EPA-906-R-96-001

MIDLOTHIAN CUMULATIVE RISK ASSESSMENT

Multimedia Planning and Permitting Division
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, TX 75202

January 31, 1996

MIDLOTHIAN CUMULATIVE RISK ASSESSMENT

VOLUME I

Multimedia Planning and Permitting Division
U.S. Enviromnental Protection Agency
Region 6
1445 Ross Avenue
Dallas, TX 75202

January 31, 1996

EXECUTIVE SUMMARY

This report presents the results of a multi-source, multi-pathway risk assessment that estimates the cancer risk and potential non-cancer health effects associated with emissions from Chaparral Steel Company, North Texas Cement Company, Texas Industries, and Holnam Texas, L.P. The conclusions of the risk assessment are as follows.

1. Available site data show that there are no cancer risk or the potential for non-cancer health effects above regulatory levels of concern even though conservative, theoretical models estimate exposures equal to or slightly above threshold levels for potential non-cancer health effects.

2. Theoretical exposures equal to or greater than threshold levels for potential non-cancer health effects result predominately from Chaparral Steel Company, not the three cement manufacturing companies.

The area subject to this study is located approximately 30 miles south of the Dallas-Ft. Worth metropolitan area. From Texas Industries (see Map 1, p. 35), the study area extends 8 miles north to Joe Pool Lake, 3 miles south, 3 miles east, and 6 miles west. The area is characterized by small hills and valleys with elevations generally ranging from approximately 800 feet mean sea level south of Texas Industries to 500 feet mean sea level at Joe Pool Lake. Predominant wind direction is from the south.

Chaparral Steel Company and Texas Industries are the two southern most facilities. Chaparral is located 0.7 miles southwest of Texas Industries. North Texas Cement Company and Holnam Texas L.P. are located approximately 4 and 5 miles northeast of Texas Industries, respectively.

With the exception of the city of Midlothian (approximate population of 5100) which is located approximately 3 miles northeast of Texas Industries, the land use of the study area is predominately agricultural with some industrial development. In addition to Joe Pool Lake (surface area approximately 7600 acres), the area also contains two privately owned lakes known as Soil Conservation Service (SCS) Lakes 9 and 10 (combined surface area of approximately 84 acres). SCS Lakes 9 & 10 are located approximately 2 to 3 miles northwest and north, respectively, of the Chaparral Steel/Texas Industries complex very near residential developments.

The methodology employed in the risk assessment is generally that specified in the U.S. Environmental Protection Agency's (EPA) *Guidance for Conducting Screening Level Risk Assessments at Facilities that Burn Hazardous Waste*. In addition, theoretical concentrations of contaminants in media were compared to actual site data. The data were provided by the Texas Natural Resource Conservation Commission with some follow-on data provided via letter by Chaparral Steel Company. The draft report was subjected to both internal and outside peer review by several government personnel considered to be experts in the field of risk assessment.

Emissions from the cement manufacturing facilities were estimated from stack tests collected during trial burns or compliance tests. Emission estimates from Chaparral Steel Company are less certain because there were no contaminant specific, actual, facility data available upon which to base emission estimates. Instead, the emission estimates are based on theoretical emission factors and the assumption that the concentration of contaminants in the emissions are similar to the concentrations of contaminants typically found in the residue from air pollution control devices at steel mills across the United States.

The fate and transport of contaminants from the facilities were modeled via the most recent draft of EPA's Industrial Source Complex (ISC) gaussian air dispersion model available at the time the study was conducted. Contaminants deposited on the soil and water and present in the air were transported into the food chain via the equations specified in the *Screening Guidance* with some minor deviations as explained in the report.

Theoretical human receptors were then exposed to contaminants via inhalation, incidental ingestion of soil, ingestion of drinking water, ingestion of beef and milk, and the ingestion of fish. Theoretical human receptors were assumed to be located in areas that reasonably approximated actual area exposure patterns. For example, residents and farmers were placed in the area at locations that appeared to support residential and farming activities based on wind shield (i.e. drive-by) observations. Region 6 also addressed infant exposure to dioxin via nursing by comparing the average daily intake of dioxin a breast feeding infant might experience to background dioxin exposures in the United States.

Region 6 also considered including the effects of the December tire fire in this assessment, but was unable to complete the evaluation because of a lack of data concerning actual emission rates of contaminants during the tire fire and the uncertainties associated with using a methodology based on long-term chronic exposures to estimate the effects from a short-term event.

None of the theoretical cancer risk estimates resulting from this study exceeded EPA's regulatory levels of concern for cumulative risk assessments. The most significant cancer risk estimate was 1 excess case out of 10,000 people for subsistence fishers that use SCS Lakes 9 & 10 as their source of fish. Estimated potential non-cancer health effects from exposures to antimony [defined as a Hazard Quotient (HQ) of three for adults and six for children] exceeded the threshold level ($HQ < 1$) for all receptors due to the drinking water pathway. Estimated exposures to cadmium equaled the threshold for subsistence fishers that derive all their fish from SCS Lakes 9 & 10, and the estimated exposure to mercury equals the threshold for subsistence fishers that derive fish from both the SCS Lakes and Joe Pool Lake.

Actual site media concentrations were compared to modeled concentrations in order to gauge both the model's ability to predict exposures and the conservatism of the risk assessment. Actual concentrations of antimony in the Midlothian drinking water system obtained from a 1993 Texas Water Commission report result in non-cancer exposures significantly less than the

threshold (HQ = 0.05). Actual concentrations of antimony and cadmium in soil north of Chaparral Steel Company around the location of two study receptors were less than the modeled values. Non-cancer exposures to mercury were discounted due to concern by EPA's Office of Research and Development that the indirect exposure methodology contains too much uncertainty with respect to mercury to be used as a risk management tool.

Fugitive emissions from Chaparral Steel Company drive the theoretical cancer risk and non-cancer exposure estimates. The unit deposition rates and air concentrations estimated for Chaparral's fugitive emissions are at least 100 times that of the cement companies. The estimated emission rates of antimony and cadmium from Chaparral are 186 times and 5 times, respectively, that of Texas Industries.

Overall, the risk assessment is considered to be conservative due to the tendency of the models to over predict contaminant concentrations in media and the generally conservative values used to estimate emissions from the cement companies. In addition, considerable uncertainties exist in the emissions estimates for Chaparral Steel Company and in the exposure scenarios. The true viability of SCS Lakes 9 & 10 to support subsistence fishing is unknown. Exposure assumptions generally reflected central tendencies rather than theoretical worst case maximum estimates.

TABLE OF CONTENTS

Page

1. INTRODUCTION 1

2. RISK ASSESSMENT METHODOLOGY 2
   2.1 Constituents of Concern 3
   2.2 Emission Sources and Emission Rates 4
   2.3 Characteristics of Study Area 20
   2.4 Scenarios and Pathways 20
   2.5 Air Dispersion Modeling 24
   2.6 Deviations from the Screening Guidance Methodology 38

3. RESULTS 41
   3.1 Background 41
   3.2 Results by Receptor Location 42
   3.2.1 Theoretical Cancer Risks Estimates 42
   3.2.2 Potential for Theoretical Non-Cancer Health Effects 46
   3.3 Overall Summary of Results 50

4. LIMITATIONS 54
   4.1 Emission Rates 54
   4.2 Parameter Uncertainty 55
   4.3 Limitations of ISCSTDFT Air Modeling 56
   4.4 Uncertainty Associated with Scenarios 56

5. CONCLUSIONS 57

REFERENCES

ATTACHMENT A: RESULTS

ATTACHMENT B: CHAPARRAL STEEL COMPANY EMISSIONS

ATTACHMENT C: CHEMICAL AND MODEL INPUTS

ATTACHMENT D: EXAMPLE CALCULATIONS

LIST OF TABLES

Page

Table 2.2.1 Arc Furnace A Emissions 8
Table 2.2.2 Arc Furnace B Emissions 9
Table 2.2.3 NTCC and TXI Estimated Emission Rates 12
Table 2.2.4 Ratio of Cumulative Stack Flow Rates 16
Table 2.2.5 Holnam Texas L.P. Emission Rates 18
Table 2.4.1 Consumption Rates and Fraction Contaminated Used in Exposure Scenarios 21
Table 2.4.2 Surface Water Parameters 23
Table 2.5.1 Air Modeling Inputs Used in ISCSTDFT Modeling 25
Table 2.5.2 TXI and NTCC Modeling Particle Information 27
Table 2.5.3 Holnam Modeling Particle Information (AP-42 Dry Process) 28
Table 2.5.4 Chaparral EAF (Stack) Modeling Particle Information for Process Emissions 28
Table 2.5.5 Chaparral Modeling Particle Information for Fugitive Emissions 29
Table 2.5.6 Results of Air Modeling: CSC Fugitive Emissions 30
Table 2.5.7 Results of Air Modeling: CSC Baghouse A 30
Table 2.5.8 Results of Air Modeling: CSC Baghouse B 31
Table 2.5.9 Results of Air Modeling: CSC Baghouse C 31
Table 2.5. 10 Results of Air Modeling: NTCC 32
Table 2.5. 11 Results of Air Modeling: TXI 32
Table 2.5.12 Results of Air Modeling: Holnam 33
Table 2.5.13 Site-Specific Receptors Locations 33
Table 3.2. 1.1 Point Al Cancer Risk Results 42
Table 3.2.1.2 Point B1 Cancer Risks Results 43
Table 3.2.1.3 Point C1 Cancer Risk Results 45
Table 3.2.2.1 Point Al Non-Cancer Effects Results 46
Table 3.2.2.2 Point Bl Non-Cancer Effect Results 48
Table 3.2.2.3 Point C I Non-Cancer Effects Results 49
Table 3.2.2.4 Lead Concentrations in Air and Soil 50
Table 3.3.1 Overall Direct and Indirect Cancer Risk Across All Carcinogenic Chemicals 53
Table 5.1 Comparison of Modeled and Measured Concentrations 58
Table 5.2 Comparison of Unit Deposition Rates and Air Concentrations 59
Table 5.3 Comparison of Emission Rates 60

LIST OF FIGURES

Page

Map 1: Points of Maximum Combined Deposition and Air Concentration 35
Map 2: Combined Deposition Contours for DEHP 36
Map 3: Combined Depostion Contours for TCDD 37

1. INTRODUCTION

This report presents screening level risk estimates for direct and indirect exposures attributable to emissions from three cement companies and a steel mill located in Midlothian, Texas. Region 6 developed the estimates by following the procedures outlined in the U.S. Environmental Protection Agency's (EPA) draft *Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Wastes*. The risk estimates presented in this report are limited by the uncertainties inherent in the models and the data upon which the analysis is based.

Region 6 attempted to minimize uncertainties by

- evaluating and incorporating area data collected by the Texas Natural Resource Conservation Commission,
- requesting emission rate information directly from each of the facilities,
- developing emission rates based on tests conducted at similar facilities when no specific data were provided, and
- analyzing the data provided for the facilities against data from other sources to evaluate its overall reasonableness.

Releases associated with combustion sources were modeled using facility-specific emissions rates, stack characteristics, and estimated representative receptor locations around the facility. The four human exposure scenarios that were considered include an adult and child resident, a subsistence farmer, and a subsistence fisher.

The report is divided into 5 sections. Section 2 of this report provides an overview of Region 6's interpretation of the direct and indirect exposure methodology presented in the *Screening Guidance*. The results of this analysis are presented in Section 3. Section 4 presents the limitation of the analysis and Section 5 summarizes Region 6's conclusions based on the information presented in the previous sections of the report. Attachment A is detailed tabulation of all the risk assessment results. Attachments B through D present the assumptions and equations used by Region 6 to estimate theoretical risk and exposures.

2. RISK ASSESSMENT METHODOLOGY

This section presents the methodology used to develop screening level risk estimates for indirect and direct exposure to emissions associated with combustion sources located at four facilities (i.e., one steel mill and three cement companies). Included in this section is a discussion of the constituents of concern, emission sources, constituent-specific emission rates, air dispersion and deposition modeling efforts, and the identification of scenario receptors that were used in calculating direct and indirect risks. Under this analysis, the direct screening assessment evaluates exposures occurring through direct inhalation and the consumption of contaminated drinking water.[1, 2] Under the indirect screening assessment, exposures occurring through all other potential pathways are considered, such as the consumption of contaminated fish obtained from nearby lakes.

This screening level risk assessment provides estimates of risk that are based on generally conservative estimates of emission rates and exposure patterns. However, the conservative estimates presented in this report are not the most theoretically conservative and the results do not reflect theoretical worst case conditions. These assumptions were used in conjunction with the models and equations offered in the U.S. Environmental Protection Agency's most recent draft of the *Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Waste*.

The original draft of this report was prepared by Research Triangle Institute under contract to the U.S. Environmental Protection Agency. Region 6 asked an independent outside panel of experts in the field of risk assessment to review the draft report. Reviewers included EPA's Office of Solid Waste and Emergency Response, Office of Air Quality Planning and Standards, Office of Research and Development, Agency for Toxic Substances and Disease Registry, California Environmental Protection Agency, and the Texas Natural Resource Conservation Commission (TNRCC). Region 6 staff reviewed the comments it received and revised the report to reflect the relevant comments.

---

[1] It should be noted that the screening level methodology applied in this analysis for exposures occurring through the consumption of contaminated drinking water does not consider the removal of pollutants by water treatment processes other than filtration and therefore is conservative and overestimates risk for this pathway.

[2] Some reviewers were concerned that readers may become confused as to whether or not the drinking water pathway is a direct or indirect pathway. Drinking water is an indirect pathway in one sense because the drinking water source, Joe Pool Lake, is assumed to become contaminated by the transport of contaminated soils and sediments from the affected area in addition to direct particle and vapor deposition onto the water body.

2.1 Constituents of Concern

The constituents considered in the indirect exposure analysis were those recommended in the *Screening Guidance*. The constituents represent those that are expected to present the highest risks to human health via indirect exposures. Listed below are the constituents considered in the indirect exposure assessment.

Dioxin and dioxin-like compounds:

2,3,7,8-substituted Polychlorinated dibenzo(p)dioxin congeners (2,3,7,8-PCDD's)
2,3,7,8-substituted Polychlorinated dibenzofuran congeners (2,3,7,8-PCDF's)

All emissions of the 2,3,7,8 substituted polychlorinated dibenzo(p)dioxins and dibenzofurans are converted to 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD) toxicity equivalents (TEQ's). All congeners will then be modeled using weighted fate and transport properties developed to represent all dioxin/furan congeners with nonzero toxicity equivalence factors (TEF's).

Polycyclic Aromatic Hydrocarbons:

Benzo(a)pyrene
Benzo(b)fluoranthene
Chrysene
Indeno(1,2,3-cd)pyrene
Benzo(a)anthracene
Benzo(k)fluoranthene
Dibenzo(a,h)anthracene

Emissions of these PAHs will be converted to benzo(a)pyrene (BaP) TEQ's and then modeled using fate and transport properties of BaP.

Polychlorinated Biphenyls (total PCB's):

total Polychlorinated biphenyls (all congeners)

All polychlorinated biphenyl congeners exposures will be evaluated as a mixture having a single carcinogenic potency.

Nitroaromatics:

1,3-Dinitrobenzene
2,6-Dinitrotoluene
Pentachloronitrobenzene
2,4-Dinitrotoluene
Nitrobenzene

Phthalates:

Bis(2-ethylhexyl) phthalate
Di(n)octyl phthalate

Other Chlorinated Organics:

Hexachlorobenzene
Pentachlorophenol

Metals:

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium (VI)
Lead
Mercury
Silver
Thallium

As part on the direct risk assessment, the above constituents were considered in addition to other volatile and semi-volatile constituents. The additional volatile and semi-volatile constituents were identified on a facility/source-specific basis. Because the lists of these constituents can be extensive and are facility/source-specific, they are not identified here. However, these constituents are identified in Section 2.2 below as required for each facility and emission source.

2.2 Emission Sources and Emission Rates

This subsection discusses each facility, its emission sources, and presents emission rates that were used in this assessment. As discussed above, this screening level risk assessment will focus on emissions from the four facilities that are the major point sources of emissions in the

Midlothian area. These facilities include Chaparral Steel Company (CSC), North Texas Cement Company (NTCC), Texas Industries (TXI), and Holnam Texas L.P. For each of these facilities, the emission sources with the greatest potential to pose risk to human health were identified. Once identified, data sources were reviewed and the emission rates that were determined to be the most appropriate for use in the assessment were selected.

Chaparral Steel Company

Chaparral Steel Company (CSC) is a large nonstainless steel mill complex that shreds and melts scrap steel that is then casted into structural steel beams and reinforcing bars.[3] CSC reported that it shredded 440,161 tons of scrap cars in 1993 and produced 1,523,895 of steel billets from its two arc furnaces known as Arc Furnace A (AFA) and Arc Furnace B (AFB).[4] Emissions from CSC include emissions from AFA and AFB (that are treated via Baghouse A, Baghouse B, and Baghouse C), meltshop fugitives, a barmill reheat furnace, an automobile shredder, and a section mill reheat furnace. Emissions of particulate matter totaled 195.3 tons/year in 1993 for the arc furnace and fugitive emissions. Particulate emissions from the two reheat furnaces were estimated at 6.88 tons/year and emissions from the automobile shredder totaled 16.5 tons/year.

In addition to the May 5, 1995, letter f rom CSC, another primary data source used in identifying emission sources, constituents of concern, and emission rates, was a May 2, 1995 printout from TNRCC's *Mini Emission Inventory from the Point Source Data Base* and the *Detailed Summary of Information Collection Request Responses For Electric Arc Furnace (EAF) NESHAP* (RTI, 1993). The *Mini Emission Inventory* printout provides estimated representative and allowable emission rates for each point source located at CSC. The inventory provides data for the following pollutants: particulates, PM_{10}, some metal oxides, hydrocarbons, methane, inorganic gas, sulfur dioxide, nitrogen dioxide, and carbon monoxide. However, data for all of these pollutants were not available for all of the identified emission sources.

Another data source used to estimate emissions was the *Detailed Summary of Information Collection Request Responses (ICR) For Electric Arc Furnace (EAF) NESHAP* which summarizes data collected from EAF steel manufacturing facilities. These data were collected in support of

---

[3] It was determined that Chaparral Steel located in Midlothian is a nonstainless steel facility based on information found in the *Detailed Summary of Information Collection Request Responses for Electric Arc Furnace (EAF) NESHAP* (RTI, 1993). In this document, facilities are assigned to the "stainless steel" or "nonstainless steel category" based on information in the "Electric Arc Furnace Roundup" in the May 1991 issue of *Iron and Steel Manufacturing* and based on product descriptions given in the ICR responses.

[4] Letter from Mr. J.M. Balbo dated May 8, 1995.

the development of maximum achievable technology (MACT) standards for this industry under the Clean Air Act and are presented along with particulate emissions data from the *Mini Emissions Inventory* in Attachment B. Finally, Region 6 received some information in a letter from CSC dated December 20, 1995, that was used to check the reasonableness of the baghouse dust concentration profile reported in the ICR.

Emissions estimates for CSC were developed by assuming that CSC's meltshop fugitive and arc furnace emissions were similar to a concentration profile of electric arc furnace baghouse dust contained in the ICR. The particulate emissions from the baghouses and the meltshop were multiplied by the EPA baghouse dust concentration in percent to estimate the emission rate of each contaminant. Emissions from the reheat furnaces were not considered because they are insignificant when compared to emissions from the arc furnace air pollution control devices and the meltshop fugitive emissions. Emissions from the automobile shredder were not considered in the risk assessment because Region 6 did not have a methodology to estimate emissions from shredder operations. With sufficient time, a reasonable methodology could be developed. However, including emissions of inorganic contaminants from the automobile shredder in the risk assessment is unlikely to result in any significant changes unless the actual concentrations of contaminants in the shredder emissions are at least 100 times greater than the assumed concentration of contaminants in the arc furnace and fugitive emissions.

The CSC constituents that were identified as being of concern included many of the metals specified previously. These metals including antimony, arsenic, cadmium, chromium, lead and mercury. In addition to these metals, zinc and nickel were identified as potential constituents of concerns for the following reasons: 1) zinc was included because it is reported as being emitted at a relatively high rate; and 2) nickel was identified in the EAF ICR report as a potential constituent of concern.

The emissions of organic contaminants from CSC was not evaluated in this risk assessment because there were no data available that could be used to develop reasonable estimates of organic emissions from CSC. The only known significant source of organic emissions from CSC are emissions associated with the combustion of natural gas in the reheat furnaces and the fluff fires.[5] Significant emissions of hazardous organic pollutants are not expected from the combustion of natural gas and no data exist upon which to base estimates of fluff fire emissions. The failure to include organic emissions from CSC in the analysis is a source of uncertainty in the overall risk assessment.

---

[5] However, the Dioxin document (U.S. EPA, 1994a) indicates that dioxin-like compounds could potentially be formed and emitted by the secondary metals industry. The potential for dioxin formation is attributed to the potential presence of chlorine in plastic in the feed material.

In summary, the assessment conducted on the Chaparral Steel focused on inorganic constituents emitted from and associated with the two EAF's. Tables 2.2.1 and 2.2.2 identify the estimated emission rates that were applied to AFA and AFB, respectively. With the exception of lead and zinc, emission estimates were developed based on the total particulates emitted from AFA and AFB and the concentration profile reported in the ICR. Emissions of lead and zinc were developed by using stoichiometry to back-calculate metal emissions from the amount of metal oxides reported and then compared to the estimated representative amount of total particulates reported.[6] Once developed, the emissions profile was multiplied by the estimated emission rates presented in Tables 2.2.1 and 2.2.2. The emission rates presented in these tables were used as inputs to the risk analyses. The rates were adjusted to reflect only PM_{10} emissions in evaluating direct inhalation risk3. These adjustments were made by multiplying the emission rates by the ratios of PM_{10} to total particulates.

Even though the emission rates for all the constituents excluding zinc and lead were developed based on analytical data reported for the steel industry as a whole, it is believed that, with the exception of antimony, a reasonable level of uncertainty is associated with the emission rates. Region 6 compared the contaminant concentrations in baghouse dust reported in the ICR against those provided by CSC with a recent letter of December 20, 1995. With the exception of antimony, the two sets of concentrations are reasonably similar. For example, the emissions profile assumes that EAF dust contains 0.33% chrome. Actual data from CSC indicates that CSC EAF dust contains 0.20 to 0.27% chrome. The emissions profile assumes that EAF dust contains 0.0033% arsenic. Actual data from CSC indicates that CSC EAF dust contains 0.0040 to 0.0054% arsenic. The emissions profile assumes cadmium to comprise 0.054% of EAF dust. CSC reports cadmium concentrations ranging from 0.05% to 0.09% in its EAF baghouse dust. The CSC data did not provide any information concerning actual concentrations of antimony, a relatively significant fraction of contaminants in the ICR profile, in its December 1995 letter. Another significant source of uncertainty is the assumption that contaminant concentrations in fugitive emission from the meltshop are similar to a concentration profile of baghouse dust. A more detailed discussion of uncertainty is provided in Section 4.

[6] It should be noted that the fraction of lead developed using reported data are very similar to those estimated using the emissions profile developed based on the K061 data. Specifically, the average fraction of lead back-calculated based on reported emissions was 1 while the profile fraction (i.e., based on EAF ICR report data) was 2.4 for lead.

Table 2.2.1 Arc Furnace A Emissions

Constituents	Arc Furnace "A" Emission Point: Baghouse "A"	Arc Furnace "A" Emission Point: Baghouse "C"	Arc Furnace "A" Emission Point: Melt Shop Fugitives
	Estimated[a] Representative (tons/yr)	Estimated[a] Representative (tons/yr)	Estimated[a] Representative (tons/yr)
Total Particulates	2.2E+01[b]	2.8E+01	3.2E+01
Arsenic	7.2E-04	9.2E-04	1.1E-03
Antimony	1.1E-01	1.5E-01	1.7E-01
Cadmium	1.2E-02	1.5E-02	1.7E-02
Chromium	7.2E-02	9.2E-02	1.1E-01
Chromium VI	1.4E-03	1.8E-03	2.2E-03
Lead	1.9E-01	4.2E-01	3.2E-01
Mercury	4.1E-05	5.3E-05	6.1E-05
Nickel	3.1E-02	3.9E-02	4.5E-02
Zinc	2.4E+00	3.0E+00	3.6E+00

a Estimated representative emission rates for lead and zinc were estimated based on reported metal oxide emission rates. In the absence of such data, constituent-specific emission rates were estimated based on actual amount of total particulates reported in *Mini Emissions Inventory* and the developed emission profile.

b Throughout this report, the terminology xEy is used to denote x times 10 raised to the power of ^{y} in order to make it easier to report a complex series of numbers. For example, 2.2E+01 stands for 2.2×10^{1} or 22. The capital letter E tells the reader that the numerical value reported is the value of the number preceding the E multiplied by the number 10 raised to the power succeeding the E. It is also important to remember that numbers with positive ^{y} values are greater than numbers with negative ^{y} values. In the earlier example 2.2E+01 stands for the number 22. However, if the number had been reported as 2.2E-01, then the true value of the number would be 0.22.

Table 2.2.2 Arc Furnace B Emissions

Constituents	Arc Furnace "B" Emission Point: Baghouse "B"	Arc Furnace "B" Emission Point: Baghouse "C"	Arc Furnace "B" Emission Point: Melt Shop Fugitives
	Estimated Representative [a] (tons/yr)	Estimated Representative [a] (tons/yr)	Estimated Representative [a] (tons/yr)
Total Particulates	5.3E+01	2.8E+01	3.2E+01
Arsenic	1.8E-03	9.2E-04	1.1E-03
Antimony	2.8E-01	1.5E-01	1.7E-01
Cadmium	2.9E-02	1.5E-02	1.7E-02
Chromium	1.8E-01	9.2E-02	1.1E-01
Chromium VI	3.6E-03	1.8E-03	2.2E-03
Lead	4.6E-01	3.2E-01	3.2E-01
Mercury	1.0E-04	5.3E-05	6.1E-05
Nickel	7.4E-02	3.9E-02	4.5E-02
Zinc	5.8E+00	2.3E+00	3.6E+00

a Estimated Representative emission rates for lead and zinc were estimated based on reported metal oxide emission rates. In the absence of such data, constituent-specific emission rates were estimated based on estimated representative amount of total particulates reported and the developed emission profile.

North Texas Cement Company (NTCC)

NTCC produces approximately 900,000 tons per year of Portland cement through the use of a wet production process that employs three kilns that may be fired with coal, natural gas, petroleum coke, wood chips, oil, and tire derived fuel. Kiln exhaust gases pass through a four stage electrostatic precipitator before being discharged to the atmosphere. Data used to estimate emissions from NTCC were collected during a trial burn and compliance test that were conducted when NTCC also burned hazardous waste derived fuel while operating as an interim status facility. NTCC has since abandoned its plans to burn hazardous waste derived fuel. The primary data sources that were used in identifying emission sources, constituents of concern, and emission rates included the following:

- *Appendix III.A to NTCC's Part B Permit Application entitled "General Engineering Report for North Texas Cement Company* (1992):" provides an overview of the facility's operations and identifies existing operating units.

- *Certificate of Compliance Form 1 (CC-1)* (August 1992): presents metal emission rates for the kilns operating at maximum feed rate and flue gas flow obtained during the BIF Trial Burn (June 1992).

- *TACB Mini Emissions Inventory Report from the Point Source Data Base* (May 2, 1995): identifies emission point sources located at the facility. However, it does not provide constituent-specific emission rates.

- Section II of a draft risk assessment protocol prepared by NTCC: presents emission rates that NTCC believes are appropriate for use in conducting a screening level risk assessment. The primary data source used in developing these rates include the Texas Reg. I Test Condition II results, June 1992 BIF Trial Burn (June 1992), and Material Safety Data Sheets (MSDSs) from Gibraltar Chemical Resources.

- Texas Reg I Test Condition I (i.e., 36% WDF) and II (i.e., 60% WDF) results for dioxins and furans.

- Texas Natural Resource Conservation Commission (TNRCC) memorandum (March 20, 1995): presented draft emission estimates proposed for use in conducting a screening level risk assessment for the facility. Data from OAQ permit, Reg I Texas Conditions I and II, and BIF Trial Burn/Certificate of Compliance are

compiled for all constituents identified in the April, 1994 version of the *Screening Guidance.*

The constituents that were included in the assessment were identified based on the preliminary list of constituents provided by the facility (i.e., an analyte list developed from the Reg I and BIF trial burns during which coal and hazardous waste were being burned) and the *Screening Guidance*. The constituents identified for inclusion in the indirect assessment include those specified in the *Screening Guidance*. In addition to those constituents, zinc and nickel which were identified as being constituents of concern for Chaparral Steel were included for NTCC.

Table 2.2.3 identifies the estimated representative rates that were applied in conducting the screening level assessment for NTCC. These emission rates are totals for all three stacks. In selecting estimated representative emission rates, attempts were made to identify emission rates that would be representative of typical operating conditions and yet be conservative enough to allow for operational upsets and account for the quality of the data. Therefore, all of the data sources were reviewed and the data supplied by the facility was selected to be most representative of these conditions. As discussed above, the primary data sources used by the facility in developing these rates included the Texas Reg. I Test Condition II (60% WDF) results, June 1992 BIF Trial Burn (June 1992), and Material Safety Data Sheets (MSDSs) from Gibraltar Chemical Resources. In the absence of data from these sources or a no detect (ND), the facility assumed that the constituent emission rate was equal to ½ a "Typical Detection Limit."[7] These emission rates were replaced with rates estimated based on one half the method detection limit (MDL) when these values were available and the data of sufficient quality. To ensure that the recommended estimated rates were reasonable, these values were compared across other identified data sources. Due to the lack of data on semi-volatile and volatile compounds, this comparison could only be conducted for the metals and dioxin/furans.

[7] Because test data were not available for PCB's, dinitrobenzene, and pentachloronitrobenzene, these compounds were assumed to have emission rates similar to the other organic species not detected (i.e., 5.4E-5).

Table 2.2.3 NTCC and TXI Estimated Emission Rates

Table 2.2.3		
Constituent	NTCC Emission Rate (lb/hr)	TXI Emission Rate (lb/hr)
Dioxins / Furans		
2378 - TCDD TEQ	8.62E-10	1.64E-8
Metals		
Antimony	9.09E-5	1.60E-4
Arsenic	1.07E-5	2.13E-4
Barium	2.65E-5	4.03E-4
Beryllium	1.77E-6	2.08E-4
Cadmium	5.18E-4	6.50E-4
Chromium Total	NA	4.27E-4
Chromium VI	2.65E-5	9.80E-9
Lead	4.17E-3	1.43E-2
Mercury	4.67E-4	3.01E-4
Nickel	2.78E-5	3.01E-4
Silver	8.69E-5	5.33E-5
Thallium	1.26E-5	5.04E-4
Zinc	5.43E-6	2.69E-3
Polycyclic Aromatic Hydrocarbons		
Benzo(a)pyrene TEQ	1.25E-4	1.43E-4
Volatile / Semivolatile Organics		
Acetone	8.82E-4	8.28E-6
Acetonitrile	5.43E-5	
Acrylonitrile	5.43E-5	
Aniline	5.43E-5	
Benzene	1.39E-2	8.28E-6
Benzyl alcohol	3.25E-6	5.94E-5
bis(2-Cholorethyl)ether	1.77E-6	5.94E-5
bis(2-Chloropropyl)ether	1.37E-6	5.94E-5
bis(2-Ethylhexyl)phthalate	4.80E-5	5.94E-5

TABLE 2.2.2		
Constituent	UTOC (grams/second)	TRI (grams/second)
Bromodichloromethane	7.58E-6	8.28E-6
Bromoform	7.58E-6	8.28E-6
Bromomethane	9.72E-4	8.28E-6
Butylbenzylphthalate	5.80E-6	5.94E-5
2-Butanone	3.03E-4	8.28E-6
Carbon disulfide	3.16E-3	8.28E-6
Carbon Tetrachloride	7.58E-6	8.28E-6
Chlorobenzene	1.26E-4	8.28E-6
4-Chloroaniline	1.59E-6	5.94E-5
Chloroethane	7.58E-6	8.28E-6
Cholorform	7.58E-6	8.28E-6
Chloromethane	1.01E-3	8.28E-6
2-Chloronaphthalene	1.00E-6	5.94E-5
2-Chlorophenol	5.43E-5	5.94E-5
Cyclohexane	5.43E-5	5.94E-5
Dibromochloromethane	7.58E-6	8.28E-6
1,2-Dichlorobenzene	2.02E-6	5.94E-5
1,4-Dichlorobenzene	1.95E-6	5.94E-5
3,3-Dichlorobenzidine	4.82E-7	1.17E-4
1,1-Dichloroethane	7.58E-6	8.28E-6
1,1-Dichloromethene	7.58E-6	8.28E-6
1,2-Dichloroethane	7.58E-6	8.28E-6
1,2-Dichloroethene	7.58E-6	8.28E-6
2,4-Dichlorophenol	2.25E-6	5.94E-5
cis 1,3-Dichloropropene	7.58E-6	8.28E-6
trans 1,2-Dichloropropene	7.58E-6	8.28E-6
Diethylphthalate	1.02E-6	5.94E-5
Dimethylphenol	5.43E-5	5.94E-5
Dimethylphthalate	1.07E-6	5.94E-5
Di-n-Butylphthalate	3.03E-7	5.94E-5

[illegible]		
[illegible]	[illegible]	[illegible]
Di-n-Octylphthalate	5.43E-5	5.94E-5
1,3-Dinitrobenzene	5.43E-5	5.94E-5
4,6-Dinitro-2-methylphenol	3.89E-6	2.97E-4
2,4-Dinitrophenol	1.06E-5	2.97E-4
2,4-Dinitrotoluene	2.80E-6	5.94E-5
2,6-Dinitrotoluene	3.75E-6	5.94E-5
Ethylbenzene	2.53E-4	8.28E-6
Hexachlorobutadiene	5.43E-5	5.94E-5
Hexachlorocyclopentadiene	6.19E-6	5.94E-5
Hexachloroethane	4.34E-6	5.94E-5
Hexachlorobenzene	2.30E-6	5.94E-5
Isophorone	5.43E-5	5.94E-5
Methanol	7.58E-6	8.28E-6
Methylene Chloride	4.42E-2	8.28E-6
Methyl Ethyl Ketone	5.43E-5	5.94E-5
4-Methyl-2-Pentanone	7.58E-6	8.28E-6
2-Methylphenol	5.43E-5	5.94E-5
4-Methyl phenol	1.64E-4	5.94E-5
2-Nitroaniline	2.64E-6	2.97E-4
Nitrobenzene	1.36E-6	5.94E-5
N-Nitro-di-n-dipropylamine	2.27E-6	5.94E-5
N-Nitrosodiphenylamine	5.43E-5	5.94E-5
PCBs	5.43E-5	3.93E-5
Pentachloronitrobenzene	5.43E-5	5.94E-5
Pentachlorophenol	3.00E-6	2.86E-5
Phenol	6.68E-4	5.94E-5
Styrene	1.39E-3	8.28E-6
Toluene	3.03E-3	8.28E-6
1,1,2,2-Tetrachloroethane	7.58E-6	8.28E-6
Tetrachloroethene	7.58E-6	8.28E-6

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
1,2,4-Trichlorobenzene	2.15E-4	5.94E-5
1,1,2-Trichloroethane	7.58E-6	8.28E-6
Trichloroethene	7.58E-6	8.28E-6
Trichlorofluoromethane	1.01E-3	5.94E-5
Vinyl Acetate	7.58E-6	8.28E-6
Vinyl Chloride	3.41E-4	8.28E-6
Xylene	1.10E-3	8.28E-6

Texas Industries (TXI)

TXI produces approximately 1,200,000 tons per year of Portland cement through the use of a wet production process that employs four kilns that may be fired with coal, natural gas, petroleum coke, wood chips, fuel oil, and hazardous waste derived fuel. Kiln exhaust gases pass through electrostatic precipitators before being discharged to the atmosphere. The primary data sources that were used in identifying emission sources, constituents of concern, and emission rates for TXI included the following:

- *Texas Industries, Inc. Part B Permit Application*: presents results from test burns conducted in August 1990 and April 1991.

- Texas Natural Resource Conservation Commission (TNRCC) memorandum (April 12, 1995): presents draft emission estimates for all constituents identified in the April, 1994 version of the *Screening Guidance*. These emission rates were used in conducting a screening level risk assessment for the facility.

- Pages 1 through 1-17 of the *Texas Industries, Inc. Trial Burn Report* (1992): presents metal emission data obtained during the 1991 trial burn.

The constituent list that was used in the assessment is the same as the list specified for the North Texas Cement Company. It was determined that applying this list to TXI is appropriate due to the similarities between the facilities' production processes and the fuel(e.g., coal, petroleum coke, and waste derived fuel) that are utilized to meet the energy requirements of the kilns. As

discussed above, the constituents on the list that were included in the indirect assessment included those specified in the *Screening Guidance*. In addition to those constituents, zinc and nickel which were identified as being constituents of concern for CSC, were included. In conducting the direct assessment, all of the constituents evaluated under the indirect assessment as well as additional volatile and semi-volatile constituents identified on the list were included.

Table 2.2.3 identifies the estimated emission rates that were used in conducting the screening level assessment for TXI. These emission rates are totals for all four stacks. In selecting estimated emission rates, attempts were made to identify rates that were representative of typical operating conditions yet still be conservative enough to account for operational upsets and the quality of the data. Since almost no facility specific data were available to estimate the emission rates of many volatile and semi-volatile compounds from TXI, organic emission rates were estimated by applying an adjustment factor to the lower limits of quantitation measured during the trial burn for the North Texas Cement Company while burning coal and hazardous waste. As seen in Table 2.2.4, the adjustment factor of approximately 1.15 was calculated as a ratio of the TXI cumulative flow rates to the NTCC cumulative stack flow rates. The PCB emission rate was extracted from the TNRCC memorandum cited in the source summary cited above. This memo states the PCB emission rate was estimated based on a 99.999% DRE and the maximum theoretical feed to the kilns.

Table 2.2.4 Ratio of Cumulative Stack Flow Rates

Facility	Number of Stacks	Stack Average Volumetric Flow Rate (DSCFM)	Cumulative Volumetric Flow Rate (DSCFM)	Ratio
TXI	4	59,900 (1992 trial burn)	239,600	1.1
NTCC	3	69,700 (Reg I tests)	209,100	

Holnam Texas L.P.

Holnam produces approximately 1,000,000 tons per year of Portland cement through the use of a dry production process that employs a preheater/precalciner and one kiln that may be fired with coal, natural gas, and tire derived fuel. Kiln exhaust gases pass through a fabric filter baghouse before being discharged to the atmosphere. The primary data sources that were used in identifying emission sources, constituents of concern, and emission rates included the following:

- *Boxcrow Cement Company Application to Amend Texas Air Control Board Permit 8996* (1992)[8]: provides an overview of the facilities operations and presents emission requested maximum allowable emission rates and emission rates obtained from stack testing.

- Letter from Holnam Texas L.P. addressed to Mr. David Weeks EPA Region VI (May 19, 1995): presents the emission rates that the facility believe are appropriate for use in the screening level assessment.

The constituents that were included in the assessment were identified based on the list of constituents provided by the facility and the *Screening Guidance*. The constituents identified for inclusion in the indirect assessment include those specified in the *Screening Guidance*. In addition to those constituents, zinc and nickel which were identified as being constituents of concern for CSC, were included as emissions of concern for Holnam. All the constituents evaluated under the indirect assessment were evaluted in the direct assessment as well as some additional volatile and semi-volatile constituents for which information were available in the Boxcrow Permit Amendment Application.

Table 2.2.5 identifies the estimated emission rates that were used in conducting the screening level assessment. The primary data source used in developing these emission rates was the Holnam Texas L.P. letter to Mr. David Weeks. The data presented in this letter were based on data obtained during 1991 stack testing. This data was judged to be most appropriate because it was collected while the facility was burning tire derived fuels and because detection limits were stated when the results were below the detection limit.

[8] Holnam Texas L.P. bought the facility from Boxcrow Cement Company.

Table 2.2.5 Holnam Texas L.P. Emission Rates

Compound	HOLNAM
Dioxins / Furans	
2378 - TCDD TEQ	9.88E-10
Metals	
Antimony	NA
Arsenic	9.00E-5
Barium	NA
Beryllium	2.00E-6
Cadmium	NA
Chromium Total	1.11E-5
Chromium VI	NA
Lead	8.00E-5
Mercury	2.52E-4
Nickel	3.78E-4
Silver	NA
Thallium	2.00E-5
Zinc	8.82E-4
Polycyclic Aromatic Hydrocarbons	
Benzo(a)pyrene TEQ	2.54E-4
Volatile / Semivolatile Organics	
Benzene	4.11E-1
bis(2-Ethylhexyl)phthalate	8.40E-5
Di-n-Octylphthalate	1.10E-4
1,3-Dinitrobenzene	1.103E-4
2,4-Dinitrotoluene	1.10E-4
2,6-Dinitrotoluene	1.10E-4
Ethylbenzene	7.27E-2
Hexachlorobenzene	1.10E-4
Methylene Chloride	6.93E-3

[illegible]	[illegible]
[illegible]	1.10E-4
PCBs	1.10E-5
[illegible]	1.10E-4
[illegible]	1.10E-6
[illegible]	9.64E-2
[illegible]	5.67E-1
[illegible]	3.39E-1

NA = Not Available. Data were not available to estimate emissions of this contaminant.

For those compounds not detected during the testing, the letter recommends applying an emission rate equal to one half the instrument detection limit (IDL). The IDL is defined in EPA guidance as the lowest amount of a chemical that can be "seen" above the normal, random noise of an analytical instrument. Region 6 modified this approach by revising the IDLs to approximate method detection limits (MDL). The modification was accomplished by multiplying the stated ½ IDL by a factor of 10. MDLs are preferred over IDLs because MDLs account for error in the sample preparation and recovery while IDLs only account for error in the instrument. Use of ½ the MDL is more conservative than using ½ the IDL to estimate contaminant emissons.

To ensure that the emission rates presented in the letter were reasonable emission rates and to identify any additional appropriate emission rates, these values were compared to the test data. Based on this comparison, several changes were made to the emission rates proposed by Holnam.

1. Emission rates of mercury were proposed in Holnam's letter were increased to match those reported in the test data. The mercury emission rate in the letter was reported as being greater than the instruments detection limit at 2E-5 grams/second. However, the "Summary of Results" from Holnam's October 1991 *Source Emissions Survey* reports mercury emisson rates at 3.8E-4 grams/second for Condition I (not using tire derived fuel) and 2.5E-4 for Condition IV (using tire derived fuel). Thus, actual tests data estimate emissions at an order of magnitude greater than suggested in Holnam's letter.

2. Emission rates for several of the metals that were not included in Holnam's letter were estimated from other data sources. The letter did not report emission rates for the chromium, nickel, thallium, and zinc. Therefore, stack emission data were extracted from

the permit amendment application to serve as estimated representative emission rates for these compounds.

Finally, the letter reports that PCB's were not analyzed for in the 1991 test. Therefore, an emission rate equal to one half the IDL (i.e., 1.1E-05 g/sec) was assumed for PCBs. One-half the IDL was assumed for PCBs rather than ½ the MDL because PCBs are not expected to be present in the fuel in any quantity other than at trace levels.

2.3 Characteristics of Study Area

The area subject to this study is located approximately 30 miles south of the Dallas-Ft. Worth metropolitan area. From TXI (see Map 1, p. 35), the study area extends 8 miles north to Joe Pool Lake, 3 miles south, 3 miles east, and 6 miles west. The area is characterized by small hills and valleys with elevations generally ranging from approximately 800 feet mean sea level south of TXI to 500 feet mean sea level at Joe Pool Lake. Predominant wind direction is from the south.

CSC and TXI are the two southern most facilities. CSC is located 0.7 miles southwest of TXI. NTCC and Holnam are located approximately 4 and 5 miles northeast of TXI, respectively.

With the exception of the city of Midlothian (approximate population of 5100) which is located approximately 3 miles northeast of TXI, the land use of the study area is predominately agricultural with some industrial development. The area is home to several small cattle operations and rural residential developments. Gardens were sighted at many homes in the area during several site visits.

In addition to Joe Pool Lake (surface area approximately 7600 acres), the area also contains two privately owned lakes known as Soil Conservation Service (SCS) Lakes 9 and 10 (combined surface area of approximately 84 acres). SCS Lakes 9 & 10 are located approximately 2 to 3 miles northwest and north, respectively, of the CSC/TXI complex very near residential developments.

2.4 Scenarios and Pathways

The four human scenarios that were considered in this screening level risk assessment are the subsistence farmer, the adult and child resident, and the subsistence fisher. The individuals included in each of these scenarios were assumed to be exposed to contaminates from the emission

sources via ingestion of above-ground vegetables, incidental ingestion of soil, consumption of drinking water and direct inhalation of particles and vapors. These exposure scenarios differed primarily in their consumption of certain foods. Specifically, only the subsistence farmer was assumed to consume contaminated beef and milk, while only the subsistence fisher was assumed to consume contaminated fish. Because the drinking water supplied to the area surrounding the facilities comes from Joe Pool Lake, exposure via contaminated drinking water was considered under all of the scenarios. Table 2.4.1 presents the consumption rates and contaminated fractions of food applied for each of the scenarios.

Although differences in consumption are the primary difference between the scenarios, other differences exits. As seen in Table 2.4.1, the ingestion rate of soil and above-ground vegetables and the inhalation rate of air differ for the child and the adult scenarios. Exposure duration is another difference. The adult resident and fisher are assumed to be exposed for 30 years, the subsistence farmer for 40 years, and the child exposed for 6 years. Attachment B lists all the exposure parameters used in calculating risks to the four human scenarios.

Table 2.4.1 Consumption Rates and Fraction Contaminated Used in Exposure Scenarios

Contaminated Food or Media	Exposure Scenario							
	Subsistence Farmer		Subsistence Fisher		Adult Resident		Child Resident	
	Rate	Fraction	Rate	Fraction	Rate	Fraction	Rate	Fraction
Beef (g FW/day)	57	1	NA	NA	NA	NA	NA	NA
Milk (g FW/day)	181	1	NA	NA	NA	NA	NA	NA
Fish (g/day)	NA	NA	60	1	NA	NA	NA	NA
Above-ground fruits and vegetables (g DW/day)[1]	19.7	1	19.7	0.25	19.7	0.25	14	0.25
Soil (mg/day)	100	--	100	--	100	--	200	--
Drinking Water (liters/day)	1.4	1	1.4	1	1.4	1	0.5	1
Air (m^3/day)	20	--	20	--	20	--	12[1]	--

Notes: DW = dry weight, FW = Fresh weight, NA = Not Applicable.
All contaminated fractions were obtained from the Exposure Factors Handbook (U.S. EPA, 1990). References for the consumption rates are contained in Attachment B.

[1] Values reflect changes from the *Screening Guidance* document.

[2] A drinking water consumption rate for adults of 1.4 L/d was applied in this analysis. As pointed out in U.S. EPA 1990a, this value may be more accurate for average consumption than the 2L/d value based on a recent EPA document that indicate that this rate may overestimate estimated representative rates. Furthermore, the 2L/d rate most likely represents a 90th percentile value.

The watersheds and water bodies considered in the analysis were selected from U.S.Geologic Survey (USGS) topographical maps and on information collected during a visit to Midlothian. The selected water bodies and watersheds that were included in the analysis are those that would be large enough to support fish and reflect the highest impact from the facilities. In addition, one of the water bodies selected (i.e., Joe Pool Lake) was identified as the City of Midlothian's primary drinking water source based on information from the Texas Department of Health. As a result, Joe Pool Lake was modeled as the drinking water source. The topographic maps were used in identifying the watersheds associated with each water body and in estimating water body and watershed surface areas. Table 2.4.2 lists the surface areas and other surface water parameters applied in the analysis.

The SCS Lake 9 & 10 watershed includes Cottonwood Creek and portions of the Newton Branch of Soap Creek. The SCS Lake watershed is also a subsection of the Joe Pool Lake watershed. Assuming that the SCS Lake watershed is sufficient to support subsistence fishing is conservative because the true viability of the SCS Lake watershed to support subsistence fishing is unknown.[9] Nevertheless, Region 6 assumed that these water bodies could potentially support subsistence activity based on their size and their nearby proximity to residential development. Furthermore, these water bodies are in an area that could be significantly impacted by the facilities' emissions due to their near central location to the facilities being evaluated in the study.

Contaminants were assumed to be emitted from the four facilities at the emission rates identified in Section 2.2, 24 hours/day, 7 days/week, 365 days/year. EPA's air dispersion model ISCSDFT was employed to estimate the fate and transport of the contaminants to the surrounding area. Soil was assumed to become contaminated by wet and dry deposition of particles and vapors. Above-ground vegetation, for human and animal consumption, were assumed to become contaminated via deposition of particles on plants, transfer of vapor phase contaminates, and uptake through the roots. Beef and milk were assumed to be contaminated via ingestion of contaminated forage (including hay), silage, grain, and soil. Fish and the drinking water source were assumed to be contaminated by deposition directly onto the water body and through contaminants transported to the water body via storm water. Additional modeling data are presented in Attachment C. Example calculations are presented in Attachment D.

[9] Both of the SCS lakes are privately owned. The property upon which SCS 10 (the northern most lake) is located is posted "No Trespassing."

Table 2.4.2 Surface Water Parameters

SCS Lakes 9 &10 Watershed	Surface Area (m^2)	Watershed Area (m^2)	Impervious Watershed Area (m^2)	Average Volumetric Flow Rate (m^3/yr)	Current Velocity (m/s)	Depth of Water Column (m)	USLE Rainfall/ Erosivity Factor
	3.4 E+05	4.4E+07	4.4E+05	2.2E+05	N/A	4 (default)	300
Joe Pool Lake Watershed	3.1E+07	3.6E+08	3.6E+06	4.4E+07	NA	16.5	300

(1) Surface areas for the watersheds and water bodies were determined from the USGS 1.25 000-scale Topographic 7.5 min X 15 min quadrangles.

(2) Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

(3) Flowrates were calculated from the watershed area and average annual surface runoff.

(4) Current velocities for lakes were not required and are listed as Not Applicable (NA).

(5) Depth for the Joe Pool Lake was based on information used in the Texas Natural Resource Conservation Commission (TNRCC) screening level assessments conducted on the same area. A central tendency depth of 4 meters was assumed for Watershed 1 water bodies based on visual inspection and topographic maps.

(6) USLE Erosivity/Rainfall Factor was obtained from USDA (1993) and was used in the universal soil loss equation.

2.5 Air Dispersion Modeling

The results of the air dispersion modeling represent the initial fate and transport of constituents in the environment. Vapor and particle air concentrations, wet and dry deposition of particles, and wet deposition of vapors were modeled. The *Screening Guidance* recommends the use of the ISCSTDFT (previously known as ISC-COMPDEP) to estimate the air concentrations and deposition rates needed for the indirect exposure assessment. ISCSTDFT is a draft version of the EPA's Industrial Source Complex Short Term Model (ISCST). It is a Gaussian plume model that is applicable in simple, intermediate, and complex terrains, and it can simulate both wet and dry deposition and plume depletion.

ISCSTDFT requires site-specific information on the facility emission sources in order to estimate air concentrations and deposition rates. The facility-specific inputs that were applied in conducting the air dispersion modeling were obtained from facility-specific information provided by TNRCC. The facility-specific emission sources that were considered in this analysis were discussed in Section 2.2.

The ISCSTDFT also requires a variety of meteorological data, which are available from several different sources. The National Weather Service Station at Dallas/Fort Worth, Texas provided the most appropriate surface data for the facility. Upper air data from Stephenville, Texas was paired with the surface data for air dispersion modeling. The National Weather Service Station in Dallas/Ft. Worth is located approximately 35 miles north of Midlothian and Stephenville is located approximately 90 miles southwest of the facilities. Five years of meteorological data, for the year 1985 and 1987-1990, were obtained from EPA's SCRAM bulletin board and were used to determine long-term average air dispersion and deposition estimates. The precipitation type, precipitation amount, and station pressure are additional meteorological data required by ISCSTDFT. These data were obtained from the Solar and Meteorological Surface Observation Network (SAMSON) CD-ROM (NOAA, 1993).

The meteorological preprocessors PCRAMMET, DEPMET, and PMERGE are needed to convert the meteorological data gathered from various sources into the format used by ISCSTDFT. PCRAMMET pairs the surface data with the upper air data to create a meteorological file that contains hourly wind speed, wind direction, atmospheric stability class, temperature, and mixing height. PMERGE prepares a precipitation amount file for the modeling of wet deposition. DEPMET creates a short term meteorological file from the outputs of PMERGE and PCRAMMET and the precipitation type from hourly surface observations. The preprocessor DEPMET also requires additional inputs based on site-specific land use data, and these inputs are listed in Table 2.5.1. DEPMET inputs were derived from recommendations from the ISCSTDFT User's Guide (US EPA, 1994d) based on the site-specific land use data. Land use

information for the facility was determined based on information from the U.S. EPA Region VI and the TNRCC and assessed through topographic maps.

The ISCSTDFT model was run using "default" model options specified in the *Guideline on Air Quality Models*. These options include the use of stack-tip downwash, buoyancy-induced dispersion, final plume rise, a routine for processing averages when calm winds occur, default values for wind profile exponents and for the vertical potential temperature gradient, and the use of upper bound estimates for super-squat buildings (U.S. EPA, 1994d).

Additional ISCSTDFT modeling options that can be important in characterizing plume dispersion are the terrain option and the building downwash algorithms. The terrain option was not used in conducting the air modeling. However, the building downwash option was used for all sources of emission except for fugitives from CSC.

Table 2.5.1 Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorological location	
Surface / upper air	Dallas, Fort Worth/Stephenville
Anemometer Height (m)	6.7 meters
DEPMET Preprocessor Inputs	
Land use within 5 km	rural
Min. M-O length (m)	2
Roughness height (m)	0.2
Displacement height (m)	1.0
Noon-time albedo (fraction)	0.2
Soil moisture available (fraction)	0.8
Net radiation absorbed in ground (fraction)	0.15
Anthropogenic heat flux (W/m^2)	0

Because facility-specific particle size distribution and the associated scavenging coefficients were not available, the distributions specified in EPA's Compilation of Air Pollutant Emission Factors (AP-42) were obtained from the Air-CHIEFS Bulletin Board on the U.S. EPA Office of Air Quality Planning and Standards' (OAQPS') Technology Transfer Network (TTN). Specifically, the wet process cement kiln particle size distribution, as seen in Table 2.5.2, was applied to both TXI and NTCC because these facilities manufacture portland cement by utilizing wet production processes. However, the dry process cement kiln particle size distribution, as seen in Table 2.5.3, was applied for Holnam. Tables 2.5.4 and 2.5.5 present the particle size

distributions applied to CSC. As seen from these tables, two distributions were applied to CSC. The controlled electric arc furnace (EAF) distribution was applied to the baghouse emissions while the uncontrolled EAF distribution was applied to the fugitive emissions. The scavenging coefficients associated with the particle size distribution were obtained from Jindal and Heinhold (1991). Liquid and frozen scavenging coefficients were set equal to each other as performed in past studies (PEI, 1986). For CSC, gases were assumed to behave as extremely small particles in the air dispersion modeling. The value of 1.7E-4 (h/mm-s) for the gas scavenging coefficient was also taken from Jindal and Heinhold (1991).

As specified in the *Screening Guidance*, the initial air dispersion modeling was conducted over a polar array of receptors, along 16 radials spaced at varying distances out to 10 kilometers. With the origin of the 10-kilometer radius placed at a point centrally located between the four facilities, attempts were made to identify the points of maximum combined deposition and air concentration, the closest residence, and the subsistence farmer using this radial array of receptors. However, the methodology specified in the *Screening Guidance* is intended for use with one facility located at the origin. As a consequence, the receptor spacing near the location of the four modeled facilities was too great (i.e.,not sufficiently refined) to determine accurately the points of maximum combined deposition and air concentration. Consequently, modeling with ISCSTDFT was repeated using a Cartesian coordinate grid with receptors spaced 500 meters apart out to 10 kilometers from the origin. In addition, the modeling was conducted using a unit emission rate of 1 gram/second from each source type located at each facility. The results of the air modeling for each receptor location of concern are presented in Tables 2.5.6 through 2.5.12.

The air modeling results were converted to chemical-specific air concentrations and deposition rates to identify the points of maximum concentration and deposition. This conversion accounted for chemical-specific emission rates (Q) and the partitioning of chemicals between the vapor and particle phases. All vapor phase air model outputs were multiplied by the fraction of emissions in the vapor phase under ambient conditions (fv) and the emission rate, Q. All particle-bound air model outputs were multiplied by the fraction of emissions in the particle phase (1-fv) and the emission rate, Q. The fraction of emissions in the vapor phase is chemical-specific and is contained in Attachment C, which lists the properties of the constituents considered in this risk analysis.

Table 2.5.2 TXI and NTCC Modeling Particle Information

Diameter (μm)	Mass-based particle size distribution	Area-based particle size distribution	Density (g/m^3)	Particle Scavenging coefficient for liquid precipitation $(s\text{-}mm/hr)^{-1}$	Particle scavenging coefficient for frozen precipitation $(s\text{-}mm/hr)^{-1}$	Gas scavenging coefficient for liquid precipitation $(s\text{-}mm/hr)^{-1}$	Gas scavenging coefficient for frozen precipitation $(s\text{-}mm/hr)^{-1}$
2.50	0.64	0.802	1.0	1.80E-4	0.7E-4	1.7E-4	0.7E-4
3.75	0.19	0.158763	1.0	2.70E-4	0.7E-4	1.7E-4	0.7E-4
7.50	0.02	0.008356	1.0	5.00E-4	0.7E-4	1.7E-4	0.7E-4
12.5	0.06	0.015041	1.0	6.62E-4	0.7E-4	1.7E-4	0.7E-4
17.5	0.07	0.012534	1.0	6.62E-4	0.7E-4	1.7E-4	0.7E-4
20.0	0.02	0.003133	1.0	6.62E-4	0.7E-4	1.7E-4	0.7E-4

Table 2.5.3 Holnam Modeling Particle Information (AP-42 Dry Process)

Diameter (μm)	Mass-based particle size distribution	Area-based particle size distribution	Density (g/m³)	Particle Scavenging coefficient for liquid precipitation (s-mm/hr)⁻¹	Particle scavenging coefficient for frozen precipitation (s-mm/hr)⁻¹
2.5	0.45	0.63	1	1.8E-4	0.7E-4
3.75	0.32	0.30	1	2.7E-4	0.7E-4
7.5	0.07	0.03	1	5E-4	0.7E-4
12.5	0.05	0.01	1	6.62E-4	0.7E-4
17.5	0.11	0.02	1	6.62E-4	0.7E-4

Table 2.5.4 Chaparral EAF (Stack) Modeling Particle Information for Process Emissions

Diameter (μm)	Mass-based particle size distribution	Area-based particle size distribution	Density (g/m³)	Particle Scavenging coefficient for liquid precipitation (s-mm/hr)⁻¹	Particle Scavenging coefficient for frozen precipitation (s-mm/hr)⁻¹
0.5	0.74	0.988	1	4E-5	4E-5
7.5	0.02	0.002	1	5E-5	5E-5
12.5	0.04	0.002	1	6.62E-4	6.62E-4
17.5	0.2	0.008	1	6.62E-4	6.62E-4

Table 2.5.5 Chaparral Modeling Particle Information for Fugitive Emissions

Diameter (μm)	Mass-based particle size distribution	Area-based particle size distribution	Density (g/m^3)	Particle Scavenging coefficient for liquid precipitation $(s\text{-}mm/hr)^{-1}$	Particle scavenging coefficient for frozen precipitation $(s\text{-}mm/hr)^{-1}$
0.5	0.08	0.30	1	40E-5	4.0E-5
0.75	0.15	0.38	1	4.0E-5	4.0E-5
1.75	0.2	0.22	1	8E-5	8E-5
3.75	0.1	0.05	1	2.7E-4	2.7E-4
7.5	0.05	0.01	1	5.0E-4	5.0E-4
12.5	0.03	0.005	1	6.62E-4	6.62E-4
20	0.39	0.04	1	6.62E-4	6.62E-4

Table 2.5.6 Results of Air Modeling: CSC Fugitive Emissions

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (sec/m^2-yr)	DRY PARTICLE DEPO. (Sec/m^2-yr)	WET PARTICLE DEPO. (Sec/m^2-yr)	AIR CONC. VAPOR ($ug\text{-}sec/g\text{-}m^3$)	WET VAPOR DEPO. (Sec/m^2-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	4.4	4.3	0.11	2.7	0.10
RECEPTOR B1	805, 2940	1000, 3000	0.02	0.92	0.01	0.78	0.01
RECEPTOR C1	-3013, -2951	-3000, -3000	61	59	2.3	37	1.3
RECEPTOR C3	-2775, -1147	-3000, -1000	31	31	0.24	18	0.19

Table 2.5.7 Results of Air Modeling: CSC Baghouse A

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (sec/m^2-yr)	DRY PARTICLE DEPO. (sec/m^2-yr)	WET PARTICLE DEPO. (sec/m^2-yr)	AIR CONC. VAPOR ($ug\text{-}sec/g\text{-}m^3$)	WET VAPOR DEPO. (sec/m^2-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	0.06	0.06	0.002	0.083	0.002
RECEPTOR B1	805, 2940	1000, 3000	0.008	0.016	1.8E-4	0.030	2.9E-4
RECEPTOR C1	-3013, -2951	-3000, -3000	2.2	2.2	0.026	2.56	0.029
RECEPTOR C3	-2775, -1147	-3000, -1000	0.32	0.32	0.003	0.375	0.004

Table 2.5.8 Results of Air Modeling: CSC Baghouse B

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (gm/m²-yr)	DRY PARTICLE DEPO. (gm/m²-yr)	WET PARTICLE DEPO. (gm/m²-yr)	AIR CONC. VAPOR (ng-sec/g-m³)	WET VAPOR DEPO. (gm/m²-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	0.003	0.032	0.002	0.033	0.003
RECEPTOR B1	805, 2940	1000, 3000	0.012	0.008	1.5E-5	0.011	2.5E-4
RECEPTOR C1	-3013, -2951	-3000, -3000	0.055	0.034	0.022	0.024	0.002
RECEPTOR C3	-2775, -1147	-3000, -1000	0.080	0.078	0.003	0.063	0.004

Table 2.5.9 Results of Air Modeling: CSC Baghouse C

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (gm/m²-yr)	DRY PARTICLE DEPO. (gm/m²-yr)	WET PARTICLE DEPO. (gm/m²-yr)	AIR CONC. VAPOR (ng-sec/g-m³)	WET VAPOR DEPO (gm/m²-yr).
RECEPTOR A1	-1550, -6540	-1500, -6500	0.031	0.028	0.002	0.029	0.003
RECEPTOR B1	805, 2940	1000, 3000	0.012	0.012	2.3E-4	0.016	3.8E-4
RECEPTOR C1	-3013, -2951	-3000, -3000	0.062	0.049	0.013	0.035	0.015
RECEPTOR C3	-2775, -1147	-3000, -1000	0.078	0.076	0.003	0.063	0.003

Table 2.5.10 Results of Air Modeling: NTCC

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (gm/m²-yr)	DRY PARTICLE DEPO. (gm/m²-yr)	WET PARTICLE DEPO. (gm/m²-yr)	AIR CONC. VAPOR (ng-sec/g-m³)	WET VAPOR DEPO. (gm/m²-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	0.013	0.012	0.001	0.023	0.001
RECEPTOR B1	805, 2940	1000, 3000	0.021	0.018	0.003	0.017	0.003
RECEPTOR C1	-3013, -2951	-3000, -3000	0.005	0.005	0.001	0.008	0.001
RECEPTOR C3	-2775, -1147	-3000, -1000	0.005	0.004	0.001	0.006	0.001

Table 2.5.11 Results of Air Modeling: TXI

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (gm/m²-yr)	DRY PARTICLE DEPO. (gm/m²-yr)	WET PARTICLE DEPO. (gm/m²-yr)	AIR CONC. VAPOR (ng-sec/g-m³)	WET VAPOR DEPO. (gm/m²-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	0.051	0.047	0.004	0.067	0.004
RECEPTOR B1	805, 2940	1000, 3000	0.009	0.009	4.4E-4	0.013	4.0E-4
RECEPTOR C1	-3013, -2951	-3000, -3000	0.111	0.001	0.010	0.004	0.008
RECEPTOR C3	-2775, -1147	-3000, -1000	0.012	0.008	0.004	0.013	0.003

Table 2.5.12 Results of Air Modeling: Holnam

LOCATION	ACTUAL COORD.	MODEL COORD.	COMBINED PARTICLE DEPO. (gm/m^2-yr)	DRY PARTICLE DEPO. (gm/m^2-yr)	WET PARTICLE DEPO. (gm/m^2-yr)	AIR CONC. VAPOR (μg-sec/g-m^2)	WET VAPOR DEPO. (gm/m^2-yr)
RECEPTOR A1	-1550, -6540	-1500, -6500	0.004	0.003	2.8E-4	0.005	2.8E-4
RECEPTOR B1	805, 2940	1000, 3000	0.006	0.001	0.005	0.003	0.003
RECEPTOR C1	-3013, -2951	-3000, -3000	0.001	0.001	5.0E-4	0.001	4.6E-4
RECEPTOR C3	-2775, -1147	-3000, -1000	0.001	0.001	0.001	0.001	0.001

Table 2.5.13 Site-Specific Receptors Locations

Receptor	Location (Distance (km)/Direction)
Resident A1 Resident B1 Resident C1	3.4 km South of TXI 1.1 km Southeast of NTCC 0.5 km North of Chaparral
Subsistence farmer A1 Subsistence farmer B1 Subsistence farmer C1	3.4 km South of TXI 1.1 km Southeast of NTCC 0.5 km North of Chaparral
Subsistence fisher location used for inhalation, vegetable and soil ingestion Site-specific watersheds used for fish ingestion by the subsistence fisher	Based on location of the residents SCS Lakes 9 & 10 Joe Pool Lake
Waterbody identified as surface drinking water source	Joe Pool Lake

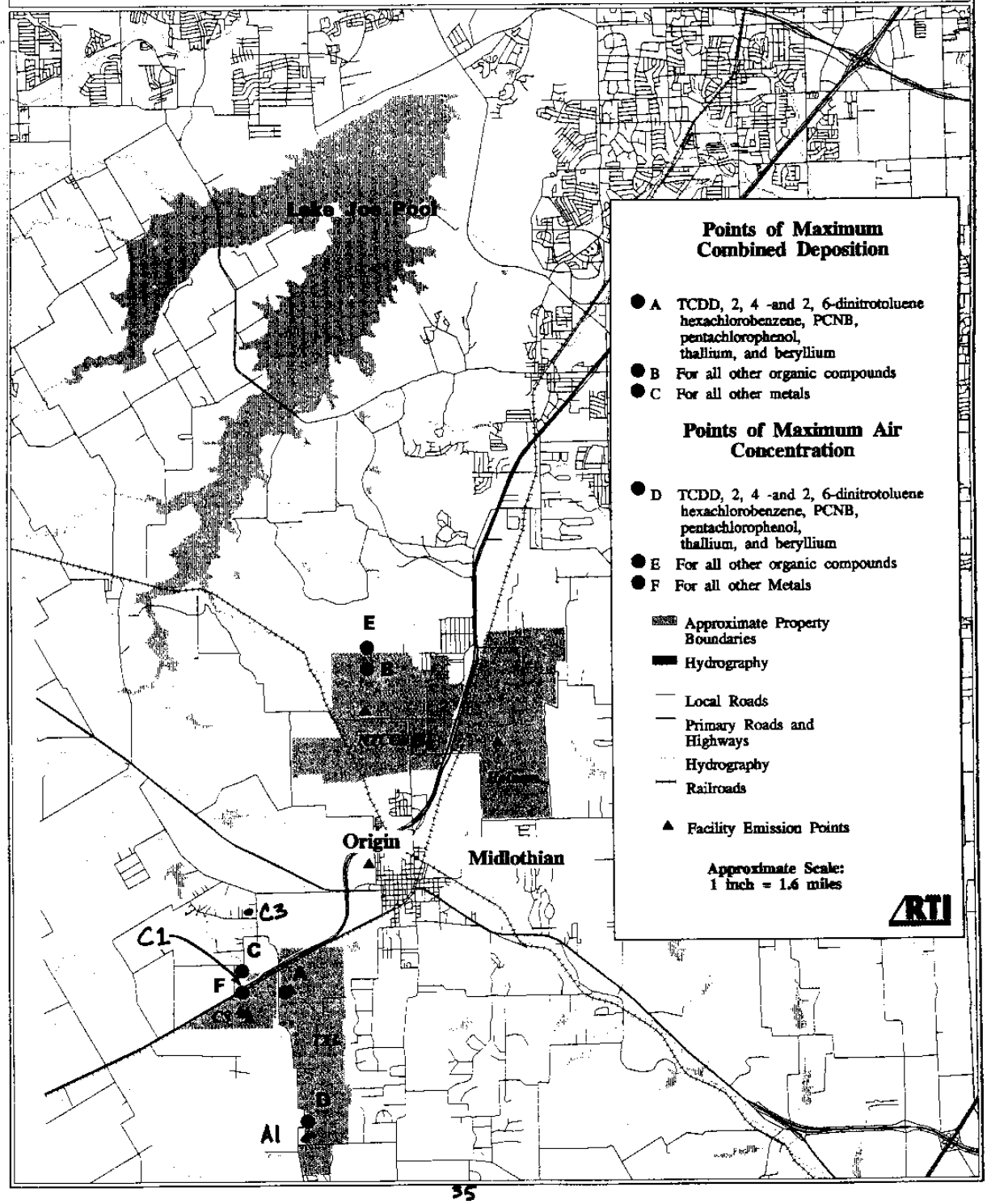
Map 1 identifies the points of maximum air concentration and combined deposition based on estimated constituent-specific emission rates. As seen from this map, there were three points of maximum air concentration and three points of maximum deposition identified. For each compound, these points were typically located in close proximity to the facility emitting the compound at the highest rate. Maps 2 and 3 graphically present the maximum combined deposition for bis(2-ethylhexyl) phthalate and maximum combined deposition for TCDD. Map 1 also shows the general location of each site specific receptor evaluated in the study.

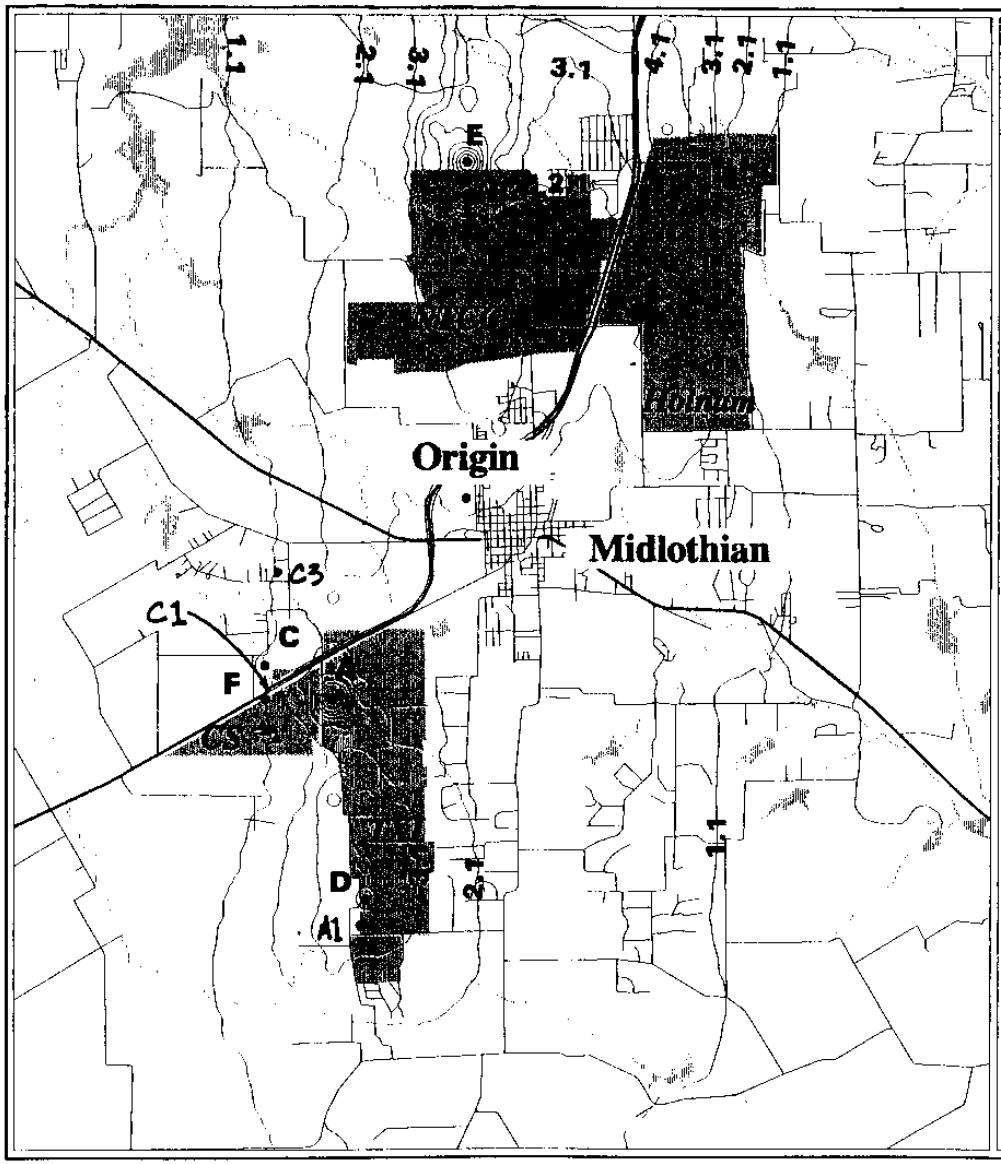
In the original draft of the report, risks at the maximum locations were estimated and reported. However, based on comments from several reviewers, Region 6 did not report risk at the maximum receptor locations in this final version of the report. Reporting risk at the maximum receptor locations was judged to be overly conservative because such an analysis would have required Region 6 to assume that maximum deposition and air concentrations occur at the same location. Such a phenomenon is not indicative of the model and would result in overly conservative estimates of risk in some instances.

Rather than estimate theoretical worst case risk, Region 6 obtained information regarding the location of several potential resident and farm locations likely to be most impacted by the facilities.[10] This information was obtained during several site visits that were conducted during the summer of 1995. As seen from Table 2.5.13, three site-specific residents/subsistence fishers and subsistence farmers were identified and modeled in the analysis. Multiple receptors were considered in order to ensure that the maximum media concentrations of each pollutant were considered because the overall risks for each pathway could vary according to which contaminant was deposited at the highest rate or was present at the highest ambient air location. Resident A1 and subsistence farmer A1, resident B1 and subsistence farmer B2, and resident C1 and subsistence farmer C3 are the receptors located closest to the points of maximum combined deposition A, B, and C, respectively. The exposed individuals assumed to live at residence A1, B1, and C1 included the adult and child resident and the subsistence fisher. The difference between the adult resident and subsistence fisher was that the fisher was additionally exposed through the consumption of contaminated fish.

[10] It should be noted that these locations do not necessarily reflect actual residences and farms based on interviews etc., but rather reflect a reasonably conservative analysis of activities as seen from driving in and about the study area. For example, residential locations typically correspond to locations of houses or similar residential-type structures. Farms were estimated based on the presence of livestock or barn type structures in the area of interest.

Map 1:
Points of Maximum Combined Deposition and Air Concentration





Map 2: Combined Deposition Contours for Bis(2-ethylhexyl)Phthalate

— Combined Deposition Contours for Bis(2-ethylhexyl)Phthalate
Base Contour 1.1E-6 g/m^2/yr
Contour Interval 1E-6 g/m^2/yr

Points of Maximum Combined Deposition

- **A** TCDD, 2, 4 -and 2, 6-dinitrotoluene, hexachlorobenzene, PCNB, pentachlorophenol, thallium and beryllium
- **B** For all other organic compounds
- **C** For all metals

Points of Maximum Air Concentration

- **D** TCDD, 2, 4 -and 2, 6-dinitrotoluene hexachlorobenzene, PCNB, pentachlorophenol, thallium, and beryllium
- **E** For all other organic compounds
- **F** For all Metals

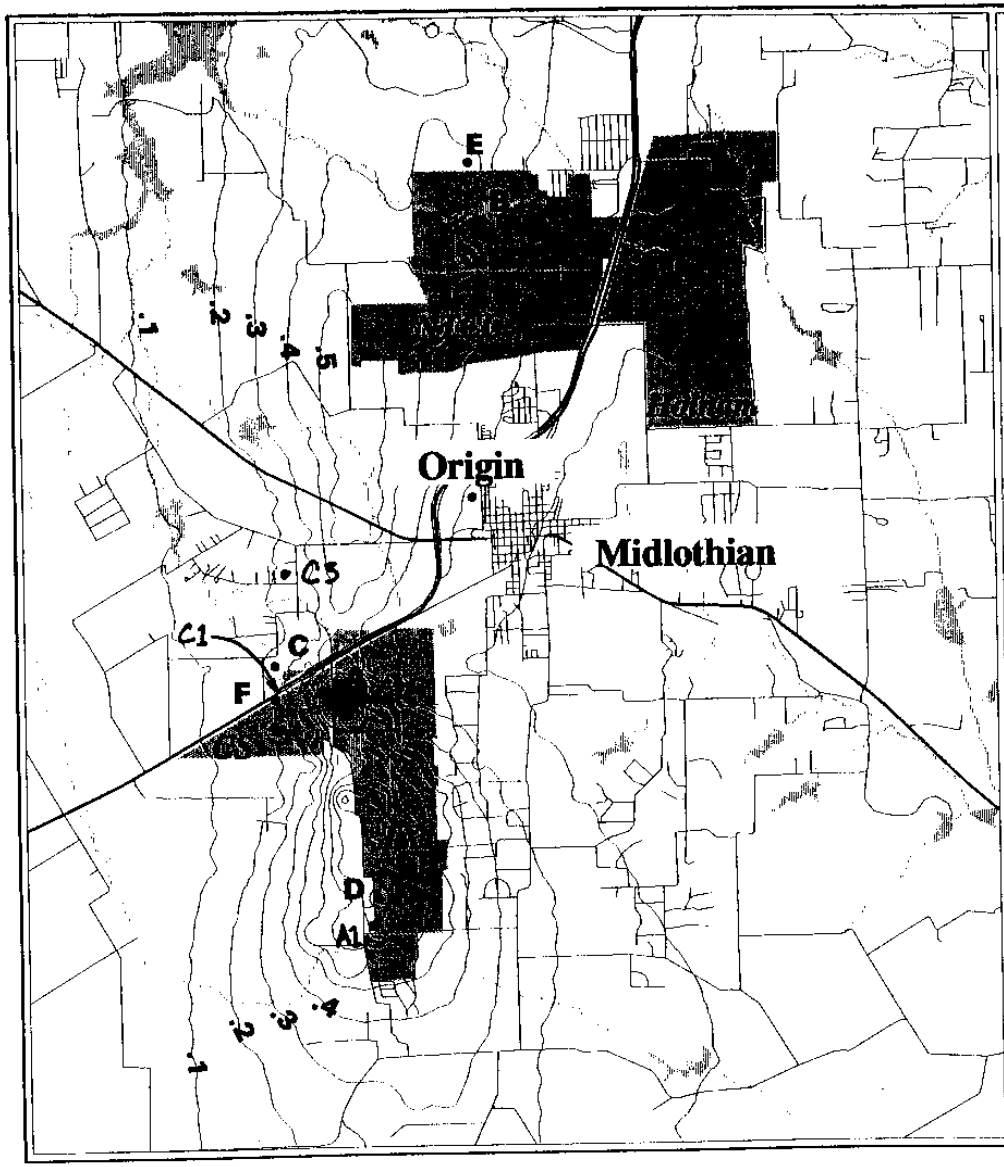
▲ **Facility Emission Points**
• **Origin**

Approximate Property Boundaries

Hydrography

Approximate Scale:
1 Inch = 1.42 Miles

RTI



Map 3: Combined Deposition Contours for TCDD

TCDD Combined Deposition Contours
Base Contour .1E-9 $g/m^2/yr$
Contour Interval .1E-9 $g/m^2/yr$

Points of Maximum Combined Deposition

- **A** TCDD, 2, 4 -and 2, 6-dinitrotoluene hexachlorobenzene, PCNB, pentachlorophenol, thallium and beryllium
- **B** For all other organic compounds
- **C** For all metals

Points of Maximum Air Concentration

- **D** TCDD, 2, 4 -and 2, 6-dinitrotoluene and hexachlorobenzene, PCNB, pentachlorphenol, thallium, and beryllium
- **E** For all other organic compounds
- **F** For all Metals

▲ **Facility Emission Points**
• **Origin**

Approximate Property Boundaries

Hydrography

Approximate Scale:
1 Inch = 1.42 Miles

RTI

2.6 Deviations from the Screening Guidance Methodology

This section summarizes instances where the methodology used in this risk assessment deviated from that contained in the *Screening Guidance* document. These instances included the estimation of soil concentration due to deposition, the development of the default watershed parameters, the use of chemical specific fate and transport parameters, and the modification of exposure parameters for the child.

The most significant deviation from the *Screening Guidance* methodology occurred in the calculation of soil concentration due to deposition of contaminants. The *Screening Guidance* gives the following equation which is used to calculate an average contaminate soil concentration for the scenario exposure duration:

$$c = \frac{\left(\frac{Ds \cdot Tc - Sc_{Tc}}{ks}\right) + \left(\frac{Sc_{Tc}}{ks} \cdot [1 - exp(-ks \cdot (T_2 - Tc)]\right)}{(T_2 - T_1)} \quad for\ T_1 < T_c \leq T$$

Equation 1

where

Sc	=	average soil concentration over exposure duration (mg/Kg)
Sc_{TC}	=	soil concentration at time Tc (mg/Kg)
Ds	=	deposition term (per unit time)
ks	=	overall soil loss constant (per unit time)
T_c	=	time period of combustion (year)
T_1	=	time at the beginning of exposure duration (year)
T_2	=	time at the end of exposure duration (year).

Equation 1 is appropriate for carcinogenic chemicals where the risk is averaged over the lifetime of an individual. Since the hazard quotient associated with chemicals not known to cause cancer chemicals is based on a reference dose and not on a lifetime exposure, the highest annual average soil concentration occurring within the exposure duration period is more appropriate. The maximum annual average soil concentration would occur at the end of the time period of combustion (which is assumed to be 30 years for this analysis) and is estimated by the following equation:

$$Sc_{Tc} = \frac{Ds \cdot (1 - exp(-ks \cdot Tc))}{ks}$$ *Equation 2*

A comparison of the two soil equations showed that the maximum annual average soil concentration can be up to two times as great as the soil concentration averaged over the entire exposure duration, depending on the type of chemical. Using Equation 1- the soil concentration averaged over the exposure duration - as directed in the *Screening Guidance*, would result in an underestimation of the risk for chemicals not known to cause cancer chemicals. Therefore, in this analysis, the soil concentrations for chemicals not known to cause cancer chemicals were calculated using Equation 2.

Equation 1 is not applicable for cases where the exposure duration (T_2) is less than time period of combustion (T_c). In such instances, the average concentration calculated from this equation can result in a negative soil concentration for some chemicals. Since the exposure duration for the child scenario was assumed to be 6 years, this equation could not be used. Instead, another soil equation was used to calculate the average soil concentration of carcinogenic chemicals for the child scenario. The equation is as follows:

$$\overline{Sc_1} = \frac{Ds}{ks \bullet (Tc - T_1)} \bullet \left[\left(Tc + \frac{\exp(-ks \bullet Tc)}{ks} \right) - \left(T_1 + \frac{\exp(-ks \bullet T_1)}{ks} \right) \right] for\ T_1 < Tc$$

Equation 3

where

Sc_1 = soil concentration over period in which exposure occurs (mg/Kg).

The T_1 in Equation 3 represents the beginning of the exposure duration and was assumed to occur at year 24 for the child. Thus, the child would be exposed over the time period having the highest average soil concentration. The above equation for the child is used only for carcinogens. As with the adult scenarios, soil concentration of chemicals not known to cause cancer chemicals was based on the maximum soil concentration (Equation 2) over the time period of exposure.

Some of the chemical inputs specified in the *Screening Guidance* have been updated and revised since the draft document was prepared in December 1994. Most notably, the fraction of mercury assumed to be in vapor is now modeled as 0.85 and not as 1 as specified in the *Screening*

Guidance. The revised vapor/particle partitioning for mercury is assumed, and it differs from that specified in the *Mercury Study Report to Congress* (U.S. EPA 1994b). The reason for this difference is attributable to where partitioning is assumed to occur. The *Report to Congress* presents the partitioning of mercury at the stack and the fraction of vapor as it would exist in stack emissions. As specified in the Addendum (U.S. EPA, 1993) and applied in this analysis, the vapor/particle partitioning is calculated at the receptor location (i.e., the watershed, the plant, the cow, etc.). The partitioning at the receptor location (i.e. at cooler, ambient temperatures) is expected to differ from the stack emissions (U.S. EPA, 1994b).

Another change incorporated into this report is the air to plant biotransfer factor (Bv) for PAHs and phthalates. The Bvs specified in this report are either based on measured data or (where measured data were available) on a modified equation. The modification reduces the Bv by a factor of 40 and is consistent with recommendations in the Dioxin document[11] (U.S. EPA 1994a). A complete list of the chemical data is contained in Attachment C. These data are consistent with both the most recent Dioxin document (U.S. EPA 1994a) and, with the exception of the vapor fraction for mercury, the *Mercury Report to Congress* (U.S. EPA, 1994b).

The beef and milk biotransfer factors for cadmium and mercury have also been changed since the December version of the *Screening Guidance* document. The revised biotransfer factors are used to calculate risks from beef or milk on a dry weight basis. The consumption rates currently used for beef and milk had to be adjusted to a dry weight to account for these new factors. The conversion factors are 0.4 and 0.1 for beef and milk, respectively (Memorandum, US EPA/ORD 1994).

Some of the exposure parameters for the child scenarios were also changed. Specifically, the consumption rate of above-ground vegetables and the inhalation rate have been revised. Values for these parameters provided in the *Screening Guidance* document were estimated by applying a body weight adjustment factor to the adults consumption and inhalation rates. Finally, the consumption rate of vegetables that was used in this analysis was revised from the *Screening Guidance* to be consistent with the *Mercury Report to Congress*, which recommends a value based on the dietary habits of children.

---

[11] The Dioxin document (U.S. EPA, 1994a) recommends reducing Bvs by 40 for dioxin and dioxin-like compounds. The PAHs and phthalates behave similarly to dioxins in the environment (i.e., they are lipophilic) and the adjustment makes the calculated values similar to the values measured for a select group of lipophilic compounds in Hites (1994).

3. RESULTS

The results of the theoretical risk assessment are presented in this section. Some general background information about risk assessment is presented followed by the specific results for each receptor location and each pathway for both theoretical carcinogenic and theoretical potential non-cancer effects. An overall summary of the results is pesented in Section 3.3. All results are presented in tabular format in Attachment A.

3.1 Background

The national risk, or probability, that an individual may develop some form of cancer from everyday sources, over a 70-year life span, is estimated at three in ten. Activities such as too much exposure to sun, occupational exposures, or dietary or smoking habits contribute to this high risk. The three in ten probability is considered the "natural incidence" of cancer in the United States.

In the Superfund program, EPA established an excess acceptable lifetime cancer risk range from one in ten thousand to one in one million. This range may be expressed as 1×10^{-4} to 1×10^{-6} (expressed throughout this report as 1E-4 to 1E-6). For example, a risk of 1×10^{-6} means that 1 person out of one million could develop cancer as a result of a lifetime exposure to a emissions from the four facilities studied in this assessment. In the Superfund program, EPA must consider the need to conduct remedial action at a site if the risk exceeds 1×10^{-6} and EPA usually requires remedial action at locations where excess cancer risks are greater than 1×10^{-4} (1 excess cancer case in ten thousand people could potentially occur).

The level of concern for non-carcinogenic contaminants is determined by calculating a Hazard Quotient (HQ) or Hazard Index (HI). An HI is the sum of the HQs for several chemicals that affect the same target organ. If the HQ or HI equals or exceeds one, there may be concern for potential exposure to site contaminants. EPA typically considers the need for taking a remedial action at locations where the HQ or HI values equal or are slightly greater than 1.0 for human populations who may reasonably be expected to be exposed. EPA usually requires remedial action at locations where HQ or HI values significantly exceed one.

3.2 Results by Receptor Location

The greatest estimated theoretical risk is 1E-4 for a subsistence fisherman that resides at either Point B1 or C1 and who fishes SCS Lakes 9 and 10. Theoretical hazard quotients equal to or slightly greater than one were estimated for all of the receptors at all three locations.

The presentation is divided into two sections; theoretical cancer risk and potential for theoretical noncancer health effects. These sections are further subdivided by receptor location.

3.2.1 Theoretical Cancer Risks Estimates

Point A1

Theoretical cancer risks for each pathway and each receptor are summarized in Table 3.2.1.1.

Table 3.2.1.1 Point A1 Cancer Risk Results

TABLE 3.2.1.1				
RECEPTOR	INDIRECT PATHWAY	DRINKING WATER PATHWAY	INHALATN PATHWAY	TOTAL
Adult Resident	3E-7	6E-6	1E-6	7E-6
Child Resident	7E-7	2E-6	6E-7	3E-6
Farmer	4E-5	7E-6	1E-6	5E-5
Fisherman SCS Lake	8E-5	6E-6	1E-6	9E-5
Fisherman Joe Pool Lake	2E-5	6E-6	1E-6	3E-5

The risks associated with the adult resident are driven by the drinking water and inhalation pathways. The primary contaminants contributing to this risk are arsenic for the drinking water pathway and cadmium for the inhalation pathway.

Two-thirds of the risks associated with the child resident are provided by the drinking water pathway with the indirect and inhalation pathways providing the additional third of the risk.

The primary contaminants contributing to the drinking water and inhalation risk are arsenic and cadmium, respectively. Dioxin, benzo(a)pyrene equivalents (BAP), and arsenic combine to make up the remainder of the indirect pathway risk.

The risks associated with the subsistence farmer are driven by the indirect pathway. Dioxin, BAP, and arsenic combine with bis-2-(ethylhexyl)phthalate (DEHP) to cause risk via the indirect pathway risk. The remaining 20% of the risk are provided by the drinking water and inhalation pathways with arsenic and cadmium, respectively, driving the risk.

The risks associated with the subsistence fishermen are driven by the indirect pathway. Arsenic is the predominate contaminant driving this risk with some contribution from dioxin and BAP. The remaining risk from the drinking water and inhalation pathways are again associated with arsenic and cadmium.

Point B1

Cancer risk for each pathway and each receptor are summarized in Table 3.2.1.2.

Table 3.2.1.2 Point B1 Cancer Risks Results

TABLE 3.2.1.2				
RECEPTOR	**INDIRECT PATHWAY**	**DRINKING WATER PATHWAY**	**INHALATN PATHWAY**	**TOTAL**
Adult Resident	6E-8	6E-6	2E-5	3E-5
Child Resident	1E-7	2E-6	9E-6	1E-5
Farmer	1E-5	7E-6	2E-5	4E-5
Fisherman SCS Lake	8E-5	6E-6	2E-5	1E-4
Fisherman Joe Pool Lake	2E-5	6E-6	2E-5	5E-5

The inhalation pathway dominates the adult resident risk at this location. The primary contaminant driving the inhalation risk is hexavalent chromium. Arsenic dominates the drinking

water risk. The indirect pathway does not significantly contribute to the overall risk to adult residents at receptor location B1. The child resident risk is also due primarily to the inhalation and drinking water pathway for similar reasons.

The risks to the subsistence farmer are controlled equally by the inhalation pathway and a combination of the indirect and drinking water pathways. Chrome VI drives the inhalation pathway risk and arsenic dominates the drinking water pathway. Dioxin, BAP, DEHP, and arsenic make up most of the indirect pathway risk.

The risks to the subsistence fisherman vary depending upon which water body is used to support subsistence activities. If the SCS lakes are the primary source of fishing, the indirect pathway drives the risk. Arsenic is primary contributor to the SCS Lake indirect pathway risks with additional contributions by dioxin, BAP, DEHP, and beryllium. If Joe Pool Lake is fishing source, then overall risk are controlled equally by the indirect and inhalation pathways with some contribution by the drinking water pathway. The drinking water and inhalation risks are attributed to arsenic and chrome VI, respectively, while the indirect pathway risk is driven by a combination of dioxin, BAP, DEHP, and PCBs.

Point C1[12]

Cancer risk for each pathway and each receptor are summarized in Table 3.2.1.3.

[12] Indirect pathway risks attributed to the subsistence farmer are actually calculated at point 7,640 feet north of Point C1, at Point C3. Subsistence farming activity was not present in the area of point C1 (which is almost directly across Highway 67 from CSC).

Table 3.2.1.3 Point C1 Cancer Risk Results

TABLE 3.2.1.3				
RECEPTOR	**INDIRECT PATHWAY**	**DRINKING WATER PATHWAY**	**INHALATN PATHWAY**	**TOTAL**
Adult Resident	1E-6	6E-6	3E-5	4E-5
Child Resident	1E-6	2E-6	2E-5	2E-5
Farmer	4E-5	7E-6	1E-5	6E-5
Fisherman SCS Lake	9E-5	6E-6	3E-5	1E-4
Fisherman Joe Pool Lake	2E-5	6E-6	3E-5	6E-5

The risks to adult residents at this location are dominated by the inhalation pathway. The primary contaminants contributing to this risk are cadmium and chrome VI. The drinking water pathway is the next most significant contributor to overall adult receptor risks, primarily due to arsenic. The indirect pathway risk is also attributed to arsenic. The source of the risk for the child pathway is the same as the adult pathway.

The most significant contributor to the subsistence farmer risk is the indirect pathway which is again driven by arsenic. Cadmium and chrome VI dominate the inhalation pathway and arsenic controls the drinking water pathway risks.

Similarly to Point B1, the risks to the subsistence fisherman varies depending upon which water body is used to support subsistence activities. If the SCS lakes are the primary source of fishing, the indirect pathway drives the risk. Arsenic is primary contributor to the SCS Lake indirect pathway risks with contributions by dioxin, BAP, DEHP, and beryllium. If Joe Pool Lake is the fishing source, then the inhalation pathway controls risk with a significant contribution by the indirect pathway and a lessor contribution by the drinking water pathway. The inhalation pathway risks are attributed to cadmium and chrome VI, respectively, while the indirect pathway risk is driven by a combination of dioxin, BAP, DEHP, and PCBs. Drinking water risk is once again due to arsenic.

3.2.2 Potential for Theoretical Non-Cancer Health Effects

The contaminants estimated to have the most significant potential for non-cancer health effects are arsenic, cadmium, chromium, mercury, and zinc. The results of the non-cancer health effects evaluation are presented for each receptor location below.

Point A1

Table 3.2.2.1 Point A1 Non-Cancer Effects Results

TABLE 3.2.2.1						
	As	Cd	Cr VI	Hg	Sb	Zn
Adult Resident	0.03	0.3	0.004	0	3	0.1
Child Resident	0.05	0.7	0.006	0.004	6	0.2
Farmer	0.05	0.4	0.005	0	3	0.1
Fisherman SCS Lake Watershed	0.4	1	0.01	1	3	0.4
Fisherman Joe Pool Lake Watershed	0.05	0.5	0.004	1	3	0.1

The analysis shows that the hazard quotient (HQ) for antimony is greater than the threshold value of one. An HQ greater than or equal to one indicates that there is a potential for noncancer health effects from antimony. However, readers are reminded that an HQ equal to or exceeding the threshold no way indicates that non-cancer health effects can or will occur, only that a potential for non-cancer effects exist based on a specific set of model and exposure assumptions. The most significant contribution to antimony exposure is through the drinking water pathway. Because the HQ for antimony was greater than one, Region 6 expanded its study to include an analysis of existing antimony concentrations in Joe Pool Lake and the Midlothian water supply. Although very little data were available, water analysis report prepared by the Texas Water Commission in 1993 was located which reports concentrations of antimony in the Midlothian water supply at less than the 0.002 milligrams per liter (mg/l) detection limit. The HQ associated with ½ this detection limit (0.001 mg/l) and the exposure parameters previously specified in Table 2.4.1 and Attachment B, is 0.05. Thus, the most recent site data available to Region 6 show no significant potential for adverse health effects from antimony.

The HQs for mercury are estimated to be at the threshold level of 1 for both fish sources and cadmium is predicted at the threshold level of one for the fisherman that uses the SCS Lakes as a primary source of fish. The HQ for mercury needs to be reviewed with extreme caution, however, as recent discussions within EPA have indicated that quantitative risk assessment results for mercury are not confident enough for purposes of rendering regulatory decisions. Indeed, the quantitative portions of the risk assessment for mercury included in the original version of the hazardous waste combustion rule were withdrawn in favor of a more qualitative approach. This change was instituted as a result of concerns within EPA regarding the risk assessment methodology's application to mercury.

The potential for non-cancer health effects from cadmium should also be viewed within the appropriate context. Readers are cautioned to remember that the SCS Lake subsistence fisher scenario is the most uncertain of the two subsistence fishing scenarios and the relatively significant uncertainties associated with the emission estimates for CSC, the predominate source of cadmium emissions in this study.

Point B1

Table 3.2.2.2 Point B1 Non-Cancer Effect Results

TABLE 3.2.2.2						
	As	Cd	Cr VI	Hg	Sb	Zn
Adult Resident	0.03	0.3	0.004	0	3	0.1
Child Resident	0.05	0.6	0.008	0.002	6	0.2
Farmer	0.04	0.3	0.01	0	3	0.1
Fisherman SCS Lake Watershed	0.4	1	0.5	1	3	0.4
Fisherman Joe Pool Lake Watershed	0.05	0.5	0.004	1	3	0.1

The results of the study again indicate that the hazard quotient for antimony is greater than the threshold value of one. The most significant contribution to antimony exposure is through the drinking water pathway. Because the HQ for antimony is greater than one, Region 6 expanded its study to include an analysis of existing antimony concentrations in Joe Pool Lake and the Midlothian water supply. A water analysis report prepared by the Texas Water Commission in

1993 reports concentrations of antimony in the Midlothian water supply as less than 0.002 milligrams per liter (mg/l). The HQ associated with 0.001 mg/l and the previously specified exposure parameters is 0.05. Thus, the most recent site data available to Region 6 show no significant potential for non-cancer health effects from antimony.

Similar to receptor Point A1, the HQs for mercury are estimated to be at the threshold level of 1 for both subsistence fisherman pathways, and cadmium is predicted at the threshold level for the fisherman that uses the SCS Lakes as a primary source of fish. The HQ for mercury needs to be reviewed with extreme caution, however, as recent discussions within EPA have indicated that quantitative risk assessment results for mercury are not confident enough for purposes of rendering regulatory decisions.

As noted in the discussion regarding Point A1, the potential for non-cancer health effects from cadmium should also be viewed within the appropriate context. Readers are cautioned to remember that the SCS Lake subsistence fisherman scenario is the most uncertain of the two subsistence fishing scenarios, and the relatively significant uncertainties associated with the emission estimates for CSC, the predominate source of cadmium emissions in this study.

Point C1

Table 3.2.2.3 Point C1 Non-Cancer Effects Results

TABLE 3.2.2.3						
	As	Cd	Cr VI	Hg	Sb	Zn
Adult Resident	0.03	0.3	0.004	0	3	0.1
Child Resident	0.05	0.7	0.006	0.004	6	0.2
Farmer	0.1	0.5	0.008	0	4	0.2
Fisherman SCS Lake Watershed	0.4	1	0.01	1	3	0.5
Fisherman Joe Pool Lake Watershed	0.06	0.8	0.005	1	3	0.2

The results for receptor Point C1 are similar to the results for Points A1 and B1. The discussion of the results is the same and is not repeated here.

1993 reports concentrations of antimony in the Midlothian water supply as less than 0.002 milligrams per liter (mg/l). The HQ associated with 0.001 mg/l and the previously specified exposure parameters is 0.05. Thus, the most recent site data available to Region 6 show no significant potential for non-cancer health effects from antimony.

Similar to receptor Point A1, the HQs for mercury are estimated to be at the threshold level of 1 for both subsistence fisherman pathways, and cadmium is predicted at the threshold level for the fisherman that uses the SCS Lakes as a primary source of fish. The HQ for mercury needs to be reviewed with extreme caution, however, as recent discussions within EPA have indicated that quantitative risk assessment results for mercury are not confident enough for purposes of rendering regulatory decisions.

As noted in the discussion regarding Point A1, the potential for non-cancer health effects from cadmium should also be viewed within the appropriate context. Readers are cautioned to remember that the SCS Lake subsistence fisherman scenario is the most uncertain of the two subsistence fishing scenarios, and the relatively significant uncertainties associated with the emission estimates for CSC, the predominate source of cadmium emissions in this study.

Point C1

Table 3.2.2.3 Point C1 Non-Cancer Effects Results

TABLE 3.2.2.3						
	As	Cd	Cr VI	Hg	Sb	Zn
Adult Resident	0.03	0.3	0.004	0	3	0.1
Child Resident	0.05	0.7	0.006	0.004	6	0.2
Farmer	0.1	0.5	0.008	0	4	0.2
Fisherman SCS Lake Watershed	0.4	1	0.01	1	3	0.5
Fisherman Joe Pool Lake Watershed	0.06	0.8	0.005	1	3	0.2

The results for receptor Point C1 are similar to the results for Points A1 and B1. The discussion of the results is the same and is not repeated here.

Lead Exposure

Because health benchmarks for lead were not available, exposure estimates are not presented for lead. Instead, lead concentrations in the air and soil were estimated and compared to standard threshold type values EPA uses to in other programs such as Superfund and the Clean Air programs. The results are shown in Table 3.2.2.4.

Lead concentrations in soil were compared to EPA Superfund's threshold level of 400 ppm for lead at Superfund sites. Further study is necessary to determine the potential health effects of lead if concentrations are found to be present above the threshold level. As seen from this table, the modeled concentrations of lead in soil are approximately five to ten times greater than the threshold level. However, results of analysis from soil samples collected at the site show that the model over predicts concentrations of lead in soil. According to TNRCC and recent unvalidated sampling by CSC, actual soil concentrations of lead north of CSC typically range from 7.95 to 141 mg/kg.

Lead concentration in air was compared with National Ambient Air Quality Standard for lead of 1.5 $\mu g/m^3$ and is also presented in Table 3.2.2.4. The model does not predict lead concentrations above the NAAQS of 1.5 $\mu g/m^3$. Air monitoring for lead conducted by TNRCC also failed to show concentrations of lead in air above the NAQQS.

Table 3.2.2.4 Lead Concentrations in Air and Soil

Exposure Scenario	Lead Concentration in Soil (mg/kg)	Ratio of Lead in Soil to 400 ppm
	Estimated Representative	Estimated Representative
Subsistence farmer	1E + 3	2.4
Adult resident	2E + 3	6.0
Child resident	2E + 3	6.0
Subsistence fisherman	2E + 3	6.0
	Air Concentration ($\mu g/m^3$)	Ratio of Lead in Air to NAAQS
	Estimated Representative	Estimated Representative
Subsistence farmer	2E - 1	.11
Adult resident	4E - 1	.28
Child resident	4E - 1	.28
Subsistence fisherman	4E - 1	.28

3.3 Overall Summary of Results

The risk assessment estimates theoretical cancer risk and the potential for theoretical non-cancer health effects from 30 years (beginning today) of emissions, associated with CSC, NTCC, TXI, and Holnam. No cancer risk above regulatory levels of concern were identified. Theoretical and conservative modeling estimates that several receptors have the potential for non-cancer health effects. However, as explained in more detail in the Section 5, actual site data shows that the models over predicts media concentrations of the principle contaminants driving the potential for theoretical non-cancer health effects; antimony and cadmium.

The most significant theoretical cancer risk is attributed to the ingestion of fish caught from SCS Lakes 9&10. Arsenic contributes up to 80% of the risk from this pathway. The next pathways that result in the greatest risk are subsistence farming, and subsistence fishing in Joe Pool Lake. A combination of organic contaminants such as dioxin, BAP and DEHP drive the subsistence farming risk while arsenic again dominates the subsistence fishing risk.

The theoretical modeling shows a potential for non-cancer effects from exposure to antimony in drinking water, and cadmium and mercury through the ingestion of fish from SCS Lakes 9 & 10. The HQ for antimony is estimated to be three for adults and six for children at every receptor location. The HQ for cadmium equals one for the subsistence fisherman that fishes SCS Lakes 9 & 10 and the mercury HQ equals one for the subsistence fisherman that fishes both SCS Lakes 9&10 and Joe Pool Lake.

The chronic oral reference dose for antimony (0.0004 mg/kg/day) contains an uncertainty of factor of 1,000. An uncertainty factor of 1000 means that the critical amount of antimony found in laboratory studies to cause potential non-cancer health effects was multiplied by 1000 to account for uncertainties in the studies before that value was used in this study to estimate the potential for non-cancer health effects. Critical health effects from studies upon which the reference dose is based include a decrease in median life span, a decrease in nonfasting blood glucose levels, altered cholesterol levels, and a decrease in the mean heart weight of males. The following tables present the overall results of the risk assessment process.

The chronic reference dose for cadmium (0.001 mg/kg/day for food and 0.0005 mg/kg/day for water) contains an uncertainty factor of 10. Critical health effects attributed to cadmium include anemia and pulmonary disease, edema, pneumonitis, possible effects on the endocrine system, defects in sensory function, and bone damage.

Citizens in the local area also requested that Region 6 consider risk to infants from dioxin via the breast milk pathway and risk from a tire fire that occurred in December, 1995, at a tire shredding facility located in the study area. To address the risk via the breastmilk pathway, Region 6 used the *Screening Guidance* methodology to estimate an infant's daily intake of dioxin if the mother were a resident, subsistence farmer, or subsistence fisher. These estimated intakes were then compared to the average adult background exposure to dioxin of 0.5 picogram (pg) per kilogram (kg) per day. Based on the modeled values, an infant's estimated daily intake of dioxin is 0.01 pg/kg/day if the mother is a resident residing at location C1, 0.45 pg/kg/day if the mother is a subsistence farmer, and 0.38 pg/kg/day if the mother is a subsistence fisher. All of these intakes are less than the comparison value of 0.5 pg/kg/day.

Region 6 considered including the effects of the December tire fire in this assessment, but was unable to complete the evaluation because of a lack of data concerning the actual emission rates of contaminants during the tire fire and the uncertainties associated with using a methodology based on long-term chronic exposures to estimate the effects from a short-term event.

Finally, Region 6 conducted a qualitative analysis of the combined effects of windblown cement kiln dust (CKD) emissions and the contaminant emissions specified in this study. This

qualitative analysis was conducted by comparing "best estimates" of high end baseline risks outlined in EPA's *Report to Congress on Cement Kiln Dust* with the maximum theoretical risk estimates presented in this report. A quantitative analysis cannot be performed because the exposure assumptions and fate and transport methodologies used in the two studies contain some differences. However, the comparison does provide a general feel for the overall contribution of CKD emissions to the theoretical risk estimated for the area.

As discussed above, the most significant cancer risk identified in the study was to a subsistence fisherman at a level of 1E-4. Pathways contributing to this risk include ingestion of fish, ingestion of drinking water, incidental ingestion of soil, ingestion of vegetables, and inhalation. The CKD *Report to Congress* provides a "best estimate" of high end baseline risk from the ingestion of fish contaminated by CKD at 4E-6. Risk from ingestion of surface water contaminated by CKD emissions are estimated at 1E-8. Risk from the ingestion of soil contaminated by CKD are estimated at 1E-7. Risk from ingestion of vegetables is estimated at 2E-6 and risk from inhalation is estimated at 2E-12. All of these risks added together do not materially affect the most significant estimate contained in this report of 1E-4. Thus, the uncertainty associated with the failure to treat risk from the emissions of CKD in a quantitative fashion does not appear to be significant.

Table 3.3.1 Overall Direct and Indirect Cancer Risk Across All Carcinogenic Chemicals

Scenario	Theoretical Risks	
	Points A1	
Adult Resident	7E-6	
Child Resident	3E-6	
Subsistence Fisher	SCS Lakes 9 & 10 9E-5	Joe Pool Lake 3E-5
Subsistence Farmer	5E-5	
	Points B1	
Adult Resident	3E-5	
Child Resident	1E-5	
Subsistence Fisherman	SCS Lakes 9 & 10 1E-4	Joe Pool Lake 5E-5
Subsistence Farmer	4E-5	
	Points C1	
Adult Resident	4E-5	
Child Resident	2E-5	
Subsistence Fisherman	SCS Lakes 9 & 10 1E-4	Joe Pool Lake 6E-5
Subsistence Farmer	6E-5	

4. LIMITATIONS

This section discusses the limitations and uncertainty associated with this screening level cumulative risk assessment. The degree to which the uncertainty needs to be quantified and the amount of uncertainty that is acceptable varies with the intent of the analysis. For a screening level analysis such as this, a high degree of uncertainty is often acceptable, provided that conservative assumptions are used to bias potential error toward protecting human health.

Uncertainty can be introduced into a health risk assessment at every step in the process. Error occurs because risk assessment is a complex process, requiring the integration of

- The release of pollutants into the environment;
- The fate and transport of pollutants in a variety of different and variable environments by processes that are often poorly understood or too complex to quantify accurately;
- The potential for adverse health effects in humans as extrapolated from animal bioassays; and
- The probability of adverse effects in a human population that is highly variable genetically, in age, in activity level, and in life style.

Even using the most accurate data with the most sophisticated models, uncertainty is inherent in the process.

4.1 Emission Rates

The availability and quality of chemical-specific emission rates presented one of the largest sources of uncertainty associated with this screening level assessment. For the cement manufacturing companies, the majority of the emission rates were based on trial burn data. Because there was only limited data and information on the quality of the data obtained during the trial burns (e.g., percent recovered) and the representativeness of the operating conditions during the trial burns, the representativeness of these emission rates could not be fully evaluated. To address this source of uncertainty, the emission rates used in the analysis were compared across available data sources to ensure that the selected emission rates were reasonable while still being conservative enough to allow for operational upsets and the uncertainty associated with the quality of the data. Region 6 is confident that the rates presented are as reasonable as can be provided

given the availability of accurate data. In fact, one of the outside reviewers noted that emission rates for dioxin were consistent with EPA's experience in preparing the *Estimating Exposure to Dioxin-Like Compounds* (draft) report.

Another significant source of uncertainty in the overall the process is the use of emission rates for CSC that were based on the assumption that baghouse and fugitive emissions contained concentrations of contaminants similar to those found in steel mill baghouse dust. Although contaminant concentrations emitted to the atmosphere from the baghouses are unlikely to contain concentrations greater than those found in the dust, the fugitive emissions could contain higher concentrations than those found in the baghouse dust since are emissions that have not yet been treated. In addition, the volume fugitive emissions could be more or less than assumed in this study because CSC's actual fugitive emissons have not been measured. Hence the uncertainty in the emission estimates for CSC are significant.

One area of uncertainty that has been addressed since the review of the draft report by outside experts is the uncertainty associated with assumed baghouse dust emissions profile. As discussed at length in Section 2.2, the emissions profile sets forth concentrations of contaminants that are very similar to CSC actual baghouse dust data with the exception of antimony and hexavalent chromium.

The lack of any method to check to the viability of antimony and hexavalent chromium emissions is significant because both of these contaminants contribute to the overall cancer risks and non-cancer effects estimates. Antimony emissions were based solely on the baghouse dust profile contained in the ICR. The ICR is based upon data from both stainless and non-stainless steel mill facilities. CSC reportedly operates a non-stainless steel mill. Hexavalent chromium emissions were estimated by assuming that the hexavalent chromium emissions constituted only two percent of total chromium emissions. This assumption of two percent is based on a table include in the Agency for Toxic Substances and Disease Registry's *Toxicological Profile for Chromium*. The actual amounts of antimony and hexavalent chromium emitted by CSC are unknown.

4.2 Parameter Uncertainty

Another area of uncertainty includes the use of standard EPA default values in the analysis. These include inhalation and consumption rates, body weight, and exposure duration and frequency, which are standard default values used in most EPA risk assessments. These parameters often assume that the exposed population is homogenous, when in estimated representative variations exist among the population. Using a single point estimate for these

variables instead of a joint probability distribution ignores a variability that may influence the results by up to a factor of two or three.

Other parameters that are subject to uncertainty are used to estimate the chemical concentration in the media and locations of interests. The meteorological data from the Dallas/Fort Worth National Weather Station provided an approximation of the meteorological conditions at the site as no site-specific data of sufficient quality were available. Different meteorologic conditions can influence the risk results by up to an order of magnitude given the same facility characteristics and surrounding land uses.

Another area of uncertainty is the use of EPA verified cancer slope factors, Reference Doses and Reference Concentration. These health benchmarks are used as single point estimates throughout the analysis. These benchmarks have both uncertainty and variability associated with them. However, the EPA has developed a process for setting verified health benchmark values to be used in all EPA risk assessments. With the exception of the dioxin and BaP toxicity equivalency methodology all health benchmarks used in this analysis are verified through the EPA's work groups and available on the EPA's Integrated Risk Information System.

4.3 Limitations of ISCSTDFT Air Modeling

The indirect exposure model used in this analysis is EPA's current methodology for addressing a variety of exposure pathways important for chemicals that bioaccumulate and persist in the environment. Implementation of this methodology requires air dispersion modeling results for wet and dry depositions and air concentrations of particles and vapors in a variety of settings. ISCSTDFT is the only air dispersion and deposition model currently available to provide such estimates from combustion sources located in both complex and non-complex terrains. ISCSTDFT was released as a draft and has not been widely applied in the present form.

4.4 Uncertainty Associated with Scenarios

The exposure scenarios included in this screening level assessment include an adult and child resident, a subsistence fisher and a subsistence farmer. Although a distribution of the characteristics (e.g., consumption rates) of each type of receptor are reasonably well characterized, population distributions for the modeled behaviors and activities have not been adequately studied. For example, little is known about the fraction of the general population that consists of subsistence farmers and fishers. Without population distributions for these receptors, the number of people likely to be exposed to contaminated media cannot be determined and,

therefore, the appropriateness of the receptors cannot be evaluated from the standpoint of population risk.

5. CONCLUSIONS

The results of this conservative screening level risk assessment are:

1. available site data show that there are no cancer risks or the potential for non-cancer health effects above regulatory levels of concern even though conservative, theoretical models estimate exposures equal to or slightly above threshold levels for potential non-cancer effects; and

2. the predominate source of the theoretical exposures above threshold levels is CSC, not the cement companies.

Region 6 arrives at the first conclusion for two reasons. First, the models and exposure scenarios upon which the estimates of risks and potential non-cancer health effects are theorized to occur are, in our judgement, conservative. The experts who reviewed this report also commented at length on the conservatism associated with the risk assessment. Because the risk assessment is conservative, actual risks and exposures are likely to be less than the estimated risk and exposures. Given this conservatism and the fact that the theoretical exposures of concern for antimony, cadmium, and mercury are in the "grey" or "borderline" range (equal to or barely over the threshold), Region 6 cannot presently justify the necessity for immediate regulatory action.

Secondly, actual measured concentrations of those contaminants that result in exposures above threshold values appear to be present in media at concentrations less than modeled concentrations. Actual exposure to antimony (the contaminant with the greatest exposure) in the Midlothian drinking water supply system equals 0.05 (see Section 3.2) rather than 3 as presented in Section 3.2. Secondly, actual measured concentrations in soil of two of the contaminants for which exposures are above threshold levels (antimony and cadmium) are less than modeled concentrations in the area north of CSC close to receptor locations C1 and C3. The measured and modeled concentrations are compared in Table 5.1 below along with background data. The fact that the measured concentrations are less than the modeled concentrations is particularly interesting given that CSC has been operating since 1975 (20 years to date) and TXI has been burning waste derived fuel since 1987 (9 years to date) and the risk assessment considers emissions for 30 years.

Table 5.1 Comparison of Modeled and Measured Concentrations

CONTMNT	MODELED SOIL CONC. (MG/KG)	MEASURED[13] (MG/KG)	LOCAL BCKGRND (MG/KG)	U.S. BCKGRND (MG/KG)
Antimony	6.3	<3	<MDL	<1 - 8.8
Cadmium	11 - 50	< 0.095 - 3.6	<MDL-0.5	0.01 - 7
Mercury	0.38	<1.0	<MDL	<0.01 - 4.6

Finally, Region 6 can currently find no basis for federal regulatory action in the Midlothian area in response to a mercury HQ equal to one. There is no basis for action because of the conservatism and uncertainty associated with the risk assessment methodology and because the measured media concentrations of mercury are less than or equal to local and U.S. background concentrations of mercury. As stated in Section 3.2, Region 6 is currently unable to judge the viability of estimated mercury exposures as represented by HQs greater than or equal to one due to uncertainties in the methodology. In addition, TNRCC has stated in its *Critical Evaluation* that concentrations of mercury in the Midlothian area are equal to or lower than local and U.S. background levels.

Some citizens and organizations may still be concerned with emissions from the four industries subject to this study despite the fact that the models and exposure scenarios used in this analysis are conservative and Region 6's determination that actual cancer risks and non-cancer health effects are below regulatory levels of concern. Furthermore, it may be of interest to local and state governmental organizations to identify the predominate source of theoretical risks from the four major industries in the area.

The predominate sources of risk from the four industries can be evaluated by comparing the emission rates and unit combined deposition and air concentrations associated with each facility. The unit combined deposition and air concentrations associated with each emission source are compared in Table 5.2 for Point C3. Emission rates are compared in Table 5.3.

[13] Measured values obtained from TNRCC's recent *Critical Evaluation of the Potential Impact of Emissions from Midlothian Industries: A Summary Report*, and CSC's *Analytical Results - Off-Site Investigation, Chaparral Steel, Midlothian, Texas.*

Table 5.2 Comparison of Unit Deposition Rates and Air Concentrations

FACILITY	UNIT COMBINED DEPO. (g/m^2-yr) per 1 g/sec	UNIT AIR CONC. (ug/m^3) per 1 g/sec
CSC Fugitives	30.8	18
CSC Baghouse A	0.320	0.37
CSC Baghouse B	0.080	0.06
CSC Baghouse C	0.078	0.063
NTCC	0.005	0.006
TXI	0.012	0.013
Holnam	0.001	0.001

As noted in Table 5.2 above, the deposition rate of contaminants from CSC are at least an order of magnitude greater than the contaminant deposition rate associated with the cement kilns. CSC's fugitive emissions overwhelm all other deposition rates by two to three orders of magnitude while Holnam's and NTCC's deposition rates at this location are almost negligible. TXI's depostion rate at at this location is greater than Holnam's and NTCC's, yet still significantly less than CSC's deposition rates.

Likewise, the unit air concentrations associated with emissions from CSC are at least 100 times greater than those associated with NTCC and Holnam. The effect of CSC's baghouse emissions on contaminant air concentrations at this location is six time the effect of TXI, the next most significant source. The effect of CSC's fugitive emissions is 1000 times the effect TXI's emissions.

A comparison of the emission rates between the four facilities in Table 5.3 again shows that CSC's emissions of antimony and cadmium dominate that of the other facilities. CSC's estimated emissions of antimony are 186 times that of TXI and CSC's emissions of cadmium are almost five times that of TXI. Thus, it is clear that the majority of the potential for theoretical noncancer health effects associated with antimony and cadmium result from CSC, not the cement manufacturing facilities.

Table 5.3 Comparison of Emission Rates

Constituents	Chaparral	NTCC	TXI	Holnam
	Estimated Representative (g/sec)	Estimated Representative (g/sec)	Estimated Representative (g/sec)	Estimated Representative (g/sec)
Antimony	2.97E-02	9.09E-05	1.60E-04	NA
Arsenic	1.89E-04	1.07E-05	2.13E-04	9.00E-05
Barium	NA	2.65E-05	4.03E-03	8.82E-04
Beryllium	NA	1.77E-06	2.08E-04	2.00E-05
Cadmium	3.02E-03	5.18E-04	6.50E-04	NA
Chromium VI	3.78E-04	2.65E-05	9.80E-09	1.11E-05 (total)
Lead	5.85E-02	4.17E-03	1.43E-02	8.00E-05
Mercury	1.06E-05	4.67E-04	3.01E-04	2.52E-04
Nickel	7.68E-03	2.78E-05	3.01E-04	3.78E-04
Silver	NA	8.96E-05	5.33E-05	NA
Thallium	NA	1.26E-05	5.04E-04	2.00E-5
Zinc	5.96E-01	5.43E-06	2.69E-03	8.82E-004

REFERENCES

General Information

4 USGS quadrangle maps (Cedar Hill, Britton, Venus, Midlothian).

Camp, Dresser, and McKee. 1989. *Watershed Management Study: Lake Michie and Little River Reservoir Watersheds*. Prepared for the County of Durham, NC.

Document entitled *Location of Known Commercial Animal Operations in the Midlothian Area.*

Draft table entitled *Emissions Estimates*. This table was prepared by the TNRCC and describes the rationale behind their selection of emission rates that are different from the rates recommended by TNRCC permit engineers in memorandums dated March 20 and April 12, 1995 (see list of items for NTCC and TXI below).

Dravo Corporation. 1976. Managing and Disposing of Residues from Environmental Control Facilities in the Steel Industry. Prepared for the U.S. EPA Office of Research and Development. Contract Number R-803619.

Geological Survey Planimetric Map, Cleburne, Texas

Geological Survey Planimetric Map, Corsicana, Texas

Geological Survey Planimetric Map, Dallas, Texas

Geological Survey Planimetric Map, Ft. Worth, Texas

Geraghty, J.J, D.W. Miller, F. Van Der Leeden, and F.L. Troise. 1973. *Water Atlas of the United States*. Water Information Center, Inc., NY.

Hites, R.A., and S.L. Simonich. 1994. Vegetation - Atmosphere Partitioning of Polycyclic Aromatic Hydrocarbons. *Env. Sci. Tech.* Vol. 28 No.5.

Jindal, M. and D. Reinhold. 1991. Development of Particulate Scavenging Coefficients to Model Wet Deposition from Industrial Combustion Sources. Paper 91-59.7. Annual Meeting - Exhibition of Air and Waste Management Association, Vancouver, BC. June 16-21, 1991.

Memorandum, from U.S. EPA\ORD, to Addressees. January 20, 1995.

PEI Associates, Inc. 1986. *Air Quality Modeling Analysis of Municipal Waste Combustors.* Prepared for the U.S. Environmental Protection Agency, Monitoring and Data Analysis Division, Research Triangle Park, NC.

Real Estate List (computer printout) for the Midlothian ISD, dated April 25, 1995. This report was developed by the Ellis County Appraisal District and specifies property owners in the area that have proven that their property is used for agricultural or ranching purposes. Code "D1" is a ranch and code "D3" is a farm.

Research Triangle Institute. 1993. Detailed Summary of Information Collection Request Responses for Electric Arc Furnace (EAF) NESHAP. Prepared for U.S. EPA Office of Air Quality Planning and Standards.

Texas Department of Health, Division of Milk and Dairy Products, Establishment Report dated April 24, 1995.

TNRCC draft report section entitled *Selection of Receptors for TXI* dated April 4, 1995.

TNRCC, 1995. *Critical Evaluation of the Potential Empact of Emissions from Midlothian Industries: A Summary Report.* Office of Air Quality/Toxicology and Risk Assessment Section. Austin, TX.

U.S. EPA, 1989. Risk Assessment Guidance for Superfund. Office of Emergency and Remedial Response. Washington, DC. EPA/540/1-89/002.

U.S. EPA. 1990. *Exposure Factors Handbook.* Office of Health and Environmental Assessment, Exposure Assessment Group. Washington, D.C. March.

U.S. EPA. 1990a. Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustion Emissions. Interim Final. Office of health and Environmental Assessment/Office of Research and Development. EPA/600/6-90/003.

U.S. EPA, 1994. Guidance for Performing Screening Level Risk Analysis at Combustion Facilities Burning Hazardous Waste. Office of Emergency and Remedial Response/Office of Solid Waste, Washington, DC.

U.S. EPA. 1994a. *Estimating Exposure to Dioxin-like Compounds. Review Draft.* Office of Research and Development. Washington D.C. June. EPA/600/6-88/0055C.

U.S. EPA. 1994b. Mercury Study Report to Congress, Office of Air Quality Planning and Standards and Office of Research and Development, Research Triangle Park, NC and Washington, DC.

U.S. EPA. 1994d. *User's Guide for the Industrial Source Complex Dispersion Models*. Office of Air Quality Planning and Standards, RTP, NC. Draft.

U.S. Department of Commerce. 1992. International Station Meteorological Climate Summary CD ROM.

Van der Leeden, F., F.L. Troise, and D.K. Todd. 1990. *The Water Encyclopedia.* Lewis Publishers, Chelsea, MI.

Chaparral Steel

Dispersion Modeling of Emissions from Large Section Mill Reheat Furnace (prepared by Forsite Corporation for Chaparral Steel) dated November 1989.

Letter and enclosures from Chaparral Steel Company to Region 6 dated May 8, 1995, responding to the Region's request for information about the emission of contaminants from Chaparral's facility.

Unsolicited letter and enclosures from Chaparral Steel Company to Region 6 dated December 20, 1995. Enclosure entitled *Ambient Monitoring Program* contains concentrations of contaminants in Chaparral's baghouse dust.

Unsolicited letter and enclosures from Chaparral Steel Company to Region 6 dated January 16, 1996. Enclosure entitled *Analytical Results - Off-Site Investigation* contains results of the analysis of soil samples collected from the area immediately north of Chaparral Steel Company.

New/Modified Source Technical Review (prepared by TNRCC) dated May 22, 1992.

TACB Mini Emissions Inventory Report (for Chaparral) from the Point Source Database dated May 2, 1995.

Texas Natural Resource Conservation Commission (TNRCC) Air Permit dated February 22, 1994.

Holnam Texas, L.P.

A letter from Holnam to TNRCC regarding the previous letter regarding dioxin emissions submitted by its consultant Trinity. The letter corrects the emission rates identified in the Trinity letter to account for sample dilution.

Letter from Holnam Texas, L.P. to Region 6 dated May 19, 1995, in response to Region 6's request for information regarding emission rates.

Letter summarizing dioxin data from Trinity Consultants to TNRCC dated November 12, 1993.

Selected portions of Holnam's (known as BoxCrow Cement Co. at the time) application to amend their air permit dated November 1992 prepared by Trinity Consultants.

TACB Mini Emissions Inventory Report (for Holnam) from the Point Source Database dated May 2, 1995.

TNRCC Air Permit for Holnam - Maximum Allowable Emission Rates. Permit number 8996 and PSD-TX-454M1. September 26, 1994.

TNRCC Air Permit for Holnam - Special Provisions. Permit number 8996 and PSD-TX-454M2. Apriil 26, 1994.

North Texas Cement Company (NTCC)

Appendix III.A., RCRA Part B Permit Application entitled *General Engineering Report for North Texas Cement Company*.

Copies of Tables 21-24 summarizing results of dioxin testing conducted November 7-9, 1991.

Draft Table 2.2 dated May 2, 1995, entitled *NTCC Emission Estimates Used in the Final Risk Assessment*. (This will eventually be used in TNRCC's risk assessment report. However, be advised that Industry states that table contains an error with regard to emissions rates for As, Be, Hg and Cr. TNRCC developed the emission rates based on permits limits in lb/hr but incorrectly

adjusted data to gram/sec).

Excerpt from a BIF test report entitled *Semivolatile/PAH Data, June 1992 BIF Test.* Excerpt includes test data from Test 2, Runs 1-3. Analyses were conducted July 19, 1992.

Excerpt from the NTCC Trial Burn Report that provides information about contaminant concentrations in NTCC's CKD.

Pages II-1 through II-12 of a risk assessment protocol prepared by NTCC. This information was provided to EPA during a meeting on May 8, 1995 with Bill Wilson of NTCC. The emission rates identified in Table II-1 are the rates NTCC believes should be used to support the risk assessment.

TACB Mini Emissions Inventory Report (for NTCC) from the Point Source Database dated May 2, 1995.

TNRCC memorandum dated March 20, 1995 from Michael Koenig to Lucy Fraiser regarding emission estimates for TNRCC's NTCC risk assessment.

TNRCC's, 1995. *North Texas Cement Company (NTCC) Modeling Approach to Risk Assessment Screening Analysis*, April 21, 1995.

Texas Industries, Inc. (TXI)

Copy of draft Table 2.2 dated May 2, 1995, entitled *TXI Emission Estimates Used in the Final Risk Assessment.* (This table will eventually be used in TNRCC's risk assessment report.)

Copy of TNRCC's draft *Texas Industries, Inc. (TXI) Modeling Approach to Risk Assessment Screening Analysis* dated April 24, 1995.

Copy of TXI's draft *Protocol for a Comprehensive Risk Assessment for the Texas Industries Facility, Midlothian, Texas* dated July 15, 1994.

Copy of draft memorandum from Paul DeCiutiis to Lucy Fraiser, dated April 12, 1995, regarding emission estimates for TNRCC's TXI risk assessment.

Copy of selected portions of Part B Permit Application (Section 5.0 [contains modeling and stack parameter/test data information]).

Copy of selected portions of *Trial Burn Report* (Volume 1, Chapter 1).

Copy of Adjacent Landowners Map identified as Figure I.G.1. The source of this information is unknown.

Excerpt from the TXI Trial Burn Report that provides information about contaminant concentrations in TXI's CKD.

Section 1 of Part B Permit Application. Contains facility background and land use information.

TNRCC Air Permit for TXI - Special Conditons. Permit Number 1360A. February 28, 1995.

TNRCC air Permit for TXI - Emission Sources - Maximum Allowable Emission Rates. Permit Number 1360A. June 6, 1994.