-pronged cross-check of the quantitative information obtained on the visits to coal producing companies:

1. Using mining engineering, geological and financial analysis expertise from members of the interview team, we asked very detailed questions about the sub-pieces of the numbers presented to validate information. For example, if a higher cost of mining was presented under a valley fill restriction, we asked for the sub-pieces of that higher cost and engaged in detailed discussion of why a particular sub-piece of cost, such as transportation of overburden to an alternate disposal area, would be that high and how it was calculated or measured. We would not leave this detailed questioning of sub-pieces until we felt we understood the numbers and that they "rang true" with our expertise and past experience.

2. Where an "after valley fill restriction" number was presented, we would ask to examine the exact corresponding "before valley fill restriction" number and compare the two. This allowed us to examine original monthly mine cost sheets, for example, or reserve calculations from periods before the mine had to be reconfigured to accommodate the loss of particular valley fills. In this manner, we could easily determine that the same methods of measurement and calculation were used for both the current numbers and the historic numbers.

3. After examining in detail a particular property that had been prepared for presentation to us to illustrate the valley fill restriction impacts, we would then ask to see actual data on another random unprepared property that was not as strongly affected by the valley fill restrictions. Often, this required the staff at the coal producing company to pull maps, mine cost sheets, reserve calculations, etc, from filing cabinets in adjoining rooms to get all of the information on this

random other property (that we often pre-selected before the visit, based upon our knowledge of the mines of the company).

This three-pronged, cross-check approach allowed us to examine all quantitative information from several different directions and test whether there appeared to be any bias (no matter how unintentional) in the numbers. In no case did we see any bias in the numbers, and we concluded our series of mine visits with a very strong feeling that we were given exactly the same internal costs and reserve/capacity numbers that the coal producers themselves were using to make operational decisions and capital investment decisions.

Furthermore, although each coal producing company has its own unique procedures and measurement techniques (which cause some differences in the meaning and interpretation of any single number), we came away with the conclusion that each producer with whom we had discussions was using technically appropriate and reliable methods of measuring and calculating their costs and capacities and of estimating their reserves. It was our task, not theirs, to adjust all of these numbers onto a common basis and to synthesize them into a set of parameters to use as new modeling inputs affecting reserves, capacities and mining costs at different types of mines under various valley fill restriction levels.

Stakeholder Feedback

General qualitative findings from our stakeholder interviews include:

- Careful review of numerous mining property maps at each of several coal producing companies supports a conclusion that there is much more difference between the topography of eastern of Kentucky and the topography of southern West Virginia than our earlier work assumed. Generally, the eastern Kentucky surface mining properties have smaller, but more numerous, valleys (including smaller watershed drainage) than do the southern West Virginia properties. This is important because a 250-acre watershed valley fill limitation affects many surface properties in West Virginia but extremely few in eastern Kentucky. However, below about 100-acre watershed size, the number of affected eastern Kentucky properties rises dramatically. Thus, even for the same type of surface mine using similar equipment, the model should use different reserve, capacity and cost adjustments in eastern Kentucky than those used in southern West Virginia (with Virginia being more similar to eastern Kentucky). In addition to geologic and topographic causes, these differences appear also to be related to variable mineral and surface ownership patterns across state lines and the size of remaining reserve blocks.

- We received strong input from the mining community that it is an egregious mistake to ignore impacts of the valley fill limitations on deep mines, especially new ones. First, many deep mines are co-dependent on related surface mines for quality blending requirements and even economic averaging arrangements.

Eliminating or reducing the surface mining has a direct impact on the viability of the deep mining in these instances. Second, the typical reject rate in Central Appalachia from a wash plant associated with a deep mine is about 50%. Thus, for every one ton of coal mined, one ton of refuse is placed in a valley fill or related impoundment. In fact, the valley fills associated with wash plant refuse are generally among the larger valley fills associated with coal mining (with generally larger watershed) but are fewer in number than surface mining valley fills. Third, the construction of a new deep mine involves other valley fill issues. Often, a new deep mine is accompanied by a new wash plant with a new valley fill for refuse. Plus, in order to "face up" the entrances to the new deep mine, a new valley fill for the mine entrance is typically needed. Collectively, industry representatives commented that it was disingenuous to think that any valley fill restrictions related to surface mining refuse would not be very quickly extended to deep mining refuse.

- During our stakeholder interviews, selected environmental community representatives expressed concern over the fact that the methodology of these economic studies does not include "ecological economics," which consider the "total cost of mining" as it is defined by many in the environmental community. Factors such as "loss of communities" and "value of the ecosystems services lost" are not being monetized into the hard dollar economics, in their view. One environmentalist commented that as long as studies such as these continue to rely on "the inadequacies of old-school economics" which deal only with whether the coal can be economically extracted, many in the environmental community would consider the approach to be patently absurd. In a telephone conversation, the opinion was expressed that "reducing this [study] to simple economics is a terrible injustice to the long-term health of our environment and life as we know it." While we at Hill & Associates are familiar with the concept of including "externality costs" (a monetary value assigned to some environmentally-desired outcome) in economic calculations, we indicated in our discussions with the environmental community representatives that we always perform our economic analyses according to the more classical, or traditional, methodology.

- During discussions with mining company representatives, input on the "reluctance to invest" issue was elicited in a manner carefully structured to avoid biasing the answers. Neutral questions were posed about the capital allocation to company projects (or, in the case of smaller companies, discussions centered on dealings with lenders who finance their new mining capacity projects). For instance, a neutral question would be raised such as "If you had a new mine project that could be designed to fit within these new valley fill restrictions and still show good economics by hitting your classical ROI target rate (but not way above it), would the decision-making process be the same today as it was 3 or 4 years ago?" In almost every case, a negative response occurred, ranging from "We know not to even submit one that is not significantly better than our traditional ROI 'hurdle' rate – It wouldn't get approved," to the more succinct "Our management definitely requires a risk premium to invest in this area today," to the even more concise "I'm trying to figure out what kind of work I'll be doing after we close down all these mines." Our conclusion was that there is clearly developing a definite reluctance to invest in this area, due to the perception of a hostile regulatory environment. This conclusion was instrumental in designing a portion of Scenario #3 described above.

Now we turn to the more quantitative findings from our stakeholder interviews. The previous study's methodology focused on county-level reduction percentages, with all surface mines in a given county reduced (in the modeling) by the same percentage both for reserves and for annual production capacity. Furthermore, no cost increases at individual mines were included in the previous study when the mining techniques were changed for the residual mining after the county-wide reduction percentage was applied. Although there was a recognition that costs at the residual mine would likely increase due to less efficient mining methods extracting remaining reserves and associated equipment costs, Steering Committee members indicated that no real research into this issue had yet been accomplished and there was no quantitative basis (at the time the previous modeling was started) for establishing a reliable estimate of individual cost increases.

By contrast, the individual stakeholder interviews of this current study resulted in recognition that (1) instead of applying reduction percentages by county, more realistic reductions for reserves and capacity would occur by type of mining (i.e., dragline mines experience one level of reduction, shovel & truck mines another reduction, front end loader operations yet another, etc.), (2) there should be different reduction percentages for reserves and capacity within each mine type category since reserves are generally reduced more than is the annual production capacity, and (3) cost increases at the residual mine (after reductions) occur and are easily quantified based on recent experience under existing CWA 404 250-acre watershed restrictions.

With regard to "1" above, it is important to note that the modeling approach is still "generic" in applying reduction factors to all members of a mining type group, but the new grouping definitions (by mine type) are more homogeneous than the previous grouping of various surface mine types in the same county. Thus, although any generic factor approach is almost guaranteed to be a little too high or too low at any selected point, the amount of these individual point errors (from reality) is much smaller when the grouping class is more homogeneous.

With regard to "3" above, the cost increases arise from two factors. First, depending on the mine type, actual changes and/or additions of equipment are often necessary as certain portions of the coal become unminable. The changed or added equipment raises the cost of mining (i.e., if it didn't, then the original mine plan would have utilized this approach). Second, even with the same type of equipment, the mix of less-expensive versus more-expensive operations often changes dramatically under the valley fill restrictions. For example, the amount of inexpensive "dozer push" may be reduced while the amount of higher-cost truck haul to a more distant site may be increased as the toe of a valley fill is designed higher up the valley to limit the amount of watershed. Relatively speaking, sites previously designed to use draglines were impacted the most; shovel jobs were impacted to a lesser degree; and properties utilizing front-end loaders were impacted to even less.

Reduction percentages and cost increases for each mine type are not presented in this report since that would violate our confidentiality agreements in those cases where there are only one or two mines in a category within a state. Rather, statewide aggregated numbers including all mine types are presented, even though separate factors for each mine type were applied. These statewide aggregations are further combined into averages for the total study area. To compare the amount of change in results from earlier inputs versus those used in this study, the aggregated averages for the total study area from the previous work will also be presented.

Mining Cost Adjustments

As previously mentioned, Hill & Associates did not increase individual mine costs (for residual mining after reserve and capacity reductions) in the earlier modeling scenarios of valley fill restrictions. The Steering Committee agreed that not enough data existed to accurately quantify those cost changes at that time. However, in this study, interviews with mining companies in Central Appalachia provided data indicating ranges of cost increases for compliance when valley fill restrictions are put in place. The costs increase for the following reasons:

Increased Trucking Distances
As the size of the fills is restricted and more fills are used, trucking distances to disposal areas increase.

Loss of Less-Expensive Dozer Push Yards
Many of the surface mines in West Virginia and Kentucky are designed to maximize the amount of overburden material that can be pushed directly into valley fills with bulldozers. This type of mine design takes advantage of the fact that pushing rock with a bulldozer is much less expensive than picking it up and moving it in rock trucks.

The material that can be moved with bulldozers is located on the flanks of the valley fills. As the fill size is decreased, the linear distance along the sides of the fills is decreased; less of the total material can be directly pushed into the fill and must be trucked.

There are two ways that valleys can be filled - from the top down or from the bottom up. The state of West Virginia is now considering a change in the mining law to eliminate the option of filling valleys from the top. If this legislation were to pass, no companies would be able to push material in from the sides. However, in these scenarios, we assume that producers will still be able to fill in the more economic manner.

Inability to use Larger Equipment
The valley fill restrictions reduce the amount of minable reserves available on most properties. In both the 250- and 75-acre cases, the active draglines would be idled and mining conducted by smaller equipment -- either a shovel or front-end loader spreads. The cost to move a cubic yard of material with a shovel is more expensive than to move a cubic yard of material with a dragline. Likewise, costs are even greater to move overburden with front-end loaders. Furthermore, the smaller equipment cannot extract coal available deeper in the hillside, and fixed costs must be spread over a smaller number of tons. Therefore, as equipment size is decreased, both the variable cost per ton and the fixed cost per ton tend to increase.

Construction of Additional Sediment Control Ponds
As companies replace fewer larger fills with many smaller fills, sediment control ponds must be constructed to control runoff in each additional watershed affected by the fills.

The following table shows the weighted average cost increases for surface mines by state.

Table 1
Weighted Average Surface Mine Cost Increases

Region	250 Acre Case	75 Acre Case
West Virginia	12.8%	25.1%
Eastern Kentucky	2.2%	4.6%
Virginia	0.0%	1.3%
Total Study Area – New	7.7%	13.7%
Total Study Area – Old	0.0%	0.0%

<u>Reserve Reductions</u>

In the original study, RTC provided a spreadsheet to Hill & Associates with estimates of recoverable reserves for the unrestricted case and each of the restricted valley fill scenarios for each of the counties in West Virginia. Hill & Associates then applied the percentage reductions to all surface mine properties on a county-by-county basis. The following table shows the percent reserve reduction by state that resulted from our adjustments on the basis of mine type for the new modeling runs.

Table 2
Weighted Average Surface Mine Reserve Reductions

Region	250 Acre Case	75 Acre Case
West Virginia	32.3%	63.4%
Eastern Kentucky	5.0%	15.2%
Virginia	0.0%	10.0%
Total Study Area – New	21.7%	45.0%
Total Study Area – Old	17.3%	46.0%

Capacity Reductions

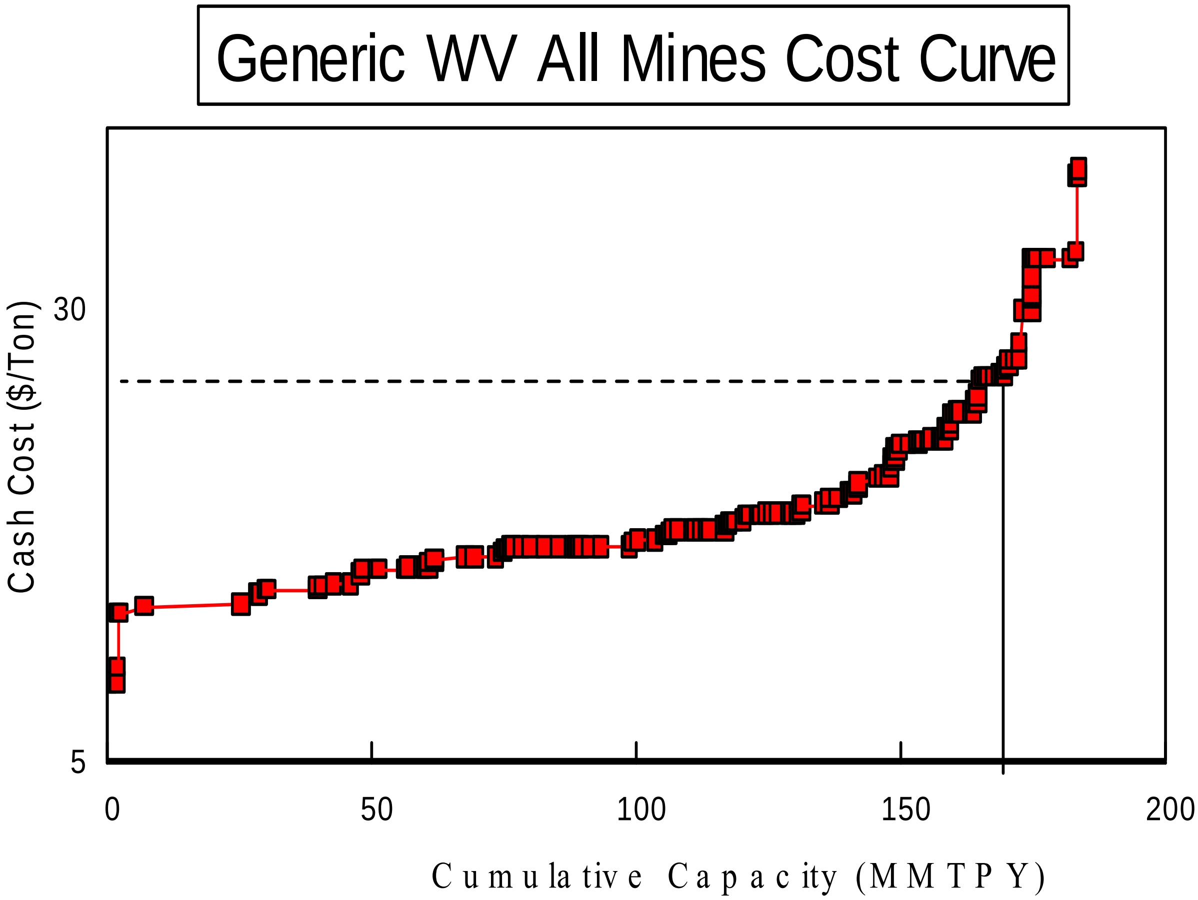
In the original study, Hill & Associates assumed, on average, that the capacity to produce coal would be reduced by the same proportion as the reserve reductions of each scenario. In this set of model runs, the production capacity was not reduced by nearly as much as the reserves. Using information from stakeholders, we used our professional judgment to derive the applied adjustments. Overall, the life of the mine is more strongly affected than is capacity.

Table 3
Weighted Average Surface Mine Capacity Reductions

Region	250 Acre Case	75 Acre Case
West Virginia	37.9%	50.8%
Eastern Kentucky	0.0%	10.0%
Virginia	0.0%	5.0%
Total Study Area – New	20.4%	31.6%
Total Study Area – Old	17.3%	46.0%

Without careful reflection, these tables can be misleading. In particular, comparing the "New" with the "Old" for the total study area indicates that the reserve and capacity reductions are only modestly higher in the "New" 250-acre setup and are actually somewhat lower in the "New" 75-acre case. However, this aggregated total does not capture the fact that the reductions were more uniformly distributed across any individual mine curve in the "Old" modeling runs. For the purposes of this discussion, the generic mining cost curve used in the previous study is presented below to explain some modeling parameters.

Figure 2



For example, a large dragline mine with low cash costs per ton is very low on the cost curve. A much smaller contour stripping operation (using front end loader equipment) is typically in the middle of the curve or even toward the upper portion. In the original study, as long as both of these mines were in the same county, they would both have the same reduction factors applied to them. Thus, the impacts tended to be distributed across the entire curve in the previous study.

Now, however, the dragline operation in this current study will have much larger reduction factors (determined for the entire class of dragline operations) applied to it, while the front end loader operation's reduction factors will be smaller. Thus, the impact of the "average" reductions shown in Table 1 above tend to fall more heavily on the lower cost side of the curve in the "New" runs of this study. That is important because it steepens and "raises" the curve more than in the "Old" runs, which makes the coal generally less competitive in the economic marketplace.

In addition to this rise in the upper part of the curve due to the "horizontal" compression (in a graphical sense in Figure 2) of capacity lower in the curve, these "New" runs have an additional vertical rise (in the graph) of certain points, due to the cost increases of the affected surface mines. Again, these cost increases will fall more heavily on the lower portion of the curve, since the dragline and shovel & truck types of mines tend to fall in this portion, and they experience higher cost increases than the "averages" shown in Table 1.

Because of the shifts, the upper portion of the curve (where demand crosses the curve and determines the market clearing price for the coal) can easily be raised an additional $4.00-$5.00 per ton for a West Virginia cost curve in the "New" 75-acre case. This rise, coupled with the "horizontal capacity compression" induced rise in the curve (which can add another few dollars), can easily make the coal much less competitive in the energy marketplace compared to other coals such as foreign coal imported into the U.S., Powder River Basin coal, or even compared to gas-fired electricity generation.

It is important to note that although costs at the upper portion of the mining cost curve can rise by several dollars per ton, this does not necessarily mean that coal prices will rise that much. In fact, demand tends to slide to the left (on a steeper, raised version of Figure 2) to a new competitive "balance point" that may still be a couple of dollars higher, but it is at a lower total of produced tonnage. Thus, there is a trade-off between lost tonnage and higher prices (due to higher costs) until a new market equilibrium point is reached.

State Comparisons

In the original study, RTC did not have detailed coal seam databases for Virginia and Kentucky, like the one used to calculate reserves in West Virginia. Therefore, RTC made comparisons of topography, slopes and drainage patterns in each of the coal-producing counties for eastern Kentucky and Virginia and selected the county in West Virginia that most closely resembled these characteristics. Hill & Associates then used this table of comparable counties as a guide to make reductions of surface reserves in Kentucky and Virginia counties. As an example, if the RTC listing showed that the topographic characteristics of Pike County, Kentucky resembled those in Mingo County, West Virginia – more than it did any of the other county in West Virginia, then Hill & Associates applied the same percentage reductions to Pike County that were used for Mingo County.

In this sensitivity analysis, Hill & Associates made adjustments to the Virginia and eastern Kentucky mines in our database according to information gathered during mine visits with producers. In addition, we weighed the adjustments with information from the OSM valley fill inventory conducted by various state agencies as part of the draft MTM/VF EIS.

In Kentucky, most of the valley fills are 100 acres or less. Only a few of the surface mines have large valley fills. We assumed that only the largest mines in Kentucky (i.e., those that produce over 1.5 million annual tons) would have significant impacts in the 250-acre scenario. Impacts to mines producing less than 1.5 million tons in Kentucky had only slight adjustments for cost, capacity and reserves at the 250-acre level. The smaller mines began to feel impacts as valley fills were restricted to 75 acres of watershed.

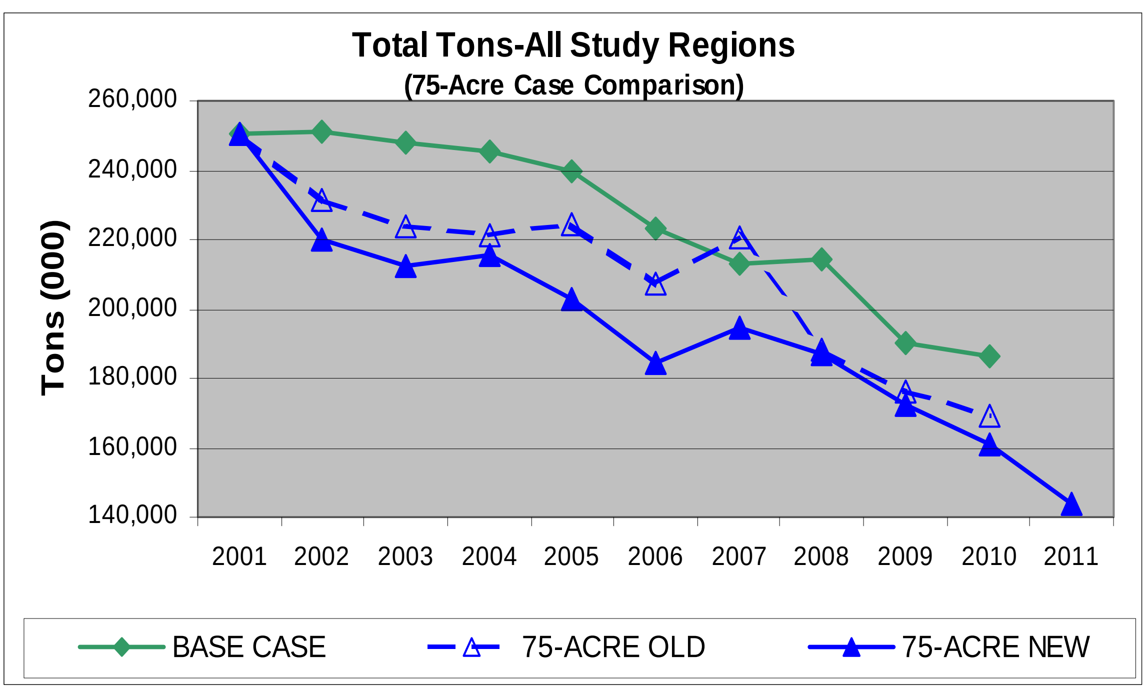
In Virginia, valley fills are even smaller than in eastern Kentucky. The surface mines there are smaller than those in other parts of Appalachia, produce less excess spoil and have more options for spoil placement other than stream valleys. Most of the spoil material is back hauled to the mining pit or placed at sites that were mined prior to SMCRA, thus requiring fewer valley fills. Also, very few mines in this area are able to use cast blasting to move overburden.

III.B. Results of the Sensitivity Modeling

75-Acre Case Production Shifts

The 75-acre case sensitivity to the new inputs (i.e., Scenario #1 defined above) results are shown on Figure 3. This figure graphs the total tons by year from the entire study region for the "Old" and the "New" 75-acre runs, as well as showing the pre-lawsuit status quo Base Case for comparison.

Figure 3



As indicated in the legend, the top line is the Base Case, the dashed line is the "Old" 75-Acre Case, and the bottom line is the "New" 75-Acre Case. Three things are immediately apparent from the graph.

First, the new adjusted model inputs (for surface mining only) cause the total production from the study area (including both surface and deep tons) to drop below the Base Case more than the "Old" 75-Acre results. Instead of falling a somewhat erratic 10-20 million annual tons below the Base Case (see the report from the previous study in the MTM/VF EIS Appendix G for a description of the causes behind the erratic "bouncing" of the "Old" results), the "New" case tends to be a somewhat more consistent 30-40 million annual tons below the Base Case. As the general decline of Central Appalachian tonnage in all cases continues (due to the declining reserve base in the region) from roughly 250 million annual tons through the 200 million annual level, this valley fill restriction impact represents approximately 15%-20% of the total production from the area.

Second, the amount of "bouncing" in the curve is somewhat less in the "New" case. This indicates that as price signals from the marketplace show a need for investment in new capacity, there is simply less available from which to draw, and we see less of the "surge that cannot be sustained" phenomenon than in the "Old" case.

Third, the last two or three points on the "New" graph appear to establish a significant trend heading substantially lower than the other two cases. This is probably due to exhaustion of the "mid-cost" deep reserves within ten years. To be sure, the deep reserves are exhausting at about this same rate in all the cases (including the Base Case) since the bottom section of Appendix Table A-3 shows that deep production is relatively unchanged across all of the cases. However, in both the Base Case and the "Old" 75-Acre case, there are more expandable surface reserves at lower segments of the cost curve (since costs were not raised in these cases) that can come on and effectively "mask" or "offset" some of the impact of exhausting deep reserves. Thus, we conclude that as deep reserves exhaust (in all cases), the overall tonnage impact will be more apparent in the "New" cases (with their raised surface mine costs) than it will be in the comparison cases where there is still some latent surface expansion available at lower cost levels.

Remember that the deep tons are assumed to be totally free from the effects of valley fill restrictions in these runs. If valley fill restrictions apply to deep mining, then a steep drop in annual production is likely to start in earlier years than shown in the graph. The fact that deep mined tonnage is staying basically at its Base Case level is the primary reason in the "New" model runs that the overall tonnage drop is not much larger than 40 million annual tons.

Also, since deep mining is more labor intensive than surface mining, the employment levels shown at the bottom of Appendix Table B-6 for the "New" 75-Acre case would drop much lower if deep mining is affected by valley fill restrictions. In the model runs, it is largely the fact that deep mining stays roughly at its Base Case levels that keeps the employment levels from falling more rapidly.

With regard to the third point noted above from Figure 3, we are faced with the question, "Why is the deep mining reserve base exhausting (in all cases) so rapidly?" The fact is that some 20% or more of existing capacity in any year expires when many small mines (and even some larger ones that have been producing for a while) simply run out of economically minable reserves. In other words, one out of every five points on the mining cost curve of Figure 2 disappears every year and must be replaced to maintain production levels. In these "New" model runs, the cost increases and reserve reductions for surface mines (especially at the more economic low end of the curve) generally price new replacement surface capacity too high to be developed. However, the deep mining expansion potential has remained the same in all cases, and it tends to be utilized (in all cases) at about the same rate until it begins to be exhausted.

Table 4 below presents the actual amount of new deep mine capacity added each year in the "New" 75-acre runs of the model. The table also presents the total amount of deep production for each year that capacity expansion is listed, along with estimates of the amount of refuse material that is going into valley fills due to this deep mined tonnage.

Table 4
New Deep Mine Capacity Added, Compared to Total Deep Production
"New" 75 Acre Case
(Million Annual Tons)

Year	New Deep Kentucky	New Deep West Virginia	New Deep Virginia	New Deep Tot. Study Area	Deep Production Tot. Study Area
2003	8.21	13.12	2.71	24.04	147.18
2004	10.22	20.30	2.72	33.24	158.03
2005	12.41	29.45	2.95	44.81	154.88
2006	10.29	34.44	3.10	47.83	140.71
2007	19.57	41.36	8.05	68.98	152.77
2008	23.02	43.92	7.27	74.21	150.07
2009	10.82	17.19	4.99	33.00	135.25
2010	43.54	41.33	8.00	92.87	127.08
2011	32.69	41.56	7.87	82.12	106.84
			Cross-Year Total	501.10	1,272.81
Lb / cu ft	100	100	100	100	100
Tons / cu yd	1.35	1.35	1.35	1.35	1.35

	Refuse Million Cu Yds	Refuse Million Cu Yds	Refuse Million Cu Yds	Refuse Million Cu Yds	Refuse Million Cu Yds
2003	6.08	9.72	2.01	17.81	109.02
2004	7.57	15.04	2.01	24.62	117.06
2005	9.19	21.81	2.19	33.19	114.73
2006	7.62	25.51	2.30	35.43	104.23
2007	14.50	30.64	5.96	51.10	113.16
2008	17.05	32.53	5.39	54.97	111.16
2009	8.01	12.73	3.70	24.44	100.19
2010	32.25	30.61	5.93	68.79	94.13
2011	24.21	30.79	5.83	60.83	79.14
			Cross-Year Total	371.19	942.82

During each single-year model run, the model tests each point on the mining cost curve to see if the cash margin (of market clearing price above that mine's cost) is large enough to earn the required ROI for that scenario. If so, then that point on the curve (that mine or reserve) is free to add capacity at the annual level possible for the property's expansion.

The model output captured in Table 4 indicates that there is sufficient economically expandable deep capacity (since no valley fill impacts on deep mines are assumed) to bring on the annual new capacities shown. Thus, we conclude that the expansion of capacity by new deep mines (in all cases, including the Base Case) has major influence on the total tonnages presented. In fact, in years 2010 and 2011, total production in the "New" 75 acre case (including both surface and deep production) has dropped to 160 million annual tons or lower, so that brand new deep mine capacity in each of those years represents more than half of the total.

The top section of Table 4 shows that the grand total of newly constructed deep mine capacity over the multi-year period is over 500 million annual tons. At that point, the annual rate of new deep capacity expansion slows down as rapid exhaustion of the economic reserves occurs. It is important to note that it is the economic reserves that are exhausting. Central Appalachia still has huge amounts of coal in the ground at this point, but it cannot be mined at cost levels that are competitive with other fuels. Simply stated, the mining costs of remaining reserves are above viable development levels.

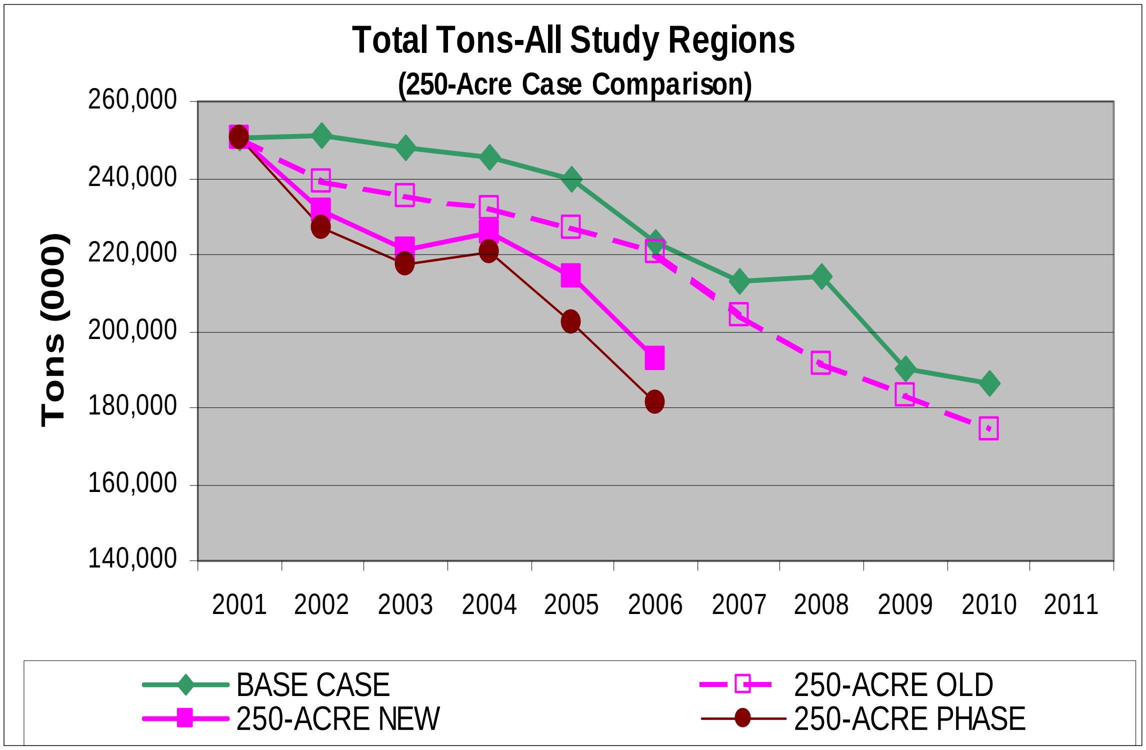
The bottom section of Table 4 indicates that the new deep mine capacity brought on in the model runs results in approximately 371 million cubic yards of refuse that must be placed in valley fills or impoundments. The total for all deep production (from both existing and new mines) approaches 1 billion cubic yards of refuse. These results are presented to highlight the magnitude of the assumption that deep mines are unaffected by the valley fill restrictions.

The bottom line is that expansions of new capacity into the mining cost curves are very sensitive (reflecting the real world condition) to costs of mining. Raising surface mine costs has priced them out of providing new capacity, but leaving deep mining costs unaffected (in the modeling) allows the deep mining to expand as rapidly as it did in the Base Case. This continues with lowest cost mines depleting reserves first, until few minable reserves remain to develop. This appears to happen in the last two or three years of the "New" 75 acre runs

250-Acre Cases Production Shifts

The 250-acre sensitivity cases (Scenarios #2 and #3 defined above) are shown on Figure 4. This figure presents results of the 250 Acre phase-in of restrictions case (including higher ROI) in the bottom graphed line; the "New" 250-Acre Case in the next-to-bottom line; the "Old" 250-Acre Case in the dashed line; and the unrestricted Base Case in the top line.

Figure 4



Not surprisingly, since Tables 2 and 3 above show a relatively stronger change in inputs compared to the old cases for the 250-acre scenarios, this graph shows generally more separation of the "New" 250-acre cases from the "Old" results than we observed in Figure 3 for the 75-acre comparison. In general, a 10-15 million ton impact in the "Old" case (below Base Case levels) has now grown to 20-30 million annual tons below the Base Case, and even 40 million tons under higher ROI constraints in the "250-Acre Phase" case (Scenario #3).

An interesting and unexpected result of these sensitivity runs is that the "New" 250-acre cases and the "New" 75-acre case all fall surprisingly close to each other at roughly 30-40 million tons below the Base Case. This level is basically at, or even below, the previous study's most restrictive 35-acre case. It is surprising that the "New" 250-acre cases are so strongly affected that they are driven down to this level. The inclusion of cost increases in these runs at the residual (after valley fill reductions) mines is the most-likely driving force.

Basically, once surface mining costs are driven high enough that very little new surface capacity can be added (this happens even in the 250-acre cases), then the deep mining properties have trouble bringing on enough new economic capacity to replace all of the annual exhaustions. This occurs even though it was assumed in these runs that each deep mine's reserves, capacity and cost are totally unaffected by the valley fill restrictions. If even small deep mine impacts from the new valley fill restrictions occur, it is Hill & Associates' opinion that even faster and larger drops in total production undoubtedly would occur, causing higher economic distress in the region.

Although the focus of this report is specifically set at the more generalized level of considering total area results, it is interesting to briefly note a couple of fairly predictable sub-segment results. First, if we were to plot state totals (which we do not since this sensitivity report is focused more generally), we would see that West Virginia is much more affected than eastern Kentucky or Virginia in all of the "New" cases (see state-by-state totals in Appendices A, B and D). This is a very predictable result from the state-level inputs shown in Tables 1, 2 and 3 above. If much higher cost increases and reserve/capacity reductions are input for West Virginia, then it is not surprising to see much higher output impacts in the model runs for this state.

Second, the same principle applies to results for surface mining compared to results for deep mining. We have already commented above on the fact that deep mining production stays relatively the same across all of the scenarios. Another way to look at this is that basically all of the 40 million ton annual drop in production comes in the surface tonnage (again, see the detailed segmented results in Appendices A, B and D). As noted above, this is not surprising since all of the input cost increases and reserve/capacity reductions were applied to surface mines only. Thus, if we were to plot surface and deep results separately (which we do not, because of the more general focus of this sensitivity study), we would see virtually all of the impacts showing up in the surface plot (actually, in the West Virginia surface plot).

Coal Price Impacts Within The Study Area

Figures 5 and 6 present weighted average coal price graphs, in a manner similar to the above tonnage production graphs, for the 75-acre cases and the 250-acre cases, respectively. It is critical to note that these graphs are showing only prices for the geographical area of this study. Any indirect impacts of pulling up prices from other coal-producing regions are not included in this analysis.

Both of the figures below use the same horizontal axis which goes through 2011, even though none of the 250-acre cases were run out through this final year. Of course, the purpose of presenting both sets of results on identical axes is to allow more direct visual comparison as the reader views both sets of graphs.

Figure 5

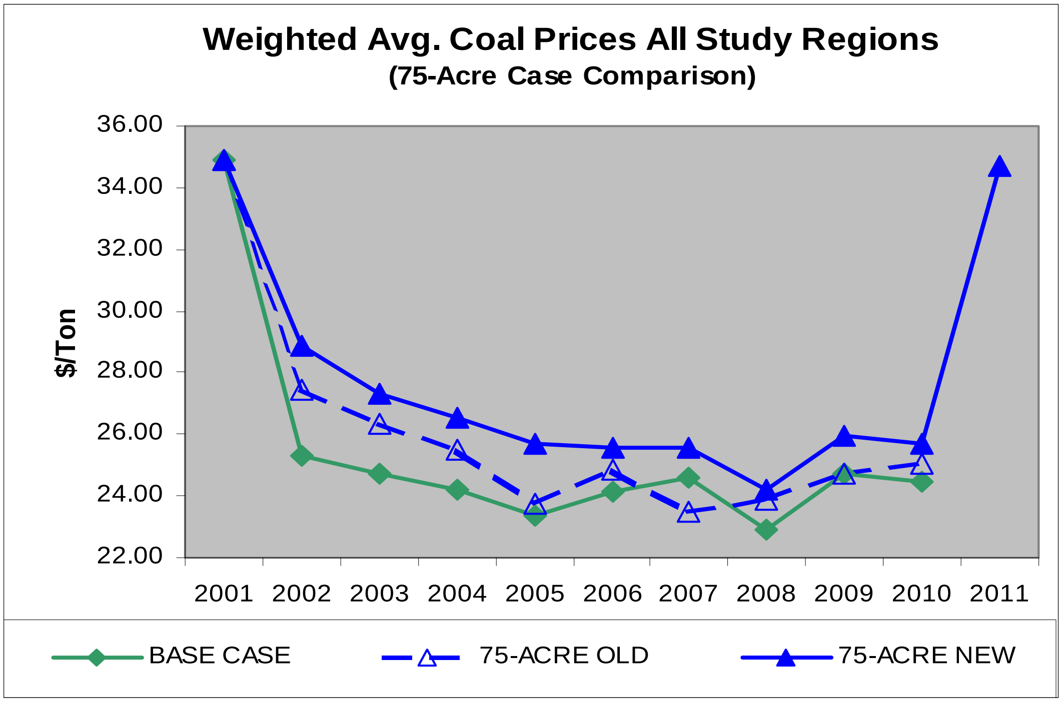
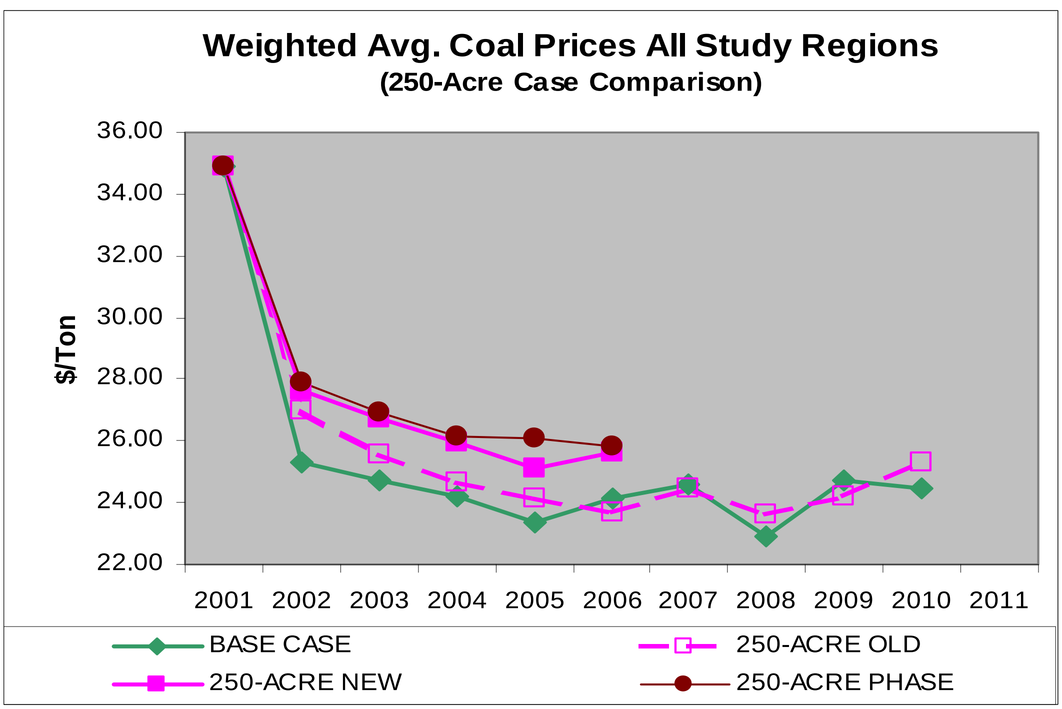


Figure 6



In general for most years, the "New" case prices in both sets of graphs gain approximately $2.00 per ton over the unrestricted Base Case. This compares to the typical "less than a dollar" differentials of the "Old" cases. In other words, price impacts have more than doubled in most years using the new model inputs of this study.

A dollar or two shift may not appear significant, given normal fluctuations in the Central Appalachian coal markets. The key is that a sustainable, systemic couple of dollars occurring at the point where demand crosses the cost curve can result in large production tonnage impacts. Figure 2, the generalized mine cost curve, illustrates that the middle portion of the curve is relatively "flat." Only a small change in the vertical value of dollars per ton at this point pushes substantial production above the market-clearing price for economical mining operations. Even when valley fill restrictions raise the curve and make it somewhat steeper, it is still flat enough in the first several years to see this phenomenon of smaller price increments associated with larger tonnage decreases.

However, if the curve is shortened year after year and additional low-cost reserves are unavailable to replenish the curve, then eventually demand crosses the curve nearer to its right-hand edge where it is much steeper and mining becomes uneconomical. This appears to occur in Figure 5 (the 75-acre comparisons) in the year 2011. As mentioned earlier, the model indicates that replacement reserves are nearing exhaustion by this last year of the runs. It is not so much that the area is running totally out of coal – There is still plenty of it in the ground. But the area is running out of economic coal. There is insufficient coal that can be mined at the $24-$26 level necessary to be competitive, even at zero cash margin.

IV. Conclusions

In summary, the following findings were obtained in this sensitivity study:

- The new realistic inputs cause a larger impact of valley fill restrictions than that observed in the prior study. This new impact reaches roughly 20% of total area production, even under the assumption that deep mines and their associated wash plants are unaffected. This impact is similar to, or below, the most restrictive 35-Acre Case of the previous study.

- Surprisingly, the 75 acre and 250 acre "New" cases show impacts of similar magnitude, primarily due to surface mine costs in both cases rising high enough to cross a threshold where new surface capacity is basically uneconomic to develop.

- Topography differences between southern West Virginia and eastern Kentucky are large enough that a valley fill watershed limit of 250 acres falls much more heavily on West Virginia. As that limit drops below about 100-acre watersheds, significant numbers of eastern Kentucky surface mines are also affected, but by a lesser amount so that overall impacts are still predominantly located in West Virginia.

- Under the assumption that both existing and new deep mines are totally unaffected by valley fill restrictions, a very large amount of new deep capacity continues to come on year-by-year in the "New" modeling runs (as it does in the Base Case). The total new deep mine capacity across 10 years in the "New" 75 acre case exceeds 500 million tons beyond that existing today. Since new deep mines often require new wash plants with new valley fills, the assumption of "no deep mining impacts" is a very critical and pivotal assumption. In fact, the results of these economic studies are unreliable if deep mines will be affected.

- Weighted average coal price for the total study area in the "New" runs is generally $2.00 per ton higher than the pre-lawsuit Base Case, compared to the previous study's result of generally less than a dollar over Base Case. However, in the last year of the full 10-year "New" 75-acre case, there is a significant upswing in coal prices, indicating the likelihood that the reserves available to replace reduced tonnage are running out.

- A definite "reluctance to invest" is developing in the study area due to uncertainty and the perception of a hostile regulatory environment. However, raising the required ROI for new investment to 20% showed only marginal impact in the 250-acre scenarios. Increased ROI did outweigh the "3-year phase-in" of restrictions, causing the "250-Acre Phase" case tonnage to fall below the "250-Acre New" levels even in the first three years of phase-in.

Table A-1

Total Tons - Surface and Deep Mines Combined
Production Tons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	37,850	37,112	36,823	33,002	31,422	32,007	33,767	35,551	31,630	26,355	
250-ACRE OLD	37,850	36,193	36,774	33,701	31,964	30,886	29,025	29,686	31,040	25,977	
250-ACRE NEW	37,850	35,914	34,876	33,122	31,512	30,637					
250-ACRE PHASE	37,850	36,065	35,027	33,013	32,197	30,929					
75-ACRE OLD	37,850	35,210	34,894	31,764	29,911	26,389	26,460	25,917	27,287	23,130	
75-ACRE NEW	37,850	36,637	34,848	33,166	31,524	30,471	29,056	29,483	30,190	28,538	26,264

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 2											
BASE CASE	49,100	46,844	46,074	46,599	41,518	33,638	35,576	35,765	27,881	27,768	
250-ACRE OLD	49,100	42,903	42,522	42,398	43,787	34,633	31,040	33,043	27,504	23,835	
250-ACRE NEW	49,100	45,180	46,092	48,356	45,080	32,806					
250-ACRE PHASE	49,100	45,180	45,689	47,683	46,759	32,242					
75-ACRE OLD	49,100	42,746	42,880	43,419	42,577	36,946	32,564	30,616	24,684	26,238	
75-ACRE NEW	49,100	45,771	46,795	49,201	44,510	31,826	33,026	32,004	26,019	27,728	24,161

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 3											
BASE CASE	1,690	1,575	1,407	1,406	1,114	1,035	1,023	993	1,104	1,106	
250-ACRE OLD	1,690	1,708	1,552	1,357	1,084	825	999	1,003	1,134	1,136	
250-ACRE NEW	1,690	1,690	1,670	1,529	1,136	1,087					
250-ACRE PHASE	1,690	1,690	1,670	1,529	1,136	1,066					
75-ACRE OLD	1,690	1,708	1,675	1,562	1,073	1,005	993	1,124	1,146	1,186	
75-ACRE NEW	1,690	1,690	1,680	1,436	986	986	1,097	986	1,117	1,087	996

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 4											
BASE CASE	90	120	50	0	0	0	0	0	40	41	
250-ACRE OLD	90	81	90	0	0	0	0	0	40	41	
250-ACRE NEW	90	80	40	40	40	10					
250-ACRE PHASE	90	80	40	40	40	10					
75-ACRE OLD	90	81	30	0	0	0	0	0	40	41	
75-ACRE NEW	90	80	40	40	40	10	0	0	40	40	50

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV C											
BASE CASE	31,460	29,662	30,447	30,018	26,772	32,447	21,555	16,371	13,869	18,263	
250-ACRE OLD	31,460	30,761	30,520	27,994	23,996	28,024	32,083	16,982	15,033	11,166	
250-ACRE NEW	31,460	24,259	20,831	19,938	20,039	16,862					
250-ACRE PHASE	31,460	23,295	20,607	19,467	15,242	14,502					
75-ACRE OLD	31,460	28,545	25,300	24,905	23,585	27,747	31,807	19,847	13,850	10,130	
75-ACRE NEW	31,460	24,692	20,377	18,117	14,198	10,120	9,591	9,594	7,812	8,058	10,469

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV E											
BASE CASE	890	658	679	699	720	740	761	782	1,004	1,026	
250-ACRE OLD	890	864	679	699	720	740	761	782	1,004	1,026	
250-ACRE NEW	890	847	847	645	645	645					
250-ACRE PHASE	890	847	847	645	786	645					
75-ACRE OLD	890	864	823	699	720	740	761	782	1,004	1,026	
75-ACRE NEW	890	847	847	786	645	645	646	787	847	845	896

Table A-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	35,080	39,019	42,631	44,639	46,765	48,241	47,147	44,586	40,898	41,454	
250-ACRE OLD	35,080	35,767	38,943	43,151	45,479	47,120	46,842	43,016	42,515	41,380	
250-ACRE NEW	35,080	35,149	37,973	41,392	45,101	48,831					
250-ACRE PHASE	35,080	35,149	37,973	41,392	43,121	44,855					
75-ACRE OLD	35,080	35,308	38,945	43,244	47,417	49,297	49,118	44,566	43,851	42,943	
75-ACRE NEW	35,080	35,149	38,074	41,392	45,101	48,831	49,732	47,806	44,069	39,926	44,660

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	5,750	5,413	4,431	1,849	1,477	1,117	1,127	1,064	544	554	
250-ACRE OLD	5,750	5,238	3,211	1,159	838	788	788	685	185	185	
250-ACRE NEW	5,750	4,610	2,574	663	352	302					
250-ACRE PHASE	5,750	5,292	3,731	1,476	773	403					
75-ACRE OLD	5,750	5,238	3,703	1,882	1,530	1,190	1,221	1,252	1,283	1,314	
75-ACRE NEW	5,750	4,004	2,605	743	342	302	308	158	308	308	348

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	61,190	62,379	55,381	58,923	66,682	50,323	46,895	56,022	50,730	46,768	
250-ACRE OLD	61,190	58,800	53,326	51,634	51,662	54,304	38,060	42,529	42,354	46,852	
250-ACRE NEW	61,190	57,515	48,722	51,006	43,514	38,411					
250-ACRE PHASE	61,190	53,179	44,181	45,899	34,685	33,758					
75-ACRE OLD	61,190	55,018	47,253	43,721	51,096	40,508	52,699	39,828	41,437	41,014	
75-ACRE NEW	61,190	44,657	39,086	41,078	38,426	38,833	44,940	39,597	38,630	31,195	12,208

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	134,370	137,131	133,568	136,128	142,415	132,868	117,484	118,824	107,044	108,066	
250-ACRE OLD	134,370	131,429	126,678	124,638	122,695	130,977	118,534	103,993	101,090	100,608	
250-ACRE NEW	134,370	122,379	110,946	113,643	109,651	105,051					
250-ACRE PHASE	134,370	117,762	107,339	108,878	94,607	94,162					
75-ACRE OLD	134,370	124,971	116,024	114,451	124,348	119,482	135,606	106,274	101,424	96,426	
75-ACRE NEW	134,370	109,349	100,988	102,115	98,712	98,731	105,217	97,941	91,666	80,332	68,580

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	88,730	85,651	84,353	81,008	74,053	66,680	70,367	72,310	60,655	55,270	
250-ACRE OLD	88,730	80,885	80,938	77,456	76,835	66,343	61,064	63,732	59,718	50,989	
250-ACRE NEW	88,730	82,865	82,678	83,047	77,769	64,540					
250-ACRE PHASE	88,730	83,016	82,427	82,265	80,132	64,247					
75-ACRE OLD	88,730	79,745	79,479	76,745	73,561	64,340	60,017	57,656	53,157	50,595	
75-ACRE NEW	88,730	84,179	83,363	83,843	77,061	63,293	63,178	62,473	57,365	57,392	51,472

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	27,200	28,032	29,777	28,516	23,013	23,929	25,132	23,123	22,491	23,071	
250-ACRE OLD	27,200	26,463	27,643	29,980	27,182	23,020	24,702	23,818	22,174	22,729	
250-ACRE NEW	27,200	26,395	27,666	29,163	26,932	23,103					
250-ACRE PHASE	27,200	26,395	27,666	29,375	27,215	22,921					
75-ACRE OLD	27,200	26,802	28,498	30,141	26,690	23,551	25,090	24,269	21,735	22,367	
75-ACRE NEW	27,200	26,758	27,837	29,737	27,081	22,710	25,970	26,307	23,293	23,237	23,722

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	250,300	250,814	247,698	245,651	239,481	223,477	212,983	214,257	190,191	186,407	
250-ACRE OLD	250,300	238,777	235,258	232,074	226,711	220,340	204,300	191,543	182,983	174,326	
250-ACRE NEW	250,300	231,640	221,291	225,852	214,352	192,693					
250-ACRE PHASE	250,300	227,173	217,431	220,518	201,954	181,330					
75-ACRE OLD	250,300	231,518	224,000	221,338	224,598	207,374	220,713	188,199	176,315	169,388	
75-ACRE NEW	250,300	220,286	212,188	215,695	202,853	184,734	194,365	186,720	172,324	160,960	143,774

Table A-2

Total Tons - Surface Mines Only
Production Tons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	17,410	19,041	18,258	14,578	14,078	13,659	13,740	12,587	10,910	9,103	
250-ACRE OLD	17,410	16,935	17,523	14,972	13,457	13,230	11,498	9,649	8,275	7,339	
250-ACRE NEW	17,410	16,850	15,701	15,190	14,322	13,680					
250-ACRE PHASE	17,410	17,001	15,761	15,200	14,372	13,740					
75-ACRE OLD	17,410	15,865	15,378	13,034	10,100	7,720	6,821	6,104	4,996	3,830	
75-ACRE NEW	17,410	16,940	15,360	15,073	13,770	13,277	12,076	9,693	8,505	7,032	7,515
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 2											
BASE CASE	19,470	19,130	16,819	13,982	13,544	12,698	12,080	13,024	11,277	10,283	
250-ACRE OLD	19,470	15,784	14,819	12,796	12,664	10,218	9,427	8,397	7,663	7,606	
250-ACRE NEW	19,470	18,289	16,413	15,129	14,253	11,923					
250-ACRE PHASE	19,470	18,289	16,169	14,919	14,615	10,988					
75-ACRE OLD	19,470	15,576	14,336	12,935	9,617	9,746	8,535	8,187	8,435	8,031	
75-ACRE NEW	19,470	18,206	16,522	14,978	12,755	10,693	10,601	10,100	9,942	8,298	9,275
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 3											
BASE CASE	1,020	819	644	634	331	221	205	205	336	338	
250-ACRE OLD	1,020	952	788	603	300	30	201	205	336	338	
250-ACRE NEW	1,020	946	926	784	391	342					
250-ACRE PHASE	1,020	946	926	784	391	322					
75-ACRE OLD	1,020	952	901	778	300	201	205	316	338	409	
75-ACRE NEW	1,020	946	926	681	231	231	342	231	362	362	433
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 4											
BASE CASE	80	120	50	0	0	0	0	0	40	41	
250-ACRE OLD	80	81	90	0	0	0	0	0	40	41	
250-ACRE NEW	80	80	40	40	40	10					
250-ACRE PHASE	80	80	40	40	40	10					
75-ACRE OLD	80	81	30	0	0	0	0	0	40	41	
75-ACRE NEW	80	80	40	40	40	10	0	0	40	40	40
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV C											
BASE CASE	23,230	22,290	22,726	21,868	21,088	27,432	16,575	12,646	11,090	15,559	
250-ACRE OLD	23,230	23,585	23,035	20,478	16,634	23,282	27,092	13,313	11,903	8,232	
250-ACRE NEW	23,230	17,183	13,465	12,144	11,731	12,182					
250-ACRE PHASE	23,230	16,220	12,412	10,066	9,860	9,820					
75-ACRE OLD	23,230	21,369	17,753	16,854	16,223	22,461	26,814	15,742	10,375	7,185	
75-ACRE NEW	23,230	17,612	13,011	10,323	5,890	5,390	5,244	4,624	5,107	5,555	7,837
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV E											
BASE CASE	630	391	401	411	422	432	442	453	664	677	
250-ACRE OLD	630	596	401	411	422	432	442	453	664	677	
250-ACRE NEW	630	585	585	383	383	383					
250-ACRE PHASE	630	585	585	383	524	383					
75-ACRE OLD	630	596	545	411	422	432	442	453	664	677	
75-ACRE NEW	630	585	585	524	383	383	383	524	585	583	634

Table A-2 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	1,480	1,175	517	144	72	254	277	216	448	471	
250-ACRE OLD	1,480	1,293	296	215	134	134	275	215	235	466	
250-ACRE NEW	1,480	1,351	533	282	282	282					
250-ACRE PHASE	1,480	1,351	533	282	282	282					
75-ACRE OLD	1,480	833	298	308	93	274	134	214	277	468	
75-ACRE NEW	1,480	1,351	633	282	282	282	282	252	464	463	604

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	1,210	1,223	1,078	328	339	349	359	370	380	390	
250-ACRE OLD	1,210	1,048	191	21	21	21	21	21	21	21	
250-ACRE NEW	1,210	1,202	362	302	302	302					
250-ACRE PHASE	1,210	1,117	392	242	242	242					
75-ACRE OLD	1,210	1,048	338	328	339	349	359	370	380	390	
75-ACRE NEW	1,210	592	392	382	292	302	302	152	302	302	342

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	27,730	30,668	27,159	29,650	32,787	17,362	12,031	17,377	17,141	15,495	
250-ACRE OLD	27,730	26,780	24,962	24,608	23,805	21,123	6,377	9,971	10,121	10,806	
250-ACRE NEW	27,730	25,324	18,830	17,098	10,377	9,696					
250-ACRE PHASE	27,730	20,989	10,489	8,199	8,209	7,942					
75-ACRE OLD	27,730	22,392	18,259	16,047	20,425	6,085	9,631	8,604	7,259	5,092	
75-ACRE NEW	27,730	12,446	9,537	7,515	6,749	6,343	5,523	4,613	5,070	5,007	4,789

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	54,280	55,747	51,882	52,401	54,708	45,828	29,684	31,061	29,723	32,592	
250-ACRE OLD	54,280	53,303	48,885	45,734	41,015	44,992	34,207	23,971	22,944	20,201	
250-ACRE NEW	54,280	45,645	33,774	30,209	23,075	22,846					
250-ACRE PHASE	54,280	40,261	24,410	19,172	19,117	18,669					
75-ACRE OLD	54,280	46,239	37,193	33,949	37,501	29,601	37,380	25,381	18,954	13,812	
75-ACRE NEW	54,280	32,585	24,159	19,026	13,596	12,700	11,734	10,166	11,528	11,911	14,205

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	37,980	39,110	35,770	29,193	27,952	26,578	26,025	25,815	22,563	19,765	
250-ACRE OLD	37,980	33,752	33,220	28,371	26,421	23,478	21,127	18,251	16,314	15,325	
250-ACRE NEW	37,980	36,166	33,079	31,143	29,006	25,955					
250-ACRE PHASE	37,980	36,316	32,896	30,943	29,419	25,060					
75-ACRE OLD	37,980	32,474	30,645	26,746	20,018	17,667	15,560	14,606	13,809	12,311	
75-ACRE NEW	37,980	36,172	32,848	30,772	26,797	24,212	23,019	20,025	18,849	15,732	17,263

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	8,330	7,737	7,855	7,412	7,390	7,616	7,642	6,562	7,649	7,185	
250-ACRE OLD	8,330	8,043	7,851	7,964	7,488	7,451	7,375	6,436	6,912	6,856	
250-ACRE NEW	8,330	8,229	7,998	7,675	7,534	7,564					
250-ACRE PHASE	8,330	8,229	7,998	7,806	7,856	7,564					
75-ACRE OLD	8,330	8,341	8,150	7,731	6,453	7,109	6,424	6,201	5,410	4,753	
75-ACRE NEW	8,330	8,289	7,998	7,866	7,582	7,111	6,840	6,465	6,699	6,236	5,469

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	100,590	102,594	95,507	89,006	90,050	80,022	63,350	63,438	59,935	59,542	
250-ACRE OLD	100,590	95,098	89,956	82,068	74,924	75,920	62,709	48,658	46,170	42,382	
250-ACRE NEW	100,590	90,040	74,851	69,027	59,616	56,365					
250-ACRE PHASE	100,590	84,806	65,303	57,921	56,392	51,292					
75-ACRE OLD	100,590	87,054	75,988	68,426	63,972	54,377	59,364	46,188	38,173	30,876	
75-ACRE NEW	100,590	77,046	65,004	57,664	47,975	44,023	41,593	36,656	37,076	33,879	36,937

Table A-3

Total Tons - Deep Mines Only
Production Tons (000)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	20,440	18,071	18,565	18,425	17,344	18,349	20,027	22,965	20,720	17,252	
250-ACRE OLD	20,440	19,258	19,251	18,729	18,507	17,656	17,527	20,037	22,765	18,637	
250-ACRE NEW	20,440	19,064	19,175	17,932	17,191	16,957					
250-ACRE PHASE	20,440	19,064	19,266	17,813	17,824	17,188					
75-ACRE OLD	20,440	19,345	19,516	18,731	19,811	18,670	19,639	19,813	22,292	19,300	
75-ACRE NEW	20,440	19,698	19,487	18,093	17,754	17,194	16,979	19,790	21,685	21,506	18,749
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 2											
BASE CASE	29,630	27,714	29,255	32,617	27,973	20,940	23,497	22,741	16,604	17,486	
250-ACRE OLD	29,630	27,119	27,703	29,602	31,123	24,415	21,613	24,646	19,841	16,229	
250-ACRE NEW	29,630	26,891	29,679	33,228	30,827	20,883					
250-ACRE PHASE	29,630	26,891	29,520	32,764	32,144	21,255					
75-ACRE OLD	29,630	27,170	28,544	30,485	32,960	27,200	24,030	22,429	16,249	18,208	
75-ACRE NEW	29,630	27,565	30,273	34,223	31,755	21,133	22,426	21,904	16,077	19,430	14,886
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 3											
BASE CASE	670	756	762	773	783	813	819	788	768	768	
250-ACRE OLD	670	757	763	753	784	794	798	798	798	798	
250-ACRE NEW	670	745	745	745	745	745					
250-ACRE PHASE	670	745	745	745	745	745					
75-ACRE OLD	670	757	773	784	773	803	788	808	808	778	
75-ACRE NEW	670	745	755	755	755	755	755	755	755	724	563
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 4											
BASE CASE	10	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	10	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	10	0	0	0	0	0					
250-ACRE PHASE	10	0	0	0	0	0					
75-ACRE OLD	10	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	10	0	0	0	0	0	0	0	0	0	10
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV C											
BASE CASE	8,230	7,372	7,721	8,150	5,684	5,015	4,980	3,726	2,779	2,704	
250-ACRE OLD	8,230	7,176	7,484	7,516	7,362	4,741	4,990	3,670	3,130	2,934	
250-ACRE NEW	8,230	7,075	7,366	7,794	8,308	4,680					
250-ACRE PHASE	8,230	7,075	8,196	9,401	5,382	4,682					
75-ACRE OLD	8,230	7,176	7,547	8,051	7,362	5,286	4,993	4,104	3,475	2,945	
75-ACRE NEW	8,230	7,080	7,366	7,794	8,308	4,730	4,347	4,970	2,705	2,502	2,632
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV E											
BASE CASE	260	267	278	288	298	308	319	329	339	349	
250-ACRE OLD	260	267	278	288	298	308	319	329	339	349	
250-ACRE NEW	260	262	262	262	262	262					
250-ACRE PHASE	260	262	262	262	262	262					
75-ACRE OLD	260	267	278	288	298	308	319	329	339	349	
75-ACRE NEW	260	262	262	262	262	262	262	262	262	262	262

Table A-3 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	33,600	37,844	42,114	44,496	46,693	47,987	46,869	44,370	40,451	40,983	
250-ACRE OLD	33,600	34,474	38,647	42,936	45,345	46,987	46,567	42,801	42,281	40,914	
250-ACRE NEW	33,600	33,798	37,440	41,109	44,819	48,548					
250-ACRE PHASE	33,600	33,798	37,440	41,109	42,839	44,572					
75-ACRE OLD	33,600	34,474	38,647	42,936	47,325	49,022	48,984	44,352	43,574	42,475	
75-ACRE NEW	33,600	33,798	37,440	41,109	44,819	48,548	49,449	47,554	43,605	39,464	44,057

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	4,540	4,189	3,353	1,521	1,138	768	768	694	164	164	
250-ACRE OLD	4,540	4,189	3,020	1,139	818	768	768	664	164	164	
250-ACRE NEW	4,540	3,408	2,212	361	50	0					
250-ACRE PHASE	4,540	4,175	3,339	1,234	531	161					
75-ACRE OLD	4,540	4,189	3,365	1,553	1,191	841	862	883	903	924	
75-ACRE NEW	4,540	3,412	2,212	361	50	0	6	6	6	6	6

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	33,460	31,711	28,221	29,273	33,894	32,961	34,864	38,644	33,589	31,274	
250-ACRE OLD	33,460	32,020	28,364	27,026	27,857	33,181	31,683	32,558	32,232	36,046	
250-ACRE NEW	33,460	32,191	29,892	33,908	33,137	28,715					
250-ACRE PHASE	33,460	32,191	33,692	37,700	26,476	25,815					
75-ACRE OLD	33,460	32,625	28,995	27,674	30,671	34,423	43,068	31,225	34,179	35,922	
75-ACRE NEW	33,460	32,211	29,549	33,563	31,678	32,490	39,417	34,984	33,560	26,188	7,419

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	80,090	81,384	81,687	83,727	87,707	87,040	87,800	87,763	77,321	75,474	
250-ACRE OLD	80,090	78,127	77,793	78,905	81,680	85,985	84,327	80,022	78,147	80,407	
250-ACRE NEW	80,090	76,734	77,172	83,434	86,576	82,205					
250-ACRE PHASE	80,090	77,501	82,929	89,706	75,490	75,493					
75-ACRE OLD	80,090	78,732	78,831	80,502	86,847	89,881	98,226	80,893	82,470	82,614	
75-ACRE NEW	80,090	76,764	76,829	83,089	85,117	86,030	93,482	87,775	80,138	68,421	54,376

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	50,750	46,541	48,583	51,814	46,101	40,102	44,342	46,494	38,092	35,505	
250-ACRE OLD	50,750	47,133	47,718	49,085	50,414	42,865	39,938	45,480	43,404	35,664	
250-ACRE NEW	50,750	46,699	49,599	51,904	48,762	38,584					
250-ACRE PHASE	50,750	46,699	49,531	51,321	50,713	39,187					
75-ACRE OLD	50,750	47,271	48,833	49,999	53,543	46,673	44,457	43,050	39,348	38,285	
75-ACRE NEW	50,750	48,007	50,515	53,071	50,263	39,082	40,159	42,448	38,516	41,660	34,209

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	18,870	20,295	21,922	21,104	15,624	16,314	17,491	16,561	14,842	15,886	
250-ACRE OLD	18,870	18,419	19,792	22,016	19,695	15,569	17,328	17,382	15,262	15,873	
250-ACRE NEW	18,870	18,167	19,669	21,488	19,398	15,539					
250-ACRE PHASE	18,870	18,167	19,669	21,570	19,359	15,358					
75-ACRE OLD	18,870	18,461	20,347	22,411	20,237	16,442	18,667	18,068	16,325	17,613	
75-ACRE NEW	18,870	18,468	19,840	21,871	19,499	15,599	19,130	19,841	16,593	17,000	18,253

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	149,710	148,220	152,191	156,645	149,431	143,455	149,633	150,819	130,256	126,865	
250-ACRE OLD	149,710	143,679	145,302	150,005	151,788	144,420	141,592	142,885	136,813	131,945	
250-ACRE NEW	149,710	141,600	146,440	156,825	154,736	136,328					
250-ACRE PHASE	149,710	142,367	152,128	162,597	145,562	130,038					
75-ACRE OLD	149,710	144,464	148,012	152,912	160,627	152,996	161,349	142,011	138,143	138,512	
75-ACRE NEW	149,710	143,240	147,184	158,031	154,878	140,711	152,772	150,065	135,248	127,082	106,837

Table B-1

Direct Coal Employment - (Number of Employees)
Base Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1608	1652	1640	1544	1633	1782	2044	1844	1535
KY_1	Surface	972	975	942	844	819	794	799	731	632	526
KY_1 Total		**2791**	**2583**	**2595**	**2484**	**2363**	**2427**	**2582**	**2775**	**2476**	**2061**
KY_2	Deep	2609	2467	2604	2903	2490	1864	2091	2024	1478	1556
KY_2	Surface	1102	1044	941	790	767	716	664	704	634	580
KY_2 Total		**3711**	**3511**	**3545**	**3693**	**3256**	**2580**	**2755**	**2728**	**2112**	**2136**
KY_3	Deep	60	67	68	69	70	72	73	70	68	68
KY_3	Surface	60	48	38	37	20	13	12	12	20	20
KY_3 Total		**120**	**116**	**106**	**106**	**89**	**85**	**85**	**82**	**88**	**88**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	8	3	0	0	0	0	0	2	2
KY_4 Total		**6**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	656	687	725	506	438	434	329	238	231
WV_C	Surface	1322	1266	1292	1244	1216	1596	966	735	643	907
WV_C Total		**2046**	**1922**	**1980**	**1969**	**1722**	**2034**	**1400**	**1063**	**881**	**1138**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	17	17	18	18	19	19	20	32	32
WV_E Total		**55**	**41**	**42**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2701	2996	3162	3311	3405	3346	3191	2903	2941
WV_N	Surface	69	51	24	8	4	15	16	13	26	28
WV_N Total		**2479**	**2752**	**3020**	**3169**	**3316**	**3420**	**3362**	**3204**	**2930**	**2968**
WV_S	Deep	404	373	298	135	101	68	68	62	15	15
WV_S	Surface	71	72	64	19	20	21	21	22	22	23
WV_S Total		**475**	**445**	**362**	**155**	**121**	**89**	**90**	**84**	**37**	**38**
WV_SW	Deep	2732	2612	2374	2448	2823	2755	3013	3379	2982	2776
WV_SW	Surface	1405	1497	1404	1567	1779	955	669	908	894	848
WV_SW Total		**4137**	**4109**	**3778**	**4015**	**4601**	**3710**	**3682**	**4288**	**3877**	**3624**
ALLEKY	Deep	4489	4142	4324	4611	4103	3569	3946	4138	3390	3160
ALLEKY	Surface	2139	2075	1925	1671	1605	1524	1475	1447	1288	1128
ALL E. KY Total		**6627**	**6217**	**6249**	**6283**	**5708**	**5093**	**5422**	**5585**	**4679**	**4288**
ALLWV	Deep	6293	6366	6380	6495	6768	6693	6890	6990	6169	5994
ALLWV	Surface	2899	2903	2802	2856	3037	2606	1692	1697	1618	1838
ALLWV Total		**9192**	**9269**	**9182**	**9352**	**9805**	**9299**	**8582**	**8687**	**7787**	**7832**
ALLVA	Deep	1538	1658	1795	1719	1227	1284	1384	1294	1136	1224
ALLVA	Surface	488	455	463	437	436	449	451	387	451	424
ALLVA Total		**2026**	**2113**	**2259**	**2156**	**1663**	**1733**	**1835**	**1681**	**1587**	**1648**
ALLREG	Deep	12319	12166	12499	12825	12098	11547	12221	12422	10695	10378
ALLREG	Surface	5526	5434	5190	4965	5078	4579	3618	3531	3358	3390
ALLREG Total		**17845**	**17600**	**17689**	**17790**	**17176**	**16125**	**15838**	**15952**	**14052**	**13767**

Table B-2

Direct Coal Employment - (Number of Employees)
250-Acre Old Case

Region	Mining Typ	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1714	1713	1667	1647	1571	1560	1783	2026	1659
KY_1	Surface	972	944	895	840	779	770	667	558	482	433
KY_1 Total		**2791**	**2657**	**2608**	**2507**	**2427**	**2341**	**2227**	**2342**	**2508**	**2092**
KY_2	Deep	2609	2414	2466	2635	2770	2173	1924	2193	1766	1444
KY_2	Surface	1102	887	829	747	743	603	556	495	452	449
KY_2 Total		**3711**	**3300**	**3295**	**3382**	**3513**	**2776**	**2480**	**2689**	**2218**	**1893**
KY_3	Deep	60	67	68	67	70	71	71	71	71	71
KY_3	Surface	60	56	47	36	18	2	12	12	20	20
KY_3 Total		**120**	**124**	**114**	**103**	**87**	**72**	**83**	**83**	**91**	**91**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	5	6	0	0	0	0	0	2	2
KY_4 Total		**6**	**5**	**6**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	630	658	669	655	422	435	324	275	251
WV_C	Surface	1322	1343	1311	1175	965	1358	1589	785	702	485
WV_C Total		**2046**	**1973**	**1969**	**1844**	**1621**	**1780**	**2024**	**1108**	**977**	**736**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	17	18	18	19	19	20	32	32
WV_E Total		**55**	**53**	**42**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2471	2759	3054	3222	3337	3310	3069	3019	2921
WV_N	Surface	69	59	16	11	8	8	16	13	14	27
WV_N Total		**2479**	**2530**	**2775**	**3065**	**3230**	**3345**	**3326**	**3081**	**3033**	**2949**
WV_S	Deep	404	373	269	101	73	68	68	59	15	15
WV_S	Surface	71	62	11	1	1	1	1	1	1	1
WV_S Total		**475**	**435**	**280**	**103**	**74**	**70**	**70**	**60**	**16**	**16**
WV_SW	Deep	2732	2633	2381	2261	2321	2764	2682	2836	2865	3202
WV_SW	Surface	1405	1347	1265	1277	1282	1138	342	534	543	596
WV_SW Total		**4137**	**3980**	**3646**	**3537**	**3603**	**3902**	**3023**	**3370**	**3408**	**3798**
ALLEKY	Deep	4489	4195	4247	4369	4487	3815	3554	4048	3863	3174
ALLEKY	Surface	2139	1891	1776	1623	1540	1374	1235	1066	956	904
ALL E. KY Total		**6627**	**6086**	**6023**	**5991**	**6027**	**5189**	**4790**	**5114**	**4819**	**4078**
ALLWV	Deep	6293	6130	6091	6111	6297	6620	6523	6317	6203	6421
ALLWV	Surface	2899	2840	2621	2481	2275	2524	1968	1352	1292	1142
ALLWV Total		**9192**	**8970**	**8712**	**8592**	**8572**	**9144**	**8491**	**7669**	**7495**	**7563**
ALLVA	Deep	1538	1491	1606	1796	1586	1214	1366	1363	1169	1219
ALLVA	Surface	488	473	463	470	442	440	435	380	408	404
ALLVA Total		**2026**	**1964**	**2069**	**2266**	**2027**	**1654**	**1801**	**1743**	**1577**	**1623**
ALLREG	Deep	12319	11816	11944	12276	12370	11649	11444	11727	11236	10813
ALLREG	Surface	5526	5205	4861	4574	4257	4338	3638	2798	2656	2451
ALLREG Total		**17845**	**17021**	**16804**	**16849**	**16627**	**15986**	**15082**	**14525**	**13891**	**13264**

Table B-3

Direct Coal Employment - (Number of Employees)
250-Acre New Case

Region	Mining Type	2001	2002	2003	2004	2005	2006
KY_1	Deep	1819	1697	1707	1596	1530	1509
KY_1	Surface	972	939	872	842	792	760
KY_1 Total		**2791**	**2636**	**2578**	**2438**	**2322**	**2269**
KY_2	Deep	2609	2393	2641	2957	2744	1859
KY_2	Surface	1102	1032	921	849	799	667
KY_2 Total		**3711**	**3425**	**3562**	**3806**	**3543**	**2526**
KY_3	Deep	60	66	66	66	66	66
KY_3	Surface	60	56	55	46	23	20
KY_3 Total		**120**	**122**	**121**	**113**	**89**	**86**
KY_4	Deep	1	0	0	0	0	0
KY_4	Surface	5	5	3	3	3	1
KY_4 Total		**6**	**5**	**3**	**3**	**3**	**1**
WV_C	Deep	724	621	647	685	731	408
WV_C	Surface	1322	974	772	699	675	703
WV_C Total		**2046**	**1596**	**1419**	**1385**	**1406**	**1111**
WV_E	Deep	23	23	23	23	23	23
WV_E	Surface	31	29	29	17	17	17
WV_E Total		**55**	**52**	**52**	**40**	**40**	**40**
WV_N	Deep	2410	2423	2672	2923	3177	3433
WV_N	Surface	69	62	26	16	16	16
WV_N Total		**2479**	**2484**	**2698**	**2939**	**3194**	**3449**
WV_S	Deep	404	303	197	32	4	0
WV_S	Surface	71	71	21	18	18	18
WV_S Total		**475**	**374**	**218**	**50**	**22**	**18**
WV_SW	Deep	2732	2645	2481	2776	2771	2472
WV_SW	Surface	1405	1309	1038	946	578	538
WV_SW Total		**4137**	**3954**	**3519**	**3722**	**3349**	**3010**
ALLEKY	Deep	4489	4156	4414	4619	4340	3434
ALLEKY	Surface	2139	2032	1850	1740	1616	1448
ALL E. KY Total		**6627**	**6188**	**6264**	**6360**	**5956**	**4882**
ALLWV	Deep	6293	6016	6020	6440	6708	6336
ALLWV	Surface	2899	2444	1886	1696	1304	1292
ALLWV Total		**9192**	**8460**	**7906**	**8136**	**8011**	**7628**
ALLVA	Deep	1538	1471	1601	1758	1568	1221
ALLVA	Surface	488	484	472	453	445	446
ALLVA Total		**2026**	**1956**	**2073**	**2211**	**2013**	**1667**
ALLREG	Deep	12319	11643	12035	12818	12616	10990
ALLREG	Surface	5526	4960	4208	3889	3365	3186
ALLREG Total		**17845**	**16603**	**16243**	**16707**	**15980**	**14176**

Table B-4

Direct Coal Employment - (Number of Employees)
250-Acre Phase-In Case

Region	Mining Type	2001	2002	2003	2004	2005	2006
KY_1	Deep	1819	1697	1715	1585	1586	1530
KY_1	Surface	972	948	875	843	795	763
KY_1 Total		**2791**	**2644**	**2590**	**2428**	**2381**	**2293**
KY_2	Deep	2609	2393	2627	2916	2861	1892
KY_2	Surface	1102	1032	907	837	820	612
KY_2 Total		**3711**	**3425**	**3534**	**3753**	**3681**	**2503**
KY_3	Deep	60	66	66	66	66	66
KY_3	Surface	60	56	55	46	23	19
KY_3 Total		**120**	**122**	**121**	**113**	**89**	**85**
KY_4	Deep	1	0	0	0	0	0
KY_4	Surface	5	5	3	3	3	1
KY_4 Total		**6**	**5**	**3**	**3**	**3**	**1**
WV_C	Deep	724	621	721	828	470	408
WV_C	Surface	1322	924	711	579	569	568
WV_C Total		**2046**	**1545**	**1432**	**1407**	**1040**	**976**
WV_E	Deep	23	23	23	23	23	23
WV_E	Surface	31	29	29	17	25	17
WV_E Total		**55**	**52**	**52**	**40**	**48**	**40**
WV_N	Deep	2410	2423	2672	2923	3043	3163
WV_N	Surface	69	62	26	16	16	16
WV_N Total		**2479**	**2484**	**2698**	**2939**	**3059**	**3179**
WV_S	Deep	404	372	297	110	47	14
WV_S	Surface	71	66	23	14	14	14
WV_S Total		**475**	**437**	**320**	**124**	**62**	**29**
WV_SW	Deep	2732	2645	2786	3074	2246	2208
WV_SW	Surface	1405	1070	573	454	454	439
WV_SW Total		**4137**	**3715**	**3359**	**3528**	**2700**	**2647**
ALLEKY	Deep	4489	4156	4408	4568	4513	3488
ALLEKY	Surface	2139	2040	1839	1729	1641	1395
ALL E. KY Total		**6627**	**6197**	**6247**	**6296**	**6154**	**4882**
ALLWV	Deep	6293	6084	6499	6959	5830	5816
ALLWV	Surface	2899	2150	1362	1080	1079	1053
ALLWV Total		**9192**	**8234**	**7861**	**8039**	**6909**	**6870**
ALLVA	Deep	1538	1471	1601	1766	1565	1204
ALLVA	Surface	488	484	472	461	464	446
VA Total		**2026**	**1956**	**2073**	**2226**	**2028**	**1651**
ALLREG	Deep	12319	11711	12508	13292	11908	10508
ALLREG	Surface	5526	4675	3673	3269	3183	2894
ALLREG Total		**17845**	**16386**	**16181**	**16561**	**15091**	**13403**

Table B-5

Direct Coal Employment - (Number of Employees)
75-Acre Old Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
KY_1	Deep	1819	1722	1737	1667	1763	1662	1748	1763	1984	1718
KY_1	Surface	972	881	820	753	583	449	402	360	295	226
KY_1 Total		**2791**	**2602**	**2557**	**2420**	**2346**	**2111**	**2150**	**2123**	**2279**	**1944**
KY_2	Deep	2609	2418	2540	2713	2933	2421	2139	1996	1446	1620
KY_2	Surface	1102	878	816	760	566	575	504	483	498	474
KY_2 Total		**3711**	**3296**	**3357**	**3473**	**3500**	**2996**	**2642**	**2479**	**1944**	**2094**
KY_3	Deep	60	67	69	70	69	71	70	72	72	69
KY_3	Surface	60	56	53	46	18	12	12	19	20	24
KY_3 Total		**120**	**124**	**122**	**116**	**87**	**83**	**82**	**91**	**92**	**93**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0
KY_4	Surface	5	5	2	0	0	0	0	0	2	2
KY_4 Total		**6**	**5**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
WV_C	Deep	724	630	663	707	655	461	437	356	299	252
WV_C	Surface	1322	1223	1029	977	934	1299	1563	918	601	412
WV_C Total		**2046**	**1853**	**1692**	**1684**	**1590**	**1760**	**2000**	**1273**	**900**	**664**
WV_E	Deep	23	24	25	26	27	27	28	29	30	31
WV_E	Surface	31	29	26	18	18	19	19	20	32	32
WV_E Total		**55**	**53**	**51**	**44**	**45**	**46**	**47**	**49**	**62**	**63**
WV_N	Deep	2410	2471	2759	3054	3356	3476	3476	3162	3093	3012
WV_N	Surface	69	42	16	16	5	16	8	13	16	28
WV_N Total		**2479**	**2513**	**2775**	**3071**	**3362**	**3492**	**3484**	**3174**	**3109**	**3040**
WV_S	Deep	404	373	299	138	106	75	77	79	80	82
WV_S	Surface	71	62	20	19	20	21	21	22	22	23
WV_S Total		**475**	**435**	**319**	**158**	**126**	**95**	**98**	**100**	**103**	**105**
WV_SW	Deep	2732	2681	2431	2318	2578	2875	3639	2779	3029	3184
WV_SW	Surface	1405	1134	936	866	1098	326	525	465	385	267
WV_SW Total		**4137**	**3815**	**3367**	**3183**	**3676**	**3201**	**4165**	**3244**	**3414**	**3451**
ALLEKY	Deep	4489	4207	4346	4450	4765	4154	3957	3831	3502	3407
ALLEKY	Surface	2139	1820	1691	1559	1167	1036	918	862	815	726
ALL E. KY Total		**6627**	**6027**	**6038**	**6009**	**5933**	**5190**	**4875**	**4693**	**4317**	**4134**
ALLWV	Deep	6293	6179	6176	6243	6722	6914	7658	6404	6531	6561
ALLWV	Surface	2899	2490	2027	1896	2077	1681	2137	1436	1056	763
ALLWV Total		**9192**	**8669**	**8204**	**8139**	**8798**	**8595**	**9795**	**7840**	**7588**	**7324**
ALLVA	Deep	1538	1495	1655	1832	1630	1288	1478	1420	1260	1370
ALLVA	Surface	488	492	481	456	381	419	379	366	319	280
ALLVA Total		**2026**	**1987**	**2136**	**2288**	**2011**	**1708**	**1857**	**1786**	**1579**	**1650**
ALLREG	Deep	12319	11880	12178	12525	13118	12356	13093	11656	11293	11338
ALLREG	Surface	5526	4802	4200	3911	3625	3136	3434	2664	2190	1769
ALLREG Total		**17845**	**16683**	**16377**	**16436**	**16742**	**15492**	**16527**	**14319**	**13483**	**13108**

Table B-6

Direct Coal Employment - (Number of Employees)
75-Acre New Case

Region	Mining Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY_1	Deep	1819	1753	1734	1610	1580	1530	1511	1761	1930	1914	1669
KY_1	Surface	972	945	852	836	760	746	687	558	490	414	443
KY_1 Total		**2791**	**2698**	**2586**	**2446**	**2340**	**2276**	**2198**	**2319**	**2420**	**2328**	**2112**
KY_2	Deep	2609	2453	2694	3046	2826	1881	1996	1949	1431	1729	1325
KY_2	Surface	1102	1027	927	842	712	600	595	565	556	458	516
KY_2 Total		**3711**	**3480**	**3622**	**3888**	**3538**	**2481**	**2591**	**2515**	**1986**	**2188**	**1841**
KY_3	Deep	60	66	67	67	67	67	67	67	67	64	50
KY_3	Surface	60	56	55	40	14	14	20	14	21	21	26
KY_3 Total		**120**	**122**	**122**	**107**	**81**	**81**	**87**	**81**	**89**	**86**	**76**
KY_4	Deep	1	0	0	0	0	0	0	0	0	0	1
KY_4	Surface	5	5	3	3	3	1	0	0	2	2	2
KY_4 Total		**6**	**5**	**3**	**3**	**3**	**1**	**0**	**0**	**2**	**2**	**3**
WV_C	Deep	724	621	647	685	731	412	378	433	232	214	225
WV_C	Surface	1322	992	747	585	328	298	291	256	275	301	436
WV_C Total		**2046**	**1613**	**1394**	**1270**	**1058**	**710**	**668**	**689**	**507**	**515**	**661**
WV_E	Deep	23	23	23	23	23	23	23	23	23	23	23
WV_E	Surface	31	29	29	25	17	17	17	25	29	29	32
WV_E Total		**55**	**52**	**52**	**48**	**40**	**40**	**40**	**48**	**52**	**52**	**55**
WV_N	Deep	2410	2423	2672	2923	3177	3433	3496	3384	3100	2809	3122
WV_N	Surface	69	62	32	16	16	16	16	15	27	27	36
WV_N Total		**2479**	**2484**	**2704**	**2939**	**3194**	**3449**	**3512**	**3399**	**3127**	**2836**	**3157**
WV_S	Deep	404	303	197	32	4	0	0	0	0	0	0
WV_S	Surface	71	35	23	23	17	18	18	9	18	18	20
WV_S Total		**475**	**338**	**220**	**55**	**22**	**18**	**18**	**9**	**18**	**18**	**20**
WV_SW	Deep	2732	2646	2455	2746	2648	2814	3350	3109	2980	2324	653
WV_SW	Surface	1405	695	541	438	394	370	321	268	295	291	278
WV_SW Total		**4137**	**3341**	**2996**	**3184**	**3042**	**3183**	**3671**	**3377**	**3274**	**2614**	**932**
ALLEKY	Deep	4489	4273	4496	4723	4473	3478	3574	3778	3428	3708	3045
ALLEKY	Surface	2139	2032	1836	1721	1488	1360	1302	1137	1069	896	987
ALL E. KY Total		**6627**	**6305**	**6332**	**6444**	**5961**	**4838**	**4876**	**4915**	**4497**	**4603**	**4032**
ALLWV	Deep	6293	6016	5994	6410	6584	6683	7247	6949	6335	5369	4023
ALLWV	Surface	2899	1812	1372	1087	772	718	662	573	643	666	802
ALLWV Total		**9192**	**7829**	**7366**	**7497**	**7355**	**7401**	**7910**	**7522**	**6978**	**6035**	**4825**
ALLVA	Deep	1538	1498	1616	1793	1577	1226	1536	1595	1305	1340	1451
ALLVA	Surface	488	488	472	464	447	420	404	381	395	368	323
ALLVA Total		**2026**	**1986**	**2088**	**2257**	**2024**	**1645**	**1939**	**1976**	**1700**	**1708**	**1774**
ALLREG	Deep	12319	11787	12106	12926	12634	11387	12357	12322	11068	10417	8519
ALLREG	Surface	5526	4333	3680	3272	2706	2497	2368	2091	2108	1929	2111
ALLREG Total		**17845**	**16120**	**15786**	**16198**	**15341**	**13884**	**14725**	**14413**	**13176**	**12347**	**10630**

Table C-1

Mine Capacity Capital Expenditures
Million Dollars

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	0.00	33.33	13.01	0.18	0.17	0.43	31.01	70.50	0.00	0.00	
250-ACRE OLD	0.00	5.09	27.10	0.00	3.77	0.00	0.00	51.85	47.09	0.00	
250-ACRE NEW	0.00	1.26	7.06	0.00	0.00	0.00					
250-ACRE PHASE	0.00	1.26	7.06	0.00	0.00	0.00					
75-ACRE OLD	0.00	2.72	16.12	0.00	31.42	0.00	31.30	1.63	31.66	0.00	
75-ACRE NEW	0.00	0.54	7.06	0.00	0.00	0.00	0.00	67.88	14.76	0.00	0.42
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 2											
BASE CASE	0.00	67.08	42.89	71.18	0.70	0.70	53.53	21.67	0.00	21.12	
250-ACRE OLD	0.00	12.60	34.51	54.21	38.50	0.00	0.00	68.61	0.00	0.00	
250-ACRE NEW	0.00	4.94	60.97	82.60	0.17	0.17					
250-ACRE PHASE	0.00	4.94	56.58	58.00	0.17	0.17					
75-ACRE OLD	0.00	12.30	33.19	54.52	80.17	0.00	0.00	0.00	1.08	39.18	
75-ACRE NEW	0.00	3.78	60.97	82.60	0.17	0.17	15.36	2.62	0.17	57.78	0.17
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 3											
BASE CASE	0.00	0.79	0.11	0.21	0.20	0.21	0.10	0.00	0.00	0.04	
250-ACRE OLD	0.00	0.39	0.13	0.21	0.20	0.21	0.08	0.05	0.00	0.04	
250-ACRE NEW	0.00	0.09	0.00	0.00	0.00	0.00					
250-ACRE PHASE	0.00	0.09	0.00	0.00	0.00	0.00					
75-ACRE OLD	0.00	0.39	0.33	0.21	0.19	0.20	0.14	0.00	0.03	0.01	
75-ACRE NEW	0.00	0.09	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
KY 4											
BASE CASE	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
250-ACRE OLD	0.00	0.02	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
250-ACRE NEW	0.00	0.01	0.00	0.00	0.00	0.00					
250-ACRE PHASE	0.00	0.01	0.00	0.00	0.00	0.00					
75-ACRE OLD	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
75-ACRE NEW	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV C											
BASE CASE	0.00	8.37	11.56	13.29	65.01	70.13	0.43	0.43	0.42	62.96	
250-ACRE OLD	0.00	7.17	12.15	14.47	4.65	96.36	40.28	0.27	0.26	0.49	
250-ACRE NEW	0.00	1.29	6.52	9.28	10.98	0.15					
250-ACRE PHASE	0.00	0.19	22.56	24.25	0.48	0.57					
75-ACRE OLD	0.00	6.69	12.04	10.45	12.14	70.47	66.64	0.69	0.68	0.66	
75-ACRE NEW	0.00	1.23	5.96	9.08	10.78	0.52	0.36	12.82	0.36	0.28	0.24
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
WV E											
BASE CASE	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40	
250-ACRE OLD	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40	
250-ACRE NEW	0.00	0.12	0.00	0.00	0.00	0.00					
250-ACRE PHASE	0.00	0.12	0.00	0.00	0.00	0.00					
75-ACRE OLD	0.00	0.42	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.40	
75-ACRE NEW	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table C-1 (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV N											
BASE CASE	0.00	145.99	144.44	78.27	77.52	37.61	22.33	14.31	0.00	16.93	
250-ACRE OLD	0.00	30.85	141.15	145.22	79.27	52.32	1.60	20.54	7.07	3.92	
250-ACRE NEW	0.00	8.89	124.02	124.94	126.36	127.05					
250-ACRE PHASE	0.00	8.89	124.02	124.94	57.06	57.19					
75-ACRE OLD	0.00	30.85	141.15	145.22	148.57	54.27	9.75	0.48	9.25	5.89	
75-ACRE NEW	0.00	8.89	124.02	124.94	126.36	127.05	27.96	22.60	0.00	0.00	160.31

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV S											
BASE CASE	0.00	0.19	0.00	0.00	0.14	0.14	0.14	0.14	0.14	0.14	
250-ACRE OLD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
250-ACRE NEW	0.00	0.00	0.00	0.00	0.00	0.00					
250-ACRE PHASE	0.00	0.00	0.00	0.00	0.00	0.00					
75-ACRE OLD	0.00	0.00	0.00	0.00	0.14	0.14	0.55	0.55	0.55	0.55	
75-ACRE NEW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV SW											
BASE CASE	0.00	55.12	12.82	102.38	218.00	5.09	124.58	199.99	0.41	14.99	
250-ACRE OLD	0.00	11.35	27.14	49.37	75.72	128.16	11.14	146.14	49.47	83.45	
250-ACRE NEW	0.00	3.07	0.00	134.05	45.54	0.75					
250-ACRE PHASE	0.00	2.68	35.22	128.80	0.21	6.55					
75-ACRE OLD	0.00	9.84	3.65	48.59	147.83	88.42	241.63	0.32	39.85	34.75	
75-ACRE NEW	0.00	1.25	0.00	127.42	29.72	105.64	183.83	65.13	0.00	0.00	0.00

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All WV											
BASE CASE	0.00	210.09	169.20	194.32	361.05	113.35	147.86	215.25	1.35	95.42	
250-ACRE OLD	0.00	49.79	180.82	209.44	160.02	277.22	53.40	167.33	57.18	88.26	
250-ACRE NEW	0.00	13.37	130.54	268.27	182.88	127.95					
250-ACRE PHASE	0.00	11.88	181.80	277.99	57.75	64.31					
75-ACRE OLD	0.00	47.80	157.22	204.64	309.06	213.68	318.95	2.42	50.71	42.25	
75-ACRE NEW	0.00	11.49	129.98	261.44	166.86	233.21	212.15	100.55	0.36	0.28	160.55

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All E. KY											
BASE CASE	0.00	101.94	56.01	71.57	1.07	1.34	84.64	92.17	0.00	21.17	
250-ACRE OLD	0.00	18.10	62.19	54.42	42.47	0.21	0.08	120.51	47.09	0.05	
250-ACRE NEW	0.00	6.30	68.03	82.60	0.17	0.17					
250-ACRE PHASE	0.00	6.30	63.64	58.00	0.17	0.17					
75-ACRE OLD	0.00	15.43	49.64	54.73	111.78	0.20	31.44	1.63	32.77	39.20	
75-ACRE NEW	0.00	4.42	68.23	82.60	0.17	0.17	15.36	70.50	14.93	57.78	0.59

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
VA											
BASE CASE	0.00	67.73	40.88	8.33	6.82	7.05	24.56	13.15	8.53	24.27	
250-ACRE OLD	0.00	19.34	44.45	53.69	6.97	7.18	30.75	13.50	8.05	9.58	
250-ACRE NEW	0.00	9.16	34.00	44.66	7.04	7.05					
250-ACRE PHASE	0.00	9.16	34.00	44.66	7.04	7.05					
75-ACRE OLD	0.00	19.35	45.70	52.59	12.57	7.33	59.92	8.05	8.26	23.08	
75-ACRE NEW	0.00	9.16	36.83	44.24	7.04	7.05	73.64	18.05	1.44	8.74	9.70

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Regions											
BASE CASE	0.00	379.76	266.09	274.22	368.94	121.74	257.06	320.57	9.88	140.86	
250-ACRE OLD	0.00	87.23	287.46	317.55	209.46	284.61	84.23	301.34	112.32	97.89	
250-ACRE NEW	0.00	28.83	232.57	395.53	190.09	135.17					
250-ACRE PHASE	0.00	27.34	279.44	380.65	64.96	71.53					
75-ACRE OLD	0.00	82.58	252.56	311.96	433.41	221.21	410.31	12.10	91.74	104.53	
75-ACRE NEW	0.00	25.07	235.04	388.28	174.07	240.43	301.15	189.10	16.73	66.80	170.84

Table D-1

Average Coal Prices
(Constant 2001 Dollars per Ton, Fob Mine)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	35.22	25.49	25.05	24.74	24.02	24.76	25.27	23.68	25.53	25.11	
250-ACRE OLD	35.22	27.22	25.87	25.31	24.81	24.39	25.14	24.52	25.08	26.45	
250-ACRE NEW	35.22	27.66	27.00	26.36	25.47	26.37					
250-ACRE PHASE	35.22	27.97	27.20	26.57	26.46	26.42					
75-ACRE OLD	35.22	27.63	26.70	26.14	24.38	25.64	24.29	24.74	25.89	26.54	
75-ACRE NEW	35.22	28.89	27.54	26.96	26.14	26.37	26.47	25.33	27.09	26.95	35.82

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 2											
BASE CASE	35.02	25.27	24.70	24.15	23.44	24.49	24.79	23.38	25.37	24.64	
250-ACRE OLD	35.02	27.00	25.44	24.67	24.14	23.86	24.83	24.15	24.80	26.17	
250-ACRE NEW	35.02	27.43	26.60	25.74	24.96	25.91					
250-ACRE PHASE	35.02	27.73	26.79	26.00	25.88	26.00					
75-ACRE OLD	35.02	27.36	26.21	25.40	23.79	25.17	23.97	24.45	25.71	26.07	
75-ACRE NEW	35.02	28.68	27.16	26.38	25.57	25.95	26.02	24.91	26.75	26.41	34.76

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 3											
BASE CASE	34.27	24.31	24.82	22.89	21.84	22.69	23.07	23.25	23.39	22.70	
250-ACRE OLD	34.27	26.19	24.65	23.49	22.73	21.85	23.05	21.62	23.07	24.00	
250-ACRE NEW	34.27	26.64	25.82	24.63	23.61	24.30					
250-ACRE PHASE	34.27	26.95	26.00	24.90	24.59	24.44					
75-ACRE OLD	34.27	26.63	25.44	25.20	22.27	24.65	22.03	23.98	23.88	23.81	
75-ACRE NEW	34.27	27.91	26.42	25.27	24.14	24.09	24.22	22.07	24.87	24.42	33.47

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 4											
BASE CASE	34.88	25.17	24.29	0.00	0.00	0.00	0.00	0.00	25.46	24.58	
250-ACRE OLD	34.88	26.85	25.01	0.00	0.00	0.00	0.00	0.00	24.75	26.03	
250-ACRE NEW	34.88	27.26	26.23	25.04	24.54	25.50					
250-ACRE PHASE	34.88	27.53	26.34	25.27	25.37	25.60					
75-ACRE OLD	34.88	27.16	25.78	0.00	0.00	0.00	0.00	0.00	25.63	26.08	
75-ACRE NEW	34.88	28.48	26.76	25.73	25.08	25.53	0.00	0.00	26.69	26.36	34.40

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV C											
BASE CASE	34.75	25.38	25.09	24.57	23.95	24.49	24.94	22.42	24.09	23.77	
250-ACRE OLD	34.75	26.96	25.97	25.19	24.73	24.16	24.72	23.32	23.70	25.03	
250-ACRE NEW	34.75	27.85	27.32	26.72	25.63	26.08					
250-ACRE PHASE	34.75	28.09	27.62	26.90	26.80	26.31					
75-ACRE OLD	34.75	27.54	26.91	26.22	24.37	25.56	23.75	23.53	24.29	24.96	
75-ACRE NEW	34.75	29.07	28.08	27.31	26.45	26.42	26.51	24.03	25.11	25.19	33.54

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV E											
BASE CASE	35.77	26.11	24.81	23.40	22.48	22.97	23.17	23.06	24.97	25.72	
250-ACRE OLD	35.77	27.61	25.57	23.62	23.04	22.58	23.13	23.38	23.60	26.21	
250-ACRE NEW	35.77	28.21	26.72	25.10	24.23	24.32					
250-ACRE PHASE	35.77	28.50	26.83	25.10	25.12	24.66					
75-ACRE OLD	35.77	27.95	26.01	24.37	22.97	23.30	22.28	23.38	23.87	25.44	
75-ACRE NEW	35.77	29.46	27.02	25.41	24.88	24.04	23.95	23.53	25.23	25.85	33.48

Table D-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	34.91	24.92	23.33	22.66	22.03	22.44	22.64	21.96	23.80	24.21	
250-ACRE OLD	34.91	26.55	24.38	22.86	22.56	22.14	22.68	22.29	22.70	24.88	
250-ACRE NEW	34.91	27.22	25.45	24.40	23.55	23.55					
250-ACRE PHASE	34.91	27.36	25.51	24.46	24.45	23.99					
75-ACRE OLD	34.91	26.79	24.81	23.71	22.42	22.67	21.82	22.25	22.79	23.85	
75-ACRE NEW	34.91	28.28	25.59	24.80	24.08	23.28	23.37	22.41	24.25	23.51	31.48

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	34.22	24.84	24.69	24.50	23.56	24.30	24.87	22.49	24.24	23.88	
250-ACRE OLD	34.22	26.39	24.99	24.50	23.86	23.51	24.49	23.23	23.70	24.52	
250-ACRE NEW	34.22	27.24	26.40	26.57	25.91	26.82					
250-ACRE PHASE	34.22	27.45	26.48	26.34	26.52	26.34					
75-ACRE OLD	34.22	26.91	25.78	25.75	23.97	25.41	23.97	23.65	24.35	24.94	
75-ACRE NEW	34.22	28.30	27.23	27.74	26.71	26.81	27.15	25.26	26.11	25.93	35.33

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	34.09	24.68	24.39	23.99	22.99	23.88	24.48	22.27	24.05	23.65	
250-ACRE OLD	34.09	26.31	25.21	24.46	23.82	23.32	24.34	23.21	23.86	24.84	
250-ACRE NEW	34.09	27.03	26.43	25.87	25.05	25.84					
250-ACRE PHASE	34.09	27.35	26.57	26.09	26.10	25.85					
75-ACRE OLD	34.09	26.84	26.01	25.38	23.41	24.88	23.31	23.55	24.40	24.85	
75-ACRE NEW	34.09	28.38	27.20	26.62	25.73	25.80	25.64	24.19	25.76	25.41	34.65

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	34.48	24.91	24.22	23.68	22.86	23.50	23.82	22.18	23.97	23.91	
250-ACRE OLD	34.48	26.54	25.13	24.07	23.53	23.07	23.78	22.85	23.35	24.89	
250-ACRE NEW	34.48	27.26	26.26	25.48	24.54	24.81					
250-ACRE PHASE	34.48	27.51	26.39	25.61	25.46	25.03					
75-ACRE OLD	34.48	26.99	25.80	24.93	23.22	24.12	22.87	23.00	23.68	24.43	
75-ACRE NEW	34.48	28.51	26.77	26.00	25.08	24.61	24.64	23.30	24.97	24.45	32.41

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	35.09	25.35	24.85	24.37	23.66	24.59	25.00	23.53	25.42	24.82	
250-ACRE OLD	35.09	27.08	25.62	24.93	24.40	24.08	24.95	24.28	24.92	26.26	
250-ACRE NEW	35.09	27.51	26.75	25.96	25.14	26.10					
250-ACRE PHASE	35.09	27.82	26.94	26.21	26.10	26.18					
75-ACRE OLD	35.09	27.47	26.41	25.70	24.01	25.35	24.08	24.57	25.76	26.23	
75-ACRE NEW	35.09	28.76	27.30	26.59	25.78	26.12	26.20	25.06	26.90	26.64	35.28

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	36.44	27.17	26.64	26.10	25.43	26.31	26.95	24.48	26.56	26.14	
250-ACRE OLD	36.44	28.92	27.52	26.53	25.89	25.77	26.78	25.48	26.38	25.15	
250-ACRE NEW	36.44	29.64	28.78	27.57	27.15	28.30					
250-ACRE PHASE	36.44	30.01	28.85	27.85	28.29	28.33					
75-ACRE OLD	36.44	29.56	28.28	27.39	25.62	27.24	25.66	26.08	27.01	25.11	
75-ACRE NEW	36.44	30.97	29.27	28.30	27.76	28.30	27.92	25.32	27.39	27.74	40.17

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	34.91	25.31	24.73	24.19	23.35	24.13	24.58	22.88	24.74	24.45	
250-ACRE OLD	34.91	26.99	25.58	24.67	24.11	23.66	24.49	23.65	24.23	25.33	
250-ACRE NEW	34.91	27.62	26.76	25.93	25.09	25.66					
250-ACRE PHASE	34.91	27.92	26.91	26.13	26.09	25.85					
75-ACRE OLD	34.91	27.45	26.33	25.53	23.76	24.86	23.52	23.88	24.72	25.06	
75-ACRE NEW	34.91	28.90	27.31	26.55	25.71	25.58	25.59	24.18	25.94	25.71	34.72

Table E-1

Megawatt-Hours of Generation

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 2											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 3											
BASE CASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634	
250-ACRE OLD	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634	
250-ACRE NEW	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443					
250-ACRE PHASE	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443					
75-ACRE OLD	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634	
75-ACRE NEW	2,123,435	2,128,837	2,134,238	2,139,640	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634	2,121,634

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 4											
BASE CASE	323,925	374,160	424,395	474,629	423,534	447,754	461,457	0	0	0	
250-ACRE OLD	323,925	374,160	424,395	474,629	423,534	447,754	0	0	0	0	
250-ACRE NEW	323,925	374,160	424,395	474,629	0	0					
250-ACRE PHASE	323,925	374,160	424,395	416,285	0	0					
75-ACRE OLD	323,925	374,160	424,395	416,285	423,534	438,972	472,038	0	0	0	
75-ACRE NEW	323,925	374,160	424,395	474,629	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV C											
BASE CASE	675,656	711,542	680,236	587,926	573,229	34,223	34,223	34,223	34,223	34,223	
250-ACRE OLD	675,656	711,542	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223	
250-ACRE NEW	675,656	711,542	599,116	587,926	34,223	34,223					
250-ACRE PHASE	675,656	711,542	599,116	587,926	34,223	34,223					
75-ACRE OLD	675,656	711,542	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223	
75-ACRE NEW	675,656	610,306	599,116	587,926	34,223	34,223	34,223	34,223	34,223	34,223	34,223

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV E											
BASE CASE	3,055,270	3,084,117	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070	
250-ACRE OLD	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070	
250-ACRE NEW	3,055,270	3,088,025	3,112,963	3,107,471	3,136,002	3,164,533					
250-ACRE PHASE	3,055,270	3,088,513	3,112,963	3,107,471	3,136,002	3,164,533					
75-ACRE OLD	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070	
75-ACRE NEW	3,055,270	3,089,002	3,112,963	3,107,471	3,136,002	3,164,533	3,194,070	3,194,070	3,194,070	3,194,070	3,194,070

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV N											
BASE CASE	21,530,733	21,835,448	21,669,331	21,547,871	21,851,469	19,403,986	19,742,119	18,830,782	18,829,724	18,830,612	
250-ACRE OLD	21,530,733	21,594,004	21,512,683	21,502,314	21,741,207	21,775,492	19,708,842	18,834,237	18,834,237	18,705,238	
250-ACRE NEW	21,530,733	21,564,015	21,512,683	21,385,248	18,920,144	18,744,508					
250-ACRE PHASE	21,530,733	21,482,364	21,512,683	21,370,064	18,922,311	18,746,741					
75-ACRE OLD	21,530,733	21,765,769	21,468,335	21,358,253	21,377,274	19,334,547	19,780,646	18,832,432	18,744,684	16,775,490	
75-ACRE NEW	21,530,733	21,459,256	21,444,980	20,394,415	19,469,692	18,792,819	21,084,586	18,830,553	16,766,117	16,854,873	18,784,214

Table E-1 (cont.)

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	59239

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	25,261,659	25,631,107	25,462,530	25,243,268	25,560,700	22,602,742	22,970,412	22,059,075	22,058,017	22,058,905	
250-ACRE OLD	25,261,659	25,394,548	25,224,762	25,197,711	24,911,432	24,974,248	22,937,135	22,062,530	22,062,530	21,933,531	
250-ACRE NEW	25,261,659	25,363,582	25,224,762	25,080,645	22,090,369	21,943,264					
250-ACRE PHASE	25,261,659	25,282,419	25,224,762	25,065,461	22,092,536	21,945,497					
75-ACRE OLD	25,261,659	25,566,313	25,180,414	25,053,650	24,547,499	22,533,303	23,008,939	22,060,725	21,972,977	20,003,783	
75-ACRE NEW	25,261,659	25,158,564	25,157,059	24,089,812	22,639,917	21,991,575	24,312,879	22,058,846	19,994,410	20,083,166	22,071,746

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,616,851	2,121,634	2,121,634	2,121,634	
250-ACRE OLD	2,447,360	2,502,997	2,558,633	2,614,269	2,568,575	2,598,197	2,155,394	2,121,634	2,121,634	2,121,634	
250-ACRE NEW	2,447,360	2,502,997	2,558,633	2,614,269	2,145,041	2,150,443					
250-ACRE PHASE	2,447,360	2,502,997	2,558,633	2,555,925	2,145,041	2,150,443					
75-ACRE OLD	2,447,360	2,502,997	2,558,633	2,555,925	2,568,575	2,589,415	2,627,432	2,121,634	2,121,634	2,121,634	
75-ACRE NEW	2,447,360	2,502,997	2,558,633	2,614,269	2,145,041	2,150,443	2,155,394	2,121,634	2,121,634	2,121,634	2,121,634

All VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	14,339,034	14,505,891	15,134,866	14,778,080	14,833,424	15,023,532	15,472,500	16,455,296	18,355,939	18,294,427	
250-ACRE OLD	14,339,034	14,516,621	14,684,765	15,029,789	14,835,977	15,015,167	15,364,766	16,458,321	18,215,708	18,979,464	
250-ACRE NEW	14,339,034	14,517,088	14,780,537	14,861,134	14,835,320	14,626,314					
250-ACRE PHASE	14,339,034	14,516,613	14,655,901	15,023,069	14,643,307	14,626,314					
75-ACRE OLD	14,339,034	14,516,621	14,560,432	14,861,643	14,835,977	14,626,314	15,745,919	16,909,042	18,358,965	18,979,464	
75-ACRE NEW	14,339,034	14,732,526	14,608,611	15,094,332	14,294,018	15,271,373	15,801,842	15,729,417	17,392,978	18,297,452	19,430,942

Total Study	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	42,048,053	42,639,995	43,156,029	42,635,617	42,962,699	40,224,471	41,059,763	40,636,005	42,535,590	42,474,966	
250-ACRE OLD	42,048,053	42,414,166	42,468,160	42,841,769	42,315,984	42,587,612	40,457,295	40,642,485	42,399,872	43,034,629	
250-ACRE NEW	42,048,053	42,383,667	42,563,932	42,556,048	39,070,730	38,720,021					
250-ACRE PHASE	42,048,053	42,302,029	42,439,296	42,644,455	38,880,884	38,722,254					
75-ACRE OLD	42,048,053	42,585,931	42,299,479	42,471,218	41,952,051	39,749,032	41,382,290	41,091,401	42,453,576	41,104,881	
75-ACRE NEW	42,048,053	42,394,087	42,324,303	41,798,413	39,078,976	39,413,391	42,270,115	39,909,897	39,509,022	40,502,252	43,624,322

Table F-1

Weighted Average Wholesale Electricity Price (Lambda Cost)
(Constant 2001 Dollars per MWHr)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 2											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 3											
BASE CASE	25.86	18.17	17.68	17.68	18.62	18.59	18.69	20.64	20.82	21.98	
250-ACRE OLD	25.86	18.42	17.47	17.60	18.83	18.36	18.86	20.71	20.90	21.73	
250-ACRE NEW	25.86	18.50	17.76	17.50	19.29	18.65					
250-ACRE PHASE	25.86	18.52	17.69	17.94	19.07	18.53					
75-ACRE OLD	25.86	18.46	17.47	17.42	18.61	18.58	18.43	20.74	20.84	21.86	
75-ACRE NEW	25.86	18.91	17.80	17.89	19.46	18.75	18.71	20.95	21.28	21.98	23.33

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 4											
BASE CASE	24.21	18.17	17.64	17.68	17.61	17.59	17.74	0.00	0.00	0.00	
250-ACRE OLD	24.21	18.42	17.43	17.59	17.80	17.39	0.00	0.00	0.00	0.00	
250-ACRE NEW	24.21	18.50	17.74	17.50	0.00	0.00					
250-ACRE PHASE	24.21	18.52	17.67	17.92	0.00	0.00					
75-ACRE OLD	24.21	18.46	17.43	17.42	17.67	17.58	17.51	0.00	0.00	0.00	
75-ACRE NEW	24.21	18.91	17.78	17.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV C											
BASE CASE	25.87	18.17	17.68	17.68	18.62	18.59	18.69	20.64	20.82	21.98	
250-ACRE OLD	25.87	18.42	17.46	17.60	18.83	18.36	18.86	20.71	20.90	21.73	
250-ACRE NEW	25.87	18.50	17.76	17.50	19.29	18.65					
250-ACRE PHASE	25.87	18.52	17.69	17.94	19.07	18.53					
75-ACRE OLD	25.87	18.46	17.46	17.42	18.61	18.58	18.43	20.74	20.84	21.86	
75-ACRE NEW	25.87	18.91	17.80	17.89	19.46	18.75	18.71	20.96	21.28	21.98	23.34

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV E											
BASE CASE	28.40	20.32	20.75	20.19	21.42	21.48	21.52	22.42	22.73	23.08	
250-ACRE OLD	28.40	20.32	20.50	20.18	21.43	21.48	21.48	22.61	22.74	23.07	
250-ACRE NEW	28.40	20.32	20.54	20.36	21.67	21.57					
250-ACRE PHASE	28.40	20.32	20.52	20.34	21.58	21.52					
75-ACRE OLD	28.40	20.32	20.51	20.21	21.42	21.48	21.48	22.34	22.94	23.07	
75-ACRE NEW	28.40	20.47	20.64	20.28	21.76	21.61	21.61	22.87	23.03	23.19	24.19

Table F-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	26.79	19.44	18.97	18.99	19.93	19.63	19.73	20.75	21.97	22.94	
250-ACRE OLD	26.79	19.70	18.75	18.91	20.14	19.37	19.82	20.83	21.82	22.73	
250-ACRE NEW	26.79	19.77	19.05	18.80	20.74	19.73					
250-ACRE PHASE	26.79	19.79	18.98	19.25	20.51	19.63					
75-ACRE OLD	26.79	19.72	18.75	18.72	19.94	19.62	19.53	20.78	21.85	22.98	
75-ACRE NEW	26.79	20.18	19.09	19.26	20.93	19.81	19.67	20.92	22.26	23.07	24.81

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	23.34

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	26.96	19.51	19.15	19.11	20.08	19.89	19.98	20.99	22.08	22.96	
250-ACRE OLD	26.96	19.74	18.94	19.04	20.30	19.64	20.05	21.09	21.95	22.78	
250-ACRE NEW	26.96	19.80	19.20	18.96	20.87	19.99					
250-ACRE PHASE	26.96	19.82	19.14	19.35	20.66	19.90					
75-ACRE OLD	26.96	19.76	18.94	18.87	20.13	19.88	19.80	21.01	22.01	22.99	
75-ACRE NEW	26.96	20.18	19.25	19.36	21.04	20.07	19.92	21.20	22.38	23.09	24.71

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	25.64	18.17	17.67	17.68	18.45	18.42	18.52	20.64	20.82	21.98	
250-ACRE OLD	25.64	18.42	17.46	17.60	18.66	18.19	18.86	20.71	20.90	21.73	
250-ACRE NEW	25.64	18.50	17.76	17.50	19.29	18.65					
250-ACRE PHASE	25.64	18.52	17.69	17.94	19.07	18.53					
75-ACRE OLD	25.64	18.46	17.46	17.42	18.46	18.41	18.26	20.74	20.84	21.86	
75-ACRE NEW	25.64	18.91	17.80	17.89	19.46	18.75	18.71	20.95	21.28	21.98	23.33

All VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	28.66	20.33	20.64	20.15	21.44	21.43	21.58	22.48	22.83	23.19	
250-ACRE OLD	28.66	20.36	20.39	20.12	21.47	21.41	21.55	22.67	22.82	23.23	
250-ACRE NEW	0.00	20.37	20.47	20.29	21.73	21.59					
250-ACRE PHASE	28.66	20.38	20.44	20.30	21.67	21.54					
75-ACRE OLD	28.66	20.37	20.40	20.15	21.44	21.51	21.40	22.37	23.03	23.26	
75-ACRE NEW	0.00	20.56	20.57	20.30	21.81	21.64	21.62	22.80	23.11	23.28	24.28

Total Study Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	26.84	19.71	19.59	19.38	20.45	20.37	20.49	21.58	22.34	23.01	
250-ACRE OLD	26.84	19.87	19.35	19.33	20.61	20.17	20.56	21.71	22.27	22.93	
250-ACRE NEW	26.84	19.92	19.56	19.34	21.11	20.52					
250-ACRE PHASE	26.84	19.93	19.50	19.60	20.95	20.44					
75-ACRE OLD	26.84	19.89	19.35	19.23	20.49	20.38	20.31	21.55	22.39	23.06	
75-ACRE NEW	26.84	20.24	19.62	19.61	21.24	20.60	20.50	21.82	22.64	23.12	24.45

Table G-1

Utilities' Environmental Clean-Up Capital Expenditures
(Constant 2001 Dollars)

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 1											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 2											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 3											
BASE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
250-ACRE OLD	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
250-ACRE NEW	0	0	0	0	6,720,191	0					
250-ACRE PHASE	0	0	0	0	6,720,191	0					
75-ACRE OLD	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
75-ACRE NEW	0	0	0	0	6,720,191	0	0	16,877,843	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
KY 4											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV C											
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WV E											
BASE CASE	0	0	0	0	7,410,199	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	7,410,199	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	7,253,680	0					
250-ACRE PHASE	0	0	0	0	7,253,680	0					
75-ACRE OLD	0	0	0	0	7,452,999	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	7,253,680	0	0	0	0	0	0

Table G-1 (cont.)

WV N	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	209,349	0	0	19,812,967	21,604,468	0	0	43,012,286	0	0	
250-ACRE OLD	209,349	0	0	34,476,811	27,818,454	0	0	43,012,286	0	0	
250-ACRE NEW	209,349	0	0	30,237,152	16,343,055	0					
250-ACRE PHASE	209,349	0	0	30,237,152	16,364,661	0					
75-ACRE OLD	209,349	0	0	35,224,441	27,517,336	0	0	43,012,286	0	0	
75-ACRE NEW	209,349	0	0	36,333,508	18,899,356	0	0	25,050,168	0	0	0

WV S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

WV SW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	0	0	0	0	0	0	
250-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
250-ACRE NEW	0	0	0	0	0	0					
250-ACRE PHASE	0	0	0	0	0	0					
75-ACRE OLD	0	0	0	0	0	0	0	0	0	0	
75-ACRE NEW	0	0	0	0	0	0	0	0	0	0	0

All WV	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	209,349	0	0	19,812,967	29,014,668	0	0	43,012,286	0	0	
250-ACRE OLD	209,349	0	0	34,476,811	35,228,653	0	0	43,012,286	0	0	
250-ACRE NEW	209,349	0	0	30,237,152	23,596,735	0					
250-ACRE PHASE	209,349	0	0	30,237,152	23,618,341	0					
75-ACRE OLD	209,349	0	0	35,224,441	34,970,336	0	0	43,012,286	0	0	
75-ACRE NEW	209,349	0	0	36,333,508	26,153,035	0	0	25,050,168	0	0	0

All E. KY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
250-ACRE OLD	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
250-ACRE NEW	0	0	0	0	6,720,191	0					
250-ACRE PHASE	0	0	0	0	6,720,191	0					
75-ACRE OLD	0	0	0	0	6,720,191	0	0	16,877,843	0	0	
75-ACRE NEW	0	0	0	0	6,720,191	0	0	16,877,843	0	0	0

VA	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	0	0	0	0	5,458,247	110,240	3,594	11,802,724	0	0	
250-ACRE OLD	0	0	0	0	5,581,295	0	111,617	28,658,885	0	0	
250-ACRE NEW	0	0	0	0	5,145,852	7,448					
250-ACRE PHASE	0	0	0	0	4,988,509	7,448					
75-ACRE OLD	0	0	0	0	5,354,984	110,134	3,594	29,000,638	0	0	
75-ACRE NEW	0	0	0	0	4,715,135	0	0	29,000,638	0	0	0

All Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	209,349	0	0	19,812,967	41,193,105	110,240	3,594	71,692,853	0	0	
250-ACRE OLD	209,349	0	0	34,476,811	47,530,138	0	111,617	88,549,014	0	0	
250-ACRE NEW	209,349	0	0	30,237,152	35,462,777	7,448					
250-ACRE PHASE	209,349	0	0	30,237,152	35,327,041	7,448					
75-ACRE OLD	209,349	0	0	35,224,441	47,045,510	110,134	3,594	88,890,767	0	0	
75-ACRE NEW	209,349	0	0	36,333,508	37,588,361	0	0	70,928,648	0	0	0

Table H-1

Electricity Capacity Capital Investments by Type

(Constant 2001 Dollars)

		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
		MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $	MW Added	Capital $
BASE CASE																					
VA	CC	0	0	288	115,392,000	365	146,052,000	364	145,548,000	384	153,592,000	394	157,736,000	541	216,376,000	0	0	561	224,284,000		
VA	GT	1,182	295,457,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0		
250-ACRE OLD																					
VA	CC	0	0	291	116,512,000	365	145,992,000	364	145,552,000	384	153,592,000	394	157,736,000	541	216,376,000	0	0	561	224,284,000		
VA	GT	1,179	294,792,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0		
250-ACRE NEW																					
VA	CC	0	0	291	116,400,000	365	146,000,000	364	145,600,000	384	153,600,000										
VA	GT	1,180	295,000,000	0	0	0	0	0	0	0	0										
VA	COAL	0	0	0	0	0	0	0	0	0	0										
250-ACRE PHASE																					
VA	CC	0	0	291	116,400,000	365	146,000,000	364	145,600,000	384	153,600,000										
VA	GT	1,179	294,750,000	0	0	0	0	0	0	0	0										
VA	COAL	0	0	0	0	0	0	0	0	0	0										
75-ACRE OLD																					
VA	CC	0	0	291	116,512,000	365	145,992,000	364	145,552,000	384	153,592,000	393	157,336,000	541	216,376,000		0	561	224,284,000		
VA	GT	1,179	294,792,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0		
75-ACRE NEW																					
VA	CC	0	0	291	116,400,000	365	146,000,000	364	145,600,000	384	153,600,000	394	157,600,000	541	216,400,000	0	0	561	224,400,000	549	219,600,000
VA	GT	1,179	294,750,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VA	COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	520	728,000,000	0	0	0	0

Table I-1

Major Coal Mine Operating Costs by Category
For Entire Study Area
(Numbers Do NOT Include Any New Costs Increases for Sensitivity Runs)

	Deep Mines $/Ton	Surface Mines $/Ton
Labor	$6.24	$4.30
Materials/Supply	$3.79	$8.36
Trucking	$1.12	$1.58
Coal Washing	$2.90	$0.40

Table J-1

Average U.S. Wholesale Electricity Price (Lambda Cost)
(Constant 2001 Dollars per MWHr)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BASE CASE	37.25	22.54	22.44	22.32	23.06	22.19	22.33	23.30	23.65	24.12	
250-ACRE OLD	37.25	22.63	22.33	22.24	23.09	22.12	22.36	23.40	23.66	24.12	
250-ACRE NEW	37.25	22.65	22.41	22.30	23.36	22.40					
250-ACRE PHASE	37.25	22.66	22.40	22.28	23.33	22.36					
75-ACRE OLD	37.25	22.64	22.34	22.26	23.07	22.17	22.12	23.41	23.64	24.12	
75-ACRE NEW	37.25	22.82	22.45	22.35	23.40	22.45	22.46	23.48	23.85	24.24	25.23

Final Case Studies Report on
Demographic Changes { TC \l1 "}
Related to Mountaintop Mining Operations

Carcassonne, Kentucky{ TC \l2 "}

August 2002

Prepared By:

Gannett Fleming

Final Case Studies Report on Demographic Changes { TC \l1 "}

Related to Mountaintop Mining Operations

August 2002

Carcassonne, Kentucky{ TC \l2 "}

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EXECUTIVE SUMMARY

The purpose of this study is to evaluate what, if any, demographic changes can be observed in communities located adjacent to large-scale mountaintop surface mining operations. The demographic evaluations presented herein for these communities were based on three decades of census data (i.e., the 1980, 1990, and 2000 decennial censuses) in order to assess the demographic trends that have occurred over time: "prior to the introduction of surface mining operations into the case study community (i.e., 1980)," "during mountaintop surface mining (i.e., 1990)," and "after mountaintop surface mining (i.e., 2000)," respectively.

Analysis of available U.S. Census data and personal accounts collected from residents in selected communities were used to identify socioeconomic shifts over a three decade period. Supplemental information was also collection to assist in the evaluation. The following are the selected case study areas.

- Hamilton District, community of Werth, Nicholas County, WV
- North Elkin District, community of Kyle, McDowell County, WV
- Hardee District, community of Naugatuck, Mingo County, WV
- Hardee District, community of Scarlet, Mingo County, WV
- Blackey Division, community of Carcassonne, Letcher County, KY
- District One, Wyoming County, WV as the Control Area.

Generally, the census data supports the personal accounts of social and economic shifts within the areas of study. Also, the high occurrence of similar experiences in four different communities adjacent to large-scale surface mining operations supports some correlation between the socioeconomic trends observed and the presence of surface mining.

Census data demographics were studied for three time periods: 1980 U.S. Census presenting data from 1970-1979 or the “pre-mining period”; 1990 U.S. Census presenting data from 1980 - 1989, or the “during-mining period”; and the 2000 U.S. Census presenting data from 1990 - 1999 or the “post-mining period”. Various social and economic demographics were analyzed, such as population, income, and employment. Hamilton District in Nicholas county was the only district that had an employment trend that would be expected; an increase for the during mining condition and a decrease for the after mining condition. Employment increased during mining in two of the four case study magisterial districts and decreased after mining in two of the four case study magisterial districts, but not the same two. The control district did not experience an increase in employment in the during mining condition but experienced a decrease in employment in the after mining condition. The number of persons working in their resident county increased in Hamilton district for the during mining condition, this was the only district where this occurred. Unemployment did not decrease in any of the case study areas for the during mining condition.

Per capita income increased during mining in only one of the case study magisterial districts. Per capita income decreased after mining in one of the case study magisterial districts and in the control district. This income increase during mining and decrease after mining was not in the same district.

Real growth in median household income decreased in double digits in all case study areas as compared to a four and a half increase nationally.

For most of the case study areas, the number of persons receiving public assistance did not decrease in the during mining condition. Public assistance decreased in one of the case study districts and in the control district in the during mining condition. The number of persons living in poverty did not decrease in the during mining condition in any of the case study districts or the control.

Educational attainment, persons receiving high school or college degrees, increased in the during mining and after mining conditions for all case study areas and the control area with one exception. High school diploma attainment did not increase in the Blackey Division in the during mining condition although college degree attainment increased.

The North Elkin District is the only case study area with a notable black/African American population. It does not appear that the economic conditions for residents of this district improved in the during mining condition. Large percentage point increases in poverty levels were experienced in McDowell County and the North Elkin district. Employment did not increase nor did income increase in this district during mining. One of the topics evaluated in this study is whether there are indications of greater relocations or displacement in non-white racial areas. A sample of property ownership data from the North Elkin District did not display a pattern of large-scale purchase of properties by extraction or land holding companies. However, a sample of property ownership data from Superior Bottom another racially integrated community shows a 52 percent shift from private ownership to land holding company ownership.

Population decreased in all of the case study areas during mining and after mining. The number of students enrolled in public school districts decreased in all of the case study areas including the control area. The senior age group is comprising an increasing percentage of the total population within each of the study areas. Population, gender and age group trends indicate a less stable and increasingly elderly population.

These trends were apparent in the personal accounts of the residents. In each of the communities for which interviews have been collected, residents cited similar economic, physical and social impacts related to surface mining. When asked about benefits from the presence of surface mining, the only benefit consistently mentioned was jobs. The creation and retention of, equitable jobs was the most important economic factor tying the communities to the surface mining industry. Each of the families interviewed was either supported by the mining industry at one point or had an immediate family member who was. The overall decline in employment and specifically the decline in mining related employment in the study areas highlights the importance of local job opportunities.

Discussion of quality of life impacts within interviews centered around physical changes to the community and individual properties and social shifts, such as changes in population and personal relationships. Some physical changes were mentioned by residents of all communities such as, occurrences of disruptive dust, deteriorated ground water and changed wildlife habitat associated with the presence of surface mining. A few residents cited positive changes but most cited negative changes.

> ...[the mountaintops] basically, for a period of time, become grasslands. Which for the all the vegetation that comes is good for the animals and the birds and environment… for them to prosper. I think this "Keep West Virginia Green"; the coal miners did not fall short in returning their areas to green."
> (resident of Werth, WV)

> "I am talking about rock, slate, goobs- probably a little coal - anything that they, dirt, anything that they would dig up on top of the mountain, when it rained it came down...It filled up the creeks. It filled up the creek beds and the creek would be wandering around and basically make into a swamp." (resident of Werth, WV)

> “I'm not against mining whatsoever, it's just that those of us that feel the effects of the damages and things like that. You know, they need to take care of us. Do something to prevent further damage, to keep us safe...” (Past Resident of Scarlet, Mingo County, WV)

While these physical impacts were not universally reported by every resident, they were consistently reported across communities and they contributed to some residents' decisions to leave their communities.

Residents from each of the communities, described close-knit and intimate social structures, often based around one or two extended families. The residents reported that the predominate change to social community was the loss of population. With the notable exception of one community, this population loss was directly attributed by residents to the presence of surface mining. In addition, property ownership records support this finding in three communities in which coal and land holding companies have purchased large percentages of land in the community. Each of these three communities had distinct individual experiences surrounding these significant population shifts; however, one common theme which emerged was the negative impacts population shifts of this scale can have on close-knit community structures. Few of these residents felt that their community was likely to recover and rebuild the same type of social networks and relationships that they once had.

I. INTRODUCTION

This study endeavors to evaluate and describe the socioeconomic changes to adjacent communities, families and individuals from the presence of large-scale surface mining within or adjacent to a community. A review of the "pre-mining", "during-mining" and "post-mining" socioeconomic conditions is evaluated.

The methodology section defines how mining conditions were determined and describes the method and criteria for case study selection. The methodology for the census data evaluation, collection of community interviews and supplemental data collection are also described in section two.

The selected case study areas and communities are defined and described in section three. Photographs of the case study areas are presented in an attachment to this report. The results of the census data evaluation are presented in section four.

Interviews with current and previous property owners and their family members were conducted. These interviews allowed individuals to express their personal and family experiences related to the presence of large-scale surface mining in their communities over time. These interviews are summarized within section five. The interviews are fully transcribed and included as an attachment to this report. The purpose of this effort is to supplement existing data within the EIS, and to provide a first-hand description of community life adjacent to large-scale surface mining. It is recognized that this is a limited sample, and therefore any conclusions drawn must take the sample size into consideration. The focus of the community narrative portion of the report is to present common themes and points of difference rather than analyze each interview in detail.

The results of the property ownership evaluation are presented in section six. The results of the school enrollment data evaluation are presented in section seven.

A review of other available studies and reports concerning the socioeconomic impacts on communities, families and individuals was conducted to aid in understanding the socioeconomic trends over time and the themes presented in the individual interviews. These studies and reports include social analysis of family and community structures in rural Appalachia, discussions of socioeconomic impacts related to large-scale community change and other sources of discussion on community impacts from surface mining. A summary of the findings of data collection efforts and the review of other relevant sources is presented in section eight. Conclusions of the demographic evaluation are presented in section nine.

II. METHODOLOGY

The purpose of this study is to evaluate what, if any, demographic changes can be observed in communities located adjacent to large-scale mountaintop surface mining operations. The demographic evaluations presented herein for these communities were based on three decades of census data (i.e., the 1980, 1990, and 2000 decennial censuses) in order to assess the demographic trends that have occurred over time: "prior to the introduction of surface mining operations into the case study community (i.e., 1980)," "during mountaintop surface mining (i.e., 1990)," and "after mountaintop surface mining (i.e., 2000)," respectively.

A. CASE STUDY AREA SELECTION CRITERIA

1. Case Study Areas

In order to study demographic changes that can be associated with the introduction of surface mountaintop mining operations, a search for six case study areas was conducted based upon specific selection criteria. Case study areas were required to lie within the project study areas of West Virginia, Kentucky and/or Virginia.

One of the case study area was selected as a control area. The control area is defined as an area which is similar in demographics, geography and economic resources but within which very little or no significant surface mining has taken place within the time period identified in the study. The control study area provides a baseline for comparison of demographic changes identified in the remaining case study areas.

The intent of the selection criteria is to identify case study areas which best fit the timing of mining (prior to surface mining - 1970 to 1980, during surface mining - 1980 to 1990, and after surface mining - 1990 -2000) and to eliminate potential case study areas whose demographic components were likely shifted by other factors. These criteria were evaluated:

- Availability of census data for demographics of interest (i.e., population, education levels, income, unemployment levels)

- Consistent size and orientation of the census county subdivisions. For example, the 1980, 1990 and 2000 data need to be reflective of the same geographic area.

- Timing of Mining. The case studies should be representative of areas for which large-scale surface mining did not occur in the vicinity until the 1980s and ceased to occur in the 1990s.

- Level of underground mining. Timing of underground mining, closure of underground mines. The case studies should be areas for which deep mine closures are not prevalent in the "during mining" period.

The following factors were also used to screen out potential case study areas. These factors were evaluated to assess the degree to which the demographic changes would most likely be attributed to other variables instead of the introduction of large-scale surface mining into the area during the three-decade study period.

- Major Infrastructure Investment
  - Transportation/Access
  - Communication/Utilities
  - Educational System e.g. expanded university system

- Natural Disaster (e.g., flood)

- Major Economic Investment
  - Major Employer other than surface mining
  - Economic Resources or Market (e.g., tourism trade) other than surface mining

The above criteria were reviewed using available state mining permit data, U.S. Census Bureau data and mapping and historic mapping. For the purposes of this report "Major" is defined as beyond the scale of investment made in similar communities, and representing a change of considerable magnitude when compared to historical investment within the area.

2. Case Study Communities

From within the selected case study areas, communities were selected to collect first-hand accounts of community life adjacent to large-scale surface mining over time. The communities were selected based upon the following criteria in order of importance:

- Proximity to large-scale surface mining;
- Relative size and economic base of the community; and
- Timing of mining criteria established for case study area selection.

These criteria were established so that residents within selected communities would have experiences relevant to the study, the community would be minimally influenced by other economic factors, and where possible conclusions could be compared to the demographic analysis of the larger case study area.

B. CENSUS DATA DESCRIPTIVE STATISTICS

Census data were collected for the case study areas on the county subdivision level (magisterial district). Descriptive statistics were performed on select demographic parameters.

An historical trend analysis of the population was developed for the study period using the total population counts from the decennial censuses. This information is presented in tabular and graphical formats, and is compared to the population trends experienced at the county and state levels. The population characteristics include age, gender, race, density, family type and household type.

Data were inventoried to characterize occupation types and industry sectors and includes an employment status comparison of males to females ages 16 and over. The major (i.e., 2-digit SIC or NAICS codes) industry sectors were used to determine changes over time in the total number of persons employed. Employment rate trends were inventoried and compared to regional trends, including the county and state.

Median income levels were compared for each period: before, during and after-mining and real income growth was evaluated. The U.S. Census provides a variety of income level parameters that can be used to measure the affluence of the local population. Specifically, median family income, median household income and per capita income levels were inventoried for each decennial census period and adjusted for inflation. The U.S. Bureau of Economic Analysis' Consumer Price Index (CPI) was used to adjust the various 1970, 1980 and 1990 income levels to the most current dollar value. The adjusted values demonstrate whether the case study areas experienced real growth in income.

The decennial census data also provides data on the number of persons receiving their income from social security, unemployment compensation, welfare or other public assistance. A historical analysis was performed to measure the change in the number of persons receiving income from these sources. This information provides insight on the trends associated with the case study area's retired population and the number of persons dependent on public assistance services.

The incomes of families and unrelated individuals are classified as being above or below poverty by comparing their total income to a cutoff or poverty threshold. The U.S. Census Bureau determines the poverty status for all persons in an area. The poverty status for each study area was inventoried and compared with the poverty status for the county and state. These values are presented in tabular and graphic formats.

C. COMMUNITY NARRATIVE INTERVIEWS

Personal accounts were collected through interviews to highlight the human aspects and quality of life impacts of large-scale mountaintop mining. A goal of the study was to collect five personal interviews per community.

The interviewed residents were selected at random according to the following procedure:

1. Parcel identification numbers for the selected community were identified based on county tax records.
2. A computer program written in the Microsoft Visual Basic programming language was used to randomly select 6 parcel numbers per case study area.
3. A review of tax records for the randomly selected parcel identification numbers was done to identify the current owner(s), and most recent private owner(s).
4. If the most recent date that the property was owned by a private individual(s) is earlier than

1980, then no interview was conducted for that parcel.

5. If individuals selected for interviews could not be located or did not wish to be interviewed, the process described above beginning with the selection of a randomly selected parcel number(s) was repeated until five interviews were conducted for each of the five case study areas.

Interviews were tape recorded and transcribed to ensure accuracy. The identities of all of the interviewed residents have been kept anonymous and no names or contact information are included in the demographic study report. Prior to the interview, the nature of the interview, the use of the information being collected and the scope of the interview were discussed with each resident.

A predetermined series of questions provided the framework for each interview to ensure a reasonable level of consistency. These questions are outlined below:

1. Individual/Family Context

Please tell me a little bit about yourself and your family.

What are your connections to this area? When did you/your family first arrive and from where?

2. Quality of Life

Did you observe or experience changes in quality of life related to community resources (schools, public services or natural resources) within the three time periods?

Was the community impacted by a change in population or shift in local demographics?

What is it about this particular community that you like? Has that changed?

Was there a change in your perspective regarding the future of the community? And did this relate to the presence of surface mining in any manner?

What have been the benefits from the presence of surface mining for your community?

4. Public Relations

What public information was available to you/the community regarding the introduction/activities of surface mining?

Were public relations between the community and the surface mining company continued beyond initial contact? In what circumstances?

5. Decision to Leave (for residents who left the community)

What were the primary factors in your decision to do so?

How did you feel about your decision to leave?

To what area did you move, and why?

Did you receive any assistance in relocating?

D. ADDITIONAL DATA

1. School Enrollment

School enrollment (grades K-12) data were gathered from local education entities (e.g., school districts, state education agencies). Enrollment data reflect community resource impacts and school closures as a function of displacement. Data were predominately collected at county and state-level school district and board of education offices. Enrollment data for each of the case study areas were collected for the periods before, during and after mining conditions where available. This information is presented in tabular and graphic formats to measure and illustrate changes in local school enrollments over time.

2. Property Transfer

Property ownership records were collected to document property ownership trends and population displacement. Data were collected from county tax assessors' offices for a series of randomly selected tax parcel numbers. The identified tax parcels were a representative group of properties from the selected area in which the community narratives were gathered, including those parcels owned by the interview residents. The record of last sale was identified for each property within the representative sample of no more than 25 properties. From card files, the following property transaction information was gathered: who sold the property, who purchased the property and when the purchase was made. Where available, the amount of purchase was also noted. As with the community narratives, the personal ownership information has been kept anonymous, and the parcel tax identification numbers are not included in the report. Individual owners are not named, but they are categorized as “individual owner,” “land holding company,” “mineral extraction company” or “other”. “Other” may include public agencies such as a municipality or school district, or private entities such as a church or fellowship hall. The real estate transfer data are presented in tabular and graphic formats to illustrate changes in property ownership patterns over time.

III. CASE STUDY AREA SELECTIONS

A. CASE STUDY AREAS AND COMMUNITIES

The U.S. Census Bureau County Subdivision was selected as the smallest geographic unit for the case study areas based upon availability of census data across a three-decade time period. Data for smaller geographic areas, such as the Census Tract, were not consistently available for 1980 census data within the project study area. A review of available mining permit and mapping data revealed that very few census county subdivisions sufficiently met the selection criteria. Based upon this review, a total of five county subdivisions were chosen which best fit the selection criteria, one of which was selected as the control area. This was one less case study area then the project goal of six. Within the five selected county subdivisions, a total of five case study communities were identified. Two of the case study communities were located in the same county subdivision and no case study community was selected within the county subdivision identified as the control area.

The following are the selected case study areas.
- Hamilton District, community of Werth, Nicholas County, WV
- North Elkin District, community of Kyle, McDowell County, WV
- Hardee District, communities of Naugatuck and Scarlet, Mingo County, WV
- Blackey Division, community of Carcassonne, Letcher County, KY
- District One, Wyoming County, WV as the Control Area

Table 1 illustrates the relationship between the case study areas (county subdivisions) and the case study communities. A brief description of each selected case study area and case study community in regards to the selection criteria is provided below.

1. Hamilton District, Nicholas County, WV

Within the Hamilton District portion of Nicholas County there are few significant areas of employment generation or large-scale investment. Summersville, the County seat of Nicholas County, lies to the south of this area and Interstate 79 lies to the north. The majority of surface mining (63 percent of permits) began in the 1980s and ended in the 1990s. An additional 23 percent of surface mining permits were issued during the 1970s and had either been completely released or had reached a level of reclamation by the 1990s. Underground mining activity through the three-decade period was minimal relative to other areas in the region, and underground mine closures were not significant during the "during-mining" period of the 1980s. U.S. Census data are available for the three-decade period for Hamilton District.

Community: Werth, WV

The community of Werth is within approximately two miles of a 100 + acre surface mine lying to the North and West. Mine permit information and mapping made available by the state of West Virginia website indicate that this site is currently being reclaimed to forest land, and fish and wildlife habitat. In addition to the above mentioned surface mine site, another surface mine which was completely bond released by the early 1990s lies along the North side of Route 55 approaching the community. The community of Werth itself has an estimated population of less than a few hundred people and only one other significant employer in the immediate area.

2. North Elkin District, McDowell County, WV

This portion of McDowell County has few significant employment centers. The largest employment center in McDowell County, Welch, is not included in the North Elkin District. There is no large-scale infrastructure, such as an Interstate highway, in this District. Of the total surface mining permits 39 percent fit exactly within the criteria established for timing of mining, and 65percent of all surface mining permits had reached at least some phase of release by the date of this report. Of the total 57 underground mining permits in the District, none of the permits ended in the 1980s. This total number of underground mining permits is within a similar range of underground mining activity in other selected case study areas. U.S. Census data were available for the three-decade period for North Elkin District.

Community: Kyle, WV

State permit data indicate a surface mine about 3/4 of a mile southwest of the community. While the permit for this 486 acre mine was revoked in 1993, the West Virginia Office of Surface Mining field office in Welch, WV confirms that prior to being revoked, the status of this mine was "Phase 3 - Released" indicating active mining in the 1980s. The community consists of less than 100 homes and a church along the highway, and down in a valley.

3. Hardee District, Mingo County, WV

Overall, Hardee District had fewer numbers of surface mining permits than other areas; however, of those permits just under half (42percent) fit the criteria for timing of mining. In addition, underground mining permits were minimal and activity on these permits is on-going, therefore, not impacting demographic shifts within the three-decade period. US Route 119 crosses a portion of the Hardee District; however, the largest employment center within the immediate region, Williamson, does not lie within the Hardee District. U.S. Census data were available for the three-decade period for Hardee District.

Community: Scarlet, WV

The community of Scarlet is located adjacent to four permits for surface mines which total more than 1000 acres, and list mountaintop removal, auger, contour and area mining. Each of these permits was first issued in the 1980s and are currently listed as in some phase of reclamation. The community of Scarlet is entirely residential and has an estimated population of less than 100.

Community: Naugatuck, WV

Within a few miles of Naugatuck to the northeast, there are several surface mining permits which total approximately 900 + acres. These sites list issue dates in the 1980s and had reached at least Phase 1 or 2 Release by the 1990s. The community of Naugatuck has a small commercial area and a population of a few hundred homes.

4. Blackey Division, Letcher County, KY

This portion of Letcher County has few significant employment centers and no large-scale infrastructure investments. Whitesburg, the Letcher County seat and the area's largest economic center, south of the Blackey District. Of the total surface mining permits 38percent fit exactly within the criteria established for timing of mining. Available data did not permit analysis of the number of underground permits which were completed in the 1980s; however, the total number of underground mining permits was within a similar range of underground mining activity in other selected case study areas. U.S. Census Bureau data are available for the three-decade period for Blackey District.

Community: Carcassonne, KY

Available Kentucky mining permit data indicate several surface mining permits immediately surrounding the community of Carcassone, all closed by the date of this report. Further visual and anecdotal evidence indicates that surface mining occurred in the 1980s and were reclaimed in the 1990s. The community of Carcassonne has an estimated population of less than 100 and no commercial areas.

5. Control Area - District One, Wyoming County, WV

Within this area of Wyoming County there are few surface mining permits, a total of eight permits within the three-decade time period. As with other areas in southwestern West Virginia, underground mining was on-going during this period and Wyoming County had a total of 47 underground mining permits which is in the middle of the range of underground mining activity for the selected case study areas. In addition, there are no significant economic centers or major infrastructure within the District One area. Wyoming County is similar to the selected case study areas in its population demographics and economic base. For example, the 1990 per capita income of Wyoming County is between that of McDowell and Nicholas Counties as shown in Table III.P.3 of the EIS. Therefore, District One fits within the criteria of a control in that the primary characteristic which differs between it and the selected case study areas is the presence of significant large-scale surface mining.

B. CASE STUDY COMMUNITIES

Each of the above selected communities met the criteria identified regarding presence of large-scale surface mining within or adjacent to the community and lie within an area also being evaluated as part of the demographic analysis presented in Section IV. While the overall county subdivision area demographic analysis focused on the pre, during and post-mining periods of 1970-1980, 1980-1990 and 1990-2000, the presence of surface mining adjacent to interview communities do not necessarily fit within these time frames. The community interviews are samples of personal and family experiences, therefore, the focus was the selection of communities where surface mining may have played a role in the socioeconomics of the community. The dates in which mining occurred was a secondary concern to the adjacency and the completion of the full pre-mining to post-mining cycle. The extent to which surface mining may have played a role in the socioeconomics of the community was defined by proximity of surface mining to the community and scale of the surface mining.

The common theme between the communities is their proximity to large-scale surface mining. The majority of the communities are small, with a total population no larger than 500 families, with the exception of Naugatuck. Scarlet could be characterized as a more traditional hollow settlement, to some scale isolated and geographically located in a ravine between mountain hillsides. Werth, Kyle and Carcassonne are also traditional family settlements but were developed predominately along either bottom land or hillside land along a road corridor.

In addition to the five study communities, a small number of interviews were collected as supplemental accounts in Blair, WV and Superior Bottom, WV. A summary of these interviews are also presented. Both Blair, WV and Superior Bottom, WV are presented as additional examples of communities with large-scale surface mining immediately adjacent to the community; however, surface mining is on-going in these communities. Therefore, since Blair and Superior Bottom are currently still within a during-mining phase, these areas do not fit the selection criteria.

IV. CENSUS DATA DESCRIPTIVE STATISTICS

The purpose of this section is to use census data to evaluate what, if any, demographic changes can be observed in the selected census county subdivisions. Census data for the demographic evaluations were collected for three distinct time periods (i.e., the 1980, 1990, and 2000 decennial censuses) to assess trends that have occurred over time: "prior to the introduction of surface mining operations into the case study community (i.e., 1980)," "during mountaintop surface mining (i.e., 1990)," and "after mountaintop surface mining (i.e., 2000)," respectively. The case study areas and their respective census divisions for which the 1980, 1990, and 2000 census data were collected are shown in Table 1. Figures 1 through 5 illustrate the location of these case study communities in relation to the census divisions within which they are located.

The North Elkin Magisterial District, which is a county subdivision of McDowell County, West Virginia is presented in Table 1. Prior to 1990, the North Elkin District consisted of three individual county subdivisions—Adkin District, Elkhorn District, and the North Fork District. In addition, the North Elkin District boundary changed between the 1990 and 2000 Censuses. Specifically, a portion of the Browns Creek District (McDowell County, WV) was annexed to the North Elkin District. Figure 1 illustrates the boundary. While this annexation caused the North Elkin District's total land area to increase from 122.1 square miles to 130.3 square miles, it is perceived not to have produced any significant impacts on the outcome of this study.

Figure 2 depicts the Hardee Magisterial District, a county subdivision of Mingo County, West Virginia. Figure 3 depicts the Hamilton Magisterial District; a subdivision of Nicholas County, West Virginia. The communities of Naugatuck and Scarlet are located in the Hardee Magisterial District, while the community of Werth is located in the Hamilton Magisterial District, West Virginia.

The District 1 Magisterial District, located in Wyoming County, West Virginia, was selected as the control area for the descriptive statistics analysis. District 1 is an area having similar demographics, geography, and economic resources as the other case study area census divisions (i.e., North Elkin, Hardee, and Hamilton Districts, and Blackey Division), but has experienced little or no significant surface mining activity within the 1980, 1990, and 2000 time periods. The control area provides a baseline of demographic comparisons identified in the five case study communities. As illustrated in Figure 4, District 1 was (i.e., 1980 and 1990 Censuses) wholly comprised of the Barkers Ridge and Slab Fork Districts.

The following sections present the descriptive statistical analysis performed for the study area states, counties, and county subdivisions. The 1980 and 1990 census data presented herein for the North Elkin District and District 1 represent, where feasible, the total census enumerations for their respective historic subdivision boundaries (e.g., the 1980 census population counts for the Adkin, Elkin, and Northfork Districts were summed to represent the total population counts for the North Elkin District).

A. POPULATION CHARACTERISTICS

1. Total Population Growth Trends

Table 2 details the 1980, 1990, and 2000 total population enumerations and growth trends for the study area states, counties, and subdivisions. All of the case study areas experienced varying rates of population decline over the 1980 to 2000 census period.

Figures 6 and 7 illustrate the population trends experienced at the county and subdivision levels, respectively. McDowell County, from 1980 to 1990, experienced the largest percentage decrease (-29.4 percent) , followed by Wyoming (-19.5 percent), Letcher (-12.0 percent), Mingo (-9.6 percent), and Nicholas (-4.8 percent). Except for Mingo County, the population declines in the study area counties slowed during the 1990 to 2000 Census period. McDowell County, however, continued to experience the largest percentage decrease (-22.4 percent), followed by Mingo (-16.3 percent), Wyoming (-11.3 percent), Letcher (-6.4 percent) and Nicholas (-0.8 percent).

Most of the study area county subdivisions experienced somewhat similar population trends as their respective counties; whereby, the rate of population decline was lower during the 1990 to 2000 census period compared to the 1980 to 1990 census period. Exceptions, however, are noted for the Hardee and Hamilton Districts; whereby, their rates of population decline increased from -10.5 percent to -13.2 percent, and -1.0 percent to -4.7 percent, respectively.

Figure 8 provides a comparative illustration of the percentage change in population enumerated for each study area and their respective county and state. This figure depicts that the largest percentage decrease in population occurred during the 1980s for the majority of the study areas. Exceptions to this trend are noted for the Hardee and Hamilton Districts. On a county basis, the largest percentage decrease in population occurred during the 1980s for all counties except for Mingo county. West Virginia as a whole had a greater decrease in population during the 1980s, while

Kentucky as a whole had a greater decrease in population during the 1990s.

In general, the population decreases experienced by the study area counties and their respective subdivisions may, in part, be associated with their respective out-migration trends. For example, from 1990 to 1997 the net domestic migration values as enumerated by the Census Bureau for the study area state and counties (Figure 9) closely resemble the population trends presented in Table 2 during the 1990 to 2000 census period. Therefore, it is highly probable, that the large population decreases experienced by the study area jurisdictions during the 1980s may have, in part, been caused by an increase in their net out-migration patterns, in other words, people left the area.

2. Population Density

Table 3 provides a historic comparison of population densities (persons per square mile) for the study area states and counties, and their respective study area subdivisions. Except for Kentucky, all surveyed jurisdictions experienced an overall decrease in their respective population densities over the 1980 to 2000 Census period.

At the county level, the largest numeric decreases in population density values over the 1980 to 2000 Census period were experienced by McDowell (-42.2), Mingo (-21.4), Wyoming(-20.6), and Letcher (-16.0) Counties, while Nicholas County experienced only a slight decrease (-2.5). At the county subdivision level, the North Elkin District experienced the largest numeric (-44.1) decrease in population density value followed by the District 1 (-23.2), Hardee (-11.6), and Hamilton (-1.2) Districts. These trends are reflective of the population trends shown in Table 2.

3. Age Group Distribution

An examination of age structure is of interest in demographic analysis because human behavior is related to life cycles. For example, increases in the school-age population affect the demand for educational services

Persons 20 to 44 years (i.e., young adult age group) of age represent the group most eligible for marriage and most frequently engaged in new household formations. This is also the prime childbearing age group. Therefore, any decline or imbalance in the number of persons within this age category will directly impact the birth rate. Furthermore, this age group represents the basic segment of the population that comprises the local labor force and the group most frequently engaged in home buying or building activities.

The mature age group, is comprised of persons ranging from 45 to 64 years of age, and tends to be more settled and at the height of their earning power. Persons 65 years of age and older (i.e., senior age group) are generally characterized as having (1) a limited purchasing power, (2) an increased demand for health and public transit services, and (3) are increasingly dependent on fixed income sources, such as social security, pensions, and/or public assistance.

Age level data (i.e., absolute number of persons ages 0-85 and over) were collected from the 1980, 1990, and 2000 Censuses for the study area states, counties, and their respective subdivisions. These data were then categorized into the four age groups and subsequently calculated as percentage distributions to represent the population age composition for each census year. Figures 10 through 13 illustrate the age group trends by study areas during the 1980 to 2000 time period.

As illustrated in Figure 10, all study area jurisdictions experienced declines in their school age populations over the 1980 to 2000 Census periods. These trends are indicative of the population declines experienced over the 1980 to 2000 census periods.

Figure 11 demonstrates that all study area jurisdictions, except for District 1, experienced increases in their young adult populations during the 1980s, which may have resulted from the shift (i.e., aging) of the 1980 school age group into the young adult age group. Supporting this aging trend is the fact that from 1990 to 2000, all study area jurisdictions experienced a decrease in their young adult populations, which likely resulted from a combination of the population declines and aging trends.

Figure 12 clearly demonstrates that the mature age group was the fastest growing segment of each study area's population during the 1990 to 2000 period. In fact, McDowell County and the North Elkin District rebounded from their young adult population declines during the 1980s. These trends are, again, indicative of an aging population.

Figure 13, demonstrates that in all study areas, the senior age group is comprising an increasingly larger percentage of the total population.

4. Gender Composition

The distribution of males and females in an area directly impacts future family formation patterns and subsequent birth rates. Traditionally, a higher proportion of females is considered more favorable to maintain a stable population. Table 4 shows the male to female ratio trends (i.e., 1980, 1990, and 2000) for the study area states, counties, and subdivisions. Values greater than 1.0 indicate that males outnumber females.

Except for the Hamilton District, the majority of the study areas populations consisted of more females than males [Other exceptions are noted for the 1980 Census where the number of males exceeded the number of females in the Hardee District (1.01) and Letcher County (1.15)]. While the majority of the study area jurisdictions experienced population decreases, Figure 14 illustrates that the majority of the study area jurisdictions experienced a greater decrease in the number of males than females over the 1980 to 2000 period (Exceptions to this trend are noted for the Hamilton and District 1 subdivisions). The overall trends presented in Table 4 and Figure 14 indicate that the majority of the study area jurisdictions are achieving a favorable mix of males to females which, again, is vital to stabilizing the study areas' population declines.

5. Household Formation Trends

A household, according to the U.S. Census Bureau, consists of people who occupy a housing unit. A house, an apartment or other group of rooms, or a single room, is regarded as a housing unit when it is occupied or intended for occupancy as separate living quarters; that is, when the occupants do not live and eat with any other persons in the structure and there is direct access from the outside through a common hall. A household includes the related family members and all the unrelated people, if any, such as lodgers, foster children, wards, or employees who share a housing unit. A person living alone in a housing unit, or a group of unrelated people sharing a housing unit such as partners or roomers, is a also considered as a household. The count of households excludes group quarters.

The Census Bureau defines two major types of households: "family" and "non-family." A family is a group of two or more people (one of whom is the householder) related by birth, marriage, or adoption and residing together; all such people (including related subfamily members) are considered as members of one family. A non-family household consists of a householder living alone (a one-person household) or where the householder shares the home exclusively with people to whom he or she is not related.

Changes in the number and types of households depend on population growth, shifts in the age composition of the population, and the decisions individuals make about their living arrangements. Demographic trends in marriage, cohabitation, divorce, fertility, and mortality also influence family and household composition. Additionally, changes in norms, values, laws, the economy, and improvements in the health of the elderly over time can influence people's decisions about how they organize their lives. The effects of these trends and individual decisions produce aggregate societal changes in household and family composition.

Raw household data (i.e., total households, total family households, and total non-family households) were collected from the 1980, 1990, and 2000 Censuses for the study area states, counties, and respective subdivision areas. The total number of family and non-family households were then calculated as a percentage of the total number of households enumerated for each census period. These enumerations are shown in Tables 5 and 6.

Table 5 demonstrates the percent change in the number of total households for each study area jurisdiction during the 1980-1990 and 1990-2000 periods. During the 1980 to 1990 period, the North Elkin District experienced the largest percentage decrease (-24.0 percent) in the number of total households, followed by McDowell County (-19.6 percent), District 1 (-11.6 percent), Wyoming County (-8.1 percent), the Hardee District (-7.5 percent), Letcher County (-2.8 percent) and Mingo County (-0.6 percent). In contrast, the Hamilton District was the sole county subdivision that experienced a percentage increase (8.7 percent) in the number of total households, followed by the 5.9 percent increase experienced by Nicholas County. These percentage increases exceeded the percentage increase experienced statewide (0.4 percent). Kentucky posted the largest percentage increase in household formations with 9.2 percent.

From 1990 to 2000, McDowell County experienced the largest percentage decrease (-13.0 percent) in the number of total households, followed by the North Elkin District (-3.4 percent), District 1 (-

3.5 percent), and Wyoming County (-0.3 percent). The remaining study area jurisdictions experienced increases in their respective number of total households. However, the percentage increases enumerated for the Hamilton (3.2 percent) and Hardee (1.6 percent) Districts were less than the percentage increase experienced statewide (6.9 percent). Likewise, the percentage increases enumerated for Letcher County (3.7 percent) and the Blackey Division (1.6 percent) were significantly lower than the percentage increase experienced by Kentucky (15.3 percent).

Table 6 demonstrates the family and non-family growth trends experienced by the study area states, counties, and county subdivisions over the 1980 to 2000 period. As shown, all jurisdictions experienced similar trends; whereby, the proportion of family households decreased while the proportion of non-family households increased over the 1980 to 2000 census periods. These trends are identical to the national level trends; whereby, the percentage of family households decreased from 73.9 percent in 1980, to 70.8 percent in 1990, to 68.8 percent in 2000, and the percentage of non-family households increased from 26.1 percent in 1980, to 29.2 percent in 1990, and to 31.2 percent in 2000.

Similar to nationwide trends, the household sizes for the study area states, counties, and subdivisions are decreasing. Table 7 presents the average household sizes (i.e., number of persons per household) for each study area jurisdiction during the 1980, 1990, and 2000 census periods. According to the U.S. Census Bureau, "changes in fertility, marriage, divorce, and mortality, have all contributed to declines in the size of the American household"(Fields 2001).

6. Race

As presented in Table 8, the 1980, 1990, and 2000 Census enumerations show that an overwhelming majority of the residents surveyed within the study area jurisdictions considered themselves to be white. Exceptions are noted, however, for McDowell County and the North Elkin District; whereby, the number of whites during all three census periods was proportionally lower than the remaining study area jurisdictions. Moreover, the percentage of whites in the North Elkin District was lower than the percentage of whites in McDowell County for all three census periods. These trends suggest that the North Elkin District has one of the highest concentrations of minorities in McDowell County.

B. EDUCATIONAL ATTAINMENT

Educational attainment is of primary importance to the general welfare and economic vitality of a local area. Skills and abilities required to compete in the labor market are acquired through the educational process. These skills, in turn, provide a degree of economic security for the individual and tend to benefit the overall economic and employment conditions of a local area.

Educational attainment data were obtained from the 1980, 1990, and 2000 Censuses for those persons 25 years and over. These raw data were then used to determine the percentage of persons who attained a high school level education (i.e., 12 years of education) and those who attained a college level education (i.e., 13 years and over). Table 9 presents the educational attainment trends for the study area states, counties, and subdivisions.

Within each study area jurisdiction, the majority of persons age 25 years and over obtained a high school level education for all census periods. From 1980 to 2000, the educational attainment levels for jurisdictions in West Virginia increased, while those in Kentucky decreased slightly. However, in both states, the proportion of persons obtaining a college level education increased significantly. These trends indicate that the education levels for the study area jurisdictions are improving.

C. PLACE OF WORK

Place of work data were gathered from the 1980, 1990, and 2000 Censuses for the study area states, counties and subdivisions to establish trends in the daily migrations of the local workforce. This information will indicate the daily commuting patterns as being within or outside the worker's place of residence.

As shown in Table 10, the majority of the study area jurisdictions' workers age 16 years and over indicated they worked in their resident counties during the 1980 through 2000 census periods. However, between 1980 and 2000, the proportion of those who worked in their resident counties steadily declined while the proportion of those who worked outside their resident counties increased.

The trends in the number of workers who worked outside their state of residence reveal that large changes occurred in most of the study area jurisdictions. In Wyoming County, for example, the number of residents who worked outside the state of West Virginia increased from 45 to 145, or by 222 percent, over the 1980 to 1990 period. Likewise, the number of District 1 residents (Note, the place of work trends for District 1 were calculated by combining the 1980 and 1990 values enumerated for the Barkers Ridge and Slab Fork Districts) who worked outside West Virginia increased from 25 to 80, or by 220 percent, during this same period. The North Elkin District also experienced a substantial shift in commuting patterns; whereby, the number of resident workers working outside West Virginia increased from 56 to 123, or by 120 percent. Other study areas, such as the Hamilton District and Nicholas County also experienced notable increases in the number of resident workers who were employed outside West Virginia. West Virginia, as a whole, experienced a 31 percent increase in the number of workers employed outside its borders between 1980 and 1990.

These place of work trends suggest that the local labor force has been impelled either by their own choosing (e.g., change of residence or employment) or by some change in the local labor market to seek employment opportunities located outside of their state or county of residence.

D. EMPLOYMENT AND OCCUPATION STATUS

An analysis of the local occupation types and industry sectors provide insight to the structure of the local economy and the changes that it has gone through between the 1980 and 2000 census periods.

Employment data were collected from the 1980, 1990, and 2000 censuses to characterize occupation types and industry sectors within which the local population (i.e., persons 16 years and over) is employed for the study area states, counties, and subdivisions. These raw data were then used to express the percentage of total persons employed (i.e., persons 16 years and over) in each industry.

1. Employment by Industry Type

The "Agriculture, Forestry, Fisheries, and Mining" industry served as the largest sector of employment for all study area jurisdictions as enumerated by the 1980 Census, see figures 15 through 22. However, this industry was not the largest sector on a state wide basis for either West Virginia or Kentucky. Both the 1990 and 2000 Census figures show a significant decrease in the percent of total workers employed by this sector. The 1990 Census, unlike the 1980 Census, reported the "Mining" industry separate from the "Agriculture, Forestry, and Fisheries" sector (Note, for comparison with the 1980 data, the 1990 data for these two industry sectors were combined). As illustrated in Figure 16, the mining industry comprised the majority of the workforce employed by the "Agriculture, Forestry, Fisheries, and Mining" sector. Moreover, the same trend possibly holds true for the 1980 Census data, because 1980 employment data collected from the U.S. Bureau of Economic Analysis for the study area counties show the majority of workers were employed by the "Mining" industry. Therefore, as demonstrated in Table 11, the majority of job losses experienced in the "Agriculture, Forestry, Fisheries, and Mining" sector was mainly due to the employment decreases in the mining industry.

Figure 15 also demonstrates that all of the study area jurisdictions experienced increases in the percentage of total persons employed in the "Professional and Related Services" industry sector over the 1980 to 2000 period. (Note: the "Professional and Related Services" figures recorded for the 2000 Census period were derived by adding the amount of individuals engaged in "Professional Services" and "Social Services"). Other service industry sectors, such as "Finance, Insurance, and Real Estate," also posted increases in the percentage of total persons employed within each study area jurisdiction. These statistics typify the national employment trends; whereby, the service sectors are employing a greater share of the nation's labor force than non-service industry sectors such as agriculture, mining, and manufacturing.

Figures 16 through 36 provide a more detailed representation of the distributions of employment by industry for each study area state, and county for the time period of 1980 to 2000.

2. Economic Base Analysis

There are a variety of techniques for conducting an economic base analysis. The objective of all economic base analyses is to identify the economic sectors that bring income into a local economy from outside the economy. These sectors are variously named "export base" or "basic industries". Manufacturing, tourism, and raw materials production are all economic sectors that typically sell much of their output to persons and firms outside of the local economy. Such sales bring money into the local economy, providing for spending on products and services produced both within and outside of the local economy.

One way to identify industries that form an economy's economic base is to examine each industries "location quotient". A location quotient is a ratio that compares an industry's share of local employment at the local level with the same industry's share of employment of the larger economy (typically the nation or the state).

A location quotient of one reflects a condition in which the share of employment in the industry is the same at the local and reference level. A location quotient greater than one indicates that the industry employs a larger share of local employment than it does at the reference level.

Interpretation of location quotients requires the following assumptions: labor productivity, total employment rates, and demand patterns are the same in the local economy and the reference economy; and the reference economy is on net self-sufficient (it produces what it consumes, and consumes what it produces). Under these conditions, a location quotient of one for an industry (say, health services) suggests that the local economy is producing health services at the same rates as the reference economy and is therefore producing exactly enough health services to meet local demand--no more and no less. A location quotient greater than one suggests that the local economy is producing more than enough health services to meet local demand; persons from outside the local economy may be coming to this area for health services. The "excess" health services is essentially a net export from the local economy and a source of outside income.

A location quotient analysis requires employment data that records employment by place of work and by industry. These data are available at the county level through the Census Bureaus's "County Business Patterns" informational series, through the U.S. Bureau of Economic Analysis, and through the state departments of labor. The county is the finest level at which such data are available, as well as the smallest level that areas in the study area could in any way be considered "economies". The County Business Patterns data were used because they provide the most consistent (across states) data at the most detailed industry disaggregations.

The formula used to calculate the LQ ratio for each industry is as follows:

$$LQ_i = \frac{E_i}{E} \div \frac{E_{Ni}}{E_N}$$

Where:
E = Total local employment
E_i = Total local employment in industry i
E_N = Total regional employment
E_{Ni} = Total regional employment in industry i

Interpreting the calculated LQ ratios is simple because only three general outcomes are possible. These are as follows:

LQ < 1.0 = All Employment is Non-Basic: A LQ that is less than one suggests that local employment is less than was expected for a given industry. Therefore, that industry is not even meeting local demand for a given good or service. Therefore, all of this employment is considered non-basic by definition.

LQ = 1.0 = All Employment is Non-Basic: A LQ that is equal to one suggests that the local employment is exactly sufficient to meet the local demand for a given good or service. Therefore, all of this employment is also considered non-basic because none of these goods or services are exported to non-local areas.

LQ > 1.0 = Some Employment is Basic: A LQ that is greater than one provides evidence of basic employment for a given industry. When an LQ > 1.0, the analyst concludes that local employment is greater than expected and it is therefore assumed that this "extra" employment is basic. These extra jobs then must export their goods and services to non-local area which, by definition, makes them basic sector employment.

Using industry sector employment data from the 1990 Census, the LQ analysis was applied to the study area county subdivisions to identify any specializations in their respective economies. These “local economies” were compared to their respective states (i.e., West Virginia and Kentucky), which represent the “reference economies.” Table 12 presents the results of this analysis. These results suggest that all of the subdivisions specialize in the mining industry. Moreover, the degree to which each subdivision specializes in this industry is high, given the level it exceeds one. Based on this assumption, the Blackey Division’s economy is more highly specialized in the mining industry than the other subdivisions.

A closer examination of local economic activity may be obtained by analyzing data from the U.S. Census Bureau’s County Business Patterns database. County Business Patterns is an annual series that provides subnational economic data by industry. The series is useful for studying the economic activity of small geographic areas, such as zip codes areas. Table 13 presents the 1997 County Business Patterns information collected for the selected zip codes for the communities of Naugatuck, West Virginia, and Carcassone, Kentucky (The zip code fo Kyle, WV, was not included in the County Business Patterns database). As shown in Table 13, Naugatuck had a total of five establishments; two of which were in the mining industry sector and employed the largest volume of persons (500-999 employees). Carcassone had four establishments; none of which were in the mining industry.

3. Employment by Occupation Type

Figures 37 through 58 illustrate the occupation types within which the study area jurisdictions' labor forces are employed during the 1980 through 2000 periods. The overall trends show a shift from a "blue collar" to a "white collar" workforce; whereby, the proportion of persons employed in the "Precision Production Craft, and Repair Occupations;" and "Operators, Fabricators, and Laborers" decreased, while the proportion of persons employed in the "Managerial and Professional Occupations;" "Technical, Sales, and Administrative Support Occupations;" and "Service Occupations" increased.
The increases within the white collar occupations were, however, mixed. For example, according to the 1990 Census, the county-level growth in the percentage of persons employed within the "Managerial and Professional Occupations" exceeded the growth experienced by the study area county subdivisions; thereby, suggesting the majority of the county-level growth occurred outside the study area subdivisions. However, data from the 2000 Census shows that this trend disseminated between 1990 and 2000 as most county subdivisions recorded levels of growth similar to that at the county level. This data suggests that these case study jurisdictions are growing at a pace similar to neighboring communities.

4. Civilian Labor Force Status

Civilian labor force data for persons 16 years and over were collected from the 1980, 1990, and 2000 Censuses and was used to calculate the unemployment rate trends as shown in Table 14. As shown, the unemployment rates for the study area states, counties, and subdivisions increased over the 1980-1990 period; thereby, reflecting a decline in the number of local employment opportunities. Moreover, the 1980 and 1990 unemployment rates for the study area counties and subdivisions exceeded–and in some cases far exceeded–the unemployment rates enumerated for their respective states, which suggests the local economic conditions were more severe than their states as a whole.

The greatest unemployment rate increases were posted by McDowell County and its North Elkin District where from 1980 to 1990, their unemployment levels rose from 13.9 percent to 28.2 percent, and from 15.3 percent to 28.2 percent, respectively. Other notable increases in unemployment rates were experienced by Mingo County (11.3 percent to 18.4 percent) and its Hardee District (9.9 percent to 22.9 percent); and Wyoming County (10.2 percent to 19.7 percent) and District 1 (12.4 percent to 20.1 percent).

Between the period of 1990 and 2000, unemployment rates in the all jurisdictions surveyed began to noticeably decrease. In some cases, such as those in McDowell County's North Elkin District, the Hardee District of Mingo County, and the Blackey Division of Letcher County (KY), the unemployment rate tumbled over 15 percent between 1990 and 2000. The sharp declines experienced during this decade contributed to an overall decline in unemployment rates between 1980 and 2000.

E. INCOME LEVELS

The analysis of income levels over time allows us to assess how rich (or poor) an area is compared to others around it, as well as to determine if an area has been growing richer or poorer over time. Income statistics are grouped into three main categories by the U.S. Census Bureau and are defined as follows:

> Per Capita Income - Calculated by dividing the aggregate income for persons 15 years and over by the total number of persons in the group.
>
> Median Family Income - A median income value representing family household units.
>
> Median Household Income - The median income value representing all households.

The income values reported for these three categories represent the total money income received by persons in the calendar year preceding the census (e.g., 1999 for 2000). Total money income, as defined by the Census Bureau, is the sum of amounts reported separately for income sources such as wages and salaries; non-farm self-employment; farm self-employment; interest, dividends, and rentals; Social Security; unemployment compensation; welfare or other public assistance; and all other income sources.

The total money income reported to the Census Bureau is gross income (i.e. prior to any subtractions for taxes, social security, or any other payroll deductions). Items such as receipts from the sale of property (unless for the purpose of an ongoing business enterprise), gifts, inheritances, or tax refunds are included in this figure.

Because of inflation an area of declining real income may appear to have growing incomes, based on the raw census-reported money income values. To adjust for inflation and demonstrate the real growth in income values, the U.S. Bureau of Labor Statistics's Consumer Price Index (CPI) was used to inflate the total money income values from one census to the next (e.g., 1990 values inflated to 2000 dollars).

The 1979, 1989, and 1999 per capita, median household, and median family income growth trends for the United States, study area states, counties, and subdivisions are shown in Tables 15 through 17. As shown in Table 15, the 1989 *reported* per capita incomes appear to exceed the 1979 *reported* per capita incomes. But when the 1979 per capita incomes are inflated to 1989 dollars, the real growth in per capita income levels decreased for all study area counties and subdivisions; thus, demonstrating the reported 1979 per capita income levels failed to match the increases in the cost of living (i.e., amount of money needed to buy the goods and services necessary to maintain a specified standard of living). Additionally, income figures for 1989, when inflated to 1999 dollars, also fail to match or exceed the 1999 reported figures. These calculations show that income in the study areas continues to increase at a slower rate than the cost of living. Similar trends were also experienced by all study area jurisdictions for their respective median household and median family income levels.

The assessment of how rich or poor the study area jurisdictions are may also be characterized by analyzing the trends in the percentage of total households receiving social security and public assistance income for the reporting periods of 1979 through 1999.

Social Security, for example, provides a base level of income for most retired people and represents a fixed income with which senior age persons rely on to support their standard of living. Communities experiencing an increase in the number of senior age persons will experience an increase in the number of households receiving Social Security payments; possibly, producing a stabilizing effect on a community's overall upward mobility and affluence.

Public assistance income is provided to qualified low-income persons or families to assist in meeting their basic survival needs. The number of households receiving public assistance provides a measure of how poor a community may be. Typically, an increase in the number of households receiving public assistance indicates an increase in the number of low-income persons or families.

Data regarding the total number of households receiving social security and public assistance income were collected from the 1980, 1990, and 2000 Censuses for the study area states, counties, and subdivisions. These data represent the total number of households that reported receiving social security and public assistance income in the calendar year preceding the census (e.g., 1999 for 2000). These raw data were then used to calculate the percentage of the total number of households receiving such incomes. The results are shown in Tables 18 and 19.

As shown in Table 18, the majority of the study area jurisdictions experienced an increase in the proportion of households receiving social security income payments each Census year. The North Elkin District and McDowell County had the largest share of their total households receiving social security income payments in both 1989 and 1999. These trends are reflective of the age group trends discussed in Section A.3.

Table 19 shows that all study areas experienced increases in the proportion of households receiving public assistance income over the 1979 and 1989 Census reporting periods. Moreover, the percentage of households receiving public assistance in study area counties and subdivisions far exceeded the percentage of households receiving public assistance at the state levels. However, this trend reversed in the 1999 Census reporting period as all jurisdictions recorded a decrease in the percentage of households receiving public assistance. In some cases, such as the Blackey Division in Lethcher County (KY), and the Hardee District in Mingo County (WV), the percentage of households receiving public assistance decreased by over 11 percent.

F. POVERTY STATUS

Poverty is one of the key statistical tools used to characterize a population. The U.S. Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is poor. If a family's total income is less than the Census Bureau's pre-established poverty-level threshold, then that family, and every individual in it is considered poor. The poverty thresholds do not vary geographically, but they are updated annually for inflation using the Consumer Price Index. The official poverty definition counts total money income before taxes and does not include capital gains taxes and noncash benefits (e.g., public housing, Medicaid, and food stamps).

Table 20 presents poverty levels as measured by the percent of persons living in households with an income below the poverty level. All study area jurisdictions, except for Kentucky, experienced an increase in the proportion of the persons whose income is below the poverty threshold during the 1979 and 1989 census reporting periods. The largest percentage point increases were experienced by McDowell County (14.2), and the Hardee (12.8) and North Elkin (12.7) Districts. More importantly, however, is that the percentage point increases of all study area counties and subdivisions exceeded the percentage point increases experienced by their respective states. Moreover, the poverty levels in the study areas were considerably higher than the state levels, both in 1979 and in 1989.

On the other hand, the 1999 Census reporting period shows that nearly every study area jurisdiction experienced a decrease in the percent of persons living in households with an income below the poverty level. The largest decrease was recorded in the Hamilton District (10.8 percent decrease) followed by the Blackey Division (9.3 percent). Additionally, between 1989 and 1999 nearly every jurisdiction reported a percentage point decrease that was greater than their respective state levels.

G. DEMOGRAPHIC SUMMARY

The following presents a summary of demographic changes in the format of questions with yes or no answers per case study area.

Did employment increase in 1990 as compared to 1980 for each study area?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (No)

Did employment decrease in 2000 as compared to 1990 for each study area?
- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (No)

- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (Yes)

Did real per capita income increase in 1990 as compared to 1980 for each study area?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (No)

Did real per capita income decrease in 2000 as compared to 1990 for each study area?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (Yes)

Did the number of persons working in their resident county increase from 1980 to 1990?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (No)

Did the number of persons working in their resident county decrease from 1990 to 2000?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (Yes)

Did unemployment decrease in 1990 as compared to 1980 for each study area?
- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)

- District One, Wyoming County, WV as the Control Area (No)

Did unemployment increase in 2000 as compared to 1990 for each study area?
- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey District, Letcher County, KY (No)
- District One District, Wyoming County, WV as the Control Area (No)

Did educational attainment increase in 1990 as compared to 1980 for each study area?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes for college), (No for high school)
- District One, Wyoming County, WV as the Control Area (Yes)

Did educational attainment increase in 2000 as compared to 1990 for each study area?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (Yes)

Did population increase in 1990 as compared to 1980 for each study area?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (No)

Did population decrease in 2000 as compared to 1990 for each study area?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (Yes)

Did non-white race increase in 1990 as compared to 1980 for each study area?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (No)

Did non-white race increase in 2000 as compared to 1990 for each study area?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (No)
- Blackey District, Letcher County, KY (No)
- District One District, Wyoming County, WV as the Control Area (No)

Did the number of miners increase during mining (1990)?

- Nicholas County, WV (No)
- McDowell County, WV (No)
- Mingo County, WV (Yes)
- Letcher County, KY (No)
- Wyoming County, WV (No)

Did the number of miners decrease in the after mining case study condition (2000)?

- Nicholas County, WV (Yes)
- McDowell County, WV (Yes)
- Mingo County, WV (Yes)
- Letcher County, KY (Yes)
- Wyoming County, WV (Yes)

Did the number of persons receiving public assistance decrease in 1990?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (Yes)

Did the number of persons receiving public assistance increase in 2000?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)

- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (No)

Did the number of persons receiving social security income decrease in 1990, as compared to 1980?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes)
- District One, Wyoming County, WV as the Control Area (No)

Did the number of persons receiving social security income decrease in 2000, as compared to 1990?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (Yes)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (No)

Did poverty status decrease in 1990, as compared to 1980?

- Hamilton District, Nicholas County, WV (No)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (No)
- Blackey Division, Letcher County, KY (No)
- District One, Wyoming County, WV as the Control Area (No)

Did poverty status decrease in 2000, as compared to 1990?

- Hamilton District, Nicholas County, WV (Yes)
- North Elkin District, McDowell County, WV (No)
- Hardee District, Mingo County, WV (Yes)
- Blackey Division, Letcher County, KY (Yes)
- District One District, Wyoming County, WV as the Control Area (Yes)

V. COMMUNITY NARRATIVE SUMMARIES

This section of the report summarizes all the interviews collected to date in each of the case study communities, Werth, WV, Kyle, WV, Naugatuck, WV, Scarlet, WV, and Carcassonne, KY. In addition, interview summaries are included for Superior Bottom, WV and Blair, WV. Each communities' interviews are summarized with selected discussion and quotations taken from multiple interviews from that community. The discussion is organized into three main aspects of community life (social, physical and economic) and the future of each community.

A. WERTH, HAMILTON DISTRICT, NICHOLAS COUNTY, WEST VIRGINIA

The community of Werth, WV currently consists of approximately 20 homes strung along Route 55 about one hour northeast of Charleston. Unlike many of the other communities in which interviews were collected, Werth at one time was home to a large employment generator other than the coal industry – the Ely Thomas saw mill. Residents reported varying employment benefits and reliance upon the mill; however, the mill itself was reported by several residents as one of the largest of its kind in the Eastern United States. The saw mill closed in the 1950s. Another distinguishing factor is that Werth is not concentrated in an isolated hollow or along a stream corridor, but rather along a county road between the county seat, Summersville, and points north and west. Werth lies just a few miles from Highway 19 which , according to residents, was completed in approximately 1975.

Existing Lumber Yard on Site of Ely Thomas Saw Mill

By varying accounts surface mining came into the Werth community area in the 1950s. At that point in time, the saw mill had reportedly already burned and been shut down; therefore, prior to surface mining the community was employed in a variety of manners including lumber, underground coal mining and farming. Residents report that Werth was a small, incorporated community of many families and some businesses, largely focused around the saw mill. Residents interviewed could not universally recall exactly when surface mining began in the Werth area; however, reports ranged from 1945 to the early 1950s.

1. Social Community

Nearly all of the interviewed residents in Werth indicated a sense of community based upon heredity of land and family and neighbor ties to the area. Feelings expressed regarding any sense of social community by the residents in Werth were less fervent and less focused on a sense of social structure and support within the Werth area than in some other communities. Werth was described as a nice place to live, to hunt and to farm. One resident stated that they moved to Werth because, "I always liked elbow room."

With the introduction of surface mining in the Werth area, residents reported little or no change in the social aspects of the community. Declining population in the area since the 1950s was believed to be linked to closure of the mill and the industry-wide decline in mining employment. Population shifts were a result of families and young, employment-age family members leaving the area in search of better job opportunities. None of the residents interviewed felt that the population change in the community was related to impacts from the presence of surface mining, rather the feelings expressed indicated that the community was accustomed to the mining industry and leaving was not considered for that reason. One family described the population shift as follows:

Excerpt From Single Interview:

Resident: Well, we lost a school down here. The umm, all the young people grew up and moved away.

Interviewer: Had any of them been employed with the coal company? That you could say 'Well, when the coal company left they lost those jobs and moved away and therefore the school had to close?'

Resident: I don't think that many of them; some of them was employed by the coal companies. But up and down through here we are just all getting older and nobody sells any of their land and so…

Interviewer: There aren't any more kids to go to school?

Resident: And the kids just grew up like ours done. He is like….he married a girl from Pittsburgh, by the way. And they both teach school in Parkersburg now.

Interviewer: So, really most of them moved away for jobs?

Resident II: Most of them. The ones that didn't want to work in the mines left.

Resident: Well, when they went to college, there wasn't anything around here for them to do. I know my granddaughter went to, she is up next to Washington, which isn't a good place to be right now.

The interviews indicate that many of the remaining residents are of retirement age. One resident speculated that without family ties to Werth, there was little draw to move into the community now. Another resident believed that the population, while small was stable, and economic growth in the tourism industry was helping to stabilize the area.

None of the residents interviewed in Werth had chosen to leave, if they had left, because of the presence of surface mining, and none reported that the coal companies had offered to purchase their home or land for anything other than mining prospects. In this manner, Werth is different from a number of the other areas where interviews were collected.

No other specific social impacts or benefits were reported by residents; however when queried about changes in their community, one resident speculated, "Well, we don't have the fields and everything, but yeah it probably psychologically might have [changed]. But as far as money is concerned I would say probably not."

2. Physical & Economic Community

Because Werth is located along a stretch of flat, bottomland, several residents reported a tradition of family farms, for subsistence and some commercial crops. Interviewers were told that a small underground mine was locally owned and operated in Werth, but none of the interviewed residents cited this an important local employer. The Ely Thomas lumber company was cited as a far more important economic generator. By the end of 1950s, the saw mill was no longer an employer in the area, and residents reported that employment sources ranged from coal mining to related industries, such as the railroad.

While some physical changes were reported by a number of residents, reports of economic benefits during the surface mining period varied. Overall, residents felt that changes in Werth happened overtime as a result of aging residents and younger generations moving out for jobs and other opportunities. Most residents felt that the presence of large-scale surface mining neither had long-term boost or negative impact on the community. When queried about the benefits brought to the community by the presence of surface mining, on resident replied: "There probably was at the time they were here, there was more money spent here that is natural. But no - the people moved and the money didn't stay here and the coal left. There may have been. There had to be something but I do not know what it would be." Another resident however indicated that the mining industry in the Werth area had contributed significantly to the local economy and provision of community facilities.

Excerpt From Single Interview:

> **Interviewer II:** Does this community itself, in terms of Werth, do you feel it has benefitted in terms of employment opportunities the mining operations offered in this area?
>
> **Resident:** Absolutely... Otherwise they would of have to go out of state. Which a lot of people in other parts, like the northern part of West Virginia where there's not many mines and not much of anything else… and I can remember 25-30 years ago they had to go

to Ohio, they had to go to South Carolina somewhere for employment.

The resident went on to say:

I know that personally because my husband had very much to do with that. It was… he's the one that ram-rodded the site for the ball fields and the high school. The new high school is right here on 19.

Interviewer: Can you tell me a little bit about that? What do you mean ram-rodded?

Resident: He furnished the equipment; he came down and did a lot of the work himself at no cost to the county.

Interviewer: He helped build it and see that it was built?

Resident: He didn't build, but he prepared the site with equipment, his own equipment from his company.... He brought his men down and he paid his men but he didn't charge anybody for it. He also was the fund-raiser for the hospital and because he was known, so well known in the community, he was able to tap the coal industry get money and got funds to start the Summersville, to expand I am sorry, to expand the Summersville hospital.

Residents overall did not feel that the community of Werth was significantly changed by the presence of surface mining aside from landscape changes in mined areas; however, some changes to specific areas were reported. For the majority of the residents interviewed two factors seemed to have shaped the types of changes reported. First, surface mining in the Werth area was carried out by at least two separate companies; and second, adjacent surface mining was reported to pre-date current environmental legislation. The second of these factors was reported to have significantly shaped the quality of work and the related physical impacts that were reported.

Surface mining was reported to have occurred from the 1950s to the present; however, most of the residents interviewed focused on physical changes in the community related to mining prior to the 1970s. In their opinion, mining methods during this period differed from current practices. One important perceived difference included the level of blasts feasible and the lack of regulations regarding disposal of overburden. Few, if any, residents reported any instances of significant dust, or damage to their homes, but some fly-rock was reported. In other communities problems with well water are often cited as having a relationship to blasting. Two residents reported problems with well water; however, they did not claim that this was certainly attributable to surface mining. More significantly in Werth, mining companies were cited as having dumped rock and spoil over the hill into the bottomland, and therefore, into the stream running parallel along the southern properties of the community.

"And when they dumped that refuse, them rocks and stuff over the hill, you know just dumped it over there, you got to see that to believe it, what that is."

Another resident described the same results:

> "That was top mines, strip mines. And they didn't have no regulations they just throwed it all over the hill, because they wanted to and I guess it was more convenient for them than to pile it up."

As a result of the clogged stream, properties and farmable land were flooded. One resident describes the situation on his property following the clogging of the stream:

> "...when they stopped it up it backed it up and stopped it all up. It filled in out here until I had a swamp in the yard. It was a swamp....I had seen these trucks, with the bed down on the ground. That much mud. And we could not bring our cars. And had to leave our cars over on the main highway. Yes, you couldn't get it over here and back because of the mud in the road....Those trucks I had seen buried down right out here until the bed was in the ground. They would have to get dozer down in here and pull them out. Now this was Tassa Coal Company. T, A, SS, A, Tassa Coal Company."

Another resident described it as follows:

> "I am talking about rock, slate, goobs- probably a little coal - anything that they, dirt, anything that they would dig up on top of the mountain, when it rained it came down...It filled up the creeks. It filled up the creek beds and the creek would be wandering around and basically make into a swamp. Which the wetlands commission now want it to be a swamp but it never was a swamp before..."

Other physical changes described included impacts to habitat and wooded areas previously used for hunting and the use of old coal rail lines for trails. The 'rails to trails' examples was cited as another way that the community and the burgeoning tourism industry has benefitted long-term from the historic presence of the coal industry in Werth . One resident stated:

> "...[the mountaintops] basically, for a period of time, become grasslands. Which for the all the vegetation that comes is good for the animals and the birds and environment… for them to prosper. I think this "Keep West Virginia Green"; the coal miners did not fall short in returning their areas to green."

3. Companies and Communities

When queried about interactions between the coal companies and the communities most residents felt there was very little interaction that wasn't initiated by residents approaching the company with specific complaints. Residents did cite having received notification of blasting activity, but did not report having seen specific permits advertised for mining activity in Werth. All the interviewed residents, who read the paper, currently see permit notices regarding new mining permit activity advertised, and generally felt these were adequate, if sometimes difficult to read. Specific complaints were generally in regards to illegibility of the maps; however one resident stated,

> "...if I didn't see the map clearly I would read the description."

An important theme echoed in nearly all of the interviews collected from the study communities was the varying levels of communication and responsiveness observed among different mining companies. Werth area residents perceived that one company was significantly more responsive to complaints and more responsible in their mining methods than another.

> "Now the company that came in after that was Hobet. And Hobet was all together different. I don't care for the mining anyway, but if you are talking about mountaintop mining. But, Hobet was 100% better than Tassa Coal Co."

Another resident stated:

> "The damage that first company done - that couldn't be reclaimed. You roll a boulder over, as big as this house, in one of them hollers you can't get it back."

Just as the individual coal companies were reported to have different work qualities, residents also expressed different levels of satisfaction gained from the different coal companies' attempts to address community complaints. While most residents felt that the coal companies had caused some physical changes to the community, they reported varying levels of responsiveness to complaints. One company was perceived as better at providing public information and addressing complaints than another. Only one resident interviewed, felt that the coal companies had done a completely adequate job in dealing with the community and had followed the letter of the law with regard to public information.

4. Summary and Community Future

Residents in Werth had varying opinions about the benefits and impacts from adjacent surface mining to the community. One consistent report, from interviewed residents who had lived in the community since the 1950s was that they felt early surface mining in the community had changed the physical value of the bottomland. The land is deemed by residents as no longer suitable for farming, an aspect of community life that had been a staple for some families in Werth. To the dismay of some of the interviewed residents, the bottomland in Werth is now designated as wetlands. A fact that several residents felt was foolish, as they believed the clogging stream to be directly related to the mining techniques of the earliest company to surface mine near Werth.

Overall, opinions regarding the positive and negative impacts from surface mining were greatly varied. However, residents consistently reported that the presence of surface mining never prompted them to leave, or try to leave the community. Population shifts seem entirely attributable to a lack of jobs or a desire to work in an industry other than mining.

Interviewed residents felt the economic future of community is likely tied more closely to overall diversification of the economy in the region. "This area has shifted to timber and tourism." Residents felt that any market for property would now rely on proximity to jobs elsewhere in the region and the mobility of the automobile.

One resident summed up his experiences living with mountaintop mining in Werth through the course of his life as follows:

> "Well you can't see it now, but there use to be a big mountain up on top of that mountain there. Well it is the same mountain, but there was a big knob. It was a lot higher and everything. They just took everything that they didn't want and threw it over the hill and then hauled the coal down the mountain. And that is just what they could do. And we suffered impacts, not at the time it was happening, but nature took it's course from everything that came down here."

B. KYLE, NORTH ELKIN DISTRICT, MCDOWELL COUNTY, WEST VIRGINIA

The community of Kyle, WV is located within the Elkhorn Creek watershed area and consists of less than 100 homes with a church along highway 52. The methodology described in section II.C of this report was followed to identify interviewees; however, individuals selected for interviews could not be located or did not wish to be interviewed. The process beginning with the selection of randomly selected parcel numbers was repeated without success. No interviews were conducted for the Kyle case study community.

C. NAUGATUCK, HARDEE DISTRICT, MINGO COUNTY, WEST VIRGINIA

Located at the junction of state Route 65 and US Route 52 in Mingo County, Naugatuck is primarily a residential community with a few hundred homes. The community of Naugatuck has a small commercial area comprised of a grocery store, a post office, and a branch of the local Bank of Mingo. Nearby a water and sewer plant is being developed to serve area residents, including those who reside in informal neighborhoods along Pigeon Creek.

Within a few miles of Naugatuck to the northeast, there are several surface mining permits which total approximately 900 + acres. US Route 119 crosses a portion of the Hardee District; however, the largest employment center within the immediate region, Williamson, does not lie within the Hardee District.

The methodology described in section II.C of this report was followed to identify interviewees; however, individuals selected for interviews could not be located or did not wish to be interviewed. The process beginning with the selection of randomly selected parcel numbers was repeated with little success. One interview was conducted for the Naugatuck case study community. Information on the social community, physical and economic community, company interaction with community and future of the community is not summarized since only one interview was able to be conducted.

D. SCARLET, HARDEE DISTRICT, MINGO COUNTY, WEST VIRGINIA

Scarlet is comprised of a stretch of road along two forks of Trace Fork Branch in Mingo County. Scarlet road is easily accessed from Highway 119, or Corridor G; however, this road reportedly was

View Down Left Fork of Scarlet Road

not completed in this area as a major highway until the last 10 - 15 years. Over time, the area grew around a few families who settled the community. Interviewed residents report that the family relationships and closeness of the community is what they valued most about Scarlet above other places.

> "We had real tight neighbors… We watched out for each other.... It was just, I don't know, family. At one point in time we were crammed. Everybody was family."

An estimated 60 or 70 families lived in the hollow prior to the 1970s. The community was reported to have amenities such as an informal ballfield. Underground mining had been in the Scarlet community, at the head of the hollow, since the childhood of its residents. Its existence was part of the culture of the hollow. One resident described waiting, as a child, for the train conductor on the afternoon coal train to distribute candy to local children each day after school.

1. Social Community

Surface mining was reported to have begun in Scarlet in the early ‘70s. Scarlet reportedly remained a close-knit, family community through the 1970s and ‘80s as surface mining continued in the area; however, in the 1990s a drastic population drop reportedly had a significant impact on the social community as well as the physical community. Residents all reported a change in the social community following the purchase of many homes by the coal company and relocation of many families. Most of the residents indicated that the process engaged in by the coal company to purchase homes and land from families in the hollow caused rifts in the community and changed relationships beyond just a physical distance. It is difficult to measure social impacts; however, one resident described the process as “pitting neighbor against neighbor.” Another resident elaborated on the problem of ‘neighbor against neighbor’ as follows:

> “Yeah, it really put a lot of strain on the community. Because everyone was afraid of. I don't know what they was afraid of. ….and then when they started talking about selling and it was like 'What are you getting?' And you'd get 1,000 phone calls and it's just like everyone was expecting to make $5.00 more dollars than the other. I mean that is just what I am saying. It just blowed the community up.”

The resident goes on to explain how this affected their family personally....

> “Then my husband happened to get a job there. And so he got a job there when all this was going on, and it had nothing to do with what was going on. He had been trying for ten years to get a job with them..... As soon as my husband got the job, I was accused of, even at that meeting, they accused us of giving the first two pay days to 'em and $1,000 for the job. I mean, that's what I went through. That's how I was talked to by my neighbors, that I had lied to them. Right in front of everyone. And I just sat there, you know, I mean, because it wasn't true. I cried when I come home. You know, I thought how could these people treat me like that? Because if they had been offered the job, or could have gotten the job, would their husbands took it? Yes, they would've.”

Despite the social implications of these changes and their affect on quality of life, not all the residents interviewed chose to leave Scarlet. Some did not leave because they were not able financially, and felt that the purchase offer made by the coal company was not sufficient. Others chose not to leave because Scarlet is their home, and despite the changes they had endured, they wanted to stay where they were. For those that left the reasons given were resoundingly concerned with the quality of life and the chance at a willing buyer for their properties.

<u>Sample Responses Taken from Several Different Interviews:</u>

Question: Why did you choose to stay?

Resident (A): “That was their attitude – ‘Take it or nothing.’ And it was nothing.”

Question: Why did you choose to move?

Resident (B): “Primary reason for moving? They made us an offer we couldn’t refuse.”

Abandoned Home in Scarlet

Resident (C): “ I would say the houses was all cracked up. Your foundation was cracked and all your friends had moved.”

The number of homes now occupied in Scarlet hollow, based upon visual survey, is no more than twenty-five. Residents who were interviewed reported that some of the homes purchased by the coal mining company are now occupied as company-housing, others are people from within the community who were relocated into other homes on Scarlet Road. The second scenario was a point of contention for some of the residents.

Other homes that were purchased remain standing, empty and dilapidated. The abandoned homes serve as a visual reminder of the loss of the community.

> “Well, that is what I told them, when they started buying people out and they started moving off and the homes that are lived in that are falling in, is an example of what they did. Cause, they tore several down…. that is one thing that I did get done. I got a couple of them that were falling in; I did get those torn down. There was one beside my mom that was falling down and I finally got them to tear one down.”

2. Physical and Economic Community

Reports of changes in the community during the presence of large-scale surface mining in Scarlet were fairly uniform from one interview to the next. Residents all reported significant amounts of dust hindering outdoor activities and in one case impacting respiratory related breathing problems. Blasting was listed as both a nuisance and in some cases believed to be above legal limits.

> "But it shook it hard because it threw me against the faucet there. I just walked in here and was getting some water, you know, and wham."

Well water problems were not reported in all cases, but one resident who remains in the hollow reports significant well water problems.

When queried about benefits received by the community from the presence of large-scale surface mining, some of residents did not see benefits to the immediate community of Scarlet, while others reported some benefits such as local employment. The reported levels of local employment varied. Underground mining had been reportedly the largest employer among the families in Scarlet. The underground mine closed in the late 1960s. One resident explained that the underground mine wound underneath the whole of the community, and therefore, it was understood that families which had settled the area would always be able to find jobs at that mine. One resident described the presence of surface mining as an employment benefit to the community as follows:

> "The younger generation, younger than myself and 'specific name'. I'd say they worked there when they was blasting, you know. That's the only thing I can see, you know, as far as a benefit. I think that's good that when people come in and brings work into our area that they hired locally. I can't say they didn't hire out of state, but I could see some of the local people getting in."

More than one specific instance of local residents seeking employment with the surface mining companies working in Scarlet and being turned down were recounted. The most stunning report indicated that local residents were told that jobs were for sale.

> "I went to a talk with the fella that was in charge of that. And he offered to sell me a job... A bribe... I was shocked. I was stunned. I really didn't catch it until the interview was over. And I was informed, 'Yes that is exactly what they are doing. Didn't you know it?' I said, "No, I did not know it."

Each of the residents interviewed reported that a few men had jobs with the surface mines at Scarlet, but that in a number of cases local men were believed to have been passed up for labor from other areas.

3. Companies and Communities

When discussing the interactions between the community and the coal company regarding the reported physical impacts, most residents reported mixed results. Those whom the coal company had successfully bought out were satisfied with the way the situation was handled by the company and their purchase prices. Concerning impact complaints, in some cases residents were satisfied, in other instances the same residents felt that their complaints were not addressed at all or fairly. Residents reported more than one company surface mined in the Scarlet area. Similar to the experiences of Werth, differences in companies and in management played an important part in the attitudes of residents toward their experiences and even jobs with the companies.

Scarlet residents also shared the feelings of the majority of Werth residents that public information regarding mining activity was not universally satisfactory, and the degree to which information was available varied by report. While the residents of Scarlet all reported seeing permit activity advertised in the local paper, they did not generally feel that these were legible or helpful to persons who may not be familiar with mining terminology or with the area. Some residents had attended community meetings with representatives from the State Department of Environmental Protection (DEP) and the mining companies. Others felt that they had never dealt directly with the mining companies regarding complaints or mining activity. Regardless of the levels of interaction, satisfaction was almost never reported.

Each of the interviews indicate that the coal company approached at least a portion of the community and made a blanket offer to purchase properties for the implied purpose of relief from the impacts of the surface mining in Scarlet. Details of the offer varied with regard to the base amounts offered, the numbers of families to which the offer was made, and the conditions associated with the offers. One resident reported that a condition of the sale of their property was that the family would agree to not relocate with the area of holdings of the company.

> "I mean, it says that you cannot, couldn't move within so many miles but you couldn't move back up that holler, Scarlet, at all. But then this area along, the four lane, you couldn't move there either they said. Just because maybe they thought they might have to buy them out if they continued stripping and…"

Several residents also indicated the following condition was attached to the sale of their property:

> "When they bought us out they said 'everything stays that's connected.' And we asked about the shrubbery, and like he said, he had his young fruit trees that he had planted that we could have picked up and moved.... But they wouldn't let us take anything that was connected to the home, tied into it like built-in cabinets....Six weeks later, somebody come along and collected them all and sold them."

Another condition, or detail of sale, for which reports differed was the option to repurchase land. Some residents had been told that following the conclusion of mining, they would have the option to repurchase, others were interested in this possibility and reported that "[the company] will not sell this land back for 200 years."

Another important variation between the residents' reports was their satisfaction with the company regarding purchase offers. Some felt they received a fair and satisfactory deal for the purchase of their property while others felt the offered purchase price was not enough to cover the purchase and move to a new home. Of those interviewed who chose to leave, nearly all were satisfied with the amount received. Relocation assistance in the amount of $5,000 was given to each of these residents in addition to the agreed upon purchase price.

4. Summary and Community Future

When queried about the quality of life in the community now, the majority of the residents were not positive. Those who had moved out, did not think they would move back for reasons including, lack of land made re-available to them, deterioration of community relationships and satisfaction with their current location. Those who remain are now facing the option of hooking onto a public water system. The residents interviewed who remain in the hollow were currently choosing not to hook-up to the water system, but each for separate reasons. Reasons ranged from a sense of independence lost and defiance against the coal mining company for having negatively impacted their water supply, to a lack of current need. Hook up fees were reported at $500, in addition to the cost and labor of laying the connection pipes. This was deemed prohibitive by a number of residents.

The reported animosity between neighbors and family members is a striking difference between the experiences in Scarlet and those reported in other communities where a large-scale purchase of homes was undertaken by the coal company. Other communities reported anger and poor relationships with the coal company itself over perceived or actual differences in the details of the sale. One commonality expressed between the communities with similar buy-out experiences was the belief that relocation costs were often underestimated by those who chose to leave, and the suggestion that many families had gone into debt.

What remains constant among the Scarlet residents' comments are their expression of the overall decline in the quality of life directly related to the presence of surface mining and the loss of the community physically and socially, despite any benefits provided. Satisfaction of the residents with the purchase offers and the satisfaction to which complaints were addressed was inconsistent. For those who left, a similar notion was expressed many times:

> "I just feel that if they was doing it for one, they should have at least offered it back to me… Give me the option of whether I want to buy it back or not. They didn't. And, I feel that if they could have moved that double-wide out for one person, why couldn't they have moved it out for me."

E. CARCASSONNE, BLACKEY DIVISION, LETCHER COUNTY, WEST VIRGINIA

The community of Carcassone, KY, is located within the Elk Creek watershed area and is currently comprised of approximately 100 families, which includes those families living in the nearby area locally referred to as Jent Mountain. The Carcassone area of Letcher County has few significant employment centers and no large-scale infrastructure investments. Located approximately 4 miles south, Highway 7 is the closest primary roadway serving the Carcassone community and it provides indirect access to Whitesburg, which is the Letcher County seat and the area's largest economic center. Residents interviewed described the community as rural and remotely located from employment opportunities outside of the mining industry. The following excerpt from an interviewee relates this characterization of the Caracassone community.

Excerpt from Single Interview:

> **Resident:** And, my son, I have two sons. One is 25 and one is 20 and both my sons had to leave here to find work because they don't want to work in the mines or on a strip job, so they left here, so now I have to drive about 3 hours to see my grandchildren. They live in Georgetown. They moved there, you know, near Lexington, where there are better jobs. And, I don't work because where we live, basically the roads and stuff, and the community where we are in, it really it doesn't pay me to work. I wouldn't make enough money to drive that far. You know, we tried that and by the times the taxes come out and all that, it doesn't pay for me to work.
>
> **Interviewer:** Right, so you are in a very much a rural, Carcassone is a very rural community……can I say that?
>
> **Resident:** Very so, very much so, very much so. If it comes and snows, everybody here has 4-wheel drive. If you don't have 4-wheel drive, most of the winter, you are sitting. You cannot get out. And, even with 4-wheel drive, a lot of times it's hard.

1. Social Community

Like many Appalachian communities, the discussions with the interviewed residents evoked that the Carcassone population is close-knit and they value their sense of community and rural quality of life. One resident said that "you can trust your neighbors" and "you've got your neighbors to look out for you." The close-knit community perception was further stressed by the residents' statements indicating that they have resided in Carcassone for most, if not all, of their entire lives. When asked to describe the existing quality of life in Carcassone, one resident stated that Carcassone is a "quiet, peaceful place. A good place to raise a family. We raised our children here and have some of our grandchildren here with us now, close to us."

The opinions of the interviewed residents' varied when queried about the impact of mining on Carcassone's social environment. Population declines, for example, were the most frequently cited social impact followed by the impacts on groundwater quantity and quality. Two interviewed residents specifically linked the loss of the area's population to the diminished groundwater supplies perceived to be caused by the mining operations. "I would say [Carcassone's population] has decreased because when they stripped most of the land here, it is harder to find good water now than what it was 25 to 30 years ago." The second resident shared the following sentiment regarding the population losses.

Excerpt from Single Interview:

> **Interviewer:** And do you have any reasoning or any idea why that population has decreased?
>
> **Resident:** Well, the main thing is because of water. The difficulty in finding suitable water for families.
>
> The mining operations' impact on local groundwater water supplies and quality were resounded by another interviewed resident. The resident perceived that the local water supply and quality has been negatively impacted by the local mining operations.

Excerpt from Single Interview:

> **Resident:** They were mining and stripping and we used to have really good well water. Our well is only like 65 feet down, something like that, and um, it just all of a sudden became real orange and nasty and you couldn't stand turning it on because it smelled and we finally contacted the coal company and uh they came and took samples and put a filter in for us.

Another interviewed resident, however, believed that the population declines were not caused by the mining operations, but rather were the result of the lack of skilled employment opportunities.

Excerpt from Single Interview:

> **Interviewer:** The question is, what……was the community impacted by change in population or shift in local demographics, we'll say again between the period of 1980 to the current to the present day.
>
> **Resident:** Uh, I don't know back then when I was growing up, it seemed like there was more people here.
>
> **Interviewer:** And, if you perceived that there were more people, do you have any reason or uh, rephrase this correctly. Any perception of why the population may have declined?
>
> **Resident:** Pretty much because once the kids grew up, there weren't nothing here to keep them. You know, jobs were, jobs still are, if you don't have a college education, you know, you either work in a fast food restaurant or you are working on a strip job and our kids have to get jobs or go off to school.

No other specific impacts to the community's social environment were reported by the interviewed residents; however, when queried about changes in their community, one resident found it disheartening that the area's scenic beauty has been destroyed. "……the mountains are gone, history's gone, uh, you see forever, used to be you would look out your window, you'd see forever the mountains. You know, I think that's the future you got there and you can see the mountains all the way in Virginia and Tennessee, you know, because you're up so high and [the mountains] are all gone."

2. Physical and Economic Community

As previously discussed, the most significant physical impact resulting from the mining operations as perceived by the interviewed residents is the diminished quantity and quality of the community's groundwater supplies.

When further queried about additional impacts on quality of life issues, two interviewed residents cited blasting as being a common problem among the area residents. According to one interviewed resident, "We had things knocked off the wall and broken foundations, concrete blocks, it was cracked and this area, several [families] have had that."

Opinions differed among the interviewed residents regarding the economic benefits of the mining operations. One interviewed resident suggested that the employment opportunities afforded by the mining companies were beneficial. "The mine company is what gives me my bread and butter. It's what gave me the house I'm living in." Others, however, suggested that the local economy is too dependent on the mining operations and few, if any, alternative employment opportunities offering competitive wages exist within the Carcassone community.

Excerpt from Single Interview:

> **Interviewer:** I was just gonna ask is any of that related to employment opportunities in your area? What is the major employer for the Carcassone area for the residents that live there.

> **Resident:** Right now I would say it is geared to the mining business other than, well we have a lot of teachers, doctors, things like that lives in this area now.
>
> **Interviewer:** And where do those teachers and doctors work? What is the local area that they work in or maybe facilities that they worked out of, where are they located?
>
> **Resident:** Well, I have a daughter and a son that are RNs and they both work in medical facilities in Perry County.

A common thread among the interviews is that the Carcassone community's basic economy appears to be highly dependent on the mining industry and alternative skilled and competitively waged employment opportunities are lacking. This statement is clearly articulated in one resident's response——"Well, if it wasn't for the mine, then what would our people be doing for money? Because we don't have nothing else here." As a result of this one industry economy, the community is experiencing a loss of its young adult populations who have obtained college-level educations and moved elsewhere for employment opportunities. It is therefore possible that this trend has produced a negative impact on the community's quality of life and has, in part, dampened Carcassone's ability to sustain its existing population.

3. Companies and Communities

Although there is indication that the mining companies approached at least a portion of the community regarding their operations, the interviewed residents, overall, seemed pessimistic about the level of contact the mining companies had with the local residents. In most cases, the mining operations limited their public involvement efforts to the pre-mining inspections and publishing of the mine permits in the local newspapers; often not seen or understood by the local residents. The following interview excerpts support this issue.

Excerpt from Single Interview:

> **Resident:** Now, not until, probably, uh, I would say a couple of years ago, I got a letter in the mail, it was certified mail, they sent me a letter and said that they were going to be mining within ½½ mile of my house and it, you know, it told about the blast signals and, you know, all that. Other than that, no, you don't hear anything.
>
> **Interviewer:** So, beyond that initial contact, you can answer yes or no, if you wish, did the surface mining company continue any contact with you or your neighbors beyond that initial contact?
>
> **Resident:** No.

Excerpt from Single Interview:

> "If I didn't read the paper, I didn't know about it. Uh, it was put in the local news in Malmego and uh if you can read that, you know they give notice in there and then sometimes it would be word-of-mouth."

4. Summary and Community Future

The resident's overall sentiment towards the presence of the mining operations in their community was mixed. On one hand, the residents felt that the mining operations were beneficial because they provided employment opportunities. But on the other hand, they felt that the employment opportunities offered are limited and that the local economy is too dependent on this one industry. To this end, it can be concluded that the future of the Carcassone community is questionable given that the area's population is decreasing. Moreover, the quality of life for those who wish to remain in Carcassone despite these odds will be jeopardized once the mining operation is over. As one interviewed resident stated, "you never know from one day to the next what your quality of life's gonna be because basically, if your husband or if you or any of your family members work in the coal business, you don't know one day from the next if you've got a job……"

F. SUPERIOR BOTTOM, WEST VIRGINIA

This community was not selected as a case study community, but was selected for collection of additional narratives. Superior Bottom is exactly that, a bottom of flat land adjacent to the larger community of Omar. Both are a short drive south of Logan. Both communities are traditionally racially integrated, which is a noteworthy characteristic. It was considered a thriving area during the first half of the twentieth century. Residents described local schools, a theater, businesses and a clubhouse in Omar. Underground mining was described as the largest employer, but there was also a mix of employment. Teaching was cited as an example of employment. Superior Bottom was described as a community consisting of a bottomland area full of homes, as well as several rows of homes on the opposite hillside. The decline of the mining industry in the later half of the century contributed to a loss in population that ultimately closed the local elementary school in the bottom. Also, as a result some homes were torn down at this point; however, the community remained largely intact and stable based on these reports. Surface mining began adjacent to Superior Bottom in the middle 1980s and continued into the 1990s.

1. Social Community

Superior Bottom residents reported very few changes in the population until the coal company began to purchase homes and/or properties in the community. With the decline in population, fewer than ten homes remain in the community, a community that was described as having closer to 30 to 40 homes at one time. One resident stated that the only negative change from the presence of surface mining was, "losing my neighbors, and losing the children." Despite these changes, residents did not feel that their quality of life had been significantly impacted. In fact, in contrast to the experiences of other communities, Superior Bottom residents noted that the close knit aspect of the community still remains and the community organization still remains, and is perhaps only diminished.

Only one of the residents had interacted with the coal company regarding purchase of their property.

This family described their experiences dealing with the company as extremely honest, responsive and helpful. This in turn, also shaped their decision to sell. One resident describes the close and trustworthy relationship they had developed with the coal company agent as follows:

> “I've been satisfied... And so I been very, you know, agreeable with him, because he's doing everything, you know, to try to please us... But he's not pushy he won't, wouldn't try to get me to change my mind. He would ask me questions, you know, make sure... And he said, I want the same things for her that I want for my mother... and I just thank God that he's like that.”

Some residents did not move during this time despite impacts, due to age, ties to the area and general affinity for the location.

> “I just grew-up here...I'm 62 years old and so I really don't' feel like going anywhere else.”

None of the residents expressed anything more than sadness over the loss of their neighbors. For the family who was relocated, the company relocated them within the same community. This was not necessarily reported to be the case for any other residents who were relocated.

2. Physical and Economic Community

Residents reported few physical changes to the community within the study period. Landscape changes and presence of blasting and dust were cited as the only physical impacts present in the community. Changes in landscape included both changes to surface mined land and the physical removal of many homes, leaving the bottomland much less densely occupied. The change in housing density and increased peacefulness was noted as a benefit, because it increased the presence of wildlife "coming down out of the mountain."

Residents described impacts from dust as hindering quality of life.

> “Basically couldn't sit on your porch. Couldn't have your doors open or anything else.”

Also reported was blasting without any audible warnings. The community has been on public water for many decades and reported no problems with this system.

Residents cited employment as a benefit to the community stating,

> “As far as jobs, yeah. It helped out fine, but as far as environmental it wasn't too good at all.”

However, residents could not recall anyone specifically in Superior Bottom who had worked in the surface mining, but several men in the larger Omar area. It was noted that fewer families were of employment age and "most of old-timers had retired."

3. Companies and Communities

When asked about their feelings of likelihood that the company will be responsive in dealing with the community in the future the resident's responses were split. One resident felt that the company had been more than accommodating, honest and responsive in their dealings. Another resident was not clear on this issue. On the one hand, the resident felt that little had come of past efforts, but also felt they believed if they decided to leave the bottom, the company would deal fairly with them.

It is particularly noteworthy that residents of Superior Bottom reported that the community was organized and had worked in the past with the State Department of Environmental Protection to address concerns about dust and overall mining activity. This organization, however, was unable to stave off the displacement that occurred.

The most recent significant decline in population in Superior Bottom did not occur until the coal company approached residents requesting to buy their lands for a haul road and for equipment storage. It was noted that the community opposed this and held public meetings with DEP representatives. However, they were unsuccessful in their opposition. Reports indicate that the company did not approach everyone, just a specific portion of homes from the bridge that provides access to the bottom and north. As stated above, the opinions of the residents interviewed varied regarding access to public information and the cooperation of the coal companies with the community.

4. Summary and Community Future

As for future of the community the residents again were split. One resident looked upon the changes as a cycle of regeneration that would depend largely upon the efforts of those that remain in the community now. Another resident did not express much optimism that things would improve.

> “If the situation doesn't get any worse than it is now, then I am satisfied.”

One resident explained their hope for the resilience of the community, regardless of any mining activity in the future, as follows:

> “You know, I saw some disappointment, but it's… they're coming back. Everyone is they're trying now to do and keep things going. One of the things I told them too, I said, well, you know, people were coming in and trashing the community. And I told them, No, we have a community action group, that we were trying to improve our community. And as long as we have one person living in that community, and this is…. is ah going on, we expect the community to be decent. And able for people to live in and clean enough for someone to come in and want to live in. To want to live in it. So, that is what we are trying to do.”

Also stated was a fear that if mining companies continue to surface mine above Superior Bottom, then "a lot of water would be coming out of there" at which point they might reconsider decisions to stay.

G. BLAIR, WEST VIRGINIA

Blair is a community west of Logan which at it's height was reportedly home to approximately 700 families. The community was linked internally and with adjacent communities by the local school and churches. Residents reported that their families originally settled in the community in the first half of twentieth century and have continued to live there since that time. Strip mining reportedly occurred in the Blair area in the 1970s, and mountaintop mining reportedly began in the early to mid 1990s.

1. Social Community

Residents described a number of aspects that made Blair a likeable and prosperous place to live. The family atmosphere, quiet environment, local sports teams (baseball and softball) and good people were cited as reasons for liking and enjoying living in Blair over the years. At one time Blair was home to several local stores, filling stations, and numerous churches. Residents say they must now drive to Logan "to buy a loaf of bread."

Empty Lots in Blair

Based upon the interviews collected, it is not clear exactly when a shift from a population of 700 families to 300 happened; however, accounts indicated that when mountaintop mining began in the Blair area only about 300 families remained in the area. One possible explanation might be an overall decline in the mining industry and its related employment in the 1980s; however, this was not clarified by the residents. In the mid 1990s residents report that the mining company in the area, believed to be Arch Mineral, purchased more than half the homes in the community. A loss of jobs related to mine closures was also reported to have contributed to the population decline. The closure of two local schools in Blair and Sharples, along with the loss over time of local businesses contributed to a decline in the social community described by one resident as follows:

> "When you loose your schools in a community, you have no reason to have a community... Families… in this community, in Sharples, when the children done something, mommies and daddies was there. When they played ball mommies and daddies was there. When they had Halloween parties, mommies and daddies was there. When they had any kind of a get together, mommies and daddies was there."

Of the interviewed residents, one family chose to leave and the other family chose to stay in Blair. Residents reported no animosity between neighbors or impacts on relationships related to decisions to stay or leave. Neither resident had any regrets regarding their decisions. The residents described their decisions as follows:

Excerpts Taken From Two Different Interviews

Decision To Remain In the Community: Resident (E)

Interviewer: Can you tell me a little bit about your decision not to move?

Resident: Well I didn't want to! I like this place, and I was born and raised here. I'm not saying I won't go. It may get so bad I might have to, but I don't want to. I don't believe I'd be satisfied anywhere else. I've looked around, looked at property and it's outrageous. I said if I had to go, I said they're gonna buy me a place. I'm not gonna go in debt. This is paid for - I don't owe a dime on it. I own this place and that place up there, those hills. If I go somewhere, their gonna buy me a place. I'm not gonna go in debt. So I don't know. I'm not gonna say I wont go, but I don't want to.

Decision To Leave The Community: Resident (F)

Interviewer: Why did you approach the company to be bought out?...

Resident: I knew that they would strip behind my house. I, my son knew how far they was gonna go, and any time you got strip mining you got a chance of a slide, especially in the spring. Here when we have a lot of rain, we have deep water, nothing to hold it back, so I felt that it was time. If I could, it was time for me to move out.

Residents reported an estimate of 65 families that "still own their own properties" in Blair. There were no visible, abandoned or dilapidated homes, only a very few boarded-up businesses. Despite the continuing "lived-in" appearance of the community, one resident reported problems with residents from other areas dumping trash in and around the community. This type of problem has social, physical and economic impacts on residents over time, impacts most often cited in urban areas where dilapidation and illegal dumping on abandoned lots can be a rampant problem.

2. Physical and Economic Community

Several types of physical changes were reported by both families interviewed for Blair including changes to landscape, wildlife habitat and air quality. One family reported damage to water quality.

In Blair, one resident reported complaints regarding on-going dust problems and well water problems having been ignored or not taken seriously by appropriate authorities. Well water was reported to be no longer potable and residents travel to springs outside the community to collect potable water for daily use. As mentioned previously, only a small number of interviews were collected in Blair, therefore, it is difficult to gage the prevalence of reported positive or negative impacts. Despite this it should be noted that reports of extensive dust from surface mining facilities and blasting techniques have been consistently raised in each of the communities, except Werth.

As in many communities in West Virginia, underground mining was both a predominate part of life in Blair and a major employer through the twentieth century. One resident explained that they had worked a number of jobs in retail and other industries, but eventually worked at the coal tipple because mining had the best wages. Residents referred to employment when asked about benefits from the presence of surface mining in the Blair area.

> "I raised three children on the miner's income....It's the best paying job in West Virginia, far as I know, is coal mining."

Each of the residents felt that the jobs generated, not only by the coal industry, but by large surface mining operations was an important benefit. Both families interviewed had been supported by the coal mining industry, as were subsequent generations in one case. One resident clearly pointed out that he relies upon the benefits and retirement he receives now that his employment is finished. However, the residents were not always consistent in their own testimonies regarding employment provided locally to Blair from adjacent mining versus overall employment benefits in the region.

Another theme which has been raised in interviews in several communities and repeated again in Blair, was the difficulty in obtaining employment with coal companies and the need for a connection or someone advocating for you to be hired.

Excerpts from two different interviews below illustrate that point.

Resident (G) "Coal is a good occupation. It is kind of dangerous, but it pays good wages.... if you can get a job. I tried to get a job down at Sharpless for probably about twelve years before I even got on down there... It is hard to get on, you have got to have somebody to pull for you."

Resident (H) "My dad's a coal miner and he was in the coal mines for I think 35 years. So he help get me in the coal mine."

3. Coal Companies and Communities

The relationship between a given coal company and the community in Blair was not significantly remarked upon by residents outside of the process through which a coal company purchased properties and displaced a number of families. Complaints regarding any impacts were directed to State officials and the relationship with the state was remarked upon as negative. Remarks regarding a coal company's direct dealings with the community indicated that those who had interacted with the company felt they were treated fairly.

In reaction to some of the physical changes, residents reported having filed complaints and spoken to the Department of Environmental Protection (DEP) and gotten less than satisfactory results. It was believed that inspectors were bought off, that residents were put off and their complaints were disregarded. One resident described the following interaction regarding his well water:

> "I took three samples to a meeting we had down at the school about our water. I took one over the weekend you know when they wasn't doing no blasting, and it looked fairly good. And I took one after they started blasting, and I showed it to 'em. And they didn't think what I was showing them was actual truth. They made fun of me, really, and I got it right of my spigot."

Residents indicated that the coal company generally did not interact with the community on a proactive basis. Public meetings were held with DEP representatives, but none of the residents reported having been informed prior to mining of possible impacts or activity. In general, knowledge of mining activities was gained through personal contacts and involvement with the mining companies.

> "They don't tell you anything. That is one problem that the community has, is they don't let the community know what they're going to do. If they had come in here and told the community what they were going to do, there might have been more people who would have sold out. I don't' know."

The residents did not consistently report seeing the permit activity advertised in the local papers. However, one resident reported, that for the advertised permits they did read, they felt that most people would not understand the information due to lack of technical knowledge in reading the maps.

Residents also alerted State officials of a trash dumping problem in their community; the problem began following the decline in population and removal of many homes.

> "They had come to the conclusion that ain't nobody around here, so why don't we make a garbage dump out of this place."

Again, the resident had complained to the DEP and felt the issue was not resolved satisfactorily.

Residents were asked about the interactions regarding coal company or land holding company purchasing of homes. One resident reported that individuals approached the coal company in most cases, seeking to leave the perceived negative impacts of surface mining (dust, decreased property values and possible flooding were noted) and to take advantage of a willing buyer. Buy-outs were reported to have begun in the middle 1990s and one resident believed that the company was interested in purchasing about 200 properties at that time. For those who had chosen to leave, they did not report this as a difficult decision. They felt the company gave them a satisfactory purchase price. When queried about any additional conditions of the sale, one resident stated the following:

> "Yeah, I had to move, I had to move out of what the company owned. At that time it was below Sharpless... I can't recall exactly the boundary line, but I couldn't move back in the neighborhood I was in. Or Sharpless, the neighborhood where the headquarters of the company was at, or their main office. I had to move outside of that."

Another resident who had chosen to stay stated the following about the dealings between the residents and the company:

> "They would think they were getting a good price for their house, because when they bought the house they didn't pay a whole lot for it. But then when they would try to buy one somewhere else, they would usually have to go in debt, most of them."

4. Summary and Community Future

While surface mining is not going on currently adjacent to the community, the period of mining and shifts in population are still somewhat recent. Residents indicated that current quality of life is diminished from the loss of population and they worry about possible future flooding. When queried about the community environment, one resident responded:

> "I can't say that it is a bad community, but there just not that many of us... There is just nothing to get us together."

The residents were not optimistic in regard to the future of Blair. They believe that the coal company eventually might buy out the whole community based on indications of possible surface mining activity in the future. One resident simply stated that there was no future for the community.

> "I believe [Blair] will finally vanish. It won't be any, if the coal company has anything to do with it. See they're wanting to go underneath us and get coal, they want the long wall.... Well they want to get us out of here, because if our property sinks, they know we're gonna sue. 'Course it's hard to get anything out of 'em. But ah they'll eventually, I'd say, get us all."

VI. PROPERTY OWNERSHIP DATA

In *Who Owns Appalachia?* Charles C.Geisler and the Appalachian Land Ownership Task Force undertook the task of identifying land ownership patterns, examining associated tax burden issues and discussing the economic and social implications of land ownership patterns nationally. The findings if the report were based on county tax data from eighty counties in six states, Alabama, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia. The Task Force report indicates that land ownership patterns, particularly patterns related to energy production and reserves have far reaching implications ranging from national energy policies to local economic development. The implications of absentee ownership and the scale of ownership of energy related lands in Appalachia is not a new issue, but very little specific information has been made available to document this issue.

The Task Force generally found that use of the land for coal mining and property ownership by distant corporations contributes to patterns of depressed tax bases and loss of agricultural lands. Lands used for coal mining, particularly strip mining, 'may limit the use of land for subsequent agricultural development,' and a lack of improvements or taxable investments in these lands result in large parcels of land which do not contribute to the tax base.

From the data collected by the Task Force, which echo the data found in other studies reviewed in the report, two themes emerge with regard to property ownership in Appalachia: (1) absentee ownership of surface rights is disproportionately high and (2) this ownership is becoming increasingly divorced from the local economy and society.

1. Absentee Ownership

Findings of the Task Force indicate that as of 1981, 13 million acres, (nearly 75 percent) of the area studied was held by absentee owners. Out-of-state ownership accounted for 47 percent, and out-of-county ownership accounted for an additional 25 percent. More specifically corporations own 40 percent of the land in the sample across six states. In West Virginia, that number is even greater; corporate ownership accounts for 59 percent of the sampled area. To further illustrate the point that a small number of large-scale owners control a large percentage of the land in Appalachia, the Task Force analyzed the concentration of ownership as well. At the time of the study, "The top one percent of the owners in the sample own 44 percent of the land in the sample...[and] the top half of the owners in the sample control 94 percent of the land in the sample." Of the fifty top owners in the sample, forty-six were corporations. (Appalachian Land Ownership Task Force, 1981)

The pervasiveness of large-scale absentee ownership, especially in West Virginia, has important and dangerous implications for local economies and social environments. Both social scientists and the Governor's Task Force use the term "colonial" or refer to a "colony" as an analogy for the social and economic structure present in Appalachia with regard to land and power. Land ownership has long been recognized as a tool for wielding power and gaining political control. For example, in a colonial setting, ownership of land means control over geographic resources and power in shaping economic development. Social theorists examining patterns of underdevelopment and poverty have applied a number of theories to causes of economic failings. The colonialism thread within those theories maintains that underdeveloped economies are shaped by their dependency upon more powerful economies and their development possibilities are controlled by absent decision-makers acting on foreign interests (Obermiller and Philliber 1994). Geisler and the Task Force quote Wunderlich, a land economist for the United States Department of Agriculture, as stating the relationship between land ownership and power as follows: "Land is a means for distributing and exercising power," (1981). The link between these ideas lies in who is controlling the power, (i.e. the land). In the case of Appalachia, the Task Force's report illustrates that it is largely not Appalachians.

> "There was nothing here. So, you can't turn up your nose at industry coming in. You've got to have something, and you want to have something that will keep young people in this area, very much. But we are very disturbed at the lack of control.(Freda Silver)" (Moore 1988)

2. Stewardship Of The Land

In addition to demonstrating who owns the majority of the land, the report also discusses the extent of corporate and non-local ownership. The separation of ownership between surface and sub-surface mineral rights is a pervasive practice in the coal fields of Appalachia and elsewhere. The resulting pattern of separation between those that occupy the land and those who control its wealth and its resources creates a distinctly unique question regarding stewardship. As in the colonial model of social theory, the decisions of absentee owners will be in their interests, not necessarily in the interests of or accounting for the interests of those who occupy the land.

The increase of surface mining and absentee ownership of surface rights creates additional issues of stewardship. The Appalachian Land Ownership Task Force report illustrates that the nature of absentee ownership in Appalachia has been changing since the 1960s. Since that time, large multi-national energy conglomerates have been acquiring and combining the interests of, smaller coal companies. While at one time the coal mining industry was focused around a local town, epitomized in the company towns throughout the region, now a local operation may ultimately be controlled by an operation thousands of miles away.

> "Allied Chemical Corporation's mineral holdings in Fayette and McDowell counties, West Virginia, have been absorbed into the larger holdings of Armco Steel and A..T. Massey" (a subsidiary of St. Joe's Minerals of New York, now in association with Royal Dutch Shell). (1981)

The implications of increasingly international forces shaping land use and economic decisions in the Appalachian region are an increased divorce between those who control and have responsibilities for stewardship of the land and those who occupy and live in proximity to those lands.

Several of the residents interviewed referred to the local mining operations and the series of companies owning the land. The residents demonstrated understanding of these ownership patterns and the shift from local companies to large multi-national interests with a depth that is likely uncharacteristic of the average American's understanding of land in their communities. In a region centered so heavily around the energy resource economy, understanding the complex nature of the ownership patterns has become a prerequisite to living in their own community, in a manner that likely few other communities in the country are required to do.

The property ownership data collected for this study illustrate on a much smaller scale, the patterns of land ownership within the selected community study areas. The findings are discussed with regard to the displacement of local populations and the increasing separation of local power and control over the communities in which they live.

A. WERTH, HAMILTON SUBDIVISION, NICHOLAS COUNTY, WEST VIRGINIA

No pattern of company ownership or purchase of privately held properties in Werth was indicated in the sample of property ownership data. Some residents reported selling land to the coal companies for mining, but the sample property ownership records support the assertion that there was no pattern of purchasing homes or buying-out communities large-scale in the Werth area. Sample data are shown in Table 21.

B. KYLE, NORTH ELKIN SUBDIVISION, MCDOWELL COUNTY, WEST VIRGINIA

A sample of property ownership data for Kyle, WV does not display a pattern of large-scale purchase of properties by extraction or land holding companies. These data are shown in Table 22. Interviews have not yet been conducted with residents of Kyle; therefore, no determination can be made if these data support the experiences of residents in the community.

C. NAUGATUCK, HARDEE DISTRICT, MINGO COUNTY, WEST VIRGINIA

Sample property ownership data for Naugatuck, West Virginia are shown in Table 23. The collected data do not display a pattern of large-scale purchase of properties by extraction or land holding companies. Two properties within the sample of 25 have been purchased by a land holding company from private owners within the last five years. No data are available from existing property tax records concerning purchase price.

D. SCARLET, HARDEE DISTRICT, MINGO COUNTY, WEST VIRGINIA

Table 24 shows recent property ownership patterns in Scarlet, West Virginia. Community interviews and the sample property ownership data both indicate a pattern of large-scale property purchases by the coal company(s) or an agent. Within the sample of 25 properties collected, 76 percent have been purchased from private owners by a land holding company. All of these purchases occurred within the last ten years which is consistent with the time frame described by residents. Previous purchase prices were not available from existing property tax records for the majority of the 76 percent now owned by land holding companies. However, data were available for three properties showing that the recorded sales price was more than double the last recorded sales price. In two instances the sales price increased by 580 and 670 percent respectively over the previous sales price in less than ten years. While a sample of three sales prices may not be representative of all such transactions, it does support indications of satisfaction in purchase price reported by some residents. None of the sales prices were compared to advertised sales prices for comparable properties to determine the relative value compared to available properties; therefore, no comment can be made on the ability of Scarlet home owners receiving the listed prices to purchase a new home in another community.

E. CARCASSONNE, BLACKEY SUBDIVISION, LETCHER COUNTY, KENTUCKY

There is no evidence of large-scale purchase of private property by extraction or land holding companies based upon the sample property ownership data in Carcassonne, KY. These sample data are shown in Table 25. Community interviews have not yet been conducted in this community; therefore, it is not possible at this time to compare these data with the experiences of residents.

F. ADDITIONAL COMMUNITIES

1. Superior Bottom, West Virginia

Of the same property ownership data for Superior Bottom, WV, 52 percent of properties have shifted from private ownership to that of land holding companies. Table 26 shows that none of the properties purchased are larger than one acre in size. These data support statements by residents in the community that roughly half of the valley bottom has been purchased by coal company interests. Residents reported, from first-hand experiences, satisfaction with purchase prices offered and settled upon with the coal company. Sale prices were not recorded for any of the properties within that 52 percent of the sample data.

2. Blair, West Virginia

Property ownership data were collected for the Blair, WV area; however, available records did not provide complete transfer of ownership information. As shown in Table 27, records for current ownership for one property and several records for previous ownership were also not available for the sample properties. Over half of the properties within the sample are currently owned by either extraction or land holding companies. Where data are available, 68 percent of the land owned by either extraction or land holding companies was purchased from private owners. Only two of the properties purchased by either extraction or land holding companies were larger than one acre, those were 10 and 11 acres respectively.

Residents interviewed in the Blair community who had chosen to sell their property to the coal company or their agent(s) were satisfied with the settled upon purchase price. The sample property ownership data indicate for two properties the sale price for transfers from private property to coal company interests. For these two properties the purchase price increased, by 176 percent and by 700 percent respectively within a fifteen year period.

VII. SCHOOL ENROLLMENT DATA

A. WEST VIRGINIA

School enrollment data collected state-wide by district are available in West Virginia beginning in 1977. Each county in West Virginia is its own school district. Presented in Table 28 are the total enrollments from 1977 - 1979 and in 5 year increments following that to 1999 for each of the school districts in the West Virginia study areas.

The overall trend of total enrollment is consistently declining since the first half of the 1980s among each of the West Virginia study areas as well as the control area. The McDowell County school District shows the greatest overall decline in total enrollments. It is important to note that the control area, Wyoming County School District, has similar drops in total enrollment over the study period despite its lack of significant surface mining activity.

B. KENTUCKY

School enrollment data for Letcher County, Kentucky are shown in Table 29 for the study period, with data missing only for the school year period of 1993-1994. Total enrollment data for the Letcher County School District, which encompasses the county in its entirety, indicate the largest decline in enrollments during the post-mining period, 1991 - 2000. Prior to the 1990 - 1991 school year, average five year enrollments only fluctuated by 100 -200 students. Between the 1989 - 1990 and 1999 - 2000 school years total enrollment dropped by 1, 228 students.

Enrollment from 1970 to 1985 for the local elementary schools serving the Carcassone area, Letcher and Campbell's Branch Elementary Schools, are shown in Table 30. Total enrollment over the 15 year period increased at both schools. The range of total enrollment over 15 years for Letcher Elementary was +/- 131 students, and the range for Campbell's Branch Elementary was +/- 37 students. A comparison of the pre-mining period, 1970 to 1979, to the first half of the during-mining period, 1980 - 1985, shows the five year average enrollments continuing to increase.

Anecdotal accounts indicate that the Letcher County school district is currently planning on consolidating all the students in the county into one high school. Enrollment data by school indicate that the local Carcassonne School closed in at the end of the 1973-1974 school year with a total enrollment of 12 students. Elementary schools which served the Carcassone/Blackey/Letcher areas were consolidated in the late 1990s. Parents and area residents at these meetings expressed concern over the loss of their local school and the impacts to the quality of education associated with increased students at Letcher Elementary School.

VIII. SUMMARY DISCUSSION

A. COMMON THEMES

Among the residents in each of the communities several themes emerged in describing their experiences living in a community adjacent to large-scale surface mining. Demographic data support many of these themes such as loss of population, declining economic environments and aging populations. The experiences shared by residents include loss of community population and community structure, struggles in obtaining available economic benefits, occurrences of similar physical changes and feelings of ineffectiveness in preventing or managing these effects. Additional common experiences shared among the study communities related to the purchase of homes and property by extraction or land holding companies and the resulting impacts of displacement.

1. Social Community

The census data demographic analysis presented in Section IV demonstrates that an overall decline in population was experienced between 1980 and 2000 in the five case study areas and one control area. While this is not shown to be consistent with the population growth rates of the respective States, West Virginia and Kentucky, it is consistent with anecdotal and economic indicators regarding employment trends within the coal mining industry. The population trends of the control study area, District One, Wyoming County, West Virginia are somewhat consistent with that of McDowell and Mingo Counties, showing a significantly higher rate of decline between 1980 and 1990 than between 1990 and 2000. Therefore, while the rate of loss of population is greater in the during mining period, it is also greater in the control study area suggesting that the presence of large-scale surface mining did not contribute to population decline.

It cannot be assumed that each of these communities was necessarily at its social and economic height at the point at which surface mining began. While no single population shift of the scale associated with the purchase of whole portions of communities were reported, several residents did reported declines in local population over time.

In each of the communities, residents noted the decline in population, but not every resident felt that this decline represented a decline in the community. However, several indications support reports of less stable communities and loss of community resources. A number of residents reported that large-scale purchasing of homes and land by the coal companies and their agents contributed to a less stable community. Property ownership data collected in Scarlet, Superior Bottom and Blair reflect these reported large-scale purchasing patterns. In each of these communities, between 44 - 76 percent of sample properties had been purchased by either a mineral extraction company or a land holding company.

2. Displacement

Traditional discourse regarding displacement of persons and families most often occurs around gentrification and urban displacement of a population by either market forces or public policy around revitalization. In recent decades, a great deal of attention has been paid to this issue; however, the possible displacement of rural populations or displacement caused by a single industry/company has not typically been a focus of the discussion. Displacement could be generally defined as the involuntary movement of a population, whether by natural disaster or market forces. One source expands this definition to include any household forced to move despite “having met all previously-imposed conditions of occupancy” or because of conditions that make occupancy “impossible, hazardous or unaffordable” (Schill and Nathan, 1983). Much research indicates that poor, minority and elderly populations bear the brunt of urban displacement, and in fact that the elderly may share an even larger percentage of that burden (Palen and London, 1984) (Schill and Nathan, 1983). As discussed in Section IV, demographic analysis of the study area counties and county subdivisions indicate that between the 1990 and 2000 U.S. Censuses the mature age group (ages 45-64) and the senior age group (ages 65 and older) are increasingly occupying a larger percentage of the total population. This trend is also noted at the state level.

The coverage in the literature of the specific issue of a private company undertaking a large-scale plan for purchasing and moving populations in rural areas is sparse. To characterize this process as strictly displacement could be considered questionable on the grounds that residents are given the option to move or not to move; however, it should be noted that residents of in Scarlet, Blair and Superior Bottom reported feeling pressured to leave. None of the interviewed residents in those three communities, whether they stayed or left, indicated that they were interested in leaving prior to the presence of surface mining or the relocation of the majority of their neighbors. Similarly, for those who left their communities and some who would have chosen to leave, the quality of life impacts and/or the opportunity presented by the coal company for a willing seller were nearly always given as a primary motivation for relocating. Almost all residents interviewed expressed a fear of possible future physical impacts and concern regarding the likelihood of flooding. Several of these residents felt that the mining companies presented the only likely opportunity for an interested purchaser at that time. Many residents may have felt that their options were limited, “In West Virginia, the coal company is the power... And the little man don't have a chance. They decide they want a piece of property their gonna get it” (Blair, WV). In this instance, the perceived power of the coal company is believed to be larger than the person, family or community, and it is out of their control or ability to fight.

The social and psychological effects of displacement are difficult to measure, and are not measured by census data alone. Literature sources indicate that displaced populations face personal hardships finding replacement housing, undergoing separation from family and community networks, and feeling powerless or ineffective (Schill and Nathan, 1983). In urban environments, displaced populations from public projects receive relocation assistance in recognition of the difficulties associated with finding affordable replacement housing. Available affordable housing in Appalachia is stymied by topography, land ownership patterns and a resulting tight and inflated market (Appalachian Land Ownership Task Force, 1981). Compounding physical obstacles are the social and psychological impacts associated with displacement.

There are many parallels between the experiences of a displaced community and other groups who have been forced to migrate and relocate, specifically with regard to loss of community and a sense of personal history. In Harriette Arnow's mid 20th Century book, *The Dollmaker*, she chronicles the trials of a family forced to move from Kentucky to Detroit in search of work. Her characterization of their displacement, while fictional, highlights some of the issues raised in the interviews collected for this report, most notably the associations of a home place to a family and personal history and culture (Rubin1998). This same sense of belonging to a culture and history tied to a geographic place is present in literature regarding the displacement of Native American Indians. In a Native American framework, Federal policies for assimilation included a movement toward individual ownership of land and therefore a purposeful disruption of traditional communally held land in order to engender concepts of "competitive individualism" over a communal culture and history (Berninghausen 1998). Such policies recognized that within that culture, primary ties to the land were not economic in nature.

Parallels can also be drawn between the memoirs of past Kentucky resident, Linda Scott DeRosier, and the manner in which the majority of residents interviewed for this report referred to their communities and the close-knit relationships developed between neighbors that were not physically related.

> “We watched out for each other. We was at the mouth of the hollow. It was just, I don't know, family. At one point in time it was family. Everybody was family. And then, of course, you start letting in, and people kept selling out, and of course, we all bonded, even the people that came in that wasn't family, we all bonded real good.” (Scarlet, WV)

From Linda Scott DeRosier’s memoirs:

> “I also know that Daddy's and Ronalta Mae's daddy Tommy Pelphrey's jobs were better than those of Frank Ward (Easter's daddy) or Kennis Holbrook (Gwen's daddy), because Uncle Frank and Uncle Kennis were sporadically employed at smaller, nonunion mines.” (DeRosier, 1999)

DeRosier's reference to all adults in the community as "Uncle" and "Aunt" reflects the unusually close-knit relationships.

Of those residents interviewed in Scarlet, Blair and Superior Bottom, only one family expressed personal dissatisfaction with their decision to leave. In that particular case, dissatisfaction was largely due to factors pertaining to their new location. The majority of interviewed residents related concerns about their abilities to find new locations which would be satisfying, and discontent over the loss of close physical and social ties to family and friends. These feelings were expressed by both residents who had left and those who had stayed, indicating the social impacts of displacement could be applied to the families which remain behind in the community as well.

Discourse regarding displacement often reviews the degree to which minority populations are more likely to be displaced. Current federal regulations require that public agencies consider unequal adverse impacts on minority and low income populations when advancing projects, such as new roads. These types of concerns are referred to as 'environmental justice' issues. Executive Order 12898 identifies the following as one of the guiding principles behind identification of environmental justice issues:

> "Agencies should recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action. These factors should include the physical sensitivity of the community or population to particular impacts; the effect of any disruption on community structure associated with the proposed action; and the nature and degree of impact on the physical and social structure."

As with other quality of life impacts, the displacement of whole communities, and even the impact upon remaining residents can be considered as a "disruption on community structure." It should be noted that each of the three communities in which displacement has occurred, Scarlet, Blair and Superior Bottom, lie within counties for which the percentage of the population below the poverty level exceeds that of the State of West Virginia for 1990. Therefore, the displacement in these communities should be considered as an environmental justice issue.

3. Community Facilities

In addition to population trends and patterns of displacement, school enrollments in these areas also reflect the decline in population and loss of families in the community. At the county level, school enrollment data indicate that each of the school districts, with the exception of Letcher County, Kentucky where data are not yet available, experienced declined enrollments over the study period. In Mingo County, West Virginia the rate of decline in enrollments from the 1980s to the 1990s jumped from (4) percent to (23) percent. Except in Nicholas County, higher rates of decline were experienced in the post-mining period. Again, this is true for the control school district as well; therefore it is difficult to attribute these declines to a presence of surface mining.

In Letcher County, Kentucky the community of Carcassonne has been impacted by school closures in the district. Anecdotal evidence indicates that the Letcher County school district is currently considering consolidating the whole district from three high schools into one. In 1998, the Letcher County School District closed Campbell's Branch Elementary, one of three elementary schools serving residents in that portion of the county. The students were consolidated into one of two remaining elementary schools. School District records of the Letcher County Board of Education meetings indicate that parents were concerned about impacts on the quality of education and social community in a now more crowded Letcher Elementary School. School consolidation was reported by residents in Scarlet and Blair in the post-mining period from 1990 to 2000. In addition to the role education plays on quality of life, schools act as physical infrastructure for public meeting space and create a focal point for interactions between families.

Closed School in Blair Area

4. Physical and Economic Community

Both the demographic analysis and the collected residents' interviews indicate physical and economic changes in the study areas and communities. Three issues were raised by residents in each of the communities studied: levels of community employment on surface mining sites; the difficulty and desirability of surface mining jobs; and physical landscape changes. Water quality and availability issues were also raised, but not in every community.

5. Employment and Place of Work

The traditional and complex relationship between the residents of southern West Virginia and the coal industry was echoed in a number of comments. Residents respected the economic benefits the coal industry offers to their communities and region; however, residents often also cited the difficulties in obtaining jobs in the industry. A resident, who ultimately obtained a job through a community connection on a softball team described his trials in getting hired on at the coal company as follows:

"Well, they paid good wages to the ones who worked there. Uh coal is a good occupation. It's kinda dangerous, but uh, it pays good wages, got good benefits, if you could get a job. I tried to get a job down Sharples for ah, probably about 12 years, before I even got on down there. One fella told me, he said, 'You the next fella I'm gonna hire.' He lost his job, pretty good while after, he lost his job, and I didn't get the job." (Blair, WV)

Demographic analysis indicates that employment within the mining industry decreased dramatically in McDowell, Nicholas and Wyoming Counties in West Virginia between 1980 and 1990. In addition, overall unemployment rates have increased in all each of the three county subdivision areas in West Virginia as well as the control area. Unemployment doubled in McDowell County and nearly doubled in the North Elkin District in McDowell County between 1980 and 1990. McDowell County had the greatest rate of decline in mining employment between 1980 and 1990. It is important to note, however, that the control study area, District 1, Wyoming County, the area with minimal surface mining activity, also lost mining employment and experienced a marked increase in unemployment.

Many residents felt that economic benefits to the local communities were limited, and only cited a few specific cases of employment generated by surface mining sites benefitting residents in the adjacent community. The results of demographic analysis of income data are similar to those of employment. Each of the county subdivision study areas in West Virginia and the control area had negative growth in median household income between 1979 and 1989. Again, McDowell County and North Elkin District had the greatest decline in median household income, the same areas with significant decreases in coal employment in the during- mining period from 1980 to 1990. Wyoming County as a whole and District One had as great and greater declines respectively in median household income over the same period; therefore, these declines cannot be clearly attributed to loss of employment or income from smaller employment bases associated with surface mining operations as opposed to underground mining operations based on this demographic analysis.

Census data regarding place of work for 1980 and 1990 indicate that in all of the West Virginia county subdivision study areas the percentage of workers who worked in West Virginia and within their county of residence declined. North Elkin County Subdivison experienced the greatest decline from 90.6 percent to 75.4 percent. District One experienced the next highest decline. Place of work data for the 2000 U.S. Census and for Blackey Division in Kentucky for 1980,'90 and'00 are not yet available. The similarity in the trend between the study areas and that of the control area is also demonstrated in the number of workers who work outside their State of residence. District One, Wyoming County experienced the greatest increase, 220 percent, followed by North Elkin, McDowell County with 119.6 percent increase, among resident workers who work outside West Virginia. These travel to work patterns reflect the decline in available employment within the study areas. Mingo County and Nicholas County and their county subdivisions were the exception, showing only small declines in resident workers who work within the county and a decline in the number of resident workers who work outside West Virginia.

While U.S. Census data for 2000 are not yet available for many economic and employment measures, the demographic analysis of pre- (1970 - 1979, represented by the 1980 U.S. Census) and during (1980 - 1989, represented by the 1990 U.S. Census) mining periods does not present a consistent pattern of improved economic stability or employment growth in the during mining period. Specifically, mining employment declined during the mining period in each of the West Virginia Counties. Several counties showed greater declines than the control county, (Wyoming). Letcher County, Kentucky was the only county evaluated which exhibited an increase in mining employment (2.6 percent) in the "during mining" period.

6. Assistance Income

Another economic and social theme often raised in discourse regarding Appalachia which was echoed by a number of residents, is a tradition of independence and self-reliance. Traditional fluctuations in the coal industry often required families to be adaptable and fill in economic gaps; however, much of the literature regarding this lifestyle indicates that taking government assistance was viewed as a weakness. One account of a father who assiduously refused to be reliant or weak is as follows: "Your in-laws will help you or your parents . If you don't want them to give it to you, you go up there and do a job for them... You work it out so you are not accepting charity" (Yarrow 1990). DeRosier provides another example, "... Daddy immediately found another job doing whatever kind of work he could scare up. One of the things he was proudest of was that he never took a day of 'rocking chair' (unemployment compensation) in his life" (DeRosier, 1999). While Appalachian culture cannot and should not be simplified into stereotypes, the demographic data highlight this point. Given the increasing unemployment, and decreasing income levels, it might be expected to find significant increases in households receiving public assistance; however, between 1979 and 1989, these rates did not increase substantially. These data could also highlight the important role social and family networks play in communities.

7. Physical Shifts

In addition to economic changes, many residents, although not all, reported changes in landscape and physical impacts in communities which they felt were directly related and attributable to the presence of surface mining. Not all of these changes were viewed as negative. "With this mine coming in it hasn't improved anything other than to free up the animals and nature to feel free to come in" (Superior Bottom, WV). Many other residents however felt that changes in surface property ownership changed the accessibility of land for hunting and fishing and that the introduction of dust, rock and overburden has negatively impacted the use of the landscape and overall quality of life. In Werth, Scarlet and Blair residents reported muddy and uninhabitable streams. As one resident explained:

> "...when these coal companies comes through here and strip, they always put a gate up. So a 4-wheeler or nothing gets through there to hunt. I don't like it, and I guess the other guys don't either, you know, who likes to ride 4-wheelers and things. But they always put a gate up… On their roads, where you can't get through. I can understand their part in a certain way, you know… if you got equipment in there, keeping people from stealing...…. 'Course I got, to me, I got to an age where I got rid of my 4-wheeler, and I'm not able to do it. So, but I like to see young guys enjoy their life like I did mine" (Werth, WV).

In some cases, a fear of future and long-term physical impacts has also changed the feelings of stability in the community. A fear of future flooding related to surface mining and associated timbering was mentioned in Werth, Superior Bottom and Blair.

> "...they stripped around to the head of this hollow and we had floods back then. And it would rain, and you'd be sittin on the front porch and you can hear that water coming down the hollow. It would all come down at one time. And we hadn't had any of that, no floods, since they've done this mountaintop. And I don't know what's gonna happen. And it worries me, but a I don't dwell on it a whole lot. But I don't know what's gonna happen." (Blair, WV)

8. Company and Community

Demographic analysis does not measure the relationships and interactions between the coal company and the communities. Reports given by residents both between communities and between interviews, and even within individual interviews were not always consistent regarding the quality and level of public information provided by the coal company and the degree of cooperation and responsiveness exhibited by the companies in regards to complaints. One universal theme that emerged was residents' varying views of different coal companies. The resident's views were shaped by a number of factors including the availability of public information, the manner in which complaints were handled, and the perceived quality of the surface mining site's operations. These factors shaped responses to questions regarding specific surface mining sites and companies adjacent to the communities; however, responses regarding surface mining as a practice or coal companies in the abstract often seemed to be shaped by larger personal and perhaps political views.

In no instance did residents report being aware of public information being made available prior to surface mining aside from legally required permit advertisements in the local papers. With the exception of Werth, residents reported being aware of planned surface mining operations and in some cases reading publicly advertised permit notifications. In Werth, several residents did not report seeing advertisements for strip mining operations which were reportedly active prior to the 1970s. It was agreed by all residents that this type of public notification was useful, especially to those residents who's personal property might be adjacent to the permit area.

The interface provided by individual company representatives or representatives of public agencies between the communities and the coal mining industry was highlighted in every community.

> "You're trying to provide jobs for people, lot of the jobs, I said you also trying to earn a living. And that God has blessed us to be past that age where we are retired and can live, you know. And I said, but if you need this to provide jobs, I won't stand in your way...He said yes, we'll hire anybody. And so based on that, and I told him I will sell." (Superior Bottom, WV)

One resident described the advantage of having a personal connection to someone within the company:

> "It was to me because see I could tell, I could talk to him. They run up around the road here, and drilled a test well. They drilled several of them, water wells. They used the water to clean off the road, too. But my spring out there went dry. I thought they had sunk the spring. See they drilled a test drill on above it there. I talked to him about it and he brought a man in here on a backhoe and they dug that out. And they hadn't been the cause. The water in the line that went up there to where the spring was, was stopped up. But they put a new line in and cemented it in and everything and they wouldn't take any money for it. They paid for it. Now that wasn't Tassa that was Hobet. Tassa wouldn't even talk to me. When they stopped the sewer system up, I went down there to see them and they didn't want to even talk to me." (Werth, WV)

With one exception, all the residents interviewed felt that coal companies did not make information regarding on-going mining activities available. Several residents in each community referred to family members and friends with jobs or connections to the companies for information.

> "Just my son knew everything what was going on. The company never approached me for nothing" (Blair, WV).

9. Community Future

While most resident did not have very optimistic views of the futures of their communities, this was not always attributed to the presence of surface mining adjacent to the community. In Werth, WV, it was noted that debris in the stream and subsequent flooding of the bottomland left the area inhospitable to farming, but most residents also felt that there was no more future for the small, independent farmers of the type which had once been in Werth. One resident in Superior Bottom, WV felt that the community was going through a necessary phase of decline as part of an overall cycle of regeneration which any community might face. In Scarlet, WV and in Blair, WV however, residents did not express anything positive regarding the near future because of the presence of surface mining and the impacts of the displaced community, such as abandoned homes and loss of community network.

Another important theme which was recurring among the community interviews was the belief and knowledge that the coal mining industry had done a lot for the West Virginia economy and specifically for some of the residents. Nearly every single family that was interviewed had either currently or in the past, a family member working in the coal mining industry. All of those interviewed, who had made their personal living in the coal industry, had worked either underground or at a prep plant. The role that the coal industry has played and will continue to play in the economies of the region is well recognized.

> "I raised three children on the miner's income" (Blair, WV).

The future role of the coal industry is not only in on-going extraction as an active employer, but in on-going benefits for retired miners. Residents in Werth and in Blair reiterated this point. As stated previously, the portion of the population ages 65 and older is increasingly representing a larger portion of the population in each of the study areas.

> "Nearly every resident expressed the belief that coal mining is necessary and desirable for the economy, but that surface mining should be done more cleanly."

> "Like I told you on the phone, I'm not against mining whatsoever, it's just that those of us that feel the effects of the damages and things like that. You know, they need to take care of us. Do something to prevent further damage, to keep us safe, you know, stuff like that. But, on the good part, for the men that need a job to support their family, it is great." (Scarlet, WV)

> "They helped me, of course I raised my family through coal mining, I got a retirement and whether I… I don't know how long that will last, but anyway I got one. So overall I think the strip mining could do a better job reclaiming the surface, that would put people that likes to hunt, that gives them more places to enjoy..." (Blair, WV)

B. INCONSISTENCIES

This section highlights points raised by residents that were not common themes. Between each community and within a given community, several points were raised that were not necessarily echoed by others, but which bear mentioning and consideration. Further investigation would be necessary to determine if these experiences were isolated.

The majority of the census data analysis supports and parallels the reports given by the residents. However, the control study area, Wyoming County and District One, showed very similar demographic patterns as that of the study areas. While the ties between the demographic patterns of the study areas and the shifts in the coal mining industry are readily apparent, the similarity between the control area and the study areas makes it difficult to determine the degree to which demographic shifts are attributable to the presence of large-scale surface mining.

1. Social Community

Shifts in population within the counties and within the county subdivision areas support the reports given by residents in the communities. The reactions and feelings expressed by the residents regarding separation from traditionally family owned land varied somewhat. Overall, residents in Scarlet and Blair expressed the strongest ties to the land. In these communities, most of the interviewed residents represented at least the second generation, and even the third to have lived in the community. Often in Scarlet, references were made to the 'home place' or 'homestead' that was the first settlement of the family in that location. In Werth and Superior Bottom, ties to the land did not seem to extend to a third generation. Many of the residents had moved there as children and subsequently raised their families in Werth, but few believed that their children would return to the area to settle. While this difference in settlement patterns appears to have no correlation to the presence of surface mining, it does seem to correlate to the discussions of the future of each community. In Werth and Superior Bottom, residents were more hopeful of a regeneration and repopulation of the community at some point in the future. In contrast, in Scarlet and Blair, residents expressed strong views that there may be no future for the community. Further social analysis could examine the link between strong family ties and the strong negative reactions to the disruption of these ties.

2. Displacement

As previously stated, the feelings expressed by residents in communities that reportedly experienced displacement, Scarlet, Blair and Superior Bottom are not entirely consistent with the types of social and psychological impacts often discussed with displacement. The majority of residents reported feelings of loss for community and social networks. However, in some cases feelings of great resentment were expressed toward other community members and the coal companies.

With regard to environmental justice, two communities in which property ownership patterns and resident interviews were collected have substantial minority populations based on demographic data and/or resident accounts. These communities are Kyle in North Elkin District, McDowell County and Superior Bottom WV. Property ownership data for these two communities show that only one community has experienced displacement, Superior Bottom. Community interviews have not yet been collected in Kyle, WV; however, as noted in Section IV.A.6., Race, North Elkin District, represents a high concentration of African American residents. Therefore, based upon available data, there is no indication that minority populations in the study area jurisdictions have suffered unequal adverse impacts compared to other populations.

3. Community Facilities

Experiences of school closures and consolidation were not reported in every community. In Werth and in Superior Bottom school consolidation was not reported in relationship to the time frame of surface mining in the community. In addition, some residents noted that the coal mining companies and the industry had helped to support local facilities, such as parks and hospitals. In fact, until the time that the coal company required land for its own uses, land adjacent to the railroad track serving the underground mine in Scarlet was reported the site of an informal ball field. These reports are in contrast to the opinion expressed by the majority of residents interviewed who felt that the presence of surface mining adjacent to their communities provided no benefits in terms of community facilities.

C. PHYSICAL AND ECONOMIC COMMUNITY

1. Employment and Place of Work

As stated in the section on physical and economic community, the results of the demographic analysis do not show a clear correlation between either employment rate or income levels and the presence of large-scale surface mining. When asked to name economic benefits to the communities from the presence of adjacent surface mining, nearly all residents felt there were little or no benefits. The few benefits that were named include retirement benefits and regional economic stability. However, the negative responses belie the evidence that these same residents reported. In each community at least one interviewed person mentioned knowing someone having a job at the adjacent surface mining operation. It is difficult to assess the extent communities benefit economically from adjacent surface mining operations.

With regard to place of work, as previously noted two of the study area counties and their county subdivision areas showed little decline in the percentage of resident workers who work in their area or State of residence, Mingo and Nicholas Counties. This pattern of retention is in contrast to rising unemployment rates on par with those of the other study area jurisdictions. While Mingo County lost a smaller percentage of its mining employment between 1980 and 1990, Wyoming County lost over half of its mining employment in the same period. One explanation of on-going economic stability offered by a resident of Werth in Nicholas County,WV was the increased development of service industry employment associated with the outdoor recreation industry in the region.

2. Assistance Income

Mingo County and Hardee District and Hamilton District in Nicholas County were also inconsistent with the other study areas with regard to patterns of households receiving Social Security income. In Mingo County between 1980 and 1990 there was no change. In Hardee and Hamilton Districts there was a decline; in fact in, Hardee District there was a 10 percent decline in the percent of household receiving Social Security income. All of other study area jurisdictions had increases in these rates. The increases in percentage of persons in the mature and senior age groups and in the percentages of the population receiving public assistance income in Mingo County and Hardee and Hamilton Districts were parallel to those of all the other study area jurisdictions; therefore, the inconsistencies in their rates of households receiving Social Security income does not appear to be attributable to population demographics.

3. Physical Shifts

The majority of reported physical changes in the communities studied were similar. However, in Scarlet, WV, Werth, WV and Blair, WV residents differed in their views of surface mining impacts to well water and the coal company’s responsiveness to any such impacts. In addition, between communities residents did not consistently report the presence of fly-rock sometimes associated with blasting techniques. For those that did report these physical impacts the effects were varied. In Werth, well water problems were addressed by the coal company to the satisfaction of the resident. In Scarlet and Blair however, residents who reported well water problems felt that their complaints were ignored and wrongfully dismissed. In Scarlet, a public water system is currently being installed, but reports were inconsistent regarding the involvement of any coal companies in implementing this system. In addition, residents faced hook-up fees, reportedly of $500, along with future water bills. Residents were quick to point out that this resource was once freely available on their property.

4. Company and Community

It is not possible to provide a uniform characterization of the relationship between the coal companies and the study communities. Residents' accounts depict these relationships as varying from very good to very bad. Three different accounts in three different communities highlight very positive experiences in dealing with the coal company regarding relocation and community benefits, but just as many residents reported poor and bad experiences regarding the same issues.

As with the experiences of residents regarding pre-blast surveys, residents reported inconsistent satisfaction from both coal mining companies and public agencies in response to complaints of impacts. Generally, many residents felt that complaints were left unaddressed or disregarded. In Werth and in Scarlet residents indicated that while complaints were acknowledged, corrective actions were never carried out. In Blair and Scarlet residents reported filing and bringing complaints to the awareness of public agencies, and the complaints were believed to be wrongfully ignored and even mocked. However, some of these same residents reported having specific complaints addressed completely to their satisfaction. Additionally, in Scarlet and Blair residents reported attending public meetings to address community complaints or issues; however, not everyone recalled such meetings and not all communities reportedly had such meetings.

Conflicting reports were also given regarding conditions associated with the purchase of homes by the coal company. Some residents were required to relocate outside of the area in which coal companies held interests while others were relocated in the same communities.

> "....it says that you cannot, couldn't move within so many miles but you couldn't move back up that holler, Scarlet, at all. But then this area along, the four lane, you couldn't move there either they said" (Scarlet, WV).

Similar accounts were given in Blair as well. Residents reported being told they may have the option to buy back their land at a future date, but other residents were told this was not an option.

> "...they said plainly we could not buy it back. Then we see that other people had the right to buy their's back" (Scarlet, WV).

Some of these discrepancies occurred within the same communities, and some are differences in the experiences of different communities with different companies or operations.

Each of these communities is adjacent to large-scale surface mining operations; however, large-scale patterns of purchasing of private property by extraction or land holding companies were reported, to date, and is evident in property records of only three communities. As discussed above, no apparent correlation can be drawn between the racial make-up of a community and decisions by coal companies to undertake large-scale purchasing of homes and/or properties.

5. Community Future

Some residents felt that additional public information would have better equipped the residents to understand and perhaps respond to the surface mining occurring around their community.

> "...I talked to several of the neighbors around up around Island Creek up to Tioga and in through there. And they said if they would have knew what was going on they could have probably stopped part of that. But we didn't know it until it was too late. We had no idea what they was doing or what it would do - the damage or anything else. I had never seen a strip mine." (Werth, WV)

Residents also indicated more consistent dealings between coal companies and families within the communities could have eased the social and psychological impacts of displacement. Other residents in Werth for example felt that the mining companies took all necessary steps to inform the public of mining activities and provided benefits which off-set any impacts.

As previously stated, opinions regarding the future of these communities varied and are possibly correlated to the level of personal values on land as part of a family heritage. The differences of opinion regarding communities' futures were in some instances more complex than simply stating the community either did or did not have a positive future. For example, in Werth residents felt that the aging population and lack of significant local employment, such as coal mines or a saw mill gave people little incentive to move into the area. These same residents also felt that there might be a future settlement of families with jobs elsewhere and they did not feel that the past presence of surface mining had impacted the future value of land for anything other than agricultural use. In contrast, in Werth, residents did not feel that it was likely nor were there employment opportunities which would retain or draw back their own children.

IX. CONCLUSIONS

The purpose of this study is to evaluate what, if any, demographic changes can be observed in communities located adjacent to mountaintop surface mining operations. Demographic data and personal accounts were collected. The demographic evaluations presented for the selected case study areas were based on three decades of census data (i.e., the 1980, 1990, and 2000 decennial censuses) in order to assess the demographic trends that have occurred over time: "prior to mountaintop surface mining operations into the case study community (i.e., 1980)," "during mountaintop surface mining (i.e., 1990)," and "after mountaintop surface mining (i.e., 2000)," respectively. Case study areas were selected based on timing of mining operations so that a comparison of pre, during and post mining conditions could be performed.

Hamilton District in Nicholas county was the only district that had an employment trend that would be expected; an increase in the during mining condition and a decrease in the after mining condition. Employment increased during mining in two of the four case study magisterial districts and decreased after mining in two of the four case study magisterial districts, but not the same two. The control district did not experience an increase in employment in the during mining condition but experienced a decrease in employment in the after mining condition. The number of persons working in their resident county increased in Hamilton district for the during mining condition, this was the only district where this occurred. Unemployment did not decrease in any of the case study areas for the during mining condition.

Per capita income increased during mining in only one of the case study magisterial districts. Per capita income decreased after mining in one of the case study magisterial districts and in the control district. This income increase during mining and decrease after mining was not in the same district. Real growth in median household income decreased in double digits in all case study areas as compared to a four and a half increase nationally.

For most of the case study areas, the number of persons receiving public assistance did not decrease in the during mining condition. Public assistance decreased in one of the case study districts and in the control district in the during mining condition. The number of persons living in poverty did not decrease in the during mining condition in any of the case study districts or the control.

Educational attainment, persons receiving high school or college degrees, increased in the during mining and after mining conditions for all case study areas and the control area with one exception. High school diploma attainment did not increase in the Blackey Division in the during mining condition although college degree attainment increased.

The North Elkin District is the only case study area with a notable black/African American population. It does not appear that the economic conditions for residents of this district improved in the during mining condition. Large percentage point increases in poverty levels were experienced in McDowell County and the North Elkin district. Employment did not increase nor did income increase in this district during mining. One of the topics evaluated in this study is whether there are indications of greater relocations or displacement in non-white racial areas. A sample of property ownership data from the North Elkin District did not display a pattern of large-scale purchase of properties by extraction or land holding companies. However, a sample of property ownership data from Superior Bottom another racially integrated community shows a 52 percent shift from private ownership to land holding company ownership.

Population decreased in all of the case study areas during mining and after mining. The number of students enrolled in public school districts decreased in all of the case study areas including the control area. All study areas experienced a decrease in their young adult populations. The senior age group is comprising an increasing percentage of the total population within each of the study areas.

Several themes emerged from personal accounts of interviewed residents when describing their experiences living in a community adjacent to mountaintop surface mining. Demographic data support many of these themes such as loss of population and aging populations. The experiences shared by residents include loss of community population and community structure, struggles in obtaining available economic benefits, occurrences of similar physical changes and feelings of ineffectiveness in preventing or managing these effects. Additional common experiences shared among the study communities related to the purchase of homes and property by extraction or land holding companies and the resulting impacts of displacement.

Tables

Attachment 1. Case Study Photographs

Attachment 2. Community Narratives (Interview Transcripts)

I. REFERENCES

Appalachian Land Ownership Task Force, *Who Owns Appalachia?* With a foreword by Charles C. Geisler, Lexington, KY: University Press of Kentucky, 1983.

Axel-Lute, Miriam. "Tales of Three Cities." *Shelterforce Online* National Housing Institute May/June 2001.

Berninghausen, Tom. "'This Ain't Real Estate:' Land and Culture in Louise Erdrich's Chippewa Tetralogy." in *Women, America and Movement: Narratives of Relocation,* ed. Susan L. Robertson, 190-209. Columbia, MO: University of Missouri Press, 1998

Billings, Dwight B. and Kathleen M. Blee. *The Road to Poverty: The Making of Wealth and Hardship in Appalachia*. Cambridge, UK: Cambridge University Press, 2000.

DeRosier, Linda Scott. *Creeker: A Woman's Journey*. Lexington, KY: University Press of Kentucky, 1999.

Fields, Jason and Lynne M. Casper. *America's Families and Living Arrangements: March 2000.* Current Population Reports, P20-537. U.S. Census Bureau, Washington, DC. 2001.

Gaventa, John. *Power and Powerlessness: Quiescence and Rebellion in an Appalachian Valley.* Oxford, UK: Clarendon Press, 1980.

Millner, Reginald. "Conversations with the 'Ole Man': The Life and Times of a Black Appalachian Coal Miner." in *Blacks in Appalachia*. Lexington, KY: University Press of Kentucky, 1985.

Moore, Warren. *Mountain Voices: A Legacy of the Blue Ridge and Great Smokies.* Chester, CT: The Globe Pequot Press, 1988.

Obermiller, Phillip J. and William W. Philliber, ed., *Appalachia in an International Context: Cross-National Comparisons of Developing Regions.* Westport, CT: Praeger Publishers, 1994.

Palen , J. John and Bruce London, ed. *Gentrification, Displacement and Neighborhood Revitalization. Social Differentials in Metropolitan Residential Displacement,* by Barrett A. Lee and David C. Hodge. Albany, NY: State University of New York Press, 1984.

Parham, Groesbeck and Gwen Robinson. "'If I Could Go Back...': An Interview with Dobbie Sanders." in *Blacks in Appalachia*. Lexington, KY: University Press of Kentucky, 1985.

Parker, Russell D. "The Black Community in a Company Town: Alcoa, Tennessee, 1919-1939." in *Blacks in Appalachia*. Lexington, KY: University Press of Kentucky, 1985.

"Rich In, Poor Out: How Do We Solve The Displacement Dilemma?" *Canadian Heritage,* August-September 1981: 8-11.

Rose, Kalima. "Beyond Gentrification." *Shelterforce Online* National Housing Institute May/June 2001.

Rubin, Rachel Lee. "'My Country is Kentucky:' Leaving Appalachia in Harriette Arnow's *The Dollmaker*," in *Women, America and Movement: Narratives of Relocation*, ed. Susan L. Roberston, 176-189. Columbia, MO: University of Missouri Press, 1998.

Schill, Michael H. and Richard P. Nathan. *Revitalizing America's Cities.* Albany, NY: State University of New York Press, 1983.

Turner, William H., and Edward J. Cabbell, ed., *Blacks in Appalachia.* With an introduction by William H. Turner. Lexington, KY: University Press of Kentucky, 1985.

Workman, Patricia Samples. "Ely-Thomas Lumber Company." *Goldenseal Winter* vol. 23, no. 4 Fall 1997: 10-22.

Yarrow, Mike. "Voices from the Coalfields: How Miners' Families Understand the Crisis of Coal." in *Communities in Economic Crisis: Appalachia and the South,* ed. John Gaventa, Barbara Ellen Smith and Alex Willingham, Philadelphia, PA: Temple University Press, 1990.

Appendix P-9
Employment Comparisons
Study Area

Case	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Annual Avg. 2002-2010
Number of Employees											
Base Case	33,906	33,439	33,609	33,801	32,634	30,638	30,093	30,310	26,699	26,158	30,820
250 acre	33,906	32,340	31,928	32,014	31,591	30,374	28,656	27,598	26,393	25,202	29,566
150 acre	33,906	32,347	31,921	31,907	31,513	29,893	29,164	27,850	26,377	24,909	29,542
75 acre	33,906	31,697	31,117	31,229	31,810	29,435	31,401	27,207	25,619	24,905	29,380
35 acre	33,906	29,978	29,280	29,084	29,464	28,948	28,081	28,149	26,304	24,385	28,186
Difference from Base Case											
250 acre		-1099	-1681	-1787	-1043	-264	-1437	-2712	-306	-956	-1254
150 acre		-1092	-1688	-1894	-1121	-745	-929	-2460	-323	-1249	-1278
75 acre		-1742	-2492	-2572	-823	-1203	1308	-3103	-1081	-1253	-1440
35 acre		-3461	-4330	-4717	-3170	-1690	-2012	-2160	-395	-1773	-2634
Percent Difference from Base Case											
250 acre		-3%	-5%	-5%	-3%	-1%	-5%	-9%	-1%	-4%	-4%
150 acre		-3%	-5%	-6%	-3%	-2%	-3%	-8%	-1%	-5%	-4%
75 acre		-5%	-7%	-8%	-3%	-4%	4%	-10%	-4%	-5%	-5%
35 acre		-10%	-13%	-14%	-10%	-6%	-7%	-7%	-1%	-7%	-9%
Percent change from 2001											
Base Case		-1%	-1%	0%	-4%	-10%	-11%	-11%	-21%	-23%	
250 acre		-5%	-6%	-6%	-7%	-10%	-15%	-19%	-22%	-26%	
150 acre		-5%	-6%	-6%	-7%	-12%	-14%	-18%	-22%	-27%	
75 acre		-7%	-8%	-8%	-6%	-13%	-7%	-20%	-24%	-27%	
35 acre		-12%	-14%	-14%	-13%	-15%	-17%	-17%	-22%	-28%	
Difference from Base as % of Total Employment (136,478)											
250 acre		-0.8%	-1.2%	-1.3%	-0.8%	-0.2%	-1.1%	-2.0%	-0.2%	-0.7%	-0.9%
150 acre		-0.8%	-1.2%	-1.4%	-0.8%	-0.5%	-0.7%	-1.8%	-0.2%	-0.9%	-0.9%
75 acre		-1.3%	-1.8%	-1.9%	-0.6%	-0.9%	1.0%	-2.3%	-0.8%	-0.9%	-1.1%
35 acre		-2.5%	-3.2%	-3.5%	-2.3%	-1.2%	-1.5%	-1.6%	-0.3%	-1.3%	-1.9%

Source: Hill and Associates 2001. Scale factors and Total Employment from West Virginia Bureau of Employment Programs (2001), Kentucky Department of Employment Services (2000), and Virginia Employment Commission (2000).

Note: Highlighted cells indicate maximum reductions for the case.

Note: The 2005 spike in base case production exagerates the apparent impacts for that year.

Table 27 - Blair, WV Property Ownership Data

Property Number	Current Owner	Parcel Size (acres)	Purchase Date	Purchase Price	Previous Owner	Purchase Date	Purchase Price
B1	Mineral Extraction Company	<1 acre	1925				
B2	Mineral Extraction Company	10 acres	1925				
B3	Land Holding Company	<1 acre	1996	$27,000 (for 2 parcels)	Private Owner(s)	1977	
B4	Land Holding Company	<1 acre	1994	$25,000			
B5	Land Holding Company	11 acres			Private Owner(s)	1993	
B6	Private Owner(s)	166 acres	1976				
B7	Private Owner(s)	.5 acres	1954				
B8	Land Holding Company	<1 acre	1992		Private Owner(s)	1990	
B9	Private Owner(s)	40 acres	1936				
B10	Land Holding Company	<1 acre	1995	$70,000	Private Owner(s)		
B11	Land Holding Company	<1 acre	1996	$27,000 (for 2 parcels)	Private Owner(s)	1977	
B12	Land Holding Company	<1 acre	1995	$33,000 (data unclear)	Private Owner(s)	1994	$500
B13	Land Holding Company	.5 acres	1992		Private Owner(s)		
B14	Land Holding Company	<1 acre	1995		Private Owner(s)	1981	
B15	Private Owner(s)	<1 acre	1977	$1,450	Private Owner(s)	1949	
B16	Land Holding Company	<1 acre	1996	$35,000*	Private Owner(s)	1982	$5,000
B17	Other						
B18	Land Holding Company	<1 acre	1995	$3,000**	Private Owner(s)	1986	$1,700
B19	Private Owner(s)	<1 acre	1969		Private Owner(s)	1954	
B20	Private Owner(s)	1.24 acres	1960				
B21	Mineral Extraction Company		1930				
B22	Private Owner(s)	not listed					
B23	Private Owner(s)	2.5 acres	1971		Private Owner(s)	1952	
B24	Land Holding Company	<1 acre	1995	$70,000	Private Owner(s)	1976	
B25	Mineral Extraction Company	<1 acre	1930				

Table 28 - West Virginia Total Enrollment by District

	Number of Students Enrolled						
School District	(2 year period) 1977-1979	1980-1984	1985-1989	% change 1980-1989	1990-1994	1995-1999	% change 1990-1999
Mingo	18,473	45,699	43,932	-4.0%	38,370	31,214	-22.9%
McDowell	25,164	58,885	49,291	-19.5%	37,386	30,099	-24.2%
Nicholas	12,873	31,169	28,421	-9.7%	25,886	24,828	-4.3%
Wyoming (Control)	17,796	43,080	39,491	-9.1%	32,618	25,921	-25.8%

*Data is based upon 1st month enrollments

Source: West Virginia Department of Education

Table 20 - Poverty Status Trends

Case Study Place	Percent of Persons for Whom Poverty Status is Determined					
	Income in 1979 Below Poverty Level	Income in 1989 Below Poverty Level	Income in 1999 Below Poverty Level		1979	1989
WEST VIRGINIA	14.1	19.7	17.9	-1.8	1,894,081	
McDowell County, WV	23.5	37.7	37.7	0.0	49,775	
North Elkin District (1)	19.8	32.5	35.3	2.8	11,588	7,595
Mingo County, WV	23.6	30.9	29.7	-1.2	37,286	
Hardee District	20.8	33.6	27.9	-5.7	3,817	3,396
Nicholas County, WV	16.7	24.4	19.2	-5.2	27,979	
Hamilton District	19.0	27.5	16.7	-10.8	3,095	3,055
Wyoming County, WV	19.3	27.9	25.1	-2.8	35,962	
District 1 District (2)	20.5	29.1	21.7	-7.4	12,146	9,023
KENTUCKY	17.6	19.0	15.8	-3.2	3,559,034	3,582,459
Letcher County, KY	27.4	31.8	27.1	-4.7	30,563	26,829
Blackey Division	30.3	33.6	24.3	-9.3	6,876	6,335

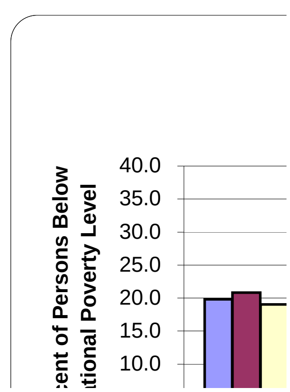
Sources: U.S. Census Bureau, 1980, 1990, and 2000 STF3A

(1) 1980 poverty levels were derived by calculating the average of the values enumerated for the Adkin, Elkhorn, and North Fork Districts.

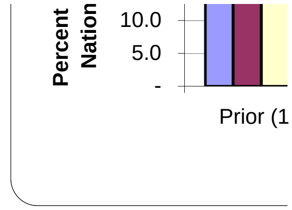
(2) 1980 poverty levels were derived by caculating the values enumerated for the Barkers Ridge and Slab Fork Districts.

Adkin District	17.0		n/a	6,358	
Elkhorn District	24.1	n/a	n/a	2,190	
North Fork District	18.3	n/a	n/a	3,040	
Barkers Ridge District	21.9	32.1	n/a	3,937	2,959
Slab Fork District	19.1	26.1	n/a	8,209	6,064

	1979	1989		1999
WEST VIRGINIA	-14.1	-19.7	-5.6	17.9
McDowell County, WV	-23.5	-37.7	-14.2	37.7
North Elkin District	-19.8	-32.5	-12.7	35.3
Mingo County, WV	-23.6	-30.9	-7.3	29.7
Hardee District	-20.8	-33.6	-12.8	27.9
Nicholas County, WV	-16.7	-24.4	-7.7	19.2
Hamilton District	-19.0	-27.5	-8.5	16.7
Wyoming County, WV	-19.3	-27.9	-8.6	25.1
District 1 District	-20.5	-29.1	-8.6	21.7
KENTUCKY	#DIV/0!	-19.0		15.8
Letcher County, KY	#DIV/0!	-31.8		27.1
Blackey Division	#DIV/0!	-33.6		24.3



	Prior (1980)	During (1990)	After (2000)	
North Elkin District	19.8	32.5	35.3	12.8
Hardee District	20.8	33.6	27.9	12.8
Hamilton District	19.0	27.5	16.7	8.5
Blackey Division	30.3	33.6	24.3	3.3
District 1 (Control)	20.5	29.1	21.7	8.6



1999
n/a
n/a
n/a
n/a
n/a
n/a
n/a
n/a
n/a
n/a
n/a
n/a

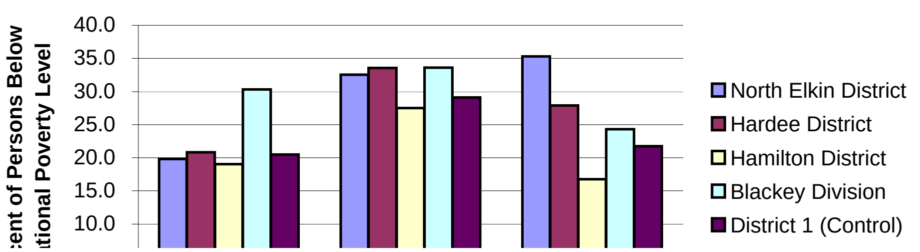
Under 5 y	178,382	
5 years	37,727	
6 to 11 ye	242,530	
12 to 17 y	251,207	
18 to 24 y	268,821	
25 to 34 y	498,760	
35 to 44 y	475,392	
45 to 54 y	329,770	
55 to 59 y	134,455	
60 to 64 y	132,794	
65 to 74 y	218,981	
75 years	131,813	

Income in 1989 below poverty level:

Under 5 y	68,983	
5 years	13,580	
6 to 11 ye	78,999	
12 to 17 y	72,450	
18 to 24 y	83,170	
25 to 34 y	101,959	
35 to 44 y	69,750	
45 to 54 y	49,964	
55 to 59 y	25,364	
60 to 64 y	26,517	
65 to 74 y	46,543	
75 years	44,548	

n/a
n/a
n/a
n/a
n/a

Figure III.P-10
Poverty Level Trends



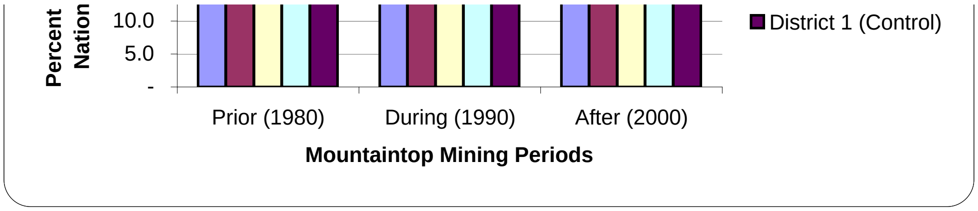

Percent
Nation
10.0
5.0
-
District 1 (Control)
Prior (1980)
During (1990)
After (2000)
Mountaintop Mining Periods

Figure 6 - County Population Trends, 1980, 1990, and 2000
Source: U.S. Census Bureau, 1980 SFT3A, 1990 and 2000 SF1A

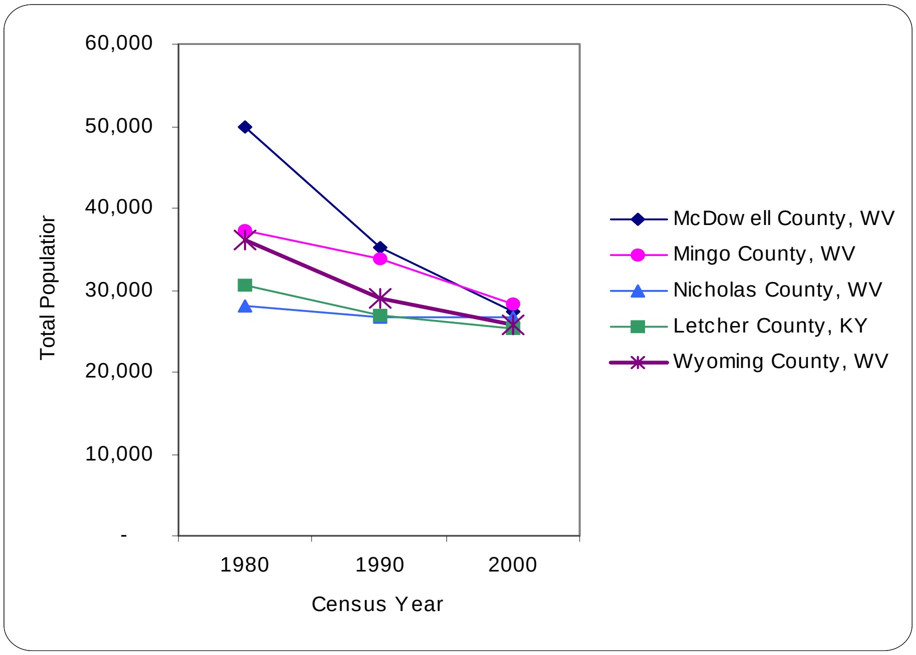


Figure 7 - County Subdivision Population Trends, 1980, 1990, and 2000
Source: U.S. Census Bureau, 1980 SFT3A, 1990 and 2000 SF1A

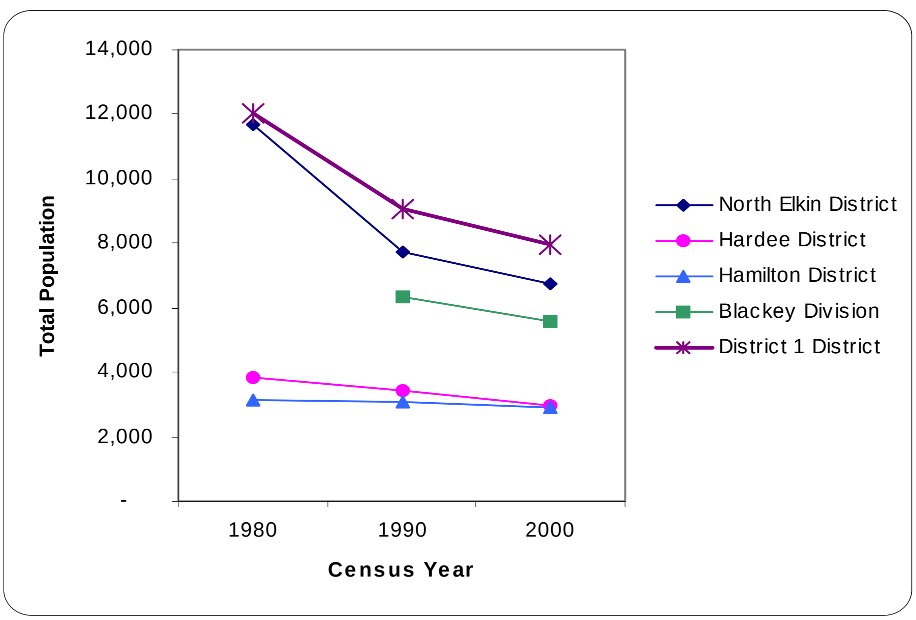
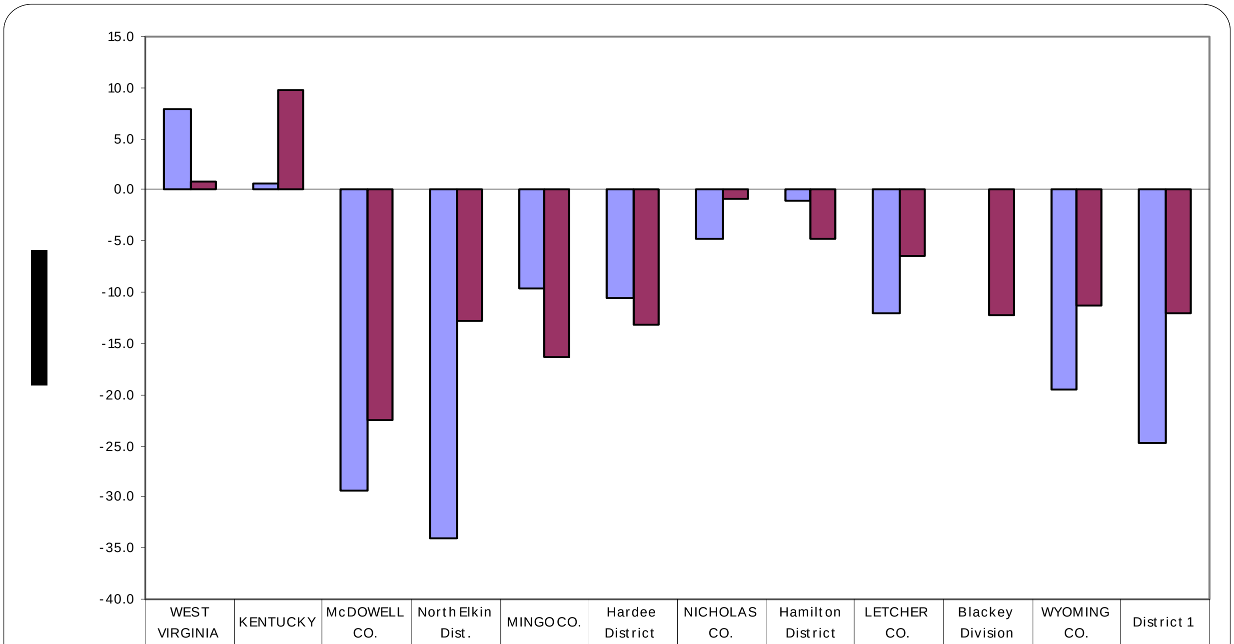


Figure 8 - Historic Comparison of Percent Change in Total Population, 1980, 1990, and 2000
Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A



	WEST VIRGINIA	KENTUCKY	McDOWELL CO.	North Elkin Dist.	MINGO CO.	Hardee District	NICHOLAS CO.	Hamilton District	LETCHER CO.	Blackey Division	WYOMING CO.	District 1
1980-90	8.0	0.7	(29.4)	(34.0)	(9.6)	(10.5)	(4.8)	(1.0)	(12.0)	-	(19.5)	(24.7)
1990-00	0.8	9.7	(22.4)	(12.8)	(16.3)	(13.2)	(0.8)	(4.7)	(6.4)	(12.2)	(11.3)	(12.1)

Figure 9 - Net Migration Trends, 1990-1997
Sources: U.S. Census Bureau

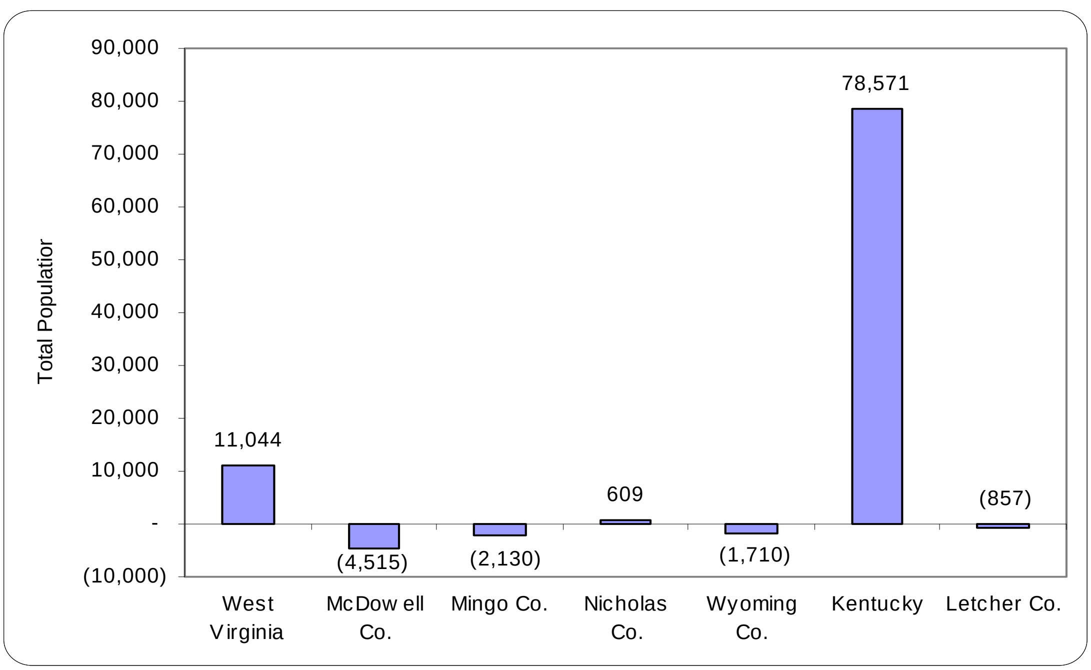


Figure 10 - School Age Group Trends
Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

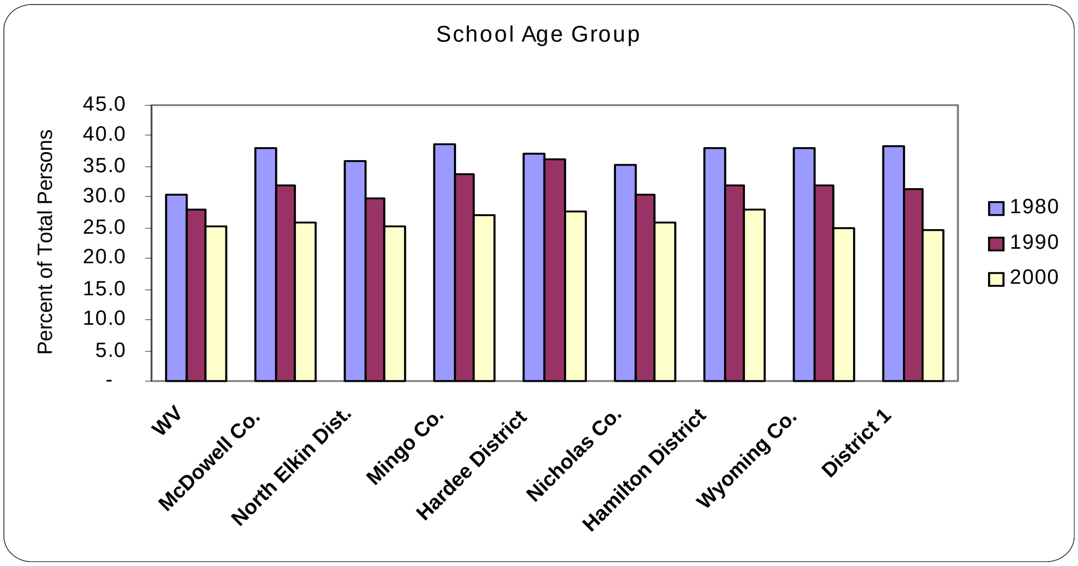


Figure 11 - Young Adult Age Group Trends
Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

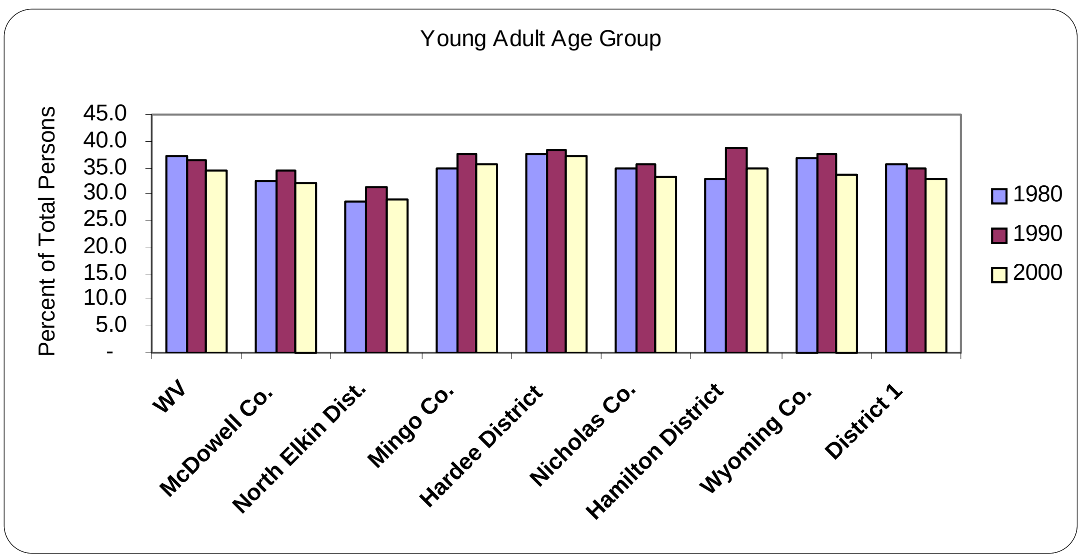


Figure 12 - Mature Age Group Trends
Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

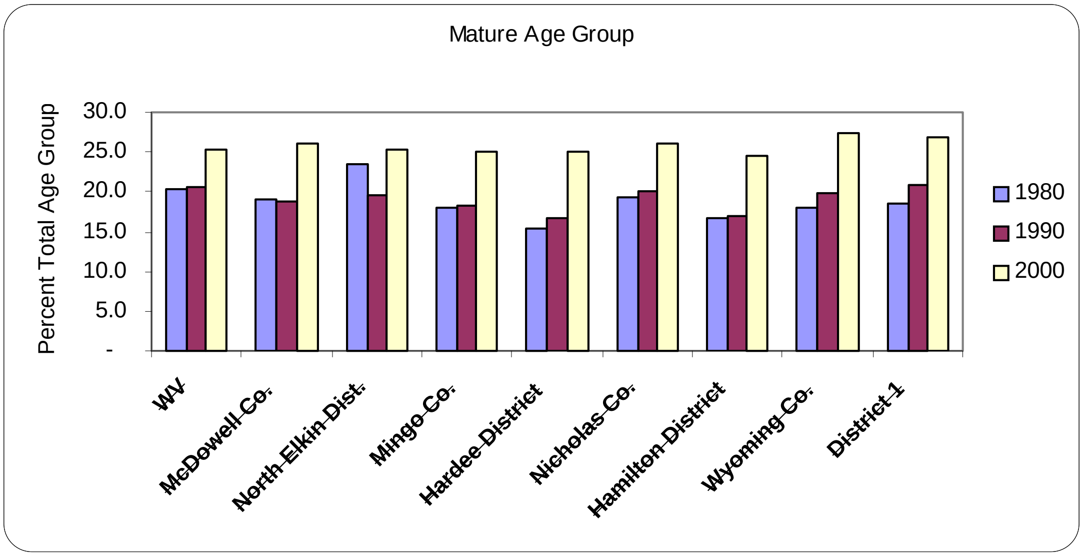


Figure 13 - Senior Age Group Trends
Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

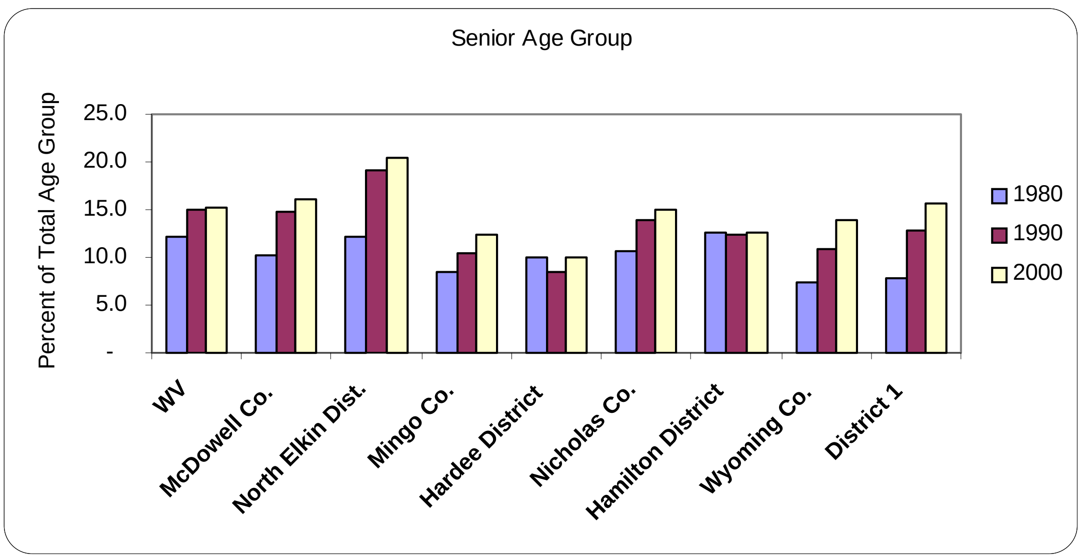
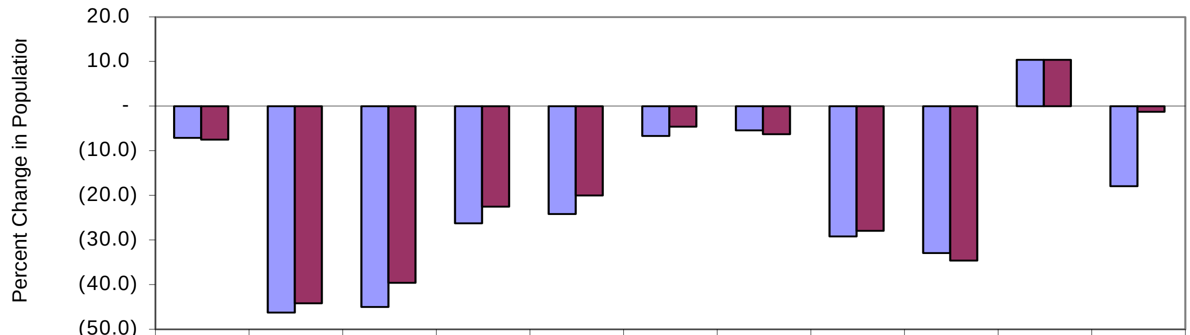


Figure 14 - Numeric Change in Male and Female Population, 1980 - 2000.
Source: U.S. Census Bureau, 1980 STF3A and 2000 SF1A



	WV	McDowell County,	North Elkin District	Mingo County, WV	Hardee District	Nicholas County, WV	Hamilton District	Wyoming County,	District 1 District	KY	Letcher County, KY
Male	(7.0)	(46.4)	(45.2)	(26.1)	(24.1)	(6.7)	(5.6)	(29.2)	(33.0)	10.4	(18.0)
Female	(7.5)	(44.2)	(39.8)	(22.6)	(19.9)	(4.4)	(6.3)	(27.9)	(34.6)	10.4	(1.3)

Figure 16 - Distribution of Employment by Industry Sector, West Virginia, 1980
Source: U.S. Census Bureau, 1980 STF3A

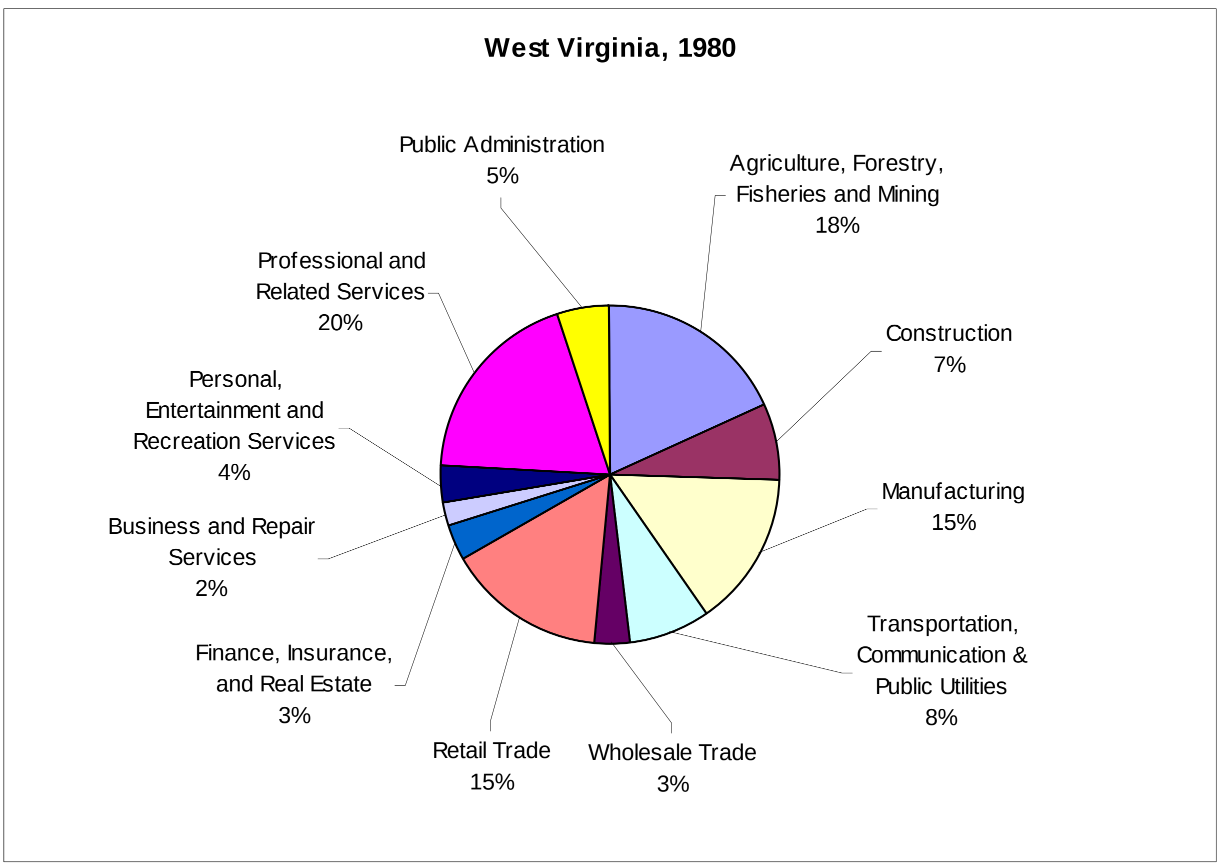


Figure 17 - Distribution of Employment by Industry Sector, McDowell County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

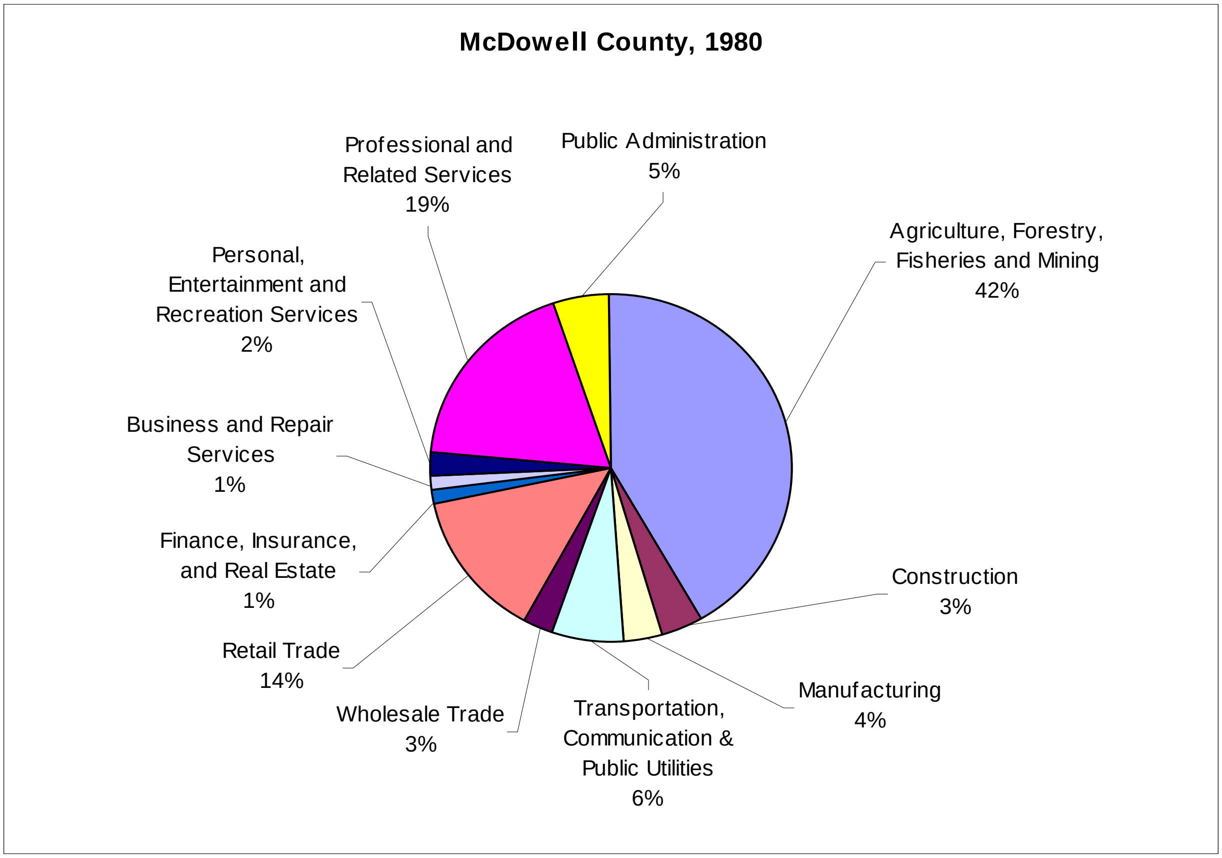


Figure 18 - Distribution of Employment by Industry Sector, Mingo County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

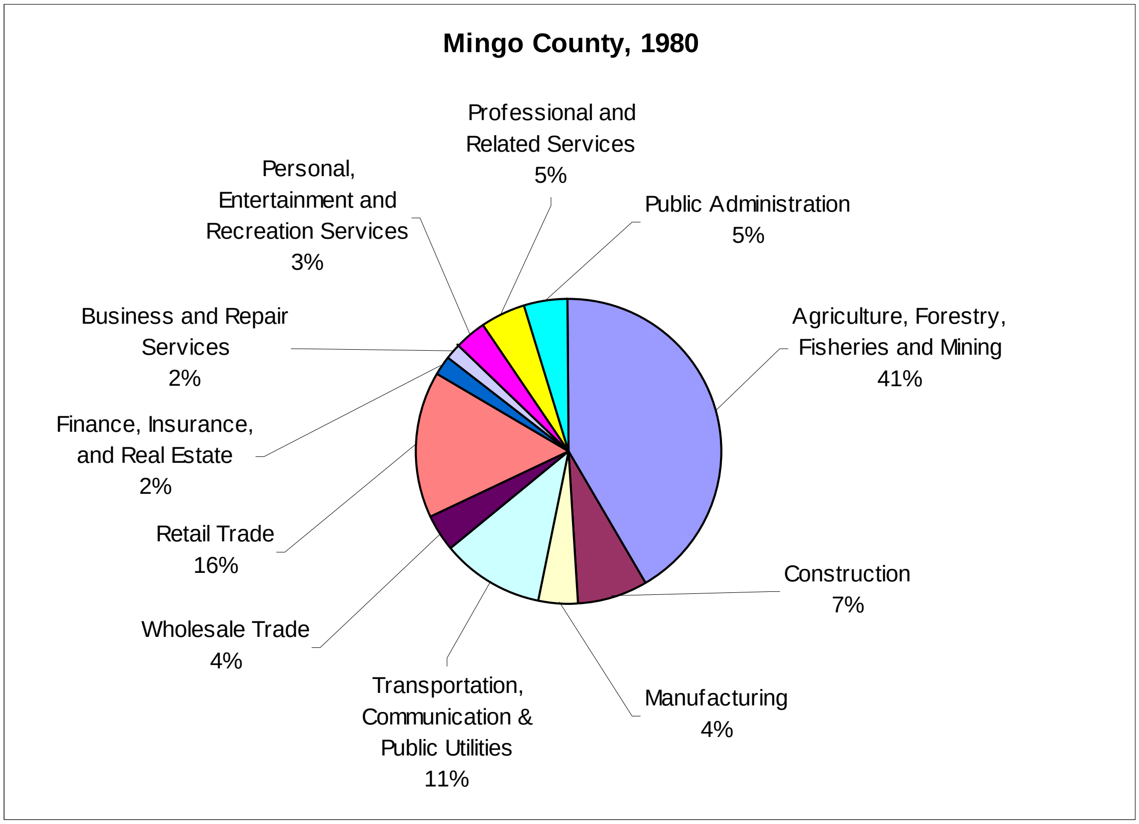


Figure 19 - Distribution of Employment by Industry Sector, Nicholas County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

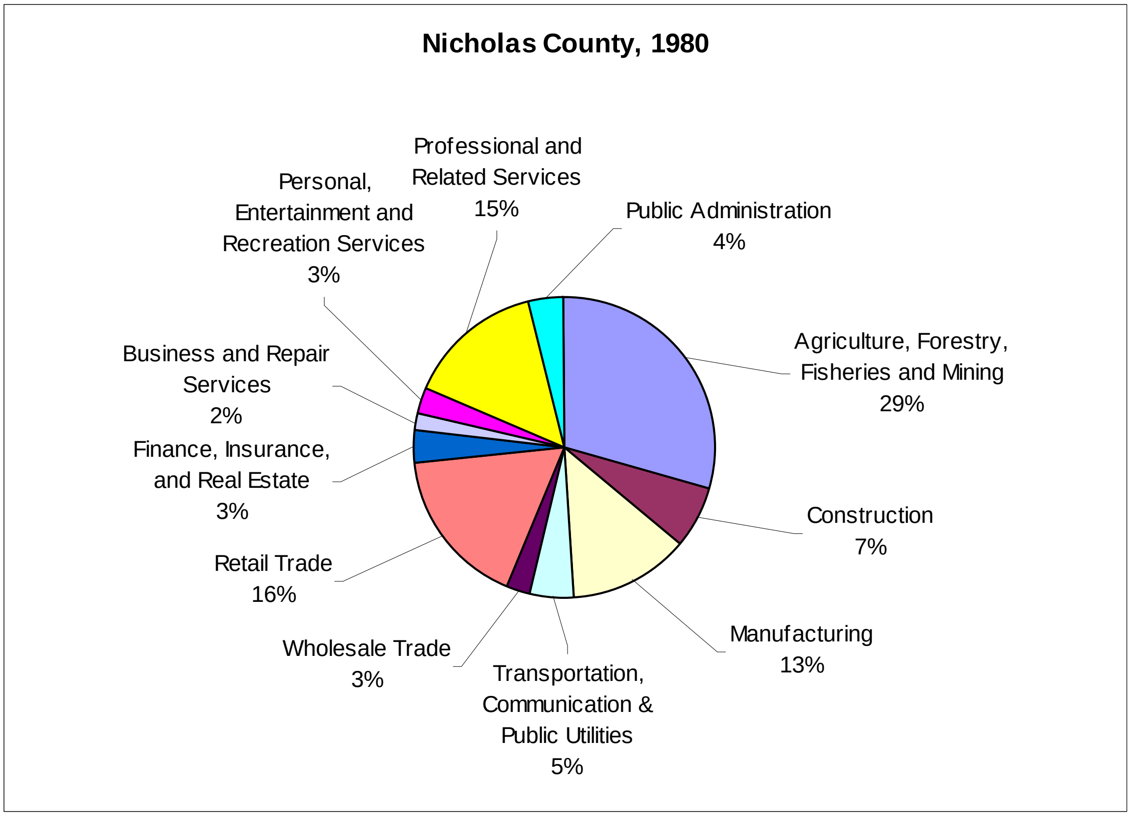


Figure 20 - Distribution of Employment by Industry Sector, Wyoming County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

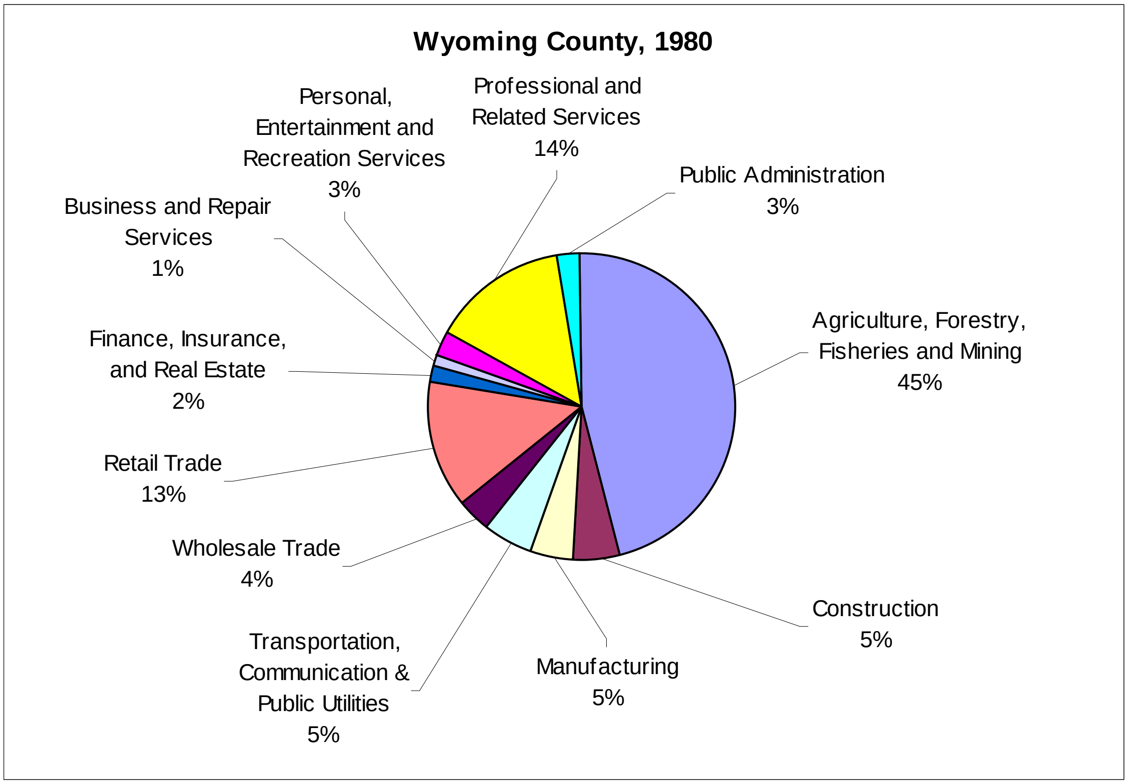


Figure 21 - Distribution of Employment by Industry Sector, Kentucky, 1980
Source: U.S. Census Bureau, 1980 STF3A

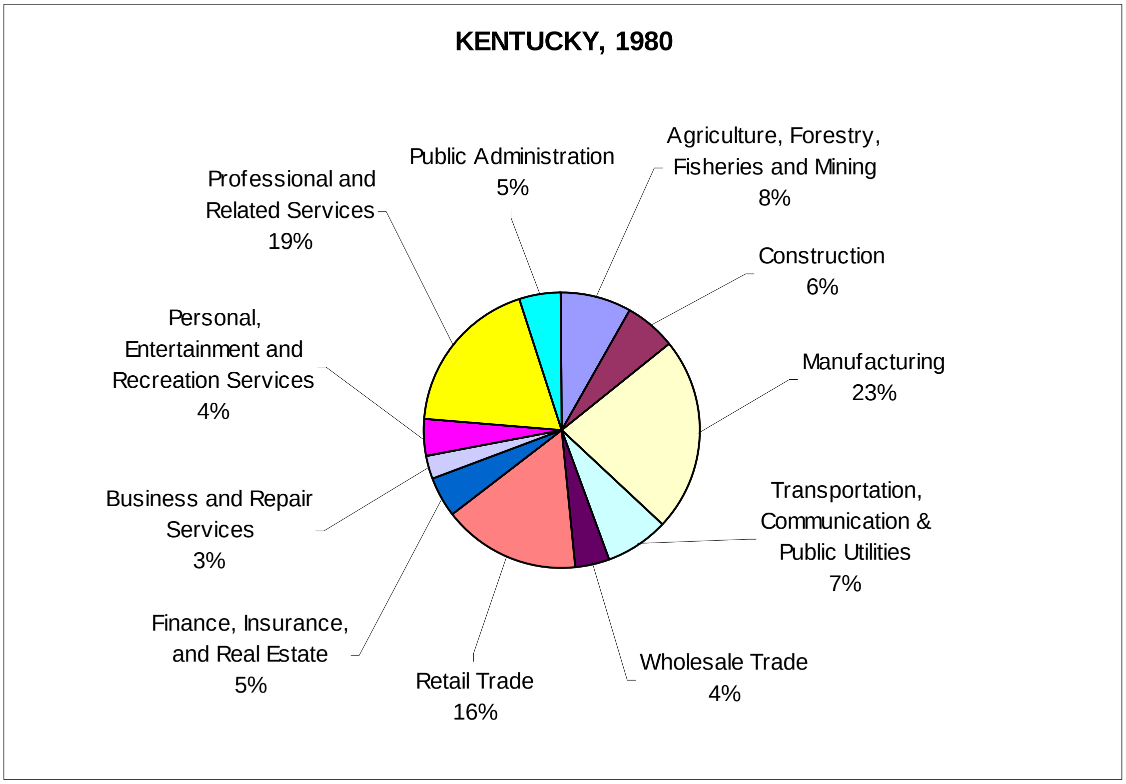


Figure 22 - Distribution of Employment by Industry Sector, Letcher County, KY, 1980
Source: U.S. Census Bureau, 1980 STF3A

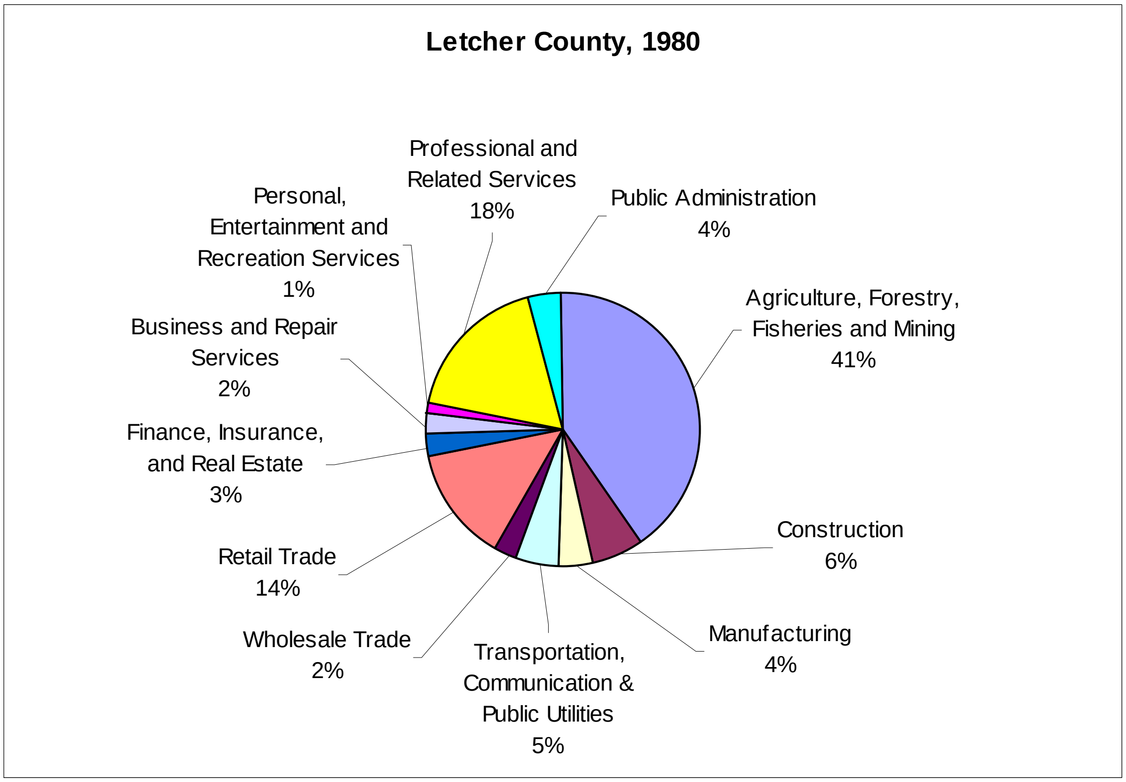


Figure 23 - Distribution of Employment by Industry Sector, West Virginia, 1990
Source: U.S. Census Bureau, 1990 STF3A

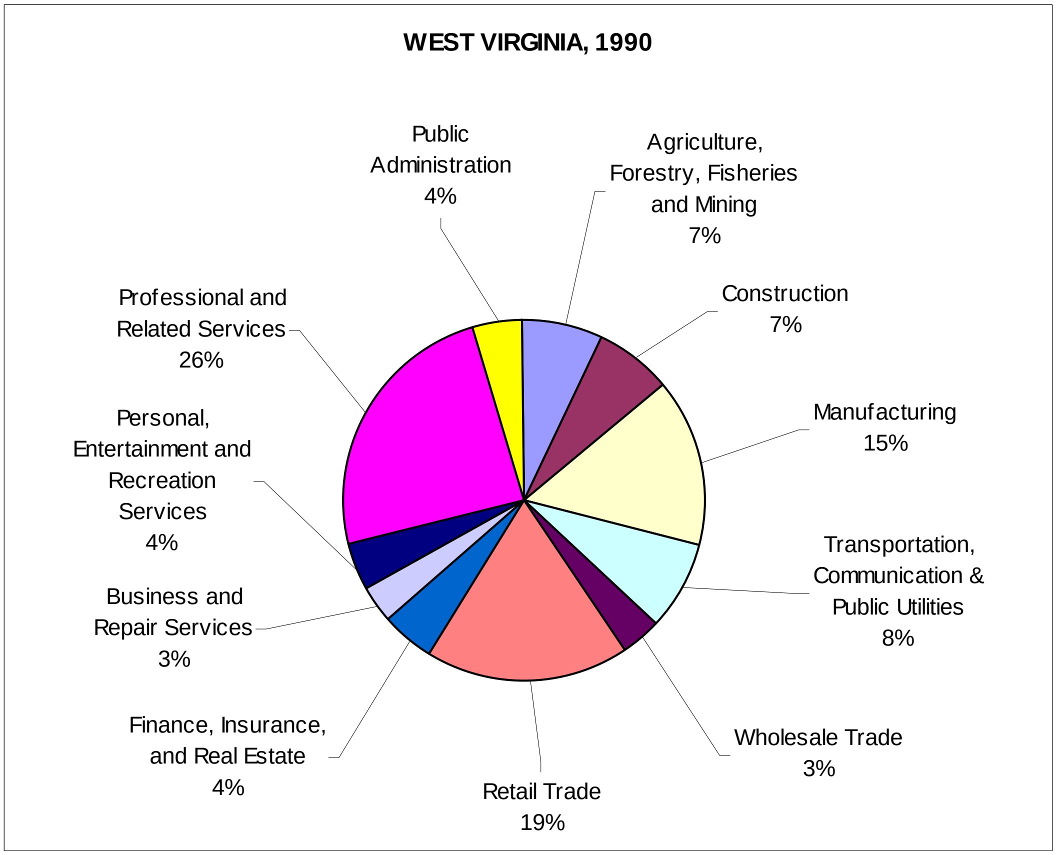


Figure 24 - Distribution of Employment by Industry Sector, McDowell County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

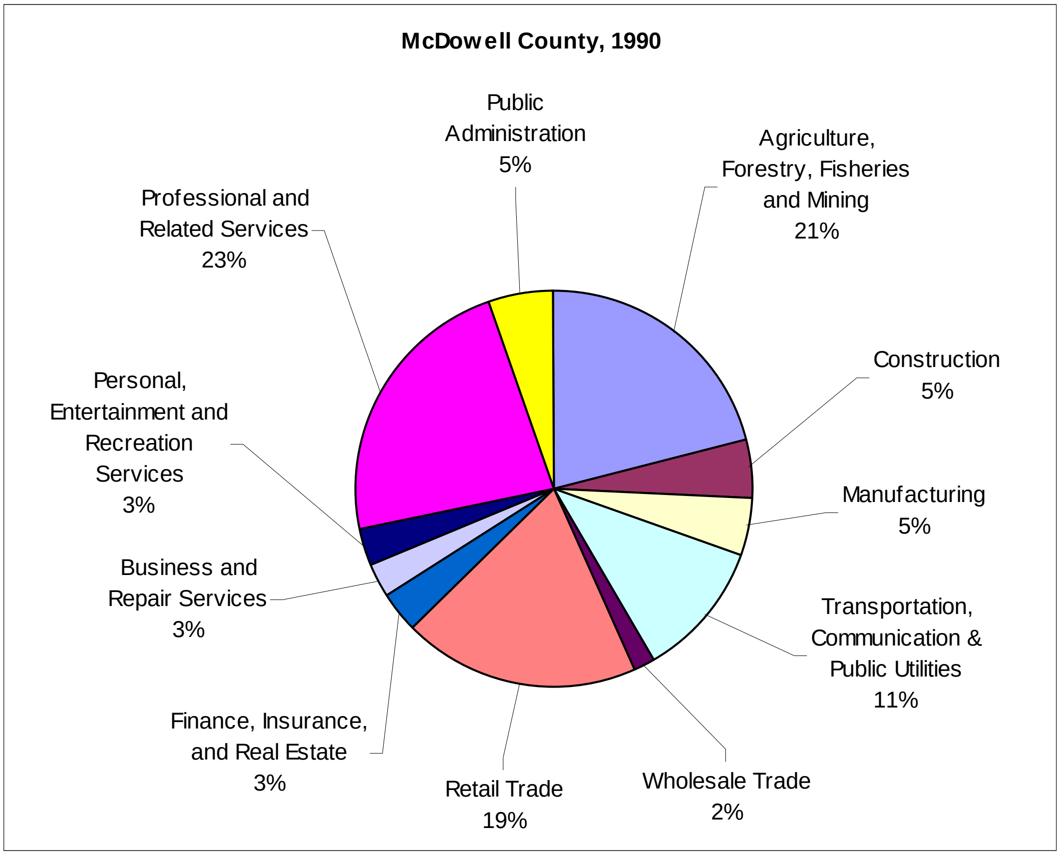


Figure 25 - Distribution of Employment by Industry Sector, Mingo County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

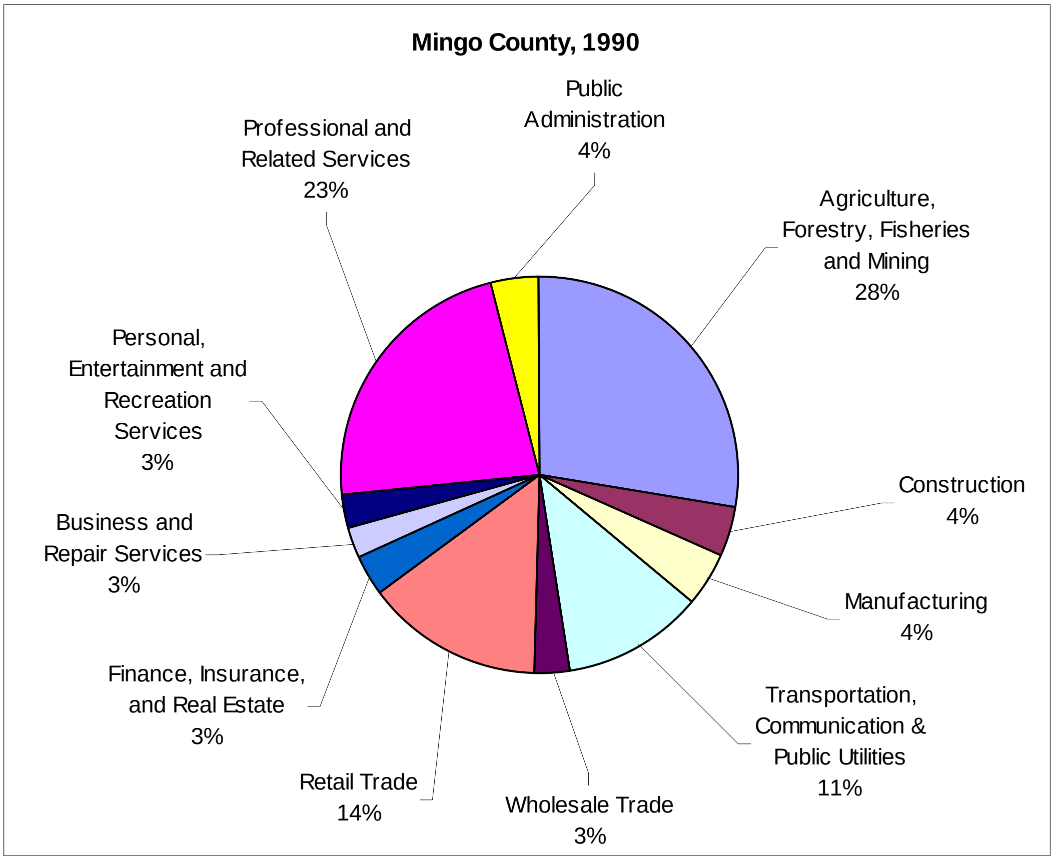


Figure 26 - Distribution of Employment by Industry Sector, Nicholas County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

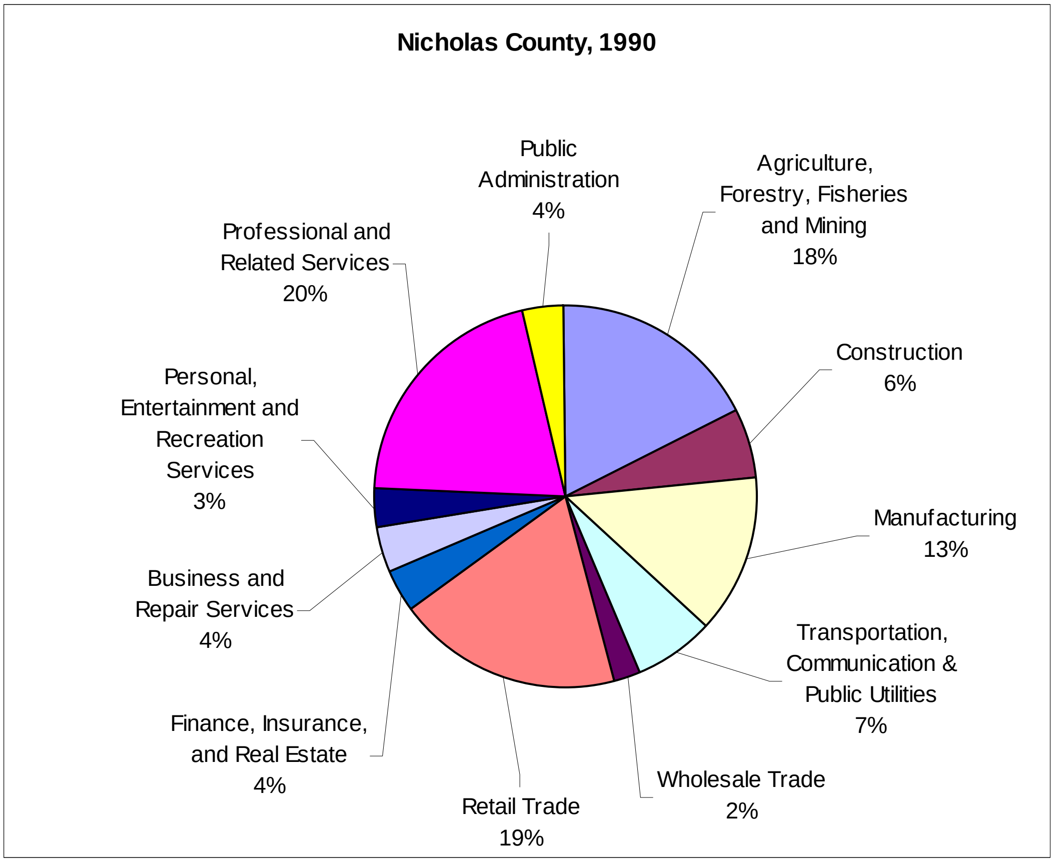


Figure 27 - Distribution of Employment by Industry Sector, Wyoming County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

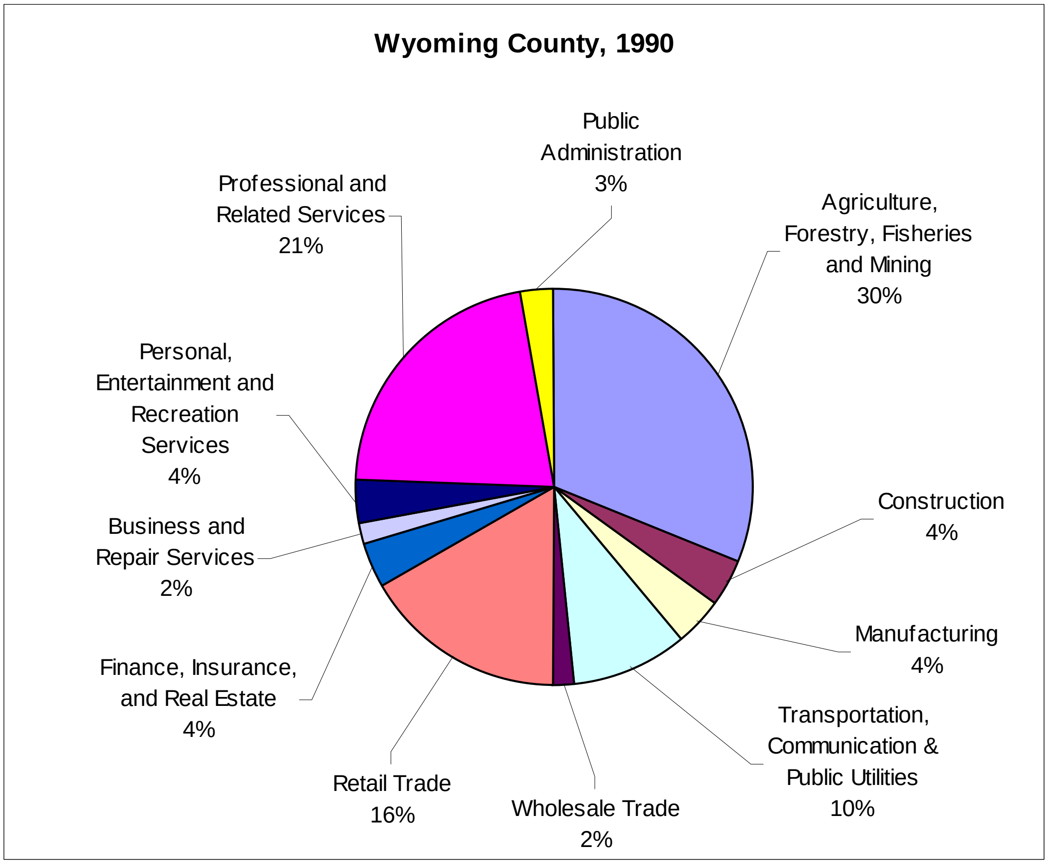


Figure 28 - Distribution of Employment by Industry Sector, Kentucky, 1990
Source: U.S. Census Bureau, 1990 STF3A

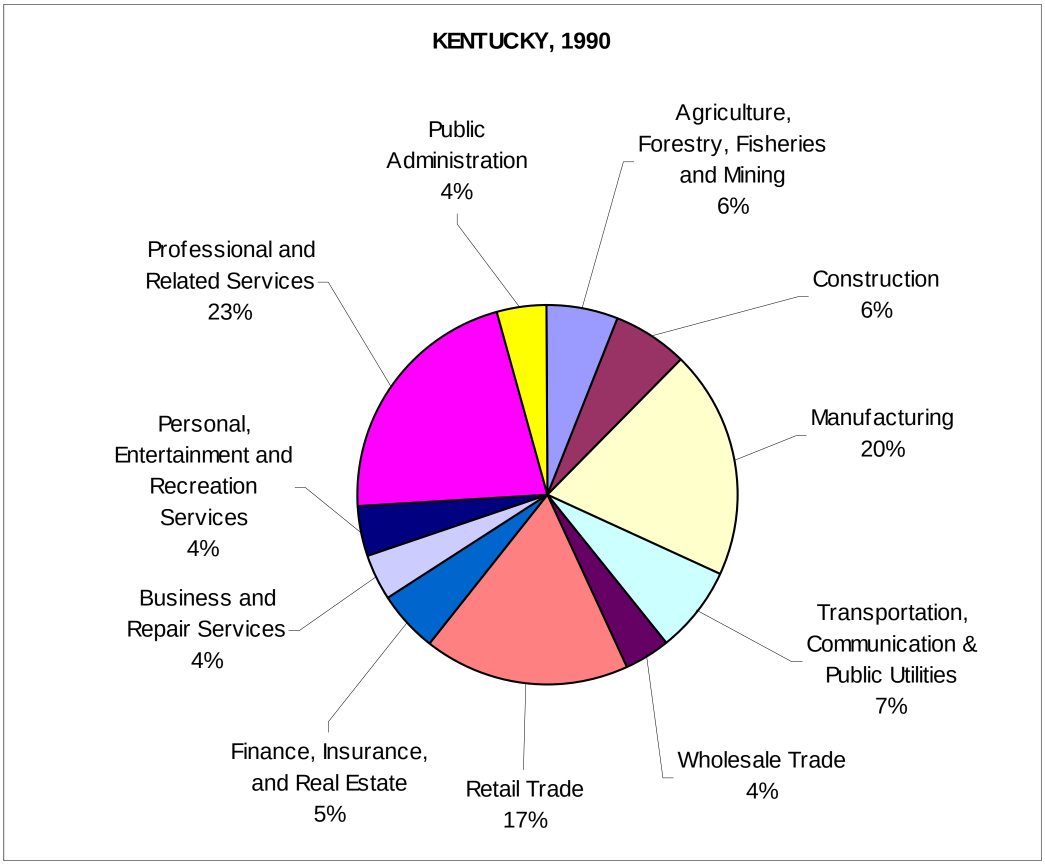


Figure 29 - Distribution of Employment by Industry Sector, Letcher County, KY, 1990
Source: U.S. Census Bureau, 1990 STF3A

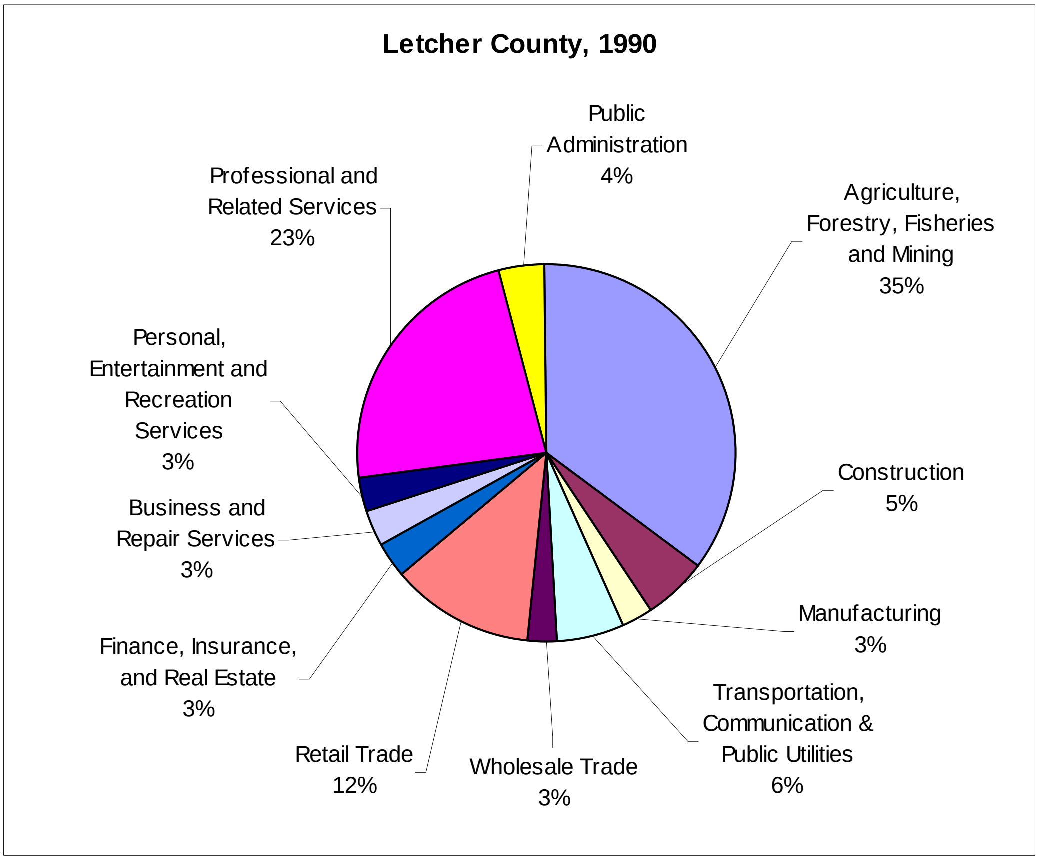


Figure 30 - Distribution of Employment by Industry Sector, West Virginia, 2000
Source: U.S. Census Bureau, 2000 STF3A

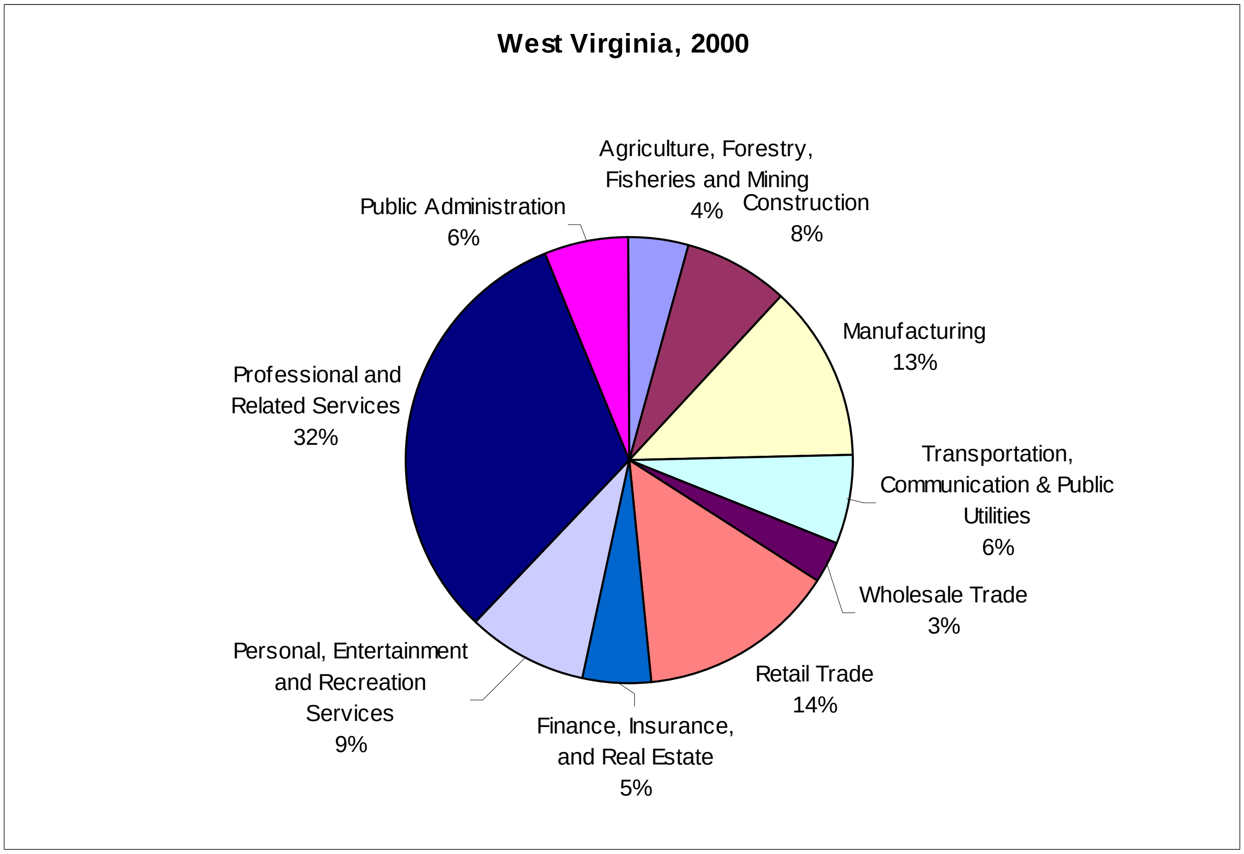


Figure 31 - Distribution of Employment by Industry Sector, McDowell County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

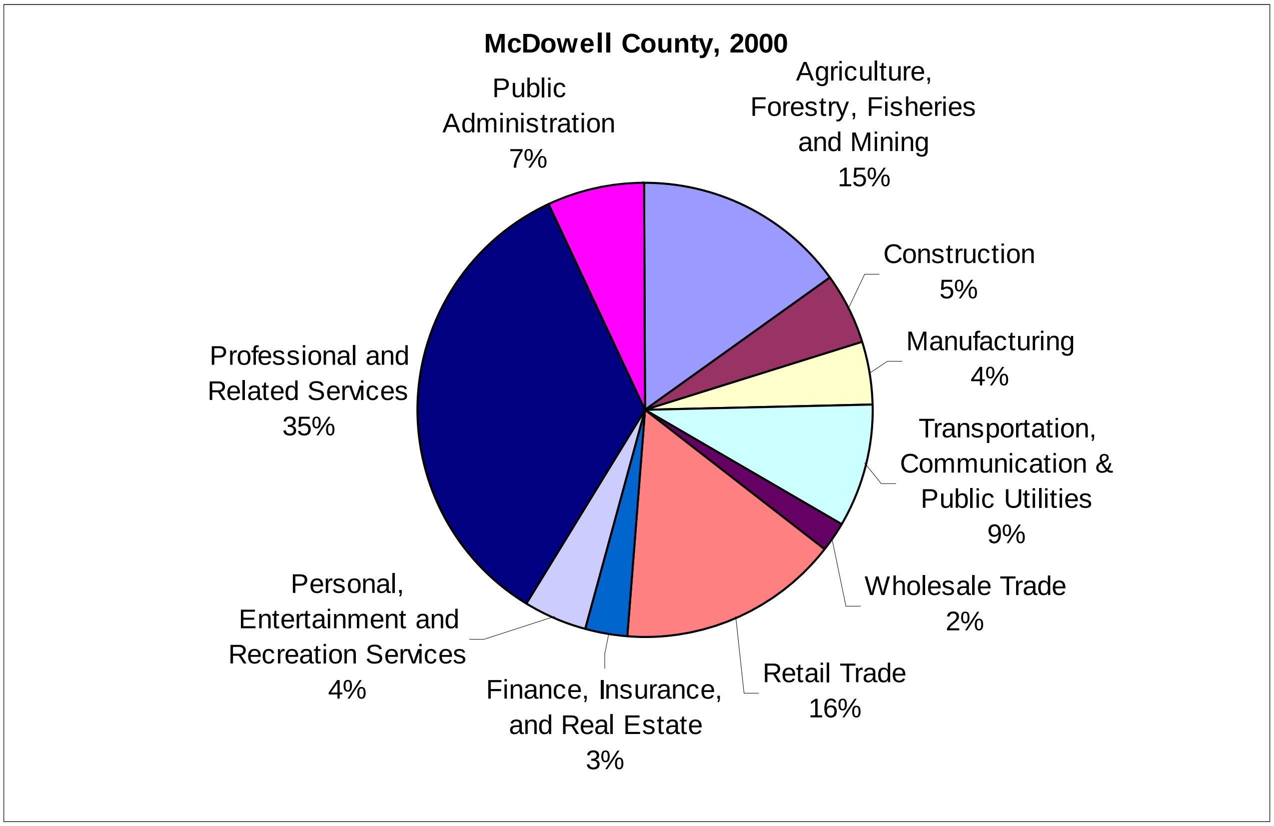


Figure 32 - Distribution of Employment by Industry Sector, Mingo County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

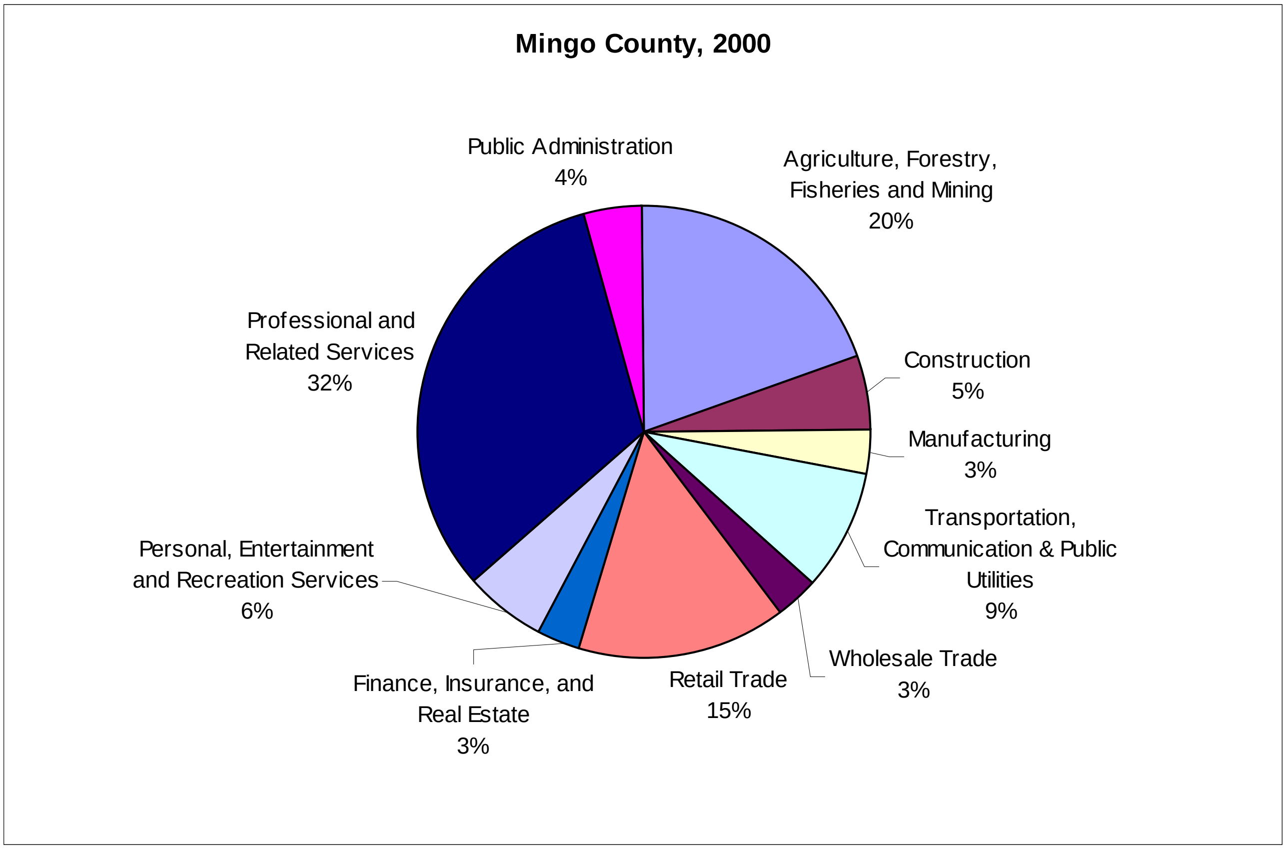


Figure 33 - Distribution of Employment by Industry Sector, Nicholas County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

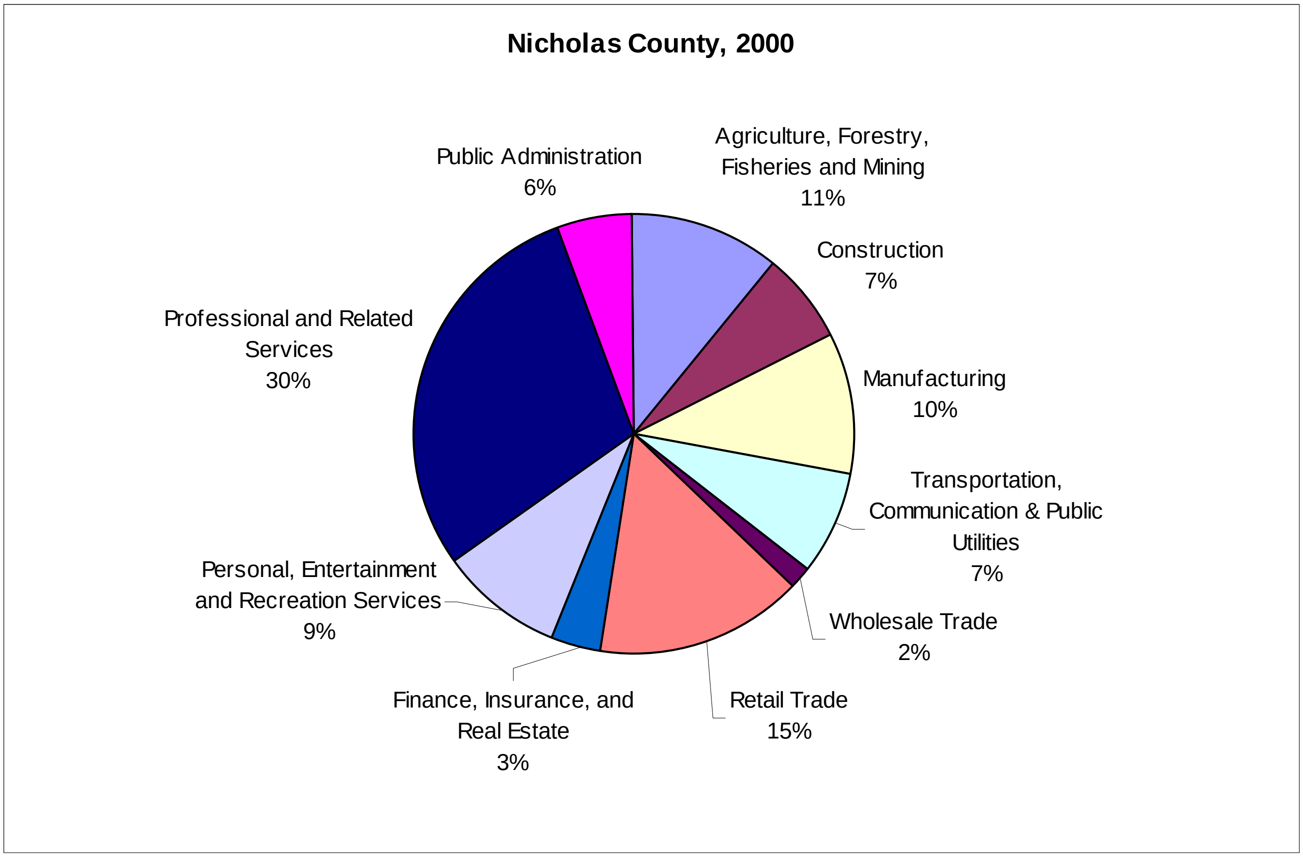


Figure 34 - Distribution of Employment by Industry Sector, Wyoming County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

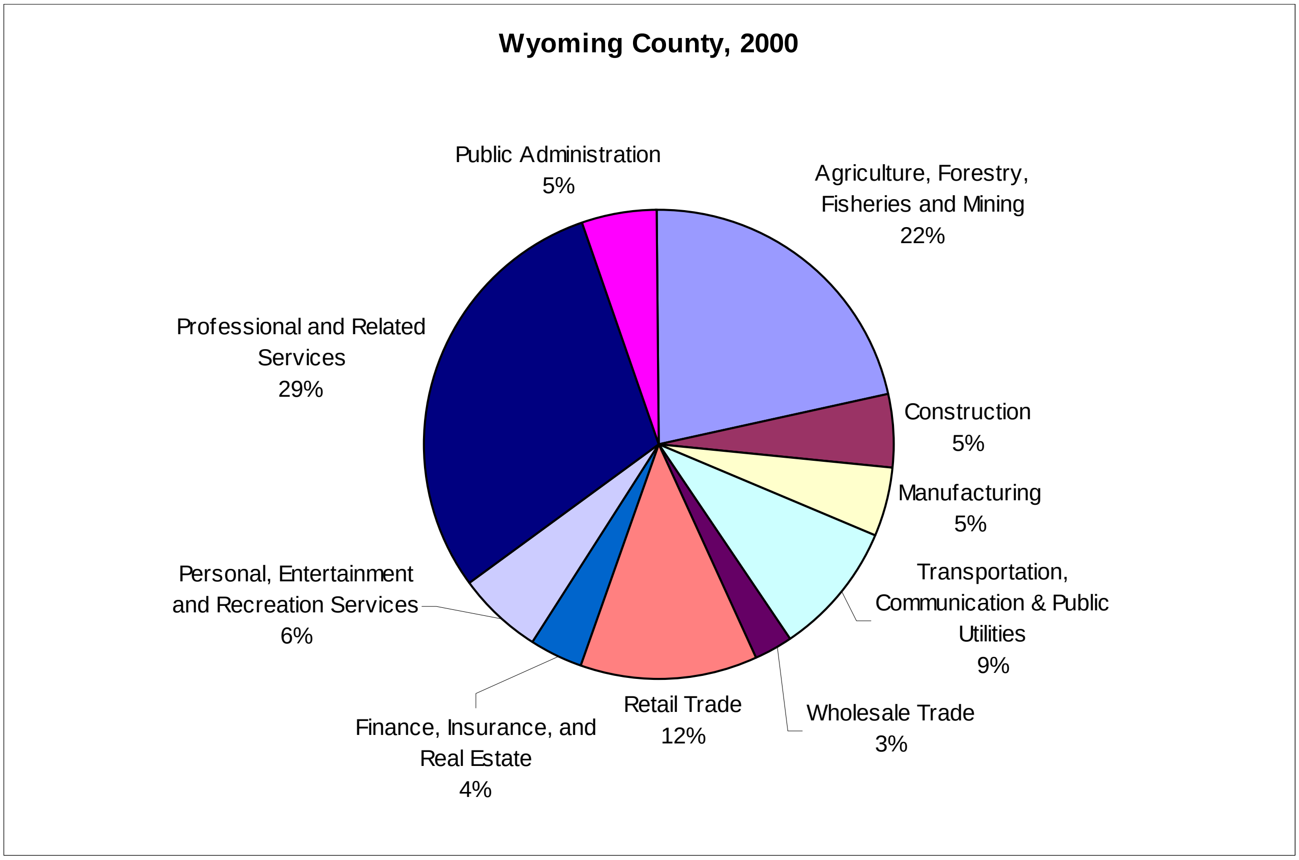


Figure 35 - Distribution of Employment by Industry Sector, Kentucky, 2000
Source: U.S. Census Bureau, 2000 STF3A

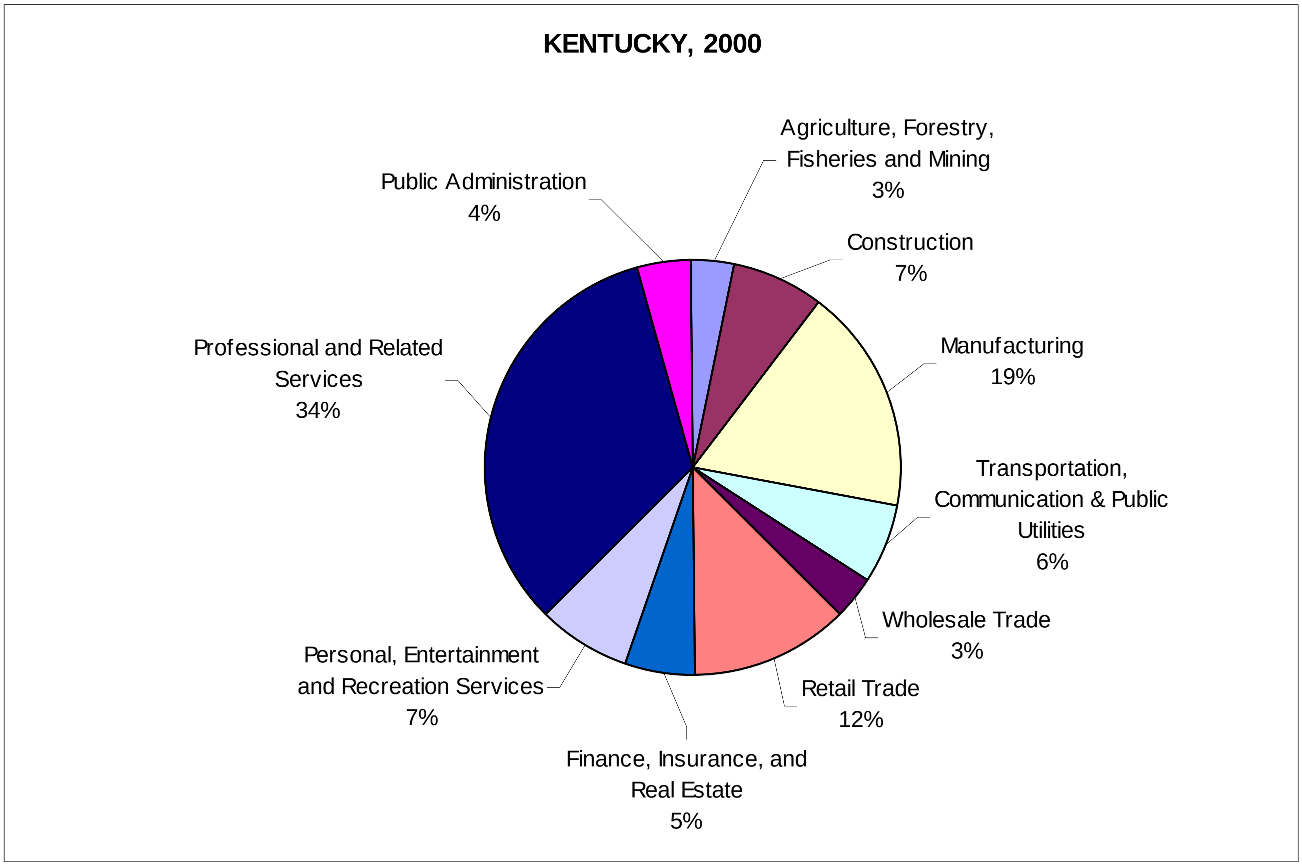


Figure 36 - Distribution of Employment by Industry Sector, Letcher County, KY, 2000
Source: U.S. Census Bureau, 2000 STF3A

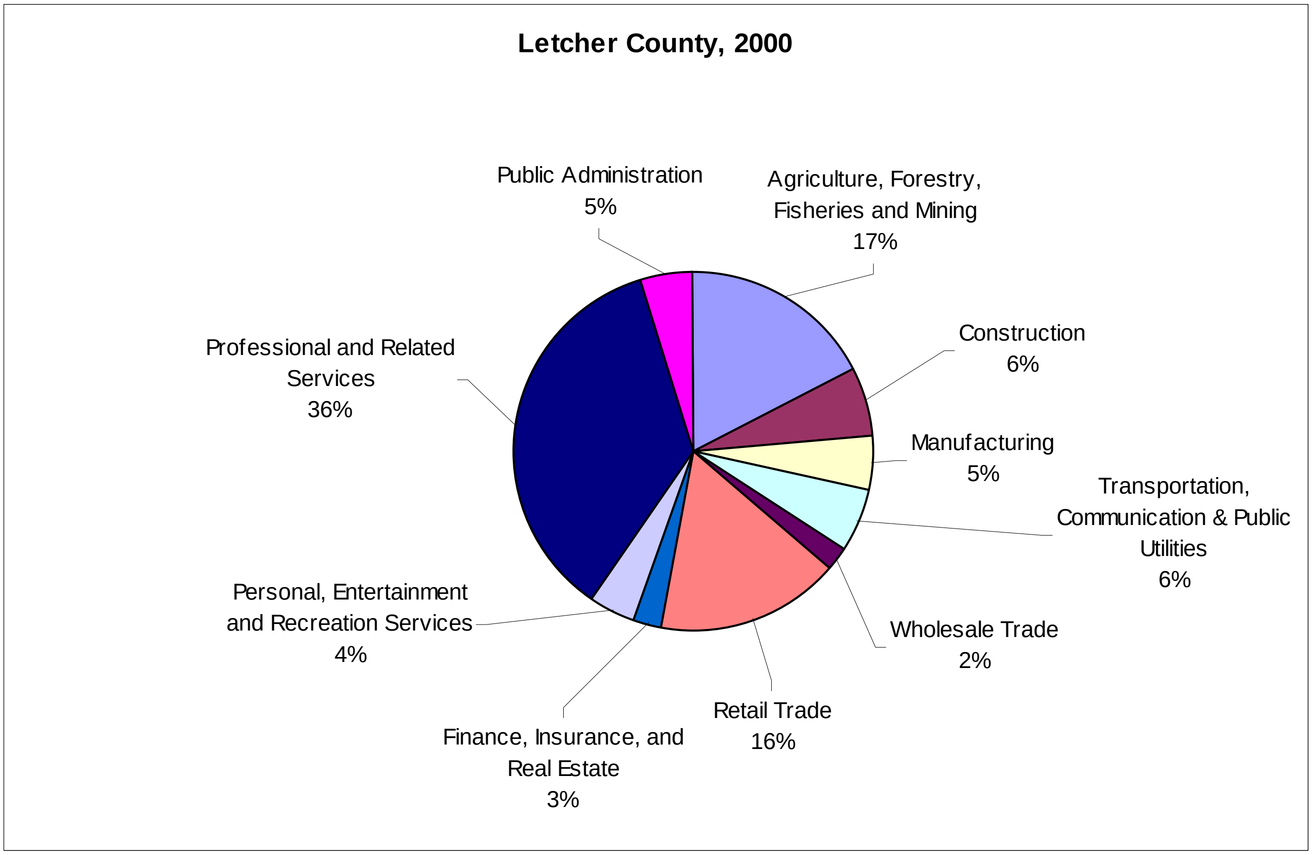


Figure 37 - Distribution of Employment by Occupation, West Virginia, 1980
Source: U.S. Census Bureau, 1980 STF3A

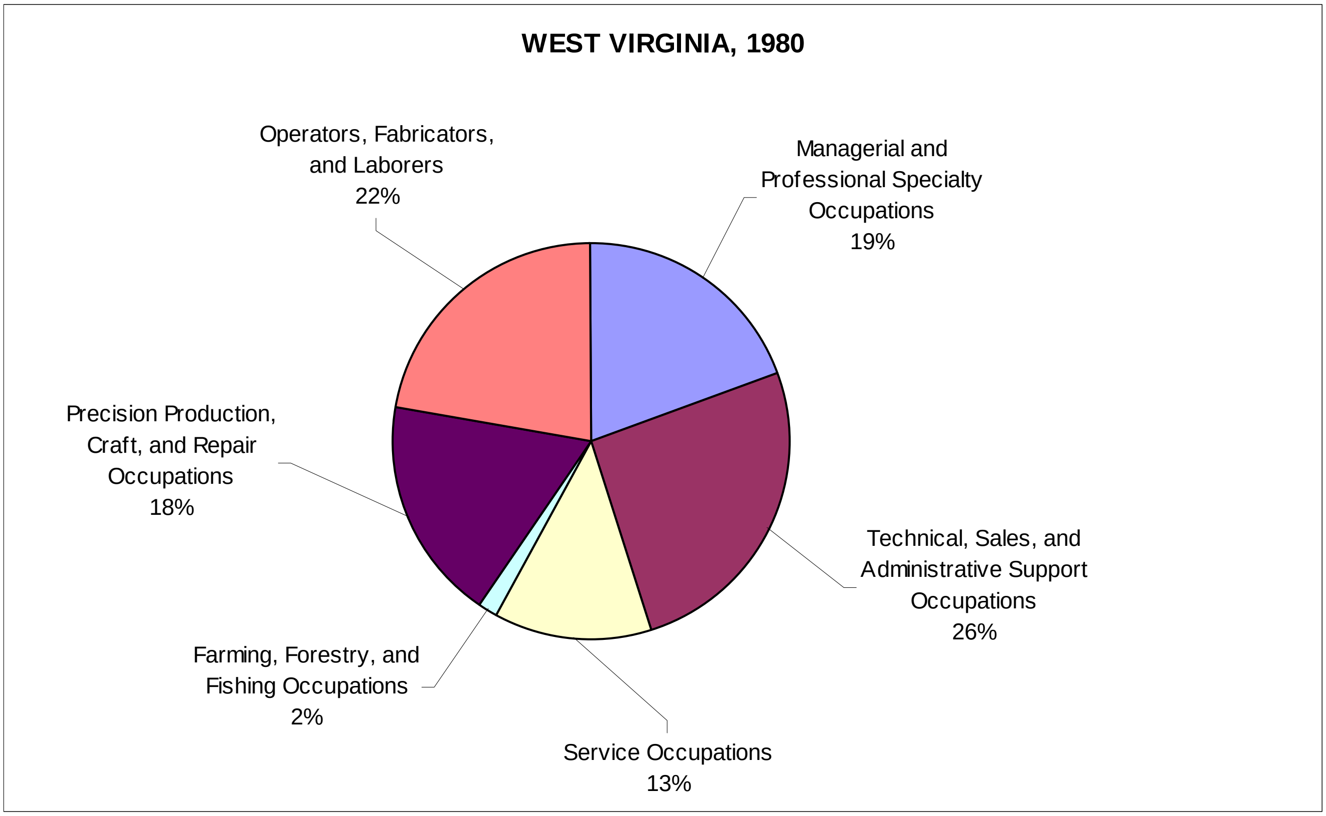


Figure 38 - Distribution of Employment by Occupation, McDowell County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

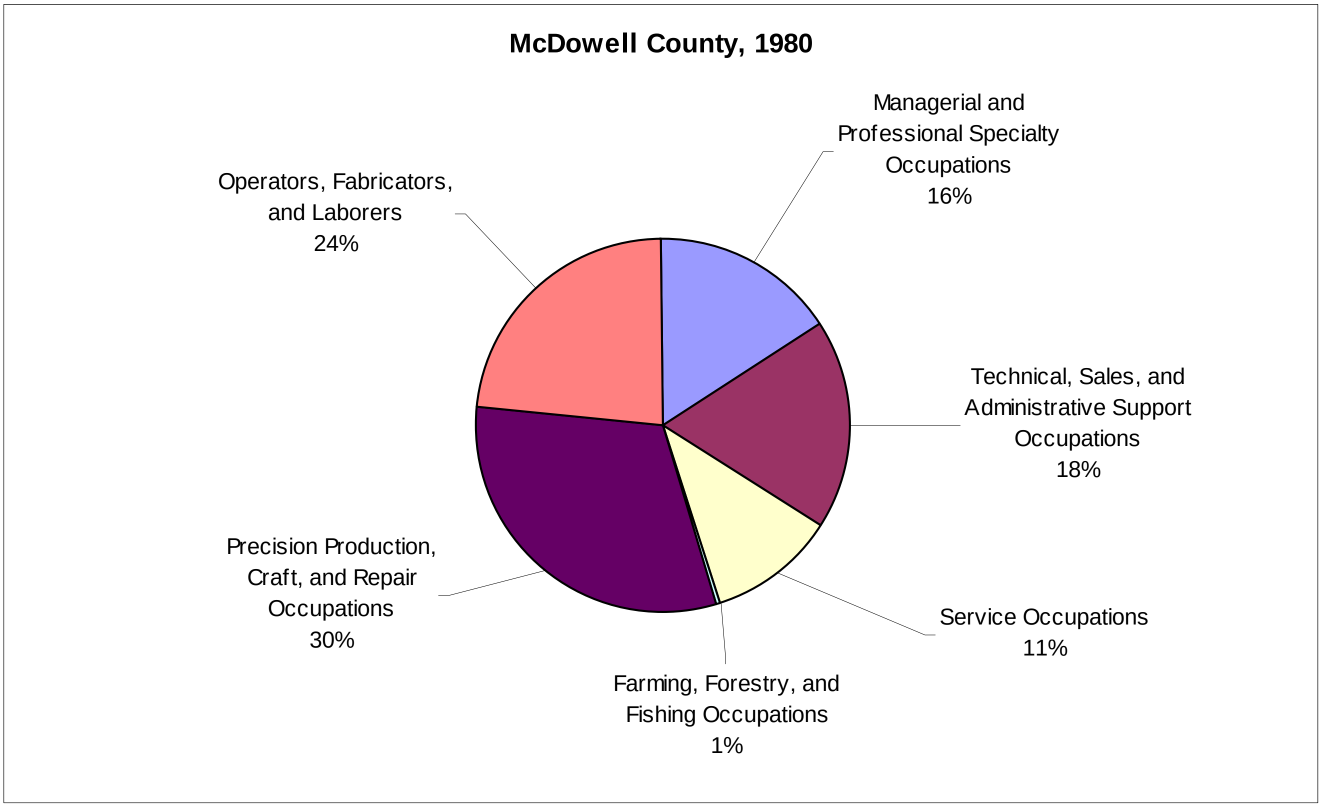


Figure 39 - Distribution of Employment by Occupation, Mingo County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

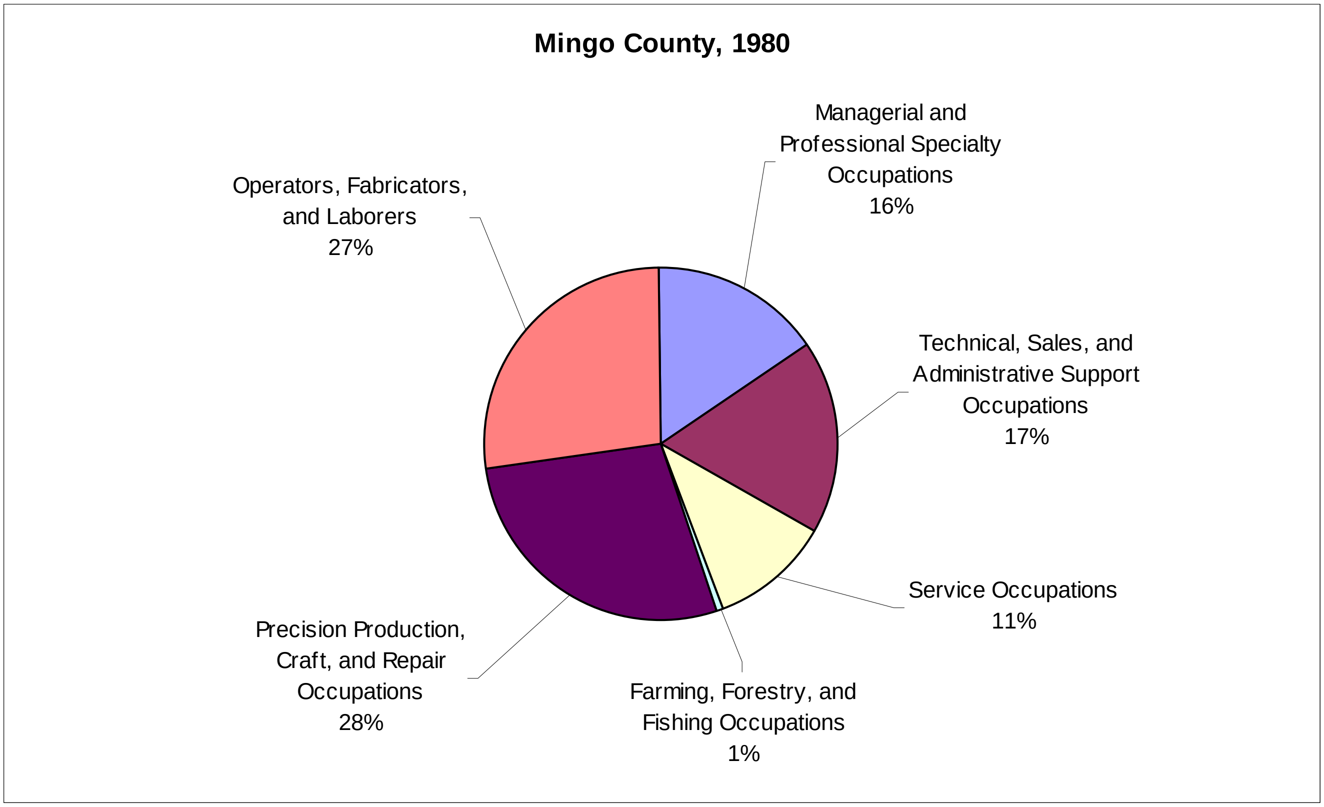


Figure 40 - Distribution of Employment by Occupation, Nicholas County, WV, 1980
Source: U.S. Census Bureau, 1980 STF3A

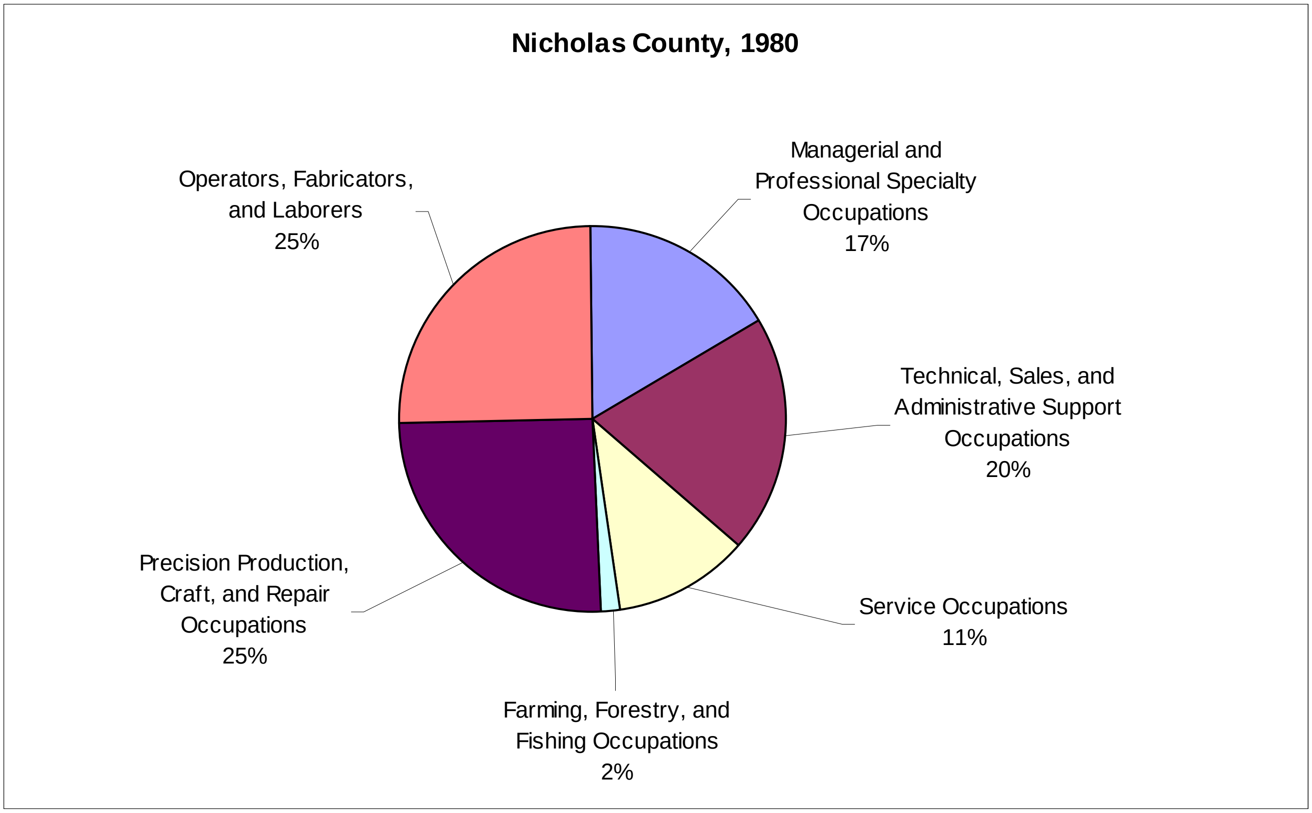


Figure 41 - Distribution of Employment by Occupation, Wyoming County, W V, 1980
Source: U.S. Census Bureau, 1980 STF3A

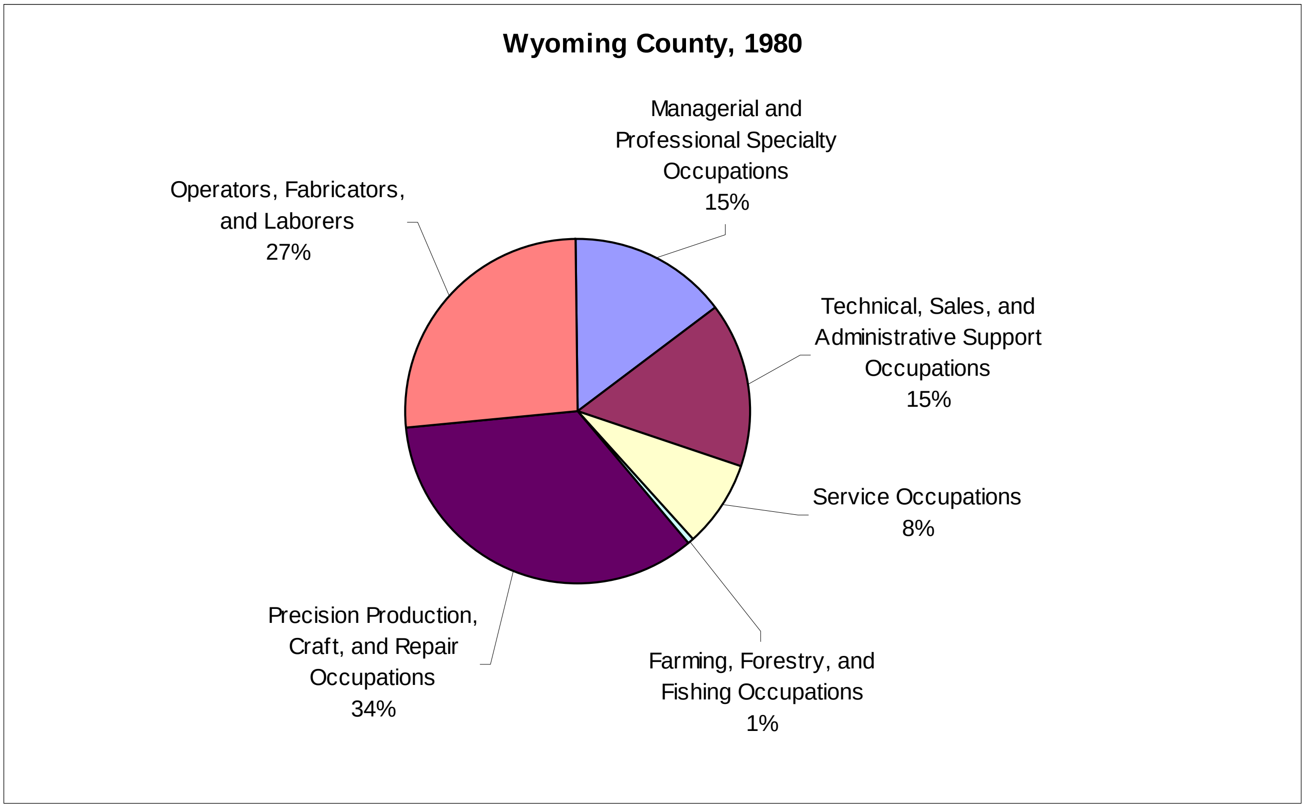


Figure 42 - Distribution of Employment by Occupation, Kentucky, 1980
Source: U.S. Census Bureau, 1980 STF3A

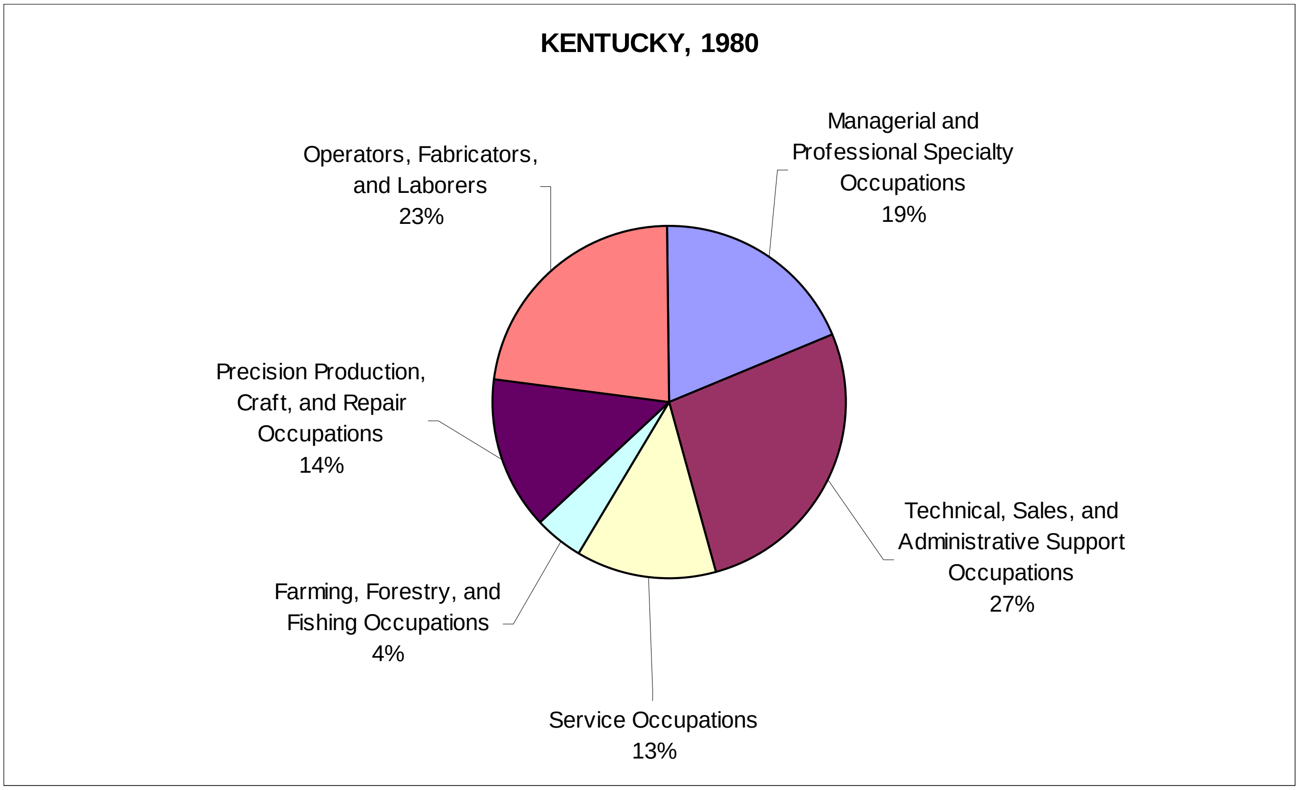


Figure 43 - Distribution of Employment by Occupation, Letcher County, KY, 1980
Source: U.S. Census Bureau, 1980 STF3A

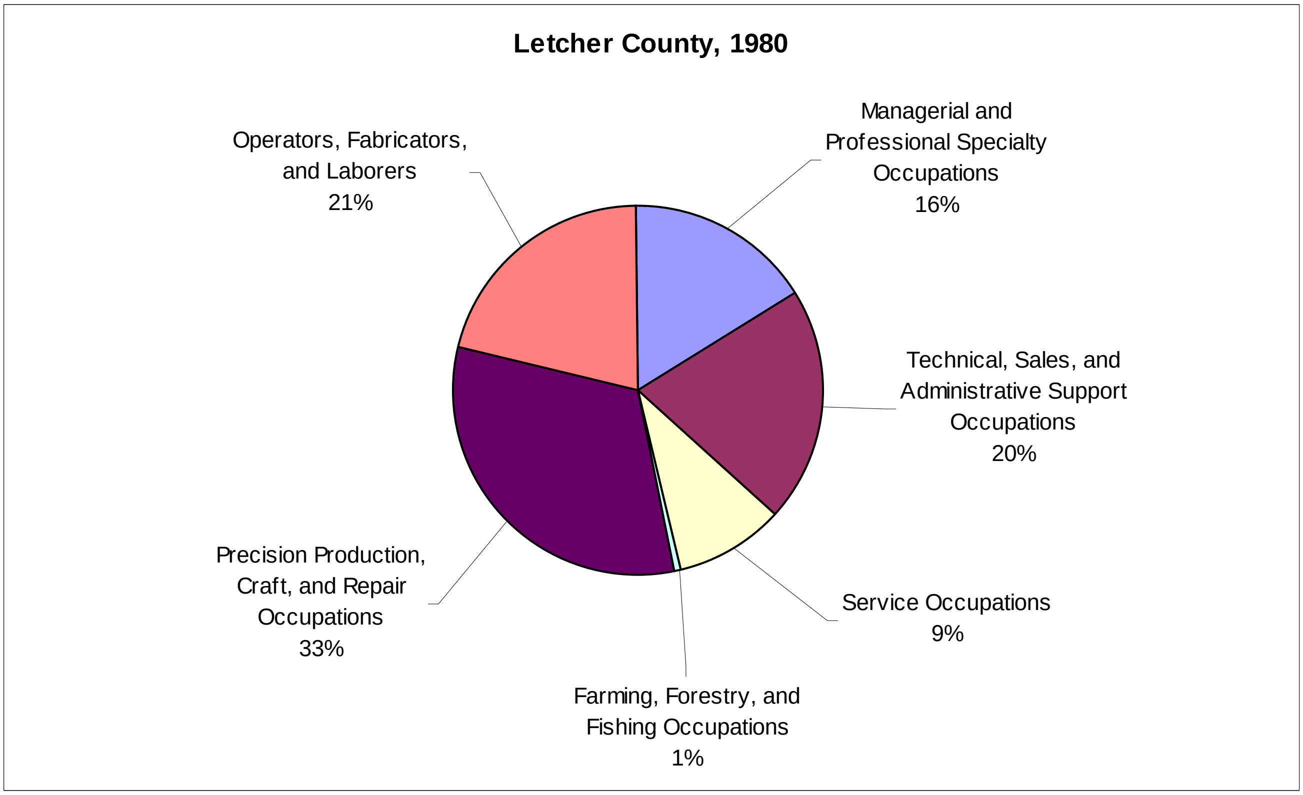


Figure 44 - Distribution of Employment by Occupation, West Virginia, 1990
Source: U.S. Census Bureau, 1990 STF3A

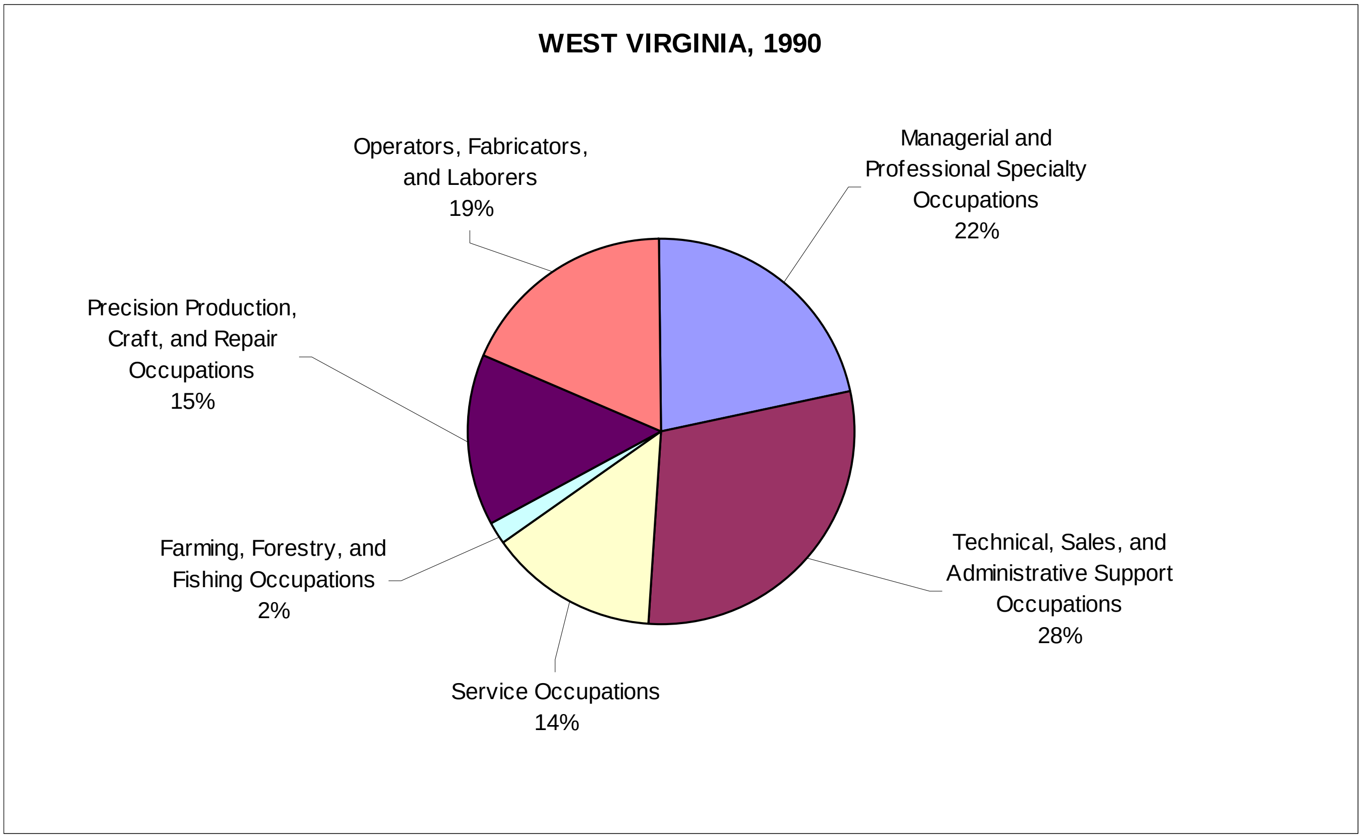


Figure 45 - Distribution of Employment by Occupation, McDowell County, WV 1990
Source: U.S. Census Bureau, 1990 STF3A

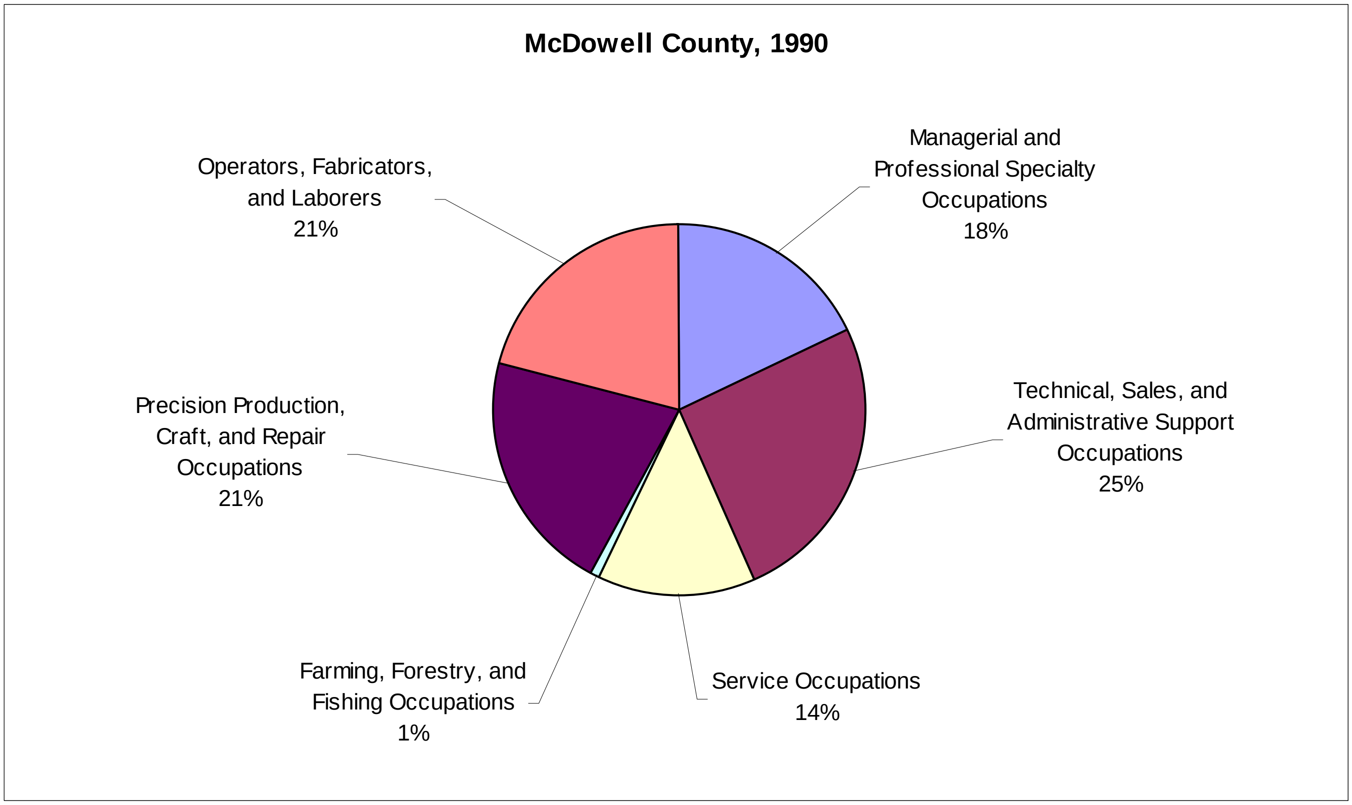


Figure 46 - Distribution of Employment by Occupation, Mingo County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

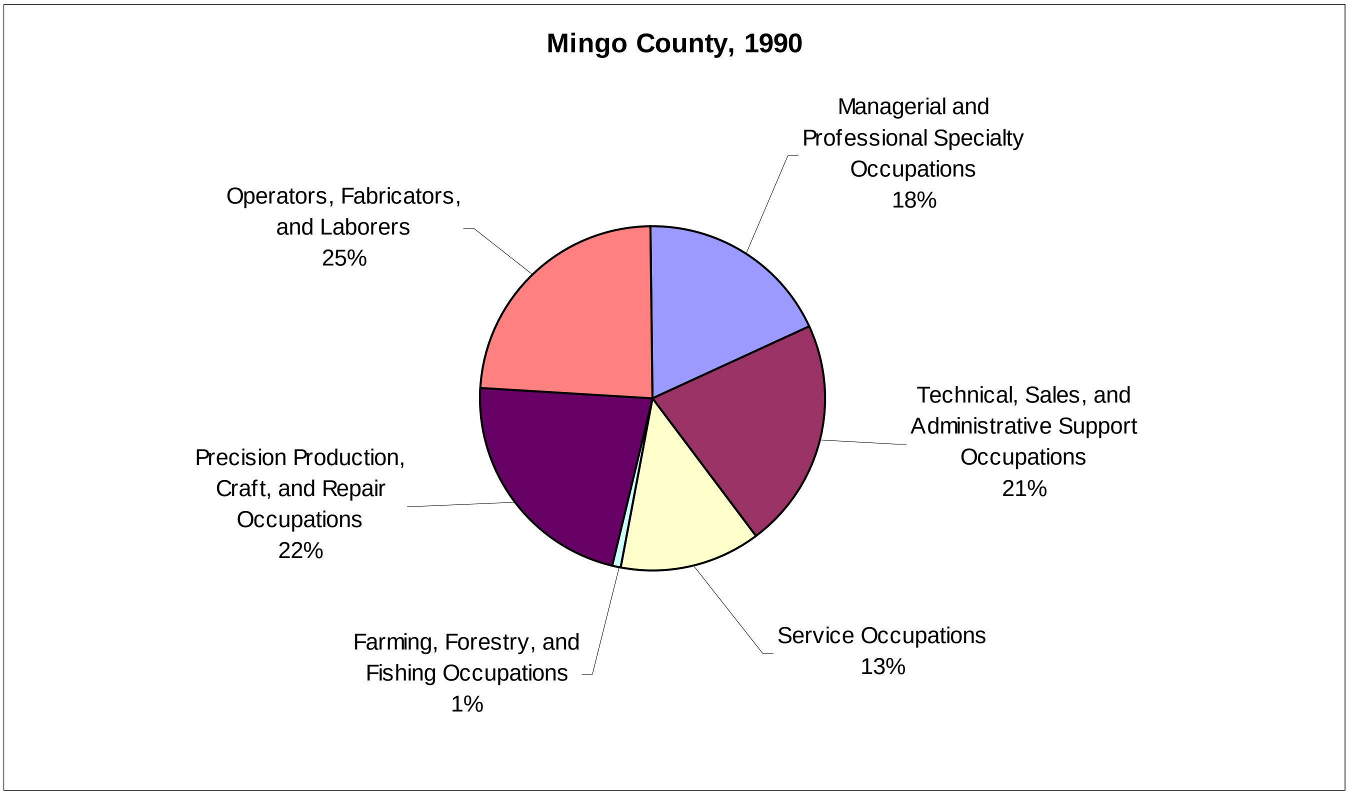


Figure 47 - Distribution of Employment by Occupation, Nicholas County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

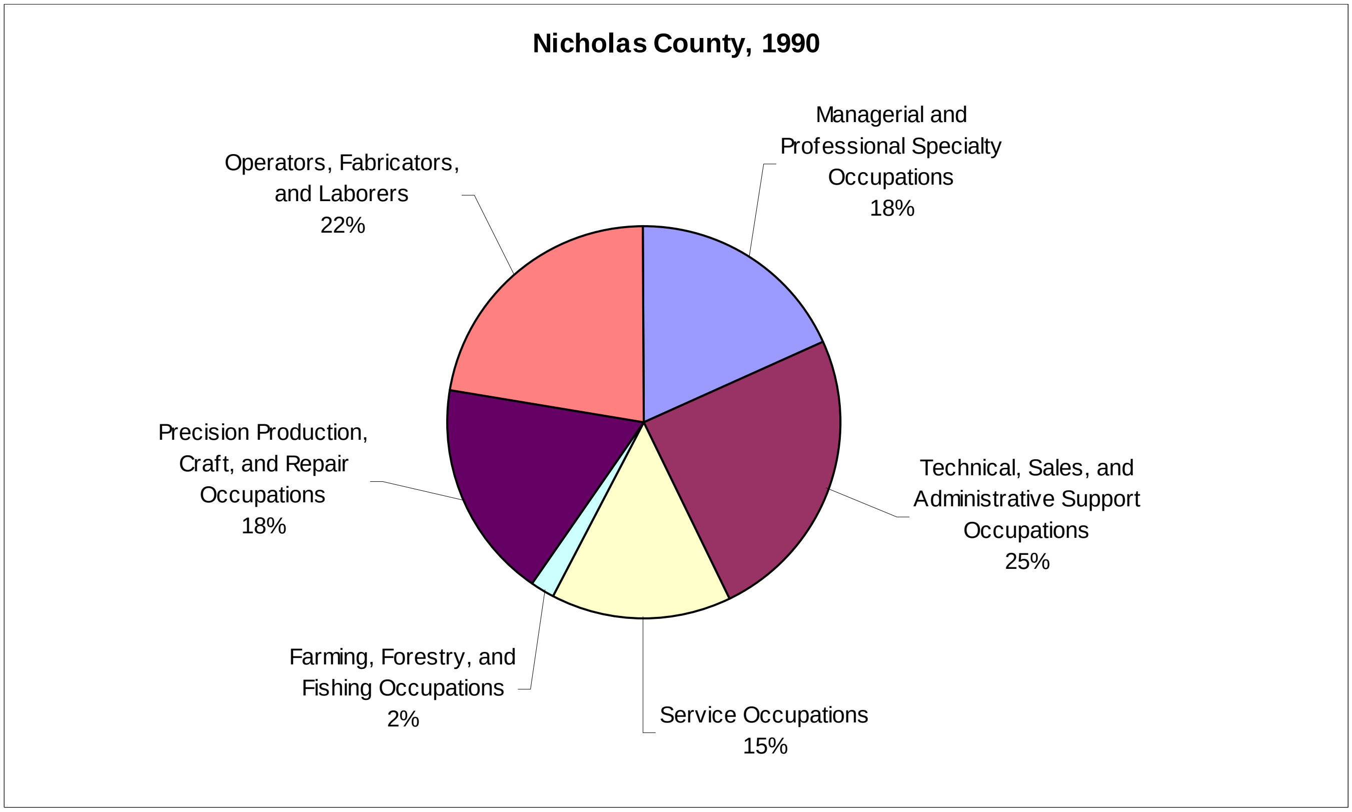


Figure 48 - Distribution of Employment by Occupation, Wyoming County, WV, 1990
Source: U.S. Census Bureau, 1990 STF3A

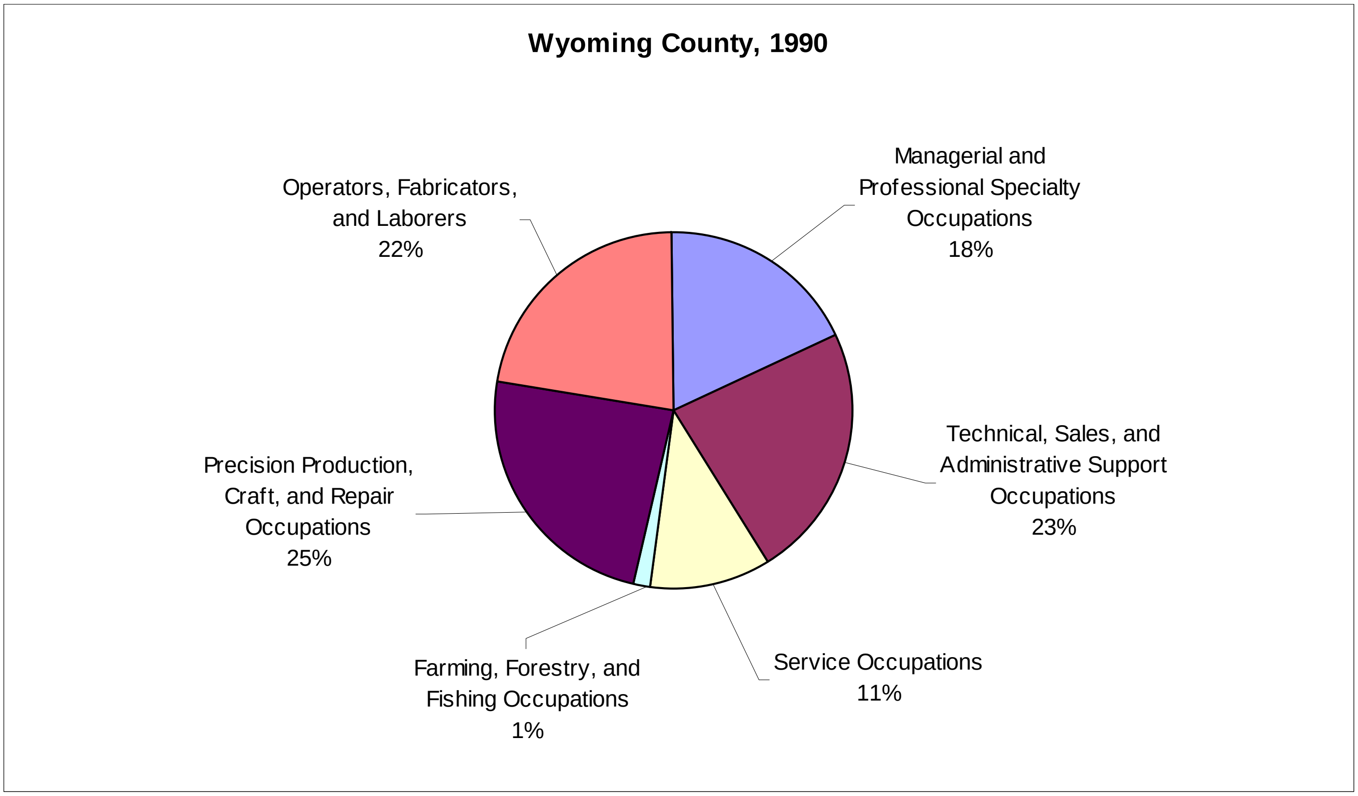


Figure 49 - Distribution of Employment by Occupation, Kentucky, 1990
Source: U.S. Census Bureau, 1990 STF3A

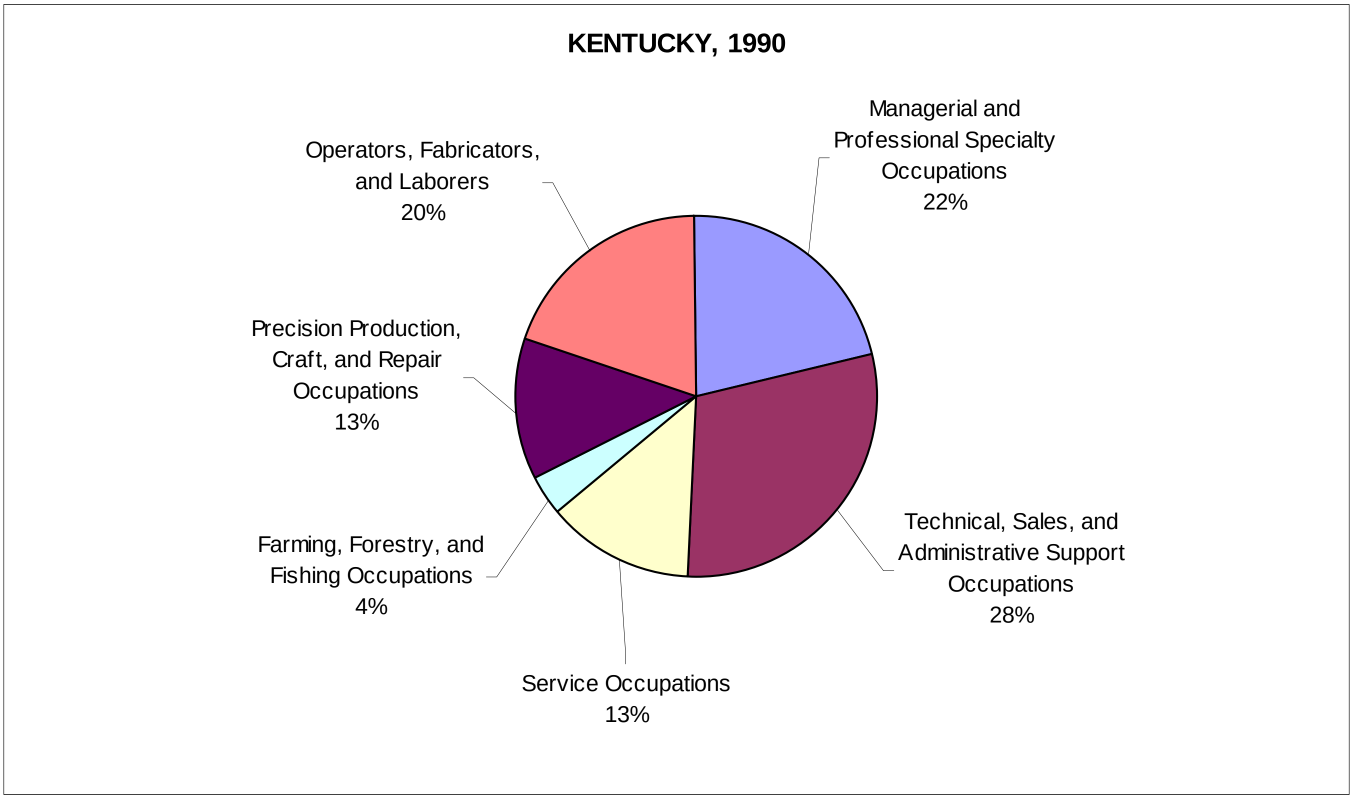


Figure 50 - Distribution of Employment by Occupation, Letcher County, KY, 1990
Source: U.S. Census Bureau, 1990 STF3A

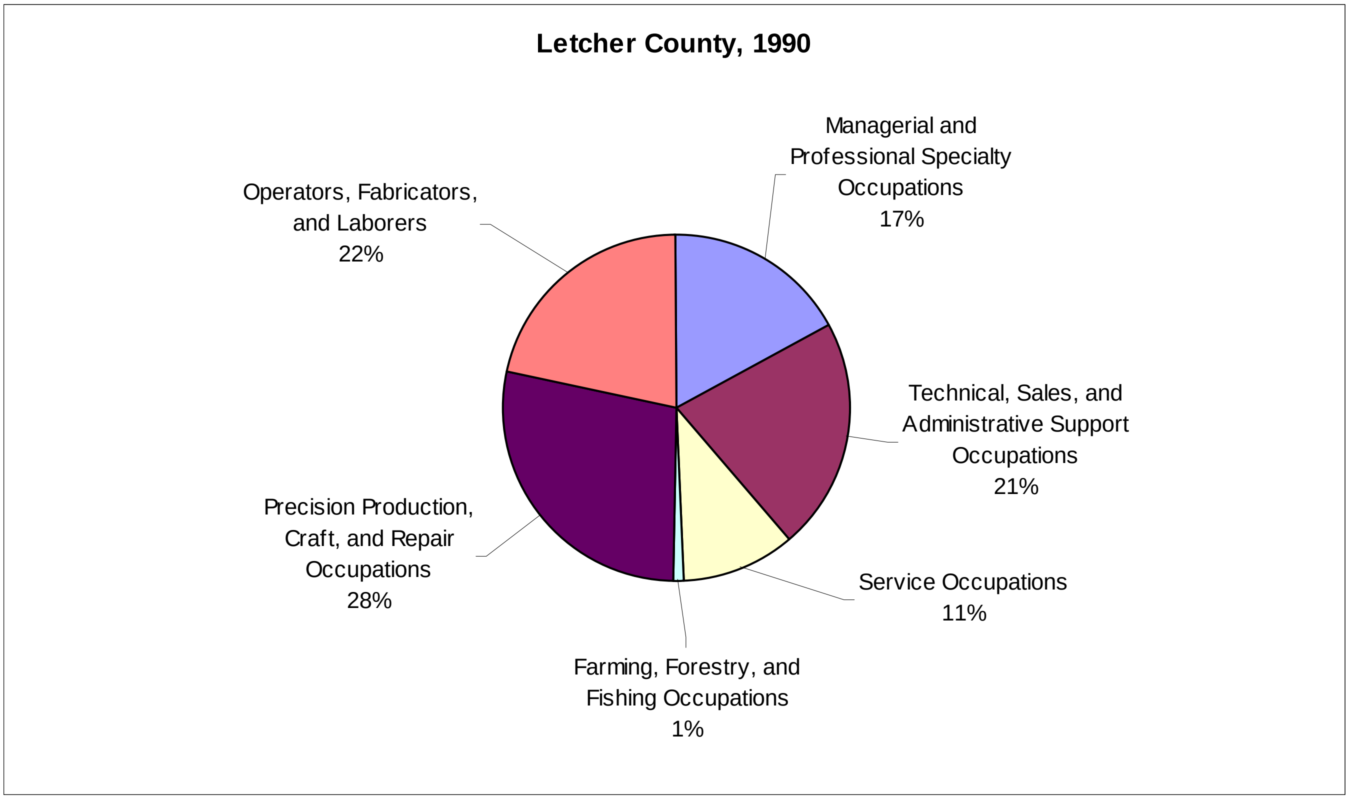


Figure 51 - Distribution of Employment by Occupation, West Virginia, 2000
Source: U.S. Census Bureau, 2000 STF3A

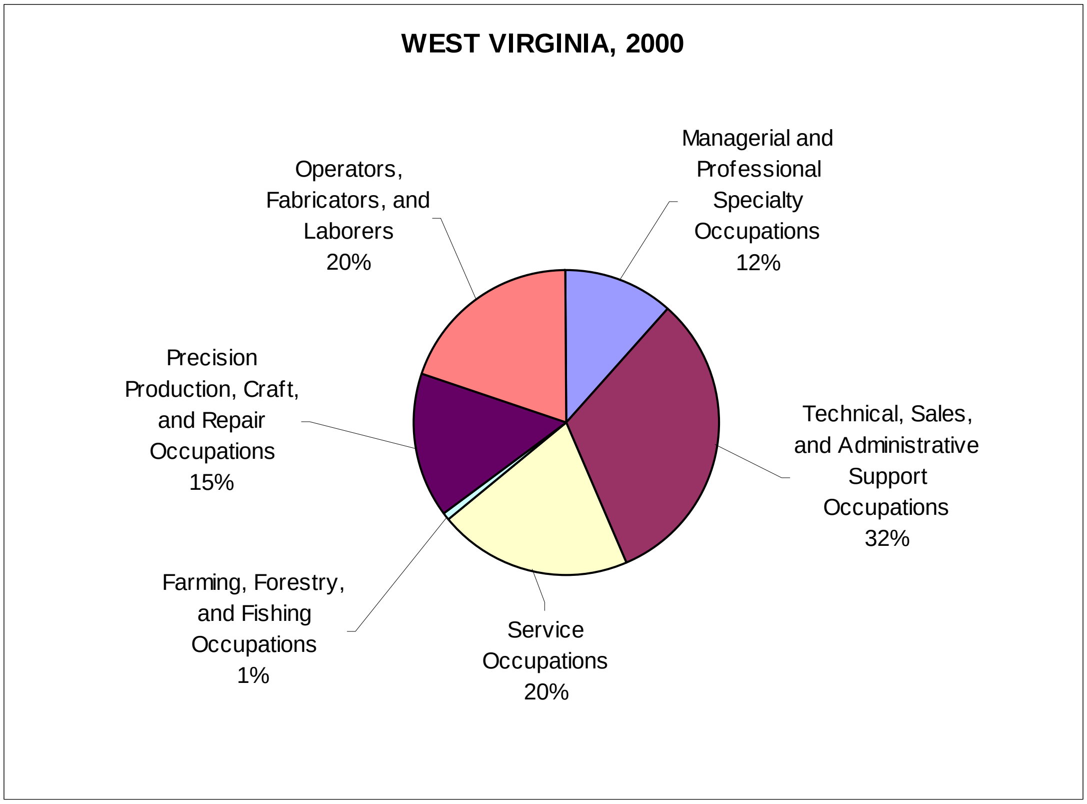


Figure 52 - Distribution of Employment by Occupation, McDowell County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

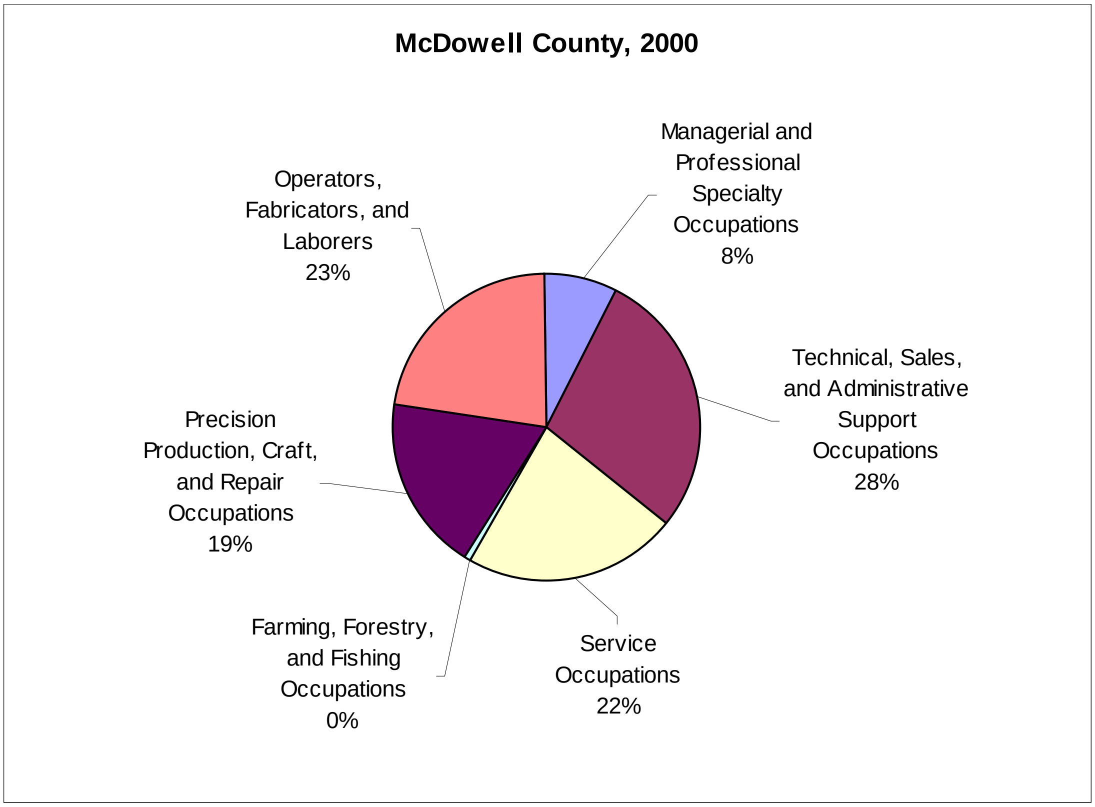


Figure 53 - Distribution of Employment by Occupation, Mingo County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

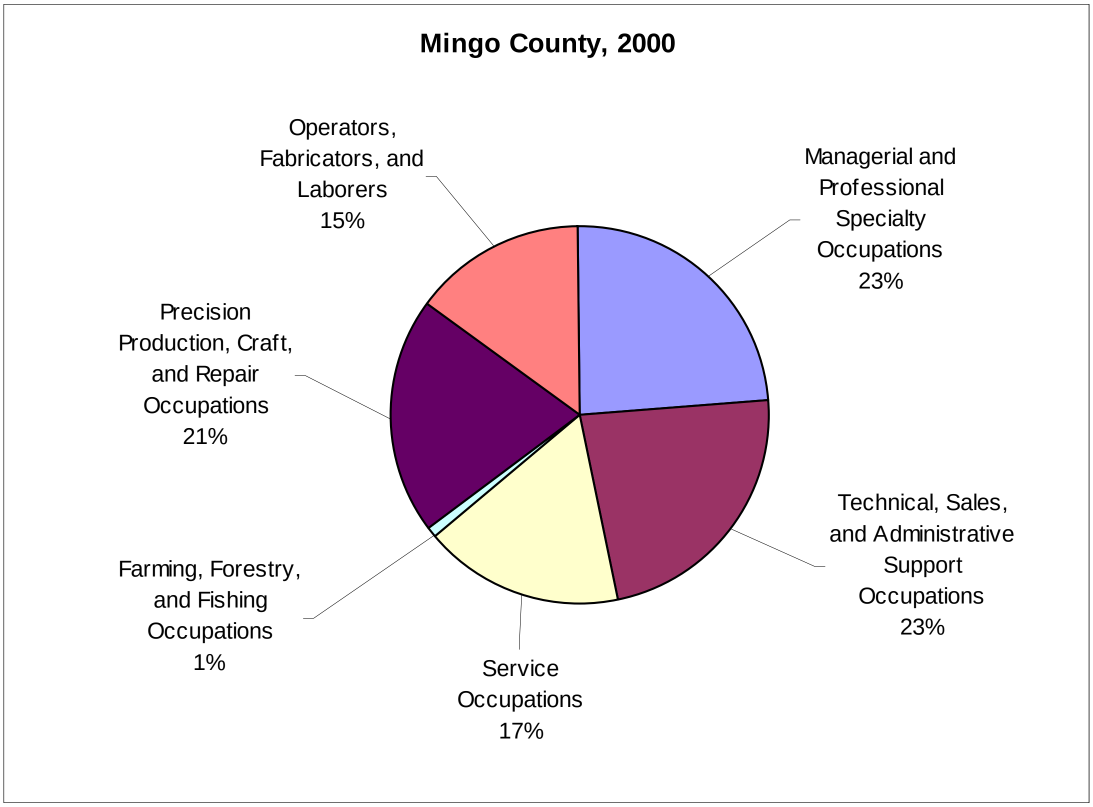


Figure 54 - Distribution of Employment by Occupation, Nicholas County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

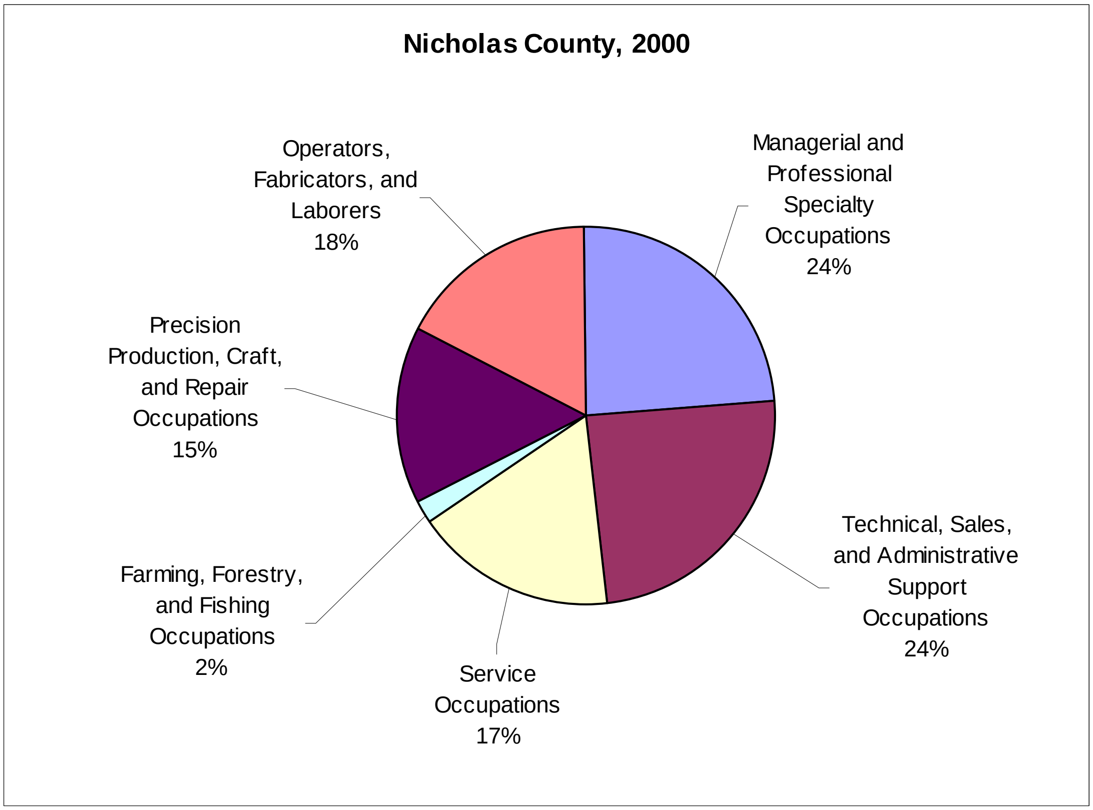


Figure 55 - Distribution of Employment by Occupation, Wyoming County, WV, 2000
Source: U.S. Census Bureau, 2000 STF3A

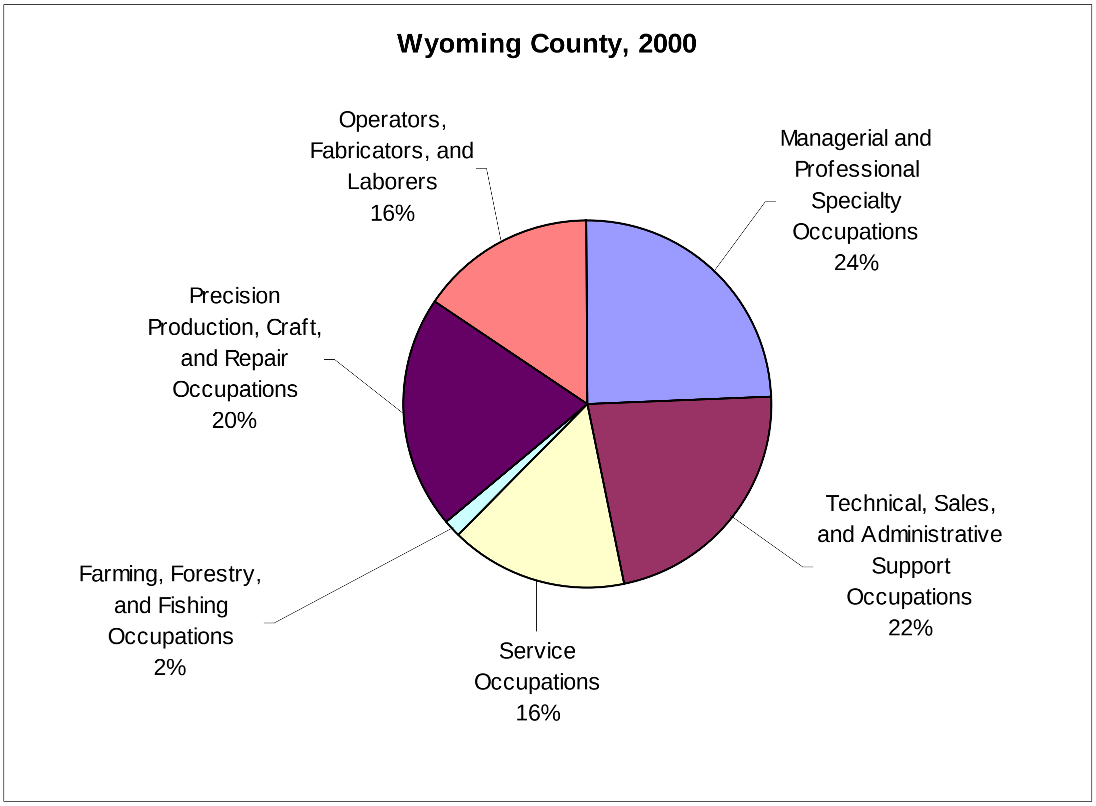


Figure 56 - Distribution of Employment by Occupation, Kentucky, 2000
Source: U.S. Census Bureau, 2000 STF3A

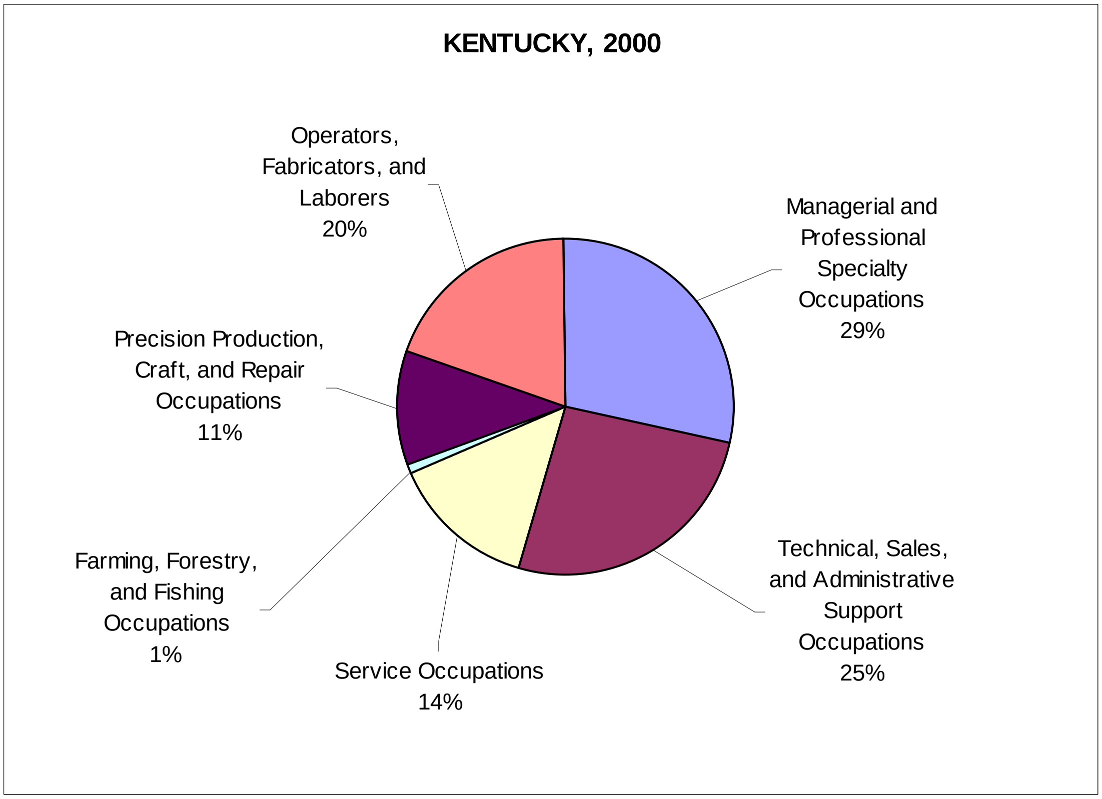


Figure 57 - Distribution of Employment by Occupation, Letcher County, KY, 2000
Source: U.S. Census Bureau, 2000 STF3A

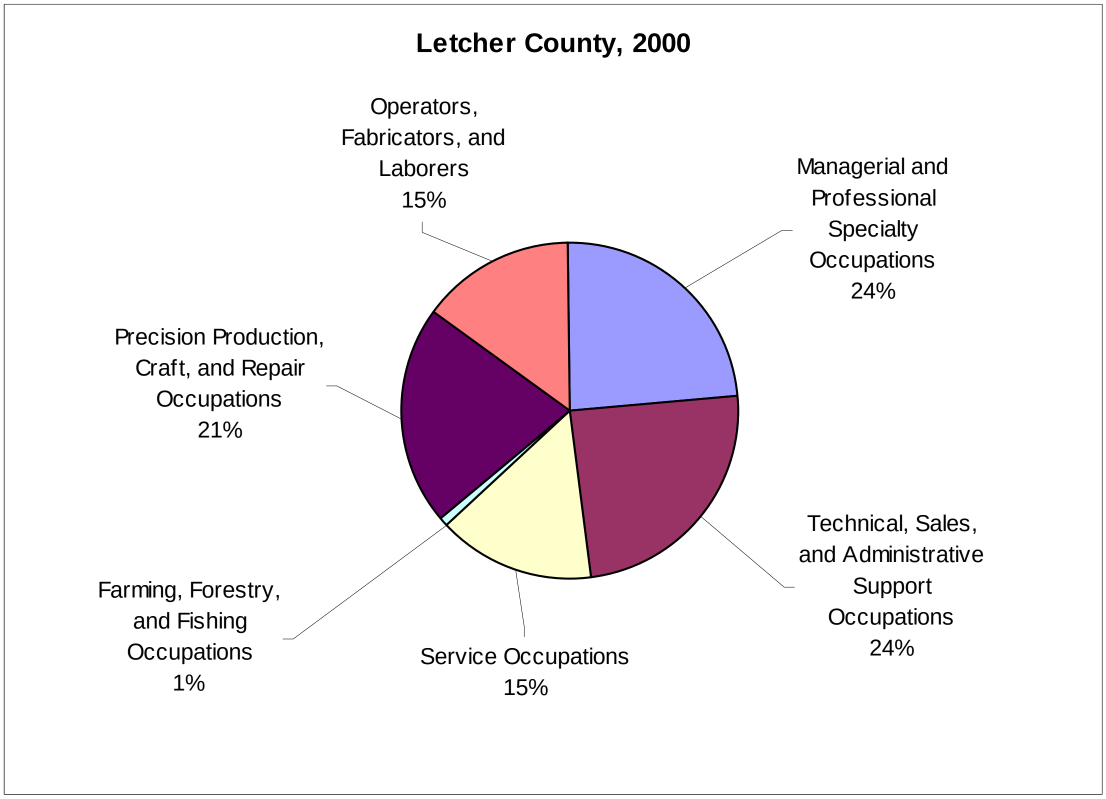


Table 1 - Case Study Communities and Respective Census Divisions by Decennial Census

<table>
<tr><th colspan="2" rowspan="2">Case Study Communities</th><th colspan="3">Census Divisions Per Decennial Censuses</th></tr>
<tr><th>1980 Census</th><th>1990 Census</th><th>2000 Census</th></tr>
<tr><td rowspan="7">MTM Study Communities</td><td rowspan="3">Kyle (McDowell County, WV)</td><td>Adkin District</td><td colspan="2" rowspan="3">North Elkin District (1)</td></tr>
<tr><td>Elkhorn District</td></tr>
<tr><td>North Fork District</td></tr>
<tr><td>Naugatuck (Mingo County, WV)</td><td colspan="3">Hardee District</td></tr>
<tr><td>Scarlet (Mingo County, WV)</td><td colspan="3">Hardee District</td></tr>
<tr><td>Werth (Nicholas County, WV)</td><td colspan="3">Hamilton District</td></tr>
<tr><td>Carcassone (Letcher County, KY)</td><td colspan="3">Blackey Division</td></tr>
<tr><td rowspan="2">Descriptive Statistics Control Area</td><td rowspan="2">(Wyoming County, WV)</td><td colspan="2">Barkers Ridge District</td><td rowspan="2">District 1 (2)</td></tr>
<tr><td colspan="2">Slab Fork District</td></tr>
</table>

Notes: (1) North Elkin Magisterial District was created from the Adkin, Elkhorn, North Fork Magisterial Districts (Date submitted 03 April 1987).

(2) District 1 was created from the Barkers Ridge and Slab Fork Districts (Date submitted 07 August 1994).

Table 2 - Population Trends

Case Study Place	Total Population			Change			
	1980	1990	2000	1980-1990		1990-2000	
				#	%	#	%
WEST VIRGINIA	1,949,644	1,793,477	1,808,344	(156,167)	(8.0)	14,867	0.8
McDowell County, WV	49,899	35,233	27,329	(14,666)	(29.4)	(7,904)	(22.4)
North Elkin District (1)	11,682	7,708	6,725	(3,974)	(34.0)	(983)	(12.8)
Mingo County, WV	37,336	33,739	28,253	(3,597)	(9.6)	(5,486)	(16.3)
Hardee District	3,817	3,417	2,967	(400)	(10.5)	(450)	(13.2)
Nicholas County, WV	28,126	26,775	26,562	(1,351)	(4.8)	(213)	(0.8)
Hamilton District	3,108	3,077	2,933	(31)	(1.0)	(144)	(4.7)
Wyoming County, WV	35,993	28,990	25,708	(7,003)	(19.5)	(3,282)	(11.3)
District 1 District (2)	*12,024*	*9,050*	7,957	(2,974)	(24.7)	(1,093)	(12.1)
KENTUCKY	3,660,777	3,685,296	4,041,769	24,519	0.7	356,473	9.7
Letcher County, KY	30,687	27,000	25,277	(3,687)	(12.0)	(1,723)	(6.4)
Blackey Division		6,324	5,554	6,324	n/a	(770)	(12.2)

Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

Notes: (1) 1980 population total for the North Elkin District was derived by adding the population counts for the Adkin, Elkhorn and North Fork Districts.

(2) 1980 and 1990 population totals for District 1 were derived by adding the population counts for Barkers Ridge and Slab Fork Districts.

Table 3 - Population Density Trends

Case Study Place	Land Area (Sq. Mi.)	Persons Per Square Mile			Numeric Change	
		1980	1990	2000	1980-1990	1990-2000
WEST VIRGINIA	24,086.6	80.9	74.5	75.1	(6.5)	0.6
McDowell County, WV	534.8	93.3	65.9	51.1	(27.4)	(14.8)
North Elkin District (1)	122.1	95.7	63.1	51.6	(32.5)	(11.5)
Mingo County, WV	422.6	88.3	79.8	66.9	(8.5)	(13.0)
Hardee District	73.6	51.9	46.4	40.3	(5.4)	(6.1)
Nicholas County, WV	648.7	43.4	41.3	40.9	(2.1)	(0.3)
Hamilton District	147.8	21.0	20.8	19.8	(0.2)	(1.0)
Wyoming County, WV	500.9	71.9	57.9	51.3	(14.0)	(6.6)
District 1 District (2)	175.9	68.4	51.4	45.2	(16.9)	(6.2)
KENTUCKY	39,732.3	92.1	92.8	101.7	0.6	9.0
Letcher County, KY	339.1	90.5	79.6	74.5	(10.9)	(5.1)
Blackey Division	131.8		48.0	42.1		(5.8)

Sources: U.S. Census Bureau, 1980 STF3A, 1990 and 2001, SF1A. TIGER/Line Files 1990 and 2000.
Notes: (1) TIGER/Line data nonexistent for 1980 level data, therefore, the 1990 TIGER/Line data for North Elkin was used in conjunction with the population totals for the Adkin, Elkhorn, and North Fork Districts to calculate the 1980 population density. Also, the 1980 and 1990 land area for North Elkin was 122.1 square miles, while the 2000 land area increased to 130.3. Figure 2 illustrates this boundary change.
(2) The District 1's 1980 population density value was derived by calculating the total population and total land area values for the Barkers Ridge and Slab Fork Districts.

Table 4 - Gender Distribution Comparison Trends

Case Study Place	Male to Female Distribution								
	1980			1990			2000		
	Male	Female	M/F Ratio	Male	Female	M/F Ratio	Male	Female	M/F Ratio
WEST VIRGINIA	945,408	1,004,236	0.94	861,731	931,746	0.92	879,170	929,174	0.95
McDowell County, WV	24,190	25,709	0.94	16,712	18,521	0.90	12,975	14,354	0.90
North Elkin District	5,690	5,986	0.95	3,606	4,112	0.88	3,120	3,605	0.87
Mingo County, WV	18,489	18,847	0.98	16,449	17,290	0.95	13,665	14,588	0.94
Hardee District	1,909	1,897	1.01	1,682	1,735	0.97	1,448	1,519	0.95
Nicholas County, WV	13,918	14,208	0.98	13,114	13,661	0.96	12,983	13,579	0.96
Hamilton District	1,571	1,547	1.02	1,545	1,532	1.01	1,483	1,450	1.02
Wyoming County, WV	17,870	18,123	0.99	14,103	14,887	0.95	12,649	13,059	0.97
District 1 District	5,864	6,160	0.95	4,319	4,731	0.91	3,927	4,030	0.97
KENTUCKY	1,789,039	1,871,738	0.96	1,785,068	1,900,228	0.94	1,975,368	2,066,401	0.96
Letcher County, KY	15,086	13,083	1.15	13,095	13,905	0.94	12,366	12,911	0.96
Blackey Division				3,078	3,262	0.94	2,734	2,820	0.97

Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2001, SF1A

Table 5 - Total Household Formation Trends

Case Study Place	Total Households			Percent Change	
	1980	1990	2000	1980-90	1990-00
WEST VIRGINIA	686,210	688,727	736,481	0.4	6.9
McDowell County, WV	15,959	12,835	11,169	(19.6)	(13.0)
North Elkin District (1)	3,721	2,828	2,732	(24.0)	(3.4)
Mingo County, WV	11,925	11,850	11,303	(0.6)	(4.6)
Hardee District	1,187	1,098	1,116	(7.5)	1.6
Nicholas County, WV	9,462	10,022	10,722	5.9	7.0
Hamilton District	1,015	1,103	1,138	8.7	3.2
Wyoming County, WV	11,407	10,488	10,454	(8.1)	(0.3)
District 1 District	3,810	3,369	3,251	(11.6)	(3.5)
KENTUCKY	1,263,355	1,379,610	1,590,647	9.2	15.3
Letcher County, KY	10,007	9,725	10,085	(2.8)	3.7
Blackey Division		2,220	2,256	-	1.6

Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

Notes: (1) The 1980 household data for the North Elkin District was derived by adding the household data collected for the Adkin, Elkhorn and North Fork Districts.

(2) The 1980 and 1990 household data for District 1 was derived by adding the household data collected for the Barkers Ridge and Slab Fork Districts

Table 6 - Family and Nonfamily Household Formation Trends

Case Study Place	Total Family Households as a Percent of Total Households			Total Nonfamily Households as a Percent of Total Households		
	1980	1990	2000	1980	1990	2000
WEST VIRGINIA	77.4	73.0	68.4	22.6	27.0	31.6
McDowell County, WV	82.0	76.0	70.2	18.5	24.0	29.8
North Elkin District	82.0	73.9	68.7	18.0	26.1	31.3
Mingo County, WV	82.1	79.1	72.7	17.5	20.9	27.3
Hardee District	87.5	83.9	79.2	12.5	16.1	20.8
Nicholas County, WV	82.1	78.0	72.4	18.0	22.0	27.6
Hamilton District	81.4	80.7	75.4	18.6	19.3	24.6
Wyoming County, WV	85.9	79.6	73.7	14.6	20.4	26.3
District 1 District	84.1	77.7	72.6	15.9	22.3	27.4
KENTUCKY	77.8	74.1	69.4	22.2	25.9	30.6
Letcher County, KY	83.2	79.6	74.0	16.8	20.4	26.0
Blackey Division		81.9	73.5	-	18.1	26.5

Sources: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

Table 7 - Average Household Size Trends

Case Study Place	Persons Per Household		
	1980	1990	2000
WEST VIRGINIA	3.68	2.60	2.46
McDowell County, WV	3.13	2.75	2.45
North Elkin District	3.14	2.73	2.46
Mingo County, WV	3.13	2.85	2.50
Hardee District	3.22	3.11	2.66
Nicholas County, WV	2.97	2.67	2.48
Hamilton District	3.06	2.79	2.58
Wyoming County, WV	3.16	2.76	2.46
District 1 District	3.16	2.69	2.45
KENTUCKY	2.90	2.67	2.54
Letcher County, KY	3.07	2.78	2.51

Table 8 - Distribution of Race by White and Black/African American

Case Study Place	Race by Percent of Total Population					
	1980		1990		2000	
	White	Black/African American	White	Black/African American	White	Black/African American
WEST VIRGINIA	96.2	3.3	96.2	3.1	95.0	3.2
McDowell County, WV	85.0	14.8	86.3	13.5	87.1	11.9
North Elkin District (1)	68.9	30.8	69.6	30.1	68.0	30.4
Mingo County, WV	96.9	2.9	97.2	2.4	96.4	2.3
Hardee District	99.6	-	99.9	0.1	99.2	0.1
Nicholas County, WV	99.7	0.01	99.6	0.01	98.8	0.1
Hamilton District	100.0	-	99.7	-	98.3	0.0
Wyoming County, WV	98.6	1.1	98.9	0.8	98.6	0.6
District 1 District	96.7	3.0	97.3	2.4	97.1	1.7
KENTUCKY	92.3	7.1	92.0	7.1	90.1	7.3
Letcher County, KY	99.2	0.7	99.0	0.7	98.7	0.5
Blackey Division	100.0	-	99.9	0.05	99.5	0.05

Source: U.S. Census Bureau, 1980 and 1990 STF3A, and 2000 SF1A

(1) The 1980 race components for the North Elkin District were derived by calculating the values dervived for the Adkin, Elkhorn, and North Fork Districts

(2) The 1980 and 1990 race components for District 1 were derived by calculating the values derived for the Barkers Ridge and Slab Fork Districts

Table 9 - Educational Attainment Trends for Persons 25 Years and Over, 1980 to 2000

Case Study Place	Percent of Persons 25 Years Old and Over by Educational Attainment Level (3)					
	1980		1990		2000	
	High School	College	High School	College	High School	College
WEST VIRGINIA	35.6	10.4	36.6	29.4	39.4	35.8
McDowell County, WV	26.3	9.6	28.2	14.1	33.1	16.9
North Elkin District (1)	28.1	10.1	34.3	14.3	39.0	20.8
Mingo County, WV	26.9	12.5	31.5	18.8	35.7	23.9
Hardee District	26.9	13.1	33.8	19.0	36.1	23.9
Nicholas County, WV	35.5	12.4	41.8	19.4	43.6	26.4
Hamilton District	28.8	7.7	36.9	16.7	39.9	25.4
Wyoming County, WV	31.4	10.8	35.5	17.5	41.8	22.5
District 1 District (2)	32.4	9.8	35.6	17.3	46.4	20.9
KENTUCKY	53.1	11.1	31.8	32.9	33.6	40.6
Letcher County, KY	37.9	6.7	27.8	17.8	32.9	25.6
Blackey Division	38.1	12.8	28.8	19.4	28.8	33.9

Source: U.S. Census Bureau, 1980, 1990, and 2000 STF3A

(1) The 1980 educational attainment levels for the North Elkin District were derived by calculating the average values for the Adkin, Elkhorn, and North Fork Districts.

(2) The 1980 and 1990 educational attainment levels for District 1 were derived by calculating the average values for the Barkers Ridge and Slab Fork Districts.

(3) High school is equivalent to completing 12 years of school and includes obtaining a high school diploma or equivalency. College includes completing 13 years or more of post high school level education and includes two and four year college programs, and graduate programs.

Table 9 - Workers 16 Years and Over by Place of Work - State and County Level

Case Study Place	Workers 16 Years and Over by Place of Work - County Level																	
	Worked in State of Residence																	
	Worked in County of Residence						Worked Outside County of Residence						Total		
	1980		1990		2000		1980		1990		2000		1980	1990	2000
	#	%	#	%	#	%	#	%	#	%	#	%			
WEST VIRGINIA	486,202	83.6	486,317	81.5	492,547	77.3	95,294	16.4	110,373	18.5	144,880	22.7	581,496	596,690	637,427
McDowell County, WV	9,392	93.2	5,524	86.2	4,311	82.3	684	6.8	882	13.8	924	17.7	10,076	6,406	5,235
North Elkin District (1)	2,191	90.6	1,077	75.4	980	73.7	226	9.4	351	24.6	350	26.3	2,417	1,428	1,330
Mingo County, WV	5,798	83.8	5,785	83.5	4,852	78.9	1,122	16.2	1,143	16.5	1,296	21.1	6,920	6,928	6,148
Hardee District	545	77.4	438	72.2	609	72.1	159	22.6	169	27.8	236	27.9	704	607	845
Nicholas County, WV	6,371	84.4	7,050	85.2	7,294	76.6	1,177	15.6	1,225	14.8	2,230	23.4	7,548	8,275	9,524
Hamilton District	752	88.5	787	86.4	817	76.5	98	11.5	124	13.6	251	23.5	850	911	1,068
Wyoming County, WV	7,134	79.2	4,809	69.3	4,641	64.2	1,871	20.8	2,126	30.7	2,591	35.8	9,005	6,935	7,232
District 1 District (2)	2,553	85.3	1,537	73.2	1,524	63.4	441	14.7	564	26.8	879	36.6	2,994	2,101	2,403
KENTUCKY	1,006,333	78.3	1,160,660	79.4			279,504	21.7	300,800	20.6			1,285,837	1,461,460	-
Letcher County, KY	5,552	79.6	5,661	80.9			1,424	20.4	1,333	19.1			6,976	6,994	-
Blackey Division	1,121	76.8	1,213	72.2			338	23.2	468	27.8			1,459	1,681	-

Case Study Place	Workers 16 Years and Over by Place of Work -State Level							
	Worked Outside State of Residence					Total		
	1980	1990	2000	Change (1980-1990)	Change (1990-2000)			
	%	%	%	%	%	1980	1990	2000
WEST VIRGINIA	6.5	9.5	11.2	3.0	1.8	622,013	659,136	718,106
McDowell County, WV	6.7	11.0	11.6	4.3	0.6	10,796	7,196	5,920
North Elkin District (1)	2.3	7.9	7.6	5.7	-0.3	2,473	1,551	1,440
Mingo County, WV	16.1	14.0	20.3	-2.0	6.3	8,244	8,057	7,712
Hardee District	21.7	14.7	19.5	-6.9	4.8	899	712	1,050
Nicholas County, WV	1.0	1.3	1.7	0.2	0.4	7,628	8,380	9,689
Hamilton District	1.7	2.5	2.2	0.7	-0.3	865	934	1,092
Wyoming County, WV	0.5	2.0	1.7	1.6	-0.3	9,050	7,080	7,359
District 1 District (2)	0.8	3.7	1.6	2.8	-2.1	3,019	2,181	2,442
KENTUCKY	5.6	6.7		1.1		1,361,732	1,565,711	
Letcher County, KY	1.6	5.5		3.8		7,093	7,400	
Blackey Division	1.0	1.5		0.6		1,473	1,707	

Sources: U.S. Census Bureau, 1980 and 1990, and 2000 SF3A

(1) 1980 place of work data for the North Elkin District was derived by totaling the place of work data enumerated for the Adkin, Elkhorn, and North Fork Districts.

(2) 1980 and 1990 place of work data for District 1 was derived by totaling the place of work data enumerated for the Barkers Ridge and Slab Fork Districts

Table 11 - Mining Employment Trends, Total Persons Employed Age 16 Years and Over

County	Total Mining Employment		Change	
	1980 (1)	1990 (2)	#	%
McDowell County, WV	7,601	1,497	(6,104)	(80.3)
Mingo County, WV	2,724	2,310	(414)	(15.2)
Nicholas County, WV	3,337	1,412	(1,925)	(57.7)
Wyoming County, WV	4,991	2,240	(2,751)	(55.1)
Letcher County, KY	2,517	2,582	65	2.6

Sources: (1) U.S. Bureau of Economic Analysis, REIS, 1980

Table 12 - Location Quotient Analysis

NAICS	Industry Sector	Place						
		McDowell Co.	Mingo Co.	Nicholas Co.	Wyoming Co.	West Virginia	Letcher Co.	Kentucky
		Number of Employees for Week Including March 12, 1999						
	TOTAL EMPLOYMENT	3,972	6,847	6,915	4,244	545,495	4,997	1,469,315
11	Agriculture, Forestry, Fishing, and Hunting	0-19	57	76	55	1,351	0-19	2,231
21	Mining	871	1,856	554	1,025	20,256	1000-2499	20,798
22	Utilities	59	20-99	20-99	55	8,320	0-19	10,496
23	Construction	20-99	310	331	272	28,257	228	81,996
31-33	Manufacturing	13	278	816	127	73,103	113	292,206
42	Wholesale Trade	105	199	232	58	22,398	412	72,525
44-45	Retail Trade	871	860	1,539	783	89,629	727	216,211
48-49	Transportation and Warehousing	143	818	427	236	14,305	325	66,537
51	Information	46	98	57	20-99	12,430	106	28,091
52	Finance and Insurance	161	240	171	113	21,920	151	61,430
53	Real Estate and Rental and Leasing	61	20-99	56	23	6,575	14	18,136
54	Professional, Scientific and Technical Services	94	210	241	80	19,091	174	50,705
55	Management of Companies and Enterprises	20-99	0-19	20-99	0-19	4,912	89	27,359
56	Administrative and Support and Waster Management and Remediation Services	20-99	410	148	200	23,196	23	75,212
61	Educational Services	0-19	20-99	-	0-19	9,008	-	24,041
62	Health Care and Social Assistance	1,052	810	1,236	653	100,330	737	199,385
71	Arts, Entertainment and Recreation	0-19	15	15	20-99	7,150	20-99	14,931
72	Accommodation and Food Services	100-249	272	573	290	51,441	343	129,217
81	Other Services (except Public Administration)	174	287	368	133	26,750	150	64,588
		Percent of Total Employment						
11	Agriculture, Forestry, Fishing, and Hunting	-	0.8	1.1	1.3	0.2	-	0.2
21	Mining	21.9	27.1	8.0	24.2	3.7	-	1.4
22	Utilities	1.5	-	-	1.3	1.5	-	0.7
23	Construction	-	4.5	4.8	6.4	5.2	4.6	5.6
31-33	Manufacturing	-	4.5	4.8	6.4	5.2	4.6	5.6
42	Wholesale Trade	0.3	4.1	11.8	3.0	13.4	2.3	19.9
44-45	Retail Trade	21.9	12.6	22.3	18.4	16.4	14.5	14.7
48-49	Transportation and Warehousing	3.6	11.9	6.2	5.6	2.6	6.5	4.5
51	Information	1.2	1.4	0.8	-	2.3	2.1	1.9
52	Finance and Insurance	4.1	3.5	2.5	2.7	4.0	3.0	4.2
53	Real Estate and Rental and Leasing	1.5	-	0.8	0.5	1.2	0.3	1.2
54	Professional, Scientific and Technical Services	2.4	3.1	3.5	1.9	3.5	3.5	3.5
55	Management of Companies and Enterprises	-	-	-	-	0.9	1.8	1.9
56	Administrative and Support and Waster Management and Remediation Services	-	6.0	2.1	4.7	4.3	0.5	5.1
61	Educational Services	-	-	-	-	1.7	-	1.6
62	Health Care and Social Assistance	26.5	11.8	17.9	15.4	18.4	14.7	13.6
71	Arts, Entertainment and Recreation	-	0.2	0.2	-	1.3	-	1.0
72	Accommodation and Food Services	-	4.0	8.3	6.8	9.4	6.9	8.8
81	Other Services (except Public Administration)	4.4	4.2	5.3	3.1	4.9	3.0	4.4
		Location Quotient						
11	Agriculture, Forestry, Fishing, and Hunting	-	3.4	4.4	5.2	1.0	-	1.0
21	Mining	5.9	7.3	2.2	6.5	1.0	-	1.0
22	Utilities	1.0	-	-	0.8	1.0	-	1.0
23	Construction	-	0.9	0.9	1.2	1.0	0.8	1.0
31-33	Manufacturing	-	0.9	0.9	1.2	1.0	0.8	1.0
42	Wholesale Trade	0.0	0.3	0.9	0.2	1.0	0.1	1.0
44-45	Retail Trade	1.3	0.8	1.4	1.1	1.0	1.0	1.0
48-49	Transportation and Warehousing	1.4	4.6	2.4	2.1	1.0	1.4	1.0
51	Information	0.5	0.6	0.4	-	1.0	1.1	1.0
52	Finance and Insurance	1.0	0.9	0.6	0.7	1.0	0.7	1.0
53	Real Estate and Rental and Leasing	1.3	-	0.7	0.4	1.0	0.2	1.0
54	Professional, Scientific and Technical Services	0.7	0.9	1.0	0.5	1.0	1.0	1.0
55	Management of Companies and Enterprises	-	-	-	-	1.0	1.0	1.0
56	Administrative and Support and Waster Management and Remediation Services	-	1.4	0.5	1.1	1.0	0.1	1.0
61	Educational Services	-	-	-	-	1.0	-	1.0
62	Health Care and Social Assistance	1.4	0.6	1.0	0.8	1.0	1.1	1.0
71	Arts, Entertainment and Recreation	-	0.2	0.2	-	1.0	-	1.0
72	Accommodation and Food Services	-	0.4	0.9	0.7	1.0	0.8	1.0
81	Other Services (except Public Administration)	0.9	0.9	1.1	0.6	1.0	0.7	1.0

Source: U.S. Census Bureau, County Business Patterns , 1999

Table 13 - Industry Sectors by Zip Code, 1997

Number of Establishments by Industry Sector and Zip Code							
SIC Code	Industry Sector	City Name, State, and Zip Code					
		Naugatuck, WV (25685)		Kyle, WV (24855)		Carcassonne, KY (41804)	
		No. of Establishments	Employee Size	No. of Establishments	Employee Size	No. of Establishments	Employee Size
000-039	Agricultural Services, Forestry, and Fishing	0	-	n/a	n/a	0	-
040-059	Mining	2	20-49 & 500-999	n/a	n/a	0	-
060-099	Construction	0	-	n/a	n/a	1	1-4
100-399	Manufacturing	0	-	n/a	n/a	0	-
400-499	Transportation and Public Utilities	0	-	n/a	n/a	1	1-4
400-579	Wholesale Trade	0	-	n/a	n/a	0	-
580-699	Retail Trade	2	10-19	n/a	n/a	1	1-4
700-720	Finance, Insurance and Real Estate	1	20-49	n/a	n/a	0	-
721-760	Services	0	-	n/a	n/a	1	1-4
900-939	Public Administration	0	-	n/a	n/a	0	-

Source: U.S. Census Bureau, County Business Patterns, 1997

Notes: n/a = U.S. Census Bureau's County Business Patterns database did not include the zip code 24855

Table 14 - Civilian Labor Force Trends for Persons 16 Years and Over

Case Study Area	Civilian Labor Force Status for Persons 16 Years and Over											
	Employed			Unemployed			Total Labor Force			Unemployment Rate		
	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
WEST VIRGINIA	689,461	671,085	732,673	63,615	71,142	58,021	753,076	742,227	790,694	9.2	10.6	7.3
McDowell County, WV	12,072	7,398	6,054	1,675	2,087	1,015	13,747	9,485	7,069	13.9	28.2	14.4
North Elkin District (1)	2,822	1,595	1,481	433	450	219	3,255	2,045	1,700	15.3	28.2	12.9
Mingo County, WV	9,362	8,396	8,046	1,060	1,541	974	10,422	9,937	9,020	11.3	18.4	10.8
Hardee District	830	757	1,093	82	173	92	912	930	1,185	9.9	22.9	7.8
Nicholas County, WV	8,492	8,575	9,883	1,118	1,359	821	9,610	9,934	10,704	13.2	15.8	7.7
Hamilton District	868	953	1,122	123	148	110	991	1,101	1,232	14.2	15.5	8.9
Wyoming County, WV	9,942	7,372	7,600	1,013	1,454	796	10,955	8,826	8,396	10.2	19.7	9.5
District 1 District (2)	3,377	2,297	2,500	418	462	255	3,795	2,759	2,755	12.4	20.1	9.3
KENTUCKY	1,531,000	1,563,960	1,798,264	133,000	124,354	109,350	1,664,000	1,688,314	1,907,614	8.7	8.0	5.7
Letcher County, KY	5,960	7,531	7,758	1,005	1,205	958	6,965	8,736	8,716	16.9	16.0	11.0
Blackey Division	1,631	1,728	50	304	326	2	1,935	2,054	52	18.6	18.9	3.8

Sources: U.S. Census Bureau, 1980 STF3A and 1990 SF3A

Notes: (1) 1980 civilian labor force values were calculated by adding the values enumerated for the Adkin, Elkhorn, and North Fork Districts.

(2) 1980 civilian labor force values were calculated by adding the values enumerated for the Barkers Ridge and Slab Fork Districts.

Table 15 - Per Capita Income Growth

Case Study Area	Census Reported 1979 Per Capita Income	Inflated 1979 Per Capita Income to 1989 Dollars (3)	Census Reported 1989 Per Capita Income	Inflated 1989 Per Capita Income to 1999 Dollars (4)	Census Reported 1999 Per Capita Income	Real Growth in Per Capita Income (Percent Change 1979 to 1989)	Real Growth in Per Capita Income (Percent Change 1989 to 1999)
UNITED STATES	$ 7,295	$ 12,460	$ 14,420	$ 20,736	$ 21,587	15.7	4.1
WEST VIRGINIA	$ 6,142	$ 10,490	$ 10,520	$ 15,128	$ 16,477	0.3	8.9
McDowell County, WV	$ 4,779	$ 8,162	$ 6,961	$ 10,010	$ 10,174	-14.7	1.6
North Elkin District (1)	$ 4,609	$ 7,872	$ 7,347	$ 10,565	$ 9,672	-6.7	-8.5
Mingo County, WV	$ 5,058	$ 8,639	$ 8,328	$ 11,976	$ 12,445	-3.6	3.9
Hardee District	$ 4,763	$ 8,135	$ 7,263	$ 10,444	$ 12,721	-10.7	21.8
Nicholas County, WV	$ 5,405	$ 9,232	$ 8,652	$ 12,442	$ 15,207	-6.3	22.2
Hamilton District	$ 4,450	$ 7,601	$ 7,498	$ 10,782	$ 15,241	-1.3	41.4
Wyoming County, WV	$ 5,467	$ 9,338	$ 8,268	$ 11,889	$ 14,220	-11.5	19.6
District 1 District (2)	$ 5,189	$ 8,862	$ 7,641	$ 10,988	$ 15,381	-13.8	40.0
KENTUCKY	$ 5,973	$ 10,202	$ 11,153	$ 16,038	$ 18,093	9.3	12.8
Letcher County, KY	$ 4,546	$ 7,765	$ 7,340	$ 10,555	$ 11,984	-5.5	13.5
Blackey Division	$ 3,928	$ 6,709	$ 6,928	$ 9,962	$ 11,279	3.3	13.2

Sources: U.S. Census Bureau, 1980 STF3A, 1990 SF3A, 2000 SF3A

(1) 1980 per capita income value for the North Elkin District was derived by averaging the 1980 per capita incomes for the Adkin, Elkhorn, and North Fork Districts.

(2) 1980 and 1990 per capita income values for District 1 were derived by averaging the 1980 and 1990 per capita income values for the Barkers Ridge and Slab Fork Districts.

Table 16 - Median Household Income Growth

Case Study Area	Census Reported 1979 Median Household Income	Inflated 1979 Median Household Income to 1989 Dollars (3)	Census Reported 1989 Median Household Income	Inflated 1989 Median Household Income to 1999 Dollars (4)	Census Reported 1999 Median Household Income	Real Growth in Median Household Income (Percent Change 1979-89)	Real Growth in Median Household Income (Percent Change 1989-99)
UNITED STATES	$ 16,841	$ 28,764	$ 30,056	$ 43,221	$ 41,994	4.5	-2.8
WEST VIRGINIA	$ 14,654	$ 25,029	$ 20,795	$ 29,903	$ 29,696	-16.9	-0.7
McDowell County, WV	$ 12,091	$ 20,651	$ 13,141	$ 18,897	$ 16,931	-36.4	-10.4
North Elkin District (1)	$ 12,652	$ 21,609	$ 14,933	$ 21,474	$ 17,204	-30.9	-19.9
Mingo County, WV	$ 12,541	$ 21,420	$ 16,066	$ 23,103	$ 21,347	-25.0	-7.6
Hardee District	$ 13,849	$ 23,654	$ 14,583	$ 20,970	$ 26,838	-38.3	28.0
Nicholas County, WV	$ 13,565	$ 23,169	$ 18,116	$ 26,051	$ 26,974	-21.8	3.5
Hamilton District	$ 11,353	$ 19,391	$ 16,969	$ 24,401	$ 27,417	-12.5	12.4
Wyoming County, WV	$ 15,870	$ 27,106	$ 17,248	$ 24,803	$ 23,932	-36.4	-3.5
District 1 District (2)	$ 14,924	$ 25,490	$ 15,873	$ 22,825	$ 24,152	-37.7	5.8
KENTUCKY	$ 13,965	$ 23,852	$ 22,534	$ 32,404	$ 33,672	-5.5	3.9
Letcher County, KY	$ 10,927	$ 18,663	$ 15,112	$ 21,731	$ 21,110	-19.0	-2.9
Blackey Division	$ 9,761	$ 16,672	$ 14,823	$ 21,315	$ 19,250	-11.1	-9.7

Sources: U.S. Census Bureau, 1980 STF3A, 1990 SF3A, 2000 SF3A

(1) 1980 per capita income value for the North Elkin District was derived by averaging the 1980 per capita incomes for the Adkin, Elkhorn, and North Fork Districts.

Table 17 - Median Family Income Growth

Case Study Area	Census Reported 1979 Median Family Income	Inflated 1979 Median Family Income to 1989 Dollars (3)	Census Reported 1989 Median Family Income	Inflated 1989 Median Family Income to 1999 Dollars (4)	Census Reported 1999 Median Family Income	Real Growth in Median Family Income (Percent Change 1979-89)	Real Growth in Median Family Income (Percent Change 1989-99)
UNITED STATES	$ 19,917	$ 34,018	$ 35,225	$ 50,654	$ 50,046	3.5	-1.2
WEST VIRGINIA	$ 17,309	$ 29,564	$ 25,603	$ 36,817	$ 36,484	-13.4	-0.9
McDowell County, WV	$ 14,124	$ 24,124	$ 15,756	$ 22,657	$ 20,496	-34.7	-9.5
North Elkin District (1)	$ 15,613	$ 26,667	$ 17,687	$ 25,434	$ 21,250	-33.7	-16.5
Mingo County, WV	$ 14,885	$ 25,423	$ 19,643	$ 28,247	$ 26,581	-22.7	-5.9
Hardee District	$ 15,339	$ 26,199	$ 17,390	$ 25,007	$ 31,765	-33.6	27.0
Nicholas County, WV	$ 15,397	$ 26,298	$ 21,390	$ 30,759	$ 32,074	-18.7	4.3
Hamilton District	$ 14,180	$ 24,219	$ 19,198	$ 27,607	$ 32,221	-20.7	16.7
Wyoming County, WV	$ 17,745	$ 30,308	$ 20,730	$ 29,810	$ 29,709	-31.6	-0.3
District 1 District (2)	$ 17,588	$ 30,040	$ 19,122	$ 27,497	$ 30,770	-36.3	11.9
KENTUCKY	$ 16,444	$ 28,086	$ 27,028	$ 38,866	$ 40,939	-3.8	5.3
Letcher County, KY	$ 12,702	$ 21,695	$ 18,229	$ 26,213	$ 24,869	-16.0	-5.1
Blackey Division	$ 10,856	$ 18,542	$ 18,459	$ 26,544	$ 20,625	-0.4	-22.3

Sources: U.S. Census Bureau, 1980 STF3A, 1990 SF3A, 2000 SF3A

(1) 1980 per capita income value for the North Elkin District was derived by averaging the 1980 per capita incomes for the Adkin, Elkhorn, and North Fork Districts.

Table 18 - Percent of Total Households Receiving Social Security Income

Case Study Place	Percent of Total Households Receiving Social Security in 1979	Percent of Total Households Receiving Social Security in 1989	Percent of Total Households Receiving Social Security in 1999
WEST VIRGINIA	32.0	34.4	33.9
McDowell County, WV	34.1	42.3	44.5
North Elkin District (1)	37.9	46.4	46.5
Mingo County, WV	34.3	34.3	39.2
Hardee District	39.0	29.9	34.9
Nicholas County, WV	31.5	34.6	36.5
Hamilton District	35.3	33.6	36.0
Wyoming County, WV	30.6	34.7	41.4
District 1 District (2)	31.0	38.8	42.2
KENTUCKY	28.5	28.9	28.5
Letcher County, KY	32.1	31.8	36.5
Blackey Division	30.2	30.1	34.9

Sources: U.S. Census Bureau, 1980, 1990, and 2000 STF3A

(1) 1979 Social Security income value for the North Elkin District was calculated using the values enumerated for the Adkin, Elkhorn, and North Fork Districts.

(2) 1979 and 1989 Social Security income values for District 1 were calculated using the values enumerated for the Barkers Ridge and Slab Fork Districts.

Table 19 - Percent of Total Households Receiving Public Assistance Income

Case Study Place	Percent of Total Households Receiving Public Assistance in 1979	Percent of Total Households Receiving Public Assistance in 1989	Percent of Total Households Receiving Public Assistance in 1999
WEST VIRGINIA	8.7	9.7	4.0
McDowell County, WV	15.7	19.7	9.8
North Elkin District (1)	13.7	15.5	10.0
Mingo County, WV	15.5	17.6	8.3
Hardee District	16.2	17.2	5.8
Nicholas County, WV	10.7	12.4	5.3
Hamilton District	12.4	16.4	5.4
Wyoming County, WV	10.3	14.3	7.3
District 1 District (2)	11.4	15.2	5.8
KENTUCKY	9.7	9.6	3.8
Letcher County, KY	14.0	13.9	8.2
Blackey Division	16.4	13.2	1.6

Sources: U.S. Census Bureau, 1980, 1990, and 2000 STF3A

(1) 1979 Social Security income value for the North Elkin District was calculated using the values enumerated for the Adkin, Elkhorn, and North Fork Districts.

(2) 1979 and 1989 Social Security income values for District 1 were calculated using the values enumerated for the Barkers Ridge and Slab Fork Districts.

Table 20 - Poverty Status Trends

Case Study Place	Percent of Persons for Whom Poverty Status is Determined		
	Income in 1979 Below Poverty Level	Income in 1989 Below Poverty Level	Income in 1999 Below Poverty Level
WEST VIRGINIA	14.1	19.7	17.9
McDowell County, WV	23.5	37.7	37.7
North Elkin District (1)	19.8	32.5	35.3
Mingo County, WV	23.6	30.9	29.7
Hardee District	20.8	33.6	27.9
Nicholas County, WV	16.7	24.4	19.2
Hamilton District	19.0	27.5	16.7
Wyoming County, WV	19.3	27.9	25.1
District 1 District (2)	20.5	29.1	21.7
KENTUCKY	17.6	19.0	15.8
Letcher County, KY	27.4	31.8	27.1
Blackey Division	30.3	33.6	24.3

Sources: U.S. Census Bureau, 1980, 1990, and 2000 STF3A

(1) 1980 poverty levels were derived by calculating the average of the values enumerated for the Adkin, Elkhorn, and North Fork Districts.

(2) 1980 poverty levels were derived by caculating the values enumerated for the Barkers Ridge and Slab Fork Districts.

Community Narratives:
Werth, Hamilton County Subdivision, Nicholas County, West Virginia

Community Narratives:
Kyle, North Elkin County Subdivision, McDowell County, West Virginia

Community Narratives:
Naugatuck, Hardee County Subdivision, Mingo County, West Virginia

Community Narratives:
Scarlet, Hardee County Subdivision, Mingo County, West Virginia

Community Narratives:
Carcassonne, Blackey County Subdivision, Letcher County, Kentucky

Community Narratives:
Superior Bottom, West Virginia

Community Narratives:
Blair, West Virginia

<u>Werth, West Virginia</u>

Werth, Hamilton District, Nicholas County, West Virginia

Werth, Hamilton District, Nicholas County, West Virginia

Existing Lumber Yard On Site of Ely Thomas Saw Mill

Abandoned Garages for Ely Thomas Employees

<u>Kyle, West Virginia</u>

Kyle, North Elkin District, McDowell County, West Virginia

Kyle, North Elkin District, McDowell County, West Virginia

Closed School Now Occasionally Used By Local Church

Homes Damaged Due to Recent Flooding

Kyle, North Elkin District, McDowell County, West Virginia

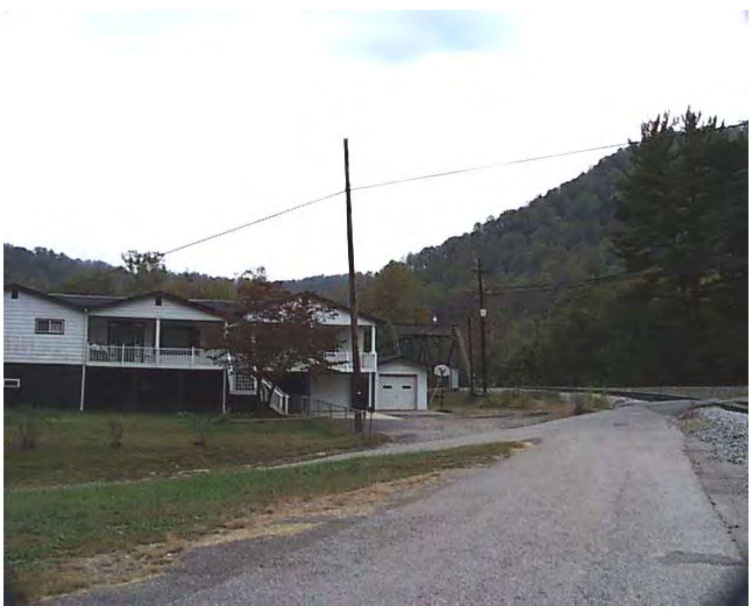
Homes Damaged Due to Recent Flooding

Kyle, North Elkin District, McDowell County, West Virginia

Naugatuck, West Virginia

Homes Adjacent to Railroad Tracks

Homes Adjacent to Railroad Tracks



Naugatuck, Hardee District, Mingo County, West Virginia

Commercial Area

Scarlet, West Virginia

Existing Community

Scarlet, Hardee District, Mingo County, West Virginia

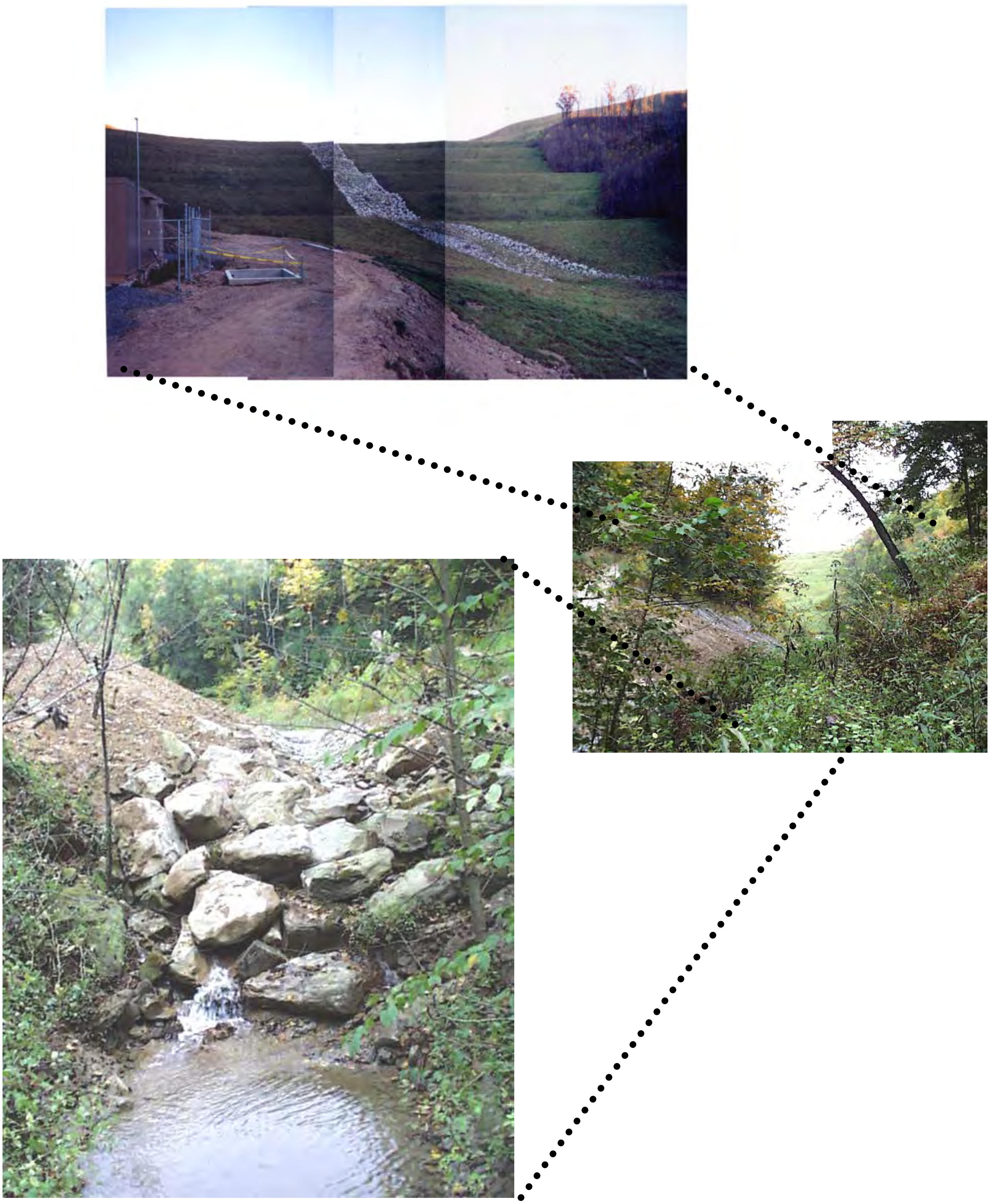
Abandoned Homes and Empty Lots

Scarlet, Hardee District, Mingo County, West Virginia

Abandoned Homes and Empty Lots

View of Valley Fill at End of Right Fork From Residence

Valley Fill at End of Right Fork



Scarlet, Hardee District, Mingo County, West Virginia

Abandoned Scarlet Plant Site

Scarlet, Hardee District, Mingo County, West Virginia

Adjacent Surface Mine Site Photos:

On Going Mining

Scarlet, Hardee District, Mingo County, West Virginia

Adjacent Surface Mine Site Photos:

On Going Mining

Reclaimed Lands

Scarlet, Hardee District, Mingo County, West Virginia

Adjacent Surface Mine Site Photos:
Industrial Park

Scarlet, Hardee District, Mingo County, West Virginia

Adjacent Surface Mine Site Photos:

Reclaimed Lands

Scarlet, Hardee District, Mingo County, West Virginia

Carcassonne, Kentucky

Carcassonne, Blackey District, Letcher County, Kentucky

Empty Lots:

Empty Lots:

<u>Superior Bottom, West Virginia</u>

Bridge into Superior Bottom Named for Local Resident

Superior Bottom, West Virginia

Closed School

Superior Bottom, West Virginia

Blair, West Virginia

Sharples School – Now Closed

Empty Lots:

Empty Lots:

Study Area Photos

Blast Warning Sign

Coal Mac Mining Company

Delbarton Historic Arched Bridge

Delbarton Public School

Delbarton,WV Public Water Installation

Abandoned Home in Scarlet, WV

Mine Entrance Signs

Duncan Fork, WV - Water Tank For Residence

[Additional Scarlet, WV Interview To Be Inserted]

[Additional Scarlet, WV Interview To Be Inserted]

[Additional Superior Bottom, WV Interview To Be Inserted]

MTM/VF EIS

Community Narrative: Blair, West Virginia

Interviewer: Um tell me a little bit about how you and your wife and your family came to live in the Blair area.

Resident: I was born here.

Interviewer: You were born here…

Resident: Yeah.

Interviewer: So your family lives here, and…

Resident: Right, my dad brought this, he just owned just about all this holler, in 1935.

Interview: Uh huh.

Resident: And uh I was born about a mile up the other holler over here and we moved here when I was about 6 months old. I lived here ever since.

Interviewer: Uh huh.

Resident: She lived over in Man, and I met her and brought her over here.

Interviewer: Uh huh, uh huh… What would you say growing up here and and in the time you lived here before the surface mining came in, what was it about this community that you liked, that you enjoyed?

Resident: Well, the people. We had, we had a pretty nice people. We had a few outlaws too, but ah the majority of the people were nice people. It's a nice community, and a lot of them just moved away. And a lot of them sorry that they moved, after they moved, but once you sell out, you can't get back.

Interviewer: So the people who were in the community, what's one of the best things for you?

Resident: Yeah, it's a quiet community, you know, we don't have…. very little ah problems. We have a few, but it's a nice place to live.

Interviewer: Uh huh. And where did a where did you work for example?

Resident: I worked for Sharples Coal.

Interviewer: Doing underground mining or surface mining or…?

Resident: Well, I worked inside for about two years and the rest of it was outside on the tipple - preparation plant.

Interviewer: Uh huh. So were you working for the company that was close by?

Resident: Yeah, they the ones that mountaintopped… they wasn't mountain topping when I was there, but maybe they stripped. But they didn't mountaintop.

Interviewer: Uh huh.

Resident: Most of it was deep mining.

Interviewer: Uh huh. And that was really the only job you've had, you've always worked for them?

Resident: No, I worked old Logan. I worked a 13 years over there and I worked for ah… started out at a car lot. I washed cars for a living.… Worked for a wholesale house, sold groceries, wholesale groceries. And I worked for another wholesale house after that, and then I worked for loading concrete. I sold concrete cinderblocks, and then I got a job at the mine. And I finished there. I had 27 years.

Interviewer: Uh huh. So about when did you start working for the mining company?

Resident: Uh 1968.

Interviewer: In '68?

Resident: Yeah.

Interviewer: And why did you, what what prompted you to take that job?
Was it you were looking for a new one you wanted a different one?

Resident: Money.

Interviewer: Money.

Resident: They paid the best wages.

Interviewer: Uh huh.

Resident II: Tell them what you were making before.

Resident: I was making $2 an hour when I went to a Sharples Coal. And I went down there I was making a probably about $4 an hour, and then they went up. When I quit I was making over about $116 a day.

Interviewer: Uh huh.

Resident: Save matters a quarter. But ah these place I worked, I know Logan, they didn't pay much. You just survived, that's about all you could say.

Interviewer: So, when did the surface mining start in Blair?

Resident: Ahh… probably about '95 somewhere around '95. I quit work in '94 and they was just getting started then. But they didn't get up to Blair 'til probably about '95–'96.

Interviewer: Uh huh. So, you never worked for this company while they were mining right here? Mountaintop mining?

Resident: No. Not mountaintopping. It was Ashland Coal when I worked for 'em. They sold out to Arch Mineral. I guess that's who owns 'em now is Arch.

Interviewer: Did you notice… Did you notice any changes in the community when the surface mining came in?

Resident: Oh sure.

Interviewer: Can you describe some of those to me?

Resident: Well, are you talking 'bout the environmentalist or just the people leaving or what?

Interviewer: Any of the changes you want to talk about.

Resident: They got to buy out your neighbors, you know, they'd had to move and ah…

Interviewer: The population left…

Resident: Yeah, and they would think they would be getting a good price for their houses, because when then brought their houses they didn't pay a whole lot for it. But when they go try to buy one somewhere else, they usually have to go in debt, most of them.

Resident II: They had have lived here for years.

Resident: Yeah,

Resident II: And they didn't realize what the company was giving them wasn't worth what they needed to…

Resident: A lot of them was just like me, they were born and raised here. And then you talk about the environment - we had put up with dust. When they put off a shot, they'd be up back the holler up here, and dust would roll down this holler. And ah, we haven't had a flood since they done all this. Back when they stripped back in the early '70s, they stripped around to the head of this holler and we had floods back then. And it would rain, and you'd be sittin on the front porch and you can hear that water coming down the holler. It would all come down at one time. And we hadn't had any of that, no floods, since they've done this mountaintop. And I don't know what's gonna happen. And it worries me, but a I don't dwell on it a whole lot. But I don't know what's gonna happen

Interviewer: Uh huh.

Resident: But ah, we ah, I called ah the Environmental Protection Agency one time about the dust come down the holler. And my brother had just washed his truck and it was sitting down here in the driveway. And he had a black Ford truck. And they came over here and he actually wiped dust of my brother's truck. Um, he wrote me a letter after he filled out his report and said there wasn't enough evidence to prove that ah they had broke the law. But they was one of the men riding over in a helicopter when that happened, and he seen it and he made 'em file for it. And that goes to tell you something that some of these people are being bought off. Because you know good and well you can't wipe dust of a man's vehicle - something's wrong. And another thing, they ruined our well water. I use to have a water softener on it and it took care of the rust. And it got to where it didn't take care of it, but now our water stinks, it smells. It's sulfur water, I guess, what it is and we don't use it other than to just flush the commode or take a bath. We don't bath in it unless we have to. And I go way up the holler to get water which comes out of the mountain to drink and to cook with, but they ruin our well water.

Interviewer: So, you said your brother filed a complaint about the dust?

Resident: I'm the one filed the complaint.

Interviewer: You filed the complaint?

Resident: My brother's truck was setting out there and he, and they wiped the dust off his truck.

Interviewer: Did you ever talk to them about any of the other things, such as the water?

Resident: Oh yeah, yeah we talked to them about it, but…

Resident II: They came up here and said to clean the well…

Resident: They wanted me to clean my well out. Said clean your well out, that's what they told me. I took, I took three samples to a meeting we had down at the school about our water. I took one over the weekend you know when they wasn't doing no blasting, and it looked fairly good. And I took one after they started blasting, and I showed it to 'em. And they didn't think what I was showing them was actual truth. They made fun of me, really, and I got it right of my spigot.

Interviewer II: And you reported that to the state department?

Resident: Oh yeah, we had a meeting down at the school, use to have environmental meeting down there. And when we first had that meeting, I asked the man, that was environmentalist man, I asked him, "What is it that you all protect?" They said, "Well, we protect against the water, protect against the air, and we protect the community." And when we got through everybody start questioning him, come to find out they was protecting nothing, he wasn't. He said that would be under another department. They put it off on somebody else on every case.

Interviewer: Uh huh.

Resident: And we didn't get a thing out of it, what we was trying to get done.

Female Interviewer: So, you never got any response about your water?

Resident: Oh no. Another man came here a while back, oh it's been…

Resident II: That's about… I think, last part of last summer.

Resident: It wouldn't be that long.

Resident II: Yes it has.

Resident: Well, he come here and he got like he was going to put us a water system in here. And ah, I was glad when he told us. I said I'll believe it when I see it. But ah, we never heard anything about that.

Resident II: It goes on 24 hours a day.

Resident: Yeah, you hear things a clanging and banging back in here ah… they'd let off shots, most of those were early in the morning or late in the evening, the shots were. They'd rattle your house, your windows would shake, your pictures rattled.

Interviewer: Was there any warning, for the shots?

Resident: Well, we couldn't hear 'em. They'd put off warnings back there on the hill, but we couldn't hear them down here.

Resident II: There were three, three horn blasts before…

Resident: Did you even hear one?

Resident II: Before the shots go off.

Resident: No, they send us letters, you know.

Resident II: We're so far away, that when the horn blasts… It's hard to hear, but when the dynamite blew you could hear that.

Resident: See, they got a dam up the holler, a run-off pond is what it's called, and I don't know what's gonna ever happen to that. They told, the environmentalist told me that when they quit they'd tear that dam out, but they ain't tore it out. It's still up there. They came down the other day, and that boy lives up the holler here said they came down and cleaned it out. That's the first time I know of them to clean it out.

Female Interviewer: Now you think that was the state or that was someone from the mining company?

Resident: That was the mining company cleaned it.

Female Interviewer: Did the mining company ever talk to you, like come around and discuss with you what was going on, or ask you if there was damage? Work with you in any way, like that?

Resident: They came here and done a pre-blast survey on my house. I called 'em, had to do that. They haven't been back since then. But I can't, I can't say that they damaged my house, other than the dust, you know, but they damaged my water.

Interviewer: Did you ever ask to have regular samples taken from the water or anything like that?

Resident: Well ah, that man that came here he took samples of my water.

Interviewer: The man that came here?

Resident: And the environmentalist that came and done the pre-blast, he took samples of my water, my water wasn't that bad when they done that.

Interviewer: Right.

Resident: Just got worst after that, they did come back two days more, By the third coming, took two samples. He said now you put water in here, and now he was mad then.

Resident II: And we haven't heard from him.

Resident: Yeah, and that ain't been to long.

Interviewer: And who do you think he worked for?

Resident: He worked for some contractor now didn't he?

Interviewer: So he was…

Resident: But he was something to do with the state now, but I don't know what it was.

Resident II: They ran a waterline from Madison, I don't know were it started at…

Resident: Elk River from what I understood, the waterline that comes through Sharples to Clothier and the Boone County line.

Resident II: And the people is hooking up on that waterline, but it didn't come through Sharples.

Resident: Well, Sharples already had a water system.

Resident II: I don't know how far up the road they did come.

Resident: They came to the Clothier line, the Boone County line.

Resident II: He may have been passing out information, because of that, I don't know.

Resident: See this… this use to be a big community, I mean there was probably about 300 hundred families that owned their home. Now I bet there's 65 that own their homes. There's a few more that the company has rented their houses out they bought, but there's about 65 families that own their property. And they'd like to buy all us out but we don't wanna sell.

Interviewer: When did that shift happen? When did it go from 300 to 65?

Resident: Well, a probably when they started buying they wasn't quite 300. They was probably… I think they said they was gonna buy 200 and some houses when they first started buying. And that way they included everybody. See it had already dropped down some then, but ah… I've got a picture if you'd like to see of Blair back in 1927. That's was before they even started this strip mining, that was back when it was a mining community.

Interviewer: Underground mining and that who people worked for, underground mining company?

Resident: Yeah, but you can see what kind of community it was then. It was a big community.

Interviewer: When the surface mining came in, in your experience did a lot of people go to work for them, from Blair and Sharples area?

Resident: Not from Blair, no.

Interviewer: No?

Resident: A whole lot of them came here from other places. Lot of 'em bringing in contractors and I was already working there then.

Interviewer: Was um… you talked a lot about some of the physical, environmental changes when the mining started, was there changes to the community like the schools were impacted or things of that nature?

Resident: We don't have no schools. These days, when they buy these out, the kids leave. And we didn't have no kids, so they closed the schools down. And they, what kids you have now, some of them I think goes Madison, some to Chapmanville. My baby girl graduated from Chapmanville, what, she go there two years?

Resident II: One year.

Resident: In her last year at Chapmanville.

Resident II: Madison? Something…

Resident: That was about the only thing that the communities like Sharples, Clothier and Blair had that we got together on. Was the schools, you know. And ah, so they got them closed down and ah we had no communication now what so ever with other communities.

Resident II: When you loose your schools in a community, you have no reason to have a community.

Resident: There was at one time we had five grocery stores. We had three service stations, now we don't have… All we got in businesses is a barber shop and a post office. That's all we got. We want to buy a loaf of bread we got to drive to Boone County line, or to Logan.

Interviewer: So the businesses are gone. Tell me a little bit more also about what you meant by when the school was closed down, the community….how did you phrase it… doesn't have a reason?

Resident II: The community is no community anymore. Children is what makes families. And if children ain't around in the community, they're going somewhere else. Then the family don't have no reason to get together for any reason. Families… in this community, in Sharples, when the children done something, mommies and daddies was there. When they played ball mommies and daddies was there. When they had Halloween parties, mommies and daddies was there. When they had any kind of a get together, mommies and daddies was there. They had mothers to do… mothers got together to do things with the children. We don't have that no more!

Resident: We, we live in an isolated area.

Resident II: Yeah.

Resident: From the top of Blair mountain, the Logan County politicians wait's 'till Boone County's election time. We can't get much from Logan until election time, then we get a little bit. And ah, from Boone County, see on up this way from Clothier that's Boone County out that way, so we don't get anything from Boone County. We tried to secede to Boone County, but it didn't go through. But ah, we have always been treated as red headed stepchild (ha ha), but ah the politicians has never done anything for us *until* election time. They come over and pat you on the back, and the people they give a little money go. And all the people they'll get out and campaign for 'em.

Resident II: There was Board of Education members that we had voted for because they had it exed on the ballot that they wouldn't vote for it – "We will not close, vote to close your schools."

Resident: They was considering to drive… that they had to take the kids the whole way to the Chapmanville. And they was considered going across Blair mountain, but they said they wouldn't go that way. But ah they did say they would never vote to close the school down, but when it come time to vote they voted and did it.

Resident II: They told us a bare face lie.

Resident: The pressure was probably put on from the State, you know, the State come in here and took over ah the board

Resident II: I'm the type of person that if I give somebody my word, I'm gonna stick to my word.

Resident: Well, he's a politician though you know politicians like to lie (ha ha). They don't like to, but they do (ha ha).

Resident II: I couldn't do that. I'm not that kind of person. "Specific name" was one of them.

Interviewer: Where there other community resources that closed down, ah churches? You said the post office is still here.

Resident: Yeah, and what did you want to know?

Interviewer: Churches, were there any churches, or libraries or any public…

Resident: No, there wasn't no library. I don't think any churches are closed yet but some of them don't meet very often.

Resident II: The Blair, the Baptist down here.

Resident: They met Sunday.

Resident II: Did they?

Resident: Yeah, they don't meet very often. But they have but about six members.

Resident II: Our property…

Resident: We came down here Church of Christ and we have ah 18 members. And ah, we use to have about 43. A lot of them have moved away, and some of them passed away. And you don't have much to work with, 'cause we're so small. But were surviving

Resident II: That land that the church property is on is on loan from the coal company. We need that.

Resident: Well, the deal was as long as they didn't need the property we could use it. That was the deed or the lease or whatever they got from them. But if they ever decide they want it, they give us a 90 day notice and we gotta move the structure. But we couldn't move it.

Interviewer: So, you'd lose the church if they decided they wanted it that land…

Resident: Right.

Interviewer: What is the community like here now with the homes and the families that are left?

Resident II: It's not the same community.

Resident: Well, I can't say it's a bad community, but there's just not many of us.

Resident II: So few of us left.

Resident: There's nothing to get us together. I mean you take you got the four churches here in Blair, and they don't never associate with one another. So, we don't get together for that reason, so there's nothing like school or anything like that to get us together. Every now and then somebody will have a baby shower or household shower or something and some of the women will get together… (The phone rings, Resident is speaking to someone on the phone)

Pause in tape.

Interviewer: Ah lets see, where were we???

Resident: You asked about the community I believe… Our community is ah it's small, but everybody just about knows everybody. We got a few people here in Blair, that we don't get acquainted with yet, that moved into company houses, not lived here very long. And ah, but the ones that's lived here along time, all of them are mostly good people. And ah were just not as big as we use to be. And we don't have anything to get us together, you know, like a community gathering. Every Memorial Day, they have a memorial get together, ah that's about the only time that the community… The people come here, you know, that's moved away for that, and that's about the only thing we had to get together on. Or unless it's a wake or something, somebody died. That's what wakes are, they're just reunions. (ha, ha)

Interviewer: Of the people who still live down here, are there some family? Is… how would you describe sort of the future of this community?

Resident: I believe it will finally vanish. It won't be any, if the coal company has anything to do with it. See they're wanting to go underneath us and get coal, they want the long wall. I don't know if you know anything about long wall mining or not… you know what happens when they long wall? Well they want to get us out of here, because if our property sinks, they know we're gonna sue. 'Course it's hard to get anything out of 'em. But ah they'll eventually, I'd say, get us all.

Interviewer: Tell me a little bit about how the company approached the community from your experience about buying out, you said 200 some homes?

Resident: The way I understood it, is the people called them. They was thinking they was getting a big price you know, for their property. Well let me give you an example: Man brought a piece of property right down here, below this house right there, he paid $18,000 for that piece of property, an it was an old house. The coal company, ah he called them, and they made him a deal - give him $24,000. So he said, "I'm making $6,000." Well my brother told him, he said "Well you go buy you a place for $24,000." And he went and moved over round Madison or somewhere over in there. He come back and told my brother, he said, "Well," he said, "You was right, you can't find nothing for that price." So you see he didn't help his self any, that's what happens to a lot of them. They're think there getting, you know a good price until they go try to buy something.

Interviewer: And you think they approached the company, to buy out because…

Resident: Most of them did. Now some of them, maybe the company might of came to them but ah, most of them would call the company and make a deal with the company.

Interviewer: And you think that was because they didn't want to live with the impact that was going on?

Resident: That's was part of it. They didn't want to live with the problems that was gonna be caused. They wanted to get out.

Interviewer: And the other part?

Resident: Oh, the other part… They thought they was getting a good deal for their property and they didn't pay that much for it. Thought he was making a profit just like that fella, he thought he was making a profit until he went to buy something some where else, and found out he, he wasn't getting a good deal. And another thing too, the people, other people would sell for and get a bigger price that what he did, and he'd hear about it, and it'd make you feel bad.

Interviewer: So did that cause tensions in the community?

Resident: Well, not between the community, but it did between who sold out to the company. They'd get made because they didn't get as much as somebody else got.

Interviewer: So they're mad at the company and not their neighbors.

Resident: Right, right. I don't think there was any problem between the community, as far as people selling out. I hate to see them go, but that was their choice.

Interviewer: Can you tell me a little bit about your decision not to move?

Resident: Well I didn't want to! I like this place, and I was born and raised here. I'm not saying I won't go. It may get so bad I might have to, but I don't want to. I don't believe I'd be satisfied anywhere else. I've looked around, looked at property and it's outrageous. I said if I had to go, I said they're gonna buy me a place. I'm not gonna go in debt. This is paid for - I don't owe a dime on it. I own this place and that place up there, those hills. If I go somewhere, their gonna buy me a place. I'm not gonna go in debt. So I don't know. I'm not gonna say I wont go, but I don't want to.

Interviewer: Have you had any interactions with someone from the company or an agent, about that possibility?

Resident: Selling out?

Interviewer: Uh huh

Resident: No, now they came in here… We own 27 acres of this hillside here. And the coal company, ah sold the timber, and they told them that they owned all the way down here behind our house. And the reason they done that there, was a the man that lives up the holler, my dad sold some property to. And he kept 27 acres, but that lawyer, their lawyer up the holler here corrected the deed. They done correct the deed and gave him 27 acres of our property. So, we didn't know nothing about that. So when the coal company come in here, or the logging company, they got to cutting our timber. And we got out there and told them they was cutting our timber. And they said no, he said, that belongs to the coal company, so we got into a lawsuit with the coal company over them cutting our timber, you know. And they finally realized that they had made a mistake so we got $15,000 for the timber they cut. We could have got more if we would of went to court, but it would of took years. So, we decided to settle out of court for $15,000. And they also made a property line, surveyed it made a property line, where our line is. But that's the only deal, the only problem that we had, with the coal company as far as them trying to take our property, or anything.

Interviewer: Have they never approached you about purchasing that 27 acres that you know?

Resident: No, no. They never, they never come to us ask us about selling out or anything. I guess they know we don't want to sell. We let it known to the community that we don't want to sell. See my brother lives there, and I live here, and my sister lives… I own this up here and she lives in that one. And ah Daddy left us, every one, a piece of property. My son and my sister lives up here. She had a piece property and above that, and she deed that to my son. And he owns it now. Then another one of my sisters owns a piece of property right above the home place here, but she sold hers. It's been sold three or four times, and finally they sold to the coal company. And ah, so we own this property and these heir ships. The hillside is heir ship, and we just don't want to sell. Don't want to go.

Interviewer: So you enjoy living here and, and the ties to the land that your family has? Is that why?

Resident: Right, right, it's not… it's a good community, I lived here all my live, I can't imagine living somewhere else, I might have to one of these day, I don't know.

Interviewer: Did you have any other ah, interactions with the company, or, or an agent of the company about what kind of mining they were going to be doing, or before they came in?

Resident: They don't tell you anything. That's one problem the community has, is they don't never let the community know what there going to do. See if they'd come in here and told, you know, what there going to do, there might have been more people that would have sold out. I don't know.

But they *still* haven't told nobody what there going to do. But we understand, and know that there going to go underneath us. They got two seams of coal down there, that they're wanting to get and they want to long wall. See, they're already coming this way, from over Danville, well actually Dehue and that way. And if Sharples gets back open back up ________________ they're going to come this way. They're going to get all this coal underneath.

Interviewer: So you've got one on the other side of you?

Resident: Well this ones not operating now, but that one over yonder is. That one over yonder is Massey and this is Arch. I don't know if I would want to buy it with all that coal and all that water Kelly's got in it. Westmoreland, Sharples, they went in to Cedar Grove, and flooded it out. Caused an explosion.

Interviewer: Those are underground minds that are flooded out?

Resident: Right. Up here, up Kelly holler here, where that mine use to be up there, see they came in from Amhurst. That all collects together back to Amhurst and the water runs out of the ground at the side of the holler up here just comes right up out the ground, from the pressure. And all that mine is filled with water. You got Westmoreland, then over this way, that comes back in towards us all that full of water. Then Sharples, go down beneath that, I'd been scared death to go in there. That water breaks through – you ain't got a chance.

Interviewer: Did you ever see information printed about what kind of permit activity or anything like that?

Resident: They put the permit's that they applied for, and they permit… when they get them in the paper. But most people don't understand those permit's, you know, where it is at or anything like that. They just see a map in there and they don't even no where it's at.

Resident II: We have at Orange Cove was suppose to have gotten a permit, for Sharples now. And if they did and when they do, they'll go across the road toward Dehue.

Resident: That's the big permit that they've had trouble over, she's takin about… Going across through… Pigeonroost, White Oak and all up through yonder. I've heard that they got part of that, but they ain't got it all now.

Interviewer: So none of that is something that you read about… or permit in the paper, that's just what you've heard through the community?

Resident II: From other sources, people in the community talk about….

Resident: You'll hear every now and then, they're going to start back up about two weeks down here. But they ain't started up yet.

Female Interviewer: Did they put the ah, permit information that's in the paper, is it in the local paper?

Resident: Yeah, the Logan Banner.

Interviewer: Logan Banner.

Interviewer: And is it… do people not understand it because it's… the way they talk about it or the maps not legible, or they are?

Resident: Some of them just don't know how to read that map.

Interviewer: Okay.

Resident: It's written down. Well the permit's are written down, but people still don't understand where they're at.

Interviewer: The maps are clear, they just don't necessarily no what they mean.

Resident: Right. Now the ones that understand it are the ones that fights against it. 'Cause they know where it's at. But ah, it's hard to fight against the coal company, and win.

Resident II: Down in West Virginia the coal company has the power. In West Virginia, the coal company is the power.

Resident: The coal is king as they say, in West Virginia.

Resident II: And the little man don't have a chance. They decide they want a piece of property their gonna get it.

Resident: Where do you live?

Female Interviewer: We're from the Philadelphia area.

Resident: Philadelphia… they mine up there too don't they?

Female Interviewer: They definitely do some mining in central Pennsylvania.

Resident: Are they mountaintopping?

Interviewer: Not much mountaintop…

Interviewer II: They use to do a lot of deep mining, but that's pretty much done.

Resident II: That's what they did here for years and years, and years is deep mining.

Resident: West Virginia, they found out it's a lot cheaper to start at the top and take the mountain down to the coal. 'Cause they get three inches of coal, if they grind into three inches of coal, they get that too. They don't waste anything but that don't care what there doing to the environment. They just throw it over the hill and fill up a holler. We got a holler up here that use that be fork up here, one holler to the right, and one to the left, and they filled the one to the right so full it ain't no holler there no more.

Resident II: When they take the hilltop off to get the coal, they don't need as many workers either…

Resident: No, it takes less men…

Resident II: So that puts men out of work. And that all most people here was doing, knows, was coal mining, in these small communities.

Resident: You all come across Blair Mountain?

Interviewer: Uh huh.

Resident II: Did you all see some garbage over there?

Interviewer: I did, along side of the road.

Resident: Yeah.

Resident II: That's another problem we have.

Resident: I don't know why the, you talk about you're an environmentalist, why can't you stop and look at that and see if you can find a name in it? I thought about doing it but hell, I said if I do somebody come along catch me and think I was gonna put it out. They'll fine me.

Resident II: When this started out here in all the houses up this holler was gone except for "Specific name" and then ours, people come up here and put garbage up our holler.

Resident: Yep, the magazine up there had their name on it. The fella that lives above me up here, he called 'em, and he told'em he done it. And he brought his garbage up there and dumped it out.

Resident II: They had come to the conclusion that ain't nobody around here, so why don't we make a garbage dump out of this place.

Resident: That's what there gonna do bring out… look like they just bring there garbage. They ought at least throw it over the hill, where people can't see it. They just throw it out the side of the road.

Interviewer: And that's people who don't want to pay, or, or maybe can't pay, don't wanna pay for someone to come take it away?

Resident: I don't know what it is.

Resident II: If I couldn't afford to pay, I would take it to the town and put it in the garbage bin somewhere in the town.

Interviewer: Ah huh.

Resident II: I mean, that's better then throwing it side the road. 'Cause we had one down here at the mouth of holler, and other people had put their stuff in our bin.

Resident: I'll tell you what, they done to us one time… We ah, they found a piece of paper on Blair Mountain where it had her name on it, and they called her and was gonna want her to bring it where she pays for garbage. And she called them and told them, she said, "Now listen….I don't like to see this littering, and I don't litter." She said, "Now that might of blown out of my car, I don't know." But they was wanting to fine us, just because they found a piece of paper. Now you look at the garbage long the road and they don't do a thing about that.

Resident II: I put ah, we have plastic bags in our car, and we put our garbage in the plastic bag in our car.

Resident: Yeah, we put garbage bags in the car.

Resident II: So, that just the messing the road up and the territory up.

Resident: The scenery, I hate to see that garbage along the road.

Interviewer: Well like you said, that their bringing it in here where you live too, 'cause they think no one lives there.

Resident II: He's got a nephew that lives up Kelley… tell um that story.

Resident: Yeah, there was a fella, he was a contractor from over on the Man side, Buffalo Creek side, somewhere, and they worked on somebody's roof. And the old shingles that they took off, they brought them up the holler up here, and dumped them. And my nephew and his wife, they found out he done it, and they called…

Resident II: They found a piece of paper where they…

Resident: Yeah, …paid for the stuff that they had worked with. So, they called 'em, and they found out through that who done it. And they called this fella and told him that they'd give him 24 hours to come and clean that up or they were gonna call, whoever they call and ask them to come over right a way. And he said, "I paid my brother to do this job, and I paid him to haul that to a garbage dump." And he said, "He brought it up there." So, he got another on of my nephews had a little ole end loader, and he hired him to load it up. And they hauled it off. But that's the way they do. It's ridiculous. You know, must garbage trucks will pick up about any garbage they pick up old washing machines, things like that. But about all people just haul off and throw 'em upside the road somewhere.

Resident II: It's really not that much. Is it $24 for a month for a large one?

Resident: For what?

Resident II: Like for our garbage thing down here? We paid how much?

Resident: About $12.

Resident II: $12, for a month. That ain't bad. And there's three of us that put our garbage in there.

Resident: There is more than than….

Resident II: Yeah, I know there are. I know.

Resident: Yeah… they're not supposed to… I've never caught any body, but I know there is people who do it.

Interviewer: What about the homes that were bought-out, what happen to them, where they?

Resident: They were tore down,

Resident II: Torn down.

Resident: Most of them, now if there's a real nice home I don't know where you noticed the one, you come off Blair mountain? They bought that one, and that's a nice one - haven't been built to long. And they kept that one. And there's a few more like that, that's kinda new. And they kept 'em and rented. They just cost you about $100 a month to rent. That's a pretty good price for rent. Some of them may be a little more, I don't know, but they said were those that way they rented them out instead of tearing them down.

Resident II: That was another thing we had round here, there was homes burning…. They just leave it a mess.

Resident: A mess.

Interviewer: They didn't haul the refuge?

Resident: Well, they didn't until the people got to complaining about it, and then uh the environmental Protection Agency, I guess, came in and got on the coal company, made 'em clean it up. But uh, it wouldn't be long after somebody moved out of one - it burned. We always figured the coal company hired somebody to set it on fire, to get rid of it probably. Cheaper to burn them than it was to tear 'em down.

Interviewer: Well, I think that pretty much covers all the questions that I wanted to ask you. Uh, did we talk about the, in terms of the coal mining industry being here in the holler, where there any benefit's that you saw? I know you said a few people were hired by the company to work there, uh were there any other benefit's?

Resident: Well, they paid good wages to the ones who worked there. Uh coal is a good occupation. It's kinda dangerous, but uh, it pays good wages, got good benefit's, if you could get a job. I tried to get a job down Sharples for ah, probably about 12 years, before I even got on down there. One fella told me, he said, "You the next fella I'm gonna hire." He lost his job, pretty good while after, he lost his job, and I didn't get the job. But there's a boy I was raised with, his brother-in-law got to be Superintendent, and we had little league baseball, and I was manager of the little league team. And he ask me, he said "Specific name, say, why don't you get a job in the coal mining?" I said, "Man, they wont hire me." So he talked to his brother-in-law, and his brother-in-law said, "You want work?" I said, "Well give me a job and see," and they gave me a job, that way - little league baseball. And I worked 27 years for them. But it's hard to get on, you gotta have somebody to pull for you. Just take somebody in the community, that's got nobody that works there, or you don't know anybody, you just can't get on. It's kinda like a family thing.

Interviewer: So you think there are jobs there, but their hiring from other places?

Resident: Oh yeah, they'd rather hire strangers than hire someone from the community.

Resident II: We know they do… was my son, that could have got hired for a job and These others got the job.

Resident: Well, what it was, they got to hiring these young boys, and 'sow and plow' - hire them to cut weeds or something like that. And if they liked them, they'd move them up, but if they didn't like them, they'd get rid of them. Well, my son, I got him a job, cutting weeds. He moved up into the warehouse, and this is still a salaried job. And two of the boss's, boys was hired after my son, and they moved them up into the union. My son he got so aggravated, he just quit. And I told him, I said "Son, you gotta be patient."

Resident II: They was the same age. One was born in February, and was born I believe in October, they was the same age. And that had *nothing* to do with it - his daddy was the boss.

Resident: It was a family thing, you know, you was in the family or in the click, you could get on, or get your son on. I had a time getting my boy a job. I went to the 'main man', and talked to him about it, and it wasn't long after I talked to him, he hired my son.

Interviewer: So, other than a few jobs, well paying jobs, would you say there are other benefit's? Did, did they improve any of the roads, or, or improve any other community things?

Resident: The State Roads, State keeps the roads up for the coal companies. I mean, if you got a coal company that's paying big taxes, State Roads will keep the roads up. It's like this Kelly holler here now, that use to be past on all the way cross over to Amerstdale. And after the coal company went out up here, it's asphalted up to where the tipple was and then it's dirt from there own up to the foot of the mountain, and there across is asphalted. But that was back in the early '60s that that was asphalted? That was when this coal company up the holler was a big business. See it's out of business now, so they don't care. The State Roads ain't gonna fix it. It's still a State highway though.

Interviewer: So, the surface mining just, uh, help me remember, here on one side it's still going on and one side it might, it might be starting up again.

Resident: Oh, they're gonna start back up. I don't know when.

Interviewer: And you said it started around middle 90s?

Resident: The mountaintopping, right.

Interviewer: Yeah…

Resident: Yeah, now this coal mine down here been down for oh, back in the probably the turn of century. But they deep mined back then, and…

Resident II: We *know* they were gonna start back up because the old… what is that thing down there…

Resident: The dragline.

Resident II: …the dragline is still there. If they wasn't gonna start back up they would have moved the dragline and put it somewhere else.

Resident: Now they started stripping back in the '70s, but the mountaintopping they didn't start to the mid '90s. The stripping, you know, I guess you know about the stripping.

Interviewer: Yeah

Resident: It's bad enough, but then the mountaintopping just take it all. If you go… where you going when you leave here?

Interviewer: Where gonna go the other way out, where gonna go up…

Resident: Down Charleston? Madison?

Interviewer: Madison, right.

Resident: When you go down the road here, you kinda watch down this side the top of the mountain and you can see the mountains been cut out about half way. And a lot of places just got grass, they ain't got no trees down so far. When you get down at the bottom there's trees, but they sewed grass, and I don't think grass is as good as trees (laugh).

Resident II: Another thing, I don't know if you all have anything to do with trees, or well I guess you do. When people come in here to cut trees down, they take what they like…

Interviewer II: Yeah, select.

Resident II: …and they leave what they don't like. And they don't clean it up, they don't, they pull in take what they like and leave. They leave *terrible* mess and we live with it!

Resident: When we had that meeting down at the school about, with the environmentalist, I ask that fella, I asked him what they protecting. He told me you know, the streams, and stuff like that. I said, "Well. I'll tell you what I said, suppose you caught me cutting trees down in the creek, and just leaving them there." I said, "What would you do?" He said "I'd tell you to get 'em out." "Well," I said, "up the holler where I live, I said they cut these trees down and left the tops of the trees right in the creek." And I said, "When it floods, you know what's gonna happen!" And he said, "Well," and he said, "there ain't no laws against the timber company." That's what he told me. And he could've made the coal company… who would've been responsible, I ask him, "I said if this comes down the holler and damage my property, who am I gonna sue?" He said, "Well, it would be the coal company, being liable." I said, "Why can't they come down there and just pull them trees tops up out of the creek?" I said, "They can do that real easy." But, they never did.

Interviewer: Well is there anything that I didn't ask you about, that you wanted to talk to us about?

Resident: I'm gonna show you that picture.

Interviewer: Yeah, I'd like to see that picture.

MTM/VF EIS

Community Narrative: Blair, West Virginia

Resident: Ya'll live in where? Pennsylvania, the steel mills?

Interviewer: Pennsylvania.

Resident: So, if you live close to a steel mill, chances your life is shortened, then if you're out in the country, is that right?

Interviewer: I'm sure there are all kinds of industries that have similar kinds of, you know the good and the bad that come with it, um, none probably as big as coal I think… But, (laugh) that's just my opinion so far, I mean, I haven't studied the other industries, so…

Resident: Okay.

Interviewer: Um, tell me a little bit about how you and your family originally came to live in Blair?

Resident: That's were I was born. My dad's a coal miner and he was in the coal mines for I think 35 years. So he help get me in the coal mine. I went to Cleveland in '54 when I finished high school. I got a job that ah, I just couldn't make ends meet. So, I come back to West Virginia and he help me get a job in the coal mines in '56. And that's where I spent ah… This is underground coal mining, I spent 3 years there. Laid off. Went back to Cleveland in '61, worked till '63. Come back to the coal mines, and I been there ever since.

Interviewer: Were you always doing underground or did you originally do…

Resident: I was always doing underground.

Interviewer: All underground.

Resident: Uh huh.

Interviewer: So you retired as an underground coal miner…

Resident: I had 34 years. I got black lungs. 'Course that comes from coal mining. 'Course they paid me for compensation, because of my lungs. To uh… I raised three children on the miner's income, so I give them the opportunity if they want to go to college. I told 'em I'd pay for it; they didn't… like me they didn't have the desire, so. The strip mining I don't know very much about it, just what I see. And my son works on strip mine but, I never did work on one. Ah.. they do, ah... they do tear the mountains off. They ah, pollute streams, that's still, ah, they still make a good living. It's the best paying job in West Virginia, far as I know, is coal mining.

Interviewer: When you…

Resident: When I lived at Blair, before I moved, I moved in '93, the strip mine hadn't come quite to my house. But by '94, after a year after I moved here, go back to my house where I live and I can see the dust from rock and stuff, you know, fly in the air. But ah, when I… asked them if they'd buy my place, they didn't come to me I went to them, they said yeah. I felt that they gave me a reasonable offer for mine; that's the reason why I'm here.

Interviewer: Let me back up and ask you, what was it that you liked about the community when you were growing up there, and when you lived there before the surface mining came in?

Resident: Okay, it was a community about 700 there were neighbors, and we knew everyone. We had softball teams; we had baseball teams. It was a nice community, clean and ah, I just enjoyed my childhood.

Interviewer: And you children were raised there?

Resident: Uh huh.

Interviewer: So they went to school in the area?

Resident: They went to school in Sharples, that's about six miles below Blair. That's a high school.

Interviewer: What was it that you would say that you noticed, or were there any changes that you noticed when the surface mining started in the community?

Resident: Right at the time, no. I can't tell where the community growed any, at that time. But by the end of it, by '94, '95 in that area, the coal company bought people out, as they did me. And today is only maybe 152–200 families, where there use to be maybe 700 or so. More than half have left out, Sharples, that's six miles below Blair. One particular place, Monclo, there's only two houses there, where at one time there was probably, maybe 80. So, you see what a fall that community had.

Interviewer: And you say you didn't see it grow any… and by that you mean you might, are you referring to the possibility that it would grow, some people moving in for jobs?

Resident: Yes. I'd say, didn't see very much grow, most, probably most the coal miners came from other communities. But Blair and Sharples did not have very much room to expand anyway.

Interviewer: In your experience, like with your son for example, is that a job that he got when the company came to your community or did people from the community get jobs there?

Resident: He worked as a supply clerk before he got the job on the outside, on the strip job. He worked in the supply house for the same company. I think he worked there, I don't remember, four or five years, and then the company gave him a job on the strip. And he's been working for them every since.

Interviewer: He a clerk in the supply house?

Resident: Uh huh.

Interviewer: Okay. Um…and he, so he was working for them before the came into the community you said? Did I hear you…

Resident: No, he worked in the same community that the mines was in.

Interviewer: Oh, okay. Before they started mining there or?

Resident: The mines, let's see, really before the strip mines was in at the time that he started clerking or not, I don't know. I just can't remember back at that particular point.

Interviewer: So, you didn't really see any growth in the community. Were there any other positives that you might have seen? Was there benefits like to the community resources, like schools, or roads, or any thing like that?

Resident: Seen no benefits. And a very little harm, I'll put it that away.

Interviewer: And very little harm?

Resident: Uh huh. Now the deep mining and the strip mining is two different types of mining. Uh, your deep mining will affect your water, it will. Well, strip mining will hurt your water too, if its surface water, but if its under the ground, then I can't see were strip mining would hurt your water. But deep mining will hurt your water. I feel that deep mining is ah, far as the environment, would be more cleaner than strip mining, because they, they don't have the dust on the outside. Strip mining has very much dust, rock dust, and also coal dust, where your deep mining, your coal goes into railroad cars, instead of hauling them in trucks. So, I feel that strip mining is more dirtier than deep mining.

Interviewer: So, what were the few impacts, the negatives that you did see?

Resident: Fishing, streams, your water. We have a few fish out here, but nothing like it was when I was growing up, or before the mines come in. Hunting, I would say that it ah, the strip mining would affect hunting…

Interviewer: Uh huh, the habitat?

Resident: ….Deep mining I couldn't see where it would. The only thing you had is a few what that called site dumps. I guess ya'll got 'em in Pennsylvania? But strip mining is to me more harm to the environment then deep mining.

Interviewer: Can you tell me a little bit… um, as you said there was maybe not a lot of benefits, but not so many negatives either. Why did you approach the company to be bought out? What was… why did you decide to do that?

Resident: I knew that they would strip behind my house. I, my son knew how far they was gonna go, and any time you got strip mining you got a chance of a slide, especially in the spring. Here when we have a lot of rain, we have deep water, nothing to hold it back, so I felt that it was time. If I could, it was time for me to move out.

Interviewer: Was that a difficult decision?

Resident: It wasn't for me, but it was for my wife. She did… it took her a year or so to get use to the place, me – it didn't bother me 'cause I like the quiet neighborhood. She said it was too quiet for her, so… (laugh)

Interviewer: Just different things that you were looking for? Did you notice any changes in the community, when ah, when the population started to leave in terms of interacting with each other or the things that you have valued before in the community?

Resident: No, I didn't see no difference in personalities. I could see, as everybody else could see that the valuation of property and stuff was going down.

Interviewer: How did that work for you when you approached the company? Did you have someone come in and appraise it or did they?

Resident: Mmmm…Yes, I don't recall the guy's name, but he did come in. I gave him a price, what I felt that it was worth. And they come in and checked it, and they said it's fair enough for them.

Interviewer: Okay. So, you estimated what you wanted and what you thought it was worth and told the company. You didn't have a third party person come in and do a value?

Resident: No.

Interviewer: Okay. So the negotiations of the company were very simple?

Resident: Uh huh.

Interviewer: Do you feel like they satisfied, you know, what you had hoped…

Resident: Yeah, by… by me asking what I felt it was worth and they gave me my price. So, I felt that I got a square deal. I could probably held back, and ask for a higher price and I'd could probably got it. But I just stick with my price and they give it to me.

Interviewer: What kind of interactions did you have with the coal company about any thing else? For example did you discuss anything with them about… you said you didn't really have, at that point, they weren't that close to you… so you didn't have any impacts to your home to complain about? Or did they ever approach you to find out?

Resident: No

Interviewer: Did you ever have interactions with the company about what they were going to be doing? I know you said your son knew…

Resident: No. Just my son knew everything what was going on. The company never approached me for nothing.

Interviewer: Did you ever see anything, ah, printed publicly about the permit activity, or what type of mining was going to go on in your community?

Resident: I never saw it. No.

Interviewer: No. Do you…

Resident: Now I asked the company, the company that… the man that I bought, that gave me the price of the land, or I asked… he did come in told me that I had six months after I sold to leave. He would go as much as a year to give me time to find me a place or to build, so I'd say he gave me a year.

Interviewer: Did he… was there any help with moving expenses or …

Resident: No.

Interviewer: No… Was there any discussion about where you could move or where you would…

Resident: No.

Interviewer: No.

Resident: Yeah, yeah, I had to move ah… I had to move ah, out of what the company owned. At that time it was below Sharples, I can't recall the exact boundary line, but I couldn't move back in the neighborhood that I was in or Sharples. The neighborhood where the company was really, that's where the headquarters was at, the main office. I had to move out by that, but later on, now they did give some of them permits after they sold to rent the house that they lived in.

Interviewer: Explain that to me again. They did give who? Other property owners?

Resident: Un huh.

Interviewer: The ability to…

Resident: Stay in the same house.

Interviewer: To rent it out? Why would some one what to do that necessarily?

Resident: I don't know. (laugh) Well, if they was just gonna give me, say if I asked for $100,000, they just gonna give me $90 and if I wanna make agreement with 'em, you give me, so long a time to live in a house. What they done, they cut the rent down to like $100 a month which is very cheap. It's just the way they work it, but at the time that I bought, now I was about the 3rd one that sold out, they didn't give me that privilege to do that. But there's some up there they did. Like later on I guess.

Interviewer: Did you ever discuss with them the possibility of buying back the land?

Resident: No. I never did. I wasn't gonna go back for one thing, and I never did have no desire to go back.

Interviewer: When they discussed with you limits to where you could move to, like with in the property areas that they owned and they were mining in, did ah, did you have the impression that was just for this current move? If you should have every wanted to move back in that area would that be allowed or just…

Resident: No, they didn't tell me I could ever move back into that area.

Interviewer: Just, you had to move out of that area.

Resident: Out of that area, yeah.

Interviewer: What kind of future… I know you don't live there now, but… what kind of future do you sort of see that the community of Blair may have now?

Resident: None.

Interviewer: Why… why do you think that is?

Resident: 'Cause I think the company is going back in there and strip again, their talking about opening it up again, on a different side of the mountain. Now whether the company will come in and buy those out up there now or not, I don't know. They may give 'em a fair price. And if they do go back in and give 'em a fair price, as I felt they did me, and give them the same opportunity I had… 'Course some of them don't wanna move. Ah, there was two or three cases, I'm not mentioning no names, where the evaluation of the house and property probably wasn't worth a $100,000, but they was asking $250,000. They was getting… they was wanting triple out of what they owned, and ah, but they wouldn't move because the company wouldn't give them the price that they was asking. Now although there is one or twp that got much more than what the value is that they got.

Interviewer: Do you think that was all on the up and up? Did uh, I know you said that some people were trying to get more, but uh, for example, do you think in your case that _______ people asked for things like repairs that weren't due to the mining or?…

Resident: I don't know. I know that there was some houses that when they set this blast off it did crack their cinderblocks and the sheet rock in their house. Now whether the company came in and gave them money for it or not, I don't know. 'Cause my house, I never had no trouble with mine.

Interviewer: And you never had any trouble with water either, right?

Resident: No, I had good water when I went there, and I had good water when I left. In fact, it was the best water in Blair. Even though it was a drill well, it wasn't surface water.

Interviewer: You said that they're gonna, they're talking about going back in there and opening up that mine, is that something you also heard from your son or did you see permit information in the paper?

Resident: He heard it, my son heard it, and it will probably be some time in this coming year. In 2002. Whether it's true or not, I don't know that.

Interviewer: Do you ever see those permits information in the paper or do you read the paper regularly?

Resident: No, I don't take the paper. No, I don't.

Interviewer: Part of what the study is looking at is, you know, what the evolution of the community was like before the mining, and during the mining and after the mining. So, I'd be interested in your thoughts on, I know we touched on it, each of those areas a little bit, over the, sort of, course of time how would you describe the changes over all?

Resident: I have to go back to uh, the time I moved, in '93. I would say it be on a downhill.

Interviewer: A downhill how, because the families were moving out or?

Resident: Families moving out. I didn't… I've not been back up where they stripped now. I don't know whether they reclaimed it after the job was done on it. That to me is a decline after I moved out. At the time I moved it was okay because it hadn't interfered with this part of the town.

Interviewer: Were there uh, I know you said that a number of people may of worked in surface mining, but not necessarily because that mine came in. Was there anyone in your experience who necessary benefited in terms of employment from the mining being right there?

Resident: Yeah, they had pretty good size operation, the strip mine. 'Course my son he got a job through that, and ah I'd have to say as far as employment, they done whole lot.

Interviewer: And in terms of just the community of Blair, if you could help me sort of understand was there a need for jobs in Blair? In the sense that you know, the mining coming in to that area was a direct benefit, did they hire local people for those jobs? Or are you speaking in a more broad sense, that the surface mining you know, is a benefit in terms of employment?

Resident: Its probably overall because we had, Sharples at that time had a deep mine. They had more one, at that time Westmoreland had two or three mines. So, far as the community, they's probably okay, but when the strip mine comes in people on the outside come in.

Interviewer: Did you ever see any changes in the schools, or any of the public facilities?

Resident: The schools dropped. I'll say the schools dropped considerable, ah course now, they don't even have a school up there. Both them schools are shut down.

Interviewer: In Sharples, where your children went?

Resident: Uh huh, where my children went, where my grandchildren went. Everything closed down, because of when that mine shut down it took a lot of people jobs.

Interviewer: So the things that you liked about that community, in terms of you know, it being quiet and a nice place to live, you said those have changed.

Resident: Uh huh.

Interviewer: Yeah…. Did I forget anything?

Interviewer II: I don't think so. I think you covered it.

Resident: She likes to talk, don't she? (laughter)

Interviewer: I tried to keep track in my head to make sure were covering everything. Did I not ask you anything about your experiences living over in that community with the surface mining that you wanted to talk about? We can get to the logging as well, but...

Resident: No.

Interviewer: You feel like you fairly well summed up what your experiences were?

Resident: Yeah, I feel that, um, okay, I can't hardly put the, I don't want to put the coal company down because they made my living for me.

Interviewer: Sure.

Resident: They helped me, of course I raised my family through coal mining, I got a retirement and whether I… I don't know how long that will last, but anyway I got one. So overall I think the strip mining could do a better job reclaiming the surface, that would put people that likes to hunt, that gives them more places to enjoy and ah that's pretty well, and we could talk about saw logging.

Interviewer: Yes, well let's do. Let me ask you one more question before we move on to that…

Resident: Okay.

Interviewer: …It just occurred to me, but you have mentioned along with the hunting the fishing as well, and you thought that that had to do with the surface mining. How exactly, the streams, the impact on the streams?

Resident: The… when it rains, in the spring here when it rains, say we get two inches of rain, that's probably a bit below normal, cause we don't get much rain here, but anyway if we get two inches or more our streams are nothing but muddy water. (laugh) Be honest with 'ya, I don't know how the fish lives in it even today, cause it's so muddy when it rains. Because don't have nothing to hold the water back, not only mines, but like I say the saw logging too. And that takes care of the fishing part, far as the hunting part where the strip is at, the mountain that they took it. It would hurt them if they don't reclaim 'em, reclaim 'em and sew the grass and stuff back in for the deers. And as far as reclaiming and puttin' trees in there, I don't see where they're doing any good about that, which they should do it. They don't.

Interviewer: And that, it sounds to me like that an important part of your lifestyle and what you probably enjoyed doing, hunting, fishing?

Resident: Yeah, I was a hunter, hunting.

Interviewer: And was it all mostly recreational, or did you use that as well? … I mean, I know my uncle for example often goes out hunting you know they make deer sausage, and all sorts of things so…

Resident: Mine was probably, it was both. That one there I killed it. That was one I killed in '74, but ah back when I was young I killed to eat. Now I can look at a squirrel and I can't kill because I don't like it. The same way with deer, I don't deer hunt. To me it's like a sport, like anything else it's enjoyable….

Interviewer: Okay. Well uh, why don't you tell me a little bit about what you wanted to share with us about the logging.

Resident: Is it all under about the same thing, coal mining, ya'll take that up?

Interviewer: Well, probably uh, probably what will happen, and I can't guarantee this… but you know, I'll share it with the project manager and its up to him to find the right person to pass it on to. The particular study that were looking at doesn't talk about logging…

Resident: Okay.

Interviewer: …except how it would relate to, you know, if the coal companies were selling off the logs, or maybe that how it might…

Resident: Yeah, they do that. Yeah, the company usually they'll sell the logs before they do the stripping. They come in and take all the logs out then they strip. And when they take the logs out they make, you know it's down here, cause you see plenty bull dozer roads, where they go in and get the timber. When they cut the timber down, they don't worry bout the cost of them. They got this deal here last year. And you sit here and watch these big trees fall and it makes you sick, especially if your hunter or sportsman. They come in here… they cut them down, leave the tops of them lay. Then you get a forest fire, and the forest fire get so big, out of hand there's and there's no way they control it, because of the tops of these trees. Anywhere they cut trees down, then you gonna have slides, where it wont hold the water back. So, here goes your, your game in the mountain - takes care of your streams and water, takes care of your fish. What they don't take the bulldozer tears it up, or they just let the trees fall over on this and tie um up. They're just not, to me, taking care of the mountains like they should, that's my feeling about it.

Interviewer: Umm hum. Now I've heard some people say that some groups actually encourage a certain amount of leaving behind, you know, logs or debris as almost habitat encouragement for animals. But are you saying that, you know, the extent that they're doing it is really beyond…

Resident: Too much, too much, yeah. They don't want to leave anything over six inches in diameter, they want to take everything bigger than that. It's through the range like that, in my lifetime, and in my kids lifetime, they can't see it get big enough to support anything.

Interviewer II: You know one thing that, you know, I noticed and we were talking about actually earlier today, is that if you look at a lot of the forest the size of the trees are pretty much the same. And they all look like they're probably, at most maybe 18 inches in diameter.

Resident: Yeah. And some of 'em and especially a beach tree, you can't use for nothing no way. To build houses cause you can't drive the nail through it. So they ain't worried about that beech tree. That's a squirrel's tree, see. They just take a bulldozer and push the stuff out of the way.

Interviewer II: Yeah. Right. I guess the question I was going to ask you, based on your memory in your lifetime, do you remember a time when there was less forest or had it been lumbered?… What it sort of tells me by the fact that there is… all the trees are about the same size and there are no huge trees, that probably within the last 50 years that there was a major lumbering…

Resident: Yeah, it hadn't been that long. Last uh…

Interviewer II: Actually, I would say probably in the '60s.

Resident: Last 30 to 40 years. Of course when I was growing up as a young boy 12-13 year old, all we had was big trees. And then see, they used, instead of using them bulldozers they used horses or mules and they didn't tear up the mountain and stuff like this bulldozer done.

Interviewer: So, what specific is it that they should be doing differently? Should they be limited to the areas they can log, and, and improving how they do it? Like not leaving behind the tops?

Resident: Tops yeah… and yeah.

Interviewer II: And more select it sounds like.

Resident: 'Course the best tree they take is the best tree for the squirrel and that's the oak. That's the main timber, and hickory. I don't know what they used that hickory for but they'll cut them down too. It's actually hard wood, I can't drive a nail through one, so.

Interviewer: Have you ever had any discussions with the State about either the coal mining or the timbering from… you know, the State, environmental protection people?

Resident: No. 'Cause I always felt that the Governor of West Virginia, like all the governors of other states, it's a money racket. You can't beat money no way, money's gonna override you. And but it's like up northern part of West Virginia, you got better roads, they cut more money out cause usually the Governor's from up in that part of the state. But can't one from Logan, I don't think we'll ever get one, cause it's crooked (laugh). But the governor of Charleston right now, Wise, whether he ever been down this part of the country or not, I don't know. You don't hear of Welch, and all this places where you hear about all these floods. It's caused from, I'll say it's caused from coal mining and from timber, that's the two main sources. And one of them not bit worst then the other one. Only thing about coal mining is a lot of times you build a dam, if that dam breaks loose with all this water behind it, and that lets everything to us… that's a bad thing, far as coal mining.

Interviewer: So at least that your saying, that at least they built the dam, or they tried to sort of deal with the issue?

Resident: Uh huh

Interviewer: Now I know they've had a lot of serious floods over near Welch recently, um, and in some other areas as well… Boone County.

Resident: Boone County's bad. And it's uh, well, you ever been up there, you'd see a lot of strip mines up in there. And like I say, they take the logs and everything else first so one of them's not a bit more blame than the other.

Interviewer: Is there anything else you wanted to be sure to tell us, or share with us from your understanding?

Resident: No. I just trying to speak the truth about it. I'm not gonna up hold one no more than any other, but it's just a situation that, ah all involve jobs. I know that. 'Course coal mine takes care more jobs than saw mills does. 'Cause one man going out there and cutting them trees down in one day, just one man can tear a lot of 'em up. But overall irons out probably about the same.

Interviewer: So you're happy living, living here now?

Resident: Yeah, I like it here. I'm between, I'm half way between Logan and Charleston. And except for Blair there, there's only, as the worst part about it, is had to go all the way to Logan, which is 12–15 miles to a hospital. Here I am in very close reach.

Interviewer: And you have health concerns, and that's important about…

Resident: Closer to the hospital, yeah. I can get to Charleston in 25 minutes. It takes about 25 minutes to get to Logan, so that's not to bad.

Interviewer: And you don't regret it at all then?

Resident: No. No, I do it of my own free will. Company didn't come to me, I went to them, so. Whether the rest of them did or not, now I… The rest of them, some of them probably went out on the same condition I did. They went and asked, because I knew the strip mines was coming through there and I felt that the quicker I get out, probably the better off I would be. Which I ain't regretted one bit. Even though I lived in Blair for practically all my life, 50 some years, I ain't regret a bit to come down here.

Interviewer: Did um, did you sign an agreement? You had mentioned about not moving into a specific area that they outlined…

Resident: Hummm…I don't recall whether I signed that or not. Or whether it was on a separate piece, or granted or not, I don't recall.

Interviewer: Well, like I said, I think we've covered all the questions I wanted to ask you, as long as there wasn't anything else you want to add… I want to be sure to give you that opportunity that I promised, so.

Resident: Well, (laugh) put it this way, help any… or help you any or not, when these coal companies comes through here and strip, they always put a gate up. So a 4-wheeler or nothing gets through there to hunt. I don't like it, and I guess the other guys don't either, you know, who likes to ride 4-wheelers and things. But they always put a gate up…

Interviewer: On their roads?

Resident: On their roads, where you can't get through. I can understand their part in a certain way, you know… if you got equipment in there, keeping people from stealing. But most time you got night watchman's things there, anyway. But they do put the gates up; they keep you out.

Interviewer: That's interesting you should mention that. We were just discussing that the sort of, the change that, that we've heard discussed as well in that regard… about a certain amount of public use of the land.

Resident: Uh huh.

Interviewer: So is that… that's definitely a change that you saw as well, then?

Resident: Strip mine, yeah, uh huh.

Interviewer: …and that was when it was owned by, you know, neighbors, or people you know, or you knew?

Resident: Probably the coal company, no, probably the coal company owned the land, or they bought it off some other guy, you know that owned it, yeah. But after they get their equipment back in there, due to stripping, they closed the road off. Which it might be good, and it might be bad, cause they have to do it some way that they would not be responsible if somebody got hurt on the 4-wheeler. Because they had one over high-walls here, you know what a high-wall is?

Interviewer: Right. We've seen 'em.

Resident: So the company could not be responsible for something like that, if they run over, you know…. 'Course I got, to me, I got to an age where I got rid of my 4-wheeler, and I'm not able to do it. So, but I like to see young guys enjoy their life like I did mine.

Interviewer: When you were young and you lived in that community, the um... the coal companies maybe owned that land for underground mining, how, what was the situation then, with being able to …

Resident: It was all together different. They didn't, I mean back then it was, these all were deep mines. Strip mining, this is a lot different from that, because you're blasting rocks. All together different from what deep mining is, and I feel that strip mining is more dirtier.

Interviewer: I'm glad you raised that point. That's a good point to bring up.

Resident: Only thing that's good about… I can see to strip mining is that you probably wouldn't have as much chance of getting black lung, as you would in deep mining. Still it's, it's not… I don't believe that strip mining is, is as clean as the inside. See, there's good parts and there's bad parts, I just told you the best I can (laugh).

Interviewer: No, I appreciate that, I really do. It's good for us to be able to talk to a number of people from the, these communities. And, and be able to hear these stories from different points of view and get a good picture of what went on, and what the experiences were like. Uh so we appreciate your taking the time.

Resident: Okay.

Interviewer: We really do. Okay.

Resident: Are ya'll Christians?

Resident: Yes.

Interviewer: O.K., great, I have you on the phone. Just to start off, would you be able to tell me a little bit about yourself and your family?

Resident: I'm married. My husband he works on a strip job. I have two children and I have family members that work on strip jobs. That's pretty much it.

Interviewer: O.K., and your family still resides in the Clarkizone community?

Resident: Yes.

Interviewer: O.K., about what is the size of your community in terms of how many people live in Clarkizone?

Resident: In Carcassone, uh, I count we got maybe 250, something like that, not many.

Interviewer: And that's currently at this time. How long have you lived in Carcassone?

Resident: Uh, since I was 7 years old. I'm 42.

Interviewer: You are 42 and you have lived there since you were 7 years old. So you have been there quite a while?

Resident: Yes, uh huh.

Interviewer: What are your connections to the Carcassone area. Did you uh, uh, apparently if you were 7 years old, does your family, uh, did they move into the area at that time, or how did you, what are your connections?

Resident: Yes, my mom and my dad are both from this area and they moved to Indiana and had me and my sisters and then they moved back here and my dad got into the coal business and they found a house over here to live in, in Carcassone.

Interviewer: So your father worked for the coal, uh, in coal mining?

Resident: Yes.

Interviewer: O.K., how long ago was that?

Resident: Uh, Dad started in about 1967, 1968.

Interviewer: O.K., I'm gonna ask you a couple of questions about your quality of life in terms of your community and how, uh, you have enjoyed uh your community.

Resident: O.K.

Interviewer: The first question. Did you observe or experience changes in quality in your quality of your life related to community resources? Uh, such as schools, public services or any types of the natural environment, like water quality concerns between the periods of we'll say 1980 up to the present time?

Resident: Uh, I'd say that the quality of the water and stuff like that, that has changed.

Interviewer: The quality of the water changed?

Resident: Yes.

Interviewer: In what way?

Resident: They were mining and stripping and we used to have really good well water. Our well is only like 65 feet down, something like that, and um, it just all of a sudden became real orange and nasty and you couldn't stand turning it on because it smelled and we finally contacted the coal company and uh they come and took samples and they put a filter in for us.

Interviewer: Did that, what, how did that affect your water quality after they installed the filter?

Resident: Well, for one thing, the water doesn't taste good like it used to. I mean it used to. It probably, you know, had a lot of stuff in it, a lot of bacteria stuff, but it just tasted really good, fresh, everybody would come to my house to get water.

Interviewer: And, is that the case today?

Resident: No. I don't have good water. I mean we got a filter, but it's different.

Interviewer: O.K. Any other besides the quality of your water, did the quantity, do you still have the amount of water that you currently did at the time before the mining affected the quality. Is there any changes in the amount of water that you receive?

Resident: So far we haven't seen that, and that's been a while, so I don't think that changed any, just like I said the water changed and well my sister-in-law, hers went dry and she had to get a well drilled and it's a problem where we live, there's no such thing as city water. It goes so far.

Interviewer: It's all on-lot well systems?

Resident: Yes, we have to drill our own wells.

Interviewer: You don't have any basically any public water services there being piped in from another source?

Resident: Yea, we don’t have that. It goes just so far and it don’t reach Carcassone yet.

Interviewer: Right. Um, what other, I’ll ask you another question. You had said that currently there are 250 people approximately living in Carcassone, is that correct?

Resident: Uh huh.

Interviewer: The question is, what . . . was the community impacted by change in population or shift in local demographics, we’ll say again between the period of 1980 to the current to the present day.

Resident: Uh, I don’t know back then when I was growing up, it seemed like there was more people here.

Interviewer: And, if you perceived that there were more people, do you have any reason or uh, rephrase this correctly. Any perception of why the population may have declined?

Resident: Pretty much because once the kids grew up, there weren’t nothing here to keep them. You know, jobs were, jobs still are, if you don’t have a college education, you know, you either work in a fast food restaurant or you are working on a strip job and our kids have to get jobs or go off to school.

Interviewer: So there was other factors basically looking for employment opportunities and if they didn’t like the choices of working in a fast food restaurant or the mining operations, they left the community, is that what you are saying?

Resident: Yea, pretty much so, I believe.

Interviewer: Or, if they wanted to get a, you know, beyond high school education that they went off to college then they of course moved out of the area as well.

Resident: Pretty much that.

Interviewer: And they uh, then I would assume that the ones that have left have never returned then?

Resident: No, its, right now, its pretty much, I guess the youngest would be like my family members, like my niece and they are continuing on over here. Uh, but uh, it’s pretty much my age and our generation go here.

Interviewer: Um, do you, can I ask the question, do you plan on living there for a long time or?

Resident: Yes, we tore down my old family home and we rebuilt and I plan on staying here. We’ve got a lot of land and my son’s going to college in the fall and uh, my daughter, she’ll be going to college.

Interviewer: O.K. What is it about Carcassone that you like. I guess, what do you like most about
Carcassone, I'll ask?

Resident: O.K., um well, for one thing, I guess where it's close near, you know, you can trust your neighbors, pretty much. Um, you have privacy, only thing is I hate the winter 'cause it's hard to get in and out if you don't have 4-wheel drive, but the summer, uh, it's really beautiful and you will have people not on top of each other, you know. You've got your neighbors to look out for you, I mean, over here, there's a lot of woods, [ ] we have I think 8 teachers that live around us and a doctor lives next door, uh.

Interviewer: Did you say teachers, 8 teachers?

Resident: 8 teachers.

Interviewer: O.K.

Resident: Uh, and then a doctor lives next door, uh, it's just I guess a close knit community, you know, they're there for you if you need them and you are there for them if you need them and pretty much you don't worry about your children and stuff like that. You know, if there is strangers that come through here and stuff, you got to worry about that, but I don't know, I guess, most of it's family really, if you come right down to it, if you go back probably 60 years, you will find that everybody's kin or something somewhere or another.

Interviewer: Right, exactly. Has, uh, during the time period when mining came in, when was mining introduced to the Carcassone community, do you know? Or is it still active?

Resident: Let's see, uh, stripping, I think come here in uh 1978, I'm not sure if that's exactly it, I know it's close, somewhere in that area is stripping, 'cause my husband, well, that was the year we got married, I believe, he, it's probably earlier than that because we got married in '78 and he worked out about a mile from where we lived out on the mountain. On a strip job. And I mean, they stripped it good, I mean, they took the whole mountain.

Interviewer: Is mining still going on in the Carcassone community now?

Resident: Uh, they mined underneath us, deep mined, about 10 years back and uh out there not real close to Carcassone, maybe 3 miles from us, I know the strip is still here.

Interviewer: So the operations are still ongoing there?

Resident: Oh yea.

Interviewer: O.K., uh, then that leads me to my next question, how it's tied into the previous question about your community. Um, since the mining operations have operated in the Carcassone community, the answers that you gave to me, uh, what do you like most about Carcassone, has any of those likeable features about your community changed or have been impacted by the mining operation?

Resident: Uh, to be honest with you no, not really, although we, you get upset if like if a shot is put off and your foundation is cracked, you know, everybody gets upset about that, but personally, no one does anything about it unless it's a lot of damage to your property.

Interviewer: O.K.

Resident: I guess it's just you're used to that being a way of life. If half your family works full strip jobs and you know and I guess you just get used to it, I don't know.

Interviewer: You sort of become accustomed to your surroundings, I guess.

Resident: Yea, um, you know when a shot goes off at 5:00 or 4:00, uh, you don't even notice it any more. It's just like an everyday thing, not unless something falls off your wall or something like that.

Interviewer: Right. Regarding the future, and again, we are still talking about quality of life issues here, based upon the current mining activity and past mining activity, do you still view that your quality of life will remain the same in the future?

Resident: That's one thing about the mine, you never know from one day to the next what your quality of life's gonna be because basically, if your husband or if you or any of your family members work in the coal business, you don't know one day from the next if you've got a job because if it's not been a bad winter, they're not selling a bunch of coal, uh, your husband may be laid off and not only him but family members and then, you know, that's way a lot of people over here rely on but, we've got a lot more now that are going through different stuff besides the mining. But for quality of life with mining, I wouldn't get I would advise it to nobody.

Interviewer: O.K., now just to repeat the answer that you had given a little bit before, you said that
people are moving south for the coal mining, is that what you said?

Resident: No, uh, they're just moving like the younger kids are normally having to leave uh home and a lot of them are not coming back over in Carcassone because there's nothing here for them really, you know, except the coal company and stuff like that. But it's like living over here I think everybody loved it. It's just to continue with their future and to make something of themselves, they pretty much have to leave not unless they become like a doctor, a teacher or something in the medical fields and stuff like that.

Interviewer: O.K., uh, what have been the benefits from the presence of surface mining in your community?

Resident: Uh, personally to me there's no benefit, uh. You know, they would keep the [ ] up, uh, donate stuff like to the community center something like that but I personally to me it paid my bills because my husband worked out there.

Interviewer: Right, right . . .

Resident: But, I hated it. I mean you should see out there. My kids on the weekends we go out there and for them to ride their four-wheelers and it's just a horrible big mess that you ride your four-wheelers through, you know.

Interviewer: In terms of where the mining has been taking place or . . .

Resident: No, I mean, its mountains are gone, history's gone, uh, you see forever, used to be you would look out your window, you see forever you see mountains. You know, I think that's the further, you got there and you can see mountains all the way in Virginia and Tennessee, you know, because you're up so high and it's all gone.

Interviewer: Right, so there's been in terms of scenic beauty, can I say that?

Resident: Yea, it's horrible.

Interviewer: O.K. The next couple of questions I want to ask you is about public relations, how the mining companies have interacted with the local community.

Resident: O.K.

Interviewer: The first question is what public information was available to you or to the community regarding the introduction or the presence of surface mining?

Resident: If I didn't read the paper, I didn't know about it. Uh, it was put in the local news in Malmego and uh if you can read that, you know they give notice in there and then sometimes it would be word-of-mouth. Sometimes someone would come and take maybe a sample of your water where they would be stripping.

Interviewer: They would come and sample your water, is that what you said?

Resident: They would come and take a sample of your water, uh, if you weren't at home, though, you know, you were out of luck. They'd come, some would come and take pictures around your home, uh, you know, in case they do any damage afterwards, they had the "before" pictures. Uh, we were at home and uh they took a snap shot of the crack in our foundation, but we never done nothing about it because we weren't here for them to take pictures, you know, to prove before and after here, and that's pretty much, you find out word-of-mouth, someone comes and says hey they're stripping around you or they're gonna strip behind you.

Interviewer: And you had said they put, did you say they put notices in the paper?

Resident: Yea, they put like notices about telling you the area that they graded, where it belongs to, know where I'm at but then they'll eventually say Carcassone area.

Interviewer: Would that be advertising the permit?

Resident: No this is to strip. They have to put it in the Mountaineer, they have to put it in the paper, uh, sometimes they strip so many different times, sometimes you will get a letter in the mail actually telling you. And a lot of times you'll see your name in the paper saying that they're gonna be stripping and you can't refuse it underneath, I mean mine underneath there, you know, I don't mind underneath it but uh, you know you'll see your name in the paper and they'll be underneath you.

Interviewer: O.K. I think you may have already touched upon a couple of things I'm gonna ask you next about the public relations. Uh, the question is were or are public relations between the community and the surface mining company continued beyond their initial contact, uh and if so, what types of circumstances.

Resident: Uh, lets see, they'll come back, like if there's a slip or you know, something like that, uh . . .

Interviewer: A slip meaning foundation or?

Resident: Well, like if they was to strip somewhere behind you know some high wall fell down behind your house, uh, like it rained a lot or something and it's because they were mining up above you or something, or stripping up above you, um they'll actually they come back for people and that's claimed their water was bad after they left and you know, and you know the miners drilled wells, they've caused a lot of wells to come dry. Um, wells went dry, we didn't have a well that dried, but you know, we got bad water, um, they'll come back and do stuff like that. Sometimes, I don't know, they did try to do everything they can after they strip, I've gotta give them credit for that.

Interviewer: O.K.

Resident: You can call and you can argue with them and they'll come out and they'll try their best to satisfy you, but if the aggravation of having to through all that plus looking at what they've done when they're through . . .

Interviewer: Right, right. Well, Resident, those are all the questions I have of you, I really appreciate your time, um, what I'm gonna do too I'm gonna give you my contact information again, if you have any follow-up questions or comments, again, my name is Troy Truax and again, I'm with Gannett Fleming, my company is Gannett Fleming, G-A-N-N-E-T-T and Fleming it's F-L-E-M-I-N-G and we're working with the Environmental Protection Agency, that's the United States Environmental Protection Agency, and my telephone number here at Gannett Fleming is 1-800-233-1055, and my extension number is 2143. And, I'll give you another individual's contact or point of reference, just to validate the, you know, why we're calling. The Environmental Protection Agencies Project Manager for this study, his name is Bill Hoffman. And, his telephone number is area code 215-814-2995.

Resident: Do you all have a web site?

Interviewer: Gannett Fleming has a web site, but I think most importantly, the Environmental Protection Agency has a web site specifically dedicated to this project. If you would go on to and uh, forgive me for not having it in front of me, it's www.epa.gov, and I believe the next is a forward slash or back slash and then type in Region 3 and hit enter, then try to do a search on Mountaintop Mining and that should take you to the exact, uh, there's a web site dedicated and there's also documents there and everything that's been uh basically been published as terms of public documents are on that web site and some background information on the project itself.

Resident: O.K.

Interviewer: And again, these interview notes, these are confidential in terms of your name, uh, you will not find any of this information that I'm aware of on that website . . .

Resident: That's okay, and if you did because, you know, I'm just being honest.

Interviewer: Right, so um, if, again, if you have any trouble with that website, please give me a call.

Resident: O.K.

Interviewer: I don't have, I'm not at my desk right now, I'm in a closed room to have some quiet for these interviews.

Resident: O.K., that's fine.

Interviewer: But, if you do have some trouble, please give me a call, I will be more than happy to help you.

Resident: O.K. Thank you very much.

Interviewer: Thank you again, and you have a good day.

Resident: O.K., you too.

Interviewer: O.K., bye now.

Resident: Bye Bye.

MTM/VF EIS
Community Narrative: Carcassone, Kentucky

Interviewer: We are good to go, I apologize. O.K. First question, could you tell me a little bit about yourself and your family and how you came to live in Carcassone?

Resident: I was raised near here, about 3 or 4 miles and then married my wife. We live on her home place and when I came back out of the service, we moved in here to take care of her mother and lived out her mother's life in this house.

Interviewer: O.K. How many years has that been then?

Resident: About 33, 34, something like that.

Interviewer: O.K., so you probably moved in there in the early 60's, mid-60's?

Resident: Early 70s.

Interviewer: Early 70s, I do my math right, early 70s, right. Um, so basically your connections to the area are through your wife?

Resident: Right

Interviewer: O.K., Now your wife, I assume that she is still residing there?

Resident: Yes she is, her mother passed away a little over a year ago and we are still living here.

Interviewer: O.K., Sorry to hear about that. Um, some questions about your quality of life, now we are looking at a time period for the Mountain Top Mining. When did, is Mountain Top Mining currently being conducted in the Carcassone area?

Resident: Right, about probably maybe a mile from where we live, approximately I would say.

Interviewer: O.K., do you know when that type of operation started in that area?

Resident: Well, they have been strip-mining here ever since we have been in this area, but and they strip-mined on our property around 10 years ago, so it's been going on 15 - 20 years in this area.

Interviewer: O.K. In terms of your quality of life, what do you like most about the Carcassone area?

Resident: Quiet, peaceful place. A good place to raise a family. We raised our children here and have some of our grandchildren here with us now, close to us.

Interviewer: O.K. How many people live in the Carcassone area. If you would say. I know it sounds like a very rural community, but how many families do you think live there right now?

Resident: Oh, probably 50 or 75.

Interviewer: O.K. In terms of what do you like most about Carcassone, the question I just asked you, have you observed any changes to those things that you enjoy in Carcassone, in terms of natural environment, the local environment, or any types of services, or like through government services or schools, or anything that you notice that has changed over the years that you may perceived has occurred form the presence of mining?

Resident: No, not in this area.

Interviewer: O.K. In terms of the population, have you noticed any changes in the local population? Has it increased or decreased?

Resident: I would say it has decreased because when they stripped most of the land here, it is harder to find good water now than what it was 25 to 30 years ago.

Interviewer: O.K. What is the water quality like? I assume you have on lot your own well there. Is that correct Emory?

Resident: Because when they stripped they drilled this well and we appear to have plenty of water, but it has to be filtered, treated in order to use it and then it's not the best quality water.

Interviewer: O.K. Was that something with the water quality? How would you describe the quality and quantity of your water when you first moved there?

Resident: When we first moved here, we had one drill well, one dug well, and we got our drinking water from a what we called a coal bank which was a mine, probably 200 feet back in, used to get their house coal from. And we walled that up and made us a reservoir and that was excellent water. Had to do very little treating of it and had more than what 3 or 4 families could use.

Interviewer: How is that source used today?

Resident: That one that we had?

Interviewer: Right, the reservoir.

Resident: They stripped that same of coal so it don't longer exist.

Interviewer: O.K. O.K. So you are saying that the population you feel is actually decreased?

Resident: I would say it probably has.

Interviewer: And do you have any reasoning or any idea why that population has decreased?

Resident: Well, the main thing is because of water. The difficulty in finding a suitable water for families.

Interviewer: O.K.

Resident: And jobs also.

Interviewer: I was just gonna ask is any of that related to employment opportunities in your area? What is the major employer for the Carcassone area for the residents that live there.

Resident: Right now I would say it is geared to the mining business other than, well we have a lot of teachers, doctors, things like that lives in this area now.

Interviewer: And where do those teachers and doctors work? What is the local area that they work in or maybe facilities that they worked out of, where are they located?

Resident: Well, I have a daughter and a son that are RNs and they both work in medical facilities in Perry County.

Interviewer: O.K. And how far away is Perry County?

Resident: Well, it is only about 3 to 4 miles from where we live but they drive probably . . . my daughter drives 8 or 10 miles and my son drives about 20 and we have a doctor and a dentist . . . two doctors and a dentist in the family and I would have to sit down and count all the teachers and they teach and lecture at Perry County in [Ivecove] which is approximately each one 20 some miles from here.

Interviewer: O.K. So basically the services that the families in Carcassone they really have to travel some distance to get to those services or employment opportunities. Is that correct?

Resident: Any employment that anyone does, they have to travel out of here if they can make a living on it. I worked for a natural gas company which mine was probably the closest of any mileage to it and I only drove probably 6 or 7 miles at the most for 30 years that I worked.

Interviewer: O.K., so you are retired right now?

Resident: Yes, I retired a little over a year ago.

Interviewer: O.K., well hopefully you are enjoying your retirement, I’m sure you are.

Resident: I am.

Interviewer: In terms of the future of Carcassone, do you and your wife plan to continue living and
residing in Carcassone?

Resident: Yes sir.

Interviewer: And do you have any . . . based upon your past perceptions and experienced in that area . . . how do you perceive, or what do you think the future of Carcassone is?

Resident: Well, they are continuing mining, from what I hear, they are gonna come back to just behind our property. I don't know if we will let them get on our property or not, but they will be right behind it and it's gonna be Mountain Top Removal I understand. I don't know what will be added to that or how it is gonna effect our water or anything like that.

Interviewer: So you are, right now, you are probably anticipating the mining companies to come in very close to your property, if not on it, possibly, but the future of Carcassone in terms of your perception is unknown at this time.

Resident: Right, because on depending on what seam of coal they would go after. We sit and most of Carcassone, most of the people in the Carcassone area sit on the on the sediment coal or just about it.

Interviewer: O.K.

Resident: They have gone a seam or 200 which would be completely underneath where everyone is. If they did that, then it would really hurt the area.

Interviewer: Now, if they would do that, would that impact your decision to stay in Carcassone?

Resident: Not if they didn't get on my land and didn't destroy my water where I couldn't find it, because when they did the mining on my property, they drilled one well 300 and some feet deep I believe it was and didn't get water. And the other one was around 200 something that we have for water, so I don't know if they come back and strip more, I don't know how it is gonna be to get water and we don't have any local water systems that's come in where we could get water from.

Interviewer: Right, everything is basically on-lot type of water systems, private water systems.

Resident: Closest public water system would be three miles, I would say.

Interviewer: O.K., so it's a little distance away from where you are at right now?

Resident: Yes, and no plans for it to come this way, not that I have heard of.

Interviewer: Have you know any local residents that have had to move out of the Carcassone area because of mining?

Resident: I have known ones that they purchase their property and the place where they lived, it was all leveled. Some of them went back later on and built on that property where they had mined and some of them put trailers on it, but several in the Carcassone area had to move when they were doing the stripping in that area.

Interviewer: Do you know where those families may have moved?

Resident: No, I don't.

Interviewer: O.K. You don't know if they were able to move locally or if they had to travel far away outside the area to find new residents?

Resident: I would say most of them moved locally, because most of the people in this area are older people that have lived here most of their lives.

Interviewer: O.K., so they have ties to the area then I would assume.

Resident: Right, it would be the majority of the young people that stay in this area either go into the education or medical field or something of that line.

Interviewer: O.K. What are the benefits . . . have there been any benefits from mining being present in the Carcassone community?

Resident: Not on my property.

Interviewer: O.K. And you don't perceive any other types of benefits that they have been able to provide to the local community or at least the community has been able to achieve from the presence of mining?

Resident: Not really that much, no. Some of the land is more level now than what it was, but the majority of it isn't worth anything as far as doing any kind of farming on it or anything.

Interviewer: In terms of that level ground, did you see any potential uses or reuse of that property other than mining operations? The leveled areas?

Resident: Yes, a person could raise cattle or something of that on it. It takes several years to get a good stand of grass to do that for my area here they had promised us some level land and we don't have any. It's far worse than what it was when they started on it.

Interviewer: So basically, your perception is that any reuse of that property would be some type of agricultural use?

Resident: Right.

Interviewer: O.K. In terms of the relationship that the mining company has had with the local citizens, including yourself, what public information was made available to you regarding the introduction of the presence of surface mining in the Carcassone area? Did they make any contact or have any correspondence with you?

Resident: Yes, two or three different times, they had a representative from a coal company come and talk to us and we were one of the last ones to give in to agree to let them use our property as a strip mine. And that was after we were promised a lot of things which we did not receive.

Interviewer: O.K. And basically those contacts were made to discuss purchasing the property for their mining use, is that correct?

Resident: No, they weren't pressuring it, they were just getting the coal off of it. Paying us royalty for . . .

Interviewer: I see, O.K.

Resident: Mining

Interviewer: So that is what they made contact for. To discuss the

Resident: Right, for the removal of the coal.

Interviewer: O.K. have you had, is your property in terms of structurally, have had any impacts from any mining activities?

Resident: Not right around the house, now the other property, where they did mine that most of it is steep. It's, well you might be able to use it for a pasture, but the only way you could mow it or clear it would be by hand or dozer, so there is really not too many benefits after they got through.

Interviewer: O.K. And in terms of the coal company making any contact with you, you haven't had them . . . uh, there hasn't been a need for them to come out and look at any possible damage that may have occurred from any types of mining activities, such as blasting, have you had any problems such as that?

Resident: When they were stripping, yes, we did.

Interviewer: Could you elaborate on that for me please?

Resident: We had things knocked off the wall and broken foundations, concrete blocks, it was cracked and this area, several have had that.

Interviewer: In your opinion, that was caused by the mining operations?

Resident: I have no doubt it was. The blast.

Interviewer: O.K. and have the mining representatives come out, company come out to your property to do any assessments of that type of damage?

Resident: Not since they quit the permit they had on our property in the other area which that has been close to 10 years ago.

Interviewer: O.K. And did they publish the mining permits in the local paper?

Resident: Right.

Interviewer: O.K., I guess that is required by law, right, state law?

Resident: Right. After they complete the mining, then they go through several phases before their bond is released for it. And I would say, I am not sure, but I would say that bond has been released on this property where they mined here, or it is awful close to it.

Interviewer: Those are all my questions, I had a few more questions, but your indication to me that you lived there basically for most of your life, at least with your wife and you have no future decision to leave the area, so we had some other questions regarding your decision to leave the area and go to another area, but it sounds like you are planning to stay there for now.

Resident: I'm an old regular Baptist Minister and church in this area where I can, so I have no intention of leaving this area.

Interviewer: O.K. Super. Well, Resident those are the questions. Again, we really do appreciate your time and interest in speaking to us, and again, your name and any other personal information will remain confidential, and this interview that we have conducted today will remain anonymous as well.

Resident: I appreciate that.

Interviewer: O.K. One last thing, do you have access to the Internet?

MTM/VF EIS
Community Narrative: Carcassone, Kentucky

Interviewer: O.K., the first question, could you just tell me a little bit about yourself and your family.?

Resident: O.K. What would you like to know? Husband?

Interviewer: A little bit about family history, where you work or where your husband works and also . . .

Resident: My husband works for a strip job and he is a dozer operator.

Interviewer: O.K.

Resident: And, my son, I have two sons. One is 25 and one is 20 and both my sons had to leave here to find work because they don't want to work in the mines or on a strip job, so they left here, so now I have to drive about 3 hours to see my grandchildren. They live in Georgetown. They moved there, you know, near Lexington, where there are better jobs. And, I don't work because where we live, basically the roads and stuff, and the community where we are in, it really it doesn't pay me to work. I wouldn't make enough money to drive that far. You know, we tried that and by the times the taxes come out and all that, it doesn't pay for me to work.

Interviewer: Right, so you are in a very much a rural, Clarkizone is a very rural community . . . can I say that?

Resident: Very so, very much so, very much so. If it comes and snows, everybody here has 4-wheel drive. If you don't have 4-wheel drive, most of the winter, you are sitting. You cannot get out. And, even with 4-wheel drive, a lot of times it's hard.

Interviewer: What are your connections to the area, Resident? You or your family? How did you come to live in Clarkizone?

Resident: I was born . . . my husband was born, in fact he was born on a bridge about a mile or two down the road. On the way to the hospital. But, I was born in Louisville. My family, my grandparents were here and my mother, my mother and father are divorced, so that is how I ended up to be here. My husband has been born and raised here. My children, you know, they went to one school the whole time here. The school bus comes at 6:45 in the morning and gets here after 4:00 in the afternoon, that's how long they are gone to school and that's starting in kindergarten.

Interviewer: Yea, that sounds like my days of going to school. I cam from a very rural area. We are actually here in Pennsylvania and that reminds me of my childhood days.

Resident: But I have seen the kids sometimes here, the roads were so bad, you know that they stopped at the road and they would let the kids off the school bus and let them walk across, and then drive the school bus across and then pick them up on the other side.

Interviewer: What . . . how many people do you say would live currently in Clarkizone? I know it's a rural area but . . .

Resident: Clarkizone is just a small area here. What it is basically it starts up . . . when people around here, when they think about it, it starts up in Elk Creek, this little part starts, it's Elk Creek, that's called Elk Creek, and then you come on up the mountain and this part here is Clarkizone and then probably not a half a mile out through here is known as Jent Mountain and I guess they called it that because there's a lot of Jents that lived there at one time, but everybody just knows that as Jent Mountain, but up there starts the strip jobs, I mean that's where you have people actually living just about in the yard, you know, they're right there, the strip jobs are right there, I mean you look and the rock trucks and everything are going. I wouldn't live there for . . . you know, you couldn't . . . no, I wouldn't want to live there. It's bad enough where I live I felt, you know, you feel the shots and hear 'em and if I have damage from them, I can just imagine what those people out there.

Interviewer: O.K. How many people live in Clark . . . I mean considering that geographic area you just defined, how many people would you say live in the community of Clarkizone?

Resident: Well, I'm gonna put Clarkizone and Jent Mountain and I would say approximately, you would be lucky 100 families, about 100 families, maybe.

Interviewer: 100 families, o.k. When did the . . . how far away is that actual is Jent Mountain where the strip operations is?

Resident: It might be a mile out there.

Interviewer: A mile from where you live currently?

Resident: Uh huh, it may be a mile.

Interviewer: Um, the next questions are focusing on quality of life issues. The first question, did you observe or experience changes in your quality of life related to community resources within the time periods that I specified from let's say 1980 to the present time?

Resident: Community Resources?

Interviewer: Let's give you an example of the quality of your schools, local services, maybe from your local government, the natural environment, the resources, those types of qualify of life issues, could you . . .

Resident: Like the government things to here, say as in our courthouse system and all that, is that included in that?

Interviewer: Right, I would say quality of life in terms of related to the Mountain Top Mining Operation. Did you see any change, any relationship there . . .

Resident: I can tell you that the situation here, especially with the mining industry, just about everybody here has a job connected to the mining industry in one way or another.

Interviewer: O.K.

Resident: And if the mines . . . everybody is dependant on that basically, more or less, and that's our problem in this community is we do not have the officials in place that they are too worried about making money theirself. Now right now, we have had a very good, you know, township, Carol Smith is trying to get us out of this. And it's just so ingrained in, you know, people, the magistrates and all this stuff, that they're beholding to the mining company, you know, they, where if you do this for me, you know, I will do this for you, you know, that kind of thing.

Interviewer: Right.

Resident: You have a whole lot of that right there. Where if you do this for me, you know, I'll give so-and-so a job in your family, you know, he can come out here and work on the strip job, we'll give him a job, you know, or we'll put him to work in the mines. And you have a whole lot of that. For us to ever make anything, bring factories in here, other things in here, you're gonna have to get away from that, you know, you're gonna have to quit being so, we need to quit being so dependent on the mining industry, because you are liable to work six weeks, I mean six months out of a year, and make oodles of money, but then you gotta look, you are laid off for six months, 18 months, you know, let alone, you know, then you've got the health quality issues too, that's like one thing with my husband, right now. You've got the dirt when they're working there, they're working in, you know, the dirt. Now, they are getting a lot better about that stuff right there, making them keep the road watered and . . . you know, the equipment with air conditioning in it, like in 19 . . . o.k. you're talking about starting in 1980?

Interviewer: As a rough time period, correct.

Resident: O.K., well back then, when my husband worked in the dozer, it was, I mean, it was mainly open cab dozers, no cab on them, no nothing on them, no air conditioning, no nothing, and I mean it was dust, they come home dirty, just, you know, nasty, and you know they are breathing that. Now, that is getting a whole lot better because, you know, they are in the enclosed cabs, they have, you know, the air conditioning, they have all that there, they are getting better about that, but they still, they need to get a whole lot better about it, they need to go to all the mines and do that and not just pick out certain ones. I think you have some of the mines, you know, the people that are in the mines that know people that are like, you know, over that, like, what's the people that they have come out there, I can't think of their name, my minds been blank, that comes and takes that, inspectors. O.K., where you have a whole lot of the people that, uh, the big wigs at the mines that knows these inspectors, and they turn their heads to a lot of things.

Interviewer: O.K., so in terms of . . . how about community resources, you talked about personal impacts there, were there anything in terms of impacts or changes to the natural environment?

Resident: Oh, yes. It doesn't even look like the same place where I live. I lived here and I hadn't been a mile up the road, I mean, I can go for a month or two and I don't go a mile up the road here, because I don't go out that way, you know, I go out the other way, and I can go out that way and I mean, I'm amazed, I'm amazed, I mean it doesn't even look like the same place, every time I go out through it's changed.

Interviewer: Right

Resident: There's a mountain gone here, a mountain gone there, you know, some of where you . . . where I live used to be trees. Where my home 's at right now, used to be . . . it was like a forest and, I mean, you know, now I've got my home here, where this was, this area where I live, right now, on what I live on, was somewhere that they strip mined back in the late 70's, early 80's. Because when we moved here, when we moved in our place, right here on our property, what it was was we bought it off of a woman, an older woman and there was a strip job that the mining company had moved her, had bought her this little piece of land here, well, they moved her here, they stripped a piece of land here and they moved her from her home out here on Jent Mountain, down to here, bought her a trailer, and gave her this land in order so that they could go up there and strip her property up there.

Interviewer: O.K.

Resident: O.K., then when they got through with her property, she got to go back up there, you know, and do whatever, but by then, it's you know, just flat, rock, dirt, which is when we moved here, that's what this was.

Interviewer: Right.

Resident: I mean it was, it was awful. I'm still going out here right now, I can't plant anything hardly for the rocks and stuff that's here that you have to dig up and I mean we had a dozer come in here. We had bit coal trucks full of dirt come in here and you know, dump the dirt and then got a dozer in here and done all that, and leveled it out and done all that stuff and then waited years before we moved, you know, our double wide, our modular home here where we've got it at now.

Interviewer: Right. Now do you have, you said about planting things. Do you mean like grass for your yard? Do you have a garden there too, Resident?

Resident: I don't have a garden of like food, but we have peach trees, we have apple trees, what
we are trying to get 'em going, you know, we've lived here . . . we moved here, we bought the land off of that woman I was telling you about in '81, in May of '81, o.k. and we have lived here ever since, but what it is we lived in a single wide trailer and there was like the road, the county road that went through and we owned a big field, like, where they had stripped is what it was, across from it,

and we had that dirt brought in and the dozer and all that and we lived in that trailer for 13 years.
.

Interviewer: O.K.

Resident: Before we came over here, you see, and put something here, so all that time, see it had that time to sit, but when you go out there to plant something, you have to take, well, you can see in my yard, several places where there are big rocks that was put here. . .

Interviewer: Right.

Resident: You know, and there's just no way to get those up. My husband said, you know, he talked about going and you know kinda like getting dynamite and dynamiting them up . . . but on the other side it makes you worry if it's even worse, and you can't do that so you just have to live with them and there's two or three rocks. One out there like in my lower yard, I'm thinking about planting creeping rocks you know going down it.

Interviewer: Right, exactly, make a rock garden out of it, so to speak.

Resident: That's what I am attempting to do right here, I have planted a lot of stuff out here that, you know, kinda incorporating that rock into it.

Interviewer: Right, exactly, try to work with what you have there.

Resident: Yes. But when you go like to plant a tree, I can't get out here and plant . . . a lot of times I can't even plant flowers because the rock is in there and you have to cut . . . my husband has to take a crow bar a lot of times, you know one of those big bars, and go down in there and have to get that rock, you know, out of there.

Interviewer: Dig the rock out before you can actually put some good soil back in.

Resident: Yea, yea, yea we have a big pile here of saw dust, rotten saw dust, that we went and got from the old saw mill that used to be back years and years and years ago, and we go and get that saw dust and just keep . . . I mean there's probably two truck loads of saw dust that we keep out there at all times, for that right there.

Interviewer: Oh, interesting. You had mentioned, a little in your conversation just now about your water supply. Could you tell me a little bit . . . uh, has that, uh, have you seen any change in your water supply since the mining operations?

Resident: When we lived here, the water, when we moved in in '81, the water that they had there, you know, the water system that that woman had, the well was 300 and some feet deep, 365 or something like that they had for that woman . . .

Interviewer: Right

Resident: O.K., there was never, I mean, there's nothing like going and getting in the shower and getting your hair all soaped up and the water would quit.

Interviewer: Oh Boy . . . I know what you mean.

Resident: So, we went through that for, I don't know how long, and come to find out, there was a mine from over on Carbon Glow, at this mine that was mined underneath of us.

Interviewer: Interesting.

Resident: And, that's where our water had been going to, and we had some people that were friends of ours that worked for that mine and they told us, you know, we're right directly underneath of you all and we are getting the water. But, of course, you know, they would tell us that that was their job, you know, and you couldn't say nothing, you know, they wouldn't have never stood up in court or anything.

Interviewer: O.K.

Resident: O.K., but finally I called the coal company, it was Golden Oak and I called them and they told me that man laughed at me, he laughed at me. He said we're nowhere you all, you know, you don't have nothing, you know, we don't have nothing to go with that.

Interviewer: Now what was the name of the coal company again?

Resident: Golden Oak Mining Company

Interviewer: Golden Oak Mining Company. O.K.

Resident: Uh huh, exactly, and I'm trying to think of the man's name that I talked to because this would have been in like '81 and '82, '83, and I'm thinking, I'm wanting to think his name was Koontz, but it may not have been that.

Interviewer: And that's o.k. We don't need that detailed information. I am trying to clarify the name of the mining company so we're . . .

Resident: That's the mining company very definitely the mining company. O.K. But anyway, let me tell you a story . . . this is a good one. O.K., when we went to move to get out double wide to put over here, we found out that this land, even though it had been deeded to us and was recorded in the courthouse, the man that had give the woman the land, you know, the older woman the land, he had give her the deed for it and it was recorded at the courthouse, but come to find out he had already sold out . . .

Interviewer: How interesting . . . interesting

Resident: beforehand . . . and so it didn't really belong to us so here we are holding the bag, we had already signed the papers on this trailer and you know when they do the title search, then they found out that it belongs to the same coal company, Golden Oak Mining Company . . .

Interviewer: Oh, interesting . . .

Resident: So I went to the mining company and explained it and I mean, it was a long, drawn out process. Now, first of all, but getting back to the well, we had to get another well drilled and what we did was, 'cause it was, I mean, we were totally out of water, totally . . .

Interviewer: And this is on your current property?

Resident: This was on the property, yes, on the property, but this was when we were in the first trailer. O.K., we finally had to have another well drilled and what we did was came over here in this field and we found out where a long time ago my grandparents had people that lived here, my family, we found out where they used to have the little house at and where their dug well was at, and what it is they had a mill down here in the creek beside of it, down here, we have a creek here, they used to have a mill here that they ground everybody's meal, o.k., but the creek isn't nowhere near now, it doesn't have enough water in it, you couldn't, you know, back then they said it was a real big, you know, roaring creek.

Interviewer: Yea, enough to power a mill.

Resident: Enough to power a mill, right here where I am at. You know, to grind corn. They ground everybody's corn here.

Interviewer: Into corn meal.

Resident: Uh huh. O.K., and what we did was we found out that the approximate location of where that dug well was at and that is where we had them drill. O.K. They hit water at like 60 feet.

Interviewer: That's pretty good.

Resident: They hit water, o.k., and then they went down 60 more feet, so my well was 120 feet deep and I'm gonna tell you when I first got that well drilled, I tried my dead level best to run that well dry. I would do everything I could and I could not run that well dry.

Interviewer: You had a good water supply there.

Resident: I had a good water supply and it was real good water. O.K., we done it across the road here because we knew that eventually we were gonna put our house here. So then when we moved our double wide in here, we hadn't been here . . . we moved in here on December 13, 1993 and I mean, it wasn't the next year, we hadn't lived here no time till they put saw dust and all the block work, you know, busted all to pieces, you could, I mean we went out there one day, I was sitting here by myself one day about 7:00 in the morning and I kept hearing this thump, thump, I tell you it sounded exactly like when you put tennis shoes in a dryer.

Interviewer: Oh yes, ha, ha, ha, ha.

Resident: But it only happened every so often and when I would hear it I would get up to try to tell where it was coming from and by the time I would . . ., it would be, you know, it would go away.

Interviewer: Right.

Resident: Well, I told my husband I kept hearing it and finally I went outside, was it something outside, and I had two or three dogs at the time and I said it must be the dogs under here, I don't know how they got under there, but it sounded like a dog hitting its head . . .

Interviewer: Underneath the house?

Resident: Yea, so I went out there and all the dogs were all sitting, they wouldn't come near the house, they were sitting here looking at the house . . .

Interviewer: Oh boy, ha, ha, ha.

Resident: So I thought there's some kind of an animal underneath of my house and they won't go near it, they're scared of it. So when my husband come home from work that night, we were sitting there eating supper and I was telling him about it, I said you're gonna have to go under there and see what kind of animal is under there, I said it's . . . and about that time, he heard that noise and he said I'm gonna go see what's under there . . . and he went out, he got up from the supper table, him eating eating supper, ran out and went around the side of the house and when he got around the side of the house, there he said every bit of our block work was busted all to pieces and you could stick your hand through there, your arm, all the way through the block work.

Interviewer: So it actually made enough gap in the block work.

Resident: Oh, it was, it was busted all to pieces and we went around the back side of our trailer and the hole and it's now five block high, it is oh oh oh block work in the back it's five blocks, you know, five concrete blocks high.

Interviewer: These are cinder blocks.

Resident: Yea, and it had actually moved that whole wall out.

Interviewer: Oh, interesting.

Resident: The whole wall out. And what it was was right where our well was at, it sat right up against our house, so there's a crack that went all the way down through our yard and it went all the way under our trailer. Come to find out, that noise that we were hearing? Was our trailer coming off the, you know how when you've got a trailer, you know, you put the block up and . .

Interviewer: You have to have some foundation there for it.

Resident: Yea, you know, you've got, well I tell you what we did, when we poured the concrete for this, poured 44 pads, my trailer is 28 x 70 and we poured 44 pads of concrete. They're 10' x 10' x 10' concrete. 10' deep, 10' wide, you know the pads. . .

Interviewer: Exactly.

Resident: And that's what they, you know, blocked the trailer up, you know how they blocked it up underneath of there. Well, it was coming off of them.

Interviewer: For goodness sakes.

Resident: That's what I was hearing. So I had to call them and they sent people out here and they went under my trailer, had to jack it up and put that back under there and I mean, I've just, I've had an awful mess with them. They've had to come out here and drill me a well. The well that they drilled didn't last a week or two, and they come, maybe a month, and then they had to come back here, the water quit. Now mind you when the water quits, it's usually always on a weekend, so you have to go all weekend with no water. . .

Interviewer: Right.

Resident: until you can get hold of them again and until they can get out here an do something about it. So sometimes there was a week there one time that I was without water.

Interviewer: Didn't have any water to go on?

Resident: No, none, none whatsoever. So anyway the well, when they drilled it, it went dry about I guess three weeks a month later, so they sent the truck back out here and they drilled it deeper. They went down deeper. O.K. Then it didn't last much longer after that. So then they come out here and built me a building, a pump house, they had put concrete floor, it has a 500 gallon water tank in it, is has the potassium filter, 'cause the water had got bad, this water when they made the big crack in my yard, done that to my trailer, you could run a glass of water and it looked just like a glass of milk.

Interviewer: Oh, interesting. Now you say "they" did it. Who are "they"?

Resident: Golden Oak Mining Company.

Interviewer: Oh, so you are talking about the mining company actually came out and did the improvements to your well.

Resident: Yes, but I'll tell you something about that. This is an observation on my part. I'm gonna tell you this. O.K., when we got this trailer I told you that we found out that the field wasn't ours, I had to go to Golden Oak, well they ended up giving it to us, deeding it to us, but I had to agree to sign a paper for them to put a pond within so many feet of us. I don't know if it was 75, 300, what it is, I've got the paper still in there, but that's the only that they would agree to give it to us, which was still very nice. They still could have kept from doing that, but they said they didn't really have any need for it and I'm gonna tell you the reason why, the reason that I think is behind this. I think that the man that they sent out there was nothing but a big . . . and I think that he thought he would get somewhere with me and was trying to score brownie points.

Interviewer: Oh, ha, ha, ha, O.K.

Resident: Now, I know that because I had to , do you see what I am getting into there, and I think a whole lot of the reason why I was so lucky in getting a whole lot of this to get done around here was because he that he thought that he could get somewhere, the mine company officials were more worried about how many women they could go. I actually asked them did they have somebody hired to go around and try to get these women, you know, 'cause their husbands are mainly at work, so they're dealing with the women.

Interviewer: Right.

Resident: And I said what did you all do, you know, in other words, the pretty women, the ones that are nice to you, that's the ones you know, did they hire you to go around and try to make the women, you know, happy, so that that's much less you all can get by with, you figure if you know, you snoocker the women, you've got it made?

Interviewer: They tried to appease you.

Resident: Yes, are you following me?

Interviewer: I know what you are saying.

Resident: Yes, yes, I mean I actually asked him if that's the reason why they had him hired.

Interviewer: Interesting. Now, you had talked about those types of impacts. Was there any impacts on the population or the local demographics from uh, during this time period, 1980, did you notice any population shifts, did people leave the area, or did people come into the area?

Resident: They packed up and people leave. When the kids grow up, I told you I have two sons, both of them left, out of here. I mean there was no jobs to be found at the time there was no jobs to be found because if the mining industry is in a slump, then, they don't hire anybody. They don't hire anybody period and I'll tell you another thing. Even with the mining companies, you've got to understand these people, these young kids when they are coming out of high school, college, the strip jobs, the mine companies, the mines, they want them to have experience.

Interviewer: Right.

Resident: Well how can they have experience if they've never, you know, you have to you have
to work somehow and you have to, you know, learn some time, but they would always want them, you, you had to have experience. Of, if you were lucky enough to have somebody with a lot of pull working there, you know, that could get you a job. That's the only way you could get a job.

Interviewer: So, local hiring practices, it was very, it was difficult in your, could you say it was difficult trying to get a job with the local mining company?

Resident: Oh, very difficult.

Interviewer: O.K.

Resident: Very difficult. In fact, you had to have family working for them already, or, you know, work experience, or you know, something like that.

Interviewer: Would you say a lot of people in your community worked for the mining company, or do most people work elsewhere.

Resident: No, most people are, just about everybody that I know, almost everybody that I know, in one situation or another, their job is related to mining, you know, they may not be directly in a mine, but there is someone, it has got something to do with the mines, or impact in it in some way. Some form or fashion.

Interviewer: And so you are saying like your two sons, for example, and are you noticing this in other families that have children of high school or college age, are they moving out of the area, or . . .

Resident: They are moving out of here.

Interviewer: And they are looking for other employment opportunities outside the area?

Resident: Yes.

Interviewer: O.K., um just an overall question, what is it that you like about Clarkizone, what do you like most about Clarkizone?

Resident: Well, I like being able to . . . I don't have, I'm not . . . like being in a city. I don't have neighbors that I'm sitting here looking when I look out my window, I'm looking at the wall of their house. I'm not looking at somebody else's yard. I have, you know, an area here that I can get out and I can take a walk through my yard and it's like walking, it's nice and quiet, I can walk down the road without, you know, meeting 1,000 cars. I can keep my doors unlocked. You know, I don't have to have my doors locked all the time. Uh, neighbors, if I need something, right now, if I need something, all I have to do is go down there and pull up in my neighbors house, and you know, if I have something go, my husband's on a fishing trip right now, and if something goes wrong here, all I know, you know, I just have to go down the road, and I'm sure some of them will come up here and help me if something tears up here or something like that. You don't find that in the city. And, I like being able to go out here and sit on my porch and look at the birds.

Interviewer: Has any of this what you just described, has any of that changed over uh, since 1980, the time that you have moved in, and has any of that, what you enjoy about Clarkizone, changed in any way?

Resident: You want to know about how many times that I have told the coal company what I thought about them because I feel like that they are inviting on my territory.

Interviewer: And you would say in terms of your privacy, can you say that your privacy . . .

Resident: I feel like that they're tearing up with I have . . . I don't want them to tear up what I have here because this is mine, I paid for it, it's mine and I don't want it destroyed.

Interviewer: Right.

Resident: Even though my husband is a dozer operator, and he, I'm sorry, but these mining companies, there has to be a better way to do this. You know, don't go in here and mess up people like me that money couldn't buy me and they couldn't come in here . . . my piece of mind here and me sitting out on my porch, watching my birds, you know, they aren't gonna buy this place from me. They might go somewhere down the road here to some of the neighbors and buy their place or something and go strip it . . .

Interviewer: O.K.

Resident: If you keep your dust and your smoke and your thoughts and the rest of it to you, but of course it don't work that way. It's a constant fight with them.

Interviewer: O.K.

Resident: It is a constant fight. And, by the way, what I was gonna tell you about the water situation earlier in the field over here, we found out they own this field and when we found that out, we also found out that they had made a mistake on the deed, their deed, their fault, their, their, they had put when we lived on that . . . the one part that we did own the acre of land that we did own, remember when I told you when our well went out and I called them and they said that they weren't anywhere around us?

Interviewer: Right.

Resident: They had used my one acre of land in my name and had used it to mine . . . they mined right directly. They had made a mistake on there and included my one acre of land in one of their permits and had been mining on it.

Interviewer: Oh, interesting.

Resident: And mining under it. Yea, I've got the papers showing it.

Interviewer: Interesting.

Resident: And I mean, it's even papers that come from them where they diagramed, I can take you back through the deeds from what the 1970s when they deeded it to her and then where it went to us, you know where it went from Billy Gilton and at the time that was his, I don't know what they called the mining company, but it was Billy Gilton was the one that was, I guess they called him Gilton or something.

Interviewer: O.K.

Resident: Uh, but I've got the deeds here at my house, showing where, you know, it's went from one to the other to the other, and I've got the papers showing where Golden Oak Mining Company made a mistake on that. I've even got papers showing where they have admitted to making a mistake on it and adding it into their back up, so I don't know what that would have, probably I could have got them in a whole lot of trouble.

Interviewer: O.K.

Resident: But see, I didn't know it until years later.

Interviewer: Right. Exactly. Are there, based upon those, what you just told me, Resident, let me ask you this question. Have there been any benefits from the presence of surface mining in Carcassone?

Resident: Well, if it wasn't for the mine, then what would our people be doing for money? Because we don't have nothing else here.

Interviewer: So they basically provide the, that's your basic, uh, employment.

Resident: Uh, the mine company is what gives me my bread and butter. That's what gave me the house that I'm living in.

Interviewer: O.K.

Resident: What pays for it. My husband works, you know, that's what he does, he operates a dozer. If that company wasn't there, then I wouldn't have. . . you know, then, then, they're paying for everything I have here.

Interviewer: O.K. So the benefit, you're telling me the benefit then is the employment opportunity that your husband has.

Resident: That, that's basically, that's one of the things, and I can tell you another thing, they do do a whole lot like as far as helping put ballparks in here, things like the road over here, side of the mountain, I can give you a good example here. Probably back about 5 years ago, 7 years ago, there was a piece of our road fell down. 7 years ago the parents were going to get together and were not gonna let the school bus, our kids ride the school bus because it was so bad. School was about to start. Now, there was, I can tell you this, it was not far from an old mine that used to be there, in fact people go there right now and get water out of it. It's got water that runs all the time and they fixed a hose up out of it and I don't know. Tons and tons of family around here, they come and get their water from there. It must be good. People come from Blackie, from down at Red Star, from everywhere to get water from that mine.

Interviewer: Right.

Resident: O.K., it was that close to that mine, but there was also a gas company that had a line through there too, so we don't know exactly the reason why the road did that. But anyway, Golden Oak Mining Company came in here and fixed the road. They, I think, furnished the equipment, or furnished half of it and the County furnished the other half and they fixed that road. It supposedly it was supposed to be like for community relations, but I found out later on that here they were, it was on TV. and all this stuff, and here they were taking the credit for it and oh, you know, wanting everybody to think, oh, they're so great for doing this, for helping this community out, and doing this for them, well, come to find out, I found out that they were getting, they had been fined for something and were gonna have to pay a fine and they didn't have to pay the fine if they helped, you know, in other words a community service project.

Interviewer: Right, in lieu of having to pay . . .

Resident: Lieu of having to pay their fine.

Interviewer: O.K.

Resident: So, you know, things like that would come out to the good hit home.

Interviewer: Right, exactly. What, in terms of the mining company, its relationship with the community, what public information was available to you or your neighbors regarding the introduction of the presence of surface mining. Do they have any information that they give to you on their activities?

Resident: Now, not until, probably, uh, I would say a couple of years ago, I got a letter in the mail, it was certified mail, they sent me a letter and said that they were going to be mining within ½ mile of my house and it, you know, it told about the blast signals and, you know, all that. Other than that, no, you don't hear anything.

Interviewer: So, beyond that initial contact, you can answer yes or no, if you wish, did the surface mining company continue any contact with you or your neighbors beyond that initial contact?

Resident: No.

Interviewer: The next couple of questions, I know this is, if you left the community, would you ever, are you planning to stay in Carcassone for a long period of time?

Resident: Yes, I would love to. This is my home, I have my home, I have my house here, I have, you know, the trees that I have planted and watch grow, but, if my husband gets without work, if the mining company, then, we would have to leave, we would have to go where the jobs was at.

Interviewer: Right, because there's no other employment opportunities there to . . .

Resident: Other employment opportunities.

Interviewer: O.K., so hat would be a factor for you to leave if the mining company left and your husband was without a job, you would basically have to leave because of that fact of unemployment.

Resident: In fact, I can tell you right now, my husband, as of right now is laid off.

Interviewer: Oh, interesting.

Resident: Yes, he just got laid off, lets see Saturday was his last day of work, but it's only supposed to be for this week, because, uh, what it is is the coal will stop, see you go through this right here too, and now this is the first time my husband has worked for the company for 9 years and he has never been laid off before and they have had their hours cut down here for the last month, month and one-half, they have cut the hours down and now they have laid them off this week because the tipple is shut down because where didn't have a bad winter, we didn't use coal, as much coal, so they have coal stockpiled up. They have too much coal stockpiled up, so they cut their hours down. See, this is the mining industry, it will be o.k., but yet look at it back three months ago, two or three months ago, they were wanting them to work 7 days a week, they were hiring people, they were begging people, they were talking about bringing people in the from the Ukrane to work because we didn't have enough workers here, they couldn't train them fast enough, you know, and they were just, coal was selling for, you know, $50 and $60 a ton and now here it is, and I've been in around the coal business long enough to know, when I see that, I know that there is a big slump fixing to follow it.

Interviewer: Oh interesting.

Resident: When you see something like that going on, a big coal burn, then you can bet that not far along following it is gonna be, it's gonna, the bucket's gonna fall, the bottoms gonna fall out from under it. This is exactly three months ago, they were begging for workers, couldn't find enough workers, and now here you are laid off.

Interviewer: Laying off workers, interesting. Well, you have given us a lot of good information. I will give you this opportunity. That's all the questions that I have, if you have anything else you want to add, feel free to, but that's all the questions we have. I had given you information up front about if you needed to contact Bill Hoffman, or if you wanted to log on to the web site to check out the project itself and where it is at in terms of the report . . .

Resident: I have it written down here.

Interviewer: Exactly, so and you have my name and information if you want to get back in touch with me, but that's all the questions I have for you.

Resident: O.K., well if you all need anything else, you can contact me.

Interviewer: Well, that's uh, that is super . . .

Interviewer: I am going to ask you several questions regarding again about Mountain Top Mining. Could you tell me a little bit about yourself and your family and how you came to live in the Naugatuck area?

Resident: Well, I have lived in the Naugatuck area all of my life. Ever since I was about six years old, lived over up on Big Branch, that mine is up there.

Interviewer: And what was the name of the bank or the Mountain?

Resident: It was more of a development where I lived up on Big Branch most of the time till I went in the service.

Interviewer: O.K., you said Big Branch?

Resident: Yea.

Interviewer: O.K., Big Branch, O.K. Did your parents reside in Naugatuck then too?

Resident: Yea.

Interviewer: So you were a life-long resident, born and raised in Naugatuck.

Resident: I was born on Marble, but I was about six years old up in here.

Interviewer: Since you were six years you lived in Naugatuck?

Resident: Yea.

Interviewer: You were born outside the area then?

Resident: Uh Huh.

Interviewer: O.K. When did your family then first arrive in Naugatuck.

Resident: I don't know, I don't remember.

Interviewer: So basically your family has had long ties to the Naugatuck community?

Resident: I was about, well we lived on Main over there in Logan County for a while, and then we moved back over here when I was six years old. Ever since.

Interviewer: O.K., so you have been in Naugatuck since you were six years old?

Resident: Yea.

Interviewer: O.K. In terms of the mining operations, we are trying to concentrate a time frame, from 1980 up to the current time, so one thing, if you could maybe keep in mind anything from 1980 to the present day when you are answering the questions that would be great. When did mining operations come into Naugatuck?

Resident: Oh, ever since I can remember the strip jobs bit the other mine deep mines things up know.

Interviewer: When did you observe, or when do you know when Mountain Top Mining type of operations came into the Naugatuck community?

Resident: I can't remember what time it was.

Interviewer: And they are currently operating now?

Resident: In some places, yea.

Interviewer: In your own opinion, what are the effects of Mountain Top Mining on the community. In your own opinion?

Resident: **[ ]**, he don't affect nobody, he just gets more work and stuff to the people. It don't affect nobody through here that way.

Interviewer: So it sort of has some positive affects then for employment opportunities, is that what you are saying?

Resident: Yea.

Interviewer: O.K. How many people live in Naugatuck. How large is Naugatuck in terms of the number of people or families that live there?

Resident: Well I guess, right through my community, there is about 50 homes.

Interviewer: About 50 homes?

Resident: Yea.

Interviewer: Have you noticed any changes in the population? Have people moved in? Has it increased or decreased over the last 20 years?

Resident: Well, it's been about the same. Somebody moved in but a lot of elder people have since then passed away and some other peoples have moved in. Younger people, you know.
Interviewer: Do you know why the younger people are moving in? Is there any reason that you can determine why they are moving into the area?

Resident: Well, they just like the location.

Interviewer: They like the surroundings and what the community has to offer I assume. O.K. Is any of that been related to the mining operations in terms of are they seeking employment at the mines or there are other reasons you think that they are . . .

Resident: They are there, most of them, is working in the mines.

Interviewer: So most of the people that live in Naugatuck are employed by the mining operations? Is that correct?

Resident: Yea.

Interviewer: O.K. Has anything . . . what do you like most about Naugatuck? Why do you stay there?

Resident: Well, it's just home to me, I have been here so long and it's a handy place for me. I told you I am a Christian and right across in front of the house is the church house, I go to church there and I can walk over to the post office and store and it's just a handy place for me.

Interviewer: So there's a lot of other things that you like about Naugatuck that keeps you there like the church and the store and the post office.

Resident: Yea, and I have been here all my life and I know a lot of people and stuff.

Interviewer: Did you ever work in the mines?

Resident: Yea.

Interviewer: You did? How long ago?

Resident: It's been a right smart bit ago. It's been 40 years, I guess, since I worked in the mines.

Interviewer: It's been almost 40 years ago since you worked in the mines?

Resident: Yea.

Interviewer: O.K., so that's been quite a long time ago, hasn't it?

Resident: Yea, the last I worked I worked at the Coppers Mine in Wyoming County.

Interviewer: In Wyoming County, and that's in West Virginia?

Resident: Yea.

Interviewer: O.K. Do you . . . in terms of do you hear anybody talk about the mining operations? Has it caused any problems for them, the people that you know, or have any feedback about the mining operations in the Naugatuck area currently?

Resident: Well, uh, all that I have talked to and things, when they talk about shut down the strip jobs, they think it's wrong, they ought to let the men work.

Interviewer: So, it is really a positive aspect that the mining operations are in Naugatuck and really for the employment opportunities, is that correct?

Resident: Yea.

Interviewer: So you haven't heard any people talk or any negative effects from the mining operations there in the community?

Resident: No.

Interviewer: O.K. Did the mining operations, have they had any contact with you about their operations in terms of notifications of their operations, or any just personal relationships that they have had in any . . . with you or any other members of your community?

Resident: No.

Interviewer: O.K. Do they announce when they are doing any operations or any blasting activities for example?

Resident: No.

Interviewer: O.K. So you are pretty much . . . you're gonna remain in the Naugatuck community probably for the rest of your life then I assume?

Resident: Yea.

Interviewer: O.K. The questions that I have the way you have answered them have . . ., you know, you have been to the point and that's great, but that's all I have for you. We are trying to get an understanding and I think your overall opinion is that the mining operations have positive affects on the community.

Resident: Yea.

Interviewer: O.K. Super. Well, with that in mind, that's all I have to ask you. We appreciate your time and you have a . . .

MTM/VF EIS
Community Narrative: Scarlet, West Virginia

Interviewer: Tell me again a little bit about how you and your family came to settle on Scarlet Road and the pre, before the mining came in. What was the, what you liked about it here.

Resident: It was a, it's a family community. My grandfather owned, probably the biggest majority of this. He lived down here where the stone wall is; there is a piece of stone took out of the corner of it. That was the home place. There was no houses up in here 'til then. And I told you, this was another mile and a half to two miles longer, it is up to the valley fill right here now. Most of these people are my aunts and uncles that lived down here. All the houses that are gone or falling in are aunts and uncle or cousins that died or was brought out and they've left. Up the other fork, have you been up the other fork?

Interviewer: Umm hum. We were up there yesterday.

Resident: We are all kind of family community. You know, everybody knew each other. There was approximately sixty or seventy families, I believe, at one time. I think there is what? Three or four up there now? It has really dropped off. This place was full of kids. It was just a community where, you know, we had a ball field. You can't tell where the ball field was but it's at the forks down there. They done away with that about ten years ago when they started this mountaintop down on 119, down there.

Interviewer: Did they… how was the ball field… was the land bought or?

Resident: No. It was at… the name of the cemetery - it was called the "specific name" cemetery, it's "specific name" cemetery - it was off there beside the railroad track. Then when they started mountaintop down there, this Consolidated, they came up there and redone the railroad tracks. And they owned so much of it so they took a dozer and "sphll", killed the ball field. Let's see… the quality of life was well you know, I guess you call us poor, you know. But we didn't bother anybody and nobody bothers us. Everybody worked their mines underground and there was no such thing as strip job you know. Like I told you, I worked almost 20 years underground. My dad worked for Island Creek down here. You see, Island Creek had a big underground mine down here from '49 to '69. And when they shut down that is when they started trying to strip.

Interviewer: Un huh. Can I just ask? Did this community grow up around the underground mines? Did a lot of the people who worked, who lived here?

Resident: No. No it didn't… Well, I guess in a way it did grow up around it because, since my grandfather owned all of this, naturally, all of his sons had a job whenever they wanted it. They mined underneath his property. And he gave them access, see there's no road up here except down to the homeplace down there, and he gave them a road, a right-of-way with a road. They built a road, but he gave them the right-of-way to come up here. And they have substations. You know what a substation is?

Interviewer: No.

Resident: That's where they have the electricity. They drill a hole down into the mines and they put electricity down.

Interviewer: Okay.

Resident: Instead of trying to take it underground, they come on the surface and drill a hole down. They had one up here on the hill. And one down the road here a little ways, you can't hardly tell where it's at. There's a brick house down here on the right. Going back out right here, there was a substation there at one time. And that is how, I guess maybe you can say that it grew up… the community grew up around that. In a way.

Interviewer: So, you said the underground mine closed about when?

Resident: About '68 or '69. I was in the service when it closed. It was running good when I left in '77. I think it shut down in '68 or '69.

Interviewer: Un huh. So you moved back here about when?

Resident: In '71. That has been thirty years ago.

Interviewer: Long time for anyone to live in one place these days.

Resident: Well, I came back here in '71. I stayed here until '78, then I moved to Delbarton. I lived in Delbarton fifteen years and then I moved back here. My dad stayed here. I am one of… my brother lives up here. That is where he lives. As a matter of fact, he was the oldest employee for Arch Coal on the job. I ream him all the time. I say, "Look what you done."

Interviewer: Did he work for the underground mine and then when that closed?

Resident: No. He started working for them in '70, when they first started…when this, this job was called Hobet 07. They started it in, I am not sure on the date, '69 or '70. They started down here on the hill. You can see the old strip. But that was… they got that permit, from what I understand, what I have been told I really don't know, it was on a temporary thing. The State told them to do it, so they could see what they could do. It was a new thing that they wanted to try. So, they got started on that and they'd seen what they could really produce with nothing. And that is where it all started from. They actually started… when they started they blasted everything over the mountain. It was terrible. It was terrible. You could see the difference. I mean when they loaded it up it just… they used it all. But a lot of it was shot over the mountain and was just left.

Interviewer: Right.

Resident: That was good. It made an awful lot of money. Then they said wait a minute, blowing it over the hill is no good. So, they stopped and thought about it and we'll try, what we call now a box cut. Called a box cut. They go in and they don't shoot over the hill. When they shot it's loaded up and carried back. It's called back fill. The spoil and overburden is back fill. So, once they remove the coal the dirt in front of it is hauled back behind then to reclaim. So they reclaim it as they go. They have an open fill of so many hundred yards. Which is good. Which was *real* good. You can tell there is a world of a difference if you go and look on that. You can drive and look on it. The road is still there. A world of difference. That was good. That didn't bother anything or hurt anything. That was good. They mined that for about seven… about seven years. Of course, that took them all the way to the head of the left fork, which runs into this, you see. It's tied into that. And that was real good. It didn't hurt anything. They shot hard, but as far as water damage, it really didn't show up. I guess probably because it was… they really wasn't shooting that hard, because there just really wasn't that much to shoot on that. So ah… there was no water problems. The water problems began in the '80s. They moved… that was in '76. They moved… they moved to the Hobet job here in '76 they started. In '80 is when the water problems started. My mother had a well drilled. I was about ten or eleven years old. She lived up there then. She had a well drilled when I was about ten or eleven and it was about 75 feet deep. It's good water. No problems. Never had a filter. Never heard of a filter. What's that, you know? It was real good water. In '80 the water starts to go. They come in and say, "We'll drill you a well. We'll put you a filter on it…. Anything you want".

Interviewer II: That was the mining company?

Resident: The mining company, yeah. Then after they got by you know what happened? They just… you know, sue 'em.

Interviewer: Was it the same company, that was doing like the box cuts down here that was over there?

Resident: Well, I *say* it was the same company… When it was here it was independently owned, but it was bought by Ashland Oil.

Interviewer: Who is Hobet?

Resident: Yeah, they bought it. In '70, I think. Before they left here, Ashland Oil bought it. Then I think by the time they got over on that side, it was actually, solely owned by Ashland Oil. Out of Gatlinsburg, I guess that is where their headquarters are. So, then in, what about five years ago, Arch Coal bought them. So, that's just the… The time line I am not sure on but that is just the way it happened.

Interviewer: So what kind of changes? …you described a community that was very tight knit, family and you had a ball field and that sort of thing. How… what kind of changes would you say occurred in the community during the mining?

Resident: Ah, when all the problems started in and they ah, more people complained, you know, about the water and stuff. The dust was real bad. You can see how close we are to it. The dragline boom, you can see it right there it was so big, and naturally you can see it right here. But you could see it through the trees and it would swing around. The closer they got to the community the more problems, naturally they are going to have more trouble. So their way around was to buy you, or you know, water wells, or whatever. So they started buying people out. And as they started that, they started pitting neighbor against neighbor.

Interviewer: What were your experiences with that?

Resident: With that? They offered to buy, now I didn't get into it. I moved back here in '93 and I really didn't get involved in it until then. My dad died in '90. I moved back here in 1993. And ah, my mom is seventy some years old. I told her well, we ought to go ahead and sell and get out, and it is only going to be worse because they kept buying people, you know. Naturally if, you're you know… it was a good thing 'cause they killed the community. The water goes and everybody falls off. The property that they purchased will set to idle for two hundred years. And you see the old houses now and that they just literally walk off and left, like a slum lord. You know, just walked off and left. And she finally agreed to it and I got a hold of this land agent. His name was "specific name", I don't know if he's still there but. But he didn't want to give her enough to go buy a place back. You can't give your place up or sell your home that is convenient to those people. You'll put yourself out on the street. You just can't do that. That's not good business and that's not smart either. But that, that was their attitude: "Take it or nothing," and it was nothing. But you hear all kinds of things. Families talk. This one talks. From what we could get, some people really got paid for their places and some didn't. But of course people who didn't aren't going to admit it, you know, that they got took. But, the bottom line is she didn't sell and we're still here. And they brought her drinking water for months, then they quit. Then she complained to the State DEP, and they told her that there was nothing they could do about it. …

Interviewer II: And when you say pit neighbor against neighbor, when they started to buy people out, what was the attitude there in terms of neighbor against neighbor? What do you mean by that?

Resident: Well they would tell some people not to drink the water and tell the others there wasn't nothing wrong with it. Now how can you go… Did you talk to "specific name" and "specific name"?

Interviewer: We haven't. We haven't had a chance to talk to them yet. We missed them last night.

Resident: They probably won't talk to you.

Interviewer: You think so?

Resident: Just, just, you know… Because "specific name" still works for them.

Interviewer: Oh really.

Resident: And that was his mother that I told you, that I was told they told her not to drink the water because she was sick. They told her not to drink the water and she lives right above my mother. So, and he still works for them.

Interviewer: That is interesting. We'll have to talk about that a little later. I'd curious to talk to them, I hope. Did you notice… well let me put it this way: What were your interactions with the coal company personally? Did you complain about anything specific to them? Did you complain to DNR or?

Resident: Not to DNR. DNR is never been involved in this, as far as I know. It has always been the State DEP. I always complained about the water and the dust. The dust was terrible.

Interviewer: So you complained straight to the State?

Resident: State DEP, yeah. I moved here in August of '93. In February of '94, February 3rd or the 4th this records had been destroyed. I'd been told that they can destroy those blast records after five years.

Interviewer: Who told you to do that?

Resident: The State guy told me they could take and destroy it after five years.

Interviewer: What was your understanding for why?

Resident: I don't know. But on that particular day the dragline on the top of the valley there, they put off a blast of a hundred and three thousands pounds of explosives. It was an open shot. You know what that means?

Interviewer II: It was basically near the surface right?

Resident: It wasn't confined - it was open. It hit a fracture in the rock, and the shock foreman and his people didn't pay attention to what they was doing and they over loaded. Didn't realize what they were doing. I guess they estimate. I don't know if they really knew. But they put down on paper a hundred and three thousand pounds of explosives. When it went out it tore the back end of the dragline out. It was down for about two to four days to a week. I was fortunate. This mobile home is tied down. I got eight or ten ties on it. Normally there are about four. I knew I was in a blasting area, so when I put it here I really tied it down. But it shook it *hard* because it threw me against the faucet there. I just walked in here and was getting some water, you know, and wham. I didn't know what happened and when I stepped on the porch there I could not see that big tree at that point at the bottom there. I *knew* it had killed the people up there. I just knew it. I just knew it killed 'em; you couldn't see nothing. There was a wall of dust. I could believe it.

Interviewer II: Did people end up getting hurt?

Resident: No. Nobody got hurt. Nobody got hurt. I listened, then I heard somebody holler and I said well somebody is alive. But the dust, you just couldn't see. And I knew… I just knew that they had killed someone.

Interviewer II: Are they supposed to give off warning signals before they do that?

Resident: They are supposed to have ah… a whistle or something.

Interviewer II: But did you hear anything?

Resident: Nah, I didn't hear it.

Interviewer II: There was no warning? I mean that you could hear, that they were going to set off a charge?

Resident: Ah… I don't know. To my knowledge, I don't think I ever did hear it. But normally they did do, they did, normally they did do there blasting around four to six.

Interviewer: So you had a basic time frame, you knew that probably if it was going to come that is when?

Resident: Yeah, but if you are not sitting there looking, then you don't pay attention to what time it is. Oops, they are going to blast. Well, hang on. No, that was just one of the things they did… with total disregard to people that lived around here. Just one. They constantly, they constantly, the surface water they constantly messed that up. With total disregard, and the State DEP won't do anything.

Interviewer: What kind of… what kind of messed up do you mean?

Resident: Well, they put black water in the creek. That is a no, no. You are not supposed to put black water in the creek.

Interviewer: What kind of… Do you have any direct contact with the coal company about umm, any of what was going on?

Resident: Any direct?

Interviewer: Yes.

Resident: No, because I would not talk to them. Because the bottom line, if you did, if you could catch one of them, was - sue us.

Interviewer: What are you going to do about it? Sue us?

Resident: Right. You going do something with the water? No. We can't do this. We can't do that. No. Sue us.

Interviewer II: You're the little man.

Resident: You're the little guy and ah - Try it, ten years from now you may get it in court, if you've got enough money to retain a lawyer for that period of time. And these lawyers around here, they wouldn't take it. Probably want to take you money, but you would never get it anywhere, so why bother? You can't fight it. If you don't have the State behind you, you are not going to get anywhere.

Interviewer: Did you ever have any direct contact or to your knowledge did your parents or your family have any direct contact with the coal company before they came in?

Resident: Before the coal company came in?

Interviewer: Yes, before the surface mine came in?

Resident: No. No. That is one of the things we talked about. To my knowledge they never came in here and done a thing. They were supposed to do an environmental study on the water and all of that stuff. I asked them for a copy of it and I never did get it. I don't believe it was ever done.

Interviewer: How about any pre blast surveys or anything like that?

Resident: They did do a pre blast survey on some homes. My mother had hers done. They done a lot of damage to her - house is old. That is one of the things that they haggled is that - Your house is old, you know so we are not going to do anything. They done a pre-blast on it. There was damage on it along with the water. She did harass them long enough that they did finally come and say well we will fix ah, drill two wells and they were suppose to fix a couple more things and I can't remember exactly what that was, put a new roof on her house. Ah they drilled a new well here for my dad. Drilled her a new well. But they never did fix the roof and stuff. And I still have the paper that they signed that they would do that. And the DEP refused to enforce, to even talk to them about that. To make them do what they promised too. They wouldn't do it. And their bottom line was we are not going to do it so. I had a report. This is my last one.

Interviewer II: That's thick!

Interviewer: You just gave the transcriber a heart attack.

Resident: This is my last one as of August the 17th about my water. See my well out there has gone dry.

Interviewer II: Where do you get your water now "specific name"?

Resident: I'll show you after a while. Yeah, the 17th. Terrible. This is just one of… This is between me and my mom's place.

Interviewer II: This is a copy of the complaint investigation with the West Virginia Division of Environmental Protection.

Resident: And that is as far as it goes.

Interviewer: So, it's basically like a receipt of the registered complaint.

Resident: Complaint. They acknowledged that I complained about it and ah it pretty well dies on the vine.

Interviewer II: What does it mean by investigation results terminated?

Resident: It means, they're just not going to do anything. The volume of my water kept… my drill well out there, the one that they drilled for my Dad… one of them. They drilled another one out here and I filled it up with concrete because it cracked and the creek was running in it. I wish I hadn't done that, but I did. I wish I hadn't done that. But they have a record of it when they checked it. I told them that I kept… see they got my dad a filter to put on it - bought him a filter for it. And I noticed over the last since I have been here, the water kept going down, the volume. And the guy told me, he said, "Well when you run out of water, we're going to have to do something about it." I said it's going to happen. I kept telling them it's going to happen. Finally one day I got up and it all shut down. The filters ran out of water and it shut down, which it is suppose to. So, that was a couple months ago. I went to him and told him, I said, "I ran out of water last night." He said, "Keep an eye on it." You know, like he is *really* going to help me this time, you know. So I kept and eye on it, you know, and a day or two later well it done all right. Then the 17th, I guess. I said it is gone. I said there is no sense fooling with it. I said it is gone. It is time to do something about it. I went and filled that out. You see how far it went.

Interviewer: And he in this case was who?

Resident: He was the inspector of the DEP for this area. For this job.

Interviewer: He was a mine inspector from DEP?

Resident: Right.

Interviewer II: So, you have no water at all now?

Resident: I have water but I am having to work for it. It is a daily problem.

Interviewer II: You have to wait for it to fill?

Resident: Fills up or I have to adjust it. I have 10 minutes reserve in it. And it is not enough to backwash one of those filters. It takes two and a half hours to run those filters out.

Interviewer II: You often during the course of the day run your well dry?

Resident: Yeah, I run dry during the day. I don't use a whole lot of water.

Interviewer II: You watch how much water you use?

Resident: Yes. I haven't washed a car in three years.

Interviewer II: These dry periods like during the summers… do you, you're really ah …

Resident: Terrible. Yes, I really have to watch the water I don't have a whole lot…

Interviewer II: Do you have to go outside the area to get water? Like bottled water or? Right there?

Interviewer: Right. Jugs.

Resident: That's drinking water. But now you see, you see what kind of problems it has created? And really we didn't ask a whole lot. After they destroyed the community water we asked them to pay for what was lost. Really you can't pay for what we lost, because we lost our independence. We were self-reliant mostly, you know we worked outside but you know we took care of ourselves. We had our own water, our own places to live and now they are going to come along, and because they want to mine coal that we had to up and give it to them. That was their attitude.

Interviewer II: So, your feeling was, you may not have minded the coal company… the mining itself, because it was, I mean what your feeling was…

Resident: The mountaintop?

Interviewer II: Right.

Resident: They way they do it I don't think it is really that profitable, considering everything.

Interviewer II: But in terms of like mining is, you know….

Resident: Mining itself? I am not against the mining. Is that what you are talking about?

Interviewer II: Yeah, I am just wondering, you know, you probably realize maybe importance of mining and how it serves the economy but the actual impacts on local communities, like Scarlet, and what may not be and what is not done to ah.. reattribute your loses, so to speak, that is probably where the…

Resident: Well like I said. If they knew, they knew what they were going to do in here, why didn't they come beforehand? Because, they didn't want to pay the people for their places or their property. Because, they knew they were going to destroy it.

Interviewer II: Did you get offered to get bought out?

Resident: Yeah at one time. But like I said they didn't offer enough… You got to have money to buy a home back. You can't give them your place and go start paying a mortgage and all this stuff for their benefit.

Interviewer II: Right.

Resident: That is like I came to your community and say I will give you so much for your place and then you've got to go. But why should you, I mean, you know, do that for me? Your not obligated to do that for me. For what?

Interviewer II: Exactly.

Resident: And that was their attitude. But this is all the complaints over the years.

Interviewer II: This is a notebook probably 4 inches thick of complaints just like you showed us here.

Resident: Yeah.

Interviewer: The property that your home sits on now, does your mother own that or do you own this property?

Resident: She does.

Interviewer: She does. It is getting windy out huh?

Resident: Oh, it is terrible out there. My electricity went off last night about 12:30 and it came on about 7:30 this morning.

Interviewer: The electricity was out where we were too last night.

Interviewer II: Yeah, we heard the wind and rain last night. Woke us up, too.

Resident: Yeah it was terrible out there.

Interviewer: What can you tell me about where you would see these permits being posted publicly. Did you ever find those?

Resident: Those were in the newspaper.

Interviewer: Did you, do you get a newspaper here that you see them in regularly?

Resident: No, not now I don't. No. They did that. I guess they really did publicize those like they were supposed to. That is one thing that I would say they probably did do right.

Interviewer II: Did you ever see the permits in the paper?

Resident: Sure.

Interviewer II: Were they legible? Could you understand what the locations were about?

Resident: Most of them. I would say about 90 percent of the time you could.

Interviewer II: You could understand it by reading what, where the locations were? Where the permit was actually being applied, to the area?

Resident: Yes. Most people can't but, you know…

Interviewer II: When you say a lot of people can't, what do you mean by that?

Resident: Well, can't read a map or understand the terms that they… they ah write under the permit and stuff. For some people that are not familiar with mining…

Interviewer II: As you are.

Resident: Right.

Interviewer II: But the average person…

Resident: …person may have difficulty, you know, understanding what they're talking about. They may be able to look at that map, if it is real legible like you say, "Yeah I can see what this is. Yeah, this is all 119 or Dunkin Fork or Myrtle or Trace Creek," and you know, they could tell where it was at. But they may not understand the terms that's written into the permit. There may be an Article 3 renewal on the water or new permit completely.

Interviewer II: Which you understand?

Resident: Yeah, I did.

Interviewer II: But anybody not evolved with the coal mining operations may have…

Resident: They had trouble they still have. All the people may not understand. My mother didn't understand.

Interviewer II: Interesting. Interesting.

Interviewer: We have talked a lot about the negative impacts and the physical impacts in the community and you know, what would you say were the benefits here?

Resident: The benefits?

Interviewer: Um hum.

Resident: I'd say probably the only good benefit to say is if you are working for them.

Interviewer: And, take your example, for example, where were you working during this time period?

Resident: I worked underground.

Interviewer: You were underground?

Resident: Yeah.

Interviewer: Did you ever consider going to work for them?

Resident: I worked for them when they had their prep plant down here. Ah, that's a good question that you asked. In 1986, I think it was. I was unemployed and I, they had a couple openings and I went to a talk with the fella that was in charge of that. And he offered to sell me a job.

Interviewer: What do you mean sell you a job?

Resident: For money.

Interviewer: He basically…

Resident: He was a foreman he was in charge…

Interviewer: A bribe?

Resident: A bribe.

Interviewer: Humm, and what was your…

Resident: I was shocked. I was stunned. I really didn't catch it until the interview was over. And I was informed, "Yes that is exactly what they are doing. Didn't you know it?" I said, "*No*, I did not know it." I said, "What happen to honor?" He said, "There is no honor among those people."

Interviewer II: So if you wanted a job you had to pay?

Resident: You had to buy it.

Interviewer II: You had to buy your job. Interesting.

Interviewer: So, what did you do? Where did you go to get work after that?

Resident: I was floored. Oh I went back underground, you know. Yeah, during that period of time, the coal industry went up and down. These guys here were real fortunate. That's one… like I say, if you were working for those people it was good. Because my… my brother who worked for them, never lost any time. They, when I worked underground it was up and down there for a *long time*. Up and down. And I would just from one to… because it was, it was,… I don't know. It was just… I guess when these guys had the big operation, I was working for smaller people who would start up and shut down for a while, you know, just up and down. But, these guys could run the large amount, you know the large tonnage. And I guess that's really what kept them going.

Interviewer: Did you ever discuss what you had encountered when you try to get a job there, with your brother? While he was working there?

Resident: That is who informed me as to what was going on. He said, "Didn't you know it?" I said, "No, I did not know it."

Interviewer: Do you think he had gone through the same thing?

Resident: No. No. See he had worked there since, for thirty years. He was there,… They bought, … he was working for that company that they bought. So they bought him when they came in.

Interviewer: Well that is interesting.

Interviewer II: To say the least. Did the other, so basically the people in Scarlet, as a community as a whole, most of those people in here were not employed by the mining company that operated?

Resident: There were, I am going to try and tell you how many there were. I think there were four.

Interviewer II: Four people?

Resident: No, I think there was five.

Interviewer II: Five. And how many, I assume they were all male, all men? How many men, you know, were in the community here in Scarlet during that time period? That is five compared to how many men?

Resident: Ummm. There was *several*. Several

Interviewer II: So, out of that five would be considered maybe a small percentage?

Resident: I would probably say maybe 20 percent. Well you take, it is not that big of a community, so five guys, you know… There was several people that they could of hired. I may be wrong in that. I believe there was just five.

Interviewer II: So was there benefit of employment, offered by the mines, if you lived here?

Resident: No. No.

Interviewer: What did ah … once this operation started to wind down, the five, or the four or five people that worked for them… Did they move with them and move out of the community? Or do they still live here and still work for them or?

Resident: No. No. There is no one working for them now.

Interviewer: That lives here?

Resident: That lives here.

Interviewer: What would you say, do you think happened?

Resident: A couple of them… let's see here, one of them still does work for them. Just one.

Interviewer II: In the Scarlet community?

Resident: Yeah, but he doesn't live here now. He was one of those that they bought out up the left fork. So he is out of the community, but he still works for them. Just like, just like "specific name" and "specific name"; he still works for them.

Interviewer: … and the other three or four?

Resident: … are retired or they work somewhere else.

Interviewer II: Did the coal companies, you know during the mountaintop mining operations, in your opinion… Did they have good public relations with the communities and then the individuals like yourself that lived in like Scarlet? Did they actually have good public relations in your opinion?

Resident: Not in my opinion. No.

Interviewer II: Other than publishing the mine permits, would you say that was part of their public relations or there was a lot more….

Resident: I would think that was required by law.

Interviewer II: Right. So above what was required…

Resident: They didn't do anything more than what was required.

Interviewer: I wanted to ask you a little bit about your decision to stay verses leaving. You had said that the offer they had been made to your mom for the property and presumably for her home and maybe your home too, was not enough to really purchase something somewhere else in your opinion. Is that what you …?

Resident: Right. Right.

Interviewer: Can you elaborate for me, a little bit on your decision to stay? Was there ever a question that maybe you would take that money anyways, because you really wanted to leave?

Resident: Ah, no. You can't go unless you got money. You know, you travel. You know the price of things, ah… I watch the homes go up everyday. Ah.. try to move right now so much it costs. Terrible. Terrible.

Interviewer II: Now when you moved from Delbarton, you lived in Delbarton for 15 years. Your decision, maybe you mentioned this earlier and I apologize, your decision to move back into Scarlet… What was your decision to move back in to Scarlet from Delbarton?

Resident: Well I didn't own my place up there. So I was living on a piece of land that my brother owned and I'd just moved back. My dad died and he had stayed here.

Interviewer II: In Scarlet?

Resident: Yeah. So I decided just to come back to the old home place.

Interviewer: You said your dad had died so your mom was alone at that point.

Resident: Right. And my wife was working in Logan so it was kind of beneficial for everybody just to move, you know.

Interviewer II: And when you moved back into Scarlet was the mining activity sort of winding down?

Resident: No. It was going strong. Remember the blast….

Interviewer II: It was still going strong. Because you had said, and that tells me because you had said about the, you could see the dragline boom and the blast that had occurred. So you moved back into the …

Resident: Yeah, right into it.

Interviewer II: Into the heart of the activity.

Resident: Yeah. Yeah.

Interviewer II: Now is there any more opportunity for this valley fill to expand or has it gone as far as it…

Resident: Well they tell me that ... I believe it is illegal. I believe it is too big. Remember that West Virginia had a problem with that. Governor Underwood signed a thing to extend those valley fills, which, I thought was illegal… was contrary to the Federal Government. That was the big brew-ha-ha that I think started all this. And I think that thing was illegal when they, way before their initial, when they initiated that thing. Because that thing has to be a mile and a half to two miles long.

Interviewer II: How far from your house here to that valley fill, the toe of it, are you? If we would drive up?

Resident: If you … Once more I don't know. But the law on it, and they're in violation of the law, too, because there is a house right over top of it. You took a picture of that right? It is all messed up.

Interviewer: Yeah. I think…. well we can drive up there and we can look. But what would you estimate.

Resident: What from my trailer here now?

Interviewer: Ahh, hun.

Resident: About four hundred feet. That is why,.. I take it back. Now what are we talking about to the toe of the valley fill?

Interviewer II: Right the toe. I would assume that is …

Resident: Rock ford? To where it's rock ford?

Interviewer II: Right.

Resident: About eight hundred feet, maybe.

Interviewer: Eight hundred feet?

Resident: I am just guessing.

Interviewer: Ahhh, hun.

Resident: But the house right there… there's a house right on top of it.

Interviewer: I think that pretty well covers most of the things that I wanted to ask you about. Is there anything you wanted to add that we didn't talk about?

Resident: I just think it is terribly unfair. What got me about this whole thing, maybe we didn't do it right…. They have a Federal Office of Surface Mining. I have never seen one of those people. Where are they at? Was we suppose to go to those people too?

Interviewer: You feel you've given the DEP…

Resident: Yeah, too much of the… we should of went, maybe we should of went to the Federal Office of Surface Mining.

Interviewer II: So you feel that your opportunity to contact the people who you felt were in charge was, in your own words you can tell me, I am trying to phrase the question…. Did you feel in your opinion you had an adequate opportunity to talk to the right people? I mean certainly, by showing this stack you thought you were talking to the right people…

Resident: I thought I was talking to the right people that would take care of it. Because the State was issuing the permits.

Interviewer II: So, there was no information given to you to say if you have concerns or want to talk to someone these are the people you should be talking to. You just sort of assumed whom you should be talking to?

Resident: Right. I did talk to these people once a year or two ago and it was kind of a negative, you know, reply that I got from them. That if the State wasn't involved in it, you know, there wasn't much they could do.

Interviewer: So you contacted the Federal OSM office?

Resident: Right. Right. And I just kind of gave up on, 'cause if those guys weren't going to do nothing then….

Interviewer II: You sort of lost hope when…

Resident: Yeah, you just give up on it. You can see here, it's kind of a lost deal, you know what I mean?

Interviewer II: And of all these complaints were any of them positive reaction or at least follow-ups that actually your complaints were addressed?

Resident: Ah, when my water ah… they still check my water once a month. This company has a contract and they come to take water samples. And ah…when he gets it and it is out of compliance he normal tells me. Sometimes he denies it. And when it is out of compliance I call these people and say, "The water is out of compliance." Never goes anywhere.

Interviewer: Do you get a record of the report?

Resident: Yeah. Yeah, but I was informed something out there the other day that if you are out of compliance they doctor the results.

Interviewer: Who? Who told you…?

Resident: The contractors.

Interviewer: Say that again.

Resident: The contractor.

Interviewer: The contractor told you?

Resident: Told me that if it goes in the lab bad, it usually comes out good. So unless I run my own water sample through my own lab and stuff, I don't know.

Interviewer: Which is certainly something that would cost a lot of money to do?

Resident: Sure. Don't you think? To take water samples and then break it down.

Interviewer II: What kind of things are they finding in your …

Resident: Water?

Interviewer II: Water?

Resident: They take the iron and all of that stuff in there.

Interviewer II: Iron content is pretty high?

Resident: Magnesium… and all that stuff. All kind of stuff. That is pretty isn't it?

Interviewer: What have you got a stack of about 50 papers there? Is that the report?

Resident: That is some of the stuff they check.

Interviewer II: These are your water sample reports from the contractor, I assume, telling you …

Interviewer: Are they in order just about?

Resident: Just about, yeah.

Interviewer: Dating back to '98 and up until now?

Resident: Ah, huh.

Interviewer II: Now basically the concentration then would indicate whether or not you are in compliance or not in compliance. Can you tell, did the individual running the tests when they gave you these reports, give you an indication of what you should be looking for on this.

Resident: No.

Interviewer II: So, are you able to tell?…

Resident: No that is solely up to me to get somebody to read that for me.

Interviewer II: You certainly,… I don't understand it.

Resident: The State has never said look, bring that over here and we'll let you sit down and we'll get somebody in here to explain that to you.

Interviewer II: So you have no idea what this information means? What the …

Resident: All I could do was compare the numbers there. I could compare if it was up or down.

Interviewer II: But that basically is only your indication of what changes might have occurred? You don't know …

Resident: I am familiar with, what is it called… the alkaline maybe, where it is acid or base. And you can really tell it goes down, straight down.

Interviewer II: Right. Like the thresh hold levels for some of these other parameters, you don't know what it means?

Resident: No. Your solids, your suspended solids and whatever. There is another one there that's got solids. Ones solely related to mining. I can't remember exactly which one it is. There's, those things jump up and down… You just, the layman is not going to be able to tell anything about that and they know that. They'd have to hire ah … all they had to do then is explain that to me and say, "Hey you must be a mile out of compliance here! How come I haven't heard anything?"

Interviewer II: Yeah, it is pretty hard for you to understand what is going on…

Resident: I would have to hire a contractor or a lab to do that for me.

Interviewer II: Did you get a log, did you say everybody gets these re…, did they get, you have to ask for these report?

Resident: They are doing mine because I am within a half mile of the mining.

Interviewer II: So anybody else….

Resident: They don't do anybody else. To my knowledge they don't do anybody else except me and maybe the guy up on the hill.

Interviewer II: So anybody else they are not getting those reports at all?

Interviewer: Could they request?

Resident: I don't know if they could even request them to be checked… to check them out. I am not familiar with that. But no, to the layman it doesn't mean anything. You would have to get a lab to do it for you. It is right there.

Interviewer II: Interesting.

Interviewer: Can you tell me a little bit about the public water coming in here?

Resident: The public water is in right now. It ah, there is water coming, I'll say down the creek. It is coming from Logan County. This water is coming from Logan County. They pulled, they put a new water line up Pine Creek to the industrial park here. Some people might say that is a plus for mountaintop. I say it is not, because they will not going to hire local people for that job. They brought a water line up to it from the Logan county water plant and they're going to run water to it from the Mingo water plant at Naugatuck, so that they will have two sources of water. I understand they use a lot of water to run that thing. So in the mean time this coal company, which is A.T. Massey, has came in and then you're right at the… Duncan Fork. Have you noticed those big white tanks in those people's yards?

Interviewer: Ah hun.

Resident: Okay they have sunk all their water. The water… the mines that they are mining, according to the DEP, is where my water comes, okay.

Interviewer: So, say that again to me.

Resident: The water that they sunk for those people, which is a lower elevation than me. Is the same water, according to the DEP, that my well was in. Okay? So he tells me way back when all this started. He said because your water is gone they will have to fix your water. I said that is great. Bam! All of a sudden all those wells, there is 130, 150 wells gone down there. And they got these wide, big, white tanks. A.T. Massey's got these big white tanks in their yard. They are hauling water in trucks.

Interviewer II: Filling up those tanks.

Resident: Right. Filling up those tanks. So now they are in the process of… My brother lives down there at the mouth of Duncan Fork across the road next to the hill, and you'll see a big white tank in his yard right there. He has got a big cinder block wall, it is a gray wall like. And he informed me they are going to force him, they are making him, they are not gong to bring him any more water. He has to hook-up onto public water in order to have water. And he may or may not get paid for them destroying his water.

Interviewer II: So how much would it cost? Do you have an opportunity to hook up to public water?

Resident: Yeah I could hook up to it any time I want to.

Interviewer II: How much is that?

Resident: Cost?

Interviewer II: Cost wise.

Resident: Ah, probably cost about $500 to hook up.

Interviewer II: And in most cases that is cost prohibitive - that is a hardship maybe?

Resident: Ah, it is a hardship and it pisses me off. It goes back, now remember we were independent. We had our own source of water and now we are forced to hook up on public water.

Interviewer II: Now you are dependant?

Resident: You're dependant on that. You've lost your independence. Now you are at the mercy of water company. You have to hook up on it. You are burdened with another monthly bill. Remember your car payments, your water bills, your electric bills come every month regardless.

Interviewer II: Because when you had a private well, like my parent do, you don't have to pay for the water. It is a natural resource.

Resident: It is a natural resource. You don't have to worry about it. You know where they water comes from. I hate city water.

Interviewer: Is that primarily, would you say, why you are not hooking up to it now?

Resident: Right. I am defiant. I won't hook on it until the very last…

Interviewer II: Until there is no other way?

Resident: Until there is no other way. Because once I hook up onto it, I might as well throw that away.

Interviewer II: And all of your complaints have been… in their…

Resident: Nullified. Gone. Zilch. Out the window.

Interviewer II: So that four-inch stack of complaints is really work going down the drain?

Resident: Down the drain. Yeah.

Interviewer II: In your opinion?

Resident: I my opinion it is gone. We get back to this down here. They told him in four months they were going to force him to hook up on it because they aren't going to bring him any more water after a certain day.

Interviewer: They told him what that day would be?

Resident: They haven't told him yet.

Interviewer: Oh.

Resident: And the DEP is not going, not going to do anything.

Interviewer: According to what they told him?

Resident: Yeah, according to what they told him. So there you have A.T. Massey which just came in and underground to destroy those wells. And the DEP refuses to intervene and do something. But getting back to me on this deal, he tells me… the mine inspector says, "When your water is gone they will have to do something." I said, "Fine. Who?" We are talking about two entities right here. We are talking about Arch Coal and Massey Energy. I said "Who?" No answer. So when my water goes I said, "Is Massey or Arch Coal going to fix my water?" And you see what happened.

Interviewer II: So out of all the impacts, and you have named off several of the mining operations, what you can tell me, what's the, what is the most significant impact? That is to come out or resulted from all these mining activities.

Resident: Most significant impact? I'd say the destruction of natural resources. Because without those, the lands… this land is worthless right now. I had this appraised again. And they appraised it as unfit to live in except for mining. The only worth of this was for mining purposes. It was not fit to live in. And I asked a couple of realtors and they said, "Yes they could come out and they could appraise your property in that manner." I said, "That is wonderful." So you live in a mining community and your property is worthless except to a coal company. And I was told that. So, they destroyed the natural resources. Before they done this mining we go back, before they started the mining now… this community was full of people then. Lots of people lived here. Everybody had good water.

Interviewer II: So is water one of those…

Resident: Water is gone. Just think about it, if you had no water, if you had no water, what would you do? Could you live in a place…?

Interviewer II: We take it for granted. I know my mom and dad, just an antidote here, my mom and dad have an on lot water well. Just like you do and it's... and the formation it is in doesn't produce as much water as other places do. We've had our well run dry. We have had to wait for the pump to fill it back up. So, and now I live on a public water supply system and I, we do take it for granted that you turn on the faucet and you have water. Back home you once in a while turn it on and you hear airline… you hear air running through the lines. So then, it *was* a hardship because you couldn't do what you wanted to do at that moment. You had to wait to it filled.

Resident: You know the saying, 'You don't miss your water until the well runs dry.' And it is true. Just like if you got up one morning and opened up the faucet and you had no water. You call the water company and 'What is the matter with it?' 'Well we had a major line break and it will be down 48 hours before you can get it.' What do you do for water?

Interviewer II: Well, you either wait or you go out and buy a jug of water like you have done.

Resident: Right. That is exactly what you do.

Interviewer II: But we are too impatient these days.

Resident: We are living in a fast paced world and we have got to have it now. Well, you know that is fine, you know, but I am trying my best to not live that way. I don't have to have it right now. Which means I will wait to the bitter end, even if it means having to do without water. So …

Interviewer II: So your quality of life has greatly been impacted?

Resident: Yes it has. Greatly.

Interviewer II: Now I don't want to say greatly, but it…

Resident: Sure.

Interviewer II: And you can tell me yes or no, was it impacted by the loss of the, of the..

Resident: Natural ... Let's call it natural resources.

Interviewer II: …natural resources?

Resident: Which one? There is water. And naturally when they were mining the dust in here was terrible. The ah, the ah explosives that they used - terrible. It settled in here. You can really tell it when they blasted. The destruction of the water and the land itself has really been, in my opinion it has been a disaster. And that goes back to them appraising your property as unfit to live in now. Well, that is what I told them, when they started buying people out and they started moving off and the homes that are lived in that are falling in, is an example of what they did. Cause, they tore several down…. that is one thing that I did get done. I got a couple of them that were falling in; I did get those torn down. There was one beside my mom that was falling down and I finally got them to tear that one down.

Interviewer II: The coal company?

Resident: The coal company. There is a couple more here that they tore down, that they were falling in. I don't know why they agreed to do it. I guess maybe I caught them on a good day or something, you know. Somebody had a plan to clean it up, you know.

Interviewer II: Is there any opportunity in your opinion, that people will eventually move back into Scarlet?

Resident: Ah, I am sure they probably would.

Interviewer II: Considering, you know, some people made see public water as a benefit. That they actually have a reliable source of water; we'll put it that way.

Resident: I said yes. I said yes. That is today. Eighteen months from now, no.

Interviewer II: What do you mean by that?

Resident: Because you got another coalmine coming. I don't know if I got it here or not. Anyway, I don't think I've got it. I probably got somewhere. Got it hidden. Anyway, going back to A.T. Massey down here. Ah…

Interviewer II: This is a legal advertisement for a permit that you are showing us?

Resident: Sure. Yes. Okay, yeah this is it. Yeah, this is a permit; see December 21st of ah… last year. Okay, this is last year for that.

Interviewer II: You're saying even though that they're… eighteen months from now, …

Resident: That they will not, they will not… People would move back, today. I would say. You know this is just my opinion. Just like you said, there is public water laid, which is good. They probably would today. That's on the assumption, that the coal company would sell their property. See all this property now belongs to the coal company.

Interviewer II: So there is no opportunity, at least right now to buy back property.

Resident: No.

Interviewer II: You are here because you own it.

Resident: Right. They will not… I was told that they will never sell that property. It will stay idle for 200 years. So, because they feel that there is a liability because if they sell it back to someone they think that they are going to be liable for something. You see. This was published back in December, which I'd been told it was coming. This is for a deep mine on number two gas that is to be put in. And you know you came by at the mouth of the holler here, when you crossed the first railroad crossing, there is a trailer there, which is a coal load out facility. Okay? That is where one of those mines is going to be, down in the ground. Okay? The same people at DE, and I took that over there, they had a map of this mine. A projection. They have engineered the map … Are you familiar with underground?

Interviewer II: Very little. I'll be honest

Resident: Very little. You know you drill holes in the ground. Okay. There are three holes to be punched in the ground. The slope on it is 981 feet long. I don't know the elevation of it. But it's down, … straight down is 400 feet deep, I think down to the coal seam, number two gas. They permitted that right there and that could be given out any time. And they could start mining.

Interviewer II: That is basically the entrance to Scarlet.

Resident: Right, the entrance to Scarlet. So when I took that over there, they said they had the permit. I said could I look at it. And I signed it out there was a big table in the back. I told the engineer, I went ah,… I said ah that looks about, that looks all right. I said, but I have got a question for you. He said yes? Where is that road at that goes to my home? He said what are you talking about? I said, I have got to have a road to go up Scarlet. It is not on the map. He said are you sure? I said railroad track, railroad track, yeah… I said where is the road? I said there is a road in here. He said no there is not. Get in your truck and go over and look.

Interviewer II: So the one that… in Scarlet there is one way in and one way out, because it goes up through the valley of the mountain and the entrance to that… to Scarlet Road …

Resident: Right. And that's where it is scheduled and ah he has yet to give me an answer on that. I said you need go take your maps and your cameras and take forty-five minutes out of your work day and go there. And throw that back to those people and tell them to give you a good ah, a good application… It is no big whoop, but you know how it goes. Up there along the road, can you tell where they are going to dig?

Interviewer II: Well actually that is what I am trying to figure out.

Resident: There are two of them. There are actually two of them.

Interviewer II: At the axis of these latitudes and longitudes?

Resident: Right. Right. There are two of them. Right here is the one at Scarlet.

Interviewer II: Yah, right here.

Resident: And this one is Hell's Creek. Remember that little prep plant that you came by?

Interviewer II: Right.

Resident: That is supposed… there is going to be two. One there and one here. And all this is number two gas. And the are going to mine from here to here or here back. And from here, they tell me, on through Logan County from this one.

Interviewer II: So this is the extent. The corner of those axis where they are showing the latitude and longitude that is the mining area proposed by this permit. And Scarlet is right in there.

Resident: Right. Like I say, I kept the old application. You know the old engineering plan.

Interviewer II: So is that…

Resident: That could come any time.

Interviewer II: Once that goes in …

Resident: Oh yeah, once that goes in, how much room do you think it is going to take down there, to put this complex in? You know, there are certain laws you have to go back so many feet, you know to separate those things.

Interviewer II: And basically the rail line that is down there now will become operable?

Resident: No.

Interviewer II: Will be gone?

Resident: Will be moved. Will be moved. According to their,.. according to their permit application. You know? That was my beef with him. I said between the railroad tracks there you don't show my road. And he didn't understand. He was supposed to check down there and he didn't get back to me. But anyway, as of today people probably would, if their property was for sale. But when this thing goes in, it will never be for sale. So…

Interviewer II: What do you think the impacts, I know we are talking about Scarlet, you know when this mountaintop mining, I mean just as a side note… when this *does* go in, what will happen, what do you think the other people around here will do? I mean …

Resident: It will be terrible in here because they scheduled a 20 foot diameter exhaust fan. You know what those are? You seen those in Pennsylvania?….

Interviewer II: For the underground?

Resident: For the underground, yes. There is going to be a 20 foot diameter fan down there and it is going to echo through this hollow plus push the dust. You know there is going to be dust around.

Interviewer: Do you know where the fan is going to go?

Resident: No. I have an idea and according to their plans, it is going to be what I call up the creek from… There is a little cemetery right there. Do you know the cemetery? The thing will be, …

Interviewer: The "specific name"?

Resident: No, not the "specific name", this is the "specific name" across from the load out right there. From the load out trailer. There is a little cemetery up on the hill there, the exhaust fan… that I read the application it will be close to it. So it is going to be noise and dust, it is going to be pushed up to this hollow. It is going to be unbearable.

Interviewer II: You being an underground mine worker…

Resident: I know exactly…

Interviewer II: You know exactly what you are talking about and how that operates?

Resident: Right. Right.

Interviewer II: Interesting.

Resident: Ah…There will be dust and noise. It all depends to what degree they're going, to what kind of complex they are really going to have.

Interviewer II: And you talked about your ingress and egress, like going and coming to and from your home on Scarlet Road. Your opinion by them not showing it there basically …

Resident: They are telling me that they are going to reroute something and they are not wanting to tell anybody. And I can't convince the gentleman at the DEP, that as a courtesy to people, they should go, and if that is an incorrect map, to go correct it. Because it is a public record and if it is incorrect, it is not right. It needs to be corrected.

Interviewer II: And to your knowledge no one has come out to actually …

Resident: No, they have not done that.

Interviewer II: …consider your request or your ah.. courtesy or concern that you expressed to them about the current location and how it interacts or relates to the proposed mining permit activity here?

Resident: Right. That's right.

Interviewer II: Interesting.

Resident: So you take this along with this and ah the place, the proper use don't fit.

Interviewer II: This here sort of land locked?

Resident: So, here we sit and ah you know … But no there is nothing to stop us from picking up today and moving.

Interviewer: But this is your home place.

Resident: Sure.

Interviewer II: This is where your current home is. You live in Scarlet.

Resident: Right. Right. I spent four years in the military. I know where Pakistan is. I know where Islamabad is. I know where Peshawar is. I know where Kabul is. 'Cause I served 18 months…. covered logistics for them in the late '60s.

Interviewer II: In the Army?

Resident: Air Force.

Resident: We had an air base in Ankara, Turkey. Where we fly the jets out of for the Croatia incident.

Interviewer: I remember reading about that base.

Resident: So, I know a little bit. I am not that ignorant.

Interviewer II: Well you certainly seen more world than what we have that is for sure. Experienced more. But um… all the solitude and comforts that you have here in the U.S isn't ah…

Resident: No, my country has been asleep for thirty years. Thirty years.

Interviewer: Is there anything else you want to be sure and tell us? We certainly appreciate…

Resident: I'll probably think of something later.

Interviewer: You can call. That is why we give you that card there.

Interviewer II: "Specific name," let me just give you our 1-800 number. I think our regular number is on here but you can call the 1-800 you can ask for me and if I can't answer your question we'll get somebody…

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Interviewer: Have her opinions too. That would be great. Why don't start off and just tell me a little bit about how you came to live on Scarlet Road in that area there. Did you have family living there?

Resident II: My wife's family was born and raised right there. Her mother and dad, her grandmother, they're all buried right there in Scarlet.

Interviewer: I saw, we saw a couple of family cemeteries up there.

Resident II: Even the great great grandfather was born there.

Resident I: My great great grandparents were buried there and they lived there.

Resident II: And I married into the family and look what happens.

Resident I: I'm not the only one. There's two more of us.

Interviewer: So you lived there. When did you get married and lived in that area.

Resident II: Oh goodness.

Resident I: 1956.

Resident II: 1956, yea.

Interviewer: So did they start to do a majority of the strip mining.

Resident II: They didn't start then. They didn't start until in the 60s.

Resident I: 70s. There was a strip back then, remember the old strip where they did the auger mining.

Resident II: I think back in the late 60s.

Resident I: No, that was in the 70s. The Hobet mine started their mountaintop removal in the late 80s.

Resident II: Ashland Oil, actually.

Resident I: Ashland Oil owns Hobet mining and they started in the 80s.

Interviewer: Well then, what would you say was one of your favorite parts about living there before the mine or during?

Resident II: Before the mine?

Interviewer: Ever, how about that.

Resident II: The peace and quiet.

Interviewer: Peace and quite, yeah.

Resident I: Everybody that we lived with and around us was friendly. Everybody was like one big family. They would help each other. We would all help each other. And, now, we are all separated and scattered just everywhere.

Resident II: We're scattered miles apart. From Chapmanville to over in Kentucky. There is some people live up in there yet.

Interviewer: We have been talking to a number of people but were hoping to talk to some people who live up there still.

Resident II: I've got a brother-in-law lives up there. They're right at the head of the left fork.

Interviewer: One of the things that we are looking at is what changed in the community after the mining came in. About what you liked about it or the physical changes or the economic changes, any of those sorts of things that you could tell us about.

Resident I: Well, one thing we all got together because we had approached … several, myself and several other residents, had went to the EPA office in Logan and we had complained about the gas and the hazards and the streams being nasty, muddy and things like that. And they come out and started talking to everybody in the community and then we went to one big meeting where they interviewed all of us that attended this meeting.

Interviewer: There were some representatives from the office in Logan or?

Resident I: Right. And also some representatives from Ashland Oil, Hobet Mining.

Resident II: Regulations then wasn't quite as strict as they are now. Especially on water quality.

They made'em clean dams and before we didn't. They put in, what, straw bales and stuff like that to help try to stop the mud and stuff. Now, they're pretty strict on it.

Interviewer: In the 70s actually they did a lot of legislation. Do you remember . . . tell me a little bit more about what you were talking about at the meetings before the mining . . .

Resident II: I didn't go to that meeting so I really couldn't comment on it too much. I know everybody was stirred up because we was getting such tremendous blasts.

Interviewer: So that was already after the mining had started – that meeting?

Resident II: Yes, it got bad there for a while. They even put a seismograph in my yard and then they quit shooting that hard, after they put the seismograph in.

Resident I: You talking about on Scarlet?

Resident II: Yes.

Interviewer: Did you see the readings on the seismograph or did they just tell you?

Resident II: Well you couldn't see them because they were on a tape inside of them. But now I had a house, a new house, from here to that fireplace from the seismograph and it was sheet rock and drywall and it cracked it to pieces. I had to go in there a fix a lot of the seams. It shook it to pieces.

Interviewer: Were there any other physical changes from your house to your….?

Resident I: Concrete cracks.

Resident II: Yea, the foundation is cracked. Water.

Resident I: My house was on a good professional, solid… everything - it was a brand new home. The concrete foundation was cinderblocks. The blasting moved it approximately, I would say, 6 to 8 inches off the foundation.

Interviewer: Did you complain directly to the company about that sort of thing?

Resident I: Yes I did.

Interviewer: What kind of an interaction did you have with the company about that?

Resident I: The company was great about it. They were very cooperative.

Interviewer: That's good. Tell me again about the meeting that you had gone to that was something that the Department of Natural Resources, the state, did those people call the company to come meet with you or how did that meeting come about?

Resident I: We insisted on the meeting so something could be done on our behalf and we blocked… we asked that their mine permit be blocked until they at least did something to accommodate us and help us first. And the permit was denied.

Resident II: You file a complaint over there and they'll set up a meeting.

(some people come into the room and a dog is barking)

Resident I: This is "specific name", our daughter.

Interviewer: Hi, I'm Alexa. Nice to meet you. We were just going through with your Mom and your grandpa here what they went through on Scarlet Road, what some of the changes that occurred on Scarlet Road after the mine came in and started to be active. You mentioned something about your water, your well?

Resident II: Yea, after they blasted so much, it started to turn black. I had perfect water, I didn't even have to have a filter on it at first, a water filter. Three houses.

Resident I: We had particles in it. Sometimes it was red too.

Resident II: Well, it did turn red, but it wasn't before.

Resident I: It stunk, it had an odor.

Resident II: It just acted like it come right out of an underground mine, that water did. Where before it was just as clear; it was perfect water.

Interviewer: Were there any other changes in the community like anything to do with employment? Did people work for the mines there?

Resident I: There was only a very few people. They brought a lot of people. That was another complaint that we brought up at that meeting. There was a lot of employees that worked right there in our back yard. They supplied jobs for hundreds of people who were brought in here from out of state instead of employing our guys that were probably more qualified and certified and had all the qualifications they needed to go to work there.

Interviewer: So were there…?

Resident I: They were denied jobs. My husband, which is "specific name's" dad, was one of them. That was one complaint that I did bring up at the meeting.

Interviewer: Did you see any benefits in the community? What kind of changes? Were some of them positive?

Resident I: While this was going on?

Interviewer: From the mining?

Resident I: No.

Resident II: No, there wasn't nothing done for us.

Resident I: Other than, you know, purchasing our property which, that was good and bad, because, why should we have to pull up stakes and move away from where we were born and raised and raised our children? Only to come around here and then this mine started up and started doing the same thing or even worse.

Interviewer: What about, um, can you tell me a little bit about, you said that your interactions with the coal company were pretty good when you had complaints, and that they were good about some of that stuff. Did you talk to them at all before they came in to the community to do the mining? Did they . . .

Resident II: No. It took a long time for them, where we could get them, we got them to the point where we could talk to them. They ignored us to start with, didn't they "specific name"? Until you started filing them complaints over there with the EPA and then they took notice. Cause they were gonna get shut down.

Resident I: By DNR.

Interviewer: Did you guys read about the permits that they posted in the paper? Did you see those?

Resident II: I read them all the time.

Interviewer: You read them all the time? Did they put them, where did they put them in the paper generally? Like in the, like right up front or is it varies, . . .

Resident I: Usually, it was like on the third page.

Resident II: Sometimes it was on the back, inside back page.

Interviewer: Did they put it in the local paper, or the papers you get here as well as the state papers?

Resident I: Local paper.

Resident II: Local paper. It is probably published it in like Logan County, the Logan paper too.

Resident I: But I noticed when they put that in there to kinda show you the map, it's not legible. You can't even hardly read it.

Resident II: You can't read it.

Resident I: You can't read where they are talking about.

Resident II: If you don't know the territory, you don't know. You wouldn't know.

Interviewer: Right, so the maps aren't very helpful at all?

Resident I: No.

Interviewer II: What would make the maps more legible?

Resident I: If they were printed in the paper. I don't know if it's the newspaper's fault or what, it's both of them, the company and the newspaper's fault. Number 1, the company doesn't specify well enough when they put the little directions and their legends and things like that and their arrows and the route number, like the road numbers, or dimensions, or whatever.

Resident II: It could be faxed in too and they're not too clear.

Resident I: Plus, you know, like when the newspaper prints it off, I don't know, it comes out looking yucky and you can't read it.

Interviewer II: So, there definitely needs to be improvement in the clarity of the maps they are providing.

Resident II: Yea, I looked at one today and you couldn't even tell nothing about it.

Interviewer: I would be interested in seeing that before I leave if you still have it.

Resident II: Well, where's your paper at?

Resident I: In the kitchen.

Interviewer: Well, you all tell me, are there any other impacts or any other changes that were in the community, for example, sometimes - schools? Did the children's population change so that the schools were changed in any way?

Resident I: Yea, the population changed. A lot of people moved out of the state, out of the county.

Interviewer: Now what that mostly because they were looking for jobs in general or because they wanted to move out of the area because the mining was going on.

Resident I: Both.

(Map is shown to interviewer)

Resident II: Now, you try to read that.

Interviewer: Yea.

Resident II: You couldn't tell east from west by that.

Interviewer II: Yea, you clearly can't read this.

Interviewer: What kind of places did most of the people that lived in the holler work? All over?

Resident II: Different mines, different things too. Some logged, some worked in the mines.

Resident I: Strip mining, underground mineing. Coal truck drivers.

Resident II: The biggest problem right in this area right now is the underground mines. That's the biggest problem.

Interviewer: Underground mines? What problems? Leaking?

Resident II: Because of the cave-ins, and the water problems. That's one reason I think we got city water all over the county now, public water.

Resident I: Well, we don't actually have it yet, but they are trying to get it put in and that would help if we could get it.

Interviewer: We saw the signs and we saw about them coming in. And some places have got it and some places haven't.

Resident II: Riffe Branch has got it, Duncan Fork's got it.

Resident I: This mine over here, okay, has destroyed the quality of our water okay. Now we are gonna have to pay a monthly bill and pay for hook-up on this new water line that is going in and that is not fair.

Resident II: $300 hook-up fee. Because of the size of it.

Resident I: I heard it was $500. And then a monthly bill.

Resident I: And we have to dig from the road . . .

Resident I: Yea, the only thing they are gonna do is put a meter in out there where their lines are and we have to dig it and put the rest of it in.

Resident I: That's a lot of digging for each one of these...

Interviewer II: So it is a $500 tap-in fee to the actual line, and you have to have a contractor that you pay for by yourselves to come in and actually install the lateral and come off the main line and actually hook up and make it serviceable . . .

Resident II: And it's all . . . I don't think . . . 90% of it is the underground mining, not strip mining. I mean, I..

Resident I: Well, that's for this area. Now, there are people in other areas that are having big time problems with strip mining and surface mining, but now right here, we're having problems with this tipple, the dust, the blasting. Not to mention, I ride four-wheeler in there and got in behind this mine where their sludge pond is and it is super, super huge. If it breaks, there will be nothing left in this bottom, we will all be washed a way.

Resident II: Now that's deep mines. That's a deep mine over there too, and a strip.

Interviewer II: Are those ponds that you're talking about up the valley here, at the head water here?

Resident I: It looks like a large lake.

Resident II: It has fine coal particles in it and they settle to the bottom . . .

Resident I: It looks, I couldn't believe it was that big.

Resident II: You read about that big coal sludge spill over in Kentucky didn't you?

Interviewer: Yeah, in Inez?

Resident II: Well, that's just like a river of goo going down the creek.

Resident I: Our creek that we have is not going to handle this if it breaks back there.

Resident I: You all have no clue how big that is.

Resident II: I seen it once.

Resident I: It's bigger. I mean it is… It is too big and too dangerous.

Interviewer: What else can you tell me about . . . we haven't talked about much about, when you decided, or when you were offered to move out of Scarlet. How did that come about? Did you approach . . .

Resident II: Well, there were so much complaints that Ashland Coal decided evidently to buy most of the people out. So, that was an opportune time for us to get out of there.

Interviewer: Had you thought about leaving before that?

Resident I: No.

Resident II: No, we didn't want to leave really.

Resident I: Why would we want to leave? We just through building a new home.

Interviewer: You built a new home?

Resident II: I had three houses there. Besides her's, new home that she built.

Interviewer: If you had to put it into words, what would you say was the reason you primarily left?

Resident II: I was afraid of getting blown off the face of the Earth.

Interviewer: Blasting?

Resident II: Blasting!

Interviewer: What was the . . . how did the discussion go between you and the company about purchasing your home?

Resident II: They were real good about it, wasn't they?

Resident I: Yea. But the gentleman who came out to work out a deal with us was extremely nice.

Resident II: Yea, I dealt with him twice.

Resident I: Cause he was… the left hand fork. They were bought out then when they first started. So, he cames down the holler, all the way to the end, purchased another property down there. We all moved down there and here they come again. The mine it's expanded . . .

Interviewer: So you actually moved twice?

Resident I: Yeah. We moved twice.

Interviewer: And so you dealt with the same agent twice?

Resident II: I built two new homes in that area.

Interviewer: When you moved the first time, did you discuss with them whether or not… did they ever talk to you about where you were moving to?

Resident II: Not really. No, not really.

Interviewer: And what would you say that . . . how did things go between you and the company in terms of fairness?

Resident II: Well, they were really fair about it. We got more than market value. You know, you couldn't have got that much at a market value.

Resident I: They told us they would give us a little more than the market base. They offered us like a certain percentage more for the inconvenience.

Interviewer: And did they help you with the move at all?

Resident I: No, we had to move ourselves.

Interviewer: Did they give you any relocation money or anything like that, any moving money?

Resident II: Yes, they give us $5,000. But $5,000 doesn't go very far on building a home. You couldn't put a roof on that house for $5,000.

Interviewer: Did they discuss with you at all whether or not they would be expanding when the first time you moved?

Resident I: No. We never dreamed it was gonna get that big.

Interviewer: One of the things that I was curious to find out from you all, given the fact that, you know, your whole family lived in there and the community was pretty closely tied to family obviously, for the people that are still there, and for the people that have moved out, do you feel like there are any tensions between or, that the community was changed in any way by that or your family relationships were changed by that?

Resident II: No, it didn't affect our family relationship at all.

Resident I: I think it did.

Resident II: You do?!

Resident I: Yea, because of the change of environment. Like you said before, it was new people.

Resident II: Oh well, I thought about location.

Interviewer II: Would you move, now since the mining is not… it really isn't active in the Scarlet area in terms of where the community that you lived, would you consider, if you were offered to buy the land back, would you consider moving back there?

Resident I: I might consider it.

Interviewer: And, as far as you know, did the mining company offer or indicate that they would offer you the opportunity to purchase your land back?

Resident II: I wouldn't. I tell you the reason why. There gonna come back there and get that coal anyway.

Interviewer: So there's, you feel there's still more coal to mine?

Resident II: Well, sure.

Resident I: There sure is. This company is headed way. This company is headed in that direction. They are already, I've been reading the newspaper, they are putting mining permits in, that one that you just had is for that area.

Resident II: 14 acres.

Resident I: I mean, every time you pick up the paper, there's more permits they keep applying for. It's not over. There's still more coal to mine.

Resident II: There's all kinds of coal in there yet.

Resident I: That old strip mine that's in there, the one they used an auger, they're gonna go back and get that. So….

Interviewer II: What made you chose this area to relocate to?

Resident II: Well, I like this bottom, and it's a nice big flat bottom and I didn't want to live across from no creek and up no holler.

Interviewer: Do you feel like you're better off? I mean I think I know maybe what you might say to that answer, but do you feel like you're better off here than you were there?

Resident I: We were until this mine started.

Resident II: Yea, that's about the way I feel about it.

Interviewer: Well, I think I covered everything that we wanted to . . .

Interviewer II: What would you feel, if there is anything the coal companies could do, do you feel that when you were in Scarlet that the coal companies, it sounds from what we are hearing that they had a good public relations program at least. If you voice an opinion, their response was you felt they were concerned enough they would come out and talk to you. You felt that they did an adequate job in that respect? I mean, granted there's some negative impacts. You folks were displaced from your community that you were born and raised in. But you felt that they responded to your concerns overall? What's your general sentiment or feeling about that?

Resident I: At first no. After all the complaints started, yes.

Resident II: After they were forced into it. It was either listen to the public or be closed down, it was as simple as that. If there was enough people going against the permits, they are not going to get it.

Interviewer: It's interesting that you raise that point, because I know I have talked to some people and sometimes you hear that they feel like they are going in and saying something isn't gonna get much done. And some people like yourselves feel differently that it's better go in and you can get something done. Why do you think you feel that way maybe?

Resident I: Because we know we can.

Resident II: Some people have a defeatist attitude about them too, you know. Oh what's the use? You can't fight the company. Well, yea you can fight the company. You see, he is defeated before we start.

Interviewer: So you just had confidence that you could get it done and that's . . .

Resident I: We're both Capricorns.

Resident II: Aquarius.

Resident I: Now that's right, you're Aquarius aren't you? We're left handed.

Interviewer: I'm not sure how I can put that in the study, but I'll try.

Resident II: Okay.

Resident I: Determination.

Resident II: I'm an Iowa Hawkeye, that's what I am.

Interviewer: Oh really?

Resident II: Yea. He's originally from Iowa.

Interviewer: I grew up in Kansas. You're a little bit closer to where I'm from . . . Kansas

Resident II: Cornhuskers.

Resident I: No, Iowa's Cornhuskers.

Resident II: No it ain't.

Interviewer: Nebraska I think are the Cornhuskers.

Resident I: I thought we were the Cornhuskers.

Resident II: Hawkeyes.

Laughing

Resident I: I remember going to school out there. Kindergarten and first grade.

Interviewer II: Did the coal company that you knew back in Scarlet, after they made the initial contact, during that time you had complained, you said that's when they started to come to you and talk to you? Did you feel that was something you had to keep complaining to keep that contact?

Resident I: Oh yea.

Resident II: Oh yea.

Interviewer: I mean if you felt that after the initial contact that you wouldn't have made any more follow-up complaints that you probably . . .

Resident I: It was a constant thing for a long time. Phone call after phone call. Letters. I mean it was just like negotiations.

Interviewer: Uh huh, that takes a certain amount of emotional and just wear and tear on your life.

Resident II: Yea, they don't, they would have kept right on the way they were going if we hadn't protested long enough. We weren't the only ones. There were a lot of people protesting.

Interviewer II: Do you feel in that respect after what the coal companies had gone through and seen, you know the, I guess the impact that it has on families and local communities, do you think that they are ever going to think about what the impacts or detriments, other than in terms of past or history, what has happened, do you think that they would start going into new areas, with their feeling would be 'let's look and see what our impacts would be on this community up front?' Or, do you think that they possibly may want to wait until . . .

Resident I: It depends on the company.

Resident II: Right, there you go.

Interviewer II: More or less one company might be . . . I'm not trying to excuse it, but I'm just trying to say that it's more of a management standpoint, like what decisions are made in terms of how the company is run, if they want to be a good neighbor, or if they don't choose to be a good neighbor, so to speak? Do you think it's based upon how the company is run?

Resident I: Right.

Interviewer II: So one area might be good, the other areas may…

Resident II: I think they ought to hire a good PR man.

Interviewer II: Do you see, I mean in the Scarlet area, I mean, overall, what was your feeling about the company? I mean, do you think they were good or . . . granted I know what you guys, I understand and hear what you have gone through, but uh . . .

Resident I: I was upset with the company, because I was a very young mother – she was a baby - when they first started. Crystal, my oldest daughter, had two small children at home and my husband, "specific name" was unemployed and very qualified, he was a truck driver. And he applied for a rock truck driving job back there. I felt, you know, I was kinda happy when I first heard, you know, that all, there was gonna be a lot of jobs, he'll get a job back there - a good paying job with insurance for my children. He didn't get it.

Interviewer II: Is there any reason why, did you understand why he was not hired? You know, if it's personal, you don't have to answer that.

Resident I: There's no reason why he should not have gotten a job. He was qualified, cause he drove truck for years.

Resident II: They would get somebody from some other area.

Interviewer II: So basically the employment opportunity was given to people that actually didn't live in the community.

Resident I: Right.

Interviewer: Are you finding any change even with other coal companies? Have you heard other people about employment benefits. I mean there is nothing . . .

Resident I: We have a lot of people in this area that does work, now Massey, A.T. Massey owns most of the permits of the mines here now. Arch Mineral_is, they purchased Ashland Oil. They have some here , but A.T. Massey is the majority. And they do employ a lot of the men in this area.

So, as far as jobs are concerned, they are employed.

Resident II: They get a lot of contract miners too.

Resident I: Yea, sometimes they use a lot of contract. But still our men are being employed.

Interviewer II: At least in this case.

Resident II: Yea.

Resident I: Yea.

Resident II: But now A.T. Massey is a company that you can't fool, they are such a huge company.

Interviewer: Uh hum, a lot of them have been bought out by companies like that. Is there anything that we haven't discussed that you want to be sure and talk to us about?

Resident II: I can't really think of anything.

Resident I: All right… you all, this interview today is you're just basically concerned with Scarlet. Why is that?

Interviewer: Because what they asked us to do was to look at five areas that were adjacent to the surface mines. Scarlet was one of the areas that was picked to talk to the people who lived in those areas to get a real assessment of what happened and that specific area. Which is not to say, you know, it wouldn't, that the discussions wouldn't have relevance about what's happening to you here, now. But, the Scarlet area was the area that was sort of picked. So, we are talking to people who lived there now and who used lived there and bought out.

Interviewer II: One of the things you are looking at is like six case study communities, if you will, and Scarlet was one of the case study communities as part of that in terms of gathering information that would help write the case studies, in addition to like all types of demographic information was actually going out and identifying randomly folks like yourself who we can actually sit down and talk to and sort of get a more of a candid objective viewpoint of what your experiences were.

Resident I: Well, why pick something that happened to us 10 years ago? Why not discuss what is going on now? Why not address the problems that are happening to the communities now?

Interviewer: Yea, I'm glad you made that... I think the idea is we won't figure out how to change what's happening now unless we understand what happened then. They'll take the information that we gather in places like Scarlet and they will be able to look at . . . because, you know, I'm sure you understand that a lot of the discussion we hear from both sides of the issue, from all sides of the issue, there's more than two …. are that some things, they tell us that some things are occurring in communities and then you hear from another group that another thing is occurring. So, if we look at an area like Scarlet where it has already happened, we can go back and look at all that, as Troy said, that demographic data, like, you know, population and income that the Census Bureau collects and get an idea of what actually did happen and then talk to those people and then, sort of use all that information to look at the legislation for now, is what that means. So that hopefully the communities where it's going on now and where it will be going on next, the next community, that if any changes, ought to be made, that's what will happen. That we will learn from this.

Resident I: I think something that needs to be done now with … the people…
I don't know what in the world we're gonna do. Like, that lives this close to this mine here. Like I said, I mean, you can look at my window sills, you can look at my ceiling fan, you can look on their back porches, in their carpet, in her house, I mean it's just nothing but black. It is dirty, nothing but coal dust. And the blasting and uh, we had a problem, or have been having a problem with these large coal trucks going in right there. There have been so many wrecks out there, due to that problem.

Resident II: And they start banging their tail gates about 5:00 in the morning. Bang, bang, bang.

Resident I: We have to listen to that "beep, beep, beep, beep", the backup horns are on all the heavy equipment. Yea. They just put in that load-out. The coals got to go up right there where you can see'em. They back up there and from that little tailgate… it sounds like an explosion. And they start, I mean you can't sleep for it. Did you hear the backup horn right there? I do!

Resident II: Sounds louder in the bedroom. Somebody evidently has been complaining about the dust because they put automatic sprinklers on the road over there.

Resident I: And, that makes another hazardous problem. It makes the road gooey.

Resident III: On this road right up here?

Resident II: No, on the roads going up to that load-out.

Resident I: I know when they start coming out of there, that junk comes out on the tires and it gets on the road. I've done that . . .

Resident II: When it first starts sprinkling rain on this road, it's slick, just like it's got a film on it.

Resident III: There was a car… a van, ran into a school bus on that hill up there because of that problem.

Interviewer II: Yea, it's just like a slime. What do they do in the winter time? Do they keep that outside . . .?

Resident II: Oh yea, they put graders and equipment on there right quick.

Resident I: Salt.

Interviewer II: Salt it down. Does that mean… Course with the snow and everything there… that would help keep maybe the dust down, cause that is moisture on it, and salt would melt, but how about when it's deep cold winter and it's a cold sunny day, I mean, how do they keep the dust or how do they protect the dust by putting water on that, certainly that would freeze up . . .

Resident I: They can't do it.

Interviewer II: Well, that's what I was thinking, that you've still got the problem in the wintertime.

Interviewer II: Yeah, one of the things, too, the reason why we are looking at, you know, Scarlet, versus what's happening now is try to get an assessment of what the community was like before the mine came in, what it was like during the mine operation when you folks were living there and of course, afterwards, we are finding out in Scarlet, residents like yourself were bought out and had to be displaced because of the activity that was going on. It sort of gives a whole scenario of what happened in that one instance. And right now, in this mine, I think we are in the period of right now. We don't know what is going to happen after this mine leaves, you know. Who knows what the future may hold . . .

Resident I: Oh, well there's several… ah, there is year, years there. Because the old type coal mining, underground mining, they couldn't get all the coal and now they have this new type of mining, miners.

Interviewer II: Did that give you in a sense a sort of a better idea, you asked the question why not look at what's going on now? The whole direction that we have been given is to look at, you know, an area, that has actually gone through the transition stage of before mining, during mining and after mining. Scarlet is one of the prime examples that has actually experienced a whole transition of what's happening. You can almost see the full effect of what occurs and you folks are the recipients of all that.

Resident I: Yea, somebody has to be the guinea pig.

(CHILD AND MOTHER SPEAKING WHILE INTERVIEWER IS TALKING)

Interviewer: I know that our information doesn't make it any easier to put up with what's going on down the road right now.

Resident II: It was an awful good little community to live in, I'll put it that way.

Interviewer II: Just as a side note, you folks had blast and pre-blast surveys done on your homes?

Resident II: Yea, we did.

Resident I: He did, before blasting started last year. They . . .

Resident II: They're talking about Scarlet.

Interviewer II: I just mean in general.

Resident I: That's something else that I have been fighting this company about. They made a statement, on paper, that they offered me a pre-blast survey on September 1999, September 19th or something like that… I got pictures and videos and tickets. I was in Decatur, Alabama, at our World Celebration Show with horses, so there's no way that they could have called me and asked me and that I would have refused a pre-blast survey. So they put together a bogus statement. Okay and then the seismograph, I don't believe those readings it for a minute. The first seismograph they had it over, on the other side of that big house there.

Resident II: These coal companies will lie like dogs.

Resident I: You can just kick it and mess it up. We know a enough about that stuff.

Interviewer: Uh huh, Uh huh.

Interviewer II: You said in Scarlet you had a seismograph instrument placed there and you questioned the readings it was giving after it was put in place.

Resident II: It absolutely shake them houses, dishes would rattle in the kitchen.

Interviewer II: Were pre-blast surveys done back in Scarlet on your homes?

Resident II: Yeah, it was on mine.

Resident I: Not mine. I don't know why.

Resident II: They done a print out of the house, where seismograph what done was sittin. They had a pre-blast survey. They just walked through and looked at it. Now they take the photographs.

Interviewer: Did it make any difference in your discussions with the coal company having that pre-blast survey?

Resident II: Did it make any difference with them?

Interviewer: Uh huh?

Resident II: Oh, not at first I don't think. I think it took a while. They were denying it. That they shooting that hard. When everybody knew they were shooting as hard as they could shoot.

Interviewer II: Now is there any, in this case, with this mine, do you think that there is better public relations or . . . involvement with the community.

Resident I: No, worse. It's worse.

Interviewer II: So I guess basically you are saying that definitely there is room for improvement.

Resident I: Absolutely.

Interviewer II: You know, in terms of . . .

Interviewer: Is there anything else that you wanted to tell us?

Resident II: Well she's held the floor so long, she won't shut up. (laughter)

Resident III: I don't know enough about that. I don't remember.

Resident I: Well, you were little.

Resident II: You remember the blast don't you?

Resident III: I do remember.

Interviewer II: How many years ago did you move away from the Scarlet area? Maybe you said that earlier.

Resident II: In 1991.

Interviewer: Do you remember at your school, lots of kids from families moving out and things like that? Was your school closed down at one point?

Resident II: Was it at Myrtle then? The grade school was in Myrtle. Do you know where Myrtle is? That was the grade school. There were a lot of kids in that hollow. Almost a bus-load.

Interviewer II: And that school was you thought was directly impacted by you being displaced or was there other factors?

Resident III: I think so, because it shut-down when we moved.

Resident I: It shut down after that. I went to grade school there.

Interviewer: Where do the kids who live there now go to school?

Resident III: A lot of them live down….

Resident I: They had to be bused farther. Lenore area.

Resident III: Everybody moved. They moved mostly to the Lenore area, kept them mostly, kinda in the same area.

Interviewer: Yea, I think that is about all the questions we have for you all.

Interviewer II: We try to keep these to around about 1 hour so that we don't take up much of…

Interviewer: If you think of something later that you want to be sure to tell us, you should feel free to call us or if you have questions about, you know, what we are going to do with the information or the study, you can call us. Or, on that letter I gave you the Environmental Protection Agency Project Manager's name and phone number and e-mail address are there so you can talk to them directly if you want. He would be happy to talk to you.

Resident II: I think the state has made it, has made Massey furnish those people water when they sunk their wells and stuff over there. And aren't they gonna pay their water bill for 20 years?

Resident I: I've been hearing that. Like I said, like they're headed towards Scarlet. Duncan Fork comes first, then Scarlet, which is very close, and they have already sunk their wells and are supplying them with water.

Interviewer: I don't know the details of what arrangements have been made for them in terms of paying for the water, but it is my understanding that they are going on public water if they are not already on it.

Resident I: Yea, I rode, you can ride, you can go up here an go up in the mountains and ride the four wheeler all the way over that area and I come upon several places where they're building water towers.

Resident II: I think that was in the long-range plan.

Interviewer: By the? By who?

Resident II: By the coal companies.

Interviewer II: The water towers?

Resident II: The water system. I think they knew, they knew what they was gonna do. They done the same thing over at Beach Creek and Bend Creek over here in that area where they use that long-wall mining. They sunk all them peoples' water over in there. You've gotta have coal mining, but ah… there is a right way and a wrong way.

Interviewer II: Yeah, it is a major economy, major part of your economy down here . . .

Resident II: Well you close a mine down, and that trickle down effect… uh huh boy…it's bad.

Resident I: A lot of people are out of work. Like I told you on the phone, I'm not against mining whatsoever, it's just that those of us that feel the effects of the damages and things like that. You know, they need to take care of us. Do something to prevent further damage, to keep us safe, you know, stuff like that. But, on the good part, for the men that need a job to support their family, it is great.

Interviewer: Well, I think that's why it's such a difficult issue.

Interviewer II: Well we thanks for your time.

Interviewer: Yeah, we really appreciate it.

Interviewer II: We do apologize up front for not calling.

Resident II: I really hope we helped you with whatever you're…

Interviewer II: Well, we want you to feel like you have helped. Because, believe me, we have had a lot of other people say we don't what we say they don't know how it's going to help, but by actually getting your input, that's part of our job in trying to contact you folks. Talk to you about these issues and that's a real big part.

MTM/VF EIS
Community Narrative: Scarlet, West Virginia

Interviewer: Tell us about how you came to live here. Let me back up. Let me put it this way, how did you come to live in Scarlet?

Resident I: My family lived there. I was raised there. I wasn't born there. I was born in Harts Fork but I was brought back home there. How it all come about is my Mom and Dad, well my grandmother and then it's actually left to my father and then I bought a piece of property off him. He sold the rest of it. So, that's how I came to live here. It was home and I didn't want to leave West Virginia. All my other families out and about in cities, like we say, and …

Resident II: I married into Scarlet Holler.

Resident I: He was married into the fortune.

Interviewer II: How did you folks meet? You were in the Navy at the time that you met her? Or before that?

Resident II: No, we met in school.

Resident I: Childhood sweethearts.

Interviewer II: You are both from the area then? Oh great.

Resident I: He is originally from Duncan Fork.

Resident II: Born and raised up there. I don't know, somebody moved to the mouth of Scarlet.

Resident I: I went to school with his brother. We were in the same class all through school, all through 12 years. Our families, you know they were church goers and my Dad was a preacher and his Dad was a Deacon at the church, that type of thing. Till death do we part, they say. I said he wasn't shaking me and I didn't want to shake him.

Resident II: We have been married what 32 years or so?

Resident I: It doesn't seem like that.

Resident II: She don't tell me what to do and I don't tell her what to do. That's basically why we get along.

Resident I: You know, disagreements come and go, but it just working through'em…that's the whole concept.

Interviewer II: Just give and take.

Resident II: People who are too strict on each other don't make it. Do they? I don't think any way.

Interviewer: How did your family come to settle there, do you know?

Resident II: That started many moons ago.

Resident I: Right, generations and generations.

Resident II: That land was originally plotted off in maybe four plots of farms, and then my Dad and Mom, right at the mouth of Scarlet, was their home place. All of that area in there. And then the mines come in and they moved them out and this and that. Well, her family was just about all of the one fork . . . but I know, originally there was three or four, and they just kept giving it out to the kids and . . .

Resident I: The biggest part of the holler was "Specific Name". And they connected that way.

Interviewer: I saw the family cemetery up on the hill.

Resident II: I liked it better then - where we lived. I did.

Interviewer: What did you like most about it would you say?

Resident II: The community and neighbors.

Resident I: We had real tight neighbors.

Resident II: Yea and there was plenty of them, you know.

Resident I: We watched out for each other. We was at the mouth of the holler. It was just, I don't know, family. At one point in time it was family. Everybody was family. And then, of course, you start letting in, and people kept selling out, and of course, we all bonded, even the people that came in that wasn't family, we all bonded real good.

Interviewer: A real sense of community that you had. Exactly.

Resident II: Yea, lots of big families.

Resident I: Yea, I can't say that I don't miss it, I do miss it cause it was home and I was raised there. But when I get trying times here, I find myself, especially when my kids are home, and they could push your last nerve . . . you know, instead of exploding, like I used to do years ago, I would get in my vehicle and I would drive up 27. By the time I got to the head of both forks, it's like, o.k., I feel better. It's gone. Took me about 30 minutes and I am a lot cooler and I can handle the situation calmly.

Interviewer: That leads me to my other question which is part of what Troy and I are looking at is how the community has changed or didn't change before the mining was there and then while the mining was there and then after it left in some cases. So, you know that sense of community that you talk about, can you tell me a little bit about how that changed or stayed the same . . . either way? After the mining moved in . . .

Resident I: While we were still living there? Is that what you are saying?

Resident II: Well, we were used to the mining cause it went on after we had been there. Then, all the sudden it started to blast and shake and your house is cracking and all that and that is when everbody . . .

Resident I: We were more used to the undergound when it was down at the mouth of that hollow that you see underground mining. So, we were always used to the commotion of mining and the dirt and all that stuff that went with the undergound mining, and the trains. It's like I said, just part of the heritage.

Resident II: You would go out in the morning and all your swings and stuff on the porch would be covered with black dust. Which, I haven't seen that in years.

Resident I: With the strip job, it was different.

Resident II: Yeah, it was a brown dirt.

Interviewer II: Well, the dirt, the actual dirt, the soil, to get to the seams themselves . . .

Resident II: You could sit there on the porch and watch the rocks raise up and settle down. It was something.

Resident I: The underground mining never affected us, or maybe I just didn't realize it. Maybe I was just too young to realize it. But, ah… It just tore the house apart, that's all. We were one of the fortunate ones living at the mouth of the hollow. It was worse the closer you got to where they were working.

Resident II: They had a wonderful company. They would come right out . . .

Interviewer II: So the company themselves, actually seemed concerned.

Resident II: They were great. They were real concerned.

Interviewer II: About what their actions, in terms of their operations and how it was actually affecting the community. They were actually coming to you without you going to them?

Resident II: Right. We never had to, no.

Resident I: I don't know if somebody had to start . . . You know, I'm sure they did.

Resident II: This one over here now, see I don't know… adjoining this company, right across the hill there, now they're shaking the snot of you. This is the one that's doing all the sinking the wells. . . this one right here, yes shakes. The windows will rattle, and they're not a bit concerned.

Interviewer II: And they let you know when they are going to blast?

Resident II: They are supposed to. We have gotten the letters, but we never heard a signal.

Resident I: There is supposed. Supposed to be a siren and then supposed to be so many seconds after that and then when they are finished you are supposed….

Resident II: You just hear, all you feel is a shake.

Interviewer II: A shake, so they've done it without any warning?

Resident II: Yeah, they are supposed to do pre-blast surveys and we signed for them and they never did come check it.

Interviewer II: Oh, so they actually… That's very interesting.

Resident II: They've never done it.

Interviewer II: Now, the other company that you talked about . . .

Resident II: Now, they were outstanding.

Interviewer II: They would do the pre-blast survey?

Resident I: I don't think they ever had a pre-blast survey.

Resident II: They didn't care. They come in and anything. If it was cracked they'd say they'd say we done it. They didn't care.

Resident I: They never did a pre-blast survey. They didn't care.

Interviewer II: This is the company that's here now?

Resident II: No, the one before, I don't know who owned that, strip out there . . . Hobet? Hobet mining, they were real good.

Resident I: They never notified, you know, that they was going to be shaking your house, or anything like that. I never remember any of it if they did, but…

Interviewer II: But they would admit that they caused damage?

Resident II: They admitted it.

Resident I: If we said, well now this, because some of the houses were new houses, a lot of them older houses, ours was an older house that had been moved in.

Resident II: And redone, we'd redone it. We bought it.

Resident I: When the four-lane was coming through, we bought an old house and moved the whole house, over on our land. It was in good shape, because they had brought it in and redone it all . . . but ah, a tear here and leak'in here, you know.

Resident II: It takes about three trucks to take it up that four-lane . . . it was cool, I tell you what it was fun to watch it. Then they brought it up the road. I don't know if you have been up Scarlet. Well, it was real wide then. All the trees were gone when they put in those tracks so we get it lucky, and they brought it right-up the track.

Interviewer II: For goodness sakes, it does sound like it's really neat.

Resident II: It was. It was really cool, and for the price, that guy done an outstanding job.

Resident I: He had our home and my son had had a home. It was a garage but he converted it into a home. And my daughter had a trailer, so we were compensated well for it. I mean it's not mine no more, you know, and it's not the families no more, but…

Resident II: I would like to have at least been able to get the land back in case the grandkids or somebody wanted it.

Interviewer II: Who owns the land. Does the mining company still own the land in that case?

Resident II: They had an option at one time there, to…

Resident I: We were supposed to have been notified when we got done, so we could buy the land back… And I never pushed it. And it's my fault that it's there's I guess.

Interviewer: Did they approach you about purchasing your home or did you approach them?

Resident II: That was in the original deal. We haven't heard nothing since them, have we?

Resident I: What, you mean when they bought our home?

Resident II: When they bought our home, we told them we needed the option.

Resident I: I guess, they probably, after… everybody…they were tearing everything up, you know all the complaints. They approached us.

Interviewer: How… Well, I'm getting ahead of myself. But, when they approached you, did you have discussions with them back and forth about how much, or did they give you a price that they were willing to pay and say . . . how did that work?

Resident II: When they bought us out?

Resident I: Well they… I can't remember no big lot of talk about price.

Resident II: No, I know they was paying fair market for what the same thing you would buy a new house for. It went by the square feet. The same thing with land, you know.

Resident I: Considering, not only did ours, but then theirs, because of all the kids with our land. We got the lot the got the lump sum in turn. We gave them what they have anyway.

Resident II: We gave the kids whatever they had… whatever their house was valued for, we give it to them. Well, I told her you know, that's only fair. Yeah, we give them whatever in here they say this was worth, and that's what they give… told us it was worth.

Resident I: We wanted to know what this, our home, plus the land, now the land is ours… what you think you'll be given us and then in turn what do you think theirs' is worth, just the house.

Interviewer: So you never went out… .they did all the appraising and gave you the information?

Resident II: Right. Then it was up to you if you accept or whatever and it was such a fair price and you know, we'd already looked at this and made an offer on it.

Interviewer II: This house was existing when you bought it, when you came here?

Resident II: This house is over 100 years old. It needed redone all that but, with all new stoves and everything. It's a great place though. Twenty-four more or less acres. We own the woods.

Interviewer II: Do you own up against the mountainside here?

Resident II: I own to the top of the hill. A lot of land. I told them to save it in case the kids need a place for a home. I don't need the money.

Resident I: Can't take it with you. I asked the Lord to take care of our needs, not our wants. Because we want too much sometimes.

Interviewer: Well that's always the case I think.

Resident I: I don't try to live up to the Jones and the neighbors.

Resident II: We have had more since we are retired now we ever had when we was working.

Resident I: I feel we have bettered ourselves.

Interviewer II: As long as you have your health and a roof and clothes on your back and food on the table, you can't complain about anything.

Resident II: Well, we got boats and campers and when we want to use them we use them. If we don't want to use them they just sit up there.

Interviewer: Actually, you mentioned an interesting point. You said you feel like you've bettered yourselves since you moved here.

Resident II: Oh yea, we did. We definitely did.

Interviewer: It's a better situation than what you moved out of?

Resident II: A lot better house.

Resident I: I wouldn't say better situation. I wouldn't say a better community. I'm just saying it . . . when you look from where was then from where we are now, it was hand-to-mouth most of the time. Of course, then he was working every day. Maybe that had nothing to do with it, but we lucked up – got into a good community, got into a good house and what we thought was a good home. We like it. And that's what I told him, as long as we like it that's all that counts.

Resident II: It is peaceful here. You…

Resident I: Contentment. Peace.

Resident II: You never hear nothing unless a dog barks at somebody.

Interviewer II: It is very quiet up here. You are removed from the road.

Resident I: That's important, I think.

Resident II: You can… My keys are the camper, and my keys are in my truck. You all can't do that no more.

Interviewer: Yeah, my mom and dad did that growing up. The keys were hanging right by the door to the house.

Resident I: If they even made it in the house. Most of the time, I can remember hanging in… hanging right there by the back door on a nail or something.

Interviewer II: Never locked our cars up. Now, where we used to live, everything was locked up, not that it was a crime, it's just that's the way my wife grew up, where you locked stuff up because you weren't born in an urban environment.

Resident II: Well, if somebody steals it and you let the key in it's your fault.

Interviewer II: That's right.

Resident I: We go on vacation, we just tell our neighbors "hey, we're going to be gone for a few days" so they will notice who is coming and going. Lock the house, but ah… We always have a key somewhere. One time we went on vacation and I thought "oh man I forgot to turn that coffee pot off. I *know* I forgot to turn that coffee pot off." Like you say, the community, here's the community thing. I'm in a good community, but I didn't call my next-door neighbors who would be able to walk right up here and turn my coffee pot off. I called somebody that lived above me at 27. Because, I mean I trust my neighbors, you know. I would give them a key in a heartbeat as far as that goes if I needed to or they needed it. But, the bond is, I called him. I said listen, I got this major thing, I am on vacation…He said, "Oh well, good where you at" and I said "I ain't got time to talk, I'll tell you about it when I get home, o.k?! What I need for you to do is I need you to go on back to the house and turn the coffee pot off." He laughed, I didn't think he was going give me a second. He said, "Well honey, consider it done. You all have fun and I'll talk to you when you get back."

Interviewer II: Oh, that's good. That gives you that peace of mind, having people like that around.

Resident I: That was some of the people that had some of the land off Mom and Dad, who lived above us.

Interviewer: Did you see a lot of people moving in when the mining came into the community? Did the people who bought the land, did they work for the mines at all?

Resident II: No, they moved out. It became a ghost town. *Now* they are moving back in, up 27? It's 'cause they tore all the houses down.

Resident I: Most of the guys, a lot of the guys, I would say, and the men, worked for Hobet that lived….

Resident II: That lived in the community.

Interviewer II: Oh that's really interesting.

Resident II: Yea, they moved out and communicated from where ever they lived.

Interviewer II: So, did you have any connection to the mines at all?

Resident II: No, I always worked underground.

Interviewer: So you actually worked on the underground mines themselves.

Resident II: Yea, I worked for 27 years or so, underground.

Interviewer II: That's interesting. Did the mining operations, did like Hobet before, or even this mine, do you know, other than, sounds like the mining company before was more concerned with what was going on in the community. . .

Resident II: They were, 100% more.

Interviewer II: So, you are not seeing any benefits, so to speak, in terms of community improvements or anything that this company might be doing?

Resident II: No, huh uh, they sample our water and that's it. That's the only thing I have ever seen out of them.

Resident I: They hired them [water samplers].

Resident II: I think the EPA might be hired them. To get the last and that first of this hollow and I think EPA done that, I don't know.

Interviewer: Probably the state I think, the Department of Natural Resources.

Resident II: Because they come up. If we are not here, they leave us a report.

Resident I: A report. The last time, when they came to get another sample, because that's what we asked for, we want the report . . .

Resident II: They came the second time to get a sample. They said, "Can we get a sample?" I said, "No you didn't leave me no report." So they was gone and they came back in about a week with a report and they said, "Can we get a sample?" And I said sure. I said, "I'm not being hard, but you live up to yours and I live up to mine." so now they . . .

Interviewer: Now, this is a company that is right next door here, is that right?

Resident II: Well, he said he worked not directly for Massey, but for I thought he said EPA wanted a first and last in this hollow. They're kinda keeping…

Resident I: It's a private . . .it's a private.

Resident II: They are going to check the water here for a year and see if they are affecting it, you know, our water. We are not in the line, as far as the mining goes…

Resident I: This company up here has sunk so many wells.

Resident II: Yea, they've sunk all of 'em. All of 'em.

Resident I: Duncan Fork, Gillman's Drive and I don't know what the name of all them places. Even upt Scarlet now.

Resident II: I know you have seen some water tanks around here, haven't you?

Interviewer: Right. Yea, somebody was just telling us about Ducan Fork this morning.

Resident II: It's bad, I'll tell you.

Interviewer II: We've seen a lot, in fact we saw at least two signs coming down the road this morning where the state is actually doing, or the USDA is doing public water supply projects.

Resident II: Yea, they are trying to get them hooked up. In Duncan Fork I think they are already starting to turn the water on there.

Resident I: Yes, it's a mess at Duncan Fork. I've got two kids up there. My daughter's got . . .

Resident II: I've got an Aunt up there… Then after they got close to the surface, they said that was over 100 years old. The well was here before, before any of these houses were here. Beautiful water too. The guy said you couldn't make it no better, he said you can't buy water this clean. I was telling him about the hand-dug well - over 100 years old. And that's the one they're testing.

Interviewer II: Go up and take a cup and drink it right from there.

Resident II: Well, it's delicious, like clear as can be.

Resident I: Used to be you could go up to the head of the hollow there and drink out of the creek too, but I wouldn't recommend that now more. Not with this anthrax and stuff…

Resident II: It stays dry, now too – the creek does.

Interviewer II: You think that's? You think that might…

Resident II: I don't know if it's just a low water table or what, but it stays dry.

Resident I: It used to run all the time.

Interviewer II: That's pretty amazing that water streams up in the hillsides, you know, you usually have some water flowing there, even in the dry period.

Resident II: We know ah well, I don't know if you've ever been in the mines but that's an awful big hole.

Resident I: Yeah, that water is going somewhere, isn't it.

Interviewer II: Two years ago, we toured the Hobet mine that Arch Coal has up 119, south of Charleston. We toured that mine and that's just unbelievable, you know, the types of operations they have on their surface mines, and I don't think you can imagine it until you actually see how vast they are. And Alexa has seen some mines, too. It's truly unbelievable.

Resident II: My wife don't like mines…

Resident I: He went to take me in where he worked underground one time. I'm like… I get in and it starts getting dark and I kinda keep getting lower and lower….

Resident II: There was big blocks on the wall…. It was a nice mine to walk in and look at. But then sandstone, they just fall right out. They're laying there, you got to go around them, they're as tall as you.

Interviewer II: Oh boy! I'd be like you.

Resident I: My babysitter, we took her with us, and we took the kids, you know. Of course, now adays they wouldn't let you do something like that. But, my babysitter loved it… Me and the baby went out to the van . . .

Interviewer: Tell me a little bit about what the things that you might have seen when you were living in Scarlet from the mining. Were there benefits in that community? I know we talked a little bit about here, but what about when you were in Scarlet?

Resident II: I don't know of any benefits other than employment and surfacing the road. I'd say they helped the road a lot because they brought a road across, then they would hardtop it all the way up. Like that one the did on the hill back there. I would say they were a big part of getting it surfaced. There's nothing cheap about Hobet.   There wasn't, I don't know about now.

Interviewer: And the employment that you talk about, was it people living in Scarlet that they hired when they came in?

Resident II: Yes, in the hollow.

Resident I: The younger generation, younger than myself and "specific name". I'd say they worked there when they was blasting, you know. That's the only thing I can see, you know, as far as a benefit. I think that's good that when people comes in and brings work into our area that they hired locally. I can't say they didn't hire out of state, but I could see some of the local people getting in.

Interviewer: What kind of . . . to the best of your knowledge, did those people, when the mine moved on, did they move on with the mine? Or…

Resident II: Most of them yes. … places like that.

Interviewer: Where were other people in that hollow employed otherwise?

Resident I: A lot of them retired. A lot of them retired. I would say probably half of them. Like the kids lived there, like I said, just a tight community. You know, their Dad is done working and retired. It was a lot of retired. Lot of, lot of generations as far as kids that worked for Hobet, their kids is now raised, you know. I guess I could say it's just like half and half. Half of them was the elderly, the older people about to retire. There were a few of the older people like they worked elsewhere. But, I'm assuming that probably if they would have applied, Hobet would have considered them it being a union, you know. I think it was union wasn't it? They have the union standards they have to go through. I am sure if "specific name" would have wanted a job - he was a good electrician, they would… He could eventually gotten on there. But he never was interested in working there.

Resident II: **I** never was interested in it... The surface job, I was always making big . . .

Resident I: He always had surface cards in case push come to shove he had to.

Interviewer: Can I ask you a couple of questions about moving out of Scarlet? Did you have any interest in doing that other than from . . . let me phrase this better . . . What would you say was your primary reason for moving?

Resident I: Primary reason for moving? Well, they made us an offer we couldn't refuse.

Resident II: I would say the houses was all cracked up. Your foundation was cracked and all your friends had moved. Then why not?

Interviewer II: I guess, you know, instead of like staying in Scarlet, they bought you out one place so there was no real reason or incentive for you to move or stay within the Scarlet area. Your option was to move totally out of the area? …. Just because of what was going on.

Resident II: Right, out of the area.

Resident I: I don't think we could have not…. The whole hollow… you either sold to them or you stayed and that's what you ended up with, with whatever you ended up with. You know what I'm saying? I don't know, but the people did stay there . . . people did stay there and pushed to get bigger and better and more . . . and I don't think they got anything out of it…. You know what I'm saying?

Resident II: They didn't even get their house fix.

Interviewer II: Your decision to move, you think was a good move?

Resident II: Yeah, I think it was…

Resident I: It was a benefit. Because this was it, you either . . .

Interviewer II: Now, you had said about your sense of community, that would probably be it sounds like . . . What was the top things that you think you miss from the Scarlet area, besides like the effects of the mine? You know you had talked about the sense of community…

Resident I: I miss family. Because like I say, I have a lot of aunts and uncles and cousins . . . you know there is a few of us in the area here, but then there's more like over in Logan County towards Chapmanville, I am sure you all realize that, it is like they're just mixed up . . . it's a sad thing that we don't see each other. That's what I miss, the bondness. Being able to walk up the holler and spend the afternoon or visa-versa. Now it's only for a funeral anymore. You know what I'm saying? Somebody died, we all come together and I say it's a shame that we have to reunite at a funeral.

Interviewer II: Yeah. We say the same thing back home.

Resident II: Oh, that's true. I don't know my cousins…

Interviewer II: It's a shame that the only time you get together is when there's a tragic - like a death in the family, or something like that.

Resident I: We talked about having like a… Like every year we talked and never have had what we call, like, a community reunion. But it has never happened. I think it would be something good. I mean it just forces you to bond, and come together…

Interviewer II: You have family reunions and almost like the community that you live in is almost like your family.

Resident II: Yea, they were good people. They were closer than family, a lot of when we left. They did for yeah, what family wouldn't.

Interviewer II: But living in this area, you are not . . .

Resident II: We do not . . . anybody here. No.

Interviewer II: You don't have that bond or relationship like you did back in Scarlet?

Resident II: No, there's no friend that close here.

Resident I: Like I say, I was born and raised up there. From the time Momma got me from the hospital, it was my friends and my family . . .

Interviewer II: So it's interesting, you felt that the mining company that is back in Scarlet was a good neighbor in one sense, but because of the events that caused you to move out because of the mining operations, sorta broke that up. So it was sort of an ironic type of situation. They were good to you in once sense in terms of their concern, but their actual affects… where the operations had been conducted . . .

Resident II: Yeah, they were… they were outstanding…

Resident I: And we, you know, we seen some of the. . . I know if this has anything to do with it . . . I know we all gotta set time to die. You know, I know that. But we seen a lot of the elderly people that did sell . . .

Resident II: They never could get satisfied. Some of them moved to like Cincinnati, and stuff. They had their own little business up there. Retired and played cards and stuff … had a hobby and it give them something to live for. And they got there, and they didn't have nothing to do so they just. . . cracked. Cause, they spent $200,000 on a place down there and couldn't get it back out of it. It was all tied up.

Resident I: Just rolled up and died. I've always…

Resident II: They didn't have enough sense to manage their own affairs, so they left their kids and the kids done dirty. They said, "No you're not going nowheres." That's what happened to my uncle and he died down there. I mean it's sad, but kids will do that.

Interviewer II: They said money is the root of all evil. I think is what they say.

Resident II: It's learned me a lot of lessons. I'm not giving mine to anybody and anything until I'm dead. I know it may sound harsh or something, but you can't trust your own kids.

Interviewer II: Yup, this day and age…..

Resident II: If you give them power of attorney, you're liable to be anywheres… Nursing home. All they've got to do is say, tough love… and then you're in a home. That's it, you can't move, you can't leave, you can't do nothing.

Interviewer II: Right, exactly right.

Resident II: I mean it's sad, I mean I'm dead serious. I never would have thought that when I was growing up, you know 18, 19, and somebody would tell me and I would say, nah you're nuts.

Resident I: You kept care of your own. You know what I'm saying? Your momma got old, you took care of her. You know, grandma moved in with you, you know. If she wasn't close enough for you to go over to her or something.

Interviewer II: Not like today. Yea, society has really changed. I think we have all come to live our own lives. I know I am as guilty of it today as anybody else. It seems like you just live in your own little world.

Resident I: You got this tunnelvision.

Interviewer II: Whatever's out there, even within your own family, you are not as concerned about them as your own welfare and being. I feel guilty about that, you know…

Resident I: Well, you need to reconsider it then. Go home and call. (laughter) "Hey, how you doing?"…

Resident II: Yea, I've got a Dad that's still involved with grand kids at 80 years old. He always has time for everybody. I can't do that, but I wish I could.

Resident I: He used to mention that "I will never be the man he is," and I don't think a lot of us will be.

Resident II: He still walks 2 to 3 miles every day. Goes out on the mountain. Looks good too.

Resident I: He took his great grandchild up the other day. My daughter went up to clean his house, she can't … my Mom's got back problems… She's a working class, you know, she's one of them 9 to 5ers, or 7 to 8, or whatever. But anyway, she leaves what needs to be done at here house and she goes up there. And of course, her husband's third shift, he's in bed, so she takes the child with her. He's 4 years old - active 4 years old. Thinks there ain't nothing like hunting and fishing. Pure country boy. She was up there cleaning them carpets and stuff. And he said "o.k. grandpa what do you want to do?" Uh, Pop Pop, sometimes he messes up and he calls him Daddy . . just like a kid. And he'll say, "Well 'Specific Name', Well I mean PaPa 'Specific Name.'" "What do you want to do? You want to go outside and rake leaves? What do you want to do?" And Pop Pop said "Well I thought I would just get my 22 and go up the hollow and shoot." Because every time he goes up there Pop Pop has to show his guns. Let me hold it, let me feel them. And, honey, he's in hog heaven… you're gonna take him up that hollow and let him shoot an automatic 22? You know. He has a 22 himself, a single shot, you know. So you got just that one shot, before you got to put another one in.

Resident II: He couldn't get his finger off the trigger. He wanted to keep shooting. He shot it like 4 or 5 times.

Interviewer II: That's a way of life. I know hunting back home that's a way of life. When deer season comes around, things shut down. Has the mining operations affected those types of enjoyments that you have had?

Resident II: No, no there's more deer than ever.

Resident I: With Hobet, I think it made the hunting more accessible. Because of the

Interviewer II: Because of the roads that were provided?

Resident I: Right, roads provided for, and you've got 4-wheel drive and you've got 4-wheelers. Or whatever, you know.

Interviewer II: Now the fishing… Did you actually see any impacts on the fishing?

Resident II: I don't know, we never did fish in the creek. We always fished in the lakes. You know, and they're what? 90 miles away, or 70 miles away where we always fished.

Resident I: Well, you fished the creek.

Resident II: I fished this creek, yea you're right. I take this boy down here and there's plenty of small mouth bass and then they'll have a spill up here at Delbarton and then there's no more fish. I mean this is over night.

Resident I: You can see the connection that takes upon the…

Resident II: I believe people report'em or something, because they clear it up. But you can't bring the fish back. I mean it… we had small mouth bass like this at the start of Spring.

Interviewer II: Right… That was just this year?

Resident II: Yea, then it comes high waters and the water, you know, you could tell muddy high water from black waters. And when the water goes down, it's black, they can't live. That cleaned them out. What in April and May, we would catch small mouth bass, even during a flood, he would take his lures down there and throw them out and bring the fish in, small mouth bass like that.

Interviewer II: And that's in the creek right down there?

Resident II: Right down at the bridge you crossed. But there's not enough small mouth bass in it now. Now, maybe next year, when they come up . . .

Interviewer: If they come up from the other creek?

Resident II: Yea, they come up from the river. He's a fisherman, I'll tell you. I hate to see the spills, you know…

Resident I: You often wonder, you know, if it is an accident or…

Resident II: Well it is always going to flood. I mean, you know, when the water gets up they always say, "Well, that broke loose a spill," you know.

Interviewer: That's what happens. Their pond…

Resident II: Their pond is over . . .

Interviewer II: Is that the cleansing pond, that they clean the . . may overflow and get into the waterway.

Resident II: Yea, so it could be true, then, if he had enough rain to raise your creek, then it could raise their pond. I hate to see it though. We don't have as many floods as we used to do we? Very seldom now, the water gets up.

Interviewer II: Yea, we could use the rain, that's for sure, but . .

Interviewer: Tell me a little bit about when you were living in Scarlet, what kind of physical impacts, you talked about the blasting and the house shaking. Did you have any specific things that occurred at your home? Did your well…Was your water fine while you were there?

Resident II: Water was fine, except, it got real gassy, super gassy. I'm telling you, it would blow the cabinet doors open. When the pump would kick on, it would blow the top off the pump house. And I went in there and it blowed cabinet doors open cause, I believe it was right by that vent. I didn't know, I didn't have enough sense to know any better when I was younger. I built it wherever the well was you know, that's where I built the pump house. What it done, it come through that vent and it would ignite dust rags and whatever you had in there, napkins or whatever, it would blow the cabinet and then I would put the fire out under the sink.

Interviewer II: Now would that be when you say it would ignite, that's actually the natural gas from the mines that would seep up in your well and when you, when the pump would turn on, of course, there's a little spark involved.

Resident I: I wouldn't say that had to do… I wouldn't really say that had to do with Hobet… I would say that the underground part of it.

Resident II: We never had that problem for years thought, I mean. We never had that problem up until all that started…

Resident I: No, we finally had to vent it. And another way of lighting it, burned it off.

Resident II: Yea, I put a vent in it.

Interviewer: Let the gas, you know, just go out.

Resident II: Yea, and lighting it, see. It would burn sometimes 4 or 5 month in a row.
Interviewer II: So you actually had natural gas coming up through your water well that you actually had to vent it off… to burn it off so you wouldn't have a hazard.

Resident II: It was dangerous. If you get a leak or something, it was dangerous to go in there with propane, cause I done it, not thinking. and just as soon as I strike that propane, it would burn hair….

Resident I: I don't know how we survived!

Interviewer II: Yet, you laugh about it.

Resident II: You don't know whether it's in there. The first time I done that. Man, I was 23-24.

Interviewer II: Did you smell the gas?

Resident I: Yes, you could smell it.

Resident II: I can't smell gas, I've been around it so much, I guess.

Interviewer II: I know yesterday, we were driving up and there were some gas wells you could see up along 119 and I could smell it and I was telling Alexa and she said she couldn't smell it.

Resident II: Well, a lot of people… I'm not sensitive to it.

Interviewer II: It depends on how sensitive your smell is.

Resident I: If you get a nostril full.

Resident II: Ya'll live in a beautiful place, but I wouldn't want to be in Pennsylvania right now.

Resident I: Well, Pennsylvania, we've been there.

Resident II: We've been through there a few times. I have some good friends from that state.

Interviewer II: Well, I really enjoy it up there.

Resident II: A guy I was in the Navy with. His dad…

Resident I: His dad owned the Coca Cola plant. Owned the company?…

Resident II: He got out of the Navy and lived about four months, I think, and got killed in a car wreck, I think.

Interviewer: It is a different lifestyle, you know everywhere you are… But I think after driving around down here, there's something really to say for living in these places that are beautiful all around you.

Resident II: If you can get used to setting on a porch, or just going camping, or going bowling. Or going hunting… If you get used to that… I'm not going to bother you.

Resident I: Just like it would be different to go from here to go to a city.

Interviewer II: Yea, that's kinda like my Mom and Dad grew up, they had an hours drive to major facilities, or something. And we grew up, I mean, right behind our house was one of the state forests in Pennsylvania. So, as a kid growing up, I entertained myself by walking the dog in the woods and going fishing, or going . . . after school my best thing was to get the 22 or the shot gun to go squirrel hunting. That was the most . . . I miss that, I don't get to do those things.

Resident II: Oh yeah, they run right through the yard now.

Interviewer II: Oh yea, they're like rats.

Resident II: I see pheasants right here in the road.

Interviewer II: Do you really?

Resident II: Yea, I've got chickens up there so I'll get some food and put it out there and watch the pheasants. . .

Resident I: Watch them and deers come in.

Resident II: You can get within from here to the door of them. I don't kill them because…. they're you know too tamed.

Interviewer II: Yea, cause they are always too tamed. There's no sport in that.

Resident I: I never forget, when we first moved up here 'cause… those boys came coming up the hollow. Come up with their grandpa or something, on a four-wheel or something and they were out there talking and it was about hunting season and things. And you know, talking about the hunting coming in, and we're saying "I'm come up here on your back porch, and I'm gonna get me a deer." And they say, "Hey you're not getting on my back porch and get no deer". If you're a man, you go out on the hills and hunt. If you're big enough to hunt, you go out to the hills and hunt. You don't kill nothing around my house.

Resident II: I see six-point deer standing in the yard.

Resident I: Well now if this deer goes up the hollow you can shoot him there, but don't shoot him in my yard.

Interviewer II: Yeah, I think the best part is just going out to hunt…. Just peaceful. Just peaceful.

Resident II: We've got cabins up those mountains.

Resident I: You just laid the law down about how you feel about it. If you're big enough to hunt you're big enough to go in the hills, if you don't expect it to come to you, you go to it. The big surroundings, the hillsides.

Interviewer: I don't mean to keep jumping back . . .

Resident I: That's alright . . .

Resident II: You do what you have to, yea, go ahead.

Interviewer: Can you tell me a little bit more about when you decided to move out of Scarlet. Did the company talk to you at all about where you were going to be moving?

Resident I: Nope. They could've care less. I mean it wasn't, it wasn't . . . that wasn't their responsibility to find us a place, it was our responsibility. They were paying for us . . . they give us plenty of time and extra time if you needed it. You know what I'm saying, it's not like you've got 90 days and that's it. Because I know it took . . . I mean it didn't take us that long. But, I'm sure it took some of the other ones longer because they weren't fortunate to find a place as fast. I didn't feel that was their responsibility, you know.

Interviewer II: They didn't compensate you for your move that you had to make?

Resident II: Yes.

Interviewer II: They did compensate you for your move?

Resident II: They gave me $5,000 moving money.

Interviewer II: Oh that's great. . . I mean I don't know if that's *great*, but that's…

Resident II: That was to move five miles. That ain't bad is it? That's why I'm saying, it is a good company.

Interviewer II: That's really good.

Resident II: $5,000. But, if you had a trailer and you know that pretty well compensated for moving the trailer, you know, 4 or 5 miles.

Resident I: That's what they gave my daughter . . .because she had a single wide trailer and she took her home with her. You know, so they compensated for getting a well drilled, you know but . . .

Interviewer II: That's interesting, I was just thinking the aspect of compensating for your property, but I was thinking boy . . . my wife and I just got done moving into our first home and ah, thinking there's expenses involved that were questions . . . they actually reimbursed or gave you some assistance on moving expenses.

Resident II: $5,000 moving expenses.

Interviewer: And you thought that that was adequate?

Resident II: I thought that was way above adequate.

Resident I: Yeah, because we didn't move what? How far are we from there? Ten miles?

Resident II: Ten miles. If that, maybe eight or ten miles, yea. Depends on which way you go. If you go over that hill . . .

Interviewer II: Now, is this mining company here, is it actually displacing people, actually forcing them to move out of the area in their operation?

Resident II: Not unless, no . . .

Resident I: Not unless because they are out of water.

Resident II: Not unless because they are out of water, or like my daughter, bought a new home for what $100,000 or so and it's got those big beams underneath her house, they've turned over. And they said, you know, the mines didn't do it.

Resident I: Going down that way under her house. Right under the matt, going right-square under her house.

Resident II: It's right under. She's got this big fancy house with that wood, you know, going down in it, a big home, and it's cracked up now.

Interviewer II: And they didn't do a preblast survey on that that you know of?

Resident II: Uh, I don't know, do you know?

Resident I: I think after the complaints and stuff started, I believe that they had sent people out, but . . .

Interviewer II: In terms of mending the situation?

Resident I: But they, it was a day late, and a dollar short there. You know what I mean?

Resident II: I believe it's a fly-by-night company. I know it is Massey, but I believe that Delbarton mining is going to be the sub-leaser and then when they go broke I believe it will be a wake-up. I believe. I mean that's the way it appears to me, I think. They put everything on hold as long as they can. Maybe it won't have to run back, fall back to that other company.

Resident I: They ain't near, they ain't near as good…. What they've done to what Hobet was.

Resident II: Hobet, Hoebet was probably Massey, I don't know, but… I don't really know.

Resident I: See that was the underground versus the strip.

Resident II: Yeah, it is like a bunch of groundhogs, digging up under you.

Resident I: If I had to say which one I would prefer, as a person, underground versus surface, I would have to say surface.

Resident II: Yea, it's a lot better I think.

Resident I: I mean, my husband worked on underground. Retired from it. As far as damage-wise, I would say, I would say that surface... I mean hate to see the hills tore up, you know. There should be stipulations to fix them back up and put your animals back and then your trees, and replant and all that stuff. That would be, that's just my personal opinion, everybody's got an opinion.

Interviewer II: Well, actually, just from the people we have talked to, it doesn't seem like the aesthetics is a big a deal as what some of the . . . like it seems like the impact that they have had in terms of personal property and water wells and things . . . it seems like that's more of a . . . that's your own personal type of feeling, you know, all the… you've got plenty of mountains, I mean, I don't know about you Alexa, but to me it just seems like we haven't heard a lot about how they've made their scenery, you know, degrade it. We may have heard a few here and there, but it doesn't seem like an overriding . . .

Resident II: They didn't seem like they hurt it up there, because they replanted… apple trees and stuff like that. It was real nice, where they've moved out.

Resident I: A lot of them is against it thought, a lot of them. You know, they go to see the underground next to the surface.

Interviewer II: Just for the pure reasons of what they are actually doing to the landscape.

Resident I: Right. Right.

Interviewer: Clarify something for me, because I didn't quite understand. When you were talking about people decided to stay versus, going ahead and being bought out. You said the people who stayed have tried to get bigger and better. Clarify what you mean by that for me.

Resident I: Well they, as a whole, the whole hollow was offered the option to sell out, you know, reasonable rates, and like I say, whatever the going rate for land and homes and stuff, you know. Everyone of us up the hollow was offered that option. Some people thought they had, I guess, thought they was gonna get rich from it I guess. You know what I'm saying? They didn't like what they offered them, you know, it wasn't enough. They couldn't move for that, and, it's not like there was $100,000 homes up there. They might be now because I think they had a couple build up there that's really nice, but . . .

Interviewer II: They were just maybe holding out for a better offer…. And it didn't happen

Resident I: For more money. Yeah, for more money. That's basically what it was. Like I said, I don't know their business, but I don't know if they ever got compensated for damages or anything.

I really don't know. But, I would say, out of the whole, I would say there was probably… they might be ten families up that holler.

Interviewer: Why would you say, I know you mentioned that you lived at the mouth of the holler…. Why would you say that you decided to move when you knew that you weren't as impacted as much? You know what I mean?

Resident I: Because… they wasn't around up back of me, they were at the head of the hollow. They were coming over the mountains from Logan County. So the people up the head of the head of the hollow was really, really impacted. You could see the impact, you know, it was visual. Your cracks down the cinder box, and some homes were made of pure cinder blocks that had cracks going all the way. So I thought, that was an advantage for us, that we lived we lived all the way down… they hadn't got all the way down behind us.

Interviewer: But you felt that they were going to get down behind you.

Resident I: I didn't see any reason why they wouldn't get down behind me. You know, they had the option . . . I don't think they ever did, to my knowledge, but they got, they got behind….. I don't know how far they did get.

Resident II: They're not done yet, up there. They got all kinds of deep mines going in, in and around that area. So, they're not really done with the land yet.

Interviewer: There is one other part of all this that we haven't talked too much about that I wanted to be sure and ask you all about and that is before the mining comes in . . . now you said, were they surface mining as long as you owned that home or?

Resident II: Yeah.

Resident I: Yeah they was, wasn't they? They was still up over in Logan County.

Resident II: Well they had that one little ole strip back in there. Then they, they really went big time after that. They were augering, you know more or less just what they could get with an auger. Yeah, it was there when we first moved in, or when we first got out of the Navy. She still lived there.

Interviewer: So, in your experiences, you lived there, probably a little bit before they were really doing very much there. Did the company come in . . . and how did you all find out what was going to be happening? I guess, is what I'm getting at…

Resident II: That . . . when they brought that ole big thing in there . . . that big crane deal that you see along the roads and stuff, and you can see across the meadows and stuff. When they brought that in, that's when they started to come around a talk to people. Well, I don't know if they started to them or until people started to complain about the blasting and then they assigned "specific name" somebody, one of the Massey people to come around and talk to us.

Interviewer: They had an agent?

Resident II: Yea, right. Then they had "specific name" or something like that, there was two or three different people. He was real nice and done everything he could. But that was, they didn't actually come around until after the people started complaining about the blasting.

Interviewer: Did you feel, see notices in the paper about the permits and things like that? Did you ever see those or read those?

Resident II: Mom probably did, I never do read the paper.

Resident I: We have had a paper and then it might . . . papers never was….

Interviewer: So you didn't really . . . so they might have been there but you didn't, you know, read the paper.

Resident I: I'm sure they were because, I think by law you are supposed to.

Resident II: . . . don't pay no attention to them, Mom does, and she reads all of it and I never did. I don't think I've ever read a paper in my life.

Interviewer II: So this permit information, you know, really, even if you knew about them, does it cause you to react in any way or is like well it's just, you know, a piece of information that doesn't mean much . . .

Resident I: It wouldn't, it wouldn't have made me mad.

Interviewer II: And seeing that permit, did that give you any thoughts of what you need to do to react to that permit notice?

Resident II: It does now, it bothers me now when I see these permits, especially if it's real close to my land this way.

Interviewer: And how do you know that it's close to your land? By the map that . . .

Resident II: Yeah, it's pretty just look at the map and tell, 'cause I know just about where my land runs.

Resident I: We don't get a paper. His mom does, so what information we got she says, "I'm gonna save this for you because there's something going on." She was telling us about what Delbarton Mining, or something like that.

Interviewer II: So actually though the information they do give in the permits, I mean, your mother can . . . she reads the paper and all and it's noticeable. I mean she knows . . .

Resident I: She's not even a high school graduate.

Resident II: She notices more than Dad, ah more so because of Dad because Dad will look at it and he pretty well knows too. He knows all these hollows by their road names.

Interviewer II: Are they always like at a set place in the paper that someone might always know where they're located?

Resident I: Right, classified.

Resident II: But there's just not a lot you can do about 'em. If they're seeking permits… if they get them they get them. A lot of people argued about them, but mostly they don't do any good. . .

Resident I: I think it states or something maybe to voice your opinion, or whatever, and maybe they got a set place, or something.

Interviewer II: So, a public meeting where you go and talk about it?

Interviewer: But you never felt like that going to those meetings or sending a letter or doing anything was gonna…..

Resident II: No, I always figured you know, if somebody could work, more power to them. You know, I mean, I know that I was always looking for a job all the times they mined, 20 some years.

Resident I: Maybe I got the wrong opinion of it. Okay, but this is my opinion: I figure, and maybe I'm wrong, maybe everybody shouldn't feel this way and maybe a lot of people feel this way is why nothing ever gets voiced on it. I figure they're gonna come and they're gonna do what they're gonna do. My little "yes" or "no" or my little conflict or discussion I might have with 'em ain't going…. because I feel that it's, it's all political. I know it's all political because it, the way it appears to me, who you know and what connections you have. That's sad.

Interviewer II: Yea, I mean it's definitely part of your economy. So there is some, ah.. influence there that ah….

Resident I: Maybe I should be more vocal or more verbal towards it.

Resident II: I don't know this time if the coal was worth what they done.

Interviewer: To the community you mean?

Resident II: Yeah, from the time you turn up the road, you're 2 or 3 miles up the road, you get down here to the four lane and take 119, 2 miles, 3 miles up the road then, all the way up to Scarlet hollow and in Scarlet Hollow. And in all them little hollows in between – the water is gone.

Resident I: They say that to attempt to drill a well it would take 100 years. That's what my daughter said.

Resident II: Yea, they said 100 years before you can drill one.

Interviewer II: To get the water supply back?

Resident I: To get the water supply back up. This is after they leave out of the area, I think. Of course, that's two different topics, you know.

Resident II: They've been what three different, they've drilled two or three times on our property.

Resident I: But they've had a lot of public meetings and officials, three to four officials. And I don't know that anybody from the coal company comes, but they did have a lot of meetings and a lot of concern. Like I said, I don't know if this is just the communities meeting with the political officials, or if in turn the people from the mining industry, I don't really know. But they, you know, I do see that happening.

Resident II: This mine was too close to the surface. Too close. Not enough coverage, that's what done it.

Interviewer II: Did the coal trucks, like the transport of coal, did they impact you in Scarlet or here?

Resident II: Not as much in Scarlet as they do here. It's pure dangerous here. I mean, you just go out here, go out here and watch, you know what I mean. That's all you gotta do watch the trucks coming. They'll take their part of the road. You have to be careful while you are all here. You could be killed with a coal truck. They're dangerous.

Resident I: I think the companies could be better with… not necessarily truck drivers in general, but the poundage, the weight they haul. Because I seen on the news the other day, this one guy said, "This is my living," and I can understand it. "This is what I feed my family with and pay my bills.

I have to load this truck as loaded as I can get it, otherwise, I'm losing money. And this is my position." Nothing personal, but still, I think the company needs to be more relatable to, and the state too, to the amount of coal that's on it. When it shuts off other vehicles, and . . .

Resident II: I think they ought to haul by rail, personally. Truck the coal to the tipple and then haul it by rail.

Resident I: They're getting it to the tipple. That's the thing, that's what these trucks are doing Baby, but it's such a long distance.

Resident II: The others, but these coming up down here are splitting it up. They can get more out of the truck and all the way down to Huntingdon. So they'll send 2,500 trucks to whatever dock, down there at Huntingdon docks creek. So they get more money out of that and then they fill the train up. It might go to the same place, but they get more money out of what they ship by truck. That's what they tell me. So, they'll split the difference, split the loads up. They'll send so many trucks to docks, for example, and then they load them.

Interviewer II: So, even though you have a rail siding up here, and rail facilities to ship the coal out from your . . . you're seeing trucks also.

Resident II: Yea, and they may be trucking the same place. But you might get more, you know more, like they told me they get more out of a truck than they do . . .

Interviewer: Is it more, you think it's because it's more economical, because I guess your rail service here is Norfolk Southern, right?

Resident II: Yea.

Interviewer: Is it just because what they charge to ship the coal versus what . . .

Resident II: Or, it might be that they need the coal right then. Or a train backs in and it might take till tomorrow to load the whole train.

Interviewer: Oh, I see, so a truck is instant. You load up one truck and it's gone.

Resident II: Yea, you just load up the truck and in two hours he's dumping.

Interviewer: Versus a train that might take 24 hours.

Resident II: Or 48 hours, or three days, depending on how much coal is on that.

Interviewer: Well, I can see that point now. Where loading time . . .

Resident II: After they get there, so they can ship it on to somewhere else…
Interviewer II: The loading time is more instantaneous, so to speak, with a tractor trailer versus.

Resident I: But you see a lot more, like I say, versus when I was young and growing up in Scarlet, and even when . . . it was never really noticeable back then, the coal trucks.

Interviewer II: Yeah there was more activity. Was Norfolk Southern always the rail carrier down here.

Resident I: I think, Chesapeake.

Resident II: Chesapeake, and Ohio, but that's, I don't know if they changed the name.

Interviewer II: Yea, they did, I know up our way that Conrail used to be the big carrier then Norfolk Southern came in.

Resident II: N & W, Norfolk and Western, yeah. I know all that stuff is collectible as far as moneywise, if you can buy anything with it on.

Interviewer II: What's amazing, they even have back home, in fact where we live, you can see the trains right out by our home and even at the rail crossing, they have a notice there that there's increase in rail traffic. So I don't know if it's . . . I don't know what's causing that, if Norfolk Southern is just better at it than the previous company, but it's interesting.

Resident II: I don't know either. But they can haul so much, can't they?

Interviewer II: It's amazing what they can haul.

Resident I: I was raised with trains. Living up, born and raised, living up Scarlet that the trains went up that way, the mines was at the mouth of the hollow. It was like 11:00 in the night you hear the train coming up. Pulling empties, pulling empties up and then backing back down. And if they come during the day to pick them up, the engineer, he would bring candy.

Resident II: That's them old timers.

Resident I: You know, that's a thing of the past too. You know what I'm saying? Gum and candy. We would look forward to him coming up during the day time… we would always hear them in the night. Probably the same engineer every night . . . That was an advantage of being the kid at the mouth of the hollow . . . All the kids would say, and they known about the schedule because all the kids knew. I would tell them, you know, hey they are throwing candy out. They ought to come down here. (laughter)

Interviewer II: Where do most people in this area work? Do they work for the mine here or do they work elsewhere? I know with surface mining, we've understood, we understand that it takes light labor because of the large equipment that they have versus underground mining, but... . .

Resident II: It's really, it's changed a lot any more. There's a few . . .

Resident I: Professionals, most people, if you ain't a coal miner, you're into the . . . I mean where the money is, the medical field. Nurses, lab techs, that's where you see a lot of the younger kids that's going, going to college for that type. Engineering. The guys will do some engineering.

Interviewer II: So they are definitely not looking towards the mine for their future employment?

Resident I: I don't think so.

Resident II: No, not as much as they used to. No.

Resident I: You know you've got some, but it's so hard to get in the mines any more.

Interviewer II: Because of the unions?

Resident I: No, not necessarily… they just…

Resident II: They're not training really, like they used to. They brought in a lot from Mexico and places like that now and training them up, Mexicans. Massey is, instead of hiring people around here. Mexicans.

Resident I: They're paying cheap wage, cheap labor, training their people. If our younger generation…

Resident II: $6.00/hour, you know, versus $15.00

Interviewer: So, that causes conflict with the unionized workers?

Resident II: Massey is not union really, so I don't know. You know, I haven't been around it, I've just seen it up there and to know for a fact that it's going on right now. That's something I never seen in my whole life, you know…

Resident I: Versus, they won't take our younger people that might be interested in going in the mines and training them. You know, pay, maybe not pay… I think might be because our kids won't take that cheap a wage.

Resident II: And they probably won't work as hard. I mean seriously, you know.

Resident I: Kids nowadays **are** lazy, you know, mine just as well as the rest of 'em. They won't give you the op. They won't say, "Hey, you've got a head on your shoulders, you know. I really think I could train you." Just like "specific name", his Dad was in the mines. One of the best electricians there was, you know, but in turn, they seen "specific name" and his brother, you know, they seen the option there. And back then, still it was hard to get in when you come it. It was just luck. "specific name" came out of the service working for a mining repair shop where they repaired the mining equipment. He was delivering something to the coal mines and they had this problem electrical-wise. They was … they was shut down, wasn't running no coal. They was a having a big situation. It's a major catastrophe, you know.

Resident II: They just didn't have no electricians. They just didn't have none.

Resident I: "specific name" said "Well, what seems to be the problem?", and they were "hmm" you know and told him what they thought might be the situation. They said "You care to look at that?" and "specific name" said I don't care a bit and they hired him, you know.

Interviewer II: Wow!

Resident I: So, that was how he become an electrician. It wasn't because….

Interviewer: So that's what you did in the mines.

Resident II: Electrician, electrician, chief electrician. But I had some, had some college electronics while I was in the Navy, they sent you to . . .

Resident I: He's been around electricity, and his Dad has done all this all his life, wired houses, and he went along with him. Now you don't just walk in off the street and say, "I think I see your situation or your problem." They'd say, "Well go put an application in." It's all special work now.

Interviewer II: Ah, being an electrician that's ah… you can almost get a job anywhere.

Resident II: I could. You know you could about name your wages. If you didn't like it, you just quit. That's what I always done.

Interviewer II: So really the community around here is really . . . I don't want to put words in your mouth, but tell me… my assessment is it's really not benefiting the community overall here, is that right or wrong?

Resident I: The mining?

Interviewer II: The mining. I mean at least in this one here.

Resident II: This one up here hasn't, I don't think ever benefited them. It's hurt them more so than anything else.

Resident I: Yeah, it's hurt their name. I know... I think the community…

Resident II: The wages are cheap here too.

Interviewer II: Right, in contrast to the other mining operation up in Scarlet.

Resident II: Yeah, the other one was done right. And they paid good wages and . . .

Interviewer II: So the management, it seems like,

Resident II: Seems like the management has gone, gone south for the winter up here.

Interviewer II: Right, the benefit, the benefit of the community, or if it is or if you want to call it a benefit, or how they make out and what impacts are being cause, . . .

Resident II: Maybe the benefit to the community is what taxes they pay, I don't know.

Interviewer II: Right, but I mean in terms of the company itself, either it's good or bad, it might come back on how well managed that company might be in terms of . . . like Hobet, it seems like they were very concerned.

Resident I: I thought they were.

Resident II: I don't believe anybody would miss them if they just left.

Interviewer II: In this situation?

Resident II: Right, if they just closed the gate up here . . .

Resident I: **'**Cause we're not personally interested, not yet. Knock on wood… Not personally impacted.

Resident II: Lot closer.

Resident I: And we're just hearing like second hand news, you know. It's second hand news, they might be more… they may be communicating more . . .

Resident II: Because if you walk this line to the end, then you will be standing in the road on their land. The mining land, so that's how close it is.

Interviewer II: So you abut right against their property?

Resident II: That's exactly right.

Interviewer II: Now the Hobet mine, you think if that one would have left… Are they still mining up there, I assume?

Resident I: No.

Resident II: No, they're mining in Boone County or somewhere…

Interviewer II: So, that town that they have left, or do you think that that has actually hurt that town that they left or do you think that they are better off now than what they were during the time when they were mining?

Resident II: Well, there's nothing up there now up in Scarlet hollow.

Interviewer II: In other words, things were better before the mine came in it seems like.

Resident II: It was a more thriving little community. They didn't have no Mayor or nothing, so it was just a spot anyway, you know. But there's nothing there now. They burned all the houses. And they, they hired somebody to come in there and burn them. So, that's what they done.

Interviewer: That actually, that leads me to one other question I wanted to ask you guys and it's a little bit more personal, so I don't want to… tell us what you want to tell us, but uh . . .

Resident II: I'll leave and let you ask her. No, I'm just kidding ya.

Interviewer: What were your feelings? I know you have described to me that it was sad to leave your family that lived there, but how did you feel about your decision to leave, you know what I mean? Did you feel like people who were staying versus the people who were leaving, were there tensions there, you know your family lived up there. Were there tensions at all, were there any?

Resident I: Not at all. No emotions, or disagreements or no hard feelings on my part and I wouldn't think, I haven't heard of any on the others. If that's what you're asking?

Interviewer: That is what I'm asking. I was just wondering . . .

Resident I: I thought you were going to ask if it impacted our marriage life.

Resident II: I liked to move, 'cause we got a nicer place. Up there, you had a little ole yard and here, got a lot of open space to do what you want.

Interviewer: I was wondering, if the community that is still there, you know, if they feel broken up, or if they still feel like they are a community and it's just sad that other people have left. You know…

Resident I: Right, they miss us. When we're around, we talk to them and they say "Oh man, you all have to come up. They really miss the community. We really miss having you all here."

Resident II: The people that stayed there also expanded. Like, if they leased her land off of them people, then they let them have what they wanted after that.

Interviewer II: Do you think Scarlet will ever, other than water problems, but do they have public water in there now?

Resident II: Yeah, they have public water.

Resident I: Did they put public water in there?

Resident II: Uh huh.

Interviewer: Since public water is there now,

Resident I: It's opt, it's not there yet. The lines are run, but the water is not here yet. The lines are run.

Interviewer: But then you've got to pressurize the lines with the water itself.

Resident II: Yeah, they came up and flushed them out. I think there was a court thing up there or something. I think they was wanting to pay their water bills for so long and then give them $2,000 or something if they would hook up. And then these people would pay for this and that and so I don't know.

Resident I: You're talking about what going on up Duncan Fork.

Resident II: Yeah, well Scarlet is the same way.

Resident I: What's going on up Duncan Fork or Scarlet or wherever, where people don't have no water. Course we have water.

Resident II: They got tanks up Scarlet now.

Resident I: There's no reason why they shouldn't be helping them people up down through here…

Resident II: Yeah, it something to think about, I don't know..

Resident I: Not that we have any need to hook up, but…

Interviewer II: Did the coal companies, did the coal companies help when the water supply went bad… Did they help actually fund that infrastructure, like public water supplies?

Interviewer: Were you all living there when that happened?

Resident I: No.

Interviewer: I mean, do they have any assistance? I mean, who paid for the water system?

Resident II: The county did. This was in the makings before the water went dry. This public water was, and allotted $20,000,000.

Interviewer: In Scarlet?

Resident II: No, around here, in this community when this public water come in. Now, Scarlet, that was just part of this deal. Part of the Hobet, you know…

Interviewer II: You think Scarlet will ever be the community that it once was?

Resident II: No.

Resident I: I would like it, I'd like for it to be. But like for it to be and wanting it to be is entirely different. The coal company could offer people, if they would, if they would do what they said they were going to do, offer people their land back if they got done, you know. If they left town and they had left town. Maybe they're planning on coming back. I believe if they would offer me back my land, I wouldn't move back up there.

Interviewer II: Okay, that was my next question. Would you . . .

Resident I: I would personally never load up, I would never move ever again.

Resident II: I would buy it, buy it just for my grand kids or my . . .

Resident I: I would like to have it to offer to the families. I don't foresee maybe my daughter that's living over in Matewan. That might be something she would like, but the rest of my family has land.

Interviewer: So as far as you know, the coal company still owns that land?

Resident I: As far as I know.

Resident II: Yeah, cause they're still leasing it.

Resident I: But they're you know, I would like to see that, you know. I think it would be good.

Interviewer II: Interesting.

Resident II: I know when we went through the woods when I was a young kid and when I moved up there. Well, I was 20, 21, 22, you know and I'm 53 now.

Interviewer II: How many people worked in Scarlet when you folks lived there?

Resident II: When we, when we left roughly, 35 or 40.

Interviewer II: That's families or people?

Resident I: There were more than that. There were more than that, Baby.

Resident II: Well, I'm talking about different families. I know there wasn't more than that. As far as people, you take 4 or 5 in each family, and that's a lot of people.

Interviewer II: That's a lot of people. How many families do you think are there now?

Resident II: Ahhh… I say if there's 10, no more than 11.

Resident I: If there's 10, no more than 15. I can almost name them.

Interviewer II: And you think that decrease in the number of families is directly due to the . . .

Resident II: To the buying out . . .

Interviewer II: To the buying out part of it.

Resident I: But, like I said, I could see the community coming back if they offered the land back to us.

Resident II: It may be a different generation than us.

Resident I: Right, but it would still, you know, I think the first opt for the land, was supposed to be made to the people they bought it off of. And then in turn we had so long to decided. If we decided not to then….

Resident II: I can close my eyes and feel I've been there, you know. Yeah…

Interviewer II: Yeah feels like the back of your hand, hun?

Resident I: But would it be to who they bought it off of versus, you know, I think the community could come back, it may not be the community that it was, but it would be, you know, growing. That's kind of scary now when you think, you know 35 or even 50 homes or whatever they was up to versus 10. It's kinda like, kinda like scary because there's so big a distance between a home.

Interviewer II: Is Scarlet close enough to places of employment, like if the people were to come back, they would come back, you know, maybe to live there. But what would, you're talking about a different generation, what would be their incentive to come back? … if they might have had family ties there?

Resident II: Because there's no land.

Interviewer: There's no . . . if they would come back . . .

Resident II: There's nothing to buy now.

Interviewer: It's land available to buy. Is there employment opportunities around, you know, that they could go to for employment?

Resident II: No more than . . . there used to be other than these stores, you know. Wal-Mart and places like that.

Interviewer: Sorta like the retail type.

Resident I: The malls unless the they can do anything professional.

Resident II: Lot of skill training down here, something to put your skill into. Like my boys was body men, working on cars and painting and stuff. So, wherever you're skilled then more or less, but there's no land to be bought now.

Resident I: You can see, you know . . .

Resident II: There are these little ½ acre lots are $30,000, you know. And it was before, you know . . . $100 per lot.

Resident I: 20 years ago, you could see a vast area between the homes, now they're like on top of each other.

Interviewer II: Especially in these valleys, you know. There's a very limited amount of land that you can actually put a house on, so to speak.

Resident I: Well, they don't care now adays. It's one deal. They build it up to where every the need it to and go on out.

Interviewer II: Exactly, exactly, that's interesting. Have you seen this community change at all too, up the holler here.

Resident II: Well, not up the holler, it's all owned. But you can see on the roads filling up, everything, any place they can buy.

Interviewer II: Even though the mine's here, they're still buying the land if it's available or buying? . . . do you see people moving in and out, like different faces or maybe you're not that connected with . . .

Resident II: No, we are not really connected that much. We don't even see no places for rent no more. Do you?

Resident I: Not a whole lot.

Interviewer: I think we've covered pretty much everything that was on our list. Did you all have anything that you wanted to add or to tell us about Scarlet?

Resident II: No, I mean, that was home, that's the only thing about it. I think I miss more than she does and it was her home. I mean it's where she was raised. But, I probably miss it more than she does. But it's, I guess, a lot to deal with . . .

Resident I: Life changes.

Resident II: Life changes. I had my kids all around me then.

Resident I: But, I miss it.

Resident II: I had my fruit trees up there that I planted, you know, they were doing real well, I come up here and didn't have no fruit trees.

Resident I: They wouldn't let us take anything, no flowers, nothing. Anything connected to the house. Like your cabinets.

Resident II: So I planted all these apples that you see here, and cherry trees, peach trees. I planted everything you see since I came here.

Interviewer: Why do you think that was? Why do you think they wouldn't let you take your flowers? … I'm sorry, we have so many voices going on over this tape, I'm afraid I'm gonna miss something. Can you explain that to me a little bit?

Resident I: When they bought us out they said "everything stays that's connected." And we asked about the shrubbery, and like he said, he had his young fruit trees that he had planted that we could have picked up and moved. It might have hurt their season, you know, for a year or two, but they would have come out of it, you know, and flourished. But they wouldn't let us take no fruit trees, no shrubbery, not that we have a lot. The fruit tree was well, he was mainly concerned about them. But they wouldn't let us take anything that was connected to the home, tied into it like built-in cabinets.

Resident II: Stoves, fireplace, you know your metal stoves.

Resident I: We did have the old fashioned heating stove and stuff.

Interviewer: Did they give you any explanation for why?

Resident I: It was just part of their buying.

Resident II: Six weeks later, somebody come along and collected them all and sold them.

Resident I: And that's kinda disgusting, you know. They broke into your homes.

Resident II: I came here and had to buy the same stove that's right in there.

Interviewer: You said, "broke into the homes", do you think it was the coal company who . . .

Resident II: Security, whoever had security on it.

Resident I: They didn't have security at first. That was before they had security, when they hired people to come in and go up and down the hollers and watch what's going on in the nights. Observe and see things like that, they just broke in different places and took things out.

Resident II: All the stoves, anything they could sell you know.

Resident I: Anything that was left that was of value they took.

Resident II: 'Cause I thought that maybe would look bad on us, you know.

Resident I: We tried to cooperate.

Resident II: Figured they'd open the door, and find it ready to move it, you know. For anybody else. I think that's what they had in mind in original, but…

Resident I: But, when I sign my name to something, you know, and it says I'm not gonna leave and not gonna take this . . . or if I tell you, 'Hey, I'm gonna sell you my home and I'm gonna sell you everything with it.' I couldn't take as much as a picture off the wall, because my word is good.

Interviewer II: Now, when they gave you your fair market value for your home, did you know that you had to leave like stoves . . .

Resident I: Well not at first we didn't, not at first.

Interviewer II: I mean you were just expecting when you moved out of your house, just like you would make a move to another place, that you could take the refrigerator . . .

Resident I: Refrigerator, the stove, you're cooking, your electric…

Resident II: You could take that, you couldn't take a water filter or nothing like that.

Resident I: Pumps, water tanks.

Resident II: And when you move into a place like this where you have to put pumps…

Resident I: Very seldom do you find in this area and I want things . . .

Resident II: I swear to you that they had to leave their blinds up here when we bought this.

Resident I: On the average, now adays, when you buy, or when you sell a place, they come connected, your blinds and things have to stay. That's just the way it is now, times have changed. But, like I said, I could sell my house today to you or to whoever else, and you would say well, I really like this, and this. You know, I would leave it like it is, for so much more you could have the whole contents. You know what I'm saying? 'Cause otherwise, it all goes with me. Because a lot of people like that, they like how it's decorated, not that mine is decorated really nice or anything. But they don't want to have to go through all that their self. They don't have time for it versus, maybe they think they don't know how.

Resident II: This house has four fire places in it, on every corner.

Interviewer: Oh really?

Resident II: That's the reason you got flat places.

Resident I: That's why they say it's 100 years old.

Resident II: You go to the other side, it's that way. The bedroom, the living room… they built them all.

Interviewer II: Each room had to have it's own heat source.

Resident I: But when we come in, they were all closed up. My first electric bill, I about had a heart attack. Started punching holes. We don't have the one in the living room open and we don't have this one here open.

Resident II: I got a fire place, you know, a fancy fire place in the bedroom. Out of what they had and then we use a stove here. We don't, still don't owe, what $35 on electric. And then in the summertime, sometimes the air condition don't run no more, you know. This place will stay cool until 2-3:00 in the afternoon. Until we have to turn any air conditioners on. She puts that plastic up because she's in her own business. All her freight comes and you don't want it to get wet, you know, in winter, it's unpredictable and the fall, so stuff. They'll leave it for her. I'm retired, so I just do whatever.

Resident I: What ever we want. Adding anything to it or not the conversation. There's nothing much more to add. You all covered a lot.

Resident II: They were fair with us, when we moved. The only thing I would like to see changes, I would like that opportunity to buy the land.

Interviewer: I'm glad you brought that up.

Resident I: I would like to have that opportunity.

Resident II: And I would say if you talk to anybody else, that would be their only.

Interviewer II: You said other people back that you knew at least in Scarlet, if they got anything else out of the deal, it would be to have the opportunity to buy their land back?

Resident I: And we was told that we would have that opportunity.

Resident II: Right, and I have never heard nothing. Now, it may still come.

Resident I: It may be that they've got something else planned for the land and they don't want to relocate people and just have to do it again.

Interviewer II: But still there's an uncertainty there. It doesn't seem like you feel there's a guarantee or you know for sure that they . . .

Resident II: People are living on there, you know, now they are still living there. We was at the mouth of it, we was the first place at the holler.

Resident I: Which was a mile and one-half, two miles off the main four lane.

Interviewer: Well, you know thanks so much for talking to us. I really appreciate you taking the time….

Resident II: I enjoyed it. It brought back a lot of memories.

Interviewer II: I'm glad, I hope you enjoyed it. We enjoyed it just as much.

Resident II: Well, I would say 90% of the people, or 95% that you talk to would say they would like to have the option to buy the land back.

Resident I: They may even want the option to move back. Like I said, I wouldn't. I've been away what 12 years, we've been up here 12 years?

Resident II: Yeah, 10 or 12 years.

Resident I: Going on 12 years. This is home now. But, that also used to be and I would like that option of having it. For hereditary reason, you know to pass down… to say hey…. I could still say hey listen, my grandpa, or my great grandpa used to own from here to here, you know. Basically almost up the whole holler, up to the fork. Generations back. His dad, and his dad's dad or something. It all started out in the family, as a family thing, that whole hollow did. Kinda like branched off – this one bought this one and that one bought that. I would like to have that option. I know I could never own what my dad owned up there, unless I got rich. Win the lottery. That was a little heart breaking, that part. "Course it was heartbreaking when my Mom and Dad sold it, I just couldn't understand why they did that. Because they were living… where were they in Ohio? They were living in Ohio. Like I say we got some good friends and neighbors out of it, but still it was… They didn't need it, so they sold it. I was fortunate to have what they sold to me. Which they seen to that, because when you buy it from for nothing, it is really about a gift to keep it. To keep the family from saying it was given to me there was money exchanged for it. But, it wasn't nothing that broke me up. Because they were selling to us kids. Don't want to say that I give you something that I didn't give to them. But, ain't none of them saying they want to live or wanting to relocate back here, so.... I was the baby . . . . gotta take care of my baby.

Interviewer II: Well, Alexa?

Interviewer: Yeah. We appreciate you giving us your time. You've got our card there if you think of any questions that you have….

MTM/VF EIS
Community Narrative: Superior Bottom, West Virginia

Interviewer: Tell me a little bit about how you and your family came to live in Superior Bottom.

Resident: Well my husband had lived there and well in fact he wasn't born in Omar he was born in Pine Creek. And then his father pastured a church there in Superior Bottom and they moved to Superior Bottom. I moved to Superior Bottom when I married him. And that is how, you know, I became a resident there of Superior Bottom.

Interviewer: About when was that?

Resident: We got married in 1948. But, we moved to Omar in 1945, but we moved up Pine Creek.

Interviewer: So when did you move back to Superior Bottom?

Resident: In 1948, we...we really didn't move away. He…. after our son was born in 1949, he lost his…well he lost his right hand in an accident at the tipple.

Interviewer: Your husband did?

Resident: My husband did. And they wouldn't hire him back, because they didn't think that he could do the work, you know, with one hand. And he was a GI, so we convinced him to go to college. And he went to, he enrolled in Blue Field State College, in September, 1949. And we went to Blue Field. And then while I was up there, he insisted that I take some classes. And so we did, so we stayed up there until he graduated in 1952. And we moved… came back to Superior Bottom and that's where we've been.

Interviewer: Oh okay. So you got a degree in teaching?

Resident: Yes…I got a degree in elementary education.

Interviewer: And what about did your husband, what did he study?

Resident: He studied um…. well, at Blue Field, they had started a course where you can be certified from kindergarten through 12^{th} grade. And he took that, they called it the single curriculum. And then he did his student teaching on the elementary level and then he did it on the secondary level. But he graduated from there, and then he went on to Marshall. And he got his masters in Principleship of Supervisory. And then he took some masters plus classes in special education, because he was a director.

Interviewer: So both of you ended up in the special education field?

Resident: Yes

Interviewer: Did you work at the school in Superior Bottom, then?

Resident: I did… I started of first at Peach Creek, in what we call the 'trainable center.' And then they transferred me back to Omar, that was when they opened up as the… on the secondary. And then they made my husband Principal and I worked there. And then when he left…he became Director of Special Education. They brought in another principal, and I stayed there until… that's where I worked until I retired.

Interviewer: Until you retired. When…. when about was it when they opened up that school and then you started working there again?

Resident: It was umn umn, Fall of '67. 1967. Because that was the year…well in fact in July of 1967, and I was going back to Marshall. And had a wreck. Well in fact, came close to losing my life. But, thank God didn't see fit to take me then. But um, then… that is when they opened it up, they opened it up, that school in September. And my husband was Principal. And on the other side, half of it they were using if for Adult Education, but they gave the Adult half of the building and we had… we had the… I'm trying to think… we had the front of the building. The front side facing the main road. And they had the back side facing the mountain side. And that was the way we started the Douglas Omar School. It was a high school, secondary level, for special ed students.

Interviewer: So at that time you were now living back in the Omar and Superior Bottom area.

Resident: Yes we were.

Interviewer: And what was the community like back then… when you were living there and working there?

Resident: We had, well it had…. it had really started going down. See that's when the mines, they started closing the mines in 54'. And people started leaving. And then um, Wheeling-Pittsburgh Steel sold the land, or leased it to someone and they would came in and truck the coal out. This was really the beginning of the depreciation of the community. And there was… most of the people didn't put anything back in the community. And then we started complaining about the dust and then they started oiling the roads. Trying to, you know, keep it straight. But, as far… it was really a close-knit community. It was.

Interviewer: Up until then or…

Resident: Well, and even now there… Some of the people who use to live there they come back. And when they come back into this area, they have to come back into Omar. And even some of them are upset now, because most of the houses are gone. And some of them look at them and tell me that it is depressing. I told them 'No, it isn't depressing.' I don't look at Superior Bottom as being a loss, and something that isn't going to come back. I looked at it as if is well, I've expressed it as a pregnant lady getting ready to give birth to something. And this is where I expect, I expect Superior Bottom to come back and I'm expecting people to live there. And…

Interviewer: So it is just going through a cycle of change.

Resident: This is what I see, and this is what I believe is happening - just a cycle of change.

Interviewer: That is interesting view point, and a very interesting way to put it.

Resident: Yes.

Interviewer: Very positive way to look at everything.

Resident: Uhm hum.

Interviewer: Tell me a little bit more what you liked about the community or what you still like about the community.

Resident: Well in fact, I liked the relationship that the people had. And well, now it is just so quiet. And the birds, more birds…we've seen more birds, different birds in the last year and a half, close to two years, than I've seen in the bottom, you know, since I've been living there. And uhm, deer come out of the mountain and we can see them. Well, of course we had a bear that came down, well of course we're not too interested in a bear (laughing). But then before I moved from my old house, there is a big tree in the back of my house and a light pole and I was across the street at one of my neighbors one day and I looked and I saw a squirrel running down… down that tree. So, we had wildlife living there. And unh, it's just so peaceful that they were coming out of the mountains.

Interviewer: So back when there were more houses and more people it wasn't so quiet?

Resident: No, it wasn't so quiet. And we didn't have so many, you know, of nature's creatures coming down. Once in awhile at night they may have a bear come out of the mountains. And one time there was a deer that ran through the community, but that was it. You just didn't see them coming into the community. And I… we didn't see the exotic birds. We've seen blue birds, small little… they almost looked like canaries, and wrens, almost every kind of bird. Blue jays, yes. It was very… To me… and I just loved to watch the birds. And I watched them and you could hear them and you could see them. And different people have been talking about what beautiful birds they have been seeing.

Interviewer: Hum… That's really an interesting and positive change that I hadn't heard any one else mention. Is the close-knit aspect of the community still there?

Resident: It is still there. It is one of the things that is unique. We are close-knit but we seem as if we don't care. You know, lot of times… but we give each other their privacy. But, when we know that one is in need or one is going through something. People will rally to see what we can do to help them. And that is the type of community that we have, and that type of relationship that we have. And unm, well I'm blessed… my daughter doesn't think I'm so blessed, but if anyone knows that someone is going through something they will call me to see what going on or call me and tell me what is going on. And usually I'll see what I can do or see where I can direct them to get some help or something like that.

Interviewer: Do you think that is likely to change in the future?

Resident: It all depends on the people and umm… if we want it to remain the same we will. And but if someone should think "Oh I can't do anything," and you have their hope. It will be, if they're positive.

Interviewer: Do you think that any of that has been affected or might be affected because of the surface mining coming in and the changes with regard to that?

Resident: You know, I saw some disappointment, but it's… they're coming back. Everyone is they're trying now to do and keep things going. One of the things I told them too, I said, well, you know, people were coming in and trashing the community. And I told them, No, we have a community action group, that we were trying to improve our community. And as long as we have one person living in that community, and this is…. is ah going on, we expect the community to be decent. And able for people to live in and clean enough for someone to come in and want to live in. To want to live in it. So, that is what we are trying to do.

Interviewer: That sounds like that is a really strong and unique, as you put it, important part of the community - that you've all come together at least in that way.

Resident: Yes we have. We've had a few that, you know, well you don't ever have complete unity. But some will backed off and umh, well they… you know, and if some people they can't get their way about something then they drop out of it. It is as if they take the ball and go home. But then these same people have needed help from the community and they've asked, and it has done. So, I can see them slowly coming back and becoming involved. The only thing that… one of the things I missed the most we don't have the children that we use to have, because we use to do positive things with the children, we would give them like a little outing, or little wiener roast, or something like a picnic, at the end of school. And then we would do something, you know, at the beginning of school and try to do something to keep them encouraged.

Interviewer: When did that change, when when did there seem to be less children?

Resident: When they started moving out of the community, and they sold their houses. Because when the coal company came in to ask to buy the houses, they only wanted, I think it was 4, no it was 3 houses, at first. 'Cause they want my house, 'cause I'm right on the corner, and the "specific name" house that was on the corner, and the other place… which it would be hard for them to turn. And the house right beside me, because it is directly in front of the bridge. And they said that if they can get that, they could make almost, a straight shot back to the mine. And one lady in the community heard that the coal company wanted to buy the houses. And he said, well he told me, he said, that he wanted to buy the ones in a row down to the school. And ah… he said, and then all the way back to the mountain, because that was what he needed, he needed that for his men, and for his equipment, you know for them to park. Well, when we knew anything, this lady had knew about it because it wasn't gonna bother the houses on the creek. And she took a petition, and got the people to sign, saying they wanted to sell. Well, when we took it to the community group we would discuss it. And my concern was if they brought in all this equipment, we had little children that lived, and most of the little ones lived in the houses along the creek, and I was concerned about them. Because sometimes they would get out, and they wouldn't be supervised, that they may get hurt. And I called him to ask him, you know, I wanted to talk with him see exactly what his plans were and he thought I was interesting in selling too, that I was speeding it up. And, I told him no, I was concerned about the children. And this is when I found out that this lady had circulated the petition, and that all of them wanted to sell.

Interviewer: So initially you, they all wanted to buy a certain number and really… the whole group of people got together and said why don't we all go. Why do you think in your experience they decided to do that?

Resident: Well, I think some of them… well it was for the money. I think that's what most of them were out, were after. But they did not get what they would have, had he ask them, you know to, to buy their homes. So, in fact different ones saying that… that they wanted to go, everybody wants to leave, he didn't have to offer them a lot of money.

Interviewer: Do you think that they got a fair deal?

Resident: Well, not as fair as they could have and he, well… As far as what we paid for the houses, we really got them very cheap, and then we had put a lot of expenses…gone to a lot of expense to repair them, remodel them. And what a lot of them got out of it, they could not have bought a house that was comparable for the amount that some of them got.

Interviewer: Tell me a little bit about your experiences, with that same process.

Resident: Well with that same process, they came and they appraised, and the lady that did the appraising, appraisal put in false pictures. She had appraised… made an appraisal of a property for another group, they wanted to put in a housing development on some property. Of the lady that bought this school property, this is one thing she was trying to do. This lady did the appraisal and the pictures, well in fact one of the things she was saying then, was that the community was too dirty, and you know, run down for it. And she put in a negative report, so the housing people turned it down. And well we didn't know that this was in the plan, this plan for the coal company was already developing and she knew about it because she was the appraiser for them. So when she came in to make the appraisal for us, to appraise our houses, you know fix up this package here, they put homes that are similar to yours. She put a picture of the house that was next door to me that she had taken on the first appraisal. 'Cause between the time of the first appraisal and the second appraisal, some renovations and remodeling had been done on that home. It didn't look like it did on the first appraisal. But she put that picture in there and I recognized it, and I pointed I out to her. And said, I told her, I said, look this _______ is a reflection on the integrity of your company. And I said it's false. And the man, I think ______ "specific name" was with him, and he looked at me and he said integrity? And the "specific name" said, but you know, I've tried to be honest with you. He said I've tried to keep my word. And I said, I know you have. I said, what you need to realize when they talk about your company, you're out here talking with the people, and you're the one they see as being dishonest. And I said this a reflection on you, as well as on your company. He thanked me. He said, I'll tell them. And I said now, I said I could not recommend this lady to do any appraisals, because of this false report.

Interviewer: And she worked for… his company?

Resident: His company, Massey, he worked for Massey. And he said I'll take it back to them and I tell them.

Interviewer: Did they give you a choice of what appraisers to use?

Resident: No, no they didn't. They had hired this lady, you know, to do these appraisals for everyone. And then of course they based it, course they went by court house, they based it on the, you know, the tax value our rate, tax rate. So what he was offering me for my home and my lot, well I couldn't have bought a new place for it. And we had, my daughter was living in Denver, Colorado, and my husband was bedfast. But let me tell you something, go back to the very first time they came to me. He and "specific name" came to me, and they apologized for coming because they had heard my husband was bedfast and was sick. And they apologized for coming because he was ill. And they said but we, and they told me what they needed, and they needed my house. They needed to expand the road. And I said well do you really need it? And he said yes, and he told me what he was doing. And I had heard a little bit about it, I said they… and they had, they had told me they didn't hire blacks. So I asked him, I said are you an equal opportunity employer? He looked at me and said yes. We hire anybody we think can do the job. And I said well okay, and I said now you need this. Your trying to provide jobs for people, lot of the jobs, I said you also trying to earn a living. And that God has blessed us to be past that age where we are retired and can live, you know. And I said, but if you need this to provide jobs, I won't stand in your way. I believe a job would be worth some place else to go. And ah… so, if you need it, and you will hire people. And I told him about my next-door neighbor and two other families right there in my community who needed work. And two of the men had sons who needed work. And I told them, I said now they need work, they can't find, and if you're willing to give them a chance, you know, if they want to apply. He said yes, we'll hire anybody. And so based on that, and I told him I will sell. And I talked with my husband he said he would sell. We were going to go Denver. Well, I would have to transport him by air ambulance. And my daughter went on the internet and found someone, well the man… we didn't know the man was dishonest. But she told me he said it would take $20,000.

Interviewer: To move your husband?

Resident: To move my husband, to fly him, you know, from West Virginia, out to Denver, Colorado. And so that would, and when they brought the appraisal I think he just offered, it was either $45 or $49,000 for my home and the vacant lot. And that would not have left enough to buy a home, it would have taken that to move my furniture. And so I told him, I said no, I can't do that. So then he offered to pay, they went on and they could it for a little over $10,000. He said, we will fly him out there and let you keep all the money. And by this time my husband had become, well he loved Omar, he was born in Omar. And he asked me had I changed my mind about going to see his brother? So I had asked if he wanted to move to …Virginia to be with his brother. Or either to Norfolk, Virginia. We have a young son there. We… our oldest son lives in Texas. I asked him, you know, if he wanted to go and live with either one of the children. And he answered no, he wanted to go where our daughter was. But he changed his mind, he was really anxious and I saw the fear on his face. And I had told him no, I said do you want to go live with "specific name"? He said no, I want to go see him, but I don't want… I want to live in Omar. Then I said, well you said you want to go live with our daughter, and her son and daughter. And he said no, I want to go see them, I want to live in Omar. And he was afraid I was gonna take him out of Omar. And I promised him I wouldn't take him out of Omar. And that totally, I said now are you, do you mean Omar *and* this house or do you mean *just* Omar? And he kept saying just Omar. And I told him, I explained it again, I broke it down. I said now if we sell this house, we stay in Omar. We'll move in a new house, is that what you want? And he said yes, it would be all right to sell this house. But I prayed and asked God if he meant *that* house - don't let me move him. We were in that house when he passed, so I'm sure that's what he meant.

Interviewer: So you stayed for how much longer than before when you originally started talking to that company?

Resident: It's been over 3 years. Over 3 years.

Interviewer: Over 3 years. And how did the company react to your decision to stay? Was that something?

Resident: They were completely satisfied with it. They told me, and then they offered me property in Pine Creek. We use to live in Pine Creek, but Pine Creek has been, it has depreciated. And then drug dealers frequent up there and I didn't want to go up there, from what I had heard. Main reason, I would have moved away from my support. 'Cause I had a young man who would come in when I had to go to the store, and sit with my husband. And then my next door neighbor, when she saw the lights on or something, she'd call and checked on me. And this is what my neighbors did. And I didn't want to move out of that secure environment. And I told them no, I didn't want to go that far and I wanted to get as close as I could. So I knew that he wasn't taking all of the property in Superior Bottom, so I asked him if I could move to the upper part, some place in Superior Bottom. He first offered me a lot behind where I was, and I thought it was on the back. I said no I didn't want that. One night I had brought my… after I brought my husband home from the hospital, and it was beautiful. And I was out there, I was just saying Lord I love this place. 'Cause I had pine trees around, and it was just so peaceful. And I said, but I've given him my word, I'll sell. And I said, I don't want to go back on my word. And it was like he spoke to me, 'And what about back here? You will still be on the corner and it would be similar to where you are.' And I could just picture my home right behind that house. So I told him I wanted it. But then that lot was tied up – the lady that had had it, you know, she didn't do right. And another young man bought it for taxes and ah but, anyway. All this went on, and I just asked the Lord to let me… if I was going to stay in Superior Bottom, let me be where he wanted me to be. And they were going to put me in front of my church. Well ran into some difficulties with the homes that we picked out at Fleetwood. And when my husband passed the one I had picked out and settled on. I was trying to get one with enough area I could bring him in to the family room with, you know, the bed. And uhm, then this man, he didn't believe the coal company was going to pay for it. He started trying to pressuring us after he realized that to go ahead and close the deal. And well anyway, when my sons came in they went down to look and to see. One of them is in air condition and heating, and he felt the gas furnace would be better, than the electric. And um, so this was one of, one of the changes we had to ask for. Then they wanted the motion detecting lights and some other things. But the little changes… that they made, he said that it would be an additional $1,000 to the cost. Well, "specific name" went down to like the payment and he told me $2,000 dollars more. Then he started pressuring "specific name and he would call me, called my son in Dunbar. Every time he would… he wouldn't call me to say anything. And then he didn't call "specific name" and "specific name" would stop calling him. "Specific name" went down to make the down payment, he wanted him to pay all of it. He said no. If I ay you all, then "specific name" may not be satisfied. And so we'd would be stuck with it. He said I'll pay you half of it and when you bring it and bring it in, I'll pay you the other half. But anyway, that is the way it went. And went through, even in the first half, he wanted to add $2,000 dollars on. And then "specific name" got upset with him and went to his friend. Back to "specific name", at "specific name" Manufactured homes. He had brought one over from "specific name" lot, over for me to see. He put it there on the lot there at Rothmore. Trying to save me from having to travel and leave my husband. Well I went in - it was a beautiful home. But the fire place was facing the door to the great room. Right behind the fire place was the kitchen. And its an "L" shape, but it was small. I was used to a large kitchen. And the washroom was very small, and then the table, the kitchen table, it was really close together. And it looked as if… only if you could sit on the end it would be comfortable. Doesn't seem as if you could be comfortable. And, I had 5 children, and I am 1 of 16 children. There is fourteen of us living. And when my sisters and brothers come, they come to my house. All of us are kinda hefty, and I just… I just had nightmares. I got claustrophobia looking at that, thinking about my family. And I needed some pantry space. Cause I had some pantry space. So I asked him if I could look some place else and he said yes, I want you to be satisfied.

Interviewer: That is interesting. So all through this really, the representative from the coal company has worked closely with you to make sure that you were satisfied. And you feel like he was very honest with you?

Resident: Yes

Interviewer: That's good. What was the arrangement in terms of were they going to purchase your current home and pay for a new one. Or they…

Resident: They…. these people are purchasing my home and giving me a new one. Debt free. And they'll landscape it for me, fence my yard. And he was going to give me a carport, but I had so much stuff that I need some storage. I had a little storage building but I didn't think that would be large enough for they could move it. So, I told him that I wanted a garage. And then I could put some stuff in the garage. And the young men who was doing it… I thought that a 1 car garage would be enough of storage space, and so we bought a package. And he said that I should have 2…a 2 car, in order to have ample storage room. So, this is what we're trying to do. And he was going to give me what he was going to pay for the carport, for the garage.

Interviewer: So you'll have to pay the difference, a little bit, but that is okay by you.

Resident: Yes.

Interviewer: So you feel like you got a very good deal. Have you talked to the company about anything else? Do you have any dealing with them about blasting or anything else that the community has experienced?

Resident: Well now with the blasting, even before it started… they came by and they told us. And they did, that was why they did appraisals of our homes and took pictures. And so that in case the damage was done because of the blasting, they would pay for the damages. And this was one of the things they said. And now since it has started, you know, we hear it sometimes. But he told us anytime, just let them know, you know, if it disturbs you. And one of the things he was trying to do with me, he said he wanted to put me up on the end by the church. Because my husband was living, and he wanted him to be away from the bridge and not get the noise of the trucks coming across the bridge. And one of the things, I know about the men who working and cleaning off my property, they was throwing stuff in the creek. And I stopped them. Then one came and cut down the tree and let it fall in the creek. And I told him. He said oh no, they'll get it up, he made them get it up. And this was one of the things he's doing, he trying to work that way, to be sure that things are not messed up, not done wrong.

Interviewer: Did they come in and talk to you, and to people in the community before they started surface mining at all?

Resident: When they came in they… Well, when he came through, talking about the property, he told me what he was going to do. And the original plan, he said, was they was going to put in a shaft mine, up behind the mountain. And that he told me, he said, they don't plan to truck coal through the community. They're building a conveyor belt to go, I think to the plant at Stirrat, and that's were they plan to send their coal.

Interviewer: So you had information about what was going to happen

Resident: Yes.

Interviewer: How satisfied are you with everything that has been arranged, for you, in terms of your move?

Resident: I've been satisfied, it's just going slower than I had thought it would. But ah, and I keep telling my daughter, but she was getting upset. And I said, we can't move ahead of Gods plans for us. He always in control, and we have to wait on him. And the other day when I was getting a little anxious, cause the cold weathers coming… And they put my new home in place in June, and then they didn't get everything finished. We… well was it June? We started to put furniture in there in August. We spent our first night in the home the 8th of October and we been moving in ever since. Waiting for them to get things, you know, fixed. And the landscaping well, instead of doing some of the grading before they put down this… They had to get, my home came in first then they had to get it off the lot, 'cause it took up most of "specific name" lot. So they had to get it in place. And so they, this is why they started the way they did. And then they're putting in another home above me and its cheaper, he explained to me, its cheaper to have multiple work done then to do one single thing. And this is what he's trying to do. And he said that the more he can save, on the landscaping and all, he'll be able to more. And ah that was one of the reasons he gave us the carport. And he went to the Health Department to see if it would be possible for us to use the same sewage system and so that saved money, freed up money for him to use, you know, towards the landscaping. And so I been very, you know, agreeable with him, because he's doing everything, you know, to try to please us. And this is, now going back to “specific name”, with the home at Fleetwood… he had gone down and he knew a lot of things. But he’s not pushy he won’t, wouldn’t try to get me to change my mind. He would ask me questions, you know, make sure. And when he came in and talked with my children and they were asking him questions. And he said yeah, he said this is some of the things he was concerned about, and he said, I don’t want you mother to be taken advantage of. He said, and I’m not going see, allow her to be. And he said, I want the same things for her that I want for my mother. And he said these are some things that need to be taken care of. He became so emotional when he was talking about that, and I just thank God that he’s like that. And he pointed out to them some things that they needed to look for and be concerned about. So that’s the kind of support I have in him.

Interviewer: That’s really wonderful.

Resident: Yes. And when I called him about some things, he said well let me call the company and see what we can do. And then call me and said it would be all right.

Interviewer: So you have faith that he’ll stick to that.________

Resident: I do, I do.

Interviewer: What about ah, do you, how do you feel about your decisions to move? You’ve explained that you feel like it s the right thing to do and that’s…

Resident: Well, I, originally, I stand on my faith in God, in the Word of God. ‘Cause you know it says if I obey him and the Word dwell in me … I can ask anything in his name and it will come unto me. And based on that, and I prayed and even when this was going on and my husband asked to stay in Omar, everyone saying you know, you don’t need to be hearing about all of this. And I asked, “specific name” about the dust and he said that… you know, he told me what he planned to do. And then I know there’s Federal, Federal regulations they have to do all they can to control the dust. But I prayed and asked the Lord he knew exactly what was going to take place in Superior Bottom. And if it would not be a place that would be good for my health or good for my husband… don’t let me stay in there. No matter what we felt, don’t let us stay where we would be in danger. And ‘cause it’s my desire to be where I can serve him and where he wants me to be. And even with the home, when it was going to be up in front of the church, I had even asked the Lord, you know, about that. But then I asked him, I said where ever in here where it will glorify you, because I want my home to glorify you. And still please me and meet my needs. And this is where we’re moving to the spot where I am. And that is the best spot. Better than the one where we were going to be. And I am content on that.

Interviewer: Let me back up a little bit and ask you about something else you had mentioned. You said that you had initially talked to the company about selling out, that you expressed to them their desire to see the people that lived in the community could get jobs. One of the things that I wanted to ask you about is what did you see as the benefit…ah what benefits did you see coming from the coal mining coming in to do surface mining. Did those jobs become a reality? Were there other benefits that you saw?

Resident: They haven't become a reality, yet. Because the permit has been held up, and they really haven't be able to start mining the coal. They have just progressed into building the road. They're building the road now, trying to get that in. And hoping and expecting to get the permit. But, the last thing…last time I talked "specific name" about it, this is one of the things he said, that they are still waiting to get the permit. But, they believe that they will get it. And as far as the people, you know, being… having jobs, you know, they had to move. And the young men, one of them is in Huntingdon. And the other one is in Logan. He is working at, I think, Bob Evans. Of course his father has another job. But his father was re-called back to the mine that he worked for. But, he's had a lot of health problems, a lot of surgery. And he said that this time it just didn't feel comfortable with going back to the mine. And the other two men…one has a back injury; and the other one went to work at the jail. And, of course he is off now with surgery and recovering from that.

Interviewer: Did they end up finding other work?

Resident: Yes they did.

Interviewer: Do you think that there will be other benefits from the surface mining coming in or are there some that I am not seeing?

Well I really believe that…well in fact one of the things that I am expecting and maybe it is just hoping. That the mines start working and they get all of their equipment and get the land fixed like they want to. I am expecting them to put in modular homes, ah manufactured homes. Maybe for some of the workers. But, this is one of the things that I am expecting them to develop the community, and develop the land.

Interviewer: That is a very good... that would be a wonderful benefit.

Resident: Umm hum, it is.

Interviewer: Are there any other impacts that you have noticed? Let me re-phrase that. Over the course of time that you have lived there, how would you say the quality of life may or may not have change in relationship to the mining coming in? Did it change that at all?

Resident: Well, from the beginning the quality of life has, you know, dropped because of the lack of mines and the lack of jobs. And with this mine coming in it hasn't improved anything the other than to free up the animals and nature to feel free to come in. And the peace that we usually have until, you hear, we hear the noise and stuff. But, I guess I've always… I, I can adjust to a change. When things start... I look for and expect the best. Until I feel, you know, that it is not going to happen. With this I am just expecting some positive effects.

Interviewer: Well that is good. I hope that that is the case.

Resident: Yeah.

Interviewer: Were there any negative changes at all?

No more than losing my neighbors, and losing the children. Well at one time we didn't have a dog, in the community. You know, not near, but then the people that lived around in Holler had a dog. Things like that, those are things that I miss and I would say is negative.

Interviewer: What kind of information do you ever see published out about the permit activity and the mining activity? Other than what you have been told first hand do you read anything or see anything?

Resident: I haven't been keeping up with it lately, but the last thing I read about was, you know, the case that is involving Blair. It had been returned to West Virginia. And the last I heard it was still held up, they had not made a decision on it. And until this decision is finalized the permits are being held up until after that decision is confirmed. That is the last that I've seen of that.

Interviewer: You read the paper regularly and take the paper?

Resident: I take, I take the Logan Banner and I take the Williamson New. And I try to keep up with it. I try to listen to the news, but for the last three weeks or maybe more. I haven't been really effective in doing that. Because when I get my paper behind, I'm reading my paper. And I end up falling asleep. (laughing)

Interviewer: Well you are busy these days with moving. Do you ever…remember ever seeing in the paper, did you read that permit information that was posted in there

Resident: Yes.

Interviewer: Did you find that it was ledge able and helpful to you?

Resident: Yes. I really did. I found out what exactly what was going on, and where it would be. And you know, I understood that part. And then I attended one of the meetings, that was when they came in and explained. I didn't hear…and one of the other meetings we had a representative from our community to go and they came back and brought us the information. So we try to keep up with it that way.

Interviewer: So they have been effective in sharing information? And that has been good? Okay.

Resident: Yes. And then, I've asked "specific name" you know, exactly what were they planning. And he would explain, you know, some of the barriers that they keep running into. One time he thought that Massey was going to back out. But, he went to the meeting and they told him, no, they were still going to go ahead. Because he is part of what you call the Stirrat Coal Company. Stirrat Coal Company is the company that will be operating under they Massey umbrella.

Interviewer: How do you spell that…the company.

Resident: S-T-I-R-R-A-T

Interviewer: I have seen that name. There's a town close by, right?

Resident: Yes, it is. It is above… up there. And that is where the tipple is, you know, or preparation plant.

Interviewer: Okay. I am trying to make sure that I asked you everything that I wanted to be sure and ask… Is there anything else that I didn't ask you about that you want to talk to me about or tell me about. It is about ten of one so…

Resident: There isn't anything else that I can think… Other than, I just thank God that he let me have the relationship that I had with "specific name" and he gaves me someone with integrity. And you know, that I really can respect. Because I couldn't deal with people that I don't respect. So far from the day…first day I met him he has been a man of his word. And he has…and he has gone through some things, trying to keep his word. But he is a wise businessman. And if you are in business you have to try to operate as economically as you can, and he is no different than a smart businessman. And I said, but when he gives his word and he follows through with it.

Interviewer: In your experience has that been the case for the others who lived around you as well?

Resident: Yes. And this is one of the things that even now… One young man very close to me got anxious, and he… Well actually, if had not been for the grace of God he could have gone to jail for what he did. And uh, it upset "specific name" terribly, but God was merciful to him. And he got out of it.

Interviewer: How fortunate then that the company and the community were able to maintain the relationship despite that.

Resident: Yes. Well actually it was one of the things that involved him and the people that he had bought the property from. He signed their name.

Interviewer: Humm… so he signed falsely?

Resident: Right. That was it… He had, he had lied to "specific name" and he is trying to be sure the everything is legal and right.

Interviewer: Let me ask you actually other thing if you still have a little bit… You tell me, if you have to go you tell me.

Resident: Okay. Yeah, because I have a meeting with the lawyer and I need to let him know I'm coming. I have to pick up the young man. Okay.

Interviewer: This is my question and you tell me if you want to answer it. Uhm…Now I'm going to forget what I was going to ask you. It went right out of my head. But, I basically I think that we covered everything.

Resident: Okay.

Interviewer: And I really appreciate you taking the time.

Resident: Okay. And I know Massey's done a lot of things. And I know in my community, even with the people that dealt honestly with him, they received the same type treatment. We had some who tried to deal on it dishonestly and they wanted to get more than their property was worth. We had some people's houses that no one lived in, they were abandoned. And some haven't lived in them for years. And they wanted to get a huge amount of money. They got angry with him because he refused to pay. If they would sell it out-right some of them would not get $5,000 dollars, but they were wanting $50,000… $30,000 and $50,000 dollars. For this house that had no porch, it's leaking, and all of that. And so I believe in being honest and fair. I know that even with my home the way it is, it was… I have the better deal. Cause if I had lived in that house, again, I would have had massive renovations and repairs. But, God has blessed me to move into one that I won't have to worry about repairs for a while.

Interviewer: And you feel like you described the community's future as something of a rebirth. So it sounds as if you have plenty of good faith that the quality of life there is going to continue to improve.

Resident: Yes.

Interviewer: And you are not concerned about… company's use of the other property degrading the future of that area?

Resident: No, no. In fact, I see a positive thing in it, and that is what I am expecting. Well, in fact, I tell them when I have a big mouth and I don't know any better than to express how I feel. And if it is going wrong, I think I can speak to whoever is there to let them know how I feel and that I think it is wrong. But, I have to stay aware of the laws and, you know, be sure that I let them know that "Hey" you are out of the guidelines. And when I do that and people know that you know what they are supposed to be doing - they respect you for it. And then they won't try to do something illegal.

Interviewer: I very much hope that is the case. I applaud your faith and really that is a wonderful thing.

Resident: Well thank you. And this is the way that I operate and this… and God has been merciful to me. And he has given me favor with "specific name" and ah… my son that lives in Albuquerque. Well all of them were concerned. They was thinking I was being taken advantage of. And my son came in and he has a friend that runs the service station. In fact, they were in Cub Scouts together, graduated from high school together. And he went down and he was talking with him about his concern. This young man is a friend to "specific name." And "specific name" had discussed me with this friend. And he had told him of all the people in the bottom that he was *definitely* going to see that I got what I wanted. I had not harassed him. I tried not to harass him. I've tried to be honest and up front with him. So I said…well I told him, I said well before I went into this I prayed. And, I said that when I started I had to stand on my faith, and I believe it is going to all right.

Interviewer: Well good.

Resident: It is taking me a long time. It will. And you know? I have to say this too: When I was young, we lived at Pine Creek. And the dust sometime from the tipple would cover our porch and we lived through that. We moved over here when they first started truck in with this. In Superior Bottom it was just…you couldn't sit on your porch from the dust. Then the Federal laws, you know, improved that. And I know now that we don't have to live like that. The dust has had an affect on other people's health. I am not too sure of what has happened to me to me that caused me to develop asthma, but I know that God is still in control. And he will help us and we, we need to work with the people that have the mine, and they need to work with us. And try say "Hey" let us earn a living, but let us keep it as safe as possible. And I think that if we approach each other with respect and understanding we can get there faster and much easier than we can when we be start fighting each other and go with the a combative attitude.

Interviewer: That is a very healthy and good way to approach it.

Resident: It is. That, to me, is the best way to approach any situation if you want to resolve it peacefully.

Interviewer: Good. Sounds like it worked, too.

Resident: It is…it does. It does.

Interviewer: Thank you for sharing all of that with me and I really appreciate it. Taking your time.

MTM/VF EIS
Community Narrative: Werth, West Virginia

Interviewer: **W**hy don't you start off by telling me how you came to live here. You said it was a boarding house before you moved in. When about was that and what brought you here?

Subject: I have lived here since I was three years old. Sixty-seven years. And my father was a, he worked for the, first he was their mechanic, Ely Thomas Lumber company. And then he was a work boss in charge of their camp. So, he got married in Montana in 1915 and when they came back from Korea why we lived here.

Interviewer: Did you move here because you had family ties or to work at the lumber company or?

Subject: He worked for a truck tractor and trailer and hauled lumber.

Interviewer: And your family has lived here for awhile, so you have a pretty good image in your mind of what this community was like before they really started to do a lot of strip mining around here?

Subject: Yes.

Interviewer: Can you tell me a little bit about what that was like compared to what it might have been like during the strip mining and after? What was the community, from what we understand predominantly made up of the lumber industry and families working there.

Subject: Yes. Nicholas County, Ely Thomas Lumber company was Nicholas County's biggest employer. Before the coal companies came in.

Interviewer: Some one was explaining to us that it was the second largest mill in ah, how did he say?

Interviewer II: I forget how that one huh,

Interviewer: Second largest mill in, in almost like the Eastern United States or something like that, I think he said.

Subject II: That is the biggest lumberyard in the Eastern United States.

Interviewer: Yeah, yeah. Pretty big and nice huh? So then, when about did the mill close down actually? I don't think I know that.

Subject: This one burned in '59.

Interviewer: So that was after they had already started to strip mine in here?

Subject: Umm, humm. This one here on the hill, Mr. Ely had umm the last part of it, had 'em shut it down because they were blasting and jarring the mill. So, some of it they had left. Not much, but some of the coal there.

Interviewer: He had them shut down the strip mining you mean?

Subject: Yes. Because of it was… of jarring his mill.

Interviewer: So then, when the strip mining moved into the area did you, what kind of changes did you notice to the community at that point.

Subject: Well not right here, not much. But on down a way the stream started filling up.

Interviewer: And that was from them, putting over the land in the holler.

Subject: Washing down in the spring.

Interviewer: So that had an impact on the physical environment, you know the streams and the flooding?

Subject: Oh yes, it is building back up here; it is going to eventually be back up here again.

Interviewer II: Do you still think there is sediment being washed down from the spoils or from the mining operations?

Subject: Oh there'd have to be.

Interviewer: Is there any changes that you saw in the people who lived around here? Where there, for example did they hire a lot of people from the community to work at the mines or did the people move in?

Subject II: Well, the mines, there are some big mines around Tioga. On up the road up here was a big mine and things and there was a lot of people that worked. But then after they got the machinery and strip mining doesn't hire them…

Interviewer: Those people mostly moved out to find other jobs?

Subject II: Oh yeah. The young people though.

Interviewer II: So the older people, you know…

Subject: Were still in this County.

Interviewer II: …were sort of established here and didn't want to move out because they owned property or had ties to the area verses the younger people who were and, had more of an opportunity to move outside for employment I guess.

Subject: Yeah they needed jobs, so they moved out.

Interviewer: What other kinds of physical impacts or changes did you see? Did you, did your house shake from the blasting?

Subject: Well, one time we had one episode where they blew rocks down and came from across the side road and we had to get on them about that. They came down to see about, that is when "specific name" ran the company.

Interviewer II: Who did you, did you actually contact this mine operator up here? How did you know who to contact?

Subject II: This use to be Island Creek when they were doing that. And they were pretty good.

Subject: The had lots of stuff at Craigsville, down to 7 miles up the road. Than ah ….

Subject II: But their tipple and everything was on back then on this mountain, so we didn't have much dust from tipple.

Interviewer II: Right.

Subject: When they came right around this edge we did, they worked on our chimney. Some that blasting did and then when they blew that rock down.

Interviewer: But they came, you say they came and worked on your chimney when you talked to them about it or?

Subject II: No we never bother to talked to them about the chimney.

Subject: Not until they washed out our road.

Interviewer: Did you not bother about the chimney because you figured they weren't going to do anything about it or…. Just figured it wasn't that big of a deal?

Subject: Oh, it was pretty hard to prove whether they did it or not. You can hear things rattle in the house when they sent off a blast but you couldn't really prove they cracked the chimney.

Interviewer II: You couldn't prove what was there before and after a certain time period.

Subject II: Anyhow we never bothered too much. As long as it didn't bother us directly. It didn't make too much difference. Though there was a lot of people at that time working.

Interviewer II: Now was your water supply then affected would you say?

Subject: Well after they ah, they use to use this holler, they used the water that came out of it. When they had a boarding house here. But after they put the coalmines in it ruined the water. You couldn't use it.

Interviewer II: Where do you folks get your water from now?

Subject: We have a well. We have a … How many foot well?

Subject II: We just have a well out there out back.

Subject: That's a well house. Where you come in, that is a well house. And it is deep. What 75 feet? And it is down to a stream it goes through.

Interviewer II: You don't have any problems with your water then now?

Subject: Not now.

Interviewer: But you didn't have, you were on that well, you were on that well system when they were right up here on the ridge? Even doing their work? Have any problems with it then?

Subject: Other than the water being yellow. It had some iron in it.

Subject II: Too much iron in it. But that doesn't maybe, probably had something to do with the mines up there. That was all deep mine most of it. And then they come through and took out, took of the tops of the deep mines to get the coal that they left.

Interviewer: Did you do any work for the deep mines? In here?

Subject II: I never worked in the mines. I don't haul coal. I hauled a little bit from the backside of the mountain, a time or two. My boss had me haul some. After that flood, I think they donated some coal to the people that had been flooded out in Webster County. My boss donated the trucks and we went and hauled some coal up to Webster County.

Interviewer II: Which flood was that? When was that?

Subject: It has been a long time.

Subject II: The Gauley River.

Interviewer II: Was this Agnes? Back in the seventies?

Subject: It seemed back then, right " specific name"?

Subject II: Yeah it was in sometime in the seventies.

Interviewer II: Probably Agnes, Hurricane Agnes, that came through. It seemed like it …

Subject: No, I don't think it, I don't believe it had a hurricane or anything connected to it. It just rained 18 inches.

Interviewer II: Oh, okay

Subject II: It rained up in the headwaters of the Greenbrier River.

Interviewer II: That would cause some damage.

Subject II: It always makes it really bad for a while. Just too much rain up the river.

Interviewer II: Sure. Exactly.

Subject II: Hadn't been any rain like that for a long time. So people that moved in were afraid.

Interviewer: Did ah, did you all notice any specific benefits form the industry being here? You know did they build a company store that was more convenient for you or did the schools improve or anything like that?

Subject: Well, there one time they had a thing in Charlestown Gazette that Nicholas County was one of the richest counties in the state. Some of the homes around that was built by people that had coal, you know, millionaires and stuff like that, you know…

Interviewer: So you have read about some benefits to the whole county but you don't necessarily know of any in Werth?

Subject: No.

Subject II: Yeah there just wasn't any … There are a few people that lived here now and then that worked in the mines or something. Didn't have too much direct contact with them. I went to work after the mill burnt down, and the company sold out what they had, I went to work for the coal company. Well it was a trucking company that hauled down below Summersville. It was the deep mines we hauled out of.

Interviewer II: So, that was your change of employment from working for the lumber company over here, when that went out of business from the fire, I assume, then you got employment with the coal companies transporting coal for them?

Subject II: Yeah I had already been driving a truck about 13 years when they…

Interviewer II: You had the experience that they needed?

Subject II: So, I got a job driving truck for the coal company.

Interviewer: What umm, what else can you tell me about, you know… after the coal companies left, how would you say the community changed from that period? You know what I mean? There were people living here, a few of them working for the mines, when they were mining and you had, you know, the physical impacts like blasting and things like that, did it … Did any of the benefits carry over after they left or did it just get better in terms of physical impacts? What would you say? Were there any changes from that sort of transition period?

Subject: Well, we lost a school down here. The umm, all the young people grew up and moved away.

Interviewer: Had any of them been employed with the coal company? That you could say 'Well, when the coal company left they lost those jobs and moved away and therefore the school had to close?'

Subject: I don't think that that many of them; some of them was employed by the coal companies. But up and down through here we are just all getting older and nobody sells any of their land and so…

Interviewer: There aren't any more kids to go to school?

Subject: And the kids just grew up like ours done. He is like….he married a girl from Pittsburgh, by the way. And they both teach school in Parkersburg now.

Interviewer: So, really most of them moved away for jobs?

Subject II: Most of them. The ones that didn't want to work in the mines left.

Subject: Well, when they went to college, there wasn't anything around here for them to do. I know my granddaughter went to, she is up next to Washington, which isn't a good place to be right now.

Interviewer: A little scary, yeah.

Subject: But she works for a computer company in human resource management. She is a hire and fire. (Laughter)

Interviewer II: She's got the fun job.

Subject: She had to lay off a bunch here last week.

Interviewer II: Oh boy, she makes some tough decisions.

Subject: Yeah.

Interviewer II: What was, in terms of, during that activity about fifty years ago the, you would say that the lumber company was the largest employer and the mining company, the mining operations came in and they became the largest employer. Is that what you had said before?

Subject: No.

Interviewer II: After the mines went away then what was the major employment around here? Is that sort of, it is sort of a unique second trans… situation, where the lumber company really wasn't around because of what had happened there. So it's almost a real, I am looking at it as a real hardship for this area because the mines went away, the lumber company burned down, so what did people do then after that time maybe in the '60s and '70s what did you do for employment? I know what you did …

Subject: I worked for the Board of Education.

Interviewer: All the way through that period?

Subject: Yeah. I started in '69.

Interviewer II: But what was the major, where did people that lived here, where did they go for their employment or …?

Subject II: Whatever mines were working. Different places. This one didn't go out 'til …

Subject: This one back up in here just went out in the last… well they are working some now, over in there. Out back over in there. But I don't think, what they do here was they closed down and then they open up a little with bit with non-union miners. And that is what they did.

Subject II: What is the bank there on the corner on cemetery road where Farmer's America use to be? What is the name of it now?

Subject: The BB&T.

Subject II: If you go in there you can see some of the pictures of the miners that worked in this area.

Interviewer II: Oh interesting.

Subject: They have these long pictures.

Subject II: They have these long pictures of the whole crew that was out.

Interviewer II: Like the panoramic type.

Subject: Yeah.

Subject II: They was sitting out in front of the mines either in the morning or evening, sometime.

Interviewer II: So some people actually continued to work up at this mining operation?

Subject: Yeah, until not too many years a go.

Interviewer II: But what did the majority of the people that lived around in this area what did they do after the majority of the mining activity left? Because we had mentioned before that once the heavy equipment started to be used then the employment, the amount of labor that that you needed wasn't as, the need wasn't there to have a lot of, you know, labor to be involved in the mining operations, maybe what it use to be at one time. Do you have a sense for what local employment was? Where people worked?

Subject II: Well it went down in West Virginia - all over. The population, there for a while was going down. And they went to North Carolina, Ohio …

Subject: Fast food places - work around down at Summersville. You got all kind of fast food places and motels and …

Interviewer: So they are working at those commercial places down in other cities close by? Like Summersville and maybe go up to even as far as?

Subject II: There are several still works in woods and things and they won't leave this country. They built a mill, you know right on down by Roywood in Summersville.

Subject: That one down here, yeah it is a big operation.

Interviewer II: Where do they get their lumber? They actually go with the mining companies? Because there is a lot of timber there to be harvested in these mountaintop mining operations, do they get their lumber from..?

Subject: I don't think so.

Subject: Ah they use to get it from; they still buy it from some of the holdings of the lumber or ah coal companies. They still probably some of them buys from them.

Interviewer II: But they have their own properties that they ah …

Subject II: They got to have some property and then a lot of it is just brought in. The logs are just brought in by independent truckers. I suppose some of them buy and sell, buy logs and timber and stuff. Because, there are a lot of different trucks that comes in here.

Subject: This kind of a mill now aren't any more. It's got two, they have compartments for them to sit in and they just push buttons.

Interviewer II: They are all laser-guided saws now a day. It is really amazing how times have changed.

Subject: That what it is.

Subject II: You have this double band mill coming now. And they don't employ near as many as the old mill like this here. They really can't afford it. For the lumber to sell for that high. They don't stack lumber any more. They like stack it when it comes out of the mill, but they don't dry it or anything.

Interviewer II: Yeah, at that time with the stacks, the smoke stacks on that picture they had a kiln or something there?

Subject II: Yeah, well they run the mill with steam.

Interviewer II: That is true. The run the mill with steam and that what?

Subject II: That is what the smoke stack is for.

Interviewer II: They didn't actually have a kiln there that they used?

Subject II: Not at this mill, they had one at Fenway. They had a motor….

Subject: They have two mills.

Subject II: They kept it in the yard 30 to 60 days. The lumber, to let it dry out. And before they sold most of it.

Interviewer II: They sold it.

Subject II: So it was all stacked behind here. Didn't have any end-loaders then. They laid it on the truck by hand.

Interviewer II: A lot of hard work I am sure. A lot of splinters to be had.

Subject: The wages back then was low really. I think your dad worked for almost 50 cents an hour, didn't he?

Subject: He worked 10 hours a day, $2 a day when it first started here in the 30s.

Interviewer II: That was the depression time too.

Subject: Yeah. Yeah in the 30s. He was glad to have that $2 a day.

Subject II: Companies just don't stay any more. They don't want to stay anymore. That what happens to the jobs, people just, … that is why they are wandering all over the country, hunting jobs you see.

Interviewer II: Go where the labor pools are at.

Subject II: Yeah you don't know when you work for a company whether it is going to last or not. It may last five years it may last ten or fifteen. But not very many of them any more last thirty or forty.

Interviewer II: Yeah it is really hard to find a lot of big old companies around, like G.E. or whomever you know, that stood the test of time. These small start up companies, boy you have to wonder how long they are going to stay in business and how lucrative they could be.

Subject: Well you can't depend on that. A cousin worked for RCA and he got moved, was laid off from them, several years ago. They just, everybody that had worked under so many years, ten something like that, and he had worked for a little under ten. And they said well they didn't want to lay him off be he was under the guidelines, so... He had to find somewhere else to go. That was when you didn't think about RCA being, …

Interviewer: Yeah. They were a good business.

Interviewer II: Exactly.

Subject: So you can't depend on any company now.

Interviewer II: So over all you didn't, probably, you folks didn't really see any direct benefit from having the mine here, whether or not it was a good or bad thing? But there was really no benefit that you got from it?

Subject: Not ah, no. Of course we didn't work for them or anything…

Subject II: Never worked in the mines…

Interviewer II: Mostly in this community, it sounds like from the people we have talked to, never really had any benefits from the mines being here, except for the few that might have actually worked for the mines.

Subject II: Yeah the ones that worked for it.

Interviewer II: But ah, do you know of, do you have any senses of how many people in this area may have worked for the mines. Actually had direct benefit from it, because that was their job? At lot, many, very few?

Subject: Did you all talk to the people down next door? I can't remember their name. In the next hollow. Did you all talk to them? He worked up here.

Interviewer: No we haven't spoken to any one yet who worked up here. We got the names, I don't know if I remember if I told you or not, we … the handful of people we're talking to were just selected at random from the people who own property in here. You know we, there are records at the county courthouses who owns the property.

Subject: Well he owns his property.

Interviewer: Well his name might have been on there but his name might not have been selected at random. You know we didn't…

Subject II: It wouldn't, his house didn't make the long list.

Subject: He would of have had more idea of how many from around here might have worked up there.

Subject II: Yeah there were a lot of them that went up that hill in the morning, up there. And we had no idea how.

Interviewer II: Had no idea where they might have came from?

Subject: No. No.

Subject II: No, they was from all around.

Interviewer II: So it wasn't like the local population here benefited as a whole because that is where their jobs came from. It doesn't, from what we're saying, …

Subject II: Well, after everybody had got an automobile, after the 2nd World War and the distance didn't matter much when this place come here and went to work. They stayed here. This building right here, and they worked at the mill and things like that.

Subject: And went home on the weekends.

Subject II: Now if you could go over around Widen, you could really get you some stories. If you found some of the older people from Widen. Once they had a hospital and school, company houses, it was a town over there a mining town.

Interviewer II: Yeah, that's interesting. We've heard that story too where a coal company comes in, there is basically nothing there; they actually set up a town almost, for their workers. That's some of the unique cases that we've, …

Subject: Hospital the whole works. Whole town works there, and he didn't want them to leave.

Subject II: Tioga was sort of a mining town too. That's just up the roadway from here. I have been through Tioga logging stuff, but I never, … We hauled the logs, some of the logs out of that country back in there where they did the mines.

Interviewer: Now was Tioga and Widen were those towns mostly built up from the underground mining.

Subject: Underground mines yeah. When they started this, however, I remember when they put the dam in down here, Summersville Dam, they said that, Mrs. Johnson, they came in you now to dedicate it and she said, "What's all those rings on the hill?" As they said she said. That's about the time they started doing all of that. That was a mess and it is really sickening to see it. Piles of mounds out here. Oh, it looked like a moonscape, when they did that.

Interviewer: Yeah, we noticed as we were coming down 19 you could see now that it is all covered in grass and kind of, …

Subject: When you first seen it, ohhh, It was horrible.

Interviewer II: What umm, you said that you, you of course had steady work hauling and driving a truck during that time that they were mining here, right up above you. Did the company ever talk to you about purchasing your home or buying you out from the impact or any thing else like that?

Subject II: No they never said anything about that.

Interviewer: Did you have any interaction with the company before they came into mine? Did they talk to the community? Or how did you find out? Did you read about notices in the paper or things like that?

Subject II: Oh they sent you notices they was going to blast.

Interviewer: Oh they did? They sent it to your house or… ?

Subject II: They sent it in the mail, registered letters. You could go to the post office and pick it up if you wasn't home when the mail boy comes with it.

Interviewer: They still do that at our, once in awhile I get a registered letter I have to go and pick up because I can't get it in my mailbox. And ah, where I live. So, so you never, do you ever see those now? Those permits postings in the newspaper?

Subject: They put a thing in the newspaper.

Subject II: I look at them once in awhile but most of them are out of our district anymore, so I don't pay much attention to them.

Interviewer: They put them in the local paper or in the…?

Subject II: Oh, they put them in, this Chronicle and the Charlestown Gazette, too. I think of all the times, where they were applying for permits and stuff.

Interviewer: So, but mostly you found out what was going on because they sent you a letter or because you saw it happening?

Subject II: Well it was, they didn't, they didn't do, they didn't go around, I don't think, to everybody and everything back then. They just started out, more or less just grew into stripping. They started out mining and then they, wanted more of the coal out so, it just grew into a strip job.

Interviewer: Did you ever think about leaving here because of what was going on?

Subject II: Oh I never guess particularly no. 'Cause it was going on all around us.

Subject: Know what there was a little coal mine up here for years. Somebody had one up here; "specific name" had one. I had one up here for years.

Interviewer II: Is that the under ground mine you still see the equipment, like the elevator?

Subject: No, No. That is up above it.

Subject II: Yeah that is "specific name".

Subject: But ah no, it is on down this way. Where that nice house is. Right there beside of it. They had one for years, you know, but you never knew anything about it. There was no blasting around or anything.

Interviewer: Right. Right.

Subject II: Well there is all kinds of deep mines like this but,...

Subject: Back in through there I guess.

Subject II: This hill up here, and then they wanted the coal that was left so they stripped it off.

Subject: And I don't know what they ever finished stripping all of it or not, cause of that 21 foot seam they said they had. They never, … they said they'd be there for years and they weren't there that many …

Subject II: They stripped what was up here I think. It's gone. They owned clear to Powell Mountain to the mountaintop.

Interviewer II: So other than the water erosion coming down, the water runoff, down the holler here, that was probably your major impact from the mining operations? Is that correct?

Subject II: Never bother us more than anything else around here.

Interviewer II: Some of the smaller things might have been some of the blasting and maybe some of the rocks that might have been flying down off the hillside there.

Subject II: Yeah, but it never did hit our house here. It hit one of the others over there at one time. But it hit the ground and rolled into the …

Interviewer II: Was it a pretty sizable rock that might have caused some pretty good damage?

Subject II: Oh, if it had hit on the roof it would have.

Interviewer II: It would have gone through the roof.

Interviewer: That's fortunate then that it didn't.

Interviewer II: Exactly.

Subject II: But that has happened in this country from roads and strip mines and everything. But we don't have any coasters yet.

Interviewer II: What do you like most about this area in terms of Werth itself and the entire area that you live in and have lived in for many years?

Subject II: Oh, it just got to be home.

Interviewer II: What you call home.

Subject II: Yeah, we have another place but we just never,… got use to this one here.

Subject: We have property in another county, over in there.

Interviewer II: This is where you call home though?

Subject II: Yeah, we have been here since I got out of the service in '53.

Interviewer: And you never thought about moving there even though you have that property, huh?

Subject: Well, we thought about it.

Subject II: We thought about it for a time or two.

Subject: Just couldn't get going.

Interviewer: Yeah. Yeah. So you seem to be settled in one place. You don't really want to pick up and move.

Subject: We've got so much here.

Interviewer: I know that feeling.

Subject II: Well we both stayed here until we retired.

Interviewer II: I know the feeling. My wife and I just got done moving into our first home and ah, and I think we are ready to stay there as long as it takes so we don't have to pack things up again and move it. That is a job and a half. That is a deterrent not to move. Is all the work you have to do to pack stuff up.

Subject II: Packing stuff is her favorite work. The garage is full. The basement is full.

Interviewer II: A lot of stuff.

Interviewer: Well you know, I think we covered pretty much…

Interviewer II: Off the list of questions, we've gone over about everything we wanted to try and talk to you about today.

Interviewer: Was there anything else that you wanted to tell us or talk about.

Subject II: I don't know. We tried to get along with everybody around, you know. We never bothered the companies much. Bothered us a whole lot but…

Interviewer II: Over all, like I said you didn't have much impact other than the storm water run-off, up, down the hollow. You didn't really have much impact form the mining operations.

Subject II: No, not much I guess.

Interviewer II: Now, we still had another topic, the sawmill itself, I mean that was your mainstay of employment to begin with. But ah …

Subject II: Yeah that is what brought me to this place.

Interviewer II: How many workers worked at the mill, in its hay day, if you will?

Subject II: "specific name" would know more reliably.

Subject: Oh no.

Subject II: Yes, you did dear. Owned witch camps for a long time.

Subject: And their own trucking, had about 12 or 14 truckers and they had …

Interviewer II: They would all come into this facility, this plant down here, right?

Subject: Yeah. And they would bring in the logs and then they had a couple that worked in the mill and down in the… unload the lumber down on the set.

Subject II: They had two, I think they had two wet lumber crews and two dry lumber crews and loaded the lumber out.

Subject: "Specific name", "specific name" was in charge of them. What was he in charge of? He's in charge of the, umm, what part of that?

Subject II: Who?

Subject: "Specific Name."

Subject II: In the mill, framing mill.

Subject: Framing mill. So it is framing mill and then …. At one time they had a steam engine ran back behind here. And that shop there to the right, was big enough to run a steam engine in to repair it. So they had a repair crew and they repaired anything about the mill. And then that's what I'm talking about the saw stop was.

Subject II: We had two or three carpenter crews.

Interviewer II: Sharpen the saw blades.

Subject: Un huh. A lot of people.

Interviewer: Sounds like a couple hundred people maybe even. Or at least...

Subject: It was a lot. With the work crews and everything else.

Interviewer II: The reason I asked is I am just sort of curious. You had such a big operation there at one time, we don't know where those people came from that worked there. Did they live right around?

Subject II: Well most of them come in with the mill. A lot of them came from...

Interviewer II: Other places in the area?

Subject II: One of the mills in where the mill was before.

Subject: He moved it over from Upshire County. That's over in, whether you know, Cannon or not. But he came from over there, "specific name". And he drove in from over there and a lot of people moved with it. My parents did and a lot of people that came, came …

Interviewer II: Now, where did they live at then, when they came to this area where did they set up, make their home?

Subject: Well they had the houses down in the… A lot of the men… this was a boarding house…

Subject II: It had fourteen rooms on top.

Subject: Thirteen rooms and a bath. Thirteen rooms and a bath.

Interviewer: My goodness. Is it still up-to date.

Subject: No we cut it off. We cut it down.

Interviewer II: So there was more stories to this than what there is currently now?

Subject II: Yeah, there was another story on top and it was sixty feet long. And it just was roomed off.

Interviewer II: Yes, this is really a nice.

Subject: And the men stayed in it and then they went home on weekends. They carpooled.

Interviewer II: Ah, so they stayed here during the week and they actually lived outside the area. Their families, wife and children …

Subject: And then there was the store building they had their own store across the road. They had a store building and an office building and up over them was rooms.

Interviewer II: Oh interesting.

Interviewer: Even more.

Subject: And then they had a yes, their garage where they worked on their trucks and stuff and they had an apartment over it. And that is where we lived. In an apartment right there.

Interviewer II: Seems like the lumber industry around, at least for Worth is concerned, had more of an impact on the community than possibly what the mining operations did?

Subject: Well of course the railway was here longer.

Interviewer II: Right. Exactly. That's interesting.

Interviewer: You mentioned something called a, I thought you said a witch camp… Is that what you said?

Subject II: Witch camp. They had, they took shanty cars and moved them to the woods. They had, well they had them so they were about 10 to 12 feet wide and they would put them on a truck and moved them from place to place. Wherever they were cutting timber they had that. And they would move their camps in there and set them up, the people would stay there that cut timber.

Interviewer II: Stayed in the woods where they were cutting their timber.

Subject II: Some of them had families somewhere else. They would come and stay. Of course that has been going on since back in the early nineteen hundreds.

Interviewer II: Long time ago.

Interviewer: I have never heard that term before. That is an unusual …

Subject II: Yeah they called them wooden camps. "Specific name" use to go with her dad to them.

Subject: Yeah.

Interviewer II: Witch camps today are hunting camps.

Subject II: Yeah those like that. Those hunting camps are more elaborate. They just had a … "specific name's" grandmother cooked at the woods camps, for years.

Interviewer II: Oh, interesting. That is very interesting.

Interviewer: Well is there anything else that was missed?

Subject II: She fixed their meals and everything, whenever they would come in. They would stay there until the next morning. Some of them they called them wood hicks. Some of them were out there for months at a time.

Interviewer II: Oh boy, that would be some life to live. I guess that is just what you got use to. You did what you did to make your living and that is how you survived back in those days. Well Alexa, I think we've covered everything. If you folks don't have anything else to add that's fine. We do appreciate you sitting down with us and …

Interviewer: Very much.

Interviewer II: Thanks for sharing your home with us for this hour. We really do appreciate it. It takes a lot for having strangers to come in, just to sit down about something that you may or may not have enjoyed in the past. But we do appreciate you talking to us and like I said if you have got any more follow-ups or concerns you know you can call the EPA directly or call one of us, to voice your opinions or concerns, or a follow up. If you think of something that you want to get back to us that is great. We appreciate it.

Interviewer: I know, how as you said it is probably frustrating to be telling us the same things…

MTM/VF EIS
Community Narrative: Werth, West Virginia

Interviewer: Let me ask you first off, how did you and your family come to live in the work area? Tell me a little bit about that background, if you would.

Subject: Well, my husband I married him in 1981. We lived in the heart of Summersville. I always liked elbowroom. So, his office was located at Werth and they had extensive properties there so, we built a log cabin behind what was originally the Muddlety grade school. So it was for convenience of having more space.

Interviewer: And you moved there as your permanent home?

Subject: Yes.

Interviewer: Okay, okay.

Subject: We have since moved to Canvas.

Interviewer: Were you living in Summersville or in this area for a particular economic reason, like for your husband or did you work for a specific industry in this area or?

Subject: I worked for Brady and Klein Coal Company.

Interviewer: And that did primarily underground mining or everything?

Subject: Well, they did underground and then they subcontracted Massey Mine Strip Mining.

Interviewer: What kind of work did you do for them?

Subject: Bookkeeping.

Interviewer: What about your husband? Did he work for the coal companies or?

Subject: He owned his own coal company.

Interviewer: He owned his own coal company. Okay. Did he do all different kinds of mining as well?

Subject: No. He mainly did deep mining. He did have some Massey mines that were stripped. Or contract, I am sorry it wasn't Massey it was contract that he had contracted the land area to them.

Interviewer: Okay. Did umm… Let me get this in order. When you moved to the Werth area, about what time was that would you say?

Subject: Eighty-four.

Interviewer: Eighty-four. So at that point really most of the surface mining in the Werth area had ceased or was there still some?

Subject: There was still some.

Interviewer: There was still some. Okay. What umm… You mentioned that you moved to that area in order to have the elbowroom. What was it that you enjoyed about that community would you say? If you had to put it into works.

Subject: The privacy of it.

Interviewer: The privacy. Ummm. Was that something that you felt changed at all because of the surface mining or no?

Subject: No. I didn't see no change. In the area that we lived.

Interviewer: Right. Right.

Interviewer II: How close in your home, how close in proximity were you to any mining operations? In this case I am talking surface mining operations.

Subject: Okay. You are talking the strips.

Interviewer II: Right.

Subject: Umm. We lived just off of Route 55. You went up a hill and around, oh maybe 500 yards or something up a hill. Before you started up that hill, on the right hand side of that road, umm, let see, I am trying to remember the people, I don't remember the people that mined it. But umm, at this present time, but it was stripped right there on that side of the road. In sometime in the mid-eighties. Eighty-six, something like that.

Interviewer: Were there any other changes in the community that you could say, were noticeable between that time, before, during or after?

Subject: Not necessarily. Coal trucks on the road. Which is…

Interviewer: Right, that is pretty standard.

Subject: Ah hum.

Interviewer: Did you, were there any physical changes to your home at all, from blasting or anything of that nature?

Subject: Oh no. No.

Interviewer: And then, I wanted to ask you about your wells. Did you have any changes, whether they were they were due to the surface mining or not? Did you have any changes to your water sources or water supply on your property?

Subject: No. No. You got to remember that we were up on the hill. The strip was down next to the road.

Interviewer: Right. So you were in an unusual position compared to some of the people in the community in that respect.

Subject: But there was a school right there, next door, and there's no, umm, no problems there. Of course you may even want to contact the Board of Education because that, at that point in time it was Muddlety grade school.

Interviewer: Did your kids go to school in that area at that point or where?

Subject: They were already grown.

Interviewer: Would you say there was any… How would you classify or how would you discuss the future of that community both when you were living there and sort of now as you see it?

Subject: Well, as I mentioned earlier, in that particular area the coal had pretty much been mined out. Stripped or deep mined. So, of course industry had to look elsewhere for, you had to look else where for employment. As you probably already know it pretty much shifted to timber and tourism in this area. And the tourism is really ah, the rafting and the lake and everything is ah, they are promoting that in Nicholas County now.

Interviewer II: Is that maybe one, some of the reasons why the commercial strip if you will, out along 19, where all the motels and restaurants have became present? Is that, do you think that is because of the tourism industry and the changes in the economy in the area?

Subject: Yeah, it is, they have found that it is a good stop off for people that when they, either way you come down on 79, if you are coming form the north, if you are coming out of Charlestown, there is a big space there that there is not hotels, motels or restaurants. As well as from the north, other than around Flatwoods, and that is still a good piece from Summersville. And it is a good stop off area for people and we have found that has been productive.

Interviewer: So, in your opinion that the community of Werth, in terms of how it relates to this industry, I mean, it's got another source of income and a lot of economical development going on to make that a positive?

Subject: Hum, hum.

Interviewer II: Is any of that economic development that is occurring today, based on the tourism industry, is any of that benefited from the past coal mining operations? Or any of that land that was formally mined, has that been ever used to promote tourism or…

Subject: I don't know about as much tourism as, in my personal opinion, you say that they flattened the mountain and that is just what is there then.

Interviewer II: Well, I might say flattened in some cases or it might have been opportunities where you know, you have seat topography if you will, you well know it ah, here in West Virginia there is possibly opportunities where we may have encountered or heard about or read about what is actually…

Subject: Highwalls?

Interviewer II: I am sorry.

Subject: You call them highwalls?

Interviewer II: Right.

Subject: But they, the reclamation has taken care of that. If you will look a little closer, that there is a certain grade that has to be there, that vegetation will grow on.

Interviewer II: Right it almost has to be put back to its original contours, as much as possible.

Subject: That is what the reclamation bill really did.

Interviewer II: Right.

Subject: And ah, that was my point I was going to get to is that they basically, for a period of time, become grasslands. Which for the all the vegetation that comes is good for the animals and the birds and environment… for them to prosper. I think this "Keep West Virginia Green"; the coal miners did not fall short in returning their areas to green.

Interviewer II: We saw a lot of people say that they have seen at least in their opinion, have notice an increase in wildlife in those areas particularly because of the vegetation that has been provided in terms of grass and forage. And also …

Subject: So it's not just left dead.

Interviewer II: Right. Exactly.

Interviewer: But would you agree with that assessment? Or, that you said that we've heard that from other people and that you would agree with that.

Subject: Yes. Oh yeah.

Interviewer II: Right.

Subject: And I think that because my family is hunters, that is a big plus.

Interviewer II: Right.

Subject: If you want to call it tourism it brings… there is some that promote hunting.

Interviewer: Absolutely.

Interviewer II: So there might be a sort of an indirect benefit, so to speak, benefits may not be completely direct but what was the mining industry and what had been left over or actually reclaimed has provided some economic benefit to this area?

Subject: And eventually there will be a forest.

Interviewer II: In your opinion. Right.

Interviewer: One of the questions I was going to ask you and this sort of leads into it, is in terms of benefits to the community if you are thinking of the community of Werth, for example, for having the mining come in, whether it is economic jobs or what have you, if you were going to, could you say what you think those benefits might be or are?

Subject: Well I think there is a lot of people had a good base of employment at the time that the coal industry was booming. From that they were able to put their children through college or whatever, which in my opinion betters any community.

Interviewer II: Does this community itself, in terms of Werth, do you feel it has benefited in terms of employment opportunities the mining operations offered in this area?

Subject: Absolutely.

Interviewer II: And direct benefit to the Werth community in terms of those people being employed?

Subject: Yes.

Interviewer II: And the benefits of them being employed, what impact, positive impact in this case possibly, have…

Subject: Otherwise they would of have to go out of state. Which a lot of people in other parts, like the northern part of West Virginia where there's not many mines and not much of anything else… and I can remember 25-30 years ago they had to go to Ohio, they had to go to South Carolina somewhere for employment.

Interviewer II: Right.

Subject: Because they didn't have that.

Interviewer: They didn't have jobs in that industry.

Interviewer II: Now what is happening now, as the mining industry in this area is waning off if you will, or moving elsewhere… What's happening to that employment base? If you could just tell me?

Subject: As I mentioned before, a lot of them shifted to timber, tourism, and when I say tourism I mean all aspects of it; motels have to have some one to manage them and all of the different restaurants, whatever. It has just shifted to another resource.

Interviewer II: So, during the mining operations you feel, in your opinion the community benefited even though the mines, now during the post-mining period, the community is still benefiting because it's been, I won't put words in your mouth, but its benefited because its changed and found other opportunities for economic incentives in terms of employment. It has actually changed with the shifting, with the times. Before…

Subject: Even the railroad tracks that came in for ah, to haul the coal out, those tracks have been taken up and they have been made into trails for tourism.

Interviewer II: Rail-trails. You talked about during-mining and post-mining, what about pre-mining what were the conditions, economic conditions here like before the mines?

Subject: I can't answer that.

Interviewer II: Okay.

Subject: I only moved to Nicholas County in sixty-eight.

Interviewer II: And the reason again, like you said you aren't in a positions to answer that question because you moved in when the mining operations were beginning to open up.

Subject: I didn't even move to the Werth area, well Summersville, until the late seventies.

Interviewer II: Interesting. Okay.

Interviewer: You would be in an unusual positions probably to answer this question, ah one of the things that we were curious about trying to find out is how the companies interacted with the community in terms of people who may have had complaints or even though they didn't have complaints and just wanted to find out what was going on, you know in terms of the mining around them.

Subject: Umm, no I am sorry I wouldn't be in a position to answer that truthfully. I do know that the coal industry did a great deal for Nicholas County. I know that personally because my husband had very much to do with that. It was… he's the one that ram-rodded the site for the ball fields and the high school. The new high school is right here on 19.

Interviewer: Can you tell me a little bit about that? What do you mean ram-rodded?

Subject: He furnished the equipment; he came down and did a lot of the work himself at no cost to the county.

Interviewer: He helped build it and see that it was built?

Subject: He didn't build, but he prepared the site with equipment, his own equipment from his company.

Interviewer II: So there was direct benefit to the community as a whole had some direct benefit due to your husband, in this case good will, and actually provided services

Subject: He brought his men down and he paid his men but he didn't charge anybody for it. He also was the fund-raiser for the hospital and because he was known, so well known in the community, he was able to tap the coal industry get money and got funds to start the Summersville, to expand I am sorry, to expand the Summersville hospital.

Interviewer II: What is, are the coal industry here is the community benefiting otherwise from the coal industry after it has left? I know during the time period, you know they have benefited, you know based upon your account, from your husband giving back to the community in terms of being a good neighbor, from the coal industry. Does the community, are they, I am not saying this in a bad context, are they still seeing benefits from the coal industry or since they have gone?

Subject: I think you would have to ask some retired miners how their health insurance is paid. Where did they get their retirement benefits from? Which I think you will get an answer that the coal industry is still very much in.

Interviewer II: Involved with the community in that sense. Interesting.

Subject: Did you not think of retirement? You know they paid into that fund they have to live on it now.

Interviewer II: Sure. Exactly. So, even though the mining operations aren't here providing a direct, in terms that they had to go else where for the mineral resources, there is still some continuing positive benefits that the coal mining industry has had for the Werth community?

Subject: Exactly.

Interviewer: This is a little bit off the subject of Werth, but do you, did you all see the permit notices that they are required to put in the paper these days? And was anything like that done that you can recall about any of the mining that is going on around Werth, that you have seen in the paper?

Subject: It is required by law.

Interviewer: So you remember seeing those?

Subject: You have to…. I mean, that is a requirement.

Interviewer II: One of the things we have talked to a couple people, we have gotten indications as we asked that same question, and said that "Yes" they have seen them and we know that the state requires them to published, the permit. Some of the information that we got, we just want to see what your reaction is to, some of the notices although they were published may not have been legible or maybe understood by non-coal mining people. People that were not associated with the coal mining operations, not use to the terminology and also to the maps that are published with the legal advertisement, may not have been clear enough. In your opinion did you feel, and legal advertisement that you saw for the permit, did you feel that they were...

Subject: I didn't… I usually, if I didn't see the map clearly I would read the description. And I well, because my husband had different sites and around and everything, I sort of had an interest, so that is why I read them. And as I said if I did not understand the map exactly where the details that they were trying to describe, I would refer to the description.

Interviewer II: Now one of those legal advertisements, of course that provides an opportunity for the public to express concerns or to have questions and have an opportunity to ask questions about the particular permit. Did your husband ever was he ever involved or have opportunities to discuss…

Subject: I really don't know.

Interviewer: That's okay we don't want you to comment on something if you really don't know.

Subject: No. No. I, really, I'm sorry.

Interviewer II: That is fine. I was just sort of curious if you, if there was any reaction to the public if there was any reaction to the advertisement?

Subject: I don't know.

Interviewer II: Okay.

Interviewer: The only other real part of the questions that I had to ask you is about your decision to no longer live in the Werth area and what that may or may not relate to any of the mines.

Subject: My husband and, he just passed away in August. He was eighty-seven years old. The reason we moved from the Werth area was the same reason almost opposite to when we got here. He felt that we needed to be closer to family, because of his age and he wanted me close to family if something should happen to him. So in ah, about four years ago, we moved to the Canvas area.

Interviewer: So the reason for moving to the Canvas area had nothing to do with the present of mining in the community?

Subject: Oh no it didn't. No. We just wanted to be closer to family. Which I live next door to my son.

Interviewer: Okay. Well you know, I think that fairly well covers all the questions that we really wanted to ask you. Did you have anything else that you wanted to say? Or wanted to discuss with us, about questions about the study or anything of that nature?

Subject: No. I just had a question when I was going to be asked earlier. Ummm, what other aspects are you going, do you go to the economic aspects, tax bases and …?

Interviewer II: One of the things that we had actually looked at early on in the study was to actually collect a variety of data in including census data, population, income, what were the employment conditions like. And that would be historic not just based upon…. Based upon County… State and County and made comparison on those. Ah, I think with that we started in seventy or maybe sixty and actually looked at each of the census, depending on census information and did studies on those. What were the labor? You know, who were people employed by during those times? Looked at mining production. Historically a lot of scientific analysis looking at the mine production on, mining production in this area verses other areas in the United States. What that resource is being used for? Electric generation power plant and so forth and so on, and also to, like Alexa said, a lot these biological like in terms of water aquatics are just a myriad of information that was looked at early on in the study. And this, Alexa pointed out, was trying to get more in tune with the community aspects. And this is really an objective stand point to these questions were really formulated to ask people that were directly involved with the mining operations. And the randomness about it is we don't, it can go both ways.

Subject: I was wondering if you had contact "specific name" at all?

Interviewer: No. That name didn't come up on the list of people.

Subject: Gracie Inc.?

Interviewer: As one of the property owners?

Subject: Um, hum.

Interviewer: I did see that.

Subject: That is "specific name." He's a politician. I didn't know whether you picked on politicians or not?

Interviewer II: Yeah all that was …

Interviewer: Not on purpose anyway.

Interviewer II: All that was done …

Subject: He uses that place right down there. He owns, the reason I asked is because he is the one that purchased the tipple from my husband, the tipple for coal.

Interviewer II: Interesting. Yeah all of the interviewees that we've sat down with and will be sitting down with in the future, are all based on random selection. Based upon the tax roles in the case studies communities that we are looking. So there is no interplay by us to select who we choose. It is all random, so whomever's name comes up. We don't know what their position is before hand only until we come and sit down and start asking you these questions to try and get more information. So we didn't know what your affiliation was before we came to this interview and ah, and our questions, I hope, aren't poignant to making you go on any defensive. We are just asking questions that everybody gets asked. To see what your position is and feel what your opinions are about the coal mining industry in this area.

Subject: Well, he wouldn't qualify because we never lived in the Werth area. He only owned property there. So I guess that is why they excluded him.

Interviewer: Right. Basically if it had said, for example, Gracie Inc. I would have moved onto the first individual or the most recent individual that was listed as a property owner.

Interviewer II: So overall just the Werth area itself, you feel that, although you can't attest to the pre-mining conditions that you felt that since you have lived here and even now, that you felt that it was a thriving community. You tell me. I am not going to, what is your overall assessment of the Werth area and how it is operating today and existing today.

Subject: Well there is really… it is growing in population. The umm…. What is the overall?

Interviewer II: Overall condition, your perspective, your opinions on the …

Subject: I think it is a pretty much a thriving community for the fact that, I don't know… West Virginia, is I think, has better employment than some other states at this time. But not living, I haven't lived there for four years, so I don't maybe… can't qualify to answer…

Interviewer II: That's fine. That is fine.

Subject: But from the looks of things, there's no not that many rundown buildings, there's not damage or anything.

Interviewer II: Right. Exactly. Okay, I appreciate that.

Interviewer: Okay, I appreciate your time. I really do. Just that you came out ……….

MTM/VF EIS
Community Narrative: Werth, WV

Interviewer: We started to talk a little bit about your Mom living in this house. How did your Mom and her family come to live in this area? And this place particularly?

Subject: Because it was a place that was for sale that my Dad could afford at the time. He was a farmer. He had been saving up to buy one and this is the one he bought. I do not know any particulars.

Interviewer: What kind of farming did they do?

Subject: We raised corn and hay and hogs and farm boys and pigs and things that we could survive with.

Interviewer: You said the house was built. Did they build the house then they moved here?

Subject: "Specific name." I don't remember which "specific name" but probably, maybe "specific name". But one of the "Specific name" built that. "Specific name" from Calhoun.

Interviewer: Did you grow up here in this house then?

Subject: From the time I was seven years old.

Interviewer: Seven, umm, umm. Lived here and went to school in the area?

Subject: I went to school at McMillan Creek School. About a mile and a half down the road.

Interviewer: Had everything from grade school to …….

Subject: One through eight grade. One room.

Interviewer: You started to tell us when we were standing outside, about what time did the surface mining and strip mining start in this area?

Subject: I would probably say that excavators started up 15 years. That would be the North site or that property probably 1944-45. And then this coal mine over here probably 1950 or '51.

Interviewer: And were these surface mines or underground?

Subject: They were surface mines. And I'm not, I wouldn't swear to those statement but that is the best that I can remember right now.

Interviewer: You were about how old then?

Subject: Probably eight or ten.

Interviewer: Eight or ten. Do you remember, a part of what the study is looking at is for a community that is adjacent to the surface mining what kind of changes may have occurred - from when before the mining was there to when the mining was there and then once it left. Did you notice and changes in the community?

Subject: Oh sure. They …the fields were are all flooded with debris from the mines. And plus my father sold probably 80 or 90 acres, which he spent the money from that trying to get his property back into shape again. And it was just a round robin- for us. And then this mine up here set off blast that would cause our well to go dry. They did drill a new well. Then we would get quite a bit of runoff from that mine too showing up on this side here.

Interviewer: So when your father sold off ……… let me back up for a second. What kind of debris are you talking about?

Subject: I am talking about rock, slate, goobs- probably a little coal - anything that they, dirt, anything that they would dig up on top of the mountain, when it rained it came down.

Interviewer: It filled up your fields? and ponds?

Subject: It filled up the creeks. It filled up the creek beds and the creek would be wandering around and basically make into a swamp. Which the wetlands commission now want it to be a swamp but it never was a swamp before. So I don't know what will happen there. And I am getting too old to be battling this stuff. I am retired and I want to be retired. I don't want to ignore it but I don't want to put forth a lot of effort.

Interviewer: I can understand that when you are retired that is the whole idea you don't want to have to put forth a lot of effort into much at all if you don't want to do it.

Subject: Well, I retired when I was 56. But I came down when my Mom, she was in bad shape mentally and that went on for 11 years, so I haven't been retired really.

Interviewer: Umhumm... You mentioned your father sold off 80 or 90 acres. He sold it to the company for mining?

Subject: Tassa Coal Co.

Interviewer: And then was that land that he had been farming?

Subject: Ah, some of it was the roadway across there he sold the right-of-way to that. We had been farming that. Ah, now that that goes up the mountain. Now the mountainside we didn't farm. So, most of it was not land that we farmed. It was woodland.

Interviewer: Do you remember at all any of the interactions between the Coal Co. and your father about selling that property?

Subject: Actually the Coal Co. worked with a "specific name". His house is down where -the one they are remodeling and fixing up. Ah, "specific name" and "specific name". I have some maps and things I probably should have brought them, but I didn't know what we were going to do. But my father was friends with him. Probably up until my father figured out what was happening to him. So actually Tassa Coal had "specific name" and "specific name" and there was one other person, I have documents at home, to ummm, they brought the land from my father. And they, like I said they strip mined it up there, took the top of the mountain off, got the coal out and they trucked it off the hill.

Interviewer: So the coal company was working with some of the property owners in the community. They bought it from your father and then they gave it to the coal company? Or they ……..

Subject: That is what it looked like to me.

Interviewer: Do you remember at all before the coal mining started any interactions between the company and the community about coming in?

Subject: No. Nope. That was 1954. Back then things were done quite a bit differently. We did have you people to protect us.

Interviewer: Well, we are trying to catch up unfortunately, I guess, with this problem. Were there specifics, you said that there, in terms of changes with the community there were some real physical changes to the environment. Were there any changes in terms of people moving out or people moving in? Or for example, the school that you mentioned? Was there any changes in the population that might have affected the school?

Subject: I don't think there was a big affect. There weren't that many people. But Raven down there use to be like deep mine and that kind. Deep mines were sort of going defunct. A lot of people that worked for the strip mines moved into those houses. You know where Raven is?

Interviewer: It is down 55 a little bit?

Subject: Right. There is that row of houses there. They built those houses for the deep mines that were adjacent to them. Then when that slowed down. The strip job was going pretty well and people came from Clarksburg, or where ever they got their people from, and lived in those houses.

Interviewer II: They actually didn't try, the population base wasn't large enough here that they didn't try to tap into local …

Subject: I don't think it changed it very much. I think that the people that were living there working in the deep mines had to go somewhere else. How many people stayed and how many people left I wouldn't know. But for a while there, there were a few more people here. That mine didn't last that long. Another company came and depends on the value of the cole, another company came and worked it awhile.

Interviewer: Did your mother talk about,……… you mentioned the blasting from the mines. Did she talk about, and you certainly would have known …………….

Subject: She talked about getting knocked off her chair.

Interviewer: Sure. Yeah. Do you have any idea, at any point, did she report that kind of a problem?

Subject: Ah yes, I think so. My older brother lived here with her. He had diabetes was married and he just sort of had a place to stay here, so he managed most of that for her. She was getting old even then. But, he handled that. Whether that was good or not I do not know. I was up in Cleveland driving a bus.

Interviewer: When you were old enough to look for work was there any reason besides from, I guess you mentioned you went to Cleveland to look for a job, did you ever consider staying here and there weren't job? Or how did you make that decision?

Subject: I worked for excavating from the deep mines for about nine months. I went into the army and got away from here and my eyes got opened. And I said 'I don't have to work in those mines.' I went to Cleveland to work for a beryllium company and the Cleveland transit system. There were a sawmill up here that I worked. Started when I was 17. I worked that for a couple of years. Ely Thomas, I don't know if you've ever heard of that….

Interviewer II: To get back on the house part - you said your mother was knocked off her chair one time by a blast?

Subject: Oh, That was just a figuratively speaking.

Interviewer II: It would shake the house? I guess my point, what I am driving at is was there structural damage to the foundation and the house? Was there actual walls where the drywall was cracked?

Subject: No doubt there was. Well like I said it ruined the aqua flow for the well and they did drill a new well. But …….

Interviewer II: That was the coal company came in once apparently your family reported it.

Subject: Well we ran out of water we couldn't keep from complaining.

Interviewer II: They obliged to drill another well and they were successful or what?

Subject: Yes they were. Well, gradually the well filled up and to get to that point, I remember just before my Mom died that the well filled up to the point where the pump on the bottom got sucked in by, where I had to take it out and cut part of that off a try to repair the damage that was done.

Interviewer II: Is that the same well that is being used out there now?

Subject: Yes.

Interviewer: Do you think there were any real benefits to this community with the surface mining being adjacent to it? Do you see any benefits that you could talk about?

Subject: There probably was at the time they were here, there was more money spent here that is natural. But no - the people moved and the money didn't stay here and the coal left. There may have been. There had to be something but I do not know what it would be.

Interviewer: You said that people left. When do you think people started to leave? During the mining from impacts or later on?

Subject: Oh no, well eventually they got the coal out. When the coal ran out then the coal company quit and these people, a lot of these people traveled with the strip job. Where ever the strip job was they would go there and live and when the strip job left they left. I assume that they kept their jobs, I do no know. But, what I am saying is that the jobs were temporarily here. And temporary means temporary. They left.

Interviewer: The people who lived here before the mining, they stayed? And are still here or?

Subject: No, this is West Virginia. Constantly people use to go to Cleveland, or they use to go to Cleveland, now they are going down South to work. Wherever the jobs are that is where they would go. Young people don't,…….. it doesn't grow here because there is no work here.

Interviewer II: During that time, the center of activity possibly for the miners and the time that those mines were active, was that Summersville, maybe?

Subject: Well for the most part what looks like a barn down there, that was called Duffy's grocery store. They had a pool hall on one side and the other side they sold beer, at one time, but I think at that time they sold groceries. If you wanted to see the people that worked up on the hill, then you went down to Duffy's.

Interviewer II: And that is just right down ….

Subject: You can see it from here. That white building down there.

Interviewer II: Ok. okay I see it.

Subject: It looks a little bit like a barn. They use to have a gas station there. That is what I would call the center of town. Of course they went to Summersville. Like me I live in Craigsville and I go to Summersville probably once a week. When we run out of something I can't get up there.

Interviewer: So you could say having a little grocery store for the community might have been a benefit for a little while? Or was that something you didn't really go to? That just the miners went to?

Subject: To who? No. My Mom didn't buy groceries there. She brought her groceries in Summersville. She would plan it so that maybe once every two weeks she'd go to get salt and whatever she needed. And you could just to make it easier you would get it all at once.

Interviewer: Do you think from your experience of talking to your mother about it, that did she ever consider moving or did the coal company ever talk to her about buying out her home? Why do you think she stayed, I guess is what I am asking?

Subject: Well, it was just a mindset. Probably like, it is like you lived somewhere and that was your home and that is the way she felt about it. No, she wouldn't sell the place.

Interviewer: Do you know if they ever asked her about it?

Subject: I do not think so, no. They didn't need it.

Interviewer: Right they weren't going to mine here.

Subject: Ok, my Dad didn't own the coal. All he was selling was the surface rights. No, there is no reason for them to be interested in this property. They were interested in the property they used to build a road across these bottomlands and that was about it. And they wanted the property to run the road up the hill for the mines. But the actual farmland - they weren't interested in.

Interviewer: Did anyone ever talk to them about the sludge in the creek?

Subject: Well sure, my Dad did. As a matter of fact he brought suit against them. That is how he got the money to buy the shovel to operate to come up the creek and clean it out. And I told you that story about the sides of the creek it made that higher and the run off water couldn't get into the creek in the right places. My dad was getting older and he wasn't farming any more. And I was the youngest of the boys and when we left that stopped the work.

Interviewer: Some of the other things we wanted to try and find out was, as I asked you, how much interaction there was between the company and the community before the coal mining came in. And one of the things that now I am sure you know is that they get posted in the newspaper, the permit, information when they get a new permit or expanding.

Subject: I have seen that.

Interviewer: Have you seen that, yeah? Do you know if your mother or anyone with you at the time ever saw anything like that or knew what was going on because of what was posted in the paper?

Subject: Well, the company came here and they told them whatever it was that they wanted. I don't know what you are saying, what, that so the community could rise and say that we don't want this? Or something like that?

Interviewer: Well no, just so to find out if individuals are aware.

Subject: I don't see what your point is - that is why I am trying to find out. Individuals were aware. Individuals who had the property, it was just legal. And they would try and contact him. Now, joe-blow down the street didn't care. He didn't then, probably don't even now. But he didn't care.

Interviewer II: I think the point is, it is pretty understanding why the coal company came to you , I mean your father, your parents, for being property owners. But they decided, just like you, that we understand that people that are not affiliated in terms of owning property or working at the mine, they don't know what has been going on around. They don't know possibly the activities that exist in mines, when the permits might be issued,………My one questions is, how did they actually post those permits in the papers? In the legal ads? Or….

Subject: It can appear anywhere in the paper. Actually there are 4 or 5 together of them, maybe on the back of the first page you will see one.

Interviewer II: But it is pretty good size? I know back in Pennsylvania where we are from, they get put in a legal notice where it is very fine print that even people with very good eyesight almost have to ……..

Subject: Right. Well that is the way it is here.

Interviewer II: I was just sort of curious is it a quarter ad or something on a page?

Subject: Now that you mentioned it. The people that did this on this side were from Pennsylvania on this side. Now on this side I don't know. But ..

Interviewer II: So the coal companies on either side here, where not affiliated? They were different outfits?

Subject: As far as I know. Who knows? They could be? I am not a legal beagle.

Interviewer II: I guess we were curious if people if they did describe to a local newspaper or happen to pick one up, if they actually realized that the activity of the mining company in terms of the permits?

Subject: There is no active group that opposed anything like that. That I know of. Most people will say, "oh good you are coming in. There is going to be mines! There is going to be money!" But it is not like it use to be.

Interviewer II: Do you think that there is a sentiment today that if a mine would actually come in, now granted - the mines that are existing are probably what is going to be there for awhile, but if a new mine would happen to come in, do you fell the public's perception would be favorable?

Subject: There would be not opposition that I am aware of.

Interviewer II: They see that as … I don't want to put words in your mouth. Do they see it as economic incentive or actually at bettering their lives…….

Subject: Some how or another they do. It just the mine didn't help us. That I could see. I mean it didn't help me. I don't know if it helped my dad in the end. It didn't help him because he took the money and put it back into the farm. I don't think he knew, and I don't suppose anyone did, what the after affects would be of the strip. And by the time he found out about it, it takes a while for the dirt and rocks to wash down, by the time he found out about it, they were virtually gone. He did manage to go to a tenant, and Tassa Coal Company by that time was gone out of business and you know how it is. Some other company was working there. Anyway, he did, I think get some money from Tassa Coal Company. They just dissolved after they got through stripping. I am sure they were aware of all of this stuff. Like you said, they were from Pennsylvania they started stripping up there long time before they moved here. I am sure they knew what they were doing and they knew what problems would happen. But, this Tassa Coal Company no longer existed, and doesn't today as far as I know.

Interviewer II: Do you think the environmental impact, nobody really, they were thinking if a coal company comes in, or the benefits of a coal company are more an economic benefit ..

Subject: OH, you are talking about a different time period. At that time period, yes. People like the idea of a coal, and the people would come to work and spend money and etc… But, it like I said I don't think anyone understood what the downside was.

Interviewer II: Like the environmental impact?

Subject: Right.

Interviewer II: To the a natural environment?

Subject: You can see what we think of it now. Because nobody is here.

Interviewer: The other part I think, of what Alexa is asking the question too, in terms of population, is that it makes sense there are no jobs here that, why, what is the incentive ………

Subject: Oh, well, ok we talked about this before. A lot of people had to go somewhere else to get a job in Pennsylvania, Florida, wherever it was. Now they are getting to be my age and retiring and where do you think they are going to come? They don't have to work any more and this isn't a bad place to live, if you can afford it.

Interviewer II: Exactly. Exactly.

Subject: So that is what I think happens. My brothers never did come back. They choose to die instead, and my sister. They never did come back.

Interviewer II: What is the population like around here now verses what it was like back in when the mining companies were here and possibly before the mines. Well actually you folks, hen your dad bought the property was the population…. seems likes there was granted an area where to have people move in?

Subject: Good point. Which area are you talking about?

Interviewer II: I say just the Werth area just in this general area where we are talking about.

Subject: There was nobody here unless they are retired or ... This guy over he works for some kind of medical outfit. There are probably at least 60 percent less than there use to be. As a matter of fact Werth up there that use to be, incorporated and you could get a meal there. A boarding house and all that is gone.

Interviewer II: In that population or that activity that was once there, was that even attributed at all maybe to the economic benefit that the coal company had.

Subject: It had nothing to do with it.

Interviewer II: No relationship at all in your opinion?

Subject: It was just brought in from out of state, for the most part.

Interviewer II: But do you say a lot like yourself being retired…. now we understand your relationship with Werth - you do not actually live here now. You live in Craigsville?

Subject: Do you want to hear this story?

Interviewer II: Well, what I was getting at too was that the other people that might live in this area, that might be retired, do they actually have ties to this area?

Subject: Yes.

Interviewer II: They didn't actually have ties somewhere else and decide to buy a place in this area because they thought it was a nice area.

Subject: No. No. It was just like you said without ties, I would never come back here. But my Mom was living in this house by herself and she had no one to look after her. She pleaded with my wife to get us to come here. I didn't get along with my mother because I didn't know she having a mental problems and she was kind of rough. But yes, so I came back. We moved our furniture in here and we stayed three weeks. And we had to rebuild the whole side of the house. The water was in it and it was just old. My son and I did. And she just kept getting more demanding and more demanding. Just how much can you give? My wife said either leave there or I am leaving you. And all that. You know how that goes. But any way, so I went to Craigsville and bought a house up there. Not particularly because I liked Craigsville because there aren't that many suitable houses around.

Interviewer: Is there anything else that we haven't asked you about, that you wanted to mention? Your community life here and what it was like?

Subject: Most of what I would be doing is bitching about the strip job and how they did. But I didn't have anything to do with that because I wasn't old enough. And now I might I don't know. But we were just taken back by something we didn't know about. By we, I mean my father. I didn't have anything to do with this. It is probably the reason you guys are doing the study. There are probably other people like us.

Interviewer II: I know that is the main thing these studies often look at whatever existing data is out there. Never really sort of, they view all what's, sort of, right there at the moment. Like focus on the mining how in terms of their production, sell off, employment. They never really get to the community the people that actually lived here or had ties to the area and actually sit down and come here. We work out of an office in Harrisburg and who we work for, they have offices maybe in a bigger city areas and really aren't into getting out or getting in touch with the local community. And one of the ways we have identified to do this is to actually talk to folks like you.

Subject: That is a good idea.

Interviewer II: This really gets your honest opinion of what the situation ……. We have other interviews scheduled this week and Alexa is coming back again another week to actually talk to other individuals like yourself. To just sit down and ask frank questions like we have and just sort of get your honest opinion. Just candid insight as to how things occurred. How things evolved. What we are trying to do is establish some patters. What was it like maybe before the mining operation opened up? What it was like during? And what it was like after the mining?

Subject: Well, my dad had this farm and like I said my brothers would help work and I worked and we had a horse and all those fields of corn and all that. We had a hog and we lived. That is the way we lived. Now, about the time we were ready to leave. The coal company came in and he sold the land. The farm got ruined. And I do not know what would have happened if the situation, if the times hadn't worked out right. Because we didn't have place to raise corn and do all that we did.

Interviewer II: What is the future? You had said you and your son are fixing the house up for a family member?

Subject: Oh, ok. This is my son's friend.

Interviewer II: Ok.

Subject: This is "specific name". He gives me advice. He if fixing the house up. I do not own the house. I got one third of it. My two brothers got a third each and they died and their kids….. So, he is going to live here I suppose.

Interviewer: Your son is going to fix it up to live her?

Subject II: Yes.

Interviewer II: Do you see any, say for example if you wanted to sell out of the family, do you see any problems? Does that worry you as to how quickly or how long it might take to sell the property?

Subject: No. I have my ….

Interviewer II: What my question is, do you think that maybe the perception of people knowing there was mining here, that possibly the house might have some damage to it that might not be apparent? And do you think that perception or what they might be thinking considering the proximity to the mine might have devalued the property?

Subject: Oh the property, I had that appraised before my mother died because we ran a little low on money for a while there and the government was going to come in and take our farm away. And so I got it appraised in case they took it. But anyway …… I don't, everybody ….that is a good point you're bring up there. My brothers knew what went on down here. Whether their children do… well one of them owns a piece and the other two will probably get one shortly. The other part, the third of it. Do they know what happened? I don't think so, I don't think they know what they are getting into. But, I'll keep my third as long as my son wants it. Whatever. I like to have family interaction.

Interviewer II: It is one thing if your farm here has stood out and there is not activity such as mining that may have done some possible, like you have already identified some damage that might have been caused by it. I am just sort of curious if any property values would have been impacted directly with or without what had happened here maybe fifty years ago in terms of the mining….

Subject: I think property values have definitely probably decreased because if someone bought this for a farm. Now you know that now the farms are big farms. A small farm it isn't the most desirable thing to do any more. It wasn't as far as I was concerned back then. This would not be that any more. About all you can do, the way I see it, is you could build, this land up here was used for pastureland, it was cropland down here below the road. The only thing I could see is some one might want to build a house here or something and work at Wal-Mart or something. I don't know.

Interviewer II: So, you don't see, I don't know, just to give and example, back where I am from we are often seeing retired individuals might be moving from larger urban areas. I live in, I grew up in a very rural area. And they like that. They like getting out of the city. They like having maybe a small farm they can so call tinker on. Coming here maybe staying on the weekends or actually eventually move here full time until they would eventually pass away and that is a piece of property they can keep in their family then. To pass on. I'll just ask the question. Do you see that as pattern in this area that might have people moving in because it might be a desirable area to retire in? Its actually very beautiful around here.

Subject: Ok in conjunction with what you said. They built this Route 19, now b__________ (count 362)

Interviewer II: OH, we drove down it. It is very pretty.

Subject: And now before we had that I don't think it would have been a very good idea. But now that they have that it is much better and in addition to that we are getting some medical facilities here. Where you don't have to go to Charlestown to get a bypass or whatever pokes you to death.

Interviewer II: Some major medical surgical procedure.

Subject: When you have stroke like I did last spring.

Interviewer II: Oh wow. Well, you are doing quite well then.

Subject: Oh no, it is just this one side.

Interviewer II: Left side. Well if you wouldn't have said anything I would not have noticed.

Interviewer: Not a bit.

Subject: I always try to hide that when it comes to beer time.

Interviewer II: I think you see the point of our interview today. I think we have tried to establish or at least try to see if there is any pattern of pre-mining activity in terms of community function itself. During the mining and what may be occurring here today after the mining operations.

Subject: Ok, mining operations in this area have been shut down long ago. Most people probably don't even remember. They probably weren't even born then. It is just some thing that happened.

Interviewer II: It is long since forgotten about because of the time frame of when it started?

Subject: I guess the new generation comes in and grows up. Especially now because of the anthrax.

Interviewer: What time do you think they finished the Route 19 about?

Subject: What time do I think they finished it? Probably 1975.

Interviewer: So about 25 years?

Subject: Well not finished like it is now. They keep finishing it. It use to be just two lanes, now it is four lanes all the way. They started this in seventy-five probably. It took quite awhile to get that done, so… That is probably a long time period. The only time I would see it is when I came home from Cleveland.

Interviewer: It looked a little different every time?

Subject: It got better all of the time. It use to have to go through swampland and winding roads.

Interviewer II: The back way home, so to speak. But that was the main roadway home?

Subject: I am surprised so many of us made it.

Interviewer: The only other thing that I think that I wanted to really ask you about is did you or your mother and father ever talk about the coal trucks going by your house? And was there a change in the community because of that kind of traffic? Or did they take another route than?

Subject: Well, the coal trucks didn't come by our house. Do you know where Muddlety is?

Interviewer: Yes.

Subject: They have a siding there where they loaded the coal onto the trains, right there. So, where the road goes by that white building over there, the farthest part of the farm… That would be the west of the farm. The farthest part of it. They would make a left there and then just go down to Muddlety. The coal trucks made a little noise but, we didn't complain. No I don't remember that the ……..

Interviewer: Probably the most noise you heard is the blasting then?

Subject: The blasting we heard, yes. And maybe the trucks a little bit.

Interviewer II: In terms of debris, like fly rocks or anything, from the blasting activity that might have came down off?

Subject: Oh yeah. There just are rocks. Oh, I don't know if it came while they were mining, or when they leveled it off and plant grass and everything. After I got down here my mom was ill and I was taking her to the hospital all of the time. So, I didn't have time to take care of the rocks. Then I started having medical problems.

Interviewer: Well, we certainly appreciate you taking your time to come talk to us. It is very helpful.

Subject: You know for what you did, you probably could have come to my house and we could have been a bit more comfortable. This the outside is …It is something, maybe like you said, it may help someone.

Interviewer II: That is the whole thing. We are not the decision makers we are just trying to do the data collection on it. And of course, the powers-that-be will possibly consider what we ….

Subject: Well in my opinion it could have been run a lot better than it was with my father. But then again we are talking how many years ago.

Interviewer II: Yeah, you also have to realize that some of the environmental policy, like NEPA, you know and all those environmental protection type agencies. The environmental protection agency itself didn't evolve until way after these mines were here.

Subject: Oh yeah, I see these other mines around Powell Mountain and they all have grass on them.

Interviewer II: There are a lot of other impacts that are being looked at. This is just for the community aspect of it in terms of the mines. There is a whole environmental component too that they are looking at in terms of other studies that are going on.

Subject: Well you can't see it now, but there use to be a big mountain up on top of that mountain there. Well it is the same mountain, but there was a big knob. It was a lot higher and everything. They just took every thing that they didn't want and threw it over the hill and then hauled the coal down the mountain. And that is just what they could do. And we suffered impacts, not at the time it was happening, but nature took it course from everything that came down here.

Interviewer: Did they do any reclamation on that? Did they plant anything up there?

Subject: Oh, I think that someone, it looked like maybe someone, planted some locust trees. Now I don't know those were natural or if they planted them there.

Interviewer: Umm. Umm. It might have been someone who came along later and did it?

Subject: It may have been some kind of ……, I don't know if it was reclamation or what. Probably if anybody did it, the State did it. Now that wasn't done until much later.

Interviewer: Yes, they didn't start doing that or requiring that until the seventies.

Subject: I came down here most of the time because my Mom was sick and I would be taking her to the hospital, trying to get her medicine or something. Cutting the grass.

Interviewer: Other things were on your mind…

Subject: Yeah, you are trying to keep two households. And that is very difficult.

Interviewer II: You had no family or friends or people that you knew that worked in the mines when you were here? Do you know of people from around this area?

Subject: Sure.

Interviewer II: And you said that most people moved out of the area to follow the mines.

Subject: No, these weren't my friends who worked in this mine up here. I was young and they were forty or fifty years old.

Interviewer II: But they weren't, they weren't acquainted with your Mom or Dad or anything?

Subject: No. Oh no. I told you I worked in the deep mines, well I excavated. Yeah I knew people up there. "Specific name" runs a used car dealership out on Route 41 and the other people they went to California.

Interviewer II: So all of their labor basically, they pulled their labor in from elsewhere?

Subject: Which mines are you talking about?

Interviewer II: Well either one. The surface mines lets say. Did they, did the labor pool, did the workers that they used….

Subject: This company used a lot of people from this area. This company basically had their crew when they came in. I guess it depends on the company and how it is set up.

Interviewer II: That is another aspect of it too. When a company comes in are they actually looking for the local people for their labor force or at least to help make up their labor force in addition to what they have?

Subject: They didn't have any rule against hiring local people. I knew at least one person that worked for them, he greased up the shovel. Up at this mine quite a few people that lived around here worked for as excavators.

Interviewer II: What would happen once that coal company moved out? …the coal was mined and they moved elsewhere? What would those people do, who lived her locally and worked at the mine? Do you know where they went if they moved with the mine? Did they keep their job?

Subject: Well, my two bothers worked at this mine and basically that started slowing down a bit. They had both been in the service and they went to Cleveland and took the GI bill and learned skills. But the one brother used his skill the rest of his life. The other one got diabetes and he came back and stayed with Mom until he died. Well, what you are asking is are these remedies or whatever and they are not. Everybody has a different set of circumstance and everybody has something different than, … Actually, when I got our of the Army I took a plane from Seattle, Washington to Cleveland and my brother wanted me to stay there and he got me to apply to a job where he worked. But anyway I did take that job. But no, I feel that happens all over the place. Whatever connections people have they certainly use those more than they use the coal company.

Interviewer II: Right.

Subject: No, it is "Goodbye, Thank you Mama." when the coal company gets through with you.

Interviewer II: So, if basically if they had ties here and lived here they're more apt to stay here than follow the coal company? At least in your experience?

Subject: No, they are more apt to go to Wyoming or Cleveland or somewhere there is the possibility to get a job. That farm work, it is like I said, not only can the big farms out farm you, but that is hard work and you do not get paid.

Interviewer II: My Dad use to do the crop farm, so I know a little bit about that and it is not a lucrative business. If you are a small gentleman farmer and just a small time operation, you need to have a bigger operation to...

Subject: Oh exactly. Things have advanced in that fifty years to the point I might, like you said be, like someone comes here and raise a garden because I wanted the fresh vegetables and to see it grow, and all of that. But commercially no. Not even a tiny bit.

Interviewer II: It is very expensive just for the instruments you have to get involved with and a lot of expense. Not just in the operations but …

Subject: My son wants to buy a tractor for him. … And guess who he'd like to pay for it? Anything else?

Interviewer: No, I think that is everything I hoped to talk to you about. Unless you have something, like I said, that you want to talk about.

Subject: The complaints I got, you hear them over and over again. I don't want to be redundant as far as my conversation.

Interviewer: I think you have given us a lot of good information.

Subject: I am not sure it's not the same thing you will get everywhere else.

Interviewer II: That is a good point. But that may also confirms some things. I mean if you keep hearing things over and over again that maybe indicates to us in a general way, that these thoughts and perceptions are true. So what you might be thinking is the same as people we will be interviewing this week and that is sort of confirmation and that maybe possibly more of a …

Subject: Yes, well I was just trying to give you information. This didn't affect me that much. I, probably my life would have been the same whether the coal company came or not. At least up to now. I inherited this part of it. No this probably didn't make any difference to me.

Interviewer: Probably a fair assumption that it made a difference to your parents and their life here? Or no?

Subject: I couldn't see that it did. Money was so,… you worked for a dollar an hour back then. Money was scarce. It probably,… like I said there were five of us and then we had my grandma lived here. She didn't help. We all had to get fed. But no like I said we raised most of our own food. Anyone who lived here worked here. My dad saw to that.

Interviewer: Well, in large part it didn't necessarily change?

Subject: Well, we don't have the fields and everything, but yeah it probably psychologically might have. But as far as money is concerned I would say probably not.

Interviewer: I really appreciate your talking to us "specific name".

Subject: Well it has been a pleasure.

Interviewer II: Thank you very much for your time.

MTM/VF EIS
Community Narrative: Werth, WV

Interviewer: You started to tell us, well, tell me a little bit about how you came to live here and how your family came to live in the Werth area.

Subject: Well, I worked in the coalmines for six years. That is how we paid for everything. And I hand loaded. And then I went to work on the railroad and I made it here so that I would have better access to,… I lived up here at Raven, on the other side of town. I moved here so that I would have better access to where I worked. I worked out of Tioga and Island Freight. I worked thirty-four years for the railroad. Invested on the railroad. When I first moved here in fifty-one the first outfit on this side, Tassa Coal Co. had just begun. Island Creek was on the other side over there. The people on that side had all kinds of trouble with Island that had all kinds of stuff from the mountain come down into their yards and everything else. And then Tassa moved in here. When I brought this place I had to put in a sewer system. Just had the outside system. And I put a sewer system in. It cost me about three thousand dollars to put it in to standard, you know, what it ought to have been. I dug a trench from the house here clear to the creek six foot deep put a tank in out there. And put three lines in there. One was over the other with rock in between the two. Well this outfit moved in and that stuff washed off the hill. The sewer system quit working. When I went over there to see what was the matter the creek, the bed of the creek, is that much higher than the discharge on the sewer system. I wanted them to repair it, but they wouldn't even talk to me about it.

Interviewer: Sediment off the …

Subject: Yes, off the hill raised the creek bed.

Interviewer: Raised the bottom of the creek bed above where your discharge pipe is so …

Subject: It was I'd say 6 feet from the bottom of the creek bed when I put that sewer system in. It filled up with silt until that was 3 foot from the bottom at least. And it filled up above that. The silt did. Until couldn't even, it couldn't … I put in another sewer system. It is not near as good and it is going to have to be redone. Because it is the original one I put in here. The one they destroyed. Because it didn't work after they, well there wasn't any way to drain it. The wasn't anything that came out of there except clear water. See, you had them two lines one over the other and them leach fields and everything else. It was a little bitty clear water that came out the bottom. That when they stopped it up it backed it up and stopped it all up. It filled in out here until I had a swamp in the yard. It was a swamp.

Subject II: Yeah, it was so muddy it was knee deep.

Subject: I had seen these trucks, with the bed down on the ground. That much mud. And we could not bring our cars. And had to leave our cars over on the main highway. Yes, you couldn't get it over here and back because of the mud in the road.

Subject II: And the kids had to go to school.

Subject: Those trucks I had seen buried down right out here until the bed was in the ground.

Interviewer II: The wheels were down in the mud.

Subject: They would have to get dozer down in here and pull them out. Now this was Tassa Coal Co. T, A, SS, A, Tassa Coal Co.

Interviewer: Yeah, I have seen that name.

Subject: Now the company that came in after that was Hobet. And Hobet was all together different. I don't care for the mining anyway, but if you are talking about mountaintop mining. But, Hobet was 100% better than Tassa Coal Co.

Interviewer II: Yeah, Hobet I think was from the original landowners. Howard and Betty is that is what someone..

Subject: I don't know. I knew the Superintendent. He was from a family around here. I knew him since he was a little fella.

Interviewer: So, he was from around this area or somewhere else?

Subject: Yes. He just recently passed away about three months ago. He was younger than I am. But I knew him, knew his dad.

Interviewer: Have you all lived in this area for your whole life?

Subject: I was born up in Tioga. Do you know where that is?

Interviewer: Yes. I have not been there but I know where it is.

Subject: I was born in Tioga in 1923. Then when I grew up I joined the Army. Then I served about 4 years in the Army. I have been around here or in Webster County ever since. She was born… her home was in Webster County.

Interviewer: So, you moved here about 1951?

Subject: Yes.

Interviewer: And they were already mining on one side,….

Subject: Yeah, and then they started on this side over here. I had to lay boards across here to get over to that road to get across the swamp. Then after they got ride of them, I hired a dragline to come in here from Peerless Eagle Coal Company. My brother was superintendent for them and he managed to get it in here. I got the dragline here. Dug up a hole for a pond and filled the yard in to make me a yard out there all at the same time. But they just made a regular swamp out of it. Right out there in that holler out there was a cornfield. And I didn't own that. "Specific name" over here owned that. But the people that rented off of them lived across the road here, across from me. And they finally got in corn. I wish you would go out there and look at. It is full of wild rose bushes, cattails, and you need hip boots to get through there. And they had a cornfield out there. Mind you. You see it never did straighten-up. And I had a water tank back up here. I drilled a hole back in…. there is a seam of coal laced in there. I drilled a hole back over top of that seam coal, there was water coming out. I took an old mine auger and went up there and drilled. And I built me a tank and fed that water right in. And that was really good water. Had gravity fed …for the house. And after they got to shooting, it got acid in it. And I took it, a sample of it to these people that put in filters. And they said that much acid I couldn't do nothing with it. It was just that much acid from where they shot.

Interviewer II: Your water supply was ruined?

Subject: Oh, it was ruined and I put another tank in out here. There was a spring out there. Before that stuff was forced off the hill and there was a spring out there. And I built me a tank out there and put a line in and a pump. And it is good water it wasn't as good as this. Now after 30 years, my boy was working for Hobet. He was sampling the water and so forth and he was a bookkeeper. And he wanted to check that and he went and got a check of it and the acid is gone. So I went and put a new line in and now I have two sources, places to get water. I can I can turn a valve and I can get that off of the hill, or I can get this out here.

Interviewer II: Now there was that one time, how long ago was that?

Subject: It took about 30 years for that to clear up.

Interviewer II: Thirty years to clear up and now it is non-acidic, it is potable?

Subject: Oh yeah, its good again now. But they're wanting to put in another mine out here, what will it be like again?

Interviewer II: Oh so they are going to pursue it?

Subject: Oh there is no doubt they are talking about it. The one fellow has the backing, and so they've got money to do it. I don't see how they will make any money. But like I said I mined for six years and that coal out there- the highest I have seen of it is about 20 inches. That is what happened to the people that tried to mine it before. They had to cut bottom with the cutting machine in order to get their cutting machine through there. I don't think you can make any money out of that, but the people that is talking about mining it I don't think have any experience in mining. One of them inherited millions from his pappy and used the money to back it. But I know he don't know anything about mining and the other fellow I don't… there is a whole lot of doubt about him.

Interviewer : That actually brings up an interesting question that I wanted to ask you all. That is how do you hear when the mining is going to come in? Do you read about it in the papers?

Subject II: We see them out there drilling and so forth.

Subject: My grandchild is an attorney - who works for the Judge. They have to come through there to get your permits and everything. And I found out about it – that they were wanting to put in another mine. Now they did deep mine out there. And like I said they had to cut bottom, and it wasn't profitable. They had to give it up. That is why they were mining there. Because it was so low. They went back here on this hill dozens of times. They had the "specific name" boy up there, that I know, he cored drilled back there and he told me that when they were in the side of the hill he couldn't actually legally tell me what they would find. Because that is suppose to be kept…. But he said that near here, on the side of the hill, they got the last coal out. He said there was about 16 inches back under the middle of the hill. Now you can't mine that deep mining. There ain't no way. Up here, in this holler above here, it runs up here at about three foot. And when they want to show somebody, the people that don't know no better, when they show somebody. That is where they take them. (laughter) They don't show them the samples where they core drilled up there.

Interviewer : So, just to finish my thought then, do you see the permits posted in the newspaper at all?

Subject: No, when they strip they are supposed to post it in the newspapers. But you'd have a hard time we had to figuring out where it is. Because when they put it in there they don't specifically specify where it is. You know. I they maybe have Braxton County on one side of the line and Nicholas County on the other and so. But to exactly where it is, they don't want you to know.

Interviewer II: It is just basically a legal ad print. They are probably small fine print that we always use to just call them as buried in the legal ads.

Subject: I don't know where they get a copy of those maps. But it is not current.

Interviewer II: Right, right.

Interviewer: Did they put it in the local paper too or only in like the state…

Subject: In the local paper, in the Nicholas County Chronicle. Recently they did have a lot of their maps in there. But it where they were trying to get their money back where they had their, … Oh, I forget what you call it, how you say, before you buy you put so much down and then they are trying to get their money back. Some of them do get their money back but they don't have anything. Now like I said, this Hobet was all together different. I'd seen what happen here. All those seams of coal that lay back north of here. When they come up here, they come together. You had 27 foot of coal on this mountain. Now you had binders in between the different seams. But you look at all that, some people really don't think that we described that there was that much coal. But that is what we said there were 27 foot of coal. Now Tassa came in they cut around and left big pieces of the middle. And then one fellow over here, he lost 2 of his coon dogs up there that went up there on that end and they came off of that high wall.

Interviewer II: Oh boy.

Subject: It took $200 and some dollars for one of them. He was very teed-off.

Interviewer II: You mean they actually fell …..

Subject: Yes, fell over the thing. Oh it looked like these pictures of the moon up there. Then when Hobet came in they took those out and leveled it off.

Subject II: It is pretty up there now.

Subject: Oh, it don't look bad. But they talk about plowing it you know. But there ain't no way. You got about two and a half inches of topsoil then it is rock. There ain't no way you can plow.

Interviewer II: Just enough to put some grass on top of it.

Subject: Yes. Yes. And the only thing that grows on it is locust trees. I planted chestnut trees up there and they got about that tall and died. There was nothing there for them and there was too much acid in the soil. And there wasn't no coal company that wanted to put out the money to put fertilizer on that to make it grow something. It costs too much.

Interviewer II: Those locust trees they will grow about anywhere.

Subject: Yeah, they grow on a dry log. Hobet tried. They are a lot better than that other outfit. But there are boulders in these hollers out here that are half as big as this house. That Tassa rolled over there and there weren't nothing nobody was going to do about them. You see they are still down in those hollers and places. And there are two big slides where they just dumped the refuse over the hill. It is dangerous, you have to go around it.

Interviewer: Can you see that from the street at all? From 55?

Subject: No. You have to go up here on the top of the hill and look over there. Before they just bumped it over the hill. Now that was Tassa that done that. Hobet didn't do any of that. Because they took the coal out and then dropped that back in. They filled it back in. But like I said you don't have no topsoil. But it is a lot better than the way it was when Tassa had it.

Interviewer: One of the things we are trying to get a gage of is how things changed in the community before the mining was there and while it was there and after. You described some real stark physical changes to the land and your water systems and I have heard stories of wells drying up and the blasting shaking the houses. Are there, did you have those types of impact as well? Did the blast shake the house? And ….

Subject: Yeah it did. My chimney out here, it cracked it. And you can see out there where I put tires and plaster it into the house. Now it hasn't moved any more. I hope it stays it has been that way for about 20 years. But that chimney it was cracked from the blast. Oh they shook the house. The windows and everything. They, both this outfit on that side and this one up here both. Yeah they put off a big enough blast.

Interviewer II: Now did you report any of that damage to the mining companies at all?

Subject: I didn't, no…

Interviewer II: You knew there was no use of doing it, because…

Subject: I will give you and idea. Now the way I see it the government. It was the State government and the County government were in with the coal operators. I will give you and example there was a guy named "specific name", over here on Little crick. He had a nice farm. He got it from his daddy. He inherited it. And he had big bottoms over there, that one bottom must have had 200 acres in it. And they flooded… now this was Island crick…. they flooded Little crick. They just filled the bottom up. The crick filled up. And then the water overflowed. And brought suit against them. And they had more money that he did. It suffered on in the courts for 4 years. And then they had a hung jury to start with. And one of the members of the jury that helped hung the jury, was the baby sitter for "specific name" which was one of their superintendents. And a few days after the trail was over here she is driving a big new automobile. She didn't have that kind of money I wonder where she got that automobile?

Interviewer II: Very interesting. We can only speculate right?

Subject: Yeah. And then they had another trial. It cleared them up again. It was, ...a some how, he got 'em. But he was about out of money. But they had another trial. The awarded him $300. Now if that wasn't a laugh. Two hundred acres of bottomland. He'd grow corn and hay. And gone. Now it was gone. There ain't no two ways about it. When cattails grow up in your bottomland you ain't going to raise hay off of it.

Interviewer II: Not at all. It is too wet.

Subject II: It filled in the crick at the end and it went into his land.

Subject: Yeah, it filled the crick. They let the refuse run off of the hill. Filled the crick up until it was level full. And there was nowhere, when the water is not allowed to leak, there is nowhere else to go…. All over his bottom!

Interviewer II: You can't grow anything except cattails in wetlands.

Subject: I am prejudice and discouraged about them coal, because I have seen enough of it to make you sick. And you know. I was down through Kentucky here about three years ago, about two or three years ago. And I came up Route … 15,… Ahh, what was that? 23 there? It comes over. And stripping down there was just like it was up here. I am telling you it would make you sick to look at it.

Interviewer: Yeah. That is part of what we are trying to get the report together. We are probably not going to change what happened in Werth. But maybe in will impact what will happen on Route 23, or some other community.

Subject: Yes down there.

Interviewer: Let me ask you something else. When you moved in, the kind of community that was here and the population that was here, did you see any change in that population that could be related to the coal mining at all? Or surface mining?

Subject II: Well, they're just not as many people here.

Subject: That did have anything to do with the surface mines. When we moved here there was a mill up here. It was an abandoned sawmill and they probably employed, oh, 8 or 9 hundred people. That mill burnt while we lived here. But you have seen them… there were several houses up there that mostly belonged to the company. That was Ely-Thomas Lumber Co. I believe it was you that wanted to know about all of those buildings? Those were the garages for the employees because they didn't live here. They lived all over and they brought their cars in there and they put them in the garages while they worked on the mill and in the yard and everywhere else. But the mill up there burnt down. My dad worked for them and when the mill burnt down, he was a lumber inspector. A lumber grader. He worked for the First Valley Lumber Co., in Tioga for 28 years. As a lumber grader. That was the second biggest mill, I think, at least in the Eastern United States.

Interviewer II: Wow.

Subject: It was a double band sawmill. And I got tapes of that old saw mill and them sawing lumber. But ah, I don't know whether you have ever seen those, big band saw mills? But you see that saw was, well it is probably 50 feet long. But it goes, you know in a …

Interviewer II: It is like a big belt.

Subject: It is like a belt pulling, like that, around and the carriage that carries the logs, you see it is steam operated. And they roll that big log over on that see, and it goes by just about that fast. And then if you are the "dogger" on the carriage they say that you were screwed in those carriages. You better get a hold, because when it back it went like that. It comes all the way back and then back again. And I mean they had to hold on when that thing went. It is steam operated. You see Tioga had a double band. They had two saws, one on one side of the mill and one on the other. They brought big logs in there at that time. I got pictures of those old engines hauling logs and they wasn't little poles like you are getting in this day and time. They was logs.

Interviewer II: There was a lot of board feet lumber in one of those things.

Subject: Oh gosh. The Lumber Company had so much lumber up there in stacks that the insurance companies wouldn't insure them. I use to ride the old No. 5 Engine of Tioga, oh they had trains. About 6 trains. And the No. 5 up there, there is a No. 4 up at Cass now. And it wrecked and rolled in the holler of Sprucey Low Gap up there, and killed three people. One of them was my uncle. Rolled over in the holler at the top of Sprucey Low Gap. But I use to ride that from down here at Summersville, I went to high school down here. And I would come to Muddlty catch that train and ride it to the Tioga. Got off down there about a mile. I got off there. But I rode that old No. 4 which was No. 5 on the Shady side.

Interviewer II: So, other than the mines, the lumber company around here did a lot of the employment.

Subject: Oh yeah. They had way more than the strip mines. The strip mine don't employ very many people.

Interviewer II: Because they let the machinery do the work.

Subject: Yeah. You it uses mostly heavy equipment operators.

Interviewer: Did you work on underground mining or the surface mining?

Subject: I worked in the underground. I loaded the trucks. I got paid for… Way back then I held the record for the most coal ever loaded in Tioga. I loaded 27 tons, 500 pounds in one day.

Interviewer II: Oh, boy!

Subject: That was the record for the most coal that was ever put out by one man.

Interviewer II: Oh my heavens.

Subject: But, back then base wages was, I think when I quit the mine, was $17 a day. Of course I was averaging about $28 a day. By hand loading, I was averaging more than the base wages. And I quit and went to work on the railroad for $9 a day.

Interviewer II: OH, you really gave up some cash there.

Interviewer: Were you looking for a change in work or what made you decide to do that?

Subject: For one thing I've got a leg broke in four places in there and oh it was dangerous and I figured I had better get out while the getting' was good. And I got a chance to go to work on the railroad. And I went to work on the railroad. But, you heard me when I was paid $9 for 8 hours. But back at that time you hardly ever worked less than 15 or 16 hours a day. So you made a little more money than that. But it was mostly overtime. Now it changed over a period of time. Now, when I retired I made something a little over $200 a shift and I hardly ever worked 8 hours. You see I belonged to the union and we cut the working hours down from 16 to 14, to 12. And when I retired, why then you could only work, they could only work you a total of 12 hours. But that is a long time.

Interviewer: Twelve hours by today standards, when the average workday is like 8 hours. A typical workday. But twelve hours, we think we work overtime when we work 12 hours. But when you pull almost double shifts working 16, that's a long time. And that is the job and you have other things to do at home.

Subject: Well, you betcha. When we just worked 12 hours, you see I had to keep the time for the crew, I had to be there ahead of time in order to fill out all the papers and after the shift was over I had still had more papers to fill out on what was done and what needed to be done. It wasn't a bad job maybe I wouldn't see a boss for 2 or 3 months. I would talk to them maybe, on the phone and on the radio. But if you had a major big job. But you could take the time I spent 12 hours and then 2 more hours that would be 14. By the time you came home and eat and sleep, you about lived on the job.

Interviewer II: Oh exactly. Like we live on the job sometimes, but that is really living on the job.

Subject: And they didn't know when Sunday come.

Interviewer II: They made you work on Sundays too?

Subject: I worked 9 months without a day off. And that includes Saturdays, Sundays and Holidays.

Interviewer II: Were you married at the time?

Subject II: Oh yeah, I did all the work here.

Interviewer II: I bet you were happy for that work schedule?

Subject: Oh, we have been married for 57 years and she said that was why. We didn't live together. I lived on the rail.

Interviewer II: You guys are doing pretty good these days. You are retired. Fifty seven years, that is quite an accomplishment.

Subject: I have been retired …. 18 years.

Subject II: It went so fast, that 18 years has.

Interviewer II: So did you notice any change? Like in the population, seems like the population from what it was before the mines came in and during? Did you see any increase in, like people, leaving alone the mill out here? Was there any noticeable change in the local economy or how many people actually lived here when the mines came?

Subject: No. Not,… Now down here below here was Raven. And they put in the deep mines. And you see all them little houses there? Now the company built most of those houses. After they put I the deep mine, it increased the population down there at Raven, that little town down there already. By quite a bit, because see all those people that lived there, most of them worked in the Raven mine. But up here and through here, no it didn't seem to make any difference when the strip outfit moved in.

Interviewer II: So, in terms of them actually adding incentives to the local community to help, you know, maybe roads or anything, no services were provided or extras added or any benefit like that was given by the coal company when they were here?

Subject: No. No.

Interviewer II: So what was here before, other than the coal in the mountaintops, you know, everything pretty much stayed the same over all?

Subject: Yeah. Nope, you see I hunted these places through here before they ever done any. And those over there too. I hunted ever since I was big enough to carry a shotgun. And I hunted all over these places and I liked to have been able to took a picture of what it looked like then and what it look like now.

Interviewer II: It is a whole difference.

Subject II: Um, Um. It makes a difference.

Subject: Oh gosh. This Island Creek, … this poor old country clear through back to Tioga the tops is all gone. And they,…

Interviewer II: So aesthetically it is not,… the view of what you had and that is actually diminished?

Subject: Oh yeah.

Interviewer II: Are you still able to hunt up here?

Subject: Yep. The fellow that owns this, there was two of them, "specific name" and "specific name". And "specific name" died. He just passed away this last summer. "Specific Name" I have know him for years and he is a good friend of mine. But ah, he owns, well I don't know how much they own. But they bought this from Tassa and Hobet. What Tassa and Hobet had, they bought it. And like I say, they own minerals and all of it. I suppose there are other people in with him but….

Interviewer II: So the coal companies didn't hold onto their land?

Subject: No, they got rid of it as soon as they could.

Interviewer II: They liquidated it off by selling it to new landowners. Private landowners?

Subject: Yeah. "Specific name" is the gentleman that owned it. And he doesn't know how much he owns. He is wealthy. But there is a big pond on the hill up there, course he didn't even know where it was. But I knew where it was, like I say I hunt, you know. And he wanted me to take this fellow up there who was going to talk about raising cattle up there in the summer time. And I asked him if he owned that. That was the only water on it. If he owned that? And he said no, and I have no idea. Now you think he owned that much land that you have no idea…

Interviewer: Oh what you own and what you don't. Yeah

Interviewer II: It is quite hard to fathom in these days. Where a lot of us just own little plots of ground where are homes are. Not like our, my grandfather who owned hundreds of acres of ground for farming. That is very interesting. Yeah, we are trying to figure out also how the ownership,… did they maintain ownership over that land and basically that is no longer available for public or private use rather? Or what happens to the ownership of the land? That is interesting that they actually sell that off.

Subject: Well, "specific name" he told me he didn't mind, he didn't like people driving in there because of the insurance if they happen to run their car over the hill.

Interviewer II: Right, there is a lot of liability there right?

Subject: He said that he didn't mind if people hunt. Anyone could hunt on his property that wanted to. But I own land in Braxton County. I own a half interest in 700 and some acres down there in one place. Me and my brother owned it. Now he passed away. But I asked "specific name" about going back there and cutting some of those locust post. I wanted to put a fence in. I was building a fence down there. He told me to just use that lot down there. And I'll get all of the locust post you want.

Interviewer II: That is very nice of him. Sounds like he was a nice gentleman.

Subject: I only wanted about eight. He was a nice feller. He was here. He came here to see me little about a week ago

Subject II: Yeah, he knocked at the door….

Subject: She didn't know him.

Subject II: I have had heart surgery and I forgot. I have had two open heart surgeries and balloon surgery and I,… my memory of people has left me. They hug me down at Wal-Mart and the Lord knows who they are. They are people I use to know.

Subject: Her nephew's wife is a doctor and she said that when they used that heart bypass machine that there were air bubbles in there and you couldn't get them out. And these air bubbles cause miniature strokes. And those miniature stokes cause you to loose your memory.

Interviewer II: There is no oxygen in there and the air bubbles that leak from the blood, your blood stream. That is interesting.

Subject: And she had that open hear surgery. She was on that bypass machine 10 hours, the last time.

Subject II: They stopped it at 5 hours and had prayer. The doctor and nursed did. And that blood started going up right to my heart.

Subject: They had trouble getting her off the bypass machine after she had been on it 10 hours. Her heart wouldn't pick up enough pressure.

Interviewer: You are sort of dependent on that sort of thing.

Subject: Yeah, and they did what they call a sausage pump. It got put in her thigh there. And it helps boost her heart and then when the nurse came out she said "It is a workin'. You've got the light at the end of the tunnel."

Subject II: Oh, I have been doing good. I was just down to about 85 lbs. I had no appetite and now you can't fill me up.

Interviewer II: Well, that is the way you want to be right?

Subject II: Yeah, I want to stay hungry all of the time. But I just could not eat nothing'.

Interviewer II: Now, did you have to go to Charlestown for those surgeries? That is quite a long way to go for that.

Subject II: Yeah. Well what happened, I was getting' company, and my arm started hurtin'. If your arm ever hurt, so I'm thinking, oh I over did. It's your heart!

Interviewer II: Yeah, there is something wrong.

Subject II: So I just ignored it. I took my tylenol and go on about my business. Well I was getting company. And I had two hound dogs. Now this was just at the end of Christmas. I had just had a big Christmas dinner and all of that stuff. Here they come up the door and I have a heart attack. I had a major heart attack. It just happened that "specific name" had a glycerin tablet.

Subject: I had heart trouble before, and I kept the glycerin tablets. I usually kept them on my, on a thing around my neck, so that I would have them handy. And she had trouble breathing, and I said that is not arthritis. You are having a heart attack. And I gave her a glycerin tablet. Well by the time I got her to Summersville, it let up. And they run her through this EKG machine and everything. And one of the doctors came in and said she was alright she could go home. About 30 minutes, that is when they get the tests back. I told my nephews "Let's go have a cup of coffee and we'll come back and pick her up." When we started to drive here they come with that EKG machine again. I said "Wait a minute there is something wrong here." Then the other doctor came in then, and I knew him, "specific name". And he said "specific name" she has had a massive heart attack and we can't do anything for her. We are going to have to send her to Charlestown. But that doctor ...

Interviewer II: Yeah, a second opinion is always better.

Subject: They sent her to Charlestown. You see they called Charlestown, and they said they had a bed arranged down there. Then they took her in an ambulance to Charlestown. For three years I spent more time in Charlestown than I did here.

Subject II: I have been in Charlestown Hospital all that time. I had a blood clot and major surgery and I don't know what else. And he called John Hopkins, Mayo Clinic, they called everybody, this doctor "specific name" did. For them to help me. And all of them refused me. Them big hospitals.

Interviewer II: Oh boy.

Subject: They thought it was too big of a risk. See she had full quadruple bypass. And it didn't work. She stopped again before she got out of the hospital. Before they released her. And then she had to have quadruple bypass again. And they couldn't get no surgeons to do it. "Specific name" he called all over the country trying to get anyone to do it. And then they done four balloon surgeries on her and then she was still having trouble and he said she was going to have to have major surgery again and so he tried to do balloon surgery again and he punched a hole thru the artery.

Interviewer II: Oh no.

Subject: Well when he did, something had to be done. And they called this, they call him a high risked surgeons, down there from one of the other hospitals. And he come over and he done the operation. Like I said it was10 hours, but he said part of it was cutting away the growths from that other doctor done first.

Interviewer II: All of the scare tissue I guess.

Subject: Scare tissue, yes. He said there was a whole lot of, a long time. Probably the biggest part of the operation was cutting away the scare tissue from your first operation.

Interviewer II: Cutting away the mistakes that other people have made.

Subject: Yes.

Subject II: And you all don't know how active I was. I would go hunting. I'd walk clear to the top of the mountain. You all wouldn't believe. I mowed. I did everything. I was healthy.

Interviewer II: You hunted too.

Subject: Are you from West Virginia?

Interviewer II: No I am actually from Fulton County, Pennsylvania. And Alexa is from Philadelphia.

Subject II: You was out there where the plane crashed, then wasn't it?

Interviewer: He is a little closer to it than I am. But yeah, that is in our neck of the woods. Not too far.

(Multiple conservations going on at once.)

Subject II: I was being prayed for all over the earth. I mean to tell you, I got letters and cards mailed from all over.

(Multiple conservations going on at once.)

Interviewer II: This your trophy?

Subject II: Yeah, yes, that is me. If I had known, I had cleaned that room up before I let anybody in there.

Interviewer: We will be right back I guess.

Subject II: O.K.

Subject II: Now we had a hunting camp down there and I am the one that keeps that thing clean.

Interviewer II: The mining, did it interrupted any of the deer population up here? Made them,… There is not much forest cover for them up on top like there us to be.

Subject: There are a lot more deer now than there was, but the mine didn't have anything to do with it. See there were very few deer I this country before they started. The family down here, "specific name", I don't know, one of them was a judge and a lawyer and I don't know who all lived… in Summersville. And they imported deer from Michigan and they built pens down here. I use to find them. I don't know whether you can still find them or not. But it is by that old "specific name" place down there. And they raised these deer and they turned a few loose every year. They are the one who stocked deer. Not the DNR but the "specific name" in Summersville was responsible for stocking the deer around this part of the country.

Interviewer II: Oh interesting. How long ago? I hear the in the early 1900's the deer population was really bad around here.

Subject: That was … I would say, when they started to turn them loose down there was in the fifties. When they started turning the deer loose. Before that there were very few deer in this country.

Interviewer II: Now it almost to like …

Subject: I got a dog out there …

Interviewer II: Like rabbits.

Subject: I got a dog out there, my grandson brought him up here when he was about that long. I didn't ask for him but I got him. He keeps the deer run off now.

Interviewer II: Right.

Subject: Now two years ago when grass was scarce, I fed them out here all winter.

Subject II: He would ring a bell and them deer would come.

Subject: See that bell over there?

Interviewer II: Yep. Yep.

Subject: I would go out there and put the feed out. And ring the bell and in 30 minutes time, there would be six or seven deer out there feeding. One morning I got up and all told there was, down there and back up here, there were 17 deer in my yard.

Interviewer II: Oh goodness, gracious.

Subject II: He would go after "specific name", that boy that loads. He'd know what "specific name" was after. He would just stop and run over there. He'd have to hurry up and get back to …

Interviewer II: They will be coming in the house after "specific name" to find out where that feed is at.

Subject: I built me a bird feeder.

Interviewer II: I see that.

Subject: Was it last winter or the year before that?

Subject II: Last winter I think.

Subject: And it holds 20 pounds. Well it was lasting about four days. There ain't that may birds out there. There are a lot of birds but….

Interviewer II: 20 pounds of feed that is a lot to be eaten.

Subject: All of a sudden, "specific name" looked out there and there was a deer licking it out.

Interviewer II: Oh goodness.

Subject: I don't those deer should be eaten out of the bird feeder. Well, I told her and she'd done run'em off. She went out there a running and a hollerin' and a hootin' at it. And this one deer looked back at her and she came back in the house and he is back in the bird feeder.

Interviewer II: Not shy at all.

Subject: She took a rug out there and stood on the back of her chair, and threw it over top of it to keep the deer out of the bird feeder.

Interviewer II: They are not shy at all.
]
Subject: Oh I enjoyed feeding them. I would go out there and shovel off snow to get down to the ground. And I picked apples down here, off of some of these trees from this old farm down here. Put them in the cellar and then in the wintertime, I would cut those up and put salt on 'em and take those out there and dump those out there. And them hole kernel corn. And boy them deer love that. They'd cleaned it up.

Interviewer II: Yeah it is like a treat for them.

Subject: They would come in there and get that every day. As soon as I'd ring that bell, there is a lot of people that come here just to see them deer. 'Cause about 4 o'clock in the evening I would go out there and feed and I would ring the bell and they would take about thirty minutes to come off of that mountain there.

Subject II: If they were going to survive, somebody had to feed them.

Interviewer: Sounds like living in this part was good for the deer and for you.

Interviewer II: Now what made you folks move,… Did you buy this? You built this house?

Subject: I built this… Well there were 4 rooms. I built this and built the den in there where you was. And the kitchen. I built those on it. And this was just four rooms here.

Interviewer II: So this house was here before you lived here.

Subject: Yeah, I brought it off of "specific name." Yeah, "specific name". I brought it off of him.

Interviewer II: What made you choose to move into the area? Was it the mines?

Subject II: No. It was on account of the phone. My sister had a phone and he couldn't get his call to work. There use to be there wasn't no phones. And so, she had one of those kind where you ring and when got he got his call, she'd call me on it.

Subject: I put a line, my brother owned the filling station over there, and they had a phone. You couldn't hardly get a phone at that time.

Interviewer II: Is that the old store over here?

Subject: It was across the road and downside of the railroad tracks. And he had a filling station and a garage where he done mechanical work. And he had a telephone. They got him a telephone because he did mechanical work and people called him. Well I brought two of these old crank phones and I put a line between here and over there. They'd call on his phone cause they needed work and he'd ring over here and tell me to go to work. That is how it worked. So, I was here where I could get to work. I 'd get the call and go to work. You see, they never knew when they was going to call you.

Interviewer II: You were on call?

Subject: I was on call 24 hours a day. And you had to go when they called ya'. That is when I moved here to get the phone call to go to work.

Interviewer II: Now, knowing the impacts of the mining up here, what you had said about your water supply and what had happened out front. Do you think that would have deterred your decision to move into the area? If you knew what the impact was?

Subject II: Oh yeah. I would have never moved here. No way!

Subject: Oh that would have never happened. There ain't no way I 'd have moved here.

Interviewer II: You are not seeing, as far as you know, your not,… As long as there is no mining occurring up here in the future you are not seeing any re-occurring, continuing impacts or influences from the mining operations.

Subject: No. Now they consider this, I don't know how far up this goes, you all would have a better idea than I do. But this is considered wetland. Well the reason it is wetland is because the crick was stopped up and it over flowed. At one time it wasn't. But they tried to mine, they wanted to mine this down in the development and they couldn't get a permit on account it was considered wetland. So, I just hope this up here is too. So they can't mine out there any more.

Interviewer II: There is a lot more restrictions on wetland development than you said back in the fifties or so. If could drain it all and didn't see any value in wetland. But now they are seeing value in it so there is more protection on it.

Subject: Yeah, I hope that wetland goes clear up to Tioga. (laughter)

Interviewer: We should be so lucky, huh?

Subject: Oh, I have had enough of these mines now. You know even Hobet here. Them trucks came off of here continually. You had dust and you had mine black dust from the coal, blowing off them coal trucks. They wasn't covered. And then you had dust from the road, you know, from where the trucks kicked up the dust from the roads. It was a nuisance all the time.

Interviewer: Where did the trucks come out? Did they come out right over here?

Subject: Come right down around the road there. You see up there? Where the little trailer is parked? Right down around the road and then they went down by, in front of my garage there. My garage even went down this way to the trickle by the train. They had a tipple down there. They moved a lot of coal off there.

Interviewer II: Now a tipple would be where the train came through, right.

Subject: Yeah, they hauled a lot of coal.

Interviewer II: A stock pile down there to load it on the train, I guess.

Subject: They run it through the tipple to sort it and to make different grades.

Interviewer II: Oh right. Like size it.

Subject: Some of it they washed and some of it was mine run and then you had different grades. Tioga mine up there had 10 different grades of coal. Of course, I had to sort that, you know from different cars. Pick up the cars when I was conductor and had to put that in the train in certain places because it went different directions. The different grades of coal.

Interviewer: So, you saw how much coal was coming out of there? When you were working on the railroad.

Subject: At one time we used 8 diesel engines, four on each end of the train. You see, we took it across Sprucey Low Gap which was a little better than a 4% grade. That is the reason for that. Now with 8 engines, I could take 70 loads of coal across there in a trip.

Interviewer II: Wow. That is a lot of coal.

Subject: Yeah and most of them were hundred pound cars. Most of that came from Island Creek. They had both the deep mines and the strip mine, Island Creek did. And they were loading union train. Union train usually consisted of about 125 cars. But ah, usually I had to make two trips across there. You see I would make one trip and take them over and store those coals. Put them in the siding over there. And then I would come back and get another trip and then I'd put them together and take them to Island Dale and turn them over to another crew that took them onto town and to Graphton. I hate to think of the amount of tonnage I hauled out of there on that railroad.

Interviewer II: Now when did you, did you basically retire fro the railroad?

Subject: Yeah.

Interviewer II: Were they still hauling coal at that time?

Subject: Yeah.

Subject II: They quit. When "specific name" quit, the train quit running.

Subject: I always laughed at them boys and said that this railroad wouldn't work without me. I quit and they did too. (laughter)

Interviewer II: From that day they were no longer operational?

Subject: They started digging the rails up. I don't know if you noticed?

Interviewer: Yeah, I saw the ties beside the road.

Subject: Yeah, they took the rails up even. I was 34 years for them. Now the rails were there when I worked.

Interviewer II: Oh sure. They were there when you quit, but soon after they weren't.

Subject II: The day he quit was the day they quit. Now that was amazing.

Subject: Now when I retired they were still using 6 engines. And we would use 3 on each end. But the coal was reduced down to where there wasn't quite as much going out.

Interviewer II: So they didn't need that 4th engine?

Subject: The reason we didn't use 8. Well they was afraid that that rear engine was probably shoving them off when they had a derail… was shoving them off of the track. They were mistaken on that. That wasn't the cause. Most of the cause of the derails was 'cause they let the track get too wide. They didn't keep it gagged in.

Interviewer II: It kept on pushing it out.

Subject: Yeah, they didn't keep it gagged in good. But this one time we had a derailment with empties. And I had four engines on the head end and three on the other. And we had a derailment and I reported the track wide. And see it was on record where the clerk recorded it two or three times and you see. It was on record. The clerk would send it in and they keep copies of all of that. And ah, because it fell in, they thought that they couldn't claim the insurance on that. So they sent specialist in here from Baltimore, to see what caused the derailment. Well anyway, they say that the helper engine pushed them off. I told them fellers, I said you boys better sit down at the table and have another meeting. That helper had 80 some cars ahead of him. He couldn't shove the train to the top of the hill, let alone turn it over and shut down, so it wasn't his fault. You all better redraw your. It is a tough call these wide tracks. You can look on the reports and see. I don't care what you call charges to, but don't you blame it on my train crew because it wasn't their fault.

Interviewer: Right it was the actually the track's fault.

Subject: I got a ranger boat over there in the garage. And bought me this…

Interviewer II: "It is not my place to run the train with a whistle I can't blow. It is not my place to say how far the train is allowed to go. It is not my place to shot off steam or even clang the bell. But let the damn thing jump the track and see who catches hell." (laughter) That is pretty good huh? They remember that huh?

Interviewer: I wanted to ask you guys to go back a little bit, when you talked about… how for example your front yard was pretty much a swamp at one point… Did the coal company ever come talk to you about buying you out? Or did you have the option if you wanted to move? Could you have done that? Did you stay for the job?

Subject: No, they never … never heard anything from any of them.

Subject II: Yeah, our yard was a swamp.

Interviewer: But they never approached you about purchasing your property? What made you decide to stay here?

Subject II: On account of the phone.

Interviewer II: You needed that line of communications for your work at the rails?

Subject: Yeah.

Interviewer: Did you have any interactions with the coal company over the years before they came in? For example the one that came in after you moved here, did they talk to you at all about what they were about to do or not?

Subject: No they tried to keep it all a secret. They didn't want no one to know what they was going to do. I don't think. I talked to several of the neighbors around up around Island Creek up to Tioga and in through there. And they said if they would have knew what was going on they could have probably stopped part of that. But we didn't know it until it was too late. We had no idea what they was doing or what it would do - the damage or anything else. I had never seen a strip mine.

Interviewer II: What would you do now, say for example if a coal mine wanted to come back in? What would be your reaction?

Subject: There ain't much I can do. Now what I own here, like they wanted to strip this in through here and I told them, I said you are welcome to go up there and walk on any of that you want to. But you keep your dozers off of that. I have had enough trouble and I don't want it stripped. You are destroying my water. I don't want my part of it stripped. So keep your dozers off of it. Well they tried to buy that on that side, and the gentleman that owns that over there said, "No way. You ain't getting' it." You see they didn't own the land. They owned the minerals.

Interviewer II: The mineral rights.

Subject: But now they own the land above that. But that wasn't where they could strip. Because that has already been stripped.

Interviewer: They need to own the surface rights to strip it.

Subject: Yeah, they have to have the surface rights, you know to strip it. They want to strip what I own in Braxton County, down there. And I told them there wasn't no way. And they said well you would make some money.

Subject II: Money ain't everything.

Subject: And we would spend your money and the money would be gone and the land would be all tore up.

Interviewer II: Yep. Money can't replace what was there that is for sure.

Subject: No, that other company put in two culverts over here in that pasture. They're little. The crick got up, the culvert stopped up, real early. So then they put in a bridge. And they used only timber. It wasn't treated or nothing and it rotted out. Well, I had trouble getting my oil in here. The heating is oil. I had to bring it in by the barrel because the oil truck couldn't get it past there. That was about the time that this outfit was moving in, Tassa. And I told ah, "specific name", the Superintendent, I told him I said "specific name" if you are going to put culverts in, put them big enough to take care of that crick or they'll just stop up and wash the road out again. He put two in that'd take care of the Gauley River!

Interviewer II: Yeah, small creeks they can get a lot of water running through them. They can come up pretty high.

Subject: Yeah, this one over here, no bigger than it is, it was up to that road this spring. It was over my garden. I have got a garden over there. And it was clear over the garden. You know it didn't hurt it all that much. Some of the tomatoes plants and some of the pepper plants died on account of it. But them culverts, if they hadn't been there we probably would have had nothing.

Interviewer II: Right exactly.

Subject II: They put the big culverts in.

Interviewer II: Look for the worst and make it through.

Interviewer: Yeah, but it was interesting that raise that point. Now you said that you knew him since he was a feller and he lived here? Was from around here? I haven't heard too many situations, from the people I have talked too, where that was necessarily the case. That the person that happened to be running the mine was from the area even or knew the people even. Do you think that was an advantage for you all?

Subject: It was to me because see I could tell, I could talk to him. They run up around the road here, and drilled a test well. They drilled several of them, water wells. They used the water to clean off the road, too. But my spring out there went dry. I thought they had sunk the spring. See they drilled a test drill on above it there. I talked to him about it and he brought a man in here on a backhoe and they dug that out. And they hadn't been the cause. The water in the line that went up there to where the spring was, was stopped up. But they put a new line in and cemented it in and everything and they wouldn't take any money for it. They paid for it. Now that wasn't Tassa that was Hobet. Tassa wouldn't even talk to me. When they stopped the sewer system up, I went down there to see them and they didn't want to even talk to me.

Interviewer II: Hobet was a little bit more approachable and that.

Subject: Oh yeah. But "specific name", he was great. And when he left here he was still the head of Hobet down there where they had those big mines in Southern West Virginia.

Interviewer: I have seen some of those, Hobet 21 and those down there…

Subject: Yeah, he was President down there of those. And he retired and moved to Florida and they brought him a ranch down there, a cattle ranch. And he passed away about three months ago. But I knew his dad and I knew his grandpa. I said you know when you are getting old when you know everybody's grandpa.

Interviewer II: Yeah, ok, if he just passed away then you did know some people way back when.

Subject: Yeah.

Interviewer: Did you know many people from around here that worked for the surface mines?

Subject II: Not that I know of. I didn't know 'em.

Subject: No, most of them that worked up there were from other places.

Interviewer II: They moved in their employment from elsewhere and set up shop there to work down here?

Subject: I don't know where Hobet is from originally before they come in here. But a lot of those people came from Beckley over here to work.

Interviewer: And in your experience they pretty much left when the mine left?

Subject: Yeah, when the mine left they left. Because then they did live her to start with. They just came in here to work on the strip.

Interviewer: When you lived here in the 50s and 60s, where there more families here than there are now or was it pretty much just like what we see here now?

Subject: There were quite a few more when we lived here. There was a house right across the road over there, where my garden is. Just right here in front of my driveway there was a house there and "specific name" lived there. And there was one, two, three more houses that have been torn down that was across the road. And then they lived in the old house that you see is down. And they lived in the big house above there and they lived, another house on this side of the road. Maybe one house down here on the bottom and one house over there on this side of the road. Now those are all gone. But most of the people that lived here are dead and gone.

Interviewer: Most of them stayed here through the mining and chose not to move away?

Subject: Yeah. They owned land and you can't just pick up and leave the piece of land that you own unless you sell it or something. There wasn't no one interested in buying; … I know they wouldn't have wanted to buy this about the time that coal company was here.

Interviewer II: That is one of the things were looking at too. How your property values probably went down hill after, … versus what they were before and then after mining operations, you probably saw a devalue in your property?

Subject: Oh yeah. You couldn't have sold this place about the time that Tassa was in here. From the mud over here in front of the house, you couldn't get your car into here.

Interviewer: You couldn't get across the mud to see the house let alone to sell it. Huh?

Interviewer II: Yeah, that would be quite a hard sell for a realtor or your own self to trying to sell it privately.

Subject: No, you couldn't have sold it when Tassa was over here. And like she said we had a swamp here in front. I had to lay boards across there, up on blocks, to get across there.

Interviewer II: That would be quite a way of life.

Subject: I didn't have the money to fight them, because see back then like I said, they had the money. They would keep you in court for three years.

Interviewer: Right. Did you notice at all, when your kids were in school, for example in some places I know that schools had been shut down because populations, you know, get smaller and smaller. Did you notice any changes in those types of things?

Subject II: No. No.

Interviewer: Kids stayed in school at the same place they started?

Subject II: Yeah.

Interviewer: Ok. Is there anything else that we haven't asked you about that you wanted to tell us about?

Subject II: Oh I don't know. Just hope no more money is up there…. (laughter)

Interviewer II: Yeah, I don't know if we can prevent that. But I think, … we don't make the decisions. We are just doing the study collection, the report effort that we are told to do. But, EPA and other agencies at the federal level and even State there, are going to look into the report and see what policy changes they might have to make. In terms of the actual mining operations itself. And part of that, would hopefully minimize some of the impact that folks like you have experienced over the years.

Subject: Yeah if any of them wants to see what that looks like, I've got a four-wheeler sitting back there, I can take them right back there and show 'em. The damaged that first company done that couldn't be reclaimed. You roll a boulder over, as big as this house, in one of them hollers you can't get it back.

Interviewer II: Oh no. Not unless you got a huge crane, a phenomenal power and the capability to climb up hills to get it back in place.

Subject: And when they dumped that refuse, them rocks and stuff over the hill, you know just dumped it over there, you got to see that to believe it, what that is.

Interviewer II: We toured a mine just south of Charlestown, Arch Coal. Did you ever hear of Arch Coal? Arch is a mine down off of the highway there south of Charlestown, but ah, I think it is the Robert T. Byrd Highway or something, it is called. We went there about two years ago. We were down there. That is just unbelievable, you know what, how much earth they can move and ah, just take it over to the next valley and start filling it up. So, a lot of refuge and debris.

Subject: They moved the shovel down there at Island Creek. It took them little over a year to shut that thing up.

Interviewer II: That mine was huge. Unbelievable.

Subject: It had enough electricity in there to run, I bet you, to run Summersville.

Interviewer: I think that is true. I have read things like that about some of those draglines, they take more energy than a small town.

Subject: They back one of them big coal trucks in the dipper and hide it. But I tell you they moved that in there on the railroad, brought it in by pieces. And then they was over a year setting it up, up there. It looked like a football field when they put it up out there, set it up.

Interviewer II: Right.

Subject: Everyone who had anything to do with moving that in there got fired.

Interviewer & Interviewer II: Oh really?

Subject: Yeah.

Interviewer: What do you think that was about?

Subject: I think, … it cost too much to operate it for what they got out of it.

Subject: Yeah.

Interviewer II: Yeah, that's a, … we actually went on one of those, I think it was called Big John or something was the name of that. And we actually stood in the bucket and we have a photograph of that, I have it back on my computer at the office, and it is just unbelievable how people, you know, six feet tall get dwarfed by that huge bucket.

Subject: Can you imagine one of these, you put a big dump truck, coal truck in it?!

Interviewer: Yeah? The whole truck?

Subject: Yeah, the truck backed into the dipper up there. I think I got pictures of it somewhere. You had to go up a big ladder to get up in. I had in one of my friends, was a crane operator on the railroad. He operated the cranes. And he said he would like to see that. Well, I called the Superintendent, he works nightly out there, he was in charge of the personnel. And I asked him about us, about me taking my crane operator over up there to see that. So I told the trainmaster on the railroad that I was going to stop my train long enough to take my crane operator and let him see that. Now he was really impressed. I said do you think you could run one like this. The one that we had was miniature compared to that.

Interviewer II: I actually got to go up in one of those too, up in the big cab, in the cabin, up in the box with the controls and it is just like grand central station up in there. Unbelievable.

Subject: That one up there was huge. That is the biggest one I have ever seen - that one up there.

Interviewer II: It was a monster.

Subject II: Have you ever been to Calhoun County?

Interviewer: I have been through it. I've not stopped there.

Subject II: They were stripping there. You can see where the town flooded and so. In the Calhoun county "specific name"?

Subject: No, not much Calhoun county.

Subject II: Well, what county was it?

Subject: Well, part of it was Fayette and down through McDowell and down in that direction.

Interviewer: I saw, I was over McDowell County a few weeks ago, around by Route 52. You know, west of Welch. And a lot of those communities have been flooded out this past summer and spring. It is sad how that happens.

Interviewer II: Did you guys get impacted by the flooding last spring, down here?

Subject: No. When we they had the big flood, about two weeks later it flooded my garden, see.

Interviewer II: When you say the big flood that is the …

Subject: That is the one in Fayetteville and all them over in through there.

Interviewer II: Just this past year?

Subject: Yeah. This past year. But about three weeks later it come and floods here and covered my garden over there. But like I said it didn't hurt anything. It didn't even bother the garden that much.

Interviewer II: Yeah, we say that on the news back home, that you folk had been impacted by the heavy rains and flooding.

Subject: Where we go to church, up there, you can't even get across the bottoms up there. The road that goes across there was completely covered. We couldn't drive through there with rains. But where we're at here, it doesn't bother me. It doesn't flood here.

Interviewer II: All right then, I think we covered everything.

Interviewer: I think we covered everything, do you?

Subject II: Well, "specific name" has told you his life story anyway! (laughter)

Interviewer II: That is perfectly, that is what we want to hear those things.

Interviewer: Yeah, that is exactly what we were hoping to get.

Interviewer II: Yes, those candid insights on what occurred and having an informal conversations with you folks. We appreciate your time.

Subject: You're sure welcome.

Interviewer II: It is good to know you folks, what little time we've spent together. From Alexa's standpoint we appreciate you folks letting us come into your home and sitting down here with you.

Subject: Yeah, most of the people that was here when this first, when Tassa was here, are dead and gone. There was a feller, "specific name", he is dead and gone. And then there was four boys that lived over there with their mother. They are all dead.

Subject II: And "specific name" lived over here across the road. They are gone.

Subject: The people that lived in these two houses are gone. "Specific name" are gone.

Subject II: We are going to be gone pretty soon, they are going to mark my own words.

Subject: And my brother he lived over there he is dead and gone. The next three houses down, the people who lived there are dead.

Interviewer II: Yeah, "specific name" he is gone. And we talked with his son, his youngest son this morning.

Subject II: Yeah, how is he?

Interviewer II: He seemed to be doing pretty good. He said he had a stoke and ..

Subject: He has had two.

Interviewer II: That is right two, and Alexa and I both told him that we couldn't tell that anything had happened to him.

MTM/VF EIS
Community Narrative: Werth, West Virginia

Interviewer: Basically, why don't you start off and tell Troy and I a little bit about how you and your family came to live in this area.

Resident: I was born and raised down in here in Muddlety there. And I bought this place here in 1944. That is where I am living here and then the farm down there 308 and three quarter acres – bought it in 1960. And ah, course they… I sold some of it across the crick there to Tassa Coal Co. And they stripped, there wasn't much on mine. I didn't own the coal, I just owned the land. It was just over, well wasn't even an acre of it, I don't think up there, of coal. But they stripped on this mountain up here. And when they first come in there, they just went around stripped the outside and tossed it over the hill. They done all that, and this about that way here. Island Creek Coal Co. they was up on this side. And they just went around and stripped around. First cutting over the hill and the rest of it, well they pushed a lot of it over the hill. I don't know what year it was they got after them about it and not let them throw it down. But it filled the creek up here and come rain it just filled the whole crick up. And ah, I don't know after I bought the farm down yonder, I guess about 1962 or 3, I got the conservation fellers, they said they would help me line up, fill up… shoot the ditches out and shoot the crick out. And when it come time to load, they were suppose to tell me how to load, and they wouldn't do it. They said that they wasn't going to do it. So, I just went down to the low end of the farm down there and I just shot the creek from up through here. And straightened it out so that it, the water would just run all over the meadows. And it stayed pretty clean since then.

Interviewer: About when was that, do you think? How long ago?

Resident: Oh it was in about '63 or '4 when I done that shooting.

Interviewer: And what time did the first mine company come into the area? About what time?

Resident: I guess that was in, in sometime in the late forties that they first come in here. They hauled the coal out down the road here.

Interviewer: Was that underground mining? Or that was …

Resident: That was top mines, strip mines. And they didn't have no regulations they just throwed it all over the hill, because they wanted to. And I guess it was more convenient for them than to pile it up. They would piled it up and then … I don't know how they done that this here. But I was up there some but not much. But down on my place down there, they stripped part of it before I owned it. And there were just a couple of knolls there and I give permission to the "specific name" boys, they were starting out, and they got in there and dug it up. And then they sold it to "specific name" I believe it was. And how he was a, he was a, pretty much operator on the mine stripping stuff. They finished stripping on the mine down there and they … that was… they leveled it off. But they didn't… just piled up the rocks there and they just up and they back lifted up and left ridges. You couldn't, it ain't, you can't… mow it or to keep the kids out. I put lime and fertilizer on it to try and get a pasture in there for my cattle. But it wouldn't, that was in '63 or 4 that I tried to plant some pine trees down there. And they wouldn't even grow. You couldn't get nothing to grow there. I mean only, there is some of this **moss –counter 42-** and a few locust trees that "specific name" growed in there. But ah, they threw rocks over the hill and they moved the timber down that way for I don't know how long. It has been better than fifty years now and they … It ain't done nothing now. Nothing on the top you can't grow anything.

Interviewer: Why do you think that is? Because the soil is too thin or..?

Resident: Yeah, just too thin. Too many rocks there too many rocks there. No moisture there for the trees to grow on, or that is my opinion of it.

Interviewer: Do you remember when they first came in did the coal company come and talk to you and the community at all?

Resident: Well they didn't, not on my property first. When the first ones come in here, the one came in and worked on this good one up here and they hauled their coal down the State Road. But ah, in… '52 or 3 they bought that place of mine over there, property. They put a big road down over there so that they could haul it without using the State Road. But it didn't, they didn't do that's when they throwed it over and come a hard rain the creek just fill clear up, with the dirt.

Interviewer: Tell me a little bit, a little bit more about why you moved here. When you first moved here.

Resident: Well I, I was the kind of the guy, a feller that didn't like to be pushed around by the mine company. I was working the mines. And me and the boss got into a kind of an argument. And I gave him a cussin' and he said he would fire me. And I told him go ahead; it didn't make a damn bit of difference to me. So he fired me, or wrote out the time. I took it down to the office they said they wouldn't… they wouldn't, they said they would give me the go ahead and work. But they didn't want me to quit. I told I was leaving, when a feller gives, the boss give you an order for your time, well you are suppose to quit. So, I went over here to Gauley River and went to work in the mines over there. And I was still living in Widen, but didn't… Well, I found out that this property here was for sale and so I went and bought it and moved in a house by the creek there. I just moved in here, and that is when I bought it in '44.

Interviewer: And you were working in an underground mine then?

Resident: Yeah. Yeah, I worked about 21 years in the mines.

Interviewer: So you continued to work for that underground mining company for a long time?

Resident: No, not too long. I quit them and went down here to this Peerless Coal Company and underground mined there. I worked there for a good while and then I went up to Tioga and worked, so... I was working Tioga when I quit.

Interviewer: Did you notice when the coal mining started here if there were economic benefit? Did people get jobs with them?

Resident: Well, they had some people working but it didn't seem like it helped much of any. The underground mines was more of an advantage then. The strip mines wasn't any benefit much… they didn't have over 15 or 20 fellas working for them.

Interviewer: Did you know any of those fellas? Were they anybody that they hired that had lived here before then?

Resident: Other than the "specific name" boy down here that worked for them. But, the rest of them, there were some of them from over in Braxton County and I don't know where the others were from.

Interviewer: So you would say there wasn't very many at all?

Resident: No.

Interviewer: Yeah. What did you like about living in this community when you first moved here?

Resident: Well, I was raised up four miles form here. I was born and raised in the community.

Interviewer: So it was home to you?

Resident: Yeah, yeah. I knew about all the people. I mean, when I come over here I knew about all the people that lived in the... up this way and down the other way and up next to Powells Mountain and down next to Summersville. Use to be I knew pretty near all the people that lived in Summersville, or was kin to a lot of them. I mean, my dad was raised down on the Brushy Fork there. I don't know where my granddaddy come from. I guess Maryland.

Interviewer: So, this was, so that was what you liked about it here? …that you knew everybody?

Resident: Yeah, well it was a pretty good community. Wasn't no crooks or crime or anything like that around.

Interviewer: That is usually a good thing in a community.

Resident: A few fellas made whiskey and drunk it. But I didn't do none of it.

Interviewer: I know you got that dog across the way; he's the only crook around, huh?

Resident: Huh?

Interviewer: The dog.

Resident: Yeah. (laughter)

Interviewer: Tell me a little bit more about when you were living here and the mining came in. What kind of changes did you see in the community? Were there physical changes? …like you said they dumped some of the stuff from the other side of the mountain and that changed the creek? Any changes to your home, for example?

Resident: No, it didn't... had a bridge across the creek over there and drove across on to the road here to go to work. It didn't change…well maybe, I mean… it changed, it had to do, my neighbor up there he had a shovel come in and clean the creek out and straighten it out and just while that backed-up, then that's when there come rain and it filled it up all the way. And mine down through here I just, well I had the shovel clean it out because it filled it up and then I got that ditch with dynamite. Got enough of it then to blowed it up so that the crick runs pretty good now.

Interviewer: Yeah. Yeah.

Resident: But I didn't have no help from anybody then.

Interviewer: Did you ever talk to them about what had happened?

Resident: No, I never talked to 'em. Nothing about that. There wasn't no use, I mean, we had no law against it, I don't reckon'. If we did, the legislation just like you are doing about the drunken drivers. They don't, they just let them do what ever they want. They give em' a day in jail and fine them a little bit. Now I seen in the Gazette where, here, about two or three weeks ago, where they tell about this terrorist attack up there that killed 6,000 people and drunken drivers in West Virginia, or not in West Virginia but in the United States, kill 16… over 16,000 each year and they don't do a damn thing about it. Looks like to me if, the government, 'course they're spending a lot of money on, about the terrorist thing, but they won't even give these drunken drivers - get them off the road.

Interviewer: Umm, humm.

Resident: They are killing 10,000 more people than the terrorist did.

Interviewer: Yeah, there are a lot of things in this country that I… that are doing worse damage than they did just in one day. It is sad. There is no question.

Resident: They do more damage; I mean cars and people, wrecking people's lives, crippling them for life and everything. They are doing a lot more damage, drunken drivers, here, in a year than most terrorist done.

Interviewer: So, but you felt talking to these guys up on the hill, wasn't going to get you anywhere.

Resident: No, it wasn't going to get you anything.

Interviewer: Okay.

Resident: They just lie about it.

Interviewer: Sorry?

Resident: They just lie about it. They stripping down on that low place down there, they coming around, it wasn't on my property but it was next to it. I wouldn't let them strip on mine down there on that seam that they was on. And they come up there; there was ah… water starting to come up in my meadow down there. I expect it was 300 yards or more. And there hadn't been no water come up there at all when I first bought the place down there. And this is when I had had it about 15 years. And I went and told them about it, "No," it wasn't their fault. It didn't make any difference; they'll deny everything. Lying don't hurt them a bit.

Interviewer: Why did you choose not to let them strip down there where you owned?

Resident: Well, I didn't like them. I let them strip after that, I mean a neighbor of mine owned land joining me there, and he said they wouldn't strip his unless they could strip mine. It wasn't… was just maybe 40 or 50 feet deep on the top of the hill there. And I felt I didn't want to keep him from selling his coal, because I wouldn't sell 'em mine. But I didn't like the people that had the mine down there. So, I done it for the fella. He had treated me right and so I thought I didn't need to hold him up on my account. But they done a good job on what they hadn't, up on the left hand-side, eastern side of it, they had stripped most of that before. On the right hand-side of the road down here, they hadn't stripped any there. But they didn't hurt that up there too much. They didn't have to go down very deep. And then at that time they didn't throw nothing over the hill.

Interviewer II: What was this meadow like before the mining operation started up? Can you remember what it was like?

Resident: Well it was good farmland all the way down through here.

Interviewer II: That was pretty much what it was used for? Crops?

Resident: Yes. Yes.

Interviewer II: Was it corn and.. ?

Resident: Well corn and hay.

Interviewer II: And that is sort of how this, what was about this community?

Resident: Yep. Yeah it was farming community.

Interviewer II: Farming community. Then the mining operations came in and I think you had said about nothing would grow down there. Is that sort of, what impact did the mining operations have on the farming community?

Resident: Well, from down what they call Crack's Fly down there, the road that goes across, the road goes across and goes over on Phillip's Run and from there up this way is pretty good shape now. But it is because of people like myself that kind of kept it cleaned out and stuff. But from there down yond way now, its, well the whole bottom just, nothing but a swamp land. There is no… you couldn't raise anything in there now. And they, the government wouldn't let them people down there at the Raven houses, they wanted to clean the creek out and sort of drain the, their septic tanks wouldn't drain good.

Interviewer II: Because the creek was backed-up and all the sediment from the spoil that was taken off, that actually caused the water not to be able to drain it just laid in there. And that what caused it to become a wetland, if you will.

Resident: It is wetland all right. But back… I remember when there was corn and hay grown and all that down there where there is nothing but a swamp now.

Interviewer: Are any … I am sorry go ahead.

Resident: They wanted to clean it out and the government wouldn't let clean it out. Told them they could clean it out if they'd put rocks in the bottom of the creek and up both sides and it would cost over a million dollars for less than a mile to do that kind of stuff. Wasn't nobody, even this whole community, didn't have that kind of money.

Interviewer: Were there any changes to your water supply?

Resident: Well, not mine. They, … I sold that over to the company and my water comes over there from a spring. I built me a tank over there. And when I lived across over on the other side there, I built that tank. And then when I built this over here, why, I put that water over here. When I sold it, I reserved that water tank - the spring and the water. And the fella that owns the land now, he talks about stripping over there. And I told him, I guess me and he will have another round of it. And I told him… He said he thought that he had it. Well, I said you better go and read it. You will see that that spring is reserved. I said you better not try tearing it up. But they never bothered my water at all. But I don't know how the other people, water was.

Interviewer: Would you say there were any benefits, in the community that you could name from the mining being here?

Resident: Not that I know of. There was a few fellas from out of here, about the only one on the creek that worked was the "specific name" boy. That worked for them.

Interviewer II: Where does everybody else work around here?

Resident: Well they, some of them worked in mines over here on Gauley River and some up here for Island Creek Coal Company.

Interviewer II: So that, would you say that that was the majority of the people around here working the mines then?

Resident: No, No. I suppose that most of them just went ahead with their farming or worked some kind of County or State job. Working for the State Road and for the County and stuff like that.

Interviewer II: Did mining companies bring any, other than employment; did it bring any other benefits to the community? Like did it, was there a local store or anything that it helped support? Like the workers would come to and help support that store or anything down in Summersville?

Resident: They didn't have no… the company didn't have no stores or anything that made a benefit that I know of.

Interviewer: What about after the mining sort of wound down around here. Did you notice a significant change in the community then at all?

Resident: No.

Interviewer: Like the "specific name" that you mentioned and a few people that you knew who worked for the mines did they, for the surface mine that is, did they move on with the surface mine company?

Resident: No. No. I don't think any of them that worked here went with them.

Interviewer: Right. Okay.

Interviewer II: So the mines didn't, even back in the '40s and '50s if you will, the mining operations that was conducted at that time was really happen or occurred before there were a lot of environmental protection laws and regulations on mining? Or if this is back, sort of, when the mining operators did what, how they saw fit, so to speak?

Resident: The cheapest way they could get the coal out.

Interviewer II: Right. …the most economical way for them to do their business.

Resident: Yeah. That's right.

Interviewer: Do you ever see… these days, I don't know if you read the paper regularly, but do you ever see permit information published in the newspaper?

Resident: Yes. The Chronicle, that's our newspaper.

Interviewer: That's local?

Resident: Yeah, that is locally… ah in Summersville down there. They generally publish the permits. Whenever they want their money from back when they put a deposit on things, they run an ad on it.

Interviewer: Um hum. Um humm. Did you have any interaction with the coal companies when they were here? About anything at all? Complaints that people might have or what they might be doing? Or did they publish public information back then?

Resident: No, not that I know of.

Interviewer II: Were the mining permit advertisements legal advertisements?

Resident: Yeah.

Interviewer II: Were they,… Could you understand what they were meaning in terms of what were the locations of the permits? Where they were being applied for and what areas were to be mined, so to speak?

Resident: Well some of them, if they describe it, it was something I knew, the landowners was mentioned in it.

Interviewer II: Could you read the map that was published along with the advertisement of the permit?

Resident: Well, some of them yes.

Interviewer II: Some of them you could read?

Resident: And some of them I couldn't, stuff was put on there that you couldn't, or I couldn't understand it.

Interviewer II: Do you think the permits of that legal advertisement is helpful? Do you ever, … do you think it is helpful or beneficial that that is published?

Resident: Yeah well, I think so. The people that their land is next to, it would help them.

Interviewer II: Do you know of anybody that actually …I am familiar with that you can actually go to a public meeting or actually get questions and concerns answered about that permit application? Did you know of anybody that actually were affected by those permits that went to those meetings or had questions for people who were advertising the permits?

Resident: Well, I don't know. The mine down there, when I let them strip, well before I give 'em permission to strip, I went over to Oak Hill, I believe it was, and talked to people about my water. It was up on top of the hill from my property down with houses. I had three houses there. I was concerned that they would cut the water off from them. And I told them I wouldn't… I was protesting it about the water. And the company they didn't ask… they come and asked me about drilling - where I wanted the well. And I, … So they drilled the well some 200 and some feet and they got me good water down there.

Interviewer II: So you went and actually were concerned about how the water impacts, was that? How they would impact your water supply?

Resident: Yeah. Well, I figured that stripping up there on top of the hill they could possibly. 'Cause it was ah, maybe 600 – 700 yards from where my water tank was.

Interviewer II: Did they use blasting techniques back then?

Resident: Oh yeah. Yeah, they blasted.

Interviewer II: Is that what you mean by affecting your water or just ….

Resident: Well, just cutting the top off of the hill basically could affect it.

Interviewer II: So when you… you had concerns, or expressed your concerns about your water supply to the coal company, they actually came out and drilled you a well? Is that what you said?

Resident: No, I went and talked to the fellas over in Oak Hill that gives them permits. That is where I went to.

Interviewer II: Oh you went to the huh,… was that the State?

Resident: Yes. That is the one that gives it, gives the maps out.

Interviewer II: Ok you went, …issued the permits and you actually went to them about what your concerns were. Were they the ones that actually, who drilled your well then?

Resident: Well, the company had the well drilled. They didn't, they'd come, the company come and asked me about the, where to drill the well at.

Interviewer II: And that was after you went to the State and expressed your concerns about it. And the State notified the company and told them that you were concerned and they came out and drilled a well for you.

Resident: Yeah. I was protesting from them stripping up there. That was before I let them strip on my place. I told them I wasn't going to let them strip on it until we decided something about it. 'Cause they could say that I give them permission to strip up there, on top of, and it wasn't there fault that the water was messed up. Because I give my permission to you.

Interviewer II: Were you satisfied with the response that you got?

Resident: Yep, yeah they …

Interviewer II: You felt that they came out and did a good job and responded to you, to your concerns?

Resident: Yep. They drilled me a good well and got good water. Most of the wells along this creek that I know of is, 'course they didn't go as deep as that one did. But ah… I had them test the water, I mean, there is a company that tests your water. What they sell is these… I don't know what you call it, these purifiers or something that takes the sulfur out and stuff. I had him test this one here of mine. I know the spring wasn't bad and it had no sulfur or iron in it. I had them go down and test the one down there and they said it was as good as this one up here.

Interviewer II: Well, that is good. That is real good.

Resident: But I made them, they drove down to the hard rock. They drilled 200 feet down. They got good water.

Interviewer II: That is real good then.

Resident: Yep. Better than what I figured they do.

Interviewer II: You were pleasantly surprised we could say.

Resident: Well, the water seemed like it was good. I mean, before it was tested I 'course we didn't know what it was for sure. But id didn't look like it had any iron or sulfur in it.

Interviewer II: Very good.

Interviewer: Did you, … I am going to change the subject a little bit from the water but ah, could you tell me a little bit what you think about the sort of future of this community? Do you see it? How would you describe it?

Resident: Well, I don't know. Some of the people may sell their land for lots and stuff. There are a lot of people wanting to buy them. A fella asked me the other day about buying some of my lot. I told him I wasn't going to sell any of it. I was gonna give it to my two boys. I was gonna fix it up.

Interviewer: So you think the future is pretty good around here? People are wanting to move in.

Resident: Yeah, there's people wanting to buy lots and land all the time.

Interviewer: And you don't think, … Do you think that the surface mining or the presence of the mining around here changed the future in any way? The way people look at it?

Resident: No, I don't think.

Interviewer: Good.

Resident: I don't think it changed it any up from what it would have been if there hadn't been mines. 'Course up that place down there where the creek is dammed up down there... But this up through where they use to fill the creek up with stuff, why I don't think, … of 'course the people who lived here like me that kept the creek cleaned out.

Interviewer II: Is there any benefit? What do you see might be used for this bottomland? Here behind your house? Is there any, … in grassland do you think that is how it will remain?

Resident: Well, it will all depends on the people… my kids with my property… This here goes to my daughter, and the big farm down there goes to the boys. It is just whether they, if they want to sell it off or what, sell all the lots. I can't say what they will do with it.

Interviewer II: That's up to them to decide when that time comes.

Resident: Yeah, both boys… I don't think either one of them will ever come back here to live. One of them built him a home in Georgia. Another built a home up in Linwood.

Interviewer II: Why ah, … you don't think they would come back? Do you have any idea or reason why they wouldn't want to come back to this area?

Resident: Well they, they just, my boy in Georgia he likes warmer weather and he is a chemical engineer and he is a... well he is a consultant. He travels all over. Well he pretty near… he goes, they got a company in Spain that he works for a good bit. And then he, these other chemical companies for the Unifoam, he is an expert on that.

Interviewer II: Oh interesting.

Resident: I guess he is about the best in the world on it.

Interviewer II: He has his roots settled down south then?

Resident: Yeah. He married a girl, a woman from down there. And his first wife died. They use, he use to work for Union Carbide. And he went, they put him down in Atlanta, Georgia, put him down there. He married this woman that lived at Stone Mountain. Her peoples lived down there so he moved up and went to work for another company in Philadelphia. He was up there about 10 years. And he went back to… he retired from them. Went to down there and built him a home there in Georgia. Now that he's a "specific name" up in the eastern panhandle. And his... he's got two kids up there. And they are both married and live up there in Martinsburg. So his family, his immediate family, I mean his kids and grandchildren they're up there.

Interviewer II: They are all married and have families of their own and they are settled where they want to? There is employment up in those areas too?

Resident: Yeah well they've just got a girl. She lives in Maryland and she got a big huh, oh I don't know how many houses, they got 4, 5, 6 houses and a condominiums up there for rent. So, they are tied up, up there a lot. If I was all three of them, I would just sell this stuff down here and forget about it.

Interviewer: How about you? How come you decided to stay here as long as you have?

Resident: Well, this is my work. I was a farmer. I worked at the farm and the coal mine and I got too old to do either one of them now. I just quit. Draw my social security.

Interviewer II: Yeah. So, did you ever think about leaving when the mining was going on because of what the impacts were?

Resident: No. No I don't. I had no desire at all to move out. After we built this house here in '54 I believe it was. No, I don't have any idea to move at all. I figured when I leaved here I would go in a box.

Interviewer II: So you built this house?

Resident: Yep. I had it built. I didn't build it.

Interviewer II: You had it built? And you moved over across the …

Resident: Yeah I just lived across the way.

Interviewer II: Over the meadow there?

Resident: Over yond side of the creek. That where the house, there was a house there when I bought the farm.

Interviewer II: Right.

Resident: But I…but I wasn't thinking about moving anywhere….

Interviewer II: So the mining operations didn't deter you? Didn't force you out of the area?

Resident: No. No.

Interviewer II: Didn't impact you in that way that you had to move out of the area?

Resident: No. No. They just caused a little bit more work for me, that's all.

Interviewer: Well you know umm, we pretty much covered most of the questions we wanted to ask you. Did you have anything else that you wanted to talk to about us? About the surface mine being in your community?

Resident: No. Not in here. But I'm sure them people down in the southern part of the State where they're mountaintop, that the flood they had, in my opinion, that was just caused because the coal mine didn't fix... didn't keep it from flooding on them.

Interviewer: Umm hum. Yeah, that could be. There are certainly lots of people looking into that.

Resident: Well, they will have to do it themselves. The legislature ain't going to help them any. They're a bunch of drunks, I think that is the reason they don't do anything that law… make an eight, .08 percent alcohol. If they don't do that and it is going to cost the State millions of dollars if they don't do it. And they don't do nothing to get the drunks off of the road, so,… And them overloaded the coal trucks and they kill people and they don't do nothing about that.

Interviewer: Can I ask you, have you personally been affected by someone that was hurt by a drunk driver?

Resident: Well, I've never been… I've seen…