

**Preliminary Remediation Goals
for CERCLIS Sites located in Ava, Douglas County, Missouri**

Sentinel Wood Treating Site,

(CERCLIS ID: MOD029684438)

12th Avenue Solvents Site,

(CERCLIS ID: MON000704015)

and

Community Laundromat Site

(CERCLIS ID: MON000704080)

Prepared for the Superfund Division
U.S. Environmental Protection Agency, Region VII

Prepared by:

Missouri Department of Health and Senior Services
Section for Environmental Public Health
930 Wildwood Drive, P.O. Box 570
Jefferson City, Missouri 65102

March 2004

30022622



Superfund



Missouri Department of Health and Senior Services

P.O. Box 570, Jefferson City, MO 65102-0570 Phone: 573-751-6400 FAX: 573-751-6010
RELAY MISSOURI for Hearing and Speech Impaired 1-800-735-2966 VOICE 1-800-735-2466

Richard C. Dunn
Director



Bob Holden
Governor

April 1, 2004

Jeremy Johnson
U.S. Environmental Protection Agency Region VII
901 North 5th Street
Kansas City, KS 66101

Re: Preliminary Remediation Goals for CERCLIS Sites in Ava, Douglas County, Missouri

Dear Mr. Johnson:

As requested by the U.S. Environmental Protection Agency through its Cooperative Risk Assessment Program, the Missouri Department of Health and Senior Services developed preliminary remediation goals (PRGs) for the Sentinel Wood Treating, 12th Avenue Solvents, and Community Laundromat Sites located in Ava, Douglas County, Missouri. PRGs were calculated for contaminants of concern in surface and subsurface soil, groundwater, surface water, and sediment. The final document, dated March 2004, is enclosed.

If you have any questions, please contact Michelle Hartman at (573) 751-6160.

Sincerely,

Scott A. Clardy, Administrator
Section for Environmental Public Health

Enclosure

SAC:GMC:DC:MDH:amh

cc: Eric Nold, U.S. EPA Region VII
Pia Capell, DNR

RECEIVED

APR 07 2004

SUPERFUND DIVISION

www.dhss.state.mo.us

The Missouri Department of Health and Senior Services protects and promotes quality of life and health for all Missourians by developing and implementing programs and systems that provide: information and education, effective regulation and oversight, quality services, and surveillance of diseases and conditions.

AN EQUAL OPPORTUNITY / AFFIRMATIVE ACTION EMPLOYER: Services provided on a nondiscriminatory basis.

**PRGs for CERCLIS Sites
Ava, Douglas County, Missouri**

Table of Contents

| <u>Section</u> | <u>Page</u> |
|---|-------------|
| 1.0 SITE DESCRIPTIONS | 1 |
| 1.1 Sentinel Wood Treating Site | 1 |
| 1.2 12 th Avenue Solvents Site..... | 2 |
| 1.3 Community Laundromat Site | 2 |
| 2.0 CONTAMINANTS OF CONCERN | 2 |
| 3.0 EVALUATION OF REASONABLE MAXIMUM EXPOSURE SCENARIOS | 3 |
| 3.1 Surface Soil | 3 |
| 3.2 Subsurface Soil | 4 |
| 3.3 Soil Migration to Groundwater | 4 |
| 3.4 Surface Water | 4 |
| 3.5 Sediment..... | 4 |
| 4.0 METHODOLOGY FOR DETERMINATION OF PRGs | 4 |
| 4.1 Direct-Contact Soil PRGs | 5 |
| 4.2 Soil Migration to Groundwater PRGs..... | 7 |
| 4.3 Surface Water PRGs | 8 |
| 4.4 Sediment PRGs | 8 |
| 5.0 CHEMICAL AND SITE-SPECIFIC INFORMATION | 9 |
| 5.1 Direct-Contact Soil, Surface Water, and Sediment PRGs | 9 |
| 5.2 Soil Migration to Groundwater PRGs..... | 10 |
| 6.0 CALCULATED PRGs | 11 |
| 6.1 Direct-Contact Surface Soil PRGs | 11 |
| 6.2 Direct-Contact Subsurface Soil PRGs | 11 |
| 6.3 Soil Migration to Groundwater PRGs..... | 11 |
| 6.4 Surface Water PRGs | 11 |
| 6.5 Sediment PRGs | 11 |
| 7.0 REFERENCES | 12 |

RECEIVED

APR 07 2004

PRGs for CERCLIS Sites Ava, Douglas County, Missouri

List of Tables

| | |
|-----------|--|
| Table 1. | Summary of Preliminary Remediation Goals |
| Table 2a. | Exposure Variable Values for Soils |
| Table 2b. | Exposure Variable Values for Soil Migration to Groundwater |
| Table 2c. | Exposure Variable Values for Surface Water and Sediment |
| Table 3. | Carcinogenic Toxicity Values for COCs |
| Table 4a. | Chronic Non-Carcinogenic Toxicity Values for COCs |
| Table 4b. | Subchronic Non-Carcinogenic Toxicity Values for COCs |
| Table 5. | Surface Soil Preliminary Remediation Goals for Residential Exposure |
| Table 6. | Surface Soil Preliminary Remediation Goals for Commercial/Industrial Worker Exposure |
| Table 7. | Subsurface Soil Preliminary Remediation Goals for Construction Worker Exposure |
| Table 8. | Soil Migration to Groundwater Preliminary Remediation Goals |
| Table 9. | Surface Water Preliminary Remediation Goals for Recreational Child Exposure |
| Table 10. | Sediment Preliminary Remediation Goals for Recreational Child Exposure |

Appendices

| | |
|--------------|---|
| Appendix A – | Calculation Worksheets for Surface Soils |
| Appendix B – | Calculation Worksheets for Subsurface Soils |
| Appendix C – | Calculation Worksheets for Chemical-Specific Soil Saturation Concentrations |
| Appendix D – | Calculation Worksheets for Soil Migration to Groundwater |
| Appendix E – | Calculation Worksheets for Surface Water |
| Appendix F – | Calculation Worksheets for Sediment |

Preliminary Remediation Goals

Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community Laundromat Site, Ava, Douglas County, Missouri

The U.S. Environmental Protection Agency (EPA) requested that the Missouri Department of Health and Senior Services (MDHSS) determine preliminary remediation goals (PRGs) for selected contaminants detected in soil, groundwater, surface water, and sediment associated with the Sentinel Wood Treating, 12th Avenue Solvents, and Community Laundromat sites located in Ava, Douglas County, Missouri. PRGs are clean-up goals developed to be protective of human health and the environment and are used during analysis of remedial alternatives.

Previously, EPA Region VII developed PRG documents for these sites for surface soils (EPA 2002e and EPA 2002f), subsurface soils (EPA 2003c), migration to groundwater (EPA 2003a), and surface water (EPA 2002g). The EPA PRG documents are included as attachments to this document.

The purpose of this document is to update and recalculate these PRGs based on updates in EPA guidance, policy, and toxicity potency values, additionally to develop PRGs for creek sediment, and finally to combine all PRGs for the media and contaminants of concern into a single document. A summary of the final PRGs for surface soil, subsurface soil, migration to groundwater, surface water, and sediment are provided in Table 1. Supporting documentation for the derivation of PRGs is contained in the remainder of this document.

1.0 Site Descriptions

The Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community Laundromat Site are all situated closely in a mixed commercial/manufacturing/agricultural/residential setting in Ava, Douglas County, Missouri. Soil, groundwater, surface water, and sediment in the area have been found to be contaminated with one or a combination of the following: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals. Descriptions of each of the sites along with a general history of past operations are provided below.

1.1 Sentinel Wood Treating Site

The Sentinel Wood Treating Site is located at 412 NW 12th Avenue in Ava. The property is owned by Sentinel Industries, Inc., who operated onsite from 1959 to the late 1980s. During its operations, Sentinel Industries first operated a facility that pressure-treated wood with pentachlorophenol (PCP) in a diesel preservative solution. Sentinel later manufactured log structures and made outdoor wood furniture onsite both using wood treated offsite with copper, chromium, and arsenic (CCA). Sawdust and scraps generated from the CCA-treated wood operations was reportedly burned onsite.

The former Sentinel property is approximately 14 acres in size. The southern portion of the site currently has several retail shops and a parking lot. The remainder of the site consists of open grounds and buildings from former operations, with at least one of these buildings currently occupied by a small business. Two intermittent unnamed tributaries enter the site from the north and northwest, respectively. The tributaries join onsite and flow to the south, exiting the site at its southern border. The creek system flows beneath NW 12th Avenue and then resurfaces on the south side of the road, and continues through a residential area and the city park, then enters the upper portion of Prairie Creek.

1.2 12th Avenue Solvents Site

The 12th Avenue Solvents Site includes the Copeland manufacturing facility at 1400 NW Third Street, the Rawlings manufacturing plant located at 400 NW 12th Avenue, a portion of the Douglas County Health Department property, and a portion of the former Sentinel Wood Treating plant.

The 12th Avenue Solvents Site consists of a groundwater plume contaminated with several VOCs. Contamination from the plume discharges as a groundwater seep within a wetland area located just south of NW 12th Avenue on property owned by the Douglas County Health Department. An underground polyvinyl chloride (PVC) pipe was installed by the Douglas County Health Department as part of a subsurface drainage system for the wetland area. This PVC pipe discharges water into a drainage ditch on private property southwest of the wetland area. The drainage then empties into the creek system that flows from the Sentinel Wood Treating Site.

The primary source area of the VOC contamination is thought to be Emerson Electric Company which formerly occupied property located at 1400 NW Third Street in Ava. Emerson Electric Company operated at the site prior to 1997 manufacturing and assembling electric motors for commercial and industrial use utilizing ethylbenzene and xylene. The property is currently occupied by Copeland Corporation, a wholly-owned subsidiary of Emerson Electric Company, and has been in operation onsite since 1997 machining cast iron parts for the manufacturing of scroll compressors.

The property is approximately 16 acres in size and is bordered on the west by the Sentinel Wood Treating Site. The Copeland facility consists of manufacturing and office space, warehouse dock areas, and support buildings. The remainder of the property consists of grassy areas east and west of the main building and a paved access road south of the building.

1.3 Community Laundromat Site

The Community Laundromat Site is located at 306 NW 12th Avenue in Ava. The site is the location of a former coin-operated public laundry facility. From approximately 1987-1995, dry cleaning operations utilizing tetrachloroethylene (PCE) were also conducted onsite.

The former Community Laundromat property is approximately 15,000 square feet in size and is located southeast of the Copeland facility. The property consists of the facility building and a gravel parking lot. The Community Laundromat Site consists of the facility property and a groundwater plume of PCE beneath the property which extends at least 0.5 mile to the southwest. The Community Laundromat is also thought to be another source of the VOC contamination associated with the 12th Avenue Solvents Site.

2.0 Contaminants of Concern (COCs)

Previous environmental investigations conducted by the EPA, the Missouri Department of Natural Resources (MDNR), and potential responsible parties (PRPs) have documented the presence of soil, groundwater, surface water, and sediment contamination associated with each of the sites. Contaminants associated with the Sentinel Wood Treating Site include PCP, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons, metals such as arsenic and chromium, and dioxins and furans (collectively referred to as dioxin). Contaminants associated with the 12th Avenue Solvents Site include benzene, toluene, ethylbenzene and xylenes (BTEX), lead, 2,4-dimethylphenol, and chlorinated VOCs. Finally, contaminants associated with the Community Laundromat Site include chlorinated VOCs, such as PCE and trichloroethylene (TCE).

For purposes of this document, contaminants from each of the previous PRG documents for surface soils, subsurface soils, migration to groundwater, and surface water have been retained as COCs. Additionally, sediment samples were compared to U.S. EPA Region IX PRGs (EPA 2002d), and compounds were retained as COCs if any samples exceeded the Region IX Residential Soil PRG or if a health-based benchmark was not available. Contaminants retained as COCs for each media are listed below:

| Surface Soil | SubSurface Soil | Groundwater | Surface Water | Sediment |
|--------------------------|--------------------------|------------------------|---------------------|------------------------|
| Benzene | Benzene | Benzene | Benzene | Pentachlorophenol |
| Toluene | Toluene | Toluene | Toluene | Benzo(a)pyrene |
| Ethylbenzene | Ethylbenzene | Ethylbenzene | Ethylbenzene | Benzo(a)anthracene |
| Xylenes | Xylenes | Xylenes | Xylenes | Benzo(b)fluoranthene |
| Trichloroethylene | Trichloroethylene | Trichloroethylene | Trichloroethylene | Dibenz(a,h)anthracene |
| Tetrachloroethylene | Tetrachloroethylene | Tetrachloroethylene | Tetrachloroethylene | Indeno(1,2,3-cd)pyrene |
| 1,2-Dichloroethane | 1,2-Dichloroethane | 1,2-Dichloroethane | 1,1-Dichloroethane | Benzo(g,h,i)perylene |
| cis-1,2-Dichloroethylene | cis-1,2-Dichloroethylene | Pentachlorophenol | 1,2-Dichloroethane | Phenanthrene |
| 1,1,1-Trichloroethane | 1,1,1-Trichloroethane | Benzo(a)pyrene | Pentachlorophenol | Dioxin |
| Pentachlorophenol | Vinyl Chloride | Benzo(a)anthracene | | |
| 2,4-Dimethylphenol | Pentachlorophenol | Benzo(b)fluoranthene | | |
| Benzo(a)pyrene | 2,4-Dimethylphenol | Benzo(k)fluoranthene | | |
| Benzo(a)anthracene | Benzo(a)pyrene | Dibenz(a,h)anthracene | | |
| Benzo(b)fluoranthene | Benzo(a)anthracene | Indeno(1,2,3-cd)pyrene | | |
| Benzo(k)fluoranthene | Benzo(b)fluoranthene | Arsenic | | |
| Dibenz(a,h)anthracene | Benzo(k)fluoranthene | Chromium | | |
| Indeno(1,2,3-cd)pyrene | Dibenz(a,h)anthracene | | | |
| Arsenic | Indeno(1,2,3-cd)pyrene | | | |
| Chromium | Arsenic | | | |
| Copper | Chromium | | | |
| Lead | Lead | | | |
| Dioxin | Dioxin | | | |

3.0 Evaluation of Reasonable Maximum Exposure Scenarios

3.1 Surface Soil

Residents and commercial/industrial workers exposed to contaminated surface soil represent the human receptors with the greatest potential exposure in the contaminated areas; therefore, exposure scenarios for surface soil are consistent with residential and commercial/industrial use of the sites and areas surrounding the sites. For the purposes of this document, surface soils range from 0-2 feet in depth. Reasonable maximum exposure scenarios were considered for residents and workers that account for chronic exposures through incidental ingestion, dermal contact, and inhalation of airborne particulates or volatiles generated from contaminated soil. The residential scenario for surface soils uses a time-weighted average to account for both children and adults in a residential scenario: a 15 kg child and a 70 kg adult exposed 350 days per year for 6 and 24 years, respectively. The occupational scenario for surface soils is for a 70 kg adult worker exposed 250 days per year for 25 years.

3.2 Subsurface Soil

Construction workers exposed to contaminated subsurface soil represent the human receptors with the greatest potential exposure in the contaminated areas. For the purposes of this document, subsurface soils range from 0 to 10 feet in depth. A reasonable maximum exposure scenario was considered for onsite construction workers that accounts for subchronic exposures through incidental ingestion, dermal contact, and inhalation of airborne particulates or volatiles generated from contaminated subsurface soil. The exposure scenario is consistent with construction workers who may be engaged in high contact soil intensive activities. The scenario assumes a 70 kg adult worker exposed 120 days per year over a period of 1 year.

3.3 Soil Migration to Groundwater

The migration to groundwater PRGs are developed to protect receptors who may ingest contaminated groundwater and to protect potentially potable groundwater aquifers. These PRGs are developed based on chemical concentrations in soil that have the potential to contaminate groundwater above acceptable groundwater concentrations, and apply to surface and subsurface soils, including soils greater than 10 feet in depth.

3.4 Surface Water

A child's recreational exposure to contaminated surface water represents the human receptor with the greatest potential exposure to the contaminated wetlands area and creek system. A reasonable maximum exposure scenario was developed to be consistent with the risk assessment conducted for the area (MDHSS 2001) and assumes a 15 kg recreational child exposed for 4 hours per day, 90 days per year, for a period of 6 years that accounts for subchronic exposures through incidental ingestion and dermal contact. It is important to note that the PRPs previously agreed to clean up the wetland area to EPA Maximum Contaminant Levels (MCLs); however, PRGs were developed for this scenario as comparison values.

3.5 Sediment

A child's recreational exposure to contaminated creek sediment represents the human receptor with the greatest potential exposure to contaminated sediment in and around the creek system. A reasonable maximum exposure scenario was developed to be consistent with the risk assessment conducted for the area (MDHSS 2001) and assumes a 15 kg recreational child exposed for 90 days per year, for a period of 6 years that accounts for subchronic exposures through incidental ingestion and dermal contact.

4.0 Methodology for Determination of PRGs

Site-specific PRGs for contaminated soils, migration of contamination from soil to groundwater, and contaminated surface water and creek sediment are calculated using the methodology discussed below. PRGs calculated for surface and subsurface soils, surface water, and creek sediment equate to an excess individual lifetime cancer risk of 1×10^{-6} or hazard quotient of 0.1 for each contaminant, excluding lead and dioxin (See Section 4.1 for a discussion on the derivation of lead and dioxin Soil PRGs and Section 4.4 for dioxin Sediment PRGs). Sites with multiple contaminants may have Cancer Risks and Hazard Indices in excess of the target risk levels, depending on the cumulative toxicity of the contaminants. PRGs calculated for migration of contamination from soil to groundwater equate to a concentration of contaminants in surface and subsurface soil that will not impact groundwater above regulatory or health benchmark target levels. Definitions of variables and specific variable values used to calculate PRGs for each media and exposure scenario are presented in Tables 2a, 2b, and 2c.

4.1 Direct-Contact Soil PRGs

Direct-contact soil PRGs were developed using formulas modified from that presented in EPA's Risk Assessment Guidance for Superfund, Volume I, Parts A and B (EPA 1989 and 1991a), and incorporate exposure parameters based on both site-specific assumptions and established EPA guidance and policies:

RESIDENTIAL EXPOSURE SCENARIO

(Chemical-specific calculation worksheets are included in Appendix A.)

Carcinogenic compounds:

$$\text{PRG} = \frac{\text{TCR} \cdot \text{AT}_c}{\text{EF} \cdot [(\text{SF}_o \cdot \text{CF}_s \cdot \text{FI} \cdot ((\text{IRS}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{IRS}_c \cdot \text{ED}_c / \text{BW}_c))) + (\text{SF}_d \cdot \text{CF}_s \cdot \text{ABS} \cdot ((\text{SA}_a \cdot \text{AF}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{SA}_c \cdot \text{AF}_c \cdot \text{ED}_c / \text{BW}_c))) + (\text{SF}_i \cdot (1/\text{VF or } 1/\text{PEF}) \cdot ((\text{IRA}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{IRA}_c \cdot \text{ED}_c / \text{BW}_c)))]}$$

Non-Carcinogenic compounds:

$$\text{PRG} = \frac{\text{THQ} \cdot \text{AT}_n}{\text{EF} \cdot [((1/\text{RfD}_o) \cdot \text{CF}_s \cdot \text{FI} \cdot ((\text{IRS}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{IRS}_c \cdot \text{ED}_c / \text{BW}_c))) + ((1/\text{RfD}_d) \cdot \text{CF}_s \cdot \text{ABS} \cdot ((\text{SA}_a \cdot \text{AF}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{SA}_c \cdot \text{AF}_c \cdot \text{ED}_c / \text{BW}_c))) + ((1/\text{RfD}_i) \cdot (1/\text{VF or } 1/\text{PEF}) \cdot ((\text{IRA}_a \cdot \text{ED}_a / \text{BW}_a) + (\text{IRA}_c \cdot \text{ED}_c / \text{BW}_c)))]}$$

OCCUPATIONAL EXPOSURE SCENARIOS

(Chemical-specific calculation worksheets for the Commercial/Industrial Worker Exposure Scenario are included in Appendix A. Chemical-specific calculation worksheets for the Construction Worker Exposure Scenario are included in Appendix B.)

Carcinogenic compounds:

$$\text{PRG} = \frac{\text{TCR} \cdot \text{BW} \cdot \text{AT}_c}{\text{EF} \cdot \text{ED} \cdot [(\text{SF}_o \cdot \text{CF}_s \cdot \text{IRS} \cdot \text{FI}) + (\text{SF}_d \cdot \text{CF}_s \cdot \text{ABS} \cdot \text{SA} \cdot \text{AF}) + (\text{SF}_i \cdot \text{IRA} \cdot [1/\text{VF or } 1/\text{PEF}])]}$$

Non-Carcinogenic compounds:

$$\text{PRG} = \frac{\text{THQ} \cdot \text{BW} \cdot \text{AT}_n}{\text{EF} \cdot \text{ED} \cdot [([1/\text{RfD}_o] \cdot \text{CF}_s \cdot \text{IRS} \cdot \text{FI}) + ([1/\text{RfD}_d] \cdot \text{CF}_s \cdot \text{ABS} \cdot \text{SA} \cdot \text{AF}) + ([1/\text{RfD}_i] \cdot \text{IRA} \cdot [1/\text{VF or } 1/\text{PEF}])]}$$

The formulae above account for possible exposure from the incidental ingestion of soil, dermal contact with soil, and inhalation of volatiles or particulates from soil that might be released into the air at the site. Residential and commercial/industrial exposure scenarios were used to develop surface soil PRGs. A construction worker scenario was used to develop subsurface soil PRGs.

As stated, the formulae above take into consideration inhalation of volatiles or particulates from soil. For volatiles, the equations incorporate a soil-to-air volatilization factor (VF) that relates the concentration of a contaminant in soil to the concentration of the contaminant in air resulting from volatilization. The VF is chemical-specific and is calculated separately for chronic and subchronic

exposures (equations, definitions of variables, and chemical-specific VF calculation worksheets are included for the residential and commercial/industrial worker scenarios in Appendix A and for the construction worker scenario in Appendix B). For non-volatiles, the equations incorporate a particulate emission factor (PEF) which represents an estimate of the relationship between soil contaminant concentrations and the concentration of these contaminants in air as a consequence of particle suspension. The PEF is also calculated separately for chronic and subchronic exposures. The residential and commercial/industrial scenarios incorporate a PEF based on fugitive dusts generated by wind erosion, while the construction worker scenario incorporates a PEF based on emissions from truck traffic on unpaved roads, which typically contribute the majority of dust emissions during construction (equations, definitions of variables, and PEF calculation worksheets are included for the residential and commercial/industrial scenarios in Appendix A and for the construction worker scenario in Appendix B).

Chemical-specific soil saturation limits (C_{sat}) were also calculated (chemical-specific C_{sat} calculation worksheets are included as Appendix C). PRGs calculated for inhalation of volatiles are applicable only if the soil contaminant concentration is at or below saturation. Above saturation, a contaminant may be present in pure liquid-phase; therefore, a comparison is made between the C_{sat} level and the calculated PRG, and the lowest value is selected as the final PRG. The C_{sat} variables are also presented in Table 2a and are calculated as follows:

$$C_{sat} = S/P_b * [(K_d * P_b) + (O_w) + (H' * O_a)]$$

Lead PRGs

Residential PRGs for Lead are derived based on EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA 2003e). The IEUBK model is designed to predict the probable blood lead concentrations for children between six months and seven years of age who have been exposed to lead through various sources (air, water, soil, dust, diet and *in utero* contributions from the mother). The model has the following functional components: an exposure component which compares lead concentrations in environmental media with the amount of lead entering a child's body. The exposure component uses environmental media-specific consumption rates and lead concentrations to estimate media-specific lead intake rates; an uptake component which compares lead intake into the lungs or digestive tract with the amount of lead absorbed into the child's blood; a biokinetic component which shows the transfer of lead between blood and other body tissues, or the elimination of lead from the body altogether; and a probability distribution component which shows the probability of a blood lead concentration greater than 10 µg/dL in an exposed child based on the parameters used in the model. The IEUBK model standardizes exposure by assuming age-weighted parameters for intake of food, water, soil, and dust. The model simulates continual growth under constant exposure levels (on a year-to-year basis). Run in the reverse, this model allows the user to calculate lead PRGs. EPA recommends that cleanup levels be determined to reduce risk to a typical child or group of children exposed to have an estimated risk of no more than 5% exceeding a blood lead of 10 µg/dL. Default parameters were used in the model while varying only the soil lead concentration to obtain the resulting PRG (results of the IEUBK model run are included in Appendix A).

Occupational PRGs for Lead are derived based on EPA's Adult Lead Methodology (ALM), (EPA 2003h). The ALM is designed to estimate fetal blood lead concentrations in women exposed to lead contaminated soils. The PRG for lead represents a concentration in soil in which there is only a 5% likelihood that a fetus would have a blood lead concentration greater than 10 µg/dL. The ALM uses specific input parameters including soil ingestion rate, exposure frequency and duration, averaging time, Soil Lead Absorption Factor (AF_s), Biokinetic Slope Factor (BKSF), Fetal/Maternal

Blood Lead Concentration Ratio ($R_{\text{fetal/maternal}}$), Baseline Blood Lead Concentration ($\text{PbB}_{\text{adult},0}$), and the Individual Blood Lead Geometric Standard Deviation (GSD_i). The values used for the $\text{PbB}_{\text{adult},0}$ and GSD_i were obtained from Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), (EPA 2002b). For the purposes of this project, a $\text{PbB}_{\text{adult},0}$ of 1.53 $\mu\text{g/dL}$ and GSD_i of 2.18 $\mu\text{g/dL}$ were used. These values are the estimated geometric mean and geometric standard deviation of blood lead concentrations in women of all races in the midwest region of the U.S. between the ages of 17 and 45. The PRG is calculated as follows (ALM variables and calculation worksheets are included for the commercial/industrial worker scenario in Appendix A and for the construction worker scenario in Appendix B):

$$\text{PRG (mg/kg)} = \frac{([\text{PbB}_{95\text{fetal}} / (R * (\text{GSD}_i^{1.645}))] - \text{PbB}_0) * \text{AT}_s}{\text{BKSF} * (\text{IR}_s * \text{AF}_s * \text{EF}_s)}$$

Dioxin PRGs

At Superfund and Resource Conservation and Recovery Act (RCRA) sites where 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and related compounds are contaminants of concern, EPA recommends one part per billion (1 ppb) as a cleanup level for 2,3,7,8-TCDD toxicity equivalents (TEQs) in residential soils which corresponds to approximately a 2.5×10^{-4} excess lifetime cancer risk and EPA additionally recommends a cleanup level within the range of 5 to 20 ppb (2,3,7,8-TCDD TEQs) for commercial/industrial soils with the lower end of the range corresponding to approximately a 1.3×10^{-4} excess lifetime cancer risk (EPA 1998a). The recommended levels are generally considered protective of human health and the environment and apply to soils at the sites.

4.2 Soil Migration to Groundwater PRGs

Soil migration to groundwater PRGs were developed using the formula presented in EPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA 2002a):

SOIL MIGRATION TO GROUNDWATER SCENARIO

(Chemical-specific calculation worksheets are included as Appendix D.)

$$\text{PRG} = C_w * [K_d + ((O_w + O_a * H') / (P_b))]$$

EPA's PRG guidance (EPA 1991a) does not address the soil migration to groundwater pathway; therefore, as stated, the methodology was derived from EPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA 2002a). The Supplemental Soil Screening Guidance addresses ingestion of groundwater contaminated by the migration of contaminants through soil to an underlying potable aquifer. The formula above produces a soil screening level (SSL) backcalculated for the migration to groundwater pathway using regulatory or health benchmark groundwater concentration limits. Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals (MCLGs), or Water Health-Based Limits (HBLs) are used as the target groundwater concentrations. MCLs are enforceable standards set by EPA as the highest level of a contaminant that is allowed in drinking water. MCLGs are non-enforceable health goals which are set by EPA at a level at which no known or anticipated adverse effect on the health of persons occurs and which allows an adequate margin of safety. HBLs are EPA-derived health benchmarks based on target cancer risks or hazard quotients.

It should be noted that the methodology for developing SSLs for the migration to groundwater pathway is based on rather conservative, simplified assumptions about the release and transport

of contaminants in the subsurface. The model employs a simple linear equilibrium soil/water partition equation to estimate the contaminant concentration in soil leachate and additionally uses a water balance equation to calculate a site-specific dilution factor to account for reduction of soil leachate concentration from mixing in an aquifer. The resulting PRG is calculated to be protective of residential or occupational land use scenarios by providing a target soil concentration to be protective of potable groundwater.

4.3 Surface Water PRGs

Surface water PRGs were developed using formulas modified from that presented in EPA's Risk Assessment Guidance for Superfund, Volume I, Part A (EPA 1989) and Draft Part E (EPA 2001c), and incorporate exposure parameters based on both site-specific assumptions and established EPA guidance and policies:

RECREATIONAL CHILD EXPOSURE SCENARIO

(Chemical-specific calculation worksheets are included as Appendix E.)

Carcinogenic compounds:

$$\text{PRG} = \frac{\text{TCR} \cdot \text{BW} \cdot \text{AT}_c}{\text{EF} \cdot \text{ED} \cdot [(\text{SF}_o \cdot \text{CR} \cdot \text{ET}) + (\text{SF}_d \cdot \text{CF}_w \cdot \text{SA}_w \cdot \text{DCF})]}$$

Non-Carcinogenic compounds:

$$\text{PRG} = \frac{\text{THQ} \cdot \text{BW} \cdot \text{AT}_n}{\text{EF} \cdot \text{ED} \cdot [([1/\text{RfD}_o] \cdot \text{CR} \cdot \text{ET}) + ([1/\text{RfD}_d] \cdot \text{CF}_w \cdot \text{SA}_w \cdot \text{DCF})]}$$

The formulae above account for possible exposure through recreational activities and include incidental ingestion of and dermal contact with contaminated water.

As stated, the formulae above take into consideration dermal contact with contaminated water. Skin is composed of two main layers, the stratum corneum and the viable epidermis, and to estimate the absorption of chemicals from water through the skin it is assumed that absorption is a function of both the thickness of the stratum corneum and the event duration. The dermal contact factor (DCF) for organic compounds is approximated by one of two equations: 1) to describe the absorption process when the chemical is only in the stratum corneum and absorption is in non-steady state; or 2) to describe the absorption process once steady-state has been reached. It is also assumed that absorption continues long after the exposure has ended and the absorbed dose (DCF) is estimated to be the total dose dissolved in the skin (equations, definitions of variables, and chemical-specific DCF calculations are also included in Appendix E).

4.4 Sediment PRGs

Sediment PRGs were developed using formulas modified from that presented in EPA's Risk Assessment Guidance for Superfund, Volume I, Parts A and B (EPA 1989 and 1991a), and incorporate exposure parameters based on both site-specific assumptions and established EPA guidance and policies:

RECREATIONAL CHILD EXPOSURE SCENARIO

(Chemical-specific calculation worksheets are included as Appendix F.)

Carcinogenic compounds:

$$\text{PRG} = \frac{\text{TCR} \cdot \text{BW} \cdot \text{AT}_c}{\text{EF} \cdot \text{ED} \cdot [(\text{SF}_o \cdot \text{CF}_s \cdot \text{IRS} \cdot \text{FI}) + (\text{SF}_d \cdot \text{CF}_s \cdot \text{ABS} \cdot \text{SA}_s \cdot \text{AF})]}$$

Non-Carcinogenic compounds:

$$\text{PRG} = \frac{\text{THQ} \cdot \text{BW} \cdot \text{AT}_n}{\text{EF} \cdot \text{ED} \cdot [([1/\text{RfD}_o] \cdot \text{CF}_s \cdot \text{IRS} \cdot \text{FI}) + ([1/\text{RfD}_d] \cdot \text{CF}_s \cdot \text{ABS} \cdot \text{SA}_s \cdot \text{AF})]}$$

The formulae above account for possible exposure through recreational activities and include incidental ingestion of and dermal contact with contaminated sediment.

Dioxin PRG

As stated previously, EPA recommends one part per billion (1 ppb) as a cleanup level for 2,3,7,8-TCDD TEQs in residential soils at Superfund and RCRA sites where 2,3,7,8-TCDD and related compounds are contaminants of concern (EPA 1998a). This recommended level also applies to sediments at the sites.

5.0 Chemical and Site-Specific Information

5.1 Direct Contact Soil, Surface Water, and Sediment PRGs

The soil, surface water, and sediment PRG equations discussed above incorporate chemical-specific Slope Factors (SF) and Reference Doses (RfD) to obtain target risk levels. SFs are the toxicity values used in assessing carcinogenic effects from exposure. SFs are defined as the plausible upper-bound estimate of the probability of carcinogenic effects per unit intake of a chemical expressed over a lifetime. RfDs are the toxicity values used in assessing non-carcinogenic effects from exposure. A chronic RfD is defined as an estimate of a daily exposure level for the human population including sensitive subpopulations that is likely to be without an appreciable risk of deleterious effects during a lifetime. According to RAGS, subchronic exposures vary in exposure durations of more than two weeks to less than seven years. Subchronic RfDs are the toxicity values used in assessing non-carcinogenic effects from subchronic exposures. Carcinogenic and non-carcinogenic toxicity values were obtained from EPA's Integrated Risk Information System (IRIS), EPA's National Center for Environmental Assessment (NCEA), or EPA's Health Effects Assessment Summary Tables (HEAST).

To estimate the contribution of dermal contact, it is necessary to convert oral SFs and RfDs to absorbed SFs and RfDs by use of an oral absorption efficiency (OAE) variable. The formulae to adjust oral toxicity values to absorbed toxicity values for use in dermal equations are:

$$\begin{aligned} \text{Carcinogenic: } & \text{SF}_{\text{oral}} (\text{mg/kg-d})^{-1} \div \text{OAE (unitless)} = \text{SF}_{\text{dermal}} (\text{mg/kg-d})^{-1} \\ \text{Non-Carcinogenic: } & \text{RfD}_{\text{oral}} (\text{mg/kg-d}) \cdot \text{OAE (unitless)} = \text{RfD}_{\text{dermal}} (\text{mg/kg-d}) \end{aligned}$$

Oral-to-dermal extrapolation is not recommended for exposure to volatiles or certain inorganics in soil; therefore, dermal contribution from soil exposure was not calculated for all COCs. For those COCs for which oral-to-dermal extrapolation is appropriate, it is necessary to adjust the dermal

intake formulae for soil contact by use of a dermal absorbance (ABS) variable. When chemical-specific absorption information was unavailable, default variables were used to assess dermal contribution as follows: ABS for SVOCs – 0.1. Additionally, oral-to-dermal extrapolation is not recommended for water contact unless the dermal route would pose more than 10% of the ingested dose. For those COCs for which oral-to-dermal extrapolation is appropriate, it is necessary to adjust the dermal intake formulae for water contact by use of the chemical-specific DCF calculation discussed in Section 4.3.

To estimate the contribution of inhalation exposure, it is necessary to convert Inhalation Unit Risks (UR_i) to SFs and Reference Concentrations (RfC) to RfDs. The formulae to adjust these values to toxicity values for use in inhalation equations are:

$$\begin{aligned}\text{Carcinogenic: } UR_i (\text{mg}/\text{m}^3)^{-1} * 70 (\text{kg}) / 20 (\text{m}^3\text{-d}) &= SF_{\text{inhalation}} (\text{mg}/\text{kg-d})^{-1} \\ \text{Non-Carcinogenic: } RfC (\text{mg}/\text{m}^3) * 20 (\text{m}^3\text{-d}) / 70 (\text{kg}) &= RfD_{\text{inhalation}} (\text{mg}/\text{kg-d})\end{aligned}$$

COC-specific SF values for each exposure pathway, including the OAE and UR_i values utilized for conversion-purposes, to calculate the Carcinogenic PRGs for surface soil, subsurface soil, surface water, and sediment are presented in Table 3. COC-specific RfD values for each exposure pathway, including the OAE and RfC values utilized for conversion-purposes, to calculate the Hazard Quotient for surface soil, subsurface soil, surface water, and sediment are presented in Tables 4a and 4b for chronic and subchronic non-cancer toxicity values, respectively.

Target Cancer Risks (TCR) and Target Hazard Quotients (THQ) could not be calculated for all contaminants of concern due to lack of toxicity information. Those constituents for which information was unavailable for the specified pathways are also presented in the aforementioned tables.

It should be noted that Tables 3 and 4 list differing toxicity values for trichloroethene. Currently, there are varied provisional toxicity values proposed for trichloroethene. The draft toxicity assessment for TCE indicates that exposure to TCE poses a higher risk to susceptible populations than was previously considered and proposes newer, more conservative toxicity values (EPA 2001a). To provide a range of PRGs, this document utilized both the newer and original provisional values and presents PRGs based on both sets of values for the residential, occupational, and recreational scenarios.

It should also be noted that Chromium VI and Chromium III are assumed to be present in a 1:6 ratio (EPA 2002d). Chromium VI is considered a known human carcinogen, while adequate data are not available to evaluate the potential carcinogenicity of Chromium III in humans. Therefore, the Chromium VI cancer toxicity potency value was used to calculate the total chromium cancer PRG. The Chromium III noncancer toxicity value was used to calculate the total chromium noncancer PRG.

5.2 Soil Migration to Groundwater PRGs

The soil migration to groundwater PRG equation discussed above incorporate chemical-specific and site-specific information to obtain target risk levels. Chemical-specific MCLs, MCLGs, or HBLs and a site-specific dilution attenuation factor (DAF) are incorporated to calculate a target soil leachate concentration (C_w). The DAF is calculated based on measured site-specific data and is the ratio of soil leachate concentration to receptor point concentration. The DAF assumes that contaminant concentrations are reduced by this factor when leachate mixes with a clean aquifer. The soil migration to groundwater PRG equation also incorporates this target soil leachate concentration with chemical-specific physical parameters and default parameters to produce the resulting PRG.

6.0 Calculated PRGs

The target risk level used in calculating the PRGs for surface and subsurface soil, surface water, and creek sediment equates to an excess individual lifetime cancer risk of 1×10^{-6} or a hazard quotient of 0.1 for each contaminant, excluding lead and dioxin. Sites with multiple contaminants may have Cancer Risks and Hazard Indices in excess of the target risk levels, depending on the cumulative toxicity of the contaminants. Lead PRGs were calculated using the IEUBK and ALM (EPA 2003g and EPA 2003k) to limit blood lead concentrations exceeding 10 $\mu\text{g}/\text{dL}$ to a likelihood of only 5% of those exposed. Dioxin PRGs were taken from EPA's OSWER Directive 9200.4-26 (EPA 1998a). PRGs calculated for migration of contamination from soil to groundwater equate to a concentration of contaminants in surface and subsurface soil that will not impact groundwater above the maximum contaminant level or other water health based limit. The PRGs calculated may be applied at these sites only.

6.1 Direct-Contact Surface Soil PRGs

Carcinogenic and non-carcinogenic PRGs were calculated for a residential and an occupational scenario for those whom may be directly exposed to contaminated surface soils at the sites. Calculation worksheets are included as appendices. The final PRG for each scenario was determined by comparing the carcinogenic and non-carcinogenic PRGs and the C_{sat} levels for each contaminant, then by selecting the lowest value. The final Surface Soil PRGs for the residential and commercial/industrial worker scenarios have been provided in Tables 5 and 6, respectively.

6.2 Direct-Contact Subsurface Soil PRGs

Carcinogenic and non-carcinogenic PRGs were calculated for a construction worker scenario for workers whom may be directly exposed to contaminated subsurface soils at the sites. Calculation worksheets are included as appendices. The final PRG was determined by comparing the carcinogenic and non-carcinogenic PRGs and the C_{sat} levels for each contaminant, then by selecting the lowest value. The final Subsurface Soil PRGs for the construction worker scenario have been provided in Table 7.

6.3 Soil Migration to Groundwater PRGs

Soil migration to groundwater PRGs were calculated to be protective for those whom may ingest contaminated groundwater from the site. Calculation worksheets are included as appendices. The final Surface and Subsurface Soil PRGs determined based on the target soil leachate concentration have been provided in Table 8.

6.4 Surface Water PRGs

5.1.2 Carcinogenic and non-carcinogenic PRGs were calculated for a recreational scenario for children whom may be directly exposed to contaminated surface water in the wetland area or creek system. Calculation worksheets are included as appendices. The final PRG was determined by comparing the carcinogenic and non-carcinogenic PRGs for each contaminant, then by selecting the lowest value. The final Surface Water PRGs for the recreational scenario along with the associated MCL for each contaminant have been provided in Table 9.

6.5 Sediment PRGs

5.1.2 Carcinogenic and non-carcinogenic PRGs were calculated for a recreational scenario for children whom may be directly exposed to creek sediment. Calculation worksheets are included as appendices. The final PRG was determined by comparing the carcinogenic and non-carcinogenic PRGs for each contaminant, then by selecting the lowest value. The final Sediment PRGs for the recreational scenario have been provided in Table 10.

7.0 References

- EPA. 1989. *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, Part A*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.
- EPA. 1991a. *Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual, Part B: Development of Risk-based Preliminary Remediation Goals*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-92/003.
- EPA. 1991b. *Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors*. Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.6-03.
- EPA. 1993. *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*. Office of Health and Environmental Assessment, Cincinnati, OH. EPA/600/R-93/089.
- EPA. 1994a. *Polynuclear Aromatic Hydrocarbons (PAHs) Slope Factors memorandum*. U.S. Environmental Protection Agency Region VII, Kansas City, KS. February 1994.
- EPA. 1994b. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*. U.S. Environmental Protection Agency, Washington, DC. EPA/540/F-94/043. OSWER Directive #9355.4-12.
- EPA. 1996a. *Soil Screening Guidance: User's Guide*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-96/018.
- EPA. 1996b. *Soil Screening Guidance: Technical Background Document*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R95/128.
- EPA. 1997. *Health Effects Assessment Summary Tables (HEAST)*. Office of Research and Development, Office of Emergency and Remedial Response, Washington, D.C. EPA 540/R-97-036.
- EPA. 1998a. *Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites memorandum*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9200.4-26.
- EPA. 1998b. *Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*. Office of Solid Waste and Emergency Response, Washington, DC. EPA/540/F-98/030. OSWER Directive #9200.4-27P.
- EPA. 2000. *Standard Default Factors memorandum*. U.S. Environmental Protection Agency Region VII, Kansas City, KS. April 2000.
- EPA. 2001a. *Trichloroethylene Health Risk Assessment: Synthesis & Characterization – External Review Draft (August 2001)*. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C. EPA/600/P-01/002A.

- EPA. 2001b. *Enforcement Action Memorandum: Request for a Removal Action at the Sentinel Wood Treating Site, Ava, Douglas County, Missouri*. United States Environmental Protection Agency Region VII, Kansas City, KS. August 23, 2001.
- EPA. 2001c. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment – Review Draft (September 2001)*. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R/99/005.
- EPA. 2001d. *Administrative Order on Consent for Removal Action, Sentinel Wood Treating Site, Ava, Douglas County, Missouri*. United States Environmental Protection Agency Region VII, Kansas City, KS.
- EPA. 2001e. *Administrative Order on Consent for Removal Action, 12th Avenue Solvents Site, Ava, Douglas County, Missouri*. United States Environmental Protection Agency Region VII, Kansas City, KS.
- MDHSS. 2001. *Estimated Risks from Residential Exposure to Prairie Creek Tributary and Garden Area South of the Sentinel Wood Treating and 12th Avenue Solvents Sites, Ava, Douglas County, Missouri*. Missouri Department of Health and Senior Services. October 2001.
- EPA. 1992-2002. *National Center for Environmental Assessment (NCEA) - Superfund Technical Support Center (STSC). Risk Assessment Issue Papers for: Arsenic* (Aug. 2002); *Benzene* (July 1996); *Benzo(a)pyrene* (Nov. 1994); *cis-1,2-Dichloroethylene* (Sept. 2002); *Ethylbenzene* (Oct. 1999); *Tetrachloroethene* (June 1997); *Toluene* (July 1999); *1,1,1-Trichloroethane* (Aug. 1999); and *Trichloroethene* (March 1992 and Feb. 1998).
- EPA. 2002a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. Office of Emergency and Remedial Response, Washington, D.C. OSWER 9355.4-24.
- EPA. 2002b. *Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phase I and 2 of the National Health and Nutrition Evaluation Survey (NHANES III)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER 9285.7-52.
- EPA. 2002c. *National Primary Drinking Water Standards*. Office of Water. July 2002.
- EPA. 2002d. *U.S. EPA Region IX: Preliminary Remediation Goals (PRGs)*. Available online at <http://www.epa.gov/region09/waste/sfund/prg/index.htm>.
- EPA. 2002e. *Preliminary Remediation Goals - Sentinel Wood Treater Site, Ava, Missouri memorandum*. United States Environmental Protection Agency Region VII, Kansas City, KS. June 20, 2002.
- EPA. 2002f. *Preliminary Remediation Goals - 12th Avenue Solvents Site, Ava, Missouri memorandum*. United States Environmental Protection Agency Region VII, Kansas City, KS. July 10, 2002.
- EPA. 2002g. *Preliminary Remediation Goals - Wetlands Area of the 12th Avenue Solvents Site, Ava, Missouri memorandum*. United States Environmental Protection Agency Region VII, Kansas City, KS. July 10, 2002.

- ESC. 2002. *Removal Assessment Report for the 12th Avenue Solvents Site, Douglas County, Missouri*. Environmental Strategies Corporation. December 19, 2002.
- MDNR. 2002. *Removal Assessment Report for the Community Laundromat Site, Douglas County, Missouri*. Missouri Department of Natural Resources. April 23, 2002.
- EPA. 2003a. *Migration to Groundwater Preliminary Remediation Goals, Sentinel Wood Treater Site, Ava, Missouri memorandum*. United States Environmental Protection Agency Region VII, Kansas City, KS. February 12, 2003.
- EPA. 2003b. E-mail communication from EPA's National Center for Environmental Assessment (NCEA) providing recommendations for subchronic values for Chromium; 2,4-Dimethylphenol, Pentachlorophenol, Tetrachloroethylene, Trichloroethylene, Vinyl Chloride, and Xylenes. March 28, 2003.
- EPA. 2003c. *Subsurface Soil Preliminary Remediation Goals, Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community Laundromat Site, Ava, Missouri memorandum*. United States Environmental Protection Agency Region VII, Kansas City, KS. April 23, 2003.
- EPA. 2003d. Letter from EPA's Office of Emergency and Remedial Response communicating recommended cancer toxicity values for evaluating inhalation and ingestion risks from exposure to tetrachloroethylene. OSWER 9285.7-75.
- EPA. 2003e. *The IEUBK Model*. Technical Review Workgroup for Lead. Available online at: <http://www.epa.gov/superfund/programs/lead/ieubk.htm>.
- EPA. 2003f. *IEUBK Frequently Asked Questions (FAQs)*. Technical Review Workgroup for Lead. Available online at: <http://www.epa.gov/superfund/programs/lead/ieubkfaq.htm>.
- EPA. 2003g. *Integrated Exposure Uptake Biokinetic Model for Lead in Children, Windows[®] version (IEUBKwin v1.0 build 255)* (November 2003) 32-bit version. Available online at: <http://www.epa.gov/superfund/programs/lead/products.htm>.
- EPA. 2003h. *Adult Lead Methodology*. Technical Review Workgroup for Lead. Available online at: <http://www.epa.gov/superfund/programs/lead/adult.htm>.
- EPA. 2003i. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*. Technical Review Workgroup for Lead. EPA-540-R-03-001.
- EPA. 2003j. *Adult Lead Methodology Frequently Asked Questions (FAQs)*. Technical Review Workgroup for Lead. Available online at: <http://www.epa.gov/superfund/programs/lead/almfaq.htm>.
- EPA. 2003k. *Adult Lead Methodology spreadsheet, Excel version (May 2003)*. Available online at: <http://www.epa.gov/superfund/programs/lead/products.htm>.

EPA. 2003l. *Superfund Information Systems - CERCLIS Database: Site Information on Sentinel Wood Treating Co. Inc., 12th Avenue Solvents, and Community Laundromat sites*. EPA webpage available at: <http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm>.

EPA. 2003m. *Integrated Risk Information System (IRIS)*. Office of Research and Development and National Center for Environmental Assessment. December 2003. IRIS webpage available at: www.epa.gov/iris/.

TTEM. 2003. *Data Summary for Removal Site Evaluation Follow-Up – Sediment Sampling Activities at the Sentinel Wood Treating Site, Ava, Missouri*. Tetra Tech EM Inc., Lenexa, Kansas. December 2003.

TABLES

Table 1.
Summary of Preliminary Remediation Goals for CERCLIS Sites located in Ava, Douglas County, Missouri

| | SURFACE SOIL (mg/kg) | | SUBSURFACE SOIL (mg/kg) | GROUNDWATER PROTECTION (mg/kg) | SURFACE WATER (mg/L) | | SEDIMENT (mg/kg) |
|---------------------------|-------------------------|------------------------------|----------------------------|-----------------------------------|-------------------------|-------|---------------------|
| | Residential | Commercial/Industrial Worker | Construction Worker | Soil Migration to Groundwater | Recreational Child | MCL | Recreational Child |
| Benzene | 0.6 | 1.4 | 3.3 | 0.002 | 0.03 | 0.005 | |
| Toluene | 125 | 225 | 75 | 0.6 | 19 | 1 | |
| Ethylbenzene | 375 | 395 | 108 | 0.7 | 0.7 | 0.7 | |
| Xylenes | 49 | 87 | 12 | 11 | 1.3 | 10 | |
| Trichloroethylene | 3.4 | 7.5 | 1.4 | 0.003 | 0.1 | 0.005 | |
| | 0.05 | 0.1 | 0.4 | | 0.004 | | |
| Tetrachloroethylene | 0.5 | 1.3 | 5.75 | 0.003 | 0.002 | 0.005 | |
| 1,1-Dichloroethane | | | | | 30 | | |
| 1,2-Dichloroethane | 0.3 | 0.6 | 2.1 | 0.001 | 0.04 | 0.005 | |
| cis-1,2-Dichloroethylene | 274 | 1022 | 1206 | | | | |
| 1,1,1-Trichloroethane | 373 | 680 | 987 | | | | |
| Vinyl Chloride | | | 2.10 | | | | |
| 2,4-Dimethylphenol | 416 | 1231 | 993 | | | | |
| Pentachlorophenol | 3 | 9 | 215 | 0.001 | 0.0005 | 0.001 | 17 |
| Benzo(a)pyrene | 0.06 | 0.2 | 4.4 | 0.4 | | | 0.4 |
| Benzo(a)anthracene | 0.6 | 2.1 | 44 | 0.08 | | | 3.6 |
| Benzo(b)fluoranthene | 0.6 | 2.1 | 44 | 0.25 | | | 3.6 |
| Benzo(k)fluoranthene | 6.2 | 21 | 438 | 2.5 | | | |
| Dibenz(a,h)anthracene | 0.06 | 0.2 | 4.4 | 0.08 | | | 0.4 |
| Indeno(1,2,3-cd)pyrene | 0.6 | 2.1 | 44 | 0.7 | | | 3.6 |
| Benzo(g,h,i)perylene | | | | | | | NC |
| Phenanthrene | | | | | | | NC |
| Arsenic | 0.4 | 1.6 | 19 | 0.3 | | | |
| Chromium (total) | 218 | 463 | 21 | 2 | | | |
| Copper | 1013 | 3781 | | | | | |
| Lead | 340 | 945 | 485 | | | | |
| Dioxin (2,3,7,8-TCDD TEQ) | 0.001 | .005 - .02 | .005 - .02 | | | | 0.001 |

NC - Not calculated due to lack of toxicity information

Table 2a.

Exposure Variable Values Used To Calculate Preliminary Remediation Goals (PRGs) in Soils
Ava, Douglas County, Missouri

| | Variable | Unit | Value |
|----------------|---|---------------------------------------|---|
| PRG Variables | PRG = Preliminary Remediation Goal | mg/kg | Calculated |
| | TCR = Target Cancer Risk | unitless | 1×10^{-6} |
| | THQ = Target Hazard Quotient | unitless | 0.1 |
| | BW = Body Weight | kg | |
| | BW _a = Adult | | 70 |
| | BW _c = Child | | 15 |
| | AT _c = Averaging Time - carcinogenic | days | 25550 |
| | AT _n = Averaging Time - noncarcinogenic | days | (ED*365) |
| | Residential | | 10950 |
| | Commercial/Industrial Worker | | 9125 |
| | Construction Worker | | 365 |
| | SF = Slope Factor | (mg/kg-day) ⁻¹ | chemical-specific |
| | SF _o = Oral | | |
| | SF _d = Dermal | | |
| | SF _i = Inhalation | | |
| | RfD = Reference Dose | mg/kg-day | chemical-specific |
| | RfD _o = Oral | | |
| | RfD _d = Dermal | | |
| | RfD _i = Inhalation | | |
| | EF = Exposure Frequency | days/year | |
| | Residential | | 350 |
| | Commercial/Industrial Worker | | 250 |
| | Construction Worker | | 120 |
| | ED = Exposure Duration | years | |
| | ED _a - Residential Adult | | 24 |
| | ED _c - Residential Child | | 6 |
| | Commercial/Industrial Worker | | 25 |
| | Construction Worker | | 1 |
| | K _f = Conversion Factor for Soils | 10 ⁻⁶ kg/mg | 0.000001 |
| | IRS = Soil Ingestion Rate | mg/day | |
| | IRS _a - Residential Adult | | 100 |
| | IRS _c - Residential Child | | 200 |
| | Commercial/Industrial Worker | | 100 |
| | Construction Worker | | 330 |
| | FI = Fraction Ingested from Contaminated Source | unitless | 1 |
| | ABS = Absorption Fraction | unitless | chemical-specific |
| | SA = Skin Surface Area Available for Contact | cm ² /day | |
| | SA _a - Residential Adult | | 5700 |
| | SA _c - Residential Child | | 2800 |
| | Commercial/Industrial Worker | | 3300 |
| | Construction Worker | | 3300 |
| | AF = Adherence Factor of Soil to Skin | mg/cm ² | |
| | AF _a - Residential Adult | | 0.07 |
| | AF _c - Residential Child | | 0.2 |
| | Commercial/Industrial Worker | | 0.2 |
| | Construction Worker | | 0.3 |
| | IRA = Inhalation Rate | m ³ /day | |
| | IRA _a = Adult | | 20 |
| | IRA _c = Child | | 10 |
| | Commercial/Industrial Worker | | 20 |
| | Construction Worker | | 20 |
| Soil Variables | VF = Soil to Air Volatilization Factor | m ³ /kg | Calculated - See Appendix A and B |
| | PEF = Particulate Emission Factor for Soils | m ³ /kg | Calculated - See Appendix A and B |
| | C _{sat} = Soil Saturation Concentration | mg/kg | Calculated |
| | S = Solubility in water | mg/L _{water} | chemical-specific |
| | P _s = Dry Soil Bulk Density | kg/L | 1.5 |
| | K _{ow} = Soil-Water Partition Coefficient | L/kg | chemical-specific (K _{ow} *f _{oc}) |
| | K _{oc} = Soil Organic Carbon Partition Coefficient | L/kg | chemical-specific |
| | f _{oc} = Fraction Organic Carbon Content of Soil | g/g | 0.006 |
| | O _w = Water-filled Soil Porosity | L _{water} /L _{soil} | 0.15 |
| | H = Dimensionless Henry's Law Constant | unitless | chemical-specific |
| | O _a = Air-filled Soil Porosity (n-O _w) | L _{air} /L _{soil} | 0.28 |
| | n = Total Soil Porosity (1-(P _s /P _w)) | L _{void} /L _{soil} | 0.43 |
| | P _s = Soil Particle Density | kg/L | 2.65 |

US EPA Region VII Standard Default Factors Memorandum (2000) or US EPA RAGS Supplemental Guidance: Standard Default Exposure Factors (1991)

US EPA Soil Screening Guidance (1996)

US EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (2002)

US EPA Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment (2001)

Table 2b.
Exposure Variable Values Used To Calculate Preliminary Remediation Goals (PRGs)
for Soil Migration to Groundwater
Ava, Douglas County, Missouri

| PRG Variables | Variable | Unit | Value |
|---------------|--|----------------------|--|
| | PRG = Preliminary Remediation Goal | mg/kg | Calculated |
| | C_w = Target Soil Leachate Concentration | mg/L | chemical-specific (MCL, MCLG, or HBL*DAF) |
| | Groundwater Target Concentration (MCL = Maximum Contaminant Level, MCLG = Maximum Contaminant Level Goal, HBL = Health-Based Limit) | mg/L | chemical-specific |
| | DAF = Dilution Attenuation Factor | unitless | Calculated - See Appendix D |
| | K_d = Soil-Water Partition Coefficient | L/kg | chemical-specific (Organics= $K_{oc} * f_{oc}$; Inorganics - Arsenic=29, Chromium=19) |
| | K_{oc} = Soil Organic Carbon/Water Partition Coefficient | L/kg | chemical-specific |
| | f_{oc} = Fraction Organic Carbon in Soil | g/g | 0.002 |
| | O_w = Water-filled Soil Porosity | L_{water}/L_{soil} | 0.3 |
| | O_a = Air-filled Soil Porosity ($n - O_w$) | L_{air}/L_{soil} | 0.13 |
| | n = Soil Porosity ($1 - (P_b/P_s)$) | L_{pore}/L_{soil} | 0.43 |
| | P_b = Dry Soil Bulk Density | kg/L | 1.5 |
| | P_s = Soil Particle Density | kg/L | 2.65 |
| | H' = Dimensionless Henry's Law Constant | unitless | chemical-specific |

US EPA Soil Screening Guidance (1996)

US EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (2002)

US EPA Drinking Water Standards and Health Advisories (2002)

Table 2c.

**Exposure Variable Values Used To Calculate Preliminary Remediation Goals (PRGs)
for Surface Water and Sediment
Ava, Douglas County, Missouri**

| PRG Variables | Variable | Unit | Value |
|---------------|--|---------------------------|-----------------------------|
| | PRG = Preliminary Remediation Goal | mg/kg-soil or mg/L-water | Calculated |
| | TCR = Target Cancer Risk | unitless | 1×10^{-6} |
| | THQ = Target Hazard Quotient | unitless | 0.1 |
| | BW = Body Weight | kg | |
| | BW _c - Child | | 15 |
| | AT _c = Averaging Time - carcinogenic | days | 25550 |
| | AT _n = Averaging Time - noncarcinogenic | days | |
| | Recreational Child | | 2190 |
| | SF = Slope Factor | (mg/kg-day) ⁻¹ | chemical-specific |
| | SF _o = Oral | | |
| | SF _d = Dermal | | |
| | RfD = Reference Dose | mg/kg-day | chemical-specific |
| | RfD _o = Oral | | |
| | RfD _d = Dermal | | |
| | ET = Exposure Time | hours/day | |
| | Recreational Child | | 4 |
| | EF = Exposure Frequency | days/year | |
| | Recreational Child | | 90 |
| | ED = Exposure Duration | years | |
| | Recreational Child | | 6 |
| | CF _s = Conversion Factor for Soils | 10 ⁻⁶ kg/mg | 0.000001 |
| | IRS = Soil Ingestion Rate | mg/day | |
| | Recreational Child | | 200 |
| | FI = Fraction Ingested from Contaminated Source | unitless | 1 |
| | ABS = Absorption Fraction | unitless | chemical-specific |
| | SA _s = Skin Surface Area Available for Sediment Contact | cm ² /day | |
| | Recreational Child | | 2800 |
| | AF = Adherence Factor of Soil to Skin | mg/cm ² | |
| | AF _c - Recreational Child | | 0.2 |
| | CR = Water Contact Rate | L/hour | 0.05 |
| | CF _w = Volumetric Conversion Factor for Water | 1 L/1000 cm ³ | 0.001 |
| | SA _w = Skin Surface Area Available for Water Contact | cm ² /hour | |
| | Recreational Child | | 3307 |
| | DCF = Dermal Contact Factor | cm-hour/day | Calculated - See Appendix E |

US EPA Region VII Standard Default Factors Memorandum (2000) or US EPA RAGS Supplemental Guidance: Standard Default Exposure Factors (1991)

US EPA Soil Screening Guidance (1996)

US EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (2002)

US EPA Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment (2001)

Table 3.
Carcinogenic Toxicity Values for COCs

| | | Carcinogenic Weight of Evidence Classification | SF _o (mg/kg-d) ⁻¹ | Reference | OAE unitless | Reference | SF _d (mg/kg-d) ⁻¹ | UR _i (mg/m ³) ⁻¹ | Reference | SF _i (mg/kg-d) ⁻¹ |
|------|---------------------------------|--|--|-----------|-----------------|-----------|--|---|-----------|--|
| COCs | Benzene | A | 5.5E-02 | I | 1 | E2 | 5.5E-02 | 7.8E-03 | I | 2.7E-02 |
| | Toluene | D | | | | | | | | |
| | Ethylbenzene | D | | | | | | | | |
| | Xylenes | D | | | | | | | | |
| | Trichloroethylene (provisional) | Under EPA's current (1986) cancer guidelines, TCE would be classified as a "probable human carcinogen" (Group B1). Under EPA's proposed (1996, 1999) cancer guidelines, TCE can be characterized as "highly likely to produce cancer in humans". | 1.1E-02 | N | 1 | E2 | 1.1E-02 | 1.7E-03 | N | 6.0E-03 |
| | Trichloroethylene (draft) | | 4.0E-01 | N | | | 4.0E-01 | | | 4.0E-01 |
| | Tetrachloroethylene | B2 | 5.4E-01 | N | 1 | E2 | 5.4E-01 | 5.9E-03 | N | 2.1E-02 |
| | 1,1-Dichloroethane | C | | | | | | | | |
| | 1,2-Dichloroethane | B2 | 9.1E-02 | I | | | 2.6E-02 | I | 9.1E-02 | |
| | cis-1,2-Dichloroethylene | D | | | | | | | | |
| | 1,1,1-Trichloroethane | D | | | | | | | | |
| | Vinyl Chloride | A | 7.5E-01 | I | | | 4.4E-03 | I | 1.5E-02 | |
| | 2,4-Dimethylphenol | | | | | | | | | |
| | Pentachlorophenol | B2 | 1.2E-01 | I | 1 | E1,2 | 1.2E-01 | | | |
| | Benzo(a)pyrene | B2 | 7.3E+00 | I | 1 | E1 | 7.3E+00 | 8.8E-01 | N | 3.1E+00 |
| | Benzo(a)anthracene | B2 | 7.3E-01 | P | 1 | E1 | 7.3E-01 | 8.8E-02 | P | 3.1E-01 |
| | Benzo(b)fluoranthene | B2 | 7.3E-01 | P | 1 | E1 | 7.3E-01 | 8.8E-02 | P | 3.1E-01 |
| | Benzo(k)fluoranthene | B2 | 7.3E-02 | P | 1 | E1 | 7.3E-02 | 8.8E-03 | P | 3.1E-02 |
| | Dibenz(a,h)anthracene | B2 | 7.3E+00 | P | 1 | E1 | 7.3E+00 | 8.8E-01 | P | 3.1E+00 |
| | Indeno(1,2,3-cd)pyrene | B2 | 7.3E-01 | P | 1 | E1 | 7.3E-01 | 8.8E-02 | P | 3.1E-01 |
| | Benzo(g,h,i)perylene | D | | | | | | | | |
| | Phenanthrene | D | | | | | | | | |
| | Arsenic | A | 1.5E+00 | I | 1 | E1 | 1.5E+00 | 4.3E+00 | I | 1.5E+01 |
| | Chromium (total) | Cr III - D; Cr VI - A (Inhalation) - D (oral) | | | | | | 1.2E+01 | I | 4.2E+01 |
| | Copper | D | | | | | | | | |
| | Lead | B2 | | | | | | | | |
| | Dioxin (2,3,7,8-TCDD TEQ) | B2 | | | | | | | | |

Carcinogenic Toxicity Values

Weight of Evidence Classifications

- A - Human Carcinogen, based on sufficient evidence from epidemiological studies
- B1 - Probable Human Carcinogen, based on sufficient evidence from animal studies and limited evidence from epidemiological studies
- B2 - Probable Human Carcinogen, based on sufficient evidence of animal studies, but inadequate epidemiological data
- C - Possible Human Carcinogen
- D - Not Classifiable as to Human Carcinogenicity

Source References

- I - US EPA, Integrated Risk Information System (IRIS), December 2003
- H - US EPA, Health Effects Assessment Summary Tables (HEAST), 1997
- N - US EPA, National Center for Environmental Assessment (NCEA)
- P - US EPA Region 7 PAH Slope Factors memorandum, 1994
- E - US EPA, Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment, 2001
 - 1 - Oral-to-Dermal Extrapolation for Soil Contact
 - 2 - Oral-to-Dermal Extrapolation for Water Contact

Not Available/Not Applicable

Route-to-Route extrapolation

Table 4a.
Chronic Non-Carcinogenic Toxicity Values for COCs

| | | RfD _o mg/kg-d | Reference | OAE unitless | Reference | RfD _d mg/kg-d | RfC mg/m ³ | Reference | RfD _i mg/kg-d |
|-------------|---------------------------------|-----------------------------|-----------|-----------------|-----------|-----------------------------|--------------------------|-----------|-----------------------------|
| COCs | Benzene | 4.0E-03 | I | | | | 3.0E-02 | I | 8.6E-03 |
| | Toluene | 2.0E-01 | I | | | | 4.0E-01 | I | 1.1E-01 |
| | Ethylbenzene | 1.0E-01 | I | | | | 1.0E+00 | I | 2.9E-01 |
| | Xylenes | 2.0E-01 | I | | | | 1.0E-01 | I | 2.9E-02 |
| | Trichloroethylene (provisional) | 6.0E-03 | N | | | | | | 6.0E-03 |
| | Trichloroethylene (draft) | 3.0E-04 | N | | | | 4.0E-02 | N | 1.1E-02 |
| | Tetrachloroethylene | 1.0E-02 | I | | | | 6.0E-01 | N | 1.7E-01 |
| | 1,2-Dichloroethane | | | | | | | | |
| | cis-1,2-Dichloroethylene | 1.0E-02 | N | | | | | | |
| | 1,1,1-Trichloroethane | 2.8E-01 | N | | | | 2.2E+00 | N | 6.3E-01 |
| | 2,4-Dimethylphenol | 2.0E-02 | I | 1 | E1 | 2.0E-02 | | | |
| | Pentachlorophenol | 3.0E-02 | I | 1 | E1 | 3.0E-02 | | | |
| | Benzo(a)pyrene | | | | | | | | |
| | Benzo(a)anthracene | | | | | | | | |
| | Benzo(b)fluoranthene | | | | | | | | |
| | Benzo(k)fluoranthene | | | | | | | | |
| | Dibenz(a,h)anthracene | | | | | | | | |
| | Indeno(1,2,3-cd)pyrene | | | | | | | | |
| | Arsenic | 3.0E-04 | I | 1 | E1 | 3.0E-04 | | | |
| | Chromium (total) | 1.5E+00 | I | | | | | | |
| | Copper | 3.7E-02 | H | | | | | | |
| | Lead | | | | | | | | |
| | Dioxin (2,3,7,8-TCDD TEQ) | | | | | | | | |

Source References

I - US EPA, Integrated Risk Information System (IRIS), December 2003

H - US EPA, Health Effects Assessment Summary Tables (HEAST), 1997

N - US EPA, National Center for Environmental Assessment (NCEA)

E - US EPA, Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment, 2001

1 - Oral-to-Dermal Extrapolation for Soil Contact

Not Available/Not Applicable

Route-to-Route extrapolation

Table 4b.
Subchronic Non-Carcinogenic Toxicity Values for COCs

| | RfD _o mg/kg-d | Reference | OAE unitless | Reference | RfD _d mg/kg-d | RfC mg/m ³ | Reference | RfD _i mg/kg-d |
|------|---------------------------------|-----------|-----------------|-----------|-----------------------------|--------------------------|-----------|-----------------------------|
| | | | | | | | | |
| COCs | Benzene | N | 1 | E2 | 3.0E-03 | 6.0E-02 | N | 1.7E-02 |
| | Toluene | H | 1 | E2 | 2.0E+00 | 9.2E-01 | N | 2.6E-01 |
| | Ethylbenzene | N | 1 | E2 | 1.0E-01 | 1.0E+00 | N | 2.9E-01 |
| | Xylenes | N | 1 | E2 | 2.0E-01 | 1.0E-01 | N | 2.9E-02 |
| | Trichloroethylene (provisional) | N | 1 | E2 | 6.0E-03 | | | 6.0E-03 |
| | Trichloroethylene (draft) | N | | | 3.0E-04 | 4.0E-02 | N | 1.1E-02 |
| | Tetrachloroethylene | N | 1 | E2 | 1.0E-02 | 6.0E-01 | N | 1.7E-01 |
| | 1,1-Dichloroethane | H | | | | 5.0E+00 | H | 1.4E+00 |
| | 1,2-Dichloroethane | | | | | | | |
| | cis-1,2-Dichloroethylene | N | | | | | | |
| | 1,1,1-Trichloroethane | N | | | | 2.2E+01 | N | 6.3E+00 |
| | Vinyl Chloride | N | | | | 1.0E-01 | N | 2.9E-02 |
| | 2,4-Dimethylphenol | N | 1 | E1 | 2.0E-02 | | | |
| | Pentachlorophenol | N | 1 | E1,2 | 3.0E-02 | | | |
| | Benzo(a)pyrene | | | | | | | |
| | Benzo(a)anthracene | | | | | | | |
| | Benzo(b)fluoranthene | | | | | | | |
| | Benzo(k)fluoranthene | | | | | | | |
| | Dibenz(a,h)anthracene | | | | | | | |
| | Indeno(1,2,3-cd)pyrene | | | | | | | |
| | Benzo(g,h,i)perylene | | | | | | | |
| | Phenanthrene | | | | | | | |
| | Arsenic | N | 1 | E1 | 5.0E-03 | | | |
| | Chromium (total) | N | | | | | | |
| | Lead | | | | | | | |
| | Dioxin (2,3,7,8-TCDD TEQ) | | | | | | | |

Source References

- I - US EPA, Integrated Risk Information System (IRIS), December 2003
- H - US EPA, Health Effects Assessment Summary Tables (HEAST), 1997
- N - US EPA, National Center for Environmental Assessment (NCEA)
- E - US EPA, Draft RAGS, Part E: Supplemental Guidance for Dermal Risk Assessment, 2001
 - 1 - Oral-to-Dermal Extrapolation for Soil Contact
 - 2 - Oral-to-Dermal Extrapolation for Water Contact

Not Available/Not Applicable
Route-to-Route extrapolation

Table 5.
Surface Soil Preliminary Remediation Goals for Residential Exposure
Ava, Douglas County, Missouri

| Chemical | Cancer Endpoint (1 x 10 ⁻⁶ TCR) | Non-Cancer Endpoint (.1 THQ) | C _{sat} | PRG (mg/kg) |
|---------------------------------|---|---------------------------------|------------------|-------------|
| Benzene | 0.62 | 6.23 | 869 | 0.6 |
| Toluene | NC | 125.43 | 654 | 125 |
| Ethylbenzene | NC | 375.39 | 395 | 375 |
| Xylenes | NC | 48.73 | 418 | 49 |
| Trichloroethylene (provisional) | 3.40 | 5.34 | 1293 | 3.4 |
| Trichloroethylene (draft) | 0.05 | 4.61 | | 0.05 |
| Tetrachloroethylene | 0.48 | 85.09 | 235 | 0.5 |
| 1,2-Dichloroethane | 0.27 | NC | 1806 | 0.3 |
| cis-1,2-Dichloroethylene | NC | 273.75 | 1206 | 274 |
| 1,1,1-Trichloroethane | NC | 373.49 | 1188 | 373 |
| 2,4-Dimethylphenol | NC | 416.13 | | 416 |
| Pentachlorophenol | 2.97 | 458.99 | | 3 |
| Benzo(a)pyrene | 0.06 | NC | | 0.06 |
| Benzo(a)anthracene | 0.62 | NC | | 0.6 |
| Benzo(b)fluoranthene | 0.62 | NC | | 0.6 |
| Benzo(k)fluoranthene | 6.20 | NC | | 6.2 |
| Dibenz(a,h)anthracene | 0.06 | NC | | 0.06 |
| Indeno(1,2,3-cd)pyrene | 0.62 | NC | | 0.6 |
| Arsenic | 0.39 | 7.50 | | 0.4 |
| Chromium (total) | 217.61 | 41062.50 | | 218 |
| Copper | NC | 1012.88 | | 1013 |
| Lead | NC | NC | | 340 |
| Dioxin (2,3,7,8-TCDF TEQ) | NC | NC | | 0.001 |

NC - Not calculated due to lack of toxicity information

Table 6.
Surface Soil Preliminary Remediation Goals for Commercial/Industrial Worker Exposure
Ava, Douglas County, Missouri

| Chemical | Cancer Endpoint (1×10^{-6} TCR) | Non-Cancer Endpoint (.1 THQ) | C _{sat} | PRG (mg/kg) |
|---------------------------------|--|---------------------------------|------------------|-------------|
| Benzene | 1.37 | 11.39 | 869 | 1.4 |
| Toluene | NC | 225.15 | 654 | 225 |
| Ethylbenzene | NC | 717.34 | 395 | 395 |
| Xylenes | NC | 86.83 | 418 | 87 |
| Trichloroethylene (provisional) | 7.46 | 9.64 | 1293 | 7.5 |
| Trichloroethylene (draft) | 0.11 | 11.60 | | 0.1 |
| Tetrachloroethylene | 1.31 | 180.32 | 235 | 1.31 |
| 1,2-Dichloroethane | 0.59 | NC | 1806 | 0.6 |
| cis-1,2-Dichloroethylene | NC | 1022.00 | 1206 | 1022 |
| 1,1,1-Trichloroethane | NC | 679.70 | 1188 | 680 |
| 2,4-Dimethylphenol | NC | 1231.33 | | 1231 |
| Pentachlorophenol | 9.00 | 1156.98 | | 9 |
| Benzo(a)pyrene | 0.21 | NC | | 0.2 |
| Benzo(a)anthracene | 2.11 | NC | | 2 |
| Benzo(b)fluoranthene | 2.11 | NC | | 2 |
| Benzo(k)fluoranthene | 21.10 | NC | | 21 |
| Dibenz(a,h)anthracene | 0.21 | NC | | 0.2 |
| Indeno(1,2,3-cd)pyrene | 2.11 | NC | | 2 |
| Arsenic | 1.59 | 25.59 | | 1.6 |
| Chromium (total) | 463.07 | 153300.00 | | 463 |
| Copper | NC | 3781.40 | | 3781 |
| Lead | NC | NC | | 945 |
| Dioxin (2,3,7,8-TCDF) TEQ | NC | NC | | .005 - .02 |

NC - Not calculated due to lack of toxicity information

Table 7.
Subsurface Soil Preliminary Remediation Goals for Construction Worker Exposure
Ava, Douglas County, Missouri

| Chemical | Cancer Endpoint (1 x 10 ⁻⁶ TCR) | Non-Cancer Endpoint (.1 THQ) | C _{sat} | PRG (mg/kg) |
|---------------------------------|---|---------------------------------|------------------|-------------|
| Benzene | 4.97 | 3.28 | 869 | 3.3 |
| Toluene | NC | 74.84 | 654 | 75 |
| Ethylbenzene | NC | 108.14 | 395 | 108 |
| Xylenes | NC | 12.42 | 418 | 12 |
| Trichloroethylene (provisional) | 27.19 | 1.39 | 1293 | 1.4 |
| Trichloroethylene (draft) | 0.41 | 2.34 | | 0.4 |
| Tetrachloroethylene | 5.75 | 29.77 | 235 | 5.75 |
| 1,2-Dichloroethane | 2.14 | NC | 1806 | 2.1 |
| cis-1,2-Dichloroethylene | NC | 6452.02 | 1206 | 1206 |
| 1,1,1-Trichloroethane | NC | 987.13 | 1188 | 987 |
| Vinyl Chloride | 3.19 | 2.10 | 1164 | 2.10 |
| 2,4-Dimethylphenol | NC | 992.62 | | 993 |
| Pentachlorophenol | 215.07 | 1106.06 | | 215 |
| Benzo(a)pyrene | 4.38 | NC | | 4.4 |
| Benzo(a)anthracene | 43.82 | NC | | 44 |
| Benzo(b)fluoranthene | 43.82 | NC | | 44 |
| Benzo(k)fluoranthene | 438.20 | NC | | 438 |
| Dibenz(a,h)anthracene | 4.38 | NC | | 4.4 |
| Indeno(1,2,3-cd)pyrene | 43.82 | NC | | 44 |
| Arsenic | 18.70 | 295.96 | | 19 |
| Chromium (total) | 20.73 | 96780.30 | | 21 |
| Lead | NC | NC | | 485 |
| Dioxin (2,3,7,8-TCDF) TEQ | NC | NC | | .005 - .02 |

NC - Not calculated due to lack of toxicity information

Table 8.
Soil Migration to Groundwater Preliminary Remediation Goals
Ava, Douglas County, Missouri

| Chemical | Migration to Groundwater | |
|------------------------|---|------------------|
| | Target Soil Leachate Concentration (mg/L) | Soil PRG (mg/kg) |
| Benzene | 0.005 | 0.002 |
| Toluene | 1 | 0.6 |
| Ethylbenzene | 0.7 | 0.7 |
| Xylenes | 10 | 11 |
| Trichloroethylene | 0.005 | 0.003 |
| Tetrachloroethylene | 0.005 | 0.003 |
| 1,2-Dichloroethane | 0.005 | 0.001 |
| Pentachlorophenol | 0.001 | 0.001 |
| Benzo(a)pyrene | 0.0002 | 0.4 |
| Benzo(a)anthracene | 0.0001 * | 0.08 |
| Benzo(b)fluoranthene | 0.0001 * | 0.25 |
| Benzo(k)fluoranthene | 0.001 * | 2.5 |
| Dibenz(a,h)anthracene | 0.00001 * | 0.08 |
| Indeno(1,2,3-cd)pyrene | 0.0001 * | 0.7 |
| Arsenic | 0.01 | 0.3 |
| Chromium (total) | 0.1 | 2 |

*HBL = Water Health-Based Limit

Table 9.
Surface Water Preliminary Remediation Goals for Recreational Child Exposure
Ava, Douglas County, Missouri

| Chemical | Cancer Endpoint (1 x 10⁻⁶ TCR) | Non-Cancer Endpoint (.1 THQ) | PRG (mg/L) | MCL (mg/L) |
|---------------------------------|--|---|-------------------|-------------------|
| Benzene | 0.03 | 0.04 | 0.03 | 0.005 |
| Toluene | NC | 18.67 | 19 | 1 |
| Ethylbenzene | NC | 0.67 | 0.7 | 0.7 |
| Xylenes | NC | 1.27 | 1.3 | 10 |
| Trichloroethylene (provisional) | 0.16 | 0.09 | 0.1 | 0.005 |
| Trichloroethylene (draft) | 0.004 | 0.005 | 0.004 | 0.005 |
| Tetrachloroethylene | 0.002 | 0.08 | 0.002 | 0.005 |
| 1,1-Dichloroethane | NC | 30.42 | 30 | |
| 1,2-Dichloroethane | 0.04 | NC | 0.04 | 0.005 |
| Pentachlorophenol | 0.0005 | 0.02 | 0.0005 | 0.001 |

NC - Not calculated due to lack of toxicity information

Table 10.
Sediment Preliminary Remediation Goals for Recreational Child Exposure
Ava, Douglas County, Missouri

| Chemical | Cancer Endpoint (1 x 10⁻⁶ TCR) | Non-Cancer Endpoint (.1 THQ) | PRG (mg/kg) |
|---------------------------|--|---|--------------------|
| Pentachlorophenol | 17.4 | 536.76 | 17 |
| Benzo(a)pyrene | 0.36 | NC | 0.4 |
| Benzo(a)anthracene | 3.56 | NC | 3.6 |
| Benzo(b)fluoranthene | 3.56 | NC | 3.6 |
| Dibenz(a,h)anthracene | 0.36 | NC | 0.4 |
| Indeno(1,2,3-cd)pyrene | 3.56 | NC | 3.6 |
| Benzo(g,h,i)perylene | NC | NC | NC |
| Phenanthrene | NC | NC | NC |
| Dioxin (2,3,7,8-TCDD TEQ) | NC | NC | 0.001 |

NC - Not calculated due to lack of toxicity information

APPENDICES

Appendix A

Calculation Worksheets for **Surface Soil PRGs**

Appendix A

Residential Exposure Scenario

Appendix A

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Residential Exposure Scenario - Carcinogenic Worksheet at 10⁻⁶ TCR

Carcinogenic PRG Formula:
TCR x ATc

$$EF \times [(Sf_o \times Cfs \times FI \times ((IRSa \times EDa / BWa) + (IRSc \times EDc / BWC))] + [Sfd \times ABS \times Cfs \times ((SAa \times AFa \times EDa / BWa) + (SAC \times AFC \times EDc / BWC))] + [Sfi \times (1/VF \text{ or } 1/PEF) \times ((IRaA \times EDa / BWa) + (IRAc \times EDc / BWC))]$$

| Variable | Value |
|--|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| TCR = Target Cancer Risk (unitless) | 0.000001 |
| BW _a = Body Weight - Adult (kg) | 70 |
| BW _c = Body Weight - Child (kg) | 15 |
| ATc = Averaging Time (days) | 25550 |
| Sf _o = Oral Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| Sfd = Dermal Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| Sfi = Inhalation Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| EF = Exposure Frequency (days/year) | 350 |
| ED _a = Exposure Duration - Adult (years) | 24 |
| ED _c = Exposure Duration - Child (years) | 6 |
| CFs = Conversion Factor for Soils (10 ⁻⁶ kg/mg) | 0.000001 |
| IRSa = Soil Ingestion Rate - Adult (mg/day) | 100 |
| IRSc = Soil Ingestion Rate - Child (mg/day) | 200 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SAa = Skin Surface Area Available for Contact - Adult (cm ² /day) | 5700 |
| SAC = Skin Surface Area Available for Contact - Child (cm ² /day) | 2800 |
| AFa = Adherence Factor of Soil to Skin - Adult (mg/cm ²) | 0.07 |
| AFC = Adherence Factor of Soil to Skin - Child (mg/cm ²) | 0.2 |
| IRaA = Inhalation Rate - Adult (m ³ /day) | 20 |
| IRAc = Inhalation Rate - Child (m ³ /day) | 10 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.36E+09 |

Calculated Intakes

| | |
|--|--------|
| General = TCR x ATc / EF | 0.0001 |
| Ingestion = Sf _o x CFs x FI x [(IRSa x EDa / BWa) + (IRSc x EDc / BWC)] | 0.0001 |
| Dermal = Sfd x ABS x CFs x [(SAa x AFa x EDa / BWa) + (SAC x AFC x EDc / BWC)] | 0.0004 |
| Inhalation = Sfi x (1/VF or 1/PEF) x [(IRaA x EDa / BWa) + (IRAc x EDc / BWC)] | 11 |
| PRG = General / SUM | |

Calculation of Carcinogenic Preliminary Remediation Goals

| Chemical | General | Sf _o | Ingestion | Sfd | ABS | Dermal | Sfi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|-----------------|-----------|---------|------|----------|---------|---------------|------------|----------|--------|
| Benzene | 0.0001 | 5.5E-02 | 6.29E-06 | | | 0.00E+00 | 2.7E-02 | 3.74E-04 | 1.11E-04 | 1.17E-04 | 0.62 |
| Toluene | | | 0.00E+00 | | | 0.00E+00 | | 2.57E-04 | 0.00E+00 | 0.00E+00 | |
| Ethylbenzene | | | 0.00E+00 | | | 0.00E+00 | | 1.89E-04 | 0.00E+00 | 0.00E+00 | |
| Xylenes | | | 0.00E+00 | | | 0.00E+00 | | 1.67E-04 | 0.00E+00 | 0.00E+00 | |
| Trichloroethylene (provisional) | | 1.1E-02 | 1.26E-06 | | | 0.00E+00 | 6.0E-03 | 3.13E-04 | 2.02E-05 | 2.15E-05 | 3.40 |
| Trichloroethylene (draft) | | 4.0E-01 | 4.57E-05 | | | 0.00E+00 | 4.0E-01 | | 1.36E-03 | 1.41E-03 | 0.05 |
| Tetrachloroethylene | | 5.4E-01 | 6.17E-05 | | | 0.00E+00 | 2.1E-02 | 4.00E-04 | 8.97E-05 | 1.51E-04 | 0.48 |
| 1,2-Dichloroethane | | 9.1E-02 | 1.04E-05 | | | 0.00E+00 | 9.1E-02 | 2.61E-04 | 2.58E-04 | 2.68E-04 | 0.27 |
| cis-1,2-Dichloroethylene | | | 0.00E+00 | | | 0.00E+00 | | 3.51E-04 | 0.00E+00 | 0.00E+00 | |
| 1,1,1-Trichloroethane | | | 0.00E+00 | | | 0.00E+00 | | 4.61E-04 | 0.00E+00 | 0.00E+00 | |
| 2,4-Dimethylphenol | | | 0.00E+00 | | 0.1 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Pentachlorophenol | | 1.2E-01 | 1.37E-05 | 1.2E-01 | 0.25 | 1.08E-05 | | 7.36E-10 | 0.00E+00 | 2.45E-05 | 2.97 |
| Benzo(a)pyrene | | 7.3E+00 | 8.34E-04 | 7.3E+00 | 0.13 | 3.42E-04 | 3.1E+00 | 7.36E-10 | 2.46E-08 | 1.18E-03 | 0.06 |
| Benzo(a)anthracene | | 7.3E-01 | 8.34E-05 | 7.3E-01 | 0.13 | 3.42E-05 | 3.1E-01 | 7.36E-10 | 2.46E-09 | 1.18E-04 | 0.62 |
| Benzo(b)fluoranthene | | 7.3E-01 | 8.34E-05 | 7.3E-01 | 0.13 | 3.42E-05 | 3.1E-01 | 7.36E-10 | 2.46E-09 | 1.18E-04 | 0.62 |
| Benzo(k)fluoranthene | | 7.3E-02 | 8.34E-06 | 7.3E-02 | 0.13 | 3.42E-06 | 3.1E-02 | 7.36E-10 | 2.46E-10 | 1.18E-05 | 6.20 |
| Dibenz(a,h)anthracene | | 7.3E+00 | 8.34E-04 | 7.3E+00 | 0.13 | 3.42E-04 | 3.1E+00 | 7.36E-10 | 2.46E-08 | 1.18E-03 | 0.06 |
| Indeno(1,2,3-cd)pyrene | | 7.3E-01 | 8.34E-05 | 7.3E-01 | 0.13 | 3.42E-05 | 3.1E-01 | 7.36E-10 | 2.46E-09 | 1.18E-04 | 0.62 |
| Arsenic | | 1.5E+00 | 1.71E-04 | 1.5E+00 | 0.03 | 1.62E-05 | 1.5E+01 | 7.36E-10 | 1.20E-07 | 1.88E-04 | 0.39 |
| Chromium (total) | | | 0.00E+00 | | | 0.00E+00 | 4.2E+01 | 7.36E-10 | 3.35E-07 | 3.35E-07 | 217.61 |
| Copper | | | 0.00E+00 | | | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |

Appendix A

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Residential Exposure Scenario - Non-Carcinogenic Worksheet at .1 THQ

Non-Carcinogenic PRG Formula:
THQ x ATn

$$EF \times \left[\left(\frac{1}{RfDo} \right) \times CFs \times FI \times \left(\frac{IRSa \times EDa}{BWa} \right) + \left(\frac{IRSc \times EDc}{BWC} \right) \right] + \left[\left(\frac{1}{RfDd} \right) \times ABS \times CFs \times \left(\frac{SAa \times AFa \times EDa}{BWa} \right) + \left(\frac{SAC \times AFc \times EDc}{BWC} \right) \right] + \left[\left(\frac{1}{RfDi} \right) \times \left(\frac{1}{VF} \text{ or } \frac{1}{PEF} \right) \times \left(\frac{IRAA \times EDa}{BWa} \right) + \left(\frac{IRAc \times EDc}{BWC} \right) \right]$$

| Variable | Value |
|--|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| THQ = Target Hazard Quotient (unitless) | 0.1 |
| BWa = Body Weight - Adult (kg) | 70 |
| BWc = Body Weight - Child (kg) | 15 |
| ATn = Averaging Time (days) | 10950 |
| RfDo = Oral Reference Dose (mg/kg-day) | chemical-specific |
| RfDd = Dermal Reference Dose (mg/kg-day) | chemical-specific |
| RfDi = Inhalation Reference Dose (mg/kg-day) | chemical-specific |
| EF = Exposure Frequency (days/year) | 350 |
| EDa = Exposure Duration - Adult (years) | 24 |
| EDc = Exposure Duration - Child (years) | 6 |
| CFs = Conversion Factor for Soils (10 ⁻⁶ kg/mg) | 0.000001 |
| IRSa = Soil Ingestion Rate - Adult (mg/day) | 100 |
| IRSc = Soil Ingestion Rate - Child (mg/day) | 200 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SAa = Skin Surface Area Available for Contact - Adult (cm ² /day) | 5700 |
| SAC = Skin Surface Area Available for Contact - Child (cm ² /day) | 2800 |
| AFa = Adherence Factor of Soil to Skin - Adult (mg/cm ²) | 0.07 |
| AFc = Adherence Factor of Soil to Skin - Child (mg/cm ²) | 0.2 |
| IRAA = Inhalation Rate - Adult (m ³ /day) | 20 |
| IRAc = Inhalation Rate - Child (m ³ /day) | 10 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.36E+09 |

Calculated Intakes

| | |
|---|--------|
| General = THQ x ATn / EF | 3 |
| Ingestion = (1/RfDo) x CFs x FI x [(IRSa x EDa / BWa) + (IRSc x EDc / BWC)] | 0.0001 |
| Dermal = (1/RfDd) x ABS x CFs x [(SAa x AFa x EDa / BWa) + (SAC x AFc x EDc / BWC)] | 0.0004 |
| Inhalation = (1/RfDi) x (1/VF or 1/PEF) x [(IRAA x EDa / BWa) + (IRAc x EDc / BWC)] | 11 |
| PRG = General / SUM | |

Calculation of Noncarcinogenic Preliminary Remediation Goals

| Chemical | General | RfDo | Ingestion | RfDd | ABS | Dermal | RfDi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|---------|-----------|---------|------|----------|---------|---------------|------------|----------|----------|
| Benzene | 3 | 4.0E-03 | 2.86E-02 | | | 0.00E+00 | 8.6E-03 | 3.74E-04 | 4.73E-01 | 5.02E-01 | 6.23 |
| Toluene | | 2.0E-01 | 5.71E-04 | | | 0.00E+00 | 1.1E-01 | 2.57E-04 | 2.44E-02 | 2.49E-02 | 125.43 |
| Ethylbenzene | | 1.0E-01 | 1.14E-03 | | | 0.00E+00 | 2.9E-01 | 1.89E-04 | 7.19E-03 | 8.33E-03 | 375.39 |
| Xylenes | | 2.0E-01 | 5.71E-04 | | | 0.00E+00 | 2.9E-02 | 1.67E-04 | 6.36E-02 | 6.42E-02 | 48.73 |
| Trichloroethylene (provisional) | | 6.0E-03 | 1.90E-02 | | | 0.00E+00 | 6.0E-03 | 3.13E-04 | 5.67E-01 | 5.86E-01 | 5.34 |
| Trichloroethylene (draft) | | 3.0E-04 | 3.81E-01 | | | 0.00E+00 | 1.1E-02 | | 2.97E-01 | 6.78E-01 | 4.61 |
| Tetrachloroethylene | | 1.0E-02 | 1.14E-02 | | | 0.00E+00 | 1.7E-01 | 4.00E-04 | 2.53E-02 | 3.68E-02 | 85.09 |
| 1,2-Dichloroethane | | | 0.00E+00 | | | 0.00E+00 | | 2.61E-04 | 0.00E+00 | 0.00E+00 | |
| cis-1,2-Dichloroethylene | | 1.0E-02 | 1.14E-02 | | | 0.00E+00 | | 3.51E-04 | 0.00E+00 | 1.14E-02 | 273.75 |
| 1,1,1-Trichloroethane | | 2.8E-01 | 4.08E-04 | | | 0.00E+00 | 6.3E-01 | 4.61E-04 | 7.97E-03 | 8.38E-03 | 373.49 |
| 2,4-Dimethylphenol | | 2.0E-02 | 5.71E-03 | 2.0E-02 | 0.1 | 1.80E-03 | | 7.36E-10 | 0.00E+00 | 7.52E-03 | 416.13 |
| Pentachlorophenol | | 3.0E-02 | 3.81E-03 | 3.0E-02 | 0.25 | 3.01E-03 | | 7.36E-10 | 0.00E+00 | 6.82E-03 | 458.99 |
| Benzo(a)pyrene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Benzo(a)anthracene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Benzo(b)fluoranthene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Benzo(k)fluoranthene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Dibenz(a,h)anthracene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Indeno(1,2,3-cd)pyrene | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Arsenic | | 3.0E-04 | 3.81E-01 | 3.0E-04 | 0.03 | 3.61E-02 | | 7.36E-10 | 0.00E+00 | 4.17E-01 | 7.50 |
| Chromium (total) | | 1.5E+00 | 7.62E-05 | | | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 7.62E-05 | 41062.50 |
| Copper | | 3.7E-02 | 3.09E-03 | | | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 3.09E-03 | 1012.88 |

Appendix A

Commercial/Industrial Worker Exposure Scenario

Appendix A

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Commercial/Industrial Worker Exposure Scenario - Carcinogenic Worksheet for 10⁶ TCR

Carcinogenic PRG Formula:

$$\text{TCR} \times \text{BW} \times \text{ATc} \\ \text{EF} \times \text{ED} \times \left[\left(\text{SFo} \times \text{CFs} \times \text{IRS} \times \text{FI} \right) + \left(\text{SFd} \times \text{CFs} \times \text{ABS} \times \text{SA} \times \text{AF} \right) + \left(\text{SFi} \times \text{IRA} \times \left(1/\text{VF} \text{ or } 1/\text{PEF} \right) \right) \right]$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| TCR = Target Cancer Risk (unitless) | 0.000001 |
| BW = Body Weight (kg) | 70 |
| ATc = Averaging Time (days) | 25550 |
| SFo = Oral Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| SFd = Dermal Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| SFi = Inhalation Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| EF = Exposure Frequency (days/year) | 250 |
| ED = Exposure Duration (years) | 25 |
| CFs = Conversion Factor for Soils (10 ⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 100 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SA = Skin Surface Area Available for Contact (cm ² /day) | 3300 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.2 |
| IRA = Inhalation Rate (m ³ /day) | 20 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.36E+09 |

Calculated Intakes

General = TCR x BW x ATc

EFD = EF x ED

Ingestion = SFo x CFs x IRS x FI

Dermal = SFd x CFs x ABS x SA x AF

Inhalation = SFi x IRA x (1/VF or 1/PEF)

PRG = General / SUM

2
6250
0.00001
0.001
20

Calculation of Carcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | SFo | Ingestion | SFd | ABS | Dermal | SFi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|------|---------|-----------|---------|------|----------|---------|---------------|------------|----------|--------|
| Benzene | 2 | 6250 | 5.5E-02 | 5.50E-06 | | | 0.00E+00 | 2.7E-02 | 3.74E-04 | 2.04E-04 | 2.10E-04 | 1.37 |
| Toluene | | | | 0.00E+00 | | | 0.00E+00 | | 2.57E-04 | 0.00E+00 | 0.00E+00 | |
| Ethylbenzene | | | | 0.00E+00 | | | 0.00E+00 | | 1.89E-04 | 0.00E+00 | 0.00E+00 | |
| Xylenes | | | | 0.00E+00 | | | 0.00E+00 | | 1.67E-04 | 0.00E+00 | 0.00E+00 | |
| Trichloroethylene (provisional) | | | 1.1E-02 | 1.10E-06 | | | 0.00E+00 | 6.0E-03 | 3.13E-04 | 3.73E-05 | 3.84E-05 | 7.46 |
| Trichloroethylene (draft) | | | 4.0E-01 | 4.00E-05 | | | 0.00E+00 | 4.0E-01 | | 2.50E-03 | 2.54E-03 | 0.11 |
| Tetrachloroethylene | | | 5.4E-01 | 5.40E-05 | | | 0.00E+00 | 2.1E-02 | 4.00E-04 | 1.65E-04 | 2.19E-04 | 1.31 |
| 1,2-Dichloroethane | | | 9.1E-02 | 9.10E-06 | | | 0.00E+00 | 9.1E-02 | 2.61E-04 | 4.75E-04 | 4.84E-04 | 0.59 |
| cis-1,2-Dichloroethylene | | | | 0.00E+00 | | | 0.00E+00 | | 3.51E-04 | 0.00E+00 | 0.00E+00 | |
| 1,1,1-Trichloroethane | | | | 0.00E+00 | | | 0.00E+00 | | 4.61E-04 | 0.00E+00 | 0.00E+00 | |
| 2,4-Dimethylphenol | | | | 0.00E+00 | | 0.1 | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |
| Pentachlorophenol | | | 1.2E-01 | 1.20E-05 | 1.2E-01 | 0.25 | 1.98E-05 | | 7.36E-10 | 0.00E+00 | 3.18E-05 | 9.00 |
| Benzo(a)pyrene | | | 7.3E+00 | 7.30E-04 | 7.3E+00 | 0.13 | 6.26E-04 | 3.1E+00 | 7.36E-10 | 4.53E-08 | 1.36E-03 | 0.21 |
| Benzo(a)anthracene | | | 7.3E-01 | 7.30E-05 | 7.3E-01 | 0.13 | 6.26E-05 | 3.1E-01 | 7.36E-10 | 4.53E-09 | 1.36E-04 | 2.11 |
| Benzo(b)fluoranthene | | | 7.3E-01 | 7.30E-05 | 7.3E-01 | 0.13 | 6.26E-05 | 3.1E-01 | 7.36E-10 | 4.53E-09 | 1.36E-04 | 2.11 |
| Benzo(k)fluoranthene | | | 7.3E-02 | 7.30E-06 | 7.3E-02 | 0.13 | 6.26E-06 | 3.1E-02 | 7.36E-10 | 4.53E-10 | 1.36E-05 | 21.10 |
| Dibenz(a,h)anthracene | | | 7.3E+00 | 7.30E-04 | 7.3E+00 | 0.13 | 6.26E-04 | 3.1E+00 | 7.36E-10 | 4.53E-08 | 1.36E-03 | 0.21 |
| Indeno(1,2,3-cd)pyrene | | | 7.3E-01 | 7.30E-05 | 7.3E-01 | 0.13 | 6.26E-05 | 3.1E-01 | 7.36E-10 | 4.53E-09 | 1.36E-04 | 2.11 |
| Arsenic | | | 1.5E+00 | 1.50E-04 | 1.5E+00 | 0.03 | 2.97E-05 | 1.5E+01 | 7.36E-10 | 2.21E-07 | 1.80E-04 | 1.59 |
| Chromium (total) | | | | 0.00E+00 | | | 0.00E+00 | 4.2E+01 | 7.36E-10 | 6.18E-07 | 6.18E-07 | 463.07 |
| Copper | | | | 0.00E+00 | | | 0.00E+00 | | 7.36E-10 | 0.00E+00 | 0.00E+00 | |

Appendix A

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Commercial/Industrial Worker Exposure Scenario - Non-Carcinogenic Worksheet for .1 THQ

Non-Carcinogenic PRG Formula:

$$THQ \times BW \times ATn$$

$$EF \times ED \times \left(\left(\frac{1}{RfDo} \right) \times CFs \times IRS \times FI \right) + \left(\left(\frac{1}{RfDd} \right) \times CFs \times ABS \times SA \times AF \right) + \left(\left(\frac{1}{RfDi} \right) \times IRA \times (1/VF \text{ or } 1/PEF) \right)$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| THQ = Target Hazard Quotient (unitless) | 0.1 |
| BW = Body Weight (kg) | 70 |
| ATn = Averaging Time (days) | 9125 |
| RfDo = Oral Reference Dose (mg/kg-day) | chemical-specific |
| RfDd = Dermal Reference Dose (mg/kg-day) | chemical-specific |
| RfDi = Inhalation Reference Dose (mg/kg-day) | chemical-specific |
| EF = Exposure Frequency (days/year) | 250 |
| ED = Exposure Duration (years) | 25 |
| CFs = Conversion Factor for Soils (10 ⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 100 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SA = Skin Surface Area Available for Contact (cm ² /day) | 3300 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.2 |
| IRA = Inhalation Rate (m ³ /day) | 20 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.36E+09 |

Calculated Intakes

| | |
|---|--------|
| General = THQ x BW x ATn | 63875 |
| EFD = EF x ED | 6250 |
| Ingestion = (1/RfDo) x CFs x IRS x FI | 0.0001 |
| Dermal = (1/RfDd) x CFs x ABS x SA x AF | 0.001 |
| Inhalation = (1/RfDi) x IRA x (1/VF or 1/PEF) | 20 |
| PRG = General / SUM | |

Calculation of Noncarcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | RfDo | Ingestion | RfDd | ABS | Dermal | RfDi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|------|---------|-----------|---------|------|----------|---------|---------------|------------|----------|----------|
| Benzene | 63875 | 6250 | 4.0E-03 | 2.50E-02 | | | 0.00E+00 | 8.6E-03 | 3.74E-04 | 8.72E-01 | 8.97E-01 | 11.39 |
| Toluene | | | 2.0E-01 | 5.00E-04 | | | 0.00E+00 | 1.1E-01 | 2.57E-04 | 4.49E-02 | 4.54E-02 | 225.15 |
| Ethylbenzene | | | 1.0E-01 | 1.00E-03 | | | 0.00E+00 | 2.9E-01 | 1.89E-04 | 1.32E-02 | 1.42E-02 | 717.34 |
| Xylenes | | | 2.0E-01 | 5.00E-04 | | | 0.00E+00 | 2.9E-02 | 1.67E-04 | 1.17E-01 | 1.18E-01 | 86.83 |
| Trichloroethylene (provisional) | | | 6.0E-03 | 1.67E-02 | | | 0.00E+00 | 6.0E-03 | | 1.04E+00 | 1.06E+00 | 9.64 |
| Trichloroethylene (draft) | | | 3.0E-04 | 3.33E-01 | | | 0.00E+00 | 1.1E-02 | 3.13E-04 | 5.48E-01 | 8.81E-01 | 11.60 |
| Tetrachloroethylene | | | 1.0E-02 | 1.00E-02 | | | 0.00E+00 | 1.7E-01 | 4.00E-04 | 4.67E-02 | 5.67E-02 | 180.32 |
| 1,2-Dichloroethane | | | | 0.00E+00 | | | 0.00E+00 | | | 2.61E-04 | 0.00E+00 | 0.00E+00 |
| cis-1,2-Dichloroethylene | | | 1.0E-02 | 1.00E-02 | | | 0.00E+00 | | | 3.51E-04 | 0.00E+00 | 1.00E-02 |
| 1,1,1-Trichloroethane | | | 2.8E-01 | 3.57E-04 | | | 0.00E+00 | 6.3E-01 | 4.61E-04 | 1.47E-02 | 1.50E-02 | 679.70 |
| 2,4-Dimethylphenol | | | 2.0E-02 | 5.00E-03 | 2.0E-02 | 0.1 | 3.30E-03 | | | 7.36E-10 | 0.00E+00 | 8.30E-03 |
| Pentachlorophenol | | | 3.0E-02 | 3.33E-03 | 3.0E-02 | 0.25 | 5.50E-03 | | | 7.36E-10 | 0.00E+00 | 8.83E-03 |
| Benzo(a)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Benzo(a)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Benzo(b)fluoranthene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Benzo(k)fluoranthene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Dibenz(a,h)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Indeno(1,2,3-cd)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 0.00E+00 |
| Arsenic | | | 3.0E-04 | 3.33E-01 | 3.0E-04 | 0.03 | 6.60E-02 | | | 7.36E-10 | 0.00E+00 | 3.99E-01 |
| Chromium (total) | | | 1.5E+00 | 6.67E-05 | | | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 6.67E-05 |
| Copper | | | 3.7E-02 | 2.70E-03 | | | 0.00E+00 | | | 7.36E-10 | 0.00E+00 | 2.70E-03 |

Appendix A

Calculation Worksheets for VF and PEF for the Residential and Commercial/Industrial Worker Exposure Scenarios

Appendix A

Calculation of Chemical-Specific Volatilization Factors for Residential and Commercial/Industrial Worker Exposures

Volatilization Factor ~ VF (m³/kg) = $[(Q/C_{vol}) * (3.14 * D_A * T)^{1/2} * 10^{-4} (m^2/cm^2)] / (2 * P_b * D_A)$

| Variable | Value |
|--|---|
| VF = Soil to Air Volatilization Factor (m ³ /kg) | Calculated |
| Q/C _{vol} = Inverse of the Ratio of the Geometric Mean Air Concentration to the Volatilization Flux at the Center of a Square Source (g/m ² -s per kg/m ³) | 68.18 |
| D _A = Apparent Diffusivity (cm ² /s) | $[(O_s^{10/3} * D_i * H') + (O_w^{10/3} * D_w)] / n^2 / [(P_b * K_d) + O_w + (O_s * H')]$ |
| T = Exposure Interval (s) | 9.50E+08 |
| P _b = Dry Soil Bulk Density (g/cm ³) | 1.5 |
| O _s = Air-filled Soil Porosity (L _{air} /L _{soil}) = n - O _w | 0.28 |
| n = Total Soil Porosity (L _{pore} /L _{soil}) = 1 - (P _b /P _s) | 0.43 |
| O _w = Water-filled Soil Porosity (L _{water} /L _{soil}) | 0.15 |
| P _s = Soil Particle Density (g/cm ³) | 2.65 |
| D _i = Diffusivity in Air (cm ² /s) | chemical-specific |
| H' = Dimensionless Henry's Law Constant (unitless) | chemical-specific |
| D _w = Diffusivity in Water (cm ² /s) | chemical-specific |
| K _d = Soil-Water Partition Coefficient (cm ³ /g) | chemical-specific (K _{oc} * f _{oc}) |
| K _{oc} = Soil Organic Carbon Partition Coefficient (cm ³ /g) | chemical-specific |
| f _{oc} = Fraction Organic Carbon in Soil (g/g) | 0.006 |

| Chemical | H' | D _i | D _w | K _{oc} | K _d | D _A | VF |
|--------------------------|----------|----------------|----------------|-----------------|----------------|----------------|------|
| Benzene | 2.28E-01 | 8.80E-02 | 9.80E-06 | 5.89E+01 | 3.53E-01 | 2.15E-03 | 2675 |
| Toluene | 2.72E-01 | 8.70E-02 | 8.60E-06 | 1.82E+02 | 1.09E+00 | 1.01E-03 | 3898 |
| Ethylbenzene | 3.23E-01 | 7.50E-02 | 7.80E-06 | 3.63E+02 | 2.18E+00 | 5.52E-04 | 5284 |
| Xylenes | 3.01E-01 | 7.00E-02 | 7.80E-06 | 4.07E+02 | 2.44E+00 | 4.32E-04 | 5972 |
| Trichloroethylene | 4.22E-01 | 7.90E-02 | 9.10E-06 | 1.66E+02 | 9.96E-01 | 1.51E-03 | 3194 |
| Tetrachloroethylene | 7.54E-01 | 7.20E-02 | 8.20E-06 | 1.55E+02 | 9.30E-01 | 2.47E-03 | 2499 |
| 1,2-Dichloroethane | 4.01E-02 | 1.04E-01 | 9.90E-06 | 1.74E+01 | 1.04E-01 | 1.05E-03 | 3834 |
| cis-1,2-Dichloroethylene | 1.67E-01 | 7.36E-02 | 1.13E-05 | 3.55E+01 | 2.13E-01 | 1.90E-03 | 2847 |
| 1,1,1-Trichloroethane | 7.05E-01 | 7.80E-02 | 8.80E-06 | 1.10E+02 | 6.60E-01 | 3.28E-03 | 2168 |
| Vinyl Chloride | 1.11E+00 | 1.06E-01 | 1.23E-05 | 1.86E+01 | 1.12E-01 | 1.49E-02 | 1018 |
| 2,4-Dimethylphenol | | | | | | | |
| Pentachlorophenol | | | | | | | |
| Benzo(a)pyrene | | | | | | | |
| Benzo(a)anthracene | | | | | | | |
| Benzo(b)fluoranthene | | | | | | | |
| Benzo(k)fluoranthene | | | | | | | |
| Dibenz(a,h)anthracene | | | | | | | |
| Indeno(1,2,3-cd)pyrene | | | | | | | |
| Arsenic | | | | | | | |
| Chromium (total) | | | | | | | |
| Copper | | | | | | | |

US EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 200;

Appendix A

Calculation of Particulate Emission Factors for Residential and Commerical/Industrial Worker Exposures

Particulate Emission Factor~PEF (m^3/kg) = $(Q/C_{\text{wind}}) * [(3600 \text{ s/h}) / (0.036 * (1-V) * (U_m/U_t)^3 * F)]$

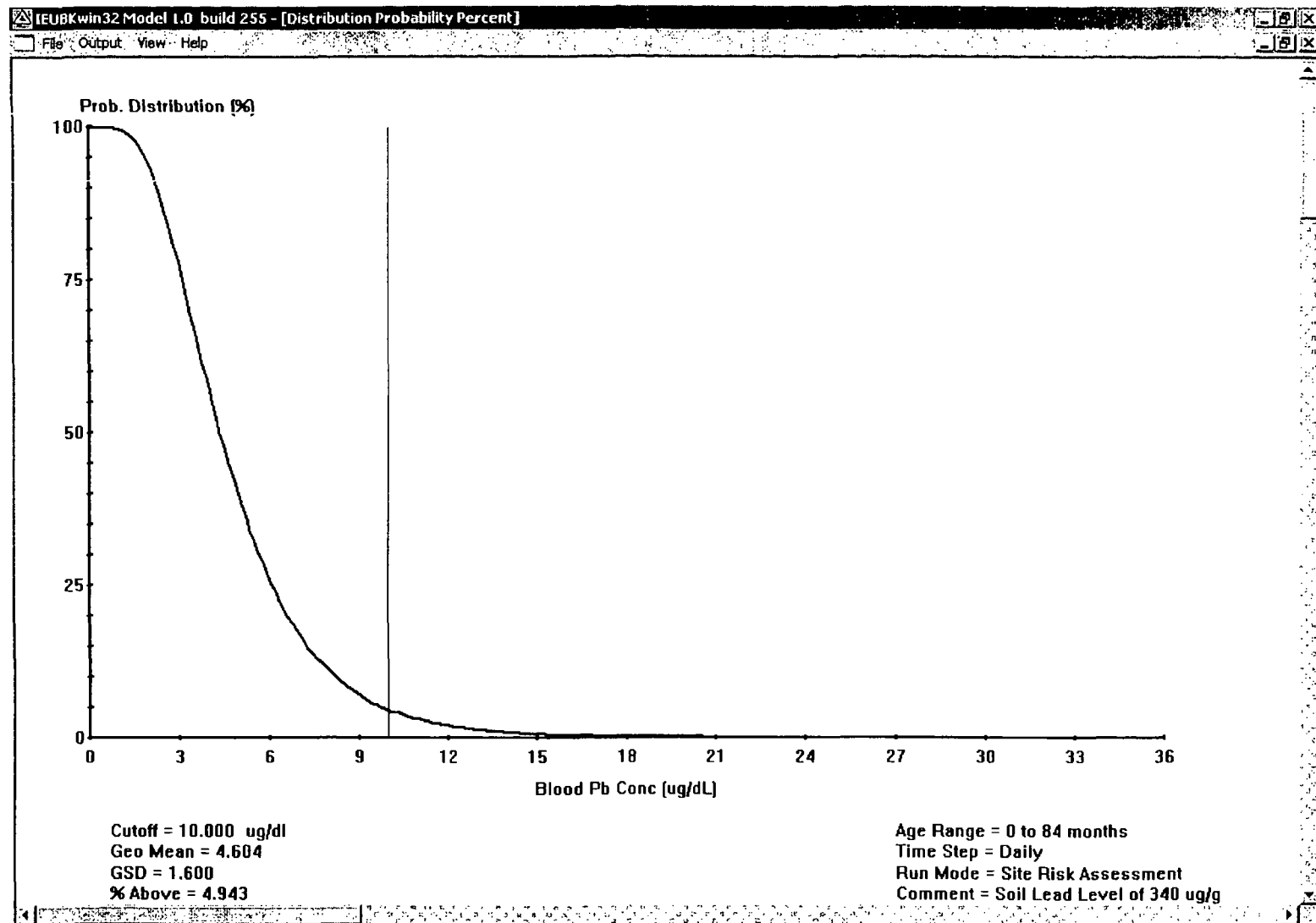
| Variable | Value |
|--|----------|
| PEF = Particulate Emission Factor (m^3/kg) | 1.36E+09 |
| Q/C_{wind} = Inverse of the Ratio of the Geometric Mean Air Concentration to the Emission Flux at the Center of a Square Source ($\text{g}/\text{m}^2\text{-s}$ per kg/m^3) | 93.77 |
| V = Fraction of Vegetative Cover (unitless) | 0.5 |
| U_m = Mean Annual Windspeed (m/s) | 4.69 |
| U_t = Equivalent Threshold Value of Windspeed at 7m (m/s) | 11.32 |
| F = Function Dependent on U_m/U_t (unitless) | 0.194 |

US EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 200;

Appendix A

IEUBK Model Run for Lead PRGs for the Residential Exposure Scenario

Appendix A



```
=====
Model Version: 1.0 Build 255
User Name: MDHSS
Date: 1/20/2004
Site Name: CERCLIS Sites
Operable Unit: Ava, Douglas County, Missouri
Run Mode: Site Risk Assessment
=====
```

Soil/Dust Data

Soil Lead Level of 340 ug/g

Run the Model

Timestep - Daily

```
=====
The time step used in this model run: 2 - Daily (once a day).
```

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

| Age | Time Outdoors (hours) | Ventilation Rate (m ³ /day) | Lung Absorption (%) | Outdoor Air Pb Conc (ug Pb/m ³) |
|------|-----------------------------|--|---------------------------|---|
| .5-1 | 1.000 | 2.000 | 32.000 | 0.100 |
| 1-2 | 2.000 | 3.000 | 32.000 | 0.100 |
| 2-3 | 3.000 | 5.000 | 32.000 | 0.100 |
| 3-4 | 4.000 | 5.000 | 32.000 | 0.100 |
| 4-5 | 4.000 | 5.000 | 32.000 | 0.100 |
| 5-6 | 4.000 | 7.000 | 32.000 | 0.100 |
| 6-7 | 4.000 | 7.000 | 32.000 | 0.100 |

***** Diet *****

| Age | Diet Intake(ug/day) |
|------|---------------------|
| .5-1 | 5.530 |
| 1-2 | 5.780 |
| 2-3 | 6.490 |
| 3-4 | 6.240 |
| 4-5 | 6.010 |
| 5-6 | 6.340 |
| 6-7 | 7.000 |

***** Drinking Water *****

Water Consumption:

| Age | Water (L/day) |
|-----|---------------|
|-----|---------------|

| | |
|------|-------|
| .5-1 | 0.200 |
| 1-2 | 0.500 |
| 2-3 | 0.520 |
| 3-4 | 0.530 |
| 4-5 | 0.550 |
| 5-6 | 0.580 |
| 6-7 | 0.590 |

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 248.000 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

| Age | Soil (ug Pb/g) | House Dust (ug Pb/g) |
|-------|----------------|----------------------|
| 0.5-1 | 340.000 | 248.000 |
| 1-2 | 340.000 | 248.000 |
| 2-3 | 340.000 | 248.000 |
| 3-4 | 340.000 | 248.000 |
| 4-5 | 340.000 | 248.000 |
| 5-6 | 340.000 | 248.000 |
| 6-7 | 340.000 | 248.000 |

***** Alternate Intake *****

| Age | Alternate (ug Pb/day) |
|-------|-----------------------|
| 0.5-1 | 0.000 |
| 1-2 | 0.000 |
| 2-3 | 0.000 |
| 3-4 | 0.000 |
| 4-5 | 0.000 |
| 5-6 | 0.000 |
| 6-7 | 0.000 |

***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

| Year | Air (ug/dL) | Diet (ug/day) | Alternate (ug/day) | Water (ug/day) |
|-------|----------------|------------------|-----------------------|-------------------|
| 0.5-1 | 0.021 | 2.480 | 0.000 | 0.359 |
| 1-2 | 0.034 | 2.557 | 0.000 | 0.885 |
| 2-3 | 0.062 | 2.913 | 0.000 | 0.933 |
| 3-4 | 0.067 | 2.843 | 0.000 | 0.966 |
| 4-5 | 0.067 | 2.813 | 0.000 | 1.030 |
| 5-6 | 0.093 | 2.998 | 0.000 | 1.097 |
| 6-7 | 0.093 | 3.325 | 0.000 | 1.121 |

| Year | Soil+Dust (ug/day) | Total (ug/day) | Blood (ug/dL) |
|-------|-----------------------|-------------------|------------------|
| 0.5-1 | 6.619 | 9.479 | 5.1 |
| 1-2 | 10.369 | 13.845 | 5.7 |
| 2-3 | 10.520 | 14.428 | 5.4 |
| 3-4 | 10.681 | 14.557 | 5.1 |
| 4-5 | 8.129 | 12.039 | 4.3 |
| 5-6 | 7.389 | 11.576 | 3.7 |
| 6-7 | 7.012 | 11.551 | 3.3 |

Appendix A

ALM Calculation Worksheet for Lead PRGs for the Commercial/Industrial Worker Exposure Scenario

Appendix A

Calculations of Lead Preliminary Remediation Goals (PRGs) - Ava, Douglas County, Missouri Commercial/Industrial Worker Exposure Scenario U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

| Exposure Variable | PRG Equation ¹ | | Description of Exposure Variable | Units | Values for Non-Residential Exposure Scenario | | | |
|-----------------------------|------------------------------|-----|--|------------------|--|------------|------------------|------------|
| | 1* | 2** | | | Using Equation 1 | | Using Equation 2 | |
| | | | | | GSDi = Hom | GSDi = Het | GSDi = Hom | GSDi = Het |
| PbB _{fetal, 0.95} | X | X | 95 th percentile PbB in fetus | ug/dL | 10 | 10 | -- | -- |
| R _{fetal/maternal} | X | X | Fetal/maternal PbB ratio | -- | 0.9 | 0.9 | -- | -- |
| BKSF | X | X | Biokinetic Slope Factor | ug/dL per ug/day | 0.4 | 0.4 | -- | -- |
| GSD _i | X | X | Geometric standard deviation PbB | -- | 2.18 | 2.18 | -- | -- |
| PbB ₀ | X | X | Baseline PbB | ug/dL | 1.53 | 1.53 | -- | -- |
| IR _S | X | | Soil ingestion rate (including soil-derived indoor dust) | g/day | 0.05 | 0.05 | -- | -- |
| IR _{S+D} | | X | Total ingestion rate of outdoor soil and indoor dust | g/day | -- | -- | -- | -- |
| W _S | | X | Weighting factor; fraction of IR _{S+D} ingested as outdoor soil | -- | -- | -- | -- | -- |
| K _{SD} | | X | Mass fraction of soil in dust | -- | -- | -- | -- | -- |
| AF _{S, D} | X | X | Absorption fraction (same for soil and dust) | -- | 0.12 | 0.12 | -- | -- |
| EF _{S, D} | X | X | Exposure frequency (same for soil and dust) | days/yr | 250 | 250 | -- | -- |
| AT _{S, D} | X | X | Averaging time (same for soil and dust) | days/yr | 365 | 365 | -- | -- |
| PRG | Preliminary Remediation Goal | | | ppm | 945 | 945 | -- | -- |

¹ Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_s, K_{SD}).

When IR_s = IR_{s+d} and W_s = 1.0, the equations yield the same PRG.

*Equation 1, based on Eq. 4 in USEPA (1996).

$$\text{PRG} = \frac{([\text{PbB}_{95\text{fetal}} / (R * (\text{GSD}_i^{1.645}))] - \text{PbB}_0) * \text{AT}_{s,d}}{\text{BKSF} * (\text{IR}_{s+d} * \text{AF}_{s,d} * \text{EF}_{s,d})}$$

**Equation 2, alternate approach based on Eq. 4 and Eq. A-19 in USEPA (1996).

$$\text{PRG} = \frac{([\text{PbB}_{\text{fetal}, 0.95} / (R * (\text{GSD}_i^{1.645}))] - \text{PbB}_0) * \text{AT}_{s,d}}{\text{BKSF} * ([(\text{IR}_{s+d}) * \text{AF}_s * \text{EF}_s * \text{W}_s] + [\text{K}_{SD} * (\text{IR}_{s+d}) * (1 - \text{W}_s) * \text{AF}_D * \text{EF}_D])}$$

Appendix B

Calculation Worksheets for Subsurface Soil PRGs

Appendix B

Construction Worker Exposure Scenario

Appendix B

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Construction Worker Exposure Scenario - Carcinogenic Worksheet for 10⁻⁶ TCR

Carcinogenic PRG Formula:

$$TCR \times BW \times ATc$$

$$EF \times ED \times [(Sf_o \times Cfs \times IRS \times FI) + (Sfd \times Cfs \times ABS \times SA \times AF) + (Sfi \times IRA \times (1/VF \text{ or } 1/PEF))]$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| TCR = Target Cancer Risk (unitless) | 0.000001 |
| BW = Body Weight (kg) | 70 |
| ATc = Averaging Time (days) | 25550 |
| Sfo = Oral Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| Sfd = Dermal Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| Sfi = Inhalation Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| EF = Exposure Frequency (days/year) | 120 |
| ED = Exposure Duration (years) | 1 |
| Cfs = Conversion Factor for Soils (10 ⁻⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 330 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SA = Skin Surface Area Available for Contact (cm ² /day) | 3300 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.3 |
| IRA = Inhalation Rate (m ³ /day) | 20 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.17E+06 |

Calculated Intakes
 General = TCR x BW x ATc
 EFD = EF x ED
 Ingestion = Sfo x Cfs x IRS x FI
 Dermal = Sfd x Cfs x ABS x SA x AF
 Inhalation = Sfi x IRA x (1/VF or 1/PEF)
 PRG = General / SUM

2
120
0.0003
0.001
20

Calculation of Carcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | Sfo | Ingestion | Sfd | ABS | Dermal | Sfi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|-----|---------|-----------|---------|------|----------|---------|---------------|------------|----------|--------|
| Benzene | 2 | 120 | 5.5E-02 | 1.82E-05 | | | 0.00E+00 | 2.7E-02 | 5.46E-03 | 2.98E-03 | 3.00E-03 | 4.97 |
| Toluene | | | | 0.00E+00 | | | 0.00E+00 | | 3.75E-03 | 0.00E+00 | 0.00E+00 | |
| Ethylbenzene | | | | 0.00E+00 | | | 0.00E+00 | | 2.77E-03 | 0.00E+00 | 0.00E+00 | |
| Xylenes | | | | 0.00E+00 | | | 0.00E+00 | | 2.45E-03 | 0.00E+00 | 0.00E+00 | |
| Trichloroethylene (provisional) | | | 1.1E-02 | 3.63E-06 | | | 0.00E+00 | 6.0E-03 | 4.58E-03 | 5.45E-04 | 5.48E-04 | 27.19 |
| Trichloroethylene (draft) | | | 4.0E-01 | 1.32E-04 | | | 0.00E+00 | 4.0E-01 | | 3.66E-02 | 3.67E-02 | 0.41 |
| Tetrachloroethylene | | | 5.4E-01 | 1.78E-04 | | | 0.00E+00 | 2.1E-02 | 5.85E-03 | 2.41E-03 | 2.59E-03 | 5.75 |
| 1,2-Dichloroethane | | | 9.1E-02 | 3.00E-05 | | | 0.00E+00 | 9.1E-02 | 3.81E-03 | 6.94E-03 | 6.97E-03 | 2.14 |
| cis-1,2-Dichloroethylene | | | | 0.00E+00 | | | 0.00E+00 | | 5.13E-03 | 0.00E+00 | 0.00E+00 | |
| 1,1,1-Trichloroethane | | | | 0.00E+00 | | | 0.00E+00 | | 6.74E-03 | 0.00E+00 | 0.00E+00 | |
| Vinyl Chloride | | | 7.5E-01 | 2.48E-04 | | | 0.00E+00 | 1.5E-02 | 1.44E-02 | 4.42E-03 | 4.67E-03 | 3.19 |
| 2,4-Dimethylphenol | | | | 0.00E+00 | | 0.1 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Pentachlorophenol | | | 1.2E-01 | 3.96E-05 | 1.2E-01 | 0.25 | 2.97E-05 | | 8.56E-07 | 0.00E+00 | 6.93E-05 | 215.07 |
| Benzo(a)pyrene | | | 7.3E+00 | 2.41E-03 | 7.3E+00 | 0.13 | 9.40E-04 | 3.1E+00 | 8.56E-07 | 5.27E-05 | 3.40E-03 | 4.38 |
| Benzo(a)anthracene | | | 7.3E-01 | 2.41E-04 | 7.3E-01 | 0.13 | 9.40E-05 | 3.1E-01 | 8.56E-07 | 5.27E-06 | 3.40E-04 | 43.82 |
| Benzo(b)fluoranthene | | | 7.3E-01 | 2.41E-04 | 7.3E-01 | 0.13 | 9.40E-05 | 3.1E-01 | 8.56E-07 | 5.27E-06 | 3.40E-04 | 43.82 |
| Benzo(k)fluoranthene | | | 7.3E-02 | 2.41E-05 | 7.3E-02 | 0.13 | 9.40E-06 | 3.1E-02 | 8.56E-07 | 5.27E-07 | 3.40E-05 | 438.20 |
| Dibenz(a,h)anthracene | | | 7.3E+00 | 2.41E-03 | 7.3E+00 | 0.13 | 9.40E-04 | 3.1E+00 | 8.56E-07 | 5.27E-05 | 3.40E-03 | 4.38 |
| Indeno(1,2,3-cd)pyrene | | | 7.3E-01 | 2.41E-04 | 7.3E-01 | 0.13 | 9.40E-05 | 3.1E-01 | 8.56E-07 | 5.27E-06 | 3.40E-04 | 43.82 |
| Arsenic | | | 1.5E+00 | 4.95E-04 | 1.5E+00 | 0.03 | 4.46E-05 | 1.5E+01 | 8.56E-07 | 2.58E-04 | 7.97E-04 | 18.70 |
| Chromium (total) | | | | 0.00E+00 | | | 0.00E+00 | 4.2E+01 | 8.56E-07 | 7.19E-04 | 7.19E-04 | 20.73 |

Appendix B

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Construction Worker Exposure Scenario - Non-Carcinogenic Worksheet for .1 THQ

Non-Carcinogenic PRG Formula:

$$THQ = \frac{THQ \times BW \times ATn}{EF \times ED \times \left[\left(\frac{1}{RfDo} \right) \times CFs \times IRS \times FI \right] + \left[\left(\frac{1}{RfDd} \right) \times CFs \times ABS \times SA \times AF \right] + \left[\left(\frac{1}{RfDi} \right) \times IRA \times \left(\frac{1}{VF} \text{ or } \frac{1}{PEF} \right) \right]}$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| THQ = Target Hazard Quotient (unitless) | 0.1 |
| BW = Body Weight (kg) | 70 |
| ATn = Averaging Time (days) | 365 |
| RfDo = Oral Reference Dose (mg/kg-day) | chemical-specific |
| RfDd = Dermal Reference Dose (mg/kg-day) | chemical-specific |
| RfDi = Inhalation Reference Dose (mg/kg-day) | chemical-specific |
| EF = Exposure Frequency (days/year) | 120 |
| ED = Exposure Duration (years) | 1 |
| CFs = Conversion Factor for Soils (10 ⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 330 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SA = Skin Surface Area Available for Contact (cm ² /day) | 3300 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.3 |
| IRA = Inhalation Rate (m ³ /day) | 20 |
| VF = Soil to Air Volatilization Factor (m ³ /kg) | chemical-specific |
| PEF = Particulate Emission Factor for Soils (m ³ /kg) | 1.17E+06 |

| | |
|---|--------|
| Calculated Intakes | |
| General = THQ x BW x ATn | 2555 |
| EFD = EF x ED | 120 |
| Ingestion = (1/RfDo) x CFs x IRS x FI | 0.0003 |
| Dermal = (1/RfDd) x CFs x ABS x SA x AF | 0.001 |
| Inhalation = (1/RfDi) x IRA x (1/VF or 1/PEF) | 20 |
| PRG = General / SUM | |

Calculation of Noncarcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | RfDo | Ingestion | RfDd | ABS | Dermal | RfDi | 1/VF or 1/PEF | Inhalation | SUM | PRG |
|---------------------------------|---------|-----|---------|-----------|---------|------|----------|---------|---------------|------------|----------|----------|
| Benzene | | | 3.0E-03 | 1.10E-01 | | | 0.00E+00 | 1.7E-02 | 5.46E-03 | 6.37E+00 | 6.48E+00 | 3.28 |
| Toluene | | | 2.0E+00 | 1.65E-04 | | | 0.00E+00 | 2.6E-01 | 3.75E-03 | 2.84E-01 | 2.84E-01 | 74.84 |
| Ethylbenzene | | | 1.0E-01 | 3.30E-03 | | | 0.00E+00 | 2.9E-01 | 2.77E-03 | 1.94E-01 | 1.97E-01 | 108.14 |
| Xylenes | | | 2.0E-01 | 1.65E-03 | | | 0.00E+00 | 2.9E-02 | 2.45E-03 | 1.71E+00 | 1.71E+00 | 12.42 |
| Trichloroethylene (provisional) | | | 6.0E-03 | 5.50E-02 | | | 0.00E+00 | 6.0E-03 | 4.58E-03 | 1.53E+01 | 1.53E+01 | 1.39 |
| Trichloroethylene (draft) | | | 3.0E-04 | 1.10E+00 | | | 0.00E+00 | 1.1E-02 | | 8.01E+00 | 9.11E+00 | 2.34 |
| Tetrachloroethylene | | | 1.0E-02 | 3.30E-02 | | | 0.00E+00 | 1.7E-01 | 5.85E-03 | 6.82E-01 | 7.15E-01 | 29.77 |
| 1,2-Dichloroethane | | | | 0.00E+00 | | | 0.00E+00 | | 3.81E-03 | 0.00E+00 | 0.00E+00 | |
| cis-1,2-Dichloroethylene | | | 1.0E-01 | 3.30E-03 | | | 0.00E+00 | | 5.13E-03 | 0.00E+00 | 3.30E-03 | 6452.02 |
| 1,1,1-Trichloroethane | | | 2.8E+00 | 1.18E-04 | | | 0.00E+00 | 6.3E+00 | 6.74E-03 | 2.15E-02 | 2.16E-02 | 987.13 |
| Vinyl Chloride | 2555 | 120 | 3.0E-03 | 1.10E-01 | | | 0.00E+00 | 2.9E-02 | 1.44E-02 | 1.00E+01 | 1.02E+01 | 2.10 |
| 2,4-Dimethylphenol | | | 2.0E-02 | 1.65E-02 | 2.0E-02 | 0.1 | 4.95E-03 | | 8.56E-07 | 0.00E+00 | 2.15E-02 | 992.62 |
| Pentachlorophenol | | | 3.0E-02 | 1.10E-02 | 3.0E-02 | 0.25 | 8.25E-03 | | 8.56E-07 | 0.00E+00 | 1.93E-02 | 1106.06 |
| Benzo(a)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Benzo(a)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Benzo(b)fluoranthene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Benzo(k)fluoranthene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Dibenz(a,h)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Indeno(1,2,3-cd)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 0.00E+00 | |
| Arsenic | | | 5.0E-03 | 6.60E-02 | 5.0E-03 | 0.03 | 5.94E-03 | | 8.56E-07 | 0.00E+00 | 7.19E-02 | 295.96 |
| Chromium (total) | | | 1.5E+00 | 2.20E-04 | | | 0.00E+00 | | 8.56E-07 | 0.00E+00 | 2.20E-04 | 96780.30 |

Appendix B

Calculation Worksheets for VF and PEF for the Construction Worker Exposure Scenario

Appendix B

Calculation of Chemical-Specific Volatilization Factors for Construction Worker Exposure

$$\text{Volatilization Factor} \sim \text{VF} (\text{m}^3/\text{kg}) = [((3.14 * D_A * T)^{1/2} / (2 * P_b * D_A)) * 10^{-4} (\text{m}^2/\text{cm}^2) * Q / C_{sa} * (1/F_D)]$$

| Variable | Value |
|---|--|
| VF = Soil to Air Volatilization Factor (m^3/kg) | Calculated |
| D_A = Apparent Diffusivity (cm^2/s) | $[[[(O_a^{10/3} * D_i * H') + (O_w^{10/3} * D_w)] / n^2] / [(P_b * K_d) + O_w + (O_a * H')]$ |
| T = Total Time Over Which Construction Occurs (s) | 3456000 |
| P_b = Dry Soil Bulk Density (g/cm^3) | 1.5 |
| Q/C_{sa} = Inverse of the Ratio of the 1-h Geometric Mean Air Concentration to the Volatilization Flux at the Center of a Square Site ($\text{g}/\text{m}^2\text{-s}$ per kg/m^3) | 14.31 |
| F_D = Dispersion Correction Factor (unitless) | 0.185 |
| O_a = Air-filled Soil Porosity (L_{air}/L_{soil}) = $n - O_w$ | 0.28 |
| n = Total Soil Porosity (L_{pore}/L_{soil}) = $1 - (P_b/P_s)$ | 0.43 |
| O_w = Water-filled Soil Porosity (L_{water}/L_{soil}) | 0.15 |
| P_s = Soil Particle Density (g/cm^3) | 2.65 |
| D_i = Diffusivity in Air (cm^2/s) | chemical-specific |
| H' = Dimensionless Henry's Law Constant (unitless) | chemical-specific |
| D_w = Diffusivity in Water (cm^2/s) | chemical-specific |
| K_d = Soil-Water Partition Coefficient (cm^3/g) | chemical-specific ($K_{oc} * f_{oc}$) |
| K_{oc} = Soil Organic Carbon Partition Coefficient (cm^3/g) | chemical-specific |
| f_{oc} = Fraction Organic Carbon in Soil (g/g) | 0.006 |

| Chemical | H' | D_i | D_w | K_{oc} | K_d | D_A | VF |
|--------------------------|----------|----------|----------|----------|----------|----------|-----|
| Benzene | 2.28E-01 | 8.80E-02 | 9.80E-06 | 5.89E+01 | 3.53E-01 | 2.15E-03 | 183 |
| Toluene | 2.72E-01 | 8.70E-02 | 8.60E-06 | 1.82E+02 | 1.09E+00 | 1.01E-03 | 267 |
| Ethylbenzene | 3.23E-01 | 7.50E-02 | 7.80E-06 | 3.63E+02 | 2.18E+00 | 5.52E-04 | 362 |
| Xylenes | 3.01E-01 | 7.00E-02 | 7.80E-06 | 4.07E+02 | 2.44E+00 | 4.32E-04 | 409 |
| Trichloroethylene | 4.22E-01 | 7.90E-02 | 9.10E-06 | 1.66E+02 | 9.96E-01 | 1.51E-03 | 219 |
| Tetrachloroethylene | 7.54E-01 | 7.20E-02 | 8.20E-06 | 1.55E+02 | 9.30E-01 | 2.47E-03 | 171 |
| 1,2-Dichloroethane | 4.01E-02 | 1.04E-01 | 9.90E-06 | 1.74E+01 | 1.04E-01 | 1.05E-03 | 262 |
| cis-1,2-Dichloroethylene | 1.67E-01 | 7.36E-02 | 1.13E-05 | 3.55E+01 | 2.13E-01 | 1.90E-03 | 195 |
| 1,1,1-Trichloroethane | 7.05E-01 | 7.80E-02 | 8.80E-06 | 1.10E+02 | 6.60E-01 | 3.28E-03 | 148 |
| Vinyl Chloride | 1.11E+00 | 1.06E-01 | 1.23E-05 | 1.86E+01 | 1.12E-01 | 1.49E-02 | 70 |
| 2,4-Dimethylphenol | | | | | | | |
| Pentachlorophenol | | | | | | | |
| Benzo(a)pyrene | | | | | | | |
| Benzo(a)anthracene | | | | | | | |
| Benzo(b)fluoranthene | | | | | | | |
| Benzo(k)fluoranthene | | | | | | | |
| Dibenz(a,h)anthracene | | | | | | | |
| Indeno(1,2,3-cd)pyrene | | | | | | | |
| Arsenic | | | | | | | |
| Chromium (total) | | | | | | | |

US EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 2001.

Appendix B

Calculation of Particulate Emission Factors for Construction Worker Exposure

$$\text{Particulate Emission Factor} \sim \text{PEF (m}^3/\text{kg)} = (Q/C_{gr}) * (1/F_D) * [(T * A_R) / (556 * (W/3)^{0.4} * ((365d/y - p) / 365d/y) * VKT)]$$

| Variable | Value |
|--|----------|
| PEF = Particulate Emission Factor (m ³ /kg) | 1.17E+06 |
| Q/C _{gr} = Inverse of the Ratio of the 1-h Geometric Mean Air Concentration to the Emission Flux Along a Straight Road Segment Bisecting a Square Site (g/m ² -s per kg/m ³) | 23.02 |
| F _D = Dispersion Correction Factor (unitless) | 0.185 |
| T = Total Time Over Which Construction Occurs (s) | 3456000 |
| A _R = Surface Area of Contaminated Road Segment (m ²) | 274.213 |
| W = Mean Vehicle Weight (tons) | 8 |
| p = Number of Days with at Least 0.01 inches of Precipitation (d/y) | 110 |
| VKT = Sum of Fleet Vehicle Kilometers Traveled During the Exposure Duration (km) | 175.5 |

US EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 2002

Appendix B

ALM Calculation Worksheet for Lead PRGs for the Construction Worker Exposure Scenario

Appendix B

Calculations of Lead Preliminary Remediation Goals (PRGs) - Ava, Douglas County, Missouri Construction Worker Exposure Scenario

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

| Exposure Variable | PRG Equation ¹ | | Description of Exposure Variable | Units | Values for Non-Residential Exposure Scenario | | | |
|-----------------------------|------------------------------|-----|--|------------------|--|------------|------------------|------------|
| | 1* | 2** | | | Using Equation 1 | | Using Equation 2 | |
| | | | | | GSDi = Hom | GSDi = Het | GSDi = Hom | GSDi = Het |
| PbB _{fetal, 0.95} | X | X | 95 th percentile PbB in fetus | ug/dL | 10 | 10 | -- | -- |
| R _{fetal/maternal} | X | X | Fetal/maternal PbB ratio | -- | 0.9 | 0.9 | -- | -- |
| BKSF | X | X | Biokinetic Slope Factor | ug/dL per ug/day | 0.4 | 0.4 | -- | -- |
| GSD _i | X | X | Geometric standard deviation PbB | -- | 2.18 | 2.18 | -- | -- |
| PbB ₀ | X | X | Baseline PbB | ug/dL | 1.53 | 1.53 | -- | -- |
| IR _S | X | | Soil ingestion rate (including soil-derived indoor dust) | g/day | 0.1 | 0.1 | -- | -- |
| IR _{S+D} | | X | Total ingestion rate of outdoor soil and indoor dust | g/day | -- | -- | -- | -- |
| W _S | | X | Weighting factor; fraction of IR _{S+D} ingested as outdoor soil | -- | -- | -- | -- | -- |
| K _{SD} | | X | Mass fraction of soil in dust | -- | -- | -- | -- | -- |
| AF _{S, D} | X | X | Absorption fraction (same for soil and dust) | -- | 0.12 | 0.12 | -- | -- |
| EF _{S, D} | X | X | Exposure frequency (same for soil and dust) | days/yr | 120 | 120 | -- | -- |
| AT _{S, D} | X | X | Averaging time (same for soil and dust) | days/yr | 180 | 180 | -- | -- |
| PRG | Preliminary Remediation Goal | | | ppm | 485 | 485 | -- | -- |

¹ Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_s, K_{SD}).

When IR_s = IR_{s+d} and W_s = 1.0, the equations yield the same PRG.

*Equation 1, based on Eq. 4 in USEPA (1996).

$$\text{PRG} = \frac{([\text{PbB}_{95\text{fetal}}/(\text{R}*(\text{GSD}_i^{1.645}))]-\text{PbB}_0)*\text{AT}_{s,d}}{\text{BKSF}*(\text{IR}_{s+d}*\text{AF}_{s,d}*\text{EF}_{s,d})}$$

**Equation 2, alternate approach based on Eq. 4 and Eq. A-19 in USEPA (1996).

$$\text{PRG} = \frac{([\text{PbB}_{\text{fetal},0.95}/(\text{R}*(\text{GSD}_i^{1.645}))]-\text{PbB}_0)*\text{AT}_{s,d}}{\text{BKSF}*((\text{IR}_{s+d})*\text{AF}_s*\text{EF}_s*W_s)+[\text{K}_{SD}*(\text{IR}_{s+d})*(1-W_s)*\text{AF}_D*\text{EF}_D]}$$

Appendix C

Calculation Worksheets for **Chemical-Specific Soil Saturation Concentrations**

Appendix C

Calculation of Chemical-Specific Soil Saturation Concentrations

$$C_{sat} \text{ (mg/kg)} = (S/P_b) * [(K_d * P_b) + (O_w) + (H' * O_a)]$$

| Variable | Value |
|---|---|
| Csat = Soil Saturation Concentration (mg/kg) | Calculated |
| S = Solubility in Water (mg/L _{water}) | chemical-specific |
| P _b = Dry Soil Bulk Density (kg/L) | 1.5 |
| K _d = Soil-Water Partition Coefficient (L/kg) | chemical-specific (K _{oc} *f _{oc}) |
| K _{oc} = Soil Organic Carbon Partition Coefficient (L/kg) | chemical-specific |
| f _{oc} = Fraction Organic Carbon Content of Soil (g/g) | 0.006 |
| O _w = Water-filled Soil Porosity (L _{water} /L _{soil}) | 0.15 |
| H' = Dimensionless Henry's Law Constant (unitless) | chemical-specific |
| O _a = Air-filled Soil Porosity (L _{air} /L _{soil}) = n - O _w | 0.28 |
| n = Total Soil Porosity (L _{pore} /L _{soil}) = 1 - (P _b /P _s) | 0.43 |
| P _s = Soil Particle Density (kg/L) | 2.65 |

Calculation of Csat

| Chemical | S | K _{oc} | K _d | H' | Csat |
|--------------------------|----------|-----------------|----------------|----------|------|
| Benzene | 1.75E+03 | 5.89E+01 | 3.53E-01 | 2.28E-01 | 869 |
| Toluene | 5.26E+02 | 1.82E+02 | 1.09E+00 | 2.72E-01 | 654 |
| Ethylbenzene | 1.69E+02 | 3.63E+02 | 2.18E+00 | 3.23E-01 | 395 |
| Xylenes | 1.61E+02 | 4.07E+02 | 2.44E+00 | 3.01E-01 | 418 |
| Trichloroethylene | 1.10E+03 | 1.66E+02 | 9.96E-01 | 4.22E-01 | 1293 |
| Tetrachloroethylene | 2.00E+02 | 1.55E+02 | 9.30E-01 | 7.54E-01 | 235 |
| 1,2-Dichloroethane | 8.52E+03 | 1.74E+01 | 1.04E-01 | 4.01E-02 | 1806 |
| cis-1,2-Dichloroethylene | 3.50E+03 | 3.55E+01 | 2.13E-01 | 1.67E-01 | 1206 |
| 1,1,1-Trichloroethane | 1.33E+03 | 1.10E+02 | 6.60E-01 | 7.05E-01 | 1188 |
| Vinyl Chloride | 2.76E+03 | 1.86E+01 | 1.12E-01 | 1.11E+00 | 1164 |
| 2,4-Dimethylphenol | | | | | |
| Pentachlorophenol | | | | | |
| Benzo(a)pyrene | | | | | |
| Benzo(a)anthracene | | | | | |
| Benzo(b)fluoranthene | | | | | |
| Benzo(k)fluoranthene | | | | | |
| Dibenz(a,h)anthracene | | | | | |
| Indeno(1,2,3-cd)pyrene | | | | | |
| Arsenic | | | | | |
| Chromium (total) | | | | | |
| Copper | | | | | |

US EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 2002

Appendix D

Calculation Worksheets for Soil Migration to Groundwater PRGs

Soil Migration to Groundwater Scenario

Appendix D

Preliminary Remediation Goals for Soil - Ava, Douglas County, Missouri Soil Screening Level Partitioning Equation for Migration to Groundwater

PRG Formula:

$$C_w * [K_d + ((O_w + O_a * H') / (P_b))]]$$

| Variable | Value |
|---|--|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| C_w = Target Soil Leachate Concentration (mg/L) | chemical-specific (MCL, MCLG, or HBL*DAF) |
| K_d = Soil-Water Partition Coefficient (L/kg) | chemical-specific (Organics= $K_{oc} * f_{oc}$; Inorganics - Arsenic=29, Chromium=19) |
| K_{oc} = Soil Organic Carbon/Water Partition Coefficient (L/kg) | chemical-specific |
| f_{oc} = Fraction Organic Carbon in Soil (g/g) | 0.002 |
| O_w = Water-filled Soil Porosity (L_{water}/L_{soil}) | 0.3 |
| O_a = Air-filled Soil Porosity (L_{air}/L_{soil}) = $n - O_w$ | 0.13 |
| n = Soil Porosity (L_{pore}/L_{soil}) = $1 - (P_b/P_s)$ | 0.43 |
| P_b = Dry Soil Bulk Density (kg/L) | 1.5 |
| P_s = Soil Particle Density (kg/L) | 2.65 |
| H' = Dimensionless Henry's Law Constant (unitless) | chemical-specific |

Calculation of Soil Migration to Groundwater Preliminary Remediation Goals

| Chemical | C_w | K_{oc} | K_d | H' | PRG |
|------------------------|-------|----------|----------|----------|-------|
| Benzene | 5E-03 | 5.89E+01 | 1.18E-01 | 2.28E-01 | 0.002 |
| Toluene | 1E+00 | 1.82E+02 | 3.64E-01 | 2.72E-01 | 0.61 |
| Ethylbenzene | 7E-01 | 3.63E+02 | 7.26E-01 | 3.23E-01 | 0.69 |
| Xylenes | 1E+01 | 4.07E+02 | 8.14E-01 | 3.01E-01 | 10.78 |
| Trichloroethylene | 5E-03 | 1.66E+02 | 3.32E-01 | 4.22E-01 | 0.003 |
| Tetrachloroethylene | 5E-03 | 1.55E+02 | 3.10E-01 | 7.54E-01 | 0.003 |
| 1,2-Dichloroethane | 5E-03 | 1.74E+01 | 3.48E-02 | 4.01E-02 | 0.001 |
| Pentachlorophenol | 1E-03 | 5.92E+02 | 1.18E+00 | 1.00E-06 | 0.001 |
| Benzo(a)pyrene | 2E-04 | 1.02E+06 | 2.04E+03 | 4.63E-05 | 0.42 |
| Benzo(a)anthracene | 1E-04 | 3.98E+05 | 7.96E+02 | 1.37E-04 | 0.08 |
| Benzo(b)fluoranthene | 1E-04 | 1.23E+06 | 2.46E+03 | 4.55E-03 | 0.25 |
| Benzo(k)fluoranthene | 1E-03 | 1.23E+06 | 2.46E+03 | 3.40E-05 | 2.55 |
| Dibenz(a,h)anthracene | 1E-05 | 3.80E+06 | 7.60E+03 | 6.03E-07 | 0.08 |
| Indeno(1,2,3-cd)pyrene | 1E-04 | 3.47E+06 | 6.94E+03 | 6.56E-05 | 0.72 |
| Arsenic | 1E-02 | | 2.90E+01 | 0.00E+00 | 0.30 |
| Chromium (total) | 1E-01 | | 1.90E+01 | 0.00E+00 | 1.99 |

Appendix D

Calculation of Chemical-Specific Target Soil Leachate Concentrations - Ava, Douglas County, Missouri

Target Soil Leachate Concentration $\sim C_w$ (mg/L) = MCL, MCLG, or HBL * DAF

| Variable | | Site Measured or Derived values |
|--|---|---------------------------------|
| C_w = Target Soil Leachate Concentration (mg/L) | Calculated | |
| Groundwater Target Concentration (mg/L) | | |
| MCL = Maximum Contaminant Level, MCLG = Maximum Contaminant Level Goal, HBL = Health-Based Limit | chemical-specific | |
| DAF = Dilution Attenuation Factor (unitless) | $[1 + ((K * i * d) / (l * L))]$ | 1.04 |
| K = Aquifer Hydraulic Conductivity (m/yr) | site-specific | 1669 |
| i = Hydraulic Gradient (m/m) | site-specific | 0.0042 |
| l = Infiltration Rate (m/yr) | site-specific | 31.78 |
| d = Mixing Zone Depth (m) | $[(0.0112 * L^2)^{0.5} + d_a * (1 - \exp((-L * i) / (K * i * d_a)))]$ | 8.53 |
| L = Source Length Parallel to Groundwater Flow (m) | site-specific | 53.34 |
| d_a = Aquifer Thickness (m) | site-specific | 2.89 |

| Chemical | Groundwater Target Concentration | C_w |
|------------------------|----------------------------------|-----------|
| Benzene | 0.005 | 0.0052 |
| Toluene | 1 | 1.04 |
| Ethylbenzene | 0.7 | 0.72 |
| Xylenes | 10 | 10.35 |
| Trichloroethylene | 0.005 | 0.0052 |
| Tetrachloroethylene | 0.005 | 0.0052 |
| 1,2-Dichloroethane | 0.005 | 0.0052 |
| Pentachlorophenol | 0.001 | 0.00104 |
| Benzo(a)pyrene | 0.0002 | 0.00021 |
| Benzo(a)anthracene | 0.0001 | 0.000104 |
| Benzo(b)fluoranthene | 0.0001 | 0.000104 |
| Benzo(k)fluoranthene | 0.001 | 0.00104 |
| Dibenz(a,h)anthracene | 0.00001 | 0.0000104 |
| Indeno(1,2,3-cd)pyrene | 0.0001 | 0.000104 |
| Arsenic | 0.01 | 0.0104 |
| Chromium (total) | 0.1 | 0.104 |

Appendix E

Calculation Worksheets for **Surface Water PRGs**

Appendix E

Recreational Child Exposure Scenario

Appendix E

Preliminary Remediation Goals for Surface Water - Ava, Douglas County, Missouri Recreational Exposure Scenario - Carcinogenic Worksheet for 10⁻⁶ TCR

Carcinogenic PRG Formula:

TCR x BW x ATc

EF x ED x [(Sfo x CR x ET) + (Sfd x CFw x SAw x DCF)]

$$\text{If } t_{\text{over}} \leq t^*, \text{ then: } DCF = 2FA * K_p * \sqrt{\frac{6L * t}{\pi}}$$

$$\text{If } t_{\text{over}} > t^*, \text{ then: } DCF = FA * K_p * \left[\frac{t}{1+B} + 2L \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/L) | Calculated |
| TCR = Target Cancer Risk (unitless) | 0.000001 |
| BWc = Body Weight (kg) | 15 |
| ATc = Averaging Time (days) | 25550 |
| Sfo = Oral Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| Sfd = Dermal Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| ET (t) = Exposure Time (hours/day) | 4 |
| EF = Exposure Frequency (days/year) | 90 |
| ED = Exposure Duration (years) | 6 |
| CR = Water Contact Rate (L/hr) | 0.05 |
| CFw = Volumetric Conversion Factor for Water (1 L/1000 cm ³) | 0.001 |
| SAw = Skin Surface Area Available for Water Contact (cm ² /hour) | 3307 |
| DCF = Dermal Contact Factor (cm-hour/day) | chemical-specific |
| FA = Fraction Absorbed (unitless) | chemical-specific |
| K _p = Dermal Permeability Coefficient of Compound in Water (cm/hr) | chemical-specific |
| L = Lag Time (hours) | chemical-specific |
| B = Ratio of the Permeability Coefficient of a Compound through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis (unitless) | chemical-specific |
| t* = Time to Reach Steady-State (hours) | chemical-specific |

Calculated Intakes

| | |
|--------------------------------|-----|
| General = TCR x BW x ATc | 0.4 |
| EFD = EF x ED | 540 |
| Ingestion = Sfo x CR x ET | 0.2 |
| Dermal = Sfd x CFw x SAw x DCF | 3.3 |
| PRG = General/SUM | |

Calculation of Carcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | Sfo | Ingestion | Sfd | Dermal 1 | FA | K _p | B | L | t* | If t _{over} ≤ t* | If t _{over} > t* | Final DCF | Dermal 2 | SUM | PRG |
|---------------------------------|---------|-----|----------|-----------|---------|----------|-----|----------------|-----|------|-------|---------------------------|---------------------------|-----------|----------|----------|--------|
| Benzene | 0.4 | 540 | 5.5E-02 | 1.10E-02 | 5.5E-02 | 1.82E-01 | 1 | 0.015 | 0.1 | 0.29 | 0.7 | 4.47E-02 | 6.41E-02 | 6.41E-02 | 1.17E-02 | 2.27E-02 | 0.03 |
| Toluene | | | 0.00E+00 | | | 0.00E+00 | 1 | 0.031 | 0.1 | 0.35 | 0.84 | | | | 0.00E+00 | 0.00E+00 | |
| Ethylbenzene | | | 0.00E+00 | | | 0.00E+00 | 1 | 0.049 | 0.2 | 0.42 | 1.01 | | | | 0.00E+00 | 0.00E+00 | |
| Xylenes | | | 0.00E+00 | | | 0.00E+00 | 1 | 0.053 | 0.2 | 0.42 | 1.01 | | | | 0.00E+00 | 0.00E+00 | |
| Trichloroethylene (provisional) | | | 1.1E-02 | 2.20E-03 | 1.1E-02 | 3.64E-02 | | | | | | | | | 2.14E-03 | 4.34E-03 | 0.16 |
| Trichloroethylene (draft) | | | 4.0E-01 | 8.00E-02 | 4.0E-01 | 1.32E+00 | 1 | 0.012 | 0.1 | 0.58 | 1.39 | 5.05E-02 | 5.89E-02 | 5.89E-02 | 7.80E-02 | 1.58E-01 | 0.004 |
| Tetrachloroethylene | | | 5.4E-01 | 1.08E-01 | 5.4E-01 | 1.79E+00 | 1 | 0.033 | 0.2 | 0.91 | 2.18 | 1.74E-01 | 1.82E-01 | 1.82E-01 | 3.25E-01 | 4.33E-01 | 0.002 |
| 1,1-Dichloroethane | | | | 0.00E+00 | | 0.00E+00 | | | | | | | | | 0.00E+00 | 0.00E+00 | |
| 1,2-Dichloroethane | | | 9.1E-02 | 1.82E-02 | | 0.00E+00 | | | | | | | | | 0.00E+00 | 1.82E-02 | 0.04 |
| Pentachlorophenol | | | 1.2E-01 | 2.40E-02 | 1.2E-01 | 3.97E-01 | 0.9 | 0.39 | 2.5 | 3.33 | 13.82 | 3.54E+00 | 5.60E+00 | 3.54E+00 | 1.41E+00 | 1.43E+00 | 0.0005 |

Appendix E

Preliminary Remediation Goals for Surface Water - Ava, Douglas County, Missouri Recreational Exposure Scenario - Non-Carcinogenic Worksheet for .1 THQ

Non-Carcinogenic PRG Formula:

$THQ \times BW \times ATn$

$EF \times ED \times \left[\left(\frac{1}{RfDo} \right) \times CR \times ET \right] + \left[\left(\frac{1}{RfDd} \right) \times CFw \times SAw \times DCF \right]$

$$\text{If } t_{event} \leq t^*, \text{ then: } DCF = 2FA \cdot K_p \cdot \sqrt{\frac{6L \cdot t}{\pi}}$$

$$\text{If } t_{event} > t^*, \text{ then: } DCF = FA \cdot K_p \cdot \left[\frac{t}{1+B} + 2L \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/L) | Calculated |
| THQ = Target Hazard Quotient (unitless) | 0.1 |
| BWc = Body Weight (kg) | 15 |
| ATn = Averaging Time (days) | 2190 |
| RfDo = Oral Reference Dose (mg/kg-day) | chemical-specific |
| RfDd = Dermal Reference Dose (mg/kg-day) | chemical-specific |
| ET (t) = Exposure Time (hours/day) | 4 |
| EF = Exposure Frequency (days/year) | 90 |
| ED = Exposure Duration (years) | 6 |
| CR = Water Contact Rate (L/hr) | 0.05 |
| CFw = Volumetric Conversion Factor for Water (1 L/1000 cm ³) | 0.001 |
| SAw = Skin Surface Area Available for Water Contact (cm ² /hour) | 3307 |
| DCF = Dermal Contact Factor (cm-hour/day) | chemical-specific |
| FA = Fraction Absorbed (unitless) | chemical-specific |
| K _p = Dermal Permeability Coefficient of Compound in Water (cm/hr) | chemical-specific |
| L _{event} = Lag Time per Event (hours) | chemical-specific |
| B = Ratio of the Permeability Coefficient of a Compound through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis (unitless) | chemical-specific |
| t* = Time to Reach Steady-State (hours) | chemical-specific |

| | |
|-------------------------------------|------|
| Calculated Intakes | |
| General = THQ x BW x ATn | 3285 |
| EFD = EF x ED | 540 |
| Ingestion = (1/RfDo) x CR x ET | 0.2 |
| Dermal = (1/RfDd) x CFw x SAw x DCF | 3.3 |
| PRG = SUM | |

Calculation of Noncarcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | RfDo | Ingestion | RfDd | Dermal 1 | FA | K _p | B | L | t* | If t _{event} ≤ t* | If t _{event} > t* | Final DA _{event} | Dermal 2 | SUM | PRG |
|---------------------------------|---------|-----|---------|-----------|---------|----------|-----|----------------|-----|------|-------|----------------------------|----------------------------|---------------------------|----------|----------|-------|
| | | | | | | | | | | | | DA _{event} | DA _{event} | | | | |
| Benzene | 3285 | 540 | 3.0E-03 | 6.67E+01 | 3.0E-03 | 1.10E+03 | 1 | 0.015 | 0.1 | 0.29 | 0.7 | 4.47E-02 | 6.41E-02 | 6.41E-02 | 7.07E+01 | 1.37E+02 | 0.04 |
| Toluene | | | 2.0E+00 | 1.00E-01 | 2.0E+00 | 1.65E+00 | 1 | 0.031 | 0.1 | 0.35 | 0.84 | 1.01E-01 | 1.37E-01 | 1.37E-01 | 2.26E-01 | 3.26E-01 | 18.67 |
| Ethylbenzene | | | 1.0E-01 | 2.00E+00 | 1.0E-01 | 3.31E+01 | 1 | 0.049 | 0.2 | 0.42 | 1.01 | 1.76E-01 | 2.12E-01 | 2.12E-01 | 7.03E+00 | 9.03E+00 | 0.67 |
| Xylenes | | | 2.0E-01 | 1.00E+00 | 2.0E-01 | 1.65E+01 | 1 | 0.053 | 0.2 | 0.42 | 1.01 | 1.90E-01 | 2.30E-01 | 2.30E-01 | 3.80E+00 | 4.80E+00 | 1.27 |
| Trichloroethylene (provisional) | | | 6.0E-03 | 3.33E+01 | 6.0E-03 | 5.51E+02 | 1 | 0.012 | 0.1 | 0.58 | 1.39 | 5.05E-02 | 5.89E-02 | 5.89E-02 | 3.25E+01 | 6.58E+01 | 0.09 |
| Trichloroethylene (draft) | | | 3.0E-04 | 6.67E+02 | 3.0E-04 | 1.10E+04 | 1 | 0.033 | 0.2 | 0.91 | 2.18 | 1.74E-01 | 1.82E-01 | 1.82E-01 | 6.01E-01 | 8.01E-01 | 0.08 |
| Tetrachloroethylene | | | 1.0E-02 | 2.00E+01 | 1.0E-02 | 3.31E+02 | 1 | 0.033 | 0.2 | 0.91 | 2.18 | 1.74E-01 | 1.82E-01 | 1.82E-01 | 6.01E-01 | 8.01E-01 | 0.08 |
| 1,1-Dichloroethane | | | 1.0E+00 | 2.00E-01 | 1.0E+00 | 0.00E+00 | | | | | | | | | 0.00E+00 | 2.00E-01 | 30.42 |
| 1,2-Dichloroethane | | | | 0.00E+00 | | 0.00E+00 | | | | | | | | | 0.00E+00 | 0.00E+00 | |
| Pentachlorophenol | | | 3.0E-02 | 6.67E+00 | 3.0E-02 | 1.10E+02 | 0.9 | 0.39 | 2.5 | 3.33 | 13.82 | 3.54E+00 | 5.60E+00 | 3.54E+00 | 3.90E+02 | 3.97E+02 | 0.02 |

Appendix F

Calculation Worksheets for **Sediment PRGs**

Appendix F

Recreational Child Exposure Scenario

Appendix F

Preliminary Remediation Goals for Sediment - Ava, Douglas County, Missouri Recreational Child Exposure Scenario - Carcinogenic Worksheet for 10^{-6} TCR

Carcinogenic PRG Formula:

$$\text{TCR} \times \text{BW} \times \text{ATc} \\ \text{EF} \times \text{ED} \times [(\text{SFo} \times \text{CFs} \times \text{IRS} \times \text{FI}) + (\text{SFd} \times \text{CFs} \times \text{ABS} \times \text{SAs} \times \text{AF})]$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| TCR = Target Cancer Risk (unitless) | 0.000001 |
| BW = Body Weight (kg) | 15 |
| ATc = Averaging Time (days) | 25550 |
| SFo = Oral Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| SFd = Dermal Slope Factor (mg/kg-day) ⁻¹ | chemical-specific |
| EF = Exposure Frequency (days/year) | 90 |
| ED = Exposure Duration (years) | 6 |
| CFs = Conversion Factor for Soils (10 ⁻⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 200 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SAs = Skin Surface Area Available for Sediment Contact (cm ² /day) | 2800 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.2 |

Calculated Intakes

| | |
|-----------------------------------|--------|
| General = TCR x BW x ATc | 0.4 |
| EFD = EF x ED | 540 |
| Ingestion = SFo x CFs x IRS x FI | 0.0002 |
| Dermal = SFd x CFs ABS x SAs x AF | 0.001 |
| PRG = General / SUM | |

Calculation of Carcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | SFo | Ingestion | SFd | ABS | Dermal | SUM | PRG |
|------------------------|---------|-----|---------|-----------|---------|------|----------|----------|-------|
| Pentachlorophenol | 0.4 | 540 | 1.2E-01 | 2.40E-05 | 1.2E-01 | 0.25 | 1.68E-05 | 4.08E-05 | 17.40 |
| Benzo(a)pyrene | | | 7.3E+00 | 1.46E-03 | 7.3E+00 | 0.13 | 5.31E-04 | 1.99E-03 | 0.36 |
| Benzo(a)anthracene | | | 7.3E-01 | 1.46E-04 | 7.3E-01 | 0.13 | 5.31E-05 | 1.99E-04 | 3.56 |
| Benzo(b)fluoranthene | | | 7.3E-01 | 1.46E-04 | 7.3E-01 | 0.13 | 5.31E-05 | 1.99E-04 | 3.56 |
| Dibenz(a,h)anthracene | | | 7.3E+00 | 1.46E-03 | 7.3E+00 | 0.13 | 5.31E-04 | 1.99E-03 | 0.36 |
| Indeno(1,2,3-cd)pyrene | | | 7.3E-01 | 1.46E-04 | 7.3E-01 | 0.13 | 5.31E-05 | 1.99E-04 | 3.56 |
| Benzo(g,h,i)perylene | | | | 0.00E+00 | | | 0.00E+00 | 0.00E+00 | |
| Phenanthrene | | | | 0.00E+00 | | | 0.00E+00 | 0.00E+00 | |

Appendix F

Preliminary Remediation Goals for Sediment - Ava, Douglas County, Missouri Recreational Child Exposure Scenario - Non-Carcinogenic Worksheet for .1 THQ

Non-Carcinogenic PRG Formula:

$$\text{THQ} = \frac{\text{THQ} \times \text{BW} \times \text{ATn}}{\text{EF} \times \text{ED} \times \left[\left(\frac{1}{\text{RfDo}} \right) \times \text{CFs} \times \text{IRS} \times \text{FI} + \left(\frac{1}{\text{RfDd}} \right) \times \text{CFs} \times \text{ABS} \times \text{SAs} \times \text{AF} \right]}$$

| Variable | Value |
|---|-------------------|
| PRG = Preliminary Remediation Goal (mg/kg) | Calculated |
| THQ = Target Hazard Quotient (unitless) | 0.1 |
| BW = Body Weight (kg) | 15 |
| ATn = Averaging Time (days) | 2190 |
| RfDo = Oral Reference Dose (mg/kg-day) | chemical-specific |
| RfDd = Dermal Reference Dose (mg/kg-day) | chemical-specific |
| EF = Exposure Frequency (days/year) | 90 |
| ED = Exposure Duration (years) | 6 |
| CFs = Conversion Factor for Soils (10 ⁻⁶ kg/mg) | 0.000001 |
| IRS = Soil Ingestion Rate (mg/day) | 200 |
| FI = Fraction Ingested from Contaminated Source (unitless) | 1 |
| ABS = Absorption Fraction (unitless) | chemical-specific |
| SAs = Skin Surface Area Available for Sediment Contact (cm ² /day) | 2800 |
| AF = Adherence Factor of Soil to Skin (mg/cm ²) | 0.2 |

Calculated Intakes

| | |
|--|--------|
| General = THQ x BW x ATn | 3285 |
| EFD = EF x ED | 540 |
| Ingestion = (1/RfDo) x CFs x IRS x FI | 0.0002 |
| Dermal = (1/RfDd) x CFs x ABS x SAs x AF | 0.001 |
| PRG = General / SUM | |

Calculation of Noncarcinogenic Preliminary Remediation Goals

| Chemical | General | EFD | RfDo | Ingestion | RfDd | ABS | Dermal | SUM | PRG |
|------------------------|---------|-----|---------|-----------|---------|------|----------|----------|--------|
| Pentachlorophenol | | | 3.0E-02 | 6.67E-03 | 3.0E-02 | 0.25 | 4.67E-03 | 1.13E-02 | 536.76 |
| Benzo(a)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | 0.00E+00 | |
| Benzo(a)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | 0.00E+00 | |
| Benzo(b)fluoranthene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | 0.00E+00 | |
| Dibenz(a,h)anthracene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | 0.00E+00 | |
| Indeno(1,2,3-cd)pyrene | | | | 0.00E+00 | | 0.13 | 0.00E+00 | 0.00E+00 | |
| Benzo(g,h,i)perylene | | | | 0.00E+00 | | | 0.00E+00 | 0.00E+00 | |
| Phenanthrene | | | | 0.00E+00 | | | 0.00E+00 | 0.00E+00 | |



ATTACHMENTS



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 N. 5TH STREET
KANSAS CITY, KANSAS 66101

JUN 20 2002

MEMORANDUM

SUBJECT: Preliminary Remediation Goals
Sentinel Wood Treater Site
Ava, Missouri

FROM: Judy Facey PhD Toxicologist *Jfacey*
ENSV/DISO

TO: Eric Nold, On-Scene Coordinator
EFLR

As you requested, I have developed Preliminary Remediation Goals (PRGs) for the Sentinel Wood Treater site, located in Ava, Missouri. PRGs were calculated to address contamination from semi-volatile organic compounds, which include polycyclic aromatic hydrocarbons, volatile organic compounds, metals and dioxin in soil. The corresponding PRGs equate to an excess individual lifetime cancer risk of 1.0×10^{-6} and are summarized in the table below. All dioxin cleanup values was taken from the Office of Solid Waste and Emergency Response Directive 9200.4-26 dated April 13, 1998. The supporting documentation for the PRGs is attached. If you have any questions, please let me know.

Commercial/ Industrial and Residential PRGs for Surface Soil

| Contaminants | Commercial/ Industrial (mg/kg) | Residential (mg/kg) |
|-------------------------|-----------------------------------|------------------------|
| Benzo(a) pyrene | 0.29 | 0.062 |
| Benzo(a) anthracene | 2.9 | 0.62 |
| Benzo(b) fluoranthene | 2.9 | 0.62 |
| Benzo(k) fluoranthene | 29 | 6.2 |
| Dibenzo(a,h) anthracene | 0.29 | 0.062 |
| Indeno(1,2,3-cd) pyrene | 29 | 0.62 |
| Pentachlorophenol | 11 | 3.0 |
| Benzene | 1.5 | 0.65 |
| Toluene (na) | 520 | 520 |
| Ethylbenzene (na) | 230 | 230 |
| Xylenes (Na) | 210 | 210 |
| Trichloroethylene | 6.1 | 2.8 |
| Tetrachloroethylene | 19 | 5.7 |
| 1,2 -Dichloroethane | 0.76 | 0.35 |
| Arsenic | 2.7 | 0.39 |
| Chromium (na) | 450 | 210 |
| Copper (na) | 76,000 | 2900 |
| Lead | 1000 | 400 |
| Dioxin | 0.005 - 0.02 | 0.001 |

Attachments

**Preliminary Remediation Goals
for Sentinel Wood Treating Site,
Ava, Missouri
June 12, 2002**

1.0 Site Description and History

The Sentinel Wood Treating Site is located at 412 NW 12th Avenue in Douglas County, Ava, Missouri and is on property owned by Sentinel Industries Inc. The former wood treating facility encompasses approximately 14 acres and is located in a commercial manufacturing/agricultural setting with private residences south of the site. The former wood treating (southern) portion of the site currently has several retail shops and a parking lot. The remainder of the site is comprised of open grounds and buildings from former wood treating operations. One building is currently occupied by a small business consisting of less than ten (10) employees.

Two intermittent unnamed creeks enter the site from the north and northwest, respectively. The creeks join on-site at a point southeast of the former Post Peeler building, and continue flowing to the south, exiting the site at its southern border. A portion of the intermittent creek is covered by an asphalt lot at the south end of the site, but resurfaces on the south side of NW 12th Avenue. The creek continues south through a residential area and a city park and enters the upper portion of Prairie Creek.

2.0 Selection of Chemicals of Potential Concern (COPC)

The site is the location of a former wood treating facility which pressure treated wood with pentachlorophenol (PCP), with diesel fuel used as a carrier. Pressure treating occurred from 1959 to approximately 1978. Sludge from the pressure treating process was either burned in an on-site boiler and/ or deposited into three on-site lagoons. The lagoons were eventually closed in-place in 1978-1979, after pressure- treating operations ceased.

In 1975, on-site operations reportedly shifted toward the manufacturing of log homes using wood treated off-site with copper, chromium, and arsenic (CCA). Information from 1980, indicates that Sentinel Industries began making outdoor furniture in addition to the log homes. Although CCA treatment occurred off-site, sawdust and scrap wood generated from on-site operations was burned in an on-site wood furnace, which was used to heat the furniture factory building.

Previous environmental investigations conducted by the United States Environmental Protection Agency (EPA) and the property owner have documented the presence of PCP in the lagoon sludge, the shallow groundwater beneath the lagoons, and on-site soils. In addition,

dioxins and furans (collectively referred as dioxin). common impurities in PCP, have been detected in the lagoon and on-site soils.

The site investigations documented the presence of semi-volatile organic compounds, which include polycyclic aromatic hydrocarbons, volatile organic compounds, metals and dioxin in surface soil. The soil sample results from the site investigation were compared to U.S. EPA Region IX industrial soil PRGs (U.S. EPA, 2000). Compounds were excluded for evaluation if at least one sample did not exceed the Region IX industrial soil PRG or if a health-based benchmark is not available

3.0 Evaluation of Reasonable Maximum Exposure Scenarios

This assessment is limited to the occupational areas of the Sentinel Wood Treatment site. Exposure scenario is consistent with commercial/ industrial use of the site. On-site workers exposed to contaminated surface soil represent the human receptors with the greatest potential exposure in the contaminated area. Reasonable maximum exposure scenario was considered for on-site workers that account for incidental ingestion, dermal contact, and inhalation of airborne particulates generated from contaminated surface soil. The scenario assumes exposure to a 70 kg adult worker for 250 days per year over a period of 25 years.

4.0. Toxicity Information

All of the COFCs considered in this evaluation are classified as either known or probable human carcinogens. The cancer slope factors used in calculating the PRGs were obtained from the Integrated Risk Information System (IRIS) or the National Center for Environmental Assessment. The cancer slope factors and weight-of-evidence determinations for the COFCs are summarized in Table 1.

5.0 Calculation of PRGs

The PRGs were calculated for surface soils located on the Sentinel Wood Treating Site area using a formula from the Risk Assessment Guidance of Superfund, Volume I, Part B (EPA, 1991b). The PRGs in this assessment primarily use default exposure parameters based on established U.S. EPA guidance and policies. The carcinogenic PRG formula, along with the exposure parameters and variable definitions, are presented below.

5.1 Dioxin

To date, EPA has selected one part per billion (1 ppb) as a cleanup level for dioxin in residential soils at Superfund and Resources Conservation and Recovery Act (RCRA) sites

where dioxin is a contaminant of concern. EPA has also, selected a cleanup level for dioxin within the range of 5 ppb to 20 ppb for commercial/ industrial soils at Superfund and RCRA sites where dioxin is a contaminant of concern.

Table 1. Summary of Carcinogenic Toxicity Information for COPCs

| Chemicals | Carcinogenicity | | |
|-------------------------|---|---|--------------------------------------|
| | Oral Slope Factor (mg/kg/day ⁻¹) | Inhal. Slope Factor (mg/kg/day ⁻¹) | Weight-of-Evidence Classification |
| Benzo(a) pyrene | 7.3E+00 (n) ¹ | 3.1E+00 (n) ¹ | B2- probable human carcinogen |
| Benzo(a) anthracene | 7.3E-01 (n) ¹ | 3.1E-01 (n) ¹ | B2- probable human carcinogen |
| Benzo(b)fluoranthene | 7.3E-01 (n) ¹ | 3.1E-01 (n) ¹ | B2- probable human carcinogen |
| Benzo(k) fluoranthene | 7.3E-02 (n) ¹ | 3.1E-02 (n) ¹ | B2- probable human carcinogen |
| Dibenzo(a,h) anthracene | 7.3E+00 (n) ¹ | 3.1E+00 (n) ¹ | B2- probable human carcinogen |
| Indeno(1,2,3-cd) pyrene | 7.3E-01 (n) ¹ | 3.1E-01 (n) ¹ | B2- probable human carcinogen |
| Pentachlorophenol | 1.2E-01 (n) ¹ | --- | B2- probable human carcinogen |
| Benzene | 5.5E-02 (i) ² | 2.7E-02 (i) ² | A- known human carcinogen |
| Toluene (na) | --- | --- | D-not classified as human car. |
| Ethylbenzene (na) | --- | --- | D-not classified as human car. |
| Xylenes (total) (na) | --- | --- | D-not classified as human car. |
| Trichloroethylene | 1.1E-02 (n) ¹ | 6.0E-03 (n) ¹ | B2- probable human carcinogen |
| Tetrachloroethylene | 5.2E-02 (n) ¹ | 2.0E-03 (n) ¹ | B2- probable human carcinogen |
| 1,2 -Dichloroethane | 9.1E-02 (i) ² | 9.1E-02 (i) ² | B2- probable human carcinogen |
| Arsenic | 1.5E+00 (i) ² | 1.5E+00 (i) ² | A- known human carcinogen |
| Chromium (total) (na) | --- | --- | D-not classified as human car. |
| Copper (na) | --- | --- | D-not classified as human car. |
| Lead | --- | --- | B2- probable human carcinogen |

¹ National Center for Environmental Health Assessment

² U.S. EPA. 2002 Integrated Risk Information System (IRIS)

³ na ~ non-cancer

Carcinogenic PRG Formula for an Industrial/Commercial Scenario:

$$\text{PRG (mg/kg)} = \frac{\text{TR} \times \text{BW}_a \times \text{AT}_c}{\text{EF} \times \text{ED} \times [(\text{SF}_o \times \text{IR}_s \times \text{CF}) + (\text{SF}_i \times \text{IR}_a \times (1/\text{PEF})) + (\text{SF}_o \times \text{SA} \times \text{ABS} \times \text{AF} \times \text{CF})]}$$

| <u>Symbol</u> | <u>Definition (units)</u> | <u>Parameter Value</u> | <u>Reference</u> |
|-----------------|--|-------------------------------|------------------|
| TR | Target Risk | 1.0E-06 | - |
| BW _a | Body weight - adult (kg) | 70 | EPA, 1989 |
| AT _c | Averaging time - carcinogens (days) | 25550 | EPA, 1989 |
| SF _o | Oral cancer slope factor (mg/kg-day) ⁻¹ | See Table 1 | - |
| SF _i | Inhalation cancer slope factor (mg/kg-day) ⁻¹ | See Table 1 | - |
| EF | Exposure frequency (days/yr) | 250 | EPA, 1991b |
| ED | Exposure duration (years) | 25 | EPA, 1991b |
| IR _s | Soil ingestion rate (mg/day) | 50 | EPA, 1991b |
| IR _a | Inhalation rate (m ³ /day) | 20 | EPA, 1991b |
| PEF | Particulate emission factor (m ³ /kg) | 1.32E+09 | EPA, 1996 |
| SA | Skin surface area (cm ²) | 3300 | EPA, 2000b |
| ABS | Skin absorption factor (unitless) | Arsenic - 0.03 PAHs - 0.13 | EPA, 2000b |
| AF | Adherence Factor (mg/cm ²) | 0.2 | EPA, 2000b |
| CF | Conversion factor | 1.0E-06 | - |

The target risk level used in calculating the PRGs for the on-site worker scenario equates to an excess individual lifetime cancer risk of 1.0×10^{-6} and 1.0×10^{-5} . The carcinogenic PRGs are summarized in Tables 2 and 3.

Table 2. Commercial/ Industrial PRGs for Surface Soil

| Contaminants | Commercial/ Industrial (mg/kg) (1 x 10 ⁻⁶) | Commercial/ Industrial (mg/kg) (1 x 10 ⁻⁵) |
|-------------------------|---|---|
| Benzo(a) pyrene | 0.29 | 2.9 |
| Benzo(a) anthracene | 2.9 | 29 |
| Benzo(b) fluoranthene | 2.9 | 29 |
| Benzo(k) fluoranthene | 29 | 290 |
| Dibenzo(a,h) anthracene | 0.29 | 2.9 |
| Indeno(1,2,3-cd) pyrene | 29 | 290 |
| Pentachlorophenol | 11 | 110 |
| Benzene | 1.5 | 15 |
| Toluene | 520 | 5,200 |
| Ethylbenzene | 230 | 2,300 |
| Xylenes | 210 | 2,100 |
| Trichloroethylene | 6.1 | 61 |
| Tetrachloroethylene | 19 | 190 |
| 1,2 -Dichloroethane | 0.76 | 7.6 |
| Arsenic | 2.7 | 27 |
| Chromium | 450 | 4,500 |
| Copper | 76,000 | 760,000 |
| Lead | 1000 | 1000 |

Table 3. Residential PRGs for Surface Soil

| Contaminants | Residential (mg/kg) (1×10^{-6}) | Residential (mg/kg) (1×10^{-5}) |
|-------------------------|---|---|
| Benzo(a) pyrene | 0.062 | 0.62 |
| Benzo(a) anthracene | 0.62 | 6.2 |
| Benzo(b) fluoranthene | 0.62 | 6.2 |
| Benzo(k) fluoranthene | 6.2 | 62 |
| Dibenzo(a,h) anthracene | 0.062 | 0.62 |
| Indeno(1,2,3-cd) pyrene | 0.62 | 6.2 |
| Pentachlorophenol | 3.0 | 30 |
| Benzene | 0.65 | 6.5 |
| Toluene | 520 | 5,200 |
| Ethylbenzene | 230 | 2,300 |
| Xylenes | 210 | 2,100 |
| Trichloroethylene | 2.8 | 28 |
| Tetrachloroethylene | 5.7 | 57 |
| 1,2 -Dichloroethane | 0.35 | 3.5 |
| Arsenic | 0.39 | 3.9 |
| Chromium | 210 | 2,100 |
| Copper | 2,900 | 29,000 |
| Lead | 400 | 400 |

6.0 References

- U.S. EPA (1989). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part A. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991a). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part B. EPA/540/R-92/003, Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991b). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Publication 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1996). Soil Screening Guidance: User's Guide. EPA/540/R-96/028. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (2000a). Region 9 Preliminary Remediation Goals (PRGs) 2000. November 2000.
- U.S. EPA. (2000b). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. EPA/540/R-99/005. Office of Solid Waste and Emergency Response, Washington, D.C.
- U.S. EPA. (2001). Integrated Risk Information System (IRIS). Available online at <http://www.epa.gov/iris>. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 N. 5TH STREET
KANSAS CITY, KANSAS 66101

JUL 10 2002

MEMORANDUM

SUBJECT: Preliminary Remediation Goals - 12th Avenue Solvents Site
Ava, Missouri

FROM: Judy Facey PhD
Toxicologist *J Facey*
ENSV/DISO

TO: Eric Nold
On-Scene Coordinator
SUPR/EFLR

As you requested, I have developed Preliminary Remediation Goals (PRGs) for the 12th Avenue Solvents site, located in Ava, Missouri. PRGs were calculated to address contamination from semi-volatile organic compounds, and volatile organic compounds in soil. The corresponding PRGs equate to an excess individual lifetime cancer risk of 1.0×10^{-6} and are summarized in the table below. The supporting documentation for the PRGs is attached. If you have any questions, please let me know.

Attachments

Commercial/ Industrial and Residential PRGs for Surface Soil

| Contaminants | Commercial/ Industrial (mg/kg) | Residential (mg/kg) |
|-----------------------------|-----------------------------------|------------------------|
| 1,1,1- Trichloroethane | 1400 | 630 |
| cis, 1, 2- Dichloroethylene | 150 | 43 |
| 2,4- Dimethylphenol | 180,000 | 1200 |
| Benzene | 1.5 | 0.65 |
| Toluene (na) | 520 (C_{sat}) | 520 (C_{sat}) |
| Ethylbenzene (na) | 230 (C_{sat}) | 230 (C_{sat}) |
| Xylenes (Na) | 210 (C_{sat}) | 210 (C_{sat}) |
| Trichloroethylene | 6.1 | 2.8 |
| Tetrachloroethylene | 19 | 5.7 |
| 1,2 -Dichloroethane | 0.76 | 0.35 |

Csat ~ Concentration of the contaminant is assumed to be 10% of the media (soil) and that is the maximum concentration of the contamination the media can hold, regardless of how much contaminant is added to the media.

**Preliminary Remediation Goals
for the 12th Avenue Solvents Site,
Ava, Missouri
July 10, 2002**

1.0 Site Description and History

The 12th Avenue Solvents site is located in the City of Ava, Douglas County, Missouri. The exact boundaries of the site have not been fully determined. However, the site includes the Copeland manufacturing facility at 1400 NW Third Street, the Rawlings manufacturing plant located at 400 NW 12th Avenue, a portion of the Douglas County Health Department property, and a portion of the former Sentinel Wood Treater plant.

The facility at 1400 NW Third Street was formerly operated by Emerson Electric Company, Specialty Motors Division and is currently occupied by the Copeland Corporation, a wholly-owned subsidiary of Emerson Electric Company. The property consists of 231,205 square feet of manufacturing and office space, warehouse/dock areas, and support locations situated on approximately 16 acres.

The 12th Avenue Solvents site is bordered to the north by agricultural land; to the east by NW Third Street, parking lots, and residences; to the south by the Douglas County Department of Health property and residential properties; and to the west by the former Sentinel Wood Treater Site.

2.0 Selection of Chemicals of Potential Concern (COPC)

Before 1968, the property was reportedly residential. From 1968 to approximately 1973 Spaulding Sporting Goods manufactured sports equipment at the facility. In 1973 Emerson Electric Company began leasing the facility and first occupied the property from June through December. In December 1973, Emerson Electric Company closed the plant for approximately one (1) year, and then operated the plant again from 1975 until the fall of 1996. During these times, Emerson Electric Company manufactured and assembled electric motors at the facility. Copeland moved into the facility in January 1997. Copeland currently leases the property from the City of Ava.

The Copeland Corporation machines cast iron parts for the manufacturing of scroll compressors. The primary raw materials used at the Copeland facility include iron castings, semi-synthetic coolant, caustic cleaners, acid coatings, and rust inhibitors. Liquid raw materials and hazardous wastes are stored in a bermed building on the west side of the facility. A generator with an associated 170-gallon #2 fuel oil aboveground storage tank, propane cylinders, and a covered trash compactor are stored on the west side of the facility.

The site investigations documented the presence of semi-volatile organic compounds, volatile organic compounds, and metals in surface soil. The soil sample results from the site investigation were compared to U.S. EPA Region IX industrial soil PRGs (U.S. EPA, 2000). Compounds were excluded for evaluation if at least one sample did not exceed the Region IX industrial soil PRG or if a health-based benchmark is not available.

3.0 Evaluation of Reasonable Maximum Exposure Scenarios

This assessment is limited to the occupational and residential areas of the 12th Avenue Solvents site. Exposure scenarios are consistent with commercial/industrial and residential use of the site and areas surrounding the site. On-site workers and residences exposed to contaminated surface soil represent the human receptors with the greatest potential exposure in the contaminated area. Reasonable maximum exposure scenarios were considered for on-site workers and residences that account for incidental ingestion, dermal contact, and inhalation of airborne particulates generated from contaminated surface soil. The scenario assumes exposure to a 70 kg adult worker for 250 days per year over a period of 25 years. It also assumes exposure to a child and adult 15 kg and 70 kg, respectively for 350 days per year over a period of 30 years.

4.0 Toxicity Information

All of the COPCs considered in this evaluation are classified as either known or probable human carcinogens. The cancer slope factors used in calculating the PRGs were obtained from the Integrated Risk Information System (IRIS) or the National Center for Environmental Assessment. The cancer slope factors and weight-of-evidence determinations for the COPCs are summarized in Table 1.

5.0 Calculation of PRGs

The PRGs were calculated for surface soils located on the 12th Avenue Solvents Site area using a formula from the Risk Assessment Guidance of Superfund, Volume I, Part B (EPA, 1991b). The PRGs in this assessment primarily use default exposure parameters based on established U.S. EPA guidance and policies. The carcinogenic PRG formula, along with the exposure parameters and variable definitions, are presented below.

5.1 Soil Saturation Limit (C_{sat})

The soil saturation concentration " C_{sat} " is the contaminant concentration at which soil pore air and pore water are saturated with the chemical and absorptive limits of the soil particles have been reached. Above this concentration, the contaminant may be present in free phase.

C_{sat} values represent chemical-physical limits in soil and is not risk based. However, since they represent the concentration at which soil pore air is saturated with a contaminant, volatile emissions reached their maximum at C_{sat} . In other words, at C_{sat} the emission flux from

soil to air for a chemical reaches a plateau. Volatile emissions will not increase above this level no matter how much more chemical is added to the soil. Chemicals with volatilization factor-based (VF) soil screening levels above C_{sat} are not likely to present a significant volatile inhalation risk at any soil concentration.

Table 1. Summary of Carcinogenic Toxicity Information for COPCs

| Chemicals | Carcinogenicity | | |
|--------------------------|---|---|--------------------------------------|
| | Oral Slope Factor (mg/kg/day ⁻¹) | Inhal. Slope Factor (mg/kg/day ⁻¹) | Weight-of-Evidence Classification |
| 1,1,1-Trichloroethane | — | — | D-not classified as human car. |
| cis1,2- Dichloroethylene | — | — | D-not classified as human car. |
| 2,4 - Dimethylphenol | — | — | E- evidence of noncar for human |
| Benzene | 5.5E-02 (i) ² | 2.7E-02 (i) ² | A- known human carcinogen |
| Toluene (na) | — | — | D-not classified as human car. |
| Ethylbenzene (na) | — | — | D-not classified as human car. |
| Xylenes (total) (na) | — | — | D-not classified as human car. |
| Trichloroethylene | 1.1E-02 (n) ¹ | 6.0E-03 (n) ¹ | B2- probable human carcinogen |
| Tetrachloroethylene | 5.2E-02 (n) ¹ | 2.0E-03 (n) ¹ | B2- probable human carcinogen |
| 1,2 -Dichloroethane | 9.1E-02 (i) ² | 9.1E-02 (i) ² | B2- probable human carcinogen |

¹ National Center for Environmental Health Assessment

² U.S. EPA. 2002 Integrated Risk Information System (IRIS)

³ na ~ non-cancer

Carcinogenic PRG Formula for an Industrial/Commercial and Residential Scenarios:

$$\text{PRG (mg/kg)} = \frac{\text{TR} \times \text{BW}_i \times \text{AT}_c}{\text{EF} \times \text{ED} \times [(\text{SF}_o \times \text{IR}_s \times \text{CF}) + (\text{SF}_i \times \text{IR}_i \times (1/\text{PEF})) + (\text{SF}_o \times \text{SA} \times \text{ABS} \times \text{AF} \times \text{CF})]}$$

| <u>Symbol</u> | <u>Definition (units)</u> | <u>Parameter Value</u> | <u>Reference</u> |
|-----------------|--|-------------------------------|------------------|
| TR | Target Risk | 1.0E-06 | - |
| BW _i | Body weight - adult /child(kg) | 70/15 | EPA, 1989 |
| AT _c | Averaging time - carcinogens (days) | 25550 | EPA, 1989 |
| SF _o | Oral cancer slope factor (mg/kg-day) ⁻¹ | See Table 1 | - |
| SF _i | Inhalation cancer slope factor (mg/kg-day) ⁻¹ | See Table 1 | - |
| EF | Exposure frequency (days/yr) | 250/350 | EPA, 1991b |
| ED | Exposure duration (years) | 25/30 | EPA, 1991b |
| IR _s | Soil ingestion rate (mg/day) | 50/100/200 | EPA, 1991b |
| IR _i | Inhalation rate (m ³ /day) | 20/10 | EPA, 1991b |
| PEF | Particulate emission factor (m ³ /kg) | 1.32E+09 | EPA, 1996 |
| SA | Skin surface area (cm ²) | 3300/5700/2800 | EPA, 2000b |
| ABS | Skin absorption factor (unitless) | Arsenic - 0.03 PAHs - 0.13 | EPA, 2000b |
| AF | Adherence Factor (mg/cm ²) | 0.2 | EPA, 2000b |
| CF | Conversion factor | 1.0E-06 | - |

The target risk level used in calculating the PRGs for the on-site worker scenario equates to an excess individual lifetime cancer risk of 1.0×10^{-6} and 1.0×10^{-5} . The carcinogenic PRGs are summarized in Tables 2 and 3.

Table 2. Commercial/ Industrial PRGs for Surface Soil

| Contaminants | Commercial/ Industrial (mg/kg) (1 X 10 ⁻⁶) | Commercial/ Industrial (mg/kg) (1 X 10 ⁻⁵) |
|---------------------------|---|---|
| 1,1,1- Trichloroethane | 1400 | 14,000 |
| cis1, 2- Dichloroethylene | 150 | 1500 |
| 2,4- Dimethylphenol | 180,000 | 1800,000 |
| Benzene | 1.5 | 15 |
| Toluene (na) | 520 (C _{sat}) | 520 (C _{sat}) |
| Ethylbenzene (na) | 230 (C _{sat}) | 230 (C _{sat}) |
| Xylenes (Na) | 210 (C _{sat}) | 210 (C _{sat}) |
| Trichloroethylene | 6.1 | 61 |
| Tetrachloroethylene | 19 | 190 |
| 1,2 -Dichloroethane | 0.76 | 7.6 |

C_{sat} ~ Concentration of the contaminant is assumed to be 10% of the media (soil) and that is the maximum concentration of the contamination the media can hold, regardless of how much contaminant is added to the media.

Table 3. Residential PRGs for Surface Soil

| Contaminants | Residential (mg/kg) (1×10^{-6}) | Residential (mg/kg) (1×10^{-5}) |
|---------------------------|---|---|
| 1,1,1- Trichloroethane | 630 | 6,300 |
| cis1, 2- Dichloroethylene | 43 | 430 |
| 2,4- Dimethylphenol | 1200 | 12,000 |
| Benzene | 0.65 | 6.5 |
| Toluene (na) | 520 (C_{sat}) | 520 (C_{sat}) |
| Ethylbenzene (na) | 230 (C_{sat}) | 230 (C_{sat}) |
| Xylenes (Na) | 210 (C_{sat}) | 210 (C_{sat}) |
| Trichloroethylene | 2.8 | 28 |
| Tetrachloroethylene | 5.7 | 57 |
| 1,2 -Dichloroethane | 0.35 | 3.5 |

C_{sat} ~ Concentration of the contaminant is assumed to be 10% of the media (soil) and that is the maximum concentration of the contamination the media can hold, regardless of how much contaminant is added to the media.

6.0 References

- U.S. EPA (1989). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part A. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991a). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part B. EPA/540/R-92/003, Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991b). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Publication 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1996). Soil Screening Guidance: User's Guide. EPA/540/R-96/028. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (2000a). Region 9 Preliminary Remediation Goals (PRGs) 2000. November 2000.
- U.S. EPA. (2000b). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. EPA/540/R-99/005. Office of Solid Waste and Emergency Response, Washington, D.C.
- U.S. EPA. (2002). Integrated Risk Information System (IRIS). Available online at <http://www.epa.gov/iris>. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.
- Environmental Strategies Corporation (May, 2001). Phase I and II Site Investigations , 12th Avenue Solvents Site, Ava, Missouri.
- Tera Tech EM Inc., (April, 2001). Site Screening Assessment for 12th Avenue Solvents Release Site, Ava, Missouri.

FILE

APR 23 2003

MEMORANDUM

SUBJECT: Subsurface Soil Preliminary Remediation Goals
Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community
Laundromat Site - Ava, Missouri

FROM: Jeremy Johnson
ENSV/DISO

TO: Eric Nold
On-Scene Coordinator
SUPR/EFLR

As you requested, I have developed Preliminary Remediation Goals (PRGs) for the Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community Laundromat Site, located in Ava, Missouri. PRGs were calculated to address contamination from semi-volatile organic compounds, which include polycyclic aromatic hydrocarbons, volatile organic compounds, metals and dioxin in subsurface soil. The construction worker scenario was evaluated for a worker who spends 120 days/year engaged in high contact soil intensive activities in the contaminated subsurface soil. The corresponding PRGs equate to an excess individual lifetime cancer risk of 1.0×10^{-6} or a hazard quotient of 0.1, whichever is lower, and are summarized in the table below. All dioxin clean-up values were taken from the Office of Solid Waste and Emergency Response Directive 9200.4-26, dated April 13, 1998. Please note these are considered preliminary clean-up goals which are subject to change and are not final remediation levels. If you have any questions, please let me know.

WorkersPRGs.wpd:dmathis:4/18/03

ENSV/DISO
Johnson

[Signature]
4/18/03

ENSV/DISO
Beringer

[Signature]
4-22-03

ENSV/DISO
Cothorn

[Signature]
4/23/03

Construction Worker PRGs for Subsurface Soils

| Contaminants | Construction Worker Exposure (mg/kg) |
|----------------------------------|--------------------------------------|
| Benzo(a)anthracene | 49 |
| Benzo(a)pyrene | 4.9 |
| Benzo(b)fluoranthene | 49 |
| Benzo(k)fluoranthene | 490 |
| Dibenz(a,h)anthracene | 4.9 |
| Indeno(1,2,3,cd)pyrene | 49 |
| Pentachlorophenol | 250 |
| Benzene | 3.5 |
| Toluene | 79 |
| Ethylbenzene | 110 |
| Xylenes | 412 (sat) |
| Trichloroethylene | 0.43 |
| Tetrachloroethylene | 13 |
| 1,2-Dichloroethane | 2.3 |
| <i>cis</i> -1,2-Dichloroethylene | 1206 (sat) |
| 1,1,1-Trichloroethane | 970 |
| Vinyl Chloride | 2.2 |
| 2,4-Dimethylphenol | 1300 |
| Arsenic | 23 |
| Chromium (total) | 45 |
| Lead | 485 |
| Dioxin | 0.005 - 0.020 |

sat: soil saturation limit: See section 5.2 of the attachment

Attachments

Attachment 1
Preliminary Remediation Goals
for Sentinel Wood Treating Site, 12th Avenue Solvents Site and
Community Laundromat Site
Ava, Missouri
April 14, 2003

1.0 Site Description and History

The Sentinel Wood Treating Site is located at 412 NW 12th Avenue in Douglas County, Ava, Missouri, and is on property owned by Sentinel Industries Inc. The former wood treating facility encompasses approximately 14 acres and is located in a commercial manufacturing/agricultural setting with private residences south of the site. The former wood treating (southern) portion of the site currently has several retail shops and a parking lot. The remainder of the site consists of open grounds and buildings from former wood treating operations. One building is currently occupied by a small business consisting of less than ten (10) employees.

The 12th Avenue Solvents Site includes the Copeland manufacturing facility at 1400 NW Third Street, the Rawlings manufacturing plant located at 400 NW 12th Avenue, a portion of the Douglas County Health Department property, and a portion of the former Sentinel Wood Treating plant. The site is bordered to the north by agricultural land; to the east by NW Third Street, parking lots, and residential properties; and to the west by the former Sentinel Wood Treating Site.

The Community Laundromat Site is located at 306 NW 12th Avenue. The site is an active coin-operated public laundry facility that formerly included on-site dry cleaning operations that utilized tetrachloroethylene (PCE). The site is bordered by commercial properties, and the former Rawlings facility and Copeland facility.

2.0 Selection of Chemicals of Potential Concern (COPC)

Previous environmental investigations conducted by the United States Environmental Protection Agency (EPA), potential responsible parties (PRPs), and the Missouri Department of Natural Resources (MDNR) have documented the presence of groundwater, soil, and surface water contamination at each of the sites. Contaminants detected at the Sentinel Wood Treating Site include pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons, and metals, including arsenic. In addition, dioxins and furans (collectively referred to as dioxin), common impurities in PCP, have been detected in the lagoon and on-site soils. Contaminants detected at the 12th Avenue Solvents site include benzene, toluene, ethylbenzene and xylenes (BTEX), lead, 2,4-dimethylphenol, and chlorinated VOCs. Finally, the Community Laundromat site contaminants include chlorinated VOCs, such as tetrachloroethylene (PCE) and trichloroethylene (TCE). For purposes of this document all chemicals listed in the Sentinel Wood Treating Consent Agreement, dated October 2001, and the 12th Avenue Solvents Administrative Order on Consent, dated September 2001, have been retained as COPCs. Also, chemicals identified in the Removal Assessment Report for the

Community Laundromat Site, dated April 2003, were retained as COPCs. These COPCs include PCE, TCE, cis-1,2-Dichloroethene, and Vinyl Chloride.

3.0 Evaluation of Reasonable Maximum Exposure Scenario

On-site construction workers exposed to contaminated subsurface soil represent the human receptors with the greatest potential exposure in the contaminated area. For the purposes of this document, subsurface soils are soils 0 to 10 feet below ground surface. Based on best professional judgement construction workers are not likely to come into contact with soils below a depth of 10 feet. Please note that the Migration to Groundwater PRGs developed for the Ava sites, dated February 2003, apply to surface soils, subsurface soils and soils greater than 10 feet below ground surface.

A reasonable maximum exposure scenario was considered for on-site construction workers that accounts for incidental ingestion, dermal contact, and inhalation of airborne particulates and volatiles generated from contaminated subsurface soil. The exposure scenario is consistent with construction workers who may be engaged in high contact soil intensive activities. The scenario assumes exposure to a 70 kg adult worker for 120 days per year over a period of 1 year.

4.0 Toxicity Information

All but six of the COPCs considered in this evaluation are classified as either known or probable human carcinogens. Cancer slope factors and unit risk factors used in calculating the PRGs were obtained from the Integrated Risk Information System (IRIS, 2002b) and the National Center for Environmental Assessment (NCEA). Values obtained from NCEA are considered provisional values. Since the exposure duration is less than seven years, EPA recommends the use of subchronic reference doses and reference concentrations. Subchronic toxicity values were obtained from the Superfund Technical Support Center (STSC) (See Attachment 2). If subchronic values were not available, chronic values, were used (See Attachment 2). These values were obtained from IRIS and NCEA. The cancer slope factors, reference doses, reference concentrations and weight-of-evidence determinations for the COPCs are summarized in Table 1.

4.1 Chromium

Chromium VI and Chromium III are assumed to be present in a 1:6 ratio (EPA, 2002a). Chromium VI is considered a known human carcinogen, while adequate data are not available to evaluate the potential carcinogenicity of Chromium III in humans. The cancer slope factor provided in the table below has been adjusted for inhalation and body weight from the Chromium VI unit risk factor of $1.2\text{E-}01 (\mu\text{g}/\text{m}^3)^{-1}$ that is available on IRIS (EPA, 2002b). The Chromium III noncancer toxicity value was used to calculate the total chromium noncancer PRG (See Attachment 2).

4.2 TCE

TCE has a range of cancer slope factors to account for risk factors that may modify the effects of TCE in different populations. The draft toxicity assessment for TCE indicates that it poses a higher risk to susceptible populations, such as infants and young children, people with chronic disease, and people with higher background exposure, than previously considered (USEPA, 2001). For purposes of this document, the original provisional value (USEPA, 1987) and the values from the draft toxicity assessment (USEPA, 2001) were used for TCE.

5.0 Calculation of PRGs

The PRGs were calculated for subsurface soils located in the Sentinel Wood Treating Site, 12th Avenue Solvents Site, and Community Laundromat Site areas using a formula from the Risk Assessment Guidance for Superfund, Volume I, Part B (EPA, 1991). The PRGs in this assessment primarily use default exposure parameters based on established U.S. EPA guidance and policies. The carcinogenic PRG and noncarcinogenic formulas, along with the exposure parameters and variable definitions, are presented below.

5.1. Dioxin

To date, EPA has selected one part per billion (1 ppb) as a clean-up level for dioxin in residential soils at Superfund and Resource Conservation and Recovery Act (RCRA) sites where dioxin is a contaminant of concern. EPA has also selected a clean-up level for dioxin within the range of 5 ppb to 20 ppb for commercial/industrial soils at Superfund and RCRA sites where dioxin is a contaminant of concern (USEPA, 1998).

5.2 Soil Saturation Limit (C_{sat})

The soil saturation concentration " C_{sat} " is the contaminant concentration at which soil pore air and pore water are saturated with the chemical and absorptive limits of the soil particles have been reached. Above this concentration, the contaminant may be present in free phase. C_{sat} values represent chemical-physical limits in soil and are not risk-based. However, since they represent the concentration at which soil pore air is saturated with a contaminant, volatile emissions reached their maximum C_{sat} . In other words, at C_{sat} the emission flux from soil to air for a chemical reaches a plateau. Volatile emissions will not increase above this level no matter how much more chemical is added to the soil. Volatile chemicals with soil screening levels above C_{sat} are not likely to present a significant volatile inhalation risk at any soil concentration.

5.3 Lead

The EPA's Adult Lead Model (ALM) was used to develop the subsurface soil lead PRG. The ALM is designed to estimate fetal blood lead concentrations in women exposed to lead contaminated soils. The PRG for lead represents a concentration in soil in which there is a 95% likelihood that a fetus would have a blood lead concentration no greater than 10 $\mu\text{g/dL}$ (USEPA,

1996). The ALM uses specific input parameters including soil ingestion rate, exposure frequency and duration, averaging time, Soil Lead Absorption Factor (AFs), Biokinetic Slope Factor (BKSF), Fetal/Maternal Blood Lead Concentration Ratio ($R_{\text{fetal/maternal}}$), Baseline Blood Lead Concentration ($\text{PbB}_{\text{adult},0}$), and the Individual Blood Lead Geometric Standard Deviation (GSD_i). The ALM uses a central tendency soil ingestion rate of 100 mg/day for a contact intensive scenario (i.e., construction work). A BKSF of 0.4 $\mu\text{g/dL}$ per $\mu\text{g/day}$ is used to relate the blood lead concentration to lead uptake. An AFs of 0.12 is used to represent the fraction of lead absorbed from the gastrointestinal tract. The values used for the $\text{PbB}_{\text{adult},0}$ and GSD_i were obtained from Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), dated March 2002. For the purposes of this project a $\text{PbB}_{\text{adult},0}$ of 1.53 $\mu\text{g/dL}$ and GSD_i of 2.18 $\mu\text{g/dL}$ were used (USEPA, 2002c). These values are the estimated geometric mean and geometric standard deviation of blood lead concentrations in women of all races in the midwest region of the U.S. between the ages of 17 and 45.

Table 1. Summary of Carcinogenic and Noncarcinogenic Toxicity Information for COPCs

| Chemicals | Carcinogenicity | | | Noncancer (Subchronic unless otherwise noted) | | |
|------------------------|---|--|-----------------------------------|---|---|-----------------------------------|
| | Oral Slope Factor (mg/kg-day^{-1}) ¹ | Inhal. Slope Factor (mg/kg-day^{-1}) | Weight-of-Evidence Classification | Reference Dose (mg/kg-day) | Reference Concentration (mg/m^3) ¹ | Critical Effect - Target Organ |
| Benzo(a)anthracene | 7.3E-01 (n) | 3.1E+00 (n) | B2 | - | - | - |
| Benzo(a)pyrene | 7.3E+00 (n) | 3.1E-01 (n) | B2 | - | - | - |
| Benzo(b)fluoranthene | 7.3E-01 (n) | 3.1E-01 (n) | B2 | - | - | - |
| Benzo(k)fluoranthene | 7.3E-02 (n) | 3.1E-02 (n) | B2 | - | - | - |
| Dibenz(a,h)anthracene | 7.3E+00 (n) | 3.1E+00 (n) | B2 | - | - | - |
| Indeno(1,2,3,cd)pyrene | 7.3E-01 (n) | 3.1E-01 (n) | B2 | - | - | - |
| Pentachlorophenol | 1.2E-01 (n) | - | B2 | 3.0E-02 (c) | - | Liver and Kidney (i) |
| Benzene | 5.5E-02 (i) | 2.2E-06 UR (i) | A | 3.00E-03 (s) | 6.0E-02 (s) | Blood (s) |
| Toluene | - | - | D | - | 9.23E-01 (s) | CNS (s) |
| Ethylbenzene | - | - | D | 1.0E-01 (s) | 1.0E+00 (s) | liver and kidney (i) fetus (s) |
| Xylenes | - | - | D | 2.0E+00 (s) | - | liver and kidney (i) |

| | | | | | | |
|---|----------------------------------|---|--------------------|--------------|----------------------|------------------------------------|
| Trichloroethylene | 2.0E-02 (n) - 4.0E-01 (n)* | 6.0E-03 (n)# 2.0E-02 (n) - 4.0E-01 (n)* | B2 | 3.0E-04 (c)* | 4.0E-2 (c)* | liver, kidney, developing fetus |
| Tetrachloroethylene | 5.2E-02 (n) | 1.0E-02 (n) | B2 | 1.0E-02 (nc) | 1.7E-01 RfDi (nc) | Liver (n) |
| 1,2-Dichloroethane | 9.1E-02 (i) | 2.6E-5 UR (i) | B2 | - | - | - |
| cis-1,2-Dichloroethylene | - | - | D | 1.0E-01 (s) | - | Blood (s) |
| 1,1,1-Trichloroethane | - | - | D | 2.0E-01 (s) | 2.2E+01 (s) | Liver and CNS (s) |
| Vinyl Chloride | 7.2E-01 (i)+ | 4.4 E-6 UR (i)+ | A | 3.0E-03 (ic) | 1.0E-01 (ic) | Liver (i) |
| 2,4-Dimethylphenol | - | - | - | 2.0E-02 (ic) | - | CNS, Blood (i) |
| Arsenic | 1.5E+00 (i) | 1.5E+00 (i) | A | 5.0E-03 (s) | 5.0E-03 RfDi (s) | Skin |
| Chromium(total) 1:6 ratio Cr VI: CrIII | - | 4.2E+01 (i) | See Section 4.1 | 1.5 (id) | - | - |
| Copper | - | - | D | - | - | - |
| Lead (See Section 5.3) | - | - | B2 | - | - | - |

n: National Center for Environmental Assessment

i: Integrated Risk Information System

s: Subchronic value provided by the Superfund Technical Support Center (See Section 4.0)

c: Chronic value (See Section 4.0)

d: Chromium III Reference Dose used for Total Chromium (See Section 4.1)

*: A range of slope factors has been developed for TCE in the draft Health Risk Assessment for TCE (USEPA, 2001). This document also provides a draft RfD and RfC.

#: Original TCE provisional value (USEPA, 1987)

+: Vinyl Chloride cancer toxicity values account for continuous lifetime exposure during adulthood

A: Known Human Carcinogen

B2: Probable Human Carcinogen

D: Not classified as to Human Carcinogenicity

UR: Unit Risk (ug/m³)⁻¹

RfDi: Inhalation Reference Dose (mg/kg-day)

Reference Concentration and Unit Risk Conversions:

For purposes of calculating PRGs, URs and RfCs were converted to inhalation slope factors and inhalation reference doses using the equations and assumptions provided below.

$$RfDi \text{ (mg/kg-day)} = \frac{RfC \text{ (mg/m}^3) \times 20 \text{ m}^3/\text{day}}{70 \text{ kg}}$$

$$SFi \text{ (mg/kg-day)}^{-1} = \frac{UR \text{ (m}^3/\text{ug}) \times 70 \text{ kg} \times 1000 \text{ ug/mg}}{20 \text{ m}^3/\text{day}}$$

SVOC and Metals Carcinogenic PRG Formula for a Construction Worker Scenario:

$$PRG \text{ (mg/kg)} = \frac{TR \times BW_c \times AT_c}{EF \times ED \times [SfO \times IR_s \times CF] + (SfO \times SA \times ABS \times AF \times CF) + (Sf_i \times IR_a \times (1/PEF))}$$

VOC Carcinogenic PRG Formula for a Construction Worker Scenario:

$$PRG \text{ (mg/kg)} = \frac{TR \times BW_c \times AT_c}{EF \times ED \times [SfO \times IR_s \times CF] + (SfO \times SA \times ABS \times AF \times CF) + (Sf_i \times IR_a \times (1/VF))}$$

SVOC and Metals Noncarcinogenic PRG Formula for a Construction Worker Scenario:

$$PRG \text{ (mg/kg)} = \frac{THQ \times BW_c \times AT_n}{EF \times ED \times [(1/RfDo \times IR_s/CF) + (1/RfDo \times (SA \times AF \times ABS)/CF) + (1/RfDi \times IR_a/PEF)]}$$

VOC Noncarcinogenic PRG Formula for a Construction Worker Scenario:

$$PRG \text{ (mg/kg)} = \frac{THQ \times BW_c \times AT_n}{EF \times ED \times [(1/RfDo \times IR_s/CF) + (1/RfDo \times (SA \times AF \times ABS)/CF) + (1/RfDi \times IR_a/VF)]}$$

Soil Saturation Limit:

$$C_{sat} \text{ (mg/kg)} = S/\bar{n}_b(K_d \times \bar{n}_b + \bar{e}_w + H' \times \bar{e}_a)$$

Lead PRG:

$$PRG \text{ (mg/kg)} = \frac{([PbB_{95} \text{ fetal}/(R^*(GSD_i^{1.645}))]-PbB_0)*AT_{Pb}}{BKSf*(IR_{Pb}*AF_s*EF_{Pb})} \quad (\text{EPA, 1996})$$

| <u>Symbol</u> | <u>Definition (units)</u> | <u>Parameter Value</u> | <u>Reference</u> |
|------------------|--------------------------------------|------------------------|------------------|
| TR | Target Risk | 10 ⁻⁶ | - |
| THQ | Target Hazard Quotient | 0.1 | - |
| BW _c | Body Weight -adult(kg) | 70 | EPA, 1989 |
| AT _c | Averaging Time -carcinogen (days) | 25550 | EPA, 1989 |
| AT _n | Averaging Time -noncarcinogen (days) | ED*365 | EPA, 1989 |
| AT _{Pb} | Averaging Time- lead (days) | 180 | EPA, 1999 |

| | | | |
|-------------------------|--|---|-----------------------------|
| EF | Exposure Frequency (days/yr) | 120 | Best Professional Judgement |
| EF _{ph} | Exposure Frequency Lead (days/yr) | 120 | EPA, 1999 |
| ED | Exposure Duration (years) | 1 | Best Professional Judgement |
| IR _a | Inhalation Rate (m ³ /day) | 20 | EPA, 2001a |
| IR _s | Soil Ingestion Rate (mg/day) | 330 | EPA, 2001a |
| IR _{ph} | Ingestion Rate Lead - contact intensive (mg/day) | 100 | EPA, 1999 |
| SA | Skin Surface Area (cm ²) | 3300 | EPA, 2001a |
| ABS | Skin absorption factor(unitless) | PAHs - 0.13 Arsenic - 0.03 Pentachlorophenol - 0.25 | EPA, 2001a |
| AF | Adherence Factor (mg/cm ² -event) | 0.3 | EPA, 2001a |
| EvF | Event Frequency (events/day) | 1 | Best Professional Judgement |
| PEF | Particulate Emission Factor (m ³ /kg) | Site Specific | EPA, 2001a |
| VF | Volatilization Factor (m ³ /kg) | Site Specific | EPA, 2001a |
| CF | Conversion Factor | 1.0E-06 | - |
| S | Solubility in water (mg/L-water) | Chemical Specific | EPA, 2001a |
| n _b | dry soil bulk density (kg/L) | 1.5 | EPA, 2001a |
| K _d | soil-water partition coefficient | organics = K _{oc} x f _{oc} | EPA, 2001a |
| K _{oc} | organic carbon partition coefficient (L/kg) | Chemical Specific | EPA, 2001a |
| f _{oc} | fraction organic carbon in soil | 0.006(0.6%) | EPA, 2001a |
| e _w | water-filled soil porosity | 0.15 | EPA, 2001a |
| H' | Henry's law constant | Chemical Specific | EPA, 2001a |
| e _a | air-filled soil porosity | n - e _w | EPA, 2001a |
| n | total soil porosity | 1 - (n _b /n _s) | EPA, 2001a |
| n _s | soil particle density (kg/L) | 2.65 | EPA, 2001a |
| PbB ₉₅ fetal | 95 th Percentile PbB in Fetus (µg/dL) | 10 | EPA, 1996 |
| R | Fetal/Maternal Blood Lead Ratio | 0.9 | EPA, 1996 |
| GSD _i | Geometric Standard Deviation - Midwest Region All Races/Ethnicities | 2.18 | EPA, 2002c |
| PbB ₀ | Baseline Blood Lead (µg/dL) Midwest Region All Races/Ethnicities | 1.53 | EPA , 2002c |
| BKSF | Biokinetic Slope Factor (µg/dL per µg/day) | 0.4 | EPA, 1996 |
| AFs | Absorption fraction | 0.12 | EPA, 1996 |

The target risk level used in calculating the PRGs for the on-site construction worker scenario equates to an excess individual lifetime cancer risk of 1.0×10^{-6} or a hazard quotient of 0.1. The PRGs are summarized in Table 2.

Table 2. Construction Worker PRGs for Subsurface Soils

| Contaminants | Cancer Endpoint (mg/kg) | Noncancer Endpoint (mg/kg) | Soil Saturation Limit (mg/kg) | Selected PRG (mg/kg) |
|--------------------------|----------------------------|-------------------------------|----------------------------------|-------------------------|
| | (1 X 10 ⁶) | THQ (0.1) | | |
| Benzo(a)anthracene | 49 | - | nc | 49 |
| Benzo(a)pyrene | 4.9 | - | nc | 4.9 |
| Benzo(b)fluoranthene | 49 | - | nc | 49 |
| Benzo(k)fluoranthene | 490 | - | nc | 490 |
| Dibenz(a,h)anthracene | 4.9 | - | nc | 4.9 |
| Indeno(1,2,3-cd)pyrene | 49 | - | nc | 49 |
| Pentachlorophenol | 250 | 1900 | nc | 250 |
| Benzene | 5.3 | 3.5 | nc | 3.5 |
| Toluene (nc) | - | 79 | 654 | 79 |
| Ethylbenzene (nc) | - | 110 | 395 | 110 |
| Xylenes (nc) | - | 130000 | 412 | 412 |
| Trichloroethylene | 0.43 8.6 29 | 2.5 | nc | 0.43 |
| Tetrachloroethylene | 13 | 31 | nc | 13 |
| 1,2-Dichloroethane | 2.3 | - | nc | 2.3 |
| cis-1,2-Dichloroethylene | - | 6300 | 1206 | 1206 |
| 1,1,1-Trichloroethane | - | 970 | 1188 | 970 |
| Vinyl Chloride | 3.3 | 2.2 | nc | 2.2 |
| 2,4-Dimethylphenol | - | 1300 | 10656 | 1300 |
| Arsenic | 23 | 320 | nc | 23 |
| Chromium | 45 | - | nc | 45 |
| Copper | - | - | nc | - |
| Lead | - | 485 | nc | 485 |

sat: Soil Saturation Limit

nc: not calculated

6.0 Uncertainties

Several uncertainties have been considered during the development of these PRGs. Areas of uncertainty include, but are not limited to: use of chronic noncancer reference doses and reference concentrations, the appropriateness of a target hazard quotient of 0.1, and the use of default exposure factors. As mentioned in Section 4.0, EPA recommends using subchronic reference doses and reference concentrations for exposures less than seven years in duration. While subchronic values were available for some of the COPCs, chronic values were used for some of the COPCs that lack subchronic values. As a result, noncancer PRGs using chronic toxicity values may be overly conservative.

There is also some uncertainty pertaining to the use of a target hazard quotient of 0.1 instead of 1. Using a target hazard quotient of 0.1 assumes that all of the COPCs act on the same target organs and that the effects are additive. While several of the COPCs have the same target organs, these chemicals may exert their adverse effects on these organs through different mechanisms and the effects may not be additive. Therefore, the calculated noncancer PRGs may be overly conservative.

Finally, there is uncertainty with the exposure parameters used to derive the PRGs. As noted in Sections 3.0 and 5.0, some of the exposure factors, including exposure duration and frequency, were based on best professional judgement. Actual duration and frequency of exposure are not known, however, they are not expected to exceed the values used.

7.0 References

- U.S. EPA. (1987). Addendum to the Health Assessment Document for Trichloroethylene: Updated Carcinogenicity Assessment for Trichloroethylene. External Review Draft EPA/600/8-82/006/FA. Office of Health and Environmental Assessment, Washington, D.C.
- U.S. EPA. (1989). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part A. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part B. EPA/540/R-92/003, Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C.
- U.S.EPA. (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. Technical Review Workgroup for Lead. Available online at <http://www.epa.gov/superfund/programs/lead/prods.htm>.

- U.S.EPA. (1998). Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites. OSWER Directive 9200.4-26. Office of Solid Waste and Emergency Response. Washington, D.C.
- U.S.EPA. (1999). Frequently Asked Questions (FAQs) on the Adult Lead Model. Technical Review Workgroup of Lead. Available online at <http://www.epa.gov/superfund/programs/lead/prods.htm>.
- U.S. EPA (2001). Trichloroethylene Health Risk Assessment: Synthesis and Characterization. External Review Draft. EPA/600/P-01/002A. Office of Research and Development. Washington, D.C.
- U.S. EPA (2001a). Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Draft Final. Office of Solid Waste and Emergency Response, Washington, D.C.
- U.S. EPA. (2002a). Region 9 Preliminary Remediation Goals (PRGs) 2002. October 2002. Available online at <http://www.epa.gov/region09/waste/sfund/prg/>.
- U.S. EPA. (2002b). Integrated Risk Information System (IRIS). Office of Research and Development, National Center for Environmental Assessment, Washington, D.C. Available online at <http://www.epa.gov/iris>.
- U.S. EPA (2002c). Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phase I and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). EPA 9285.7-52. Technical Review Workgroup for Lead. Available online at <http://www.epa.gov/superfund/programs/lead/prods.htm>.

Attachment 2

SUPERFUND STSC
Sent by: Ann Parker

To: Jeremy Johnson/ARTD/R7/USEPA/US@EPA
cc: Eric Nold/SUPR/R7/USEPA/US@EPA
Subject: Re: Request for Sub-chronic Toxicity values

03/26/2003 01:32 PM



Superfund Health Risk Technical Support Center

c/o US Environmental Protection Agency

26 W. Martin L. King Drive (G-4)

Cincinnati, OH 45268

Ph: 513-569-7300

Fax: 513-569-7159

STSC.Superfund@epa.gov

Support provided by IntelliTech Systems, Inc.

Greetings,

I have reviewed your list of chemicals for any subchronic toxicity information that we have available. We have subchronic risk assessment issue papers for Arsenic, Benzene, cis-1,2-Dichloroethylene, Ethylbenzene, Toluene, and 1,1,1-Trichloroethane. I have attached a Word Perfect file containing these papers to this email.

Dr. Harlal Choudhury advises that chronic values on IRIS can be used as subchronic values without any adjustments for the chemicals on your list that have values on IRIS. These chemicals include: Chromium (for total, use Chromium III), 2,4-Dimethylphenol, Pentachlorophenol, Tetrachloroethylene, Vinyl Chloride, and Xylenes. In addition, the chronic external review draft values for Trichloroethylene can also be used as subchronic values without any adjustments. The external review draft can be found at <http://cfpub.epa.gov/ncea/cfm/recorddisplay.cfm?deid=23249>. Please feel free to contact us if you have any other questions.

Thank you,
Ann Parker
STSC



sentinel wood.wpd

Jeremy Johnson/ARTD/R7/USEPA/US@EPA



Jeremy
Johnson/ARTD/R7/USE
PA/US@EPA

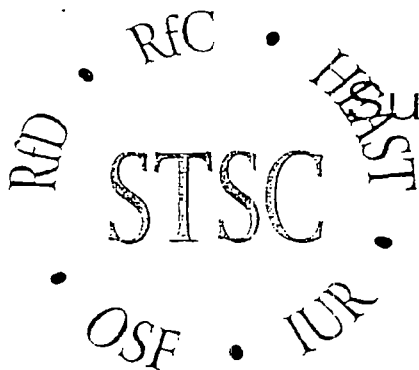
03/27/03 04:15 PM

To: STSC.Superfund@epamail.epa.gov
cc: Eric Nold/SUPR/R7/USEPA/US@EPA
Subject: Request for Sub-chronic Toxicity values

See the attached request form

Thanks

Jeremy Johnson
EPA Region 7



Superfund Technical Support Center
National Center for Environmental Assessment
U.S. Environmental Protection Agency
26 West Martin Luther King Drive, MS-117
Cincinnati, Ohio 45268

Harlal Choudhury/Director, Pat Daunt/Administrator
Hotline 513-569-7300, FAX 513-569-7159, E-Mail: STSC.Superfund@epa.gov

March 28, 2003

Jeremy Johnson
US EPA - Region VII

ASSISTANCE REQUESTED:

Requested toxicity information on Arsenic, Benzene, Ethylbenzene, Toluene, and 1,1,1-Trichloroethane. (*Sentinel Wood Treating Co., Inc.*)

ENCLOSED INFORMATION:

Attachment 1: Risk Assessment Issue Paper for: Derivation of a Provisional Subchronic Inhalation RfC for Benzene (CASRN 71-43-2)

Attachment 2: Risk Assessment Issue Paper for: Derivation of a Provisional Subchronic RfD for Benzene (CASRN 71-43-2)

Attachment 3: Risk Assessment Issue Paper for: Derivation of a Subchronic RfC for Ethylbenzene (CASRN 100-41-4)

Attachment 4: Risk Assessment Issue Paper for: Derivation of a Subchronic RfD for Ethylbenzene (CASRN 100-41-4)

Attachment 5: Risk Assessment Issue Paper for: Deriving a Provisional Subchronic Inhalation RfC for Toluene (CASRN 108-88-3)

Attachment 6: Risk Assessment Issue Paper for: Derivation of Provisional Chronic and Subchronic RfCs for 1,1,1-Trichloroethane (CASRN. 71-55-6)

FEB 12 2003

FILE

MEMORANDUM

SUBJECT: Migration to Groundwater Preliminary Remediation Goals
Sentinel Wood Treater Site
Ava, Missouri

FROM: Jeremy Johnson
ENSV/DISO

TO: Eric Nold
On-Scene Coordinator
SUPR/EFLR

As you requested, I have developed Preliminary Remediation Goals (PRGs) for the Sentinel Wood Treater site, 12th Avenue Solvents site, and Community Laundromat site, located in Ava, Missouri. PRGs were calculated to address contamination from semi-volatile organic compounds, which include polycyclic aromatic hydrocarbons, volatile organic compounds, and metals in surface and subsurface soil. The migration to groundwater scenario was evaluated and the corresponding PRGs equate to a concentration of contaminants in surface and subsurface soils that will not impact groundwater above the maximum contaminant level (MCL) or other relevant water health based limit (HBL). The supporting documentation from the PRGs is attached. Please note these PRGs are subject to change and are not final remediation levels. If you have any questions, please let me know.

Migration to Groundwater PRGs

| Contaminants | PRGs(mg/kg) | | |
|--------------------------------|----------------------------------|--------------------------------|--|
| Benzo(a)anthracene | 0.082 | | |
| Benzo(a)pyrene | 0.42 | | |
| Benzo(b)fluoranthene | 0.26 | | |
| Benzo(k)fluoranthene | 2.5 | | |
| Dibenz(a,h)anthracene | 0.080 | | |
| Indeno(1,2,3,cd)pyrene | 0.72 | | |
| wp{wp}.bk1:dmathis:2/6/03 | | | |
| ENSV/DISO Johnson 2/7/03 | ENSV/DISO Beringer 2/11/03 | ENSV/DISO Morris 2/11/03 | |

| | |
|---------------------|-------|
| Toluene | 1 |
| Ethylbenzene | 0.7 |
| Xylenes | 10 |
| Trichloroethylene | 0.005 |
| Tetrachloroethylene | 0.005 |
| 1,2-Dichloroethane | 0.005 |
| Arsenic | 0.005 |
| Chromium(total) | 0.1 |

*HBL: Water Health-Based Limit (EPA 2001)

PRG Formula for Migration to Groundwater:

$$PRG(\text{mg/kg}) = C_w [Kd + (\epsilon_w + \epsilon_a H') / \bar{n}_b]$$

Derivation of Dilution Attenuation Factor

$$DAF = 1 + (K \cdot i \cdot d) / (I \cdot L)$$

Estimation of Mixing Zone Depth

$$d = (0.0112L^2)^{0.5} + d_a(1 - \exp[(-L \cdot I) / (K \cdot i \cdot d_a)])$$

Target Soil Leachate Concentration (C_w)

$$C_w = (\text{MCL or Water Health Based Limit}) \cdot DAF$$

| <u>Symbol</u> | <u>Definition (units)</u> | <u>Parameter Value</u> | <u>Reference</u> |
|---------------|---|--|-------------------------------------|
| Kd | soil-water partition coefficient (L/kg) | organics Kd = Koc * foc inorganics (See Reference) Chemical Specific | EPA, 2001 EPA, 2001 EPA, 2001 |
| Koc | soil organic carbon/water partition coef. (L/kg) | | |
| foc | fraction organic carbon in soil (g/g) | 0.002 | EPA, 2001 |
| ϵ_w | water-filled soil porosity (Lwater/Lsoil) | 0.3 | EPA, 2001 |
| ϵ_a | air-filled soil porosity (Lair/Lsoil) | $n - \epsilon_w$ | EPA, 2001 |
| \bar{n}_b | dry soil bulk density (kg/L) | 1.5 | EPA, 2001 |
| n | soil porosity (Lpore/Lsoil) | $1 - (\bar{n}_b / \bar{n}_s)$ | EPA, 2001 |
| H' | Henry's law constant(dimensionless) | Chemical Specific (assume to be zero for inorganic except Mercury) | EPA, 2001 |
| K | aquifer hydraulic conductivity (m/yr) | Site Specific: | 1669 m/yr Attachment 2 |
| i | hydraulic gradient (m/m) | Site Specific: | 0.0042 |

| | | | |
|-------|--|----------------|--|
| I | infiltration rate (m/yr) | Site Specific: | 31.78 Attachment 2 |
| d | mixing zone depth (m) | Site Specific: | See equation "Estimation of Mixing Zone Depth" |
| L | source length parallel to groundwater flow | Site Specific: | 53.34 m See Section 3.1 |
| d_a | aquifer thickness (m) | Site Specific: | 2.89 m Attachment 2 |

6.0 References

U.S. EPA (2001) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Draft Final. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. EPA (2002). Region 9 Preliminary Remediation Goals (PRGs) 2002. October 2002.

Attachment 2
PRG Supporting Documentation

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Bob Holden, Governor • Stephen M. Mahfood, Director

DIVISION OF GEOLOGY AND LAND SURVEY
P.O. Box 250 111 Fairgrounds Rd. Rolla, MO 65402-0250
(573) 368-2100
FAX (573) 368-2111

RECEIVED

SEP 13 2001

HAZARDOUS WASTE PROGRAM
DEPT. OF NATURAL RESOURCES

MEMORANDUM

DATE: September 10, 2001

TO: Valerie Wilder, Environmental Specialist
Hazardous Waste Program, DEQ

FROM: *W. Little*
William W. Little, Geologist
Geological Survey Program, DGLS

SUBJECT: Geologic Summary of Sentinel Wood Treating, Inc. (Douglas County), MO

LOCATION: W ½, NE ¼, NW ¼, Sec. 11, T. 26 N., R. 16 W., Ava 7.5 Minute Quadrangle,
Douglas County, Missouri
36° 57' 45" N latitude and 92° 39' 57" W longitude

SITE LOCATION AND PHYSIOGRAPHIC SETTING

The Sentinel Wood Treating site is located on the north side of 12th Avenue, approximately 0.5 mile east of State Highway 5 in the City of Ava (Douglas County) Missouri. The site lies within the west ½ of the northeast ¼ of the northwest ¼ of Section 11, Township 26 North, Range 16 West. Approximate map coordinates for the site are 36° 57' 45" North latitude and 92° 39' 57" West longitude. Elevation is approximately 1270 feet above mean sea level.

The site lies within the Ozark Plateau region of the Interior Highlands Physiographic Province (Fenneman, 1938; Stohr et al., 1981). This portion of the Ozark Plateau consists mostly of rolling hills and broad ridges bound by narrow, moderate- to steep-sided drainages (USGS 1951a, 1951b, 1982a, 1982c) cut into Ordovician-age stratigraphic units (Koenig, 1959a, 1959b, 1959c; Robertson, 1985; Whitfield, 1985, 1986). The Sentinel Wood Treating site is situated near the northern end of a small drainage on a gentle south-dipping slope. The site is bordered by pasture to the north and west, industrial plants on the east, and 12th Avenue to the south. Residential areas are present short distances from the site in all directions.

Memo to Valerie Wilder

September 10, 2001

Page 2 (Sentinel Wood Treating)

GROUNDWATER PATHWAY

Stratigraphy

Quaternary Deposits

Surficial materials: Monitoring wells were installed at the site between January 30 and February 2, 2001. Cuttings derived from the drilling of these wells, together with over twenty soil and Geoprobe borings, were logged by Michael A. Siemens of MDNR/DGLS and provide the following general characteristics. Surficial materials range in total thickness from 8 to 20 feet. The uppermost 0.5 to 11 feet are typically fill deposits related to excavation and are composed of clayey gravel and gravelly clay. These are underlain by 2 to 20 feet of interbedded clay, silt, sand, and gravel. Correlation between boreholes is inconsistent, suggesting that these deposits are also discontinuous laterally; however, overall, there appears to be a downward increase in gravel content.

Ozark Aquifer

Jefferson City Dolomite: The Jefferson City Dolomite is approximately 185 feet thick in the Ava area (CDM Federal Programs, 1993) and is well-exposed in road cuts along the margins of State Highway 5. Composition is variable both vertically and laterally but consists mostly of alternating beds of finely crystalline argillaceous dolomite and medium-grained dolomite with thin beds of chert and fine-grained sandstone scattered throughout (CDM Federal Programs, 1993; Rueff, 2000; site visit, November 20 – 21, 2000). Borings for monitoring wells penetrated the upper 40 feet of the Jefferson City Dolomite (Siemens, 2001). Cuttings from these borings consist of silty to sandy dolomite interstratified with chert and thin partings of carbonaceous shale. A single bed of sandstone was encountered in each of the borings.

Vertical water migration is limited mostly to the upper 5 feet of the unit where weathering has produced large solution voids (Dean, 1977; Whitfield, 1979). Upon reaching the top of unweathered bedrock, the flow becomes primarily horizontal (Dean, 1977; Rueff, 2000). Permeability through the rest of the unit is restricted mostly to bedding plane solution and discontinuous vertical fractures, leading to a leaky aquitard within the aquifer (Whitfield, 1979; Hollman, 1998; Rueff, 2000; site visit, November 20 – 21, 2000).

Roubidoux Formation: The Roubidoux Formation is about 190 feet in thickness and consists of fine- to medium-grained sandstone, dolomitic sandstone, and cherty fine-grained dolomite (CDM Federal Programs, 1993; site visit, November 20 – 21, 2000). Where exposed at the surface, the sandstone is medium-grained and well-sorted with highly rounded and spherical grains. Cementation is moderate to poor. These characteristics make the unit highly conducive to vertical and lateral fluid flow. Permeability is enhanced by significant dissolution along bedding surfaces and vertical fractures (Whitfield, 1979; site visit, November 20 – 21, 2000).

Memo to Valerie Wilder
September 10, 2001
Page 3 (Sentinel Wood Treating)

Gasconade Dolomite: The Gasconade Dolomite does not outcrop within the target area but has been described from drill cores by CDM Federal Programs (1993). It is around 350 feet thick and grades from coarsely crystalline cherty dolomite near the bottom to more finely-crystalline, less cherty dolomite at the top. At the base of the Gasconade Dolomite is a seventy-foot-thick bed of medium-grained sandy dolomite called the Gunter Sandstone Member.

Eminence Dolomite: The Eminence Dolomite is not exposed in the target area. Based on descriptions by CDM Federal Programs (1993), it is nearly 200 feet in thickness and consists of massive-bedded, medium- to coarse-grained dolomite with scattered nodules and angular fragments of chert, particularly in the upper part.

Potosi Dolomite: The Potosi Dolomite is not exposed in the target area. Based on well logs, it is about 100 feet thick and is made up of medium- to fine-grained dolomite. Archer (1997) has indicated that the Potosi Dolomite is the most prolific water-bearing unit in the Houston area, located about 50 miles to the northeast of Ava.

St. Francois Confining Unit

Derby-Doerun Dolomite and Davis Formation: The Derby-Doerun Dolomite and Davis Formations are not exposed in the target area; however, based on well logs, they are composed primarily of interbedded shale, dolomite, and sandstone.

St. Francois Aquifer

Several units that comprise the St. Francois Aquifer are probably present beneath the target area; including the Bonneterre Dolomite, Reagan Sandstone, and Lamotte Sandstone; however, none are used as domestic or public water supplies in the Ava region (MDNR/DGLS well log files). Therefore, they have not been included as part of this report.

Hydrology

Quaternary Deposits

Siemens (2001) reported the presence of a perched water table at three feet below ground surface in elevated portions of the site and at shallower depths in topographically lower areas based on water content in soil borings taken during the installation of MDNR monitoring wells in February 2001. Depth measurements taken from these monitoring wells show a steady decrease in water table elevation of 0.5 to 2 feet, depending on well location, between late March and middle May 2001 (Table 2). Kingston Environmental Services (1999) also recorded water table depths of three to six feet below ground surface from three temporary monitoring wells that they emplaced at the site. Siemens (2001) identified small pores and fractures in these deposits which can increase rates of fluid transport through an otherwise relatively impervious fine-grained material. Based on data obtained from their temporary monitoring wells, Kingston

3ft - 6ft to water
9 - 20 ft surficial material
3: 5ft - 17ft
2ft - 14ft
Avg. 5ft + 2ft + 17ft + 14ft
= 10ft
2.89m

Memo to Valerie Wilder

September 10, 2001

Page 4 (Sentinel Wood Treating)

Environmental Services (1999) reported a southeastern groundwater flow direction. The Kingston wells were all located to the west of a small north-south oriented channel that runs through the site, most likely indicating topographic control of groundwater flow in surficial sediments. Accordingly, flow in surficial deposits located on the east side of the channel are expected to be to the southwest toward the same channel.

Soil boring logs from Siemens (2001) are found below.

SB-01

| | | |
|--------------------|--|--------------|
| 0-1.2 feet | Light-gray gravel (fill) (damp) | |
| 1.2-1.4 feet | Dark-brown, clayey gravel (fill) (damp) | |
| 1.4-3 feet | Light-gray gravel (fill) (damp to wet) | 2-18 - 15 ft |
| 3-4 feet | Dark-red, sandy, clayey gravel (wet) | |
| 4-7 feet | Mottled, dark-red and light-brown, gravelly clay (wet) | |
| 7-10 feet | Mottled, dark-red and light-gray, gravelly, silty clay (wet) | |
| 10-17 feet | Light-red, clayey gravel with a 0.3 foot sandy zone at 16 feet (wet) | |
| 17-18 feet | Mottled, light- and dark-brown, clayey silt (wet) | |
| Refusal at 18 feet | | |

SB-02

| | | |
|--------------------|---|---------|
| 0-2.5 feet | Light-red, clayey gravel with a piece of wood at 2 feet (fill) (damp) | |
| 2.5-3.2 feet | Dark-brown, silty clay (stained) (damp to wet) | |
| 3.2-3.5 feet | Dark-brown, silty sand (stained) (wet) | |
| 3.5-5.7 feet | Dark-brown, silty, sandy clay (wet) | |
| 5.7-10 feet | Light-red, clayey gravel (wet) | 3-17 ft |
| 10-10.5 feet | Light-red, silty clay (wet) | 14 ft |
| 10.5-11 feet | Light-red, clayey, fine-grained sand (wet) | |
| 11-12.5 feet | Light-red, silty clay (wet) | |
| 12.5-12.7 feet | Light-brown, silty dolostone | |
| 12.7-13 feet | Light-red, silty clay (wet) | |
| 13-15.7 feet | Mottled, dark-gray, and light- and dark-red, gravelly, silty clay (wet) | |
| 15.7-16 feet | Dark-brown, clayey gravel (wet) | |
| 16-17 feet | Light-brown, silty, clayey gravel (wet) | |
| Refusal at 17 feet | | |

SB-03

| | | |
|--------------|--|---------|
| 0-0.2 feet | Dark-brown, organic soil (fill) (damp) | |
| 0.2-0.7 feet | Light-brown, clayey gravel (fill) (damp) | |
| 0.7-2.3 feet | Light-red, gravelly clay (fill) (damp) | |
| 2.3-3.2 feet | Dark-brown, silty clay (damp to wet) | 2-16 ft |
| 3.2-3.7 feet | Dark-brown, sandy clay (wet) | 14 ft |
| 3.7-3.9 feet | Light-brown, fine-grained sand (wet) | |

Memo to Valerie Wilder
September 10, 2001
Page 5 (Sentinel Wood Treating)

3.9-5 feet Dark-brown, clayey silt (wet)
5-14 feet Mottled, light-brown and light-red, gravelly clay (wet)
14-16 feet Light-brown, cherry clay (wet)
Refusal 16 feet

SB-04

0-1.5 feet Light-brown, clayey gravel (fill) (damp)
1.5-2.5 feet Dark-brown, sandy, gravelly, silty clay (damp)
2.5-4 feet Light-brown, gravelly, sandy clay (damp to wet)
4-5.5 feet Light-brown, gravelly, silty clay (wet)
5.5-7 feet Mottled, light-brown and light-red, gravelly clay (wet)
7-7.3 feet Light-gray, coarse-grained chert sand (wet)
7.3-10 feet Mottled, light-red and light-brown, gravelly clay (wet)
10-13 feet Light-red, gravelly clay (wet)
Refusal at 13 feet

2-13 ft
11 ft

SB-05

0-1.2 feet Dark-brown, gravelly clay (fill) (damp)
1.2-3.9 feet Mottled, light-red and light-brown, silty clay (damp to wet)
3.9-10 feet Light-red, gravelly, silty clay (wet)
10-10.2 feet Light-red, clayey, chert sand (wet)
10.2-16 feet Mottled, light-red and light-brown, gravelly, silty clay (wet)
16-18 feet Light-red, gravelly, silty clay (wet)
18-18.6 feet Light-red, clayey sand (wet)
18.6-19.5 feet Light-brown, silty clay (wet)
Refusal at 19.5 feet

4-20 ft
16 ft

SB-06

0-0.8 feet Dark-brown, silty, clayey gravel (fill) (damp)
0.8-2.4 feet Dark-brown, silty clay (slight petroleum odor) (fill) (damp)
2.4-4 feet Dark-gray, silty clay (damp to wet)
4-6.8 feet Mottled, light-gray and light-brown, gravelly, silty clay (wet)
6.8-11 feet Mottled, light-red and light-brown, gravelly, silty clay (wet)
Refusal at 11 feet

4-11 ft
7 ft

SB-07

0-2 feet Dark-brown, clayey gravel (fill) (damp)
2-3.1 feet Dark-brown, clayey silt (damp to wet)
3.1-5.3 feet Light-brown, gravelly, sandy, silty clay (wet)
5.3-10 feet Mottled, light-red and light-brown, gravelly, silty clay (wet)
10-12 feet Light-red, gravelly, silty clay (wet)
Refusal at 12 feet

3-12 ft
9 ft

Memo to Valerie Wilder

September 10, 2001

Page 6 (Sentinel Wood Treating)

SB-08

0-0.4 feet Dark-brown, silty clay (fill) (damp)
0.4-4 feet Light-brown, gravelly, silty clay (damp to wet)

SB-09

0-0.9 feet Dark-brown, clayey gravel (fill) (damp)
0.9-4 feet Mottled, light-brown and light-red, gravelly, silty clay (damp to wet)
4-4.8 feet Light-gray, gravelly clay (wet) 4-12 - 8 ft
4.8-7 feet Light-brown, gravelly, silty clay (wet)
7-10 feet Mottled, light-gray and light-brown, gravelly, silty clay (wet)
10-11.5 feet Mottled, light-red and light-brown, gravelly, silty clay (wet)
Refusal at 11.5 feet

SB-10

0-1.5 feet Dark-brown, gravelly clay (fill) (damp)
1.5-3.5 feet Mottled, dark-brown and dark-gray, silty clay (damp to wet) 3-12 ft
3.5-7 feet Mottled, dark-brown and light-red, gravelly, silty clay (wet)
7-12 feet Mottled, light-gray and light-brown, gravelly, silty clay (wet) 7 ft
Refusal at 12 feet

SB-11

0-1.1 feet Dark-brown, gravelly clay (fill) (damp)
1.1-4 feet Dark-gray, silty clay (wet) 1-10 - 9 ft
4-7 feet Light-red, gravelly, silty clay (wet)
7-9.3 feet Mottled, light-gray and light-red, gravelly, silty clay (wet)
9.3-9.5 feet Mottled, dark-brown and light-red, silty clay (wet)
Refusal at 9.5 feet

SB-12

0-1 feet Concrete
1-4 feet Dark-brown, gravelly, silty clay (fill) (wet) 1-9 ft
4-5 feet Light-brown, sandy clay (wet) - 8 ft
5-6 feet Dark-brown, silty, sandy clay (wet)
6-7 feet Dark-red, gravelly clay (wet)
7-8.5 feet Mottled, light-red and light-gray, gravelly, silty clay (wet)
8.5-8.7 feet Mottled, light-brown and light-red, gravelly, silty clay (wet)
8.7-9 feet Light-red, clayey, very-coarse grained, chert sand (wet)
9-9.5 feet Mottled, light-brown and light-red, gravelly, silty clay (wet)
Refusal at 9.5 feet

Memo to Valerie Wilder
September 10, 2001
Page 7 (Sentinel Wood Treating)

SB-13

| | | |
|--------------------|---|---------|
| 0-1 feet | Concrete | |
| 1-2.3 feet | Dark-brown, silty, clayey gravel (fill) (wet) | 1-10 ft |
| 2.3-4 feet | Dark-brown, silty clay (fill) (wet) | |
| 4-5 feet | Dark-brown, gravelly, silty clay (fill) (wet) | 7 ft |
| 5-5.2 feet | Dark-brown, very-coarse grained, chert sand (fill) (wet) | |
| 5.2-6 feet | Dark-brown, gravelly, silty clay (fill) (wet) | |
| 6-6.8 feet | Dark-brown, very-coarse grained, chert sand (fill) (wet) | |
| 6.8-7 feet | Dark-brown, gravelly, silty clay (wet) | |
| 7-10 feet | Mottled, light-brown and light-gray, gravelly, silty clay (wet) | |
| Refusal at 10 feet | | |

SB-14

| | | |
|---------------------|---|--------|
| 0-1 feet | Concrete | 1-9 ft |
| 1-2 feet | Dark-brown, silty, clayey gravel (fill) (wet) | |
| 2-3 feet | Dark-brown, silty clay (fill) (wet) | -8 ft |
| 3-4 feet | Light-brown, silty clay (wet) | |
| 4-9 feet | Mottled, light-brown and light-gray, gravelly, silty clay (wet) | |
| Refusal at 9 feet | | |

SB-15

| | | |
|----------|--|----------|
| 0-1 feet | Concrete | 1-8 7 ft |
| 1-2 feet | Light-brown, silty, clayey gravel (fill) (wet) | |
| 2-8 feet | Black, gravelly, silty clay (fill) (wet) | |

Sample recovery was very poor at this location. The samples from 2 to 8 feet contained water with free product. Refusal at 8 feet.

SB-16

| | | |
|--------------------|--|-------|
| 0-0.5 feet | Concrete | 10 ft |
| 0.5-4 feet | Dark-brown, silty, clayey gravel (fill) (wet) | |
| 4-7 feet | Dark-brown, silty clay (fill) (wet) | |
| 7-11 feet | Mottled, dark-brown and dark-gray, gravelly, silty clay (fill) (wet) | |
| Refusal at 11 feet | | |

SB-17

| | |
|-----------|--|
| 0-4 feet | Dark-brown, silty, clayey gravel (fill) (wet) |
| 4-7 feet | Dark-brown, stained, chert gravel (fill) (wet) |
| 7-10 feet | No returns |

SB-27

| | |
|------------|--|
| 0-1 feet | Dark-brown, silty clay (organic soil) (damp) |
| 1-5.2 feet | Light-brown, gravelly, silty clay (wet) |

Memo to Valerie Wilder

September 10, 2001

Page 8 (Sentinel Wood Treating)

5.2-9 feet Mottled, light-brown and light-red, silty clay (wet)

Refusal at 9 feet

SB-28

0-2 feet Dark-brown, silty clay (organic soil) (damp)

2-5 feet Mottled, light-brown and light-red, silty, clayey gravel (wet)

5-7 feet Mottled, light-brown and light-red, silty clay (wet)

Ozark Aquifer

All wells within the target area produce from the Ozark Aquifer (Hollman, 1998; MDNR/DGLS well log records). Domestic wells obtain water primarily from the Jefferson City Formation; whereas, municipal wells draw mostly from the much deeper Gunter Sandstone Member of the Gasconade Dolomite and from the Eminence Dolomite (Hollman, 1998; Rueff, 2000; MDNR/DGLS well log records).

MDNR/DGLS well log records show depths of 125 to 175 feet to the top of the regional water table. Shallower, perched water tables are also apparent within the Jefferson City Dolomite, particularly between 50 and 75 feet below the ground surface. These are probably local features which vary with depth and are related to the low vertical permeability of the Jefferson City Dolomite. Most water movement within the Jefferson City is horizontal along bedding planes (Whitfield, 1979; Hollman, 1998; Rueff, 2000; site visit, November 20 - 21, 2000). Both shallow and deep groundwater flow within the Ozark Aquifer is interpreted to be to the southwest based on topography, drainage patterns, and stratigraphic dip. Rueff (2000) had previously suggested that deep groundwater flow was to the southeast toward the Mansfield Fault based on MDNR dye trace studies; however, those studies were conducted about three miles to the northeast of the site and on the opposite side of a drainage divide and, therefore, could be under the influence of different groundwater flow controls. The recently installed DNR monitoring wells concur with a generally southerly flow direction; however, due to placement of wells on opposite sides of the north-south channel that divides the site, a more specific direction of movement cannot be determined. Placement of the background well (MDNRMW-1) on the western side of the channel was necessitated by the presence of the Copeland facility which precluded the finding of a suitable location to the east of the creek (Siemens, personal communication, 2001).

Abundant, well-developed karst features, including sinkholes, solution valleys, losing streams, and springs are prevalent features of the Ozark Aquifer throughout the Ava region (Whitfield, 1979; CDM Federal Programs, 1993; Rueff, 2000; Missouri Speleological Society, 1999). Therefore, this would be a karst aquifer.

Memo to Valerie Wilder

September 10, 2001

Page 9 (Sentinel Wood Treating)

Installation of MDNR Monitoring Wells

Three monitoring wells were emplaced within the upper portion of the Jefferson City Dolomite to establish groundwater flow directions and to identify potential contaminant movement from the site. Two sources are suspected, former lagoons located in the northwest corner of the site and the former wood treatment area in the southern part of the site west of the stream channel. Each of these wells penetrates 9 to 14 feet of unconsolidated material and is embedded approximately 25 feet into bedrock of the Jefferson City Dolomite (Bachle, 2001; Siemens, 2001). A background well (MDNRMW-1) was placed approximately 450 feet north of the site to obtain background water conditions. A second well (MDNRMW-2) was positioned near the eastern border of the site in a straight line between the lagoons and Ava City well #4. The final well (MDNRMW-3) was placed in the southeastern part of the Dollar General store parking lot. Logs for the three wells are included below.

MDNRMW-1 (from Bachle, 2001)

| | |
|------------|---|
| 0-14 feet | Red clay and silty clay, water at approximately 6 feet |
| 14-39 feet | Dry, competent, fine-grained dolomite with shale partings |
| 39-41 feet | Medium-grained dolomitic sand, water producing |
| TD 41 feet | |

MDNRMW-2 (from Siemens, 2001)

| | |
|------------|--|
| 0-14 feet | Overburden |
| 14-19 feet | Weathered, light-brown, finely crystalline, silty dolostone with light-brown, cryptocrystalline chert |
| 19-24 feet | Weathered, light-brown, finely crystalline, silty dolostone with light-brown, cryptocrystalline chert and light-gray, very-fine grained sandstone with black, carbonaceous shale partings and carbonate cement |
| 24-29 feet | Light-brown, finely crystalline, silty dolostone with mottled, light-gray and light-brown, cryptocrystalline chert |
| 29-34 feet | Light-brown, finely crystalline, silty dolostone with mottled, light-gray and light-brown, cryptocrystalline chert |
| 34-39 feet | Dark-gray, finely crystalline, dolostone with black, carbonaceous shale partings |
| 39-41 feet | Light-gray, finely crystalline, dolostone with black, carbonaceous shale partings and light-brown, finely crystalline, silty dolostone |
| TD 41 feet | |

MDNRMW-3 (from Siemens, 2001)

| | |
|----------|------------|
| 0-9 feet | Overburden |
|----------|------------|

| | |
|------------|--|
| 9-10 feet | Dark-gray, finely crystalline, dolostone with black, carbonaceous shale partings |
| 10-15 feet | Light-brown, finely crystalline, silty dolostone and light-gray, very-fine grained sandstone |
| 15-20 feet | Light-brown, finely crystalline, dolostone with light-brown, cryptocrystalline chert |
| 20-25 feet | Light-brown, finely crystalline, sandy dolostone with light-brown, cryptocrystalline chert, black, carbonaceous shale partings, and a strong diesel odor |
| 25-30 feet | Light-brown, finely crystalline, dolostone and light-gray, finely crystalline, sandy dolostone |
| 30-35 feet | Light-gray, finely crystalline, dolostone with light-gray, cryptocrystalline chert |
| TD 35 feet | |

Each well includes a ten-foot long, 2-inch diameter stainless steel screen; a filter pack of sand that extends 3 to 8 feet above the screen; 19 to 24 feet of PVC casing; and is sealed with hydrated bentonite chips (Bachle, 2001; Siemens, 2001). Well construction information is shown graphically in Figures 1a, 1b, and 1c (obtained from Michael A. Siemens).

St. Francois Confining Unit

The St. Francois Confining Unit is 350 to 400 feet thick and provides a significant impediment to vertical groundwater transport.

St. Francois Aquifer

The St. Francois Aquifer is found over 1400 feet below the ground surface and is separated from the Ozark Aquifer by the St. Francois Confining Unit. Because of these factors, the St. Francois Aquifer is unlikely to have been impacted by contamination from the Sentinel site.

Structural Features

Bedrock shows a relatively gentle southward dip. Two northwest-trending faults have been identified 1.25 and 1.5 miles to the southwest of the site and a third is located about 3.5 miles to the southwest (McCracken, 1971; Robertson, 1985; Rueff, 2000). Because of the small amount of vertical offset along these faults, they are not expected to produce significant discontinuities within the Ozark Aquifer.

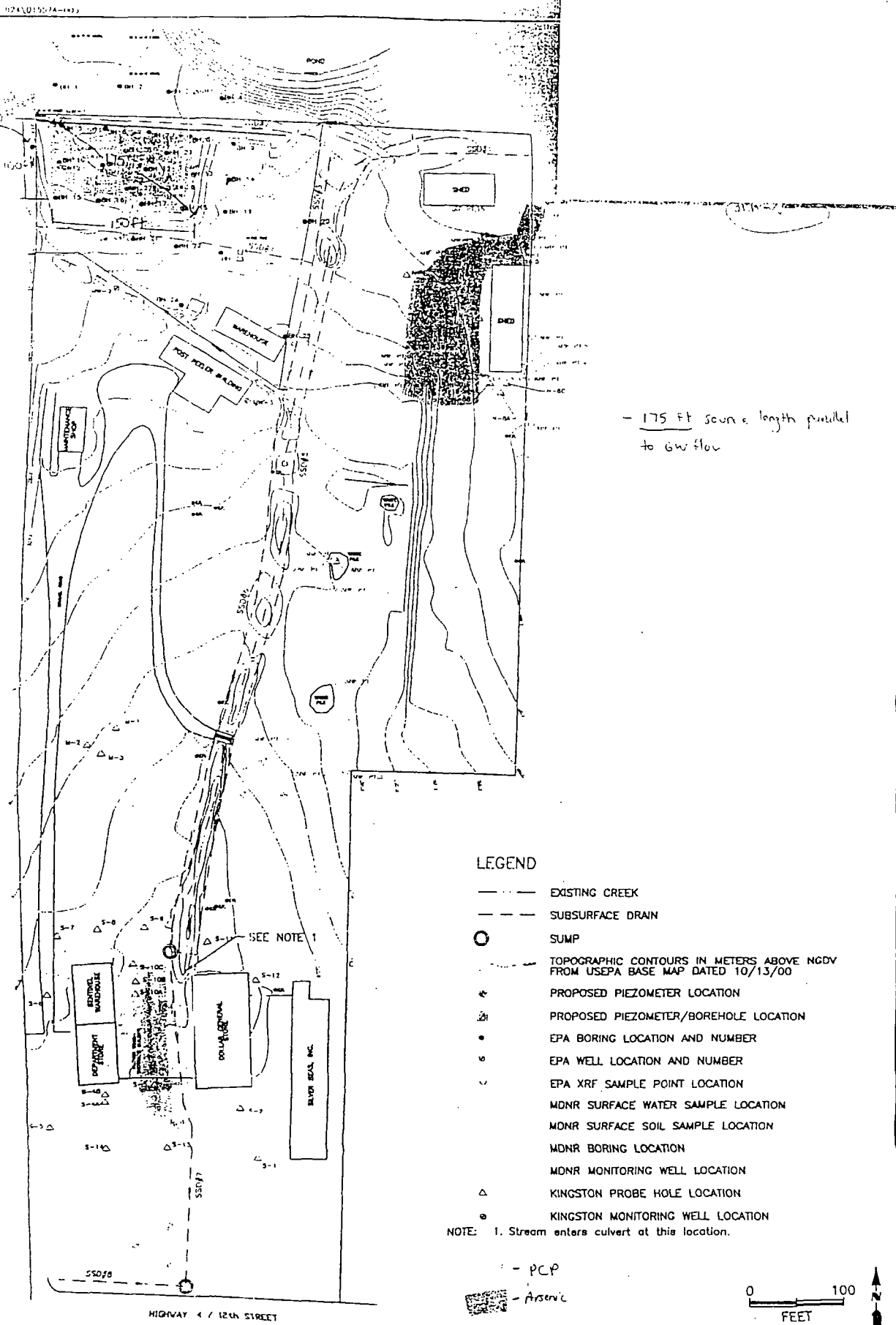
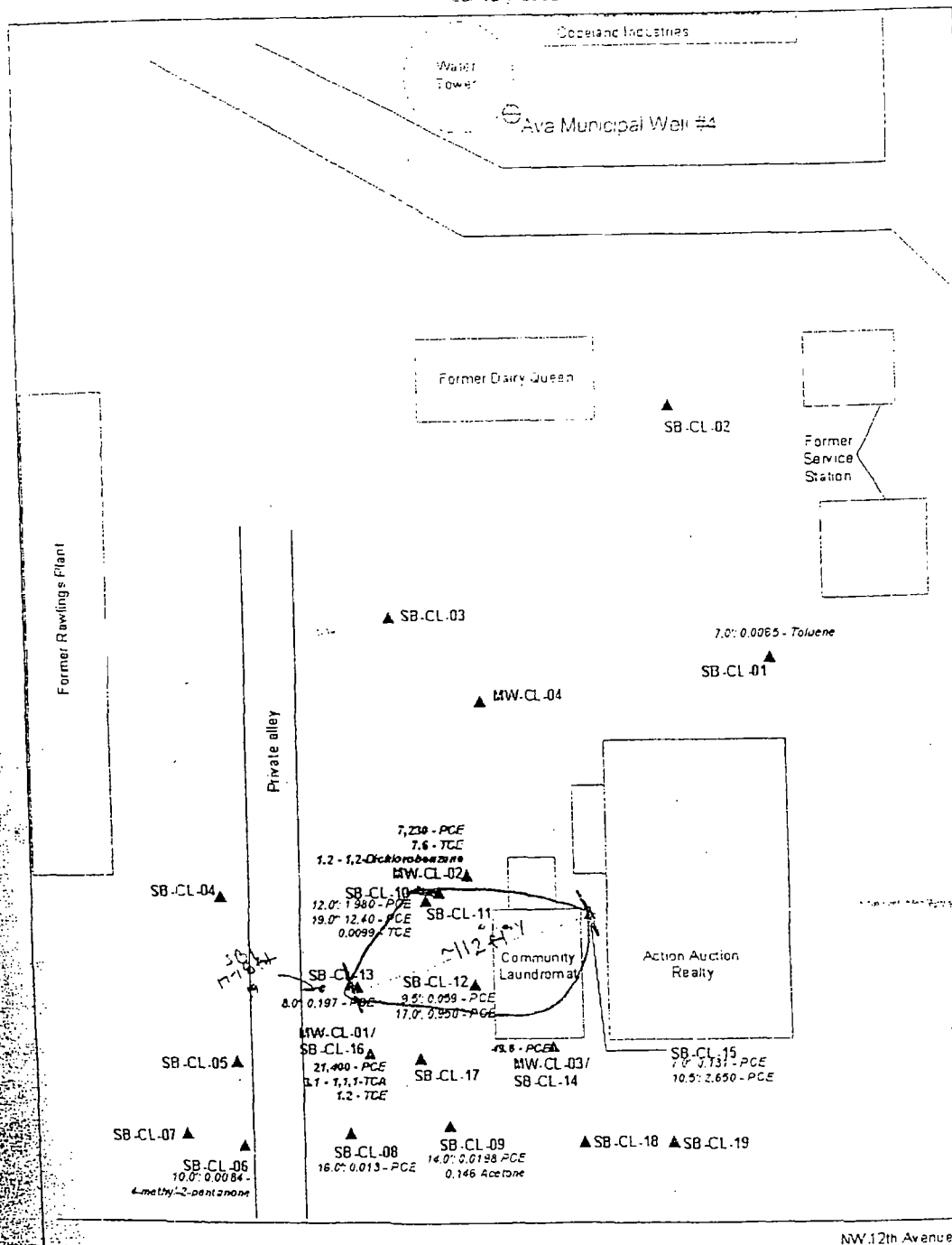
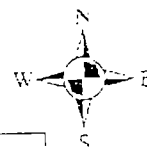


Figure 2
Community Laundromat
Removal Assessment Sampling Results
306 NW 12th Avenue
Ave, MO
January 2002



Water results are shown in **ppb**, in **bold**.
Soil results are shown in **ppm** at the depth indicated.

Sample Listing

| | | | |
|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|
| SB-CL-01 0210559 - 4.5' depth | SB-CL-06 0210566 - 10.0' depth | SB-CL-10 0210573 - 12.0' depth | SB-CL-15 0210583 - 7.0' depth |
| 0210560 - 7.0' depth | SB-CL-07 0210567 - 12.5' depth | 0210574 - 19.0' depth | 0210584 - 10.5' depth |
| SB-CL-02 0210561 - 15.5' depth | SB-CL-08 0210568 - 8.0' depth | SB-CL-12 0210575 - 9.5' depth | SB-CL-18 0210585 - 9.5' depth |
| 0210562 - 18.0' depth | 0210569 - 16.0' depth | 0210577 - 17.0' depth | 0210586 - 11.5' depth |
| SB-CL-03 0210563 - 11.0' depth | SB-CL-09 0210571 - 12.0' depth | SB-CL-13 0210578 - 2.5' depth | SB-CL-19 0210588 - 6.0' depth |
| SB-CL-04 0210564 - 1.5' depth | 0210572 - 14.0' depth | 0210579 - 8.0' depth | |
| SB-CL-05 0210565 - 20.0' depth | | SB-CL-14 0210582 - 9.0' depth | |

(Sample 0210580, a water grab collected from the "Old Spring House" was collected at a point southwest of the site and is off the map scale)

COPELAND FACILITY

FORMER 7,000-GAL.
VARNISH TANK

FORMER
XYLENE/VARNISH
AST PUMPS

FORMER PAINT
THINNER LINE

SB-7

DMW-3

DMW-4

SB-8

SB-6

DMW-5

DMW-6

FORMER 7,000-GAL.
XYLENE TANK

SB-5

SB-2

MW-2

SB-4

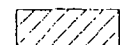
DMW-1

XYLENE/VARNISH LINES

PUMP

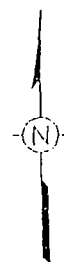
FORMER 1,000-GAL.
LIGHT AROMATIC SOLVENT NAPHTHA

LEGEND

 PREVIOUS EXCAVATION AREAS

● SOIL BORINGS

⊕ EXISTING MONITORING WELL



SCALE IN FEET

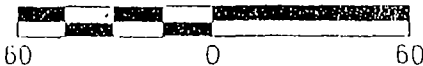


Figure 4

PREVIOUS INVESTIGATIONS

12TH AVENUE SOLVENTS SITE
AVA, MISSOURI

PREPARED FOR
EMERSON

Drawn By: KCP 10/16/01

Checked:

Approved:

Doc Number: 13055002

PROPRINT

PRINTING • COPYING • DIGITAL SERVICES

1916 Clay, N. Kansas City, MO 64116

(816) 421-0298 • FAX (816) 471-4370

E-mail: filetransfer@proprintkc.com

www.proprintkc.com

Information provided by
Eric Nold, OSC

Area

$$\text{gradient} = \frac{1'' \text{ in } 20'}{1'' \text{ in } 240''}$$

0.0042

$$K_{\text{overburden}} = \frac{5.9 \times 10^{-3} \text{ cm/sec}}{15 \text{ ft/day}}$$

$$K_{\text{upper bedrock}} = \left. \begin{array}{l} 25.09 \text{ ft/day} \\ 11.24 \text{ ft/day} \\ 8.89 \text{ ft/day} \end{array} \right\} \sim 15 \text{ ft/day}$$

$$\text{infiltration rate} \approx \frac{4 \text{ ft in } 14 \text{ days}}{21 \text{ days}}$$

$$\begin{array}{l} \text{specific yield } 1.45 \times 10^{-5} \text{ ft/ft} \\ \text{in bedrock } 4.67 \times 10^{-4} \text{ ft/ft} \end{array}$$

2001

| January | February | March | April | May | June |
|---|---|---|---|---|---|
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 |
| July | August | September | October | November | December |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 |



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 N. 5TH STREET
KANSAS CITY, KANSAS 66101

JUL 10 2002

MEMORANDUM

SUBJECT: Preliminary Remediation Goals - Wetlands Area of the 12th Avenue Solvents Site, Ava, Missouri

FROM: Judy Facey PhD
Toxicologist *J. Facey*
ENSV/DISO

TO: Eric Nold
On-Scene Coordinator
SUPR/EFLR

As you requested, I have developed Preliminary Remediation Goals (PRGs) for the 12th Avenue Solvents site wetland area, located in Ava, Missouri. The corresponding PRGs equate to an excess individual lifetime cancer risk of 1.0×10^{-6} or the Office of Drinking Water Maximum Contaminant Level (MCLs) and are summarized in the table below. It is important to note that this evaluation is limited to the wetland area which is drained via surface water flow, and also by an underground polyvinyl chloride (PVC) pipe into the unnamed stream. The supporting documentation for the PRGs is attached. If you have any questions, please let me know.

Attachments

MCLs/PRGs for water discharging into unnamed creek from Wetland Area

| Contaminants | MCL (ug/L) | PRGs (ug/L) |
|-------------------------|---------------|----------------|
| Benzene | 5 | ---- |
| Toluene (na) | 1000 | ---- |
| Ethylbenzene (na) | 700 | ---- |
| Xylenes (Na) | 10,000 | ---- |
| Trichloroethylene | 5 | ---- |
| Tetrachloroethylene | 5 | ---- |
| cis 1,2 -Dichloroethane | 5 | ---- |
| 1,1- Dichloroethane | ---- | 43,800 |

**Preliminary Remediation Goals
for the Wetland Area of the
12th Avenue Solvents Site,
Ava, Missouri
July 10, 2002**

1.0 Site Description and History

The 12th Avenue Solvents site is located in the City of Ava, Douglas County, Missouri. The exact boundaries of the site have not been fully determined. However, the site includes the Copeland manufacturing facility at 1400 NW Third Street, the Rawlings manufacturing plant located at 400 NW 12th Avenue, a portion of the Douglas County Health Department property, and a portion of the former Sentinel Wood Treater plant.

The facility at 1400 NW Third Street was formerly operated by Emerson Electric Company, Specialty Motors Division and is currently occupied by the Copeland Corporation, a wholly-owned subsidiary of Emerson Electric Company. The property consists of 231,205 square feet of manufacturing and office space, warehouse/dock areas, and support locations situated on approximately 16 acres.

The 12th Avenue Solvents site is bordered to the north by agricultural land; to the east by NW Third Street, parking lots, and residences; to the south by the Douglas County Department of Health property and residential properties; and to the west by the former Sentinel Wood Treater Site.

In December 2000, The Missouri Department of Natural Resources (MDNR) collected surface water and sediment samples from two drainage features downgradient of the Sentinel Wood Treater site. Two sampling points were located along an unnamed stream (a tributary to Prairie Creek) which drains the Sentinel site, above and below the stream's confluence with a smaller ditch which drains a small wetland area. The wetlands are drained via surface flow, and also by an underground PVC pipe which was installed by the Douglas County Health Department as part of a subsurface drainage system. Based on visual inspection only, the wetland area appears to be recharged by groundwater coming from the northeast, in the direction of multiple facilities, including the Copeland Corporation, and Rawlings Sporting Goods.

2.0 Selection of Chemicals of Potential Concern (COPC)

From the MDNR's December 2000 sampling, results indicate that the wetland area and the associated drainage ditch appeared to be a source of volatile organic compounds (VOCs) not necessarily associated with the Sentinel Wood Treater site. High levels of total xylenes (27,000 µg/L), ethylbenzene (10,500 µg/L), cis-1,2-dichloroethane (146 µg/L), toluene (79.3 µg/L), 1,1-

dichloroethane (51.5 µg/L), tetrachloroethene (2.4 µg/L), benzene (2.3 µg/L) and other compounds were reported in the surface water sample from the ditch.

The surface water sample results from the site investigation were compared to U.S. EPA Region IX tap water PRGs (U.S. EPA, 2000). Compounds were excluded for evaluation if at least one sample did not exceed the Region IX tap water PRG or if a health-based benchmark is not available.

The surface water was compared to the U.S. EPA Region IX tap water PRGs because the surface water is draining from the wetland area via surface water flow and also by an underground PVC pipe into the unnamed stream. From previous visits to the site, it is known that this unnamed stream is used by children from the area. At different points along this unnamed stream there is the potential for incidental ingestion to children who are exposed.

3.0 Evaluation of Reasonable Maximum Exposure Scenarios

This assessment is limited to the wetland areas of the 12th Avenue Solvents site. Exposure scenarios are consistent with recreational exposure to solvents in the surface water of the unnamed creek as the drainage from the wetland is discharging into the creek. A child's recreational exposure to contaminated surface water represent the human receptor with the greatest potential exposure to the contaminations entering the unnamed creek. Due to the potential for incidental ingestion of the contaminated surface water the EPA Office of Drinking Water values is used as defaults. A reasonable maximum exposure scenario was considered for recreational exposure that accounts for incidental ingestion and dermal contact, where MCL was not available.

4.0 Toxicity Information

All of the COPCs considered in this evaluation are classified as either known or probable human carcinogens. The cancer slope factors used in calculating the PRGs were obtained from the Integrated Risk Information System (IRIS) or the National Center for Environmental Assessment. The cancer slope factors and weight-of-evidence determinations for the COPCs are summarized in Table 1.

5.0 Calculation of PRGs

The PRGs were calculated for surface water located in the Wetland area of the 12th Avenue Solvents Site using a formula from the Risk Assessment Guidance of Superfund, Volume I, Part B (EPA, 1991b). The PRGs in this assessment primarily use default exposure parameters based on established U.S. EPA guidance and policies. The noncarcinogenic PRG formula, along with the exposure parameters and variable definitions, are presented below.

Table 1. Summary of Carcinogenic Toxicity Information for COPCs

| Chemicals | Carcinogenicity | | |
|----------------------|---|--|--------------------------------------|
| | Oral Slope Factor (mg/kg/day ⁻¹) | Oral Ref. Dose (mg/kg/day ⁻¹) | Weight-of-Evidence Classification |
| 1,1 Dichloroethane | — | 1.0E-02 (h) | D-not classified as human car. |
| Benzene | 5.5E-02 (i) | 3.0E-03 (i) | A- known human carcinogen |
| Toluene (na) | — | 2.0E-01 (i) | D-not classified as human car. |
| Ethylbenzene (na) | — | 1.0E-01 (i) | D-not classified as human car. |
| Xylenes (total) (na) | — | 2.0E+00 (i) | D-not classified as human car. |
| Trichloroethylene | 1.1E-02 (n) | 6.0E-03 (n) | B2- probable human carcinogen |
| Tetrachloroethylene | 5.2E-02 (n) | 1.0E-02 (n) | B2- probable human carcinogen |
| 1,2 -Dichloroethane | 9.1E-02 (i) | 3.0E-02 (i) | B2- probable human carcinogen |

n ~ National Center for Environmental Health Assessment

i ~ U.S. EPA. 2002 Integrated Risk Information System (IRIS)

na ~ non-cancer

h ~ Health Effects Assessment Summary Tables

Non-carcinogenic PRG Formula for an Residential/ Recreational Scenario:

$$\text{PRG (ug/L)} = \frac{\text{THQ} \times \text{Bwc} \times \text{AT}_n \times 1000 \text{ ug/mg}}{\text{EF} \times \text{ED} [(\text{IRW}_a / \text{RfD}_o) + (\text{Vfw} \times \text{IRAc}) / \text{RfDi}]}$$

| <u>Symbol</u> | <u>Definition (units)</u> | <u>Parameter Value</u> | <u>Reference</u> |
|------------------|---|------------------------|------------------|
| THQ | Target hazard quotient | 1 | - |
| BW _c | Body weight - child (kg) | 15 | EPA, 1989 |
| AT _n | Averaging time - noncarcinogens (days) | ED*365 | EPA, 1989 |
| RfD _o | Oral cancer slope factor (mg/kg-day) ⁻¹ | See Table 1 | - |
| RfD _i | Oral Reference Dose (mg/kg-day) ⁻¹ | See Table 1 | - |
| EF | Exposure frequency (days/yr) | 25 | EPA, 1991b |
| IR _w | Water Ingestion (mL/day) | 50 | EPA, 1991b |
| IR _c | Inhalation rate (m ³ /day) | 10 | EPA, 1991b |
| VF | Volatilization factor for water (L/m ³) | 0.5 | EPA, 1996 |
| ED | Exposure Duration (yrs) | 6 | EPA, 1991b |
| ABS | Skin absorption factor (unitless) | 0.1 | EPA, 2000b |
| CF | Conversion factor | 1.0E-06 | - |

The target risk level used in calculating the PRGs for the recreational child equates to an hazard quotient of 1 . The MCLs and PRGs are summarized in Table 2.

Table 2. MCLs/PRGs for water discharging into unnamed creek from Wetland Area

| Contaminants | MCL (ug/L) | PRGs (ug/L) |
|-------------------------|---------------|----------------|
| Benzene | 5 | ---- |
| Toluene (na) | 1000 | ---- |
| Ethylbenzene (na) | 700 | ---- |
| Xylenes (Na) | 10,000 | ---- |
| Trichloroethylene | 5 | ---- |
| Tetrachloroethylene | 5 | ---- |
| cis 1,2 -Dichlcroethane | 5 | ---- |
| 1,1- Dichloroethane | ---- | 43,800 |

6.0 References

- U.S. EPA (1989). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part A. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991a). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part B. EPA/540/R-92/003, Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1991b). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Publication 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA. (1996). Soil Screening Guidance: User's Guide. EPA/540/R-96/028. Office of Emergency and Remedial Response, Washington, D.C.
- U.S. EPA (2000). Drinking Water Standards and Health Advisories. Available online at <http://www.epa.gov/ost/drinking/standards>. Office of Water, EPA 822-B-00-001, Summer 2000.
- U.S. EPA. (2000a). Region 9 Preliminary Remediation Goals (PRGs) 2000. November 2000.
- U.S. EPA. (2000b). Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. EPA/540/R-99/005. Office of Solid Waste and Emergency Response, Washington, D.C.
- U.S. EPA. (2001). Integrated Risk Information System (IRIS). Available online at <http://www.epa.gov/iris>. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.
- Environmental Strategies Corporation (May, 2001). Phase I and II Site Investigations , 12th Avenue Solvents Site, Ava, Missouri.
- Tera Tech EM Inc., (April, 2001). Site Screening Assessment for 12th Avenue Solvents Release Site, Ava, Missouri.



Roger Riemann
<rriemann@sbcglobal.net>
12/31/2004 01:58 PM

To "Fred A Lafser Jr." <resfal@aol.com>, Pia Capell
<nrcapell@dnr.state.mo.us>, Eric
Nold/SUPR/R7/USEPA/US@EPA

cc

bcc

Subject Sentinel Alternative Time-Critical Removal Action Work Plan
Responses to November 12 Questions

Eric, attached are to files responding to your questions on the above subject work plan. One is a scan of your questions and our responses and the other is an Excel spreadsheet of the reformatted schedule.

Our responses to your asterisked questions are made in italicized font. If you have any additional questions please contact me by email or phone at 314 741-4231, cell 314 402-3872.

Sincerely,
Roger Riemann



12 16 E Nold response[1].doc Project Schedule 8-25-04 Reformatted 12-04.xls

R.E: Review of Re-revised Alternate Time-Critical Removal Action Work Plan
(RAWP) Submitted August 23, 2004, for the Sentinel Wood Treating Site

Dear Mr. Lafser:

As the designated project coordinator for the Sentinel Wood Treating site (Sentinel Site), I am submitting to you the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR) response to the Alternate Time-Critical RAWP, Quality Assurance Project Plan (QAPP) addendum, Sampling Plan addendum, and Health and Safety Plan addendum that you submitted for review in August 2004. Submission of these documents was required under the Administrative Order on Consent (AOC), dated September 17, 2001, between the EPA, MDNR, and Sentinel Industries, Inc.

As described in the AOC under section IX part 42, Submissions Requiring EPA Approval, all plans and reports which require submission for EPA approval shall: a) be approved in whole or in part; b) be approved with modifications; c) disapprove in whole or in part and direct the Respondent to resubmit after incorporation of EPA and MDNR comments; d) disapprove the submission and assume responsibility for performing all or any part of the response activities; or e) any combination of the above.

The following is a summary of the EPA and the MDNR determination for the plan you submitted for approval. The Alternative Time-Critical RAWP is approved with comment, pending addressing certain comments.

The following are the EPA specific comments to the plan and the MDNR comments are attached. The ***EPA is requiring that any comment with an asterisk be addressed in a*** separate document back to the EPA within the reporting time-line as outlined in the AOC. Field work involving excavation should not be initiated before this document is received and reviewed by the EPA and the MDNR. This does not require the re-submission of the work plan unless it is easier and/or less expensive to do so. The EPA is aware that some of the comments for the work plan are mentioned in your cover letter, but would have been better served if they were incorporated into the work plan itself.

Cover Letter,

*The third paragraph says based on MDNR soil samples in 2002 - proves polycyclic aromatic hydrocarbons (PAHs) in sediments are not from Sentinel - what about the PAH results from the lagoon samples collected by EPA? Some PAH analysis will be necessary when excavation and treatment of the lagoon area is initiated.

Wood treating creosote is a mixture of over 200 chemical compounds most of which are aromatic hydrocarbons. Phenanthrene, Anthracene, Pyrene, Chrysene, Benzo-a-pyrene, and Naphthalene are only a few of the many compounds. From the EPA sample analyses we do not see samples with hits on all these compounds. We may see one or two of the compounds at most in any one sample but if you have coal tar creosote contamination you expect to see a plethora of these compounds and many more. This is why we believe PAH did not come from the site. Of those individual compounds which were identified in the lagoon area none were over Missouri CALM Industrial targets.

what about BTH 18 +
seep 14?

Alternate Time-Critical Removal Action Work Plan

Section 2 page 3 - Why is Figure 7 the first figure referenced. Where are the references to Figures 1-6? Why are there two sets of Figures at the end of the text?

* Section 3.2, page 5, fourth paragraph - Why did you only calculate/re-calculate for the 110 parts per million (ppm) isopleth? Do you plan on leaving everything in the lagoon area below 110 ppm behind and not treated?

110 ppm and below will remain on site as planned at this time. This decision will be reevaluated with EPA involvement after initial excavations and risk/based considerations.

OK

* Section 3.2, page 6, last paragraph - If you would consider some of this material for offsite disposal, why not the contaminated sludge in the cement vault/oil water separator in the treatment area?

From discussions with the owner and previous employees the oil/water separator was back filled with chat/gravel before the concrete pad was laid over the area. It is possible the material below the fill may require offsite disposal. At this time since the oil/water separator has been a significant point of concern we will plan to remove the sludge to a lined container pending a more rigorous examination of the material properties and analytical makeup. If the physical and chemical properties allow incorporation into the biological treatment, we will discuss this with you at that time.

OK

Section 4.0 The Environmental Strategies Consulting, LLC (ESC) report refers to shallow bedrock wells in highly weathered bedrock as the "B" zone and deep bedrock wells in the competent bedrock as the "C" zone.

* Section 5.0, page 9, second paragraph - once treatment goals are met, the material will be removed and put where/taken where?

Treated material meeting treatment goals will be removed from the bioremediation treatment cell and remain onsite and used to contour and level the site. It will be seeded to stabilize the soil.

OK

Section 5.0, page 9, Phase 1 - I thought the inoculants were going to come from excavation of the roads on the east side of the creek.

Aerobic inoculants are to come from the lower road on the east side of the creek.

OK

Section 5.0, page 9, Phase 2 - I did not know any roads on the west side were contaminated.

Roads on the west side of the creek are not contaminated. Some excavated material from the lower road on the east side of the creek will be moved to the west bioremediation treatment cell as inoculant.

OK

* Section 5.2.2, page 11 - Where is your documentation to show why you are confident that chemical oxidation will work on this material? After the potassium permanganate or hydrogen peroxide treatment of the confined source (cement vault material) meets the removal goal for pentachlorophenol (PCP), will your test for dioxin equivalents?

Potassium Permanganate, Peroxide, and Ozone have all been use as an effective means of dechlorination of organic compounds. "In Situ Chemical Oxidation Using Potassium Permanganate, DOE/EM-0496, U.S. Department of Energy, Office of Environmental Management, Office of Science and Technology, September 1999. As indicated in section 3.2 above we will excavate the material to a lined container pending a more rigorous analysis of the chemical and physical properties of the material in this area before an informed decision can be made for reclamation.

OK

* Section 6. 1, page 15 - Do you plan on sampling the off-site clay before it is brought on the site to make sure it is "clean"?

Off-site clay was obtained from the City of Ava excavations from the deep undisturbed, subsoil roadway excavations up gradient and northwest of the site. A baseline sample will be collected and analyzed.

OK

* Section 6.2, page 16 - Shouldn't the "baseline" levels for PCP and dioxin be taken after spreading out the contaminated soil and before adding the sawdust and/or inoculants?

The reason the baseline is taken after the sawdust and inoculants are added is to plot aerobic degradation. If we take baseline before additions our next sampling (after additions) will show a false data point. Obviously there is some dilution of the contaminated soil but the additions are not for dilution but to provide loft, bacteria and nutrients to the mix. Additionally, the tilling of the materials provides for a more uniform mixture and therefore a more consistent bacterial metabolic breakdown of the pentachlorophenol across the cell. We strive to have uniformity and ideally would like the whole volume of material in the bioremediation treatment cell to have the same

Thats my point. shouldn't you know the baseline concentration before you start mixing so you know if it will even work?

concentration of pentachlorophenol before startup.

Section 6.3, page 17 - The last sentence of the first paragraph does not make sense. I assume the backup samples will go into the treatment cell once it is determined that they are no longer needed.

The other back-up samples will be returned to the treatment cell if not needed.

* Section 6.5, page 17 - What about real time monitoring for volatile organic compounds (VOCs) around the perimeter. The photoionization detector (PID) may, or may not, be sensitive for PCP, but it will give you readings from other contaminants when you start excavating. I think it is critical to have real time perimeter, monitoring since many constituents will migrate off-site above their odor threshold value, thereby raising concern as to what the community is being exposed to and at what levels. You will need to be able to prove that nothing is exceeding a health based number.

The carrier for the pentachlorophenol is diesel fuel which like PCP is also not sensitive to photoionization detectors. We will have a PID available for real-time monitoring during excavation to show no VOC's are present or are migrating over property boundaries.

Section 7.2, page 18 - Shouldn't the heading read anaerobic instead of aerobic?

Section 7.2, page 18 - Reference 7 where?

Anaerobic and reference should be 10 on page 9.

* Section 9, page 23 - The abbreviations in the project schedule are not all easy to understand/interpret- This is very important information. Please change the page setup from portrait to landscape with each year on a separate page so there is enough room to explain everything i.e.. what does "sup" mean?). Also, put them in chronologic order as they will occur as previously requested. The term "west road" is now confusing - is this the westernmost road on the east side of the creek or is this referring to the west road on the west side of the creek? It is confusing here and in Section 5. Shouldn't the piezometers and monitoring wells be installed and sampled before any other work is initiated? Where is the annual sampling in the project schedule? Operate biotreatment cell with SI - what is SI? A text description from start to finish of this section might be necessary (might not if the above suggestions are completed).

The Schedule has been reformatted and expanded as suggested and is attached as a separate file in our email..

* Section 10, page 24 - There are no sample quantity numbers for the 2-4 week moisture and pH samples. The activated carbon sample numbers do not add up. There should be an initial effluent sample analyzed to verify the first months discharge is ok. For

OK

OK EPA
will monitor
w/ PID + FID
if necessary

OK

OK

the bioremediation soils, shouldn't there be a baseline/initial sample for dioxin, PAHs, PCP, and OA1/OA2 (especially dioxin since Appendix A says dioxin does not biodegrade)?

Since moisture are taken on a two to four week basis and usually after additions of chemical fertilizers and watering we did not provide this depth of detail to the sampling plan. We will have a baseline for PCP, Dioxin Equivalents, OA-2 after the bioremediation treatment cell is mixed.

what about the activated Carbon numbers not adding up?

* Appendix D - You mentioned that this facility was discussing the idea of self imposing a dioxin maximum concentration for receiving F032 waste, what is their final verdict?

Off site facilities will respond when we have a representative sample of the actual material to be shipped. The physical as well as chemical properties determine whether the material can be accepted. We will not understand the physical properties until excavation. Some flexibility is required here.

ok

Quality Assurance Project Plan

Section 1.6. page 3, first paragraph - not the RAWP but the Alternative Time-Critical RAWP. Last paragraph - says 30 parts per million (ppm) PCP will be the cleanup goal, but in the work plan there were areas only being excavated that were above

110 ppm, not 30? The last sentence explains the treatment area but what about lagoon soils where you say only excavating everything above 110 ppm and evaluating the rest?

Section 1.7, page 4 - This is a good brief summary of the tasks at hand Section

1.10, page 8 - Is a two year record retention what was required in the

* Section 2, page 10 - I still think that sampling/analysis of PAHs and total petroleum hydrocarbons (TPHs) for clearance may be necessary and should be accounted for.

We have included TPH and Dioxin sampling in excavation boundary samples. Polynuclear Aromatic Hydrocarbons will not be tested because sampling results at the site do not indicate creosote or coal tar was used in the process.

what about BH 18 + Sept 14?

made copy of 2000 table to give to Roger R.

Section 2.2, page 12 - second paragraph - until the cleanup goal is achieved or bedrock is encountered?

Sample Plan

Title - Sampling Plan for Alternative Time-Critical Removal Action?

* Purpose, page 2 - Don't you plan on collecting verification sampling in the treatment area next to the concrete culvert? What about sampling of the cement vault/oil water separator's liquids/sludges?

We do plan on collecting verification sampling in the excavation next to the concrete culvert. From discussions with the owner and previous employees the oil/water separator sump was back filled with cha/gravel before the concrete pad was laid over the area. It is possible the material below the fill may require offsite disposal. At this time since the oil/water separator has been a significant point of concern we will plan to remove the sludge to a lined container pending a more rigorous examination of the material properties and analytical makeup.

OK

Section 2, page 4 - Should the "%" actually be "1/4"?

Section 5_1.2.1, page 8 - Table I says that location SW-3 will also be sampled but was not mentioned in this section?

Section 5.4, page 9 - What about PAHs and TPHs?

Health and Safety Plan Addendum

Purpose, page 3 - Excavation area may *be* left open for extended periods of time?

* Section 2.2, page 5 - Odor will be an issue and will only be able to be explained away as just "odor" if some type of real *time* monitoring or air sampling is done at the perimeter of the property or near the entrance of the on-site businesses.

We will have a photoionization detector on site for real-time monitoring of VOC during excavation.

OK

* Section 2.2, page 5 - With respect to the treatment plant sump material, if this is the worst material, why will you be using potassium permanganate (and/or hydrogen peroxide) when all of the text and the appendixes to the work plan refer to oxygen releasing compounds (ORC) and hydrogen releasing compounds (HRC), nothing on potassium permanganate or hydrogen peroxide? The National Institute for Occupational Safety and Health (NIOSH) guide says that hydrogen peroxide may spontaneously combust when in contact with combustible material, has this been taken into consideration? Will potentially exceeding *the* immediately dangerous to life and health (IDLH) for hydrogen peroxide in the cement vault be an issue?

From discussions with the owner and previous employees the oil/water separator was

back filled with chat/gravel before the concrete pad was laid over the area. Lafser personally observed the drilling and core samples from the oil/water separator. While the driller log may id the bottom two-foot range, only the bottom 1 to 3 inches of the core was stained and oily, and it appeared to be mixed with chat. The MDNR sample was from the liquid at the very bottom of the core at refusal and was incorrectly identified as groundwater. The sample did not reflect the entire two foot section of core, only the bottom 1 inch. It is possible the material at the bottom of the fill may require offsite disposal. At this time since the oil/water separator has been a significant point of concern and we will plan to remove the sludge to a lined container pending a more rigorous examination of the material properties and analytical makeup. Treatment of pentachlorophenol by oxidation may be a moot point if the level of dioxin equivalents is above the target of 20 ppb.

Section 2.3, page 5 - The heading for *this section* does not match the content.

November 8, 2004

Mr. Eric Nold
On Scene Coordinator
U.S. EPA, Region VII
901 North 5th Street
Kansas City, KS 66101

Re: Sentinel Wood Alternate Time-Critical Removal Action Work Plan

Dear Mr. Nold:

I have reviewed the *subject* report and have the following comments for your consideration.

3.2 Lagoon Area Northwest Part of Site

*It is stated that only data point BH-16 in the west lagoon shows PCP levels above the action levels. How are you referring to action levels? On figure 6 data point B14- 10, located in the west lagoon, detected PCP at 63 ppm at the 2-4ft interval and BH-11 detected PCP at 120 ppm at the 6-8ft interval. There were three draft actions levels set for PCP (11, 30, 110 ppm) and these two points exceed all three of them.

If we look at a hard 110 ppm as the maximum action level, yes BH-11 is 120 ppm at the 6-8 interval 10 ppm higher than the 110 and probably well in the margin of error for soil samples, however when considering the west lagoon in general the contamination levels in the west lagoon are an order of magnitude below those found in the central lagoon. The obvious hot spot and area of greatest concern is the central lagoon. The plan would be start excavations in the center core of the contamination and work out till perimeter compliance samples met the 110 ppm action level. If we look at absolute numbers you are correct.

3.4 Former Treatment Plant

*It states in this section that the amount of soil estimated to be removed from the area is 320 cubic yards at the 110 ppm boundary taken to bedrock at 10 feet (p.6). However in your previous May 04 Assessment report (p. 18) you said that you estimated about 650 cubic yards at the 110 ppm boundary taken to bedrock at 15 feet. How come this has changed?

The original volume was based on a prolate spheroid formed by rotation of an ellipse about its major axis. We rotated about the major axis 360 degrees and should have only rotated 180 degrees, since we were only excavating from the ground surface down.

JK

Also why is there no mention of the concrete vault material volume in this section? It is located in the former treatment area. I understand that it may be unknown but it should be mentioned.

The amount of material in the concrete oil/water separator can be calculated however this is not the amount of material to be treated. From discussions with the owner and previous employees the oil/water separator sump was back filled with chat/gravel before the concrete pad was laid over the area. Lafser personally observed the drilling and core samples from the oil/water separator. While the driller log may id the bottom two-foot range, only the bottom 1 to 3 inches of the core was stained and oily, and it appeared to be mixed with chat. The MDNR sample was from the liquid at the very bottom of the core at refusal and was incorrectly identified as groundwater. The sample did not reflect the entire two foot section of core, only the bottom 1 inch. It is possible the material at the bottom of the fill may require offsite disposal. At this time since the oil/water separator has been a significant point of concern and we will plan to remove the sludge to a lined container pending a more rigorous examination of the material properties and analytical makeup. Treatment of pentachlorophenol by oxidation may be a moot point if the level of dioxin equivalents is above the target of 20 ppb.

OK

5 Approach for Remediation

It is stated that when the treatment goals are met, the material will be removed and the next phase of material will be excavated and placed in the facility. Do you have ideas of where this treated soil will be placed on site.

We will discuss with EPA and Sentinel when final concentrations are known.

5.2.2 Former Treatment Collection Sump

This sump has also been referred to as a concrete vault in the removal assessment report and then as a former oil-water separator in Figure 6 contained in this work plan. It needs to be consistently referred to as the same name in all reports.

*This section is confusing. It states in this section that the highly contaminated material in this sump will be treated in place with a chemical oxidant solution. However in the Approach to Remediation Section it is discussed that reuse of recoverable high Btu solids and tars at the site may be used as a fuel source for a permitted Industrial Boiler if it isn't cost-prohibited. It was my understanding that the highly contaminated material in the sump and in the lagoons was this high Btu solid you are referring to from past discussions. So is it being treated with chemical oxidation, or being shipped off-site to be used as a fuel source,

Not your answer? When EPA asked the question you said it would be used as contour fill on site

or both?

From discussions with the owner and previous employees the oil/water separator sump was back filled with chat/gravel before the concrete pad was laid over the area. It is possible the material below the fill may require offsite disposal. At this time since the oil/water separator has been a significant point of concern we will plan to remove the sludge to a lined container pending a more rigorous examination of the physical and material properties and analytical makeup.

Also chemical oxidation will not break down dioxin which could be present at elevated levels in this sludge material if PCP levels are above 1500 ppm. It is stated that 5000 ppm PCP level exist in the sump. Where did this number come from?

5000 ppm was from the DNRSB15GW which was the material on the end of the core sample at the bottom of the concrete water-oil separator.

There should be more sampling of this material once this area is excavated.

We do plan additional characterization of this material.

Then another section, Former Treatment Plant, it seems like a third option is presented for this area. It states that the west side of the on site creek culvert will be left open for a period of time for evaluation and that plans cannot be formulated until you have a better visual understanding of the situation. This seems like you presented three different options for the same area (highly contaminated material in sump).

As described above, the concrete oil/water separator is totally separate from the from the area next to the culvert. If you look at Figure 6 the oil/water separator (concrete vault) is shown as a rectangle on the west side of the old treatment plant outline. Think of the concrete oil/water separator as a separate 19' X 9' X 7' box.

You state that the zone of highly contaminated materials (>1000 ppm PCP) will left in place and treated and lesser contaminated materials above this will be removed and treated. However the excavated soils below 30 ppm PCP will be stored on site and as previously mentioned anything above 110 ppm will be excavated and treated on-site. So what happens to the contaminated soil between 30-110 ppm?

These soils depending on the depth and location would be handled on a risk/based discussion with the Agency.

HRC is mentioned as a food source to stimulate *anaerobes* to be used for the highly contaminated material left in place. But it is stated that a chemical oxidant such as hydrogen peroxide or potassium permanganate will be used for treatment. So which will be used?

KMnO₄ was only considered for use for the oil/water separator's bottom sludge

* How will the integrity of the sump/vault bottom be determined? It is stated that you plan on treating the highly contaminated material at the bottom in *place* but how do you know the vault isn't leaking or contains cracks? There was a sample, SB-09, that was located close to the sump/vault area that found PCP at 910 ppm.

We have reconsidered treatment and will remove the material to an enclosed container pending a more rigorous examination of the material properties and analytical makeup.

OK

6.3 Clearance Sampling Criteria for Excavation

* It states that all visible stained soil will be excavated from the areas and distributed in the bioremediation treatment cell. The excavated soils should be sampled before it goes into the bioremediation cell. You have to confirm that you aren't putting too highly contaminated material in your bioremediation cell.

Based on the sampling of the whole site there are few samples >1000 ppm. It has been shown that the PCP metabolizing bacteria are capable of metabolizing PCP >2000 ppm. We have set 1000 ppm as our maximum bioremediation treatable concentration. This does not mean greater than 1000 ppm would be going into the site. 1200 ppm soils would be mixed with lower PCP soils to make them treatable. Just like incineration requires the blending of a highly volatile waste with a lower BTU content waste in order to make the waste stream treatable, and controlled as to not damage the incinerator.

Obviously we want our bioremediation treatment cell to have a very homogeneous concentration of PCP. Other sites where we have similar bioremediation operations we target PCP baselines in the 400-600 ppm range.

*Collecting one aliquot for each 1000 sq. ft of excavated areas is not enough to be representative.

What do you feel is acceptable? 1000 square ft. equates to an aliquot sample for every 32 X 32 foot square section. Would an aliquot from every 20 X 20 feet be acceptable for a 400 square foot composite sample?

7.6 HRC Application Rates

It states that material removed from the trenches will be tested and moved to the bioremediation cell if it above 30 ppm. There also needs to be a maximum level of PCP that will be allowed in the bioremediation cell as well. From the cover letter it looks like the maximum might be 2000 ppm PCP?

As stated several times previously, we cannot and do not need to limit the concentration in each bucket of material added to the treatment area, only the total baseline concentration needs to be limited. We cannot commit to shipping anything off-site until more is known about the chemical AND PHYSICAL properties of the material. This will be required to gain approval from any off-site facility. We cannot be certain the material can be accepted anywhere.. We do not plan to dilute the material to solve the problem, but only to dilute the material concentrations to the limits of the treatment technology (bacteria). This practice occurs with every treatment technology—fuel blending, incineration, neutralization, solidification, etc.

Sincerely,

HAZARDOUS WASTE PROGRAM

Pia Capell, Environmental Specialist Superfund
Section

PEC:ta

9 PROJECT SCHEDULE

| | | | | | | | | | | | | |
|--|-------------|------|------|------|------|------|------|------|------|-------|------|------|
| REVISED December, 2004 | | | | | | | | | | | | |
| SENTINEL PROPOSED SCHEDULE | | | | | | | | | | | | |
| LAFSER & ASSOCIATES, INC. | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| | Mo-1(9-04?) | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo11 | Mo12 |
| COMMENCE IMPLEMENTATION - 2004-5 | | | | | | | | | | | | |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| CLAY/BENTONITE LINER CONSTRUCTION | X | X | | | | | | | | | | |
| PUBLIC MEETING | | X | | | | | | | | | | |
| UCI PERMIT APPLICATION | | X | | | | | | | | | | |
| ERECT/BUILD 100'X200'GREENHOUSE #1 ON WEST SIDE OF CREEK | | X | X | | | | | | | | | |
| BERMS ERECTED AND SUMP AND ELECTRIC INSTALLED | | X | | | | | | | | | | |
| DEVELOPMENT OF AND TEST INOCULATES | | X | X | | | | | | | | | |
| INSTALL HRC TRENCHES AND DISTRIBUTORS | | | X | X | | | | | | | | |
| EXCAVATE / COMPLIANCE TEST OLD PLANT & HRC TRENCHES | | | X | X | | | | | | | | |
| FILL AND BLEND CELL WITH PLANT/TRENCH SOILS | | | X | X | | | | | | | | |
| QUARTERLY SURFACE WATER SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING | | | X | | | X | | | X | | | X |
| OPERATE BIOREMEDIATION TREATMENT CELL | | | | X | | | X | X | X | X | X | X |
| MONTHLY BIO TREATMENT CELL SAMPLING | | | | X | | | | X | X | X | X | X |
| INSTALL 2 PIEZOMETERS | | | | | X | | | | | | | |
| INSTALL MONITORING WELLS | | | | | X | | | | | | | |
| ERECT/BUILD 100'X200'GREENHOUSE #2 | | | | | | X | X | | | | | |
| OPERATE / TEST / CARBON SOUTH SUMP | | | | | | | X | X | X | X | X | X |
| EXCAVATION CLEARANCE TEST WEST ROAD | | | | | | | | X | | | | |

9 PROJECT SCHEDULE

| YEAR 2 - 2005-6 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
|---|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| OPERATE/TEST/CARBON/ SOUTH SUMP | X | X | X | | | | X | X | X | X | X | X |
| OPERATE BIO TREATMENT CELL WEST SIDE OF CREEK | X | X | | | | | X | X | X | X | X | X |
| MONTHLY BIOTREATMENT CELL SAMPLING | X | X | | | | | | | X | X | X | X |
| SURFACE WATER STREAM SAMPLING/QA/QC | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING / QA/QC | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING / QA/QC | | | X | | | X | | | X | | | X |
| CHARACTERIZATION OF LAGOON | | | | X | | | | | | | | |
| YEAR 3 - 2006-7 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| OPERATE/TEST/CARBON/ SOUTH SUMP | X | X | X | | | | X | X | X | X | X | X |
| OPERATE BIOREMEDIATION TREATMENT CELL | X | X | | | | | X | X | X | X | X | X |
| MONTHLY BIOTREATMENT CELL SAMPLING | X | X | | | | | | | X | X | X | X |
| REPLENISH HRC TRENCHES | X | X | | | | | | | | | | |
| EXCAVATE/ REMOVE YEAR 1-2 TREATED SOILS FROM TREATMENT CELL | | X | X | | | | | | | | | |
| SURFACE WATER STREAM SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING | | | X | | | X | | | X | | | X |
| FILL/DEVELOP BIOREMEDIATION CELL WEST FOR EAST ROAD SOILS | | | X | | | | | | | | | |
| EXCAVATE /CLEARANCE TEST EAST ROAD SOILS | | | X | | | | | | | | | |
| FILL BIO CELL WITH WEST LAGOON MAT'L | | | | | X | X | | | | | | |
| PARTIAL EXCAVATION OF LAGOONS FOR DISPOSAL/TREATMENT | | | | | X | X | | | | | | |
| OFFSITE DISPOSAL / TREATMENT | | | | | | X | | | | | | |

9 PROJECT SCHEDULE

| YEAR 4 - 2007-8 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
|---------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| OPERATE/TEST/CARBON/ SOUTH SUMP | X | X | X | | | | X | X | X | X | X | X |
| OPERATE BIOREMEDIATION TREATMENT CELL | X | X | | | | | X | X | X | X | X | X |
| MONTHLY BIOTREATMENT CELL SAMPLING | X | X | | | | | | | X | X | X | X |
| SURFACE WATER STREAM SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING | | | X | | | X | | | X | | | X |

9 PROJECT SCHEDULE

| YEAR 5 - 2008-9 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
|--|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| OPERATE/TEST/CARBON/ SOUTH SUMP | X | X | X | | | | X | X | X | X | X | X |
| OPERATE BIOREMEDIATION TREATMENT CELL | X | X | | | | | X | X | X | X | X | X |
| REPLENISH HRC TRENCHES | X | X | | | | | | | | | | |
| MONTHLY BIOTREATMENT CELL SAMPLING | | X | | | | | | | X | X | X | X |
| SURFACE WATER STREAM SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING | | | X | | | X | | | X | | | X |
| EXCAVATION OF YEAR 3-4 TREATED SOILS | | | | X | X | | | | | | | |
| EXCAVATION/COMPLIANCE TEST CENTRAL LAGOON MATERIAL | | | | | X | X | | | | | | |
| FILL BIO CELL WITH CENTER LAGOON MAT'L | | | | | X | X | | | | | | |

9 PROJECT SCHEDULE

| YEAR 6 - 2009-10 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
|---------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | X | X | X | X | X |
| OPERATE/TEST/CARBON/ SOUTH SUMP | X | X | X | | | | X | X | X | X | X | X |
| OPERATE BIOREMEDIATION TREATMENT CELL | X | X | | | | | X | X | X | X | X | X |
| MONTHLY BIOTREATMENT CELL SAMPLING | X | X | | | | | | | X | X | X | X |
| SURFACE WATER STREAM SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY WELL SAMPLING | | | X | | | X | | | X | | | X |
| QUARTERLY HRC MICROWELL SAMPLING | | | X | | | X | | | X | | | X |

9 PROJECT SCHEDULE

| YEAR 7 2010-11 | Mo-1 | Mo-2 | Mo-3 | Mo-4 | Mo-5 | Mo-6 | Mo-7 | Mo-8 | Mo-9 | Mo-10 | Mo-11 | Mo-12 |
|---------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG |
| PROGRESS REPORTS TO EPA (15TH) | X | X | X | X | X | X | X | | | | | |
| OPERATE BIOREMEDIATION TREATMENT CELL | X | X | X | | | | | | | | | |
| MONTHLY BIOTREATMENT CELL SAMPLING | X | X | X | | | | | | | | | |
| REMOVE/CLOSE WELLS | | | X | | | | | | | | | |
| REMOVE/CLOSE HRC TRENCHES | | | | X | | | | | | | | |
| FINAL REPORT | | | | | | | X | | | | | |
| REMOVE GREENHOUSES | | | | | | | | X | | | | |
| FINAL GRADE /SEED SITE | | | | | | | | | X | | | |



U.S. EPA REGION 7
EMERGENCY RESPONSE
901 NORTH 5th STREET
KANSAS CITY, KANSAS 66101
SPILL LINE (913) 281-0991
FAX (913) 551-7157

SUBJECT Sentinel - Response
to Comments on Work Plan dated 12/5/01
PAGE NUMBER 1 OF 1
PREPARED BY Nold DATE 2/23
ACTIVITY NUMBER _____

- don't completely agree with your response to our question about the PAH's in the cover letter
- Section 6.2 page 16 - I still think a ^{check w/ Tim + Dave to see what they did} composite sample of each batch should be taken before adding the "fluff" to see what the "pre-treatment" concentration was - this will positively show what is attributable to dilution versus that from biodegradation. EPA will probably collect these samples if you don't - therefore you will need to coordinate field work during that time w/ the Agency so samples can be collected before mixing in the sawdust, nutrients, + inoculants
- sect. 6.5 page 17 - ^{check w/ Tim + Dave} EPA will use PID + FID if necessary
- Set 10 pg 24 - what about the activated carbon sample numbers not adding up?
- QAPP Sect 2 pg 10 - what about BH18 & Seep 14 results for PAH's?

Sentinel Industries, Inc.

SINCE 1957

P.O. Box 165 • Ashland, Missouri 65010 • 573-657-2164 • Fax 573-657-2484

April 13, 2005

RECEIVED

APR 15 2005

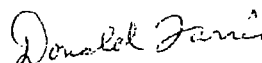
SUPERFUND DIVISION

Mr. Eric Nold
Enforcement / Fund-Lead Removal Branch
U.S. Environmental Protection Agency
Region VII
Kansas City, KS 66101

Dear Mr. Nold,

Please consider this letter a formal request to have a copy sent to me via U.S. Mail or by E-Mail (djfarris@socket.net) on all correspondence to Lafser & Associates, Inc. and David Shore of Lathrop & Gage.

Sincerely,



Donald D. Farris
President



FROM:

Eric Nold

DATE:

4/13/05

Phone #: (913) 551-7488
Superfund Division
Region 7

TO:

Fred Lafser +

PAGES TO FOLLOW:

9

Roger Riemann (314) 741-4388

COMMENTS:

Roger - attached is the memo w/ attachments
you sent me on April 5th. Although I am now aware that
the letter Sentinel recieved did not have any asterisk
marks on it - the one you attached is not exactly what
was sent out (missing questions 10-12 + gap between 8+9).
I have therefore attached the original electronic copy
I emailed to my office manager for printing which
does include the intended asterisk marks. I
apologize for my oversight in sending out the
incorrect version. The agency still beleives the
comments w/ an asterisk are significant enough
to require Sentinel to address. I understand
that you may need additional time to address
these comments because of my mistake.
Call me with questions. Eric Nold
(913) 551-7488

LAFSER & ASSOCIATES, INC
638 CHAMBLEE LANE
ST. LOUIS, MISSOURI 63141
314 878-4021

RECEIVED

APR 07 2005

SUPERFUND DIVISION

April 5, 2005

Mr. Eric Nold
Enforcement / Fund-Lead Removal Branch
U.S. Environmental Protection Agency
Region VII
Kansas City, Kansas 66101

RE: March 24, 2005 Correspondence on Sentinel Alternate Time-Critical Removal
Action Work Plan.

Dear Mr. Nold,

At the end of the above referenced correspondence you indicated that you had not received a response from Sentinel to EPA/MDNR's comments from your review of the Revised Time Critical Removal Action and Removal Assessment Report. (Comments attached)

We believed from the fourth paragraph of that document a written response was required only for those comments with an asterisk to be addressed in a separate document back to the EPA. In the document Mr. Farris and I received from your office, there were no asterisked comments for the EPA or MDNR comments, leading us to believe a written response was not required.

If this is in error please indicate which comments you wish formal written responses. My telephone is 314 741-4231, Fax 314 741-4388, and email rriemann@sbcglobal.net.

Sincerely,



Roger A. Riemann
Sr. Environmental Scientist

Cc: Don Farris
David Shorr

Enclosure



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 NORTH 5TH STREET
KANSAS CITY, KANSAS 66101

NOV 5 2004

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Fred Lafser
Lafser & Associates, Inc.
638 Chamblee Lane
St. Louis, Missouri 63141

RE: Review of Revised Time-Critical Removal Action and Removal Assessment
Report Submitted April 30, 2004, for Sentinel Wood Treating Site

Dear Mr. Lafser:

As the designated project coordinator for the Sentinel Wood Treating site (Sentinel Site), I am submitting to you the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR) official response to the Time-Critical Removal Action and Removal Assessment Report that you submitted for review in April 2004 (see enclosure). Submission of this document was required under the Administrative Order on Consent (AOC), dated September 17, 2001, between the EPA, the MDNR, and Sentinel Industries, Inc.

As described in the AOC under section IX part 42, Submissions Requiring EPA Approval, all plans and reports which require submission for EPA approval shall: a) be approved in whole or in part; b) be approved with modifications; c) disapprove in whole or in part and direct the Respondent to resubmit after incorporation of EPA and MDNR comments; d) disapprove the submission and assume responsibility for performing all or any part of the response activities; or e) any combination of the above.

The following is a summary of the EPA and the MDNR's determination for the report which you submitted for approval. The Time-Critical Removal Action and Removal Assessment Report is approved with comment, pending addressing certain comments.

The following are the EPA's specific comments to the report and the MDNR's are attached. The EPA is requiring that any comment with an asterisk be addressed in a separate document back to the EPA within the reporting time-line as outlined in the AOC. This does not require the re-submission of the removal assessment report unless it is easier and/or less expensive to do so.



1. Page 7, Section 3.2 - Says 21 pages for Table 1 and List of Tables on page 4 (?) says 26 pages - which is it?
2. Page 10, Section 5.1 - First sentence - Figure 4 shows the piezometer locations - probably should reference Figures 3 and 4 here.
- 3. Page 12, Section 5.3 - C - Piezometer 15 doesn't show a detection based on elevated detection limits so why describe it with piezometers 9, 10, and 11 as being high? More importantly, the data displayed in Figure 10 doesn't match the data displayed in Figure 21 for piezometers 9, 10, 11, 15, and 16. Based on Table 1 (if that is correct) it appears that Figure 10 is not correct.
- 4. Page 12, Section 5.3 - D - an explanation of where you think this is coming from is needed since it is south of the southernmost East-West diversion system trench?
- 5. Page 14, Section 5.5 - Last paragraph - here you refer to the initial material in the south sump as sludge. Earlier in Section 4.3 it was described as a "thin oily film" - which is it?
6. Page 14, Section 5.6 - On Figure 8 what are the hand written numbers next to the "x's" - PCP results? What units? Was Sed 5 taken prior to the wall extension that was built? Table 14 is results of mag survey - change to Figure 13.
7. Page 14, Section 5.7 - This should be one of the most important sections of the entire Removal Assessment report and has the most data since 1997 (or 1998 or 2000 or 2002). Either need to change the heading name for 5.7 or include Sections 5.8-5.11 as sub-headings. Maybe just change 5.7 to Treatment area soil sampling. Why list sample results for ground water here and create the necessity to look up soil results in two different tables? Differing units on Figure 10 for ground water, soil, and isopleths make it confusing to interpret. Table 11 is for the roadways - not treatment area. Table 13 is for sediment results, Table 12 is soil boring results.
8. Page 15, Section 5.8 - Need to reference Table 11 here.
9. Page 15, Section 5.9 - Last sentence doesn't make sense as written.

13. Page 18, Section 6.5 - Classification says roadways were contaminated from applying sediment sludge from oil water separator but section 5.8 says it is from drippage during product storage after treatment - which is it?

14. Page 20, Section 8 - Conclusion #2 - Figure 20 doesn't show PZ-6 in the ground water drainage diversion system, but north of it.

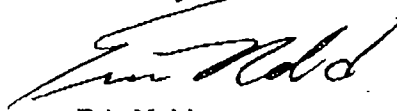
15. Page 20, Section 8 - Based on all the data that's been collected since 2000, I can think of many more conclusions that are important and could be made here. Especially positive ones (i.e. ponds north of the site not impacted above health based concerns; municipal wells not impacted by Sentinel contaminants at this time; currently, direct exposure to highly contaminated material unlikely; does not appear that ground water south of the site and east of the creek has been impacted, etc.).

16. Page 21, Section 9 - bullet #7 - Do you mean 1 to 2 cubic-yards of sediment?

17. Table 1. Subsurface Soil - doesn't show any dioxin equivalents above 1.0 ppb - this is not true - are the results actually in ppt?

If you have any questions concerning the EPA's and the MDNR's review and comments on the above referenced plans, please call me at (913) 551-7488 or Pia Capell, MDNR at (573) 751-2115.

Sincerely,



Eric Nold
On-Scene Coordinator
Enforcement/Fund-Lead Removal Branch

Enclosure

Mr. Eric Nold
October 22, 2004
Page 2

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Bob Holden, Governor • Stephen M. Mahfood, Director

www.dnr.mo.gov

RECEIVED

NOV 1 2004

SUPERFUND DIVISION

October 22, 2004

Mr. Eric Nold
On Scene Coordinator
U.S. EPA, Region VII
901 North 5th Street
Kansas City, KS 66101

Re: Sentinel Wood Removal Action and Assessment Report

Dear Mr. Nold:

I have reviewed the subject report and have the following comments for your consideration.

5.4 Surface Water Management

In the last sentence, it is stated that no samples have been taken from the monitoring pipe and the area is scheduled for excavation. Will monitoring happen after the excavation?

6.0 Contaminated Soil Volume Estimates

Some areas measure the volume in 22, 110, and 1100 ppm PCP and other areas are measured in 11 and 110 ppm PCP. Seems like there should be some consistency in volumes measured.

6.4 Old Treatment Plant

It is stated that only the bottom 2-3 inches above refusal contained visible contamination, the bottom material was oily water but was inappropriately referred to as "groundwater" by MDNR, and that the highest sample tested was 860 ppm in the bottom sludge in the vault.

The sampling and log notes for the boreholes in the concrete vault taken during the ESI show in SB-15 that from around 6.5 – 7 feet to refusal at 8 feet there was visible contaminated material (PCP = 860 ppm, dioxin = 5.67 ppb). In the other boring, SB-17, there was contaminated

Integrity and excellence in all we do



Mr. Eric Nold
October 22, 2004
Page 2

material encountered at 2.5-3.5' (PCP = 1200 ppm, dioxin = 7.17 ppb) with refusal at around 12 feet. So the statement that only the bottom 2-3 inches above refusal were visibly contaminated does not seem accurate.

The liquid samples were referred to as groundwater in the narrative portion of the ESI Sampling Report, but were correctly referred to as "liquid waste" in the ESI Narrative Report (which is the main report for the site) and in all tables describing samples.

Lastly the highest PCP concentration in this vault area from the soil/waste material was in SB-17 from the 2.5-3.5' depth at 1,200 ppm, not 860 ppm.

9.0 Recommendations

In recommendation #2 it says that the small amount of sludge in the bottom of the vault should be assessed but there is no potential options proposed. As is stated earlier, we believe there is more than 1 inch of visibly contaminated oily material that will have to be addressed.

Either collecting deeper groundwater samples or drilling deeper wells into the B zone fractured bedrock on-site at different locations should have also been recommended. PCP was found in a well drilled to 35 feet downgradient of the site. There doesn't seem to be any on-site groundwater data for anything besides shallow groundwater.

Sincerely,

HAZARDOUS WASTE PROGRAM



Pia Capell, Environmental Specialist
Superfund Section

PEC:ta

*As you will see - questions/comments
3, 4, 5, 12, 13, & 17 have
an asterisk.*

Fred Lafser
Lafser & Associates, Inc.
638 Chamblee Lane
St. Louis, Missouri 63141

RE: Review of revised Time-Critical Removal Action and Removal Assessment Report
submitted April 30, 2004, for Sentinel Wood Treating Site

Dear Mr. Lafser,

As the designated project coordinator for the Sentinel Wood Treating Site (Sentinel Site), I am submitting to you the Environmental Protection Agency (EPA) and Missouri Department of Natural Resources (MDNR) (attached) official response to the Time-Critical Removal Action and Removal Assessment Report that you submitted for review in April 2004. Submission of this document was required under the Administrative Order on Consent (AOC), dated September 17, 2001, between the EPA, MDNR, and Sentinel Industries, Inc.

As described in the AOC under section IX part 42, Submissions Requiring EPA Approval, all plans and reports which require submission for EPA approval shall:
a) be approved in whole or in part; b) be approved with modifications; c) disapprove in whole or in part and direct the Respondent to resubmit after incorporation of EPA and MDNR comments; d) disapprove the submission and assume responsibility for performing all or any part of the response activities; or e) any combination of the above.

The following is a summary of EPA and MDNR's determination for the report which you submitted for approval. The Time-Critical Removal Action and Removal Assessment Report is approved with comment, pending addressing certain comments.

The following are EPA's specific comments to the report and MDNR's are attached. EPA is requiring that any comment with an asterisk be addressed in a separate document back to EPA. This does not require the resubmission of the removal assessment report unless it is easier and/or less expensive to do so.

1. Page 7, Section 3.2 - Says 21 pages for Table 1 and List of Tables on page 4 (?) says 26 pages - which is it?
2. Page 10, Section 5.1 - First sentence - Figure 4 shows the piezometer locations - probably should reference Figures 3 and 4 here.

*3. Page 12, Section 5.3 - C - Piezometer 15 doesn't show a detection based on elevated detection limits so why describe it with piezometers 9, 10, and 11 as being high? More importantly, the data displayed in Figure 10 doesn't match the data displayed in Figure 21 for piezometers 9, 10, 11, 15, and 16. Based on Table 1 (if that is correct) it appears that Figure 10 is not correct.

*4. Page 12, Section 5.3 - D - an explanation of where you think this is coming from is needed since it is south of the southernmost East-West diversion system trench?

*5. Page 14, Section 5.5 - Last paragraph - here you refer to the initial material in the south sump as sludge. Earlier in Section 4.3 it was described as a "thin oily film" - which is it?

6. Page 14, Section 5.6 - On Figure 8 what are the hand written numbers next to the "x's" - PCP results? What units? Was Sed 5 taken prior to the wall extension that was built? Table 14 is results of mag survey - change to Figure 13.

7. Page 14, Section 5.7 - This should be one of the most important sections of the entire Removal Assessment report and has the most data since 1997 (or 1998 or 2000 or 2002). Either need to change the heading name for 5.7 or include Sections 5.8-5.11 as sub-headings. Maybe just change 5.7 to Treatment area soil sampling. Why list sample results for ground water here and make us look up soil results in two different tables? Differing units on Figure 10 for ground water, soil, and isopleths make it confusing to interpret. Table 11 is for the roadways - not treatment area. Table 13 is for sediment results, Table 12 is soil boring results.

8. Page 15, Section 5.8 - Need to reference Table 11 here.

9. Page 15, Section 5.9 - Last sentence doesn't make sense as written.

10. Page 16, Section 5.10 - Why isn't the EPA report described here part of the reference list at the end of this report?

11. Page 17, Section 6.1 - What does the last sentence have to do with soil volume estimates?

*12. Page 18, Section 6.4 - see MDNR's comments.

*13. Page 18, Section 6.5 - Classification says roadways were contaminated from applying sediment sludge from oil water separator but section 5.8 says it is from drippage during product storage after treatment - which is it?

14. Page 20, Section 8 - Conclusion #2 - Figure 20 doesn't show PZ-6 in the ground water drainage diversion system, but north of it.

15. Page 20, Section 8 - Based on all the data that's been collected since 2000, I can think of many more conclusions that are important and could be made here. Especially positive ones (i.e.

ponds north of the site not impacted above health based concerns; municipal wells not impacted by Sentinel contaminants at this time; currently, direct exposure to highly contaminated material unlikely; does not appear that ground water south of the site and east of the creek has been impacted, etc.).

16. Page 21, Section 9 - bullet #7 - Do you mean 1 to 2 cubic yards of sediment?

*17. Table 1. Subsurface Soil - doesn't show any dioxin equivalents above 1.0 ppb - this is not true - are the results actually in ppt?

If you have any questions concerning EPA and MDNR's review and comments on the above referenced plans, please call me at (913) 551-7488 or Pia Capell, MDNR at (573) 751-2115.

Sincerely,

Eric Nold
On-Scene Coordinator
Enforcement/Fund-Lead Removal Branch