UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

RECORD OF DECISION
SOUTH MINNEAPOLIS RESIDENTIAL SOIL CONTAMINATION SITE
MN000509136
MINNEAPOLIS, MINNESOTA

SEPTEMBER 5, 2008

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Abbreviations and Acronyms

AgVIC	Agricultural Voluntary Investigation & Cleanup
ARAR	applicable or relevant and appropriate requirements
As_2O_3	arsenic trioxide
ATSDR	Agency for Toxic Substances and Disease Registry
BHHRA	baseline human health risk assessment
bgs	below ground surface
CAG	Community Advisory Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CIP	Community Involvement Plan
CMC	CMC Heartland Partners
COC	chemical of concern
COPC	chemical of potential concern
CSM	conceptual site model
CTE	central tendency exposure
CWI	County Well Index
DLI	Department of Labor and Industry
Eco-SSLs	U.S. EPA Ecological Soil Screening Levels
EJ	Environmental Justice
ELCR	excess lifetime cancer risk
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
°F	degrees farenheit
FIELDS	U.S. EPA Field Environmental Decision Support Group
FS	feasibility study
HCRRA	Hennepin County Railroad Authority
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ICs	institutional controls
IRIS	Integrated Risk Information System
ISC3	Industrial Source Complex 3
Lite Yard Property	CMC Heartland Lite Yard property
LOEL	lowest observed adverse effect level
m^2	square meters
MCL	maximum contaminant levels
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
mg/kg	milligrams per kilogram
ug/l	microgram per liter

MSL	mean sea level
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
$NaAsO_2$	sodium arsenate
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PPB	parts per billion
PRG	preliminary remediation goals
PRP	potentially responsible party
RAO	remedial action objective
REMACOR	Reactive Metals & Alloy Corporation
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RD	remedial design
Reade	Reade Manufacturing Company
Rfd	reference dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SF	slope factor
SLERA	screening level ecological risk assessment
SMRSCS	South Minneapolis Residential Soil Contamination Site
SRV	soil reference value
TAL	target analyte list metals
TMV	toxicity, mobility or volume
UAO	unilateral administrative order
UNM	University of New Mexico
XRF	x-ray fluorescence
yd^3	cubic yards

PART 1: THE DECLARATION

1.0 Site Name and Location

The South Minneapolis Residential Soil Contamination Site (SMRSCS or Site) is located in Minneapolis, Hennepin County, Minnesota. The Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification number is MN000509136.

2.0 Statement of Basis and Purpose

This decision document presents the selected remedial action for the South Minneapolis Residential Soil Contamination Site located in Minneapolis, Minnesota. The remedy was developed in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Specifically, this decision document has been prepared in compliance with CERCLA Section 117 and NCP Section 300.435(c)(2)(11). This decision document explains the factual and legal basis for selecting the remedy for this Site. The information supporting this remedial action decision is contained in the administrative record for this Site. The Administrative Record file is available for review at the United States Environmental Protection Agency (EPA) Region 5 Records Center, 77 West Jackson Boulevard, Chicago, Illinois, and at the following information repositories:

- Green Institute
  2801 21st Ave. S.
  Suite 100
  Minneapolis, MN

- City of Minneapolis Police Department
  1201 – B East Franklin Ave.
  Minneapolis, MN

- Minneapolis Central Library
  300 Nicollet Mall, 2nd Floor
  Minneapolis, MN

- Minneapolis Public Library
  East Lake Branch
  2727 East Lake Street
  Minneapolis, MN

3.0 Assessment of Site

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

4.0 Description of Selected Remedy

The selected remedy is the final remedy for the Site. The remedy addresses the risks posed by the arsenic-contaminated soils that present the principal threat at the Site. Principal threat wastes are defined as those source materials considered highly toxic or highly mobile that generally cannot be reliably contained or would present significant risk to human health or the environment should exposure occur.

The following are the major components of the remedy selected in this ROD:

- Inventory and documentation of the existing conditions of the areas requiring the remedy;
- Excavation of soil (to a depth of 12 inches below grade in yards, and to a depth of 18 inches below grade in garden areas) that has total arsenic concentrations above 25 milligrams per kilogram (mg/kg), or parts per million (ppm);
- Post-excavation soil sampling to document the concentrations in the remaining soils;
- If the samples at the base of the excavation exceed the deep soil arsenic cleanup standard, 95 mg/kg, then excavation will continue until the deep soil cleanup standard is met, or to a maximum depth of ten feet;
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Backfilling excavation with clean fill and topsoil to the original grade;
- Restoration of the excavated areas (i.e., restoring vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory);
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a permitted and compliant Resource Conservation Recovery Act (RCRA) subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:
  - Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or
  - Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.

- If cleanup standards are not obtained at the bottom of the excavation, institutional controls would be placed on the land in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure.

5.0 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action and is cost effective. This remedy utilizes permanent solutions and alternate treatment technologies to the maximum extent practicable for this Site. However, because treatment of the principal threats at the Site was not found to be practicable, this remedy does not satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principle element.

If fully implemented, this remedy can potentially result in either one of the following circumstances: 1) this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposures, and thus, a five-year review would not be required, or 2) If cleanup standards are exceeded at the maximum excavation depth, or if complete excavation is not otherwise possible, this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure at a limited number of locations. Under this second set of circumstances a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

6.0 Data Certification Checklist

The following information is included in The Declaration (Part 1) and the Decision Summary (Part 2) of this ROD, while additional information can be found in the Administrative Record file for this Site:

6.1 Chemicals of concern (COCs) and their respective concentrations (see Section 14.1.1 - Contaminant of Concern);

6.2 Baseline risk represented by the COCs (see Section 14.0 – Summary of Site Risks);

6.3 Remediation goals (i.e., cleanup goals) established for the COCs and the basis for the goals (see Section 19.4.1 - Final Cleanup Levels);

6.4 How source materials constituting principal threats are addressed (see Sections 20.0- Statutory Determinations and Section 18.0 - Principal Threat Wastes);

6.5 Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the Baseline Human Health Risk Assessment and this ROD (see Section 13.0 - Current and Potential Future Land Uses);

6.6 Potential land and ground water use that will be available at the Site as a result of the Selected Remedy (see Sections 13.0 - Current and Potential Future Land Uses;

6.7 Estimated capital, lifetime operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see Section19.3 - Cost Estimate for the Selected Remedy; and Tables 11.9 – 11.13 - Cost Estimate Details for Alternative 2C); and,

6.8 Key factor(s) that led to selecting the remedy (see Section 14.3 - Basis for Remedial Action).

7.0 Authorizing Signatures

Richard C Karl

Richard C. Karl, Director
Superfund Division

9-5-08
Date

PART 2: THE DECISION SUMMARY

8.0 Site Name, Location, and Brief Description

The South Minneapolis Residential Soil Contamination Site (the Site) is located in Minneapolis, Hennepin County, Minnesota. The area encompassed by the Site includes residential, commercial, industrial, and municipal properties. The Site is largely residential, with much of the housing built from the early 1900s through 1930s. Figure 1 provides the location of the Site and Figure 2 illustrates the property usage at the Site and in the Site investigation area. The general geographical coordinates for the Site are 44.952187 degrees north 93.240479 degrees west.

In Minnesota, the low-income percentage is 27% and the minority percentage is 12%. To meet the Environmental Justice (EJ) concern criteria, the area within 1 mile of the Site must have a population that is twice the State low-income percentage and/or twice the State minority percentage. That is, the area must be at least 54% low income and/or 24% minority. For this Site the low income percentage is 52%, and the minority percentage is 57%, as determined by LandView IV EJ analysis. The Site therefore meets EPA's EJ criteria.

Prevailing summer winds were determined to be from the southeast toward the northwest; therefore, the residential area located directly downwind of the CMC Heartland Site (also known as the CMC Heartland Lite Yard property) became the focus of the initial sampling effort (EPA, 2005a). The CMC Heartland Lite Yard property is located at the northwest corner of Hiawatha Avenue and 28th Street. The Site investigation was later expanded to include all residential properties, schools and parks within the approximate ¾-mile radius centered on the former CMC Heartland Site, based upon the results of an air dispersion model.

Most of the residences were built from the early 1900s through 1930s. A typical residential block has approximately 30 properties with an average lot size of approximately 5,500 square feet (0.1 acre).

The Site was added to the United States Environmental Protection Agency National Priorities List (NPL) on September 19, 2007. The risk posed by exposure of residents to arsenic contaminated soil resulting from releases from the Site was the primary reason for the listing.

9.0 Site History and Enforcement Activities

9.1 History

The Chicago, Milwaukee, St. Paul, and Pacific Railroad Company (Milwaukee Railroad) owned the property located at 2016 28th Street East, formerly known as the CMC

Heartland Site, beginning in 1880. The Milwaukee Railroad declared bankruptcy in 1985, and as a result of the bankruptcy, the CMC Heartland Site property was transferred to CMC Heartland Partners (CMC) on November 8, 1993. 2800 Hiawatha LLC, on August 15, 2005, acquired the former CMC Heartland Site property.

From 1938 to 1969, Reade Manufacturing Company (Reade) leased the CMC Heartland Site property from the Milwaukee Railroad. From 1938 to 1963, Reade blended, stored, and distributed arsenical herbicides and pesticides at the CMC Heartland Site property. During the 1940s, Reade also produced an arsenic-based grasshopper insecticide (Geomega, 2004). During Reade's operations, arsenic trioxide was unloaded from railroad hopper cars to an open conveyor belt, resulting in powdered arsenic trioxide being released into the air and onto the CMC Heartland Site property.

From 1963 to 1968, U.S. Borax subleased the CMC Heartland Site property from Reade. U.S. Borax manufactured, shipped, and stored borate-based herbicides. Although U.S. Borax did not receive new shipments of powdered arsenic trioxide, its operations at the CMC Heartland Site property disturbed and dispersed arsenic contamination still present from Reade's operations. In January 1968, a storage tank containing liquid sodium arsenite ($NaAsO_2$) ruptured, releasing approximate 3,000 gallons of liquid sodium arsenite from a 25,000-gallon storage tank onto an area approximately 1,000 square meters (m^2) that was subsequently covered with approximately 6 inches of sand (Geomega, 2004). In the period after 1968, Rollins Oil Company and subsequently Bituminous Roadways, an asphalt road construction company, occupied the property.

Arsenic contamination was discovered by the Minnesota Department of Transportation (MnDOT) in 1994 during a reconstruction of the Hiawatha Avenue corridor adjacent to the CMC Heartland Site property. After the arsenic contamination was identified in 1994, an additional investigation was performed at the property. By 1996, Bituminous Roadways had placed one to two feet of crushed asphalt over the CMC Heartland Site property to keep further dust from blowing off the property and to minimize human exposure to surface soil (Geomega, 2004). Remedial actions were performed under the oversight of the Minnesota Department of Agriculture (MDA) Superfund Program at the CMC Heartland Site in 2004 and 2005. The property has subsequently been redeveloped. At present, the former CMC Heartland Site property is owned by 2800 Hiawatha, LLC and is occupied by the Hiawatha Business Center, an approximate 60,000 square foot light industrial building (Peer, 2005).

As the result of the investigation at the CMC Heartland Site, the Minnesota Department of Health (MDH) recommended in 1999 that soil sampling be performed in residential areas near the CMC Heartland Site property due to the elevated arsenic concentrations. Prevailing summer winds were determined to be from the southeast toward the northwest; therefore, the residential area located directly downwind of the CMC Heartland Site property became the focus of the initial sampling effort (EPA, 2005a). Investigations in the residential neighborhood performed by the MDH and Minnesota Department of Agriculture (MDA) identified arsenic impacts in the shallow soils. The MDA requested assistance from EPA in 2004 after sampling efforts in the residential neighborhood identified properties with elevated arsenic concentrations.

9.2 Previous Investigations and Remediation

As noted, numerous investigations and response activities have been conducted at the CMC Heartland Site property and within the South Minneapolis Residential Soil Contamination Site area. The major investigations and response actions are summarized below.

9.2.1 1994 MnDOT

In 1994, the MnDOT performed an investigation of the entire Hiawatha Avenue corridor for reconstruction. Hiawatha Avenue runs along the eastern side of the CMC Heartland Site and the investigation included the easternmost part of the CMC Heartland Site. Organochlorine pesticides and elevated levels of arsenic were detected in some borings along Hiawatha Avenue near the CMC Heartland Site (MDA, 2000).

9.2.2 1995 MnDOT and MDA

In July 1995, MnDOT joined MDA's voluntary cleanup program, now called the AgVIC program, to further investigate the arsenic contamination in the highway corridor. The investigation indicated that the arsenic came from the CMC Heartland Site (MDA, 2000).

9.2.3 1995 CMC Heartland Partners

In December 1995, CMC completed an investigation that indicated the former Reade Manufacturing Company was likely the primary source for the arsenic in the Hiawatha Avenue corridor near the Site. A subsequent investigation focused on the soil near the location of the former manufacturing building (MDA, 2000).

9.2.4 2000 MDH Health Consultation

In December 2000, the MDH finalized the *Health Consultation Report* for the CMC Heartland Site. The Health Consultation evaluated environmental conditions based on previous investigations, evaluated health effects, and developed recommendations for reducing or eliminating exposure to the contaminants. In the MDH Health Consultation, information was provided on a well receptor survey for the area within one mile of the CMC Heartland Site. The well receptor survey identified 39 wells including twelve (12) public supply wells, seven (7) commercial, three (3) industrial use wells, fifteen (15) monitoring wells, and two (2) test wells.

MDH recommendations in the Health Consultation included additional characterization of soil and groundwater, Site access and soil management improvements, and institutional controls (MDH, 2000).

9.2.5 2001 MDA and MDH

The MDH recommended soil sampling in residential areas due to elevated concentrations of arsenic at the CMC Heartland Site. In June 2001, MDA in conjunction with MDH conducted a limited sampling event at residential properties to the west (crosswind) and northwest (downwind) of the CMC Heartland Site. Results of the 2001 MDA sampling event indicated arsenic concentrations (24 to 210 milligrams per kilogram (mg/kg)) in soil at 6 of the 11 downwind properties sampled (MDA, 2004b).

Based on the limited sampling data, MDA and MDH established 4 to 5 mg/kg as the preliminary background arsenic concentration in the sampling area. Based on the June 2001 sampling event and neighborhood concerns, MDA and MDH determined that more extensive sampling to the northwest and west of the CMC Heartland Lite Yard property was warranted. As a result, MDA conducted a second study in the neighborhood in 2003.

9.2.6 2002 The Green Institute

In 2002, The Green Institute performed an investigation at three garden properties as part of a property transfer investigation. During the investigation, elevated arsenic was detected in the four surface soil samples collected from Garden 8, which is located at 2426 17th Avenue South. Concentrations ranged from 24 mg/kg to 38 mg/kg .

During a supplemental investigation in September 2002, an additional 13 samples (7 samples to a depth of 3 inches and 6 samples to a depth of 3 feet) were collected from Garden 8 and results ranged from 1.8 mg/kg to 34 mg/kg. A remedial action plan to excavate the arsenic-impacted soil from Garden 8 and dispose of the material offsite was approved by the Minnesota Pollution Control Agency on April 23, 2003 (MPCA, 2003A).

9.2.7 2003 Powderhorn Residents Group

In April 2003, a Phase II Environmental Site Assessment (ESA) was performed for the Powderhorn Residents Group for redevelopment of the Village in Phillips, generally located between Bloomington Avenue and 17th Avenue South on the south side of 24th Street East. Samples were collected during the Phase II from three depth intervals (0 to 3 inches, 1.5 to 2.0 feet, and 3.5 to 4.0 feet) at 11 locations using a probe. Arsenic was detected at concentrations from non-detect to 328 mg/kg (STS, 2003). A response action plan was subsequently prepared to excavate arsenic-impacted soil and dispose of offsite. The response action plan was approved by the MPCA on October 30, 2003 (MPCA, 2003B).

9.2.8 2003 Hennepin County Railroad Authority

Hennepin County Railroad Authority (HCRRA) sampled the railroad corridor near the southwest corner CMC Heartland Site in 2000. Soil samples were collected at five locations along the railroad corridor and analyzed for arsenic. In 3 of the 5 samples, arsenic was detected at or above the MPCA Residential Soil Reference Value (SRV) of 12 mg/kg. The SRV is considered a screening level, i.e. it is used to indicate whether further investigation is warranted, and is not considered an action level. The 3 locations at or above the Recreational SRV were located nearest the CMC Heartland Site and defined the western boundary of the railroad corridor for investigation in 2003 (Geomatrix, 2003A).

In May 2003, Geomatrix performed an investigation for HCRRA in the section of the former railroad corridor with arsenic concentrations above the Recreational SRV as delineated in 2000. The former railroad corridor was being redeveloped into a recreational pedestrian/bike pathway. A direct-push rig was used to collect discrete samples from depth intervals of 0.5-feet, 1-foot and 2-feet bgs at 40 locations. A total of 33 samples collected from 25 locations had exceedances of the Recreational SRV, with a maximum detection of 85 mg/kg (Geomatrix, 2003A).

To address arsenic concentrations greater than the Recreational SRV, a Response Action Plan was prepared to excavate approximately 500 cubic yards (yd^3) of impacted soil for offsite disposal and placement of 12 inches of clean soil cover (Geomatrix, 2003B).

9.2.9 2003 MDA

In September 2003, a more extensive sampling event was performed by MDA in the Phillips neighborhood to attempt to attribute the elevated arsenic concentrations in the Phillips neighborhood to wind deposition of impacted soil from the CMC Heartland Site. The sampling design was developed to obtain statistically valid data with a grid overlain on the Phillips Neighborhood with the majority of the samples falling on residential properties.

Delta Environmental Consultants, Inc. (Delta) collected soil samples from a total of 242 locations and 167 properties. An additional 12 replicate samples were collected for quality control and 23 co-located samples for an indication of spatial variability. Each sample was a composite using a "five on dice" pattern. Arsenic concentrations greater than or equal to the MPCA unrestricted land use standard (10 mg/kg) were detected in 35 samples from 27 properties. Arsenic was detected in 11 samples at concentrations greater than 100 mg/kg and four of those samples contained arsenic concentrations exceeding 200 mg/kg (MDA, 2004b).

9.2.10 2004 EPA

Following the September 2003 sampling event, the MDA requested EPA assistance to determine if a time critical removal action was warranted. The EPA agreed to perform an additional investigation, enforcement action, and time critical removal action (MDA, 2004b). In May and June 2004, Tetra Tech EM Inc. (Tetra Tech) conducted sampling under contract to EPA to evaluate soil quality on residential properties. The goal of the sampling was to identify arsenic-impacted properties and provide additional delineation of previously identified arsenic impacts. Samples were collected from 192 properties, primarily in the vicinity of properties previously identified as hotspots, from a depth of 0 to 3 inches bgs. Several samples were also collected about ¾ of a mile west and northwest of the Site area in an attempt to define a clean boundary around the perimeter of the Phillips Neighborhood where arsenic impacts had been detected.

The EPA, in consultation with the Agency for Toxic Substances and Disease Registry (ATSDR), determined that an arsenic concentration equal to or greater than 95 mg/kg in surface soils posed an acute risk to human health and warranted emergency removal actions. Based on the results from multiple sampling events conducted in the Phillips neighborhood, 30 properties were identified that exceeded the 95 mg/kg criteria. To mitigate this threat EPA, excavated the top 12 inches of soil from the yard, and the top 18 inches of soil from play areas and gardens.

On average, 106 yd^3 of arsenic-impacted soil was removed from each property. Post-excavation soil samples to document the residual arsenic concentrations in each yard were collected. The properties were backfilled to pre-existing grade with clean topsoil and seeded with grass seed following the completion of excavation.

9.2.11 2005 through 2008 EPA

In August 2005, EPA, sampled 540 additional properties in the Phillips neighborhood to ensure that 100 percent of the residential properties most likely to be impacted by wind deposition from the former CMC Heartland Site were evaluated for potential impacts. Another 60 properties were also sampled to identify if areas in other wind directions surrounding the CMC Heartland Site could have been impacted. That sampling identified another 31 properties with arsenic concentrations above 95 mg/kg. Removal activities performed were consistent with 2004 and commenced on September 20, 2005.

Results from the 2006 and 2007 residential soil sampling during the remedial investigation discussed below brought the total number of properties requiring removal actions to 197. As of spring 2008, 163 properties had soil removals completed. The remaining 34 properties are anticipated to be completed by the end of 2008.

In December 2005, the EPA Field Environmental Decision Support (FIELDS) Group performed an investigation to see if it could fingerprint the source(s) of the arsenic contamination, and to evaluate spatial relationships with other metals. Twenty-two (22) samples collected in multiple directions from the CMC Heartland Site were analyzed for target analyte list (TAL) metals. From the 22 samples, 10 samples with higher arsenic concentrations were clustered together in a statistically significant "hot spot." The 22 metals were evaluated within and outside the "hot spot" to determine if there was a correlation between arsenic and other metals. No correlation, or "fingerprint". between arsenic and the 22 metals analyzed were identified.

9.2.12 Former CMC Heartland Lite Yard Remediation

From 1996 through 2004, the former CMC Heartland Site (CMC Heartland Lite Yard property) was covered with 1 to 2 feet of crushed asphalt and clean fill to prevent dust from blowing offsite until a permanent cleanup was conducted. Remedial actions were performed at the former CMC Heartland Site in 2004 and involved excavation, stabilization, and off-site disposal of arsenic-impacted soil. Site cleanup standards of 20 mg/kg total arsenic and 525 mg/kg total lead were established for the soils within 4 feet of planned finished development grades to prevent direct-contact exposure to contaminated soil and to allow for commercial development of the property (Peer, 2006).

More than 24,000 yd^3 of contaminated soil was removed from the "hot spot" on the Site and layback (Peer, 2005). The "hot spot" was an area with elevated arsenic concentrations from ground surface to the water table located approximately 24 feet bgs that may have resulted from a previous spill or the area of highest use and/or storage (MDA, 2004a). An additional 18,200 yd^3 of shallow soil was excavated within the upper 4 feet of planned development grade outside the "hot spot." Outside the CMC Heartland Site, 10,200 yd^3 of shallow soil was removed from the northwest Hennepin County Railroad Authority (HCRRA) Corridor and 3,000 yd^3 was removed from the south HCRRA stockpiles. Depending on concentrations, the excavated soils were stabilized and disposed of offsite as industrial waste or disposed of offsite as industrial waste without stabilization. A limited quantity of soil was reused onsite with the approval of the MDA (Peer, 2005).

Clean fill was imported and placed to restore the excavated areas to planned development grades with a permanent 4 foot cover on the contaminated soils left in place; soils greater than 4 feet deep on a property used for commercial purposes are generally considered inaccessible. Although some soils remain onsite, which do not meet the soil cleanup goal of 20 mg/kg for arsenic, these soils are covered by 4 feet of clean fill and crushed bituminous asphalt, restricting access and protecting human health (Peer, 2005).

The removal of "hot spot" soils was estimated to result in a 95 percent reduction in loading to the groundwater. Institutional controls restrict access to residual contaminated soils and groundwater left on the CMC Heartland Site (MDA, 2004a).

9.2.13 Groundwater Investigation

In October 2005, the MDA approved the 2005 Ground Water Monitoring Plan prepared by Peer on behalf of CMC under the AgVIC program. The 2005 Ground Water Monitoring Plan includes 5 years of groundwater quality monitoring, including semi-annual sampling and testing for dissolved arsenic (Peer, 2006). After the 5 years of monitoring, the entire data set will be evaluated and a decision made for future groundwater monitoring, corrective actions, or other alternatives. A groundwater arsenic plume extending approximately 1,800 feet west-southwest of the former CMC Heartland Site has been monitored since 1996.

The Site geology at the CMC Heartland Site consists of fill and coarse-grained terrace deposits to depths of 18 to 30 feet. The terrace deposits are underlain by 25 to 30 feet of glacial till. Groundwater flow in the unconsolidated deposits is to the west-southwest, estimated at 34 to 81 feet per year. The plume is confined to the terrace and glacial till deposits. The glacial till is underlain by the Platteville limestone and the St. Peter sandstone. Groundwater flow in the St. Peter sandstone is to the northeast, estimated to be 150 feet per year (MDH, 2005).

The highest observed arsenic concentration in groundwater (320,000 micrograms per liter (μg/L) measured in monitoring well MW-9 in 1996) was detected in the overburden near the former "hot spot." Remedial actions were performed in 2004 and the former "hot spot" soils were excavated which was anticipated to result in a reduction of the arsenic loading to the groundwater. As of May 2006, the monitoring well network consists of 14 wells screened in the overburden, one well in the Platteville limestone, and three wells in the St. Peter sandstone. In May 2006, the highest dissolved arsenic concentration was observed in an overburden well downgradient of the former "hot spot" at 16,000 parts per billion (ppb) (Peer, 2006).

There are no private drinking water wells within the Site area. The municipality supplies all drinking water and the Mississippi River is the source of the water. City of Minneapolis, Minnesota Code of Ordinances Chapter 9, Section 1 requires all properties within the city to connect to the municipal water supply. A Special Well Construction Area (SWCA) has been established by the MDH related to the arsenic plume from the former CMC Heartland Site. The SWCA, which took effect on April 1, 2005, applies to the construction, repair, and sealing of all wells and will remain in effect until further notice. This area includes the area bounded by East 26th Street on the north, 26th Avenue on the east, Lake Street on the south, and Bloomington Avenue South on the west, within the city of Minneapolis (MDH, 2005).

9.2.14 Concurrent 2006 Investigation Activities

In 2006, concurrent with the investigation activities described in Section 12.8, EPA performed supplemental investigation activities. These activities included high-density, property specific sampling for arsenic using x-ray fluorescence (XRF) and microscopy and petrography analyses for evaluation of the forms of arsenic present. The goal of the XRF was to evaluate the application of XRF for use in field measurements of arsenic and to evaluate small-scale, property specific variability.

9.3 History of CERCLA Enforcement Activities

The Potentially Responsible Parties (PRPs) which have been identified for this Site are CMC Heartland Partners (CMC), former owner; U.S. Borax (Borax), former operator; Reade Manufacturing (Reade), former operator; and Reactive Metals & Alloy Corporation (REMACOR), potential successor to Reade.

CERCLA Section 104(e) Information Requests were issued to Borax, CMC, Reade and REMACOR on May 26, 2004, in order to obtain information about their various operations at the Lite Yard Site.

General Notice letters were issued to Reade, Borax and CMC on June 21, 2004. Borax declined to conduct a removal action at the Site, asserting that it was not responsible for all or most of the contamination that dispersed beyond the Lite Yard property. CMC stated that they would only conduct the action if Borax also consented to participate. The Reade Manufacturing Company that operated at the Lite Yard is now defunct. The existing Reade and REMACOR companies do not appear to be viable, liable entities.

On September 3, 2004, EPA issued a Unilateral Administrative Order (UAO) to both Borax and CMC. The UAO required Borax and CMC to clean up arsenic contamination at all identified residences with arsenic levels at or above 95 mg/kg. Borax and CMC declined to perform the time-critical removal action under the UAO for the same reasons they provided in response to the general notice letters..

General Notice letters were again issued to both CMC and Borax on January 24, 2005, requesting that CMC Heartland and Borax negotiate to perform a Remedial Investigation/Feasibility Study and additional removal actions. Both companies declined to perform the work.

CMC subsequently filed for bankruptcy on April 28, 2006. EPA filed a proof of claim in that bankruptcy, seeking payment of past and future cleanup costs for this Site.

10.0 Community Involvement

This section of the ROD describes EPA's community involvement activities. The EPA has been actively engaged with the affected community and has strived to advocate and strengthen early and meaningful community participation during EPA's remedial activities at the Site. The provisions of Sections 113(k)(2) (B)(i)-(v) and 117 of CERCLA have been satisfied

10.1 Community Involvement Plan

The Community Involvement Plan (CIP) for the Site was prepared in July 2005. This CIP specifies the community involvement activities that EPA has undertaken, and will continue to undertake, during the remedial activities planned for the Site.

10.2 Community Meetings

The EPA, MDA, and MDH have conducted numerous community meetings during the course of the Removal Action and RI/FS for the Site and provided public notices of these meetings in order to encourage the community's participation. The U.S. EPA has also been invited to several meetings with local groups.

Since 2004, the year EPA's became involved at this Site, the Agency has held twenty-two (22) public meetings and availability sessions. Major meetings have been held at the YWCA located at 2121 East Lake Street, but on many occasions meetings have been held at other locations throughout the affected area in an effort to make the meetings available to all of the local communities impacted by the Site. Meetings have been held at Powderhorn Park, the Franklin Avenue Safety Center, and the Minneapolis Public Library Lake Street Branch. The following is a summary of the most recent meetings.

On Tuesday, December 12, 2006, EPA sponsored an informal meeting at the YWCA on Lake Street to explore the formation of a Community Advisory Group (CAG).

On September 26, 2006, EPA held a public meeting at the Lake Street YWCA to discuss sample results, explain the risk assessment process and get the public's input on the assumptions used in the risk assessment. About 50 people attended the meeting. On October 30, 2007, EPA held a public meeting at the Lake Street YWCA to discuss the results of the risk assessment and to discuss the results of the analyses of the soil sample data. About 50 people attended the meeting. The EPA also held open houses on November 13, 14, and 15, 2007 as a follow up to the October 30 meeting.

10.3 Community Meeting for Proposed Plan

A public comment period on the proposed plan for the ROD for this Site was held from June 2, 2008 to July 1, 2008. In addition, a public meeting was held on June 11, 2008, at the YWCA located at 2121 E. Lake Street, Minneapolis, Minnesota. At this meeting, representatives from EPA answered questions about problems at the Site and the remedial alternatives under consideration. Approximately 40 people attended that meeting. Comments and questions from the public were also accepted at the meeting. Approximately 7 comments were received orally at the public meeting and 9 letters with written comments were received by the Agency. Approximately 15 comments were submitted through email or EPA's web page. Comments received during the public comment period and EPA's responses to those comments are included in the attached responsiveness summary. Copies of all documents pertaining to this Record of Decision (ROD) can be found at the information repositories listed in Section 10.5.

10.4 Fact Sheets/Mailings

Throughout the Removal and Remedial processes, EPA mailed out post cards announcing public meetings, and fact sheets that updated the public on the status of the project. Mailings were sent out to approximately 10,000 homes. Because of the multi-lingual nature of the area the mailings were translated into 4 languages; English, Spanish, Hmong and Somali. Eventually the translations were limited to English and Spanish, but Hmong and Somali were available upon request.

10.5 Local Information Repositories/ Web Page

The EPA has developed and maintained public local information repositories for this Site at the following four locations:

- Green Institute
  2801 21st Ave. S.
  Suite 100
  Minneapolis, MN

- City of Minneapolis
  Police Department
  Attn: Carla Nielson
  1201-B E. Franklin Ave.
  Minneapolis, MN

- Minneapolis Central Library
  300 Nicollet Mall, 2nd Floor
  Minneapolis, MN

- Minneapolis Public Library
  East Lake Branch
  2727 E. Lake St.
  Minneapolis, MN

In addition EPA has developed and maintained a web page for this project. The page can be found at: http://epa.gov/region5/sites/cmcheartland.

11.0 Scope and Role of Response Action

This ROD addresses the first and final remedial action for the Site. The threats posed by this Site to human health and the environment are from arsenic contaminated soil. The main component of the selected remedy includes excavation and off-site disposal of soils contaminated above the cleanup criteria. This remedy builds upon removal actions performed at this Site which addressed arsenic contaminated soils at approximately 197 residential properties. Those properties had arsenic soil levels above the removal action level of 95 mg/kg. The EPA determined that levels above 95 mg/kg presented an immediate health threat to residents. The remedy selected in this ROD will address the long-term health threats posed by residential soils contaminated with arsenic concentrations above 25 mg/kg. The selection of the final cleanup standard is based on the site-specific risk assessment and an evaluation under the nine criteria as required by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP).

The contaminated soil is the source material for arsenic contamination at the Site and is classified as principal threat waste. Principal threat wastes are considered to be those source materials that are highly toxic or highly mobile that generally cannot be reliably contained or would present significant risk to human health or the environment should exposure occur.

12.0 Site Characteristics

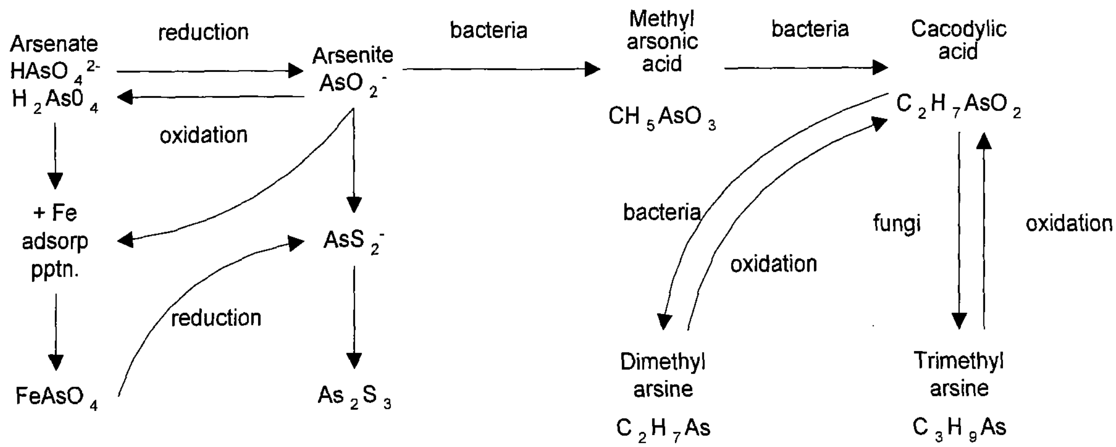
This section of the ROD provides a brief, comprehensive overview of the Site's soils, geology, surface water hydrology, and hydrogeology; the sampling strategy chosen for the Site; the Conceptual Site Model; and the nature and extent of contamination at the Site. Detailed information about the Site's characteristics can be found in the Remedial Investigation (RI) Report.

12.1 Conceptual Site Model

Arsenic was present in the form of arsenic trioxide (As_2O_3) in arsenical pesticides manufactured at Reade Manufacturing from the 1930s to 1960s, and in the ingredients used to make the pesticides. The EPA and MDA believe the arsenical pesticides and ingredients were dispersed into the surrounding residential neighborhood by aerial dispersion while loading the pesticide and raw materials on and off railcars. Dispersion continued to occur to a lesser extent from U.S. Borax's operations in the 1960s. An aerial dispersion model performed by EPA identified a potential boundary of approximately ¾ of a mile from the plant site, within which deposition of the arsenical pesticides and ingredients may have occurred. This is based on historical wind patterns and other meteorlogical information from the Minneapolis/Saint Paul Airport weather station for the years 1984 through 1990. It is also based on particle size and other information on the plant operations. However, the arsenic concentrations detected in the residential properties are not wholly consistent with a conceptual site model based only on air dispersion so it does not appear that all of the elevated arsenic concentrations in soil are solely attributable to the CMC Heartland Site. The occurrence of elevated arsenic in all directions, across much of the investigation area indicates the highest levels of arsenic especially at greater distances from the CMC Heartland Lite Yard property may also partially be the result of a property specific use or application (e.g. fertilizer or pesticide application, use of pressure treated lumber, on-property disposal of coal ash, importation of arsenic containing soil, etc.). Arsenic concentration distributions are also likely affected by the many years since the original release, property use, paving, grading, and other anthropogenic activity, as well as weathering and erosion,

Arsenic is mobile in the environment through different mechanisms. Arsenic can be transferred through oxidation, reduction, adsorption, dissolution, precipitation, and volatilization (Nriagu 1994). A simplified model of the arsenic transfer cycle is provided below.

In soils, arsenic can be subjected to oxidation, reduction, and methylation reactions in either the trivalent or pentavalent state (Nriagu 1994). The chemical transformations of arsenic in soils are illustrated below. Arsenic is most likely no longer present in the soils in the original valence state.



Transformations of arsenic in soils
modified from Arsenic in the Environment Part I: Cycling and Characterization, Nriagu, 1994

Figure 6

Several potential exposure pathways exist at the Site for adult and child residents. There is potential accidental ingestion (via hand-to-mouth activities), dermal contact (through the skin), and inhalation (outdoor air) exposures of arsenic in soil and outdoor air. In addition, there is a potential for intake through ingestion of homegrown garden vegetables grown in impacted soil.

Groundwater was not evaluated as an exposure route for purposes of EPA's investigations. Groundwater is being addressed through MDA's Superfund program. Remedial actions performed at the CMC Heartland Site property (former Reade Manufacturing Site) included excavation of highly contaminated soils to minimize loading to the groundwater. A municipal water supply is used in the area, and private wells have not been identified during previous investigations.

12.2 Topography

Topography within the Site is relatively low relief with elevations ranging from approximately 830 to 860 feet above mean sea level (msl). Topographic elevations generally decrease to the east. Greater relief is present surrounding the pedestrian and bike pathway that is located in the former railroad corridor at the southwest corner of the CMC Heartland Site. Outside the boundaries of the Site, greater relief is also present near rivers and lakes.

The residential areas of the Site consist primarily of residences on grassed lots. Commercial and industrial areas typically have little open ground and are mainly asphalt or concrete and buildings. Schools, parks, and a cemetery comprise the majority of the open areas greater than 1 acre within the Site.

12.3 Meteorology

Climate in the city of Minneapolis is typically characterized with warm humid summers and cold winters. The annual mean temperature is 45.4°F with the highest monthly mean temperature in July (73.2°F) and lowest in January (13.1°F). Average annual rainfall is 29.4 inches with an annual average of 115 days with precipitation of 0.01 inches or more. The prevailing wind is from the northwest with an average wind speed of 10.5 miles per hour. However, windrose data show that in the summer months prevailing winds are from the southeast.

12.4 Surface Water Hydrology

There are no surface water bodies located within the Site area. Although outside the boundaries of the Site, the Mississippi River is the main water body near the Site and Powderhorn Lake is a small lake in Powderhorn Park located outside the southwest boundary. This ROD does not address contamination or risks associated with the Mississippi River or Powderhorn Lake since these surface water bodies are not within the boundaries of the Site.

12.5 Geology

12.5.1 Regional Geology

A number of continental glaciers are believed to have covered Hennepin County and deposited glacial till and outwash collectively referred to as "glacial drift". The thickness of the drift ranges from a few feet in the southeast corner of the county to approximately 450 feet in preglacial valleys. In most places, the drift is 100 to 200 feet deep (U.S. Department of Agriculture (USDA, 2004). Underlying the glacial drift is a thin layer of discontinuous shale and the Platteville Limestone over the St. Peter Sandstone.

12.5.2 Site Geology

A review of boring logs throughout the Site area from the County Well Index (CWI) indicates that the glacial till varies from 50 to 75 feet in thickness and is typically underlain by the Platteville limestone to a depth ranging from 80 to 100 feet bgs. The Glenwood shale is discontinuous and is present in some borings as a thin layer between the Platteville limestone and St. Peter sandstone. In a portion of the Site, the St. Peter sandstone is the uppermost bedrock unit in a north-south trending bedrock valley. The St. Peter sandstone extends to approximately 250 feet bgs and is underlain by the Prairie Du Chien Group Dolomite to a depth of approximately 370 feet bgs.

12.6 Hydrogeology

12.6.1 Regional Hydrogeology

The glacial drift is a heterogeneous mixture of till, outwash, and terrace deposits from several glacial stages. In general, the shale at the base of the Platteville Limestone is the upper confining layer for the St. Peter Sandstone. The confining layer is impermeable glacial drift when this shale is not present. The St. Peter Sandstone is under the water table and artesian conditions in upland areas while it is mainly under water table conditions near river valleys. Recharge of the aquifers occurs mostly from overlying glacial drift. Discharge from the aquifers takes place along the Minnesota and Mississippi Rivers as springs and seeps. Of the aquifers, the glacial drift, the St. Peter Sandstone, the Shakopee and Oneota Dolomites, the Jordan Sandstone, the Franconia and Galesville Sandstones, and the Mount Simon and Hinckley Sandstones yield large amounts of water.

12.6.2 Site Hydrogeology

Monitoring wells at the CMC Heartland Site are screened in the glacial drift, Platteville Limestone, and St. Peter Sandstone. Groundwater monitoring has indicated that arsenic impacts in groundwater appear to be limited to the glacial drift. Groundwater flow in the glacial drift is to the west-southwest, estimated at 34 to 81 feet per year (MDH, 2005). Groundwater flow in the St. Peter Sandstone is to the northeast, estimated to be 150 feet per year, and appears to be controlled by the Mississippi River (MDH, 2005).

12.7 Sampling Strategy

The sampling strategy for the Site addressed these key issues in order to determine the nature and extent of contamination at the Site:

- Define the nature and extent of contamination in the residential areas surrounding the former plant site;
- Collect surface soil samples from the front and back yards (or other areas potentially used by the resident) for total arsenic analysis;
- Identify properties where arsenic concentrations create an immediate health risk (>95 parts per million);
- Define the horizontal extent of arsenic in surface soil;
- Differentiate sources of arsenic within the affected area; and,
- Characterize the vertical distribution of total arsenic in soils within the limits of the EPA air dispersion model for the Site.

Because of the ubiquitous nature of arsenic in the environment (both naturally occurring and anthropogenic), differentiating arsenic contamination from the facility from other sources was problematic. Several sampling strategies and analytical techniques were evaluated. Fingerprinting the materials was determined to be ineffectual because the arsenic trioxide used in the pesticide manufactured at the Site was also used in other products that may have been commonly used in the area. Also, aging and environmental exposure of the arsenic over 50 plus years since the release would have diminished any type of fingerprint that might have existed.

Instead, EPA based the sampling design on an air dispersion model. Numerous assumptions were necessary for the creation of the aerial dispersion model. Using information on how the facility operated and wind-rose data for the Minneapolis area, EPA ran the Industrial Source Complex 3 (ISC3) model. The model results predicted that air dispersion from the CMC Heartland Site would result in arsenic deposition of arsenic concentrations greater than 10 parts per million on properties within the boundary identified in Figure 3. To evaluate the conceptual site model of air dispersion from the CMC Heartland Site, the RI was developed to sample 100 percent of the residential properties within the modeled air dispersion boundary. The modeled boundary was modified slightly to include sampling of entire blocks as shown in Figure 3. This boundary defined the extent of the Site for the purposes of the sampling effort, and ultimately, based on the data analyses discussed below, this boundary defines the extent of the Site for purposes of the ROD.

12.8 Nature and Extent of Soil Contamination

This section summarizes the nature and extent of contamination identified in soils at the Site. The nature and extent is based on results of surface soil sampling performed at the Site from 2001 through 2006 and subsurface soil sampling results from the August 2006 sampling event, along with information on subsurface conditions from the removal actions performed to date. Based on previous sampling efforts, and the Site history, arsenic was identified as the only contaminant of concern at this Site. Therefore, arsenic results were evaluated to determine the extent of the contamination and identify properties and areas where arsenic concentrations create an immediate health risk (greater than 95 mg/kg). Groundwater was characterized in previous studies under State authorities and a current groundwater source remedy and monitoring program is in place. Groundwater is not discussed in depth in this section.

The results from the surface and subsurface soil investigations within the Site indicate that arsenic in the soil is present at varying concentrations at properties across the area (see Figure 7). Background concentrations were identified as ranging up to 16 milligrams per kilogram (mg/kg) and arsenic soil concentrations within the Site area range from background concentrations up to 2,880 mg/kg. The vertical extent of arsenic concentrations above background appears to be no greater than 3 feet bgs.

Of the 3,578 properties sampled, 197 residential properties were found to have concentrations above the removal action level of 95 mg/kg, and are scattered throughout the Site investigation area. The 197 properties with results over 95 mg/kg have been, and continue to be addressed through EPA's removal authorities. The removal actions are anticipated to be complete by the end of 2008. All sample results from the schools and parks were within background levels.

12.8.1 Contamination Source

As previously described the conceptual Site model for the source of the arsenic contamination within the Site is the CMC Heartland Site. Arsenic-based pesticides and herbicides were blended, stored, and distributed at the CMC Heartland Site from 1938 through 1963. These products contained arsenic trioxide, which was delivered to the Site by rail, and unloaded from rail cars on uncovered conveyor belts. Arsenic trioxide is a fine powder that would be susceptible to airborne dispersal, the transport mechanism evaluated from the CMC Heartland Site. Dispersion of arsenic-contaminated material continued to occur to a lesser extent during U.S. Borax's operations from 1963 to 1968.

The MnDOT identified arsenic impacts in the area in 1994 during reconstruction of Hiawatha Avenue near the CMC Heartland Site. Subsequent investigations at the CMC Heartland Site property detected arsenic in surface soil at concentrations up to 5,000 mg/kg (MDA, 2004a). Other locations evaluated in the RI as potential sources of arsenic in the area included the railroad and the City of Minneapolis incinerator. The railroad corridor and incinerator which are located in the SMRSCS investigation area near the CMC Heartland Site, were ruled out as primary sources of the arsenic contamination.

Arsenic trioxide was delivered by rail to the CMC Heartland Site during the blending of arsenic-based pesticides and herbicides, so in 2000, HCRRA sampled the railroad corridor near the southwest corner of the CMC Heartland Site. Arsenic was detected and concentrations decreased with distance from the CMC Heartland Site from the east to west. During investigations in 2003, arsenic was detected in the railroad corridor at concentrations above the state Recreational Soil Reference Value at 25 of the 40 sample locations. The maximum arsenic concentration detected was 85 mg/kg. These results were orders of magnitude less than concentrations detected at the CMC Heartland Site and limited to the area nearest the CMC Heartland Site. The railroad corridor was therefore not further evaluated as the source of arsenic in the conceptual site model.

In July 2004, EPA collected two ash samples from the City of Minneapolis incinerator facility. Sample results for the two samples were 66 mg/kg and 110 mg/kg. These concentrations were orders of magnitude less than concentrations detected at the CMC Heartland Site and the incinerator was therefore not further evaluated as the source of arsenic in the conceptual site model. This further supported the conclusion that the operations at the former plant site were the source of the area-wide arsenic contamination.

12.8.2 Surface Soil

Soil sampling was conducted from 2001 to 2006 in the Site area to evaluate potential arsenic contamination in the residential neighborhoods surrounding the CMC Heartland Site. The sampling activities were performed in 2006 to determine arsenic concentrations at 100 percent of the residential properties within the SMRSCS for evaluation of arsenic distribution and identification of properties and areas where arsenic concentrations create an immediate health risk (greater than 95 mg/kg).

The surface soil samples collected in 2001 through 2005 had been concentrated primarily in the area to the northwest of the CMC Heartland Site, as the prevailing winds in this area were from the southeast to the northwest in the summer months; the months that the facility was active. The 2006 surface soil investigation focused on sampling in an approximate ¾-mile radius in all directions from the CMC Heartland Site at residential properties, schools, and parks not previously sampled, in order to characterize the horizontal distribution of arsenic in soils within the limits of the EPA air dispersion model for the Site. Figures 4 and 5 provide the locations of the surface soil arsenic sample locations and results used in this ROD.

Arsenic surface soil sample results at the Site ranged from 0.11 mg/kg to 2,880 mg/kg. Out of 3,578 properties sampled during the 2001 to 2006 investigations, a total of 197 properties were identified with arsenic results greater than 95 mg/kg. An additional 135 properties within the Site were not sampled between 2001 and 2006 due to property owner access refusal. Table 1 provides a summary of the maximum arsenic concentration detected per property from the combined 2001 to 2006 data set.

TABLE 1
Arsenic Distribution By Property In Surface Soils
South Minneapolis Residential Soil Contamination Site — Minneapolis, Minnesota

	<10 mg/kg	≥10 and <20 mg/kg	≥20 and <30 mg/kg	≥30 and <60 mg/kg	≥60 and <95 mg/kg	≥95 mg/kg
Number of Properties	2,600	302	127	232	120	197

12.8.2.1 Background Evaluation

To evaluate background concentrations, a statistical analysis was performed using 7,519 surface soil sample results collected between 2001 and 2006.

Probability plots graph the measured concentrations against those expected if the data (or the transformed data) are normally distributed. As a result, the data points tend to form straight lines when the data resemble a normal distribution (or when the log-transformed results resemble a lognormal distribution). The probability plots indicate that the Site arsenic data are neither normally nor log normally distributed, but suggest the existence of two distinct and different distributions. The distributions consist of "background" levels and a population that is distinctly different, limited to concentrations in excess of approximately 16 to 17 mg/kg.

As a result of the statistical analyses, the background range identified for the Site includes the following: less than 10 mg/kg represents background; greater than 10 mg/kg and less than 17 mg/kg represents mixed results background and contaminated soils and so may or may not show Site-related impacts; and equal to or greater than 17 mg/kg soils are affected by Site-related arsenic contamination. For the purpose of this ROD, background concentrations will be considered 16 mg/kg and less.

TABLE 2
Site Data Subset Summary Statistics
South Minneapolis Residential Soil Contamination Site — Minneapolis, Minnesota

Arsenic Concentration Range	N	Range (mg/kg)	Median (mg/kg)	Mean (mg/kg)	Standard Deviation	95% Upper Confidence Limit	Coefficient of Variation
Likely Uncontaminated	5929	0.11-10	4.90	5.07	1.84	5.02, 5.11	0.363
Mixed Population	431	10.06 - 17	12.0	12.67	1.94	12.48, 12.85	0.153
Exceeds Background	1159	17.1 - 2880	45.9	86.6	150.0	78.0, 95.3	1.731

12.8.3 Subsurface Soil

Information regarding arsenic concentrations in the subsurface soils has been obtained in two ways. First, subsurface soil sampling was conducted in August 2006 at select residential properties. The subsurface soil sampling was performed to characterize the vertical distribution of arsenic in soils within the limits of the Site. The vertical distribution was used to identify whether arsenic impacts were limited to surface soils as expected with air dispersion and to evaluate vertical migration of arsenic and potential leaching from the soils. Second, subsurface soil samples have been taken from the base of the excavations at properties where soils removals have been performed (134 properties). The purpose of these samples has been to characterize the arsenic concentrations remaining at the base of the excavations. These post-excavation samples were not intended to fully characterize the arsenic concentrations deeper than 12 to 18 inches below the ground surface. However, they provide some information in regards to concentration gradients within the first foot of soil at properties with very high pre-excavation surface soil arsenic concentrations.

In the August 2006 sampling effort, a total of 120 subsurface soil samples (excluding quality control samples) were collected from 20 soil borings. The samples were collected from 1-foot intervals from ground surface to a depth of 5 feet, and one sample was collected at a depth of 10 feet.

The associated surface soil (0- to 3-inch) sample results ranged from a concentration of 2.3 mg/kg up to 293 mg/kg. Arsenic concentrations found in the subsurface ranged from 0.48 mg/kg to 224 mg/kg. Arsenic at concentrations above background was limited to the upper 2 to 3 feet bgs. Of the 20 total soil borings, 4 borings had arsenic concentrations above the background concentration to a maximum depth of 2 feet bgs. One boring location had arsenic concentrations above background down to a maximum depth of 3 feet bgs.

The results from the 2006 subsurface soil investigation indicate that the arsenic in the soil above background is located in most cases within the upper 2 feet of the soils. This indicates that the mobility of the arsenic in the soils is limited.

EPA has collected and analyzed approximately 256 post-excavation samples from the 163 properties where soil removals have taken place. Eleven sample results showed an increase from the surface to the base of the excavation, however the remaining 245 showed a decrease in concentration with an average six-fold decrease in arsenic concentration. Thirty-seven post-excavation samples showed arsenic concentrations above 95 mg/kg at the base of the excavation. However, only four of those locations had higher arsenic concentrations at the base of the excavation than at the surface. This data adds support to the conclusions of the 2006 subsurface soil investigation that the Site related arsenic contamination should remain in the upper two feet of the Site soils, and generally, subsurface soil arsenic concentrations above the acute risk based concentration of 95 mg/kg should be limited to those properties with surface soil arsenic concentrations above 95 mg/kg.

12.8.4 Affected Areas

This RI focused on the residential properties, parks, and schools within the Site area. Arsenic above background concentrations is found throughout the Site, and affected areas include yards, lawns, gardens, and other unpaved surfaces of residential properties. Elevated arsenic above background concentrations was not detected at any schools or parks. The properties with elevated arsenic were located across most of the Site. To evaluate the affected areas with the conceptual site model of aerial dispersion from the CMC Heartland Site, statistical analyses were performed on the data set for trends in direction and distance of affected areas from the CMC Heartland Site and age of the properties relative to operations at the CMC Heartland Site.

12.8.4.1 Directionality

Arsenic concentrations were evaluated in different directions and distances from the CMC Heartland Site in order to determine if the contaminant distribution was consistent with the prevailing winds relative to the facility. Statistical analyses showed that evaluating arsenic concentrations as both a function of distance and direction from the Site were inconclusive overall, with arsenic concentrations exceeding 95 mg/kg located in all directions and at virtually all distances. These results are likely the result of the length of time since the original release as well as the anthropogenic activity in area.

Directional plots of arsenic at different concentration levels showed a significant, but weak correlation between distance in a specific direction and concentration for five directions. Arsenic soil concentrations appeared to be increasing with distance to the northeast and south, while decreasing to the northwest, west, and southeast. The decreasing trends are consistent with aerial dispersion from the CMC Heartland Site but present only in a few directions from the CMC Heartland Site and the overall variability in the data limits the predictability of these relationships. The likelihood of intervening acts at many properties in the investigation area make it very hard to evaluate statistical significance. Some of those acts (e.g., pesticide application, importing fill) could increase surface arsenic levels, while others (tilling, sodding, construction) could decrease surface arsenic levels. In addition, these decreasing trends are strongest at lower arsenic concentrations (background concentrations) and do not fully explain the higher concentrations. The Site conceptual model, based on contamination due to aerial dispersion only, does not fully account for the relatively high concentrations of arsenic in all directions and distances.

12.8.4.2 Relationships with Housing Age

Pesticide formulation activities by Reade Manufacturing occurred at the CMC Heartland Site from 1938 through 1963 and is considered the period that would be primarily responsible for airborne dispersion from the plant site. Property specific activities since that time may have affected the arsenic concentrations in the surface soils at residential properties, specifically new home construction. Therefore, residential property age was evaluated with surface soil arsenic concentrations to determine if properties with homes constructed prior to or during pesticide formulation activities at the CMC Heartland Site have greater surface soil arsenic concentrations than residential properties constructed after 1963 (EPA, 2007b). Because activity at the Site decreased significantly after 1963, dispersion after that point may likely have been limited only to the residences in close proximity to the Lite Yard.

Home construction dates and spatial data were obtained from Hennepin County, with data current through August 2005. For this evaluation, residential properties evaluated considered all apartments, condominiums, duplexes, townhouses, and single-family residences. Because multiple samples had been collected from each property (i.e., front yard, back yard) only the maximum arsenic concentration per residential property was used (EPA, 2007b).

A scatter-plot of maximum arsenic concentration versus home age indicates a gradual increase in concentrations with an increase in the age of the property as shown in the Figure 8 below.

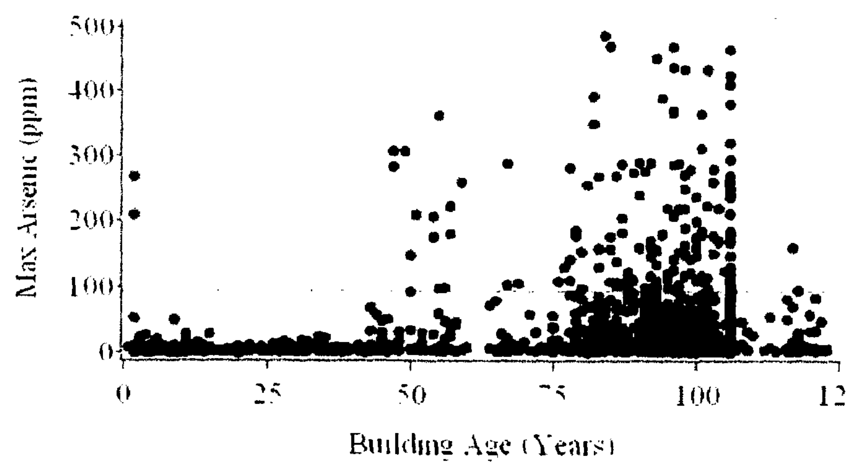


Figure 8

Further investigation of this relationship indicated that homes constructed prior to 1963 had a proportionally greater number of arsenic concentrations above 95 mg/kg than homes constructed after 1963 (EPA, 2007b). Approximately 9 properties with homes constructed post-1963, have arsenic concentrations above 25 mg/kg. Approximately 17 properties with homes constructed post-1963 have arsenic concentrations above 16 mg/kg. The ages of homes are randomly distributed throughout the study area, as are the arsenic concentrations. This analysis would seem to indicate that whatever process caused the high arsenic concentrations is no longer occurring to the same extent.

13.0 Current and Potential Future Land and Water Uses

13.1 Land Uses

The area encompassed by the Site includes residential, commercial, industrial, and municipal properties. The Site is largely residential, with much of the housing built from the early 1900s through 1930s. The former plant site property has been redeveloped as a commercial warehouse facility and includes a family clinic. Land use in the Site area has been fairly consistent over the years, with residential properties remaining residential. The land use is not anticipated to significantly change. The City of Minneapolis does have an enforced zoning program.

13.2 Ground-Water and Surface Water Uses

There are no private drinking water wells within the Site area. The municipality supplies all drinking water and the Mississippi River is the source of the water. City of Minneapolis, Minnesota Code of Ordinances Chapter 9, Section 1 requires all properties within the city to connect to the municipal water supply. A Special Well Construction Area (SWCA) has been established by the MDH related to the arsenic plume from the former CMC Heartland Site. The SWCA, which took effect on April 1, 2005, applies to the construction, repair, and sealing of all wells and will remain in effect until further notice. This area includes the area bounded by East 26th Street on the north, 26th Avenue on the east, Lake Street on the south, and Bloomington Avenue South on the west, within the city of Minneapolis (MDH, 2005).

The SWCA requires that: 1) Permit applications and plans for water-supply wells and monitoring wells must be submitted to the City of Minneapolis, which will then consult with MDH. Notifications and plans for dewatering wells must be submitted to the MDH, which will then consult with the city of Minneapolis. The SWCA requires that both the city of Minneapolis and the MDH will consult with the MDA; 2) Construction of a new well, or modification of the depth of an existing well, may not take place until plans have been reviewed and approved; 3) Special well construction and/or monitoring requirements may be imposed depending on well location and use in order to protect public health and groundwater quality and to prevent contaminant migration; 4) Water-supply wells will not be approved for completion in the terrace deposits, glacial drift, Platteville limestone, or St. Peter sandstone in the SWCA for any consumptive uses or other uses involving human contact, including drinking, cooking, bathing, manufacturing or processing of food, drink, or pharmaceuticals, or to supply water to plumbing fixtures accessible to humans; 5) For all water-supply wells (including remedial wells), dewatering wells, and monitoring wells, a sampling plan and schedule to monitor arsenic concentrations must be submitted and approved prior to start of well construction. Approvals must be obtained from the appropriate local and/or state agencies for any discharge of water from these wells; 6) Well construction or reconstruction will not be approved if the MDH, in consultation with the MDA, concludes that the proposed construction or reconstruction may interfere with remediation efforts, cause further spread of contamination, or result in human exposure to contaminants at concentrations exceeding U.S.EPA Maximum Contaminant Levels (MCLs) or Minnesota Health Risk Limits (HRLs); 7) The permanent sealing of a well completed in bedrock may not take place until after the MDH and the city of Minneapolis (water-supply wells and monitoring wells) have reviewed and approved the plans for the proposed sealing. In addition to the required notification or permit, the plan must include the following information: street address; original well depth; current well depth; casing type(s), diameter(s), depth(s); methods for identifying and sealing any open annular space; methods for identifying and removing any obstructions; and grout materials and methods.

14.0 Summary of Site Risks

The baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this Site. A Baseline Human Health Risk Assessment (BHHRA) for the Site was completed in September 2007. A Screening Level Ecological Risk Assessment (SLERA) for the Site was completed in November 2007.

14.1 Summary of Baseline Human Health Risk Assessment

The South Minneapolis Residential Soil Contamination Site BHHRA followed a four-step process:

a. Hazard identification (Identification of COCs),
b. Exposure assessment,
c. Toxicity assessment, and
d. Risk characterization.

The EPA used an exposure point concentration (EPC) for each COC and the reasonable maximum exposure (RME) scenario and central tendency exposure (CTE) to estimate risk. The term "RME" refers to a type of high-end exposure estimated by using default values, and is typically used as the basis for action at a Superfund site. The term "CTE" refers to an average exposure that is more likely to occur at a site. Reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were estimated for residents and construction workers.

To assess potential exposures to arsenic at the Site, potential intakes were quantified. A soil EPC based on background (16 mg/kg) was first evaluated. Potential risks associated with three additional soil EPCs were quantified:

- 95 mg/kg (the removal action level)
- 500 mg/kg (a value close to the mean concentration of residential yards currently above the removal action level)
- 1,500 mg/kg (the approximate maximum detected concentration at homes that have not yet been remediated)

The baseline HHRA provided an evaluation of the carcinogenic and non-carcinogenic risks associated with current and future exposures by residents (adult and child), residents (adult and child) with vegetable gardens, and construction workers. The potential exposure routes that were quantified included accidental ingestion (through hand-to-mouth activities), dermal contact (through the skin), and inhalation of arsenic in soil and outdoor air. In addition, potential intakes for residents were quantified for the ingestion of homegrown garden vegetables grown in arsenic-impacted soil. The HHRA identified that arsenic is present in the SMRSCS at concentrations that result in an estimated risk above EPA's target risk levels.

The HHRA calculated risk-based PRGs for arsenic for residents with and without vegetable gardens and for construction workers. The calculations indicate that arsenic concentrations of 25 mg/kg (or less) are protective of persons residing in the area for up to 50 years with vegetable gardens, and arsenic concentrations of 261 mg/kg (or less) are protective of construction workers.

The HHRA estimated that most of the risk is from incidental ingestion of soil and dust (approximately 70 percent) and eating garden vegetables (approximately 25 percent). A small proportion of estimated risk (approximately 4 percent) is from dermal contact with soil, and a very small relative proportion of potential risk (less than 0.05 percent) is from inhalation of dusts. The estimated risks likely exaggerate the estimates of potential risk due to uncertainties and very conservative assumptions required throughout the HHRA process.

14.1.1 Chemical of Potential Concern Selection Process

Chemicals of potential concern (COPCs) are contaminants that potentially present the greatest human health concerns (i.e., those present in the highest concentrations, with the widest distribution over the Site, or that exhibit the highest mobility or the highest toxicity). The purpose of identifying COPCs is to focus the risk assessment on the most important contaminants found at a site. Table 3 summarizes the data pertaining to the selection of the COPC for this Site. The only COPC at the SMRSCS is arsenic. Arsenic trioxide is the chemical that was used in the pesticide formulation at the former plant site and is the material that, due to its physical characteristics and handling, would have become entrained in the air, deposited on the facility soils, and migrated onto surrounding area soils. There is no information, from on-site sampling or historical information, indicating that other chemicals were used at the facility that would have migrated off-site, impacting the surrounding neighborhood. Arsenic was the only chemical sampled for, and analyzed during the RI. Arsenic is the only contaminant of concern (COC) for the Site.

14.1.2 Data Used in the HHRA

- Soil samples were collected during the RI field activities, and during post-excavation sampling at remediated properties. For each property sampled, a five-point composite soil sample was collected from the yard from depth intervals within 0-18 inches. If more than one sizable yard was present on a property (e.g., front yard, side yard, and/or backyard), one five-point composite sample was collected from each yard. The available dataset consists of 7,521 soil samples that were collected through the end of 2007 (including original samples and post-remediation samples) for arsenic analysis. All data were validated in accordance with EPA's Quality Assurance/Quality Control (QA/QC) process.

As mentioned above the data set consists of 7,521 soil samples, representing 3,578 properties. Arsenic was detected in all samples. The concentrations ranged from 0.11 mg/kg up to 2,880 mg/kg. Probability plots of the Site arsenic data were performed to analyze background concentrations ranges for arsenic. As discussed above in Section 12.7.2.1, the analysis determined that background concentrations within the Site area can range as high as 16 mg/kg. Tables 2 and 3 summarize the soil sampling data.

14.1.3 Potential Receptors and Exposure Pathways and Exposures Quantified

A BHHRA conceptual site model (CSM) was prepared for the Site, presenting the potential chemical exposure media, exposure points, receptors (current and future), and exposure routes. The CSM is provided in Table 4 and is discussed further above in Section 12.1. Various realistic potential receptors were identified at the Site based on the CSM and were addressed in the BHHRA and are also summarized in Table 4. Exposure point concentrations (EPCs) were calculated for the COPCs in each data grouping and used in estimating potential intakes and risks for the following receptors:

Current/Future Residential Adult and Child— For both adult and child residents, potential accidental ingestion (via hand-to-mouth activities), dermal contact (through the skin), and inhalation (outdoor air) exposures of arsenic in soil and outdoor air were quantified. In addition, potential intakes were quantified for ingestion of homegrown garden vegetables based on modeled concentrations in vegetables grown in arsenic contaminated soil. The pathways include resident child, daycare child, and recreational child.

Current/Future Construction Worker—Workers engaged in short-term remodeling or construction activities at residential properties to soil depths of 5 feet.

14.1.3.1 Exposure Point Concentrations

To assess potential exposures to arsenic at the Site, potential intakes were quantified. A soil EPC based on background (16 mg/kg) was first evaluated. Potential risks associated with three additional soil EPCs were quantified:

- 95 mg/kg (the removal action level);
- 500 mg/kg (a value close to the mean concentration of residential yards currently above the removal action level); and,
- 1,500 mg/kg (the approximate maximum detected concentration at homes that have not yet been remediated)

Multiple soil EPCs are not presented in the risk calculations since risk estimates are directly proportional to EPCs, and when risk estimates are calculated for one soil EPC, the estimated risks associated with other EPCs can be calculated by applying the ratio of the original EPC to the associated risk estimate.

14.1.3.2 Exposure Factors

Reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were estimated for residents and construction workers. The exposure factors used in the RME and CTE intake calculations are presented in Tables 5.1 through 5.9.

Detailed calculations for the derivation of body weight, skin surface area, and dermal absorption factors used in the intake calculations are provided in Tables 6.1 and 6.2. Exposure parameters used in this risk analysis are identified in Tables 5.1 through 5.9. A few of the key parameters used in the HHRA are listed below:

- Adult and child residents and construction workers were evaluated as potential receptors in the area;
- Residents were assumed to be exposed to arsenic in soil or dust through incidental ingestion for 350 days/year; construction workers were assumed to be exposed to soil for 90 days/year;
- Residents were assumed to be exposed to arsenic adhered to soil particulates in ambient air and to dermally contact soil for 185 days/year (the number of days where the soil is not snow-covered and it is not raining in Minneapolis);
- Residents were assumed to grow vegetables in their home gardens. The homegrown garden vegetables were categorized into two groups: aboveground vegetables (e.g., eggplants, tomatoes, and leafy vegetables) and belowground vegetables (e.g., carrots and potatoes). Over an assumed 4-month growing period during the year, residents are assumed to consume aboveground vegetables for 90 days and belowground vegetables for 60 days; and,
- The HHRA assumed residents were exposed to arsenic in soil/dust for 50 years (to evaluate a high-end exposure) and 15 years (to evaluate an average exposure); 10-year exposures were assumed for construction workers (to evaluate a high-end exposure) and 1 year (to evaluate an average exposure).

14.1.4 Toxicity Assessment

The following hierarchy of sources was used to obtain toxicity data for arsenic in soil at the Site:

- EPA Integrated Risk Information System
- Provisional Peer-Reviewed Toxicity Values (EPA Region 9, 2004)
- Health Effects Assessment Summary Tables (EPA, 1997a)

Noncancer toxicity values used in the HHRA are presented in Tables 7.1 through 7.2 and cancer toxicity values are presented in Tables 8.1 and 8.2.

IRIS provides a database of human health effects that may result from exposure to arsenic. Arsenic is a human carcinogen that can be inhaled, ingested, or absorbed. Studies have shown that arsenic intake can be associated with certain types of cancer such as lung, liver, kidney, bladder, and skin. The RfD is an estimate of a daily exposure to people that will not cause appreciable risks during a lifetime. The RfD for arsenic is based on human chronic oral exposure studies and a safety factor of 3. The RfD is based on the Lowest Observed Adverse Effect Level (LOAEL) and the critical health effects are hyperpigmentation, keratosis and possible vascular complications.

Toxicity values provided by EPA typically reflect doses to study subjects via ingestion or inhalation exposures. However, dermal exposures are expressed as absorbed doses. Therefore, the absorbed-dose intakes for dermal exposure must be used with absorbed-dose toxicity values. The absorbed-dose toxicity values were calculated by applying oral absorption factors to administered-dose toxicity values.

14.1.5 Risk Characterization

For carcinogens, risks are generally expressed as the increased incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk (ELCR) is calculated from the following equation:

Risk = CDI x SF

where: risk = a unitless probability (e.g., 2 x 10_{-5}) of an individual's developing cancer
CDI = chronic daily intake (mg/kg-day)
SF = slope factor, expressed as (mg/kg-day)-1.

These risks are probabilities that usually are expressed in scientific notation (e.g.,$1x10^{-6}$). An excess lifetime cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of Site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. The EPA's generally acceptable risk range for Site-related exposures is $1x10^{-4}$ to $1x10^{-6}$.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ <1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that Site-related exposures may present a risk to human health. The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where: CDI = Chronic daily intake
RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term). SF = slope factor, expressed as (mg/kg-day)-1.

Potential excess lifetime cancer risks (ELCRs) and hazard indexes (HIs) were calculated using RME and CTE assumptions for identified receptors and exposure pathways. The calculated ELCRs and HIs are presented in Tables 7.1 through 7.3 and summarized in Tables 9.1 through 9.3 and Tables 10.1 through 10.3 of HHRA Appendix A. The potential risks calculated for each receptor/exposure pathway combination are presented in the Table 9 of this ROD.

The HHRA estimated that most of the risk is from incidental ingestion of soil and dust (approximately 70 percent) and eating garden vegetables (approximately 25 percent). A small proportion of estimated risk (approximately 4 percent) is from dermal contact with soil, and a very small relative proportion of potential risk (<0.05 percent) is from inhalation of dusts.

TABLE 9

RME and CTE Scenario Risk Estimates For Various Arsenic Concentrations

South Minneapolis Residential Soil Contamination Site — Minneapolis, Minnesota

Lifetime Cancer Risk Estimates	RME Arsenic Concentration (mg/kg)					CTE Arsenic Concentration (mg/kg)				
	16	25	95	500	1500	16	25	95	500	1500
Aggregate Child/Adult Resident (with garden vegetable consumption)	6×10^{-5}	1×10^{-4}	4×10^{-4}	2×10^{-3}	6×10^{-3}	--	--	--	--	--
Aggregate Child/Adult Resident (without garden vegetable consumption)	5×10^{-5}	8×10^{-5}	3×10^{-4}	1×10^{-3}	4×10^{-3}	1×10^{-5}	2×10^{-5}	8×10^{-5}	4×10^{-4}	1×10^{-3}
Construction Worker	4×10^{-6}	6×10^{-6}	2×10^{-5}	1×10^{-4}	4×10^{-4}	2×10^{-7}	3×10^{-7}	1×10^{-6}	7×10^{-6}	2×10^{-5}
Hazard Index Estimates	**RME Arsenic Concentration (mg/kg)**					**CTE Arsenic Concentration (mg/kg)**				
	16	25	95	500	1500	16	25	95	500	1500
Infant/Child Resident (with garden vegetable consumption)	0.6	1	4	20	60	--	--	--	--	--
Infant/Child Resident (without garden vegetable consumption)	0.6	1	3	17	52	0.3	0.5	2	8	25
Construction Worker	0.06	.01	0.4	2	6	0.1	0.2	0.8	4	13

Notes:

Lifetime cancer risks were calculated for aggregate adult/child residents since lifetime cancer risks are averaged over a lifetime.

HIs were calculated for aggregate infant/child residents only since HIs calculated for this receptor are more conservative than the HI for an adult resident.

Highlighted values exceed the target range.

14.1.5.1 Current / Future Residential Adult and Child (With Garden Vegetable Consumption)

Potential ingestion, dermal contact, and inhalation exposures to arsenic in surface soil were quantified for adult and child residents in a residential setting. Under the RME scenario, the consumption of vegetables from the garden was included in the calculations. ELCRs and HIs were not calculated for the CTE scenario which assumed that vegetables will be grown in community gardens with background arsenic concentrations or the vegetables would be purchased. Therefore, this pathway is incomplete. Under the RME scenarios using EPCs ranging from 16 mg/kg (background) up to 1500 mg/kg (approximate maximum detection), scenarios have estimated risks above the target range. The ELCR exceeds 1×10^{-4} for EPCs of 95 mg/kg, 500 mg/kg and 1500 mg/kg for the RME scenario. The estimated HI exceeds 1 with EPCs of 95 mg/kg, 500 mg/kg and 1500 mg/kg under the RME scenario. Therefore, arsenic was identified as a chemical of concern (COC) for adult and child residents at residential properties with a garden.

14.1.5.2 Current / Future Residential Adult and Child (Without Garden Vegetable Consumption)

Potential ingestion, dermal contact, and inhalation exposures to arsenic in surface soil were quantified for adult and child residents in a residential setting. Under the RME and CTE scenarios using EPCs ranging from 16 mg/kg (background) up to 1,500 mg/kg (approximate maximum detection), scenarios have estimated risks above the target range. The ELCR exceeds 1×10^{-4} for EPCs of 95 mg/kg, 500 mg/kg and 1,500 mg/kg for the RME scenario and 500 mg/kg and 1,500 mg/kg for the CTE scenario. The estimated HI exceeds 1 with EPCs of 95 mg/kg, 500 mg/kg and 1500 mg/kg under both the RME and CTE scenarios. Therefore, arsenic was identified as a COC for adult and child residents at residential properties.

14.1.5.3 Current / Future Construction Worker

Potential ingestion, dermal contact, and inhalation exposures to arsenic in soil to depths of 5 feet were quantified for a construction worker in the SMRSCS. Under the RME and CTE scenarios using EPCs ranging from 16 mg/kg (background) up to 1,500 mg/kg (approximate maximum detection), scenarios have estimated risks above the target range. The ELCR exceeds 1×10^{-4} for EPCs of 1,500 mg/kg for the RME scenario. The estimated HI exceeds 1 with EPCs of 500 mg/kg and 1,500 mg/kg under both the RME and CTE scenarios. Therefore, arsenic was identified as a COC for construction workers at residential properties, and PRGs for arsenic will be identified in the FS.

14.1.6 Uncertainties

The calculated excess lifetime cancer risks (ELCRs) and hazard indices for RME scenarios are estimates of potential upper-bound risks that are useful in regulatory decision-making. It is improper to consider the risk estimates to be representative of actual risk to potentially exposed individuals because risks were estimated by making numerous conservative assumptions (that is, assumptions that overestimate potential exposure and potential risk).

Various uncertainties are associated with the risk estimates. Some exposure and toxicity assumptions have greater amounts of scientific data supporting them than others. Uncertainty is introduced into the risk assessment process every time an assumption is made. In regulatory risk assessment, the methodology dictates that assumptions err on the side of overestimating potential exposure and risk. The effect of using numerous assumptions, each of which overestimates potential risk, is to exaggerate estimates of potential risk. Such estimates do provide a very conservative estimate that likely overstates the potential health impacts associated with a site.

Unsieved soil samples were analyzed for total arsenic although arsenic concentrations may vary by particle size. If higher arsenic concentrations are associated with smaller grain size (e.g., the particle size [less than 250 microns] that adheres to people's hands and is ingested), then actual EPCs for receptors will be higher than the concentrations measured for unsieved soil samples. Consequently, the use of unsieved soil samples may result in an slight underestimate of exposure.

In this HHRA, the specific form of arsenic was not known. In surface soil, inorganic arsenic almost always predominates; therefore, for this HHRA, the arsenic was assumed to be in the form of inorganic arsenic. Inorganic arsenic is more toxic than organic arsenic; the use of toxicity values for inorganic arsenic is thereby expected to result in an overestimate of exposure.

Some of the EPA default exposure factor values (e.g., exposure duration) were increased based on input received during the September 26, 2006 public meeting. In addition, the relative bioavailability of arsenic in soil was assumed to be 90 percent due to the lack of site-specific bioavailability information; the risk estimates presented in the HHRA are based on 90 percent bioavailability. These assumptions would both also result in an overestimate of exposure.

14.2 Summary of Screening Level Ecological Risk Assessment

A screening level ecological risk assessment (SLERA) was prepared for the Site in accordance with the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (EPA, 1997b). The following sections summarize the results of the SLERA that was completed in November 2007 (CH2M Hill, 2007b). In summary, no population level risks are expected.

14.2.1 Preliminary Problem Formulation

The Site investigation area includes approximately 1,480 acres of residential, industrial, commercial, and municipal properties. It is estimated that approximately 300 of the 1,480 acres would be considered habitat for evaluation in this ERA. The majority of the habitat in the SMRSCS is in the form of maintained areas that are of marginal quality for support of ecological receptors. A cemetery and several parks cover approximately 50 of the 300 acres, with the remainder being lawns, gardens, and other landscaping maintained by residents.

Ecological receptors that may be exposed to arsenic in soil include plants, invertebrates, birds and mammals that are common to residential areas (e.g., maple trees, earthworms, American robin, fox, squirrel, and raccoon). There are no water bodies or wetlands within the SMRSCS.

14.2.2 Ecological Effect Evaluation

EPA Ecological Soil Screening Levels (Eco-SSLs) were used to evaluate the potential for arsenic in soils to pose a risk to ecological receptors inhabiting the Site. Eco-SSLs are soil concentrations protective of ecological receptors that are in contact with soil or consume biota that live in or on soil. Eco-SSLs for arsenic are as follows: 18 mg/kg for plants, 43 mg/kg for avian wildlife, and 46 mg/kg for mammalian wildlife (CH2M Hill, 2007b). No Eco-SSL has been developed for the exposure of invertebrates to arsenic.

14.2.3 Screening Level Exposure Estimate and Risk Calculation

The maximum concentration of arsenic detected in soil was 2,880 mg/kg. This concentration exceeds the Eco-SSLs for plants, birds, and mammals, indicating the potential for risk. Because the maximum detected concentration exceeded the soil screening levels for arsenic, the ERA process was continued to the exposure assumption refinement step.

14.2.4 Refinement of Exposure Assumptions

As discussed below, no population level risks are expected based on the analyses completed by EPA. A total of 7,521 surface soil samples were collected and analyzed for arsenic from 3,578 residential properties, schools, and parks comprising an area of over 618 acres. This sample density results in an average of 12 samples per acre, assuming equal sample distribution. Due to the high sample density, central tendency measures (e.g., mean and median) can provide a realistic estimate of the potential exposure to ecological receptors within the estimated 300 acres of habitat in the SMRSCS.

The mean and median arsenic concentrations were 18.1 and 5.6 mg/kg, respectively. The mean arsenic concentration of 18.1 mg/kg is just above the Eco-SSL of 18 mg/kg indicating that plants could potentially be a risk. However, review of the data set indicates that there was a subset of samples with elevated detections that substantially biased the average concentration. If the arsenic sample results with the highest 10 concentrations are removed from the data set (highest 0.13 percent of all samples), the mean concentration drops to 16.5 mg/kg, while the median remains 5.6 mg/kg. If the highest 20 concentrations are excluded from the data set (0.27 percent of all samples), the average concentration drops further to 15.7 mg/kg.

Exclusion of samples with the highest 10 arsenic concentrations resulted in mean and median concentrations that are less than the Eco-SSLs, indicating that concentrations are protective of ecological receptors, based on average exposures. Assuming samples were distributed evenly on a spatial basis, the 10 excluded samples would represent only 0.4 acres out of 300 acres.

To further assess the exposure assumptions used in the ecological risk assessment EPA evaluated the Site data using the the robin as an indicator species. The average residential lot size is approximately 0.12 acres (0.049 hectares). By overlaying the robin home ranges on properties, the average soil concentration within the home range can be calculated and compared to the avian Eco-SSL of 43 mg/kg. For this evaluation, the home range of 0.42 hectrare (range: 0.12 hectares to 0.84 hectrares) for robins on a campus in Tennessee was overlain on residential areas to determine the average soil concentration in the robin home range.

Three sample locations were selected to represent specific arsenic concentrations in soil. The concentrations evaluated include: the maximum concentration observed (2,880 mg/kg), the removal cleanup level (95 mg/kg) and the avian Eco-SSL (43 mg/kg). Sample results within a 36 meter (120 foot) radius of each selected sample location were used to calculate the average concentration in each 0.42 ha robin home range. In these three locations, the average concentration in the robin home range consisted of results from seven to ten residential properties, consistent with the assumed average lot size of 0.049 ha (0.12 acres). The average soil concentration for the robin home range centered on the 2,880 mg/kg sample location was 318 mg/kg, exceeding the avian Eco-SSL of 43 mg/kg. The average soil concentration centered on the 95 mg/kg and 43 mg/kg results were both below the avian Eco-SSL. Due to the variability in the arsenic concentrations throughout the SMRSCS, these results will vary by location.

Based on these analyses no population level risks are expected. The samples with the highest 10 concentrations were not all detected in the same area and were all located within the residential areas. All sample results from the parks and cemetery, which would be considered the higher quality habitat, were within background levels (less than 10 mg/kg). In addition, human health PRGs of 16 mg/kg and 25 mg/kg were developed in the RI and presented in the FS. The human health PRGs are lower than the Eco-SSL of 43 mg/kg for avian wildlife and 46 for mammalian wildlife. Therefore, the remediation will be driven by human health risk and the PRGs of 16 mg/kg and 25 mg/kg are protective of the ecological receptors evaluated.

14.2.5 Uncertainties

One source of uncertainty in the ERA is the lack of an Eco-SSL for invertebrates, particularly earthworms. Efroymson et al. (1997) present a screening benchmark concentration for the toxicity of arsenic to earthworms of 60 mg/kg. This is higher than the average and median concentrations of arsenic samples collected at the Site.

14.2.6 SLERA Conclusion

No population-level ecological risks are expected from arsenic in Site soils. In addition, the eco-SSLs are all higher than the human health PRGs, and as such, no ecological PRGs were developed as part of the FS.

Within individual home ranges, the average arsenic concentration may exceed Eco-SSLs where maximum soil concentrations were observed. Removal actions have already been performed at many properties where the arsenic results in soil exceeded 95 mg/kg. All removal actions are expected to be completed by the end of 2008. Removal of the soil with the highest arsenic concentrations reduces the ecological risk from the SMRSCS, but population level ecological risk could occur in areas prior to the removal action where the maximum soil concentrations exist.

Human health PRGs of 16 mg/kg and 25 mg/kg were developed in the RI and presented in the FS. The human health PRGs are lower than the Eco-SSL of 43 mg/kg for avian wildlife and 46 for mammalian wildlife. Therefore, the remediation will be driven by human health risk and the PRGs of 16 mg/kg and 25 mg/kg are protective of the ecological receptors evaluated.

14.3 Basis for Remedial Action

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Residential properties with elevated arsenic were identified in the Site area in all directions and across much of the Site. Statistical analyses provide some correlation with the CMC Heartland Site; however, the analyses do not indicate the CMC Heartland Site property is wholly responsible for all of the arsenic impacts, particularly the highly elevated arsenic results further removed from the CMC Heartland Lite Yard property.

The EPA used the results of the ISC3 air dispersion model to estimate the extent of the impact the operations at the former plant site had on the surrounding area. The model results suggested that the plant impacted an area with an approximately ¾ mile radius. Sampling of all the residential properties within that area found decreasing arsenic concentration trends present in a few directions from the CMC Heartland Site. These trends are strongest at lower arsenic concentrations and the overall variability in the data limits the predictability of these relationships. The statistical analyses shows contribution of arsenic by the plant site property to the surrounding area. The Site conceptual model, of arsenic contamination due to aerial dispersion, does not fully account for all of the relatively high concentrations of arsenic in all directions and distances which do not demonstrate directional or distance trends with the CMC Heartland Site property. However, the likelihood of intervening acts at many properties in the investigation area make it very hard to evaluate statistical significance. Some of those acts (e.g., pesticide application) could increase surface arsenic levels, while others (tilling, sodding, construction) could decrease surface arsenic levels.

Evaluation of the age of the homes relative to the most active period of arsenical pesticide and herbicide production at the CMC Heartland Site property by Reade Manufacturing indicated that homes constructed prior to 1963 had a proportionally greater number of arsenic concentrations above 95 mg/kg than homes constructed after 1963 when arsenical pesticide and herbicide blending and distribution at the CMC Heartland Site ceased and dispersion was limited to disturbance of arsenic contamination already present in the soil at the plant. The ages of homes ranges widely throughout the study area, as do the arsenic concentrations.

A baseline HHRA estimated the carcinogenic and non-carcinogenic risks to an adult/child resident and a construction worker in the Site area. The potential exposure routes that were quantified included: accidental ingestion (via hand-to-mouth activities), dermal contact (through the skin), and inhalation of arsenic in soil and outdoor air. In addition, potential intakes for residents were quantified for the ingestion of homegrown garden vegetables grown in impacted soil. The HHRA identified arsenic is present at concentrations that result in an estimated risk above EPA's target risk levels for a resident and construction worker.

The HHRA found that arsenic concentrations greater than 25 mg/kg pose a carcinogenic risk greater than $1x10^{-4}$ and an HI greater than 1 for persons residing in the area for up to 50 years with vegetable gardens and arsenic concentrations of 261 mg/kg (or less) are protective of constructions workers.

The HHRA estimated that most of the risk is from incidental ingestion of soil and dust (approximately 70 percent) and eating garden vegetables (approximately 25 percent). A small proportion of estimated risk (approximately 4 percent) is from dermal contact with soil, and a very small relative proportion of potential risk (<0.05 percent) is from inhalation of dusts.

15.0 Remedial Action Objectives

15.1 Remedial Action Objectives

Remedial Action Objectives (RAOs) are goals specific to media or operable units for protecting human health and the environment. Risk can be associated with current or potential future exposures. RAOs should be as specific as possible but not so specific that the range of alternatives to be developed is unduly limited. Objectives aimed at protecting human health and the environment should specify 1) constituents of concern (COCs), 2) exposure routes and receptors, and 3) an acceptable contaminant level or range of levels for each exposure route (that is, a Preliminary Remediation Goal) (EPA, 1988).

RAOs were developed for the Site in part based on the contaminant levels and exposure pathways found to present potentially unacceptable risk to human health as determined during the RI. The RAOs, remediation goals, and remediation strategies developed address constituents posing unacceptable risks to residents. Arsenic concentrations present in surface soil exceeded the background and risk-based screening levels for arsenic. Therefore, RAOs will address arsenic and concentrations in soil.

The RAO for soil is to control concentrations of arsenic in soil to limit resident contact and minimize the potential for dermal contact, ingestion, and inhalation exposures.

As discussed above, the HHRA estimated that most of the risk is from incidental ingestion of soil and dust and eating garden vegetables. A small proportion of estimated risk is from dermal contact with soil, and a very small relative proportion of potential risk is from inhalation of dusts. The RAO for the Site takes into consideration that control of soil concentrations of arsenic will address each of the exposure pathways contributing to the overall risk.

15.2 Preliminary Remediation Goals

PRGs are risk-based or ARAR-based chemical-specific concentrations that help further define the RAOs. PRGs are considered preliminary, in that the final remedial goals are defined in the ROD once a remedy is selected for the Site. The PRGs are used to define the extent of contaminated media requiring remedial action. PRGs were developed considering the following ARARs:

- Chemical-specific ARARs
- Chemical-specific to-be-considered ARARs

PRGs were developed for arsenic in soil. The PRGs for soil were selected to protect residents and construction workers from ingestion, dermal contact, and inhalation exposures. For arsenic in shallow soils, PRGs of 16 mg/kg and 25 mg/kg were selected. These PRGs were based on target excess cancer risks in the range of 1×10^{-6} to 1×10^{-4} and/or a hazard index of 1, unless the risk-based concentration is lower than the background upper tolerance limit, in which case, the background upper tolerance limit is used. The background concentration of 16 mg/kg has carcinogenic risk of 6×10^{-5} and a hazard index of 0.6. An arsenic concentration of 25 mg/kg has a carcinogenic risk of 1×10^{-4} and a hazard index of 1.0.

For arsenic in deep soil, greater than 12 to 18 inches below grade, a PRG of 95 mg/kg was selected. Construction workers are the population most likely to be exposed to contaminated soils deeper than 12 inches. Arsenic concentrations of 261 mg/kg represent a hazard index of 1.0 and carcinogenic risk of 7×10^{-5} for construction workers. Resident exposure to high arsenic concentrations in deep soil is only expected in rare circumstances and only for short periods of time and less frequently than the construction worker. Any risks from exposure to arsenic contamination in the deep soil would be mitigated through the inevitable mixing of the deep soil with the clean, shallow soil, resulting in lower exposure point concentrations. . Therefore, a PRG of 95 mg/kg, based on the acute exposure risk level provided by ATSDR, is considered appropriate and protective for the long-term. This arsenic level represents a lifetime carcinogenic central tendency exposure risk for residents of 8×10^{-5}. Again, these risks are mitigated by the inevitable mixing of clean shallow soil with the deep soil and the fact that chronic exposure to the deep soils is not a reasonable assumption.

Soil maps and soil properties within the SMRSCS were reviewed from the Hennepin County Soil Survey. The soil types throughout the majority of the SMRSCS are rated as low to moderate frost heave potential. A limited portion of the Site has soil types with high frost heave potential. However, frost heave is more of a concern in saturated soils and with drained urban setting and the water table at depth of approximately 25-feet, frost action is not expected to cause significant soil mixing. Therefore, there is little potential for contaminated material to be brought to the surface through frost heave.

16.0 Description of Alternatives

Six alternatives were developed for the Site in the Feasibility Study. Alternative 2C represents the final selected remedy presented in this ROD.

1. Alternative 1 - No Action
2. Alternative 2A - Removal of soil with arsenic levels above 25 mg/kg, to a depth of 12 inches (18 inches in garden areas) and landfill disposal
3. Alternative 2B - Removal of soil with arsenic levels above 16 mg/kg, to a depth of 12 inches (18 inches in garden areas) and landfill disposal
4. Alternative 2C - Removal of soil with arsenic levels above 25 mg/kg, to a depth of 12 inches (18 inches in garden areas) and landfill disposal; removal of soil deeper than 12 inches with arsenic levels above 95 mg/kg
5. Alternative 3A - Removal of all soil with arsenic levels above 25 mg/kg and landfill disposal
6. Alternative 3B - Removal of all soil with arsenic levels above 16 mg/kg and landfill disposal

16.1 Description of Remedy Components

16.1.1 Common Elements Each Remedial Alternative

Each of the remedial alternatives considered, with the exception of Alternative 1 – No Action, rely on the same elements to address the risks associated with arsenic contaminated soil. The primary component of each of the alternatives is soil excavation and off-site disposal. Each of the alternatives requires heavy equipment to be brought to each affected property to excavate the soils containing arsenic above the selected cleanup level. Alternatives 2A and 3A use 25 mg/kg as the cleanup level. Alternatives 2B and 3B use 16 mg/kg as the cleanup level. Alternative 2C uses a cleanup level of 25 mg/kg for soils less than 12 to 18 inches below grade, and 95 mg/kg for deeper soils. In each alternative soils are trucked off-site to a permitted landfill for ultimate disposal. Each alternative includes provisions for disposal of the excavated material at a Subtitle D, solid waste landfill or Subtitle C, hazardous waste landfill, dependant on the results of waste characterization samples. All of the alternatives require backfilling of the excavations with clean fill to the original grade and restoration of vegetation through seeding and planting replacement plants. All of the alternatives include sampling the base of the excavation area to document the concentration of arsenic in the remaining soils. Each of the alternatives also includes provisions for institutional controls on properties where arsenic concentrations remain in the soils above the selected cleanup level.

Based on the analyses of housing age versus arsenic concentrations, EPA believes that properties with houses built after 1963 and with elevated arsenic levels should not be included in the cleanup selected in this ROD unless additional information is obtained to more specifically attribute the arsenic concentrations to the plant site. Approximately 9 properties with homes constructed post-1963 have arsenic concentrations above 25mg/kg. Approximately 17 properties with homes constructed post-1963 have arsenic concentrations above 16 mg/kg. If attribution is not made to the plant site the State of Minnesota has agree that the State will fund the cleanup of the properties with homes constructed after 1963. For purposes of cost estimating, EPA is assumed to cleanup all of the properties.

16.1.2 Distinguishing Features of Each Remedial Alternative

The four remedial alternatives considered for this Site, excluding Alternative 1- No Action, have two features that distinguish them from each other; 1) arsenic soil cleanup level, and 2) depth of excavation.

Alternatives 2A and 3A use 25 mg/kg as the cleanup level. Alternatives 2B and 3B use 16 mg/kg as the cleanup level. Alternative 2C used 25 mg/kg for shallow soils and 95 mg/kg for deep soil, i.e. soils more than 12 to 18 inches below grade. Twenty-five (25) mg/kg represents an arsenic concentration with an excess lifetime cancer risk of 1×10^{-4}, and a non-cancer hazard index of 1.0. Sixteen (16) mg/kg represents background levels for arsenic in local soil. Ninety-five (95) mg/kg represents a level which would not pose an unacceptable risk to construction workers, who are most likely to be exposed to the deep soil. The risk assessment calculated a construction worker PRG of 261 mg/kg, which is based on a hazard index of 1.0. The 95 mg/kg level is also based on a potential acute exposure of a resident to the deep soil. The result is Alternatives 2A would require the excavation of soil at 488 properties. Alternative 3A would require the excavation of soil at 602 properties. The additional 114 properties represent properties where removals will have already addressed shallow soil, but will require deep soil to be excavated. Alternatives 2B and 3B would require excavation of soils at 631 and 782 properties, respectively. Again, the difference in property numbers represents properties where removals will have already addressed shallow soil, but will require deep soil to be excavated. Alternative 2C would require excavation and disposal of soil from 488 properties.

Alternatives 2A and 3A require excavating contaminated soils to a depth of 12 inches below grade in yards and to a depth of 18 inches below grade in gardens. Alternatives 2B, 2C and 3B require excavation of all soils exceeding the arsenic soil cleanup standard, regardless of depth. Estimated volumes of soil that would be excavated under Alternative 2A would be 35,875 cubic yards (cy). Alternative 2B and 2C would require 48,514 cy, and 41,775 cy, respectively. Alternative 3A would require excavation and disposal of 64,472 cy, and 3B would require 76,676 cy. The estimates assume an average excavation depth of 18 inches for Alternatives 3A and 3B.

Under each alternative there is a likelihood that some soils exceeding the selected cleanup level may remain on some properties. Under Alternatives 2A and 2B the likelihood is greater based on the results from verification sampling results from the completed removal work, where over 100 of the properties had verification sample results above 16 mg/kg. Because Alternatives 2A and 2B only require excavation to a maximum depth of 18 inches (similar to the removal work), these properties would require institutional controls to prevent future exposure to these soils. Alternatives 2C, 3A and 3B require excavation of soils exceeding the cleanup level regardless of depth, so there should be no need for institutional controls on these properties. However, there is a possibility that exceedances might continue to be encountered at depth. EPA would not have excavations go deeper than 10 feet (foundation footing depth) and may require institutional controls in those cases. Soil sampling at depth at approximately 20 properties during the RI indicates that arsenic exceedances generally can be expected to be limited to the top 3 feet of soil. Therefore, it is expected that the number of properties requiring ICs under Alternative 2C, 3A and 3B is far less than those under Alternatives 2A and 2B. ICs may also be necessary if complete excavation is not practical given physical conditions at the property, e.g narrow properties, or structures susceptible to damage.

16.1.3 Alternative 1 - No Action

Alternative 1 consists of taking no action. The NCP requires that a no-action alternative be retained as a baseline for comparison to the other approaches. No action would leave affected soil in place at the Site. There are no capital or operation and maintenance costs associated with Alternative 1.

16.1.4 Alternative 2A - Removal of Soil Exceeding Cleanup Standard to a Depth of 12 Inches and Landfill Disposal – Arsenic Cleanup Standard of 25 mg/kg

Estimated Time for Construction: 4 years
Estimated Time to Reach Remediation Goals: 4 years
Estimated Capital Costs: $16,075,123
Estimated Lifetime O&M Costs: $120,000
Estimated Total Present Worth Costs: $15,600,000
Discount Rate: 2.8
Number of Years Costs are Projected: 30

Alternative 2A consists of excavating the soil with arsenic levels exceeding the risk-based arsenic cleanup standard of 25 mg/kg, followed by offsite disposal at a permitted RCRA Subtitle D landfill. Soil samples will be collected to document arsenic concentration in remaining soils after reaching the excavation extents. The excavation will then be filled with clean soil and restored to its original condition to the extent practicable.

The main components of Alternative 2A include the following:

- Excavating contaminated soils to a depth of 12 inches below grade in yards and to a depth of 18 inches below grade in gardens.

- Collecting soil samples to document the arsenic concentrations in the remaining soils.
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a certified RCRA subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:
    - Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or
    - Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.
- Backfilling excavation with clean fill and topsoil to the original grade.
- Restoring the vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory.
- If cleanup standards are not attained at the lower extents of excavation (12 inches below grade in yards or 18 inches below grade in gardens), institutional controls would be employed in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure.

16.1.5 Alternative 2B - Removal of Soil Exceeding Cleanup Standard to a Depth of 12 Inches and Landfill Disposal – Arsenic Cleanup Standard of 16 mg/kg

Estimated Time for Construction: 6 years
Estimated Time to Reach Remediation Goals: 6 years
Estimated Capital Costs: $21516,548
Estimated Lifetime O&M Costs: $120,000
Estimated Total Present Worth Costs: $20,318,640
Discount Rate: 2.8
Number of Years Costs are Projected: 30

Alternative 2B consists of excavating the soil with arsenic levels exceeding the arsenic background standard of 16 mg/kg, followed by offsite disposal at a permitted RCRA Subtitle D landfill. Soil samples will be collected to document arsenic concentration in remaining soils after reaching the excavation extents. The excavation will then be filled with clean soil and restored to its original condition to the extent practicable.

The main components of Alternative 2B include the following:

- Excavating contaminated soils to a depth of 12 inches below grade in yards and to a depth of 18 inches below grade in gardens.
- Collecting soil samples to document the concentrations in the remaining soils.
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a certified RCRA subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:
  - Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or
  - Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.
- Backfilling excavation with clean fill and topsoil to the original grade.
- Restoring the vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory.
- If the cleanup standards are not attained at the lower extents of excavation (12 inches below grade in yards or 18 inches below grade in gardens), institutional controls would be employed in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure

16.1.6 Alternative 2C - Removal of Soil Exceeding Cleanup Standard and Landfill Disposal –Shallow Soil Arsenic Cleanup Standard of 25 mg/kg, Deep Soil Arsenic Cleanup Standard of 95 mg/kg

Estimated Time for Construction: 4 years
Estimated Time to Reach Remediation Goals: 4 years
Estimated Capital Costs: $16,200,000
Estimated Lifetime O&M Costs: $0
Estimated Total Present Worth Costs: $17,900,000
Discount Rate: 2.8
Number of Years Costs are Projected: 4

Alternative 2C consists of excavating the soil with arsenic levels exceeding the cleanup standard of 25 mg/kg, followed by offsite disposal at a permitted RCRA Subtitle D landfill. Soil samples will be collected to document arsenic concentration in remaining soils after reaching the excavation extents. If the sample results from the base of the excavation show remaining soils to have arsenic levels above 95 mg/kg the excavation will continue until the levels are below 95 mg/kg, or to a maximum depth of 10 feet. The excavation will then be filled with clean soil and restored to its original condition, to the extent practical.

The main components of Alternative 2C include the following:

- Excavating soils with total arsenic concentrations above 25 mg/kg, the shallow soil cleanup standard, to a depth of 12 inches below grade in yards, and to a depth of 18 inches below grade in garden areas;
- Collecting soil samples to document the concentrations in the remaining soils;
- If the samples at the base of the excavation exceed the deep soil arsenic cleanup standard, 95 mg/kg, then excavation will continue until the deep soil cleanup standard is met, or to a maximum depth of ten feet;
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a certified RCRA subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions so handling and disposal of RCRA hazardous waste and is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:
  - Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or
  - Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.
- Backfilling excavation with clean fill and topsoil to the original grade;
- Restoring the vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory; and,
- If cleanup standards are not obtained at the lower extents of excavation institutional controls would be employed in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure.

16.1.7 Alternative 3A - Removal of Soil Exceeding Cleanup Standard and Landfill Disposal – Arsenic Cleanup Standard of 25 mg/kg

Estimated Time for Construction: 4 years
Estimated Time to Reach Remediation Goals: 4 years
Estimated Capital Costs: $20,209,148
Estimated Lifetime O&M Costs: NA
Estimated Total Present Worth Costs: $19,613,852
Discount Rate: 2.8
Number of Years Costs are Projected: 4

Alternative 3A consists of excavating all soils with arsenic levels exceeding the risk-based arsenic cleanup standard of 25 mg/kg, followed by offsite disposal at a RCRA Subtitle D landfill. Soil excavations would not go deeper than 10 feet, which is the foundation depth for the area. Soil samples will be collected to document arsenic concentration in remaining soils after reaching the excavation extents. The excavation will then be backfilled with clean soil and restored to its original condition to the extent practicable.

The main components of Alternative 3A include the following:

- Excavating all soils exceeding the arsenic cleanup standard of 25 mg/kg, to a maximum depth of 10 feet.
- Collecting soil samples to document the concentrations in the remaining soils.
- If the cleanup standards are not attained at the lower extents of excavation, institutional controls would be employed in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure.
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation if the cleanup standards are not attained at the lower extents of excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a certified RCRA subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:

  – Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or;
  – Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.
- Backfilling excavation with clean fill and topsoil to the original grade.
- Restoring the vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory.

16.1.8 Alternative 3B - Removal of Soil Exceeding Cleanup Standard and Landfill Disposal – Arsenic Cleanup Standard of 16 mg/kg

Estimated Time for Construction: 6 years
Estimated Time to Reach Remediation Goals: 7 years
Estimated Capital Costs: $27,026,398
Estimated Lifetime O&M Costs: NA
Estimated Total Present Worth Costs: $25,521,736
Discount Rate: 2.8
Number of Years Costs are Projected: 6

Alternative 3B consists of excavating all soils with arsenic levels exceeding the arsenic background standard of 16 mg/kg, followed by offsite disposal at a RCRA Subtitle D landfill. Soil samples will be collected to document arsenic concentration in remaining soils after reaching the excavation extents. The excavation will then be backfilled with clean soil and restored to its original condition to the extent practicable.

The main components of Alternative 3B include the following:

- Excavating all soils exceeding the arsenic cleanup standard of 16 mg/kg.
- Collecting soil samples to document the concentrations in the remaining soils.
- If cleanup standards are not attained at the lower extents of excavation, institutional controls would be employed in the form of use restrictions to define areas of remaining concern or zoning and permit requirements to limit exposure.
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation if the cleanup standards are not attained at the lower extents of excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a certified RCRA subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:

  - Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or

  - Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.

- Backfilling excavation with clean fill and topsoil to the original grade.
- Restoring the vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory.

16.2 Key Applicable or Relevant and Appropriate Requirements

Alternative 1, No-Action, does not comply with the requirements of CERCLA since there would be no remediation to protect public health and the environment. Alternatives 2A, 2B, 2C, 3A, and 3B will be designed and operated to comply with all federal and state ARARs concerning hazardous and nonhazardous waste treatment/disposal facilities and air emissions. Table 10 (Summary of ARARs) summarizes the ARARs for Alternatives 2A, 2B, 2C, 3A, and 3B, and shows how they will be complied with.

16.3 Long-Term Reliability of the Remedy

The magnitude of risks at the Site for Alternative 1 is likely to remain the same since contaminated soils will remain on the Site that pose a risk to human health. Arsenic contaminated soils will be excavated and disposed off-site in a permitted landfill under all of the other alternatives. It is likely that contaminated soils would remain on-site, on some properties, under Alternatives 2A and 2B, however a high visibility barrier would be placed above those soils prior to backfilling with clean soil and institutional controls would be put in place to minimize any potential for future exposure to the residual contamination. Alternatives 2C, 3A and 3B require complete excavation and off-site disposal of all the soils contaminated above cleanup standards except for contamination below 10 feet.

16.4 Quantities of Untreated Waste

None of the alternatives include treatment of waste material unless, when it is tested, it is determined to be characteristically hazardous waste. Soils are not listed hazardous waste and are not expected to be characteristically hazardous. However, if the soils are determined to be characteristic hazardous waste, they will be treated prior to disposal to reduce toxicity and mobility. Under Alternative 2A approximately 35,878 cubic yards of contaminated soil would excavated and disposed off-site. Alternative 2B would result in the excavation and disposal of approximately 48,514 cubic yards of soil. Alternatives 3A and 3B would require the excavation and disposal of an estimated 51,250 and 69,306 cubic yards of soil, respectively. Alternative 2C would result in the excavation and disposal of approximately 41,775 cubic yards of soil.

16.5 Expected Outcome of Each Alternative

Implementation and completion of the selected remedy for the soils as described in Alternatives 2A, 2B, 2C, 3A, and 3B will allow the Site to be used for residential use. The estimated time for the design and construction of Alternatives 2A, 2B, 2C, 3A, and 3B is 4, 6, 4, 5, and 7 years, respectively. Unrestricted residential use can begin immediately upon completion of the remedial action for the soils.

17.0 Comparative Analysis of Alternatives

EPA uses nine NCP criteria to evaluate remedial alternatives for the cleanup of a release. The criteria are summarized below. These nine criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met in order for an alternative to be eligible for selection. The balancing criteria are used to weigh major tradeoffs amongst alternatives. The modifying criteria are state acceptance and community acceptance. Each of the alternatives considered are individually compared against each of the nine criteria described below.

Threshold Criteria:

1. Overall protection of human health and the environment. Alternatives shall be assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals consistent with 40 C.F.R. § 300.430(e)(2)(1). Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARS.

2. Compliance with ARARs. The Alternatives shall be assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers under 40 C.F.R. § 300.430(f)(1)(ii)(C).

Balancing Criteria:

3. Long-term effectiveness and permanence. Alternatives shall be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered, as appropriate, include the following:

    a. Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

    b. Adequacy and reliability of controls such as containment systems and restrictive covenants that are necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

4. Reduction of toxicity, mobility, or volume through treatment. The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the Site. Factors that shall be considered, as appropriate, include the following:

a. The treatment or recycling processes the alternatives employ and materials they will treat;

b. The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

c. The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;

d. The degree to which the treatment is irreversible;

e. The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and

f. The degree to which treatment reduces the inherent hazards posed by principal threats at the Site.

5. Short-term effectiveness. The short-term impacts of alternatives shall be assessed considering the following:

   a. Short-term risks that might be posed to the community during implementation of an alternative;

   b. Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;

   c. Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and

   d. Time until protection is achieved.

6. Implementability. The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors as appropriate:

   a. Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy;

   b. Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions); and,

c. Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

7. Cost. The types of costs that shall be assessed include the following:

   a. Capital costs, including both direct and indirect costs;

   b. Annual operation and maintenance costs; and

   c. Net present value of capital and O&M costs.

Modifying Criteria:

8. State acceptance. The state concerns that shall be assessed include the following:

   a. The state's position and key concerns related to the preferred alternative and other alternatives; and

   b. State comments on ARARs or the proposed use of waivers.

9. Community acceptance. This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose.

17.1 Overall Protection of Human Health and the Environment

For each alternative considered, except Alternative 1, No Action, the remedial action objective (RAO) is prevention of human exposure through dermal contact, ingestion, or inhalation to contaminated soil that presents an unacceptable risk (i.e., hazard index (HI) greater than 1 or excess lifetime cancer risk (ELCR) greater than the 1×10^{-4} to 1×10^{-6} risk range). Alternative 1, No Action, is not protective because it does not eliminate the exposure pathways for residents. Alternatives 2A, 2B, 2C, 3A, and B, are considered protective of human health and the environment.

Alternatives 2A, 2C, and 3A use a risk-based arsenic cleanup standard of 25 mg/kg. Alternatives 2B and 3B use a cleanup standard based on the calculated background concentration of 16 mg/kg for the Site investigation area. The calculated site-specific RME carcinogenic risk for 25 mg/kg is $1x10^{-4}$ and for 16 mg/kg is $6x10^{-5}$. The risk levels associated with both cleanup standards are within, but at the upper end of, EPA's acceptable risk range.

Alternative 2A and 2B rely on a combination of excavation and disposal, soil cover and institutional controls to meet the RAOs. From data collected in the RI and during interim removal actions, the arsenic concentrations are generally the greatest in the surface soils and therefore pose the greatest risk. Excavation and disposal removes the highest concentration soils, and soil cover and institutional controls address residual concentrations. Alternative 2A and 2B are permanent and protective; however, arsenic may remain at depth and maintenance of institutional controls may be required to maintain protectiveness. However, because the contamination is assumed to have been originally deposited at the surface, it is reasonable to assume that only properties that have surface soil concentrations above the removal action level would have significant levels at depth. Of the 134 properties that have had removal actions completed, only 30 have had levels above 95 ppm at the base of the excavations. Alternative 2C, 3A and 3B are also considered protective. They could be considered more protective of human health and the environment since all of the impacted soils are eliminated from future exposure. Maintenance of institutional controls will not be necessary under Alternatives 2C, 3A, and 3B unless complete excavation is not practical due to physical constraints at a property.

17.2 Compliance with ARARs

All alternatives are expected to comply with ARARs. Because Alternative 1 would leave contaminated soil on-site and would result in continued long-term exposure of residents that alternative does not meet the requirement of CERCLA to be protective of human health and the environment.

17.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of alternatives vary as a result of the adequacy and reliability of the systems implemented. Alternatives 2C, 3A and 3B offer a higher degree of long-term effectiveness than Alternatives 2A and 2B because they are expected to achieve the greatest removal of arsenic from the soils through excavation and off-site disposal. Alternatives 2A and 2B will likely require implementation and maintenance of institutional controls on those properties where contamination remains on-site. Alternatives 2C, 3A and 3B require excavation and off-site disposal of all contaminated soils down to a maximum depth of 10 feet. These alternatives differ in the cleanup standards used to define the depth and volume of excavation. Based on previous subsurface soil sampling it is not likely that contamination would be found as deep as 10 feet, but if found institutional controls may then be required on that property. On some properties it may not be possible to excavate deeper than 12 inches without damaging structures. In these cases institutional controls may also be necessary to address deeper contaminated soils.

17.4 Reduction in Toxicity, Mobility, and Volume Through Treatment

Alternative 1 does not provide any reduction of toxicity, mobility and volume through treatment. Alternatives 2A, 2B, 2C, 3A, and 3B do not include treatment technologies, and therefore, are not expected to provide a reduction in toxicity, mobility and volume. Soils are not listed hazardous waste and are not expected to be characteristically hazardous. However, if the soils are determined to be characteristic hazardous waste, they will be treated prior to disposal to reduce toxicity and mobility.

17.5 Short-Term Effectiveness

Alternative 3B has the highest risk to workers and the community, due to the increased excavation volumes requiring deeper excavations, increased truck traffic on narrow residential streets, and longer time to implement the remedy. The requirement for more extensive and deeper excavations carries higher risks when excavating on narrow lots, adjacent to older homes, as is the case at this Site. Alternatives 3A and 2B have the next highest risk to workers and community and Alternative 2A and 2C have the lowest risks due to the shortest time to implement the remedy and lowest excavation and transportation quantities.

Alternatives 2A, 2B, 2C, 3A, and 3B may have minimal impacts with respect to the protection of workers, the community, or the environment during remedial construction, assuming adequate monitoring is conducted and mitigative actions are taken. Air monitoring would be important for these alternatives that include excavation, as workers would need to be in the appropriate health and safety protection level during intrusive activities. Also, emission control techniques such as the use of dust suppressants would be employed, as needed, to minimize adverse effects on workers and the community.

17.6 Implementability

All alternatives can be implemented with readily available materials and methods. One challenge is in determining the appropriate excavation depth in Alternative 2C, 3A and 3B to remove all soils above the cleanup level. This can be accomplished by collecting vertical soil samples from the yards with a hand auger or direct-push rig prior to excavation. However, this adds an additional layer of complexity and administrative tracking for the implementation of the remedy. For this reason, Alternative 2A and 2B are more readily technically implementable than Alternative 3A and 3B. Alternative 2C is slightly less implementable than Alternatives 2A and 2B because of the few properties that will require deep excavation.

However, Alternatives 2A and 2B are more difficult in regards to administrative implementability because of the potential for a greater number of properties requiring institutional controls due to soil exceeding the PRGs that will remain at depth on the properties.

The greatest implementability challenge is in the number of properties requiring remedial actions which ultimately determines the quantity of soil for disposal and imported fill material required. Therefore, Alternative 2A is the most readily implementable, followed by Alternatives 2C and then 2B because of the increased excavation and fill quantities. Alternative 3A has similar quantities to Alternative 2B, but is more difficult to implement due to the vertical profiling and varying excavation depths. Alternative 3B is the least implementable.

17.7 Cost

A detailed cost analysis, and the basis of the estimated costs for each of the alternatives is presented in Tables 11.1 through 11.13. The tables break down the estimated capital, O&M, and present net worth cost.

The no further action alternative has the least present worth cost. The remaining alternatives listed from lowest present worth cost to highest are: Alternative 2A at $15,600,000; Alternative 2C at $17,900,000; Alternative 2B at $20,400,000; Alternative 3A at $24,000,000; and Alternative 3B at $30,300,000.

17.8 State Acceptance

The State of Minnesota has assisted in the development and review of the Administrative Record and has participated in the development and implementation of the sampling activities and community involvement work. It is expected that the State of Minnesota will concur with this remedy selection.

17.9 Community Acceptance

The specific public comments received, and EPA's responses are outlined in the attached Responsiveness Summary.

17.10 Summary of Comparative Analysis of Alternatives

Each of the cleanup options was evaluated against the nine criteria discussed above. EPA has selected Alternative 2C as the final remedy because it provides the best balance between the nine evaluation criteria. EPA concluded that Alternative 1, No Action, would not protect people or the environment and was eliminated from consideration. All of the remaining alternatives are protective and meet all state and federal applicable or relevant and appropriate requirements.

Of the remaining alternatives, Alternative 2C is the most cost-effective. Alternatives 2B and 3B have lower final arsenic cleanup levels than 2C, but the risk reduction is not justified. Both 16 mg/kg and 25 mg/kg are in the upper end of the acceptable risk range with ELCRs or $1x10^{-4}$ and $6x10^{-5}$, respectively. However, because of the potential increased short-term risks, difficulties implementing the remedies, and the substantially higher costs associated with the lower cleanup levels, EPA believes the minimal further reduction in risk is not cost effective. Moreover, the additional excavation work adds two years to the project, significantly increasing disruption to the residents and creating additional project and waste transportation and handling issues.

Alternatives 2C, 3A, and 3B would provide a higher degree of long-term protection from exposure to arsenic than Alternatives 2A and 2B because more contaminated soil would be removed from the yards. When fully implemented, Alternatives 2C, 3A, and 3B will result in unrestricted use of the properties. Alternatives 2A and 2B may result in some elevated levels of contamination being left below 12 to 18 inches. However, Alternatives 2A and 2B minimize this difference by using restrictions or notices to discourage digging at depths where contamination remains.

Alternative 2A has the lowest short-term risk to workers and the community because it affects the fewest number of properties and has the lowest amount of soil requiring removal. Alternatives 2C, 3A and 3B require deeper excavations that pose higher risk of damage to structures, increased truck traffic, and longer time to implement the cleanup plan. Proper construction management can help control those risks. Alternatives 2A, 2B, 2C, 3A and 3B have minimal risks with respect to causing arsenic dust and the protection of workers or residents because air monitoring would be conducted. If necessary, dust suppressants would be used to minimize potential exposure to arsenic dust.

The alternatives can be implemented with readily available materials and methods. Alternatives 3A and 3B could be more difficult because of the challenge in determining the correct depth for digging. This could be accomplished by collecting vertical soil samples from the yards with a hand auger or a direct-push rig before removing soil. However, this approach would make this more complex and require additional administrative tracking.

18.0 Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430(a)(l)(iii)(A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. The soils contaminated with arsenic levels above the PRG at the Site are considered to be "principal threat wastes" because the concentrations present pose a significant risk under a residential exposure scenario. Those wastes will be removed to a permitted landfill where they can be contained. Treatment of the arsenic contaminated soils was not considered feasible due to the residential nature of the Site and the high overall cost of treatment as compared to the alternatives considered.

19.0 Selected Remedy

19.1 Summary of Rationale for the Selected Remedy

Based upon considerations of the requirements of CERCLA, the NCP and balancing of the nine criteria, EPA has determined that Alternative 2C is the most appropriate for the South Minneapolis Residential Soil Contamination Site.

Alternative 2C is protective of human health and the environment, meets all Federal and State ARARs, and meets all of the remedial action objectives through attainment of cleanup levels. This alternative was selected over the other alternatives because it is easily implemented, expected to achieve substantial and long-term permanence and risk reduction through off-site disposal of the contaminated soils, and is expected to allow unrestricted use of the residential properties. Because the waste material will be disposed off-site, O&M activities and five-year reviews of the soil remedy will not be required, unless complete excavation of the deep contaminated soil is not possible.

Alternative 2C provides the best balance of tradeoffs between alternatives with respect to the balancing and modifying criteria. EPA considers Alternative 2C the most cost-effective alternative. Based on the limited number of public comments received during the public meeting held by EPA to present the Proposed Plan and comments received during the public comment period, the public prefers Alternative 2B.

19.2 Detailed Description of the Selected Remedy

The following are the major components of the remedy selected in this ROD:

- Inventory and documentation of the existing conditions of the areas requiring the remedy;
- Excavation of soil (to a depth of 12 inches below grade in yards, and to a depth of 18 inches below grade in garden areas) that has total arsenic concentrations above 25 milligrams per kilogram (mg/kg), or parts per million (ppm);
- Post-excavation soil sampling to document the concentrations in the remaining soils;
- If the samples at the base of the excavation exceed the deep soil arsenic cleanup standard, 95 mg/kg, then excavation will continue until the deep soil cleanup standard is met, or to a maximum depth of ten feet;
- Placement of a permeable and permanent high visibility marker layer in the bottom of the excavation. The marker layer will provide a visual barrier over soils that were not excavated during the remedial actions and may contain residual contamination above the shallow soil cleanup standard;
- Backfilling excavation with clean fill and topsoil to the original grade;
- Restoration of the excavated areas (i.e., restoring vegetation by seeding the final graded surface and planting replacement plants identified prior to excavation during an inventory);
- Collecting samples from excavated soil to verify that the soil is not characteristically hazardous and may be transported to, and disposed of at, a permitted and compliant Resource Conservation Recovery Act (RCRA) subtitle D landfill. Soil has not been found to be characteristically hazardous during interim removal actions and so handling and disposal of RCRA hazardous waste is not anticipated to be required for this remedial alternative. However, if soil is characteristically hazardous, the soil may be managed as follows:

  - o Stabilized and solidified at a centralized offsite treatment area prior to disposal at a RCRA subtitle D landfill, or
  - o Transported and disposed of as a characteristically hazardous waste at a RCRA subtitle C landfill.
- If cleanup standards are not obtained at the bottom of the excavation, institutional controls would be placed on the land in the form of use restrictions to define areas of remaining concern, or zoning and permit requirements to limit exposure.

19.3 Cost Estimate

Tables 11.9 through 11.13 detail the estimated costs to implement and construct Alternative 2C. The estimated total cost to implement and construct the selected remedy presented in this ROD is $17,900,000. The information in this cost estimate for the Selected Remedy is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a technical memorandum in the Administrative Record file, an Explanation of Significant Differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

19.4 Expected Outcome of Selected Remedy

At the completion of this remedial action each property cleaned will be suitable for unrestricted residential use. An expected outcome of the selected remedy is that the soils at the Site will no longer present an unacceptable risk to human health because all of the arsenic contaminated soils will be transported off-site to a permitted waste disposal facility.

19.4.1 Final Cleanup Levels

The purpose of this response action is to control risks posed by direct contact with arsenic contaminated soil. Since no Federal or State ARARs exist for arsenic in soil, the action levels for arsenic were determined through a site-specific risk analysis. The results of the baseline risk assessment indicate that existing conditions at the Site pose an excess lifetime cancer risk of $6x10^{-3}$ from direct contact with arsenic contaminated soils. The soil arsenic background concentration of 16 mg/kg has carcinogenic risk of 6×10^{-5} and a hazard index of 0.6. This remedy will address all soils 12 to 18 inches below grade, contaminated with arsenic in excess of 25 mg/kg which would correspond to an excess lifetime cancer risk of $1x10^{-4}$. Figure 7 shows the sample locations that exceed the selected cleanup levels.

This remedy will also address all soils deeper than 12 to 18 inches below grade contaminated with arsenic in excess of 95 mg/kg. Construction workers are the population most likely to be exposed to contaminated soils deeper than 12 inches.

Arsenic concentrations of 261 mg/kg represent a hazard index of 1.0 and carcinogenic risk of $7x10^{-5}$ for construction workers. Resident exposure to high arsenic concentrations in deep soil is only expected in rare circumstances and only for short periods of time and less frequently than the construction worker. Any risks from exposure to arsenic contamination in the deep soil would be mitigated through the inevitable mixing of the deep soil with the clean, shallow soil, resulting in lower exposure point concentrations. Therefore, the acute exposure based removal action level of 95 mg/kg, is considered appropriate and protective for the long-term. In terms of chronic, lifetime exposures, 95 mg/kg arsenic represents a chronic reasonable maximum exposure carcinogenic risk for residents of $4x10^{-4}$ and a hazard index of 4.0. This arsenic level represents a lifetime carcinogenic central tendency exposure risk for residents of $8x10^{-5}$ and a central tendency hazard index of 2.0. Again, these risks are mitigated by the inevitable mixing of clean shallow soil with the deep soil and the fact that chronic exposure to the deep soils is not a reasonable assumption.

19.4.2 Anticipated Community Impacts

The selected remedy will provide community revitalization impacts because it will allow the Site to be returned to unrestricted residential use when completed. Through public notices the community is currently urged by the State and EPA to limit exposure to the contaminated soils. The Site is located in an environmental justice area and the remedy will serve to lessen environmental impacts on the community.

20.0 Statutory Determinations

The selected remedy must satisfy the requirements of Section 121 (a) through (f) of CERCLA to:

1. Protect human health and the environment;
2. Comply with ARARs or justify a waiver;
3. Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
4. Satisfy a preference for treatment that reduces toxicity, mobility, or volume as a principle element of the remedy.

The implementation of the selected alternative at the South Minneapolis Residential Soil Contamination Site satisfies these requirements of CERCLA Section 121 as follows:

20.1 Protection of Human Health and the Environment

Implementation of the selected alternative will reduce and control potential risks to human health posed by exposure to arsenic contaminated soils. Protection of human health and the environment will be achieved through excavation and off-site disposal of the contaminated soils. If necessary, institutional controls will be put in place to minimize the potential for exposure to residual soil contamination. The cleanup level will attain the $1x10^{-4}$ to $1x10^{-6}$ risk level as required by the NCP.

No unacceptable short-term risks will be caused by implementation of the remedy. Some short-term risks will be created by excavation activities, but these risks can be minimized through proper mitigative measures during construction.

20.2 Compliance with Applicable or Relevant and Appropriate

The NCP §§300.430(f)(5)(ii)(B) and (C) require that a ROD describe the Federal and State ARARs that the Selected Remedy will attain, or provide justification for any waivers. ARARs include substantive provisions of any promulgated Federal or more stringent State environmental standards, requirements, criteria, or limitations that are determined to be legally ARARs for a CERCLA site or action. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are requirements that, while not legally "applicable" to circumstances at a particular CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited.

The selected remedy, excavation and off-site disposal of arsenic-contaminated soils, will comply with all Federal and any more stringent State ARARs that are applicable to the Site. CERCLA §121(d) states that remedial actions must attain or exceed ARARs. The location-specific, chemical-specific, and activity-specific ARARs for the Site are presented in Table 10 (Summary of ARARs) and summarize how Alternative 2C will comply with ARARs.

20.3 Cost-Effectiveness

Cost-effectiveness compares the effectiveness of an alternative in proportion to its cost of providing environmental benefits. The selected remedy, Alternative 2C, has been determined to afford overall effectiveness proportional to its cost. Alternative 2C carries low costs in comparison to the other alternatives. Alternative 2A, 2B, 2C, 3A and 3B are considered protective of human health and the environment. The selected remedy affords the greatest effectiveness proportional to its cost as compared to the other alternatives that meet all threshold criteria.

20.4 Utilization of Permanent Solutions to the Maximum Extent Practicable

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in the most cost effective manner for this Site. Alternative 2C is a protective alternative. None of the alternatives considered include treatment of the contaminated soils unless they are found to be characteristically hazardous. Excavation and off-site disposal of the contaminated soil will permanently prevent exposure of the residents to arsenic contamination.

20.5 Preference for Treatment as a Principal Element

Based on current information, EPA believes that the selected remedy is protective of human health and the environment and utilizes permanent solutions and alternative treatment technologies to the maximum extent possible. The remedy, however, does not satisfy the statutory preference for treatment of the hazardous substances present at the Site as a principal element because such treatment was not found to be practical or cost effective. Most technologies were dropped for consideration based on implementation issues due to the residential nature of the properties, or from the additional costs associated with treatment. If characterized as hazardous, however, the material may be treated off-site prior to disposal.

20.6 Five-Year Review Requirements

If fully implemented, this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action. However, if cleanup standards are still exceeded at the maximum practicable excavation depth, this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure at a limited number of locations. Under those circumstances a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

20.7 Summary

Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best trade-offs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, and considering state and community acceptance.

The selected remedy offers a high degree of long-term effectiveness and permanence. These benefits are achieved at a reasonable cost.

The total estimated costs for the selected remedy at this Site are as follows:

Alternative	Total Capital Cost	Total O&M	Total Present Worth
2C	$16,200,000	$ 0	$17,900.000

21.0 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

There are no significant changes to the preferred alternative as presented in the proposed plan.

Part 3: Responsiveness Summary

This Responsiveness Summary has been prepared to meet the requirements of Sections 113(k)(2)(B)(iv) and 117(b) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA), which requires the United States Environmental Protection Agency (EPA) to respond "...to each of the significant comments, criticisms, and new data submitted in written or oral presentations" on a proposed plan for remedial action. The Responsiveness Summary addresses concerns expressed by the public, potentially responsible parties (PRPs), and governmental bodies in written and oral comments received by EPA and the State regarding the proposed remedy for the South Minneapolis Residential Soil Contamination Site, Minneapolis, Minnesota.

Public Comment Period

A public comment period on the Proposed Plan for this Site was held from June 2, 2008 to July 1, 2008. As part of the public comment period, EPA held a public meeting on June 11, 2008. The Agency accepted both written and oral comments and questions at the meeting. Approximately 40 people attended the meeting. Approximately 7 comments were received orally at the public meeting and 9 letters with written comments were received by the Agency. Approximately 15 comments were submitted through email or's web page.

The next section contains a summary of the substantive comments received and the EPA's responses to those comments. Complete copies of all of the comments can be found in the administrative record.

Public Comments

Comments from General Public

Comment #1:

One commenter stated concern about the length of time required to complete the cleanup. One commenter stated that more crews should be added to shorten the time required to complete the work. One commenter stated that their child has lived in their home since she was two, and will be eight by the time the cleanup is complete. The commenter also said that she didn't think the investigation was completed efficiently and that studies from other sites should have been relied upon to make decisions at this site, instead of using time to replicate studies.

Response #1:

The timeframes estimated in the feasibility study are primarily developed to compare relative differences in remediation timeframes between alternatives. These timeframes should not be considered a final projection of remediation timeframe. A more accurate timeframe will be developed as part of the Remedial Design process and consideration will be given to methods to effectuate work as efficiently and safely as possible, given the constraints within the neighborhood (e.g., traffic flow, staging areas). We will certainly evaluate the best practices achieved during the removal action and look towards improving our methodology, based on lessons learned from the On-Scene Coordinator. The Agency's goal is to complete the work as efficiently, effectively, and safely as possible. Ultimately however, the remediation timeframe for a project like this will be governed by factors that will not be known until construction actually begins. These factors include weather, access to the properties, and resource availability.

Every effort will be made during the Remedial Design to identify ways to expedite the cleanup process. As noted by the commenter, the use of multiple crews may be a way to expedite the work. Part of the evaluation during the Remedial Design will be to determine the number of crews that can effectively and efficiently work within the site area. Experience gained from the Removal Program's work over the last 3 years has shown that there are limiting factors to the number of crews that can effectively work in the area. One such factor is the availability of space to store equipment. It has been an extremely difficult task locating space to store equipment during the removal process and they have used a small number of crews (3-5) to complete the 30 to 60 yards per year. The feasibility study has estimated that it may take 4 years to cleanup approximately 488 properties under Alternative 2C, or over 100 properties per year. While we think this is an achievable goal, it will require a great deal of space to accommodate the necessary crews. We hope to work with the City of Minneapolis, to identify, or make available, the resources needed to efficiently complete this work. However based on our knowledge of the area, its space limitations, and traffic congestion, we think that 4 years is a reasonable estimate to complete the work.

To the extent that we could, EPA used information gained from other sites, or programs, to develop a cleanup plan at the South Minneapolis Residential Soil Contamination Site. For example, the Agency has developed guidance documents like the August 2003, *Superfund Lead-Contaminated Residential Sites Handbook* which was used to develop the sampling plans and cleanup approach for this site. Knowledge gained from other sites did allow us to greatly focus the Feasibility Study and only look at alternatives that had a reasonable likelihood of succeeding. However, CERCLA and the NCP require the Agency to perform site-specific investigations, including a site-specific risk assessment. Every site has different circumstances, e.g., the type of contaminant, the extent of contamination, the media affected, property use in the area, and the population affected. For example, a cleanup selected for an arsenic contamination in a rural mining area may not be appropriate for a site in large city. In order to develop a cleanup plan that will be effective in addressing the risks posed by the site contamination, it is imperative to perform a site-specific investigation and analyses.

Comment #2:

One commenter suggested that EPA consider composted material to put on top of the "toxic dirt." They stated that it would be a "whole lot easier and cheaper, more pleasant, and less use of fossil fuels." They suggested that covering up the contaminated dirt would be preferable to taking out, and replacing, trees, shrubs and grasses. They wondered if stirring up the arsenic laced dirt into the air isn't a risky procedure in terms of people breathing it in. They provided a chapter from the *Human Manure Handbook*, by Joseph Jenkins to support the idea that applying compost to the soils would result in less bioavailable arsenic in the soil.

Response #2:

EPA evaluated technologies other than excavation and off-site disposal for this site. The details are contained in the Feasibility Study contained in the Administrative Record. One technology considered was phytoremediation with ferns. Ferns are known to take up arsenic from the soil. The ferns would be planted in contaminated areas and harvested. Ultimately, this technology was eliminated from consideration because of the length of time it would require to achieve cleanup standards, and the practicality of planting ferns across peoples' residential properties, and limiting other uses of the peoples front and backyards.

The literature cited by the commenter presents only information on the effect of composting on the bioavailability of lead in soils. No data was presented on arsenic bioavailability. However, assuming the technology would work on arsenic, it appears from the article that the technology still requires working the compost into the soil. It therefore has some of the same soil handling issues as the selected remedy of excavation and off-site disposal. The information provided also does not address whether the affect of composting on the material is permanent or if it is reversible over-time. It also does not address the volume of compost that would be required to effectively treat the soil. The concern is that bringing in excessive volumes of compost may adversely affect ground elevation and cause drainage and/or foundation issues. In addition, the composting effort would be very labor intensive, creating substantial worker exposures to arsenic.

EPA believes that excavation and off-site disposal is the only approach demonstrated to effectively and permanently minimize the residents' exposure to the contaminated soil.

Comment #3:

One commenter stated that this is "...a total waste of money, for a piece of ground that no one will use. The risks are so minimal. The expenditures of federal dollars simply reinforces the need for more government money. If the site is so bad how come people haven't been dying in the preceding years?

This is what happens when bleeding heart liberal democrats use their heart instead of their brain. Do alternative #1 and forget it."

Response #3

EPA respectfully disagrees with the commenter.

EPA performed a baseline risk assessment at this site. The baseline risk assessment is an analysis of the potential adverse health effects (current or future) caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action).

The risks posed by arsenic at this site exceed levels deemed to be considered safe (as established by statute and regulation). EPA generally describes risks in terms of probability or the specific chance of getting cancer. At this site, adults and children in the neighborhood currently have a direct contact exposure threat from the arsenic with a 1 in 10,000 (1×10^{-3}) probability of getting cancer. This level exceeds what Congress has deemed an acceptable health risk. Therefore, EPA is required by law to take an action. The commenter should also note that the properties we are cleaning up have a current and future use as homes for hundreds of people.

Finally, the risk assessment performed by the Agency looks at probabilities and does not do an evaluation of the state of people's current health. This program is only required to analyze potential current and future risks from contaminants.

Comment #4:

One commenter stated that their property is right on the edge of the site and no one has contacted them (e.g., called to discuss soil removal) and they do not know if their home is being considered for cleanup. Another commenter suggested that the Site be expanded to include all homes out to the Mississippi River.

Response #4:

The commenter should have received information from EPA throughout the RI/FS process. The Agency has continually reached out to the community to keep them informed about the cleanup, including the decision to limit the site investigation area to the air dispersion boundary. The Agency's mailing list has included everyone living within one mile of the former plant site. The Site investigation area is a ¾ mile radius from the pesticide manufacturing plant formerly located at 28th and Hiawatha. The intent was to include people outside of the area that was affected by the Site so they too would know the status of the Site. As a result, the mailing list includes approximately 10,000 properties. EPA has also held public availability sessions throughout the Site area at several times during EPA's involvement at the Site. Those meetings were announced through mailings, newspaper advertisements, and press releases.

EPA's authority is limited to the area that was impacted by contamination from the pesticide manufacturing plant known as the Lite Yard. While there may be properties outside of the investigation area with high levels of arsenic, the Agency's investigations show that the effects from the plant site (and so the scope of EPA's legal authority under Superfund) are limited to the area already investigated. The commenter's property is outside of the area that the Agency believes may have been affected.

While the Superfund Program cannot cleanup properties outside of our site investigation area we can work with the owners to identify ways to minimize the risks associated with exposure to the soils. A fact sheet can be found at http://epa.gov/region5/sites/cmcheartland/pdfs/fs_english_200605.pdf, which explains ways to reduce exposure to the contaminated soil.

Residential properties with elevated arsenic were identified in the Site area in all directions and across much of the Site. Statistical analyses provide some correlation with the CMC Heartland Site; however, the analyses do not indicate the CMC Heartland Site property is wholly responsible for all of the arsenic impacts, particularly the highly elevated arsenic results further removed from the CMC Heartland Lite Yard property.

EPA used the results of the ISC3 air dispersion model to estimate the extent of the impact the former plant site had on the surrounding residential area. The model results suggested that the plant likely impacted an area with an approximately ¾ mile radius. Sampling of all the residential properties within that area found decreasing arsenic concentration trends present in a few directions from the CMC Heartland Site. These trends are strongest at lower arsenic concentrations and the overall variability in the data limits the predictability of these relationships. This shows contribution of arsenic by the plant site property to the surrounding area. The site conceptual model, of arsenic contamination due to aerial dispersion, does not fully account for all of the relatively high concentrations of arsenic in all directions and distances which do not demonstrate directional or distance trends with the CMC Heartland Site property. The likelihood of intervening acts at many properties in the investigation area makes it very hard to evaluate statistical significance. Some of those acts (e.g., pesticide application) could increase surface arsenic levels, while others (tilling, sodding, and construction) could decrease surface arsenic levels.

Based on the results of the air dispersion model EPA believes that contribution from the facility is limited to the approximate ¾ mile radius area sampled in the remedial investigation and depicted in Figure 3 of the ROD. While the data did indicate some contribution from the plant site to the surrounding area, it does not support impacts beyond the area already tested. Therefore, the agency will not be expanding the site area beyond the current boundaries. While there is uncertainty, in some cases, about the levels of contribution from various sources of the elevated arsenic, the arsenic concentrations are present at levels that pose a human health risk and require some action by EPA.

Comment #5:

Several commenters said that they would like to see EPA select 16 parts per million as the arsenic cleanup standard for the Site. One stated that we need to safeguard as many people as possible and cleaning up 488 properties is not enough. They requested that we please follow Council Member Gary Schiff's recommendation that would have properties cleaned up to 16 parts of arsenic per million parts soil, affecting 631 properties.

Another commenter stated that they are concerned by the current clean up plan and do believe that the level of contamination that qualifies for clean up should be lowered, and additional yards should be cleaned.

Several commenters stated that they believe Alternative 3B should be selected. One stated that the fiscally responsible, long-term mitigation measure for this issue is Alternative 3B. The right solution is to permanently remove all of the soil with arsenic levels above 16 mg/kg at the South Minneapolis Soil Contamination Site. One said compromising this alternative will only put future generations at risk and create even greater expenses and mitigation needs in the long-term. They said their children and their children's safety are worth the extra investment to do it right this time. One commenter suggested that this would be an investment to lower hospitalization and health care costs related to the soil and air contamination. One commenter said that EPA's cleanup plan focuses on the long-term effectiveness and permanence of removing contaminated soil from their neighborhood. It is the most cost-effective approach to saving future generations from undergoing costly mitigation measures

Response #5:

The Agency acknowledges the comments, but based upon considerations of the requirements of CERCLA, the NCP, and balancing of the nine criteria, EPA believes that Alternative 2C, and a cleanup level of 25 mg/kg arsenic, is the most appropriate for the South Minneapolis Residential Soil Contamination Site. Alternative 2C provides the best balance of tradeoffs between alternatives with respect to the balancing and modifying criteria. EPA considers Alternative 2C the most cost-effective alternative.

The purpose of this response action is to control risks posed by direct contact with arsenic contaminated soil as a result of releases from the pesticide manufacturing plant formerly located at 28th and Hiawatha. Since no Federal or State ARARs exist for arsenic in soil, the preliminary remediation goals for arsenic were determined through a site-specific risk analysis and the final cleanup levels were selected based on risk management principles and the analysis of each alternative against the nine evaluation criteria, consistent with the NCP.

EPA believes the minimal risk reduction that might be achieved through a cleanup standard of 16 mg/kg versus one of 25 mg/kg is offset by other factors such as decreased short-term effectiveness, implementability, and increased cost. Along with an increase in the number of properties that would need to be cleaned up using 16 mg/kg as the cleanup standard would come increased risk from truck traffic, increased risk of property damage, and increased risk to the cleanup crews. Also as the number of affected properties increases do does the difficulty in getting all of the property owners to agree to allow the cleanup. We do not believe it is cost effective to spend an additional 25% more on the remedy only to have a final cancer risk that is within the same order of magnitude as the proposed remedy and at the same time increasing the short-term risk, decreasing the implementability. In addition, the greater scope of excavation work adds two years to the project, significantly increasing disruption and inconvenience to the residents and creating additional project and waste transportation and handling issues.

The Agency believes that a full understanding of the risk assessment results and its uncertainties is necessary to understanding the risk management decisions that are being made at this Site. Table 9 from the Record of Decision summarizes the risk associated by various arsenic concentrations found at the Site. EPA generally considers people to be safe if the risk of getting cancer from contamination is as high as one in 10,000 (or $1x10^{-4}$), and as low as one in 1 million (or $1x10^{-6}$). As a measure of health impacts other than cancer, or non-carcinogenic risks, EPA uses what is called a hazard index. Generally, noncarcinogenic risks are considered unacceptable if the hazard index is greater than 1.0.

To ensure public health is protected, EPA uses worst-case, or "high-end" assumptions to determine risks. High-end estimates like these ensure that the actual chance of getting cancer will likely be below EPA's risk estimate. The level EPA considers "safe" is likely to over-state the actual human cancer risks. It's important to understand that the risk estimates are intended to provide the basis for EPA's decisions about cleaning up a site. They do not actually predict health outcomes.

The results of the baseline risk assessment for the Site indicate that existing conditions at the site pose an excess lifetime cancer risk as high as 6 in 1000 (or $6x10^{-3}$)from direct contact with arsenic contaminated soils. The soil arsenic background concentration of 16 mg/kg has a carcinogenic risk of 6 in 100,000 (6×10^{-5}) and a hazard index of 0.6. The selected remedy will address soil contaminated with arsenic in excess of 25 mg/kg which would correspond to an excess lifetime cancer risk of 1 in 10,000 ($1x10^{-4}$) and a hazard index of 1. Another way of looking at it is that soil contamination presents a (conservatively estimated) risk of 1 in 10,000 for arsenic concentrations of 25 mg/kg and of 0.6 in 10,000 for arsenic concentrations of 16 mg/kg.

Risk calculations are estimates built on a number of assumptions. Because of those assumptions, risk assessments have many uncertainties that have to be taken into account when the results are evaluated. Because of the types of conservative assumptions that were required to calculate the risks at this site, it is likely that this risk assessment has overestimated the risks, making the difference between 16 and 25 mg/kg even less significant. For example, the ability of the human body to take up arsenic, or be bioavailable, is an important input to the calculation. In this risk assessment, in the absence of any site specific data on bioavailability, EPA assumed that 90% of the arsenic in the soils is bioavailable. We assumed this because arsenic trioxide, as a pure substance, is very bioavailable. However, this material has been exposed to the environment for 50 to 60 years and become weathered. It has likely become associated with other minerals in the soil, making it much less bioavailable. Other forms of arsenic, which are less bioavailable are also naturally present in the soil and part of the total arsenic concentrations being reported. Based on this it is reasonable to assume that the risk associated with 25 mg/kg is much lower than the $1x10^{-4}$ reported in the risk assessment.

Another factor causing overestimation of the risk is the assumption that a resident will be exposed to the contamination for 50 years. EPA's *Risk Assessment Guidance for Superfund (RAGS)* (EPA/540/1-89/002) recommends using 30 years when site specific data is not available, as is the case here. During the risk assessment process the Agency received a comment that a longer exposure period should be used because people may not live in the same house longer than 30 years, but they will live in the same general area for a longer period. The Agency decided to use 50 years instead of 30. The potential effect is an almost 60% increase in the calculated risk estimate.

One measure of the overestimation of the risk can be made by comparing the reasonable maximum exposure to an average, or central tendency exposure (CTE) risk for the same population. If the Agency were to base a cleanup decision on the average exposure scenario, arsenic levels as high as 119 mg/kg would fall within the acceptable risk range. This would indicate that by using the conservative assumptions in this risk assessment, risks to the average person may be overestimated by as much as 3 fold.

All of the factors that tend to over inflate the risk calculations will tend to minimize any potential risk difference between two arsenic concentrations. The calculated risks for 16 mg/kg and 25 mg/kg of arsenic are both within EPA's acceptable risk range and both are within the same order of magnitude..

This remedy will also address all soils deeper than 12 to 18 inches below grade contaminated with arsenic in excess of 95 mg/kg. Construction workers are the population most likely to be exposed to contaminated soils deeper than 12 inches. Arsenic concentrations of 261 mg/kg represent a hazard index of 1.0 and carcinogenic risk of $7x10^{-5}$ for construction workers. Resident exposure to high arsenic concentrations in deep soil is only expected in rare circumstances and only for short periods of time and less frequently than the construction worker. Any risks from exposure to arsenic contamination in the deep soil would be mitigated through the inevitable mixing of the deep soil with the clean, shallow soil, resulting in lower exposure point concentrations. Therefore, the acute exposure-based removal action level of 95 mg/kg, is considered appropriate and protective for the long-term. In terms of chronic, lifetime exposures, 95 mg/kg arsenic represents a chronic reasonable maximum exposure carcinogenic risk for residents of $4x10^{-4}$ and a hazard index of 4.0. This arsenic level represents a lifetime carcinogenic central tendency exposure risk for residents of $8x10^{-5}$ and a central tendency hazard index of 2.0. Again, these risks are mitigated by the inevitable mixing of clean shallow soil with the deep soil and the fact that chronic exposure to the deep soils is not a reasonable assumption.

Comment #8:

One commenter stated that the magnitude of this project makes it the opportunity to clean the Site to background levels. They said that EPA as the infrastructure in place and will be able to work through the implementations obstacle to a more thorough cleanup.

Their primary concern is the ability of the public to assess the cleanup proposals because it is not clear how the Agency selected 16 mg/kg as the background level for arsenic in the Site soils. They believe that 10 mg/kg should be used as background instead of 16 mg/kg because it represents the population of data that is "clearly background", instead of 16 mg/kg which represents the lower limits of the population that is a mixture of background concentrations and anthropogenic arsenic. They also stated that if EPA is not willing to use 10 mg/kg instead of 16 mg/kg then the Agency should explain the alteration of the "clearly background" figure in the written and oral presentations of its cleanup proposals to the public. The commenter questioned, "If readings below 10 mg/kg were identified as "clearly background," then why apply a reading for "potentially impacted" soil to establish the background level? And if there is a range of readings for "potentially impacted soil" from 10 mg/kg to 16 mg/kg, why choose the uppermost limit for the background level (why 16 and not 10)?" They also said that earlier in the project the Agency referred to lower concentrations, (e.g, "lower than 10") as background for the area. They said the difference in the background level alters the significance of the EPA preferred plan to remove "shallow" soil above 25 mg/kg (Plan 2C). They stated that the bottom line is that what appears to be an unreasoned inflation of the background arsenic level does not give citizens an accurate context in which to assess EPA cleanup plans.

Response #8

EPA respectfully disagrees with the suggestion that the "clearly background" arsenic concentration range, or 10 mg/kg, be used as the basis for the remediation goals rather than 16 mg/kg. The challenge at this site has been to identify the background concentration for arsenic in soils that have many potential sources of arsenic beyond the former plant site. Because of the numerous possible sources of arsenic in an urban environment like south Minneapolis, it was necessary to derive a background concentration based on a statistical evaluation of the available data.

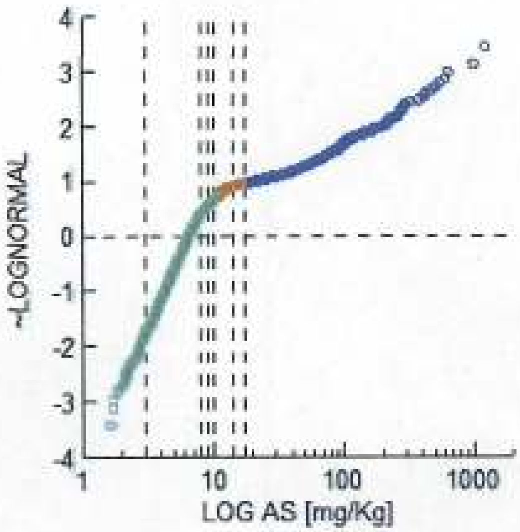
The commenter acknowledges that based on the statistical evaluation, discussed in more detail below, there are three populations of arsenic results at the site: 1) those that are clearly background, 2) those that are clearly a separate population, and 3) those that are mixture of the two. The question posed by the commenter is, should the Agency consider the mixed population part of the background, or not? Our evaluation of the data shows that the "mixed population" likely consists of levels that are not site related, i.e. background, but because of influences from other sources it is impossible to differentiate the populations at these levels. EPA believes it is appropriate, and consistent with Agency policy and guidance, to include the mixed population as part of the background population. Further, the risk assessment estimates the excess lifetime cancer risk from exposure to 10 mg/kg of arsenic at $4x10^{-5}$ which is not significantly less than the risk at

16 mg/kg of $6x10^{-5}$. Therefore, the Agency's decision on the selected remedy would not likely change even if the background concentration was dropped from 16 mg/kg to 10 mg/kg.

EPA's policy on handling background concentrations is discussed in the April 26, 2002 OSWER Directive 9285.6-0, *Role of Background in the CERCLA Cleanup Program* and also in the July 1996, *Superfund Soil Screening Guidance: User's Guide (Publication 9355.4-23)*. As the OSWER Directive states, "Generally, under CERCLA, cleanup levels are not set at concentrations below natural background levels. Similarly, for anthropogenic contaminant concentrations, the CERCLA program normally does not set cleanup levels below anthropogenic background concentrations." The Soil Screening Guidance states, the intent of this policy "is to avoid creating 'clean islands' amid widespread contamination".

To evaluate background concentrations at this site, a statistical analysis was performed using 7,519 surface soil sample results collected between 2001 and 2006. Probability plots graph the measured concentrations against those expected if the data (or the transformed data) are normally distributed. As a result, the data points tend to form straight lines when the data resemble a normal distribution (or when the log-transformed results resemble a lognormal distribution).

The figure below indicates several things. First, the arsenic data are neither normally nor log normally distributed. Next, the break in the plots suggests the existence of two distinct and different distributions. The set of color-coded green points corresponds to lower 'background' levels while the dark blue points indicate a population that is distinctly different, evidencing a flatter slope, limited to concentrations in excess of approximately 16-17 mg/kg. Points coded red suggest a region of potentially 'mixed' results, the range over which the highest background and the lowest contaminated results overlap. The subsets indicated in the arsenic probability plot correspond to arsenic levels from the minimum detected to 10 mg/Kg (preliminarily 'background'), concentrations in excess of 17 mg/Kg (exceeding background) and the intermediate concentrations greater than 10 mg/Kg but less than 17 mg/Kg, which are mixed points, overlapping the upper bound of background and lower bound of contamination.



The broken lines cut the x-axis at arsenic concentrations which correspond to literature values originally proposed by various parties for background arsenic concentrations at the site, including:

• Minnesota Department of Health (MDH)/Minnesota Department of Agriculture (MDA) determined background concentration of 4–5 mg/kg (Tetra Tech, 2005);

• US Borax investigation neighborhood background concentration of 7.15 mg/kg (Geomega, 2004);

• Background arsenic concentration of 12 mg/kg or lower (MDA, 2003); and,

• Morris Arsenic Dump background (Morris, MN) of 3 – 14 mg/kg (EPA, 2006).

We need to note here that the Agency's understanding of arsenic background at this site has been evolving over the course of our investigations. As at any site, as more data is gathered more is learned and the conceptual site model for a site is changed. Early comments regarding background were based on the best available information, which was limited. Having now sampled almost every property within the investigation area, we believe we now have a better understanding of the urban background levels of arsenic in soils.

The arsenic results less than 10 mg/kg (5929 results) represent the majority of available results. Background concentrations may actually be higher, but cannot be seen in the data because of the affect of site related contamination on the distributions.

Again, EPA's policy is to not clean up background concentrations of contaminants. In this case, the Agency has identified that the population of data with concentrations above 16 mg/kg is clearly not background. Therefore, the Agency has determined it appropriate to use 16 mg/kg in the decision process instead of 10 mg/kg as suggested by the commenter.

Comment #9:

One commenter expressed their concerns regarding EPA's proposed clean-up of the South Minneapolis Neighborhood. As a resident homeowner, mother of a toddler and a landlord in this neighborhood, I have many reasons to be concerned. While there are financial implications for myself and my neighborhood if EPA does not implement an adequate cleanup, nothing concerns me more than the health of my daughter or the health of the child I am currently carrying. In EPA's May 2008 mailing on the proposed cleanup, you discuss under "Health Risks to People and the Environment" that the most direct way one can be exposed to arsenic is by getting dirt on one's hands and then touching one's mouth or accidentally swallowing contaminated soil. It has been very stressful to have to worry about whether or not my daughter is incidentally ingesting contaminated soil when we play outside in our yard or neighborhood park. It is very depressing to notify friends who are over with their children for playdates with my daughter that they need to take extra precautions at my home because my neighborhood has arsenic contamination.

I am concerned and confused as to why EPA has selected a cleanup criteria of 25 ppm arsenic when area background has been determined to be 16 ppm arsenic and the Minnesota Pollution Control Agency's (MPCA) cleanup criteria for residential neighborhoods in the state of Minnesota is 5 ppm arsenic (http://www.pca.state.mn.us/publications/risk-tier2srv.xls). The South Minneapolis Residential Soil Contamination Site is, as its name states, a residential neighborhood and it is, of course, in the state of Minnesota. I do not see any logical justification for a cleanup that is below the state-mandated risk-based guidelines of 5 ppm arsenic.

I am an environmental scientist at an engineering company and am aware of more stringent cleanup criteria imposed by EPA at other arsenic contaminated sites in Minnesota (e.g. the St. Regis Paper Company Superfund Site). My South Minneapolis neighborhood warrants as stringent a cleanup as other neighborhoods with arsenic contamination.

In addition to my concerns regarding EPA's proposed alternative, I feel that the analytical results clearly indicate that the site has not been fully or adequately characterized. EPA's proposed wind distribution model for contaminant migration does not explain the migration of arsenic contamination within the neighborhood when one evaluates the analytical results. The analytical results do not identify a decrease in contaminant concentration with distance from the source, and there does not appear to be an identifiable plume with concentrations that can be readily contoured. I feel strongly that additional samples need to be collected in order to characterize the site.

I am hopeful that the EPA will address the above issues in their continued evaluation of the site, and that the arsenic contamination in my neighborhood will be addressed in accordance with MPCA guidelines.

Response #9:

The Agency understands the great concern residents have about their children being exposed to the contamination in the Site area. Throughout the investigation and cleanups both the federal and state agencies have worked to provide the residents with the information they need to make the appropriate decisions to ensure their families are protected, and to cleanup up properties as quickly as we can. In 2004, shortly after becoming aware of the high levels of arsenic in the area EPA began performing soil removals at the properties with the highest levels. At the same time the Agency began community involvement activities to make people aware of the problem.

It is true that other sites in the country have used lower cleanup standards for arsenic. However, there are also sites in the country that have used higher cleanup standards. A quick review of cleanup levels used across the country shows cleanup levels as low as 2 mg/kg (Valley Wood Preserving Site, California) and as high as 300 mg/kg (Triumph Mine Tailings Site, Idaho). The reasons for the differences can be varied, but highlight the fact that site-specific circumstances are used to determine cleanup standards at Superfund sites. There is no federal cleanup level for arsenic in soils. Nor is there a consensus across states on what final cleanup should be. In some cases there may be a State that has a promulgated standard that may be used, but that is not the case in Minnesota. Minnesota's Risk Based Site Evaluation program also recognizes the need to use site-specific information to establish cleanup levels. The 5 parts per million standard cited by the commenter is the Minnesota Pollution Control Agency's Soil Reference Value SRV. As stated in the August 9, 2006, *Health Consultation, Off Site Soils: CMC Heartland Partners LiteYard Site,* prepared by the Minnesota Department of Health,"The SRV is a screening number and indicates a level of a contaminant that warrants further consideration." SRV's are not promulgated standards and are not intended to be used as final cleanup levels for sites. They are used to screen sites to determine if more studies should be performed.

Absent a promulgated standard, to select a final cleanup standard, EPA's Superfund Program must rely on site-specific studies, including a remedial investigation, a risk assessment, and the analysis of cleanup alternatives against the nine-evaluation criteria, as specified by the NCP. As discussed above in the response to Comment #8, EPA policy does not allow the Agency to cleanup to levels below background, which in this case is 16 mg/kg. Also, as discussed in more detail in the responses to Comments #5, EPA believes that 25 mg/kg is a protective cleanup standard provides and is the most appropriate for the South Minneapolis Residential Soil Contamination Site. Alternative 2C provides the best balance of tradeoffs between alternatives with respect to the balancing and modifying criteria.

Comment #10:

Two commenters asked the Agency to please cleanup the site and not to choose doing nothing. One stated that EPA has waited too long for action.

Response #10:

The Agency has worked as quickly as possible to cleanup this site. The site was brought to the Agency's attention in 2004 and it began soil removals that same year. This site has had some difficult technical issues to address before a final cleanup plan was selected, but we believe we have worked through those issues as quickly as possible.

Comment #11

Several commenters said they heard EPA will not clean up the arsenic contaminated soil around the community. They hope that isn't true for the children's sake and the future of the community. One commenter had great concern over the Agency not cleaning up the neighborhood. They stated that many lives, and the lives of many children, depend on the cleanup. One of the commenters wondered if we would choose not to cleanup the neighborhood if it was mostly white and wealthy. Another commenter stated that if this was a well to do neighborhood something would be done. They stated that it is detrimental to all the babies, children and families that live and work in the community.

Response #11

EPA believes the commenters have misinterpreted the proposed plan. EPA is in fact taking action to help protect all of the residents from the unacceptable risks posed by the arsenic contamination in the site area. This cleanup plan is based on the risk to children who live in the area. EPA has selected Alternative 2C which requires the cleanup of approximately 488 properties.

Comment #12:

The opportunity for the public to comment on the arsenic clean-up or lack of clean-up by EPA needed to have been widely publicized in a timely manner in order for EPA to have a comprehensive understanding of the public's concerns regarding this matter. Secondly, EPA's disregard for the health of the community in which the arsenic triangle is located is inhumane. Inhumanity, including preventive illnesses caused by toxic poisons such as arsenic, deteriorates the longevity and quality of life for all human beings, not just low-income, people of color.

Response #12:

EPA respectfully disagrees with the commenter. The Agency provided adequate advance notice of the public comment period and made that announcement widely available in several different ways. The announcement of the proposed plan public comment period and public meeting was mailed out to 10,000 recipients prior to the meeting and a notice was published in the Circle Newspaper on June 1, 2008. Also, an insert announcing the meeting was included in the June 2008 edition of the Corcoran newspaper. A press release was also sent out to all of the local news media prior to the public meeting.

The Agency has not disregarded the health of the community. When all of the cleanup work is completed approximately 700 properties will have been cleaned up. The Agency is cleaning up all soils that pose an unacceptable risk to all of the residents, regardless of race or income.

Comment #13:

One commenter said they've worked in the Phillips community for the past 10 years and lived nearby for 40+ years and has great concern for not cleaning up this community. The contamination is everywhere. They work and serve their clients many who live in this community. Many of their friends and relatives live and work here. EPA must keep cleaning up this area. Many lives and the lives of many children depend on this. We need a healthy environment for future generations.

Response #13:

EPA acknowledges the comment. The Agency is doing what it can under its authorities to cleanup the arsenic contamination in the area.

Comment #14:

One commenter stated that they like Alternative 3A, but it has to be accompanied by replacing any plants, shrubs, etc. They have put a lot of money into the landscaping of their yard.

Response #14:

EPA acknowledges the comment; however respectfully disagrees that Alternative 3A should be selected. As discussed above, the Agency believes that Alternative 2C performs best when evaluated against the nine evaluation criteria, and is the most cost-effective cleanup plan. The selected alternative, 2C, does include provisions for the replacement of plants and the restoration of the properties to their original conditions, to the extent practicable.

Comment #15:

One commenter stated that they have over 30 varieties of hostas that are 10-20 years old, as well as other unusual plants, mature trees (including evergreens with shallow roots) and a relatively weed free lawn (through hand weeding every year). Removal of 12 to 18 inches of soil would effectively destroy the award-winning yard and likely kill some of the mature trees (including elms which would be severely impacted by damage due to

Dutch elm disease). Values reported for her yard vary from 26 to 63 mg/kg. Contaminant levels in soils, especially those covered by vegetation and mulch are not usually a consumption risk except for unsupervised children who shouldn't be eating soil for other reasons. The proposed dirt removal remediation stirs up soil, and potentially creates airborne arsenic contaminated dust, a higher danger than inert soil. Is there a chelation solution less invasive and disruptive than soil removal? What is the trend? They suspect arsenic values are declining with time. Would resampling show something? Is there an opt-out since sampling was voluntary initially? What scientific resources can they use to obtain more information?

Response #15:

EPA will do what we can to minimize the disturbance to the property and to find a way to preserve the landscaping, to the extent practicable. However, the commenter is correct, that if excavation is necessary much of the landscaping may need to be replaced. This is the unavoidable reality if we hope to permanently cleanup the arsenic contamination. The commenter is also correct, that covering the contaminated soil with mulch or vegetation is one means of preventing exposure to the contaminated soil. However, that is a short-term solution. In order for such a remedy to succeed it would require constant maintenance into the foreseeable future. While the current owner might agree to maintain the cover, there is no guarantee that they would be able to, or that future owners would be willing, or able to do the same. In the end, while there will be some short term disruption to the landscaping, it is most cost effective to remove the soil from the property.

It is possible for dust to be generated during the cleanup. Part of the cleanup plan will require constant monitoring of dust using air sampling equipment. If at any time unacceptable levels are detected, measures will be employed to control the dust, such as wetting the soil during excavation or application of other dust suppressants. It should be noted that in the 4 years of construction at the site under the Removal Program, and constant air monitoring, the Agency has never detected unacceptable levels of dust.

There are technologies available that treat soil to bind the arsenic making it less bioavailable. However, those technologies are not appropriate for a residential setting. They likely would require mixing the soil with some type of amendment. So you would have the same soil handling issues as excavation. The technologies would likely take much more time to complete and would require long-term monitoring to ensure that the contamination remained bound to the amendment. Excavation and off-site disposal is more permanent, more easily implemented, and cost-effective than the on-site treatment that the commenter is suggesting.

Total arsenic levels would not decline with time. Arsenic is a heavy metal and does not degrade. The only way for levels to lower would be via mixing the soil with clean soil or other amendment, i.e. through dilution.

There is no "opt out" to the cleanup. EPA believes that it is important to cleanup every property to make sure that all current and future residents are protected from the potential exposure to the contamination. At some point others may live on the property and have different lifestyles that would cause them to have more in contact with the soil, or less willing to maintain a cover over the soil. The Agency believes the permanent solution of excavation and off-site disposal is the most appropriate for this area. If for some reason an owner refuses to allow access to EPA to complete the cleanup, the Agency may seek to put use restriction and/or other notices on the property to ensure others will not be exposed to the contaminated soil.

There are numerous sources of information on arsenic and the available cleanup technologies, including local universities. One very good resource is EPA's Clu-in web site located at: http://www.clu-in.org/contaminantfocus/default.focus/sec/arsenic/cat/Overview. The web paged contains basic background information on arsenic and links to documents covering many aspects of the cleanup process for arsenic.

Comments from Public Officials

Comment #16:

Councilman Schiff stated that cleaning to background and doing a more thorough job makes the most sense to mitigate against cumulative health effects that are known in the neighborhood from other environmental impacts. The length of time should be shortened by adding more crews to the work area.

Response #16:

The comment raises issues similar to those addressed above. The reader should refer to Response #1, Response #5, and Response #7.

Comments from PRPs:

Comment # 17:

The commenter stated that EPA continues to suggest that the former CMC Lite Yard Site is the source of elevated arsenic concentrations found on the SMRSCS properties that are subject to cleanup. Despite the fact that U.S.EPA's own data and statistical analyses cannot link the former CMC Lite Yard Site to concentrations of arsenic in residential soil above normal background levels, EPA continues to use disproven air dispersion transport assumptions in its selection of residential properties proposed for cleanup (i.e. properties with elevated concentrations of arsenic located within a 3/4 mile radius of the CMC Lite Yard Site). The commenter is concerned that some of EPA's comments are misleading with respect to the sources of arsenic contamination in residential soils at the SMRSC.

The commenter asserts that EPA continued to make allegations implicating the former CMC Lite Yard Site even after it published statistical data evaluations and modeling documents reporting contrary conclusions as to source. They presented the following quotes from EPA:

- "Arsenic concentrations greater than background may not be linked to the CMC Heartland Site."
- "...small scale variability is not negatively related to distance from the CMC site... these areas of small-scale variability may be indicators of alternative anthropogenic sources of Arsenic (e.g. pesticide application.)".
- "...this looks like a general problem with arsenic throughout the area that we can't tie back to the CMC plant, so we don't have authority to address anything outside that area."

The commenter stated that to date, EPA has collected and analyzed thousands of arsenic samples within the SMRSCS. However, no statistically significant evidence or link to the former CMC Lite Yard Site has been made. Moreover, it asserts that EPA's reports conclude that the underlying assumption of contaminant transport that formed the basis of the identification of the source area and SMRSCS boundary are not supported by the data. Therefore, the commenter felt that claims filed by EPA in the CMC Heartland Partners bankruptcy matter for $29.4 million associated with the SMRSCS are unsupported and without merit.

The commenter stated that the data collected to date and statistical evaluations conducted by EPA and its contractors do not support the governing conceptual site model and underlying assumption that the former CMC Lite Yard Site is the primary source of arsenic contamination to the SMRSCS properties that are subject to cleanup.

They asserted that these reports provide strong statistical evidence upon which to conclude that the former CMC Lite Yard Site is not the primary source of arsenic contamination to the SMRSCS properties that are subject to cleanup. The RI Report concludes that, "Arsenic concentrations greater than background may not be linked to the CMC Heartland Site." This statement has important ramifications because only properties with arsenic concentrations in soil significantly above background concentrations will be remediated under EPA's May 2008 proposed cleanup decision for the SRMSCS.

Expected Data Trends

The commenter stated that the statistical analyses performed by EPA and its contractor indicate that site data do not support the assumed conceptual site model (aerial deposition of arsenic from the former CMC Lite Yard Site to properties within a 3/4 mile radius), making the assumed SRMSCS boundaries arbitrary and inaccurate. The observed spatial patterns of arsenic concentrations in soil provide insight into the source. For example, if the former CMC Lite Yard Site is the source of elevated arsenic concentrations the following data trends would be expected, but were not observed:

- Maximum arsenic concentrations decreasing with distance from the former CMC Lite Yard Site in all directions.

- Higher arsenic concentrations in primary downwind directions (northwest and southeast).

- An even distribution of arsenic concentrations in areas at similar distances and directions from the former CMC Lite Yard Site, i.e., variability should be present at a large scale, not varying widely from one property to the next.

- Arsenic concentration should not vary with property use. Schools, cemeteries, parks, and residential properties at similar distances and directions from the former CMC Lite Yard Site should be affected to the same degree.

If elevated arsenic concentrations are due to homeowner applications of chemicals, different trends in data would be expected, and were observed:

- A random pattern of elevated arsenic throughout the defined area;

- High small-scale variability in data (dramatic differences from property to property);

- The absence of elevated arsenic concentrations in non-residential soil;

- Arsenic concentrations increasing with home age (more time for buildup of arsenic in soil due to multiple applications of chemicals over time);

<u>Support for Sources of Arsenic other than the former CMC Lite Yard Site</u>

The commenter said the EPA's statistical evaluation of data and air dispersion modeling efforts provide several lines of evidence supporting sources of arsenic other than the former CMC Lite Yard Site. They stated the arsenic soil concentration data do not show the expected pattern of decreasing concentration as distance from the source increases. The absence of spatial patterns in elevated arsenic concentrations is inconsistent with the former CMC Lite Yard Site as the primary source of arsenic contamination to the SMRSCS properties that are subject to cleanup. The observed random scatter of arsenic in soil suggests that there are other sources contributing to elevated arsenic concentrations in the SMRSCS.

Moreover, the commenter asserts that if the former CMC Lite Yard Site was the source of elevated arsenic in the SMRSCS, one would expect that soil contamination show strong patterns of spatial gradients with distance and a correlation with wind rose frequencies.

However, there is a lack of concentration decay patterns in not only the primary downwind directions, but in all wind directions.

Distance is one of the major factors influencing airborne contaminant deposition and the magnitude of soil contamination from a source. If air dispersion from a source close to ground level were the primary transport mechanism, higher arsenic concentrations would be expected in closer proximity to the former CMC Lite Yard Site, rather than clustered at the southern-most extent of the study area as shown by the data. The CH2MHILL surface soil statistical evaluation concludes that the concentration trends are present in only some directions from the former CMC Lite Yard Site and the trends are weak with a high variability in the data limiting predictability of the relationships. In addition, the FIELDS air dispersion modeling report states that "small scale variability is not negatively related to distance from the former CMC Lite Yard Site, as would be expected if air-dispersion were a primary transport mechanism. Therefore these areas of small-scale variability may be indicators of alternative anthropogenic sources of Arsenic (e.g. pesticide application.)".

The RI Report suggests that a weak positive correlation between home age and elevated arsenic concentration is consistent with deposition occurring at these properties during the active period of manufacturing at the former CMC Lite Yard Site. This is not the only possible explanation. A positive correlation between home age and contaminant concentration is also consistent with a longer history of use of household or lawn chemicals. Note that a positive correlation between home age and lead concentrations in residential soil and dust is indicative of lead-based paint contamination.

A comparison of arsenic concentrations at residential properties to parks, schools and cemeteries corroborates this conclusion. The RI Report states that the sample results from the parks, schools, and the cemetery were within background levels (less than 10 mg/kg). The only properties where elevated levels of arsenic were detected are residential. As properties at similar distances and directions from the former CMC Lite Yard Site should be affected similarly, this result provides further support to the concept that the elevated arsenic concentrations are associated with household chemicals, rather than releases from the former CMC Lite Yard Site.

To summarize, the commenter states that EPA has admitted that it cannot link elevated arsenic concentrations (i.e., those that require remediation) to aerial deposition from sources at the former CMC Lite Yard Site. The proposed plan for the SMRSCS (the boundary for which is now shown to be baseless and therefore arbitrary) is to excavate and dispose of soil at concentrations of soil above 25 mg/kg in the first foot and 95 mg/kg at greater depth at an estimated cost of $17.9 million. Funds for these activities, while supported by the results of the risk assessment, cannot be justly recovered from the commenter.

Response #17:

EPA respectfully disagrees with the comment. The Superfund Program is based on the concept of strict, joint and several liability. Therefore, it is not necessary for the Agency to demonstrate that all of the contamination is from the plant site before taking an action and/or recovering its costs. EPA's statistical analysis of the sampling data makes a prima facie case that all or most of the homes requiring cleanup at the Site were contaminated with arsenic from the Lite Yard operations, even if other sources of contamination were involved, too. The facts and the legal standard place the burden on the potentially responsible parties to specifically demonstrate that contamination at certain properties is wholly unassociated with Lite Yard operations. For the reasons discussed in the ROD and in the Responsiveness Summary, given all the variables it would be extremely hard to make that demonstration. Strict, joint and several liability would therefore apply to the owners and operators of the Lite Yard, who would in turn have the right to seek contribution from other parties responsible for contamination at the Site.

The fact that the releases from the former plant site occurred 40 to 70 years ago, into a highly active residential area, was a complicating factor when trying to define the area of contamination. Disturbances to the area soils by residents, perhaps bringing in fill, turning soil, or even applying arsenic-containing materials, likely masks concentration trends that exist and would otherwise more clearly support EPA's conceptual site model. By using an air dispersion model EPA was able to define an area that may have been impacted by releases from the plant site. The model was based on the available information on the plant operations and the materials (arsenic trioxide) used at the facility. The results of the model predicted an area of about a ¾ mile radius might have been impacted.

We agree with the commenter that the arsenic concentrations detected in the residential properties are not wholly consistent with a conceptual site model based only on air dispersion, and it does appear that not all of the elevated arsenic concentrations in soil are solely attributable to the CMC Heartland Lite Yard operations. The occurrence of elevated arsenic in all directions, across much of the investigation area indicates some of the highest levels of arsenic, especially at greater distances from the CMC Heartland Lite Yard property, may also partially be the result of a property specific use or application (e.g. fertilizer or pesticide application, use of pressure treated lumber, on-property disposal of coal ash). However, when looking at the data as a whole EPA believes the former plant site is also likely the source of high arsenic levels seen throughout this area, and especially in close proximity to the Lite Yard. The trend analyses of all the data show that in the northwest, west and southwest directions there is a decreasing concentration trend moving away from the site, seen most clearly at lower concentrations. The decreasing trends are consistent with aerial dispersion from the former plant site.

Counter to what the commenter stated, the directions where we see decreasing trends are in the directions of the prevailing winds in the summer months when the plant was operating. While the conceptual site model suggests that air dispersion occurred primarily in the summer months when winds are predominantly to the northwest, there is a component of the wind patterns that does blow to the southwest and southeast. It is therefore quite possible that arsenic from the site was dispersed to these areas. While the statistical analysis of the trend to the southeast does not seem to support the expected decreasing concentrations, this analysis is hampered by the absence of data within the first 1000 meters from the source due to redevelopment within that area. On the other hand, arsenic concentrations to the southwest do show a decreasing trend.

The likelihood of intervening acts at many properties in the investigation area makes it very hard to evaluate statistical significance. Some of those acts (e.g., pesticide application) could increase surface arsenic levels, while others (tilling, sodding, and construction) could decrease surface arsenic levels. In addition to the directional trend data, the fact that properties with homes built after 1960 predominantly have concentrations near background, supports EPA's conceptual site model. In approximately 1960, active shipments of powdered arsenic to the Lite Yard ceased. From that point on, air dispersion of the residual arsenic from the Lite Yard would have been more limited and more localized (to residences in close proximity). If common use of pesticides was the primary explanation for the residential arsenic contamination at the Site; we would expect to see elevated levels on properties from both the pre- and post - 1960 periods. However, we do not.

This all indicates that the elevated arsenic levels likely resulted from some source other than pesticide application. All of this information supports EPA's conclusion that the former plant site has caused elevated levels of arsenic in the soils of the surrounding areas, and that the area affected is limited to the current investigation area as defined by the results of EPA's air dispersion model.

References

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FIGURES

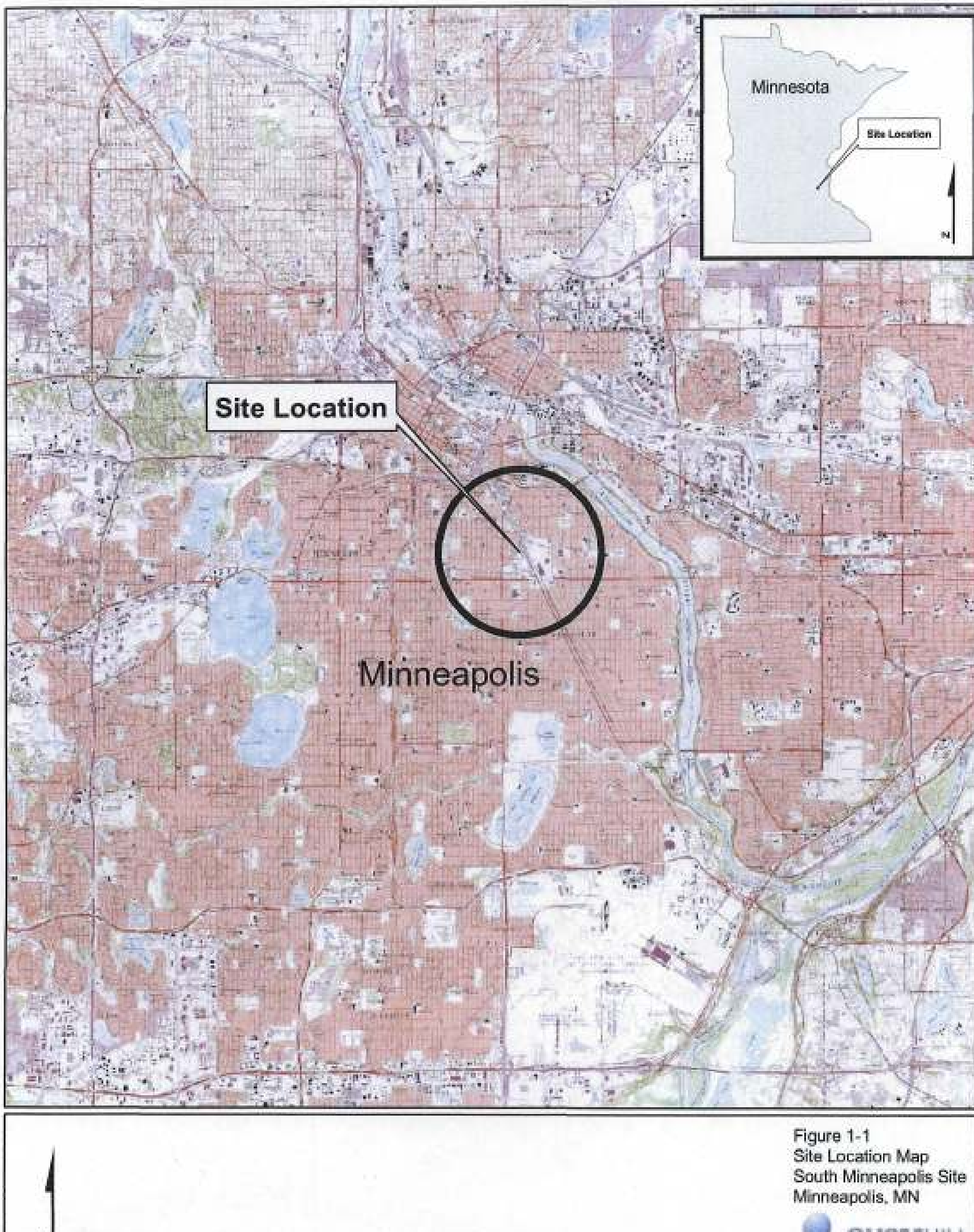

Figure 1-1
Site Location Map
South Minneapolis Site
Minneapolis, MN

MKE \\WAVE\PROJ\EPA\336732-SOUTH_MINNEAPOLIS\MXDS\FINAL_REPORT\FIG01-1_SITE_LOCATION_MAP.MXD 8/30/2007 09:48:46

Figure 1

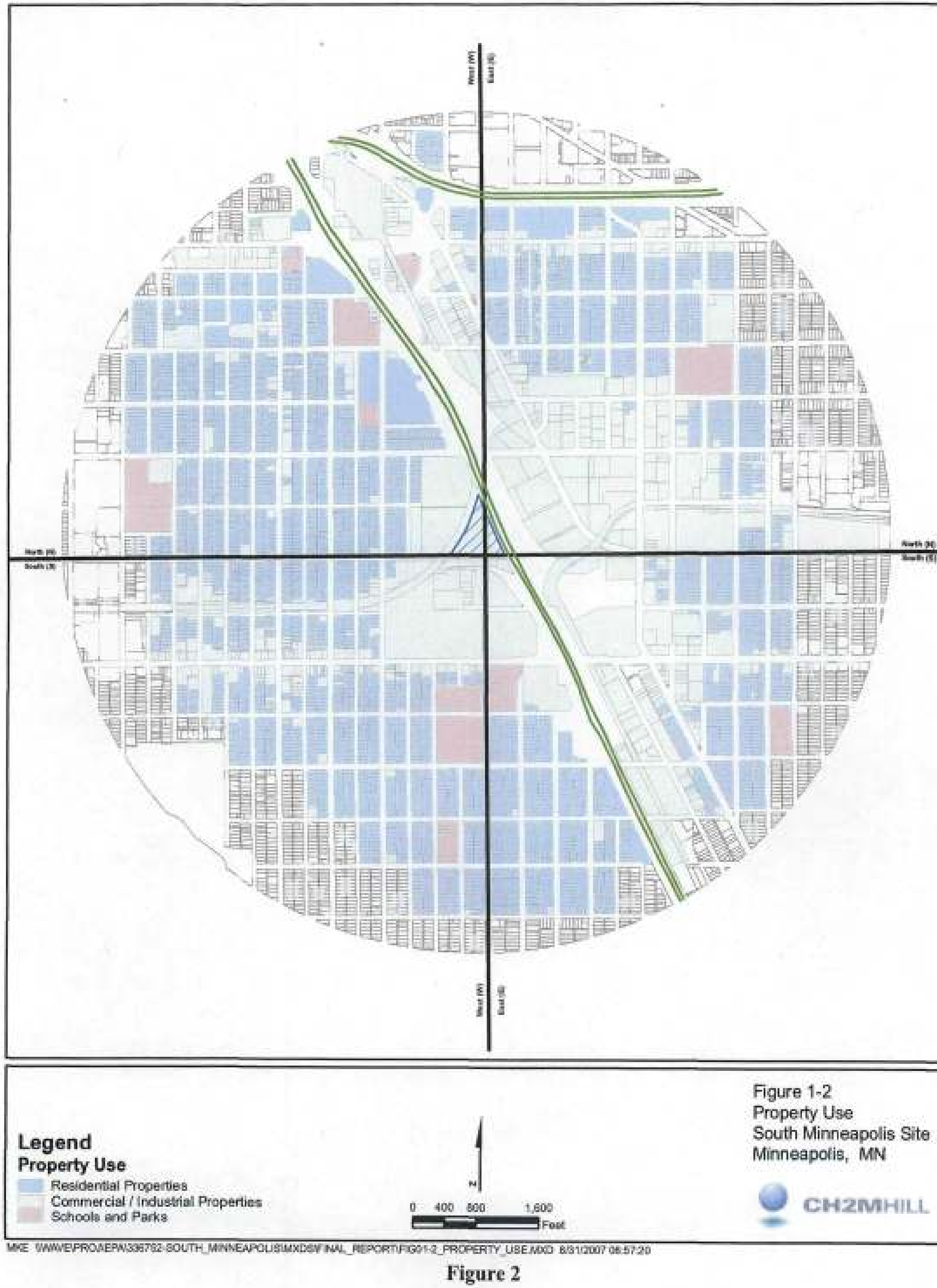
West (W)
East (E)
North (N)
South (S)
Legend
Property Use
Residential Properties
Commercial / Industrial Properties
Schools and Parks
N
0 400 800 1,600
Feet
Figure 1-2
Property Use
South Minneapolis Site
Minneapolis, MN
CH2MHILL
MKE \\WWE\PROJ\EPA\336792-SOUTH_MINNEAPOLIS\MXDS\FINAL_REPORT\FIG01-2_PROPERTY_USE.MXD 8/31/2007 08:57:20

Figure 2

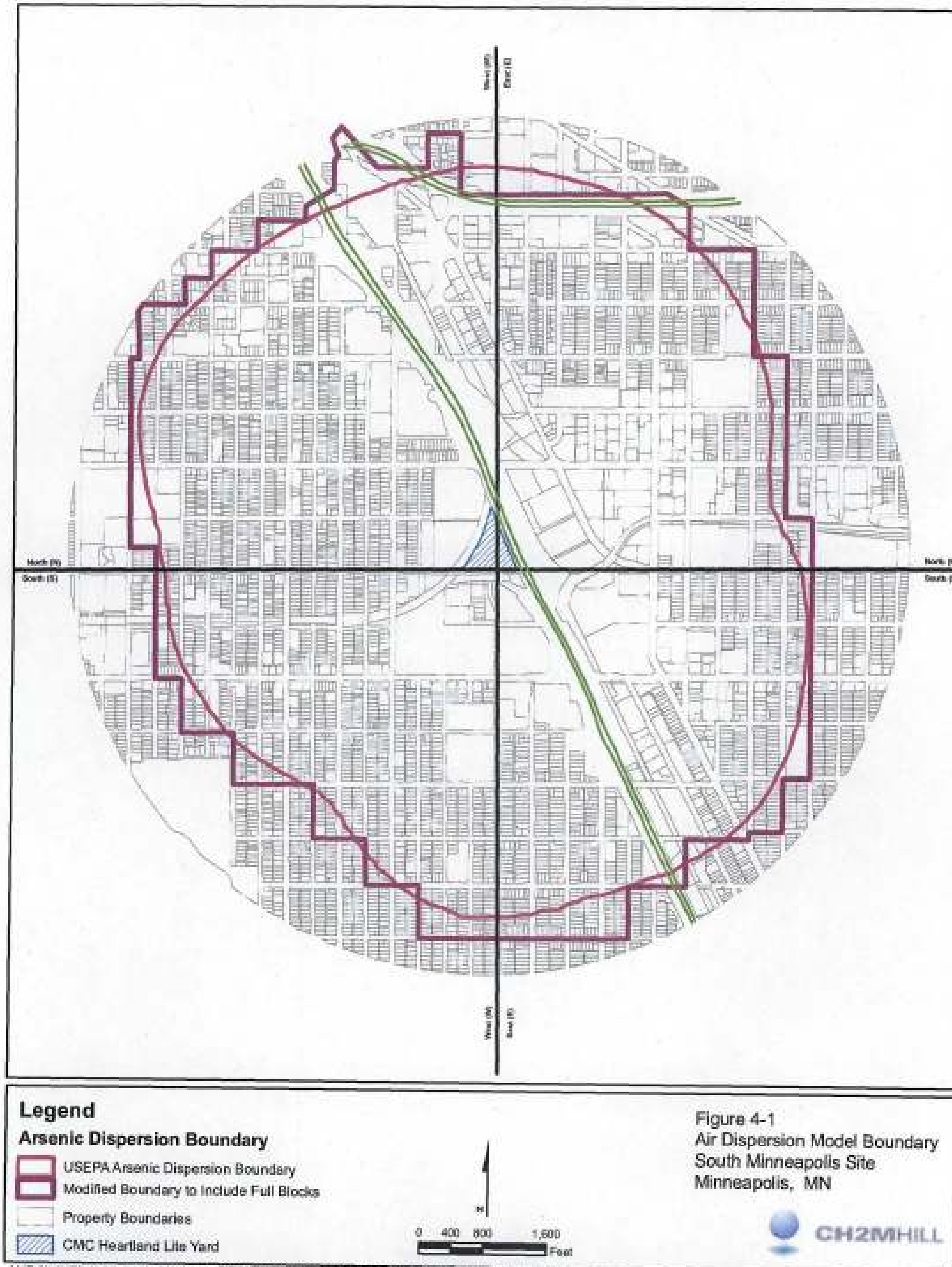

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Figure 3

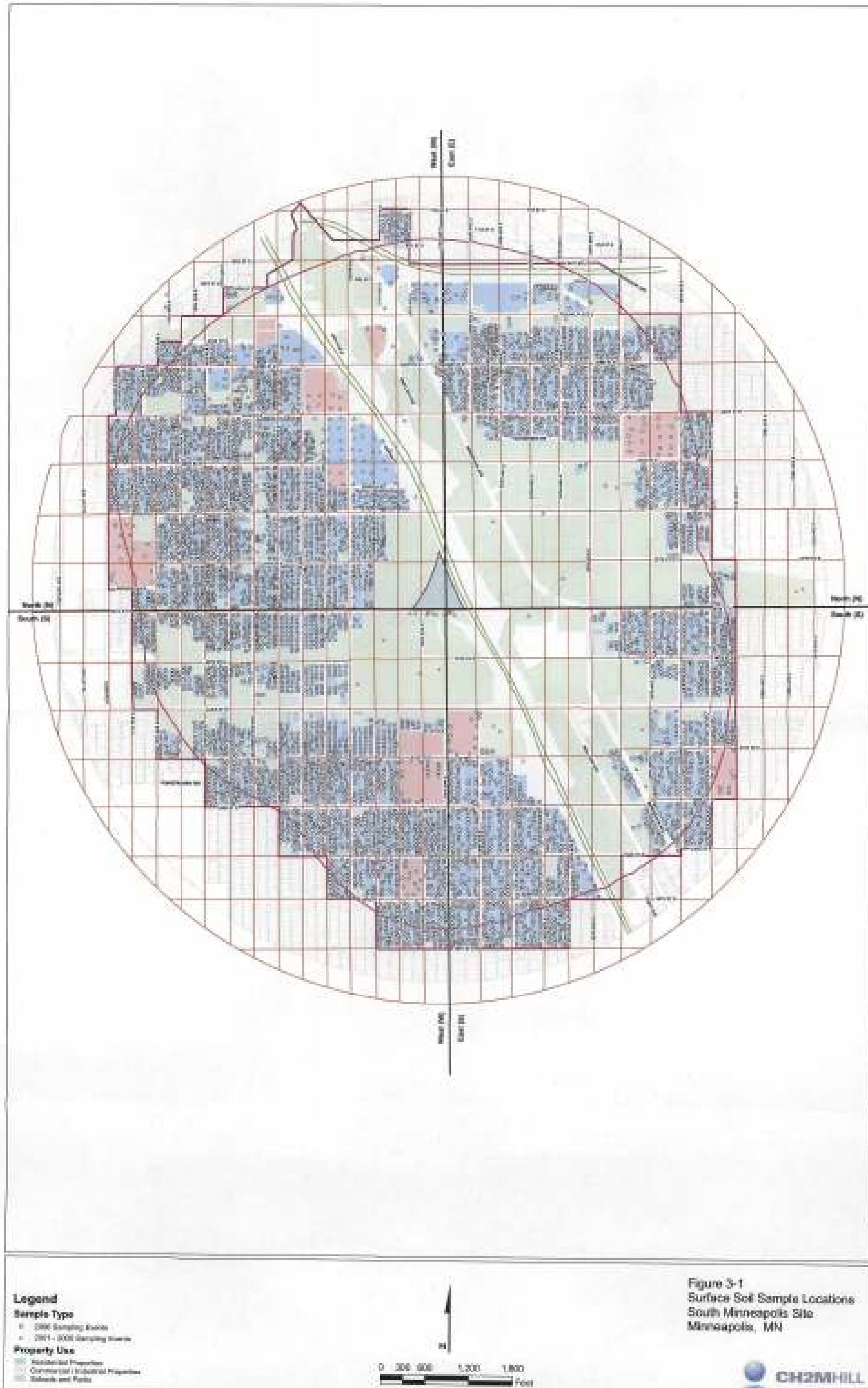
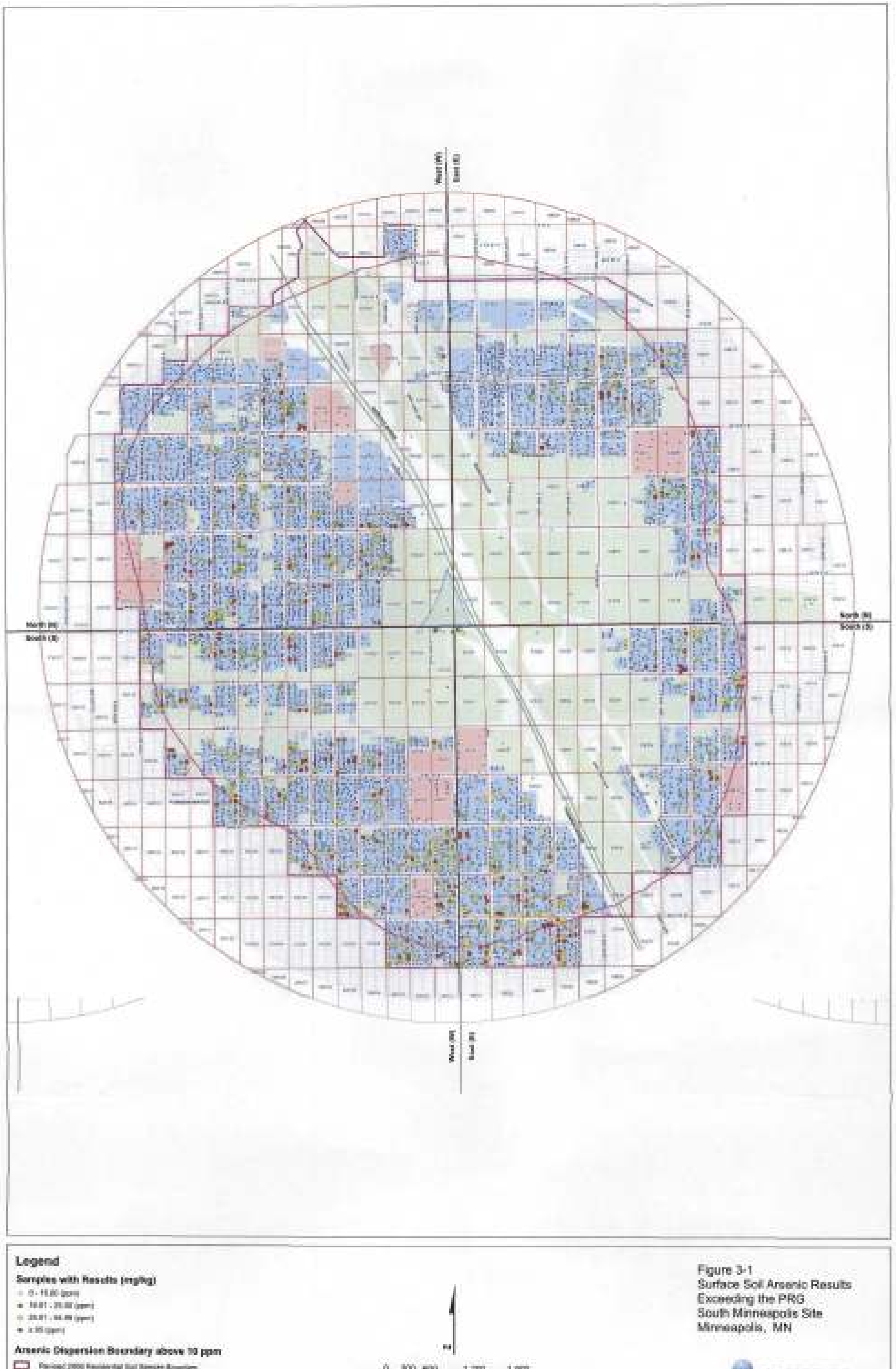

Legend
Sample Type
Property Use
0 300 600 1,200 1,800
Feet
Figure 3-1
Surface Soil Sample Locations
South Minneapolis Site
Minneapolis, MN
CH2MHILL

Figure 4

West (W)
East (E)
7TH ST S
BUTLER PL
FRANKLIN AVE E
21ST ST E
22ND ST E
23RD ST E
24TH ST E
EVERGREEN DR
25TH ST E
27TH ST E
29TH ST E
LAKE ST E
31ST ST E
CEDAR AVE S
Legend
Sample Type
Subsurface Soil Sampling Location
Property Use
Residential Properties
Commercial/ Industrial Property
Schools and Parks
0 150 300 600 900
Feet
Figure 3-2
Subsurface Soil Sample Locations
South Minneapolis Site
Minneapolis, MN
CH2MHILL

Figure 5



North (N)
South (S)
Legend
Samples with Results (mg/kg)
Arsenic Dispersion Boundary above 10 ppm
0 300 600 1,200 1,800
Feet
Figure 3-1
Surface Soil Arsenic Results
Exceeding the PRG
South Minneapolis Site
Minneapolis, MN
CH2MHILL

Figure 7

TABLES

Table 3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration Qualifier	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (4)
Surface Soil																
Residential	7440-38-2	Arsenic	1.61	380	mg/kg	S3W05-10	1481/1481	NA	380	10 - 16	0.39	ca	NA	NA	Yes	ASL
Commercial	7440-38-2	Arsenic	2.32	140	mg/kg	S1E01-01	32/32	NA	140	10 - 16	0.39	ca	NA	NA	Yes	ASL
Commercial/Industrial	7440-38-2	Arsenic	0.11	14	mg/kg	N1W10-13	53/53	NA	14	10 - 16	0.39	ca	NA	NA	Yes	ASL
Vacant	7440-38-2	Arsenic	1.7	14	mg/kg	N2E02-01	12/12	NA	14	10 - 16	0.39	ca	NA	NA	Yes	ASL

(1) Maximum concentration is used for screening.

(2) The range of background concentrations was obtained from CH2M HILL, 2006.

(3) EPA Region 9 Preliminary Remediation Goals (PRGs) for Residential Soil Based on an ELCR of $1x10^{-6}$.

(4) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

TABLE 4

SELECTION OF EXPOSURE PATHWAYS/ CONCEPTUAL SITE MODEL

South Minneapolis Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Surface Soil	Surface Soil	Resident	Adult/Child	Ingestion, Dermal Contact	Quant	Residents may contact arsenic in impacted soil.
		Ambient Air	Emissions from Surface Soil			Inhalation	Quant	Residents may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
		Indoor Dust	Indoor Dust			Ingestion	Quant	Residents may ingest indoor dust potentially impacted through fugitive dust emissions from impacted soil or from tracking indoors.
		Garden Vegetables	Garden Vegetables			Ingestion	Quant	Residents may consume garden vegetables grown on impacted soil.
		Soil	Soil (0-5 ft)	Construction Worker	Adult	Ingestion, Dermal Contact	Quant	Construction workers may contact arsenic in impacted soil.
		Ambient Air	Emissions from Soil			Inhalation	Quant	Construction workers may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
	Groundwater	--	--	--	--	--	-- (1)	No private potable wells are located within the area. The neighborhood over the plume is served by City of Minneapolis water. Municipal wells are not impacted. Future soil sampling (to a depth of 10 feet) will evaluate the potential for off-site soil to impact groundwater via leaching.
	Surface Water, Sediment	--	--	--	--	--	--	No ponds or streams are located within the investigation area. A lake is present to the southwest outside the investigation area.

Note:

(1) Groundwater exposure pathways are being investigated.

Type of Analysis:

Quant - Quantitative Analysis

TABLE 5.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	80	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(6)	IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C/E	Exposure Duration, Infant/Child	7	years	(5)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	149	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(6)	IR-S-Adj (mg-year/kd-day) =
				ED-A	Exposure Duration, Adult	44	years	(4)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				EF	Exposure Frequency	350	days/year	(1)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	236	mg-year/kg-day	Calculated	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C/E	Exposure Duration, Infant/Child	7	years	(5)	(ED-A x SA-A x SSAF-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	515	mg-year/kg-day	Calculated (2,3)	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				ED-A	Exposure Duration, Adult	44	years	(4)	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-A x SA-A x SSAF-A / BW-A)
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Adult SA includes head, hands, forearms, and lower legs.

(3) Child SA includes head, hands, forearms, lower legs, and feet.

(4) Based on community input provided during the September 26, 2006 public meeting.

(5) Infant/child (1 to 8 yrs).

(6) Professional Judgment

TABLE 5.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Resident	Infant/Child	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	3.4	m^3/day	calculated	
				ED-C/E	Exposure Duration, Infant/Child	7	years	(3)	IN-Adj (m^3-year/kg-day) =
				EF	Exposure Frequency	185	days/year	(1)	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	12.7	m^3/day	calculated	
				ED-A	Exposure Duration, Adult	44	years	(2)	IN-Adj (m^3-year/kg-day) =
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Based on community input provided during the September 26, 2006 public meeting.

(3) Infant/child (1 to 8 yrs).

TABLE 5.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Garden Vegetables

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Garden Vegetables	CS	Chemical Concentration in Soil	16	mg/kg	background	
				FI	Fraction of Vegetables Consumed	50%	unitless	(10)	
				ABSgi	Bioavailability Factor (GI Absorption)	100%	unitless	(10)	
				ED-C/E	Exposure Duration, Infant/Child	7	years	(10)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
			(Above-ground Vegetable)	Cveg_ag	Chemical Concentration in Above-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_ag	Plant-Soil Bioconcentration Factor (above-ground)	0.00633	unitless	EPA, 2005 (2)	Cveg_ag x FI x ABSgi x IR-Veg x EF x ED x CF1 x 1/AT
				IR-Veg-ag	Ingestion Rate of Vegetables (above-ground)	0.007	kg/kg-day	Calculated	Cveg_ag = CS x Br_ag
				CF1	Moisture Content (above-ground)	17.4%	kg (dry)/ kg (wet)	ATSDR, 2003	
				EF	Exposure Frequency (above-ground)	90	days/year	(9)	
			(Below-ground Vegetable)	Cveg_bg	Chemical Concentration in Below-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_bg	Plant-Soil Bioconcentration Factor (below-ground)	0.008	unitless	EPA, 2005 (3)	Cveg_bg x FI x ABSgi x IR-Veg x EF x ED x CF2 x 1/AT
				IR-Veg-bg	Ingestion Rate of Vegetables (below-ground)	0.003	kg/kg-day	Calculated	Cveg_bg = CS x Br_bg
				CF2	Moisture Content (below-ground)	22.2%	kg (dry)/ kg (wet)	ATSDR, 2003	
				EF	Exposure Frequency (below-ground)	60	days/year	(9)	
		Child/Adult	Garden Vegetables	CS	Chemical Concentration in Soil	16	mg/kg	background	
				FI	Fraction of Vegetables Consumed	50%	unitless	(10)	
				ABSgi	Bioavailability Factor (GI Absorption)	100%	unitless	(10)	
				ED-A	Exposure Duration, Adult	44	years	(1)	
				BW-A	Body Weight , Adult	70	kg	EPA, 1991	
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				BW-C	Body Weight , Child	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
			(Above-ground Vegetable)	Cveg_ag	Chemical Concentration in Above-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_ag	Plant-Soil Bioconcentration Factor (above-ground)	0.00633	unitless	EPA, 2005 (2)	Cveg_ag x FI x ABSgi x IR-Veg-Adj x EF x CF1 x 1/AT
				CF1	Moisture Content (above-ground)	17.4%	kg (dry)/ kg (wet)	ATSDR, 2003	Cveg_ag = CS x Br_ag
				IR-Veg-A_ag	Ingestion Rate of Garden Vegetables, Adult (above-ground)	0.325	kg/day	EPA, 1997 (4,6,7,8)	
				IR-Veg-C_ag	Ingestion Rate of Garden Vegetables, Child (above-ground)	0.121	kg/day	EPA, 1997 (5,6,7,8)	IR-Veg-Adj (kg-year/kd-day) =
				IR-Veg-Adj	Ingestion Rate of Vegetables, Age-adjusted	0.253	kg-year/kg-day	Calculated	(ED-C x IR-Veg-C / BW-C) + (ED-A x IR-Veg-A / BW-A)
				EF	Exposure Frequency	90	days/year	(9)	
			(Below-ground Vegetable)	Cveg_bg	Chemical Concentration in Below-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_bg	Plant-Soil Bioconcentration Factor (below-ground)	0.008	unitless	EPA, 2005 (3)	Cveg_bg x FI x ABSgi x IR-Veg-Adj x EF x CF2 x 1/AT
				CF2	Moisture Content (below-ground)	22.2%	kg (dry)/ kg (wet)	ATSDR, 2003	Cveg_bg = CS x Br_bg
				IR-Veg-A_bg	Ingestion Rate of Garden Vegetables, Adult (below-ground)	0.139	kg/day	EPA, 1997 (4,6,7,8)	
				IR-Veg-C_bg	Ingestion Rate of Garden Vegetables, Child (below-ground)	0.052	kg/day	EPA, 1997 (5,6,7,8)	IR-Veg-Adj (kg-year/kd-day) =
				IR-Veg-Adj	Ingestion Rate of Vegetables, Age-adjusted	0.108	kg-year/kg-day	Calculated	(ED-C x IR-Veg-C / BW-C) + (ED-A x IR-Veg-A / BW-A)
				EF	Exposure Frequency	60	days/year	(9)	

Sources:

ATSDR, 2003: Health Consultation Arsenic Soil Clean-up Levels El Paso County Metal Survey.

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2005: Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA530-R-05-006.

TABLE 5.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Garden Vegetables

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

(1) Based on community input provided during the September 26, 2006 public meeting.

(2) Plant-soil bioconcentration factor for arsenic for above-ground produce.

(3) Plant-soil bioconcentration factor for arsenic for below-ground produce. $VG_{rootveg}$ value of 1.0 is used.

(4) Intake rate of homegrown vegetables (for Midwest region) was obtained from Table 13-15. Units were converted to kg/day using an assumed body weight of 60 kg.

(5) Intake rate of homegrown vegetables (1-5 year old children) was obtained from Table 13-13. Units were converted to kg/day using an average body weight of boys and girls (see Table 4.3 Supplement).

(6) Assumed that 30% of their consumption rate is of below-ground vegs and 70% is above-ground vegetables.

(7) Approximately equivalent to 1.02 lbs/day (adult) and 0.39 lbs/day (child).

(8) 95th percentile was used for the RME scenario.

(9) Assumed that vegetables are grown for a 4-month period and above-ground vegetables are eaten for only 3 months and below-ground vegs are eaten for only 2 months.

(10) Best professional judgment.

TABLE 5.3.Supplement

VALUES USED FOR INTAKE OF HOMEGROWN VEGETABLES

South Minneapolis Site

Body Weight (kg)[1]				Body Weight (kg)[2]		Intake of Homegrown Vegetables (g/kg-day)[3]	Intake of Homegrown Vegetables (g/day)[4]
Age	Boys Mean	Girls Mean	Boys and Girls Mean	Age	Boys and Girls Mean	95th percentile	95th percentile
1 year	11.8	10.8	11.3	1 - 2 years	12.3	19.6	241
2 years	13.6	13	13.3				
3 years	15.7	14.9	15.3	3 -5 years	17.5	7.74	135
4 years	17.8	17	17.4				
5 years	19.8	19.6	19.7				
6 years	23	22.1	22.6	6 - 7 years	23.75	6.16	146
7 years	25.1	24.7	24.9				
					Average [5] =	10.68	169

Sources:

EPA, 1997: Exposure Factors Handbook (EFH). EPA/600/P-95/002F.

Notes:

(1) Body weights were obtained from Table 7-3 of the EFH (EPA, 1997).

(2) Mean Body weights calculated for three infant/child age groups (1-2 yrs, 3-5 yrs, and 6-7 yrs).

(3) Intakes for homegrown vegetables were obtained from Table 13-13 of the EFH (EPA, 1997).

(4) Intakes for homegrown vegetables were calculated by multiplying body weight by intake.

(5) Average intake for homegrown vegetables.

TABLE 5.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 2002	CS x IR-S x RBAF x EF x ED x CF1 x 1/BW x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(4)	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	10	years	(3)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3650	days	(3)	
Dermal	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004 (1)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2002	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	10	years	(3)	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	(3)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) SA includes head, hands, and forearms.

(2) Best Professional Judgment

(3) Based on community input provided during the September 26, 2006 public meeting.

(4) Professional Judgment

TABLE 5.5.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Worker	Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	NA	m^3/kg	--	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 2002	
				EF	Exposure Frequency	90	days/year	(1)	
				ED	Exposure Duration	10	years	(2)	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	(2)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. EPA/540/F-95/041.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Best Professional Judgment

(2) Based on community input provided during the September 26, 2006 public meeting.

TABLE 5.6.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	40	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(5)	IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C/E	Exposure Duration, Infant/Child	7	years	(4)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	45	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--		IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	46	mg-year/kg-day	Calculated	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C/E	Exposure Duration, Infant/Child	7	years	(4)	(ED-A x SA-A x SSAF-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	52	mg-year/kg-day	Calculated (2,3)	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	(ED-A x SA-A x SSAF-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Adult SA includes head, hands, forearms, and lower legs.

(3) Child SA includes head, hands, forearms, lower legs, and feet.

(4) Infant/child (1 to 8 yrs)

(5) Professional Judgment

TABLE 5.7.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Resident	Infant/Child	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	3.4	m^3/day	calculated	IN-Adj (m^3-year/kg-day) =
				ED-C/E	Exposure Duration, Infant/Child	7	years	(2)	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		Child/Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	4.7	m^3/day	calculated	
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	IN-Adj (m^3-year/kg-day) =
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(4) Infant/child (1 to 8 yrs).

TABLE 5.8.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	170	mg/day	(1)	CS x IR-S x RBAF x EF x ED x CF1 x 1/BW x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(4)	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 2002	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(2)	
Dermal	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004 (3)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2002	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	–	EPA, 2004	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 2002	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(2)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

TABLE 5.9.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Worker	Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	NA	m^3/kg	--	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 2002	
				EF	Exposure Frequency	90	days/year	(1)	
				ED	Exposure Duration	1	years	EPA, 2002	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(1)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. EPA/540/F-95/041.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Best Professional Judgment

TABLE 6.1. Supplement
CALCULATION OF AGE-ADJUSTED INTAKE RATES
REASONABLE MAXIMUM EXPOSURE / CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Age	Mean BW[2] (kg)	Ingestion						Dermal							Inhalation				
		IR-S		ED		IR-S-Adj (IR * ED) / BW		SSAF[3]		SA[3,4,5]	ED		DA-Adj (SSAF*SA*ED)/BW		IN[2]	ED		IN-Adj (IN*ED)/BW	
		RME[1]	CTE[2]	RME	CTE	RME	CTE	RME	CTE		RME	CTE	RME	CTE	RME/CTE	RME	CTE	RME	CTE
1 year	11.3	200	100	1	1	17.7	8.8	0.2	0.04	2571	1	1	45.50	9.10	6.8	1	1	0.60	0.60
2 years	13.3	200	100	1	1	15.0	7.5	0.2	0.04	2434	1	1	36.60	7.32	6.8	1	1	0.51	0.51
3 years	15.3	200	100	1	1	13.1	6.5	0.2	0.04	2893	1	1	37.81	7.56	8.3	1	1	0.54	0.54
4 years	17.4	200	100	1	1	11.5	5.7	0.2	0.04	3175	1	1	36.49	7.30	8.3	1	1	0.48	0.48
5 years	19.7	200	100	1	1	10.2	5.1	0.2	0.04	3255	1	1	33.04	6.61	8.3	1	1	0.42	0.42
6 years	22.6	200	100	1	1	8.9	4.4	0.2	0.04	3538	1	1	31.38	6.28	10.0	1	1	0.44	0.44
7 years	24.9	100	50	1	1	4.0	2.0	0.1	0.01	3884	1	1	15.60	1.56	10.0	1	1	0.40	0.40
			Total =	7	7	80	40			**Total =**	7	7	236	46	**Total =**	7	7	3.40	3.40

Footnotes:

[1] EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

[2] EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

[3] EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

[4] SA for adult includes head, hands, forearms, and lower legs; SA for child includes head, hands, forearms, lower legs, and feet.

[5] SA was calculated for child using Exhibit C-1 of RAGS Part E.

[6] Age-adjusted intake factors using EPA's default values.

BW - body weight (kg)
DA - Adj - adjusted dermal absorption (mg-year/kg-day)
ED - exposure duration (years)
IN - inhalation rate (m^3/day)
IN-Adj - adjusted inhalation rate (m^3/day)
IR-S - soil ingestion rate (mg/day)
IR-S-Adj - adjusted soil ingestion rate (mg-year/kg-day)
SA - skin surface area (cm^2)
SSAF - soil-to-skin adherence factor (mg/cm^2-day)

TABLE 6.2. Supplement
CALCULATION OF AGE-ADJUSTED INTAKE RATES
REASONABLE MAXIMUM EXPOSURE / CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Age	Mean BW[2] (kg)	Ingestion						Dermal							Inhalation				
		IR-S		ED		IR-S-Adj (IR * ED) / BW		SSAF[3]		SA[3,4,5]	ED		DA-Adj (SSAF*SA*ED)/BW		IN[2]	ED		IN-Adj (IN*ED)/BW	
		RME[1]	CTE[2]	RME	CTE	RME	CTE	RME	CTE		RME	CTE	RME	CTE	RME/CTE	RME	CTE	RME	CTE
1 year	11.3	200	100	1	1	17.7	8.8	0.2	0.04	2571	1	1	45.50	9.10	6.8	1	1	0.60	0.60
2 years	13.3	200	100	1	1	15.0	7.5	0.2	0.04	2434	1	1	36.60	7.32	6.8	1	1	0.51	0.51
3 years	15.3	200	100	1	1	13.1	6.5	0.2	0.04	2893	1	1	37.81	7.56	8.3	1	1	0.54	0.54
4 years	17.4	200	100	1	1	11.5	5.7	0.2	0.04	3175	1	1	36.49	7.30	8.3	1	1	0.48	0.48
5 years	19.7	200	100	1	1	10.2	5.1	0.2	0.04	3255	1	1	33.04	6.61	8.3	1	1	0.42	0.42
6 years	22.6	200	100	1	1	8.9	4.4	0.2	0.04	3538	1	1	31.38	6.28	10.0	1	1	0.44	0.44
7 years	24.9	100	50	1	NA	4.0	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.40	NA
8 years	28.1	100	50	1	NA	3.6	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.36	NA
9 years	31.5	100	50	1	NA	3.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.43	NA
10 years	36.3	100	50	1	NA	2.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.37	NA
11 years	41.1	100	50	1	NA	2.4	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.33	NA
12 years	45.3	100	50	1	NA	2.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.30	NA
13 years	50.4	100	50	1	NA	2.0	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.27	NA
14 years	56.0	100	50	1	NA	1.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.24	NA
15 years	58.1	100	50	1	NA	1.7	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.25	NA
16 years	67.1	100	50	1	NA	1.5	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.22	NA
17 years	63.2	100	50	1	NA	1.6	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.23	NA
18 < 25 years	67.2	100	50	7	5	10.4	3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 < 35 years	71.5	100	50	10	4	14.0	2.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35 < 45 years	74.0	100	50	10	NA	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
45 < 55 years	74.5	100	50	6	NA	8.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<7 to <18	45.6	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	12	NA	106.82	NA	NA	NA	NA	NA	NA
Adult (>18)	69.3	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	32	9	187.41	7.53	13.25	33	9	6.31	1.72
			Total =	50	15	149	45			Total =	50	15	515	52	Total =	50	15	12.7	4.72

Footnotes:

[1] EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

[2] EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

[3] EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

[4] SA for adult includes head, hands, forearms, and lower legs; SA for child includes head, hands, forearms, lower legs, and feet.

[5] SA was calculated for child using Exhibit C-1 of RAGS Part E.

[6] Age-adjusted intake factors using EPA's default values.

BW - body weight (kg)
DA - Adj - adjusted dermal absorption (mg-year/kg-day)
ED - exposure duration (years)
IN - inhalation rate (m^3/day)
IN-Adj - adjusted inhalation rate (m^3/day)
IR-S - soil ingestion rate (mg/day)
IR-S-Adj - adjusted soil ingestion rate (mg-year/kg-day)
SA - skin surface area (cm^2)
SSAF - soil-to-skin adherence factor (mg/cm^2-day)

TABLE 7.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Uncertainty Factor	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	3.0E-04	mg/kg-day	0.95	3.0E-04	mg/kg-day	skin	3	IRIS	04/07/2006

Note:

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral RfD not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, the Oral RfD was used as Absorbed RfD for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

TABLE 7.2

NON-CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Uncertainty Factor	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	NA	NA	NA	NA	NA	NA	NA	NA

Definitions: NA = Not Available

TABLE 8.1

CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	95%	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral cancer slope factor not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, Oral Cancer Slope Factor is used as Absorbed Cancer Slope Factor for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

TABLE 8.2

CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

TABLE 10

South Minneapolis Residential Soil Contamination Site

Summary of Applicable or Relevant and Appropriate Requirements

Potential Federal Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if that waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 62.11, 264.10-12 and 268.7	Applicable	Applicable for any operation where hazardous waste is generated. The extracted material is not expected to be a RCRA hazardous waste, but will be tested for hazardous characteristics
Hazardous waste accumulation	Generator may accumulate waste on-site for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate Hazardous waste.	40 CFR 262.34	Applicable	If waste generated at SMRSCS is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Container storage	Containers of RCRA hazardous waste must be: - Maintained in good condition. - Compatible with hazardous waste to be stored. - Closed during storage except to add or remove waste.	Storage of RCRA hazardous waste before treatment, disposal or storage elsewhere, in a container.	40 CFR264.171, 172, 173	Applicable or Relevant and Appropriate, if nonhazardous	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities. If hazardous wastes are not generated, ARAR determination would be relevant and appropriate.

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Container Storage (continued)	Inspect container storage areas weekly for deterioration.	Storage of RCRA hazardous waste before treatment, disposal or storage elsewhere, in a container.	40 CFR 264.174	Applicable or Relevant and Appropriate, if nonhazardous	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities. If hazardous wastes are not generated, ARAR determination would be relevant and appropriate.
	At closure, remove all hazardous waste and residues from the contain-ment system, and decontaminate or remove all containers, liners.		40 CFR 264.178	Applicable	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268.40 and 40 CFR 268.7	Applicable	Applicable to disposal of soil containing land disposal restricted RCRA hazardous waste if it is placed outside of the area of contamination. The wastes generated from the response action may potentially be RCRA hazardous wastes.

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Closure with no postclosure care	General performance standard requires elimination of need for further maintenance and control; elimination of postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products.	Land based unit containing hazardous waste. RCRA hazardous waste placed at site, or placed in another unit. Cleanup to health-based standards that will not require long-term management. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated in-situ, or consolidated within area of contamination.	40 CFR 264.111 and 40 CFR 264.310	Applicable or Relevant and Appropriate, if nonhazardous	Requirements are applicable only if soils are determined to be characteristically hazardous wastes. If hazardous wastes are not generated, ARAR would be relevant and appropriate. In either case, the standard is taken care of through the measures developed in the ROD,

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
U.S. Department of Transportation					
Hazardous and Solid Waste Transportation	Packaging, documentation, and transport requirements for hazardous waste.	Offsite transport of hazardous waste.	40 CFR 262.20 - 23 and 40 CFR 262.30 - 32	Applicable	Substantive portions of these requirements would be ARARs for on-site activities preparing to transport hazardous and solid wastes. Off-site transportation and disposal must comply with all legal requirements, including EPA's Off-Site Rule.
Hazardous Materials Transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq. or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the Federal Government.	49 CFR 171.2(f)	Applicable	Substantive portions of these requirements would be ARARs for on-site activities preparing to transport hazardous and solid wastes. Off-site transportation and disposal must comply with all legal requirements, including EPA's Off-Site Rule.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Potentially Applicable	

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
U.S. Department of Transportation					
Hazardous Materials Marking, Labeling, and Placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.300	Applicable	Substantive portions of these requirements would be ARARs for on-site activities preparing to transport hazardous and solid wastes. Off-site transportation and disposal must comply with all legal requirements, including EPA's Off-Site Rule.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Applicable	
	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.		49 CFR 172.302	Applicable	

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
U.S. Department of Transportation					
Hazardous Materials Marking, Labeling, and Placarding (continued)	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.		49 CFR 172.303	Applicable	
	The marking must be durable, in English, in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Applicable	
	Labeling of hazardous material packages shall be as specified in the list.		49 CFR 172.400	Applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Applicable	

TABLE 10
Summmary of ARARs (Continued)
Potential Federal Action-Specific ARARs (continued)

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
U.S. Department of Transportation					
Hazardous Materials Marking, Labeling, and Placarding	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.504	Applicable	Substantive portions of these requirements would be ARARs for on-site activities preparing to transport hazardous and solid wastes. Off-site transportation and disposal must comply with all legal requirements, including EPA's Off-Site Rule.
Clean Water Act, Section 404					
Excavation	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	Stormwater management will be required during construction activities.
Occupational Safety and Health Administration (OSHA)					
Hazardous waste work	Requirements for hazardous waste workers such as training, personal protective equipment (PPE), and clothing must be met.	Hazardous waste work.	29 CFR 1904, 29 CFR 1910, 29 CFR 1926	TBC	The remedial action at the SMRSCS may involve hazardous waste workers; therefore, the requirements of OSHA must be met.

TABLE 10
Summmary of ARARs (Continued)

Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Waste Regulations					
Onsite waste generation	Waste generator shall determine if that waste is hazardous waste.	Generator of hazardous waste.	Minnesota Rules Parts 7045.0214, 7045.1300	Applicable	Applicable for any operation where waste is generated. The extracted material is not expected to be a RCRA hazardous waste, but
Hazardous waste accumulation	Generator may accumulate waste on-site for 90 days or less or must complyg with requirements for operating a storage facility.	Accumulate hazardous waste.	Minnesota Rules Part 7045.0292	Applicable	If waste generated at SMRSCS is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.

TABLE 10
Summmary of ARARs (Continued)

Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Waste Regulations					
Container storage	Containers of RCRA hazardous waste must be marked, packaged, labeled, placarded and loaded in accordance with regulations.	Storage of RCRA hazardous waste before treatment, disposal or storage elsewhere, in a container.	Minnesota Rules Part 7045.0270	Applicable or Relevant and Appropriate, if nonhazardous	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities. If hazardous wastes are not generated, ARAR would be relevant and appropriate.
	Containers must have sturdy leakproof construction and be constructed of materials not incompatible with wastes. Containers must be sealed except when it is necessary to add, remove or treat a hazardous waste.	Storage of RCRA hazardous waste before treatment, disposal or storage elsewhere, in a container.	Minnesota Rules Part 7045.0626 Subp. 2 - 4	Potentially Applicable or Relevant and Appropriate, if nonhazardous	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities. If hazardous wastes are not generated, ARAR determination would be relevant and appropriate.
	Inspect container storage areas weekly for deterioration.		Minnesota Rules Part 7045.0626 Subp. 5		
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners.		Minnesota Rules Part 7045.0626 Subp. 8	Potentially Applicable	Container storage requirements are applicable only if hazardous wastes are Generated and accumulated on-site in containers or liners during remedial activities.

TABLE 10
Summmary of ARARs (Continued)

Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Waste Regulations					
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	Minnesota Rules Part 7045.0534	Potentially Applicable	Applicable to disposal of soil containing land disposal restricted RCRA hazardous waste if it is placed outside of the area of contamination. The wastes generated from the response action may potentially be RCRA hazardous wastes.
Offsite transport and disposal	MPCA permit standards (except air quality)	Permits and Certifications	Minnesota Rules Ch. 7001	Applicable	Substantive permit requirements will be met for any on-site storage, treatment, or disposal of solid waste or hazardous waste.
Site listing	State Superfund Law	Minnesota Environmental Response And Liability Act (MERLA)	Minnesota Stat. §§ 115B.01-0.241	TBC	Any release or threatened release of a hazardous substance occurring on or after July 1, 1983, including any release which began before July 1, 1983, and continued after that date.
Solid Waste and Water Supply Regulations					
Storage, characterization and transportation of solid waste	Requirements and standards for solid waste	Solid Waste	Minnesota Rules Ch. 7035	Applicable	Solid waste requirements are applicable for storage and transport of soils generated during remedial activities. Excavated soils are anticipated to be solid waste and not hazardous.
Surface Water Quality					
Storm water discharge	MPCA may require a permit for any discharges to the Waters of the state	Permits Required	Minnesota Stat. § 115.03	Applicable	Stormwater management will be required for construction activities and substantive requirements will be met, but no permit is necessary under CERCLA Section 121(e).

TABLE 10
Summmary of ARARs (Continued)

Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Groundwater Quality					
Discharge to groundwater	Nondegradation goal, prohibition of discharge to saturated zone, limitation on discharge to unsaturated zone, remediation requirements	Underground Waters	Minnesota Rules Ch. 7060	Applicable	Best management practices are applicable to prevent degradation of groundwater quality.
Discharge to groundwater	Non-degradation goal, promotion of best management practices	Ground Water Protection Act	Minnesota Stat. Ch. 103H	Applicable	Best management practices are applicable to prevent degradation of groundwater quality.
Air Quality					
Air emissions	Duty to notify and abate excessive or abnormal unpermitted air missions	Air Release Reporting	Minnesota Stat. § 116.061	Applicable	These regulations are applicable in connection with activities that disturb soil and result in emissions during remedial activities.
Air emissions	Air quality rules	Air Pollution Standards	Minnesota Rules Chs. 7005, 7007, 7009, 7017	Applicable	These regulations are applicable in connection with activities that disturb soil or excavation during remedial activities.
Health and Safety					
Worker protection	Standards for worker health, safety and training (DLI)	Health and Safety	Minnesota Rules Ch. 5205	TBC	Requirements must be met for health and safety of workers
	Agricultural chemical permitting, control, liability, incidents and Enforcement law	Agricultural Chemical Control Laws	Minnesota Stat. § 18B, 18C, 18D	TBC	Regulation for agricultural chemicals and corrective actions.

TABLE 10
Summmary of ARARs (Continued)

Potential Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior. Reasonable mitigation and enhancement measures must be taken, including live propagation, transplantation, and habitit acquisition and improvement.	Determination of effect upon endangered or threatened species or its habitat by conducting biological assessments.	16 USC 1531; 16 USC 1536(a); 50 CFR 81, 225, 402	Applicable	There are no records of endangered plant and animal species located at residential properties within the SMRSCS. This regulation is only applicable if the situation changes.
Migratory Bird Treaty Act of 1972					
Migratory bird area	Protects almost all species of native birds in the U.S. from unregulated "take" which can include poisoning at hazardous waste sites.	Presence of migratory birds.	16 USC Section 703	Applicable	Construction activities will be limited to mowed and maintained residential properties, it is unlikely that ground nesting birds will be affected.

TABLE 10 Summmary of ARARs (Continued)					
Potential State Location-Specific ARARs					
Location	**Requirement**	**Prerequisite**	**Citation**	**Applicability Determination**	**Comments**
Endangered Species					
Endangered Species	Protection of endangered species (DNR)	Endangered Species	Minn. Rules Ch. 6134	Applicable	There are no records of endangered plant and animal species located at residential properties within the SMRSCS. This regulation is only applicable if the situation changes.
Potential Chemical-Specific ARARs					
Chemicals & Relevant Media	**Requirement**	**Prerequisites**	**Citation**	**ARAR or TBC**	**Comments**
Soil					
Soil	Acceptable risk-based concentration that causes a lifetime carcinogenic risk of 1 in 100,000	Incidental soil ingestion, dermal contact with soil, and inhalation of outdoor vapors and particulates from soil.	MPCA Risk-Based Guidance For The Soil - Human Health Pathway	TBC	Considered in development of risk-based PRG

TABLE 11.1
Basis of the Alternative 2A Cost Estimate
South Minneapolis Residential Soil Contamination Site

	Range	Front Yard	Back Yard	Other Yard	Number of Properties	Areas (ft²) Front (1000 ft²)	Back (2000 ft²)	Other (500 ft²)	Total	Volumes (cy) Yards (90% to 12")	Gardens and Planting Beds (10% to 18")	Total
Excavation Quantities for Properties with Arsenic >25 ppm where no Previous Removals Performed												
No Previous Removal	>25 and <95 with no result >95	319	229	26	411	319,000	458,000	13,000	790,000	26,333	4,389	30,722
Previously Unsampled Properties					135							
Properties with Results over PRG	>25				606							
Total Properties Sampled	0.11 to 2880				3579							
Estimated Number of Additional Removals	>25	18	13	1	23	18,000	26,000	500	44,500	1,483	247	1,731
Estimated Number of Properties with no Previous Removal		**337**	**242**	**27**	**434**	**337,000**	**484,000**	**13,500**	**834,500**	**27,817**	**4,636**	**32,453**
Excavation at Properties with Arsenic >25 ppm where Previous Removals were Performed												
Additional 2007/2008 Removal Required	>25 and <65	9	35	4	46	9,000	70,000	2,000	81,000	2,700	450	3,150
Additional 2004 - 2006 Removal Required	>25 and <30	1	3		4	1,000	6,000	-	7,000	233	39	272
Additional Excavation Due to Yards >25 ppm		**10**	**38**	**4**	**50**	**10,000**	**76,000**	**2,000**	**88,000**	**2,933**	**489**	**3,422**
Excavation for Alternative 2												
Total Excavation		**347**	**280**	**31**	**484**	**347,000**	**560,000**	**15,500**	**922,500**	**30,750**	**5,125**	**35,875**

	Qty	Unit	Assumption
Characterization			
Properties to characterize	136	properties	Properties previously unable to sample
Characterization Samples	272	samples	Assumed 2 samples/yard if previously unable to be sampled
Characterization Samples (Field Duplicates)	28	samples	10% of samples
Characterization Samples (MS/MSD)	3	samples	5% of samples
Excavation			
Confirmation Samples	658	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	66	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	7	samples	5% of confirmation samples
Disposal	35,875	cy	
	53,813	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	108	samples	1/500 tons
Restoration			
Total Excavation Area	922,500	ft²	
Excavation Area of Yards	830,250	ft²	Assume 90% of excavation area
Clean Fill	415,125	ft²	6" in yards, none in gardens
	15,375	cy	
Clean Fill Analysis	16	samples	1 sample/1000 cy
Excavation Area of Gardens	92,250	ft²	Assume 10% of excavation area
Topsoil in Gardens	138,375	ft²	18" in gardens/beds
	5,125	cy	
Topsoil in Yards	415,125	ft²	6" in yards
	15,375	cy	
Total Topsoil	20,500	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	21	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	830,250	ft²	90% (no seed/fertilizer in gardens/beds)

Table 11.2
Basis of the Alternative 2B Cost Estimate
South Minneapolis Residential Soil Contamination Site

						Areas (ft²)				Volumes (cy)		
	Range	Front Yard	Back Yard	Other Yard	Number of Properties	Front (1000 ft²)	Back (2000 ft²)	Other (500 ft²)	Total	Yards (90% to 12")	Gardens and Planting Beds (10% to 18")	Total
Excavation Quantities for Properties with Arsenic >16 ppm where no Previous Removals Performed												
No Previous Removal	>16 and <95 with no result >95	422	319	39	542	422,000	638,000	19,500	1,079,500	35,983	5,997	41,981
Previously Unsampled Properties					136							
Properties with Results over PRG	>16				737							
Total Properties Sampled	0.11 to 2990				3579							
Estimated Number of Additional Removals	>16	22	16	2	28	22,000	32,000	1,000	55,000	1,833	396	2,138
Estimated Number of Properties with no Previous Removal		**444**	**335**	**41**	**570**	**444,000**	**670,000**	**20,500**	**1,134,500**	**37,817**	**6,302**	**44,119**
Excavation at Properties with Arsenic >16 ppm where Previous Removals were Performed												
Additional 2007/2008 Removal Required	>16 and <95	12	42	4	55	12,000	84,000	2,000	98,000	3,267	544	3,811
Additional 2004 - 2006 Removal Required	>16 and <30	3	6	0	9	3,000	12,000	-	15,000	500	83	583
Additional Excavation Due to Yards >16 ppm		**15**	**48**	**4**	**64**	**15,000**	**96,000**	**2,000**	**113,000**	**3,767**	**628**	**4,394**
Excavation for Alternative 2												
Total Excavation		**459**	**383**	**45**	**634**	**459,000**	**766,000**	**22,500**	**1,247,500**	**41,583**	**6,931**	**48,514**

	Qty	Unit	Assumption
Characterization			
Properties to characterize	136	properties	Properties previously unable to sample
Estimated % with Results >16 ppm at Depth	272	samples	Assumed 2 samples/yard if previously unable to be sampled
Characterization Samples (Field Duplicates)	28	samples	10% of samples
Characterization Samples (MS/MSD)	3	samples	5% of samples
Excavation			
Confirmation Samples	887	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	89	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	9	samples	5% of confirmation samples
Disposal	48,514	cy	
	72,771	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	146	samples	1/500 tons
Restoration			
Total Excavation Area	1,247,500	ft²	
Excavation Area of Yards	1,122,750	ft²	Assume 90% of excavation area
Clean Fill	561,375	ft²	6" in yards, none in gardens
	20,792	cy	
Clean Fill Analysis	21	samples	1 sample/1000 cy
Excavation Area of Gardens	124,750	ft²	Assume 10% of excavation area
Topsoil in Gardens	187,125	ft²	18" in gardens/beds
	6,931	cy	
Topsoil in Yards	561,375	ft²	6" in yards
	20,792	cy	
Total Topsoil	27,723	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	28	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	1,122,750	ft²	90% (no seed/fertilizer in gardens/beds)

Table 11.3
Basis of the Alternative 3A Cost Estimate
South Minneapolis Residential Soil Contamination Site

						Areas (ft²)				Volumes (cy)		
	Range	Front Yard	Back Yard	Other Yard	Number of Properties	Front (1000 ft²)	Back (2000 ft²)	Other (500 ft²)	Total	Yards (90% to 18")	Gardens and Planting Beds (10% to 18")	Total
Excavation Quantities for Properties with Arsenic >25 ppm where no Previous Removals Performed												
No Previous Removal	>25 and <95 with no result >95	319	229	26	411	319,000	458,000	13,000	790,000	39,500	4,389	43,889
Previously Unsampled Properties					136							
Properties with Results over PRG	>25				808							
Total Properties Sampled	0.11 to 2880				3578							
Estimated Number of Additional Removals	>25	18	13	1	23	18,000	26,000	500	44,500	2,225	247	2,472
Estimated Number of Properties with no Previous Removal		**337**	**242**	**27**	**434**	**337,000**	**484,000**	**13,500**	**834,500**	**41,725**	**4,636**	**46,361**
Excavation at Properties with Arsenic >25 ppm where Previous Removals were Performed												
Additional 2007/2008 Removal Required	>25 and <95	9	35	4	48	9,000	70,000	2,000	81,000	4,050	450	4,500
Additional 2004 - 2006 Removal Required	>25 and <30	1	3		4	1,000	6,000	-	7,000	350	39	389
Additional Excavation Due to Yards >25 ppm		**10**	**38**	**4**	**50**	**10,000**	**76,000**	**2,000**	**88,000**	**4,400**	**489**	**4,889**
Excavation at Properties with Arsenic >25 ppm at Depth where Previous Removals were Performed												
Total Excavation	>95 and >30 in same property	29	21	0	30							
2005 Removals	>95 and >30 in same property	30	28	0	31							
2006 Removals	>95 and >30 in same property	35	19	1	35							
2007/2008 Removals	>95 Only	82	41	6	101							
Total Removal Properties	>95	176	109	6	197							
Estimated % with Results >25 ppm at Depth					0.6							
Removal at Depth Required	**>95 Properties x 0.6**	**106**	**65**	**4**	**118**	**106,000**	**130,000**	**2,000**	**238,000**	**11,900**	**1,322**	**13,222**
Excavation for Alternative 3												
Total Excavation		**453**	**345**	**35**	**602**	**453,000**	**690,000**	**17,500**	**1,160,500**	**58,025**	**6,447**	**64,472**

	Qty	Unit	Assumption
Characterization			
Properties to characterize	136	properties	Properties previously unable to sample
Characterization Samples	272	samples	Assumed 2 samples/yard if previously unable to be sampled
Characterization Samples (Field Duplicates)	28	samples	10% of samples
Characterization Samples (MS/MSD)	3	samples	5% of samples
Vertical Profiling for Excavation Depth	833	yards	Total number of yards to excavate
Characterization Samples	2,499	samples	Assumed 3 depth intervals / yard
Characterization Samples (Field Duplicates)	250	samples	10% of characterization samples
Characterization Samples (MS/MSD)	25	samples	5% of characterization samples
Excavation			
Confirmation Samples	833	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	84	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	9	samples	5% of confirmation samples
Disposal	64,472	cy	Does not include peelback soil which will be used as clean fill
	96,708	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	194	samples	1/500 tons
Restoration			
Total Excavation Area	1,160,500	ft²	

Excavation Area of Yards	1,044,450	ft^2	Assume 90% of excavation area
Clean Fill Need	1,044,450	ft^3	12" in yards, none in gardens
	38,683	cy	
Imported Clean Fill Total	38,683	cy	
Clean Fill Analysis	39	samples	1 sample/1000 cy
Excavation Area of Gardens	116,050	ft^2	Assume 10% *of excavation area*
Topsoil in Gardens	174,075	ft^3	*18" in gardens/beds*
	6,447	cy	
Topsoil in Yards	522,225	ft^3	6" in yards
	19,342	cy	
Total Topsoil	25,789	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	26	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	1,044,450	ft^2	90% (no seed/fertilizer in gardens/beds)

Table 11.4
Basis of the Alternative 3B Cost Estimate
South Minneapolis Residential Soil Contamination Site

						Areas (ft²)				Volumes (cy)		
	Range	Front Yard	Back Yard	Other Yard	Number of Properties	Front (1000 ft²)	Back (2000 ft²)	Other (500 ft²)	Total	Yards (90% to 18")	Gardens and Planting Beds (10% to 18")	Total
Excavation Quantities for Properties with Arsenic >16 ppm where no Previous Removals Performed												
No Previous Removal	>16 and <95 with no result >95	422	319	39	542	422,000	638,000	19,500	1,079,500	53,975	5,997	59,972
Previously Unsampled Properties					138							
Properties with Results over PRG	>16				737							
Total Properties Sampled	0.11 to 2880				3570							
Estimated Number of Additional Removals	>16	22	16	2	28	22,000	32,000	1,000	55,000	2,750	306	3,056
Estimated Number of Properties with no Previous Removal		**444**	**335**	**41**	**570**	**444,000**	**670,000**	**20,500**	**1,134,500**	**56,725**	**6,303**	**63,028**
Excavation at Properties with Arsenic >16 ppm where Previous Removals were Performed												
Additional 2007/2008 Removal Required	>16 and <95	12	42	4	55	12,000	84,000	2,000	98,000	4,900	544	5,444
Additional 2004 - 2006 Removal Required	>16 and <30	3	6	0	8	3,000	12,000	-	15,000	750	83	833
Additional Excavation Due to Yards >16 ppm		**15**	**48**	**4**	**64**	**15,000**	**96,000**	**2,000**	**113,000**	**5,650**	**628**	**6,278**
Excavation at Properties with Arsenic >16 ppm at Depth where Previous Removals were Performed												
Total Excavation	>95 and >30 in same property	29	21	0	30							
2005 Removals	>95 and >30 in same property	30	28	0	31							
2006 Removals	>95 and >30 in same property	35	19	1	35							
2007/2008 Removals	>95 Only	82	41	5	101							
Total Removal Properties	>95	176	109	6	197							
Estimated % with Results >16 ppm at Depth					75%							
Removal at Depth Required	**>95 Properties x 0.75**	**132**	**82**	**5**	**148**	**132,000**	**164,000**	**2,500**	**298,500**	**14,925**	**1,658**	**16,583**
Excavation for Alternative 3												
Total Excavation		**591**	**465**	**50**	**782**	**591,000**	**930,000**	**25,000**	**1,546,000**	**77,300**	**8,589**	**85,889**

	Qty	Unit	Assumption
Characterization			
Properties to characterize	136	properties	Properties previously unable to sample
Characterization Samples	272	samples	Assumed 2 samples/yard if previously unable to be sampled
Characterization Samples (Field Duplicates)	28	samples	10% of samples
Characterization Samples (MS/MSD)	3	samples	5% of samples
Vertical Profiling for Excavation Depth	1,106	yards	Total number of yards to excavate
Characterization Samples	3,318	samples	Assumed 3 depth intervals / yard
Characterization Samples (Field Duplicates)	332	samples	10% of characterization samples
Characterization Samples (MS/MSD)	34	samples	5% of characterization samples
Excavation			
Confirmation Samples	1,106	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	111	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	12	samples	5% of confirmation samples
Disposal	85,889	cy	Does not include peelback soil which will be used as clean fill
	128,833	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	258	samples	1/500 tons
Restoration			
Total Excavation Area	1,546,000	ft²	

Excavation Area of Yards	1,391,400	ft^2	Assume 90% of excavation area
Clean Fill Need	1,391,400	ft^3	12" in yards, none in gardens
	51,533	cy	
Imported Clean Fill Total	51,533	cy	
Clean Fill Analysis	52	samples	1 sample/1000 cy
Excavation Area of Gardens	154,600	ft^2	Assume 10% of excavation area
Topsoil in Gardens	231,900	ft^3	18" in gardens/beds
	8,589	cy	
Topsoil in Yards	695,700	ft^3	6" in yards
	25,767	cy	
Total Topsoil	34,356	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	35	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	1,391,400	ft^2	90% (no seed/fertilizer in gardens/beds)

Table 11.5 Alternative 2A—Removal of Soil Exceeding the PRG of 25 mg/kg to a Depth of 12-Inches and Landfil

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to 12" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Site Investigation Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Access Agreement	4	hr	$ 100.00	$ 400	
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	2	ea	$ 25.00	$ 50	
Reporting	1	hr	$ 100.00	$ 100	
Property Subtotal					**$750**
Properties Previously Not Characterized	136	properties			
Site Investigation Total (A)					**$102,000**

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air M	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,180**
Properties for Removal	484	properties			
Property Specific Total (B)					**$2,991,120**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	35,875	yd^3	$ 75	$ 2,690,625	
Documentation Sampling-SW 846 - 6020	731	each	$ 25	$ 18,275	
Soil Waste T&D (multiply by 1.5)	53,813	ton	$ 20	$ 1,076,250	
TCLP (Waste Characterization)	108	each	$ 1,100	$ 118,800	
Restoration					
Barrier Fabric	830,250	ft^2	$ 0.10	$ 83,025	
Clean Fill Purchase and Delivery	15,375	yd^3	$ 7	$ 107,625	
Clean Fill (Placed and Compacted)	15,375	yd^3	$ 45	$ 691,875	
Clean Fill Analysis	16	each	$ 1,200	$ 19,200	
Topsoil Purchase and Delivery	20,500	yd^3	$ 16	$ 328,000	
Top Soil (Placed and Compacted)	20,500	yd^3	$ 50	$ 1,025,000	
Topsoil Analysis	21	each	$ 1,200	$ 25,200	
Seeding/Fertilizer (seed and straw)	830,250	ft^2	$ 0.08	$ 66,420	
Stormwater Management	30,000	gal	$ 3.00	$ 90,000	
Mobilization/Demobilization	4	ea	$ 250,000	$ 1,000,000	
Non-Property Specific Total (C)					**$7,340,295**

Associated Planning and Construction Costs		
Remedial Design	LS	$400,000
Construction Oversight/Project Management	20%	$2,086,683
Reporting	10%	$1,043,342
Institutional Controls	LS	$25,000
Contingency	20%	$2,086,683
Associated Planning and Construction Total (D)		**$5,641,708**

Table 11.5 Alternative 2A—Removal of Soil Exceeding the PRG of 25 mg/kg to a Depth of 12-Inches and Landfil

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to 12" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Capital Cost Total			
Subtotal of Capital Costs (A + B + C + D)			**$16,075,123**
Duration of Remedial Actions	4 years		
Capital Cost Per Year			**$4,018,781**
Present Worth of Capital Costs		*2.3% Discount Rate*	
Year 0		1.0000	$4,018,781
Year 1		0.9775	$3,928,427
Year 2		0.9555	$3,840,104
Year 3		0.9341	$3,753,768
Capital Cost Present Value			**$15,541,080**

Operation and Maintenance Costs						
Five Year Review						
Review of Regulations		1	ls	$ 10,000	$ 10,000	
Reporting		1	ls	$ 10,000	$ 10,000	
Cost of O&M (5-year review)					$	**20,000**
Present Worth of O&M					*2.8% Discount Rate*	
Year 5					0.8710	$17,421
Year 10					0.7587	$15,174
Year 15					0.6609	$13,217
Year 20					0.5756	$11,512
Year 25					0.5014	$10,028
Year 30					0.4367	$8,734
O&M Present Value						**$76,086**

$15,617,166

Total Present Value of Alternative 2A (reported to 3 significant figures) **$15,600,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft^2). Impervious surfaces assumed to cover 1,500 ft^2 and excavation will not be performed under impervious surfaces. Average area requiring excavation per property is estimated at 3,000 ft^2 with the front yard assumed to be 1,000 ft^2 and back yard

2. Quantity Assumptions

Property counts are based on sample results through 2006.

For the 136 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on the percentage of properties requiring removal that were sampled between 2001 and 2006.

The 2004 - 2008 removals for properties with concentrations >95 ppm being completed separately. Removals performed from 2004 - 2006 had removal of areas >95 ppm and additional areas of those properties if the other sample results were >30 ppm. Removals performed in 2007 and 2008 had removal of only areas >95 ppm.

3. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.
Sample frequency for confirmation sampling is 1 composite sample per yard. Two yards per property are assumed.
Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 6 in of clean fill and a 6 in of top soil.
Seeding will be representative of local native grasses.
Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing and grubbing.

5. Schedule Assumptions

Site investigation activities assumed to be completed within 2 weeks.
Work at an individual property assumed to be completed within 7 work days.

Table 11.6 Alternative 2B—Removal of Soil Exceeding the PRG of 16 mg/kg to a Depth of 12-Inches and Landfil

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to 12" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Site Investigation Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Access Agreement	4	hr	$ 100.00	$ 400	
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	2	ea	$ 25.00	$ 50	
Reporting	1	hr	$ 100.00	$ 100	
Property Subtotal					**$750**
Properties Previously Not Characterized	136	properties			
Site Investigation Total (A)					**$102,000**

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air M	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,180**
Properties for Removal	634	properties			
Property Specific Total (B)					**$3,918,120**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	48,514	yd^3	$ 75	$ 3,638,542	
Documentation Sampling-SW 846 - 6020	985	each	$ 25	$ 24,625	
Soil Waste T&D (multiply by 1.5)	72,771	ton	$ 20	$ 1,455,417	
TCLP (Waste Characterization)	146	each	$ 1,100	$ 160,600	
Restoration					
Barrier Fabric	1,122,750	ft^2	$ 0.10	$ 112,275	
Clean Fill Purchase and Delivery	20,792	yd^3	$ 7	$ 145,542	
Clean Fill (Placed and Compacted)	20,792	yd^3	$ 45	$ 935,625	
Clean Fill Analysis	21	each	$ 1,200	$ 25,200	
Topsoil Purchase and Delivery	27,722	yd^3	$ 16	$ 443,556	
Top Soil (Placed and Compacted)	27,722	yd^3	$ 50	$ 1,386,111	
Topsoil Analysis	28	each	$ 1,200	$ 33,600	
Seeding/Fertilizer (seed and straw)	1,122,750	ft^2	$ 0.08	$ 89,820	
Stormwater Management	30,000	gal	$ 3.00	$ 90,000	
Mobilization/Demobilization	6	ea	$ 250,000	$ 1,500,000	
Non-Property Specific Total (C)					**$10,040,912**

Associated Planning and Construction Costs		
Remedial Design	LS	$400,000
Construction Oversight/Project Management	20%	$2,812,206
Reporting	10%	$1,406,103
Institutional Controls	LS	$25,000
Contingency	20%	$2,812,206
Associated Planning and Construction Total (D)		**$7,455,516**

Table 11.6 Alternative 2B—Removal of Soil Exceeding the PRG of 16 mg/kg to a Depth of 12-Inches and Landfil

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to 12" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Capital Cost Total			
Subtotal of Capital Costs (A + B + C + D)			**$21,516,548**
Duration of Remedial Actions	6 years		
Capital Cost Per Year			**$3,586,091**
Present Worth of Capital Costs		***2.35% Discount Rate***	
Year 0		1.0000	$3,586,091
Year 1		0.9770	$3,503,753
Year 2		0.9546	$3,423,305
Year 3		0.9327	$3,344,705
Year 4		0.9113	$3,267,909
Year 5		0.8904	$3,192,876
Capital Cost Present Value			**$20,318,640**

Operation and Maintenance Costs						
Five Year Review						
Review of Regulations	1	ls	$ 10,000	$ 10,000		
Reporting	1	ls	$ 10,000	$ 10,000		
Cost of O&M (5-year review)					$	**20,000**
Present Worth of O&M				***2.8% Discount Rate***		
Year 5				0.8710	$	17,421
Year 10				0.7587	$	15,174
Year 15				0.6609	$	13,217
Year 20				0.5756	$	11,512
Year 25				0.5014	$	10,028
Year 30				0.4367	$	8,734
O&M Present Value						**$76,086**

$20,394,726

Total Cost of Alternative 2B (reported to 3 significant figures) **$20,400,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft^2). Impervious surfaces assumed to cover 1,500 ft^2 and excavation will not be performed under impervious surfaces. Average area requiring excavation per property is estimated at 3,000 ft^2 with the fr

2. Quantity Assumptions

Property counts are based on sample results through 2006.

For the 138 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on the percentage of properties requiring removal that were sampled between 2001 and 2006.

The 2004 - 2008 removals for properties with concentrations >95 ppm being completed separately. Removals performed from 2004 - 2006 had removal of areas >95 ppm and additional areas of those properties if the other sample results were >30 ppm. Removals performed in 2007 and 2008 had removal of only areas >95 ppm.

3. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.

Sample frequency for confirmation sampling is 1 composite sample per yard. Two yards per property are assumed.

Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 6 in of clean fill and a 6 in of top soil.

Seeding will be representative of local native grasses.

Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing and grubbing.

5. Schedule Assumptions

Site investigation activities assumed to be completed within 2 weeks.

Work at an individual property assumed to be completed within 7 work days.

Table 11.7 Alternative 3A—Removal of Soil Exceeding PRG of 25 mg/kg and Landfill Disposal

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to an average of 18" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Site Investigation Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Access Agreement	4	hr	$ 100.00	$ 400	
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	2	ea	$ 25.00	$ 50	
Reporting	1	hr	$ 100.00	$ 100	
Property Subtotal					**$750**
Properties Previously Not Characterized	136	properties			
Site Investigation Total (A)					**$102,000**

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Vertical Delineation Sampling					
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	6	each	$ 25.00	$ 150	
Equipment and Supplies	1	each	$ 25.00	$ 25	
Reporting	1	hr	$ 100.00	$ 100	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air M	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,655**
Properties for Removal	602	properties			
Property Specific Total (B)					**$4,006,310**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	64,472	yd^3	$ 75	$ 4,835,417	
Documentation Sampling-SW 846 - 6020	926	each	$ 25	$ 23,150	
Soil Waste T&D (multiply by 1.5)	96,708	ton	$ 20	$ 1,934,167	
TCLP (Waste Characterization)	194	each	$ 1,100	$ 213,400	
Restoration					
Clean Fill Purchase and Delivery	38,683	yd^3	$ 7	$ 270,783	
Clean Fill (Placed and Compacted)	38,683	yd^3	$ 45	$ 1,740,750	
Clean Fill Analysis	39	each	$ 1,200	$ 46,800	
Topsoil Purchase and Delivery	25,789	yd^3	$ 16	$ 412,622	
Top Soil (Placed and Compacted)	25,789	yd^3	$ 50	$ 1,289,444	
Topsoil Analysis	26	each	$ 1,200	$ 31,200	
Seeding/Fertilizer (seed and straw)	1,044,450	ft^2	$ 0.08	$ 83,556	
Stormwater Management	50,000	gal	$ 3.00	$ 150,000	
Mobilization/Demobilization	5	each	$ 250,000	$ 1,250,000	
Non-Property Specific Total (C)					**$12,281,289**

Table 11.7 Alternative 3A—Removal of Soil Exceeding PRG of 25 mg/kg and Landfill Disposal		
South Minneapolis Residential Soil Contamination Site		
Description: Excavation of soils to an average of 18" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.		
Associated Planning and Construction Costs		
Remedial Design	LS	$500,000
Construction Oversight/Project Management	20%	$3,277,920
Reporting	10%	$1,638,960
Contingency	20%	$3,277,920
Associated Planning and Construction Total (D)		**$8,694,800**

Capital Cost Total		
Subtotal of Capital Costs (A + B + C + D)		**$25,084,399**
Duration of Remedial Actions	5 years	
Capital Cost Per Year		**$5,016,880**
Present Worth of Capital Costs	*2.3% Discount Rate*	
Year 0	1.0000	$5,016,880
Year 1	0.9775	$4,904,086
Year 2	0.9555	$4,793,828
Year 3	0.9341	$4,686,049
Year 4	0.9131	$4,580,693
Capital Cost Present Value		**$23,981,535**

$23,981,535

Total Cost of Alternative 3A (reported to 3 significant figures) **$24,000,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft^2). Impervious surfaces assumed to cover 1,500 ft^2. Average area requiring excavation per property is estimated at 3,000 ft^2. Excavation will not be performed under impervious surfaces. Front yard assumed to be 1,000 ft^2 and back yard assumed 2,000 ft^2

2. Quantity Assumptions

Property counts are based on sample results through 2006.

For the 136 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on the percentage of properties requiring removal that were sampled between 2001 and 2006.

The 2004 removal confirmation samples were used to estimate the percentage of properties that require excavation beyond 12 inches. An average excavation depth of 18 inches was assumed based on properties being required to 12 inches or 24 inches.

The 2004 - 2008 removals for properties with concentrations >95 ppm being completed separately. Removals performed from 2004 - 2006 had removal of areas >95 ppm and additional areas of those properties if the other sample results were >30 ppm. Removals performed in 2007 and 2008 had removal of only areas >95 ppm.

3. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.

Sample frequency for confirmation sampling is 1 composite sample per yard. Two yards per property are assumed.

Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 12 in of clean fill and a 6 in of top soil.

Seeding will be representative of local native grasses.

Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing.

Table 11.8 Alternative 3B—Removal of Soil Exceeding PRG of 16 mg/kg and Landfill Disposal

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to an average of 18" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Site Investigation Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Access Agreement	4	hr	$ 100.00	$ 400	
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	2	ea	$ 25.00	$ 50	
Reporting	1	hr	$ 100.00	$ 100	
Property Subtotal					**$750**
Properties Previously Not Characterized	136	properties			
Site Investigation Total (A)					**$102,000**

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Vertical Delineation Sampling					
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	6	each	$ 25.00	$ 150	
Equipment and Supplies	1	each	$ 25.00	$ 25	
Reporting	1	hr	$ 100.00	$ 100	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air I	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,655**
Properties for Removal	782	properties			
Property Specific Total (B)					**$5,204,210**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	85,889	yd^3	$ 75	$ 6,441,667	
Documentation Sampling-SW 846 - 6020	1,229	each	$ 25	$ 30,725	
Soil Waste T&D (multiply by 1.5)	128,833	ton	$ 20	$ 2,576,667	
TCLP (Waste Characterization)	258	each	$ 1,100	$ 283,800	
Restoration					
Clean Fill Purchase and Delivery	51,533	yd^3	$ 7	$ 360,733	
General Fill (Placed and Compacted)	51,533	yd^3	$ 45	$ 2,319,000	
Clean Fill Analysis	52	each	$ 1,200	$ 62,400	
Topsoil Purchase and Delivery	34,356	yd^3	$ 16	$ 549,689	
Top Soil (Placed and Compacted)	34,356	yd^3	$ 50	$ 1,717,778	
Topsoil Analysis	35	each	$ 1,200	$ 42,000	
Seeding/Fertilizer (seed and straw)	1,391,400	ft^2	$ 0.08	$ 111,312	
Stormwater Management	50,000	gal	$ 3.00	$ 150,000	
Mobilization/Demobilization	7	each	$ 250,000	$ 1,750,000	
Non-Property Specific Total (C)					**$16,395,770**

Table 11.8 Alternative 3B—Removal of Soil Exceeding PRG of 16 mg/kg and Landfill Disposal *South Minneapolis Residential Soil Contamination Site*		
Description: Excavation of soils to an average of 18" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.		
Associated Planning and Construction Costs		
Remedial Design	LS	$500,000
Construction Oversight/Project Management	20%	$4,340,396
Reporting	10%	$2,170,198
Contingency	20%	$4,340,396
Associated Planning and Construction Total (D)		**$11,350,990**

Capital Cost Total		
Subtotal of Capital Costs (A + B + C + D)		**$33,052,971**
Duration of Remedial Actions	7 years	
Capital Cost Per Year		**$4,721,853**
Present Worth of Capital Costs	***2.4% Discount Rate***	
Year 0	1.0000	$4,721,853
Year 1	0.9766	$4,611,185
Year 2	0.9537	$4,503,110
Year 3	0.9313	$4,397,568
Year 4	0.9095	$4,294,500
Year 5	0.8882	$4,193,848
Year 6	0.8674	$4,095,555
Capital Cost Present Value		**$30,817,618**

$30,817,618

Total Cost of Alternative 3B (reported to 3 significant figures) **$30,800,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft^2). Impervious surfaces assumed to cover 1,500 ft^2. Average area requiring excavation per property is estimated at 3,000 ft^2. Excavation will not be performed under impervious surfaces. Front yard as

2. Quantity Assumptions

Property counts are based on sample results through 2006.

For the 136 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on the percentage of properties requiring removal that were sampled between 2001 and 2006.

The 2004 removal confirmation samples were used to estimate the percentage of properties that require excavation beyond 12 inches. An average excavation depth of 18 inches was assumed based on properties being required to 12 inches or 24 inches.

The 2004 - 2008 removals for properties with concentrations >95 ppm being completed separately. Removals performed from 2004 - 2006 had removal of areas >95 ppm and additional areas of those properties if the other sample results were >30 ppm. Removals performed in 2007 and 2008 had removal of only areas >95 ppm.

3. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.

Sample frequency for confirmation sampling is 1 composite sample per yard. Two yards per property are assumed.

Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 12 in of clean fill and a 6 in of top soil.

Seeding will be representative of local native grasses.

Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing.

Alternative 2C - Cost Estimate

Table 11.9

Basis of the 95 mg/kg Excavation at Depth Alternative

South Minneapolis Residential Soil Contamination Site

	Range	Front Yard	Back Yard	Other	Total
Property Determination					
Removal Properties	>95	166	76	14	197
Previously Unsampled Properties					*136*
Properties with Results over PRG	>95				*197*
Total Properties Sampled	*0.11 to 2880*				*3578*
Estimated Number of Additional Removals	>95	6	3	0	7
Estimated Total Number of Removal Properties	**>95**	**172**	**79**	**14**	**204**
Percentage of Confirmation Samples above PRG	>95				*15%*
Estimated Number of Removal Properties >125 mg/kg at Depth		**26**	**12**	**2**	**31**
Quantities		Front ($1000\ ft^2$)	Back ($2000\ ft^2$)	Other ($500\ ft^2$)	*Total*
Excavation Areas	sf	26000	24000	1000	51000
Excavation Volumes	cf	78000	72000	3000	153000

	Qty	Unit	Assumption
Excavation			
Confirmation Samples	40	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	4	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	1	samples	5% of confirmation samples
Disposal	153,000	cf	
	5,667	cy	
	8,500	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	17	samples	1/500 tons
Restoration			
Total Excavation Area	51,000	ft^2	
Excavation Area of Yards	45,900	ft^2	Assume 90% of excavation area
Clean Fill	122,400	ft^3	30" in yards, 18" in gardens
	4,533	cy	
Clean Fill Analysis	5	samples	1 sample/1000 cy
Excavation Area of Gardens	5,100	ft^2	Assume 10% of excavation area
Topsoil in Gardens	7,650	ft^3	18" in gardens/beds
	283	cy	
Topsoil in Yards	22,950	ft^3	6" in yards
	850	cy	
Total Topsoil	1,133	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	2	samples	1 sample/1000 cy

Seeding/Fertilizer (seed and straw)	45,900	ft^2	90% (no seed/fertilizer in gardens/beds)

Table 11.10 Alternative 2A—Removal of Soil Exceeding the PRG of 25 mg/kg without Institutional Controls

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils to 12" in yards and 18" in gardens, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Site Investigation Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Access Agreement	4	hr	$ 100.00	$ 400	
Sampling Labor	2	hr	$ 100.00	$ 200	
Sample Analysis	2	ea	$ 25.00	$ 50	
Reporting	1	hr	$ 100.00	$ 100	
Property Subtotal					**$75**
Properties Previously Not Characterized	136	properties			
Site Investigation Total (A1)					**$102,00**

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air Monitoring)	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,180**
Properties for Removal	488	properties			
Property Specific Total (B1)					**$3,015,840**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	36,108	yd^3	$ 75	$ 2,708,125	
Documentation Sampling-SW 846 - 6020	736	each	$ 25	$ 18,400	
Soil Waste T&D (multiply by 1.5)	54,163	ton	$ 20	$ 1,083,250	
TCLP (Waste Characterization)	109	each	$ 1,100	$ 119,900	
Restoration					
Barrier Fabric	835,650	ft^2	$ 0.10	$ 83,565	

Clean Fill Purchase and Delivery	15,475	yd³	$	7	$	108,325
Clean Fill (Placed and Compacted)	15,475	yd³	$	45	$	696,375
Clean Fill Analysis	16	each	$	1,200	$	19,200
Topsoil Purchase and Delivery	20,633	yd³	$	16	$	330,133
Top Soil (Placed and Compacted)	20,633	yd³	$	50	$	1,031,667
Topsoil Analysis	21	each	$	1,200	$	25,200
Seeding/Fertilizer (seed and straw)	835,650	ft²	$	0.08	$	66,852
Stormwater Management	30,000	gal	$	3.00	$	90,000
Mobilization/Demobilization	4	ea	$	250,000	$	1,025,000
Non-Property Specific Total (C1)						**$7,405,99**

Associated Planning and Construction Costs		
Remedial Design	LS	$400,00
Construction Oversight/Project Management	20%	$2,104,76
Reporting	10%	$1,052,38
Contingency	20%	$2,104,76
Associated Planning and Construction Total (D1)		**$5,661,91**

Capital Cost Total		
Subtotal of Capital Costs (A1 + B1 + C1 + D1)		**$16,185,748**
Duration of Remedial Actions	4years	
Capital Cost Per Year		**$3,947,743**
Present Worth of Capital Costs		***2.3%Discount Rate***
Year 0	1.0000	$3,947,743
Year 1	0.9775	$3,858,987
Year 2	0.9555	$3,772,226
Year 3	0.9341	$3,687,415
Capital Cost Present Value		**$15,266,371**

Total Present Value of Alternative 2A **(reported to 3 significant figures)** **(E1)** **$15,300,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft²). Impervious surfaces assumed to cover 1,500 ft² and excavation will not be performed under impervious surfaces. Average area requiring excavation per property is estimated at 3,000 ft² with the fr

2. Quantity Assumptions

Property counts are based on sample results through 2006.

For the 136 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on the percentage of properties requiring removal that were sampled between 2001 and 2006.

The 2004 - 2008 removals for properties with concentrations >95 ppm being completed separately. Removals performed from 2004 - 2006 had removal of areas >95 ppm and additional areas of those properties if the other sample results were >30 ppm. Removals p

3. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.
Sample frequency for confirmation sampling is 1 composite sample per yard. Two yards per property are assumed.
Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 6 in of clean fill and a 6 in of top soil.
Seeding will be representative of local native grasses.
Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing and grubbing.

5. Schedule Assumptions

Site investigation activities assumed to be completed within 2 weeks.
Work at an individual property assumed to be completed within 7 work days.

Table 11.11 Basis of the Alternative 2A Cost Estimate

South Minneapolis Residential Soil Contamination Site

							Areas (ft²)				Volumes (cy)	
	Range	Front Yard	Back Yard	Other Yard	Number of Properties	Front (1000 ft²)	Back (2000 ft²)	Other (500 ft²)	Total	Yards (90% to 12")	Gardens and Planting Beds (10% to 18")	Total
Excavation Quantities for Properties with Arsenic >25 ppm where no Previous Removals Performed												
No Previous Removal	>25 and <95 with no result >95	317	229	26	410	317,000	458,000	13,000	788,000	26,267	4,378	30,644
Previously Unsampled Properties					*136*							
Properties with Results over PRG	*>25*				*608*							
Total Properties Sampled	*0.11 to 2880*				*3578*							
Estimated Number of Additional Removals	>25	18	13	1	23	18,000	26,000	500	44,500	1,483	247	1,731
Estimated Number of Properties with no Previous Removal		**335**	**242**	**27**	**433**	**335,000**	**484,000**	**13,500**	**832,500**	**27,750**	**4,625**	**32,375**
Excavation at Properties with Arsenic >25 ppm where Previous Removals were Performed												
Additional 2007/2008 Removal Required	>25 and <95	10	38	6	51	10,000	76,000	3,000	89,000	2,967	494	3,461
Additional 2004 - 2006 Removal Required	>25 and <30	1	3		4	1,000	6,000	-	7,000	233	39	272
Additional Excavation Due to Yards >25 ppm		**11**	**41**	**6**	**55**	**11,000**	**82,000**	**3,000**	**96,000**	**3,200**	**533**	**3,733**
Excavation for Alternative 2												

Total Excavation		**346**	**283**	**33**	**488**	**346,000**	**566,000**	**16,500**	**928,500**	**30,950**	**5,158**	**36,108**

	Qty	Unit	Assumption
Characterization			
Properties to characterize	136	properties	Properties previously unable to sample
Characterization Samples	272	samples	Assumed 2 samples/yard if previously unable to be sampled
Characterization Samples (Field Duplicates)	28	samples	10% of samples
Characterization Samples (MS/MSD)	3	samples	5% of samples
Excavation			
Confirmation Samples	662	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	67	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	7	samples	5% of confirmation samples
Disposal	36,108	cy	
	54,163	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	109	samples	1/500 tons
Restoration			
Total Excavation Area	928,500	ft^2	
Excavation Area of Yards	835,650	ft^2	Assume 90% of excavation area
Clean Fill	417,825	ft^3	6" in yards, none in gardens
	15,475	cy	
Clean Fill Analysis	16	samples	1 sample/1000 cy
Excavation Area of Gardens	92,850	ft^2	Assume 10% of excavation area
Topsoil in Gardens	139,275	ft^3	18" in gardens/beds
	5,158	cy	
Topsoil in Yards	417,825	ft^3	6" in yards

	15,475	cy	
Total Topsoil	20,633	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	21	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	835,650	ft^2	90% (no seed/fertilizer in gardens/beds)

Table 11.12
Basis of the 95 mg/kg Excavation at Depth Alternative
South Minneapolis Residential Soil Contamination Site

	Range	Front Yard	Back Yard	Other	Total
Property Determination					
Removal Properties	>95	166	76	14	197
Previously Unsampled Properties					*136*
Properties with Results over PRG	>95				*197*
Total Properties Sampled	*0.11 to 2880*				*3578*
Estimated Number of Additional Removals	>95	6	3	0	7
Estimated Total Number of Removal Properties	**>95**	**172**	**79**	**14**	**204**
Percentage of Confirmation Samples above PRG	>95				*15%*
Estimated Number of Removal Properties >125 mg/kg at Depth		**26**	**12**	**2**	**31**
Quantities		**Front (1000 ft^2)**	**Back (2000 ft^2)**	**Other (500 ft^2)**	***Total***
Excavation Areas	sf	26000	24000	1000	51000
Excavation Volumes	cf	78000	72000	3000	153000

	Qty	Unit	Assumption
Excavation			
Confirmation Samples	40	samples	1 sample/yard to be excavated
Confirmation Samples (Field Duplicates)	4	samples	10% of confirmation samples
Confirmation Samples (MS/MSD)	1	samples	5% of confirmation samples
Disposal	153,000	cf	
	5,667	cy	
	8,500	ton	Assumed correction of 1.5
Waste Characterization Sampling (samples)	17	samples	1/500 tons
Restoration			
Total Excavation Area	51,000	ft^2	
Excavation Area of Yards	45,900	ft^2	Assume 90% of excavation area
Clean Fill	122,400	ft^3	30" in yards, 18" in gardens
	4,533	cy	
Clean Fill Analysis	5	samples	1 sample/1000 cy
Excavation Area of Gardens	5,100	ft^2	Assume 10% of excavation area
Topsoil in Gardens	7,650	ft^3	18" in gardens/beds
	283	cy	
Topsoil in Yards	22,950	ft^3	6" in yards
	850	cy	
Total Topsoil	1,133	cy	6" in yards, 18" in gardens and beds
Topsoil Analysis	2	samples	1 sample/1000 cy
Seeding/Fertilizer (seed and straw)	45,900	ft^2	90% (no seed/fertilizer in gardens/beds)

Table 11.13
Removal of Soil at Depth Exceeding the PRG of 95 mg/kg and Landfill Disposal

South Minneapolis Residential Soil Contamination Site

Description: Excavation of soils, transportation and disposal, and site restoration which includes backfill, topsoil, and seeding.

Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Property Requirements					
Access Agreement	4	hr	$ 100.00	$ 400	
Property Checklists/Inventory/Photo/Video	4	hr	$ 100.00	$ 400	
Survey Support					
Pre/Post Residential Lot Survey	1	LS	$ 2,000	$ 2,000	
Site Preparation					
Utility Locate	1	LS	$ 100	$ 100	
Environmental Protection (Erosion Control & Air Monitoring)	1	LS	$ 150	$ 150	
Fence Removal for Access	10	LF	$ 3.00	$ 30	
Site Clearing	1	LS	$ 200	$ 200	
Restoration					
Tree/Shrub/Plant Restoration	1	LS	$ 1,000	$ 1,000	
Fence Restoration	10	LF	$ 40	$ 400	
Vegetation Maintenance (30 days)	1	LS	$ 1,500.00	$ 1,500	
Property Subtotal					**$6,180**
Properties for Removal	31	properties			
Property Specific Total (A2)					**$191,580**

Non-Property Specific Cost					
Description	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Total**
Soil Excavation	5,667	yd^3	$ 75	$ 425,000	
Documentation Sampling-SW 846 - 6020	45	each	$ 25	$ 1,125	
Soil Waste T&D (multiply by 1.5)	8,500	ton	$ 20	$ 170,000	
TCLP (Waste Characterization)	17	each	$ 1,100	$ 18,700	
Restoration					
Barrier Fabric	45,900	ft^2	$ 0.10	$ 4,590	
Clean Fill Purchase and Delivery	4,533	yd^3	$ 7	$ 31,733	
Clean Fill (Placed and Compacted)	4,533	yd^3	$ 45	$ 204,000	

Clean Fill Analysis	5	each	$ 1,200	$ 6,000	
Topsoil Purchase and Delivery	1,133	yd^3	$ 16	$ 18,133	
Top Soil (Placed and Compacted)	1,133	yd^3	$ 50	$ 56,667	
Topsoil Analysis	2	each	$ 1,200	$ 2,400	
Seeding/Fertilizer (seed and straw)	45,900	ft^2	$ 0.08	$ 3,672	
Stormwater Management	30,000	gal	$ 3.00	$ 90,000	
Mobilization/Demobilization	1	ea	$ 250,000	$ 250,000	
Non-Property Specific Total (B2)					**$1,282,020**

Associated Planning and Construction Costs		
Remedial Design	LS	$400,000
Construction Oversight/Project Management	20%	$294,720
Reporting	10%	$147,360
Contingency	20%	$294,720
Associated Planning and Construction Total (C2)		**$1,136,800**

Capital Cost Total	
Subtotal of Capital Costs (A + B + C)	**$2,610,401**

Total Present Value of Alternative 2A (reported to 2 significant figures) **(D2)**	**$2,600,000**
Total Present Value of Alternative 2C (D1 + D2) (reported to 2 significant figures)	**$17,900,000**

Assumptions

1. Property Assumptions

Average parcel size is approximately 0.1 acres (4,500 ft^2). Impervious surfaces assumed to cover 1,500 ft^2 and excavation will not be performed under impervious surfaces. Average area requiring excavation per property is estimated at 3,000 ft^2 with the front yard assumed to be 1,000 ft^2 and back yard assumed 2,000 ft^2

2. Quantity Assumptions

Property counts are based on confirmation results through 2007.

For the 136 properties unable to be sampled through 2006, the percentage of properties that would require removal was estimated based on :he percentage of properties requiring removal that were sampled between 2001 and 2006.

Only the 197 removal properties were considered in the evaluation of properties requiring excavation at depth. Properties with surface soil :oncentrations below 95 mg/kg are not expected to have concentrations above 95 mg/kg at 12-inches.

Excavation quantities were estimated using an assumed 3-foot excavation depth. However, excavation will proceed until below 95 mg/kg or a naximum depth of 10-feet.

I. Sampling Requirements

Waste characterization sampling for disposal includes 1 TCLP sample per 500 cy.
Sample frequency for confirmation sampling is 1 composite sample per yard.
Sampling frequency for clean backfill and topsoil is 1 TCLP sample per 1,000 yd^3.

4. Site Restoration

Backfill includes 30 in of clean fill and a 6 in of top soil for yards and 18 in of clean fill and 18 in of top soil for gardens.
Seeding will be representative of local native grasses.
Trees and shrubs will be replaced in lots only where they previously existed. Inventory taken before clearing and grubbing.

5. Schedule Assumptions

Assumed the work could be completed in one construction season.

ADMINISTRATIVE RECORD INDEX

U.S. ENVIRONMENTAL PROTECTION AGENCY
REMEDIAL ACTION

ADMINISTRATIVE RECORD
FOR
SOUTH MINNEAPOLIS RESIDENTIAL SOIL CONTAMINATION SITE
AKA CMC HEARTLAND SITE
MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

ORIGINAL
MAY 21, 2008

NO.	DATE	AUTHOR	RECIPIENT	TITLE/DESCRIPTION	PAGES
1	00/00/00		File	Presentation Slides re: Background Information on the CMC Heartland Site **(SDMS ID: 286333)**	30
2	00/00/00		File	Presentation Slides re: Trend Analysis of South Minneapolis Surface Soil Results **(SDMS ID: 286314)**	7
3	00/00/00		File	Chart re: Summary of Surface Soil Arsenic Concentrations: Maximum Arsenic Concentrations Per Sampled Property at the South Minneapolis Soil Contamination Site **(SDMS ID: 286311)**	1
4	00/00/00		File	Charts re: Arsenic Concentrations (XRF LAB) vs. LEAD XRF Relative to XRF Detection Limit **(SDMS ID: 286323)**	2
5	00/00/00	FIELDS U.S. EPA	File	Map re: Sampling Locations 1 Mile from CMC Heartland Facility, Properties Constructed Pre-1963 are Distinguished from Those Constructed Post-1963 **(SDMS ID: 286336)**	1
6	00/00/00	U.S. EPA	Public	One Outreach-Four Languages a Timeline of Outreach Efforts in Coordination with Cleanup and Sampling Activities at the South Minneapolis Neighborhood Soil Contamination Site **(SDMS ID: 286337)**	1
7	00/00/00		File	Drawings re: Sampling Locations for Arsenic at 16th Avenue South at the South Minneapolis Soil Contamination Site **(SDMS ID: 28631**	30

NO.	DATE	AUTHOR	RECIPIENT	TITLE/DESCRIPTION	PAGES
8	00/00/00		File	Drawings re: Sampling Locations for Arsenic at 18th Avenue South at the South Minneapolis Soil Contamination Site **(SDMS ID: 286320)**	36
9	00/00/00		File	Report re: Lead-Arsenic Interferences with XRF **(SDMS ID: 259870)**	3
10	00/00/00		File	Bibliography re: Arsenic Uptake by Vegetable Crops **(SDMS ID: 259871)**	4
11	00/00/00	U.S. EPA	Public	U.S. EPA Hand-out: "EPA Needs Your Help" Interviews re: Arsenic Contamination in Neighbor-hood Yards April 20 & 21 **(SDMS ID: 259873)**	1
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15	00/00/00	City Council, Minneapolis	U.S. EPA	City Council of the City Minneapolis Requests that the U.S. EPA Test Powder-horn Park for Arsenic as Part of Their Ongoing Testing Efforts **(SDMS ID: 286300)**	2
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20	1967	Byron, W., *et al* U.S. Dept. of Health, Education & Welfare	File	Toxicology and Applied Pharmacology 10, 132-147 (1967) "Pathological Changes in Rats and Dogs from Two-Year Feeding of Sodium Arsenite or Sodium Arsenate" **(SDMS ID: 286304)**	16
21	1983	Baker, D., University of Minnesota	File	Technical Bulletin: Climate of Minnesota Part XIV-Wind Climatology and Wind Power **(SDMS ID: 259790)**	49
22	1984	Shacklette, H. & J. Boerngen, U.S. Dept. of the Interior	File	U.S. Geological Survey Professional Paper 1270: Element Concentrations in Soils & Other Surficial Materials of the Conterminous United States **(SDMS ID: 259791)**	63
23	1986	Glanzman, R., CH2M HILL	U.S. EPA	Presentation Materials: Arsenic Background and Associated Elements Controlling Mobility in Groundwater **(SDMS ID: 259792)**	23
24	1994	Eisler, R., U.S. National Biological Survey	File	*Arsenic in the Environment, Part II: Human Health and Ecosystem Effects* (1994) A Review of Arsenic Hazards to Plants and Animals with Emphasis on Fishery and Wildlife Resources **(SDMS ID: 286305)**	11
25	12/18/95	Peer Environmental & Engineering Resources, Inc.	CMC Heartland Partners	Phase II Investigation CMC Heartland Partners Site, East 28th Street and State Highway 55 **(SDMS ID: 286291)**	15

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26	01/16/96	Jansen, S. & K. Larsen, Peer Environmental & Engineering Resources, Inc.	Loughran, M., Minnesota Dept. of Agriculture	Letter re: Supplemental Investigation Results and Additional Investigation Work Plan (Round #3) at the CMC Heartland Partners Site w/Attachments **(SDMS ID: 286290)**	43
27	1998	Van Alpen, M., National Environmental Health Forum	File	National Environmental Health Forum Monographs General Series No. 2, "Paint Film Components" **(SDMS ID:286340)**	146
28	1999	Saha, J., Indian Institute of Technology & K. Saha, School of Tropical Medicine	File	Critical Reviews in Environmental Science and Technology, 29(3): 281-313 (1999) A Review of Arsenic Poisoning and its Effects on Human Health **(SDMS ID: 286306)**	33
29	2000	Kock, I., et al., Environmental Sciences Group	File	Environmental Science and Technology, Vol. 34, 22-26: The Predominance of Inorganic Arsenic Species in Plants from Yellowknife, Northwest Territories, Canada **(SDMS ID: 259793)**	5
30	2000	Peijnenburg, R., *et al* National Institute of Public Health & the Environment, The Netherlands	File	Archives of Environmental Contamination & Toxicology 39, 420-430 (2000) Qualifications of Metal Bioavailability for Lettuce (Lactuca sativa L.) in Field Soils **(SDMS ID: 286303)**	11
31	03/2000	Cobb, G., Texas Tech University, *et al*	File	SETAC Journals Online: Vol. 19, Issue 3 (2000) Environmental Toxicology and Chemistry pp. 600-607, Accumulation of Heavy Metals by Vegetables Grown in Mine Wastes **(SDMS ID: 286279)**	14
32	09/2000	ATSDR	Public	Public Health Statement: Summary Chapter from Toxicological Profiles for Arsenic w/Attached ToxFAQs **(SDMS ID: 259851)**	15
33	10/2000	Minnesota Dept. of Agriculture	Public	Fact Sheet: Site Information for the CMC Heartland Lite Yard Site **(SDMS ID: 259813)**	6

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34	2001	Folkes, D., et al.,	File	Arsenic Exposure and Health Effects, Ch. 8, pp. 97-113: Impacts of Historic Arsenical Pesticide Use on Residential Soils in Denver, Colorado **(SDMS ID: 259820)**	17
35	2001	Davis, A., Geomega & D. Sherwin, et al., Chevron Environmental Management Company	File	Environmental Science & Technology, Vol. 35: An Analysis of Soil Arsenic Records of Decision **(SDMS ID: 269206)**	6
36	2001	Zillioux, E., Florida Power & Light Company	File	Environmental Forensics Vol. 2, pp. 115-116, Arsenic Background Definition: Introduction and Objectives **(SDMS ID: 259876)**	2
37	2001	Folkes, D., EnviroGroup Limited, et al.	File	Environmental Forensics Vol. 2, pp.127-139, Contributions of Pesticide Use to Urban Background Contributions of Arsenic in Denver, CO, U.S.A. **(SDMS ID: 259877)**	13
38	2001	Chirenje, T., University of Florida, et al.	File	Environmental Forensics Vol. 2, pp. 141-153 Protocol Development for Assessing Arsenic Background Concentrations in Florida Urban Soils **(SDMS ID: 259878)**	13
39	2001	Portier, K., University of Florida	File	Environmental Forensics Vol. 2, pp. 155-160, Statistical Issues in Assessing Anthropogenic Background for Arsenic **(SDMS ID: 259879)**	6
40	2001	Cline, P., Golder Associates, Inc.	File	Environmental Forensics Vol. 2, pp. 161-168 Risk-Based Decision Process for Arsenic in Soils: Implications of Conservative Protocols **(SDMS ID: 259880)**	8

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42	03/00/01	Ministry of the Environment, Ontario, Canada	File	Fact Sheet: Arsenic in the Environment **(SDMS ID: 259804)**	3
43	07/00/01	Peryea, F., Washington State University	File	Gardening on Lead and Arsenic-Contaminated Soils **(SDMS ID: 259805)**	13
44	12/00/01	Eastern Research Group	ATSDR	Summary Report: Hair Analysis Panel Discussion: Exploring the State of the Science June 12-13, 2001 **(SDMS ID: 259821)**	77
45	2002	Kennedy, S., RJ Lee Group, Inc., et al.	File	Environmental Forensics Vol. 3, pp. 131-143 Speciation & Characterization of Heavy Metal-Contaminated Soils Using Computer-Controlled Scanning Electron Microscopy **(SDMS ID: 269204)**	13
46	2002-2005	Minnesota Dept. of Agriculture	File	Fertilizer Heavy Metal Analysis and Summary **(SDMS ID: 299551)**	47
47	2002	Dahlin, C., U.S. Dept. of Energy	File	Environmental Forensics Vol. 3, pp. 191-201 Sequential Extraction Versus Comprehensive Characterization of Heavy Metal Species in Brownfield Soils **(SDMS ID: 269205)**	11
48	04/00/03	ATSDR	Public	Fact Sheet: Analysis of Hair Samples: How do Hair Sampling Results Relate to Environmental Exposures? **(SDMS ID: 259807)**	4
49	05/00/03	Minnesota Dept. of Agriculture	Public	Fact Sheet: Determining Off Site Impacts in the Phillips Neighborhood, CMC Heartland Lite Yard Site **(SDMS ID: 259812)**	6

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51	12/00/03	ATSDR	Public	Fact Sheet: ToxFaqs for Arsenic **(SDMS ID: 259808)**	4
52	2004	Denver Dept. of Environmental Health	U.S. EPA	Report: Historic Arsenical Pesticide Research (FINAL) **(SDMS ID: 259803)**	86
53	2004	Yost, L., Exponent, et al	File	Human and Ecological Risk Assessment Vol. 10 No. 5 473-483 "Estimation of Dietary Intake of Inorganic Arsenic in U.S. Children **(SDMS ID: 286309)**	6
54	03/00/04	Exponent	CMC Heartland Partners	Field Data Report: CMC Heartland Partners, Lite Yard Site **(SDMS ID: 286289)**	34
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59	06/16/04	Johnson, M., ATSDR & R. Messing, Minnesota Dept. of Health	Rhame, K., U.S. EPA	Letter re: Request for Im-mediate Action at the CMC Heartland Lite Yard Site **(SDMS ID: 222887)**	2

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61	06/25/04	Morrison & Foerster, LLP	Ropski, C., U.S. EPA	Letter re: U.S. Borax's Response to .S. EPA's Re-Request for Information Regarding the CMC Heartland Partners Lite Yard Site **(SDMS ID: 222889)**	3
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74	2005	Inov-X Systems, Inc.	File	Application Brief - Alpha *Series: Portable XRF Technology* for Analysis of Arsenic and Lead in Soil **(SDMS ID: 286310)**	2
75	01/24/05	Carney, W., U.S. EPA	Distribution List	Letter re: General Notice of Potential Liability for CMC Heartland Residential Area Site **(SDMS ID: 239961)**	4
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144	2007	Jonker, M. Utrecht University, the Netherlands, *et al*	File	Environmental Science and Technology vol. 41, No. 21, (2007) Predicting PAH Bioaccumulation and Toxicity in Earthworms Exposed to Manufactured Gas Plant Soils with Solid-Phase Microextraction **(SDMS ID: 286299)**	7
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146	01/31/07	Spilde, M., University of New Mexico	Lockheed Martin/ REAC	Results of Heavy Mineral Separation, Sequential Extraction, and Petrography on Arsenic-Contaminated Soil: Interim Report on Sample "2609 12^{th} Front" **(SDMS ID: 286326)**	24
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U.S. ENVIRONMENTAL PROTECTION AGENCY
REMEDIAL ACTION

ADMINISTRATIVE RECORD
FOR
SOUTH MINNEAPOLIS RESIDENTIAL SOIL CONTAMINATION SITE
AKA CMC HEARTLAND SITE
MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

UPDATE #1
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