PB98-963910
EPA 541-R98-066
October 1998

EPA Superfund
Record of Decision:

Langley AFB/NASA Langley Center
Area E Warehouse OU
Hampton, VA
9/28/1998

RECORD OF DECISION

NASA LANGLEY RESEARCH CENTER

AREA E WAREHOUSE OU

September 1998

RECORD OF DECISION
NASA LANGLEY RESEARCH CENTER

DECLARATION

SITE NAME AND LOCATION

NASA Langley Research Center (NASA LaRC)
Area E Warehouse Operable Unit
Hampton, Virginia

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for the Area E Warehouse Operable Unit (OU) at the NASA Langley Research Center (LaRC) in Hampton, Virginia (the "Site"), chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. §9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision is based on the Administrative Record for this Site.

The Virginia Department of Environmental Quality (VDEQ) concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this OU, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The Area E Warehouse OU cleanup is part of a comprehensive environmental investigation and cleanup currently being performed at the NASA LaRC under the CERCLA program. NASA LaRC is currently addressing five OUs under its environmental remediation program. The remaining four OUs will be addressed in future RODs.

This action addresses the principle threat at the OU by imposing land use restrictions that will prevent any non-industrial activities to take place on the OU.

The selected remedy is the implementation of institutional controls, which include:

1) the prohibition of use of the property for purposes other than industrial (e.g., residential, child care or recreational use);
2) inputting these restrictions in the NASA LaRC Master Plan;
3) within 90 days of ROD signature, NASA shall produce a survey plat prepared by a professional land surveyor registered by the Commonwealth of Virginia indicating the location and dimensions of the Area E Warehouse Operable Unit and the extent of the soil contamination. The plat shall contain a note, prominently displayed, which states the owner's future obligation to restrict the land use of the property. The plat shall be submitted to the local recording authority;
4) NASA shall incorporate these restrictions and supply a copy of the plat into any real property documents necessary for transferring ownership from NASA, in the unlikely event that NASA sells the property. The real property document would also include a discussion of the National Priorities List (NPL) status of this Site, as well as a description of the soil contamination;
5) The NASA LaRC Environmental Engineering Office Head will certify to USEPA on an annual basis that there have been no violations of these prohibitions. If a violation has occurred, a description of the violation and corrective actions to be taken will be provided.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. The remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this OU.

Because this remedy may result in hazardous substances remaining onsite, a review will be conducted within 5 years after the commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

J F Creedon ______________________ 9/16/98 ____________

Dr. Jeremiah F. Creedon — Date
Director
NASA Langley Research Center

Abraham Ferdas ______________________ 9/28/98 ____________

Abraham Ferdas — Date
Director
Hazardous Site Cleanup Division
U.S. Environmental Protection Agency, Region III

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

RECORD OF DECISION

NASA LANGLEY RESEARCH CENTER
AREA E WAREHOUSE OPERABLE UNIT

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

NASA LaRC is a 787-acre NASA research center located in southeastern Virginia in the Hampton Roads area. NASA LaRC is bounded by State Route 172 on the West, by Brick Kiln Creek to the North and byLangley Air Force Base to the South and East (Figure 1). NASA LaRC together with Langley Air Force Base was proposed to the National Priorities List (NPL) in 1993 and finalized in 1994.

The Area E Warehouse OU is located along the eastern boundary between NASA LaRC and Langley Air Force Base. The Area E Warehouse OU is approximately 4.5 acres in size (Figure 2). The area houses several structures which encompass approximately ¼ of the OU. The site includes the area immediately surrounding Buildings 1170 to 1174 as shown in Figure 2. Storm sewers located on the site discharge into a small ditch approximately 120 feet long located immediately adjacent to the Area E Warehouse OU. The ditch discharges into the site-wide drainage system which ultimately discharges into the Tabbs Creek estuary. The distance from the drainage ditch to Tabbs Creek is approximately ¼ of a mile.

The Area E Warehouse OU serves as a storage and distribution center for all supplies and materials for the NASA LaRC facility. The area includes mainly asphalt and gravel road surfaces and warehouse structures. Drums, which are stored on pallets, containing raw products (lubricating oils, solvents, etc.) to be issued for use throughout the Center, rolls of electrical conduit, and miscellaneous equipment occupy approximately 40 percent of the warehouse area. Approximately 10 percent of the area is covered with grass.

The OU is in close proximity to Tabbs Creek and within the tidal zone of the Chesapeake Bay (Figure 1). Marine wetlands are common in the surrounding area, and the Plum Tree Island National Wildlife Refuge is located approximately four miles northeast of the OU. The northeast portion of the OU is located within the 100-year flood plain, coinciding approximately with the 8.5-foot elevation contour.

The site is located within the Atlantic Coastal Plain physiographic province. The geology of the area, primarily flat lying marine sediments, consists of the Norfolk Formation and the Yorktown Formation. The uppermost soil unit at the site consists of varying sequences of silt, clay, and silty to clayey sands belonging to the Norfolk Formation. In the boring drilled for the Site Inspection, this unit occurs from 0 to 9 feet in depth and consists of brown, mottled orange and gray soils. They are typically dry to moist and slightly to moderately plastic. The underlying Yorktown Formation consists of gray silty clay and clayey silt with abundant shells and shell fragments. It is typically wet to saturated, moderately to highly plastic and occasionally mottled. Local sand lenses are common, as are partially indurated shelly layers (coquina). The Yorktown Formation extends to approximately 400 feet below grade at the site.

Groundwater in the area can be found at a depth of 5 to 50 feet below the land surface. This aquifer, known as the Columbia aquifer, is brackish and is limited to lawn and garden watering. Both the Yorktown and the Yorktown-Eastover aquifers underlie the Columbia aquifer. The Yorktown-Eastover aquifer is confined and is used as a source of domestic potable water.

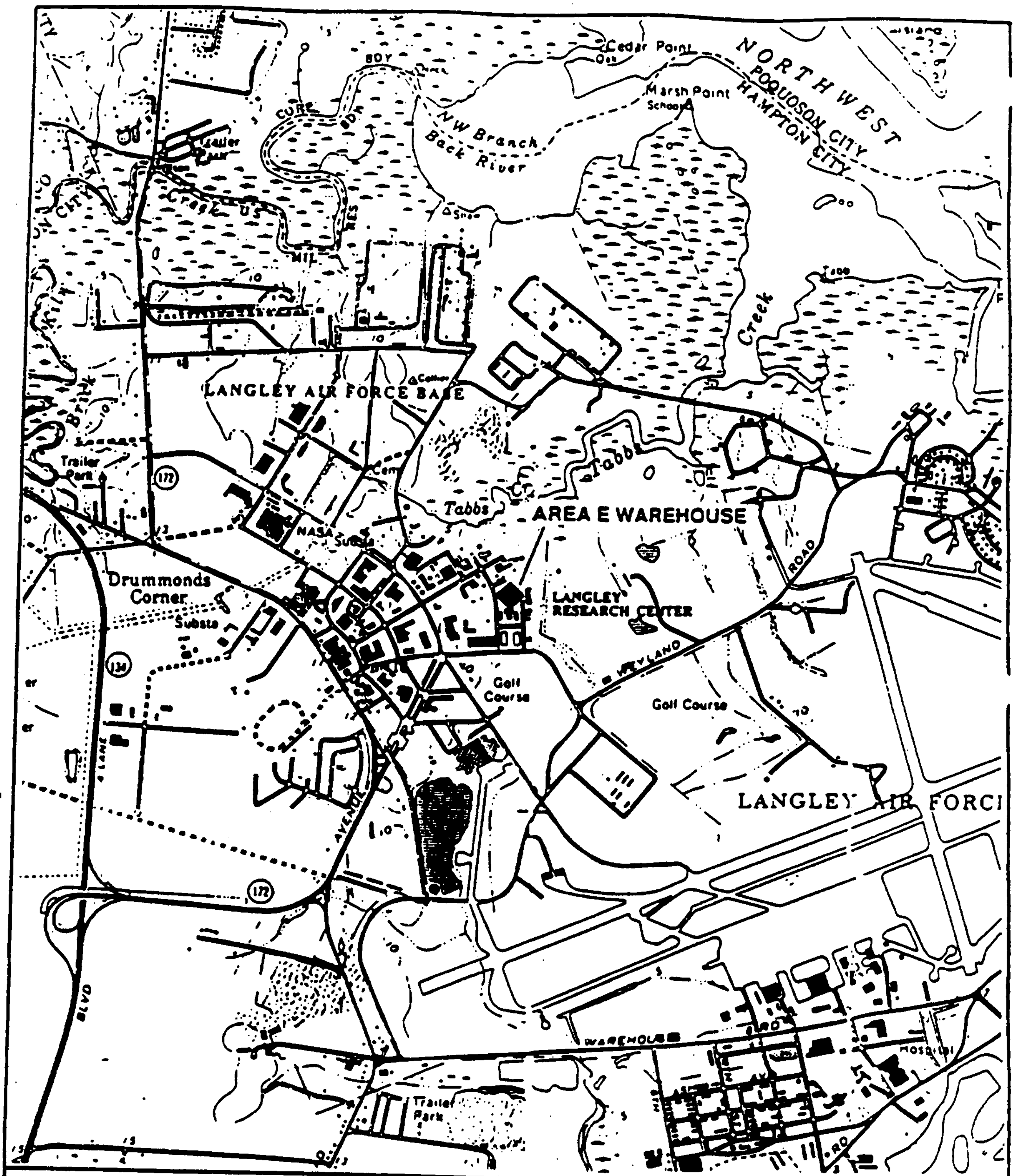


FIGURE 1
SITE LOCATION MAP
NASA LARC AREA E

Prepared by Ebasco Services Incorporated

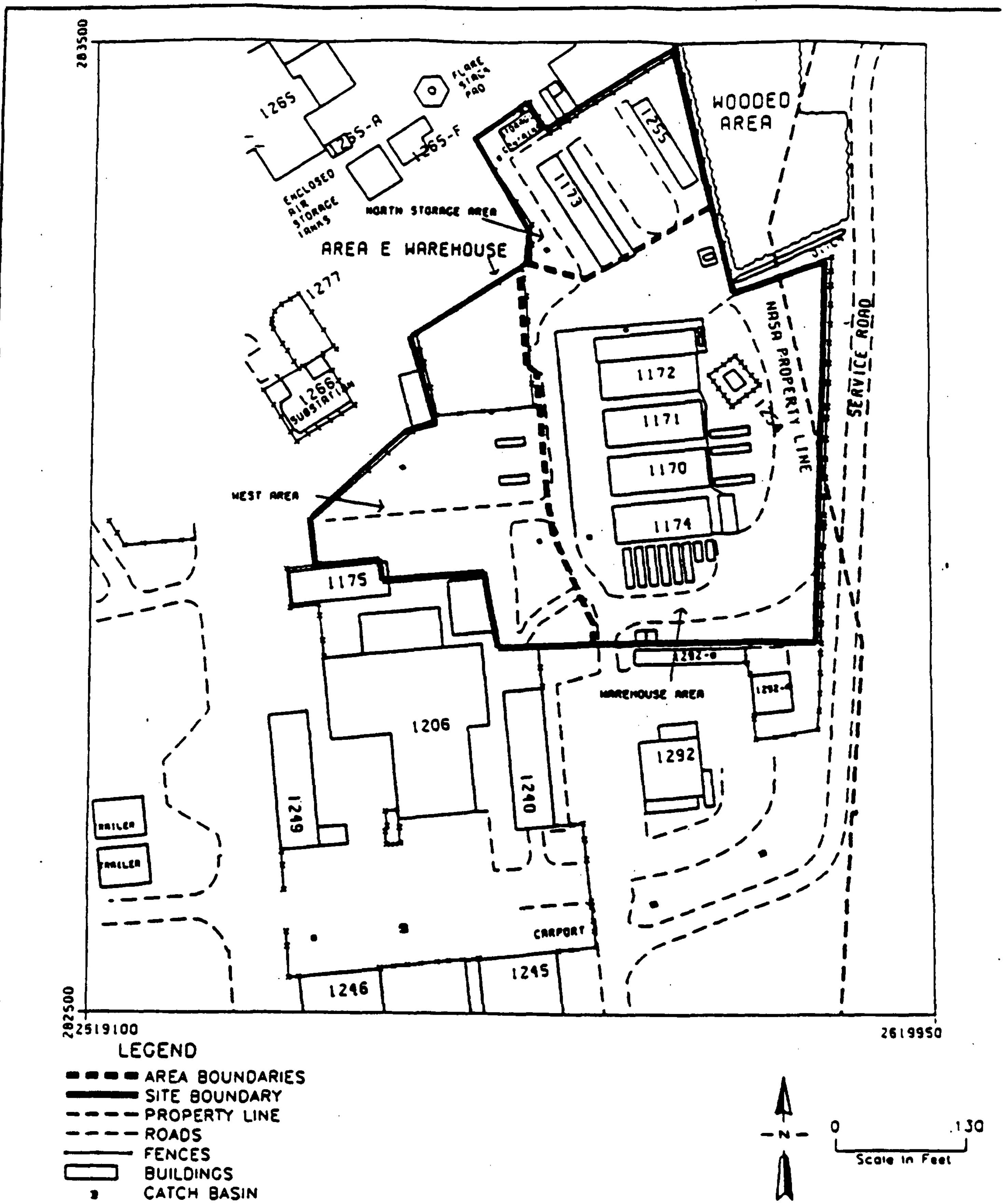


FIGURE 2

AREA E WAREHOUSE LAYOUT

Prepared by: Ebasco Services Inc.

II. SITE HISTORY

This section describes the history of waste disposal, and CERCLA investigations response actions at the Site.

A. HISTORY OF WASTE DISPOSAL

The primary function of NASA LaRC is the research and development of advanced technologies for aircraft and spacecraft. Specific studies center on instrumentation, materials fatigue, acoustics, aerodynamics, and guidance control. In conducting its research and development mission, NASA LaRC requires many support facilities including Underground Storage Tanks (USTs) for fuel and other raw products, power plants, wind tunnels, laboratories and administrative buildings. All of these facilities have the potential to impact the environment through disposal activities, transfer operations and inadvertent releases such as spills or mechanical malfunctions.

There are currently 5 Operable Units being investigated under CERCLA at NASA LaRC. They include: the Construction Debris Landfill, the Chemical Waste Pit, Tabbs Creek, Stratton Substation and Area E Warehouse. A brief summary of these areas is provided on Table 1. Figure 1 provides the location of these areas. The 4 remaining Operable Units will be addressed in future Records of Decision.

Table 1. Summary of Operable Units Under CERCLA Investigations

OU Name	Findings	Current Status
Construction Debris Landfill	Organic and inorganic contaminants found in groundwater, surface water, sediment, and soil.	Draft Remedial Investigation/Feasibility Study (RI/FS) under regulatory review
Chemical Waste Pit	Chemical wastes reportedly buried at the site.	Chemical Waste Pit was found to be located within the boundaries of the Construction Debris Landfill (CDL) OU and is addressed in the CDL RI/FS.
Tabbs Creek	PCB/PCT contamination in sediments.	Final RI/FS completed.
Stratton Substation	PCB contaminated soil.	Draft Final Focused RI/FS currently under regulatory review.

The Area E Warehouse serves as a storage distribution center for all supplies and materials for the NASA LaRC facility. The Area E Warehouse is used by LaRC to store raw products under cover and in original packing for use in day-to-day operational activities and as a staging area and temporary storage for outgoing construction wastes prior to off-site disposal. From the 1960's to 1990, a small outdoor staging area was used for the storage of both hazardous and non-hazardous waste materials. In addition, polychlorinated biphenyl transformers were stored within the Area E Warehouse OU. Past activities have included some on-site spills within the warehouse area.

B. CERCLA INVESTIGATIONS

NASA completed CERCLA Preliminary Assessment (PA) and Site Inspection (SI) Reports in 1988 and 1989, respectively. In 1993, NASA LaRC, together with Langley Air Force Base (LAFB), was proposed for inclusion on the National Priorities List (NPL) and finalized in 1994. A Federal Facilities Agreement (FFA) was signed by EPA, NASA and the Virginia Department of Environmental Quality (VDEQ) in 1994. The FFA establishes a procedural framework and schedule for implementing site cleanups at NASA LaRC (the Site).

NASA has investigated hazardous releases at the Site in multiple investigations. Previous investigations at the Area E Warehouse OU include a Preliminary Assessment (PA) completed in April 1988, a Site Inspection in May 1989 (Ebasco, 1989), a Site Assessment in November, 1990 (Ebasco, 1990), and a Contamination Assessment in October 1992 (Ebasco, 1992). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, mandates that the Environmental Protection Agency (USEPA) establish a docket of federal facilities where hazardous waste has been generated, stored, treated, or disposed in the past. The PA identified the Area E Warehouse as requiring further investigation of past waste handling activities through completion of a Site Inspection (SI).

The SI identified the contaminants of concern at the Area E Warehouse OU as mercury, lead, manganese, and polychlorinated biphenyls (PCBs). Because of the presence of mercury, lead, manganese, and PCBs in Area E Warehouse soil, NASA proceeded with a Site Assessment (SA) to establish the risk posed from the contaminants and to develop a course of action to remove the contaminants from the OU, if necessary.

Consequently, a Contamination Assessment (CA) was conducted to further delineate the extent of PCB contamination at the OU as well as conducting a focused sediment sampling effort in a nearby drainage ditch. In addition an Addendum to the SA was prepared in August of 1995 to clarify the data presentation in the original SA Report.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, NASA, in conjunction with EPA, issued a Proposed Plan on January 26, 1998, presenting the preferred remedial alternative for the Area E Warehouse OU. The Proposed Plan and the supporting documentation became available for review at that time and are among the documents which comprise the CERCLA Administrative Record for NASA LaRC.

The Administrative Record is available for review by the public at the following information repositories:

- Poquoson Public Library
  800 City Hall Avenue
  Poquoson, Virginia.

- Floyd L. Thompson Library
  NASA LaRC
  Hampton, Virginia

An announcement for an availability session, the comment period, and the availability of the Administrative Record for the remedy for the Area E Warehouse OU was published in the Daily Press on January 25, 1998. Additionally, the Notice of Availability was mailed to local municipal and government agencies and residents in the vicinity of the Site.

The public comment period for the Proposed Plan was from January 26, 1998 to March 11, 1998. A public availability session was held at the Virginia Air and Space museum in Hampton, Virginia on February 5, 1998 to inform the public of all the remedial alternatives and to seek public comments. At this meeting, representatives from NASA, USEPA, VDEQ, and Foster Wheeler (an environmental consultant) were available to answer questions about conditions at the site and the remedial alternatives under consideration. Responses to the comments received during this period are included in the Responsiveness Summary section of this ROD.

This Record of Decision presents the selected remedial action for the Area E Warehouse OU in accordance with CERCLA and, to the extent practicable, the National Contingency Plan (NCP).

All documents considered or relied upon in reaching the remedy selection decision contained in this ROD are included in the Administrative Record for the Site and can be reviewed at the information repositories.

IV. SCOPE AND ROLE OF THIS REMEDIAL ACTION

Discrete portions of an NPL site are often managed more effectively as Operable Units. NASA has organized work to date into five operable units. This ROD addresses the Area E Warehouse OU. The remaining Operable Units are:

- Construction Debris Landfill
- Chemical Waste Pit
- Tabbs Creek
- Stratton Substation

These four remaining Operable Units are currently being independently investigated under CERCLA and will be addressed in future Records of Decision.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

Summarized below are the relevant findings of the work to date with regard to contaminated soil located within the boundaries of the Area E Warehouse OU.

A. SITE CHARACTERISTICS

1. Geology

LaRC is situated within the Atlantic Coastal Plain physiographic province, which consists of an eastward thickening sedimentary wedge composed of unconsolidated gravels, sands, silts, and clays, with variable amounts of marine fossils. LaRC is underlain by approximately 2,000 feet of unconsolidated sediments.

The uppermost soil units (excluding fill material) are Holocene age deposits and Pleistocene deposits of the Norfolk Formation. Holocene deposits, consisting of organic clays, silts, and silty clays, are encountered in proximity to the margins of tidal estuaries that border LaRC. These deposits are up to 30 feet thick along the northern border of the facility. Away from the tidal estuaries, surface soils consist of the Norfolk Formation, a member of the Pleistocene Age Columbia Group. Soils of the Norfolk Formation consist of sequences of silt, clay, and silty to clayey sands that are typically dry to moist and slightly to moderately plastic. An erosional surface separates this unit from the underlying Bacons Castle Formation.

The Pliocene Age Bacon Castle Formation, composed of the Moore House Member, occurs at depths of 50 to 60 feet at LaRC. The Moore House Member consists of sequences of silty sands containing marl and shell hash lenses. These marl and hash lenses are absent at some locations. The Mogarts Beach Member of the Yorktown Formation is encountered at depths of 70 to 80 feet. The Mogarts Beach Member is a distinctive hydrologic unit consisting of blue clay of up to 15 feet in thickness; however, it is absent at some locations.

2. Hydrogeology

Groundwater in the area can be found at a depth of 5 to 50 feet below the land surface. This aquifer, known as the Columbia aquifer, is brackish and, its use is limited to lawn and garden watering. Both the Yorktown and the Yorktown-Eastover aquifers underlie the Columbia aquifer. The Yorktown-Eastover aquifer is confined and is used as a source of domestic potable water.

3. Meteorology

The climate at the Site is characterized by mild winters and warm and humid summers. The climate is affected by the Chesapeake Bay and Atlantic Ocean to the east and mountains to the west. During the winter, temperatures reach a high of near 50 with lows in the 30s. In the summer, the highs are generally in the 80s with lows around 70.

The mean annual precipitation at the Site is 44.15 inches. Maximum precipitation occurs in July and August, while the minimum occurs in November and April. However, precipitation is distributed throughout the year. The average number of days with precipitation ranges from 7 to 11 days per month and 110 days per year. Snowfall in the winter averages 10 inches per year, however, it is extremely variable, ranging annually from 0 to 45 inches.

The prevailing wind direction is south-southwest in April and May, southwest in June to September, and north in October to March. The average wind speed is 5 to 8 knots.

4. Ecology

Open land, woodland, wetland and aquatic habitats are all found within or near NASA LaRC. These include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, creeks, tributaries and steams. While the majority of the Area E Warehouse OU is paved/graveled, runoff from the OU flows to a small drainage ditch approximately 120 feet in length and located immediately adjacent to the Area E Warehouse OU. The ditch discharges into the site-wide drainage system which ultimately discharges into the Tabbs Creek estuary. The distance from the drainage ditch to Tabbs Creek is approximately ¼ of a mile.

5. Soils

Soil at the Area E Warehouse OU has generally been graded and/or filled to support buildings and road surfaces. Coarse sand and gravel is found within the upper two feet of the ground surface. Grass covered areas were graded with topsoil and some subsurface soil samples encountered the Norfolk Formation.

6. Groundwater Use

Groundwater in the area can be found at a depth of 5 to 50 feet below the land surface. This aquifer, known as the Columbia aquifer, is brackish and, its use is limited to lawn and garden watering. It is currently not used or usable as a source of potable water. Both the Yorktown and the Yorktown-Eastover aquifers underlie the Columbia aquifer. The Yorktown-Eastover aquifer is confined and is used at other locations as a source of domestic potable water.

B. NATURE AND EXTENT OF CONTAMINATION

In April of 1988 a Preliminary Assessment (PA) was completed for NASA LaRC which included the Area E Warehouse OU. Based on the results of this study a Site Inspection (SI) was completed in May of 1989. The SI recommended that additional sampling and investigation be conducted at the Area E Warehouse OU. NASA proceeded with a Site Assessment (SA) in 1990 to establish the potential risk posed from OU contaminants.

The SA involved the identification and detailed evaluation of potential remedial alternatives and concluded with a recommendation of the preferred remedial alternative.

A Contamination Assessment (CA) was conducted in October 1992 to further delineate the extent of contaminated soil at the OU. A focused sediment sampling effort in the nearby drainage ditch was also conducted in 1994. In addition, an Addendum to the SA was prepared in August of 1995 to clarify the data presentation in the original SA report.

The following is a summary of the sampling results of these investigations.

SOIL

<u>Metals</u>

A total of 47 soil samples [(35 surface soil (0-6 inches) and 12 subsurface soil (6-24")] were collected at the Area E Warehouse for metal analysis during the SA (Figure 3). The metals were characterized using two analytical approaches: the total concentration of inorganic constituents of concern ("Total Metals") in the samples; and the metals concentration in leachate produced by the Toxic Characteristic Leaching Procedure (TCLP).

Lead was detected in ~~all~~ soil samples ranging from 3.1 to 63 mg/Kg. Lead was not detected above twice the background reasonable maximum exposure (RME) (20.7 mg/Kg) level in any of the subsurface soil samples. The RME is the 95% upper confidence limit of the arithmetic mean. In surface soil samples, lead was detected slightly above twice the background in one warehouse area (44 mg/Kg) and two north storage area samples (47 and 63 mg/Kg) obtained from the site. TCLP results for lead were reported in three samples with a range from 0.085 to 0.434 mg/L. The regulatory TCLP limit for lead is 5 mg/Kg.

Trace amounts of mercury were detected above twice the background soil values at the site. The concentrations ranged from non-detected to 2 mg/Kg. No mercury was detected in the TCLP leachate.

Manganese was detected above twice the background soil sample values. Concentrations were reported at 1,100 mg/Kg and 913 mg/Kg in warehouse area surface soil samples, and 1,220 mg/Kg in one subsurface soil collected in the west area of the site. The mean value for manganese concentrations was the highest for the warehouse surface soil samples which was statistically significant. Manganese was not detected above twice the RME in subsurface or surface soil samples collected from the north storage area of the site.

PCBs

Surface and subsurface soil samples were obtained from Area E and analyzed for PCBs during the SI, SA and CA (Figure 4). The result of surface soil samples collected from 2 to 7 inches below grade showed that PCBs were detected in 41 of the 53 surface soil samples. A frequency distribution of these detections includes:

> 1,000 μg/Kg -	10 samples
200 μg/Kg - 1,000 μg/Kg -	11 samples
< 200 μg/Kg -	20 samples

The highest PCB concentration (4,800 μg/Kg) was detected at S-SS-17-01, at the southeast corner of Building 1170. Soil sample SS03-01, which exhibited a PCB concentration of 4,300 μg/Kg, was collected approximately 15 feet west of S-SS-17-01. Soil samples S-SS-02-01 and S-SS-03-01, located northeast of Building 1206, contained PCBs at a concentration of 2,500 μg/Kg and 3,100 μg/Kg, respectively. The geometric mean of PCBs detected in the surface soil is 324 μg/Kg.

A total of 25 subsurface soil samples were obtained from 8 to 55 inches; most samples were between 10 inches and 22 inches. PCBs were detected in 10 of the 25 samples. A frequency distribution of these detections includes:

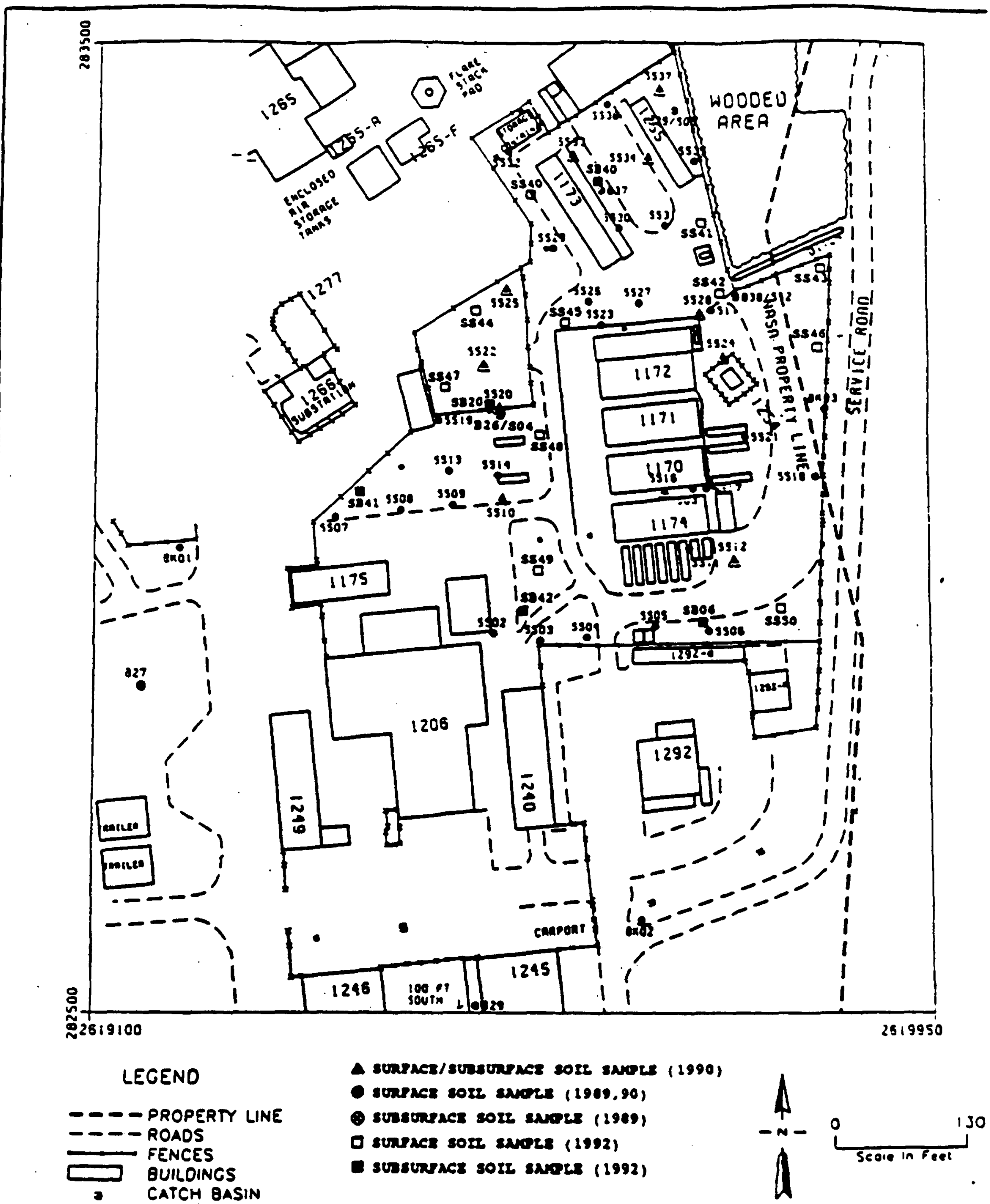
> 1,000 μg/Kg -	2 samples
200 μg/Kg - 1,000 μg/Kg -	4 samples
< 200 μg/Kg -	4 samples

The highest PCB concentration (3,800 μg/Kg) was detected at SB37-01, east of Building 1173, at a depth of 10 inches below grade. The geometric mean of PCBs detected in subsurface soil is 226 μg/Kg.

GROUNDWATER

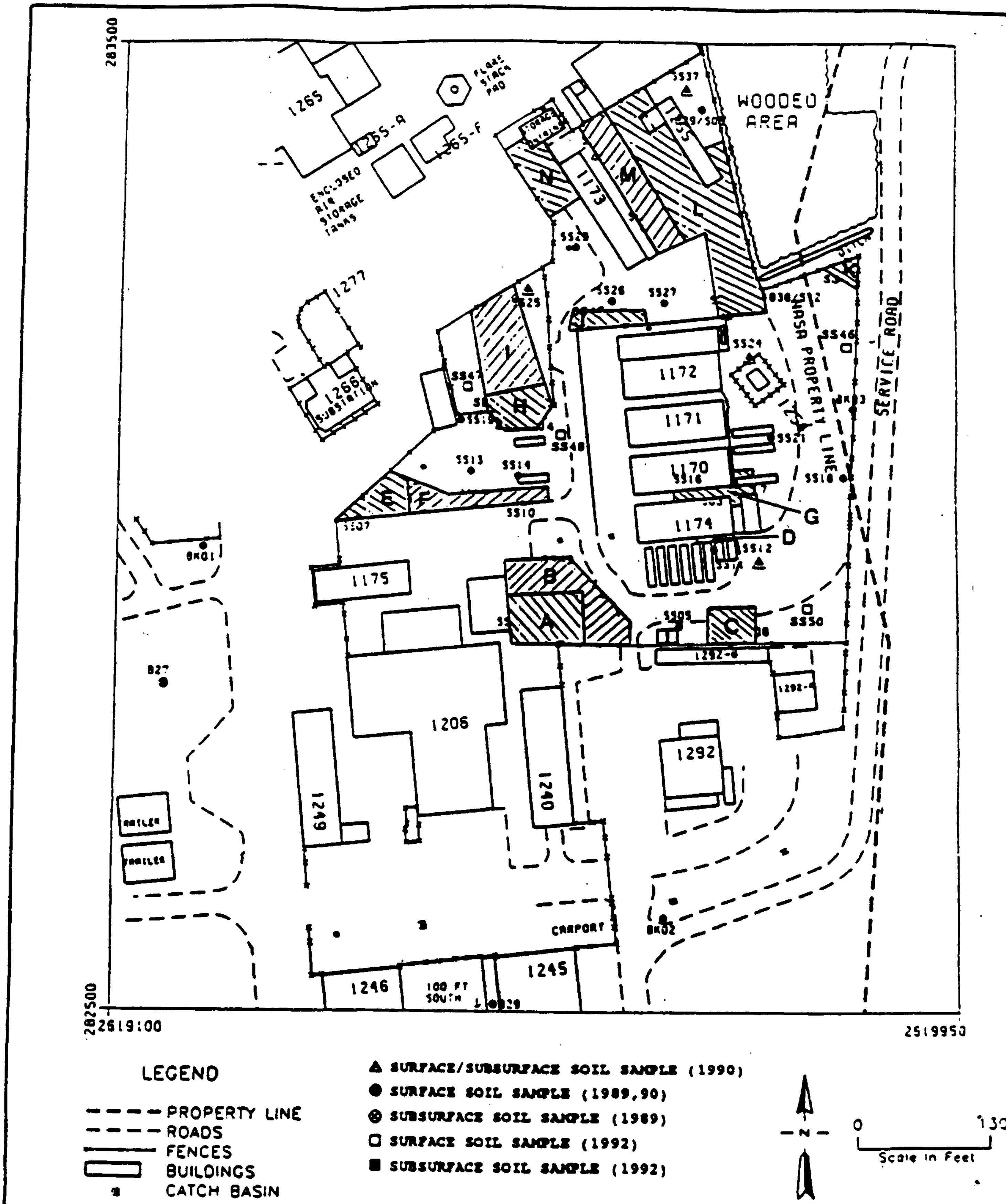
Metals

One groundwater sample was collected from the Columbia aquifer at the west area of the site and was reported with concentrations at 56 and 1,280 μg/L for lead and manganese, respectively. These concentrations, however, are consistent with naturally occurring background levels of these constituents in the area of Area E Warehouse OU and are not attributable to present or past activities at this OU. The mercury result was rejected; however,



NOTE: Prefix B and S for 1989 sample locations
Prefix SS and BK for 1990 sample locations
Prefix SS and SB for 1992 sample locations

FIGURE 3
SOIL SAMPLING LOCATIONS
NASA LARC AREA E SITE
Prepared by: Ebasco services Incorporated



NOTE: Prefix B and S for 1989 sample locations
Prefix SS and BK for 1990 sample locations
Prefix SS and SB for 1992 sample locations

FIGURE 4
AREAS ABOVE 90 ug/kg RISK-BASED LEVEL
NASA LARC AREA E SITE
Prepared by: Ebasco Services Incorporated

the reported value was below the detection limit.

PCBs

Two groundwater samples were collected in the west area of the site (Figure 5). No PCBs were detected.

SEDIMENT

Two surface sediment samples were collected at a depth from 0 to 1 foot from the drainage ditch that drains the stormwater runoff from the Area E Warehouse site (Figure 6). Both locations showed extremely low concentrations of PCBs, 10.1 and 143 μg/Kg, respectively. The results revealed that the migration of PCBs from the site was insignificant.

Contaminant Fate and Transport

The environmental fate and transport of the contaminants present at the Area E Warehouse Site was studied to determine the potential for continued on-site and off-site migration of the contaminants of concern. The results of the study concluded that metals and PCBs exhibit relatively high persistence in the environment of the site. Due to the low solubility of these contaminants in water, low vapor pressure, and strong adsorption to soils, sediments, and organic matter, adsorption is the predominant fate process for the metals and PCBs at the site.

Since the terrain of the site area is flat with a shallow groundwater table below the ground surface, the most probable path of migration for contaminants is into the groundwater. The potential migration of the contaminants was predicted by using the Rapid Assessment Groundwater Model (Donnigian, et al., 1985). The results of the model showed there would be insignificant metal leachate concentrations (approximately 1.6×10^{-31} mg/L) reaching the 3 foot depth in ten years. No Aroclor 1260 would migrate to the depth even when the analysis was extended to 30 years. Aroclor 1260 is one of the major PCB compounds detected in soil of the site. Therefore, the potential migration of the site contaminants to the groundwater system is minimal.

VI. SUMMARY OF SITE RISKS

A risk assessment was conducted in the SA in accordance with the latest EPA policy on Risk Assessments (USEPA, 1989). The results are summarized below.

Human Health Risk Assessment

Health risks are based on a conservative estimate of the potential carcinogenic risk or potential to cause other health effects not related to cancer. Carcinogenic risks and noncarcinogenic risks were evaluated as part of the risk assessment; three factors were considered:

1. nature and extent of contaminants at the OU,
2. the pathways through which human and ecological receptors are or may be exposed to those contaminants at the OU, and
3. potential toxic effects of those contaminants.

For this OU, the human health risk assessment was based on exposure to soil under industrial land use scenarios. Surface water was not evaluated because human health receptors are not exposed to this medium at this OU. In addition, neither organic compounds nor PCBs were detected in groundwater. Only metals were detected in the Columbia aquifer. The detected concentrations, however, are consistent with naturally occurring background levels in the area of this OU and are not attributable to present or past activities at this OU. Even if water from the Columbia aquifer were used for drinking, unacceptable risks would not be expected and, therefore, no action is required for addressing groundwater.

Cancer risks are expressed as a number reflecting the increased chance that a person will develop cancer, if

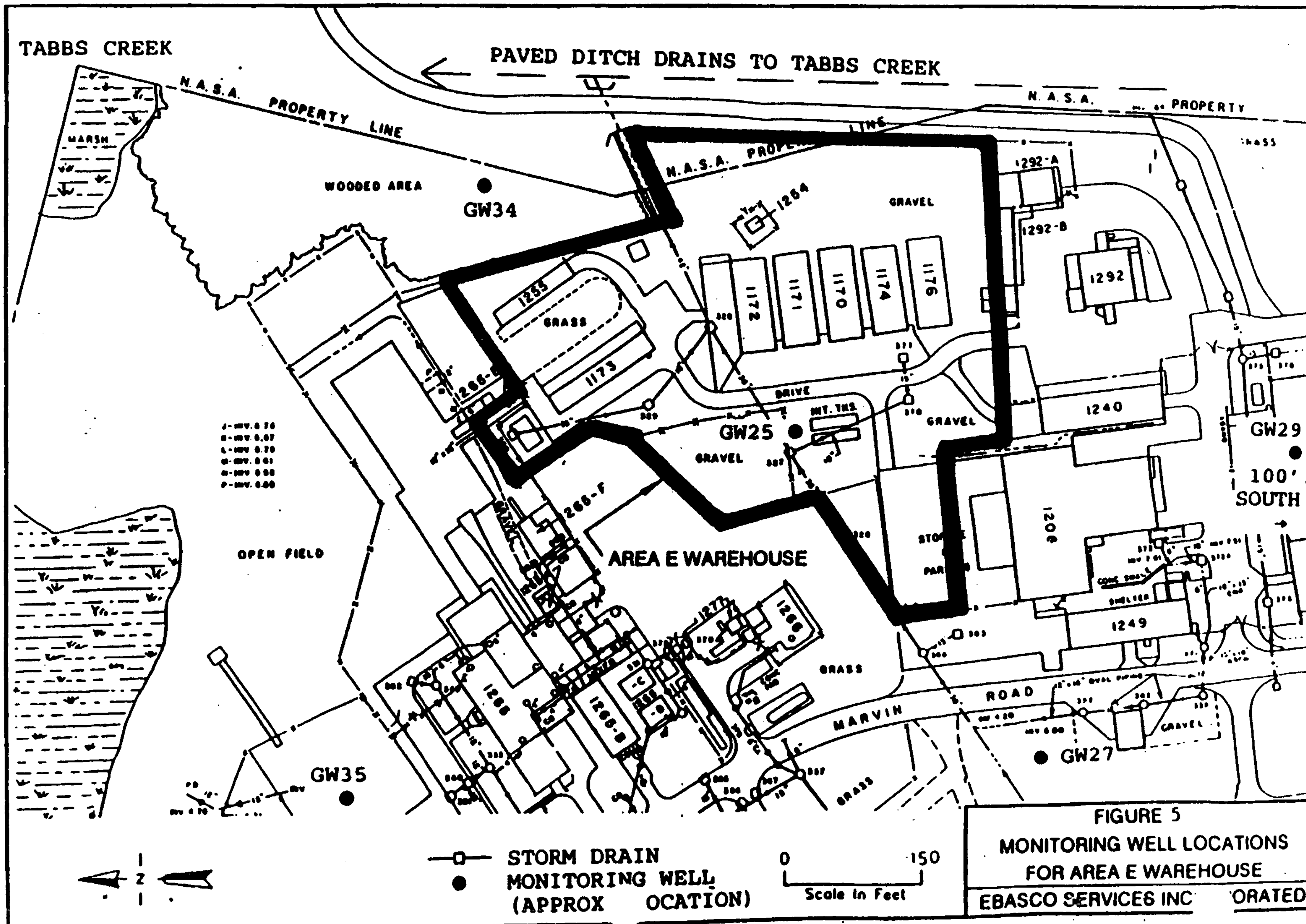


FIGURE 5
MONITORING WELL LOCATIONS
FOR AREA E WAREHOUSE
EBASCO SERVICES INC ORATED

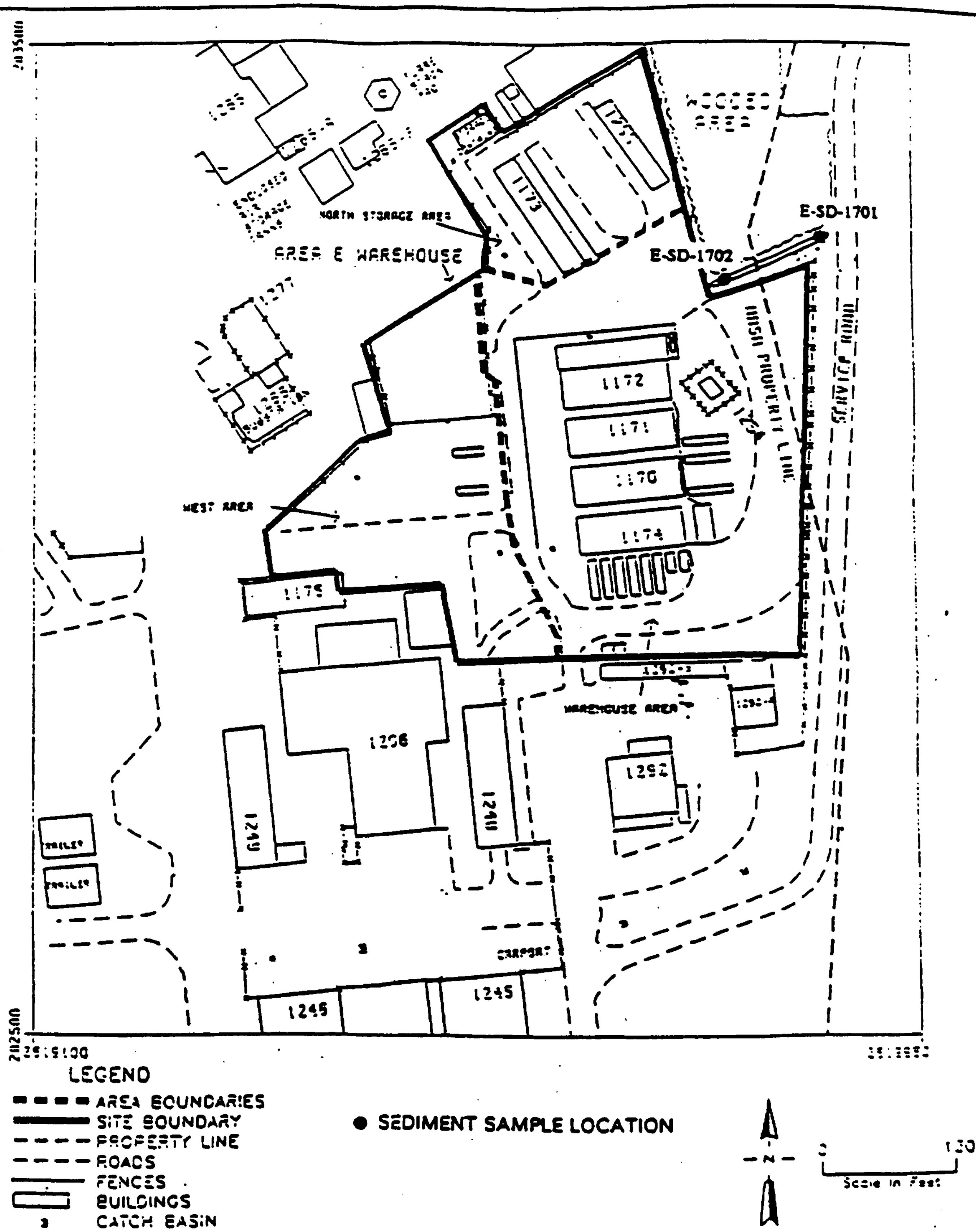


FIGURE 6

AREA E WAREHOUSE SAMPLING LOCATIONS

Prepared by: Ebasco Services Inc.

he/she is directly exposed (i.e., through working at the OU) to the contaminants found in the groundwater, surface water, soil and sediment at the OU for 30 years. For example, EPA's acceptable risk range for cancer is 1×10^{-4} to 1×10^{-6}, meaning there is one additional chance in ten thousand (1×10^{-4}) to one additional chance in one million (1×10^{-6}) that a person will develop cancer if exposed to a hazardous waste site. The risk associated with developing other health effects is expressed as a hazard index. A hazard index of one or less means that a person exposed to a hazardous waste site is unlikely to experience adverse health effects. A hazard index is also used to evaluate ecological risks.

Direct contact, including oral and dermal exposures of contaminated soils, for LaRC workers was calculated for the Risk Assessment. The assumptions and results are presented in Tables 1 and 2. The lifetime cancer risk from PCB exposure for the workers at the Area E Warehouse site is calculated at 4.9×10^{-5}. This lifetime risk is within the EPA's acceptable risk range of 1×10^{-6} to 1×10^{-4}. The HI for the non-carcinogenic risk due to exposure to metals in contaminated soils was estimated to be 0.2, which is below the target of 1.0.

Potential exposures to site-related contamination under future use were also considered. However, it is unlikely that the use of this area will change in the succeeding years as it is a part of a large government-owned research center.

The major uncertainties in the Risk Assessment are the exposure factors (duration and magnitude). Since daily occupation of the warehouse area does not presently occur, the exposure assumption that a worker will be on site each working date and exposed to soil under the exposure conditions each day is conservative. The uncertainty in the risk assessment, based on the given soil concentrations and exposure factors, is estimated to be a factor of ten on the high side.

Ecological Risk Assessment

The two potential pathways for ecological impact identified were through sediment transport of contaminated soils to the estuary and/or groundwater infiltration. Sediment transport is through surface runoff which carries contaminated soil into the storm drain, and ultimately into the estuary. Because of the flat profile of the area, sediment transport is very unlikely. The sediment samples collected from the storm drain adjacent to the site reveal only extremely low levels of PCBs.

Both metals and PCBs exceeded ecological screening levels for soils which suggests potential risk to the environment. Soil screening levels which are exceeded include:

Manganese:	330 ppm
Lead:	10 ppm
Mercury:	0.15 ppm
PCBs:	0.10 ppm

Although soil screening levels have been exceeded in the soil at the Area E Warehouse OU, there is no indication from samples taken in the storm drain or in the estuary that there exists an ecological risk as a result of surface runoff from the site. In addition, because of the current industrial setting of the Area E Warehouse OU it is a very unlikely location for a terrestrial habitat.

CONCLUSIONS

The remedial objective for the Area E Warehouse is to protect human health and the environment. Because the current and anticipated future land use is non-residential, soils were evaluated only for construction worker exposure. As indicated above, the risk posed to the construction worker is within EPA's acceptable risk range, however, actual or threatened releases from hazardous substances may present an imminent and substantial endangerment to public health or welfare under a non-industrial exposure scenario. The specific remedial objective for this operable unit, therefore, is to assure that the property use does not allow non-industrial exposure to the soils.

VII. DESCRIPTION OF ALTERNATIVES

The Site Assessment for the Area E Warehouse OU presents three alternatives that address risks posed by PCBs and metals contaminated soil. The soil remediation technologies were identified and screened using effectiveness and implementability as the criteria. The screening process is described in Table 5. Table 6 summarizes the process options that were screened, including the no-action alternative. Three process options (no-action, gravel/asphalt cap, and off-site landfill) were retained to form alternatives, with two process options retained as support technologies. Using these retained process options, three alternatives: 1) no-action; 2) excavation/off-site disposal; and 3) capping were developed for detailed analysis as follows. In addition, a fourth alternative was developed and discussed in a letter from NASA to EPA and VDEQ. This alternative is a hybrid alternative referred to as institutional controls and was also retained.

Alternative 1 - No Action

The NCP requires that a "no action" alternative be considered to provide a baseline for comparison with action alternatives. Under this alternative, no remedial action would be undertaken at this time to address contaminated soil at the Area E Warehouse OU.

- Capital Cost: $0
- Operations and maintenance (O&M) cost: $0
- Net present worth: $0

Alternative 2 - Excavation and Off-Site Disposal

This alternative involves excavating approximately 3,700 cubic yards of contaminated soil and disposing the material in an approved off-site facility. Upon completion of the excavation, clean material would be used to backfill the excavated areas. The site would be restored back to the original level and condition including regrading to promote drainage and revegetation as appropriate to prevent soil erosion.

Long-term monitoring would not be included with this alternative. A confirmatory sampling program, however, would be undertaken during the remedial action to ensure contaminated soil above the cleanup level has been removed.

- Capital Costs: $1,500,000
- Operations and maintenance (O&M) cost: $0
- Net present worth: $1,500,000

Alternative 3 - Containment

This alternative consists of covering the contaminated areas with clean soil or gravel. If the existing contaminated area is a grassy area, then a 10" top soil cap would be installed. If the existing area is covered with gravel, then the existing gravel should be removed prior to the placement of new gravel or top soil, or alternatively, a 6" layer of asphalt mix shall be placed on top of the contaminated gravel. In addition, this alternative would incorporate institutional controls and a long-term monitoring plan. Also, a confirmatory sampling program would be undertaken during the remedial action to delineate the PCB-contaminated areas to be covered to ensure the effectiveness of the remedy.

- Capital Costs: $168,000
- Operations and maintenance (O&M) cost: $0
- Net present worth: $168,000

Alternative 4 - Institutional Controls

This alternative consists of a use restriction on the property to prevent non-industrial activities (e.g., residential, child care, or recreational uses). These restrictions include: 1) the prohibition of use of the property for purposes other than industrial (e.g., residential, child care, or recreational use); 2) inputting these restrictions in the NASA LaRC Master Plan; 3) within 90 days of ROD signature, NASA shall produce a survey plat prepared by a professional land-surveyor registered by the Commonwealth of Virginia indicating the location and dimensions of the Area E Warehouse Operable Unit and the extent of the soil contamination. The plat shall contain a note, prominently displayed, which states the owner's future obligation to restrict the land use of the property. The plat shall be submitted to the local recording authority; 4) NASA shall incorporate these restrictions and supply a copy of the plat into any real property documents necessary for transferring ownership from NASA, in the unlikely event that NASA sells the property. The real property document would also include a discussion of the National Priorities List (NPL) status of this Site, as well as a description of the soil contamination; 5) The NASA LaRC Environmental Engineering Office Head will certify to USEPA on an annual basis that there have been no violations of these prohibitions. If a violation has occurred, a description of the violation and corrective actions to be taken will be provided.

In addition, the presence of the existing security fence around the OU serves to limit access to the OU. Although the purpose of the fence around the OU is for providing security (its presence and maintenance is not part of this alternative) it also limits the individuals who may be exposed to the contaminated soils by preventing unauthorized access.

- Capital Costs: $2,000
- Operations and maintenance (O&M) cost: $500
- Net present worth: $16,500

The cost figures included here are estimates which reflect a reeavluation of the cost since the release of the Proposed Plan. This difference results from adding extra components to the alternative. See Section XI, Documentation of Significant Changes, below.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against the following nine evaluation criteria: overall protection of human health and the environment; compliance with applicable and relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility and/or volume (TMV); short-term effectiveness; implementability; cost, state acceptance; and community acceptance.

A comparative analysis for the four alternatives based on these evaluation criteria is presented in the following sections.

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1, No Action, provides no reduction in risk to humans and the environment. Alternatives 2 and 3 would provide adequate protection of human health and the environment by eliminating, reducing or controlling risk through removal, engineering controls, or institutional controls. Alternative 4 would prevent exposure through access restrictions and other institutional controls.

B. COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Under Alternatives 2, 3 and 4, all applicable or relevant and appropriate requirements (ARARs), would be met. (Specific ARARs for the remedy in this case are identified in Section X.B. of this ROD).

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 2 would be the most effective since it would permanently remove the contaminated media from the site. Alternative 3, the installation of a cover, although less permanent than alternative 2, effectively mitigates the risk associated with direct contact or ingestion of the contaminated media. The long-term effectiveness will depend on maintenance of the cover and the adherence to imposed land-use restrictions. Since the contaminants would remain on-site, Alternative 3 would provide less protection then Alternative 2. Alternative 1 would not provide added protection from the contaminated soil. Alternative 4 will continue to prevent exposure and prevent unacceptable risk by, among other things, prohibiting a non-industrial use of the property.

D. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME BY TREATMENT

Alternatives 1 and 4 provide no reduction in the contaminant toxicity, mobility or volume of contaminated soil. Alternative 2, excavation and off-site disposal, would effectively reduce the contaminant levels on-site. However, Alternative 2 achieves this goal by moving the contaminated media to another location (off-site landfill) where its mobility is reduced but its toxicity and volume are unchanged. Alternative 3 would reduce the contaminant mobility somewhat through the use of a soil cover, but toxicity and volume would remain the same.

E. SHORT-TERM EFFECTIVENESS

No short-term impacts to human health and the environment are associated with the implementation of Alternatives 1 or 4, no action and institutional controls respectively, because physical remedial actions are not undertaken. For Alternatives 2 and 3, which require excavation or containment, the potential short term risks are those associated with dermal contact with and ingestion of the contaminated soil by workers. NASA, however, would minimize these short-term risks by implementing controls and procedures to ensure, to the greatest extent possible, that such dermal contact and ingestion did not occur. In the cases of these alternatives, workers would be required to wear protective equipment during activities where they may be exposed to hazardous materials. The short-term risk associated with Alternative 2 would be potentially greater than Alternative 3 because of the additional handling of the contaminated soil.

F. IMPLEMENTABILITY

Alternative 1, no action, can be easily implemented because there are no construction, storage, equipment or disposal considerations. Alternatives 2 and 3 (excavation/off-site disposal and containment) each are relatively easy to implement because the required labor, equipment and materials are readily available. However, Alternative 3 may be less implementable because of the change of existing OU topographic features. In addition, Alternative 3 would require a long-term monitoring plan. Alternative 4 involves the restriction of future uses of the OU to industrial activities. Implementation of Alternative 4 is relatively easy.

G. COST

Alternatives 1 has no costs associated with it. Alternative 4, institutional controls, is estimated to cost $16,500. Alternative 3, containment, costs are estimated to be $168,000. Alternative 2, excavation/off-site disposal, costs are estimated to be $1,500,000 and is the most expensive.

H. STATE ACCEPTANCE

The Virginia Department of Environmental Quality concurs with the selection of Alternative 4, institutional controls, as the selected remedy for this OU.

I. COMMUNITY ACCEPTANCE

An availability session on the Proposed Plan was held on February 5, 1998 in Hampton, Virginia. Comments received orally and/or in writing at the availability session are referenced in the Responsiveness Summary (Section XII of this ROD). No written or oral comments were received outside of the availability session during the public comment period.

IX. SELECTED REMEDY

Following review and consideration of the information in the Administrative Record file, requirements of CERCLA and the NCP, and public comments received on the Proposed Remedial Action Plan, NASA and EPA, in consultation with VDEQ, have selected Alternative 4: Institutional Controls as the remedy for the Area E Warehouse Operable Unit. This remedy would prevent unacceptable exposure to contaminated soils.

Based on available information, NASA and EPA believe that the selected remedy would be protective of human health and the environment, would be cost effective, and would provide the best balance of trade-offs among the alternatives with respect to the evaluation criteria.

The selected remedy for the Area E Warehouse OU includes the following major components:

1) the prohibition of use of the property for purposes other than industrial (e.g., residential, child care, or recreational use),

2) inputting these restrictions in the NASA LaRC Master Plan ,

3) within 90 days of ROD signature, NASA shall produce a survey plat prepared by a professional land surveyor registered by the Commonwealth of Virginia indicating the location and dimensions of the Area E Warehouse Operable Unit and the extent of the soil contamination. The plat shall contain a note, prominently displayed, which states the owner's future obligation to restrict the land use of the property. The plat shall be submitted to the local recording authority,

4) NASA shall incorporate these restrictions and supply a copy of the plat into any real property documents necessary for transferring ownership from NASA, in the unlikely event that NASA sells the property. The real property document would also include a discussion of the National Priorities List (NPL) status of this Site, as well as a description of the soil contamination,

5) The NASA LaRC Environmental Engineering Office Head will certify to USEPA on an annual basis that there have been no violations of these prohibitions. If a violation has occurred, a description of the violation and corrective actions to be taken will be provided.

The present worth of this remedy is $16,500.

PERFORMANCE STANDARDS

A prohibition of use of the property for purposes other than industrial (e.g., residential, child care, or recreational use) will be imposed. All use restrictions will be inputted into the NASA LaRC Master Plan. Within 90 days of ROD signature, NASA shall produce a survey plat prepared by a professional land surveyor registered by the Commonwealth of Virginia indicating the location and dimensions of the Area E Warehouse Operable Unit and the extent of the soil contamination. The plat shall contain a note, prominently displayed, which states the owner's future obligation to restrict the land use of the property. The plat shall be submitted to the local recording authority. NASA shall incorporate these restrictions and supply a copy of the plat into any real property documents necessary for transfering ownership from NASA, in the unlikely event that NASA sells the property. The real property document would also include a discussion of the National Priorities List (NPL) status of this Site, as well as a description of the soil contamination. In addition, the NASA LaRC Environmental Engineering Office Head will certify to USEPA on an annual basis that there have been no violations of these prohibitions. If a violation has occurred, a description of the violation and corrective actions to be taken will be provided.

A 5-year review will be conducted in order to evaluate continuing protectiveness of human health and the environment. Each required 5-year review will culminate in the preparation of a report. Specifically, the effectiveness of the selected remedy will be reviewed, and a determination will be made as to whether adverse changes in risk have occurred at the Area E Warehouse OU. The effectiveness of use restrictions will be evaluated and changes may be recommended at that time.

X. STATUTORY DETERMINATIONS

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy, Alternative 4, would protect human health and the environment by preventing exposure through the use restrictions and other institutional controls.

B. COMPLIANCE WITH ARARS

The selected remedy will comply with all ARARs

1. Chemical-Specific ARARs

There are no chemical-specific ARARs for the selected remedy.

2. Location-Specific ARARs

There are no location-specific ARARs for the selected remedy at this OU.

3. Action-Specific ARARs

There are no action-specific ARARs for the selected remedy.

C. COST EFFECTIVENESS

The selected remedy is cost-effective. The present worth cost of Alternative 4 is $16,500.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective and timely manner. Of those alternatives that are protective of human health and the environment and comply with ARARs, the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability and cost, while also considering the statutory preference for treatment as a principal element and considering state and community acceptance: The selected remedy addresses the principal threats posed by contaminated soils given the reasonably anticipated future use of the site.

E. PREFERENCE FOR TREATMENT AS A PRINCIPLE ELEMENT

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Treatment remedies were not considered because of low levels of contamination. Although no active treatment is employed with the selected remedy, the selected alternative would limit exposure to contaminated soils.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The preferred alternative in the Proposed Plan was Alternative 4: Institutional Controls. The only significant changes to the proposed alternative described in the Proposed Plan is the addition of the survey plat requirement, incorporation of these restrictions into the NASA LaRC Master Plan and the annual reporting on the continued application of the institutional controls.

XII. RESPONSIVENESS SUMMARY

A. OVERVIEW

In a Proposed Plan released for public comment on January 26, 1998, NASA, with the support of EPA, identified Alternative 4 as the preferred remedial alternative for the Area E Warehouse OU at the Site. Alternative 4 in the Proposed Plan was as described in Section VIII, with the additions discussed in Section XI.

There were no written comments received as a result of the public comment period. There were written comments submitted during the February 5, 1998 availability session. After evaluating and addressing these comments, NASA and EPA have decided to select Alternative 4 as the remedy for the Area E Warehouse OU. Comments and the associated responses of NASA and EPA are described below after a brief discussion of community involvement to date.

B. COMMUNITY INVOLVEMENT TO DATE

NASA and EPA established a public comment period from January 26, 1998 to March 11, 1998 for interested parties to comment on the Proposed Plan, the Site Assessment, Contamination Assessment, focused sediment sampling reports and other documents pertaining to the Area E Warehouse OU. These and all other documents considered or relied upon during the remedy selection process for the Area E Warehouse OU are included in the Administrative Record, which has been in two information repositories accessible to the public since the beginning of the public comment period for the Area E Warehouse OU. An availability session was held at the Virginia Air and Space Museum, Hampton, Virginia on February 5, 1998, to present the Proposed Plan, answer questions, and accept both oral and written comments on the Area E Warehouse OU remedial alternatives. One person attended this session.

This Responsiveness Summary, required by CERCLA, provides a summary of citizens' comments identified and received during the public comment period and the responses of NASA and EPA in selecting the remedy for the Area E Warehouse OU. Responses to these comments are included in the section below.

C. SUMMARY OF COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD AND COMMENT RESPONSES

Comment #1:

My particular question was about the plan to test Tabbs Creek over the years in the future. I was told that this testing of biota would occur 2-4 times per year over the next five years. I agree this is good, but 5 years may be too short - term; should be a long range plan as well.

Response #1:

The Tabbs Creek OU will be addressed in a future Proposed Plan and ROD. A monitoring plan will be included in any remediation that may take place in Tabbs Creek. The details of the monitoring have yet to be developed. This concern will be considered at that time.

Comment #2:

Groundwater may be contaminated in the future, so the suggestion to preclude the use of groundwater in the future should be implemented.

Response #2:

Groundwater at the Area E Warehouse OU does not currently pose a threat to human health or the environment. Upon completion of the studies at the remaining OUs, a determination will be made on what actions if any are necessary to address groundwater.

REFERENCES

Anderson, E.N., S. Browne, Duletsky, and T. Warn (1984). Development of Statistical Distribution or Ranges of Standard Factors Used in Exposure Assessments. Draft Final Report prepared for USEPA, Office of Health Environmental Assessment under Contract No. 68-02-3510.

Donnigian Jr., Anthony S., T.Y. Richard Lo, and W. Shanahan (1985). "Rapid Assessment of Potential Ground Water Contaminations. EPA Report. Contract No. 68-03-3116.

Ebasco, 1988. "Preliminary Assessment Report For Langley Resource Center."

Ebasco, 1989. "Report of Site Inspection, NASA, Langley Resource Center."

Ebasco, 1990. "Area E Warehouse Site Assessment, LaRC, Hampton, VA."

Ebasco, 1992. "Final Contamination Assessment Report, Area E Warehouse, LaRC, Hampton, VA."

U.S. Environmental Protection Agency, 1990. "Guidance on Remedial Actions for Superfund Sites with PCB Contamination." EPA 540 G-90-007. August.

U.S. Environmental Protection Agency, 1989. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual." OSWER Directive 9285.7-01a, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency, 1988. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA." Interim Final.

APPENDIX A

TABLES

TABLE 2
EXPOSURE AND INTAKE ASSUMPTIONS FOR
DERMAL CONTACT AND INGESTION
NASA LANGLEY RESEARCH CENTER

	Workers
Age Group	18-70
Dermal Exposure to Soil (day/year)	78
Duration of Exposure (years)	44
Frequency of Exposures (Days/yr)	244
Dermal Soil Deposition (mg/cm^2)	1.4
Skin Surface Area Exposed (cm^2)	3,600
Dermal Absorption Factors:	
PCBs	12%
Metals	1.0%
Gut Absorption Factors:	
PCBs	50%
Metals	50%
Soil Ingestion (mg/day)	100

Sources: Skin surface areas exposed are from Anderson, et. al., (1984); other parameter values were derived as described in the SA report.

TABLE 3
AREA E WAREHOUSE
HAZARD INDEX AND EXCESS CANCER RISK
LANGLEY RESEARCH CENTER

Non-Carcinogenic Effects:

CDI(D)(mg/kg/day) = C(mg/kg) * DR(mg/cm^2) * AFd * SA(cm^2) * DE/365(days/days) * 10^-6(kg/mg) / BW(kg)

CDI = CDI(D) + CDI(I)   CDI(I)(mg/kg/day) = C(mg/kg) * Ie(mg/day) * AFI * DE/365(days/days) * 10^-6(kg/mg) / BW(kg)

Compound	Soil Conc. (mg/kg)	AF's ed/100 AFd	AFi	Dermal Dep. Rate (mg/cm^2)	RfD (mg/kg/day)	Chronic Daily Intake and Risk for Age Group (years): West CDI	West CDI/RfD	Warehouse CDI	Warehouse CDI/RfD	North CDI	North CDI/RfD
	Soil Conc. (mg/kg) Pb ====================>					2.4E+01		1.9E+01		3.7E+01	
	Mn ====================>					4.0E=02		6.5E+02		4.3E+02	
	Hg ====================>					5.0E-01		4.0E-01		7.3E+00	
Lead		0.01	0.50	1.4E+00	1.4E-04	4.3E-06	3.0E-02	1.0E-05	7.2E-02	1.3E-05	9.4E-02
Manganese		0.01	0.50	1.4E+00	2.0E-01	7.1E-05	3.5E-04	3.5E-04	1.7E-03	1.5E-04	7.7E-04
Mercury		0.01	0.50	1.4E+00	3.0E-04	8.9E-08	3.0E-04	2.1E-07	7.0E-04	7.0E-04	8.6E-03
				Hazard Index ==========>			3.1E-02		7.4E-02		1.0E-01

TABLE 3 (Continued)
AREA E WAREHOUSE
HAZARD INDEX AND EXCESS CANCER RISK
LANGLEY RESEARCH CENTER

Area E Warehouse/Surface Soil				
	Area of Exposure =====>	West	Warehouse	North
Exposure Route: Soil (Dermal Contact & Accidental Ingestion)	Exposure Factors:			
	% Time Exposed per area	20%	40%	40%
	Days Exposed (per year)	220	220	220
Scenario: Long-Term Representative Exposure	Fractional days per year	44	88	88
Source: Surface Soil (Present and Future)	Years Exposed (per 70 year life)	42	42	42
Receptor: LARC Workers	Body Weight (kg) Soil Ingestion (mg/day) Surface Area Exposed (cm^2)	70 100 3,800	70 200 3,800	70 100 3,800

Carcinogenic Effects:

CDI = CDI(D) + CDI (I)

CDI(D)(mg/kg/day) = C(mg/kg) * DR(mg/cm^2) * AFd * SA(cm^2) * DE/365(days/days) * YE/70(years/years) * 10^-6(kg/mg) / BW(kg)

CDI(I)(mg/k) CDI(I)(mg/kg/day) = C(mg/kg) * Ie(mg/day) * AFI * DE/365(days/days) * YE/70(years/years) * 10^-6(kg/mg) / BW(kg)

Compound	AF's % Absorbed		Dermal Dep. Rate	CPF (1/(mg/kg/day))	Chronic Daily Intake and Cancer Risk for Age Group (years):						Lifetime Risk
					--------- West ---------		------ Warehouse ------		--------- North ---------		
	AFd	AFi	(mg/cm^2)		CDI	Risk	CDI	Risk	CDI	Risk	
	Soil Conc. (mg/kg)		============>		1.2E+00		1.2E+00		1.1E+00		
PCBs	12%	50%	1.4E+00	1.2E+01	8.4E-07	9.7E-06	1.8E-06	2.1E-05	1.6E-06	1.9E-05	4.9E-05
			Total Risk ========>			9.7E-06		2.1E-05		1.9E-05	4.9E-05

TABLE 4
CLEAN-UP SOIL CONCENTRATION
AREA E WAREHOUSE/SURFACE SOIL
NASA LANGLEY RESEARCH CENTER

Exposure Route: Soil (Dermal Contact & Accidental Ingestion)	Area of Exposure =========>	West	Warehouse	North
	% Time exposed per area	20%	40%	40%
	Days Exposed (per year)	220	220	220
Scenario: Long-Term Representative Exposure	Fractional days per year	44	88	88
Source: Surface Soil (Present and Future)	Years Exposed (per 70 year life)	42	42	42
Receptor: LaRC Workers	Body Weight (kg)	70	70	70
	Soil Ingestion (mg/day)	100	200	100
	Surface Area Exposed (cm^2)	3,800	3,800	3,800

Carcinogenic Effects: CDI = CDI[D] + CDI[I]

CDI[D](mg/kg/day) = C(mg/kg) * DR(mg/cm^2) * AFd * SA(cm^2) * DE/365(days/days) * YE/70(years/years) * 10^-6(kg/mg) / BW(kg)

CDI[I](mg/kg/day) = C(mg/kg) * Is(mg/day) * AFi * DE/365(days/days) * YE/70(years/years) * 10^-6(kg/mg) / BW(kg)

Compound	AF's % Absorbed		Dermal Dep. Rate	CPF (1/(mg/kg/day))	Chronic Daily Intake and Cancer Risk for Age Group (years):						Lifetime Risk
					---------- West ----------		------- Warehouse -------		---------- North ----------		
	AFd	AFi	(mg/cm^2)		CDI	Risk	CDI	Risk	CDI	Risk	
	Soil Conc. (mg/kg)		============>		9.0E-02		9.0E-02		9.0E-02		
PCBs	12%	50%	1.4E+00	7.7E+00	6.4E-08	4.9E-07	1.4E-07	1.1E-06	1.3E-07	9.9E-07	2.5E-06
			Total Risk	========>		4.9E-07		1.1E-06		9.9E-07	2.5E-06

TABLE 5
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
No-Action	The site is not remediated in any way. Low level of contaminants remain on site.	Carcinogenic risk is within EPA's acceptable lifetime risk range 1×10^{-6} to 1×10^{-4}.	Easily implemented. Cost: Low	Retained for further consideration.
Limited Action: Monitoring	Perform periodic analysis of site soils to monitor concentrations and extent of contamination.	Effective for monitoring levels of soil contamination and migration. However, due to the low levels of soil contamination, it is unlikely that PCBs would migrate to groundwater or surface water at levels posing significant threats.	Easily implemented. Cost: Low/Moderate	Eliminated as long as the site use is kept the same.
Capping: Gravel/Asphalt Cap	Cover contaminated soil with a single layer of asphalt or gravel.	Reduces mobility of contaminants and risk of direct contact; however, contaminants remain on-site and may be exposed from erosion/rutting.	Construction is relatively easy. Change in elevation due to installation of cap may change the drainage pattern of the area. Cost: Low/Moderate	Retained for further consideration.
RCRA Cap	Cover contaminated soil with a multi-layer cap consisting of top soil, synthetic membranes, impermeable soil, and drainage layer.	• Reduces mobility of contaminants and risk of direct contact; however, contaminants remain on-site. • Meets RCRA requirements. • RCRA system is reliable since cracking is minimized. • RCRA system is reliable for reducing infiltration; however, it is no more reliable than a non-RCRA system for reducing contact risks.	• Construction requires multiple steps and is time consuming. • More periodic maintenance required than with non-RCRA layer cap. • Heavy vehicular traffic on-site may have adverse effect on RCRA cap. • Change in elevation due to installation of cap would limit current use of property. Cost: High	Eliminated due to special site constraints.
Removal: Excavation	Contaminated soil would be removed with common construction equipment.	• Effective at removing contaminated soil. • Requires further treatment/disposal. • Will not reduce volume or toxicity of contaminated soil.	• Technically feasible. • Can be done using common construction equipment. Cost: Low	Retained for further consideration as a support technology.

TABLE 5 (Continued)
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
Physical Treatment: Solid Processing	Consists of physically sorting and/or modifying the size and distribution of the soil that may be excavated.	• Does not reduce toxicity or mobility of contaminants, but may reduce volume of contaminated material. • May enhance subsequent treatment by increasing the specific surface area of the soil. • More of a pretreatment than a treatment.	• Requires significant materials handling. • Is required as a pretreatment for many alternatives. Cost: Low	Eliminated. Treatment of soil not required.
Physical Treatment: Dewatering	Process to remove excess (free) liquid from saturated materials prior to treatment.	• Effectively dewaters materials for subsequent treatment. • Support technology. • Does not reduce mobility or toxicity of handled materials. May result in significant reduction in water content. • May be required prior to some treatment or disposal technologies.	• Implementability of dewatering methods may be difficult due to limited available staging areas. • Treatment of drained water, if required, would require off-site handling and disposal. Cost: Low	Eliminated. Excavation is limited to unsaturated zone.
Solvent Extraction: *In-Situ* Soil Flushing	Contaminants are removed from soils via *in-situ* solvent infiltration. Contaminated solvents are recovered for subsequent treatment and/or disposal.	• Organic solvent used for PCB extraction may be considered hazardous. • Individual contaminants may require separate solvents. • Reduces volume of contaminants in soils; however, produces large volumes of contaminated solvents which require collection and treatment. • Reliability of complete contact with all contaminated soils is questionable. • Achievable level of contaminant removal may not be adequate to attain necessary action levels.	• Typically complex processes, difficult to implement. • Potential for loss of solvents during implementation. • Pilot testing required. • Requires special provisions (i.e., sheet piling) to ensure complete collection of contaminated solvents. • Collection of all flushing solvent may be extremely difficult. • Collected solvents require treatment to reduce toxicity. Cost: Moderate	Eliminated due to potential for adverse environmental effects and anticipated difficulty in implementation.

TABLE 5 (Continued)
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
TEA Extraction	Extraction of organics from excavated soils is achieved by contacting the soils in a reaction vessel with a triethylamine (TEA) solvent to extract chemicals.	• Produces small quantity of high concentration residual for disposal. • Pilot test data for PCB treatment is available for soils, sediments, and sludges. • Site concentrations may make achieving action levels difficult.	• Typically complex processes, difficult to implement. • Pilot tests required. • Commercially available but limited supply of units. • Excavation and dewatering required. • Potential for release of contaminants. • Collected dewatering liquids require treatment. Cost: Moderate	Eliminated due to inability of technology to reach action levels for PCBs.
Critical Fluid Extraction	Fluids in their critical state are used to extract organics from excavated soil. Process used in laboratory and industry to remove PCBs from transformer oil.	• Achievable level of contaminant removal may not be sufficient to attain action levels. • Still in bench/pilot stage for solids. • Reduces TMV of contaminants. • Requires further treatment of small volume/high concentration residual waste.	• May be difficult to implement. • Availability uncertain since in early stage of development. Cost: Moderate	Eliminated due to difficulty of technology to reach action levels for PCBs.
Fixation/Stabilization: Solidification	Addition of pozzolanic reagents to create a non-leachable material which is easier to handle.	• Effectiveness varies with reagents used. • Pilot tests required to evaluate reduction mobility. • Does not reduce the toxicity of contaminated material and results in a volume increase. • May not be effective in immobilizing PCBs. • Effective in stabilizing inorganics in matrix.	• Volume of immobilized soil may be increased by 40% due to addition of solidifying agent. • Requires skilled labor, as it may be a complex process. • Site space constraints associated with batch mixing should be considered. • Dewatering of wastes is not required. • Long-term effectiveness must be evaluated by monitoring. Cost: Moderate	Eliminated due to unproven effectiveness in immobilizing PCBs at the site.

TABLE 5 (Continued)
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
Biological Treatment: Liquid-Solids Contact *In-Situ* Treatment Land Application	Bacteria are used to degrade specific organic contaminants. May be performed *in-situ*, or in a batch reactor after excavation.	• Laboratory demonstrations have shown PCB compounds to be biodegradable. Mercury may be toxic and inhibit growth. Treatment of organics only. • PCB breakdown in the range of 40 to 90 percent may be achievable. • Bench scale testing and pilot study required. • Biological treatment has resulted reduction of PCBs to less than 1 ppm in <u>some</u> bench scale tests. • Reaction products have not been characterized and the effectiveness of these methods is controversial.	• Specific work with biological degradation of PCBs is still experimental. • May produce waste residuals requiring further treatment and/or disposal. • Process has not been developed sufficiently to permit accurate prediction of effectiveness. <u>Cost</u>: Moderate	Eliminated due to experimental nature, lack of pilot scale data, and probability of not meeting the action levels for PCB contaminated soil.
Chemical Treatment: Ultraviolet (UV) Oxidation	Contaminated solids are fed as a slurry into a mixing tank, where ozone is added and the mixture is simultaneously exposed to ultraviolet radiation and ultrasonic energy. The ultrasonic energy aids in extraction of PCBs from the solids, and UV/ozone irradiation results in destruction of PCBs.	• This technology may destroy PCBs associated with soils as low as 2 ppm. • Reduces toxicity of contaminants. • Bench scale testing and pilot study required to determine actual cleanup levels that can be achieved. • Has not been proven to work directly on solids. May work if PCBs are in water; however, PCBs are not readily available.	• Availability of process is limited, as it is still in its experimental stages. • Pilot study will probably be required. • Site space constraints associated with soil excavation should be considered. • Very little work has been done in this area. <u>Cost</u>: High	Eliminated due to experimental nature of process and lack of available pilot test equipment and data.
Chemical Treatment: Dechlorination with Potassium Polyethylene Glycol (KPEG) Reagent	KPEG reagent (a mixture of polyethylene glycol, potassium hydroxide, and DMSO) is mixed at a 1:1 ratio with contaminated soil in a batch treatment reactor. The reagent mixture is heated and refluxed until reaction is complete. Reaction products are KCl and non-chlorinated biphenyls. May apply directly to soil slurry mixture or as solvents used to extract PCBs from soil.	• Has been used in bench scale test to treat PCB contaminated soil to less than 2 ppm. • Pilot testing of KPEG has been successful to less than 5 ppm PCBs. • Cannot obtain 90 ppb risk-based cleanup level.	• Pilot tests currently underway at a number of sites. • Site space constraints associated with treatment and excavation should be considered. • Dewatering of soil may be required to prevent deactivation of reagent.	Eliminated due to inability of technology to reach risk-based action levels for PCB.

TABLE 5 (Continued)
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
Thermal Treatment: Off-site Incineration	Two types of off-site incinerators are available: rotary kiln and infrared systems. Rotary kiln introduces waste and auxiliary fuel at the high end of the kiln; wastes are thermally destroyed as they rotate through the kiln. Infrared consists of a primary chamber of carbon steel lined with layers of light-weight ceramic fiber blanket. The infrared energy is provided by silicon carbide-resistant heating elements. The material to be processed is conveyed through the furnace.	• Performance data for incinerators are well-demonstrated with high efficiency for destroying organic wastes. • Will achieve target cleanup levels. • Performance data are reliable. • Process will generate clean soil and only a minimal amount of ash residue, which would be handled by the incineration facility. • Reduces TMV. • Is not effective for inorganics treatment. • Dewatering of soils may be required.	• Currently approximately four operating facilities are located in the U.S. All four facilities are running at capacity. Capacity is therefore limited. • Excavation, drumming, loading, and transportation are necessary. Cost: High	Eliminated due to cost ineffective!
On-Site Incineration	Same as off-site, except that a mobile incinerator would be located at the Area E Warehouse site.	• Performance data for incineration are well-demonstrated with high efficiency for destroying organic wastes. • Will achieve target cleanup levels. • Reliability in the field has not been well-demonstrated. Currently has been used at only a few waste sites. • Reduces TMV. • Is not effective for metals treatment. • Pre-treatment of soil may be required.	• Mobile and transportable units are available for on-site incineration. • On-site incineration requires permitting if a permanent facility is to be built. A mobile incinerator does not require permitting if it is constructed and operated on-site. • Air pollution control equipment is typically required. • Ash from on-site incineration must be delisted or placed in a RCRA facility. • Site space constraints associated with treatment and excavation should be considered. Cost: High	Eliminated due to high cost.
Thermal Treatment: Vitrification	Electrodes inserted into soil (*in-situ*) containing significant levels of silicates. Graphite is placed on the soil surface to connect the electrodes. The heat generated from this system causes a melt that gradually works downward through the soil. Inorganics are trapped in the melted silicates that cool to a form of obsidian (i.e., very strong glass). Other organics are thermally destroyed in the process.	• Highly effective in reducing toxicity, mobility and volume of contaminants. • Destroys organic contaminants and binds other contaminants in glass-like mass. • Unproven in large-scale applications for PCBs at hazardous waste sites.	• Commercial mobile treatment units are not currently available. • Electricity source is needed. • Can be used in most soils with moderately low permeabilities (< 10E-5 cm/sec). Cost: High	Eliminated due to unproven status and lack of large-scale application for PCB treatment

TABLE 5 (Continued)
SCREENING OF SOIL REMEDIAL TECHNOLOGIES
AREA E WAREHOUSE SITE
NASA LANGLEY RESEARCH CENTER

Technology Type: Process Option(s)	Description	Effectiveness	Implementability	Status
Thermal Treatment: Low-Temperature Thermal Extraction	Organic wastes are removed from soil by introducing heated air into a reactor with the soil to strip contamination from soil. Excavation is required for treatment.	• Has been demonstrated to remove certain organics from solids. • Not proven and not likely to remove PCBs and other non-volatile contaminants. • Another technology would be required to destroy organics removed. • Reduces volumes of waste.	• Implementable. Could be constructed on-site or preassembled mobile units could be transported to the site. • Site space constraints associated with excavation should be considered. • May be used in association with other treatment processes. Cost: High	Eliminated due to inability to effectively treat PCBs and inorganics.
On-Site Disposal: On-Site Landfill	Soil from contaminated areas are excavated and disposed of in an approved facility constructed on-site.	• Reliable method to contain wastes. • Volume or toxicity of waste is not reduced. • Protective by reducing direct exposure to contaminated materials.	• Water-saturated materials would require either solidification or dewatering prior to landfilling. • Continued maintenance and long-term monitoring are requiring. • Potential long-term liability for waste remaining on-site. Cost: Moderate	Eliminated due to site location considerations, including lack of sufficient space.
Off-Site Disposal: Off-Site Landfill	Wastes with PCBs <50 ppm are excavated, transported, and disposed of at a Virginia Department of Waste Management approved off-site landfill.	• Effective in reducing direct contact risk. • Volume or toxicity of waste is not decreased. • Exposure to soil during excavation and transportation could pose a health hazard.	• Requires transportation. • Potential for long-term liability for waste placed in landfill. • Off-site landfill capacity is limited. • Increased risk of exposure during excavation/transportation. Cost: Moderate	Retained for further consideration.

TABLE 6
SUMMARY OF ALTERNATIVE SCREENING
SOIL REMEDIAL TECHNOLOGIES
NASA AREA E WAREHOUSE SITE ASSESSMENT

General Response Actions	Remedial Technology Types	Process Options	Status
No-Action		No-Action	Retained
Limited Action	Monitoring	Monitoring	Eliminated
Containment Actions	Capping	Gravel/Asphalt Cap	Retained
		RCRA Type	Eliminated
Removal Actions	Excavation	Excavation	Retained*
Treatment Actions	Physical Treatment	Solids Processing	Eliminated
		Dewatering	Eliminated
	Solvent Extraction	*In-Situ* Soil Flushing	Eliminated
		TEA Extraction	Eliminated
		Critical Fluid Extraction	Eliminated
	Fixation/Stabilization	Solidification	Eliminated
	Biological Treatment	Liquid-Solids Contact	Eliminated
		In-Situ Treatment	Eliminated
		Land Application	Eliminated
		UV/Oxidation	Eliminated
	Chemical Treatment	Dechlorination KPEG	Eliminated
	Thermal Treatment	Off-Site Incineration	Eliminated
		On-Site Incineration	Eliminated
		Vitrification	Eliminated
		Low Temperature Thermal Extraction	Eliminated
Disposal Actions	On-Site Disposal	On-Site Landfill	Eliminated
	Off-Site Disposal	Off-Site Landfill	Retained

Note: * = As support technology