

Summary of Data Gaps Report

St. Maries Creosote Site Remedial Investigation/Feasibility Study St. Maries, Idaho

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RETEC Project Number: MARB1-15656-210

Prepared for:

**Marten Brown, Inc.
1911 - 2nd Avenue
Seattle, Washington 98101**

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March 15, 2002

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List of Acronyms and Abbreviations

µg/L	micrograms per liter
ARARs	applicable or relevant and appropriate requirements
AST	aboveground storage tank
BERA	baseline ecological risk assessment
bgs	below ground surface
BLRA	Baseline Human Health and Ecological Risk Assessment
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
cm/sec	centimeters per second
COC	chemicals of concern
COI	chemicals of interest
COPC	chemicals of potential concern
cPAHs	carcinogenic polynuclear aromatic hydrocarbons
CSM	conceptual site model
DAF	Dilution-Attenuation Factor
DNAPL	dense nonaqueous-phase liquid
DQI	data quality indicator
DQO	data quality objective
E&E	Ecology and Environment
ERAGS	Ecological Risk Assessment Guidance for Superfund
FID	flame ionization detector
ft/ft	feet per foot
GC/MS	gas chromatography/mass spectrometer
g/mole	grams per mole
HPLC	high-performance liquid chromatography
IA	Integrated Assessment
IAA	Integrated Assessment Addendum
LNAPL	light nonaqueous-phase liquid
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeters
mm Hg	millimeters of mercury
MNR	monitored natural recovery
MRL	method reporting limit
NAPL	nonaqueous-phase liquid
NCP	National Contingency Plan
ND	not detected above the MRL
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCP	pentachlorophenol
POTW	publicly-owned treatment works

List of Acronyms and Abbreviations

PRGs	preliminary remediation goals
PRP	potentially responsible party
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
Respondents	Carney Products and City of St. Maries
RI/FS	Remedial Investigation/Feasibility Study
SIM	selective ion monitoring
Site	St. Maries Creosote Site
SOW	Statement of Work
SQG	sediment quality guidelines
START	Superfund Technical Assessment and Response Team
SVOC	semivolatile organic compound
TAL	total analyte list
TBC	to be considered
TOC	total organic carbon
Tribe	Coeur d'Alene Tribe
UAO	Unilateral Administrative Order
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1 Introduction

The St. Maries PRP Group, consisting of Carney Products and the City of St. Maries, has entered into an Administrative Order of Consent (AOC; [Comprehensive Environmental Response, Compensation and Liability Act] CERCLA-10-2001-0137) with the U.S. Environmental Protection Agency (USEPA) and the Coeur d'Alene Tribe (Tribe). The USEPA and the Tribe operate under a government-to-government relationship. The AOC calls for the Respondents (Carney Products and the City of St. Maries) to complete a remedial investigation and feasibility study (RI/FS) for the St. Maries Creosote Site (Site) in St. Maries, Idaho (Figure 1-1). This data gaps study is a preliminary step in this RI/FS work.

This data gap report serves three main purposes: (1) to summarize information previously generated at the Site, and (2) to develop preliminary remedial action alternatives, and (3) to identify information that is required to adequately complete the RI/FS as described in the Statement of Work (SOW) attached to the AOC. Previous reports summarizing site investigation and remedial actions have been completed by the Respondents and the USEPA in an effort to characterize and define the extent of impacts. The previous investigations have identified impacts related to creosote use in soil, groundwater, surface water, and adjacent sediment.

1.1 Purpose/Objective

The purpose of the Data Gaps Report is to summarize the information that has previously been obtained for the Site, to identify preliminary remedial action alternatives, and to identify the information that is required to successfully complete the RI/FS. This Data Gaps Report represents the first step in developing the RI/FS Work Plan. This report discusses data gaps; the specific sampling locations, frequency, and methods to address these data gaps will be discussed in the RI/FS Work Plan. The chemicals of interest (COIs) will also be identified in the RI/FS Work Plan.

The purpose of the RI/FS is to investigate the nature, extent, and mobility of contamination as necessary to assess the potential risk to human health and the environment and to develop and evaluate potential remedial alternatives to eliminate, reduce, or control identified risks.

The Statement of Work identifies the following primary objectives of the RI/FS for the Site:

- Further determine the nature and extent of creosote and other related contaminants (Site chemicals of concern [COCs]), in the soil and groundwater at the former wood treating facility.

- Determine the nature and extent of Site COCs in the sediments of the St. Joe River.
- Estimate the contaminant migration pathways including fluxes and rates through zones of migration.
- Characterize any nonaqueous-phase liquids (NAPL) in the soil or groundwater within the Study Area.
- Identify the Applicable and Relevant and Appropriate Requirements (ARARs) for Site remediation.
- Evaluate the potential risk, if any, of Site contaminants of concern to nearby domestic water users and users of the St. Joe River.
- Evaluate the potential human health and ecological risks posed by the contaminants in the soil, groundwater, surface water, and sediment.
- Evaluate impacts to Tribal water quality standards, which are potential ARARs.
- Develop Conceptual Site Model.

1.2 Site Background

The Site is located on the outskirts of the town of St. Maries, Idaho (population 2,500), along the south bank of the St. Joe River (Figure 1-1). The Site is located within the boundaries of the Coeur d'Alene Indian Reservation. The facility operated as a creosote wood treating plant beginning in the late 1930s and was dismantled around 1964, and the area was leveled in the mid-1960s. The former creosote treating operation covered approximately 0.7 acre. Since approximately 1965, the area has been used for pole peeling, sorting, and storage.

In December 1998, the City of St. Maries reported to the federal National Response Center a product sheen on the riverbank and in the water of the St. Joe River. On January 26, 1999, USEPA issued a Unilateral Administrative Order (UAO) to both the City of St. Maries, who has leased the property to various entities since the 1930s, and Carney Products, the current property lessee. The UAO required: (1) mitigation of observed creosote seeps, (2) removal of creosote-contaminated soil along the riverbank, and (3) performance of a site investigation to characterize soil and groundwater contamination in and around the area of the former wood treating facility. Since notification of the release, the Respondents have maintained boom and sorbent pads at the Site in an effort to control any impacts to surface water from the upland area.

In February 1999, the City of St. Maries and Carney Products conducted a removal action at the Site with USEPA oversight. That action included excavation and removal of approximately 195 tons of debris and contaminated soil along the St. Joe riverbank in the area of the observed seeping creosote. The area of excavation was about 85 feet long, 10 feet wide, and up to 9 feet deep. Since completion of the removal action, however, small areas of sheening have been observed intermittently on the river surface near the removal area. Observations indicate that the petroleum sheens are sourced some distance below the water surface and migrate upward through the water column before reaching the surface and appearing as a sheen.

USEPA conducted additional sampling in November 1999 to further characterize the extent of contamination in river sediments. The results of this sampling event indicated elevated levels of polycyclic aromatic hydrocarbons (PAHs) in St. Joe River sediments, particularly along the riverbank adjacent to the Site. Contamination was also detected in samples collected from the river sediments as far as 500 feet downstream of the Site and 50 feet beyond the south shore of the St. Joe River.

Substantial work has been completed in evaluating the extent of contamination in the soil and groundwater of the upland portion of the Site. This work included the installation of eight groundwater monitoring wells (four shallow and four deep), 18 subsurface soil borings, and the collection of soil and groundwater samples for analysis. In addition to this, approximately 190 soil, sediment, groundwater, and surface water samples have been collected and analyzed by Ecology and Environment (E&E). Results of previous investigations are summarized in the following reports:

- EMCON, 1998. *Environmental Site Reconnaissance and Historical Review, Leased Portion of Carney Products Company Ltd., St. Maries, Idaho*. December.
- EMCON, 1999. *Removal Site Assessment and Removal Action Reports, St. Maries Creosote Site, St. Maries, Idaho*. April.
- E&E, 1999a. *St. Maries Creosote Site Integrated Assessment Report*. May.
- E&E, 2000. *St. Maries Creosote Site Integrated Assessment Addendum, St. Maries, Idaho*. June.

These investigations are discussed in more detail in Section 3.1.

2 Summary of Facility Operations

This section presents a summary of facility operations as determined by reviewing historical sources of information that included site photographs and historic maps of the Site and surrounding property. Photographs and the map are provided in Appendix A.

2.1 Aerial Photographs

Aerial photographs of the subject Site and surrounding property from 1951, 1956, 1960, 1964, 1965, 1974, and 1981 were reviewed to determine past Site operations and areas of the property where the COIs may have been used. Photographs were acquired from various sources and used various scales. The following paragraphs describe the images that were identified in each of the photographs.

1951 (Photo 1). Aerial photograph taken at low altitude from the north side of the St. Joe River, looking southwest at the Site. Review of the photo indicated that the property was being operated as a pole yard with what appears to be a pole treating area. Entry to the property was through the flood control dike located parallel to Railroad Avenue, southeast of the creosote treating area. The entry road lies in a north-south direction and then splits to run east and west, parallel to the St. Joe River. There are two sets of rail lines that run parallel to the river with one located adjacent to the river and one located about two-thirds of the way between the river and the flood control dike. The rail lines converge as they progress westward across the property with the southernmost track curving around the west side of the boiler building and converging with the northern track that passes along the northern side of the boiler building (Figure 2-1).

There are several pole decks at the property. Most of the poles appear to have been previously peeled and placed at the property for storage and drying prior to treatment. A minor amount of poles were identified in the central portion of the property. Several floating log booms were observed in the St. Joe River, adjacent to the property. A pole peeler building is evident in the eastern portion of the property. However, the remainder of the eastern portion of the property is not visible in the photo.

The western portion of the property has four structures located on it. The structures appear to be a small office, a small workshop or tool building, a larger building that appears to be associated with pole treating, and a very small structure. The larger building has a large smokestack emanating from the roof and aboveground storage tanks (AST) located on the northwest corner of the building. There appear to be several poles standing vertically adjacent to the building (presumably in butt vats). A rail crane, located adjacent to the vertical poles and immediately south of the river, is evident in the photograph. The rail car associated with the rail crane appears to have several poles lying

horizontally on the car. There is an obvious discoloration between the east end of the poles and the west end. This discoloration may indicate that after the poles had been treated with creosote, they were placed directly on the rail cars for distribution off site. Scaffolding or a working platform of three stories was noted on the north side of the building, east of the aboveground tank(s). This platform appeared to be holding the poles in a vertical position. The description on the lower right edge of the photograph states “Carney, St. Maries Yard...1951.”

1956 (Photo 2). A St. Maries Newspaper photograph from April 1956 of the boiler building and two ASTs was taken from the flood control dike apparently looking northeast. The property is flooded and the ASTs appear to be at least 20 feet in height with one tank being approximately 5 feet taller than the other. A large stack of wood was located adjacent to the ASTs. This wood was likely used to fire the wood-fueled boiler.

1960 (Photo 3). The subject property appears to have changed little from the 1951 photograph. There are some additional structures located on an adjacent parcel (Potlatch), approximately 0.25 to 0.5 mile west of the pole treating area. There appears to be only one AST adjacent to the boiler building in this photograph. Additionally, the pole peeling area at the eastern edge of the property is visible with an associated chip burner. Activity in this area of the property appears to be limited at the time of the photograph. Observation of the pole decks indicated that there were few, if any, unpeeled poles stored on site and numerous poles had been peeled and placed in the yard for storage. Treated poles are not observed in the photograph. A small amount of darker colored soil is evident north and east of the boiler building in the area of the rail line. Several log booms are noted floating in the St. Joe River adjacent to the property. Office areas and maintenance facilities appear to be located off site, south of the flood control dike, adjacent to the entrance to the property. B.J. Carney & Co. stationery, in use in November 1963, lists the St. Maries site as a B.J. Carney & Co. treatment plant.

1964 (Photo 4). Based on an August 21, 1964, photo, the majority of the property appears to have changed little from the previous photograph. The property entry from Railroad Avenue first splits off to the east to the pole peeling area and burner and also curves to the west toward the pole treating area. The photograph indicates that the treatment plant has been partially dismantled. The upright creosote storage tanks have been removed, the boiler building appears to be 90 percent dismantled, and three creosote treatment vats are still in the ground. Rail cranes are still operating at the property. Office areas and maintenance facilities are still evident south of the dike adjacent to the property entrance. Several log booms are evident in the river adjacent to the property (August 21, 1964, Western Ways, Inc.).

1965 (Photo 5). A July 7, 1965, photograph shows that the eastern edge of the property is similar to past photographs. The burner in this photograph is working, as smoke is evident. The western portion of the property has changed, as the boiler building is no longer evident. There appears to be a depression where the butt vats were previously identified. It appears that the area around the vats has been demolished and leveled. There are several pole decks at the property, and there appears to be one main road and two rail lines in the working area of the property. Each of these runs parallel to the river. The southernmost rail line curves northerly toward the eastern edge of the property and connects with the second rail line. There appear to be both unpeeled and peeled poles located in the pole deck area. Office areas and maintenance facilities appear to be located off site, south of the flood control dike, adjacent to the entrance to the property (July 7, 1965, Western Ways Inc., Corvallis, Oregon).

1965 (Photo 6). A September 7, 1968, photograph shows that the property is still operating as a pole yard. The area of the former treatment plant has been leveled and the depressions where the butt vats were previously located are no longer present (September 7, 1968, Western Ways, Inc.).

1974 (Photo 7). The subject property is still operating as a pole yard. The office building and the tool shed associated with the former boiler building have been removed from the property. The former boiler area appears to be used for a loading and unloading area, as there are no structures or pole decks identified in this area. Use of any hazardous materials in the area of the former boiler building is not evident in the photograph. Changes in the eastern portion of the property consist of the construction of a larger pole peeling building and the construction of a chip storage bin. It also appears that the burner has been removed from the property. A new office building has been constructed south of the dike adjacent to main entry to the property (June 13, 1974, Idaho Reprographics, Inc.).

1981 (Photo 8). The property has been regraded (primarily the central portion of the property between the former treating area and the peeling area), and the arrangement of the pole decks has been reconfigured. The rail cranes as well as the rail lines previously used at the property are not evident in the photo. There are now three parallel roads that cross the property in an east-west direction. Use of the west end of the property appears to be limited. The area of the former boiler is still leveled and vacant with a minor amount of poles stored in one area. Use of any hazardous materials in the area of the former boiler building is not evident in the photograph (May 28, 1981, Idaho Reprographics, Inc.).

2.2 Site Map

A Site map was reviewed to determine past site activities and observe the layout of the past operations. The map reviewed was a site survey for the

property that was dated February 25, 1964 and is provided in Appendix A. The map was titled B.J. Carney Company, St. Maries, Idaho. The scale on the map was 1 inch equals 40 feet and was prepared under the direction of Charles H. Scribner. The map identified five structures at the property. Two structures, the peeler and the burner, were located at the eastern end of the property. The other three structures identified were the boiler building, the office, and a tool shed. Additionally, “three creosote butt treat tanks” are positioned immediately north of the boiler building.

2.3 Summary

Photographs and maps show a pole treating operation active on the Site in the middle 1900s. Photographs indicate that the area of active treating is less than one acre. B.J. Carney & Co. was involved in the operation and maintenance of the treating operation from approximately 1942 to 1964, when it was demolished and the treatment facilities were removed. The east end of the property was typically used to peel the logs and handle the chips produced in the peeling process. Early operation of the property included an on-site burner to incinerate the wood chips. Later, a chip storage bin was constructed and the chips were stored on site for later sale to outside companies. The central portion of the property was typically used for untreated pole storage. Poles placed in this area were first moved about by rail crane, followed later on by movement with rubber-tire loaders. Treatment operations were conducted on the west portion of the property. After approximately 1965, this area of the property was used as a pole loading and unloading area.

During treating operations, poles treated at the Site were placed vertically in vats and the vats were flooded with creosote. The poles were then removed from the vats and placed on railroad cars for distribution.

Photographs and maps indicate that pole treatment was limited to the area where the initial Site Assessment was completed. Additionally, interviews with former workers at the Site indicate that the boiler used to heat the creosote was fired by wood and not petroleum products or coal. Green pole storage occurred in all areas of the property. On-site storage of treated poles was not identified in any of the photographs reviewed. The 1951 photograph suggested that the treated poles were loaded directly from the vats to the flatbed railcars. A long-term operator on the river has indicated no recollection of open barges or barrels of creosote being delivered to the site. He also stated that treated poles were never shipped by water (Murphy, 2001).

3 Summary of Previous Investigations

This section summarizes the activities and results of previous site investigations. The summary of findings is compiled by media investigated and includes soil, groundwater, sediment, and surface water.

3.1 Previous Investigations

Investigation activities at the Site have included:

- A review of historical records;
- Site reconnaissance;
- Surface and subsurface soil sampling;
- Sediment sampling;
- Monitoring well installation and groundwater sampling;
- Geoprobe™ sampling of groundwater;
- Surface water sampling;
- Additional soil sampling; and
- Remedial excavation.

A brief description of the scope of each of the activities is provided in chronological order in the following subsections. Figure 3-1 shows all upland soil and groundwater sampling locations. Figure 3-2 shows sediment and surface water sampling locations in the vicinity of the site. Additional sediment and surface water sampling locations are shown in Appendix B. Analytical results are presented in Tables 3-1 through 3-11 and Appendix B, and a discussion of the results is presented in Sections 3.3 and 3.4.

3.1.1 Preliminary Assessment – December 1998

A preliminary assessment of the Site was conducted by EMCON (now IT Corporation) in November and December 1998 (EMCON, 1998). The assessment included a site reconnaissance and an information review, which included a review of readily available aerial photographs and a site blueprint. A Sanborn Fire Insurance Map review was to be performed, but no maps were available.

The site reconnaissance revealed that the Site is currently being used as a pole staging yard for Carney Products Company, Ltd., prior to sorting for peeling and processing. No current treatment of peeled logs and/or a pole treating facility were observed during the site reconnaissance. The surface area of the Site was observed to be stained with what appeared to be petroleum-type products. Sheens were noted in stormwater puddles during the site reconnaissance. Soil staining and a noticeable odor were present along the St. Joe River bank located on the Site's northern boundary. A sheen was also

observed in the St. Joe River adjacent to the Site. The wood treating operations noted in the aerial photographs and map described in Section 2 were located 50 to 75 feet south of the St. Joe River bank.

EMCON concluded that a release of an oily substance—likely creosote, based upon site information—had occurred at the Site. The USEPA was informed of the results of this assessment in December 1998.

3.1.2 Limited Removal Assessment – January 1999

The USEPA tasked E&E with providing environmental consulting services under an USEPA Region 10 Superfund Technical Assessment and Response Team (START) contract (E&E, 1999a). In January 1999, E&E performed a limited assessment at the Site which included a site visit, photographic documentation, and the collection of four soil samples and two surface water samples. The Integrated Assessment Report (E&E, 1999a) provides results of data collected and photographic documentation. The soil and water samples were taken in the vicinity of the soil staining and seepage adjacent to and in the St. Joe River that was documented in EMCON's preliminary assessment (seepage area).

The soil and water samples were analyzed for semivolatile organic compounds (SVOCs) by Contract Laboratory Program (CLP) OLM03.2 and total analyte list (TAL) metals by CLP ILM04.0. The results of these analyses indicated that both soil and surface water have been impacted with SVOCs, and in particular PAHs. The results of the samples are discussed in Section 3.3 of this report.

3.1.3 Removal Site Assessment – February and March 1999

A removal site assessment was performed by EMCON in February and March 1999 to evaluate the following:

- The vertical and horizontal extent of creosote contamination in subsurface soil and groundwater;
- Assessment of the geotechnical factors relevant to creosote migration in soil and groundwater; and
- Assessment of groundwater hydrology and connectivity to surface water as necessary to characterize the potential for migration of creosote to surface water via groundwater discharge (EMCON, 1999).

These objectives were determined through the completion of hand auger borings, Geoprobe™ borings, and installation and sampling of monitoring

wells. Hand auger borings, Geoprobe™ borings, and monitoring well locations are presented on Figure 3-1.

A total of seven hand auger soil borings (HA-1 through HA-7) were completed to a depth of 2 feet below ground surface (bgs) along approximately 350 feet of exposed riverbank. Soil samples were collected from 0 to 1 foot bgs and 1 to 2 feet bgs and analyzed for PAHs by USEPA Method 8100.

A total of 18 upland Geoprobe™ borings were completed at the Site. All sample locations are shown on Figure 3-1. Depths of the borings ranged from 15 to 30 feet bgs. Soil samples were collected continuously in each of the Geoprobe™ borings. Soil samples were selected for laboratory analyses based upon field observations. A total of 35 soil samples were analyzed for PAHs by USEPA Method 8100. To confirm the results of the USEPA Method 8100, three samples were analyzed for PAHs using USEPA Method 8270. An additional three soil samples were analyzed for total organic carbon (TOC) by USEPA Method 9060. Groundwater samples were collected from 12 of the Geoprobe™ boring locations. Groundwater samples were collected from three of the locations (GP-1, GP-2, and GP-3) at a depth of approximately 30 feet bgs. The remaining samples were collected from a depth of approximately 15 to 18 feet bgs. The samples were analyzed for PAHs by USEPA Method 8270. The results of the Geoprobe™ groundwater samples were used to identify the locations of the groundwater monitoring wells.

Based on the results of the Geoprobe™ investigation, eight 2-inch-diameter monitoring wells were installed at the Site. The monitoring wells were paired in four locations with one well typically screened from 5 to 20 feet bgs (shallow) and one well typically screened from 40 to 55 feet bgs (deep). Continuous soil samples were collected from monitoring well MW-1S and MW-1D; soil samples were collected at 5-foot intervals from MW-2D, MW-3D, and MW-4D. Selected soil samples (11 total) were analyzed for PAHs by USEPA Method 8270, and one sample was analyzed for PAHs by USEPA Method 8100. Additionally, six samples were analyzed for TOC, and three bulk samples were collected and analyzed for physical characteristics including grain size analysis and permeability. Groundwater samples were collected from each of the monitoring wells and analyzed for PAHs by USEPA Method 8270.

The surveyed groundwater elevation was measured in each of the monitoring wells three times during the month of March 1999 and compared to the water elevation of the St. Joe River measured on the same days. The data was used to evaluate the direction and properties of groundwater flow and the connectivity of groundwater with surface water.

3.1.4 Removal Action – February and March 1999

In February 1999, EMCON excavated approximately 200 tons of impacted soil from a stretch of riverbank that had been identified in December 1998 as a source of a sheen floating in the St. Joe River (seepage area) (EMCON, 1999). The USEPA was concerned that this sheen was a direct exposure risk to human health and the environment. The length of the excavation encompassed the sheen and extended from the area upstream of the identified seeps to approximately 85 feet along the riverbank. The depth of the excavation at the toe of the slope was approximately 3 feet and the overall width of the excavation was approximately 15 to 20 feet. Depth of the excavation coincided with the river level elevation at that time. The impacted soil was replaced with clean fill and riprap. The soil was transported and disposed of properly.

In March 1999, an additional removal action was conducted by EMCON to remove a reoccurring sheen that was identified after the main removal activity had been completed. Approximately 35 gallons of sediment was hand excavated and placed into a Department of Transportation-approved drum for disposal.

3.1.5 Integrated Assessment – May 1999

An integrated assessment (IA) was performed by E&E under the START contract (E&E, 1999a). The purpose of the IA was to:

- Oversee and utilize data collected during EMCON's removal assessment activities;
- Collect additional data from the activities to fulfill the site assessment requirements at the Site;
- Provide the USEPA with adequate information to determine whether the Site is eligible for placement on the National Priorities List (NPL);
- Determine off-site migration of contaminants; and
- Document any threat or potential threat to public health or the environment posed by the Site.

A total of 34 subsurface soil samples were analyzed by E&E for PAHs by various methods. Thirty of the soil samples were split samples collected by EMCON during removal assessment activities and relinquished to E&E. Two soil samples were collected from 1 to 2 feet bgs from the hand auger boring locations, 20 soil samples were collected from depths ranging from 5 to 27 feet bgs during the Geoprobe™ sampling activities, and 8 soil samples were collected from depths ranging from 5 to 62.5 feet bgs during the drilling of the

eight on-site monitoring wells. An additional four soil samples were collected by E&E from the bottom of the removal action excavation performed by EMCON at the riverbank. All sample locations are shown on Figure 3-1.

A total of 11 split groundwater samples were collected by EMCON and relinquished to E&E for analysis. Three groundwater samples were collected from the Geoprobe™ borings at 15 feet, 18 feet, and 30 feet bgs. Eight groundwater samples were collected from the newly installed groundwater monitoring wells.

A total of 10 co-located sediment and surface water sample sets were collected from the St. Joe River. Sediment samples were collected at a depth of 0 to 6 inches bgs in the St. Joe River basin. One of the sediment/water sample sets was collected as background samples, seven of the sample sets were collected along the bank adjacent to, as well as downstream of the Site, and two sample sets were collected from the wetlands along the north bank of the river, approximately 2 miles downstream of the Site.

All samples collected during the IA were analyzed for volatile organic compounds (VOCs) by CLP OLM03.1, SVOCs by CLP OLM03.1, organochlorine pesticides and polychlorinated biphenyls (PCBs) by CLP OLM03.1, TAL metals by CLP ILM04.0, and TOC by USEPA Method 9060.

3.1.6 Integrated Assessment Addendum – November 1999

Additional field activities and assessment were performed by E&E (Integrated Assessment Addendum [IAA]) in November 1999 and reported in June 2000 (E&E, 2000). The USEPA requested additional assessment to address the extent of creosote-impacted sediments in the St. Joe River basin adjacent to and downstream of the Site and to further support the listing of the Site on the NPL.

A total of 43 sediment samples were collected by E&E at depths between 0 and 6 inches bgs within the St. Joe River basin. Four of the sediment samples were collected upstream of the Site and used as background samples. Sampling locations are shown in Figure 3-2 and Appendix B. Sediment samples were collected approximately 10 feet from each bank, in the middle of the river, and between the shore sample and mid-river samples.

Two surface water samples were collected by E&E. One sample was collected slightly downstream of an outfall located near the northeastern edge of the Site within the St. Joe River. The other surface water sample was collected in Mutch Creek, which flows through the City of St. Maries and drains into the St. Joe River, and is considered a background sample.

All samples collected during the IAA were analyzed for VOCs by CLP OLM03.1, SVOCs by CLP OLM03.1, and TOC by USEPA Method 9060.

3.2 Data Adequacy

For the purposes of evaluating data gaps, the data usability has been evaluated with regard to the following general components:

- The comparability of the data sets;
- The sensitivity of the analytical methods used; and
- The selectivity of the methods used.

Data evaluated for adequacy were collected during previous investigations (Removal Site Assessment and Removal Action Report [RSA], the Integrated Assessment [IA], and the Integrated Assessment Addendum [IAA]; see Sections 3.1 and 3.4). A total of 98 soil samples, 31 groundwater samples, 53 sediment samples, and 14 surface water samples were collected and the data evaluated.

3.2.1 Summary of Data Validation

Data presented in the RSA were judged to be acceptable for their intended use with the accuracy and precision within the acceptable range for the analytical method. The RSA data were validated with regard to holding times, laboratory instrument performance, calibration standards, method blank results, matrix spikes and matrix spike duplicates, laboratory control standards, internal standards, compound identification and quantification, and completeness. The IA data were validated following the guidance of USEPA 1990 and USEPA 1994a and 1994b. Data were deemed to meet project defined DQOs for precision, accuracy, representativeness, completeness, and comparability defined in the Sampling and Quality Assurance Plan (E&E, 1999a). Less than 10 percent of the results were qualified or rejected. The IAA data were validated following the guidance of USEPA 1994a. Data were deemed to meet project defined DQOs (90 percent) for precision, accuracy, representativeness, completeness, and comparability. Project DQOs are listed in the Sampling and Quality Assurance Plan (E&E, 1999b).

3.2.2 Comparability

Comparability is the qualitative measure of confidence that two data sets can be considered equivalent in regard to the measurement of a specific variable or group of variables. This discussion focuses on analyses of all three data sets and analytical methods.

Data presented in the RSA were analyzed for SVOCs and PAHs following USEPA Methods 8270 and 8100, respectively. The samples from the IA were analyzed following the CLP OLM03.1 method for SVOCs, VOCs, and organochlorine pesticides and PCBs. The TAL metals were analyzed

following CLP ILM04.0. The IA TOC sediment samples were analyzed following USEPA Method 9060. Samples from the IAA study were analyzed following USEPA Methods 8270, 8260, and 9060 for SVOCs, VOCs, and TOC, respectively.

CLP methods were developed for Superfund site sample analysis. These methods have a high level of detail, spelling out each step within the method and very stringent QC requirements. Samples analyzed following CLP Method OLM03.1 are comparable to those analyzed following USEPA Methods 8270 and 8260 (Northeast Analytical, 1998). Samples from the IAA, and some samples from the RSA, were analyzed following the USEPA methods and are comparable. Many of the samples from the RSA were analyzed by USEPA Method 8100 for PAHs. This method indicates the presence or absence of the target analytes with the quantitative amount as estimated. A representative number of the samples were confirmed by GC/MS Method 8270. Many of the detected results agreed within the 0 to 50 percent RPD soil QC limits as defined by USEPA Region I for field duplicates, and the non-detects were confirmed at a lower reporting limit.

For the purposes of the RI/FS Work Plan, the data generated from these three studies can be combined and quantitatively compared as one data set for nature and extent evaluations, except where data were qualified.

3.2.3 Selectivity and Appropriateness of Method

Selectivity is defined as the ability of a method or technique to discriminate from other target analytes or from similar-behaving, but non-target analytes. Appropriateness of the method used for analysis considers how well the nature and extent of contamination can be determined and possible routes of migration for the contamination based on analyses selected.

The USEPA Method 8270 for SVOCs uses a GC/MS (gas chromatography/mass spectrometry) detector and can be used to quantitatively detect approximately 241 target analytes; the CLP Method OLM03.1 also uses a GC/MS detector and has a standard target analyte list of 64 analytes. The USEPA Method 8100 uses a GC/flame ionization detector (FID) to determine the presence or absence of 14 PAH compounds and their corresponding concentrations. The USEPA Method 8260 for VOCs uses a GC/MS detector to quantitatively detect about 121 target analytes, while the CLP Method OLM03.1 uses a GC/MS detector and has a standard target analyte list of 33 analytes. Twenty-four metals are on the target analyte list (TAL) for CLP Method ILM04.0. Metals were not analyzed using any other methods.

The analytical methods used for the RSA, IA and IAA all appear to be sufficiently selective for the quantitative determination of nature and extent of contamination at the Site. In general, USEPA Method 8100 was used to screen soil samples and determine where additional borings might be required;

Method 8270 was used to quantitatively confirm the results of the previous testing using Method 8100. USEPA Method 8100 uses a GC/FID, while USEPA Method 8270 employs GC/MS. As 13 percent of the 8100 data was confirmed by the GC/MS Method 8270, the results from USEPA Method 8100 may be used to determine the nature and extent of contamination at the Site.

3.2.4 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different concentrations of the variable of interest. Sensitivity is often used synonymously with the terms “detection limit” or “reporting limit.”

This discussion is focused on the sensitivity of the PAH data for all three data sets. Reporting limits for soil generally ranged between 0.3 and 30.3 mg/kg, which exceeded screening levels for benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene whose screening levels ranged between 0.08 and 0.8 mg/kg (Tables 3-3 and 3-4). Groundwater reporting limits were 0.1 or 10 µg/L, typically exceeding screening levels for carcinogenic PAHs, which ranged from 0.009 to 0.92 µg/L (Tables 3-5 and 3-6). Surface water reporting limits were 1 or 10 µg/L, exceeding screening levels for carcinogenic PAHs of 0.0038 and 0.018 µg/L (Tables 3-10 and 3-11). Sediment sample reporting limits range from 198 to 1,590 µg/kg (Tables 3-8 and 3-9). The reporting limits for indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene, all above 400 µg/kg, consistently exceeded screening levels. A reporting limit of 16,000 µg/kg was noted for an acenaphthylene sample, which has no screening level (Table 3-7). Method 8270C-SIM was not developed at the time of analysis of these samples, so the GC/MS-SIM detector could not be used to achieve lower reporting limits.

The results for all media and analyte groups of the three data sets were also examined for frequency of qualification or non-detection. Of the soil results, 55 percent were not detected, and 63 percent of groundwater results were not detected. Sediment and surface water results were not detected with 75 and 82 percent frequency, respectively. For all media, soil had 27 percent of detected results qualified, groundwater 34 percent of detected results qualified, sediment 42 percent of detected results qualified, and surface water had 93 percent of its detected results qualified. Of the non-detected data for all media, between 21 and 29 percent of the reporting limits exceeded screening levels. Comparing the number of qualified results to the total number of results, less than 10 percent were qualified for any media. Of the detected results, soil had 23 percent detected and not qualified, groundwater had 16 percent detected and not qualified, sediment had 10 percent detected and not qualified, and surface water had 0.7 percent detected and not qualified.

These data are adequate for qualitative use in the determination of nature and extent of contamination across the Site. The high degree of non-detection combined with the reporting limits exceeding screening levels indicates the analytical methods were not highly sensitive.

3.2.5 Summary

The existing data collected at St. Maries and presented here met validation criteria established by each reporting document. The three data sets are comparable and can be combined. With regards to selectivity and appropriateness of method, the USEPA and CLP methods used yielded results of adequate sensitivity to be used quantitatively in the determination of the nature and extent of contamination at this Site. Sensitivity of the results is variable within each media type. Based on sensitivity, the results can be used qualitatively for the determination of nature and extent of contamination across the Site. Less than 10 percent of the total results were qualified. Less than 23 percent of results for any media were both detected and not qualified and are adequate for quantitative use in determination of nature and extent of contamination at the Site.

3.3 Summary of Site Geologic and Hydrogeologic Conditions

3.3.1 Regional Geology

The Site is located on the south bank of the St. Joe River. The ancestral St. Joe River carved a river valley into basement Precambrian Belt Series rocks. Glacial outburst floods from ancient Lake Missoula approximately 10,000 years ago dammed the river valley downstream from the Site and formed Lake Coeur d'Alene. The lake formation resulted in the raising of the base elevation of the St. Joe River and filling of the valley with fluvial sediments. The current St. Joe River flows in a valley underlain by an alluvial and deltaic floodplain comprised of interbedded sand and silt to a depth of at least 65 feet below grade.

3.3.2 Local Geology

Subsurface soils at the Site consisted of approximately 2 to 5 feet of imported materials overlying at least 63 feet of native fluvial and deltaic deposits. The site stratigraphy has been grouped into the following units that are continuous beneath the Site:

- **Fill.** Surface soils and the riverbank were stabilized with imported materials composed of gravel, crushed rock, and silty sand. The fill thickness ranges from 2 to 5 feet. Areas of higher traffic loading during the operation of the treating plant contained a greater thickness of fill. The depth of the fill unit increases closer to the river.

- **Upper Silt Unit.** The uppermost native unit is composed of approximately 2 to 15 feet of dark gray to brown soft, moist silt, with occasional roots and organic debris. The unit occurs at 2 to 20 feet bgs. Beneath the central and eastern portion of the Site, a silty sand zone occurs at approximately 13 to 17 feet within the upper silt unit. Sieve analyses of representative samples indicate that soil is classified as “ML” or silt, according to the Unified Soil Classification System (USCS). More than 79 percent of the sample passed through the #200 sieve and the effective size was calculated as 0.0077 millimeters (mm). The vertical hydraulic conductivity of the sample was 9×10^{-5} centimeters per second (cm/sec). A preliminary estimate of horizontal hydraulic conductivity is one order of magnitude greater than the vertical hydraulic conductivity, or 9×10^{-4} cm/sec.
- **Interbedded Sand and Silt Unit.** This unit is composed of interbedded dark brown silt and silty sand layers ranging in thickness from 1/8 inch to several inches. The approximately 13-foot-thick unit was encountered at depths ranging from 20 to 33 feet bgs.
- **Sand Unit.** The sand unit consists of fine to medium sand with little silt and rare thin silt layers. The sand unit thickness ranges from 15 to 22 feet thick and was encountered at depths ranging from 33 to 55 feet bgs. Sieve analyses of representative samples indicate that the soil is classified as “SP-SM” according to the USCS. Only 10 percent of the sample passed the #200 sieve and the effective size was calculated as 0.075 mm. The vertical hydraulic conductivity of the sample was 5×10^{-4} cm/sec. The estimated hydraulic conductivity based on the Hazen method is 6×10^{-3} cm/sec.
- **Lower Silt Unit.** This unit consists of brown to gray silt with some fine sand and occasional fine sand layers. The lower silt unit is at least 10 feet thick and was encountered at depths ranging from 45 to 63 feet bgs. Geology below 63 feet bgs has not been evaluated at the Site. A transition zone consisting of 5 to 10 feet of interbedded silt and sand layers occurs occasionally between the sand and lower silt units. Sieve analyses of representative samples indicate that the soil is classified as “ML” according to the USCS. More than 79 percent of the sample passed through the #200 sieve and the effective size was calculated as 0.042 mm. The vertical hydraulic conductivity of the sample was 9×10^{-6} cm/sec. A preliminary estimate of the horizontal hydraulic conductivity is one order of magnitude greater than the vertical hydraulic conductivity, or 9×10^{-5} cm/sec.

Cross section locations are shown on Figure 3-1 and simplified subsurface cross sections of the Site are presented in Figures 3-3 and 3-4. The subsurface classifications presented above are general descriptions. The numerous

individual silt and sand layers within the units encountered during drilling are not shown on the cross sections.

3.3.3 Hydrogeology

Groundwater was initially encountered at a depth of 5 to 7 feet bgs, and was observed in all four native geologic units to a maximum depth of 63 feet bgs. Shallow monitoring wells (MW-1S to MW-4S) were installed in the upper silt unit, and deep monitoring wells (MW-1D to MW-4D) were installed in the sand unit.

3.3.4 Groundwater Elevations

In March 1999, depth to water in shallow wells MW-1S through MW-4S ranged from approximately 3 to 7 feet bgs, at an elevation of 2,128.5 to 2,131.6 feet, relative to Avista datum. Depth to water in deep wells MW-1D through MW-4D ranged from 8.5 to 9.5 feet bgs, at an elevation of 2,126.2 to 2,127.5 feet. Groundwater elevations in the sand unit were approximately 2 to 4 feet lower than in the upper silt unit, indicating a downward vertical gradient between the upper silt unit and the sand unit during March 1999. Assuming a vertical separation of approximately 30 feet between the upper silt and sand units, the vertical gradient between the units in March 1999 was 0.1 feet per foot (ft/ft).

The St. Joe River elevation at the time of the measurements ranged between 2,127.1 and 2,127.7 feet. Shallow groundwater elevation contour maps for each measurement period in March 1999 are presented on Figures 3-5, 3-6, and 3-7. Groundwater elevation measurements versus time are shown on Figure 3-8.

Changes in groundwater elevations in the upper silt unit at MW-1S through MW-4S did not match changes in the St. Joe River stage, indicating: (1) that the interbedded sand and silt layer between the upper silt unit and the sand unit hydraulically isolates the two units; and (2) that at the low river stage in March, the St. Joe River is not hydraulically connected to the upper silt unit. At times of the year when the river stage rises to above the water levels in the upper silt unit, surface water likely recharges a portion of the upper silt unit. As the river stage drops later in the year, this recharged water will discharge back into the St. Joe River. The net impact of this fluctuation will be assessed after collection of additional data. The estimated horizontal hydraulic gradient of the upper silt unit in March 1999 was at 0.02 ft/ft.

Changes in groundwater elevations in the sand unit at MW-1D, MW-2D, and MW-3D closely match each other, and closely match changes in the stage of the St. Joe River. This strongly suggests hydraulic connection within the unit at these well locations, and hydraulic connection between the St. Joe River and the sand unit, at least within 100 feet of the river. Water levels at MW-4D

did not respond to river stage, suggesting that the hydraulic connection attenuates with distance.

The St. Joe River stage varies in elevation from approximately 2,121 feet (winter level) to 2,128 feet (summer level) and has risen to 2,144 feet during spring runoff/flood stage. Extrapolating the response of groundwater elevations in wells MW-1D, MW-2D, and MW-3D suggests that during spring runoff/flood stage, the water levels in the sand unit will be higher than those in the upper silt unit, reversing the vertical gradient. The Site sometimes floods during the spring runoff.

Groundwater levels and river stage will be monitored at the Site as part of the RI/FS to evaluate the vertical and lateral hydraulic connection, and the effect of periodic Site flooding. Additional hydrogeologic characterization may be supported with well pumping tests or *in-situ* slug tests.

3.3.5 Groundwater Flow

The March 1999 groundwater elevation data indicate that groundwater within the upper silt unit flows northerly towards the St. Joe River. Using the estimated hydraulic conductivity value of 9×10^{-4} cm/sec for the upper silt unit, a porosity of 30 percent, and the March 1999 horizontal hydraulic gradient of 0.02 ft/ft, the preliminary estimate of horizontal groundwater velocity in the upper silt unit is 0.16 feet per day. This rate was calculated for March 1999 and may not be representative of flow rates experienced throughout the year as the gradient and flow direction may vary somewhat depending on river stage.

Groundwater elevations in deep wells indicate groundwater flow was away from the river within the sand unit during March 1999. Groundwater contours for the deep wells were not plotted because insufficient groundwater elevation and river stage data exist to interpret groundwater flow that appears to be strongly influenced by the river stage. Existing data suggest that groundwater flow directions within the sand unit will vary through the year depending on river stage. Groundwater flow likely will reverse during the year. Water level and river stage data show the hydraulic gradient between MW-4D and the St. Joe River reversing twice in March 1999, and the hydraulic gradient between MW-4D and MW-1D reversing once during March 1999.

The coincident changes in water elevations in the sand unit and the St. Joe River indicate a hydraulic pressure response. Groundwater may not steadily discharge from the sand unit into the river. At times of high river stage, the river will release water into the saturated zones, and this water will be released back into the river before any other water from the saturated zones discharges to the river. During high river stage, groundwater will move laterally in the direction of the river flow, rather than discharge to the river. Additional groundwater and surface water elevation data will be required to gain a

complete understanding of groundwater and surface water interaction and average groundwater velocity within the sand unit.

The preliminary estimate of vertical groundwater velocity for March 1999 is 0.19 feet per day. This estimate was calculated using an estimated vertical hydraulic conductivity value of 2×10^{-4} cm/sec (harmonic mean value between the upper silt unit and sand unit values); however, this condition is expected to be transient and may vary significantly throughout the year depending on river stage.

3.4 Nature and Distribution of Contaminants

Previous investigations indicate that former wood treating operations at the Site between approximately 1935 and 1965 have impacted subsurface soil, groundwater, sediment, and surface water. Records indicate that creosote was the wood treating solution used at the Site. As such, PAHs are expected to be the primary COCs for the Site. For data collected to date, the distribution of PAH compounds is the most useful tool in assessing the nature and distribution of Site impacts. VOCs, TAL metals, and organochlorine pesticides and PCBs were generally not detected in concentrations above screening levels. In cases where detectable concentrations were reported, the results were not above those reported in background samples; therefore, the results are not discussed further in this section. COIs and a more detailed comparison of detection limits of specific compounds to screening criteria for media of concern are presented in Section 6.2. Additional sampling may be warranted in areas where detection limits exceed screening criteria. Specific analytical results are also included in Tables 3-1 through 3-11 and Appendix B.

The previous assessment activities at the Site have revealed that carcinogenic PAHs (cPAHs) are typically present in samples collected in association with the Site. The seven cPAH compounds are benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene. Cleanup levels for cPAHs are typically much more stringent than non-carcinogenic PAHs. Plans for the Site include evaluating both cPAHs and non-carcinogenic PAHs. However, for illustrative purposes, this discussion compares the cPAH results to the screening values to represent the current Site knowledge regarding the extent of contamination for media of concern.

The following is a list of the screening values utilized for each media of concern at the Site:

- **Soil.** USEPA Region 9 Preliminary Remediation Goals (PRGs) – Soil Screening Levels, Migration to Groundwater (Dilution-Attenuation Factor [DAF] 1) (USEPA, 2000);

- **Groundwater.** USEPA Region 9 PRGs – Tap Water (USEPA, 2000);
- **Sediment.** Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Ontario Ministry of the Environment, 1993); and
- **Surface Water.** Water Quality Standards for Surface Waters of the Coeur d’Alene Tribe (Surface Water Quality Standards, Coeur d’Alene Tribe, 2000).

These screening values are used in the presentation of the site data only to evaluate if additional characterization is needed for each medium at the Site. The values are not intended to be used as Site cleanup goals.

3.4.1 Soil

Soil samples collected during assessment activities at the Site are divided for presentation into two areas: the riverbank and the upland area.

- **The riverbank,** the area directly adjacent to the St. Joe River, includes the near-surface samples collected during the Limited Removal Assessment and the hand auger boring samples collected during the Removal Site Assessment in early 1999.
- **The upland area** is the area south of the exposed riverbank and includes all Geoprobe™ borings and monitoring well locations.

Riverbank

Near-surface soil samples collected during the Limited Removal Assessment in the seepage area of the riverbank prior to the removal action had total cPAH (sum of cPAHs) concentrations ranging from 62 milligrams per kilogram (mg/kg) to 33,390 mg/kg (Table 3-1). After the completion of the soil excavation removal action, an additional four soil samples were collected at the bottom of the excavation. These soil samples had total cPAH concentrations ranging from 141.5 mg/kg to 527 mg/kg (Table 3-2).

The Removal Site Assessment bank samples were collected prior to execution in the area near the toe of the excavation. Soil samples collected from 0 to 2 feet bgs from the hand auger borings had total cPAH concentrations ranging from 0.32 mg/kg (HA-2, 0 to 1 feet bgs) to 4,918 mg/kg (HA-5, 1 to 2 feet bgs). The hand auger boring locations and total cPAH concentrations are presented on Figure 3-9. Analytical results are provided in Table 3-3. All seven hand auger borings contained at least one cPAH compound that exceeds the screening levels. The highest cPAH concentrations are located in the vicinity of the seepage area near HA-4 and HA-5.

Upland Area

The distribution of cPAH-impact to soil is presented on Figures 3-3, 3-4, and 3-9. Analytical results are provided in Table 3-4. Upland area soil sampling has focused on characterizing subsurface soil. Based on the analytical results from the removal assessment, the highest concentrations of cPAHs (1,428 mg/kg) in soil in the upland area are located in the vicinity of the former butt vats at a depth of 15 feet bgs in boring GP-11. As depicted on Figure 3-3, the extent of contamination to the east and west appears to be confined between monitoring wells MW-2D and MW-3D. Soil contamination to the south appears to extend slightly south of MW-4D, although contamination is bounded at depth in this direction (Figure 3-4). The soil sample located at MW-4D at a depth of 5 feet had a total cPAH concentration of 0.70 mg/kg and had one exceedance of the screening level (benzo(a)anthracene).

Soil boring GP-25 had elevated cPAH concentrations to the southwest (14.28 mg/kg [13 feet bgs] and 29.81 mg/kg [7 feet bgs]). The concentrations noted in this boring do not clearly follow the radial pattern of contamination away from the butt vats. Soil borings GP-16 and GP-26 located to the north and east of GP-25 had total cPAH concentrations below the method reporting limit (MRL). This aberration could potentially be due to a point source of contamination in the vicinity of GP-25. Alternatively, the detections could be related to lithologic variations in the soil.

During the drilling of MW-1D, cPAHs were detected in soil samples collected to the total depth of 62.5 feet bgs. Concentrations were a maximum of 1,428 mg/kg at approximately 15 feet bgs. Concentrations decreased with depth, and total cPAH concentrations at depths of 50 to 63 feet bgs were between 1 and 7 mg/kg. The boring log for the hole indicates that the product was observed at a maximum depth of 35 feet. The presence of cPAHs at depth in MW-1D is considered suspect. This boring was drilled using hollow-stem auger techniques, through areas noted as containing product. Drilling difficulties (heaving sands) were encountered at depth, and water was added to the borehole. Cross-contamination associated with carry-down of contaminants during drilling is a possibility given these conditions. Therefore, the total depth of PAHs in soil in the former treating area is considered a data gap and will be addressed in Section 8.

Observations from boring logs are generally consistent with the chemical data. Boring logs indicate that the majority of product (creosote) noted during soil sampling is limited to an area extending approximately 60 feet radially from the former treating area. From 60 to between 120 and 140 feet from the former treating area to the west and south, sheens and little or no creosote were noted in boring logs. Sheens without creosote are indicative of groundwater impacts hydraulically downgradient of creosote in the subsurface. In areas located greater than 60 feet from the treating area and to the east, southeast, and northeast, no creosote, sheen, or odor were noted.

Lack of impacts in the easterly direction suggest no creosote migration or groundwater transport in this direction.

Two Geoprobe™ borings and one boring for well installation were located to the northwest of the former treating area and near the shoreline (GP-2, GP-28, and MW-2). The borings in this area note odor, but no sheening. Creosote is only noted in one Geoprobe™ at a depth of 25 feet. This depth is deeper than the creosote noted in the hand augers at the shoreline. Existing data does not show a clear connection between the former treating area where the most significant upland impacts are located and the riverbank. Collection of additional data to assess this relationship is warranted.

The final consideration regarding the upland impacts is the presence of product (creosote) noted in boring logs. Boring logs do not indicate whether the product is mobile or residual. In investigations completed to date, the only well screened across an interval listed as containing product is MW-1S. Product was noted at depths from 17 to 23 feet bgs. The well is screened to a depth of 21 feet bgs, and, therefore, intercepts 4 feet of soil noted as containing product. Previous investigations indicate no accumulation of product in this well suggesting that the product is residual. The nature of product at the site (mobile versus residual) will be assessed further during the RI/FS.

3.4.2 Groundwater

Groundwater samples were collected at the Site from 12 Geoprobe™ borings and 8 monitoring wells. The distribution of cPAHs in groundwater at the Site is presented on Figures 3-10, 3-11, and 3-12. Analytical data is provided in Tables 3-5 and 3-6. Geoprobe™ and monitoring well data are presented; however, the Geoprobe™ data should be considered for screening purposes only. Data collected from monitoring wells can be used for remedial decision making.

The Geoprobe™ samples were collected as a guide for the selection of monitoring well locations. The cPAH concentrations in groundwater samples from Geoprobe™ locations are not considered representative of actual groundwater concentrations. Geoprobe™ are not constructed and sampled to minimize solids in the samples. The cPAH compounds are relatively insoluble, and substantial concentrations are indicative of sediment in the sample and not necessarily of groundwater impacts. The variation in groundwater results related to sampling methods is illustrated by the concentrations noted in Geoprobe™ GP-28 and the lack of detections in the well MW-2S, located less than 20 feet away (Figure 3-10). As such, the Geoprobe™ data should be used as a screening tool to evaluate relative impacts, but not as a true indicator of groundwater quality for determining the extent of groundwater contamination or completing risk-based analyses.

Monitoring wells MW-1S and MW-1D were installed to evaluate groundwater concentrations in the source area. The MW-2, MW-3, and MW-4 wells were installed to verify the extent of contamination at the Site. In monitoring wells MW-2S, MW-2D, MW-3S, MW-3D, MW-4S, and MW-4D, cPAHs were not detected at a limit of 0.1 micrograms per liter ($\mu\text{g/L}$). While this detection limit exceeds the screening level for some of the cPAHs, these results suggest that these wells generally bound the area of groundwater contamination. A few non-carcinogenic PAHs were detected, and concentrations were below screening levels.

The groundwater concentration in well MW-1S is representative of the concentration in the source area. The only cPAH detected in MW-1S was benzo(a)anthracene. The remaining cPAHs were not present at the detection limit of $10 \mu\text{g/L}$. Similarly, in well MW-1D, cPAH were not present at the detection limit of $10 \mu\text{g/L}$. While the lack of detections is valuable information, additional data collection with lower detection limits will be necessary. Non-carcinogenic PAHs were detected in both wells. In MW-1S, naphthalene, acenaphthene, and fluorene were detected above screening values. In MW-1D, naphthalene is the only non-carcinogenic PAH detected above screening values. As indicated above, cross-contamination associated with drilling methods is a concern for MW-1D.

The distribution of impacts noted in Geoprobe™ samples is similar to monitoring wells (although cPAH results are higher as discussed above). Results of the Geoprobe™ groundwater sampling at the Site indicate that the highest concentrations of cPAHs in groundwater are located south of the former boiler room in boring GP-10 ($71.2 \mu\text{g/L}$) and GP-14 ($187.6 \mu\text{g/L}$) at depths of 15 and 18 feet bgs, respectively. The cPAH concentrations in groundwater were lower, but still detectable in Geoprobe™ borings surrounding the former treating areas: GP-28 to the northwest ($6.8 \mu\text{g/L}$ at a depth of 15 feet bgs), GP-15 to the northeast ($13.2 \mu\text{g/L}$ at a depth of 18 feet bgs), GP-18 to the southeast ($4.4 \mu\text{g/L}$ at a depth of 15 feet bgs), and GP-16 to the southwest ($9.59 \mu\text{g/L}$ at a depth of 15 feet bgs).

In general, Geoprobe™ and monitoring well data indicate that groundwater impacted with cPAHs is present in areas where cPAHs are detected in the soil. At some locations, particularly southwest of the former treating area, cPAHs were detected in groundwater from Geoprobe™ borings, but not in similar depth soil samples (e.g. GP-16, GP-23, GP-26). The detections in groundwater and not in soil may be related to lower detection limits in groundwater, or due to the distribution of DNAPL in the subsurface. Boring logs indicate that, away from the source area, the creosote is present in sand interbeds between siltier layers. The finer-grained zones above and below these sandy layers may have little or no creosote impacts. As such, soils will show no cPAH concentrations. When a Geoprobe™ is screened across an interval, water is produced from the most permeable beds, where dissolved

PAHs may be present. In this way, PAHs may be detected in groundwater samples, but not in soil samples from a similar interval.

As depicted on Figures 3-11 and 3-12, cPAH-impact to groundwater appears to be confined to the west by MW-2S/D, to the east by MW-3S/D, and to the south by MW-4S/D. The extent of contamination to the north in the direction of St. Joe River is not known at this time. The depth of groundwater contamination below the Site also needs to be evaluated further. Although laboratory results from groundwater samples collected at MW-1D indicate that no cPAHs were detected in the samples, the method reporting limit is higher than the PRG screening levels. Naphthalene in the groundwater sample collected from MW-1D had a concentration of 3,090 µg/L, above the screening criteria. Finally, concerns exist regarding the potential for cross-contamination at well MW-1D.

3.4.3 Sediment

Ten sediment samples were collected by E&E during the IA. The two wetland samples collected 2 miles downstream contained minor concentrations of cPAHs, but none of the individual compounds exceeds screening levels. Analytical data is shown on Table 3-7. Sediment sample locations in the immediate vicinity of the Site are presented on Figure 3-13 along with the distribution of cPAHs in sediment. The sample that was designated as a background sample during the IA (RVD10SD; Figure 3-13) contained a total cPAH concentration of 2.55 mg/kg, with three of the compounds exceeding the screening levels. Two sediment samples collected approximately 0.25 mile downstream contained total cPAH concentrations of 0.6 mg/kg and 3.63 mg/kg with zero and three screening level exceedances, respectively. The sample collected downstream of the outfall contained a total cPAH concentration of 34.42 mg/kg with exceedances of all established screening levels. The remaining sediment samples from this sampling event had total cPAH concentrations ranging from 26.1 mg/kg to 3,490 mg/kg (all screening levels in all samples were exceeded).

Forty-three sediment samples were collected by E&E during the IAA (Tables 3-8 and 3-9). Four background samples were collected (SD-28, SD-29, SD-41, and SD-42) and did not contain detectable concentrations of PAHs. Sediment contamination by cPAHs is limited to the southern half of the river. The highest cPAH concentrations are located in the vicinity of the former seepage area north of the former treatment area. Concentrations of total cPAHs directly north and downgradient of the Site on the southern half of the river range from 0.99 mg/kg (near the eastern edge of the Site) to 985 mg/kg (approximately 50 feet north of the former seepage area of the riverbank).

Sediment samples collected approximately 1,000 feet downstream of the Site contained total cPAHs ranging from not detected above the MRL (ND) to

3.25 mg/kg. Sediment samples collected approximately 500 feet downstream of the Site ranged from ND to 2.81 mg/kg.

3.4.4 Surface Water

Two surface water samples were collected by E&E during the January 1999 limited removal assessment in the vicinity of the former seepage area (Table 3-10 and Appendix B). The water samples had a total cPAH concentration of 12 and 17 µg/L. The screening levels for each constituent were exceeded except for indeno(1,2,3-cd)pyrene and dibenzo(a,h)anthracene. These constituents were ND, although the detection levels for these two constituents were over three orders of magnitude higher than screening levels. No other PAHs exceeded established screening levels.

Ten co-located surface water/sediment samples were collected during the IA (Figure 3-2; Table 3-11). The locations of these samples are described in Section 3.1.5. The background sample did not contain detectable PAHs. The outfall sample contained an estimated concentration of chrysene (0.5 µg/L); all other cPAHs were ND. All samples downgradient of the former seepage area did not contain detectable cPAHs. The sample collected slightly downgradient of the former seepage area contained a concentration of bis(2-ethylhexyl)phthalate of 40 µg/L, which is above the screening level (1.16 µg/L). The two surface samples collected in the former seepage area contained estimated cPAH concentrations of 1.3 and 19 µg/L.

One background surface water sample (SW01) and one surface water sample collected downstream of the stormwater outfall northeast of the Site were collected during the IAA. The samples did not contain detectable PAHs. It should be noted that the cPAH method reporting limits for all surface water analyses exceeded the screening levels.

4 Conceptual Site Model

At this phase of the St. Maries Creosote site RI/FS project, the CSM presents a preliminary understanding and projection of site conditions. The CSM was developed from the information gathered during the previous investigations described in Section 3, existing knowledge concerning creosote behavior, and other site conditions. Development of a CSM early in the RI/FS process helps to identify data gaps and to guide in the collection of appropriate data of appropriate quality to assess risks and evaluate potential remedial actions. The CSM will be refined and revised throughout the project as additional data is collected and site conditions are better understood.

The CSM is subdivided into discussions of sources, migration pathways, and exposure pathways. The sources or potential sources, migration pathways, and exposure pathways are illustrated on Figure 4-1; migration and exposure pathways are summarized on Table 4-1. Uncertainties in the CSM associated with the sources, migration pathways, and exposure pathways are carried into the DQO process. Table 4-1 refers to DQO investigation objectives presented in Section 5, which address the data gaps. The general CSM is illustrated on Figure 4-1.

4.1 Sources of Contamination

The primary upland source of contamination at the Site is the former treating area. The former treating area encompasses the area of the butt vats, storage tanks, and the roads and railroad tracks located immediately adjacent to the vats. Historical information indicates that creosote was brought to the site by rail and treated poles left the site by railroad or road. Records indicate that the treating solution used at St. Maries is creosote, which is denser than water. Boring observations note product located at depth below the water table, further supporting the expectation that the product at St. Maries is a dense nonaqueous-phase liquid, or DNAPL. In subsequent discussions, the creosote product identified at the site is referred to as DNAPL. The primary COIs in creosote are PAHs. Other COIs may be associated with the creosote; the presence of other COIs will be discussed in the RI/FS Work Plan.

Surficial soils in the former treating area are primarily fill placed on the Site since treating operations ceased. Soil underlying the surficial fill in the former treating area is contaminated with creosote constituents. DNAPL was observed in the soil at and below the water table. The majority of DNAPL in soil is restricted to area less than 200 by 200 feet. The deepest noted occurrence of DNAPL is 35 feet bgs. While existing wells north of the former treating area have not accumulated DNAPL, the mobility of the DNAPL (whether it is residual or mobile) will be evaluated further.

Limited additional DNAPL may be present at shallow depths along the railroad tracks or the roadway surrounding the former treating area. This

DNAPL would be associated with drippage as poles were loaded for transport. At creosote sites, drippage generally forms a relatively solid, immobile shallow DNAPL-impacted layer in the soil. The types of impacts likely associated with such drippage are similar to that noted in well MW-4S where a thin, shallow layer of soil with product was observed. Surface soil quality in these potential drippage areas is a data gap.

The PAHs and DNAPL noted in the riverbank (EMCON, 1999) and adjacent sediments could be a primary or secondary source. The impacted riverbank soil and adjacent sediments would be considered a primary source if they resulted from overland discharge of waste during operation or demolition. Alternatively, the PAHs in the sediments may be a secondary source, being associated with migration of constituents from the uplands (the former treating area). The source of the PAHs in the riverbank and adjacent sediments is unclear because a significant DNAPL pathway between the Site and the riverbank has not been identified to date. In addition, some debris and solidified chunks of creosote sludge-like material resembling tank bottoms have been noted on the bank. Collection of additional data to determine whether sediment contamination is related to the upland source is warranted. This data gap will be addressed by observations made during drilling and coring in the upland between the impacted sediment area and the former treating area, along the bank, and in the sediments.

Creosote was released from these primary source areas by spills, leaks, drips, and potentially by disposal of wastes. The creosote DNAPL, and the affected soil, groundwater, and sediment are the secondary (or tertiary) sources.

For the purposes of the CSM in the data gaps report, the convention of previous work has been used to estimate the apparent lateral extent of impacts. For soil, the apparent extent of impacts is based on concentration of cPAHs exceeding the screening levels, except for those compounds where the screening level is less than the detection limit. For compounds where the screening level is less than the detection limit, the detection limit has been used to define the apparent extent of contamination. Figure 3-9 shows the apparent extent of impacted soil in the former treating area. Based on detectable levels and screening levels, the lateral extent of the uplands source area appears to be defined except for along the bank of the St. Joe River, where the most easterly (HA-1) and westerly (HA-7) samples contain cPAHs above screening levels. The vertical extent of impacts in this area is not clearly defined, as cPAH impacts were observed in all locations except GP-5. The depth of PAHs in soils at MW-1D is unclear due to potential cross contamination during drilling.

Similarly to soil contaminant delineation, previous work has estimated the lateral extent of sediment impacts based on concentration of cPAHs exceeding the screening levels, except for those compounds where the screening level is

less than the detection limit. For compounds where the screening level is less than the detection limit, the detection limit has been used to define the apparent extent of contamination. Figure 3-13 depicts the apparent lateral extent of sediment contamination adjacent to the Site. The lateral extent of contamination downstream has not been defined. Samples have only been collected from the top 6 inches of sediment; therefore, the vertical extent of contamination is unknown. In addition, areas where the previous study detection limits exceed screening levels and lower detection limits are readily achievable may warrant additional sampling. These areas will be further defined in the RI/FS Work Plan.

4.2 Potential Migration Pathways

Potential contaminant migration pathways at the St. Maries Site include soil, sediment, groundwater, and DNAPL pathways as shown on Figure 4-1. Each of these pathways is discussed in greater detail in the following sections.

4.2.1 DNAPL Migration

When creosote is released to the subsurface, it migrates vertically through the unsaturated zone with some lateral spreading, resulting primarily from the effects of capillary forces (Schwille, 1988). Small differences in soil water content and grain size may provide sufficient capillary resistance to vertical flow to cause lateral DNAPL spreading in the unsaturated zone. Alternatively, dry soil conditions and the presence of vertical pathways (e.g., root holes, coarse-grained materials, and fractures) will minimize lateral spreading while enhancing downward flow (Cohen and Mercer, 1993).

As DNAPL migrates through the unsaturated zone, a significant portion is trapped as residual material in the porous media. Residual saturation is the DNAPL concentration below which fluid drainage will not occur. The depletion of DNAPL that occurs through this entrapment of residual DNAPL may exhaust the mobile DNAPL body prior to reaching the water table (given a sufficiently small release or a thick unsaturated zone). The downward movement of creosote, combined with the trapping of residual creosote, produces a smearing or staining effect in the portions of the unsaturated zone through which the creosote migrated. Constituents in the residual DNAPL will slowly dissolve into, and migrate with, infiltrating precipitation to the water table. In this way, residual DNAPL may provide a long-term source to groundwater (see Section 4.2.2). Some DNAPL may also volatilize and migrate through the unsaturated zone to air. The volatilization pathway is a more significant issue with more volatile DNAPLs such as solvents (see Section 4.2.5).

Any DNAPL not immobilized in the unsaturated zone as residual material will eventually encounter the groundwater table. Upon reaching the capillary fringe (immediately above the water table), DNAPL will tend to spread

laterally and accumulate until the gravitational pressure of the DNAPL exceeds the entry pressure of the underlying saturated zone. The amount of spreading depends on the soil type at the water table and the amount of overlying DNAPL. When DNAPL enters the saturated zone, it displaces water (which has a lower specific gravity) and continues to migrate under pressure and gravity forces.

In the saturated zone, DNAPLs such as creosote form a separate liquid phase, since their water solubility is very low. Preferential spreading of the DNAPL will occur when less permeable layers or fractures are encountered. Mobile DNAPL will flow preferentially through zones of higher permeability (i.e., sand versus silt). If the DNAPL volume is sufficient, it will migrate downward until it encounters an impermeable barrier upon which it will pool. It may then continue to flow laterally until the mobile portion of the plume is exhausted, or until underlying permeable material is again encountered. At this point, downward migration of the plume will continue. For lithologically complex sites where sand, silt, and clay are interbedded within an aquifer, the distribution of DNAPL in the aquifer will be very heterogeneous, with DNAPL perched on impermeable layers (i.e., silt and clays) and saturating more permeable layers (Cohen and Mercer, 1993).

DNAPL in the soil matrix, either above or below the water table, may discharge into an adjacent surface water body. The character of the discharge will depend on the flow rate in the surface water body itself, and the rate DNAPL is being delivered to the surface water body. DNAPL constituents will leach into the surface water; the DNAPL generally experiences some phase separation when being discharged. A floating sheen will appear on the surface of the water body. Where DNAPL is being actively discharged to the surface water body, globules of the DNAPL will roll down the mudline of the surface water body. Where DNAPL is being delivered to the mudline at a slow rate, actual globules of product may not be observed; the discharge may be difficult to identify and may be water with a heavy sheen. At the Site, globules of DNAPL have not been observed discharging into the surface water body. The seeps have been evidenced by a floating sheen on the surface water.

The flow of DNAPL is primarily controlled by gravity (density greater than water) and capillary pressures. Groundwater advective forces have a negligible affect on the flow of DNAPL (particularly creosote). The direction of flow is governed by the slope of the impermeable barrier layer and capillary forces. Physical properties of a mobile DNAPL consisting of creosote differ significantly from those of groundwater (i.e., higher viscosity and surface tension). Creosote typically moves much slower than groundwater.

Data suggests that DNAPL was released at the former St. Maries treating area, and that any releases ceased approximately 35 years ago. Based on notations in logs, DNAPL has migrated downward through the unsaturated zone and the saturated zone. Some notations indicate that the product is present in sand interbeds, where it may have migrated some distance laterally. Notations of thin product layers at depths of 5 to 25 feet bgs in borings located 60 to 80 feet from the former treating area also suggest some lateral spreading in sand beds. It is not clear if product in the seep area is related to overland disposal or lateral spreading. In a boring between the former treating area and the seep area, free product was not present at the appropriate depth to transport DNAPL to the seep area. Additional borings between the former treating area and the seep area will help constrain the source of the seeps.

DNAPL can occur in the subsurface in either a free or residual state. Free DNAPL occurs in soil pores under pressures greater than atmospheric pressure, while residual DNAPL occurs in soil pores under pressures less than atmospheric pressure. Free DNAPL will accumulate in wells. Free DNAPL may be either mobile (able to migrate) or immobile. Immobile free DNAPL results from downgradient barriers to migration (i.e., stratigraphic changes or pinching out of fractures) or the lack of a sufficient driving force (e.g., removal of source). Residual DNAPL is immobile, and residual DNAPL will not move into a well open to the atmosphere.

Thick deposits of clearly mobile product have not been encountered at St. Maries. DNAPL has not accumulated in MW-1S, the Site well that is screened across an interval noted as containing product. Existing site data does not clearly indicate whether the DNAPL identified in borings is residual, stratigraphically trapped, or currently mobile.

4.2.2 Dissolution (Leaching to Groundwater)

Compounds in creosote or sorbed to soils will partition into soil pore water or groundwater. Creosote is a complex mixture of numerous individual compounds that will separate and partition differently into soil and water based on the properties of the individual chemicals present. The property that governs the extent to which a chemical will dissolve in groundwater is its effective solubility limit. A compound that has a high effective solubility is more likely to dissolve in groundwater than a compound with a lower effective solubility.

Infiltrating water migrates through impacted soil in the unsaturated zone. A portion of the constituents partition from the soil or vapor phase into the infiltrating water and form a leachate. This leachate then migrates to the water table, where it is diluted in groundwater. The extent of this dilution is based on the infiltration rate, groundwater velocity, source width, and height of the mixing zone in the water column. Where the DNAPL or impacted soil

exists below the water table, the compounds partition directly into the groundwater.

The pathway for sediment leaching to surface water is similar to soil leaching to groundwater. Particle size and organic carbon content of the sediment can significantly affect the partitioning of contaminants to the surface water; TOC analyses will provide important information to access partitioning.

4.2.3 Surficial Soil and Sediment Migration

The Site floods periodically. Site conditions suggest that floodwaters are not erosive, but rather backing up of water in Lake Coeur d'Alene. Nevertheless, the potential for off-site migration of COIs during floods will be assessed during the RI.

Transport of surficial impacted sediment in the riverbed as the river scours and redeposits the sediment is a potential migration pathway. The St. Joe River in the vicinity of the Site has been characterized as a "slackwater reservoir during much of the year" (Idaho Fish and Game, 1999) so redistribution of sediment, if occurring, is likely limited to higher flows during spring runoff. The potential for sediment transport is a data gap to be addressed in the RI/FS.

4.2.4 Dissolved-phase Contaminant Migration

Migration of creosote constituents dissolved in groundwater is controlled by the groundwater gradient, dispersion, retardation, and microbial degradation. Once dissolved in groundwater, compounds can migrate with groundwater flow by advection. Migration rates will depend on the aquifer characteristics (hydraulic gradient and hydraulic conductivity) and on characteristics of the dissolved constituents (solubility, partitioning, etc.). Dissolved constituents may interact with soil particles along the flow path through adsorption and other processes that retard or slow the migration of dissolved constituents. The retardation factor indicates the extent to which migration of a dissolved constituent is slowed relative to the groundwater velocity.

Once dissolved, the rate at which a chemical migrates is based on its retardation rate. Therefore, the risk associated with the groundwater transport pathway will be dominated by constituents in DNAPL with high water solubilities and low retardation rates.

Generally, creosote is primarily comprised of the low molecular weight PAHs (naphthalene and phenanthrene). Naphthalene is the PAH likely to be most widely distributed in groundwater, due both to its low retardation factor (7) and high effective solubility (11.5 milligrams per liter [mg/L]). Based on common compositions of creosote and solubility limits, other constituents such as phenanthrene, acenaphthene, fluorene, and indeno(1,2,3-cd)pyrene are

likely to be present in the area of a DNAPL source. Of these constituents, only acenaphthene and fluorene are likely to migrate rapidly from the source.

Groundwater flow direction at the site has been established for March, but likely varies seasonally and may be affected by flooding. Groundwater flow characteristics and the hydraulic interaction between the groundwater and the river need to be further defined during the RI for both the upper and lower sandy units.

4.2.5 Volatilization

The mechanisms described for dissolved-phase migration also apply to vapor-phase fate and transport; however, the processes occur in air instead of water. Evolution of contaminant vapors to unsaturated soil may occur from residual soil, constituents dissolved in groundwater, or NAPL sources. The extent of vapor evolution is primarily dependent on the vapor pressure of the contaminants present in the source material. The vapor pressure of a chemical is largely a function of its boiling point, which is in turn strongly influenced by its structure and molecular weight. For example, benzene (molecular weight of 78.1 grams per mole [g/mole]), which is comprised of a single aromatic ring, has a relatively high vapor pressure (95 millimeters of mercury [mm Hg]). Naphthalene, the most volatile PAH in creosote, has a vapor pressure two orders of magnitude lower (0.23 mm Hg). In general, compounds such as benzene may present a significant risk to human health through vapor migration pathways because of their high volatility. Less volatile compounds, such as PAHs, which have vapor pressures ranging from 0.23 to 9.6×10^{-12} mm Hg, present little to no risk for this pathway.

Volatilization is generally not a transport mechanism considered at creosote sites. A screening level risk evaluation for a site worker indicates a hazard index of 0.016 from inhalation of volatilized naphthalene (the most volatile PAH in creosote). This value is well below the target hazard quotient of 1 and indicates that the volatilization exposure pathway does not warrant further consideration at the Site. Additional detail on the risk evaluation is included in Appendix C.

4.2.6 Wind Erosion and Atmospheric Dispersion

Compounds can also migrate from surface soil to air as solid particulates (dust). Once released to ambient air, the migration of these compounds is controlled by wind direction and speed, cloud cover, air temperature, and other factors, including the formation of inversions and fog.

4.3 Potential Exposure Pathways

Identification of potential exposure pathways is tentative at this time. More work will be needed during the RI and Risk Assessment to further assess the validity of the pathways and receptors referred to in this discussion. This

assessment will include site interviews, literature searches, file reviews, and modeling exercises. These assessment activities will be combined with Site data collected during the RI to refine the list of potential receptors and exposure pathways.

As illustrated on Figure 4-1, both human and ecological receptors exist at the St. Maries site. Human receptors include:

- Site workers who contact soil. Direct contact with surface soil is considered the most likely exposure pathway. Exposure to subsurface soil by excavation workers is considered a potential pathway/receptor at this time. However, this pathway is considered less significant. The Site is on a floodplain and periodically inundated by water. As such, subsurface excavation is very infrequent, and can readily be addressed with proper controls.
- Human ingestion of groundwater as drinking water. Site groundwater is not currently used for drinking water purposes and City water is available. However, initial assessment indicates that groundwater is used in the surrounding area and, therefore, this receptor is retained for further analysis.
- Human ingestion of affected organisms or biota. These receptors will include recreation and subsistence fisherman, as well as hunters and gatherers.
- Other recreational or subsistence water users exposed to chemicals in surface water and/or sediments through direct contact.

Identification of ecological receptor species at this stage of the RI/FS process is very preliminary. Additional study is needed to identify appropriate receptors. Benthic macroinvertebrates are potentially at risk. These organisms generally colonize the upper 6 inches of the sediments. Fish may also be at risk. Fish species potentially utilizing the areas of the St. Joe River around the Site are listed in the IA and include brown and black bullheads, cutthroat trout, northern pikeminnow, and the bull trout (*Salvelinus confluentus*). Wildlife potentially foraging in or near the river (i.e., waterfowl) and amphibians and reptiles are also potential receptors; however, further study is needed to determine level of risk. For plants, the available benchmarks are higher than for benthic macroinvertebrates; therefore, levels protective of the benthos will be protective of plants.

5 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements specified to ensure that data of appropriate quality and usefulness are collected during field activities. DQOs are established prior to data collection specifying the degree of accuracy and quality of the data required to support regulatory decisions during remedial planning activities (USEPA, 1994c). They are planning tools developed early-on in a project to provide a logical framework for problem solving, clearly linking historical information and sampling/analysis efforts to an action and a decision.

For the purposes of this Summary of Data Gaps Report, DQOs are presented as preliminary planning tools to address information needed to define a protective remedy for the Site. This includes information needed to evaluate:

- Extent of impacts;
- Migration and exposure pathways identified in the CSM; and
- Feasibility of appropriate remedies.

The DQOs will be refined in the RI/FS Work Plan. The general types of data planned (i.e., soil borings or sediment cores) to evaluate these DQOs are expressed in Table 5-1. The RI/FS Work Plan will expand the DQO tables and include sample quantities, depths, sampling methods, and laboratory analyses. The DQO process links data needs to the conceptual site model, risk, and remedy evaluation and ultimately focus the investigation towards a remedy decision.

5.1 DQO Process

The DQO process, as defined by USEPA, is "...a strategic planning approach based on Scientific Method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect" (USEPA, 2000).

The seven-step DQO process recommended by USEPA (USEPA, 2000) includes:

- 1) State the Problem (summarize the problem from which data collection is required, and develop a CSM; assemble a DQO planning team).
- 2) Identify the Decision (develop a decision statement such as exceedance of a regulatory level, that requires new environmental data to address the problem).

- 3) Identify Inputs to the Decision (list the information needed to support the decisions and specify which inputs require new environmental measurements).
- 4) Define the Study Boundaries (define the spatial and temporal aspects of the environmental media that the data must represent to support a decision).
- 5) Develop a Decision Rule (develop a logical “If...then...” testable hypothesis statement that defines the conditions required to choose a remedial action).
- 6) Specify Limits on Decision Errors (specify the acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data; this step balances the precision of measurements against the cost of sampling and time constraints).
- 7) Optimize the Design for Obtaining Data (identify the most resource-effective sampling and analysis design for enabling a decision ruling).

The goal of the USEPA in using DQOs is to “minimize expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data. At the same time, the data collected should have sufficient quality and quantity to support defensible decision making” (USEPA, 1994c). Planning how to gather environmental data that can acceptably fill information gaps is the purpose of the DQO process (Crumbling, 2001). DQOs are qualitative and quantitative statements that translate non-technical project goals into technical project-specific decision goals. DQOs are goal-oriented statements intended to:

- Clarify the study objectives and remediation goals;
- Define the most appropriate type of data to collect to fill the data gaps; and
- Specify tolerable limits on decision errors to establish quantity and quality of data.

These measures of data quality are called data quality indicators (DQIs). DQIs are the measures of the individual data characteristics (the quality attributes) that collectively tend to be grouped under the general term “analytical data quality.” For example, some of these attributes may include: sample detection limit, quantification limits, bias, precision, completeness, etc., and are generally discussed and evaluated through the Quality Assurance Project Plan (QAPP).

The following sections describe the development of site-specific DQOs. To guide the development of DQOs for the St. Maries RI/FS, the documents titled *Guidance for the Data Quality Objectives Process* (USEPA, 1994c) and *Data Quality Objectives Process for Hazardous Waste Site Investigations* (USEPA, 2000) were followed.

5.2 Problem Statement

The first step in the DQO process, State the Problem, is summarized in this section to establish the foundation, purpose, and need for a site investigation study. Steps two through five of the DQO process are described in the accompanying table. Guidance indicates that this step should summarize the contamination problem that will require new environmental data and identify the resources available to resolve the problem.

5.2.1 Members of the Planning Team

The members of the planning team are the USEPA (supported by their contractor the U.S. Army Corps of Engineers), the Coeur d'Alene Tribe (supported by their contractor Ridolfi), and the St. Maries PRP group (supported by their consultant RETEC).

5.2.2 Conceptual Site Model

The conceptual site model for the St. Maries Site, which describes potential sources and migration and exposure pathways, was presented in Section 4. Section 4 lists migration and exposure pathways of potential concern. If additional data is needed to address these pathways, then that data gap has been carried forward into this DQO section and Section 8.

5.2.3 Summary Statement of the Problem

The St. Maries Creosote Site was historically used for creosote wood treating. Soil, groundwater, surface water, and sediments have been affected by historic treating activities. A cost-effective remedy that is protective of human health and the environment needs to be defined. This will include further defining the nature and extent of contamination, migration pathways, exposure scenarios, and appropriate remedial actions.

5.3 Investigation Objectives/Decision Rules

The study objective is to collect sufficient information to determine if remedial actions are warranted at the Site. To meet this objective, the DQOs for the Site were designed to answer four basic questions:

- 1) Where do COIs exceed risk-based screening levels and background levels (source characterization)?

- 2) What are the potential migration pathways for COIs in soil, groundwater, NAPL, and sediment?
- 3) Are human and ecological receptors at risk now or in the future from COCs (exposure characterization)?
- 4) Which feasible remedial technologies will cost-effectively protect human health and the environment?

DQOs are intended to “holistically” address site-wide objectives and include exposure, fate, and transport pathways across media and receptors. For discussion purposes, the conceptual DQOs for the St. Maries Site are presented in Table 5-1. The first five steps of the DQO process are outlined in this table using the framework of the four basic RI/FS elements listed above.

5.4 Uncertainty Analysis

The goal of the DQO uncertainty analysis is to both qualitatively, and quantitatively to the degree possible, define the degree of confidence that exists with the estimations of extent, exposure, effects, and remedial technologies. Bounding the certainty of estimates, especially risk estimates, is a developing science. Within the USEPA guidance documents and recent practical recommendations by several researchers, the potential areas of uncertainty to be identified and addressed include: the CSM, data uncertainty, temporal uncertainty, spatial variability, toxic exposure uncertainty, and quantitative uncertainty. At this time, this uncertainty analysis is largely qualitative relative to the DQOs. Uncertainty is summarized below along with our efforts to resolve each uncertainty.

- **CSM.** Are the fate and transport, uptake mechanisms, and selected receptors sufficiently understood to adequately characterize the risks to sensitive habitat and species? There have been several site investigations to determine the nature and extent of chemical releases associated with present and past site operations. These investigations have included: installation of groundwater monitoring wells (soil and groundwater samples, rate and direction of groundwater movement), and collection of surface sediment and riverbank samples (migration of COIs to the river and risk to receptors). There is some uncertainty associated with the horizontal and vertical extent of impacts in both the upland soils and groundwater and the subsurface river sediments. A portion of the uncertainty is related to detection limits exceeding screening criteria. Limited additional sampling is needed to characterize the horizontal extent. Additional boring and sediment cores will be collected to address the vertical extent of COIs. Results will be reviewed for data completeness, usability, comparability, and representativeness in accordance with the project QAPP. There is some uncertainty associated with the groundwater flow direction and

the interaction with the St. Joe River; additional studies will be conducted to address these uncertainties. There is some uncertainty as to whether the receptors identified within the CSM adequately represent the ecosystem, and other species potentially at risk. The selection of important receptor species will be done in consultation with local stakeholders and agencies.

- **Chemicals of Potential Concern (COPCs).** The COPCs are determined by comparing all chemicals analyzed to screening levels for different media that are protective of different receptors. Therefore, the COPCs represent the chemicals that will likely cause the most significant health effects. The risk assessment is unlikely to underestimate cancer risks or noncancer health effects because of influences from chemicals that were screened out.

All of the PAHs will be retained for further analysis using USEPA Method 8270-SIM for lower detection limits. Despite no record of pentachlorophenol (PCP) use at the Site, there is concern that current detection limits are sufficiently low to demonstrate no PCP risk. The RI/FS Work Plan will compare the method detection limits to the screening levels and determine if PCP or other compounds should be retained as a COPC.

- **Human Health.** The uncertainties in the human health risk assessment reflect the uncertainties in the two principal components of the risk assessment: the exposure assessment and toxicity assessment. The exposure assessment includes the identification of COPCs (discussed above), the identification and screening of potential receptors, the development of intake assumptions, and the calculation of exposure point concentrations. Much uncertainty exists on the location of these receptors relative to the source and consumption rates used by local residents. This uncertainty will be addressed through interviews with local residents and literature-gathering efforts to determine the extent of consumption, habitat, population, location, frequency, chemical analysis, and Site conditions, all of which will influence the risk assessment. The toxicity assessment includes two types of health effects: cancer and noncancer effects. Cancer slope factors and/or reference doses will be used to estimate toxicity.
- **Human and Ecological Health.** This section will evaluate the potential for COPC uptake from bedded sediments and pore water into the aquatic food chain. Assumptions will be made regarding the partitioning of chemicals into the porewaters and surface waters and the rate of uptake. If point estimates at the mean and 95 percent upper confidence limits, expressed as hazard quotients, are used it is possible that these comparisons will tend to overpredict actual observed effects

with field verification studies. This source of error is acceptable in an USEPA Risk Assessment. There is a reasonable degree of uncertainty that actual impacts exist from exposure to toxic chemicals without quantitative field corroboration.

- **Ecological Risk.** Screening efforts will focus on COI that may also be present in site media and cause toxicity to biota. Biological testing of sediment samples addresses all compounds in the sediment, and results are not compound-specific; any compound that could exhibit an adverse biological effect on test organisms will be expressed through the test.
- **Ecological Health.** Ecological health in the surface sediments of the St. Joe River will be assessed through bulk sediment toxicity testing using appropriate benthic invertebrate species. Toxicity testing assesses the cumulative effects of individual compounds in sediment (either by synergistic or additive methods) and predicts toxicity based on the actual bioavailable fractions of the compounds in the sediments. Other physical factors, such as ammonia and grain size, can alter the predictive ability of toxicity tests, but selection of appropriate reference area sediments should assist in identifying or explaining the influence of the site-specific physical or chemical effects.
- **Temporal and Spatial Variability.** Sediment and soil PAH concentrations tend to show a relatively slow rate of change over time. Samples collected in the past 8 years are expected to be representative of current conditions. Groundwater and surface water concentrations tend to show more seasonal variability and are generally dependent on seasonal fluctuations of rainfall and flow. Therefore, uncertainty associated with these media will be addressed by repeat sampling of the same stations during wet and dry season sampling events. There is some uncertainty associated with more long-term variability (i.e., 10-year climate cycles) that will not be addressed by sampling efforts. Long-term rainfall, river height, and river flow patterns will be evaluated, if available, to determine the long-term (i.e., 10-year) variability of water-related parameters. Through previous experience at similar sites and media, there will be a high degree of certainty related to the spatial variability of COI concentrations in media. Interpolations of concentrations will be made between actual data points and carefully reviewed for unacceptable levels of uncertainty. All samples will be collected and analyzed as discrete samples to preserve the spatial integrity of the analysis. For sediment cores, depth-wise samples may be up to 1 to 2 feet thick to ensure adequate sample volume, but these samples will still be considered “discrete” samples since stratigraphy contacts and sequences will be preserved.

- **Technology Screening.** Based on our previous experience at creosote-related sites, the technology screening process will be representative of tested, implementable, feasible, and cost-effective technologies that can be used to remediate creosote-impacted soil, groundwater, and sediment. Site-specific natural attenuation processes and potential will be evaluated to assess the Site's ability to address impacts by natural attenuation. Physical characteristics of the soil and any product recovered will be further evaluated to address other remedial options.

6 Baseline Human Health and Ecological Risk Assessment

The RI/FS Work Plan will describe the steps planned to complete a Baseline Human Health and Ecological Risk Assessment (BLRA). This section provides a preliminary description of the objectives, COIs, and endpoints for both human and ecological risks in an effort to define any potential data gaps not otherwise discussed. Receptors of concern were discussed in Section 4.

The objective of a risk assessment is, as defined by USEPA, “to characterize and quantify the current and potential risks that may exist if no further remedial action is taken.” The BLRA is intended to provide an assessment of risks to human health and the environment that will support selection of a remedy to eliminate, reduce, or control those risks. A draft baseline assessment and a final baseline assessment that incorporates USEPA and Coeur d’Alene Tribe comments will be prepared. There is no requirement for a preliminary or screening assessment as Site contamination has been confirmed.

6.1 Objectives

For the purposes of this study, the objectives of a site-specific risk assessment for the St. Maries Creosote Site are to define the current (or baseline) human health and ecological risks associated with the COCs. The specific media of interest include the soils, groundwater, sediments, surface waters, and biota in the St. Joe River in the vicinity of the Site. In summary, the primary objectives of the BLRA are to:

- Define the sources, COCs, receptors, and pathways at risk;
- Identify the extent of exposure;
- Determine the extent and likelihood of actual or potential impacts; and
- Describe the uncertainty associated with characterized risk.

6.2 Chemicals of Interest

A total of five historical sampling activities have been conducted at the Site. Samples were collected from soil, groundwater, surface sediment, and surface water. Samples were analyzed for VOCs, SVOCs, metals, organochlorine pesticides, and PCBs. According to historical information and Site analytical data, SVOCs, consisting mostly of PAHs, are present at elevated concentrations in soil, groundwater, and surface sediments. These contaminants appear to be associated with past creosote treating activities at the Site.

This data gaps report has focused on the distribution of PAHs (primarily cPAHs) for defining the nature and extent of contamination and potential data

gaps. A few other SVOCs have been identified at the Site. Metals have generally been below screening levels or consistent with background levels. VOCs, organochlorine pesticides, or PCBs have not been detected at significant concentrations above screening levels. Therefore, the focus for this report has been on PAHs.

Nevertheless, a detailed analysis of screening levels, results, and detection limits needs to be completed to assess the chemicals to be included in further testing during RI sampling, and the frequency of testing necessary. For example, the USEPA is concerned because PCP detection limits are above screening criteria, and, therefore, the presence of low-level PCP has not been evaluated sufficiently at the Site. Evaluation of constituents to be included in RI sampling will be completed as part of the RI/FS Work Plan.

In summary, both the carcinogenic and noncarcinogenic PAH compounds will be retained as COIs for further evaluation. The need to retain other compounds (i.e., other SVOCs) will be evaluated during the RI/FS Work Plan.

6.3 Human Health Risk

Targeted media for the Human Health Risk Assessment include surface soil, groundwater, surface water, and sediment. Some soil and groundwater samples collected from the upland property contained elevated levels of PAHs. Impacted surface soils may be an exposure pathway to on-site workers and residents. Impacted groundwater may be an exposure pathway to off-site groundwater aquifers if the COIs have migrated off site.

Surface sediment samples collected from the St. Joe River contained elevated levels of PAHs. Impacted surface sediments may be an exposure pathway to humans via dermal contact, direct ingestion of sediment/surface water, or ingestion of contaminated biota.

Assessment endpoints for the Risk Assessment will focus on human health values to be protected, and may include:

- Ability to safely drink the groundwater in the surrounding area;
- Ability to recreate in the river;
- Ability to safely eat local fish, waterfowl, and vegetation;
- Ability to safely conduct subsistence hunting and gathering activities in or near the River; and
- Ability to safely work at the Site.

Measurement endpoints express measured or observed responses of biological or ecological systems to environmental contamination. The measurements relate back to the assessment endpoints. Measurements for the surface water and groundwater typically include collection of water samples and comparison to federal acute and chronic water quality criteria to determine consumption safety. Measurements for safe consumption and recreation typically include modeling efforts to determine partitioning coefficients, consumption rates, and community diversity and abundance. Modeling would be conducted on field collected surface sediment samples. Bioaccumulation in animals will be assessed through modeling as described below in the ecological risk assessment. Measurement of direct tissue samples is not currently planned. Measurements for safe working environments typically include collection of surface soil samples and comparison to regulatory-derived exposure/toxicity values.

6.4 Ecological Risk

The target media for the ecological risk assessment are surface water and sediment. Based on assessments completed to date, the target habitat is the river. Samples taken from the wetlands two miles downstream of the Site did not contain constituent concentrations exceeding the sediment quality guidelines (SQGs), and sample RV03SD (Figure 3-13) showed constituent concentrations below the SQGs. Therefore, the wetlands are not of concern in assessing risk from the St. Maries Site.

SQGs were developed to be protective of benthic macroinvertebrates (organisms completing at least a portion of their life cycle in the sediments). Because SQGs have been exceeded, a potential for risk to these organisms may exist. Therefore, the river habitat is of concern and likely requires further investigation.

The river and adjacent terrestrial habitats should be characterized in accordance with “Checklist for Ecological Assessment/Sampling” from *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS; USEPA Environmental Response Team, 1997). While some pertinent information has been collected, additional information is needed to complete this checklist.

Finally, water samples should be collected in the river just above the sediments near previous sediment sampling locations representing the contamination gradient. Seeps along the riverbank were not sampled during the IA because the river water level was too high during the field effort. These seeps should be sampled, if appropriate, to estimate whether groundwater discharge is a significant contaminant loading source to surface water or sediments.

Assessment endpoints focus on ecological value to be protected, and may include:

- Benthic macroinvertebrate survival, growth, and community diversity and abundance;
- Fish community health, and maintenance; and
- Wildlife survival, development, and reproduction.

Measurement endpoints express measured or observed responses of biological or ecological systems to environmental contamination. The measurements relate back to the assessment endpoints. Measurements for the benthic macroinvertebrates typically include toxicity tests to determine the effects of the sediments on survival and growth and community surveys to determine community diversity and abundance. Both measures can be accomplished with results obtained from sediment dredge/grab samples. If other wildlife endpoints are identified then they will be evaluated using literature-derived toxicity information.

For the purposes of this study, the first step to evaluating risk to ecological receptors will be the collection of surface sediment samples for biological toxicity testing (and chemical testing). Results will be compared to reference areas. To address bioaccumulation potential (for both fish health and human health via consumption), default partitioning and uptake assumptions will be used to evaluate potential exposure concentrations in aquatic receptors. The tribal consumption rates identified in the Coeur d'Alene Human Health Risk Assessment will be used to determine potential risks from ingestion of fish and other aquatic species as appropriate. Other modeling assumptions will be used to determine bioaccumulation risks to other receptors of interest. A third step to evaluating risk could be collection of tissue samples.

7 Preliminary Remedial Action Alternatives

7.1 Preliminary and Potential ARARs

A preliminary list of ARARs and other laws was generated using existing information in the record for the Site. Current activities, including the preparation of this data gaps report and the planning for the RI/FS are being performed pursuant to CERCLA and the National Contingency Plan (NCP) (40 CFR 300). Remedial action will also be performed pursuant to CERCLA and the NCP and in compliance with ARARs. If an ARAR cannot be practicably achieved, a justification for a waiver from the specific ARAR will be provided in the feasibility study, and an alternate standard will be recommended. Additional guidelines, which are not ARARs, will be considered in developing and evaluating remedial action alternatives for the Site. Such guidelines are identified as information to be considered (TBC).

ARARs may apply to site cleanup action for several different reasons. Laws that regulate the concentrations of hazardous substances present at the Site are referred to as chemical-specific requirements. Other laws may be applicable because they establish standards for the type of cleanup action that may be implemented (e.g., water discharge requirements) or for the general site setting (e.g., shoreline protection requirements). These latter items are referred to as action-specific and location-specific requirements, respectively. The following sections list potentially applicable chemical, location, and action-specific ARARs that may be applicable to this project.

7.1.1 Chemical-Specific

Chemical-specific ARARs define concentration limits for environmental media. These requirements may be used to set cleanup levels for COCs in soil, water, and sediment. The principal chemical-specific ARARs and TBCs for St. Maries site cleanup include:

USEPA Region 9 Preliminary Remediation Goals. Soil screening level (DAF 1) and tap water standards have been identified as TBCs and will be considered in establishing action levels for soil and groundwater, respectively.

Ontario Provincial Sediment Quality Guidelines – Lowest Effect Level. USEPA has expressed a preference to use the Ontario Provincial Sediment Quality Guidelines to establish action levels for sediment. These guidelines are TBCs for the site.

Water Quality Standards for Surface Waters of the Coeur d'Alene Tribe – Human Health Criteria (water and organisms). Tribal surface water quality standards are ARARs and are applicable for establishing action levels for surface water.

7.1.2 Location-Specific

Location-specific ARARs place constraints or define requirements for remedial activities that occur in environmentally sensitive areas (e.g., wetlands, floodplains). The principal location-specific ARARs and TBCs for sediment cleanup in St. Maries site cleanup are:

Floodplain Management Executive Order 11988, 40 CFR 6, Appendix A. The Site is located in the floodplain of the St. Joe River. The evaluation of remedial action alternatives will need to consider the impact of any construction on the floodplain.

7.1.3 Action-Specific

Action-specific ARARs govern the design, performance, or operational aspects of contaminated materials management. The principal action-specific ARARs and TBCs for St. Maries site cleanup are:

Hazardous Waste Management Regulations (RCRA) 40 CFR Subchapter I. Activities that involve the active management of media that contain listed hazardous waste, as defined in the USEPA's "contained-in" policy, will trigger standards for managing hazardous waste pursuant to the Resource Conservation and Recovery Act (RCRA). Such materials managed on site are subject to Land Disposal Restrictions (40 CFR 268) unless they are within the contiguous Area of Contamination or managed pursuant to alternative standards approved as part of the selection of the remedial action corrective action management unit (CAMU). Non-*in-situ* storage or treatment or disposal of such materials on site would trigger applicable RCRA requirements for these activities (40 CFR 264). If materials are sent off site for treatment and disposal, the requirements for generators of hazardous waste (40 CFR 262) would apply.

Clean Water Act 40 CFR 122-125 (NPDES). If water is generated as part of the remedial action, such as extracted groundwater or excess water from sediment dredging, the requirements of the Clean Water Act will apply to the discharge. Water discharge would require a National Pollutant Discharge Elimination System (NPDES) permit.

Section 10 - Rivers and Harbors Act. This federal statute contains provisions for minimizing adverse effects from dredge and fill work conducted within navigable waterways of the United States.

40 CFR Part 403. Discharge of pollutants to publicly-owned treatment works (POTW) to be considered.

Clean Water Act, Section 404. Actions that involve dredging sediment or placing materials in the St. Joe River will need to meet the substantive requirements of Section 404 of the Clean Water Act.

Endangered Species Act. Must consider potential effects of construction on endangered species, bald eagle (*Haliaeetus leucocephalus*) and bull trout (*Salvelinus confluentus*).

National Ambient Air Quality Standards 40 CFR Part 50. Consideration of airborne contamination as a result of remediation activities.

Local Air Pollution Control Agency. Construction approval may be required for air contaminant sources and air pollution control equipment.

Occupational Safety and Health Administration 29 CFR Part 1910.120. Health and safety requirements for on-site workers.

County or City Building Permit, Grading Permit, Shoreline Permit. Building permit may be needed prior to construction of permanent structures; grading permit needed prior to removal or placement of soil.

7.2 Remedial Technologies

This section of the report identifies potential remediation technologies for impacted soil, groundwater, and sediment at the Site. Remedial technologies are identified in this document to determine the need for collection of additional data to evaluate the effectiveness of these technologies. Technologies will be further evaluated in the RI/FS Work Plan and the feasibility study report. This section provides brief descriptions of potential remedial technologies. Site data needed to further evaluate technology effectiveness is discussed briefly in this section and presented in further detail in Section 8.3.

The SOW references the following guidance documents which were reviewed during preparation of this report:

- *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites* (USEPA Report Number 540-R-95-128); and
- *Treatability Studies for Wood Preserving Sites* (USEPA Report Numbers 68-C2-0108, 68-C5-001, and 600-R-98-026).

An additional document, *Feasibility Study/Record of Decision Analysis for Wood Treater Sites with Contaminated Soils, Sediments, and Sludges* was also reviewed. This document provides the technical basis for limiting Site remedial analysis to only those technologies outlined in *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites*. This technical guidance will be included as part of the Administrative Record supporting the rationale for a presumptive remedies approach.

The USEPA *Guidance for Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) provides a framework for identifying appropriate technologies and developing remedial alternatives designed to meet remedial action objectives. The general procedure is to first identify general response actions within which technologies may be grouped. The following general response actions are considered for soil, groundwater, and sediment at the St. Maries Site:

- No Action;
- Institutional Controls/Monitoring;
- Containment;
- Removal (with subsequent treatment, reuse, and/or disposal); and
- *In-situ* Treatment.

The remedial technologies identified in the above-referenced documents along with additional potentially applicable remedial technologies are discussed within the appropriate general response action. The first two general response actions are discussed below for the entire Site. The remaining response actions are discussed separately for soil, groundwater, and sediment, as appropriate. Each technology is discussed along with potential data requirements needed for RI/FS activities.

7.2.1 No Action

The NCP requires that “no action” be evaluated as a general response action. No action means that no active remedial measures are implemented to remove, treat, contain, or otherwise control contaminated media. Further, no steps are taken to monitor site conditions or limit site access and use. This response is typically carried forward in the feasibility study as a remedial alternative. In this manner, “no action” serves as the baseline for evaluating the effectiveness of other technology-based cleanup alternatives.

7.2.2 Institutional Controls and Monitoring

Institutional controls and monitoring are typical components of comprehensive site remedies (except no action).

Institutional Controls

Institutional controls ensure that future development considers the known contamination in the subsurface and the remedial measures that have been implemented. Possible control measures include installation of fencing and signs to limit access to the site and/or imposition of deed restrictions at the site to preclude certain types of land use.

Monitoring

Groundwater

Monitoring is a universal component of any groundwater remedy. Monitoring provides essential data for evaluating the performance of remedial systems and the extent to which compliance with action and cleanup levels is being achieved. Each remedial action alternative developed for groundwater at the St. Maries Site will have a monitoring program that reflects the form and layout of the remedial systems. Monitoring data will be used to assess compliance with cleanup levels and/or the performance of installed remedial systems.

Monitoring can also be conducted to confirm that compounds are naturally attenuating. Natural attenuation refers to naturally occurring chemical, physical, and biological processes that contain or degrade environmental contaminants. Chemical adsorption to aquifer materials and microbial biodegradation of organic contaminants are common examples of natural processes that may reduce availability of a contaminant or degrade it to less toxic or nontoxic constituents. Natural attenuation requires that specific conditions exist in the subsurface. Demonstration of natural attenuation processes requires monitoring of contaminants and other indicator compounds. Groundwater samples can be collected and analyzed for potential electron acceptors (oxygen, iron, nitrate, manganese, and sulfate) and potential metabolic byproducts (methane, carbon dioxide, ferrous iron, nitrogen, dissolved manganese, and sulfide). Field parameters that can be measured during sampling to aid in the evaluation of natural attenuation processes include pH, redox potential, temperature, conductivity, turbidity, and dissolved oxygen. This monitoring can be supported by numerical and analytical modeling and/or laboratory demonstrations.

Sediment

Sediment monitoring can be conducted to confirm monitored natural recovery (MNR), which refers to the beneficial effects of natural processes that reduce surface sediment concentrations. These processes include biodegradation, diffusion, dilution, sorption, volatilization, chemical and biochemical stabilization of contaminants, and burial by natural deposition of cleaner sediments. MNR can be an effective alternative under the appropriate conditions. MNR can be further evaluated by conducting a sedimentation rate analysis.

7.2.3 Containment

Containment is the isolation of the contaminant in a manner that does not allow movement beyond a predetermined point, generally the Site boundaries. Containment technologies can be applied to soil, groundwater, or sediment as described in the following sections.

Soil

Soil capping technologies are designed to minimize direct human exposure to the contaminants and, in some cases, reduce contaminant mobility by isolating the affected soils in place. A surface cap could also protect against erosion and soil transport during floods. Caps can consist of a clean soil layer to provide a physical barrier to direct human contact with the affected soils, and/or a layer of low-permeability materials (e.g., asphalt) that provide a barrier to both direct exposure and infiltration to the affected soils. Maintenance of the cap would be required to ensure cap integrity and long-term effectiveness.

Soil impacts can also be contained by immobilization, which is the process of reducing the mobility of the contaminant by physically limiting its contact (solidification) with a mobile phase or by chemically binding the contamination (stabilization). Immobilization is a presumptive remedy for wood treater sites with inorganic contaminants and is less effective with organic constituents. Therefore use of this technology at the St. Maries Site is considered unlikely.

Existing Site characterization data is likely adequate to evaluate soil containment technologies. Soil data will be reviewed to verify that metals are not the primary COC at this Site.

Groundwater

Groundwater containment can be completed through different technologies including groundwater extraction and barrier wall installation (or combination of methods).

Groundwater extraction can be used to hydraulically control contaminated groundwater and prevent further contaminant migration. Groundwater is typically extracted through the use of groundwater extraction wells or trenches, followed by *ex-situ* treatment using established water treatment processes. Treated water could potentially be discharged to the St. Joe River under a NPDES permit. Groundwater extraction together with *ex-situ* treatment is commonly referred to as “pump and treat.”

Impermeable barrier walls, such as slurry walls or sheet piling, can be installed along a vertical plane in the subsurface to provide a barrier to contaminant flow. Slurry walls are installed by excavating a trench and backfilling the trench with a soil-bentonite or soil-cement mixture, producing a barrier with a hydraulic conductivity of 10^{-6} to 10^{-9} cm/sec, although more permeable barriers may be sufficiently effective. Sheet pile barrier walls are installed by driving interlocking sheet piling into the subsurface. Permeability of sheet pile barriers is limited to leakage through the interlocking joints, which can be sealed (e.g., via grout injection) in some cases to minimize leakage.

To evaluate barrier wall containment technologies, different construction methods must be considered. This entails the depth of a barrier wall and geotechnical properties of the soil. If a slurry-type wall is to be considered, then the suitability of the native soil for reuse in the slurry mixture and the waste disposal issues related to the excess soil need to be evaluated. Review of soil grain size and soil and groundwater contaminant characteristics can be used to complete this evaluation. For sheet pile containment, concerns include the ability to maintain the integrity of the linkages and the depth and potential physical blockages (cobbles, buried timbers, etc.). Compatibility of the barrier material with the contaminants can be important (e.g., some contaminants are not compatible with bentonite slurry).

The effectiveness of groundwater containment systems can be further evaluated by characterizing the hydraulic properties of the aquifer and determining the nature and extent of groundwater impacts above cleanup levels. Characterization of site hydrogeology is also necessary to ensure the containment system is appropriately located and to evaluate the effect of the containment system on groundwater flow.

Sediment

Impacted sediment can be contained by capping contaminated sediments *in situ*. Capping isolates contaminants from the overlying water column and prevents direct contact with aquatic biota. In addition, capping provides new unimpacted substrate for recolonization by benthic organisms. Capping is considered effective at isolating low-solubility and highly sorbed contaminants, where the principal transport mechanism is sediment resuspension and deposition. Caps can also be enhanced with low-permeability material (e.g., granular activated carbon) to address more soluble contaminants. Cap designs should minimize the potential for sediment resuspension under normal and extreme (flood) conditions. Cap placement as a remedial alternative assumes source control and minimal potential for recontamination from upstream sources via sediment transport. Specific cap materials, thicknesses, and other design parameters are selected based on site-specific conditions (e.g., navigational constraints) and design criteria.

The effectiveness of capping as a remedial technology can be further evaluated by modeling of cap consolidation and other parameters (USEPA, 1998). Physical characteristics of the river (e.g., river flow dynamics, scour potential, bathymetry) and navigational constraints will also be evaluated.

7.2.4 Removal and Treatment

Soil

Soil excavation involves the use of conventional construction equipment to remove contaminated soil and clean overburden. Excavation may include

shoring, localized control of groundwater and surface water, segregation and stockpiling of excavated clean overburden and contaminated soil, and backfilling and regrading. Contaminated soil may require dewatering prior to treatment or disposal, and the water produced from dewatering may need to be treated. Excavation of contaminated soil is a prerequisite to any *ex-situ* treatment process.

The feasibility of soil excavation as a remedial alternative is also a function of waste designations and associated treatment and disposal requirements. Impacted soil at the site may be considered as F034 designated hazardous waste. If the soils are F034, they are subject to RCRA restrictions on land disposal. Technologies that may be applicable for management of excavated soil are described in the following sections. With the exception of soil washing, the technologies described below are presumptive remedies for contaminated soils, sediments, and sludges constituting the principal threats at wood treater sites (USEPA Report Number 540-R-95-128).

Delineation of the nature and extent of soil contamination and determination of the volume of impacted soil that exceeds site cleanup levels is necessary to evaluate all of the soil removal and treatment technologies described in this section.

Bioremediation

Bioremediation is based on the natural biochemical reactions mediated by microorganisms that result in degradation of organic contaminants. In practice, bioremediation can be implemented as an *in-situ* or *ex-situ* process. Aerobic biodegradation converts organic matter and compounds to intermediate organic compounds and final decomposition products that include daughter compounds, carbon dioxide, water, humic materials, and microbial cell matter. If practicable, anaerobic biodegradation converts the contaminants to carbon dioxide, methane, and microbial cell matter. Anaerobic metabolism has a more limited range of organic substrates than aerobic metabolism. Depending on contaminant characteristics, volume of material, and site characteristics, bioremediation may require several years to complete. Typically, *in-situ* bioremediation takes longer than *ex-situ* bioremediation. To accelerate the rate of bioremediation, addition of nutrients, oxygen, or other enhancements to the subsurface or the *ex-situ* treatment cells is required.

Bioremediation is proven for treatment of a wide variety of compounds. The success of bioremediation is site- and contaminant-specific. Extensive literature concerning biotreatment of PAHs is available. Studies have indicated that bioremediation of creosote contamination works well on 2-, 3-, and 4-ring compounds but generally very poorly on 5- and 6-ring compounds. Nevertheless, bioremediation has been successfully applied at numerous

former creosote wood treating sites including several CERCLA sites (e.g., Live Oak, Florida).

During the evaluation of bioremediation, the type and concentration of contaminants and the soil matrix properties are important considerations. Treatability studies are often necessary when evaluating bioremediation options for relatively difficult-to-degrade compounds such as cPAHs.

Thermal Desorption

Thermal desorption requires excavation of soil and physical separation of contaminants from soil, sediment, or sludge using heat. Thermal desorption does not destroy the contaminants and uses heat and/or mechanical methods to volatilize the contaminants into a gas stream. Subsequent treatment of the off-gas stream is then necessary, usually in a thermal oxidizer. The more volatile the contaminant, the more successful the thermal desorption process. The process requires significant material handling operations and may consume large amounts of fuel. Thermal desorption can treat halogenated phenols and cresols as well as volatile non-halogenated organic compounds. The success of thermal desorption decreases with the higher-ring PAH compounds because of their higher boiling points.

Compliance with ARARs and other laws must be considered when determining whether thermal desorption is conducted on or off site. Availability of thermal desorption facilities must also be considered. On-site thermal desorption may be performed with a mobile unit; however, space availability, community concerns, and the ability to meet air requirements make this option infeasible. Thermal desorption may also be conducted off site; however, the facility used must be permitted to accept material from the Site. No off-site thermal treating facilities for listed hazardous wastes currently exist in the United States. If site soils are considered F034 waste, thermal desorption will not be considered.

Site data required for the evaluation of thermal desorption in soils focuses on soil characteristics for handling and heat transfer and contaminant characteristics.

Incineration

Incineration treats organic contamination by subjecting it to high temperatures (greater than 1,000 degrees Fahrenheit), oxygen, and a flame. During the process, volatilization and combustion convert the organic contaminants to carbon dioxide, water, hydrogen chloride, and sulfur oxides. Incineration generates several waste streams and off-gas treatment is required. Incineration has a better success rate than other wood treating presumptive remedies; however, permitting requirements for on-site incineration are significant and often, public approval of the technology cannot be obtained.

Off-site incineration is limited to a few fixed-location permitted facilities and is extremely expensive, typically on the order of \$300 to \$400 per cubic yard. It is anticipated that site limitations and public acceptance will eliminate the use of on-site incineration as a remedy for the Site. Additionally, the high cost associated with off-site incineration will preclude its use as a viable remedial option. In fact, the cost of incineration is expensive as compared with other alternatives that provide protection of human health and the environment. Additional consideration of this alternative is likely to be limited.

Site data required for the evaluation of incineration is similar to that of other thermal treatment technologies and focuses on soil characteristics for handling and heat transfer and contaminant characteristics.

Soil Washing

Soil washing reduces the volume of contaminated soils by consolidating the fine-grained soils, which frequently contain the majority of the contaminants. The process separates soils by size and removes contaminants to the extent possible from the coarser fraction of the soil by using equipment common to the mineral and ore processing industries, such as screening, gravity separation, hydrocyclones, pug mills, and attrition scrubbing machines. Contamination is then consolidated into process water containing wet fine-grained soil, which needs to be further treated by changing pH, and/or adding surfactants, leaching agents, or chelating agents. Soil washing requires water treatment for the remaining process water.

Commercialization of the soil washing process is not extensive. Several demonstration projects were performed in the late 1980s, but there have been no large-scale applications at wood preserving sites. If soils from the site are considered F034 listed hazardous waste, a determination that removes the listed designation from the coarser, less contaminated fraction of the soils would be required for the soil washing process to be cost-effective as a means of volume reduction. Based on the lack of readily available processors, no demonstrated successes of soil washing at wood treating sites, and high costs involved in determining the effectiveness of soil washing (large scale pilot studies), further consideration of soil washing is likely to be limited in scope.

Site data that could be collected to determine the effectiveness of soil washing includes analysis of soil grain size and contaminant concentrations relative to grain size. In addition, the effectiveness of different process equipment in separating soils by grain size water processing requirements for process water would be evaluated to determine the economic feasibility and end goals of soil washing.

NAPL

DNAPL Recovery

If results of the RI show that free, mobile DNAPL has been observed at the Site, recovery wells could be installed to opportunistically recover free DNAPL. Wells would be installed at locations believed to provide the greatest opportunity for DNAPL recovery. Wells would be equipped with collection sumps. Based on the amount of DNAPL accumulated in the recovery wells, DNAPL could be recovered either by bailing by hand or with a product recovery pump. Recovered DNAPL would be consolidated into drums on site and shipped off site for recycling, incineration, or disposal in accordance with applicable regulations.

Further evaluation of the nature and extent of NAPL is necessary to evaluate the effectiveness of this remedial technology.

Enhanced Steam Recovery

In-situ steam stripping involves the injection of steam into the aquifer formation to enhance the stripping of volatile contaminants and to mobilize contaminants for extraction from a multiphase recovery well. Mass reduction is principally achieved by altering the temperature-dependent properties of contaminants in order to increase their mobility and facilitate their removal. Mobility is enhanced through one or more of the following mechanisms:

- Volatilization due to increased vapor pressure;
- Dissolution due to increased solubility;
- Liquid flow due to reduced viscosity and/or density;
- Desorption due to decreased solid-phase adsorption and organic-matter absorption; and
- Molecular diffusion in aqueous and gaseous phase due to increased diffusion coefficients.

Steam is injected in injection wells at the boiling point of water under the depth being treated, optimally bringing the entire treated volume to the boiling point of water. Steam injection can displace mobile contaminants in front of the steam, and vaporize residual volatile contaminants. Condensation will occur at the advancing thermal front, creating a bank of contaminant in front of the advancing steam. Volatile contaminants can thus be recovered in both liquid and vapor phases. DNAPL mobilization may also occur as a result of the lowered interfacial tensions resulting from the increase in temperature.

The main recovery mechanism for contaminants in the steam zone is steam displacement (stripping). Steam stripping occurs as the injected steam sweeps the contaminant vapor to the condensation front, where the vapors condense. Steam injection may be beneficial for removing any trapped ganglia of DNAPL that cannot be removed by pumping or other viscous forces.

Typically, sandy media are more easily treated by steam injection than clays. The injection process requires permeability sufficient to achieve an adequate flow of the injected fluid. Therefore, more permeable soils will allow a faster introduction of heat and the lower injection pressures that are favorable for evaporation to occur. To some extent, heterogeneity, e.g., lenses of less permeable material, can be overcome by conduction of the heat into the less permeable lenses. In some cases, low natural permeability can be increased by hydraulic or pneumatic fracturing of the formation to increase the rate of injection and promote direct contact of the steam with the contaminant. Steam injection can also be part of the dynamic underground stripping process, which includes steam injection into permeable areas for the physical displacement and volatilization of contaminants and electrical heating of low-permeability layers to volatilize contaminants.

Enhanced steam recovery is an innovative technology and successful application of this technology at creosote sites has been limited.

Like other thermal technologies discussed, site data required for the evaluation of *in-situ* steam stripping soils focuses on soil characteristics for heat transfer and NAPL characteristics. Required data specifically includes the nature and extent of contamination, and soil characterization including grain size analysis. As steam is also introduced below the water table, it is important to understand the nature and extent in the saturated media as well as unsaturated soils.

Electrical Heating

Electrical heating is a potential means to enhance the recovery of organic contaminants in the subsurface. An increase in temperature increases the mobility of contaminants, making contaminants available for removal by conventional remediation processes such as vapor extraction. Subsurface ground heating can be achieved through electrical resistance heating. An electric current is passed between two or more electrodes installed in the ground, and the intervening soil is heated because of its resistance to the current flow. Since the electrical conductivity of a dry soil is low, a high moisture content needs to be maintained.

Electrical heating is capable of enhancing recovery from fine-grained soils over large areas. It may be used in conjunction with other types of enhanced recovery based on soil type and distribution. This technology has been used for treatment of chlorinated compounds, PCBs, pesticides, and light

hydrocarbons as NAPL and dissolved-phase contaminants. Electrical heating has been used in conjunction with steam stripping at wood treating sites, but due to the limited number of sites, is yet to be a proven remedial technology for wood-treating sites.

Like other thermal technologies discussed, site data required for the evaluation of electrical heating focuses on soil characteristics for heat transfer and NAPL characteristics.

Sediment

Impacted sediment removal can be accomplished by dredging. Dredging is one of the most common remedial alternatives currently used throughout the world, and dredging can effectively reduce total concentrations and contaminant mass. With careful planning, application in appropriate environments, and use of engineering controls, dredging can be an effective tool to remove contaminated sediments. Hydraulic or mechanical dredging can be accomplished with minimal contaminant resuspension and transport during operations. However, removal options require water quality monitoring during and after activities and management of materials following removal. Following removal, sediment could be treated using one of the technologies described in the soil removal section.

Information needed to evaluate dredging as a sediment removal technology includes the nature and extent of sediment contamination, river characteristics, and physical properties of sediment in impacted areas. If dredging is selected as a remedial technology for sediment, elutriate testing could be conducted to evaluate the effect of dredging on water and air quality.

7.2.5 *In-situ* Treatment

The only *in-situ* treatment technology for soil and sediment included in the presumptive remedy guidance is bioremediation, which was discussed in Section 7.2.4. Additional *in-situ* treatment technologies have not been identified at this time.

8 Data Required and Investigative Strategy

This section summarizes data gaps previously identified in this report. Specific data gaps related to source characterization, characterization of migration and exposure pathways, and evaluation of remedial technologies are described throughout the document and DQO process. A summary of these data gaps is presented in Table 8-1. This table is a preliminary list of items to be addressed in the RI and may be amended as necessary during preparation of the RI/FS Work Plan. The table subdivides data gaps by media for clarity. There are interactions between media and between the upland and the river. The table attempts to capture this interaction. The media to be investigated in the RI are:

- Soil;
- Groundwater;
- Sediment; and
- Surface water.

Table 8-1 is divided into two columns describing the identified data gap and what type of data needs to be collected to address the data gap.

The proposed technical tools, approaches, and methods that will be used to resolve these data gaps (and answer the DQO questions) will be detailed in the RI/FS Work Plan. However, prior to collection of additional data, the first, and most critical, data gap requiring resolution is finalizing the list of COIs. This data gap requires priority resolution regarding the analyte list, analytical methods, detection limits, and uncertainty surrounding analytical limitations. This data gap will be resolved in the RI/FS Work Plan.

Treatability testing has not been included in Table 8-1 because the need for testing is still being evaluated. Treatability testing may be conducted to aid in evaluation of the effectiveness of some remedial technologies. Treatability tests could potentially consist of testing to determine if excavated soil and sediment concentrations can be reduced through *ex-situ* bioremediation, elutriate testing to evaluate the potential effects of dredging on water and air quality, and compatibility testing of possible barrier wall materials with Site soil and groundwater. The need for treatability studies will be further evaluated in the RI/FS Work Plan.

9 References

- Barnhouse, L. W. and G. W. Suter II, 1996. *Guide for Developing Data Quality Objectives for Ecological Risk Assessment at DOE Oak Ridge Operations Facilities*. Prepared for the United States Department of Energy. Prepared by the Environmental Restoration Risk Assessment Program, Oak Ridge National Laboratory, Tennessee. Website: http://www.ornl.gov/doe_oro/dqo/dqmain.htm. ES/ER/TM-185/R1. June.
- Cohen, R., and J. Mercer, 1993. *DNAPL Site Evaluation*. CRC Press, Boca Raton, Florida.
- Crumbling, D. M, 2001. *Current Perspectives in Site Remediation and Monitoring: Clarifying DQO Terminology Usage to Support Modernization of Site Cleanup Practice*. EPA 542-R-01-014. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. October.
- Ecology and Environment, Inc. (E&E), 1999a. *St. Maries Creosote Site Integrated Assessment Report*. May.
- Ecology and Environment, Inc. (E&E), 1999b. *Sampling and Quality Assurance Plan for St. Maries Creosote Site Inspection*, prepared for the USEPA, Region 10, under Superfund Technical Assessment and Response Team Contract No. 68-W6-0008, Technical Direction Document No. 98-12-0009.
- Ecology and Environment, Inc. (E&E), 1999c. *Sampling and Quality Assurance Plan for St. Maries Creosote Site Integrated Assessment Addendum*, prepared for the USEPA, Region 10, under Superfund Technical Assessment and Response Team Contract No. 68-W6-0008, Technical Direction Document No. 98-12-0009.
- Ecology and Environment, Inc. (E&E), 2000. *St. Maries Creosote Site Integrated Assessment Addendum, St. Maries, Idaho*. June.
- EMCON, 1998. *Environmental Site Reconnaissance and Historical Review, Leased Portion of Carney Products Company Ltd., St. Maries, Idaho*. December.
- EMCON, 1999. *Removal Site Assessment and Removal Action Reports, St. Maries Creosote Site, St. Maries, Idaho*. April.
- Murphy, Henry, 2001. *Personal Communication Regarding St. Joe River Shipments*. November.

- Northeast Analytical, Inc., 1998. *Guide to Environmental Analytical Methods 4th Edition*. Robert E. Wagner, Chief Editor. Genium Publishing Corporation, Schenectady, New York. June.
- Ontario Ministry of the Environment, 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*. August.
- Schwille, F., 1988. *Dense Chlorinated Solvents in Porous and Fractured Media*. Lewis Publishers, Chelsea, Michigan. 146 p.
- USEPA, 1990. *Quality Assurance/Quality Control Guidance for Removal Activities, Data Validation Procedures*. April.
- USEPA, 1994a. *National Functional Guidelines for Organic Data Review*. EPA-540-R-94-090. Washington, D.C.
- USEPA, 1994b. *National Functional Guidelines for Inorganic Data Review*. EPA-540-R-94-013. Washington, D.C.
- USEPA, 1994c. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4. EPA/600/R-96/055. Office of Research and Development, United States Environmental Protection Agency. September.
- USEPA, 1995. *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites*. EPA-540-R-95-128. December.
- USEPA, 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Environmental Response Team, United States Environmental Protection Agency, Washington, D.C.
- USEPA, 1998. *Treatability Studies for Wood Preserving Sites*. EPA-68-C2-0108, EPA-68-C5-001, and EPA-600-R-98-026. March.
- USEPA, 1998. *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments*. EPA/905/B96-004
- USEPA, 2000. *Data Quality Objectives Process for Hazardous Waste Site Investigations*. EPA QA/G-4HW Final. EPA/600/R-00/007. Office of Environmental Information, United States Environmental Protection Agency. January.
- USEPA, 2000. *Preliminary Remediation Goals, Region 9*. Washington, D.C.