January 2015

FORMER REYNOLDS METALS REDUCTION PLANT – LONGVIEW

Remedial Investigation and Feasibility Study

Submitted by Anchor QEA, LLC
On Behalf of Northwest Alloys, Inc., and Millennium Bulk Terminals – Longview, LLC

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

FORMER REYNOLDS METALS REDUCTION PLANT – LONGVIEW

Prepared for

Washington State Department of Ecology

On Behalf of

Northwest Alloys, Inc.

Millennium Bulk Terminals – Longview, LLC

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LIST OF ACRONYMS AND ABBREVIATIONS

µg	microgram
AEC	Anion exchange capacity
Alcoa	Alcoa, Inc.
Anchor	Anchor Environmental, L.L.C.
Anchor QEA	Anchor QEA, LLC
AO	Agreed Order
AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
bgs	below ground surface
BICC	BICC Cable Corporation
BPA	Bonneville Power Administration
Calbag	Calbag Metals Co.
CAP	Cleanup Action Plan
CDID	Consolidated Diking Improvement District
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH2M Hill	CH2M Hill, Inc.
Closed BMP Facility	Closed Black Mud Pond Facility
cm	centimeter
COC	chemical of concern
COPEC	Chemical of potential ecological concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
CSL	Cleanup Screening Level

CVI	Chinook Ventures, Inc.
CWA	Clean Water Act
DCA	Disproportionate cost analysis
DMMP	Dredged Material Management Program
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EIC	Ecological indicator concentration
ELW	extreme low water
EMCON	EMCON, Inc.
Envirocon	Envirocon, Inc.
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
Facility 71	Industrial Wastewater Chemical Treatment Plant
Facility 73	Stormwater Retention Basin and Filter Plant
Facility 77	Outfall Sump/Pump Station
Former Reynolds Plant	former Reynolds Metals Reduction Plant
FS	Feasibility Study
FSDS	field sampling data sheet
G&O	Gibbs & Olson, Inc.
GIS	geographic information system
gpm	gallons per minute
HCID	hydrocarbon identification
HELP	Hydrologic Evaluation of Landfill Performance
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HTM	heat transfer media
K_d	solid-water partition coefficient
kg	kilogram
L	liter
MBTL	Millennium Bulk Terminals – Longview, LLC

MCL	maximum contaminant level
meq	milli-equivalents
MFG	McCully Frick & Gillman, Inc.
MFP	monofluorophosphate
MGY	million gallons per year
Mint Farm	City of Longview Mint Farm Well Field
MSL	mean sea level
mg	milligram
MTCA	Model Toxics Control Act
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
Northwest Alloys	Northwest Alloys, Inc.
NPDES	National Pollutant Discharge Elimination System
NWTPH-Dx	Northwest Total Petroleum Hydrocarbons diesel-range extended (analytical method)
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
PNE	Pacific Northern Environmental
PNG	Pacific Northern Geoscience
pitch	coal tar pitch
POC	point of compliance
PQL	practical quantitation limit
PRB	permeable reactive barrier
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act

RCW	Revised Code of Washington
REL	remediation level
Reynolds	Reynolds Metals Company
RI	Remedial Investigation
RI/FS Study Area	Former Reynolds Plant and adjacent areas investigated during the RI/FS
SAP	Sampling and Analysis Plan
SCO	Sediment Cleanup Objective
SEM	scanning electron microscopy
SMS	Sediment Management Standards
SPL	spent potliner
SPLP	synthetic precipitation leaching procedure
SU	site unit
SVOC	semivolatile organic compound
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEE	Terrestrial Ecological Evaluation
TPH	total petroleum hydrocarbon
TPH-Dx	total petroleum hydrocarbon – diesel range
TS	total solids
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TSS	total suspended solids
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USC	United States Code
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

WAD	weak acid dissociable
WBZ	water bearing zone
WDNR	Washington State Department of Natural Resources
WRIA	Water Resource Inventory Area
XRD	X-ray diffraction

1 INTRODUCTION

This document presents the findings of a Remedial Investigation (RI)/Feasibility Study (FS) at the former Reynolds Metals Reduction Plant (Former Reynolds Plant) located at 4029 Industrial Way in Longview, Washington. The location of the Former Reynolds Plant is shown on Plate 1-1.

1.1 Location of the Former Reynolds Plant

The Former Reynolds Plant is located in Cowlitz County, approximately 2.9 miles northwest of the center of Longview and 4.8 miles northwest of Interstate 5. The Former Reynolds Plant is located along-side the Columbia River at river mile 63 (statute miles) based on the information in National Oceanic and Atmospheric Administration (NOAA) Chart 18524, Edition 37 dated June 2011. The physical plant, buildings and other improvements are owned by Millennium Bulk Terminals – Longview, LLC (MBTL) while the upland property is owned by Northwest Alloys, Inc. (Northwest Alloys). Northwest Alloys is a wholly owned subsidiary of Alcoa, Inc. (Alcoa). The Former Reynolds Plant also includes a dock and two outfalls located within the Columbia River adjacent to the property owned by Northwest Alloys.

As described in Section 2, the Former Reynolds Plant was formerly used for the manufacture of aluminum. Aluminum manufacturing operations ended in 2001, and portions of the Former Reynolds Plant have since been decommissioned. MBTL operates a bulk products terminal that handles multiple products, including alumina, which is required for operation of an active Alcoa aluminum manufacturing facility near Wenatchee.

1.2 The RI/FS Evaluates Model Toxics Control Act Cleanup Requirements

The purpose of the RI/FS is to evaluate the nature and extent of contamination associated with the facility and to evaluate remedy alternatives, consistent with the requirements of the Model Toxics Control Act (MTCA) and its implementing regulations (Washington Administrative Code [WAC] Chapter 173-340). The MTCA regulations are implemented by the Washington State Department of Ecology (Ecology) to address the cleanup of contaminated soils, groundwater, or other media within the state of Washington.

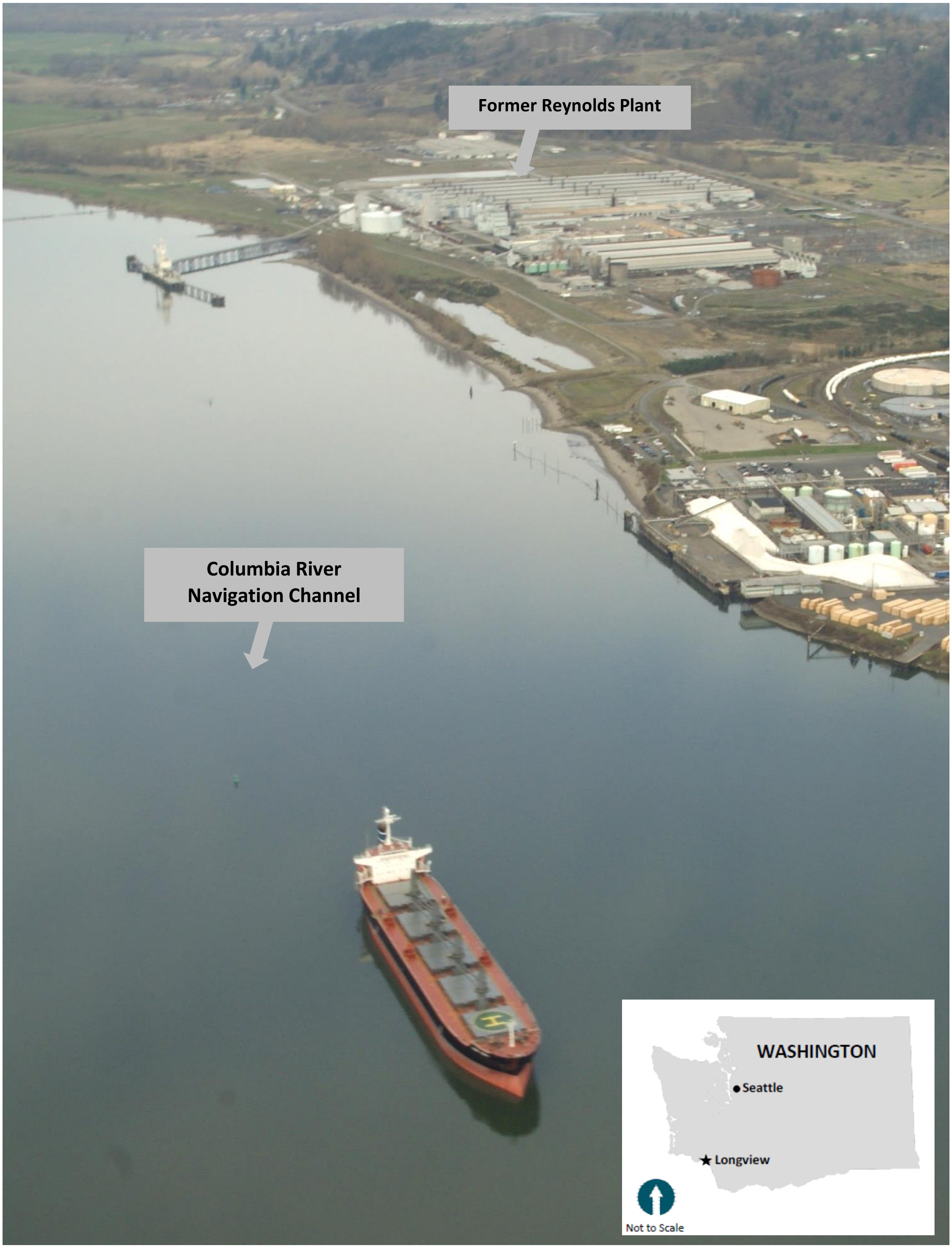
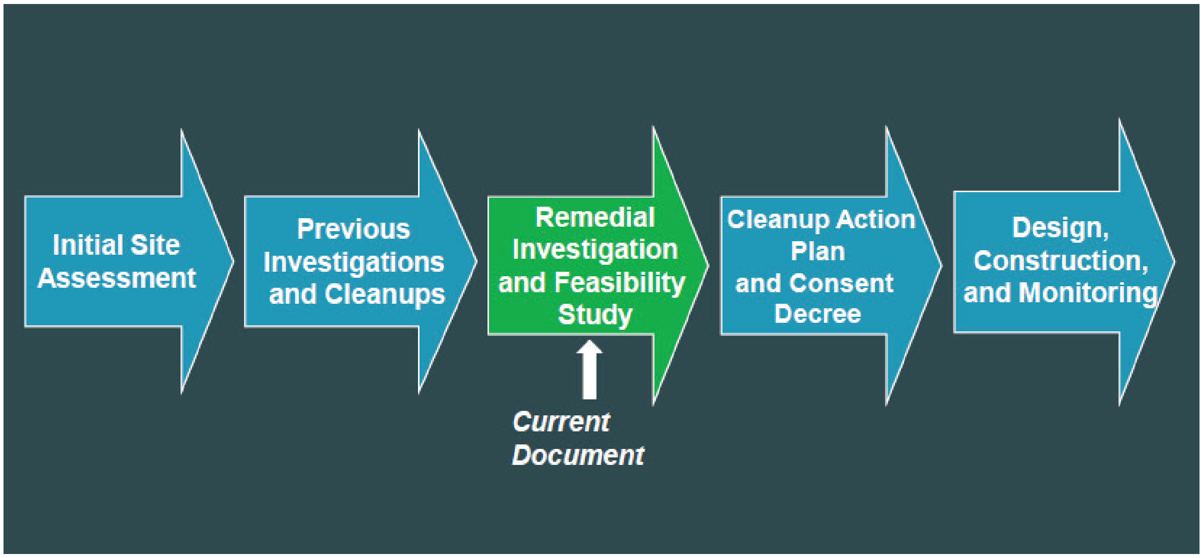


Plate 1-1
Location of the Former Reynolds Plant
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

Plate 1-2 Role of the RI/FS in the MTCA Cleanup Process



Under MTCA, the RI/FS includes two parts. The RI completes the investigation of potential contaminants at the Former Reynolds Plant. The FS then evaluates potential options for cleanup. The selection of a final cleanup action occurs in a separate step and is documented in a Cleanup Action Plan.

As shown on Plate 1-2, the RI/FS is one of several steps in the cleanup process under MTCA. That process begins with the initial site assessment performed by Ecology. During the site assessment, Ecology reviews available data and establishes the agency's priority ranking for site investigation and cleanup. During its site assessment, Ecology ranked the Former Reynolds Plant as a "5," the lowest priority on Ecology's 5-point scale.

Since completion of the initial assessment and site ranking, a number of investigations and cleanup actions have been completed. The previously completed cleanup actions (see Section 2.4) have resolved cleanup issues for a number of areas within the Former Reynolds Plant. The previous investigations provide extensive site characterization data for the remaining areas of the site. Data developed as part of these previous investigations have been considered as part of Ecology's scoping of the current RI/FS.

The RI/FS includes investigation work to complete the characterization of environmental conditions at a site and an evaluation of a range of cleanup alternatives that address MTCA cleanup requirements. The RI/FS includes identification of a preferred remedial action alternative based on MTCA requirements and criteria.

Final cleanup decisions are to be specified in an MTCA Cleanup Action Plan. The Cleanup Action Plan is a separate document from this RI/FS. Design and implementation of the cleanup action will be performed after finalization of the Cleanup Action Plan and court approval of the consent decree.

The work described in this RI/FS has been performed consistent with the requirements of Agreed Order (AO) No. DE-8940. The AO is a formal agreement that was entered into by Ecology, Northwest Alloys (as the property owner), and MBTL (as the owner of the improvements, property tenant, and terminal operator). The specific scope of RI/FS investigation activities was defined in several Work Plan documents. These include an RI Work Plan, approved by Ecology in June 2007 (Anchor QEA 2007a); a Work Plan Addendum (Anchor QEA 2011a), approved by Ecology in August 2011; and additional addenda submitted in December 2011 (Anchor QEA 2011b, 2011c) and in November 2012 (Anchor QEA 2012a).

1.3 The RI/FS Is Separate from Property Redevelopment Proposals

Although reasonably anticipated future land uses can be taken into account in the MTCA process for a brownfield site, the RI/FS (and the MTCA process generally) is not a component of any current or future land use proposal at or in the vicinity of the Northwest Alloys property. Consistent with MTCA requirements, all RI/FS documents and final cleanup decisions consider the types of land use authorized for the property (i.e., industrial, commercial, or residential) and the activities that may occur in the future within and adjacent to a cleanup site. In this case, the Former Reynolds Plant is located within an existing industrial area and is zoned for industrial uses, as described in Section 2. Therefore, the RI/FS considers potential exposure risks and cleanup requirements within the context of ongoing industrial uses.

Portions of the Former Reynolds Plant are currently used for transloading and shipping bulk materials. MBTL has applied for permits for a separate proposed project at the property for the export of coal. Although the environmental review process for MBTL's proposed coal export terminal is separate from the RI/FS, use of the facility for expanded bulk materials shipping is a potential future land use that may be considered in the MTCA process for a brownfield site such as the Former Reynolds Plant. Nonetheless, the cleanup decision and its implementation are separate actions that would take place regardless of any particular reuse plan for the Former Reynolds Plant or vicinity.

1.4 The RI/FS Evaluates a Broad Study Area

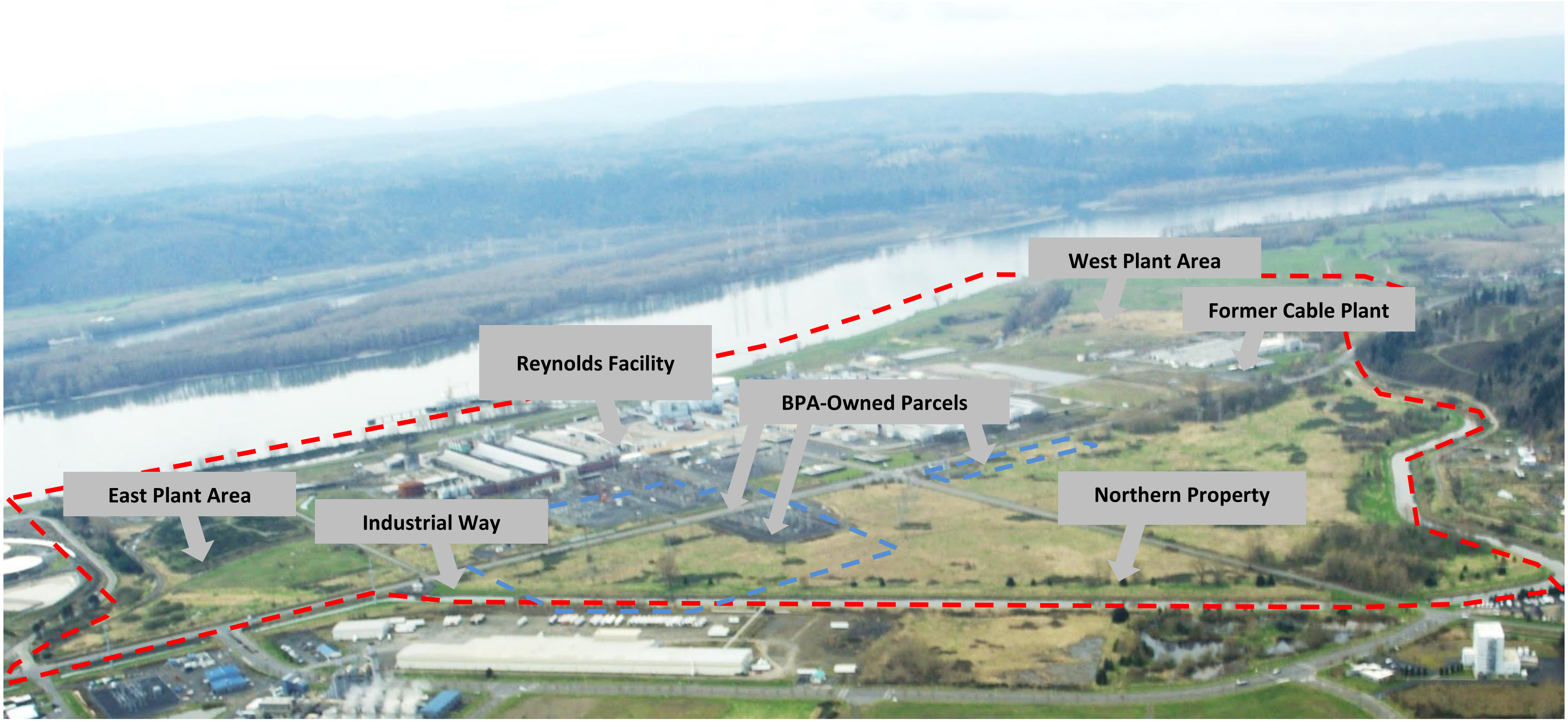
To ensure the completeness of the study, the RI/FS Study Area included evaluation and testing both within the boundaries of the Former Reynolds Plant and in adjacent areas specified by Ecology. Investigation within these adjacent areas is consistent with MTCA requirements to determine the nature and extent of contamination but does not necessarily indicate the presence of contamination or environmental impacts associated with the Former Reynolds Plant.

Plate 1-3 shows the extent of the properties owned by Northwest Alloys. This ownership includes property located on both the north and south sides of Industrial Way. Only the southern portions (i.e., the parcels located south of Industrial Way) of the property owned by Northwest Alloys were used for aluminum manufacturing operations. The Former Reynolds Plant in this area occupied approximately 436 acres. This total includes the property associated with the former Cable Plant and property located west of the main aluminum manufacturing facilities (see Section 2.2 for further discussion).

The Northwest Alloys property located north of Industrial Way (just under 100 acres) was never included in the aluminum manufacturing operations. That northern property remains undeveloped except for a small office building (former credit union property), an old softball field, and power lines.

The characteristics of the RI/FS Study Area, including both the Former Reynolds Plant and adjacent areas, are discussed in Section 2. The RI/FS Study Area includes the Northwest Alloys owned property, portions of the regional ditch system operated by the Consolidated Diking Improvement District (CDID), and adjacent areas of the Columbia River.

As part of its final cleanup decision documented in the Cleanup Action Plan, Ecology will define the boundaries of the cleanup "Site" (the area within which Ecology's cleanup decision is applied). This Site boundary may be different (i.e., smaller) than the current RI/FS Study Area.



The approximate boundaries of the Northwest Alloys-owned properties are shown outlined in red. This includes the mostly undeveloped Northern Property located north of Industrial Way, which was never used for industrial activities. The Reynolds Facility (including the aluminum manufacturing operations and the former Cable Plant) were all located within 436 acres of Northwest Alloys property located south of Industrial Way. The alumina receiving dock is located within the Columbia River on properties leased from the Department of Natural Resources. The separate parcels shown outlined in blue are owned by the Bonneville Power Administration (BPA) and are located between the northern and southern Northwest Alloys properties.

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Plate 1-3

Northwest Alloys Property and Vicinity
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

1.5 Report Organization

This RI/FS report is organized as follows:

- **Section 2 – Study Area Background.** This section presents information regarding historical operations and materials handled, investigations, and cleanup actions, as well as facility decommissioning, demolition, and waste removal activities.
- **Section 3 – Remedial Investigation Methods.** This section provides an overview of the RI activities conducted between 2006 and 2013, including deviations from the work plans listed in Section 1.2.
- **Section 4 – Geology, Hydrology, and Hydrogeology.** This section discusses the geologic, hydrologic, and hydrogeologic characteristics of the RI/FS Study Area.
- **Section 5 – Remedial Investigation Findings.** This section presents the RI findings based on the chemical and physical testing conducted between 2006 and 2013 and considering other pre-existing data, as appropriate.
- **Section 6 – Fate and Transport Evaluation.** This section evaluates site-specific fate and transport processes that restrict the potential movement of chemicals associated with the Former Reynolds Plant.
- **Section 7 – Conceptual Site Model.** This section summarizes the RI findings and presents the conceptual site model (CSM). The CSM summarizes the exposure pathways and receptors applicable to the RI/FS Study Area.
- **Section 8 – Cleanup Action Requirements.** This section establishes remedial action objectives (RAOs), as appropriate, and identifies potentially applicable federal and local regulations; it also establishes cleanup standards.
- **Section 9 – Screening of Cleanup Technologies.** This section identifies a range of remedial technologies potentially suitable for use as part of the final cleanup action. Technologies that have been shown to be effective and implementable at other similar cleanup sites are retained for consideration as part of the development of cleanup alternatives.
- **Section 10 – Description of Cleanup Alternatives.** This section describes the six cleanup alternatives, each addressing the cleanup action requirements set forth in Section 8.
- **Section 11 – Evaluation of Cleanup Alternatives.** This section evaluates the cleanup alternatives using criteria defined in the MTCA regulations.

- **Section 12 – Preferred Remedial Alternative.** This section describes the preferred cleanup alternative.
- **Section 13 – References.**

Appendices to this RI/FS report include key historical reports, RI field sampling logs, recent sampling data validation and laboratory reports not previously reported, and supporting fate and transport modeling documentation.

Throughout this report, compass directions are provided based on true north. This differs from some historical documents associated with the Former Reynolds Plant that were developed using a site-specific "plant-north" coordinate system. That site-specific coordinate system was shifted approximately 50 degrees from true north.

2 RI/FS STUDY AREA BACKGROUND

The Former Reynolds Plant is located within an industrial region and has been historically used for aluminum manufacturing operations. The aluminum manufacturing processes historically conducted at the Former Reynolds Plant are well understood for the following reasons:

- The process itself was invented in 1882 and is largely unchanged since that time.
- The first aluminum operations in Longview were constructed in 1941 and were added onto in the 1960s.
- No other industrial manufacturing has occurred at the Former Reynolds Plant.
- Extensive documentation of facility operations exist.

Prior to completion of the current RI/FS, extensive work has been conducted to decommission inactive portions of the facilities, remove industrial materials and wastes from the property, and to conduct closures and cleanup actions. These completed actions are described in this section. The RI/FS testing program builds on this information to complete the investigation of environmental conditions within the RI/FS Study Area and to provide the basis for evaluating final cleanup requirements for the Former Reynolds Plant under MTCA regulations.

2.1 Current Land Uses Are Industrial

The Former Reynolds Plant is located within a portion of the property owned by Northwest Alloys. Northwest Alloys owns a total of approximately 536 acres of property. Only the southern portion of this property (approximately 436 acres located south of Industrial Way) was included in the historical aluminum manufacturing operations (see Plate 1-3). The Northwest Alloys property located north of Industrial Way remains undeveloped except for a small building that was a credit union, an old softball field and power lines.

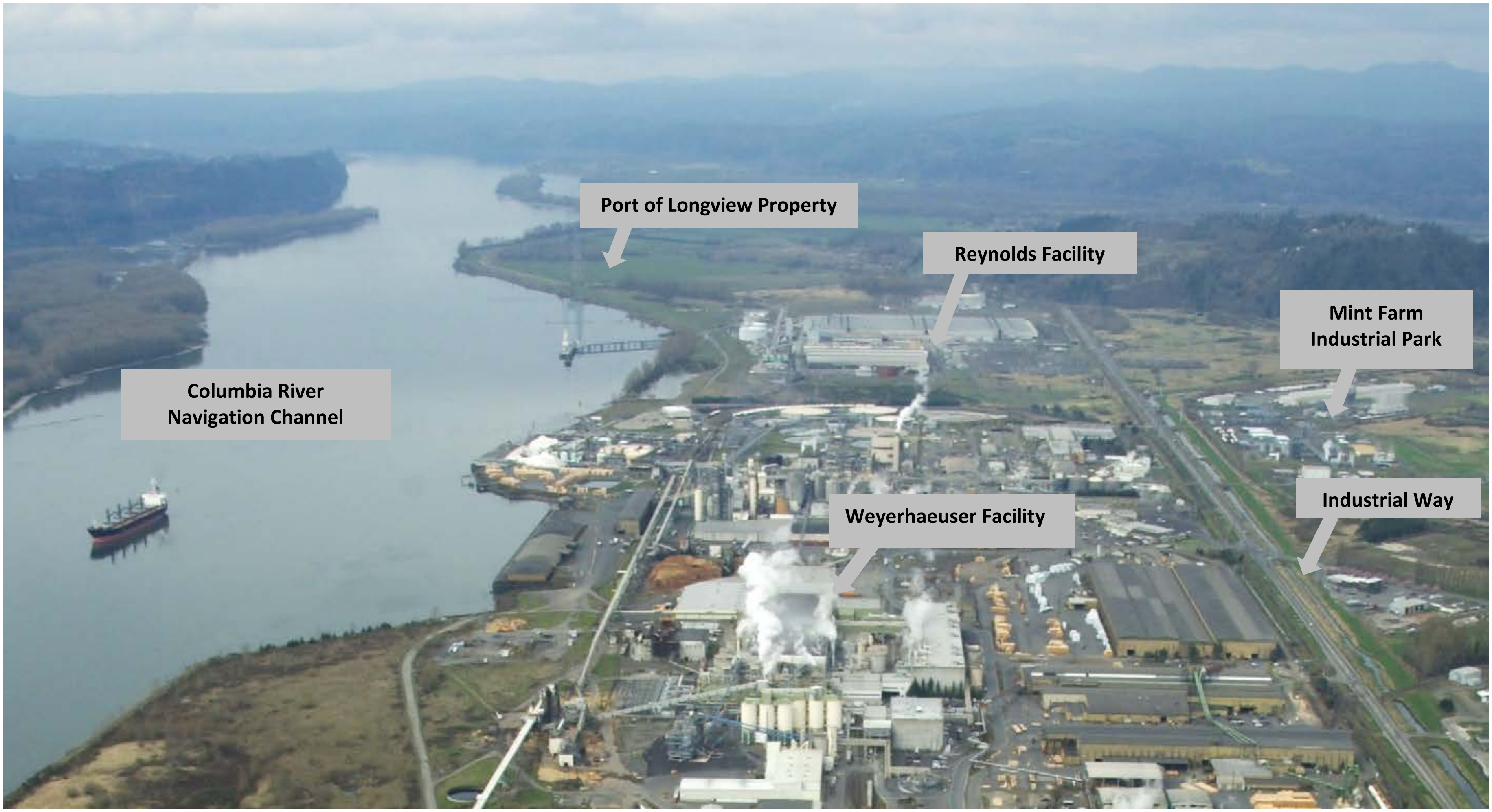
The Former Reynolds Plant also includes an existing dock structure and two wastewater outfalls that are located within the Columbia River. The Northwest Alloys-owned property extends to the extreme low water (ELW) mark within the Columbia River. The aquatic lands located waterward of the ELW mark within the Columbia River are owned by the state of Washington and are managed by the Washington State Department of Natural Resources

(WDNR). Portions of the dock and outfalls are located on land leased by Northwest Alloys from WDNR under Aquatics Lands Lease No. 20-B09222.

The Northwest Alloys properties are currently leased to MBTL for operation of a bulk products terminal. MBTL has leased the property since January 2011 when it purchased the facility assets from Chinook Ventures, Inc. (CVI), and entered into a lease agreement with Northwest Alloys. The MBTL terminal currently handles several bulk products that have been historically managed at the Former Reynolds Plant. These products include alumina and coal. Alumina is received by ship, stored, and is transloaded into railcars for shipment to an operating aluminum manufacturing facility, Alcoa Wenatchee, in Malaga Washington. These alumina shipments are critical to the operation of that facility. MBTL also receives by rail, stores, and transports by truck coal for a neighboring facility. Other materials handled at the facility since aluminum production ceased are carbon for the steel industry, cement, fly ash, green petroleum coke, and miscellaneous other materials.

The Former Reynolds Plant is located within an industrial land use corridor located along Industrial Way/Highway 432 and the Columbia River navigation channel (see Plate 2-1). The Former Reynolds Plant and the adjacent properties are zoned for industrial uses. Uses at these adjacent properties include the following:

- **Properties to the West.** The majority of the property located to the west of the Former Reynolds Plant has been purchased by the Port of Longview. This property is currently vacant. Other smaller properties located to the west include a closed landfill, a small MBTL-owned parcel (located between the Port of Longview property and the Columbia River), and a CDID pump station (the Reynolds Pump Station) located on a small CDID-owned parcel located adjacent to the Columbia River
- **Properties to the East (Weyerhaeuser).** A Weyerhaeuser wood/paper products facility is located immediately to the east (upstream) of the Former Reynolds Plant. The Weyerhaeuser industrial facility is complex and includes multiple affiliated operations.
- **Properties to the North.** The properties located to the northeast include the Mint Farm Industrial Park, which is owned by the City of Longview. Other properties located to the north and northwest include several Bonneville Power Administration (BPA)-owned properties located along Industrial Way/Highway 432, a quarry, and other privately owned hillside acreage.



The Reynolds Facility is located along Highway 432 (Industrial Way), adjacent to the Columbia River navigation channel. All properties in the vicinity are zoned and used for industrial purposes. The property west of the Reynolds Facility is owned by the Port of Longview. The Mint Farm Industrial Park located northeast of the Reynolds Facility is owned by the City of Longview. The Weyerhaeuser Facility is located immediately east of the Reynolds Facility.

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Plate 2-1
Adjacent Industrial Land Uses
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

A significant feature within the adjacent portions of the Longview area is the CDID system of levees and approximately 35 miles of drainage ditches. The CDID flood protection system includes both protection by the dikes against external flooding from the Cowlitz and Columbia rivers, and protection from internal flooding from storm drainage runoff and groundwater from lands found adjacent to and inside the levee system. The mission statement of the CDID is to "protect life, property, and environment by providing comprehensive flood protection for the portions of the City of Longview, the City of Kelso, and Cowlitz County that fall within its jurisdictional boundaries" (CDID 2013). The CDID system has permitted safe development in the surrounding floodplain areas including areas at elevations below the Columbia River level. Permitted discharges from publicly and privately owned properties occur throughout the ditch system, and as result, the CDID is a secondary permittee on the Cowlitz County/Kelso/Longview Municipal National Pollutant Discharge Elimination System (NPDES) permit.

The CDID diking and drainage system includes structures located on CDID-owned properties, rights-of-way, easements, and privately owned property. CDID facilities located within or near the Former Reynolds Plant include the following:

- **CDID Levee.** A CDID levee extends along the shoreline of the Columbia River across the full river frontage of the site. That levee is located on Northwest Alloys-owned property, which is on land subject to a CDID right-of-way agreement.
- **Industrial Way Ditches.** CDID drainage ditches are located along portions of Industrial Way on property not owned by Northwest Alloys.
- **CDID Ditch No. 14.** The drainage ditch located along the western edge of the RI/FS Study Area, CDID Ditch No. 14, is located on Northwest Alloys-owned property, with the exception of the CDID-owned and operated pump station (also known as the Reynolds Pump Station) located next to the Columbia River. That pump station is located on CDID-owned property.
- **Industrial Way Pump Station Outfall Easement.** An easement for the underground discharge line connecting the Industrial Way pump station to its outfall is located along the eastern portion of the Northwest Alloys-owned property.

2.2 Historical Reynolds Metals Operations

Industrial use of the Former Reynolds Plant began in approximately 1941 with the development of the aluminum production operations by Reynolds Metals Company (Reynolds). The manufacturing capabilities were expanded in the 1960s. The operations at the Former Reynolds Plant focused on primary aluminum production, without extensive downstream product manufacturing facilities. Historical facility operations are well documented and include the following:

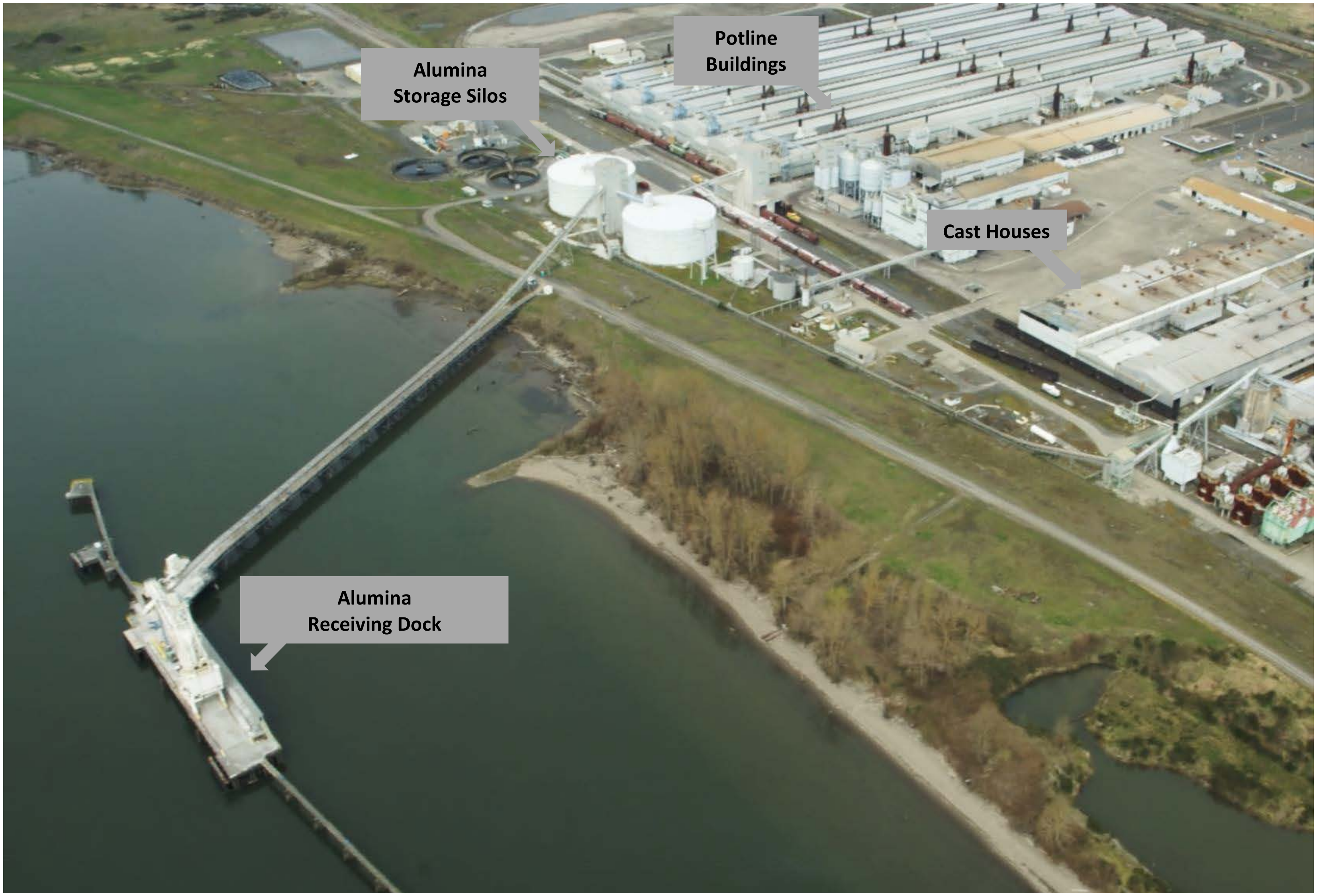
- Aluminum Production Facilities (Section 2.2.1)
- Former Cable Plant Operations (Section 2.2.2)
- Former On-site Recycling Processes (Section 2.2.3)
- Industrial Landfills (Section 2.2.4)
- Other Reynolds-associated Operations (Section 2.2.5)

2.2.1 Aluminum Production Facilities

Aluminum production operations were initiated in 1941, with construction and operation of the first aluminum production (i.e., reduction or smelting) and casting operations. In 1967, operations expanded to include additional aluminum production capacity in what is known as the North Plant.

The aluminum production process used at the Former Reynolds Plant is summarized on Plates 2-2 and 2-3. In that process, alumina ore was received by ship or by rail. Alumina was unloaded and transferred to the alumina storage silos and from there to the potline buildings (see Plate 2-2).

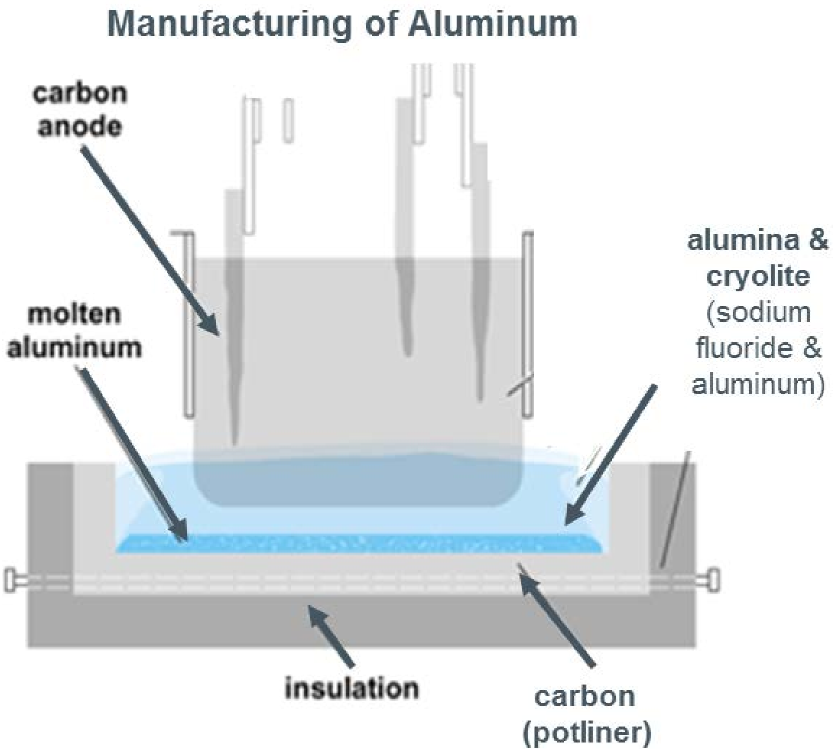
The potline buildings included an extensive series of pots (see Plate 2-3) in which the reduction process was performed. In the aluminum reduction process, alumina was placed in the pots and dissolved in a material known as cryolite (containing sodium, fluoride, and aluminum). The resulting molten material consisting of alumina and cryolite is called bath. Electricity was then passed through the mixture, between an anode and a cathode (potliner), producing molten aluminum. Both the anode and the cathodes were made on site from carbonaceous materials.



Alumina used at the Reynolds Facility was received by ship. The alumina was transferred to storage silos and then used in the potline buildings to produce molten aluminum (see Plate 2-3). The aluminum was then cast into solid form inside the cast houses. The aluminum manufacturing was curtailed in 2001, but the dock and storage silos remain in use for import of bulk products, including alumina required by the operating aluminum facility in Wenatchee.

Plate 2-2

Aluminum Manufacturing Facilities



The diagram (top) illustrates the aluminum manufacturing or “reduction” process. Solid alumina is placed in a “pot” and dissolved in a cryolite solution (consisting of sodium, fluoride, and aluminum). Electricity is then passed through the material in the pot to produce molten aluminum. The photograph (bottom) from the late 1960s shows one of the Reynolds “potlines” (the A-line in Room 51) during Longview plant operations.

ANCHOR QEA

Plate 2-3

Overview of the Aluminum Reduction Process
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

The molten aluminum produced in the potlines was transferred to the casting facility where it was cast into a variety of products, including t-bar (t-ingots), extrusion billets, and sheet ingots. The two cast houses are shown on Plate 2-2.

The anodes and cathodes used in the reduction process were produced on site from carbonaceous materials. These raw materials were received by rail and truck and included calcined petroleum coke, coal tar pitch (pitch), and anthracite coal. The pitch used at the Longview facility was a hard, asphalt-like material that was solid except when heated. Use of this asphalt-like form of the pitch minimized the potential for significant spills or dust generation during its handling (in comparison to the types of pitch handled at some aluminum production facilities). The pitch used at the Former Reynolds Plant was received by rail and transferred into storage tanks. These heated storage tanks had distribution lines that connected the tanks and the carbon plant.

The anodes used at the Former Reynolds Plant were of the Söderberg design (as opposed to the pre-baked anode, which is more commonly used within the aluminum industry). One benefit of the Söderberg design is that it does not require the use of a baking furnace to bake and harden the anode. As a result, the facility did not produce extensive quantities of spent furnace brick waste, which is common at some aluminum production facilities using pre-baked anodes.

Electricity used in the aluminum production process was obtained from the off-property BPA electrical yards (see Plate 1-3). This electricity was routed through two Reynolds-owned rectifier yards (the north and south yards). The rectifiers were used to convert the alternating current electricity received from BPA to direct current required in the aluminum production process. One rectifier yard was located next to each set of potlines. The south rectifier yard began operating in 1941, and the north rectifier yard began operating in 1967. The original rectifiers in the south yard were mercury-arc rectifiers but were replaced with solid-state rectifiers during the 1980s. Some electrical transformers and capacitors were located within the rectifier yards, and smaller transformers and capacitors were located within other portions of the Former Reynolds Plant as necessary to support facility operations.

2.2.2 Former Cable Plant Operations

The former Cable Plant (see Plate 1-3) is located within the Former Reynolds Plant, to the west of the aluminum production areas. The Cable Plant was constructed in the late 1960s. It produced electrical cable products, including aluminum wire, rods, and insulated (polyethylene and polyvinyl) low and medium voltage cable.

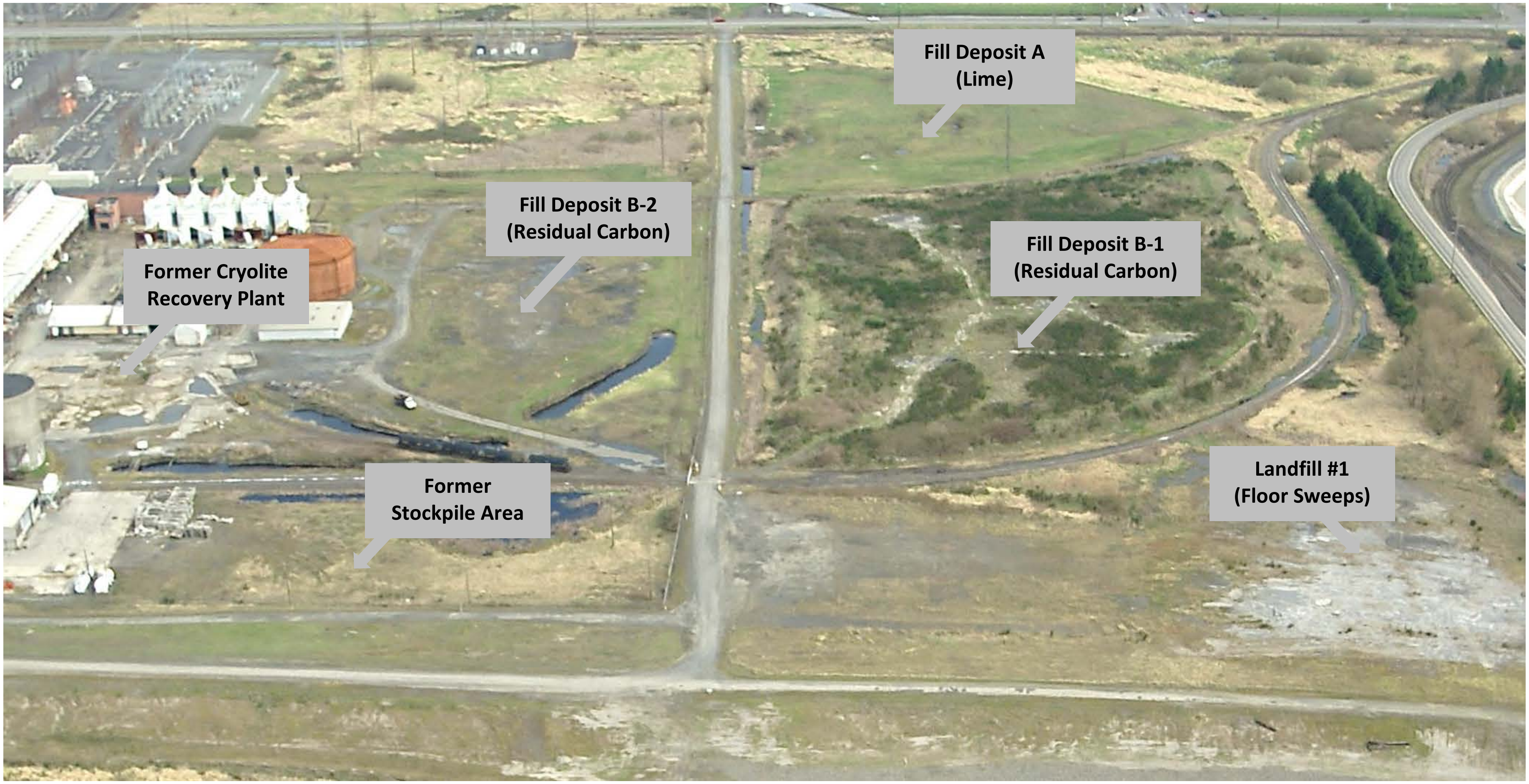
The Cable Plant received molten aluminum from the aluminum production facilities and processed it in three furnaces—a continuous ingot caster, a rolling mill, and wire drawers. Ancillary structures associated with the Cable Plant included office buildings, parking, and an on-site sanitary wastewater treatment plant.

Although Reynolds owned both the aluminum production facilities and the Cable Plant, the facilities were managed by different entities within the company and generally functioned independently. The Cable Plant assets were sold to BICC Cable Corporation (BICC) in 1992 and production immediately ceased. BICC removed all the assets from the buildings and returned ownership of the empty buildings to Reynolds in the mid-1990s. Since that time, the facility has been primarily inactive, only used sporadically for storage.

2.2.3 Former On-site Recycling Processes

One byproduct that is produced during aluminum manufacturing is known as spent potliner (SPL). The potliner consists of the carbon lining of the pots (see Plate 2-3) in which the molten aluminum is produced (Ecology 1982). Over time this lining eventually becomes compromised and must be replaced. The SPL contains fluoride (from the cryolite solution used in the process) and polycyclic aromatic hydrocarbon (PAH) compounds (from the carbon materials). SPL can also contain cyanide, which can be produced during operation of the pots when nitrogen in the air combines with carbon in the carbonaceous materials. The levels of cyanide in SPL can vary depending on the specific production methods used and pot technology.

At the Former Reynolds Plant, a recycling process was operated to recover reusable materials from SPL. This process was conducted in the former Cryolite Recovery Plant (see Plate 2-4) located in the East Plant area. The former Cryolite Recovery Plant was constructed in 1953.



The East Plant area includes the location of the former on-site recycling process that was used to recover reuseable materials (cryolite) from the spent lining from the aluminum pots. The former material stockpile and the cryolite recovery plant (above-left) have long since been removed and testing has been performed in each of these areas (see Section 2.4.5). Lime used in the process was managed in Fill Deposit A (above-right). The residual carbon that remained after cryolite recovery was managed in constructed fill areas within the Reynolds Facility, including Fill Deposits B-1 and B-2 (above). These fill areas were closed in the 1960s and 1970s and were subsequently capped with clean soil. Also present in the East Plant area is a closed landfill used during aluminum manufacturing operations to manage floor sweeps from the potline buildings. That landfill was closed in the early 1980s.

ANCHOR QEA

Plate 2-4

Features of the East Plant Area

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

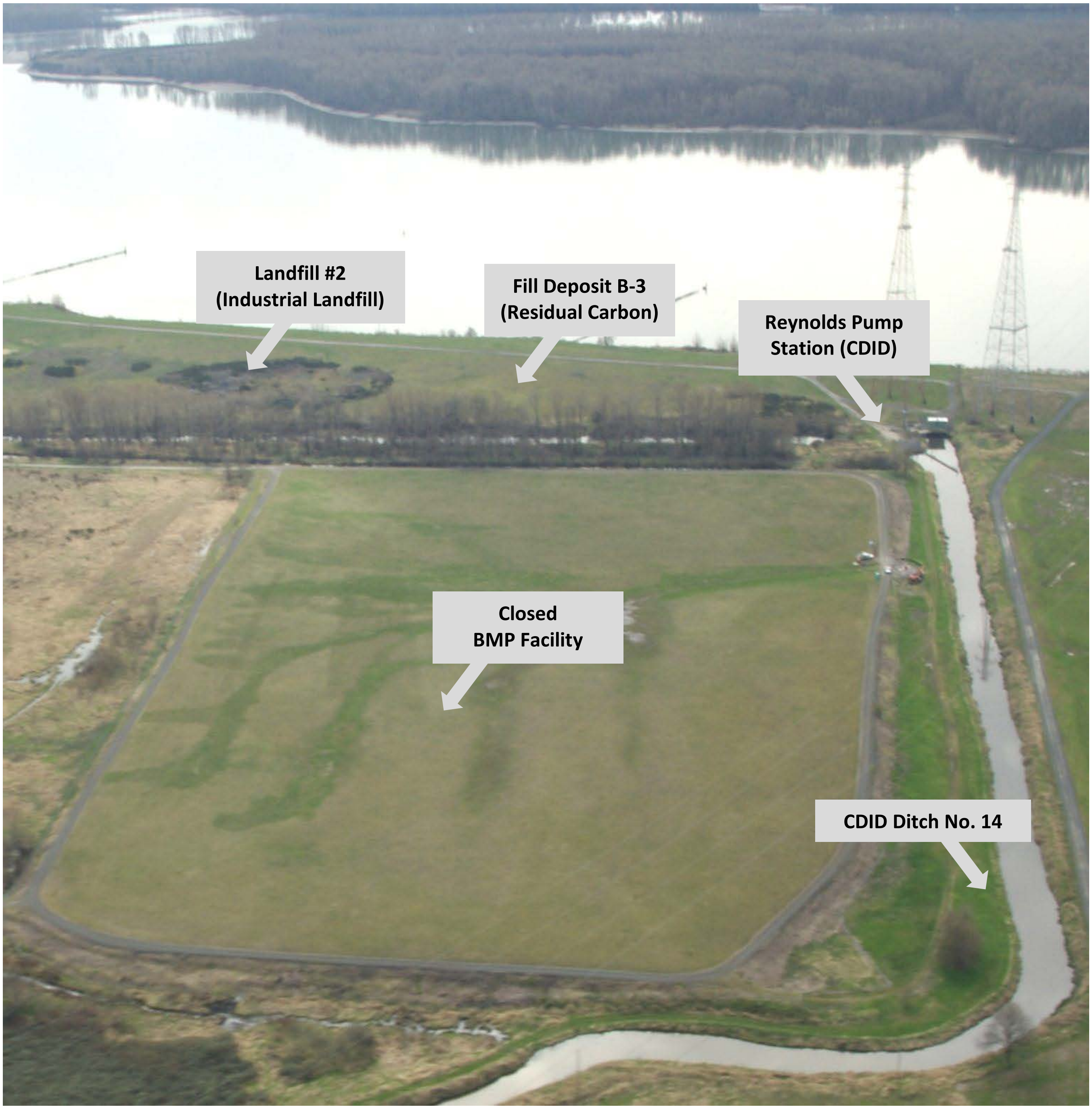
The Cryolite Recovery Plant reclaimed electrolyte that was absorbed into the spent carbonaceous pot lining. The SPL recycled at the Former Reynolds Plant came both from the site, as well as from other northwest aluminum reduction plants.

The Cryolite Recovery Plant also recovered reusable fluoride compounds from the wet air emission control system solids (underflow solids). These solids were generated during operation of the wet electrostatic precipitators, which were used to control air emissions from the aluminum manufacturing process. These underflow solids were collected in thickener tanks (also known as clarifiers) operated at two locations within the Former Reynolds Plant.

Cryolite recovery involved a multiple-step process. The feedstock consisted of SPL that was stockpiled in the southwestern portion of the plant (see Plate 2-4). This material was crushed, ground, and blended with underflow solids. The material was then slurried with an alkaline sodium hydroxide solution, which extracted fluoride compounds from the solid materials for reuse. The slurry was pumped to a thickener where the liquor was separated from the remaining treated solids, which were composed primarily of residual carbon. During plant operations these solids were termed black mud due to the characteristic dark color associated with the carbon present in the solids. The residual carbon was disposed in several fill deposits constructed within the Former Reynolds Plant (see Fill Deposits B-1, B-2, and B-3 on Plates 2-4 and 2-5).

Lime was processed at the site to produce the sodium hydroxide solution used in the cryolite recovery process. Spent lime (known during plant operations as “white mud” due to its characteristic white color) was generated during this process. This spent lime was initially segregated and managed in Fill Deposit A located in the East Plant area (see Plate 2-4). After Fill Deposit A was closed in the 1970s, the spent lime was no longer segregated and was combined and managed with the residual carbon.

The final steps in cryolite recovery included separating the cryolite using precipitation and filtration. The solids from the filter were dried in a rotary kiln and multi-hearth “herreshoff” furnace. The dried cryolite was reused within the Former Reynolds Plant or was sold to other facilities for reuse.



A Consolidated Diking and Improvement District (CDID) ditch (No. 14) and CDID pump station (Reynolds Pump Station) are located along the edge of the West Plant area. The West Plant area includes Fill Deposit B-3 (above center), which was used during the 1960s and early 1970s to manage residual carbon from the on-site recycling process. This area was closed in the early 1970s and was subsequently capped with clean soil. The West Plant area also includes the Closed BMP Facility, which was closed in the early 1990s, including construction of a landfill cap and implementation of a maintenance and monitoring program under with a formal Ecology-approved closure/post-closure plan. The West Plant area also includes a landfill (Landfill #2; above left) which was used to manage industrial debris from until it was closed in the early 1980s.

Plate 2-5

Features of the West Plant Area

The Cryolite Recovery Plant continued operation until May 1990. After that time, all SPL generated during aluminum manufacturing was shipped off site to permitted treatment, storage, and disposal facilities (TSDFs). The Cryolite Recovery Plant structures have since been removed, and this portion of the Former Reynolds Plant is now vacant (see Plate 2-4).

Regulatory requirements associated with handling and recycling of SPL and with the cryolite recovery process changed over time. Reynolds operations changed over time in compliance with those requirements:

- Between the 1950s and the 1980s, the SPL used as the raw material for the cryolite recovery process was not subject to special regulation. The SPL was stored in the designated stockpile area and was used in the recovery process.
- In 1982, the State of Washington adopted the dangerous waste regulations (WAC Chapter 173-303) to meet federal Resource Conservation and Recovery Act (RCRA) requirements. These regulations were directed at ongoing waste generation activities, not at previously operated fill placement activities. These regulations had limited effect on the active cryolite recovery process. Reynolds considered the SPL to be a raw material to the former Cryolite Recovery Plant for the recovery of fluoride compounds, not a waste. SPL was not a listed federal hazardous waste at that time. In 1982, Ecology tested Reynolds SPL and determined that if considered a waste, it would not be designated as a hazardous or dangerous waste.
- Regulatory requirements associated with SPL stockpiling and handling increased during the 1980s. Based on concerns about potential impacts to groundwater in the stockpile area, Reynolds entered into an agreement with Ecology in July of 1983 (AO No. DE 83-293 issued under the authority of Revised Code of Washington [RCW] 90.48, not RCW 70.105; Ecology 1983) to remove the SPL stockpile in a time span of 5.5 years. In addition, SPL was no longer imported from other off-site facilities. During the 5.5-year work period, the stockpiled SPL was covered, and groundwater monitoring wells were installed upgradient and downgradient of the pile. Reynolds met the technical and schedule requirements established by AO DE 83-293, including removal of the stockpiled SPL. Most of the stockpiled SPL was processed and recycled in the Cryolite Recovery Plant. SPL that was imbedded in the underlying soils was excavated and disposed of in an off-site permitted hazardous waste TSDF.

- Subsequent regulatory changes included the listing of SPL (waste code K088) under the federal hazardous waste regulations. The federal regulations were promulgated on September 13, 1988 (53 Federal Register 35412). The State of Washington adopted the listing and incorporated it into WAC 173-303-9904 on April 7, 1991. No deposits of SPL are known to remain within the Former Reynolds Plant. The stockpile of SPL was completely removed, and all SPL generated after closure of the Cryolite Recovery Plant was managed by off-site disposal at appropriately permitted TSDFs.

The residual carbon generated during the cryolite recovery process had different chemical properties than the original raw materials, and the historical management of residual carbon is discussed in more detail below:

- Between the 1950s and 1972, residual carbon generated from the cryolite recovery process was landfilled in designated management areas located in the East Plant and West Plant areas. Originally, the residual carbon material was placed in a constructed deposit just to the east of the former Cryolite Recovery Plant (see Fill Deposit B-2; see Plate 2-4). An additional fill deposit (Fill Deposit B-1; see Plate 2-4) was constructed along the eastern edge of the property. These fill deposits were excavated at least once, and the materials were placed in the southwestern portion of the property near the industrial landfill (see Fill Deposit B-3; see Plate 2-5). Placement of residual carbon in these three fill deposits ceased in 1972. These three fill areas were capped with soil in 1988.
- Residual carbon produced at the Former Reynolds Plant after 1972 was managed in an impoundment constructed within the western plant area. This 33-acre facility was formally closed in 1991. That closure was subject to additional regulatory requirements under the Washington Dangerous Waste regulations in place at that time. In accordance with an Ecology-approved closure plan meeting the requirements of WAC 173-303 (see Closed BMP Facility; see Plate 2-5), the closure included the construction of a landfill cap, the filing of restrictive covenants, and implementation of a long-term operation and monitoring plan. The closure and post-closure requirements were associated with a state regulatory requirement (Washington-specific waste designation), which has since been modified by the State. The Closure/Post Closure Plan (Reynolds and CH2M Hill 1991) was submitted to Ecology in 1991, and the final cover was constructed in 1992. Closure and subsequent

operation and monitoring of the facility have been performed in accordance with the Ecology-approved Closure/Post Closure Plan (Reynolds and CH2M Hill 1991). The closed facility has continued to meet the plan requirements, and Ecology has continued to implement its oversight role during implementation of this post-closure monitoring and maintenance, as described in Appendix B.

- Residual carbon deposits remain present in several managed disposal areas within areas of the East Plant and West Plant (see Plates 2-4 and 2-5). These areas were developed prior to the application of the K088 waste listings for SPL. This residual carbon is not SPL, and the cryolite recovery process modifies the material such that the residual carbon does not maintain the levels of chemicals for which the K088 waste code was established (i.e., if the carbon deposits are excavated and tested, they are not a characteristic hazardous waste under state or federal criteria). However, under federal rules, some of the regulatory requirements intended for application to unprocessed SPL also restrict management options for the residual carbon deposits should these deposits be excavated and removed from the property. These additional requirements do not apply to the in-place management of these residual carbon materials. These regulatory considerations are analyzed as part of the FS (see Section 8).

2.2.4 Industrial Landfills

The Former Reynolds Plant includes three historical on-site landfills, which were used during facility operations for construction debris and other materials. Use of these three landfills ceased in the 1980s prior to implementation of more restrictive regulations affecting landfills operated since that time. The following is a brief description of each historical landfill:

- **Landfill #1** (floor sweeps, see Plate 2-4) was used for the dry materials swept from the floors in the potlines. These materials included alumina, bath, cryolite, and aluminum fluoride.
- **Landfill #2** (industrial, see Plate 2-5) was used primarily for management of inert wastes, including scrap calcined petroleum coke, ore, cryolite, aluminum fluoride, bath, brick, concrete, and miscellaneous dry materials. Standard practices were not to place liquids in the landfill.
- **Landfill #3** (construction debris, see Plate 2-6) contains concrete debris and other inert plant wastes similar to those in the industrial landfill (Landfill #2).

A former landfill (Landfill #3, above) was used to manage construction debris during the 1970s. It is located on Northwest Alloys owned property between the CDID levee and the Columbia River.

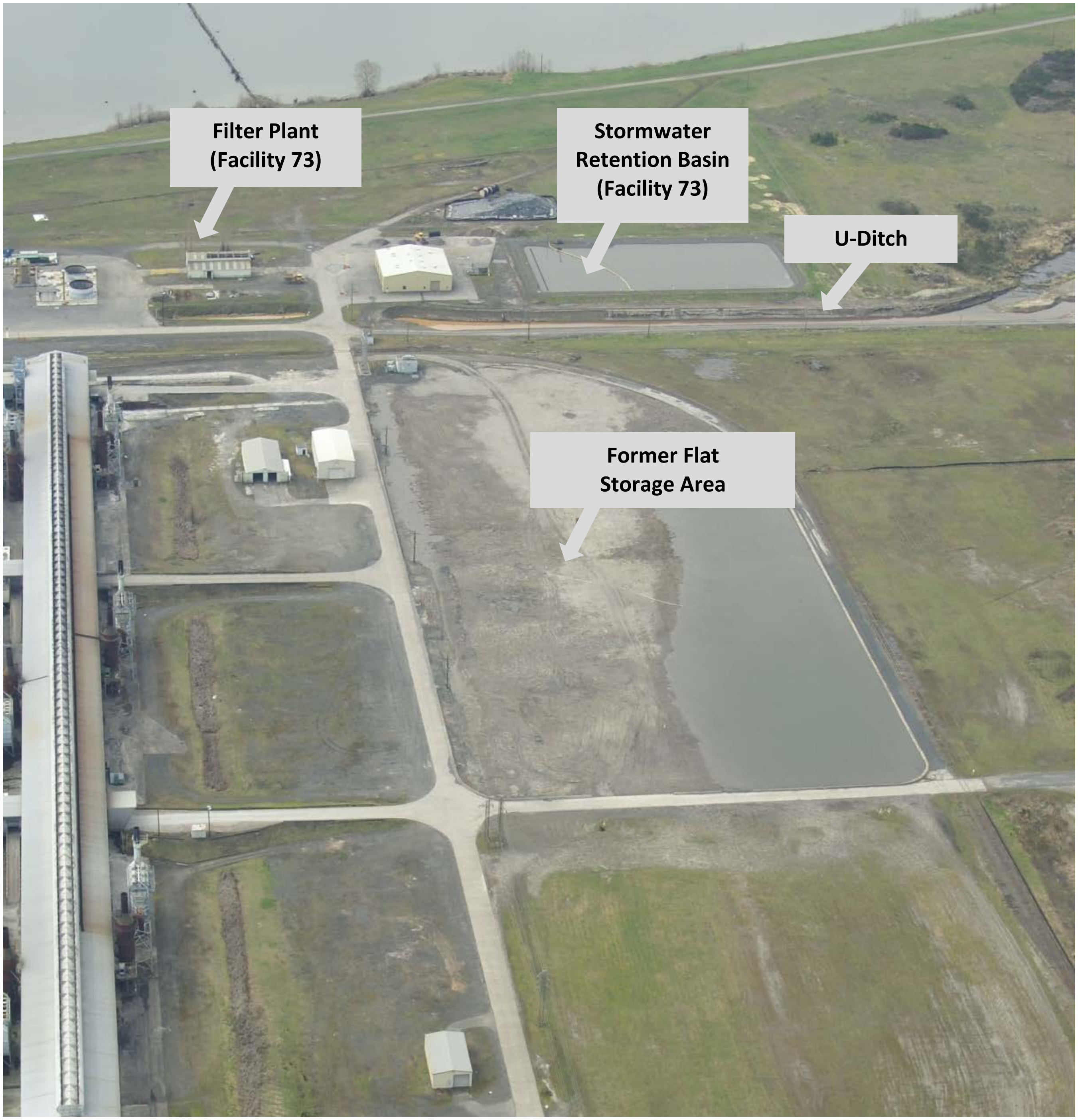
Plate 2-6

Location of the Construction Debris Landfill
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

2.2.5 Reynolds-associated Operations

During its operation, the Former Reynolds Plant included an extensive staff with a peak number of more than 1,200 employees. The facility had more than 800 employees at the time of its closure in 2001. The facility included many support operations necessary for aluminum manufacturing. These Reynolds-associated operations included the following:

- **Maintenance Facilities.** The Former Reynolds Plant had a complete maintenance department to support plant operations. These activities were largely performed in the central plant maintenance buildings. The maintenance department utilized land to the west of the western potlines as a scrap yard in the location later used by CVI as a flat material storage area (see Plate 2-7). Scrap metal was placed in this area for reuse or off-site recycling.
- **Water Supply Wells.** Nine water production wells are located at the Former Reynolds Plant. Production well numbers 1 to 4 were installed during construction of the South Plant potlines in the early 1940s, and well numbers 5 to 8 were installed during construction of the North Plant potlines in 1967. The deepest production well (No. 7) was drilled to a depth of 410 feet below ground surface (bgs). An additional production well was installed to service the Cable Plant in 1968. Monitoring of the water system was performed by Reynolds consistent with Washington State Department of Health requirements. This monitoring has shown that the water generated from these wells is clean except for the presence of naturally occurring iron, manganese, and arsenic, which are characteristic of the regional water supply aquifer under this portion of Cowlitz County. Currently, drinking water for the Northwest Alloys property is obtained from the City of Longview using a newly installed water supply connection. The water supply wells generate process water for continued industrial use.
- **Wastewater Treatment Systems.** The Former Reynolds Plant is serviced by two wastewater treatment systems. A domestic wastewater treatment system (sanitary treatment plant) was constructed in the 1940s and updated in the 1960s. This facility is still in use today. The treatment system discharges are regulated under the site NPDES permit No. WA-000008-6. The Industrial Wastewater Chemical Treatment Plant (Facility 71), the Retention Basin, and the Filter Plant (Facility 73) were added between 1988 and 1994 (see Plate 2-7). These systems treated industrial wastewater from the air emissions equipment and commingled stormwater and process water prior to discharge.



The former flat storage area was located west of the potline buildings. This area was used by CVI for storage of bulk products. The bulk products stored in this area by CVI and the associated structures installed by CVI have been removed. The main on-site wastewater treatment facilities, permitted under the facility's National Pollutant Discharge Elimination System (NPDES) permit, are located in between this area and the Columbia River. MBTL recently completed the removal of accumulated solids from the retention pond, and the removal of debris and fill material that had been placed in the U-Ditch by CVI. The U-Ditch is part of the on-site water management system regulated under the NPDES permit.

Plate 2-7

Material Removal and Cleanup Areas – Former Flat Storage Area and Vicinity

2.3 Historical Uses after Closure of Former Reynolds Plant

In 2000, Alcoa purchased Reynolds as a wholly owned subsidiary. As a requirement of this transaction, Reynolds was required to divest the Longview smelter. To fulfill this obligation, Reynolds sold the facility to Longview Aluminum in 2001 but retained ownership of the land. Reynolds then entered into a ground lease with Longview Aluminum. Longview Aluminum immediately closed the aluminum production operations, and the facility has not produced aluminum since that date. Longview Aluminum declared bankruptcy in 2003, and Development Services, Inc., took over operations for the bankruptcy court as the trustee of the estate.

In December 2004, CVI purchased the Longview assets from the bankruptcy trustee and entered into a long-term ground lease with Reynolds. Reynolds continued to retain ownership of the land. In September 2005, ownership of the land transferred from Reynolds to Northwest Alloys, both wholly owned subsidiaries of Alcoa.

CVI was the sole operator of the facility and associated Northwest Alloys-owned properties between 2004 and 2011. CVI operated a terminal for the import, handling, and export of dry bulk materials, such as alumina, coal, green petroleum coke, cement, fly ash, slag, and other materials.

During its occupancy, CVI decommissioned the majority of the facilities associated with aluminum manufacturing operations and recycled materials from smelters being decommissioned throughout the northwest region. These activities included the removal and disposal or recycling of alumina, electrolyte bath, coal, and carbon products.

In addition to aluminum manufacturing products, CVI handled a variety of other materials for various customers. These products were generally handled in new equipment and facilities developed by CVI. Products handled by CVI included cement, fly ash, coal, green petroleum coke, lignin, scrap metal, and thin stillage (an agricultural byproduct of corn-based ethanol manufacturing). CVI initiated development of handling facilities for liquid caustic soda (sodium hydroxide), but these facilities were not completed, and the product was not handled at the property.

On January 11, 2011, CVI sold its Longview assets to MBTL. MBTL has subsequently removed most of the structures that were constructed by CVI and has continued facility decommissioning, removal, and cleanup activities, as described in Section 2.4.

2.4 Previous Decommissioning and Cleanup Activities

Extensive decommissioning, demolition, waste removal, and cleanup activities have been conducted to date at the Former Reynolds Plant. These actions have been conducted in coordination with Ecology. Extensive quantities of material have been appropriately reused, recycled, or disposed of using permitted off-site facilities. These actions have improved site safety and have helped to return the property to productive reuse.

2.4.1 Decommissioning of the Former Reynolds Plant

Extensive facility decommissioning and demolition activities have been conducted since cessation of aluminum production in 2001. A detailed description of these activities as of June 2011 is provided in the report *Demolition and Cleanup Accomplishments at the Former Reynolds Longview Reduction Plant* (Northwest Alloys 2011). A summary of accomplishments between June 2011 and December 2012 is provided in the report *Addendum to Demolition and Cleanup Accomplishments at the Former Reynolds Longview Reduction Plant* (Northwest Alloys and MBTL 2013).

In May 2004, Reynolds hired Envirocon, Inc. (Envirocon), to demolish the Cryolite Recovery Plant. Materials removed during that project included approximately 800 tons of metals, 150 tons of concrete, 161 tons of construction debris, 132 tons of brick/refractory and 850 tons of underflow solids. A total of 40 potroom transformers were sold by the bankruptcy trustee to Calbag Metals Co. (Calbag) in Portland, Oregon. Calbag recycled the transformer metals and transformer oil.

During the period from 2004 through January 2011, CVI conducted decommissioning, cleanup, and off-site disposal and recycling activities in several areas of the Former Reynolds Plant, including the following:

- **Plant-Wide Demolition and Cleanup Work.** In 2005, Envirocon was hired to perform the demolition of the North Plant and South Plant potrooms under a work plan approved by Ecology. Additional work was self-performed by CVI. Demolition and cleanup accomplishments during this period include the following:

  - Reduction plant equipment in the north and south potrooms was removed. Wastes generated in the process were managed in accordance with local, state and federal requirements. Metals including copper, aluminum, and steel were recycled. Anode carbon was reused and SPL and bath were appropriately disposed of off site.
  - The potrooms were cleaned, including the outside courtyards.
  - The fume control systems attached to the potrooms were cleaned. In addition, the fume sludge handling equipment including piping, tanks and clarifiers were cleaned.
  - Equipment in the two cast houses was demolished and cleaned. The furnaces and other casting equipment were removed and the rooms were cleaned, including the casting pits.
  - The mixer side of the Carbon Plant used for blending carbonaceous products for anodes was demolished and cleaned. The mixers and related piping were removed and recycled.
  - The maintenance buildings, the pot digging building, the pin-and-channel building, pot relining building and compressor buildings were cleaned.
  - The unloading tower and the central loading/unloading tower were cleaned, including the South Plant alumina handling system.
  - The wastewater and stormwater systems were cleaned including the Wastewater Treatment Plant, the storm lines, and the stormwater multi-media filter building.
  - The Cable Plant cast house and warehouse were cleaned.
  - Other materials, including scrap metals, used oil, and unused transformers were recycled.

- **Soil Cleanup Work.** As described in Section 2.4.3, soil cleanup work was conducted in several areas, including the former scrap yard, the Cryolite Area ditches, the former warehouse fuel island and the heat transfer media (HTM) Oil Area.
- Over the period that CVI owned the plant, the following materials were removed and recycled or appropriately disposed at permitted off-site facilities (Northwest Alloys 2011):
  - 3,568 tons of copper (recycled)
  - 7,578 tons of aluminum (recycled)

  - 38,440 tons of steel (recycled)
  - 24,324 tons of anode carbon (beneficially reused or recycled)
  - 29,270 tons of hazardous waste (disposed off site)
  - 9,688 tons of non-hazardous waste and contaminated soils (disposed off site)

2.4.2 Removal of Materials by MBTL

Following the sale of the CVI assets in January 2011, MBTL took ownership of the facility assets. Since then, MBTL has continued to remove the remaining aluminum smelting equipment, materials, and wastes from the property, as well as materials that remained from CVI operations.

As part of its acquisition of the facility assets, MBTL leased approximately 2 to 3 acres to CVI for temporary storage of some remaining CVI equipment that had not been removed prior to the closing date. CVI equipment was relocated to the temporary storage area by May 2011 (Northwest Alloys 2011). This lease for the temporary storage area expired in August 2011, and CVI-owned equipment was no longer present on the property after August 2011.

As CVI equipment was cleared from the property, MBTL proceeded to clear debris and waste materials from areas formerly operated by CVI. Initial activities included clearing and disposal of scrap wood, metal, and other debris. Equipment and debris were removed from the parking lots, and the main courtyards were swept and cleaned by MBTL. From January 2011 through December 2012, MBTL conducted or coordinated the removal and reuse, recycling, or appropriately permitted off-site disposal of the following materials (quantities are approximate; Northwest Alloys and MBTL 2013):

- 700 tons of cleanup debris (disposed off site)
- 90 tons of wood waste (disposed off site)
- 1,200 tons of scrap metal (recycled)
- 20 tons of pitch-contaminated debris (disposed off site)
- 200 tons of underflow solids (disposed off site)
- 1.8 million gallons of thin stillage (disposed off site)
- 2.8 million gallons of stormwater runoff from the flat storage area (disposed off site)

- More than 6,500 tons of alkaline ore from the north and south pot rooms (disposed off site)
- 2,500 tons of alumina ore (removed by product owner)
- 20,000 tons of carbon (recycled off site)
- 26,000 tons of fly ash (reused off site)

During this same time period, MBTL conducted additional abatement, removal and facility repair activities including the following:

- **Machine shop floor.** The machine shop floor in the maintenance building was equipped with a wood block floor. Testing showed that the oil and mastic in the floor contained asbestos, polychlorinated biphenyls (PCBs), and lead. An abatement contractor was hired by MBTL to remove the floor. The project was completed in 3 months, and approximately 68 tons of flooring, including some of the cement under and around the perimeter of the floor, was removed and disposed of in a permitted Toxic Substances Control Act (TSCA) and hazardous waste landfill in Arlington, Oregon (Northwest Alloys and MBTL 2013).
- **Flat storage area.** The flat storage area was developed by CVI in the western area of the property, between the potline buildings and the Cable Plant (see Plate 2-7). CVI constructed a pad structure from cement-amended soil for stockpiling bulk products, such as green petroleum coke and coal. More than 100,000 tons of green petroleum coke was left in the flat storage area when CVI vacated the property. Ecology approved an MBTL plan to remove the remaining petroleum coke (MBTL 2012; Ecology 2012a). During spring and summer of 2012, MBTL coordinated with Conoco Phillips, the owner of the product, to ship all remaining petroleum coke off site by truck (Ecology 2012a). Ecology also authorized removal of the pad structure. Final removal and decommissioning of the flat storage pad was completed by MBTL as of December 2012 (see Plate 2-7). More than 21,000 tons of cement were removed as part of the pad decommissioning and shipped to a permitted landfill in Hillsboro, Oregon.
- **Stormwater retention pond.** As part of routine stormwater pond maintenance, approximately 1,000 tons of pond solids were removed from the Stormwater Retention Basin (see Plate 2-7 and Appendix C). The removed solids had accumulated in the basin since the previous cleanout in approximately 2001. These

solids were characterized for disposal purposes prior to and outside of the RI/FS process. The removed solids were disposed of in an appropriate and permitted disposal facility off site.

- **U-Ditch reconnection.** The U-ditch is an earthen stormwater ditch located in the southwestern portion of the Former Reynolds Plant (see Plate 2-7). A portion of the U-ditch channel had been filled by CVI, and Ecology had ordered CVI to re-establish the connection of the U-ditch (Ecology Administrative Order No. 8027; Ecology 2010). MBTL completed the connection in fall 2012, with the removal of fill and debris from the U-ditch. As part of the reconnection project, MBTL characterized and removed more than 14,000 tons of debris from the property, which was disposed of off site at a permitted landfill in Hillsboro, Oregon (Northwest Alloys and MBTL 2013). Following debris removal and grading activities, sampling was conducted in November 2012 to characterize soils underlying the U-ditch. This post-removal soil sampling included the collection of surface grab samples from sidewalls and within the base of the final graded U-ditch channel, as outlined in the U-ditch Sampling and Analysis Plan (MBTL 2012). Results of confirmation sampling are presented in Appendix A.

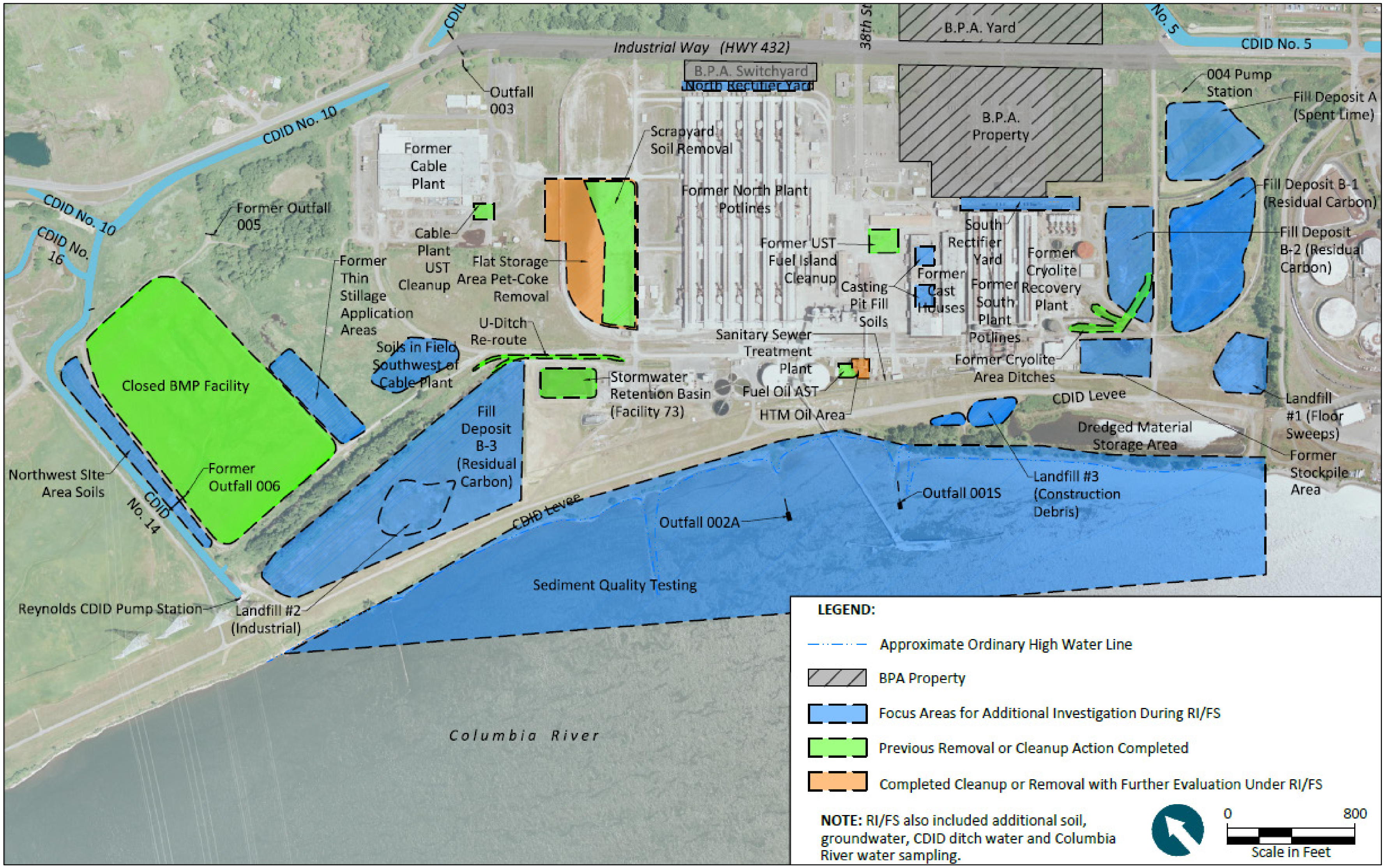
2.4.3 Previously Completed Cleanup Actions

A number of cleanup actions were completed prior to the current RI/FS to address areas of localized soil contamination. These actions have been completed in coordination with Ecology. The locations of these cleanup areas are shown on Plates 2-7, 2-8, and 2-9. A brief summary of these completed actions is provided in the bullets below. Additional supporting information is included in Appendix A.

- **Scrap Yard Soil Cleanup.** The scrap yard was located west of the former North Plant potlines (see Plate 2-9) and was historically used during Former Reynolds Plant operations for the handling of materials designated for reuse or off-site recycling (Anchor 2007a). Approximately 200 cubic yards of PAH-impacted soil in this area were removed by CVI. Soil samples collected after the cleanup confirmed that soil PAH concentrations were less than the MTCA Industrial Use cleanup levels (Anchor 2007b).

As described in Section 2.4, several investigation and cleanup actions have been completed prior to the development of the Remedial Investigation/Feasibility Study (RI/FS). Three of these areas are shown in the above photograph: 1) Petroleum-contaminated soils located near a former fuel island (above right) were removed; 2) Petroleum-contaminated soils adjacent to an above-ground storage tank (above left) were removed to the extent practicable without damaging the tank structure, and the remaining impacted soils in this area are subject to restrictive covenants filed for the property; and 3) A separate release of heat transfer media (HTM; similar to mineral oil) occurred near the pitch storage tanks. Soils in this area were removed, and additional testing in this area was performed as part of the RI/FS.

Plate 2-8
Locations of Previous Cleanup Actions – Central Plant Area
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



A series of removal and cleanup actions (green areas) have been completed in coordination with Washington Department of Ecology. The Remedial Investigation/Feasibility Study (RI/FS) investigates conditions within the remaining areas of the facility, building on the extensive data set available from previous environmental investigations as described in Section 2.4.5. As described in Section 3, the RI investigations include targeted work in the blue areas shown above, as well as additional testing in the adjacent RI/FS Study Areas.

ANCHOR QEA

Plate 2-9

Summary of Previous Cleanup and Removal Areas and Remedial Investigation Focus Areas
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

  - Initial sampling of the scrap yard was completed in July 2000 (MFG 2000). Soil samples were analyzed for RCRA metals, PCBs, and PAHs. Of these parameters, only PAH compounds exceeded these cleanup levels. The area of impacted soil was delineated, and the soil cleanup was completed in 2005 by CVI as a voluntary cleanup action.
  - As shown on Plate 2-9, the scrapyard footprint was later included within the flat storage area developed by CVI. The RI/FS includes additional testing in this area to assess soil quality following the removal of the stored products and the flat storage pad.

- **Cable Plant Underground Storage Tank Cleanup.** An underground storage tank (UST) located adjacent to the Cable Plant (see Plate 2-9) was removed in 2001. Localized gasoline-impacted soil and groundwater in this area were cleaned up with Ecology oversight under the Voluntary Cleanup Program. In 2003, Ecology provided a No Further Action determination for this area (Anchor 2003).

  - A 1,000-gallon gasoline UST was originally installed by Reynolds in 1974 to fuel company vehicles and equipment. Petroleum-impacted soils and groundwater were identified, and Ecology was notified of the impacts in November 1991 when Reynolds removed the UST (PNE 1991). In 1992, additional soil and groundwater sampling was conducted at the site (PNE 1992). Additional soil and groundwater sampling was conducted in 1993 (PNE 1993) and 1994 as part of a focused RI/FS (PNG 1994).
  - Soil impacted with total petroleum hydrocarbon (TPH) was excavated and removed from the site in 1994. Confirmation testing of remaining soils showed that cleanup levels had been achieved (PNG 1994), and follow-up quarterly groundwater monitoring was conducted (EMCON 1996). Groundwater monitoring continued until 1997.
  - Final remediation was documented in the *Voluntary Cleanup Report – Underground Gasoline Tank – Former Reynolds Longview Cable Plant*, which was submitted to Ecology on January 9, 2003 (Anchor 2003). Ecology provided a No Further Action determination for this area in a letter dated February 19, 2003 (Anchor 2003).

- **Warehouse UST and Fuel Island Cleanup.** A cleanup was completed to address a localized area of diesel-impacted soil associated with a former UST fuel island (see Plate 2-9). Soils from this area were excavated and treated successfully using on-site bioremediation. After treatment, the soils complied with MTCA Method A cleanup levels. With Ecology's approval, the treated soils were reused on-site as fill.
  - The UST fuel island was located approximately 25 feet from a 10,000-gallon UST, which was decommissioned in May 2004. The decommissioning of the UST was conducted by the bankruptcy trustee in June 2004 (Evren Northwest 2004). Sampling was performed following removal of the tank, lines, and dispenser. Gasoline and PAH constituents were not detected, and benzene concentrations were below applicable groundwater cleanup levels in a confirmation groundwater sample collected from the tank excavation.
  - No gasoline was detected in soil adjacent to the tank, fuel lines, or dispensers. Gasoline, PAH compounds, and benzene concentrations in a temporary well point were not detected in groundwater or were below applicable cleanup levels. However, elevated diesel-impacted soil was present under the middle dispenser between 2 and 9 feet bgs (Evren Northwest 2004).
  - The petroleum-contaminated soil in the fuel island area was removed in October 2007 by CVI (Northwest Alloys 2011). Soils excavated from the former UST fuel island were treated using bioremediation. The treatment successfully reduced soil concentration to below MTCA Method A cleanup levels. With Ecology's approval, the treated soil was used for fill within former equipment concrete pits in the Cable Plant warehouse floor (Northwest Alloys 2011).

- **Soil Removal from the Former Cryolite Area Ditches.** During 2008, soils containing elevated PAH concentrations were removed from the three ditches located southeast of the former cryolite plant (see Plate 2-9). The cleanup included removal of 5 to 6 feet of material from the bottom and sides of the ditches. The three cryolite area ditches historically managed stormwater runoff from the area around the former Cryolite Recovery Plant. Ditch water from this area is managed as part of the on-site wastewater treatment plant. Sampling performed in 2002 indicated that the soils contained PAH concentrations in excess of industrial soil cleanup levels (MFG 2003). Other constituents were below industrial soil cleanup levels. During the cleanup in

2008, approximately 2,663 tons of material were removed and disposed in an off-site Subtitle D landfill (Northwest Alloys 2011). Confirmation sampling established that the soil in the bottom of the ditches was below Method A soil cleanup levels.

- **Cleanup at the Diesel Aboveground Storage Tank.** In 1991, Reynolds conducted an independent cleanup action to remove approximate 480 cubic yards of diesel-impacted soils adjacent to the 200,000-gallon diesel aboveground storage tank (AST). The tank is located between the alumina silos and the carbon plant (see Plates 2-8 and 2-9). Testing of groundwater indicated that the impacts were limited to soil (Reynolds 1991). The excavation removed all of the impacted soils that could be safely accessed without compromising the integrity of the tank foundation. The excavated soils were treated using on-site bioremediation. The cleanup of the diesel AST area included recording of institutional controls for the localized area of impacted soils remaining contained in place between the active tank foundation (Reynolds 1991).
- **Cleanup of Other Reported Spills to Soil.** During the history of the Former Reynolds Plant, a number of other release events were reviewed as part of the RI/FS planning (e.g., Ecology 1978, 1980, and 1988; Reynolds 1984a, 1986a, and 1986b; see Appendix A). Completed cleanup actions in response to these other spill events included the following:

  - **Drum Soil Cleanup (1984).** In July 1984, a release from a drum was noted near Shed No. 1 near the North Plant at the Reynolds site (Reynolds 1984b). The remaining liquid in the container was removed and placed into secure drums. PCBs were detected in soil samples, and associated impacted soils were removed in October 1984, and July and August 1985 (Reynolds 1984b, 1986c). The total quantity of soil removed initially included seventy-seven 55-gallon drums of soil, with follow-up excavations generating 105 cubic yards of soil. Final confirmation samples verified that trichlorobenzene and PCB concentrations were below 1 milligram per kilogram (mg/kg; i.e., below the current industrial and residential soil cleanup levels; Ecology 1986). On February 20, 1986, Ecology approved the work as complete based on review of Reynolds' summary report and laboratory results (Ecology 1986).
  - **Cleanup of Heat Transfer Media.** During CVI operations at the site, a release of HTM oil from the tank heating system was discovered within the containment

area around the pitch storage tanks (see Plate 2-8). HTM oil is similar to mineral oil. CVI removed oil-impacted soil in the HTM Oil Area. As described in Section 3.1, additional soil and groundwater sampling was conducted as part of the RI/FS to document current conditions in this area.

2.4.4 Closure and Post-Closure Monitoring of the BMP Facility

As described in Section 2.2.3, the 33-acre impoundment located in the northwestern area of the Former Reynolds Plant was formally closed in 1992. The closed black mud pond facility (Closed BMP Facility) location is shown on Plates 2-5 and 2-9. Since 1992, the Closed BMP Facility has been subject to an ongoing maintenance and monitoring program, as specified in the Ecology-approved Closure/Post Closure Plan (Reynolds and CH2M Hill 1991). The Closed BMP Facility has continued to meet the plan requirements, as described in Appendix B. A brief summary of closure and post-closure activities is described in the following (additional details are available in Appendix B):

- **Summary of Closure Activities.** The impoundment was closed in 1992 with the construction of a landfill cover consistent with the Ecology-approved Closure/Post-Closure Plan (Reynolds and CH2M Hill 1991). The closure system included an engineered cap consisting of a multi-layer, low permeability cover and drainage conveyance (Reynolds 1992).
- **Operation and Monitoring.** Since closure, quarterly groundwater and surface water monitoring has been performed at the site as part of the ongoing compliance monitoring program. Annual reports, which include the results of quarterly groundwater and surface water monitoring since 1984, are kept on file at the Former Reynolds Plant, in accordance with the Ecology-approved Closure/Post-Closure Plan (Reynolds and CH2M Hill 1991), which was prepared in accordance with WAC Chapter 173-303 requirements. The monitoring program includes nine groundwater monitoring wells ("RL-series") and two surface water sampling locations in the CDID Ditch No. 14. Groundwater monitoring data have shown decreasing trends in fluoride and alkalinity in many of the monitoring wells since completion of the closure activities (Anchor QEA 2011e).
- **2011 Cover Repair.** During 2011, cover repair and maintenance activities were performed. The repair action was performed consistent with an engineering plan

developed by Gibbs & Olson, Inc. (G&O), and approved by Ecology in July 2011 to address stormwater drainage issues with a portion of the landfill cover (Anchor QEA 2011d). Other work included the development of an updated maintenance plan to address invasive blackberries and weeds on the cover (Anchor QEA 2011d). Maintenance and inspection activities outlined in the plan include routine mowing of the cover in accordance with the schedule and recommendations outlined in the G&O engineering plan and compliance with inspection requirements established by the 1992 Operation and Maintenance Manual prepared by Reynolds (Reynolds 1992).

2.4.5 Other Site Investigations Prior to the RI/FS

In addition to the information gathered during previous cleanup actions, extensive environmental characterization data have been developed during previous investigations. The data from these investigations provided a very good understanding of the environmental conditions present at the Former Reynolds Plant prior to initiation of the current RI/FS study. This previous information was considered by Ecology in developing the scope of required investigations necessary to fill data gaps for the RI/FS, as described in Section 3. Areas of the Former Reynolds Plant that had previously been investigated included the following:

- **Fill Deposit A (Spent Lime).** The fill deposit located in the northeastern area of the Former Reynolds Plant (Fill Deposit A, see Plate 2-4) was investigated in 2000 as part of field investigations conducted by McCully Frick & Gillman, Inc. (MFG), for the *Phase II Environmental Site Assessment* (MFG 2000).
- **Fill Deposit B-1.** The fill deposits containing residual carbon and located along the eastern edge of the property (Fill Deposit B-1, see Plate 2-4) were investigated in 2002 (MFG 2003).
- **Former SPL Stockpile Area.** The former SPL stockpile area was located southeast of the Cryolite Recovery Plant (see Plate 2-4). Reynolds installed six groundwater monitoring wells ("R-series" wells) in the SPL area in October 1982 (Ecology 1985). These wells were monitored quarterly from 1983 to 2002 and have been part of an ongoing quarterly monitoring program since 2011. Soil sampling was performed in this area following removal of the SPL stockpile and associated soils (Reynolds 1988).

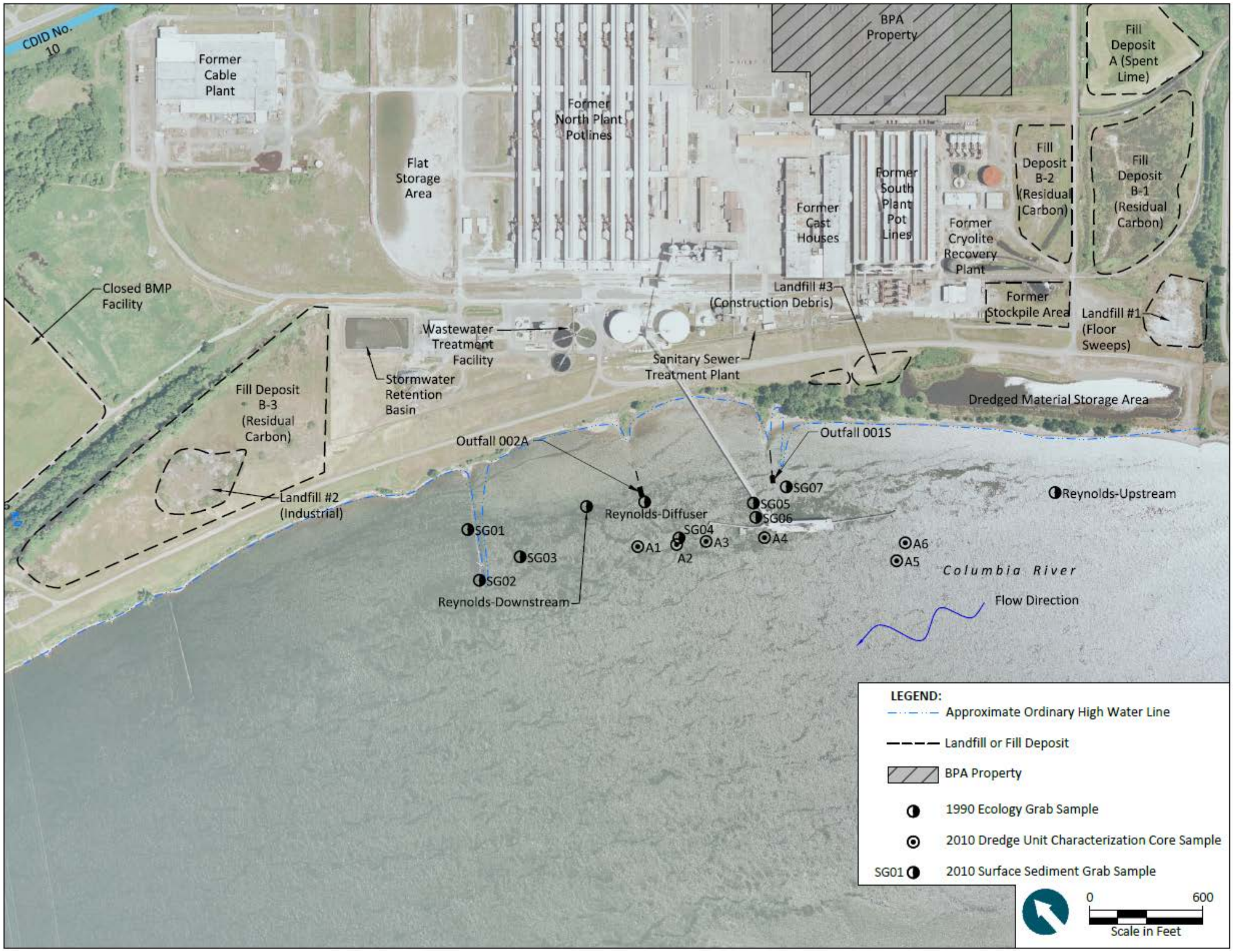
In 2002, MFG conducted soil and groundwater testing in the area of the former SPL stockpile; no SPL was observed in the area (MFG 2003).

- **Cryolite Recovery Plant and Fill Deposit B-2.** As described in Section 2.2.3, the Cryolite Recovery Plant has been removed. Environmental testing of soils and groundwater has been performed within the former plant footprint and vicinity. MFG conducted sampling of surface and subsurface soils in the Cryolite Recovery Plant area in both 2000 and 2002. Soils beneath the Cryolite Recovery Plant did not contain elevated fluoride levels. In contrast, elevated fluoride was detected in areas east of the former plant location, in the area where residual carbon was managed (Fill Deposit B-2, see Plate 2-4). Testing in this area identified preliminary material thicknesses and provided information on the concentrations of fluoride, cyanide, and PAHs in the material (MFG 2003).
- **Landfill #1 (floor sweeps).** The floor sweeps landfill is located in the southeast corner of the site (Landfill #1, see Plate 2-4). Soil and groundwater quality in this area was investigated by MFG in 2000 and 2002, providing information on the levels of fluoride, cyanide, metals, petroleum, and PAHs in these materials (MFG 2003).
- **Landfill #2 (industrial) and Fill Deposit B-3.** Environmental testing has been completed in the southwest corner of the property, near the industrial landfill (Landfill #2, see Plate 2-5) and Fill Deposit B-3 (see Plate 2-5) containing residual carbon. This work was initiated in 1985 (Sweet, Edwards, and Associates, Inc. 1986) with the installation of soil borings installed through the Industrial Landfill and the installation of soil borings and monitoring wells in adjacent areas. Additional groundwater testing was later performed in this area in July of 2000 (MFG 2000) and again in 2002 (MFG 2003).
- **Sediment Investigations.** Investigations of Columbia River sediments adjacent to the Former Reynolds Plant were conducted in 1990 and 2010. The locations of these previous sediment sampling locations are shown on Plate 2-10. Neither study identified the presence of sediment contamination.

  - **1990 Sediment Sampling by Ecology.** In February 1990, Ecology conducted sediment sampling offshore of the site as part of a Class II NPDES Inspection at the Reynolds site (Ecology 1991). Sediment sample locations included three stations adjacent to Outfall 002A; the three sediment samples were identified as Upstream, Diffuser, and Downstream (see Plate 2-10). Chemical testing included priority pollutants (fluoride, cyanide, volatile organic compounds [VOCs], PAHs, pesticides, and PCB Aroclors; Ecology 1991). No sediment impacts were detected near the Outfall 002A discharge. PCBs and pesticides were not detected in any of the test samples. Bioassays using *Hyallela azteca* and Microtox found no indication of toxicity in the sediment samples (Ecology 1991).

- **2010 Sediment Sampling.** In 2010, Ecology issued AO No. 7392, requiring CVI to investigate surface and subsurface sediments in the vicinity of the existing dock and berthing areas. The order was issued in response to a release of petroleum coke at the site in February 2010 (Anchor QEA 2010a). The results of this study are presented in the *DMMP Suitability Determination* (DMMP 2010). Testing included seven surface sediment grab samples at a depth interval of 0 to 10 cm below the mudline at the locations shown on Plate 2-10. Testing also included analysis of subsurface sediment samples that were collected within the shoaled berth area. Subsurface sediment samples (locations are shown on Plate 2-10) were analyzed for conventional parameters, metals, PAHs, semivolatile organic compounds (SVOCs), PCBs, and pesticides (DMMP 2010; Anchor QEA 2010b). None of the surface or subsurface test results exceeded screening levels approved by the Dredged Material Management Program (DMMP 2010). Following review of the sampling report, the DMMP issued a suitability determination approving the sediments in the berth area for management by open-water disposal. Dredging of this area has since been completed. The DMMP also approved the use of a "moderate" sampling density for any future dredge material characterization work at the site.

The data available for the Former Reynolds Plant prior to the initiation of the current RI/FS study is extensive. These data include information on soil, groundwater, and sediment quality with testing throughout most of the facility. This information was considered by Ecology in developing the scope of required investigations necessary to fill data gaps for the RI/FS, as described in Section 3.



Multiple rounds of sediment testing have been performed previously adjacent to the Former Reynolds Plant. These have included testing by the Washington Department of Ecology in 1990, as well as both surface (grab sample) testing and subsurface (core sample) testing performed in 2010. No areas of sediment contamination were identified during these investigations.

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Plate 2-10

Columbia River Sediments near the Former Reynolds Plant Have Been Tested Previously
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

2.5 Summary of Conditions Prior to the RI/FS

As described in Section 2.1 and 2.2, the history of the Former Reynolds Plant is well documented. Multiple cleanup actions and environmental investigations have already been completed (see Sections 2.3 and 2.4, respectively). This RI/FS builds on the existing information available for the Former Reynolds Plant. The available information was considered by Ecology during its initial site assessment of the Former Reynolds Plant, when Ecology ranked the Former Reynolds Plant as a "5," the lowest priority on Ecology's 5-point scale.

The understanding of the current environmental setting and conditions for the RI/FS includes the following:

- The Former Reynolds Plant is zoned for industrial uses and is located within an industrial area. Therefore, the RI/FS considers potential exposure risks and cleanup requirements within the context of ongoing industrial uses.
- The facility has been historically used for aluminum manufacturing operations. The former processes conducted at the facility are limited and are well understood due to the presence of documentation of facility operations.
- Prior to completion of the current RI/FS, extensive work has been conducted to decommission inactive manufacturing facilities, remove industrial materials and wastes from the property, and conduct closures and cleanup actions within portions of the facility.
- The chemicals associated with historic aluminum manufacturing operations are well understood and have been evaluated during previous investigation and cleanup activities. Environmental considerations are principally associated with the former landfills and fill deposits present at the site. These localized areas contain primarily PAHs and fluoride from aluminum manufacturing processes.
- Activities conducted by CVI following termination of aluminum manufacturing operations have been reviewed by Ecology. Additional testing has been incorporated into the RI/FS work to determine whether any of these activities resulted in contamination requiring cleanup under MTCA.
- The RI/FS testing program builds on all existing information to complete the investigation of environmental conditions within the RI/FS Study Area and to provide

the basis for evaluating final cleanup requirements for the Former Reynolds Plant under MTCA regulations.

Section 3 describes the Ecology-identified data gaps and the additional investigation work completed during the current RI/FS. Sections 4, 5, and 6 describe the updated understanding of site conditions, including the findings of the RI investigations.

3 REMEDIAL INVESTIGATION METHODS

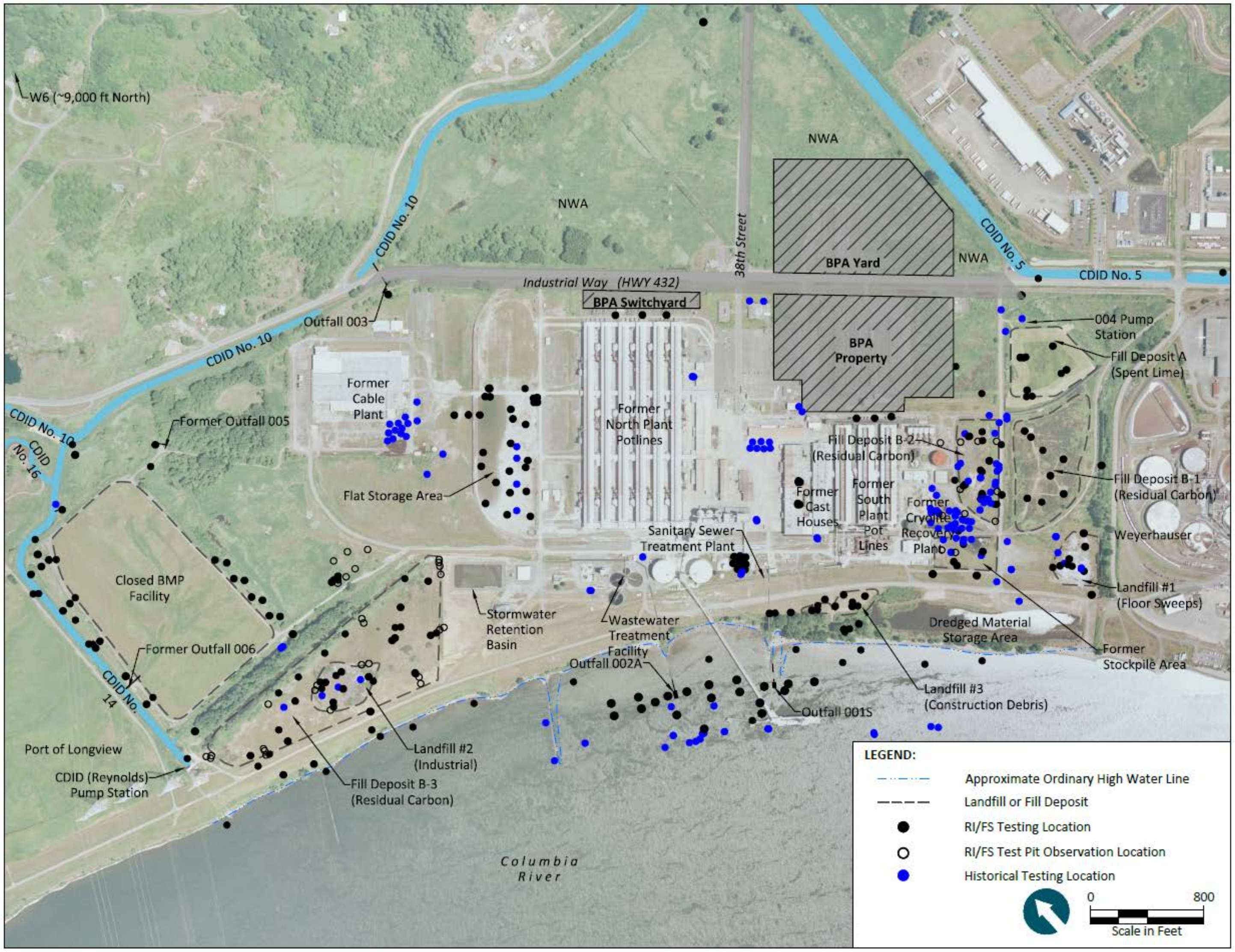
Prior to developing the current RI/FS, extensive environmental testing information was available for the Former Reynolds Plant from previous investigation, cleanup, and closure activities, as described in Section 2. Ecology reviewed this information and defined focus areas for further evaluation during the RI/FS. These RI/FS focus areas are shown on Plate 2-9.

Ecology then defined specific data gaps and testing requirements for the RI/FS. These requirements were documented in a series of work plans and addenda, as described subsequently. Plate 3-1 shows the locations of the resulting testing that was implemented as part of the current RI/FS. The balance of this section provides a detailed description of the intent of the additional investigations and the methods used for their implementation. The investigations included testing within the Former Reynolds Plant, as well as within adjacent portions of the RI/FS Study Area.

3.1 Work Plan Development

The RI/FS work included multiple phases of investigation activity. The scope of these investigations was developed by Ecology and was documented in the following series of work plans and addenda:

- Prior to developing the RI Work Plan (Anchor 2007a), a summary of previous investigations was compiled as the *ALCOA Longview Facility Data Report* (Anchor 2006). The report included tabular and graphical summaries of existing analytical data, geologic and hydrogeologic information, and available site geochemical data.
- An RI Work Plan (Anchor 2007a) was subsequently reviewed and approved by Ecology. The work plan included soil, groundwater, and surface water investigations to document environmental conditions at the site. The investigation included testing for chemicals of concern (COCs) known to be present at the site from historical operations and as verified by previous testing. These COCs included fluoride, cyanide, PAH compounds, and petroleum (certain site areas). The RI work included testing for other parameters, (PCBs, solvents, pesticides, and heavy metals). It also included testing for site geochemical parameters that are useful in assessing contaminant fate and transport.



Extensive testing was performed during the current remedial investigation and feasibility study (RI/FS). The black symbols above show the locations of environmental testing performed during the RI/FS. The different types of testing included in that work are shown on Plates 3-2 through 3-6. The locations of environmental testing performed prior to development of the RI/FS are shown in blue.

Plate 3-1
Overview of Remedial Investigation Testing Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

- After completion of initial RI activities, an RI Work Plan Addendum (Anchor QEA 2011a) was prepared in 2011 and approved by Ecology. The document defined additional investigations to be performed under Ecology direction. A follow-up memorandum specified the locations of two monitoring wells and a geochemical testing program to be performed (Anchor QEA 2011b).
- A second Work Plan Addendum was also approved by Ecology to address installation and sampling of a new monitoring well near Landfill #3 (Anchor QEA 2011c).
- A *Draft Remedial Investigation and Feasibility Study Report* (Draft RI/FS; Anchor QEA 2012b) was completed in March of 2012 and provided to Ecology on March 31, 2012, for review. In a letter dated June 28, 2012, Ecology identified several data gaps and requested that supplemental investigations be performed prior to finalizing the RI/FS. Work Plan Addendum No. 3 (Anchor QEA 2012a) outlines the procedures used for the data gaps investigation in response to Ecology's comment letter. Work Plan Addendum No. 3 was provided to Ecology on November 30, 2012, and following Ecology approval, the data gap investigations were conducted in the fall of 2012 and early 2013.

The subsequent sections describe the field investigations and testing performed as part of the RI/FS conducted under the previously described Work Plans. The investigation work is summarized in the following subsections:

- **Section 3.2 – Focus Areas Identified for Supplemental Sampling**, including the main areas identified by Ecology for further investigation as part of the RI/FS
- **Section 3.3 – Hydrogeologic Field Investigation**, including use of existing and newly installed monitoring wells and piezometers, measurement of groundwater gradients and hydraulic conductivities, and completion of a groundwater tidal study
- **Section 3.4 – Aerial Photograph Review** to provide information to Ecology for use in identifying locations for environmental testing
- **Section 3.5 – Chemical Testing**, including analysis of site landfill and fill deposit materials, soil, lysimeter soil and porewater, groundwater, ditch and surface water, and sediment

3.2 Focus Areas Identified for Supplemental Sampling

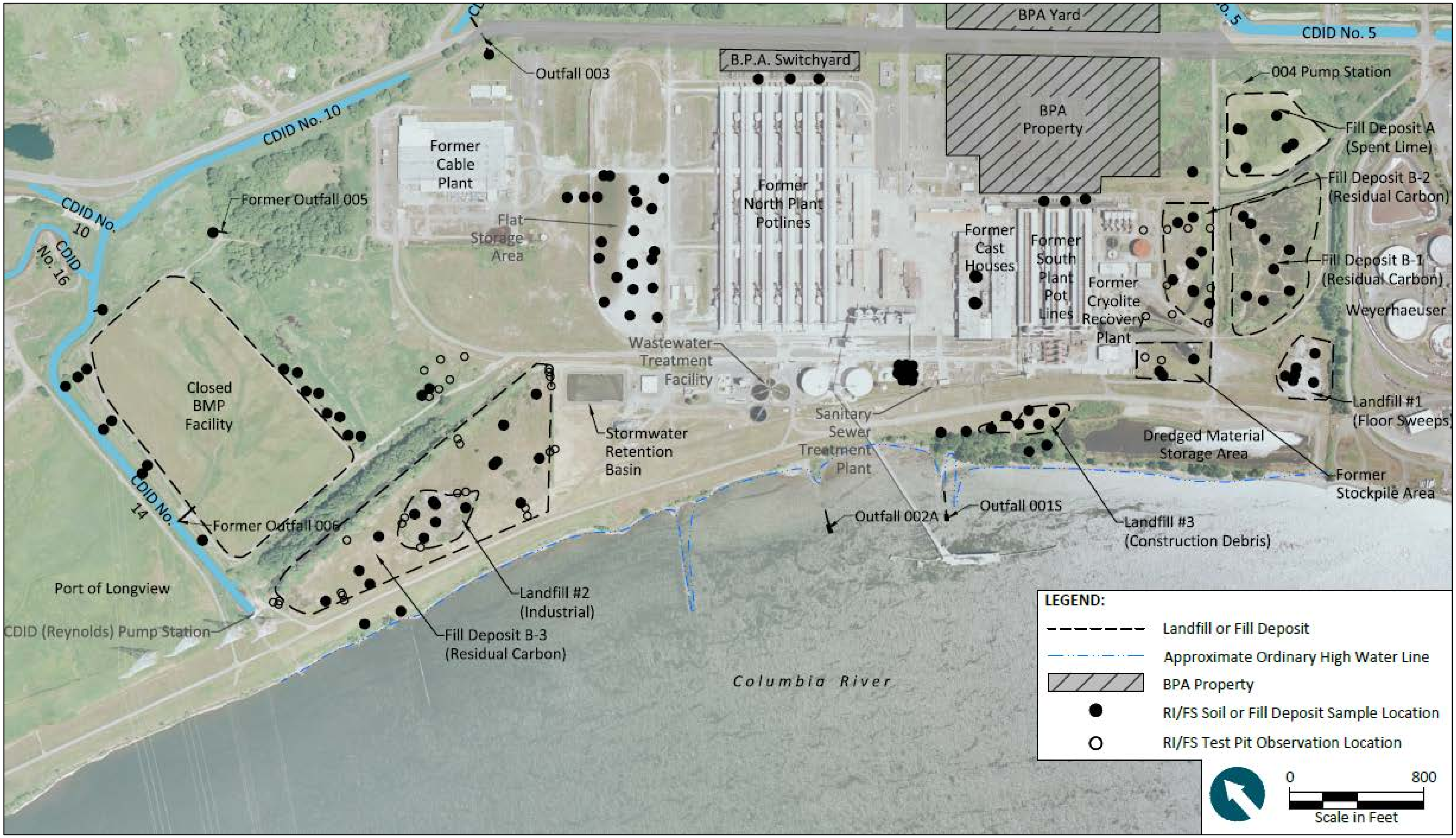
Several focus areas (see Plate 2-9) were identified by Ecology for further investigation as part of the RI/FS. These areas were discussed in detail in the RI Work Plan Addenda (Anchor QEA 2011a, 2011b, 2012a). To fill data gaps identified by Ecology, supplemental sampling was required to update surface water and groundwater data for the RI/FS Study Area. Soil and sediment testing data were also required from each of the specific areas described in the following subsections.

3.2.1 Field Southwest of the Cable Plant

Ecology requested that sampling be performed in a portion of the field located southwest of the Cable Plant (see Plate 2-9) based on concerns that a small quantity of fill materials potentially containing elevated fluoride or cyanide may have been re-graded in that area during CVI's operations (Anchor QEA 2011a). Geotechnical investigations have been performed in this area and did not indicate the presence of waste fill material. In order to further investigate potential impacts to soils in the field located southwest of the Cable Plant, test pits were excavated as part of RI activities (Anchor QEA 2011a). Test pit locations are shown on Plate 3-2 and Figure 3-1.

3.2.2 Former Thin Stillage Application Areas

One of the products handled by CVI was thin stillage. Thin stillage can contain elevated levels of nutrients, including nitrogen, nitrate, nitrite, phosphate, and potassium. Some thin stillage was land-applied by CVI in the area located east of the Closed BMP Facility. Ecology requested that surficial soil sampling be conducted in the former thin stillage application areas (see Plate 2-9) to determine if any accumulations of thin stillage remain in surficial soils at a level that could potentially impact site conditions (Anchor QEA 2011a). Sampling locations are shown on Plate 3-2 and Figure 3-1.



Soil, landfill, and fill deposit testing performed during the remedial investigation and feasibility study (RI/FS) was extensive. The testing included soil borings and test pits to collect soils for laboratory analysis, and additional observation test pits to assess the presence or to verify the extent of fill deposits. The testing program was developed to address specific data gaps identified by Washington Department of Ecology.

Plate 3-2

Remedial Investigation Soil, Landfill, and Fill Deposit Testing Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

Additional soil sampling was conducted in this area to verify that no wastes or impacted soils are present in this area. Test pit locations are shown on Plate 3-2 and Figure 3-1.

3.2.3 Flat Storage Area

CVI developed a flat storage area for handling petroleum coke and coal in the central portion of the site (see Plates 2-7 and 2-9). Ecology requested that soil sampling be conducted throughout the flat storage area to determine if contaminants associated with the petroleum coke product stored in the area may have leached into surrounding soils (Anchor QEA 2011a). Historical laboratory analyses of the petroleum coke stored at the site detected elevated concentrations of PAHs (Ecology 2009). Soil and groundwater sampling in the vicinity of the flat storage area were included as part of RI activities in 2011, 2012, and 2013. Sampling in 2011 was conducted before the cement storage pad was removed from the area. Supplemental sampling in 2012 and early 2013 were performed following pad removal. Final soil sampling locations are shown on Plate 3-2 and Figure 3-1.

3.2.4 Casting Pit Fill Soils

CVI decommissioned and filled two casting pits located within one of the two cast houses (see Plates 2-2 and 2-9) and finished the fill by capping the pits with concrete (Anchor QEA 2011a). The casting pits are concrete-lined structures approximately 20 to 30 feet bgs that were formerly used in the direct chill casting of molten aluminum (Anchor QEA 2011a). Ecology requested that soil sampling be performed within the two filled casting pits to ensure no materials exceeding proposed site cleanup levels were disposed of in the pits during fill activity. As requested by Ecology, soil samples were collected from the casting pits as part of RI activities in 2011 (Anchor QEA 2011a). Soil sampling locations are shown on Plate 3-2 and Figure 3-1.

3.2.5 Heat Transfer Media Release Area

During CVI operations at the site, a release of HTM from the tank heating system was discovered within the containment area between the two easternmost pitch storage tanks (HTM Oil Area, see Plate 2-8 and 2-9). HTM is a hydrocarbon product similar to mineral oil. Partial removal of contaminated soil was performed by CVI in the vicinity of the HTM Oil Area.

Additional soil and groundwater sampling were conducted during 2011 and 2012 RI activities to document current conditions in this area. Final soil sampling locations are shown on Plate 3-2 and Figure 3-1.

3.2.6 Landfill #3 (Construction Debris)

A former landfill containing construction debris was identified in the southeastern portion of the site (see Plates 2-6 and 2-9). The debris fill in this area was identified by CVI during on-site soil excavation and grading activities (Anchor QEA 2011a). During 2011 and 2012 RI activities, soil test pits were excavated, and a new groundwater monitoring well was installed and sampled in the construction debris landfill (Landfill #3) to further delineate the vertical and horizontal extent and composition of the fill material. Test pit locations are shown on Plate 3-2 and Figure 3-1.

3.2.7 Drainage Pathway Soils Adjacent to Outfalls 003 and 005

Ecology requested sampling of drainage pathway soils in the on-site drainages located between Outfalls 003 and 005 and the adjacent CDID ditches. To comply with Ecology requests, RI sampling was performed in order to further characterize the historical stormwater discharge pathway and to address potential transport pathways leading to the CDID ditch system. Ditch soil sampling locations are shown on Plate 3-2 and Figure 3-1.

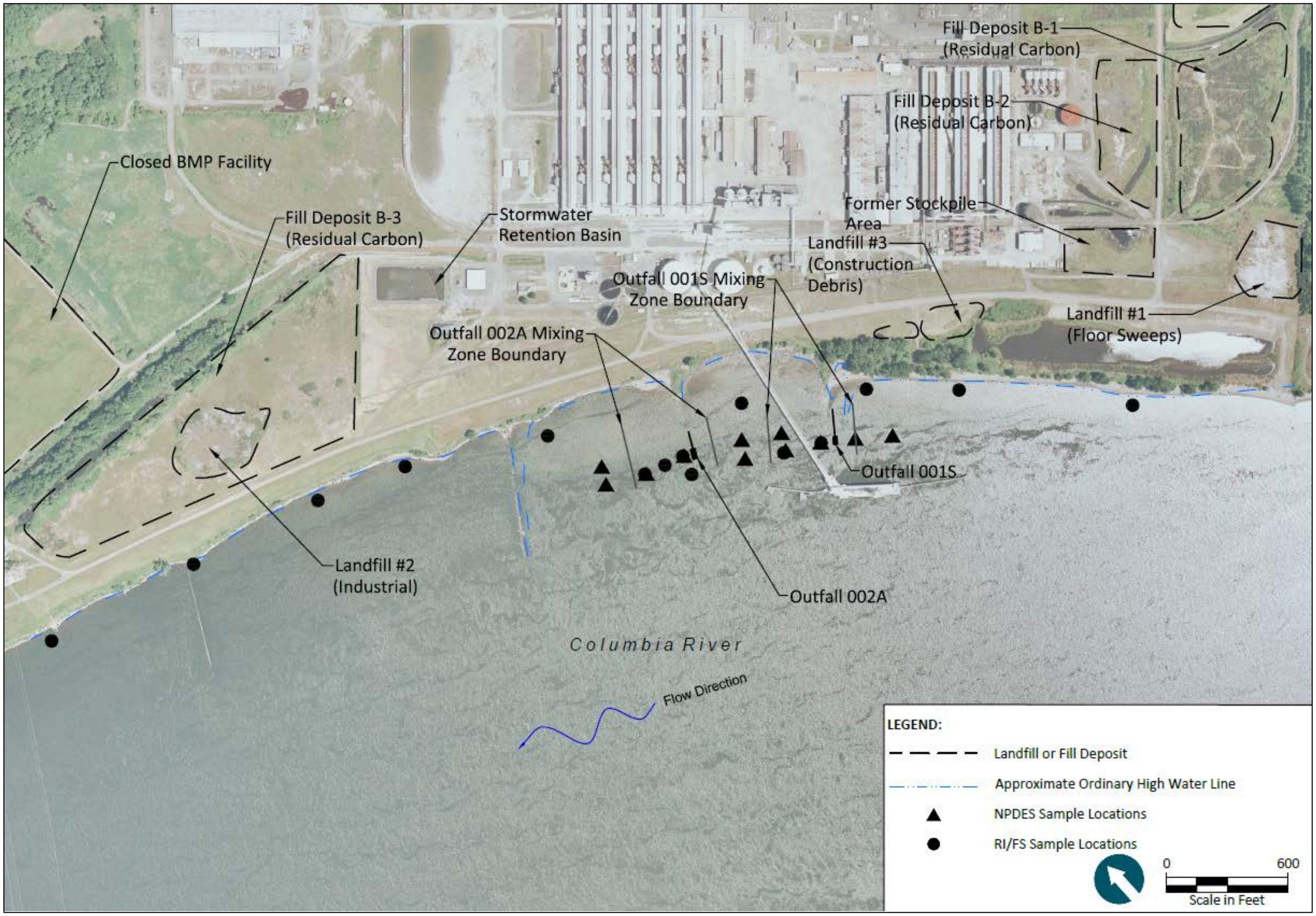
3.2.8 Characterization of Landfill Contents and Fill Deposits

Ecology requested collection of test samples from within the three on-site landfills and within the four fill deposits containing spent lime (Fill Deposit A; see Plate 2-4) and residual carbon (Fill Deposits B-1 and B-2 on Plate 2-4; and Fill Deposit B-3 on Plate 2-5). The intent of this sampling was to verify the types and concentrations of materials contained within these areas. Test pits were excavated, and both discrete and composite samples were collected of mud and fill materials and submitted for chemical testing. Test pit locations are shown on Plate 3-2 and on Figure 3-1. Testing was also performed using fish bioassays to compare against Ecology's characterization requirements under WAC Chapter 173-303 regulations.

3.2.9 Sampling of Columbia River Sediments

Ecology requested the completion of additional sediment quality testing at specific locations to supplement previous studies conducted in 1990 and 2010 (see Plate 2-10). These RI/FS sampling locations were approved by Ecology in Work Plan Addendum No. 3, and the sampling was conducted during December of 2012. In addition, sediment testing was performed by MBTL during December of 2012 to support the renewal of the facility's NPDES permit (NPDES permit number WA-000008-6) and to satisfy Sediment Management Standard (SMS) requirements for baseline characterization of active outfall discharge areas. RI/FS and NPDES sediment testing locations are shown on Plate 3-3 and Figure 3-2. The results of both the RI/FS and NPDES sediment investigations are described in this RI/FS in Section 5 of this document, and the collection and testing approach is summarized as follows:

- RI/FS sediment testing included collection of surface sediment samples from eight nearshore locations, two locations near Outfall 001S, two locations near Outfall 002A and one location near the CDID outfall from Ditch No. 14. Sediments (0 to 10 cm) at each of these locations were analyzed for SMS parameters and PCB congeners.
- The NPDES testing included collection and analysis of surface sediment samples from 13 offshore stations within the mixing zones of Outfalls 001S and 002A. Each of these samples was analyzed for chemical parameters at two depth intervals (0 to 2 cm and 0 to 10 cm). Samples were analyzed for PAHs, PCB Aroclors, aluminum, fluoride, cyanide, and conventional parameters. Additional sampling methodology and rationale is outlined in the *NPDES Sediment Sampling and Analysis Plan* (Anchor QEA 2012c). Chemical testing was also conducted for the 0 to 10 cm interval at two contingent sample locations in the vicinity Outfall 002A. Confirmational bioassay testing was performed on three sediment samples collected near Outfall 002A consistent with the *NPDES Sediment Sampling and Analysis Plan* (Anchor QEA 2012c).



The Remedial Investigation and Feasibility Study (RI/FS) included extensive testing of sediment quality within the Columbia River near the Reynolds Facility. Testing locations sampled during the RI/FS are shown above. Refer to Plate 2-9 for the locations of sediment sampling locations tested prior to the RI/FS.

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Plate 3-3

RI/FS Sediment Sampling Locations

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

3.3 Hydrogeologic Field Investigation

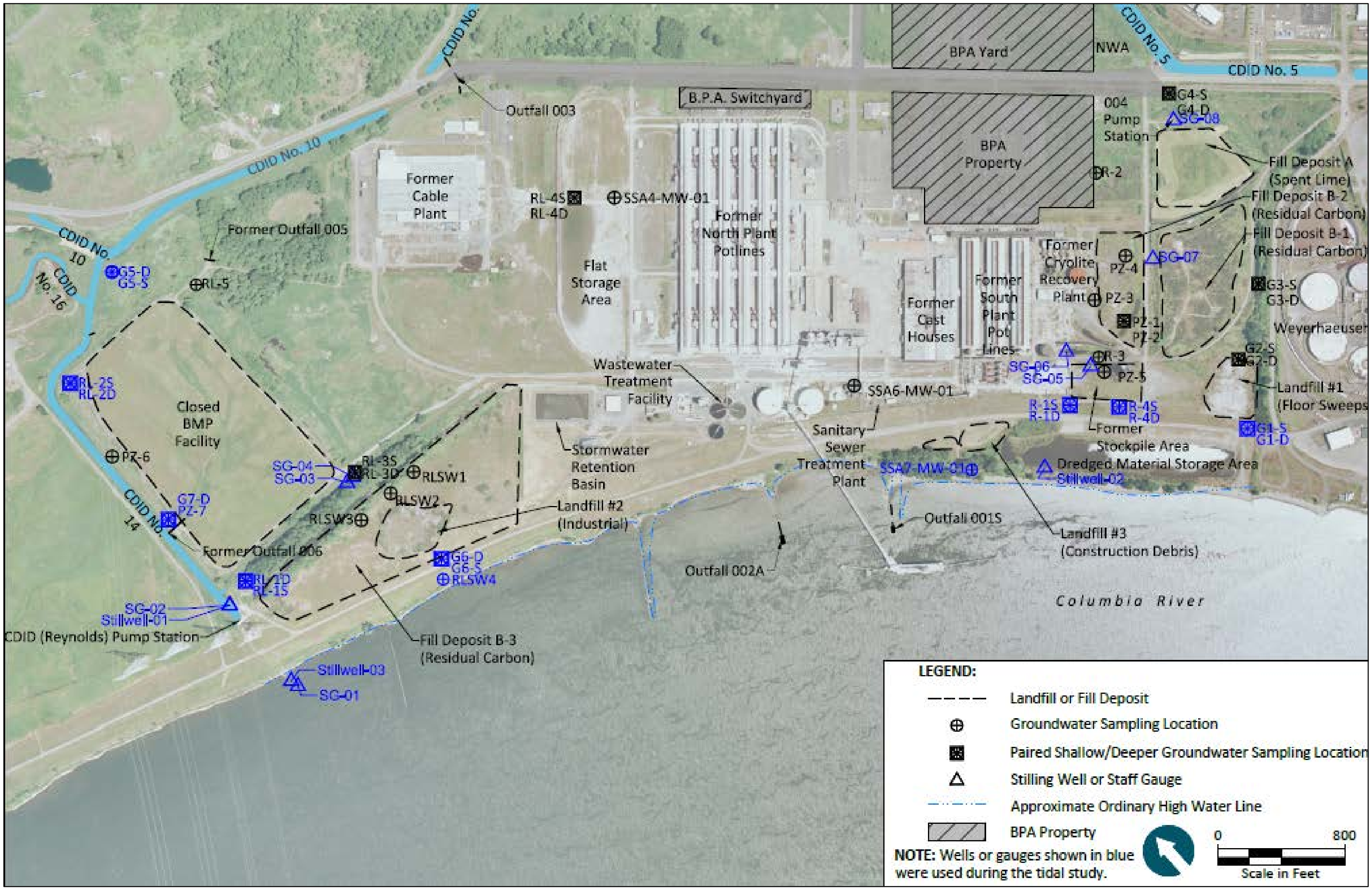
Hydrogeologic field investigations were conducted to supplement available data and to better characterize the presence and movement of groundwater at the Former Reynolds Plant. The field activities included monitoring well installation, monitoring well development, measurement of groundwater, surface water and ditch water elevations, completion of a tidal study, and slug testing (a technique used to assess the hydraulic conductivity of the aquifer matrix). Unless noted, all hydrogeologic field investigation activities were completed in accordance with the RI Work Plan (Anchor 2007a) and RI Work Plan Addenda (Anchor QEA 2011a, 2011b, 2012a).

These supplemental hydrogeologic investigations build on the previous investigation activities completed by Sweet, Edwards, and Associates, Inc., Reynolds, CH2M Hill, Inc. (CH2M Hill), and MFG. Copies of previous investigation reports prepared by these companies were submitted to Ecology in August 2006 and were summarized as part of the Alcoa Longview Facility Data Report (Anchor 2006). The supplemental studies also build on regional hydrogeologic data developed by the City of Longview for use in water supply planning (Kennedy/Jenks 2010).

3.3.1 Monitoring Well Installation

To supplement existing monitoring wells installed at the site, an additional 13 groundwater monitoring wells were installed in September 2006. Four shallow and deep pairs of wells were installed in the East Groundwater Area (G1-S/G1-D, G2-S/G2-D, G3-S/G3-D, and G4-S/G4-D), and two pairs of monitoring wells were installed in the West Groundwater Area (G5-S/G5-D and G6-S/G6-D). In addition, a single deeper monitoring well (G7-D) was installed in the West Groundwater Area adjacent to an existing shallow piezometer (PZ-7). These well locations are illustrated on Plate 3-4 and on Figure 3-3.

Three shallow groundwater monitoring wells were installed during January and February 2012 to evaluate groundwater quality in areas where soil and/or fill impacts were identified. These wells were installed in the flat storage area (SSA4-MW-01), the HTM Oil Area (SSA6-MW-01), and adjacent to Landfill #3 (SSA7-MW-01) and are shown on Figure 3-3.



During the remedial investigation and feasibility study (RI/FS), groundwater testing was performed throughout the Reynolds Facility. Groundwater monitoring parameters varied by location as directed by the Washington Department of Ecology. The groundwater testing also included evaluation of groundwater tidal influences during a tidal study conducted in the fall of 2012 (that study included the locations highlighted in blue above).

Plate 3-4

RI/FS Groundwater Monitoring and Tidal Study Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

All of the monitoring wells were installed by Cascade Drilling, Inc., of Portland, Oregon, using a hollow stem auger drilling rig. Materials encountered during drilling were logged under the direction of an Anchor QEA geologist, and Anchor QEA personnel supervised the construction of the monitoring wells. Appendix D includes copies of the boring logs, well construction details for all site monitoring wells, and a summary of well construction data.

All newly installed monitoring wells were surveyed after installation relative to the North American Vertical Datum of 1988 (NAVD88) and Washington State Plane South North American Datum of 1983 (NAD83) horizontal datum. All existing monitoring wells were re-surveyed in 2006 relative to each datum.

3.3.2 Monitoring Well Development

After construction of the monitoring wells and prior to collection of groundwater elevation data and groundwater samples, new monitoring wells were developed to optimize hydraulic communication between the screened intervals and the surrounding formations. Well development was completed with the use of a surge block and pump. During development, field parameters were monitored to evaluate the adequacy of development. Well development logs for new (2006 through 2012) and existing wells requiring redevelopment prior to groundwater sampling and slug testing are included in Appendix D-1.

3.3.3 Measurement of Groundwater and Surface Water Elevations

Depths to water were measured at all site monitoring wells and piezometers in 2006 (September and October), 2011 (July and October), and 2012 (October and December; see Appendix D-1) using an electric water level sounder. Groundwater elevations at monitoring wells were calculated by subtracting the measured depth to water from surveyed measuring point elevations relative to NAVD88.

In 2006, surface water and ditch water elevations were monitored by electronic pressure transducers deployed at the following locations: the CDID ditch next to the Reynolds pump station, the CDID ditch approximately 200 feet downstream of the Industrial Way pump station, and the Columbia River at the site's dock facility. A review of the 2006 surface water elevation data collected from the transducer deployed in the Columbia River indicated the magnitude of the tidal fluctuations was much lower than anticipated. Discussions with field personnel indicate they were unable to safely secure the transducer to a dock piling, the result being the transducer moved upstream and downstream with tidal fluctuations. Accordingly, Columbia River surface water elevation data collected from the site dock were substituted with surface water elevation data collected by NOAA at the Longview Bridge. All surface water elevation data are presented relative to NAVD88.

3.3.4 Slug Testing

In order to characterize the hydraulic conductivity of the soils encountered at the site, slug tests were completed at ten site monitoring wells on October 23 through 25, 2006. The following monitoring wells were tested: G1D, G2D, G3D, G4D, G5D, G6D, G7D, R1D, RL-3D, and RL-4D. Slug testing was performed consistent with U.S. Environmental Protection Agency (EPA) Slug Test Standard Operating Procedure 2046, Revision 0.0, dated December 3, 1994, and the RI Work Plan (Anchor 2007a).

It should be noted that prior to performing the slug tests, monitoring wells were developed or redeveloped in order to maximize the hydraulic communication between the well and the surrounding formation. Slug tests were conducted at each well location by adding and removing a “slug” of known volume from each well and measuring the response of the water table as it returned to pre-test static conditions. Introduction and removal of the slug resulted in an approximate water level change of 3 feet at most of the wells. Both a falling head (inserting a slug) and a rising head (removing a slug) test were performed on ten monitoring wells. A rising head test was not performed at monitoring wells G4D, G7D, and RL-3D due to the relatively long recovery time noted in the falling head test. A detailed memorandum describing the data collection methods, evaluation methods, and field data sheets is presented in Appendix D-2.

3.3.5 2012 Tidal Study

A tidal study was implemented in late September 2012 to evaluate the tidal influence, if any, on the groundwater flow directions at high and low tide. In addition, data from the tidal study were used to evaluate the mean groundwater gradient in the shallow aquifer and used in the groundwater flow model discussed in Section 6.5.

Non-vented pressure transducers were deployed in a series of wells across the site, as shown on Plate 3-4 and Figure 3-3. Prior to the start of the tidal study, each transducer was suspended approximately 1 foot from the bottom of each well using Kevlar cord, the length of the cord was recorded in the field notes, and the well casing was left open to the atmosphere. A manual water level was recorded at the time of deployment, as well as at the time of transducer retrieval, to allow for quality control of the electronic data being collected. Pressure readings were automatically recorded every 15 minutes during the 96-hour tidal study and were saved onboard the transducers until final download at the conclusion of the study. A barometric pressure transducer was placed near the Cryolite Recovery Plant building to collect atmospheric pressure data representative of the site (see Figure 3-3). The barometric pressure data were used to correct transducer data collected from wells that were part of the tidal study network.

Findings of the tidal study are discussed in more detail in Section 4 and Section 6.

3.4 Aerial Photograph Review

An aerial photograph collection of the entire Northwest Alloys-owned property, including the site and portions located north of Industrial Way, was assembled and reviewed in accordance with the requirements of the AO and as described in the RI Work Plan (Anchor 2007a). The review was conducted to assist Ecology in identifying areas of site disturbance or use that could have been associated with the management or release of wastes or contaminated materials.

Available aerial photographs were compiled and reviewed. These photographs are included in Appendix D-3. Part of the property that was reviewed in the photographs includes land owned by Northwest Alloys immediately north of Industrial Way. This portion of the property is primarily vacant land, with the exception of the building previously occupied by the Reynolds Credit Union, an old softball field, and BPA power transmission towers and lines.

No industrial activities were visible in the aerial photographs. Earth moving activity occurred on the property during the construction of the North Plant potlines and during the construction of the softball fields. Borrow piles were created and actively used during these times. One area of interest was noted in the northeast corner of the property in the June 29, 1974 and September 29, 1980 photographs, whereby Ecology required collection of soil samples from the surface and at depth. The comments on the reviewed aerial photographs are included in Appendix D-3. The results of the soil sampling are presented in Section 5.

3.5 Chemical Testing

RI chemical testing activities were conducted at the site between 2006 and 2013. Unless noted, all field sampling activities were performed in accordance with the Ecology-approved RI Work Plan (Anchor 2007a) and RI Work Plan Addenda (Anchor QEA 2011a, 2011b, 2011c, 2012a). Initial testing was performed between 2006 and 2007, consistent with the RI Work Plan (Anchor 2007a). Supplemental testing was performed during 2011, 2012, and 2013 consistent with the Work Plan Addenda (Anchor QEA 2011a, 2011b, 2011c, 2012a). The 2011 to 2013 supplemental investigation activities included collection and testing of landfill and fill deposit materials, lysimeter soil and porewater, soil, groundwater, ditch and surface water, sediment, and geochemical testing of site soils to support contaminant fate and transport evaluations.

In 2006 and 2007, analytes for groundwater and surface water monitoring locations included broad testing for fluoride and cyanide. Monitoring wells in selected locations were also sampled for PAHs, which are known to be present at the site but are infrequently detected in groundwater. Selected wells were also tested for other priority pollutants. Soils were sampled for both site COCs and additional priority pollutants where historical aerial photographs showed a potential land disturbance in the field north of Industrial Way (North Field area), in the former north and south rectifier yards, and at Landfill #1 (floor sweeps, see Plate 2-4) and at Landfill #2 (industrial, see Plate 2-5). In addition, a total of three shallow lysimeters were installed at Landfill #1 (floor sweeps) and former SPL stockpile area (see Plate 2-9) and were sampled for fluoride and cyanide.

In 2011, 2012, and early 2013, additional sampling was completed at Ecology's request to address remaining data gaps. Supplemental investigations were described in the Work Plan Addenda (Anchor QEA 2011a, 2011b, 2011c) and included comprehensive groundwater, surface water, and ditch water monitoring; installation of three new groundwater monitoring wells; soil sampling throughout the Former Reynolds Plant; a diver survey of the dock area; and an evaluation of material partitioning and geochemistry in support of updated fate and transport modeling.

The information from these supplemental investigation activities was included in the Draft RI/FS provided to Ecology on March 30, 2012. Ecology issued comments on the Draft RI/FS on June 28, 2012, documenting data gaps that required additional field sampling and analytical testing prior to the completion of the RI/FS. The requested field sampling approach was described in Work Plan Addendum No. 3 (Anchor QEA 2012a) and included sediment testing in the Columbia River, sampling of outfall drainage pathway soils, additional site groundwater monitoring, characterization of the materials in the three landfills and four fill deposits, additional surface and ditch water sampling, and follow up soil sampling in the flat storage area.

The following sections summarize the RI data collection activities. Unless noted, sampling was performed consistent with the Ecology-approved *Sampling and Analysis Plan* (SAP; Anchor 2007a [see Appendix A]) and SAP Addendum (Anchor QEA 2011a [see Attachment B]). A summary of RI sampling is included in Appendix D-4.

3.5.1 Landfill and Fill Deposit Sampling

Testing of landfill and fill deposit materials was performed during 2011 and in 2012. In each case, test pits were extended from the ground surface to the base of each landfill or fill deposit, or to the maximum depth that could be safely excavated. Testing locations are shown on Plate 3-2 and on Figure 3-1.

Testing of Landfill #3 (construction debris) was performed in 2011. That investigation included extensive testing of discrete soil samples. The remaining deposits were tested in 2012.

For the 2012 testing, samples representing a single vertical composite across each landfill or fill deposit were collected at all test pit locations. Composite samples consisted of equal portions of discrete samples collected at 2-foot intervals, which began at a depth of 2 feet below the surface of the deposit of interest. Field screening with a photoionization detector

(PID) was used to determine if TPH, extractable petroleum hydrocarbons (EPH), and VOC analysis were appropriate. Surficial cover soils (above landfill and fill deposits) were not included in the composite sample used for characterization. Once sampling was complete, each test pit was backfilled and the surficial cover over the landfill or fill deposit was compacted using the backhoe.

Samples were collected from the following deposits (refer to Plate 3-2 and Figure 3-1 for sampling locations):

- **Landfill #1 (floor sweeps).** Three test pits were excavated, and composite samples were analyzed for fluoride, cyanide (weak acid dissociable [WAD] and total), metals (total and toxicity characteristic leaching procedure [TCLP]), SVOCs, and PCBs.
- **Landfill #2 (industrial)**. Five test pits were excavated, and composite samples were analyzed for fluoride, cyanide (WAD and total), metals (total and TCLP), SVOCs, and PCBs.
- **Landfill #3 (construction debris)**. Investigated during 2011 RI activities, ten test pits were excavated, and discrete samples were analyzed for fluoride, cyanide, sulfate, PAHs, PCBs, and TPH. Discrete sampling targeted observed fill material, with additional soil samples analyzed for intervals above and below apparent fill material.
- **Fill Deposit A (Spent Lime).** Four test pits were excavated, and composite samples were analyzed for total metals, fluoride, cyanide (WAD and total), and PAHs. One composite sample was also analyzed for TCLP metals, SVOCs, and PCBs.
- **Fill Deposit B-1 (Residual Carbon, East Plant Area)**. Five test pits were excavated, and composite samples were analyzed for total metals, fluoride, cyanide (WAD and total), and PAHs. One composite sample was also analyzed for TCLP metals, SVOCs, and PCBs.
- **Fill Deposit B-2 (Residual Carbon, East Plant Area).** Four test pits were excavated, and composite samples were analyzed for total metals, fluoride, cyanide (WAD and total), and PAHs. One of the composite samples was also analyzed for TCLP metals, SVOCs, and PCBs.
- **Fill Deposit B-3 (Residual Carbon, West Plant Area).** Eight test pits were excavated, and composite samples were analyzed for total metals, fluoride, cyanide (WAD and total), and PAHs. One of the composites was also analyzed for TCLP metals, SVOCs, and PCBs.

Based on field screening of excavated material, at least one discrete sample from each landfill or fill deposit, except the area east of the former Cryolite Recovery Plant, was analyzed for VOCs.

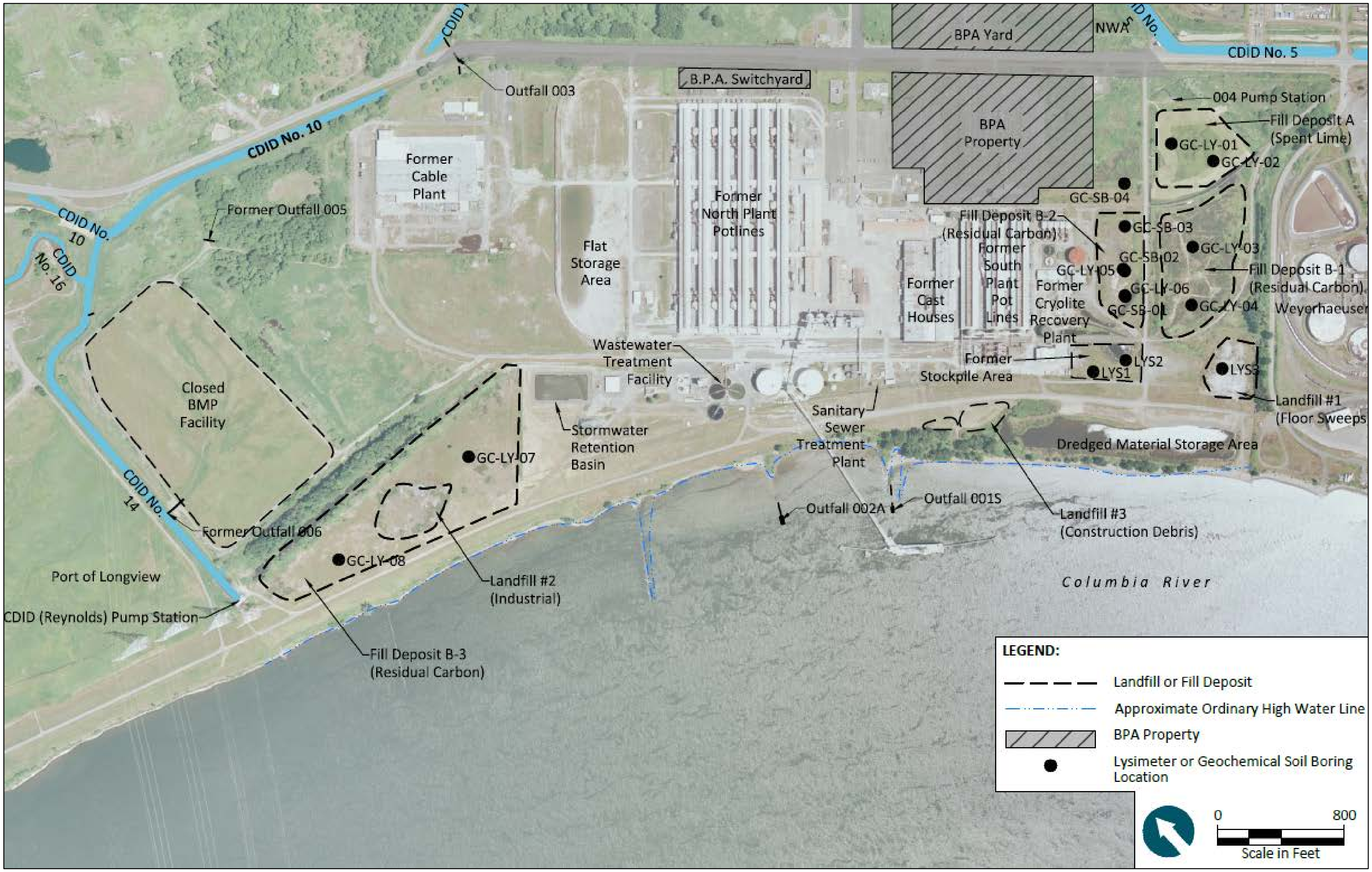
One composite sample each from Landfills #1 and #2 and one composite sample each from Fill Deposits A, B-1, B-2, and B-3 were tested for waste toxicity using a 96-hour trout bioassay test. This test is used by Ecology under WAC Chapter 173-303 to evaluate potential classifications for materials designated for off-site management (i.e., treatment or disposal). Testing was performed by CH2M Hill (Corvallis, Oregon). Soil boring and test pit logs are included in Appendix D-1.

As part of 2006 RI activities, sampling also included two samples collected from the floor sweeps landfill (sample S2) and industrial landfill (sample S3) to evaluate landfill wastes in these areas (see Figure 3-1). Both fill deposit samples were collected from the 0 to 0.5 feet depth interval and analyzed for priority pollutants including fluoride, cyanide, priority pollutant metals, PCB Aroclors, PAHs, VOCs, and pesticides.

In addition, four samples were collected during February 2007 and submitted for synthetic precipitation leaching procedure (SPLP) testing in order to estimate the potential leachability of fluoride and cyanide from soils collected in the former SPL stockpile area, Landfill #1 (floor sweeps), and from Fill Deposit B-1 containing residual carbon (SPLP 1, 2, 3, and 4; see Figure 3-1). Samples were analyzed for bulk fluoride and cyanide and for leachable fluoride and cyanide using the SPLP extraction method.

3.5.2 Lysimeter Installation and Sampling

Lysimeters were sampled in 2006 and 2012 (see Plate 3-5 and Figure 3-4) to assess fluoride partitioning to evaluate the quality of porewater in contact with fill deposit materials containing elevated fluoride. Lysimeters were installed within the RI/FS focus areas, including the fill deposits used to manage spent lime (Fill Deposit A) and residual carbon (Fill Deposits B-1, B-2, and B-3).



The Remedial Investigation and Feasibility Study (RI/FS) included specific tests to assess the geochemical processes controlling the mobility of fluoride, which is present within the landfills and fill deposits. This testing included placement of lysimeters to evaluate the characteristics of porewater in contact with the fill. Geochemical test borings were used to assess the types of geochemical processes that are occurring naturally within the soils at the Reynolds Facility.

Plate 3-5

RI/FS Lysimeter and Geochemical Test Boring Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

In 2006, three lysimeters were installed in the former SPL stockpile area and floor sweeps landfill. The installation details and boring logs for these lysimeters are included in Appendix D-5.

As part of the 2012 RI activities, eight new ceramic suction (Soil Moisture Equipment Corp.) lysimeters were installed and sampled in Fill Deposits A, B-1, B-2, and B-3 (see Plate 3-5 and Figure 3-4). Each lysimeter was installed using a 2.25-inch-diameter hand auger, and the ceramic cup was placed at least 6 inches below the target material deposits (e.g., spent lime or residual carbon material) at the depth where water was first encountered. At the depth that each lysimeter was installed, one soil sample was collected and composited from the auger cuttings; these soil samples were analyzed for total fluoride.

Following installation, all lysimeter borings were backfilled in order by: 1) a silica slurry (surrounding the ceramic cup); 2) “native” excavated soils; 3) bentonite pellets (approximately a 1-foot-diameter seal); and 4) top soil. During the week after installation and 24 hours before sampling events, lysimeters were completely purged of water, and field parameters (including volume, conductivity, and pre- and post-vacuum pressures) were measured to ensure that lysimeters were functioning properly and that representative porewater was sampled in each lysimeter. The installation and development log sheets for these eight lysimeters are included in Appendix D-5.

In January 2012, a total of 16 water samples were collected from the eight new lysimeters. Samples were collected during two discrete sampling events, spanning a period of 35 days after the lysimeters were installed. The first round of lysimeter sampling occurred on January 4; these water samples were analyzed for conventional parameters, dissolved metals, and dissolved fluoride. The second round of lysimeter sampling was performed on January 25 to confirm the first round fluoride results. These water samples were analyzed for total and dissolved fluoride. The third round of lysimeter sampling was performed on September 26, 2012, to confirm previous results and to assess whether results may vary due to seasonality.

Lysimeter porewater samples were analyzed for fluoride (total and dissolved), total chloride, total phosphate, sulfate, dissolved metals (aluminum, calcium, iron, magnesium, manganese, potassium, sodium, and silicon), pH, and alkalinity. Lysimeter GC-LY-03 did not yield sufficient sample volume for laboratory analysis. In addition, samples from GC-LY-01 and CG-LY-02 had insufficient volume for dissolved fluoride analysis; however, all other parameters were analyzed.

The lysimeter soil and porewater results from these sampling events are used to evaluate pore-water fluoride concentrations within each fill deposit and to support the fluoride fate and transport evaluation described in Section 6.

3.5.3 Geochemical Soil Borings

As part of the current RI/FS, targeted testing was performed to evaluate soil properties that affect the mobility of fluoride in groundwater. The testing was targeted in Fill Deposit B-2 and in the area immediately downgradient (see Plate 3-5 and Figure 3-4). Geochemical work in 2011 and 2012 included installation of four borings and testing of soil mineralogy. Geochemical sampling details are included in Appendix D-5.

Geochemical soil borings were advanced into the saturated zone along a southwest-northeast trending transect (see Figure 3-4). At each location, soil samples were collected using direct-push boring sampling methods. Direct-push sampling was performed consistent with methods defined in the Work Plan Addendum (Anchor QEA 2011a).

3.5.4 Other Soil Sampling and Analysis

Plate 3-2 and Figure 3-1 show the locations of soil observations and chemical sampling conducted as part of the RI/FS. Except for the deviations outlined subsequently, all soil sampling activities were performed in accordance with the 2007 RI Work Plan (Anchor 2007a) and RI Work Plan Addenda (Anchor QEA 2011a, 2011b, 2011c, 2012a). Soil boring and test pit logs are included in Appendix D-1. Additional descriptions of the testing conducted in each area are provided in the following:

- **Northern Property Soils.** A potential disturbance in north field soils (north of Industrial Way) was identified during a review of historical aerial photographs. Soils in this area were sampled in 2006 to investigate for potential impacts by plant waste materials. Soil samples were collected from the 0.5- to 1-foot bgs and 1.5- to 2-foot bgs depth intervals at sampling location S1 (see Figure 3-1). Both soil samples were analyzed for fluoride, cyanide, and PAHs.

- **North and South Rectifier Yards.** In 2006, soil sampling was conducted in the north and south rectifier yards. A total of six soil samples (RY1 to RY6) were collected from rectifier yards near the large transformer/rectifiers. Soil samples from the rectifier yards were collected from depths of 0 to 0.5 feet bgs and tested for PCBs, TPH, and mercury.
- **Field Southwest of the Cable Plant.** Soil sampling was performed in the field southwest of the Cable Plant to investigate whether any aluminum manufacturing materials containing fluoride, cyanide (e.g., residual carbon), or petroleum were present. Eight test pits were excavated in this area. Only apparent native soils were encountered in six of the eight pits. Soils in two of the test pits appeared slightly different from surrounding soils. Soils from these two pits were sampled and analyzed for fluoride, cyanide, TPH, and PAHs.
- **Thin Stillage Application Areas.** Surficial soil sampling was performed in the former thin stillage application areas to investigate potential nutrient impacts to soil. Hand shovels were used to excavate shallow test plots within locations where thin stillage was applied. Grab samples of shallow soils (0 to 0.5 feet bgs) from within the test plots were analyzed for nutrient compounds typically associated with thin stillage (total nitrogen, nitrate, nitrite, ammonia, total and available phosphorous, and potassium). Four test plots were excavated along two transects. Reference samples were also obtained from two shallow test plots located away from areas of thin stillage application, specifically southwest of the application areas, between the CDID levee and the Columbia River. Reference samples were analyzed for the same constituents as the samples from the thin stillage application areas.
- **Northwestern Area.** Soil sampling was performed in the northwestern area of the Former Reynolds Plant, between the Closed BMP Facility and CDID Ditch No. 14 (see Plate 2-9). Testing was conducted to verify that there were no deposits of residual carbon or other aluminum manufacturing wastes in this area. Shallow subsurface soils were sampled using test pits excavated along four sampling transects. Grab samples were collected from each test pit representing the 2- to 3-foot bgs soil interval and analyzed for fluoride and cyanide (WAD and total).

- **Flat Storage Area.** Soil sampling was conducted in 2011, 2012, and 2013 in the flat storage area to determine if PAHs associated with green petroleum coke products stored in this area may have become entrained into underlying soils. Soil sampling is summarized in Appendix D-4 and included areas adjacent to the storage pad where stormwater runoff may have accumulated during CVI operations.
  - In 2011, sampling was performed at 11 locations using direct-push borings within each of the nine quadrants that cover the entire storage pad area and in two adjacent areas. Soil samples from beneath the storage pad were collected at 1-foot intervals to a maximum sampling depth of 5 feet bgs or the observed depth to groundwater, whichever was encountered first. The first two sample intervals from each location were analyzed for PAHs (as an indicator of petroleum coke). Deeper soil samples (2- to 3- and 3- to 4-foot intervals) from location AQ-SSA4-05 were also analyzed due to elevated concentrations of PAHs in shallow soil intervals. Prior to sampling, stored product was removed from the sample locations, and the composition and integrity of the pad was visually assessed. Sampling included coring or cutting of the pad to expose underlying soils for access.
  - In 2012 and 2013, additional soil samples were collected in the flat storage area to supplement 2011 sampling data. The additional sampling in 2012 and 2013 was performed after the petroleum coke was removed and after the cement storage pad structure was removed from the area. In 2012, 12 test pits were excavated to a maximum depth of 3 to 4.5 feet bgs. Soil samples were collected in 1-foot vertical increments from the ground surface until groundwater was encountered. Based on field observations, individual samples were either submitted for PAH analysis or archived. Four test pits were excavated and sampled in January 2013 to provide improved delineation of an area of PAH contamination in the northeast corner of the flat storage area. Samples were collected consistent with the test pit procedures outlined in the SAP addenda (Anchor QEA 2011e; Attachment B of Anchor QEA 2012a); soil samples were submitted for PAH analysis.
- **Casting Pit Soils.** Casting pits are located within the former Cast Houses (see Plates 2-3 and 2-9). Two of these casting pits were decommissioned by filling with sandy on-site soils and capping with concrete. These casting pit fill soils were

sampled using direct-push borings to assess the nature of the fill material. Three borings were placed in each of the two casting pit areas, as shown on Figure 3-1. Soil samples were collected at depth intervals of 8 to 10 and 14 to 16 feet bgs, except for location AQ-SSA5-05, in which the shallower sample was collected at a depth interval of 5 to 7 feet bgs. All samples were analyzed for PAHs and fluoride (see Appendix D-4).

- **HTM Oil Area.** Soil sampling was conducted within the HTM Oil Area to complete previous soil characterization activities and to verify that this area has been adequately remediated. Soil sampling was performed using limited access, direct-push borings at 11 locations within the containment area—four locations between the pitch storage tanks, three locations south of the tanks, one location west of the tanks, and three additional locations north of the tanks. Appendix D-4 presents a summary of the sampling and testing details, and Figure 3-1 presents the soil sampling locations. Soils from each boring were continuously sampled and field screened using visual inspection techniques and sheen testing. A total of 27 soil samples were analyzed for Northwest Total Petroleum Hydrocarbons diesel-range (NWTPH-Dx), with silica gel cleanup to assess petroleum concentrations. A minimum of two soil samples were collected from each boring; additional samples were collected when potentially impacted soil intervals were observed. Based on the NWTPH-Dx results, three soil sample intervals were analyzed for EPH to provide petroleum fractionation data for assessing a site-specific TPH cleanup level.
- **Construction Debris Landfill.** Test pits were completed in the construction debris landfill (Landfill #3 on Plate 2-6) to evaluate the lateral and vertical extent of the landfill, and to assess the chemical composition of the fill. A total of ten test pits (AQ-SSA7-01 through AQ-SSA7-10) were excavated to a minimum depth of 7 feet bgs or to the base of the apparent fill material, where observed. Figure 3-1 includes Landfill #3 test pit locations. Three test pits (AQ-SSA7-04, -05, and -06) were relocated to the east because the planned locations were located within wooded areas inaccessible to the test pit excavation equipment.
- **Outfall Drainage Pathway Soils.** A total of three samples were collected from the on-site drainages located between Outfalls 003 and 005 and the CDID ditches. Sampling in these areas was conducted at Ecology's request to further characterize the historical stormwater discharge pathway to CDID ditches. Soils were collected using

a hand-trowel or hand-auger, and individual soil samples were collected at two intervals, 0 to 10 cm and 0.5 to 1 foot, respectively. The surface soil samples (0 to 10 cm) were submitted for laboratory analysis for total solids (TS), SMS metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), and PCB Aroclors. The 0.5- to 1-foot sample was archived.

3.5.5 Groundwater Sampling

Several groundwater sampling events have been conducted as part of the RI. Plate 3-4 and Figure 3-3 show the locations of the groundwater monitoring wells sampled, and each individual groundwater monitoring event is discussed in more detail subsequently.

In 2006, the site-wide monitoring well network was sampled for fluoride, cyanide, and conventional analytes, including field parameters (e.g., pH and dissolved oxygen [DO]), consistent with the RI Work Plan (Anchor 2007a). Two samples were collected for priority pollutants adjacent and downgradient of Landfill #2 (RLSW-2) and Landfill #1 (G2-S). Both of these wells are screened in the shallow groundwater screen interval to evaluate potential impacts of fill material in these areas.

In 2007, the following eight monitoring wells were sampled for PAHs: G1-S, G2-S, G6-S, PZ-1, PZ-3, PZ-4, PZ-5, and RLSW-2. These wells were selected for PAH sampling due to their proximity to potential PAH sources.

During 2011 and 2012, supplemental groundwater sampling was conducted as part of the site-wide groundwater data collection and subsequent data gaps investigation, as described in the Work Plan Addendum No. 1 (Anchor QEA 2011a), Work Plan Addendum No. 2 (Anchor QEA 2011c), and Work Plan Addendum No. 3 (Anchor QEA 2012a).

Groundwater monitoring activities in 2011 were performed for the site-wide monitoring well network, including the five well series G, PZ, R, RL, and RLSW (see Figure 3-3). The 2011 sampling occurred during two events—a July collection event and an October collection event—to evaluate potential seasonal variations in groundwater quality. Groundwater monitoring wells were sampled in 2011 to assess potential changes in constituent levels since 2006 and 2007 groundwater sampling events associated with the 2007 RI sampling event (Anchor 2007b).

Groundwater testing parameters for all 2011 samples are included in Appendix D-4. Groundwater samples associated with this investigation were collected from the following wells:

- All 13 "G series" monitoring wells
- All 7 "PZ series" piezometers
- All 6 "R series" wells
- All 13 "RL series" wells
- All 4 "RLSW series" wells

In 2011, all groundwater monitoring wells were sampled in accordance with the procedures and methods approved in the 2007 RI Work Plan (Anchor 2007a) and as described in the SAP Addendum (Anchor QEA 2011e). Water elevations were measured in each well at the time of sampling. Field measurements included temperature, pH, sulfide, DO, ferrous iron, oxidation reduction potential (ORP), and conductivity. Laboratory analyses included total dissolved solids (TDS), total suspended solids (TSS), alkalinity, fluoride, total chloride, total phosphorous, cyanide (free, WAD, and total), sulfate, and dissolved metals, including aluminum, calcium, iron, magnesium, manganese, potassium, silicon, and sodium. In addition, several wells were tested for PAHs (e.g., PZ-1 to PZ-5, G6-S and G6-D, to R series wells, and RL-4S). All sampled wells and analytical parameters are summarized in Appendix D-4. Groundwater field sampling data sheets (FSDS) are included in Appendix D-1.

Three new groundwater monitoring wells were installed and sampled in February 2012 in response to Ecology comments. These wells include the following:

- SSA4-MW-01 (located just north of the Flat Storage Area)
- SSA6-MW-01 (within the HTM Oil Area)
- SSA7-MW-01 (adjacent to Landfill #3)

The locations of these wells are shown on Plate 3-4 and Figure 3-3. These three wells were sampled at the time of installation in February 2012 and as part of the RI groundwater monitoring event in October 2012.

Groundwater monitoring activities in October 2012 were performed for a subset of the site-wide monitoring well network, including wells from all six well series G, PZ, R, RL, RLSW, and the newly installed SSA wells (see Figure 3-3). Groundwater monitoring wells sampled in 2012 include the following:

- All 13 “G-series” wells
- All 7 “PZ-series” wells
- All 4 “RLSW-series” wells
- All 3 “SSA-series” wells
- R-2
- RL-1S

In 2012, all groundwater monitoring wells were sampled in accordance with the procedures and methods approved in the 2007 RI Work Plan (Anchor 2007a) and as described in the SAP Addendum (Anchor QEA 2012a; Attachment B to Work Plan Addendum No. 3). Water elevations were measured in each well at the time of sampling. Field measurements included temperature, pH, turbidity, sulfide, DO, ferrous iron, ORP, and conductivity. Laboratory analyses included TDS, TSS, alkalinity, fluoride, total chloride, sulfate, total phosphorous, cyanide (free, WAD, and total), sulfate, as well as dissolved metals, including aluminum, calcium, iron, magnesium, manganese, potassium, silicon, and sodium.

A subset of wells was also analyzed for an extended suite of priority pollutant chemicals (total and dissolved metals, SVOCs, low-level PCB Aroclors, and VOCs). These locations were selected by Ecology pollutant testing based on their locations downgradient from the on-site landfills and fill deposits.

- G2-S (downgradient of the Landfill #1)
- RLSW-3 (downgradient of Landfill #2),
- G4-S (downgradient of Fill Deposits A and B-1)
- R-2 (downgradient of Fill Deposit B-2)
- RL-1S (downgradient of Fill Deposit B-3)

Selected groundwater wells were re-sampled in December 2012. The follow-up sampling event consisted of sampling groundwater from the following wells and analyzing for:

- RLSW-3: PAHs
- G1-S and G1-D: Total and dissolved cyanide (WAD, free, and total)
- G2-S and G2-D: PAHs
- SSA6-MW-01: Total petroleum hydrocarbon – diesel range (TPH-Dx; with and without silica gel cleanup)

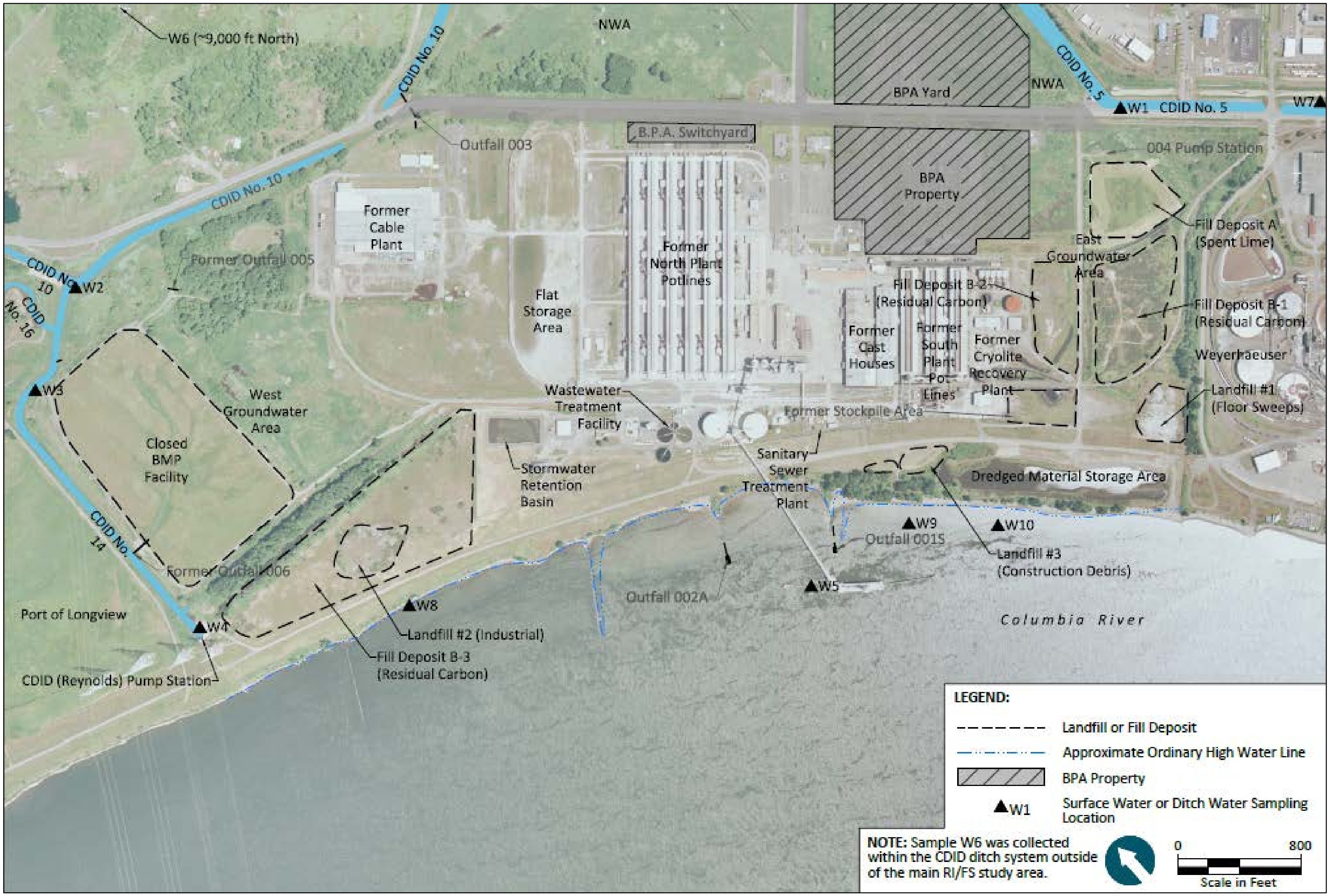
All sampled wells and analytical parameters are summarized in Appendix D-4. Groundwater FSDS are included in Appendix D-1.

3.5.6 Ditch and Surface Water Sampling

The RI/FS included extensive sampling of surface water from the Columbia River and ditch water from the CID ditch system within and adjacent to the RI/FS Study Area. Surface water and ditch water sampling locations are shown on Plate 3-6 and on Figure 3-5.

Water samples were collected from the following four areas during the 2006, 2011, and 2012 RI activities:

- CDID ditch water was collected from three locations adjacent to the Former Reynolds Plant (W2, W3, and W4). Sampling in 2006 was performed 1 foot below the water surface. During 2011 and 2012, these samples were collected from 0.5 feet above the mudline.
- Background CDID ditch system water was collected from locations outside of the site boundaries (W1, W6, and W7). Sampling in 2006 was performed 1 foot below the water surface. During 2011 and 2012, these samples were collected from 0.5 feet above the mudline.
- Columbia River water was collected from the dock (W5). This sample was collected from 2 feet below the water surface.
- Nearshore Columbia River water was collected along the shoreline (W8, W9, and W10). These locations were first sampled during the 2012 RI activities and were collected from just above the mudline.



The Remedial Investigation and feasibility study (RI/FS) included extensive testing of water quality within the Columbia River and within the CDID ditch system near the Reynolds Facility. RI/FS surface water and CDID ditch water testing locations are shown above (black triangles).

Plate 3-6

RI/FS Surface Water and CDID Ditch Water Sampling Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

In 2011, ditch and surface water sampling was conducted in parallel with the July and October groundwater monitoring event described in the Section 3.3.2. Field measurements included temperature, pH, sulfide, DO, ferrous iron, ORP, and conductivity. Laboratory analyses included TDS, TSS, alkalinity, fluoride, total chloride, total phosphorous, cyanide (free, WAD, and total), sulfate, and dissolved metals, including aluminum, calcium, iron, magnesium, manganese, potassium, silicon, and sodium. In 2011, the only deviation from the SAP Addendum was an adjustment to the analytical sampling parameters from the October 2011 sampling event; in October, surface and ditch water samples were tested for dissolved fluoride and cyanide and field filtered at the time of collection.

In 2012, surface water sampling was conducted in parallel with the October groundwater monitoring and RI sampling event. The same field parameters were monitored, and the same laboratory analyses were conducted in 2012 as in 2011 with the exception that both fluoride and metals (including aluminum, calcium, iron, magnesium, manganese, potassium, silicon, and sodium) were analyzed for total and dissolved concentrations in 2012. The only deviation from Work Plan Addendum No. 3 was that surface and ditch water samples were collected from Stations W1 through W7 in addition to the proposed samples from W8, W9, and W10 (see Figure 3-5). A summary of surface and ditch water analytical testing methods is presented in Appendix D-4.

4 GEOLOGIC AND HYDROGEOLOGIC SETTING

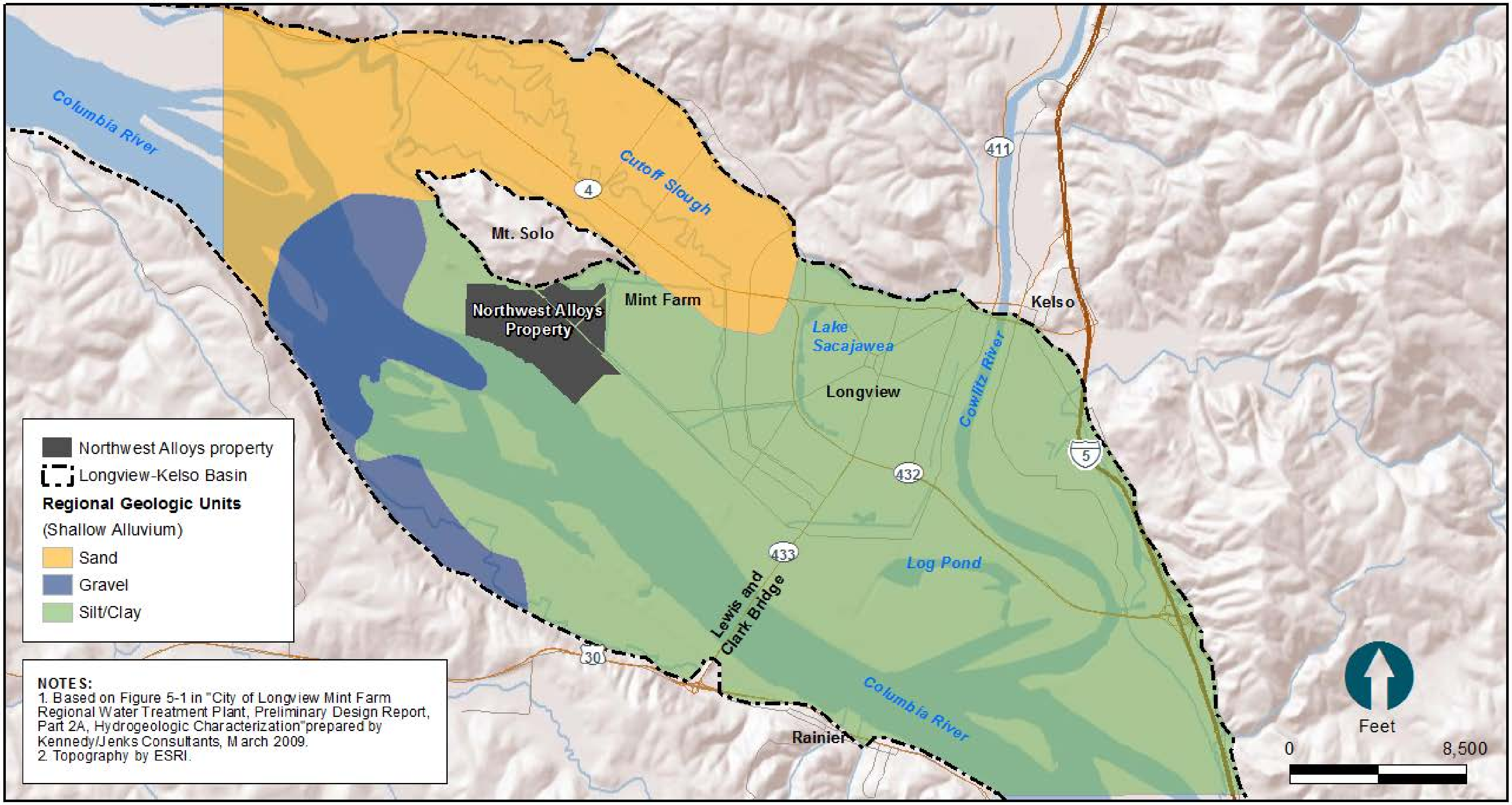
This section summarizes the geologic and hydrogeologic setting of the Former Reynolds Plant and RI/FS Study Area. This information was derived from previous studies performed at the facility, testing performed during the RI/FS, and regional studies conducted within the Longview area. Information presented in this section is organized as follows:

- **Study Area Geologic Conditions (Section 4.1).** The properties of the shallow surficial soils are presented, along with the properties of the underlying soil strata. These strata include the Upper and Lower Alluvium. The geologic conditions are relevant to the distribution and behavior of groundwater within the RI/FS Study Area.
- **Hydrologic Influences (Section 4.2).** The Columbia River and the CDID ditch system both influence the behavior of groundwater within the RI/FS Study Area. Section 4.2 presents and discusses these influences.
- **Study Area Hydrogeology (Section 4.3).** Section 4.3 discusses the presence and behavior of groundwater within the RI/FS Study Area as developed during RI/FS studies and regional studies.

This section introduces the overall groundwater CSM. Elements of the groundwater CSM are discussed in Sections 4.1 through 4.3. This groundwater CSM is expanded as part of the fate and transport analysis and overall CSM in Sections 6 and 7, respectively.

4.1 Study Area Geologic Conditions

The RI/FS Study Area is located within the Longview-Kelso basin (see Plate 4-1), a topographic and structural depression formed by the Cascadia subduction zone (Evarts et al. 2009). The Longview-Kelso basin is composed primarily of Tertiary age bedrock overlain by Quaternary age unconsolidated alluvium. Bedrock units include volcanic rocks of the Grays River formation and thinly interbedded sandstone, siltstone, and shale layers of the Cowlitz Formation (Phipps 1987; Walsh 1987).



NOTES:
1. Based on Figure 5-1 in "City of Longview Mint Farm Regional Water Treatment Plant, Preliminary Design Report, Part 2A, Hydrogeologic Characterization" prepared by Kennedy/Jenks Consultants, March 2009.
2. Topography by ESRI.

The Northwest Alloys Property and Remedial Investigation/Feasibility Study area are located atop a regional geologic layer of silt/clay soils (known as the Upper Alluvium) that extends beneath most of the Longview-Kelso basin. The silt/clay layer beneath the Northwest Alloys Property averages approximately 200 feet in thickness and separates surficial groundwater from deeper water-bearing strata. The above figure illustrates the extent of this silt/clay layer, as mapped by the City of Longview (Kennedy Jenks 2009).

Plate 4-1

Northwest Alloys Property Is Located atop a Regional Layer of Silt and Clay Soil
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

The layers of the alluvium include thick sequences of the catastrophic Missoula flood deposits (coarse-grained sand and gravel) overlain by channel and floodplain deposits (silt, fine-grained sand, and clay) of the Columbia and Cowlitz Rivers (Swanson et al. 1993; Evarts et al. 2009). This two-layer alluvial system is illustrated in the groundwater CSM (see Plate 4-2).

Plate 4-1 shows the characteristics of the Upper Alluvium within the Longview-Kelso basin. In the RI/FS Study Area and beneath most of the Longview area, the upper portion of the alluvium (Upper Alluvium) consists of fine-grained sand, silt, and clay overlying the much deeper sequence of coarser-grained gravels and cobbles (Lower Alluvium):

- **Upper Alluvium.** As shown on Plate 4-1, the characteristics of the Upper Alluvium vary within the Longview-Kelso basin. However, in the RI/FS Study Area, the Upper Alluvium consists of fine-grained silt and clay deposits. Analysis of shallow and deep boring logs from the Former Reynolds Plant water supply wells from studies performed for the City of Longview Mint Farm Well Field (Mint Farm) confirm the Upper Alluvium locally consists of interbedded silt and fine-grained sand layers, with minor fractions of silty sand, sandy silt, and clay interbeds. This fine-grained Upper Alluvium averages approximately 200 feet in thickness beneath the RI/FS Study Area. The unit is approximately 200 to 300 feet thick along the Columbia River shoreline, thinning to 130 to 190 feet in the northeastern portion of the RI/FS Study Area.
- **Lower Alluvium.** The Lower Alluvium consists of the deeper, coarse-grained geologic unit containing gravels and cobbles. Many of the water production wells located within the Former Reynolds Plant and on nearby industrial properties (including those of the Mint Farm) are completed within these coarse-grained gravel deposits. Not all production wells are completed in the Lower Alluvium. Several of the deepest water production wells in the region also penetrate bedrock beneath this layer. Beneath the RI/FS Study Area and Mint Farm areas, the Lower Alluvium consists of coarse-grained sand and gravel deposits and ranges in thickness from 100 to 350 feet.

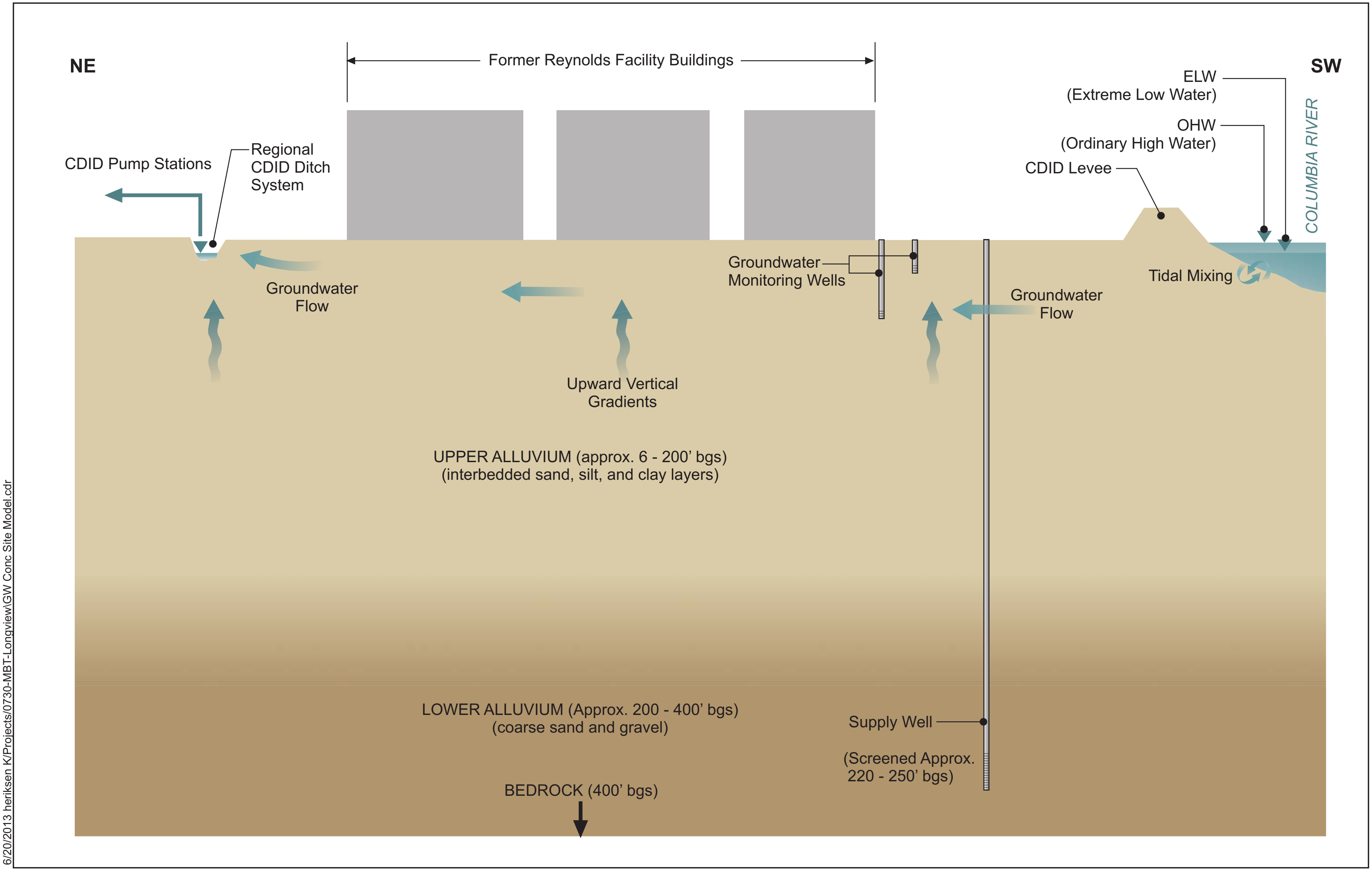


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Plate 4-2

Groundwater Conceptual Site Model
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Surficial soils within the RI/FS Study Area can contain other types of soil, including anthropogenic fill deposits, or other disturbances to the Upper Alluvium. Fill has been placed on the Former Reynolds Plant during its development, including coarse-grained dredged material from the Columbia River, coarse-grained materials used to construct the CDID levy, and other materials. Other disturbances include ditching, grading, and filling during site development and re-development.

4.2 Hydrologic Influences

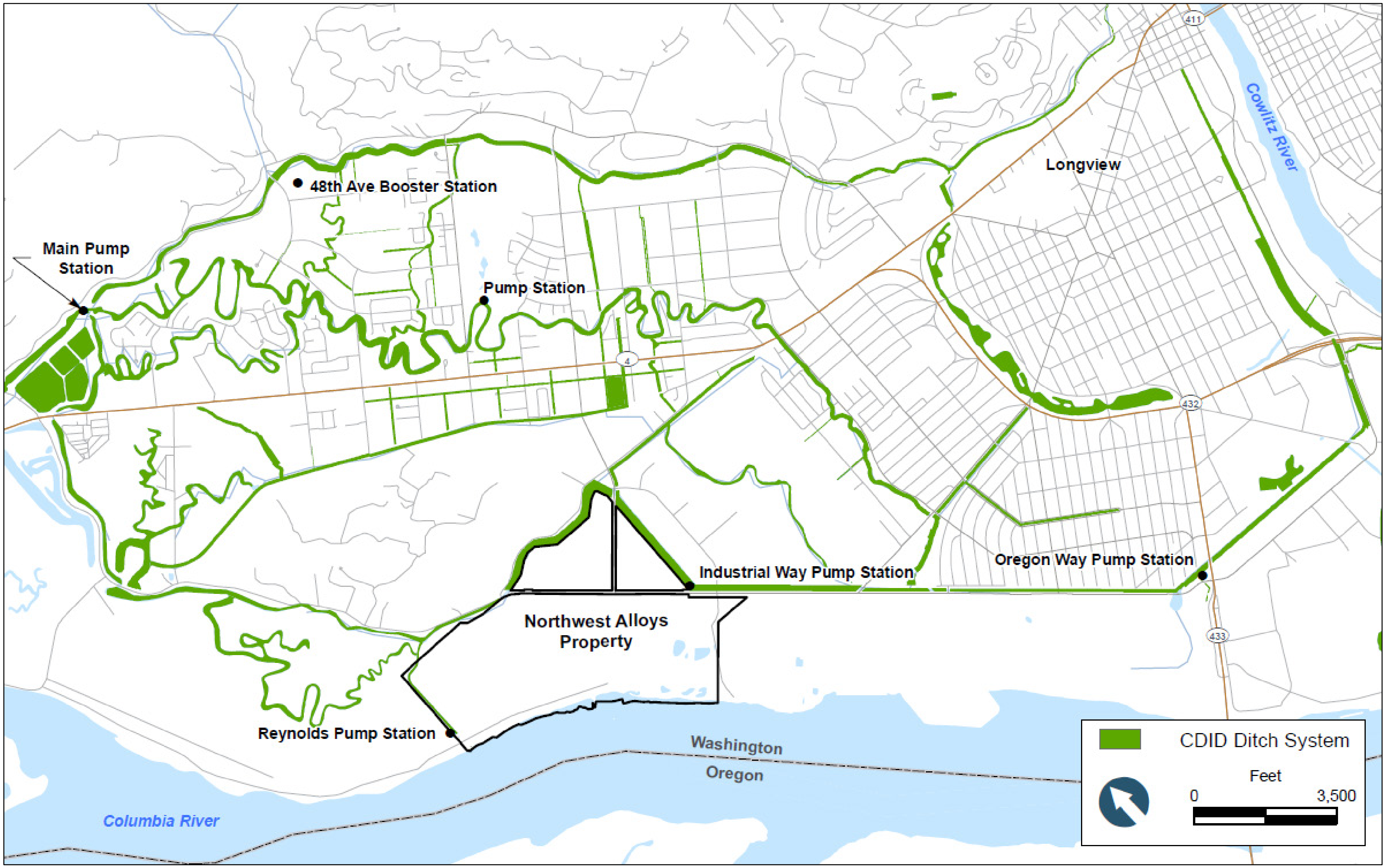
The behavior of groundwater within the RI/FS Study Area is influenced by the area hydrology. Local hydrologic influences include the Columbia River, the surface ditches of the regional CDID Ditch system and those of the on-site NPDES ditch system. The influences of these features on groundwater are described below.

4.2.1 CDID Ditch System

The RI/FS Study Area is located in the southeastern corner of the Grays/Elochman Water Resource Inventory Area (WRIA) 25. The average ground surface within the Former Reynolds Plant is approximately 12 feet above mean sea level (MSL), though there is extensive topographic variation within the facility.

The Columbia River is located along the southern side of the Former Reynolds Plant. A CDID flood control levee is located along the shoreline. This levee is part of a larger network of dikes and levees originally constructed by U.S. Army Corps of Engineers (USACE) along the Columbia River shoreline during the 1920s to protect Longview properties from flooding by the Columbia River. Along the Former Reynolds Plant, the height of the levee averages approximately 32 feet above MSL.

As shown on Plate 4-3, a network (approximately 35 miles) of drainage ditches is operated throughout the Longview/Kelso basin by the CDID. These ditches were excavated by the USACE to drain both stormwater and shallow groundwater from properties within the district (see Plate 4-3) and permit development within the flood plain. The nearest CDID ditches are located along the north and west sides of the RI/FS Study Area.



Shallow groundwater flow directions in the Longview area are affected by the ditch system operated by the Consolidated Diking and Improvement District (CDID). Groundwater and stormwater are actively pumped by the CDID from the ditches to maintain water levels below those in the Columbia River. At the Reynolds Facility, this results in a flow of shallow groundwater away from the river and toward the CDID ditches (to the north and west).

Plate 4-3

Regional CDID Ditch System Influences Shallow Groundwater Flow Directions
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

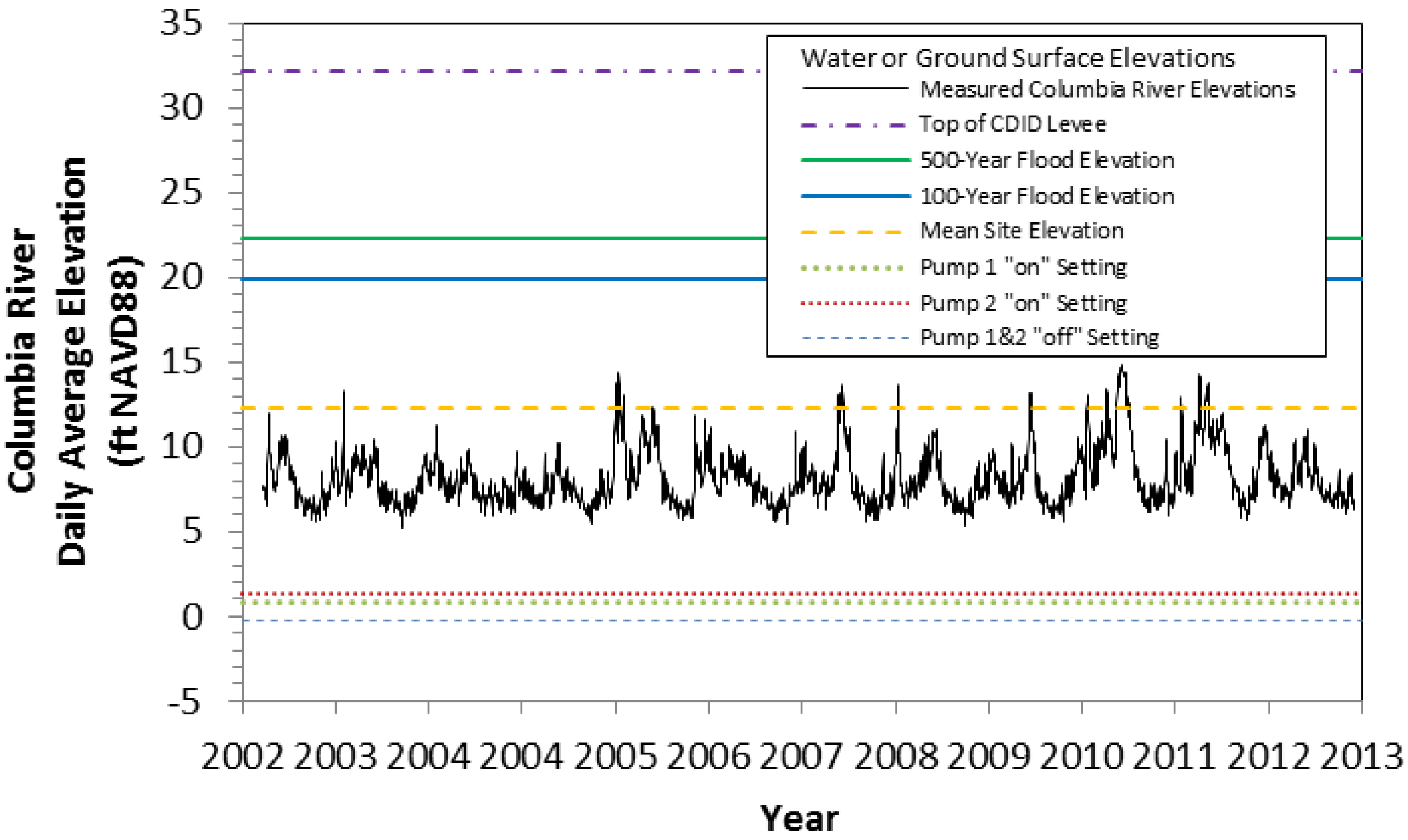
The CDID ditches are structurally isolated from the Columbia River but ultimately discharge to the Columbia River through a series of pump stations and gated valves. The CDID ditch system receives stormwater from the cities of Longview and Kelso, and other areas in Cowlitz County, plus a number of industrial discharges (Ecology 1993).

The water levels within the CDID ditch system are maintained by active pumping at levels beneath those of the Columbia River. Plate 4-3 shows the locations of the ditches and CDID pump stations in the vicinity of the RI/FS Study Area. The closest pump stations are the Industrial Way pump station (located northeast of the Former Reynolds Plant), and the Reynolds pump station located at the southwest corner of the Former Reynolds Plant.

Plate 4-4 illustrates that the water levels within the CDID ditch system are maintained at levels several feet lower than those in the Columbia River. Specifically, that plate shows the following control elevations established for operation of the two large pumps within the Reynolds Pump station located adjacent to the Former Reynolds Plant:

- The two pumps in the Reynolds pump station activate when ditch water elevations exceed just over 1 foot above MSL. The two pump control levels differ slightly.
- The pumps in the Reynolds pump station deactivate when ditch water elevations fall below a specified minimum, just below MSL.
- In contrast to the tightly controlled elevations of the CDID ditches, the water levels within the Columbia River vary seasonally due to typical weather and rainfall, and hourly due to the effects of tides on the Columbia River. Average daily elevations of the Columbia River are shown on Plate 4-4 for the period 2002 to 2012. These average elevations typically range between about 5 to 15 feet above sea level.

The pumping of the CDID ditches tends to induce groundwater gradients toward the ditch system. For the RI/FS Study Area, this results in a groundwater gradient from the Columbia River (with its higher water surface elevation) north and west toward the CDID ditches.



Water levels in the Consolidated Diking and Improvement District (CDID) ditch system are maintained at levels below the elevation of the Columbia River by intermittent pumping. The dotted red and dotted green lines in the above figure show the water levels at which the pumps at the Reynolds Pump Station activate (station is located adjacent within the RI/FS study area). These levels are well below those of the Columbia River. The river levels vary over each year by season, weather (i.e., rainfall and snowmelt), and daily tidal fluctuations. Daily average river levels between March 2002 and November 2013 are shown above based on NOAA gage 9440422. Refer to Plate 4-7 for information on daily tidal fluctuations. Also shown above are the 100-year and 500-year flood levels predicted by the U.S. Corps of Engineers for the Columbia River.

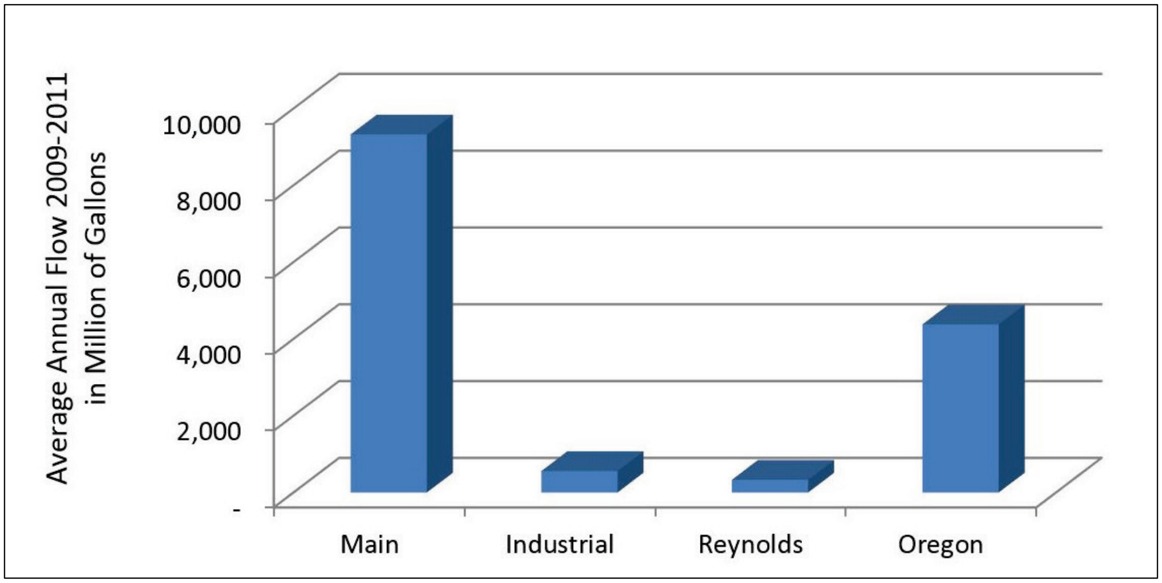
Plate 4-4

The CDID Ditches Are Maintained at Water Levels Below Those of the Columbia River

In addition to influencing the flow of shallow groundwater, the CDID ditches receive discharges of stormwater from residential, commercial and industrial properties throughout the Longview area. The CDID is a secondary permittee on the Cowlitz County/Kelso/Longview Municipal NPDES permit.

The movement of CDID ditch water within the RI/FS Study Area varies depending on the water levels in the ditches and the operation of the pump stations. The Lower System of CDID consists of four pumping stations: the Main Pump Station, Oregon Way Pump Station, Industrial Way Pump Station, and Reynolds Pump Station (see Plate 4-3) all of which are owned and operated by the CDID. Flow within the ditch system can be toward the east (toward the Industrial Way Pump or Oregon Way pump stations), toward the southwest (toward the Reynolds pump station) or toward the northwest (toward the Main Pump Station). Based on pumping data for the lower system obtained from CDID for the years 2009 to 2011 (see Plate 4-5), the average annual volume pumped from all four lower CDID pump stations was approximately 14.5 billion gallons. Of this average volume, approximately 64 percent was pumped by the Main Pump Station (9.3 billion gallons), 30 percent by the Oregon Way Pump Station (4.4 billion gallons), 4 percent by the Industrial Way Pump Station (0.56 billion gallons), and 2 percent by the Reynolds Pump Station (0.331 billion gallons).

Plate 4-5 Average Annual Flow from Lower CDID Pumping Stations (2009 to 2011)



4.2.2 NPDES Drainage Ditch System

In addition to the CDID ditches, numerous on-site ditches collect stormwater runoff. Like the CDID ditch system, these ditches can also influence/extract shallow groundwater. Plate 4-6 shows the principal internal ditch systems. The water collected from these ditches is managed consistent with NPDES permit number WA-000008-6.

The Former Reynolds Plant includes three outfalls that are managed under the facility's NPDES permit. Outfalls 003 and 005 discharge stormwater from limited site areas to the CDID ditch system along the north side of the Former Reynolds Plant. Other facility waters are treated and discharged to the Columbia River via Outfall 002A. The waters collected from the Former Leachate Ditch and the Cryolite Area Ditches are first treated at Facility 71 and are then collected at Outfall Sump/Pump Station (Facility 77) along with the flow from other facility pumps and ditches. All waters co-mingled at Facility 77 (treated wastewater, process water, and stormwater) are then pumped through the treatment system at Facility 73 (including the retention basin and the filter plant) prior to being discharged at Outfall 002A.

4.3 Study Area Hydrogeology

As shown on Plate 4-2, there are several water bearing zones (WBZ) beneath the RI/FS Study Area. These include those of the Lower Alluvium, the Upper Alluvium, and the surficial soils. The on-site water supply wells are completed within the Lower Alluvium. However, it is the shallow groundwater within the Upper Alluvium and the surficial soils that is most relevant to the RI/FS.

The groundwater monitoring wells developed as part of environmental monitoring programs and the RI/FS are completed within the surficial soils and in some cases within the Upper Alluvium. The depth of these well completions varies. The depth of the deepest environmental monitoring well within the network is 38 feet bgs. Generally the monitoring wells indicated as "shallow" are screened across the first water table encountered, with depths of less than 19 feet bgs. The monitoring wells indicated as "deep" are screened slightly deeper, between 19 and 38 feet bgs (see Plate 4-2). None of these wells penetrate into the Lower Alluvium, which is on average more than 200 feet bgs.

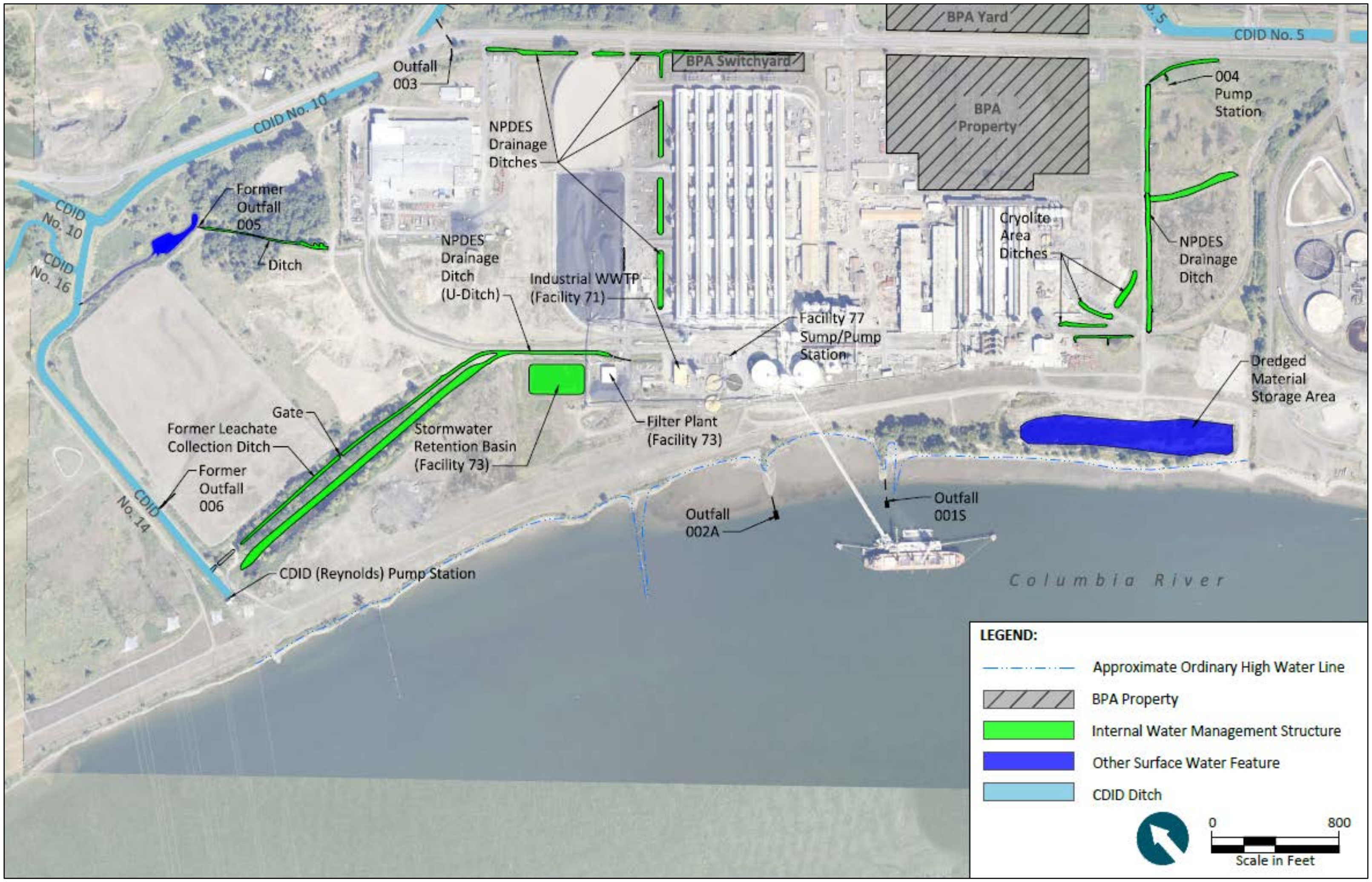
Observations from site hydrogeologic investigations and monitoring well logs indicate that the conditions encountered in the upper soils vary by location due to natural variations in the top of the Upper Alluvium, and due to variations in the history of site development and the composition of surficial soils overlying the Upper Alluvium. Generally, deeper wells and borings within the Former Reynolds Plant encountered discontinuous and interbedded fine-grained sand, silt, and clay layers.

4.3.1 Groundwater Gradients

Groundwater flow in the shallow WBZ of the surficial soils and the Upper Alluvium is influenced primarily by the Columbia River, the regional CDID ditch system, and by the on-site NPDES ditches. Precipitation recharge and seasonal fluctuations are noted in this upper zone. Tidal influences are noted in areas near the Columbia River, as described in Section 4.3.2.

Figures 4-1 and 4-2 located at the back of this section illustrate the groundwater gradients measured during the end of the dry season (October 2012) and during the wet season (December 2012). Based on these observed water levels, shallow groundwater within this upper WBZ typically flows north and west, away from the Columbia River toward the CDID ditches. The on-site NPDES ditches appear to also influence groundwater gradients in some localized areas (i.e., in areas where the water level maintained in the on-site ditches was below that of the nearby groundwater).

Seasonal variations in groundwater elevations were noted in the shallow WBZ. Groundwater elevations were higher (with variation up to 2 feet) in the wet season than during the dry season. This is reasonable given the higher rates of precipitation and estimated groundwater recharge during the wet season, and also given the higher Columbia River levels that typically occur during winter months. The extent of seasonal variation differed by well location.



The Reynolds Facility includes an internal network of ditches and three outfalls that are managed under the facility's NPDES permit. Outfalls 003 and 005 discharge stormwater from limited site areas to the CDID ditch system. Other facility waters are treated and discharged to the Columbia River via Outfall 002A. The waters collected from the Former Leachate Ditch and the Cryolite Area Ditches are first treated at Facility 71 and are then collected at Facility 77 along with the flow from other facility pumps and ditches. All waters co-mingled at Facility 77 (including treated wastewater, process water, and stormwater) are then pumped through the treatment system at Facility 73 (including the retention basin and the filter plant) prior to being discharged at Outfall 002A.

Plate 4-6

Internal Ditch System Is Managed Under the Facility's NPDES Permit
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

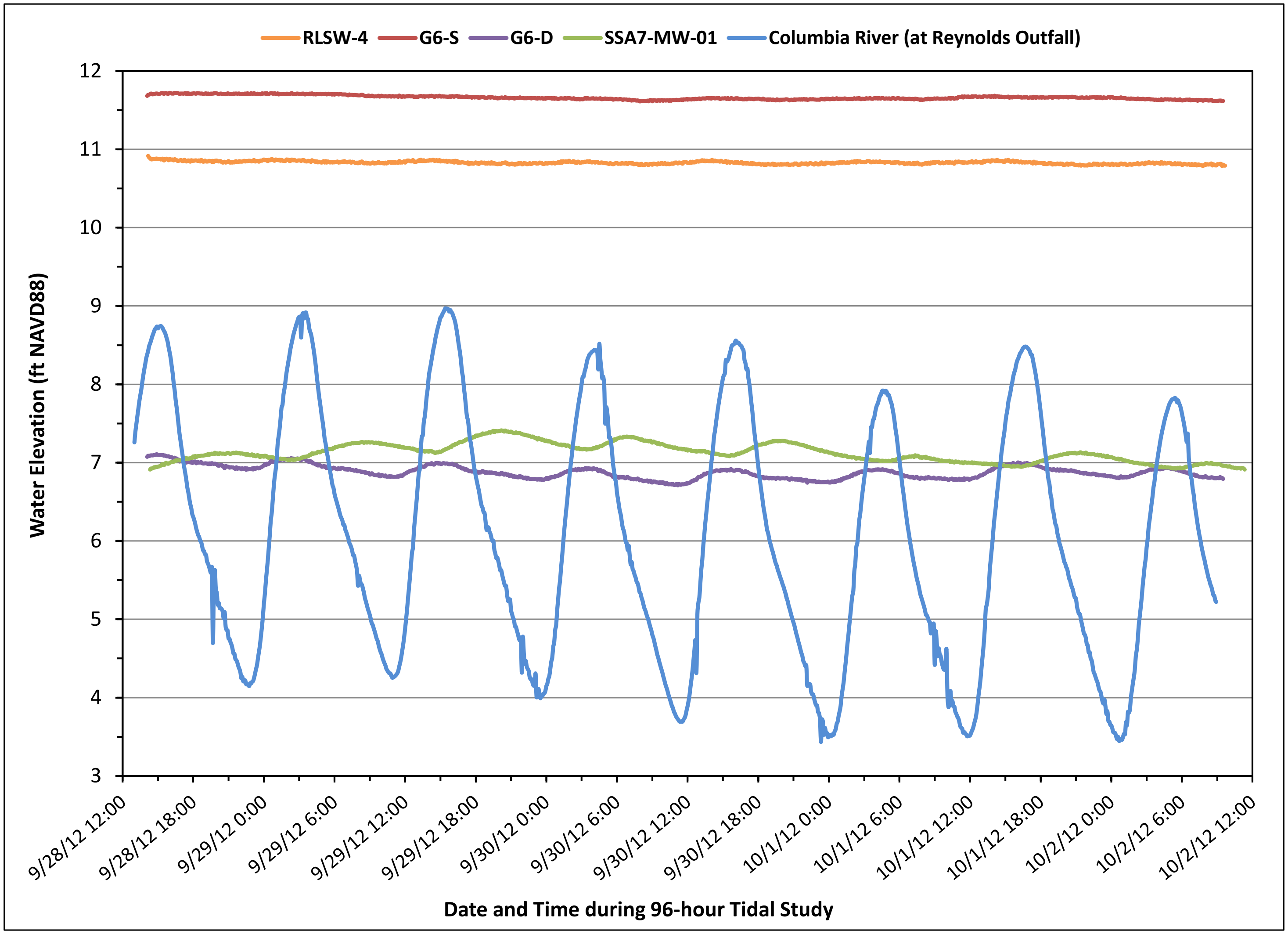
Some of the environmental monitoring wells exhibited unusually high groundwater elevations in comparison to adjacent wells. These conditions have been noted at wells G6-S and RLSW-4, which are located along the CDID levee near the Columbia River. The water elevations in these wells also have not correlated well with river stage in comparison to deeper-screened wells in these areas (see Plate 4-7). The observations from these wells suggest that groundwater in this area is perched on low permeability silt and clay layers, as noted in the boring logs for these wells. In December 2012 (and to a certain extent October 2012), relatively high groundwater elevations were observed at wells R-1S, R-4S, and G1-S, which are also located along the CDID levee near the Columbia River.

Figure 4-3 shows the estimated bottom elevations of landfill and fill deposits and how they are influenced by groundwater during wet weather conditions. Figure 4-3 was developed using information contained in Appendix D-6. In the East Groundwater Area, solid media in Fill Deposit A, Fill Deposit B-2, and Landfill #1 is in contact with or beneath the wet weather groundwater elevations. The test pits excavated within Fill Deposit B-1 were not able to fully penetrate the fill deposit (see Appendix D); therefore, the bottom elevation is unknown. Fill in this deposit extend below the maximum water table elevations depicted by the groundwater elevation contours in Figure 4-3. The fill deposits in the West Groundwater Area (Landfill #2 and Fill Deposit #3) appear to be predominantly above underlying groundwater during wet weather conditions.

4.3.2 Tidal Effects

As discussed in Section 4.2, the water levels within the Columbia River fluctuate with the tides. These fluctuations were documented during a 96-hour tidal study conducted in late September and early October of 2012. During that tidal study, the Columbia River elevation fluctuated over 5 feet (see Plate 4-7).

The extent of tidal influences on groundwater within the Longview/Kelso basin has been evaluated by others. Tidal influences tend to propagate furthest in the coarse-grained Lower Alluvium and to a much lesser degree within the fine-grained Upper Alluvium or in the surficial soils.



Water Levels in the Columbia River near the Reynolds Facility vary not only with season and weather, but also with the tides. Water levels in the river fluctuated by approximately 4 to 5 feet between high and low tides during the Fall 2012 tidal study. Tidal fluctuations induce mixing of non-perched groundwater in nearshore areas (see tidal fluctuations as measured in wells G6-D and SSA7-MW-01). These fluctuations are not observed in wells located in the interior of the facility or in wells located in perched groundwater units (see the lack of fluctuation in perched wells RLSW-4 and G6-S).

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Plate 4-7

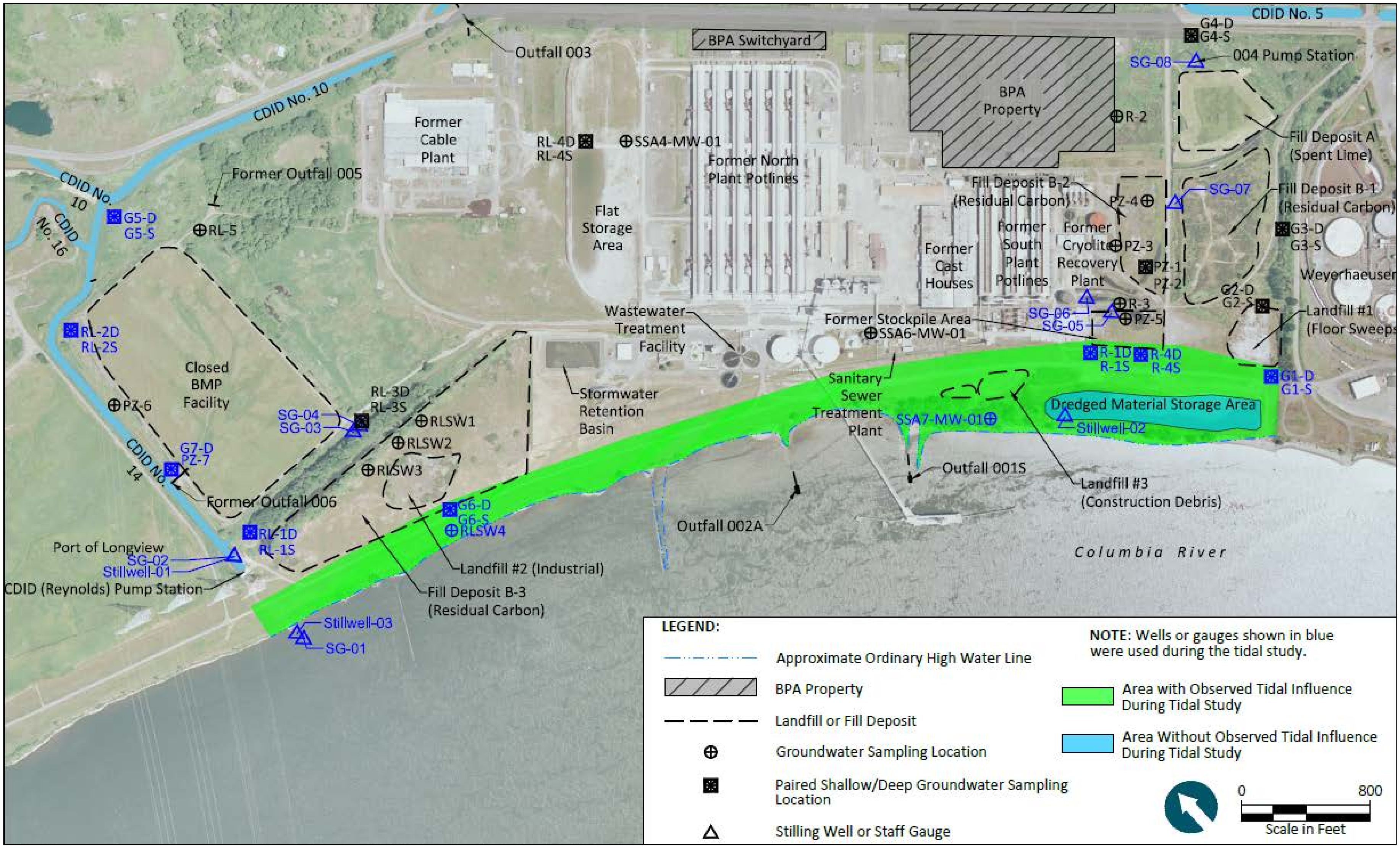
Columbia River Water Levels Fluctuate Due to Tides

As part of the October 2012 tidal study, the extent of tidal variation of groundwater elevations in the environmental monitoring wells was assessed. Results are shown on Plate 4-8. Tidal influences were measurable in wells located nearest to the Columbia River (i.e., in wells SSA7-MW-01, R-1, R-4, G1, and G6-D). The tidal effects were somewhat more pronounced in the deeper well within each well pair (e.g., R-1D and G1-D), with the exception of well pair R-4, in which similar tidal effects were noted in R-4S and R-4D. Over the course of the 96-hour tidal study, the groundwater elevations in the above-listed wells fluctuated up to a maximum of 0.5 feet. The greatest tidal influence observed at monitoring well SSA7-MW-01, which is located within a shallow sand unit adjacent to the river.

4.3.3 Hydraulic Conductivities and Vertical Gradients

Hydraulic conductivities were measured in the environmental monitoring wells during the RI/FS to provide a point of comparison to those measured in the Upper Alluvium and Lower Alluvium during regional studies performed by others. The hydraulic conductivities were measured both during "slug tests," and using the information developed during the tidal study.

- **Shallow Water Bearing Zone.** The hydraulic conductivities within the environmental monitoring wells completed in the shallow WBZ varied by location (see Figure 4-4 for measured values). The observed variation is reasonable given the variable nature of the surficial fill soils and the variable contacts with the Upper Alluvium. The measured hydraulic conductivities in the environmental monitoring wells ranged from a low of 0.003 to a high of 16 feet per day.
- **Upper Alluvium.** Hydraulic conductivities were measured during the City of Longview's preliminary design studies for the water production wells at the Mint Farm (Kennedy/Jenks 2010). These measurements were performed using laboratory measurements. Of eleven representative samples of the Upper Alluvium, nine were from silt deposits, with measured conductivities between $3\text{x}10^{-4}$ and $3\text{x}10^{-5}$ feet per day. Two of eleven samples from the Upper Alluvium were collected from layers containing higher sand content, with measured conductivities ranging from 0.3 feet per day to 3 feet per day.



Tidal influences in the Columbia River result in fluctuations in groundwater elevations in nearshore areas. During the fall of 2012, the extent of tidal influences on groundwater in the shallow groundwater WBZ measured. Tidal influences extended several hundred feet into the upland, just past the inshore boundary of the CDID levee. The extent of tidal response varied by well. Monitoring wells G6-S and RLSW-4, located in a perched groundwater unit, exhibited no tidal response (see Section 4.3.1 and Plate 4-7). No tidal variation was measured within the dredged material storage area.

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Plate 4-8

Groundwater near the Columbia River Is Also Tidally Influenced
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

- **Lower Alluvium.** The conductivities of the coarse grained Lower Alluvium were also reported in the City of Longview's design study (Kennedy/Jenks 2010). The conductivity for this layer was estimated to range between 20 and 2,500 feet per day, with an average of about 725 feet per day (Kennedy/Jenks 2010).

Vertical gradients between the Lower Alluvium and Upper Alluvium were assessed as part of the City of Longview's preliminary design studies. During June and November 2009, vertical gradients in well pairs completed in each alluvium layer showed the presence of an upward gradient. In most of the paired sentinel wells, groundwater heads measured in the shallow wells were from 2 to 5 feet lower than those in adjacent deep wells. The study concluded that the aquifer within the Lower Alluvium behaved as a confined system near the Columbia River where the silty deposits of the Upper Alluvium were the thickest (Kennedy/Jenks 2010). This includes the area surrounding the RI/FS Study Area.

5 REMEDIAL INVESTIGATION FINDINGS

This section describes the findings of the RI, including presentation of the results of chemical and biological testing of different media. Results of testing for each media are compared against appropriate screening levels, and the key findings are summarized in Section 5.6. This section is organized as follows:

- Section 5.1 – Summary of Screening Levels by Media
- Section 5.2 – Testing Results for Soils, Landfills, and Fill Deposits
- Section 5.3 – Testing Results for Groundwater
- Section 5.4 – Testing Results for CDID Ditches and Surface Water
- Section 5.5 – Testing Results for Sediments
- Section 5.6 – Key Remedial Investigation Findings

The information presented in this section documents the types and concentrations of compounds present in soil, surface water, groundwater, and sediment at the Former Reynolds Plant.

Following the presentation of RI findings in this section, Section 6 presents a detailed evaluation of the factors limiting the fate and transport of fluoride in groundwater. That evaluation draws on the information contained in Section 4 and Section 5 of this report. Section 7 then presents an overall CSM for use in developing the FS.

5.1 Summary of Screening Levels by Media

The findings of the RI testing program have been evaluated against a set of screening levels appropriate to different media (e.g., soils and groundwater). The purpose of the screening process is to identify those constituents that may be present at concentrations that require further evaluation under MTCA. The screening levels are based on the MTCA regulations and on other potentially applicable or relevant state or federal regulations or guidance, as described in this section.

The screening levels presented in this section do not necessarily represent final cleanup levels applicable to the RI/FS Study Area (refer to Section 8 of the RI/FS for a detailed discussion of potentially applicable cleanup requirements). However, they are intended to provide a conservative (i.e., stringent) basis for reviewing the chemical and biological testing data for soil, groundwater, surface water, and sediment.

5.1.1 Screening Levels for Soils, Landfills, and Fill Deposits

The RI/FS Study Area includes areas of soil that may have been impacted by historical industrial activities. In addition, the RI/FS Study Area includes three closed landfills and several fill deposits used during operation of the Former Reynolds Plant to manage spent lime and residual carbon.

Screening levels for soils, landfills, and fill deposits consider MTCA cleanup levels protective of industrial site uses, as well as those protective of groundwater. Where available, MTCA Method A and Method C soil cleanup levels for industrial land uses are used as initial screening criteria. The Method A values are conservative because they include default assumptions intended to be protective of groundwater at all sites; these assumptions may not be applicable to the conditions at the Former Reynolds Plant. When Method A cleanup levels are not available, Method C values are applied. Method B soil cleanup levels are applicable for unrestricted residential use. These residential criteria are not applicable to the Former Reynolds Plant given its zoning and its long history of industrial uses. However, they provide a point of reference for how low the constituent levels are in soils outside of the landfills and fill deposits.

Soil, landfill materials and fill deposit screening levels are presented in Table 5-1. These include the following:

- **MTCA Method A Industrial Soil Cleanup Levels** (WAC 173-340-745). MTCA Method A Industrial soil cleanup levels are based on industrial land use. Specifically these cleanup levels consider values protective of adult industrial workers. MTCA Method A levels also include conservative assumptions regarding the chemical concentrations that would be protective of groundwater quality. These conservative assumptions may not be applicable to conditions at the Former Reynolds Plant.
- **MTCA Method C Industrial Soil Cleanup Levels** (WAC 173-340-745). MTCA Method C levels are based on a direct-contact exposure scenario. These cleanup

levels are protective of industrial workers. These values are used for those parameters for which Method A Industrial Soil Cleanup Levels are not available.

- **Natural Background.** MTCA regulations consider background chemical concentrations as part of data screening and development of cleanup levels. Consistent with WAC 173-340-200, the term "natural background" includes both naturally occurring concentrations and anthropogenic concentrations that are distributed over very large areas. As defined under the MTCA rule, natural background represents "the concentration of hazardous substance consistently present in the environment that has not been influenced by localized human activities […] also, low concentrations of some particularly persistent organic compounds such as PCBs can be found in surficial soils and sediment throughout much of the state due to global distribution of these hazardous substances. These low concentrations would be considered natural background."

As part of the RI testing program, the contents of the on-site landfills and fill deposits were also subjected to testing using state and federal testing protocols (i.e., testing under the TCLP and Washington State bioassay testing protocols for characterization of Dangerous Wastes) applicable to the characterization of materials designated for off-site management. These tests are different from the screening levels described previously in that they are not applicable to the soil, landfills and fill deposits when managed in place within the Former Reynolds Plant. Rather, this testing was conducted in order to provide information useful in evaluating the costs of different material management options during the FS.

Additionally, the FS (refer to Section 8) considers other potential data screening and evaluation procedures to ensure protection of terrestrial ecological receptors (e.g., birds and mammals) consistent with MTCA regulatory requirements. The terrestrial ecological evaluation (TEE) is described in Section 8 and includes review of soil quality data applicable to MTCA TEE requirements.

5.1.2 Screening Levels for Groundwater

The groundwater contained in the fill soil and shallow silt/clay soils of the Upper Alluvium within the Reynolds Facility is not used as a drinking water source. The fine-grained texture and low hydraulic conductivities of the Upper Alluvium, in conjunction with the upward groundwater gradients between the lower water supply aquifer and the Upper Alluvium, severely limit the potential for this shallow groundwater to impact potential sources of drinking water.

Despite the foregoing, the data screening process for groundwater included consideration of regulatory requirements applicable to groundwater that is used as a drinking water source. Groundwater screening levels are presented in Table 5-1 and include the following:

- **MTCA Method A Groundwater Cleanup Levels** (WAC 173-340-720). These levels consider risks associated with ingestion of drinking water.
- **State Drinking Water Maximum Contaminant Levels** (MCLs; WAC 246-290-310). These levels assume drinking water as the highest beneficial use of groundwater and are typically more stringent than the national drinking water standards.
- **Natural Background.** As with soil screening levels, MTCA regulations consider background chemical concentrations as part of data screening and development of cleanup levels for groundwater.

Throughout most of the Former Reynolds Plant, shallow groundwater has the potential to migrate toward the CDID ditch system or to the Columbia River. As part of the data screening process, groundwater data were also compared against screening levels for surface water (see Section 5.1.3). These screening levels do not directly apply to shallow groundwater located within the Former Reynolds Plant.

5.1.3 Screening Levels for Surface Water

Screening levels for surface water consider both the protection of aquatic life, as well as the protection of potential consumptive surface water uses (e.g., consumptive use). These screening levels are considered when evaluating water quality within the Columbia River, and within the CDID ditch system (see Section 4.2.1). These screening levels are conservatively evaluated for water quality within the CDID ditch system because water contained in that system is periodically discharged into the Columbia River. The CDID ditches are considered waters of the state subject to protection at applicable surface water quality guidelines. The Columbia River includes fish and other potential aquatic receptors, and is additionally designated for water supply uses. Surface water screening levels do not apply to the on-site ditch system that is part of the NPDES permitted water management system for the Former Reynolds Plant (see Section 4.2.2). That system is subject to treatment, discharge and monitoring requirements of the NPDES program.

Surface water screening levels presented in Table 5-1 were assembled based on MTCA procedures for establishing cleanup levels. Accordingly, these values presented represent the most stringent of the available criteria from the following Applicable or Relevant and Appropriate Requirements (ARARs):

- **State Surface Water Quality Standards** (WAC Chapter 173-201A). These standards are based on protection of aquatic life in freshwater as evaluated using chronic exposure scenarios for sensitive aquatic receptors.
- **The National Toxics Rule** (40 Code of Federal Regulations [CFR] Part 131). The National Toxics Rule provides chemical-specific, numeric criteria protective of human health and aquatic life.
- **State Drinking Water MCLs** (WAC Chapter 246-290). The MCLs are used where applicable. The MCLs are protective of potential consumptive use of surface water.
- **Natural Background.** As with soil and groundwater screening levels, MTCA regulations and other state and federal rules consider background chemical concentrations as part of data screening and the development of cleanup levels for surface water.

5.1.4 Screening Levels for Sediment

The SMS (WAC Chapter 173-204; as updated by Ecology in February 2013 [Ecology 2013a]) include numeric chemical criteria and bioassay testing criteria applicable to freshwater sediments. These criteria were used as screening levels for sediments within the Columbia River.

The development of cleanup levels under the SMS rule also considers the limitations (e.g., quantitation limits) of chemical testing methods, potential natural and regional background influences on sediment quality, and adjustments for certain bioaccumulative compounds to ensure protection of human health. These other considerations are evaluated further as part of Section 8 of the FS. Sediment screening levels and biological testing criteria are presented in Table 5-1, and include the SMS sediment cleanup objective (SCO) and the cleanup screening level (CSL).

5.2 Testing Results for Soils, Landfills, and Fill Deposits

Extensive testing was conducted during the RI/FS for soils throughout the Former Reynolds Plant. This testing program also included evaluation of the contents of three landfills and the other fill deposits present within the Former Reynolds Plant. The figures and plates in this section summarize these data together. Detailed testing data are presented in the data tables by type of media. The following testing data are presented in this section:

- **Testing of Landfill and Constructed Fill Deposits.** Three landfills and four fill deposits were constructed within the Former Reynolds Plant for management of construction debris, industrial materials, spent lime and residual carbon (see Tables 5-2 through 5-9 for detailed testing data). These materials were tested extensively to document their contents and to provide a basis for evaluating the protectiveness of their current conditions. Testing was also conducted to inform the FS evaluation of potential material management options.
- **Geochemical Testing.** Specialized testing was performed within the fill deposits containing spent lime and residual carbon, and within soils to inform the evaluation of fluoride fate and transport properties. These geochemical testing data are presented in Section 5.2.10. The detailed evaluation of these data is conducted in Section 6. The geochemical testing data are presented in Tables 5-9 (SPLP testing results), 5-10 (lysimeter testing results) and 5-11 (soil geochemical testing results).
- **Testing of Soils.** RI/FS testing data for other facility soils are presented in Tables 5-12 through 5-17. These data include testing of soils located adjacent to landfills and fill deposits, and testing in localized areas identified by Ecology. The scope of testing for these samples varies based on Ecology-specified information needs developed as part of the RI/FS Work Plan process. As described in Section 3, the areas targeted for soil testing included the following:
    - The field north of Industrial Way (north field area)
    - The field southwest of the Cable Plant
    - The northwest site area

- The former flat storage area
- Fill in the former casting pits
- Soils in the HTM Oil Area
- Soils adjacent to Landfill #3 (construction debris)
- Outfall drainage areas near facility Outfalls 003 and 005
- Former thin stillage application areas

Results of testing for soil, landfill and fill deposit materials are described in the following subsections. For ease in readability, the discussion is organized by testing parameter.

5.2.1 Cyanide

As part of the RI/FS, extensive testing was conducted for cyanide in soil, landfill contents and fill deposits. Cyanide testing was performed because (as described in Section 2.2.3) certain aluminum manufacturing byproducts can contain cyanide. During aluminum manufacturing, varying levels of cyanide compounds can be produced when nitrogen in air combines with carbon in the carbonaceous materials of the pot lining. No areas of SPL are known to remain at the facility. Residual carbon (a byproduct of the cryolite recovery process) is managed within closed fill deposits at the facility, but the residual carbon no longer maintains the chemical properties of the original potliner due to the activities conducted during the recycling process, and would not be expected to contain high cyanide levels.

The RI/FS testing for cyanide included both testing for total cyanide and WAD cyanide in soil. The total cyanide measurement includes forms of cyanide that are not available or reactive, as well as the more available forms of cyanide measured by the WAD cyanide test.

As shown on Plate 5-1 and Figure 5-1, total cyanide levels within soils, landfills, and fill deposit materials throughout the Former Reynolds Plant were very low. None of the tested samples exceeded soil screening levels. Measured concentrations in all samples were below both the MTCA soil cleanup levels applicable to industrial sites (MTCA Method C Cleanup Level; 70,000 mg/kg), as well as the more stringent criteria established under MTCA for residential sites (MTCA Method B Cleanup Level; 1,600 mg/kg). As described in Section 8, soil total cyanide levels were below the concentrations considered protective of ecological receptors.

5.2.2 Fluoride

Fluoride can be present in aluminum manufacturing byproducts due to its use in the manufacturing process. As part of the RI/FS, extensive testing was conducted for fluoride in the on-site landfills used to manage floor sweeps, construction debris and other plant materials, and also in the fill deposits used to manage spent lime (Fill Deposit A) and residual carbon (Fill Deposits B-1, B-2, and B-3). Extensive testing was also conducted in other facility soils. Results of that testing are summarized on Plate 5-2 and on Figure 5-2.

Consistent with the typical properties of spent lime and residual carbon from the aluminum manufacturing process, fluoride levels within the landfills and fill deposits typically ranged between 1 and 9 percent. These concentrations are below the screening levels applicable to industrial land uses (MTCA Method C soil cleanup levels; 210,000 mg/kg). This means that the concentrations of fluoride in these materials are protective of on-site workers.

1. 1,600 mg/kg = MTCA Method B soil cleanup level (WAC 173-340-740)
2. 70,000 mg/kg = MTCA Method C soil cleanup level (WAC 173-340-745)

Soil within the RI/FS Study Area has been extensively tested for total cyanide. None of the soil, landfill, or fill deposit samples tested exceeded screening levels applicable to industrial sites (MCTA Method C cleanup levels). Cyanide concentrations were also well below the more stringent soil cleanup levels applicable to residential properties (green symbols above represent soil samples with cyanide concentrations less than the MCTA Method B residential cleanup level of 1,600 milligrams per kilogram [mg/kg]). Refer to Figure 5-1 and Tables 5-2, 5-9, 5-10, and 5-12 for detailed testing results.

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Plate 5-1

RI/FS Soil, Landfill and Fill Deposit Testing Results - Total Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Fluoride is present within the spent lime and residual carbon managed in the on-site landfills and fill deposits at the Reynolds Facility. Soil testing has shown that outside of these defined fill areas fluoride concentrations comply with residential soil cleanup levels (green symbols above show soil samples with fluoride concentrations less than the MTCA Method B residential soil cleanup levels). None of the landfill or fill deposit samples (blue symbols) exceeded the soil cleanup levels (MTCA Method C) applicable to industrial sites. Results confirm that fluoride is contained within the managed fill areas and that site soils are safe for on-site industrial workers. Refer to Figure 5-2 and Tables 5-2, 5-9, 5-10, 5-11, and 5-12 for detailed testing results.

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Plate 5-2

RI/FS Soil, Landfill and Fill Deposit Testing Results - Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

In areas outside of the landfills and fill deposits, fluoride concentrations were very low. In these other areas of the Former Reynolds Plant, all measured fluoride concentrations were below the MTCA Method B residential screening level of 4,800 mg/kg. These residential criteria are not applicable to the Former Reynolds Plant given its zoning and its long history of industrial uses. However, they provide a point of reference for how low the fluoride levels are in soils outside of the landfills and fill deposits.

As described in Section 8, the existing fluoride concentrations in soils throughout the facility were evaluated for potential risks to terrestrial ecological receptors. The only materials that exceeded protective levels for fluoride are the materials contained within the closed fill and landfill deposits. These materials are currently capped. Options for the long-term management of these fill and landfill deposits are discussed further as part of the FS.

Evaluation of groundwater data (see Section 5.3) indicates that the soil quality outside of the landfills and fill deposits is protective of groundwater quality. Groundwater fluoride concentrations do not exceed applicable screening levels except in the immediate vicinity of these landfills and fill deposits.

5.2.3 Polycyclic Aromatic Hydrocarbons

Extensive testing of soil, landfill materials and fill deposits was performed for PAH compounds. These compounds are present in the carbonaceous materials used to construct the anodes and pot linings used in the aluminum manufacturing process. In particular, the pitch-based binder material used for constructing anodes tends to contain elevated concentrations of these compounds. These compounds are typically elevated in the residual carbon managed in the on-site fill deposits, and in other materials managed in the on-site landfills.

Plate 5-3 and Figure 5-4 summarize the results of RI/FS testing for PAH compounds, specifically the carcinogenic polycyclic aromatic hydrocarbon (cPAH) compounds that have the most stringent screening levels. Both Method A Industrial Soil Cleanup Levels (which are based on default groundwater protection assumptions that may not be applicable to the facility) and Method C Industrial Soil Cleanup Levels (which ensure protection of industrial workers) are available and are used to screen the data on Plate 5-3. As shown on Plate 5-3, cPAH concentrations were elevated in certain areas of the Former Reynolds Plant. Areas with cPAH concentrations in subsurface soils exceeding applicable screening levels included the following:

- Landfills #1, #2, and #3 (floor sweeps landfill, industrial landfill, and construction debris landfill)
- Fill Deposits B-1, B-2, and B-3 (residual carbon deposits)
- Northeast corner of the former flat storage area
- Soils near the cryolite area ditches (testing data from pre-RI/FS studies)
- Soil in and near the former stockpile area (testing data from pre-RI/FS studies)

With the exception of a single localized soil sample in the northeast corner of the former flat storage area, the only soil samples that exceeded the Method C Industrial Soil Cleanup Levels for cPAH (yellow sampling data on Plate 5-3) are the subsurface soils contained within Landfill #1 (floor sweeps) and Landfill #2 (industrial), and in the fill deposits containing residual carbon (Fill Deposits B-1, B-2, and B-3). These landfills and fill deposits are currently contained and do not present an exposure risk to on-site industrial workers. The one sample in the flat storage area that exceeded Method C Industrial Soil Cleanup Level exceeded the cleanup level only slightly, and three samples within 50 feet of that location were below this soil cleanup level. These factors indicate that the elevated cPAH concentrations in this location are extremely localized and are not likely to impact on-site industrial workers.

In addition to evaluating the soil PAH concentrations against cleanup levels protective of on-site workers as described above, soils were screened against default cleanup levels intended by Ecology to ensure protection of groundwater quality. Soils and fill materials exceeding the MTCA Method A Soil Cleanup Level for Industrial Sites (blue data symbols shown on Plate 5-3) were present in additional areas including Landfill #3 (construction debris) and in soils near the Cryolite Area ditches and the Former Stockpile Area. The Method A Soil Cleanup Level is based on default parameters for the protection of groundwater that may not be applicable to the facility. Groundwater data for PAH compounds (see Section 5.3) indicate that these compounds have very limited mobility under facility conditions and these generally do not exceed screening levels in shallow groundwater at the facility. Naphthalene (one of the non-carcinogenic PAH compounds) exceeded the

MTCA Method A cleanup level (also based on default parameters for protection of groundwater quality) within selected samples in some of the same deposits containing elevated cPAH compounds. Method A exceedances for naphthalene were noted in samples from Landfill #1, Landfill #2, and from Fill Deposits B-1 and B-3 (residual carbon). None of the samples exceeded MTCA cleanup levels based on direct-contact exposures for residential or industrial land uses. See Figure 5-6 for a summary of the naphthalene results in soils, landfills, and fill deposit materials.

Soil concentrations of PAH (including both cPAH and naphthalene) did not exceed applicable screening levels in other portions of the Former Reynolds Plant or the Northwest Alloys property located north of Industrial Way. The areas that complied with PAH screening levels included the following:

- Northwest Alloys property located north of Industrial Way
- Stormwater drainage areas near facility Outfalls 003 and 005
- Agricultural field southwest of the former Cable Plant
- Casting pit fill soils
- Materials within fill deposit A (spent lime)
- Soils located between Landfill #3 (construction debris) and the Columbia River
- Soils within the footprint of the former cryolite plant (pre-RI/FS sampling data)

In summary, the results of testing indicate that PAH concentrations in site surface soils are protective of industrial workers, with the exception of one localized exceedance in the northeast corner of the flat storage area. Management of soils in that portion of the flat storage area is addressed in the FS. In other portions of the facility, elevated PAH concentrations are limited to the subsurface soils contained within the landfills and residual carbon fill deposits. Industrial workers are not exposed to these soils during regular on-site work activities.

As described in Section 8, the PAH concentrations in areas outside of the landfill and fill deposits are protective of ecological receptors. Groundwater testing data are summarized in Section 5.3 and indicate that except within certain landfill and fill deposits, PAHs are not elevated in shallow groundwater at the Former Reynolds Plant.

TEQ = Benzo(a)pyrene Toxicity Equivalent
1. 2 mg/kg = MTCA Method A soil cleanup level for industrial soil (WAC 173-340-745)
2. 18 mg/kg = MTCA Method C soil cleanup level for industrial soil (WAC 173-340-745)

Samples of soil, landfill contents, and fill deposits throughout the Reynolds facility have been tested extensively for carcinogenic PAH (cPAH) compounds. In most facility areas, these parameters are present at concentrations below applicable industrial site screening levels (MTCA Method A and Method C industrial soil screening levels, as designated by the green and blue symbols above). Concentrations exceeding the industrial soil screening levels (MTCA Method C cleanup levels for industrial sites or 18 mg/kg; designated by the yellow symbols above) are present in the residual carbon and landfill materials managed in the on-site landfills and fill deposits. A localized exceedance is also located in the northeastern corner of the flat storage area.
Refer to Figure 5-4 and Tables 5-5 and 5-14 for detailed cPAH testing results.

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Plate 5-3
RI/FS Soil, Landfill and Fill Deposit Testing Results - cPAH
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

5.2.4 Polychlorinated Biphenyls

Testing for PCBs was conducted as part of the RI/FS. As noted in Section 2, the aluminum manufacturing operations at the Former Reynolds Plant did not include the types of operations (e.g., rolling mills) that have been associated with PCB impacts at other aluminum manufacturing sites. The RI/FS included targeted testing within the footprint of former electrical facilities (rectifier yards) as well as testing within the landfills, fill deposits and stormwater drainage areas.

Results of PCB testing are shown on Plate 5-4 and Figure 5-5. The green symbols shown on Plate 5-4 represent soil and fill samples with total PCB (Aroclors) concentrations less than the MTCA Method A screening level applicable to industrial sites (10 mg/kg). None of the measured soil concentrations exceeded this Method A screening level.

As described in Section 8, the measured PCB concentrations were all less than the levels considered protective of terrestrial ecological receptors. As described in Section 5.3, PCBs have not been detected in any of the groundwater samples.

Soils within the RI/FS Study Area have been extensively tested for PCBs, including soils near former electrical equipment (recitfier yards), soils in stormwater drainage areas, and samples of landfill and fill deposit materials. None of the soil, landfill, or fill deposit samples tested exceeded screening levels applicable to industrial sites (MTCA Method A industrial soil cleanup levels). Refer to Figure 5-5 and Tables 5-5 (landfill and fill deposit samples) and 5-15 (soil samples) for detailed testing results.

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Plate 5-4

RI/FS Soil, Landfill and Fill Deposit Testing Results - Total PCBs (Aroclors)
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

5.2.5 Metals and TCLP Metals

The RI/FS testing program included extensive testing of soils, landfills, and fill deposits. Results of testing for heavy metals are summarized in Tables 5-3 (landfill materials and fill deposits) and 5-13 (other facility soils). Results confirm that concentrations of heavy metals are very low within the Former Reynolds Plant.

As described in the following bulleted list, with the exception of localized metals exceedances in the landfill deposits, concentrations of heavy metals were below screening levels applicable to industrial sites:

- **Fill Deposits A (spent lime) and B-1, B-2, and B-3 (residual carbon).** No exceedances of screening levels were noted for 13 of the 14 heavy metals, including antimony, arsenic, barium, beryllium, cadmium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc (see Table 5-3). Total chromium concentrations in most fill deposit samples were below the natural background concentrations (42 mg/kg) estimated by Ecology for the state of Washington (Ecology 1994). A single sample of residual carbon contained chromium (43.1 mg/kg) in excess of this value. This result is not statistically significant as defined under MTCA compliance monitoring requirements (WAC 173-340-740). The detected chromium concentration was also well below the screening level based on chromium III (2,000 mg/kg), which is the most common form of chromium.
- **Landfill #1 (floor sweeps) and Landfill #2 (industrial landfill).** Heavy metals concentrations generally complied with screening levels in the tested landfill contents (see Table 5-3). No exceedances were noted for 11 of the 14 heavy metals tested, including antimony, barium, beryllium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc. Sporadic exceedances were noted for arsenic, cadmium and chromium. For arsenic all samples were below both the Method A and Method C industrial soil screening levels, and only 1 of 10 samples exceeded the Method A screening level. Cadmium slightly exceeded (by less than two-fold) the Method A screening levels (2 mg/kg) in three of ten samples tested. Chromium concentrations exceeded the natural background concentrations for total chromium (42 mg/kg; Ecology 1994) in five of ten samples but were below the screening level based on chromium III (2,000 mg/kg, the most common form of chromium) in all samples.

- **Rectifier Yard Soils**. Soils in the rectifier yards were tested for mercury (to verify that historical use of mercury-containing electrical components did not result in impacts to site soils). No mercury was detected in these soil samples (see Table 5-13).
- **Drainage Area Soils**. Heavy metals tested in stormwater drainage area soils (in the vicinity of Outfalls 003 and 005) were below screening levels for 9 of 10 metals, including antimony, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc (see Table 5-13). Arsenic concentrations near Outfall 5 were below screening levels. The sample collected adjacent to the CDID ditch (sample AQ-OF5D; see Figure 5-3) and the sample collected near Outfall 003 were both intermediate between the MTCA Method A and Method C cleanup levels.

In addition to the testing of heavy metals in the soil, landfill and fill deposits, Ecology requested that the landfill and fill deposit materials be evaluated for TCLP metals. This test is not used as part of MTCA cleanup level evaluations. Rather, the TCLP metals test is used under state and federal regulations to determine whether soils or other materials designated for off-site management require special management under State Dangerous Waste or Federal Hazardous Waste regulations. Bioassay tests are also used by the State of Washington as part of this classification process. Bioassay tests were performed on landfill and fill deposit samples described as follows:

- **TCLP Testing Data (see Table 5-4).** Four fill deposit samples and 8 landfill samples were tested for TCLP metals. No exceedances of test criteria were noted in any of the samples.
- **Waste Bioassay Testing.** As an additional verification step, one sample from each of the fill deposits and from Landfills #1 and #2 were tested under the Washington state bioassay test used by Ecology as part of state waste classification procedures. No toxicity was measured in any of the test samples, indicating that none of the samples tested would characterize as Dangerous Waste under Washington State criteria (WAC 173-303-100). Results of bioassay testing are contained in Appendix F.

5.2.6 Total Petroleum Hydrocarbons

Testing for petroleum hydrocarbons was performed in several areas of the Former Reynolds Plant during the RI/FS. Exploratory testing was performed in the rectifier yards, the field southwest of the Cable Plant, and in the three landfills and in Fill Deposit B-1 and B-2. Follow-up testing was also performed within the HTM Oil Area. No areas of petroleum exceeding applicable screening levels were identified during that testing, as summarized in the following:

- **Rectifier Yard Soils.** Seven samples from the rectifier yards (at RY1, RY2, RY3, RY4, RY5, and RY6) were analyzed for petroleum. None of these samples exceeded the soil screening levels (see Table 5-16).
- **Field Southwest of the Cable Plant.** Two samples from the field southwest of the cable plant (at AQ-SSA1-03 and -06) were analyzed for petroleum. Neither of these samples exceeded the soil screening levels (see Table 5-16).
- **Landfill #3 (construction debris).** Testing for petroleum was performed in the construction debris landfill using the hydrocarbon identification (HCID) and NWTPH-Dx methods. Based on TPH-HCID detections for two samples from Station AQ-SSA7-05 in the Landfill #3 (construction debris) area (see Table 5-7), these samples were selected for follow-up analysis via NWTPH-Dx. Petroleum concentrations in both samples were below the soil screening levels.
- **Landfills #1 (floor sweeps) and #2 (industrial) and Fill Deposits B-1 and B-2 (residual carbon).** Samples of selected landfill and fill deposit materials from Landfill #1 (floor sweeps), Landfill #2 (industrial landfill), and Fill Deposits B-1 and B-2 containing residual carbon were initially submitted for petroleum testing using both the NWTPH-Dx and EPH analytical methods. The two tests were performed to provide multiple lines of evidence to help distinguish between petroleum hydrocarbons and the PAH-containing carbonaceous materials known to be present in these deposits. These landfills and fill deposits all contained carbonaceous aluminum manufacturing byproducts and elevated PAH concentrations (see Section 5.2.3). Results of the petroleum analysis were flagged by the analytical laboratory as being inconsistent with the properties of petroleum. A detailed review of the chromatogram traces indicated that the results of these tests did not contain petroleum hydrocarbons, and that results were not valid due to interference from PAH compounds present in the samples. The findings confirm that no petroleum was present at elevated concentrations in these materials. A full discussion of the NWTPH-Dx data and chromatogram analysis for these samples is provided in Appendix F.

- **HTM Oil Area.** Twenty-seven soil samples from the HTM Oil Area were analyzed for petroleum hydrocarbons. TPH concentrations for five samples from the HTM Oil Area exceeded the default MTCA Method A soil screening level (2,000 mg/kg for the sum of diesel and oil-range hydrocarbons). Based on the NWTPH-Dx results, three soil sample intervals were analyzed using the Washington State EPH method to provide information for developing site-specific TPH cleanup levels protective of groundwater and direct contact for the HTM Oil Area. Results of EPH testing were used along with Ecology's TPH Workbook to develop a site-specific cleanup level (Ecology 2007, 2011; see Appendix G). Results indicated that the petroleum concentrations tested were below levels protective of direct contact risk and of groundwater quality. A site-specific soil cleanup level of 12,050 mg/kg was developed based on protection of direct contact for unrestricted land use and for protection of groundwater quality (see Appendix G). None of the measured soil petroleum concentrations exceeded this value. Additionally, groundwater testing has been performed in this area (see Section 5.3), and no impacts to groundwater have been detected.

5.2.7 Volatile Organic Compounds

Testing was performed for VOCs during the RI/FS (see Table 5-8 and Figure 5-7). No chlorinated solvents or other typical VOCs were identified in excess of applicable screening levels (see Table 5-8). These results are consistent with findings from groundwater studies (see Section 5.3), which do not indicate VOC impacts in facility groundwater.

Soil testing performed during 2006 included testing of fill samples from Landfills #1 (floor sweeps) and #2 (industrial landfill). No VOCs exceeded applicable screening levels in these samples.

During 2012, additional testing was performed on 17 samples of landfill materials from Landfill #1 (floor sweeps), Landfill #2 (industrial landfill) and Fill Deposits A (spent lime), and B-1, B-2, and B-3 (residual carbon). No chlorinated solvents or other typical VOCs exceeded applicable screening levels in these samples other than naphthalene.

Based on separate testing of PAH compounds using the SVOC test method (see Section 5.2.3 and Figure 5-6), naphthalene is known to be present in the landfills and fill deposits. Naphthalene is a PAH compound associated with the carbonaceous aluminum manufacturing byproducts, and it is included within the list of analytes that can be measured using the VOC test method. Naphthalene concentrations measured in two samples tested using the VOC test method exceeded the soil screening level (MTCA Method A cleanup level). This included one sample from Landfill #1 (floor sweeps) and one sample from Landfill #2 (industrial). These results are consistent with the findings of the testing performed using the SVOC test method.

5.2.8 Pesticides

As part of the comprehensive nature of the RI/FS testing program, the RI/FS included testing for pesticides in fill samples from the Old Industrial Landfill and Floor Sweeps Landfill. Pesticides were not detected in either sample.

5.2.9 Nutrients

During operation of the facility by CVI, thin stillage (an agricultural byproduct from ethanol manufacturing that is sometimes used as cattle feed) was applied to a portion of the field located southwest of the Cable Plant. Consistent with Ecology requirements, nutrient testing was performed to determine if soils in this area had high residual levels of nutrients (elevated levels of the nutrients nitrogen and phosphorous can be present in thin stillage). Testing included analysis of eight test samples from the thin stillage application areas, and two unaffected samples from clean reference areas where no thin stillage was applied. Test parameters included ammonia, nitrate, phosphorous, potassium, total Kjeldahl nitrogen, total organic carbon, and TS.

Results of nutrient testing are summarized in Table 5-17. The range of nutrient concentrations in the test samples was not significantly different from the concentrations of nutrients in the reference samples.

5.2.10 Soil Geochemical Testing

Fluoride in groundwater can geochemically interact with soils, immobilizing fluoride or retarding its movement. To assess the potential effects of facility soils on fluoride fate and transport, specialized geochemical testing was performed in selected portions of the Former Reynolds Plant. Geochemical testing included the following:

- **Soil SPLP Testing.** Several samples of soil were tested using the SPLP. Results from this testing are summarized in Table 5-9.
- **Lysimeter Testing.** Lysimeters were installed in several of the fill deposits containing spent lime and residual carbon in order to develop a direct measurement of the concentrations of fluoride and cyanide in the soil porewater. These lysimeters were placed directly in the lime and carbon materials containing elevated fluoride. Testing also included measurement of pore-water geochemical properties useful for evaluating fluoride fate and transport processes. Lysimeter testing data are summarized in Table 5-10 and as follows:
  - **Cyanide.** Free cyanide concentrations measured in the lysimeters were very low, ranging from non-detect (less than 0.0005 milligrams per liter [mg/L]) to 0.00822 mg/L. These concentrations are well below the groundwater screening levels (MCL; 0.2 mg/L). These results are consistent with the results of groundwater testing, which has shown very low or non-detectable groundwater cyanide concentrations even in wells located within or adjacent to the fill deposits.
  - **Fluoride.** Lysimeter testing included three rounds of fluoride analysis. The fluoride concentrations measured in the different lysimeters ranged from 53.8 mg/L to 164 mg/L. The highest concentrations were measured in Fill Deposit B-2, which also had the highest measured groundwater fluoride concentrations (see Section 5.3.2).
  - **Geochemical Parameters.** Geochemical parameters measured in the lysimeters included aluminum, calcium, iron, magnesium, manganese, potassium, silicon, and sodium, and groundwater pH and redox potential. The pH was highest in the spent lime deposits, which is consistent with the known properties of this material. Refer to Table 5-10 for detailed testing results.
- **Geochemical Test Borings.** Four test borings were placed within and downgradient of Fill Deposit B-2, located east of the former Cryolite Recovery Plant. These borings

were used to collect soil test samples for specialized geochemical testing. Soil samples from the borings were initially tested for fluoride, TOC, pH, and TS. The data from these analyses are presented in Table 5-11. Geochemical test boring results confirmed the presence of soils and fill materials containing elevated fluoride and carbon concentrations in the upper samples from the first three borings (GC-SB-01, GC-SB-02, and GC-SB-03). The concentrations of fluoride in the shallow soil samples from these borings ranged up to 54,000 mg/kg. Below 7.5 feet bgs, the fluoride concentrations decreased rapidly with depth. Fluoride concentrations in the soils beneath the fill deposit and in the boring (GC-SB-04) located north of the deposit were very low, typical of background soil concentrations. Subsamples from the geochemical test borings were used for evaluation of soil geochemical properties. That work is described separately in Section 6.2 and in Appendix H.

5.3 Testing Results for Groundwater

Testing of groundwater was conducted over a series of multiple sampling events. The primary sampling events occurred in September and October 2006, July 2011, October 2011, and October 2012. Specific testing parameters varied with sampling event, consistent with Ecology testing requirements defined in the RI/FS Work Plan and Addenda (see Section 3).

Groundwater data are presented in tabular format for the West Groundwater Area (see Tables 5-18a to 5-18f) and for the East Groundwater Area (see Tables 5-19a to 5-19e). Sampling data are presented in the figures (see Figures 5-8a through 5-12) at the end of this section. Key findings are summarized in the plates within the section and are described below.

5.3.1 Cyanide

Groundwater cyanide concentrations within the Former Reynolds Plant are very low and have decreased over time. Testing has included measurements of total, WAD, and free cyanide, and testing of both unfiltered and filtered groundwater samples.

In the West Groundwater Area, none of the groundwater samples collected during any of the RI/FS sampling events (during 2006, 2011, and 2012) exceeded the groundwater MCL

(0.2 mg/L) for free cyanide (see Table 5-18 b). Concentrations of free cyanide also exhibited a decrease between 2006 and the 2011 and 2012 sampling events. As shown on Plate 5-5, the green data symbols indicated that 2012 free cyanide concentrations in all West Groundwater Area samples were below both the groundwater screening levels (0.2 mg/L) and surface water screening levels (0.0052 mg/L). Cyanide testing results are presented for 2006, 2011, and 2012 sampling events on Figures 5-8a through 5-8e.

In the East Groundwater Area, concentrations of free cyanide also exhibited a substantial decrease between 2006 and the 2011 and 2012 sampling events. One of the groundwater samples (location PZ-5 located near the Former Stockpile Area) slightly exceeded the groundwater MCL in 2006, but concentrations decreased significantly by the 2011 and 2012 sampling events. During 2011 and 2012, none of the free cyanide results in the East Groundwater Area (see Table 5-19 b) exceeded the groundwater MCL (0.2 mg/L). As shown on Plate 5-5, the 2012 free cyanide concentrations in most East Groundwater Area samples were below both the groundwater screening level (0.2 mg/L) and surface water screening level (0.0052 mg/L). Only three locations (two near the former Stockpile Area and one near Landfill #1 (floor sweeps) remained in excess of the surface water screening levels (refer to the blue data symbols on Plate 5-5). Wells located downgradient of these locations are clean (as shown by the green data symbols on Plate 5-5), with free cyanide concentrations less than the surface water screening level. These results confirm that groundwater is protective of water quality in the adjacent CDID ditches. Refer to Table 5-19b and Figures 5-8a through 5-8e for detailed testing results.

Groundwater within the Reynolds Facility has been tested extensively for cyanide, including testing of wells screened at the water table and at deeper intervals within the silty/clay of the upper alluvium (testing locations at paired wells are shown by the stacked boxes above). Cyanide concentrations in all of the groundwater samples tested in 2011 and 2012 were well below the safe drinking water standard (groundwater MCL, 0.2 milligrams per liter [mg/L]). Testing also confirmed that cyanide concentrations in groundwater in downgradient locations near the CDID ditches and along the Columbia River comply with water quality levels established for protection of fish and aquatic life. Refer to Figures 5-8a through 5-8e and Tables 5-18b and 5-19b for detailed testing results.

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Plate 5-5

RI/FS 2012 Groundwater Testing Results - Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

5.3.2 Fluoride

Groundwater fluoride concentrations within most of the Former Reynolds Plant are below groundwater screening levels. The exception to this is the shallow groundwater located within or immediately adjacent to the existing landfills and fill deposits. Groundwater testing was performed during 2006, 2011 and 2012 to document current fluoride distribution. Testing included sampling of both total and dissolved fluoride. Detailed sampling results are presented in Tables 5-18b and 5-19b, and on Figures 5-9a through 5-9e. Data from the most recent events in 2012 are summarized on Plate 5-6 for total fluoride. Green data symbols on that Plate and on Figures 5-9a through 5-9e represent groundwater fluoride concentrations that are below the drinking water MCL (4.0 mg/L).

In the West Groundwater Area, the highest concentrations of fluoride are measured in wells located within Fill Deposit B-3 and adjacent to Landfill #2 (industrial landfill), and in the wells located immediately downgradient of the Closed BMP Facility (see Plate 5-6). Additional details regarding West Groundwater Area fluoride concentrations are as follows:

- Concentrations of fluoride in the wells located adjacent to the Closed BMP Facility have been decreasing over time as documented during the groundwater post-closure monitoring (refer to the groundwater trend analysis in Appendix B). This decrease confirms that the closure of that facility is functioning as expected.
- Concentrations of fluoride in groundwater within and adjacent to Landfill #2 and Fill Deposit B-3 attenuate rapidly with distance from the fill materials. The concentrations of fluoride in wells located within or immediately adjacent to the deposits (RLSW-1, RLSW-2 and RLSW-3 and G6-S; see Figures 5-9a through 5-9e) are similar to the fluoride concentrations measured in lysimeters placed within the deposits. In contrast, fluoride concentrations in the well pair located just downgradient of the deposits, adjacent to the CDID ditch (RL-1S and RL-1D) are very low. The deeper well in the pair complies with the groundwater MCL (4 mg/L) and the fluoride concentration in the shallower groundwater well is roughly ten-fold lower than the fluoride concentration measured in wells immediately adjacent to the fill deposit.

Groundwater within the Reynolds Facility has been tested extensively for fluoride. The mobility of fluoride in groundwater is limited by: 1) the geochemical properties of the area soils; and 2) the upward groundwater gradients between the deeper aquifer and the thick layer of silt and clay soils (upper alluvium) on which the facility is located. Elevated fluoride levels (blue, yellow, and purple symbols above) are present only in the shallow groundwater located immediately adjacent to the landfills and fill deposits. The groundwater quality in downgradient areas, and all deep water supply wells (results not shown) are below the screening levels protective of drinking water (green symbols above indicate groundwater fluoride concentrations less than the MCL of 4 milligrams per liter [mg/L]). Refer to Figures 5-9a through 5-9e and Tables 5-18b and 5-19b for detailed testing results.

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Plate 5-6

RI/FS 2012 Groundwater Testing Results - Total Fluoride
Remedial Investigation/Feasibility Study
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In the East Groundwater Area, groundwater monitoring data show that fluoride concentrations attenuate rapidly with distance from the fill and landfill deposits, which are summarized as follows:

- **Fill Deposit A (spent lime) and B-1 (residual carbon).** Groundwater concentrations immediately downgradient of these deposits comply with the groundwater MCL (see well pair G4-S and G4-D on Figures 5-9a through 5-9e). This is more than 10-fold to 20-fold lower than the concentrations of fluoride measured in the lysimeters within the fill deposits.
- **Landfill #1 (floor sweeps).** Two well pairs are located immediately adjacent to this landfill (less than 10 feet from the landfill contents). In both well pairs, the deeper groundwater samples comply with the groundwater MCL, and the fluoride concentration in the shallower groundwater samples slightly exceed the MCL.
- **Fill Deposit B-2 (residual carbon).** The highest groundwater fluoride concentrations within the Former Reynolds Plant are located within Fill Deposit B-2, located just east of the former Cryolite Recovery Plant. The groundwater wells in this area are located within the fill deposit and immediately adjacent to the former Stockpile Area and cryolite area ditches. Groundwater in this area has elevated alkalinity, which enhances fluoride solubility. In contrast, the groundwater fluoride concentrations immediately downgradient of this deposit (Well R-2; see Figures 5-9a through 5-9e) are consistently below the MCL, showing that fluoride in this area is relatively immobile.
- **Landfill #3 (construction debris).** One well is located adjacent to Landfill #3. The fluoride concentration in this well (SSA7-MW01; see Figures 5-9a through 5-9e) slightly exceeds the MCL.

Taken together with other RI/FS monitoring data, the groundwater data for fluoride demonstrate that the closure of the Closed BMP Facility has been effective, and that the elevated fluoride present in shallow groundwater adjacent to the other landfill and fill deposits is localized and relatively immobile. The higher concentrations of fluoride present within Fill Deposit B-2 appear to be a function of the fill deposits and the geochemical properties of this area, including the elevated alkalinity of groundwater.

Groundwater fluoride concentrations attenuate rapidly with depth and with distance laterally from these landfills and fill deposits. This has been observed in all areas of the Former Reynolds Plant, including the areas near Fill Deposit B-2. Surface water monitoring (see Section 5.4) demonstrates that the fluoride present in the shallow groundwater is not impacting water quality in the adjacent CDID ditches located downgradient from the Former Reynolds Plant.

Section 6 presents the results of an expanded analysis of the factors limiting fluoride mobility in the Former Reynolds Plant groundwater. That analysis includes analysis of detailed geochemical testing information, and provides estimates of how these natural processes interact to limit fluoride mobility in groundwater under existing conditions. The FS includes additional evaluations of how potential soil and groundwater remediation methods may modify these existing conditions. This understanding is used to inform the evaluation of remedial alternatives as presented in Section 10.

5.3.3 Polycyclic Aromatic Hydrocarbons

As requested by Ecology, groundwater samples from selected locations were analyzed for PAH compounds. Results from each round of sampling (2007, 2011, and 2012) are presented on Figures 5-10a, 5-10b and 5-10c respectively, and in Tables 5-18e and 5-19d. Plate 5-7 shows the maximum concentration of cPAH compounds measured during each of those sampling events.

None of the measured cPAH concentrations from the West Groundwater Area exceeded groundwater screening levels (MTCA Method A groundwater cleanup levels). As shown on Plate 5-7 by the green data symbols, groundwater concentrations of cPAH in the West Groundwater Area were less than both the Method A groundwater cleanup levels, and also the Method B surface water screening levels. Testing locations include wells located immediately adjacent to Fill Deposit B-3 (residual carbon) and Landfill #2 (industrial). No exceedances of either the groundwater screening levels or the surface water screening levels were noted for the groundwater wells located adjacent to the Flat Storage area (see Plate 5-7).

Groundwater within the Reynolds Facility has been tested extensively for carcinogenic PAH (cPAH) compounds. The cPAH concentrations in groundwater samples tested in 2007, 2011, and 2012 were all below the MTCA screening level protective of drinking water quality (MTCA Method A groundwater cleanup level, 0.1 milligrams per liter [mg/L] (expressed as Benzo(a)pyrene toxic equivalents or TEQ) except for three wells. One of these wells were located adjacent to Landfill #1 (Floor Sweeps) and the other two were located within Fill Deposit B-2 (Residual Carbon). Testing confirmed that cPAH concentrations in groundwater in downgradient locations near the CDID ditches and along-side the Columbia River comply with MTCA Method B surface water cleanup levels (0.030 ug/L). Refer to Figures 5-10a through 5-10c and Tables 5-18e and 5-19d for detailed testing results.

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Plate 5-7
RI/FS 2007-2012 Groundwater Testing Results - Total cPAHs as TEQ
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Though naphthalene was detected at elevated soil concentrations within Landfill #2 (industrial) and within Fill Deposit B-3 (residual carbon), no exceedances of groundwater screening levels were noted for this compound. The absence of elevated naphthalene concentrations in the West Groundwater Area is not surprising because of two factors. First, the high organic carbon content of the landfill and residual carbon materials tends to limit naphthalene leachability and thereby minimize the potential for naphthalene to impact shallow groundwater. Second, naphthalene is a biodegradable compound under typical groundwater conditions, which further limits the potential for naphthalene to persist in groundwater.

In the East Groundwater Area, cPAH concentrations during the 2012 sampling events were below the groundwater screening levels (MTCA Method A Groundwater Cleanup Levels; 0.10 micrograms per liter [µg/L]) in all locations except for the wells located immediately within or adjacent to fill deposits. These three localized areas (refer to purple sample data symbols on Plate 5-7) included wells located immediately adjacent to Landfill #1 (floor sweeps) and Fill Deposit B-2 (residual carbon). The cPAH concentration in wells located further downgradient were less than both the groundwater screening level and the surface water screening level (MTCA Method B Surface Water Cleanup Level; 0.030 µg/L), indicating that groundwater quality is protective of surface water quality in the adjacent CDID ditches (refer to green sample data symbols on Plate 5-7).

No exceedances of groundwater or surface water screening levels for cPAH were noted in the well located between Landfill #3 (construction debris) and the Columbia River (see Plate 5-7).

5.3.4 Polychlorinated Biphenyls

As part of the RI/FS testing program, Ecology required testing for PCBs in groundwater at wells located immediately downgradient of the landfills and fill deposits. As summarized on Plate 5-8, no PCBs were detected in any of the groundwater samples analyzed (green sample data symbols on Plate 5-8 indicate non-detect results for PCBs in groundwater). Results of groundwater testing are consistent with PCB sampling in soils, which did not identify any

PCBs in excess of soil screening levels. Refer to Figure 5-11 and in Tables 5-18f and 5-19e for detailed sampling results.

5.3.5 Heavy Metals

Sampling for heavy metals was performed during 2011 and 2012 at selected locations identified by Ecology, and is summarized as follows:

- During July and October of 2011, the dissolved metals arsenic, chromium, copper, and nickel were analyzed at all nine "RL" series monitoring wells in the West Groundwater Area.
- During October of 2012, total and dissolved arsenic, chromium, copper, and nickel were analyzed at well SSA4-MW-01 in the West Groundwater Area and at wells SSA6-MW-01 and SSA7-MW-01 located in the East Groundwater Area.
- Both total and dissolved priority pollutant metals were analyzed at wells located downgradient from the landfills and fill deposits. These wells included locations RL-1S and RLSW-3 in the West Groundwater Area and wells G2-S, G4-S, and R-2 in the East Groundwater Area.

Results from all heavy metals testing events are presented in Tables 5-18c and d (West Groundwater Area) and Table 5-19c (East Groundwater Area). Findings of this testing indicate that groundwater heavy metals concentrations are below applicable screening levels:

- In both the West Groundwater Area and the East Groundwater Area, all dissolved arsenic concentrations were less than the background arsenic concentrations estimated for Cowlitz County. Concentrations of arsenic in regional Cowlitz County supply wells are available from the Washington Department of Health. Available data for the period 2001 to 2011 range up to approximately 55 µg/L, with a median value of approximately 10 µg/L and a 90 percentile value of 42 µg/L.

As part of the RI/FS, Ecology required groundwater samples at selected locations to be tested for the presence of PCBs. No PCBs were detected in any of the groundwater samples analyzed (groundwater samples tested for PCBs and in which PCBs were not detected are indicated by the green symbols above.) Refer to Figure 5-11 and Tables 5-18f and 5-19e for detailed testing results.

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Plate 5-8

RI/FS 2012 Groundwater Testing Results - Total PCB Aroclors
Remedial Investigation/Feasibility Study
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- All other heavy metals testing results for the West Groundwater Area and East Groundwater Area were less than the groundwater screening levels. The only exception was one RI/FS sampling result for dissolved chromium in well RL-2S (66.7 µg/L). That result slightly exceeded the groundwater screening level (50 µg/L; MTCA Method A) for chromium VI but was well below the screening level for chromium III, the more common chromium species. Follow-up testing (see Appendix E) confirmed that no chromium VI was detectable in this well (reporting limit 1 µg/L). Therefore, reported chromium levels in well RL-2S consist primarily of chromium III and do not represent an exceedance of MTCA groundwater screening levels. All other 2011 and 2012 samples were below applicable groundwater screening levels for dissolved chromium, copper, and lead.
- In addition to the data collected for the RI/FS, historical groundwater data collected prior to the RI by CVI (see Appendix C) and collected subsequently by MBTL as part of quarterly monitoring activities were also reviewed. These data, contained in Appendix C, included elevated readings for chromium, nickel, and copper in well RL-5 in the West Groundwater Area and in well R-3 in the East Groundwater Area. These elevated readings were shown to be biased high by the presence of dissolved salts, which are known to cause method interferences with the analytical methods used.
- Follow-up testing using alternative analytical methods that are not adversely affected by dissolved salts (i.e., EPA Method 1640; EPA 1997) demonstrated much lower concentrations, well below applicable groundwater or surface water screening levels. This follow-up testing is described in Appendix E, along with a summary of how the method interference issue was identified and quantified.

5.3.6 Volatile Organic Compounds

As part of the RI/FS testing program, VOCs were analyzed at selected locations within the Former Reynolds Plant. Green sample data symbols on Plate 5-9 indicate locations were VOCs were tested for in groundwater but were not detected. The designated testing locations were located downgradient of landfill and fill deposits as shown on Plate 5-9.

No VOC compounds were detected in any of the groundwater samples analyzed. These results are consistent with the soil VOC testing results, which did not identify any chlorinated solvents or typical VOCs in excess of applicable soil screening levels. Refer to Figure 5-12 and Tables 5-18f and 5-19e for detailed testing results. VOC detection limits were below applicable screening levels for most VOC compounds. VOC detection limits slightly exceeded applicable screening levels for 1,2-dichloropropane, bromodichloromethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,2-dibromoethane, and vinyl chloride. There is no indication that these compounds were used at the Former Reynolds Plant, and none of the parent compounds that can result in production of these compounds (e.g., TCE as a parent compound for vinyl chloride) were detected.

5.3.7 Total Petroleum Hydrocarbons

The RI/FS testing program included analysis for petroleum hydrocarbons in the HTM Oil Area. That testing included installation and sampling of a new groundwater monitoring well (SSA6-MW-01).

Groundwater testing results are presented in Table 5-19f. Testing for this well was performed three times, including in January 2012, October 2012 and December 2012. Measured NWTPH-Dx concentrations (performed with silica gel cleanup) were well below groundwater screening levels. The maximum detected concentration of petroleum in groundwater was 0.23 mg/L (the sum of diesel and oil range TPH), well below the groundwater screening level of 0.5 mg/L. EPH were also tested for this groundwater sample in January 2012. EPH concentrations were below method detection limits.

5.3.8 Groundwater Geochemical Parameters

As part of the RI/FS groundwater testing program, geochemical parameters were analyzed to provide inputs to the evaluation of fluoride fate and transport properties contained within Section 6 of this RI/FS. That testing included analysis of conventional parameters in the field at the time of groundwater sampling and laboratory analysis of geochemical indicator parameters.

As part of the RI/FS testing program, Ecology required testing of groundwater for VOCs in areas located downgradient of certain landfill and fill deposits. No VOCs were detected in any of these groundwater samples. Refer to Figure 5-12 and Tables 5-18f and 5-19e for detailed testing results.

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Plate 5-9

RI/FS 2012 Groundwater Testing Results - VOCs
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Field testing of geochemical parameters included evaluation of groundwater pH. The pH of most groundwater within the Former Reynolds Plant is near neutral, ranging typically between 6 and 8. Alkaline groundwater is located in two areas of the facility. Alkalinity is significant in that it can enhance the solubility of fluoride.

Areas with notable alkalinity in groundwater included the following:

- Shallow groundwater wells PZ-6 and RL-2S located near the Closed BMP Facility have elevated pH values (higher than other West Groundwater Area wells; ranging between 8.4 and 9.8). Analysis of historical trends indicates that the pH in these wells has been decreasing (approaching neutral pH) since closure of the facility.
- In the East Groundwater Area, alkaline groundwater was present in the vicinity of the Former Stockpile Area and Fill Deposit B-2. Groundwater pH in this area ranged from 8.35 to 10.51. This alkalinity correlates with higher fluoride solubility in groundwater in this area.

Results of other geochemical testing are included in Table 5-18a (West Groundwater Area) and 5-19a (East Groundwater Area). These results are discussed further as part of the fate and transport analysis in Section 6.

5.4 Testing Results for CDID Ditches and Surface Water

The RI/FS testing program included extensive testing of surface water quality within the Columbia River and CDID ditches within the RI/FS Study Area. Surface water samples were collected from these areas during the 2006, 2011, and 2012 sampling events. The ditch and surface water results are presented in Table 5-20, and on Figures 5-13a, 5-13b, 5-14a, and 5-14b. Key findings are discussed as follows.

5.4.1 Cyanide

Testing for cyanide was conducted within the Columbia River and the CDID ditches within the RI/FS Study Area. Testing included analysis of total, WAD cyanide, and free cyanide. Free cyanide results were compared to surface water screening levels (State of Washington water quality criteria).

None of the surface water samples exceeded surface water screening levels for free cyanide during the 2006, 2011 or 2012 sampling events. Plate 5-10 shows the results of the 2012 sampling event which was the most extensive. Green sample data symbols in that figure represent sampling locations at which free cyanide was tested for but was not detected above the surface water screening level (0.0052 mg/L).

Results of cyanide testing in surface water confirm that conditions within the Former Reynolds Plant do not exceed surface water quality criteria for COCs. Refer to Table 5-20 and to Figures 5-13a and 5-13b for detailed testing results.

5.4.2 Fluoride

Extensive testing was performed for fluoride in surface water samples from the Columbia River and CDID ditches located within the RI/FS Study Area. The testing program included evaluation of both total and dissolved fluoride concentrations. Testing was performed during 2006, 2011, and 2012.

Results of surface water testing confirm that surface water quality in the Columbia River and CDID ditches does not exceed surface water quality criteria for the COCs. The fluoride concentrations in all RI/FS surface water testing samples were below the applicable surface water screening level (groundwater MCL, 4 mg/L). Concentrations of fluoride in the Columbia River samples were consistently below 0.2 mg/L. Refer to Plate 5-11, Table 5-20, and to Figures 5-14a and 5-14b for detailed testing results.

5.4.3 Geochemical Testing Parameters

As part of the RI/FS testing program, surface water samples from the Columbia River and from the CDID ditches were analyzed for geochemical parameters. These included analysis of field parameters at the time of sampling and laboratory analysis of additional parameters (aluminum, calcium, iron, magnesium, manganese, potassium, silicon, sodium, chloride, alkalinity, suspended solids, and TDS). The geochemical data are presented in Table 5-20. These data have been incorporated into the analysis of fluoride fate and transport (see Section 6).

1. 0.0052 mg/L = surface water quality criterion (WAC 173-201a)

Extensive testing has been performed during the RI/FS to verify the protection of water quality in the Columbia River and in the CDID ditches located adjacent to the Reynolds Facility. The green symbols shown above identify ditch and surface water sampling locations analyzed for cyanide during 2012; all tested samples complied with water quality criteria established by Washington State for the protection of aquatic life. Refer to Figures 5-13a and 5-13b and Table 5-20 for detailed testing results.

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Plate 5-10

RI/FS 2012 Surface Water and Ditch Water Testing Results - Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Extensive fluoride testing has been performed during the RI/FS to verify the protection of water quality in the Columbia River and in the CDID ditches located adjacent to the Reynolds facility. The green symbols shown above identify ditch and surface water sampling locations tested for fluoride during the most recent sampling events in 2012. None of the tested samples exceeded the RI/FS screening level (groundwater MCL; 4 milligrams per liter [mg/L]). The highest concentrations measured in the Columbia River were less than 0.2 mg/L. Refer to Figures 5-14a and 5-14b and Table 5-20 for detailed testing results.

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Plate 5-11

RI/FS 2012 Surface Water and Ditch Water Testing Results - Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

5.5 Testing Results for Sediments

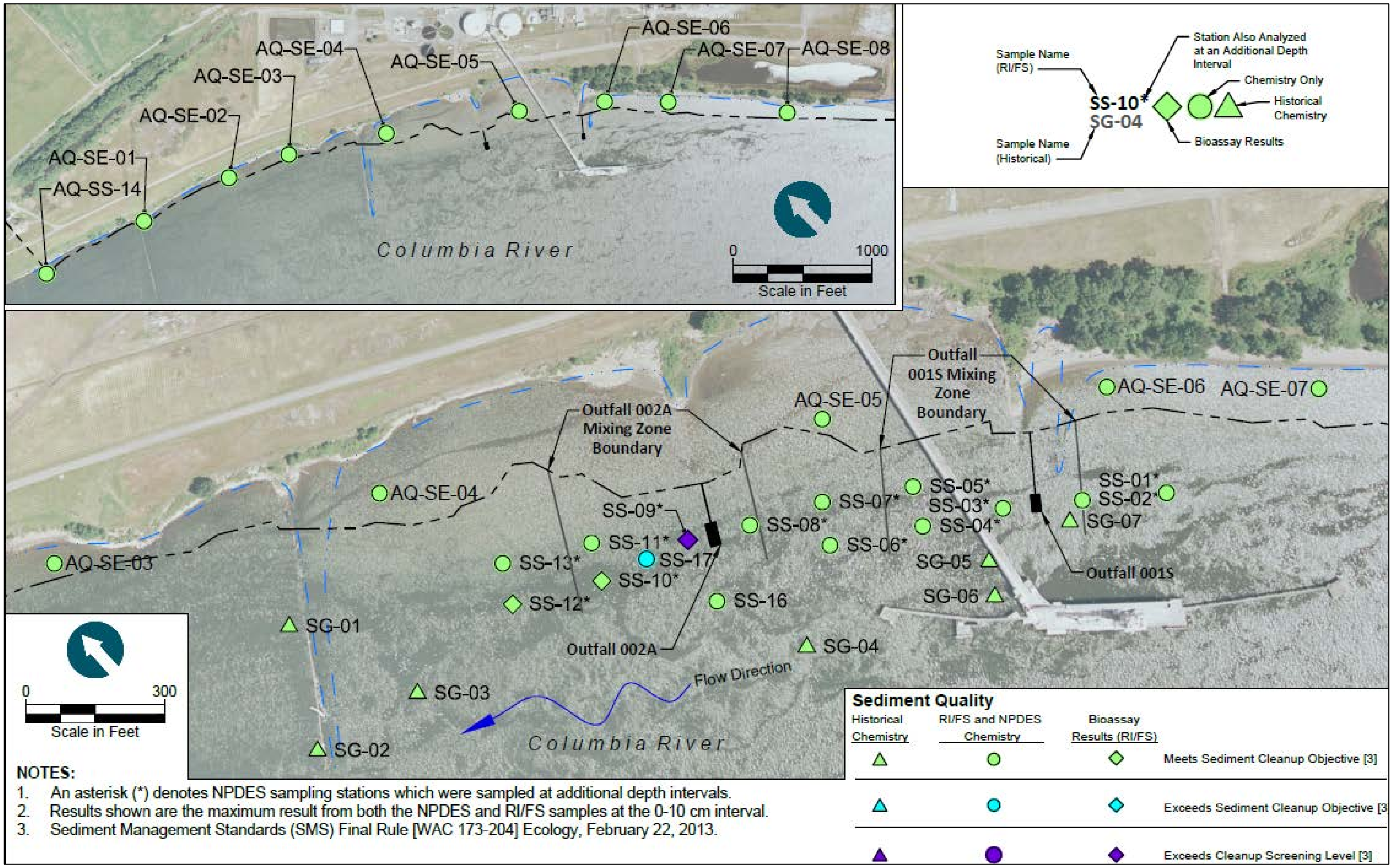
As part of the RI/FS, samples of sediment were analyzed from nearshore and offshore areas within the Columbia River. These data supplement previous testing data available from previous sampling efforts (see Section 2). The RI/FS testing program was coordinated with routine sediment monitoring performed as part of the NPDES monitoring requirements. Both RI/FS and NPDES testing data are summarized in this section. The combined testing program included analysis of eight nearshore sediment samples, and analysis of 14 offshore sediment samples.

The specific analytical testing parameters were defined by Ecology as part of the Work Plan approval process. Most sediment samples were analyzed at the 0- to 10-cm sampling interval, which is representative of the sediment bioactive zone regulated by the Sediment SMS (WAC Chapter 173-204). The NPDES sampling stations located in the vicinity of the two Former Reynolds Plant outfalls were also analyzed at the 0- to 2-cm sampling interval to provide potential information regarding sediment quality trends. These trends can be useful in distinguishing between historical and ongoing chemical inputs.

As part of the testing program, samples were archived for use in conducting conformational bioassay testing. During the integrated testing program, bioassay testing was performed at three sampling stations. The results of sediment testing from the combined sampling program are summarized on Plate 5-12. Detailed sampling results are presented on Figure 5-15 and in Tables 5-21 and 5-22. Key findings are summarized in the following subsections.

5.5.1 Results of Sediment Chemical Testing

The results of sediment chemical testing were compared to SMS criteria for freshwater sediments as defined in Ecology's February 2013 update of the SMS rule (Ecology 2013a). No exceedances of the SCOs defined in that rule were noted in any of the eight nearshore sediment samples, or in 10 of the 14 offshore sediment samples. Confirmational bioassays were conducted at three of the four stations (SS-09, SS-10, and SS-12) at which exceedances were detected.



NOTES:
1. An asterisk (*) denotes NPDES sampling stations which were sampled at additional depth intervals.
2. Results shown are the maximum result from both the NPDES and RI/FS samples at the 0-10 cm interval.
3. Sediment Management Standards (SMS) Final Rule [WAC 173-204] Ecology, February 22, 2013.

Extensive sediment testing was performed in the Columbia River to supplement previously available sediment quality data. No exceedances of sediment screening levels (Washington State freshwater Sediment Cleanup Objectives [SCO]) were noted at the sampling locations designated by the green triangles (2010 testing data) and green circles (RI/FS and NPDES sampling locations) above. Confirmational bioassay results demonstrated compliance with the SCO at two additional testing locations (SS-10 and SS-12; green diamonds). A localized area immediately adjacent to Outfall 002A exceeded the SCO (blue circle) and Cleanup Screening Level (CSL; purple diamond). However, vertical profile testing demonstrated that sediment quality in this area is recovering, as demonstrated by substantial improvements in the recently deposited sediment (0- to 2-cm sample) in comparison to the deeper sampling interval (0 to 10 cm). Refer to Tables 5-21 and 5-22 for detailed sediment chemical testing results and Table 5-23 for bioassay testing results.

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Plate 5-12

Sediment Chemical and Bioassay Testing Results

As described in Section 8, sediment quality data for the bioactive zone sediments (0 to 10 cm) were also evaluated to assess whether the concentrations of detectable bioaccumulative compounds (cPAH and PCBs) were protective of human health. This evaluation is described in Appendix I and included screening of PCB compounds against the practical quantitation limit (PQL) and completion of a human health risk evaluation for cPAH compounds using the methods defined by Ecology pursuant to the requirements of the updated SMS rule. As described in Appendix I, the concentrations of PCB compounds were less than the applicable PQL, and health risks associated with detectable cPAH compounds were less than both the 10^{-5} and 10^{-6} risk levels defined as protective in the SMS rule.

5.5.2 Results of Confirmational Bioassay Testing

Confirmational sediment bioassay tests were conducted at three sampling stations (SS-09, SS1-10, and SS-12, as shown on Plate 5-12). That testing was conducted consistent with the NPDES sampling plan (Anchor QEA 2012c) and included analysis using the amphipod (*Hyallela azteca*) and midge (*Chironomus tentans*) bioassays. The findings of the sediment bioassays are summarized in Table 5-23.

Results of bioassay testing demonstrated that no benthic impacts were occurring at sediment testing Stations SS-10 and SS-12. Bioassay results for these stations complied with the interpretive criteria contained in the SMS rule.

Bioassay results indicated the presence of potential sediment toxicity only at one station (Station SS-09), located immediately downstream from Outfall 002A. Bioassay responses at that location exceeded the SMS interpretive criteria for both the amphipod and midge bioassays.

As noted in the following section, the sediment trend analysis indicated that chemical concentrations (both PAH and PCB concentrations) at Station SS-09 were significantly lower in surface sediment concentration (0- to 2-cm interval) than in the deeper sediment interval (0 to 10 cm) submitted for bioassay testing (see Section 5.5.3). Results confirm that the sediment quality in this area is recovering over time, and that the elevated chemical concentrations are not the result of an ongoing release.

5.5.3 Sediment Trend Analysis

The integrated RI/FS and NPDES testing program included analysis of sediment trends using analysis of sediment samples from different depth intervals.

First, the NPDES testing program included analysis of paired 0- to 2-cm and 0- to 10-cm sampling intervals at multiple testing locations. For sampling Station SS-09 where bioassay test responses in the 0- to 10-cm sample indicated a potential for localized benthic impacts, the results from the 0- to 2-cm sampling interval provide information regarding the trends in sediment analyte levels over time.

For both PAH compounds and PCBs, the concentrations measured in the 0- to 2-cm samples were substantially reduced in comparison to the 0- to 10-cm sampling interval (average of test sample and verification sample; see Table 5-21). The concentrations of total PCBs and PAH decreased seven-fold to more than ten-fold between the deeper sediments (0- to 10-cm interval) and the more recent sediments (0- to 2-cm interval).

The results of the sediment trend analysis indicate that the chemicals present in sediments at Station SS-09 are the result of historical discharges, rather than an ongoing discharge. This is reasonable given the termination of aluminum manufacturing operations in 2001, the subsequent cleaning of the combined stormwater and wastewater system in 2010, and the routine cleanout of solids from the stormwater retention basin in 2012. These completed actions address potential source control issues associated with Outfall 002A.

Sediment testing was also conducted at depth at Station SS-09. This testing was conducted to verify the thickness of the sediment layer containing elevated chemical constituents at this location. Chemical concentrations in an interval analyzed from the 18- to 24-cm sampling were below the SCO for all PAH compounds. Dibenzofuran concentrations in that sample slightly exceeded the SCO for that compound. Based on these results, the sediments containing exceedances of the SCO for PAH compounds are limited to approximately 18 cm (approximately 6 inches) in thickness. Results demonstrate that the area of impact at Outfall 002A is limited in both area and depth and is recovering over time.

5.5.4 Ecology Determination for Sediments near Outfall 002A

Consistent with direction provided by Ecology, the area of sediments located adjacent to Outfall 002A and exceeding bioassay performance standards (i.e., the localized area of sediments represented by sample Station SS-09) has been carried forward for further revaluation in the FS.

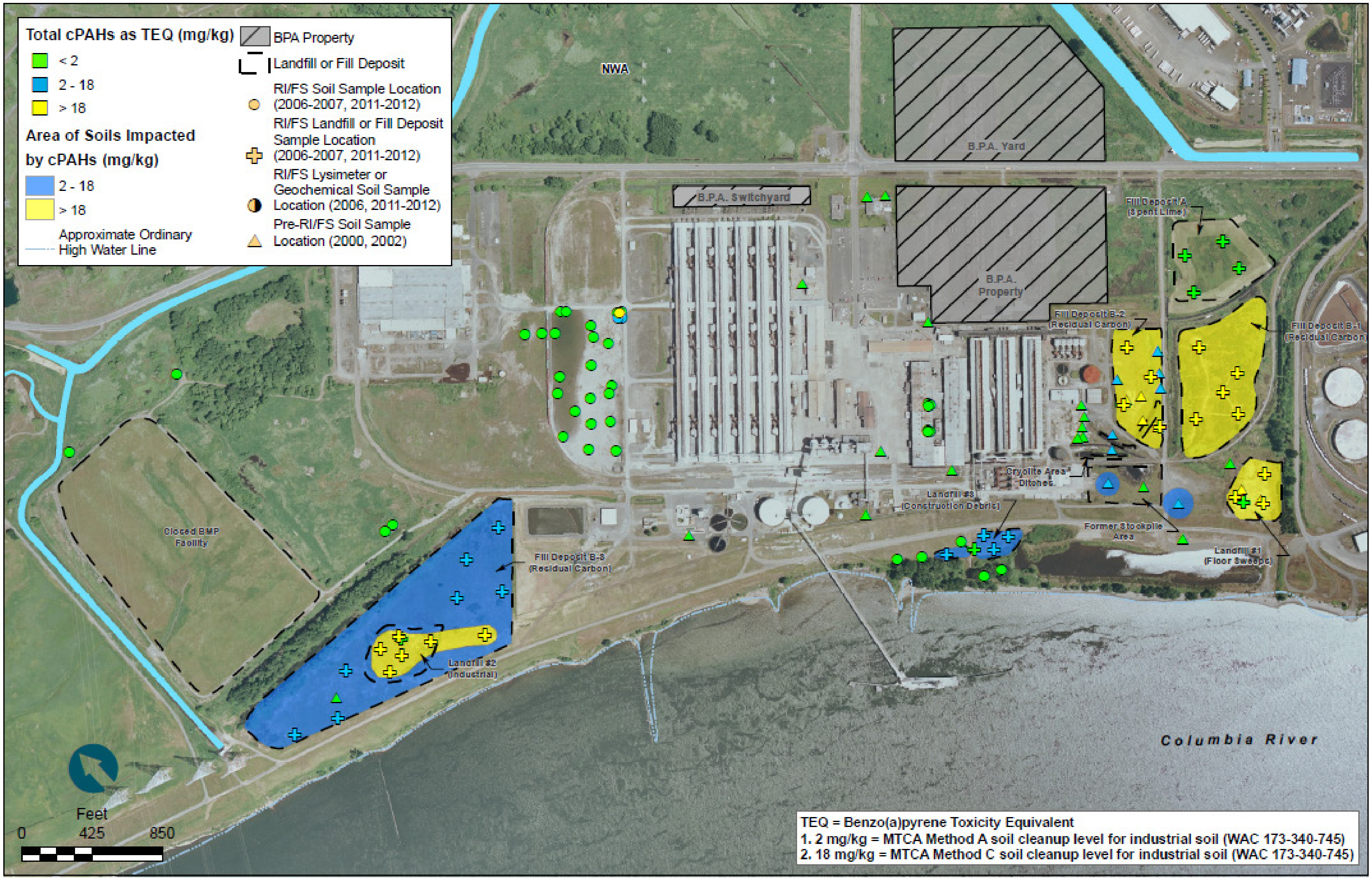
5.6 Key Remedial Investigation Findings

Key findings from the RI are summarized in Plates 5-12 through 5-15 and include the following:

- Surface soil quality throughout the majority of the Former Reynolds Plant is protective of industrial workers. The one exception to this is a single, localized soil sampling location within the northeast corner of the flat storage area (see Plate 5-13). The management of this area is to be addressed in the FS.
- The contents of several of the closed landfills and fill deposits at the facility contain elevated concentrations of PAH compounds (see Plate 5-13). Fluoride concentrations in these materials are generally between the residential and industrial soil cleanup levels (see Plate 5-14). These materials are contained and not exposed to industrial workers during normal on-site work activities. The long-term management of the landfills and fill deposits is addressed as part of the FS.
- There are no exceedances of soil screening levels for mercury, PCBs, solvents, or pesticides.
- Soil quality outside of the contained landfills and fill deposits is protective of terrestrial exposures, as described in Section 8. The long-term management of the landfills and fill deposits is addressed as part of the FS.
- No VOCs or PCBs were detected in groundwater. Cyanide levels are protective of drinking water and surface water quality. Fluoride and PAH concentrations are elevated only in groundwater present in the upper fill and silt/clay soils immediately within or adjacent to the landfill and fill deposits (see Plate 5-15). Monitoring shows that these constituents have limited mobility and are not impacting downgradient groundwater or surface water quality. Section 6 includes a detailed evaluation of fluoride fate and transport properties.

- Surface water quality within the Columbia River and CDID ditches was extensively evaluated during the RI/FS. No impacts to surface water quality were detected.
- Columbia River sediments were tested extensively during coordinated RI/FS and NPDES monitoring events. No impacts to nearshore or offshore sediments were noted, except for a localized area immediately adjacent to Outfall 002A. Bioassay testing criteria were exceeded at only a single test station (Station SS-09) in that area. Trend analysis indicates that sediments in this extremely localized area are recovering over time, and concentrations of PCBs and cPAH compounds did not exceed criteria for human health protection as contained in the updated SMS rule. However, Ecology requested that the localized area adjacent to Outfall 002A be carried forward for evaluation in the FS.

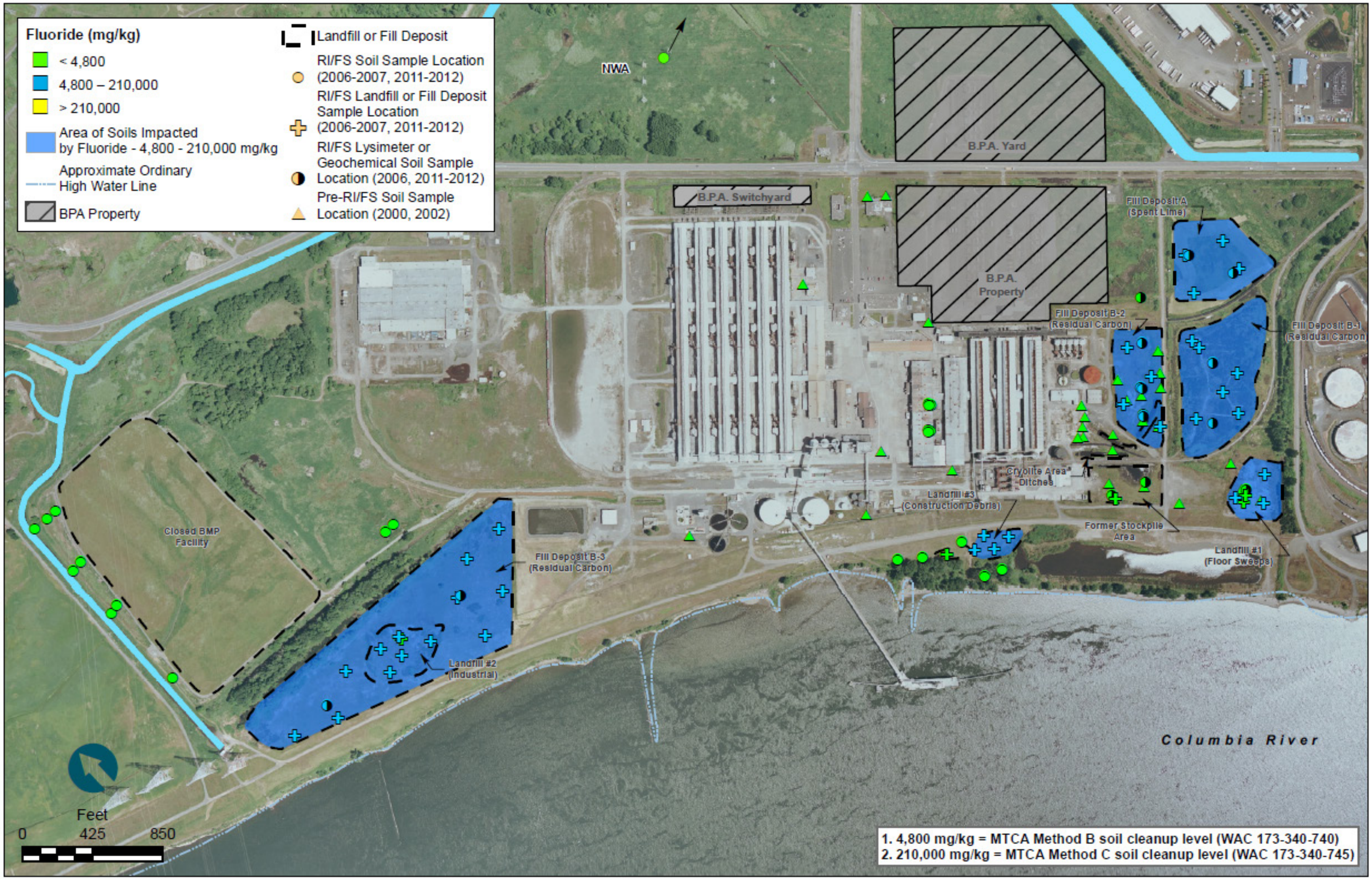
Section 6 provides a summary of fluoride fate and transport processes occurring at the Former Reynolds Plant within shallow groundwater. Section 7 then provides an overall CSM, based on the RI/FS investigation findings.



Concentrations of carcinogenic PAH compounds in soil throughout most of the Reynolds Facility comply with soil cleanup standards protective of industrial workers (MTCA Method C soil cleanup levels). A localized area of soil exceeding these standards remains in the former flat storage area, and isolated deposits of pitch are located near the pitch storage tanks. The management of soils in these two areas is discussed further in the FS. In addition, concentrations of carcinogenic PAH compounds are elevated in the residual carbon and other materials contained in the on-site landfills and fill deposits. These areas are currently contained by soil caps. The long-term management of these fill and landfill deposits is discussed in the FS.

Plate 5-13

Summary of Soil and Fill Deposits Containing Elevated cPAH Concentrations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

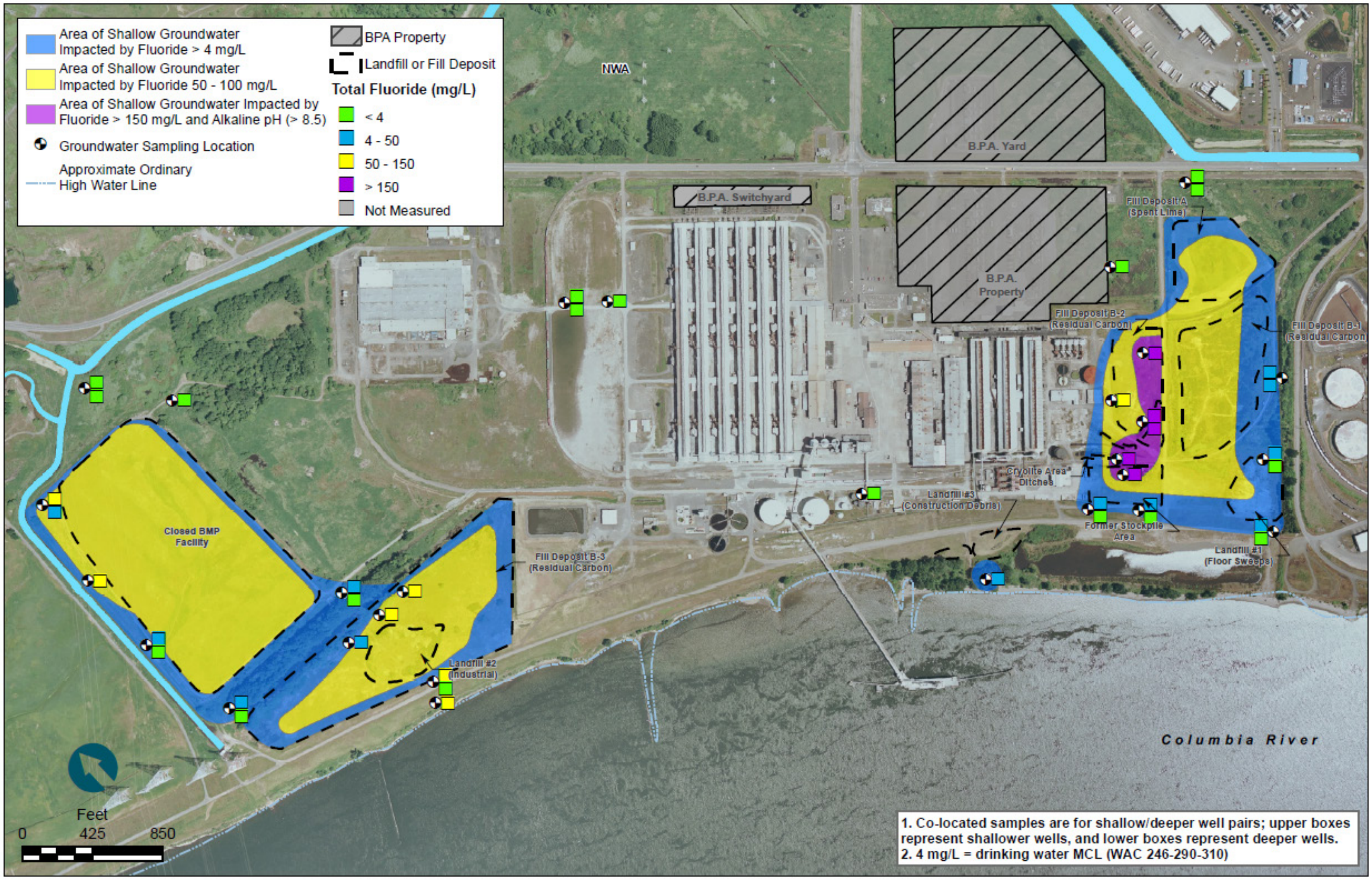


1. 4,800 mg/kg = MTCA Method B soil cleanup level (WAC 173-340-740)
2. 210,000 mg/kg = MTCA Method C soil cleanup level (WAC 173-340-745)

Concentrations of fluoride throughout the Reynolds Facility comply with soil cleanup standards protective of industrial workers (MTCA Method C soil cleanup levels). This is true of both soils and the contents of the landfills and fill deposits. Outside of the landfill and fill deposits, which are currently contained by soil caps, the soil fluoride levels comply with soil cleanup standards protective of residential land uses (MTCA Method B soil cleanup levels), and standards protective of potential terrestrial ecological exposures. The long-term management of these fill and landfill deposits is discussed in the FS.

Plate 5-14

Summary of Soil and Fill Areas Containing Elevated Fluoride Concentrations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



1. Co-located samples are for shallow/deeper well pairs; upper boxes represent shallower wells, and lower boxes represent deeper wells.
2. 4 mg/L = drinking water MCL (WAC 246-290-310)

The Reynolds Facility is located on top of a thick sequence of silty clay soils known as the upper alluvium. Shallow groundwater within the uppermost portion of this water bearing zone exhibits elevated fluoride levels only immediately adjacent to the landfill and fill deposits. The long-term management of these areas (highlighted in this plate) is discussed in the FS. The quality of deep groundwater in the lower alluvium is protected by the thickness of the silty/clay soil deposits and the upward groundwater gradients between the two water-bearing zones. No impacts have been observed in the deep groundwater. Natural processes limiting the mobility of fluoride in groundwater are discussed further in Sections 6 and 7 of the RI/FS.

Plate 5-15

Summary of Areas Containing Elevated Concentrations of Fluoride in Shallow Groundwater
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

6 FATE AND TRANSPORT EVALUATION

This section summarizes assessment activities performed as part of the RI to characterize the fate and transport properties of fluoride in site soils and groundwater. These assessment activities use data from field and laboratory testing, and integrated geochemical and hydrogeologic modeling. As discussed in Section 5, fluoride is the primary COC for groundwater at both the West and East Groundwater Areas. The factors affecting the transport and attenuation of fluoride in groundwater at the site were evaluated based on a synthesis of geochemical, hydrogeological, and other data.

The fate and transport work included detailed evaluations of natural processes occurring along potential chemical migration pathways, including each of the following:

- Geochemical factors limiting the leaching of fluoride from source areas (areas of elevated fluoride concentrations) to groundwater (see Section 6.1)
- Natural geochemical and hydrogeologic processes affecting the fate of fluoride in saturated soils, solid media (i.e., residual carbon), and groundwater downgradient of source areas (see Section 6.2)
- Geochemical and other interactions occurring at the point of exchange between groundwater and ditch water (see Section 6.3) and between groundwater and surface water in the Columbia River (see Section 6.4)
- In addition, groundwater fate and transport modeling was performed to quantitatively evaluate the long-term effectiveness and reliability of these geochemical processes in attenuating fluoride in groundwater and preventing potential surface water quality impacts (see Section 6.5)

The data used in the fate and transport evaluations are presented in Sections 4 and 5. Site hydrogeologic information was presented in Section 4, including groundwater gradients, surface water and ditch water elevations, and properties associated with the silt and clays present in the upper alluvial aquifer. Section 5 presented the chemical testing data for fluoride and for selected geochemical properties measured in site soils and solid media. Also presented in Section 5 are porewater data collected from lysimeters, groundwater data, and data from ditch water and surface water.

Additional data collected specifically to inform the fate and transport analyses are presented in Appendix H. Mineralogical testing data presented in that appendix provides information used to assess fluoride attenuation capacity within site subsurface soils. The data were collected within the East Groundwater Area and included measurement of total fluoride and total organic carbon concentration in site soils and solid media; identification of mineral phases by powder X-ray diffraction (XRD) and high-resolution scanning electron microscopy (SEM); quantification of iron, aluminum, and manganese oxides by selective extraction; and determination of cation exchange capacity (CEC) and anion exchange capacity (AEC). These data are summarized in Appendix H.

6.1 Processes Controlling Fluoride Leachability in Source Areas

Most fluoride concentrations within site soils and solid media are well below MTCA direct-contact screening levels for unrestricted and industrial land use. However, there are several areas within the site where soils or solid media contain elevated concentrations of fluoride (typically at fluoride concentrations between 1 and 6 percent) from former smelter operations and where closure or remediation work has not been completed. Source areas containing soils/solid media with elevated fluoride levels and included in the geochemical testing program are:

- Fill Deposits B-3 and B-1 located in southwest and eastern portion of the study area, respectively
- Fill Deposit A located in the northeast portion of the study area
- Fill Deposit B-2

Other potential source areas investigated as part of the RI included Landfill #1, Landfill #3, and the Former Stockpile Area. Previous testing data from Landfill #1 indicated fluoride concentrations were less than 0.2 percent in these solids. Testing in Landfill #3 included chemical analysis, but not geochemical testing, of solid media and groundwater. Testing data collected in the Former Stockpile Area have shown that previous actions successfully removed source materials from that third area. None of the borings completed in the Former Stockpile Area identified elevated (i.e., percent levels) fluoride concentrations.

For the fill deposits, testing was performed to evaluate the factors controlling the leaching of fluoride from remaining source areas. Leaching can occur when soils or solid media contact either precipitation (i.e., rainwater) or groundwater. Rates of leaching are controlled by the properties of the media and water, including a number of chemical reactions occurring between fluoride and other naturally occurring components of groundwater and soil (such as calcium, phosphate, or iron). These soil properties and the associated chemical reactions tend to restrict fluoride mobility by limiting dissolved fluoride concentrations. Solubility controls on fluoride leachability were evaluated through the following: 1) direct measurement of porewater concentrations; 2) a review of the material composition; and 3) chemical speciation modeling performed using the porewater geochemical data. Some testing using lysimeters and SPLP testing was also performed in the Former Stockpile Area.

The following sections (see Sections 6.1.1 through 6.1.4) describe the findings of the source-area leachability testing.

6.1.1 Residual Carbon Deposits

Residual carbon was generated during the operation of the on-site cryolite recovery process. Historical analyses of residual carbon indicate that it typically includes the following principal constituents (chemical composition and constituent concentrations can vary):

- Calcium carbonate (approximately 48 percent)
- Alumina (16 percent)
- Carbon (12 percent)
- Fluoride compounds (up to 8 percent) of which calcium fluoride (fluorite) is a significant proportion (3 percent)
- Sodium (3 percent)
- Iron (0.7 percent)
- Sulfate (0.3 percent)

During the RI, dissolved fluoride concentrations were measured directly in porewater samples collected from lysimeters placed within on-site fill deposits. Two of these lysimeters were installed in Fill Deposit B-1 in the East Groundwater Area (GC-LY-03 and GC-LY-04), and two were installed in Fill Deposit B-3 in the southwest portion of the site (GC-LY-07 and GC-LY-08). Fluoride concentrations in these residual carbon materials ranged from 2 to 6 percent. The dissolved fluoride concentrations in the porewater as measured in the lysimeters were relatively low, ranging from 47.8 to 80 milligrams per liter (mg/L; equivalent to 0.005 to 0.008 percent).

Geochemical speciation modeling results indicate that the residual carbon porewaters are consistently undersaturated with respect to relatively soluble fluoride species but are slightly supersaturated or close to equilibrium with respect to fluorite (CaF_2). This indicates that any soluble fluorides originally present in residual carbon (e.g., sodium fluoride [NaF] and cryolite [Na_3AlF_6]) would tend to dissolve into the porewater within these deposits, but that dissolved fluoride concentrations are controlled by the precipitation of fluorite once its solubility is reached, according to the following reaction:

$$Ca^{2+} + 2\,F^{-} \rightleftharpoons CaF_{2(s)} \tag{6-1}$$

Dissolved calcium concentrations in porewater from the lysimeters installed in Fill Deposits B-1 and B-3 range from 2.4 to 40.7 mg/L. The calcium needed for precipitation of fluoride is provided by dissolution of the abundant calcium carbonate (calcite) present in the residual carbon, according to the following reaction:

$$CaCO_{3(s)} \rightleftharpoons Ca^{2+} + CO_3^{2-} \tag{6-2}$$

Speciation modeling results show that the residual carbon porewaters are generally moderately undersaturated with respect to calcite, indicating conditions are favorable to its dissolution, thereby providing a continuous supply of dissolved calcium to porewater, as it is simultaneously removed by precipitation of fluorite. Based on the calcium carbonate content of the residual carbon, the amount of calcite available far exceeds what would be required to sequester all the fluoride present in the residual carbon as fluorite.

SPLP leach testing was conducted in 2007 on a shallow sample (SPLP4) collected from Fill Deposit B-1 in the East Groundwater Area. While the total fluoride concentration was 29,500 mg per kg, the leachate concentration was 18.0 mg/L. Total fluoride concentrations in residual carbon samples co-located with lysimeters in the fill deposit range from 16,000 to

61,800 mg/kg. The solid-water partition coefficient (K_d) for fluoride is calculated according to the following equation, where C_s is the solid media concentration (mg/kg) and C_w is the dissolved concentration (mg/L):

$$K_d = \frac{C_s}{C_w} \tag{6-3}$$

K_d estimates do not represent the complexities of the factors affecting fluoride leachability. However, they do provide a quantitative estimate of the effectiveness of fluoride solubility in limiting leaching. As shown in Table 6-1, the calculated K_d estimates for the residual carbon samples ranged from 204 to 1,093 L/kg for the lysimeters and 1,639 L/kg for the SPLP test sample, with an overall average of 880 L/kg for the lysimeter and SPLP data combined. These values are reasonable given the calcium-mediated limitations on fluorite solubility and the excess of calcium present in the materials.

6.1.2 Fill Deposit A

Spent lime was also produced during the cryolite recovery process, specifically from the production of sodium hydroxide (for use in the recovery process) from limestone. The typical composition of spent lime includes the following principal constituents:

- Calcium carbonate (approximately 82 percent)
- Calcium fluoride (up to 9 percent)
- Sodium (2 percent)

Dissolved fluoride concentrations in Fill Deposit A porewater samples were measured directly from two lysimeters installed within the spent lime at Fill Deposit A locations GC-LY-01 and GC-LY-02. The measured fluoride concentrations in the collected porewater from these two lysimeters ranged from 88.5 to 94 mg/L.

Geochemical speciation modeling results for spent lime porewater indicate that porewater in the spent lime is close to equilibrium with respect to both fluorite and calcite. Dissolved fluoride concentrations in the spent lime porewater are controlled by the solubility of fluorite. This is similar to the conditions present in the residual carbon fill deposits. The slightly higher fluoride concentrations relative to residual carbon porewaters are explained by the lower dissolved calcium concentrations (1.1 to 1.5 mg/L). The lower calcium concentrations in spent lime porewater are due to the lower solubility of calcite at the higher pH of the spent lime (pH 9.8 to 11.1) relative to residual carbon (pH 7.4 to 8.7).

Dissolved fluoride concentrations in equilibrium with fluorite are related to calcium concentrations through the solubility product of fluorite (the square brackets in the following equation denote the activity of dissolved species):

$$K_{sp} = [Ca^{2+}] \times [F^{-}]^2 = 10^{-10.46} \; at \; 25°\mathrm{C} \tag{6-4}$$

As shown in Table 6-1, the average measured K_d value for the spent lime is 682 L/kg, with a range of 636 to 728 L/kg. As expected, these K_d values are similar to those calculated for the residual carbon, due to the similarity of the processes controlling fluoride transport.

6.1.3 Fill Deposit B-2

Fill Deposit B-2 is more complex than the other fill deposits at the site. In addition to deposits of residual carbon, the area has also been impacted by alkaline discharges to nearby ditches and surface soil. Multiple types of testing have been performed in this area in order to understand factors controlling fluoride leachability from residual carbon and also to understand how solid media and groundwater properties affect the potential mobility of fluoride in site soils and groundwater.

Dissolved fluoride concentrations in porewater samples were measured directly from two lysimeters placed in this area. These were installed at locations GC-LY-05 and GC-LY-06. The measured fluoride concentrations ranged from 73 to 187 mg/L. Solid media fluoride concentrations measured in the paired samples collected from the lysimeter installations were 0.27 and 0.64 percent, respectively. However, solid media samples collected from other borings (GC-SB-01 and GC-SB-02) placed in the immediate vicinity as part of geochemical evaluations had fluoride concentrations ranging from 0.12 to 4.6 percent. This increased variability of solid media composition and the presence of elevated groundwater fluoride and alkalinity in this area make the analysis of leaching properties more complex for these materials.

Section 6.2 provides a more complete discussion of the factors affecting fluoride mobility in the vicinity of Fill Deposit B-2.

6.1.4 Former Stockpile Area

As part of the first round (2006) of RI testing, lysimeter and SPLP testing work was conducted within the Former Stockpile Area. That testing was conducted in parallel with soil bulk fluoride concentration testing to verify that SPL had been removed from this area successfully and to assess potential fluoride transport properties in this area.

This Former Stockpile Area was historically used for stockpiling of SPL used in cryolite plant operations. The SPL was formerly stored in on-site stockpiles prior to processing. The composition of SPL typically consists primarily of carbon (13 to 69 percent), with sodium (8.6 to 22 percent), aluminum (7 to 22 percent), fluoride (7 to 22 percent), and lesser amounts of other constituents, such as silicon, calcium, and iron (Spiegel and Pelis 1990).

As described in Section 2.2.3, the SPL stockpile was removed in the 1990s, consistent with Ecology requirements after the shutdown of the cryolite plant. Testing performed in the Former Stockpile Area at the time of removal and during subsequent soil investigations has shown that the SPL was successfully removed. However, shallow groundwater in this area remains impacted by elevated fluoride levels associated with the East Groundwater Area. The fluoride concentrations remaining in soils of this area are below MTCA direct contact cleanup levels for unrestricted land use. Measured total fluoride concentrations in soil have ranged up to 0.13 percent, well below the typical fluoride concentrations in the SPL materials (typically 7 to 22 percent), which were previously removed.

As shown in Table 5-10, the average dissolved fluoride concentrations in porewater samples collected from two lysimeters at the Former Stockpile Area (installed and sampled three times in 2006; LYS1 and LYS2) were 34.6 and 59.5 mg/L, respectively. Total fluoride concentrations in co-located soil samples collected during lysimeter installation were 523 and 1,310 mg/kg, respectively. These lysimeters were located in an area of very shallow groundwater, and porewater samples collected from these lysimeters may have included contributions from area groundwater.

Dissolved calcium concentrations were not measured in the porewater samples, but the dissolved fluoride at LYS2 is consistent with values measured in porewater at other areas where aqueous fluoride concentrations have been shown to be controlled by calcium-mediated fluorite solubility. The lower dissolved fluoride concentration at LYS1 correlates with lower soil fluoride than at LYS2 and suggests that fluoride leaching from low fluoride soils is partly controlled by adsorption-desorption reactions on soil oxide and clay components.

SPLP testing was also conducted on one shallow soil sample (SPLP3) collected from the Former Stockpile Area (see Table 5-13). That soil sample had a very low total fluoride concentration of 784 mg/kg. SPLP testing of that soil sample resulted in a leachate concentration of 9.1 mg/L. A preliminary soil-water partitioning coefficient calculated based on these data is 86 L/kg. This value is significantly lower than in the residual carbon and spent lime deposits, reflecting the different mechanisms controlling partitioning and leaching from soils and solid media with lower total fluoride concentrations.

6.1.5 Summary of Factors Controlling Source-Area Leachability

The leachability of fluoride from materials with high fluoride content such as residual carbon and spent lime present in source areas is primarily limited by fluorite (calcium fluoride) solubility, which regulates dissolved fluoride concentrations. This process relies on a source of calcium, which is present in these materials as calcium carbonate. The quantities of calcium carbonate in residual carbon and spent lime exceed the fluoride concentrations, therefore, providing the capacity to sequester essentially all of the fluoride as fluorite in these materials. Adsorption-desorption reactions also appear to be operating but only as a controlling factor for leaching from soils with relatively low total fluoride concentrations where fluorite solubility is not exceeded in porewater. The average K_d for residual carbon and spent lime is 823 L/kg (see Table 6-1).

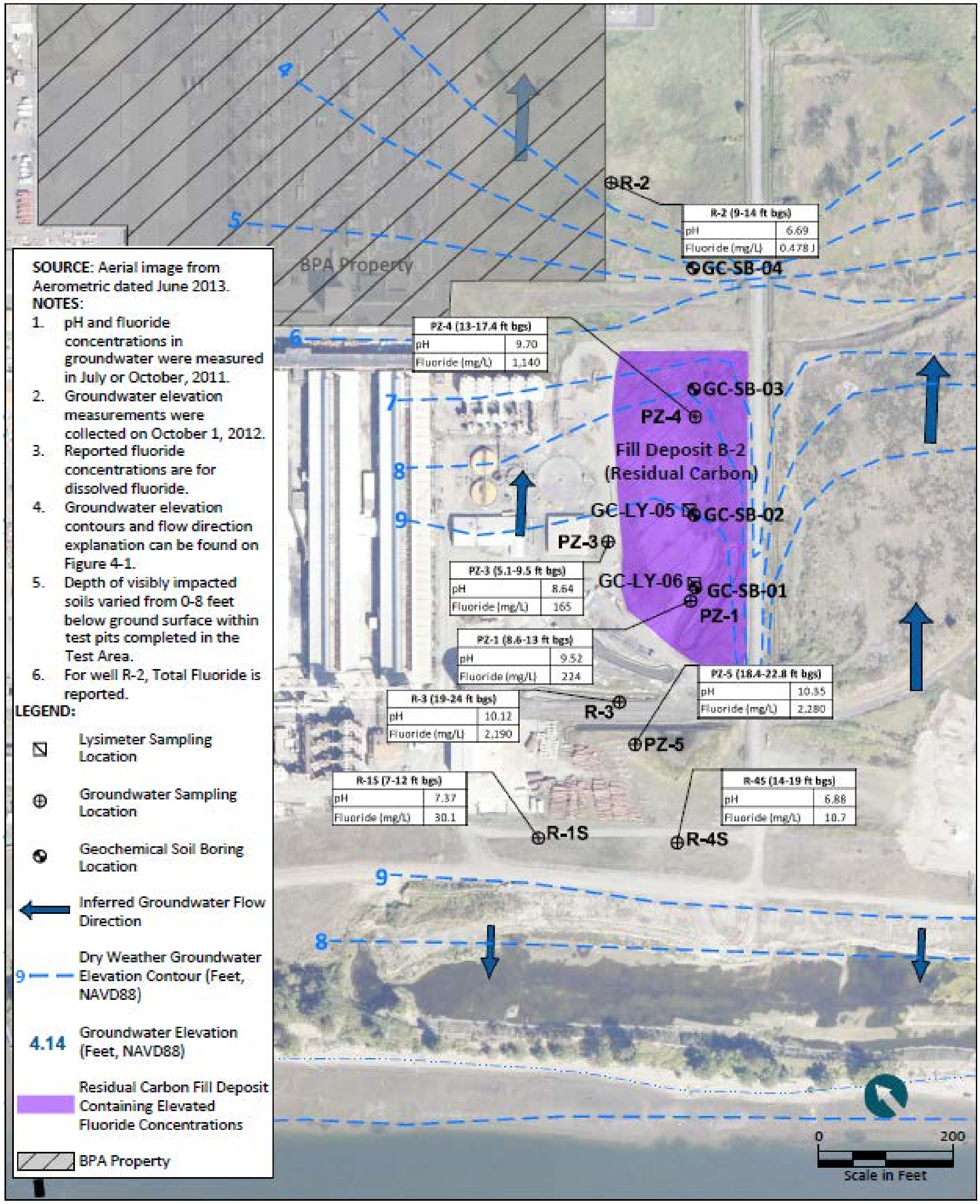
6.2 Geochemical Processes Occurring in Site Soils and Groundwater

A detailed analysis of site geochemical processes was performed within a test area established in a portion of the East Groundwater Area (see Plate 6-1). This test area was selected for detailed evaluation based on the following considerations:

- This area includes shallow deposits of solid media containing elevated fluoride concentrations, so both desorption and transport processes can be evaluated in this area.
- The highest fluoride concentrations in groundwater are located in this area, and extensive groundwater data exist both within and downgradient of the area.
- Groundwater gradients are well defined in this area and are understood both vertically and horizontally.
- Groundwater fluoride concentrations attenuate rapidly with distance along the groundwater transport pathway, providing an opportunity to assess geochemical properties across a range of fluoride concentrations.
- Extensive groundwater testing data are available, including characterization of geochemical parameters.

Within the test area, extensive solid media and groundwater data were synthesized to document the different processes occurring that impact fluoride leaching and mobility, as well as to evaluate the potential attenuation of fluoride transport in groundwater. Following a summary of background conditions within the test area, each of the various geochemical processes identified are described separately in Sections 6.2.2 through 6.2.5. Refer to Section 6.1.3 for a discussion of leaching test data applicable to this area:

- Section 6.2.1: Geochemical Test Area Conditions and Test Methods
- Section 6.2.2: Precipitation of Fluorite
- Section 6.2.3: Precipitation of Fluorophosphate Minerals
- Section 6.2.4: Anion Exchange on Clays
- Section 6.2.5: Adsorption on Aluminum and Iron Oxides



SOURCE: Aerial image from Aerometric dated June 2013.

NOTES:

1. pH and fluoride concentrations in groundwater were measured in July or October, 2011.
2. Groundwater elevation measurements were collected on October 1, 2012.
3. Reported fluoride concentrations are for dissolved fluoride.
4. Groundwater elevation contours and flow direction explanation can be found on Figure 4-1.
5. Depth of visibly impacted soils varied from 0-8 feet below ground surface within test pits completed in the Test Area.
6. For well R-2, Total Fluoride is reported.

LEGEND:

☒	Lysimeter Sampling Location
⊕	Groundwater Sampling Location
●	Geochemical Soil Boring Location
←	Inferred Groundwater Flow Direction
9 – –	Dry Weather Groundwater Elevation Contour (Feet, NAVD88)
4.14	Groundwater Elevation (Feet, NAVD88)
🟪	Residual Carbon Fill Deposit Containing Elevated Fluoride Concentrations
▨	BPA Property

R-2 (9-14 ft bgs)	
pH	6.69
Fluoride (mg/L)	0.478 J

PZ-4 (13-17.4 ft bgs)	
pH	9.70
Fluoride (mg/L)	1,140

PZ-3 (5.1-9.5 ft bgs)	
pH	8.64
Fluoride (mg/L)	165

PZ-1 (8.6-13 ft bgs)	
pH	9.52
Fluoride (mg/L)	224

PZ-5 (18.4-22.8 ft bgs)	
pH	10.35
Fluoride (mg/L)	2,280

R-3 (19-24 ft bgs)	
pH	10.12
Fluoride (mg/L)	2,190

R-1S (7-12 ft bgs)	
pH	7.37
Fluoride (mg/L)	30.1

R-4S (14-19 ft bgs)	
pH	6.88
Fluoride (mg/L)	10.7

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Plate 6-1
Geochemical Test Area Conditions
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

6.2.1 Geochemical Test Area Conditions and Test Methods

Plate 6-1 indicates the location of the geochemical test area. Shallow groundwater quality in the area is the result of both the presence of fluoride-containing solid media (generally present 1 to 7.5 feet bgs) and fluoride and alkalinity releases in aqueous phase during historical cryolite plant operations. Test area groundwater contains elevated concentrations of both dissolved fluoride and sodium. The groundwater pH in a portion of the test area is more alkaline (pH ranges from less than 9 to more than 10) than surrounding groundwater.

The groundwater gradients in the test area are well defined, and shallow groundwater flows in a northeasterly direction away from the Columbia River and toward the CDID ditch located north of the site (see Figures 4-1 and 4-2). Vertical groundwater gradients in this area are generally upward. As discussed in Section 4, groundwater elevation data collected at the site show that in both the West and East Groundwater Areas, groundwater in the upper alluvium WBZ north of the CDID levee dike flows to the north, northwest, and/or northeast and ultimately discharges into the CDID ditch system (see Figures 4-1 and 4-2). In the vicinity of the CDID and on-site ditches, the upper alluvium WBZ is generally characterized by upward gradients, due to the hydraulic influence of the ditch system. As discussed in Section 5, water quality in the CDID ditches is not impacted. Groundwater elevations in both the shallow and slightly deeper (approximately 30 feet bgs) wells completed in the upper alluvium WBZ are higher than surface water elevations in the nearby ditches, indicating upper alluvium groundwater ultimately discharges to the CDID ditch system. Away from the Columbia River and CDID ditches, vertical hydraulic gradients across the site tend to be weak, consistent with predominantly horizontal groundwater flow.

The major mineralogy of natural alluvial soils at the site consists of quartz, plagioclase (calcium-rich) feldspar, alkali (sodium or potassium) feldspar, and smectite clay (montmorillonite). Calcium and magnesium are the predominant exchangeable cations in native montmorillonite. Iron, aluminum, and manganese oxides are also ubiquitously present in varying amounts and likely form surface coatings on the other mineral particles.

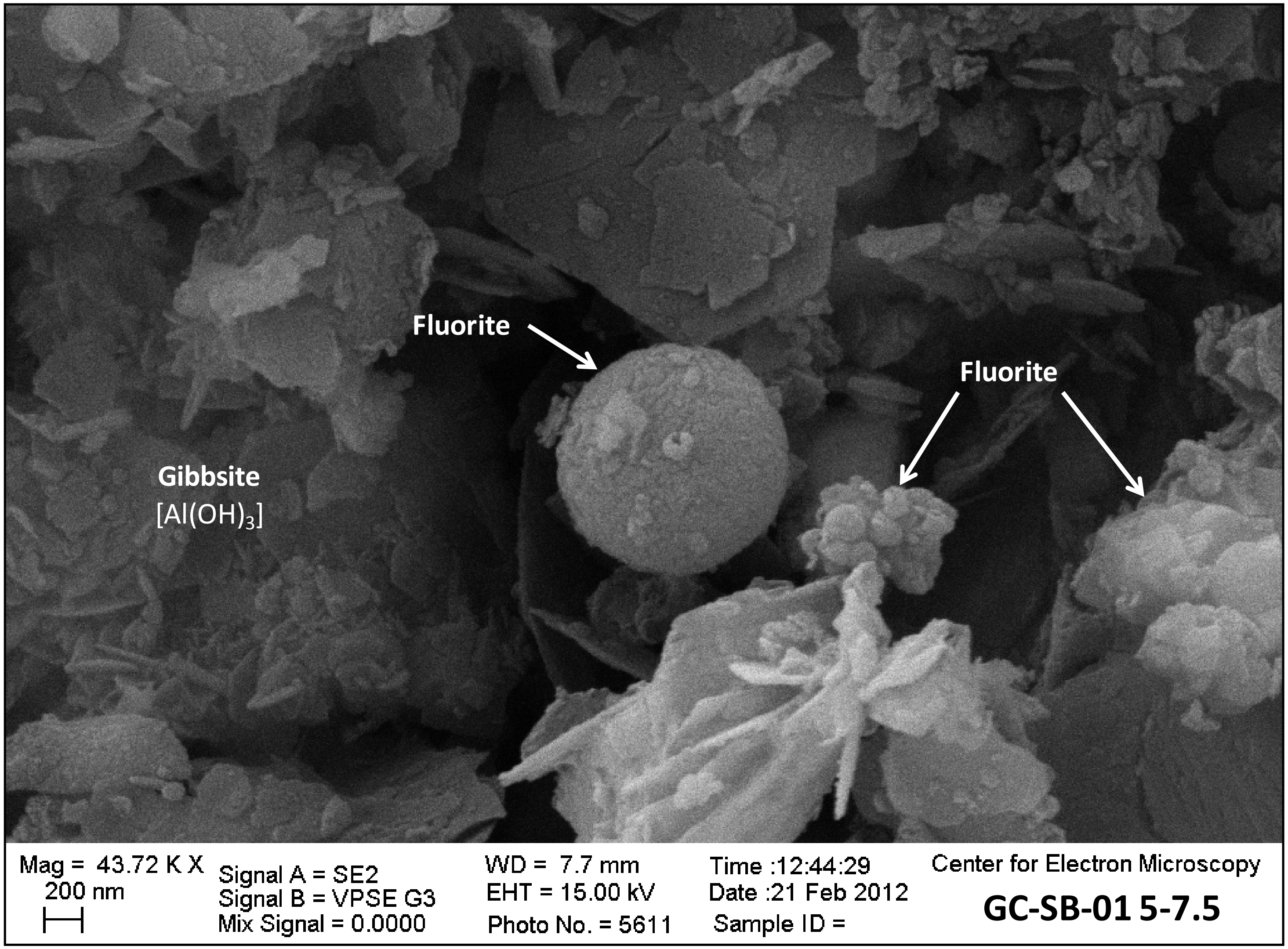
Geochemical testing included installation of four borings that were advanced to 20 feet bgs along a southwest-northeast transect following the northerly groundwater flow direction. The transect provides for assessment of soil/solid media and groundwater geochemical processes occurring along the primary migration pathway, north toward the CDID ditch. As shown on Plate 6-1, the borings extended from the cryolite area ditches near PZ-1 to a location downgradient of PZ-4 (GC-SB-01 to GC-SB-04; see Plate 3-5). No fluoride migration has been noted past location PZ-4 during RI groundwater sampling.

At each of the four test borings, soil/solid media samples were collected at 2.5-foot-depth intervals to a total depth of 20 feet. Selected samples were analyzed for mineralogical and geochemical characteristics to identify the forms of fluoride present and quantify constituents that are available to react with and limit the mobility of fluoride in groundwater. Fluoride leaching data presented in Section 6.1 and groundwater data presented in Section 5 were also used as part of the geochemical evaluations described subsequently and in Appendix H.

6.2.2 Precipitation of Fluorite

The mineralogical effects of infiltration of alkaline sodium fluoride solutions are overprinted on the native soils within portions of the test area. Most notably, fluorite is present to depths of 7.5 feet in GC-SB-01, GC-SB-02, and GC-SB-03 (see Plate 6-2).

Crystal morphologies such as those shown on Plate 6-2 indicate that fluorite has precipitated in-place from groundwater. Precipitation of fluorite requires calcium, which is derived from two sources: 1) exchangeable calcium present in clays; and 2) calcium derived from the dissolution of plagioclase feldspars. Cation exchange reactions of sodium in alkaline groundwater with calcium on smectite release calcium to groundwater. This is supported by the inverse relationship between exchangeable calcium and exchangeable sodium in solid media (see Plate 6-3).



Crystal morphologies such as those shown in this scanning electron micrograph indicate that fluorite (CaF_2) has precipitated in-place from groundwater. Precipitation of fluorite requires calcium, which is derived from two sources: 1) exchangeable calcium present in clays; and 2) calcium derived from the dissolution of plagioclase feldspars. Cation exchange reactions of sodium in alkaline groundwater with calcium on smectite release calcium to groundwater, driving the precipitation of fluorite.

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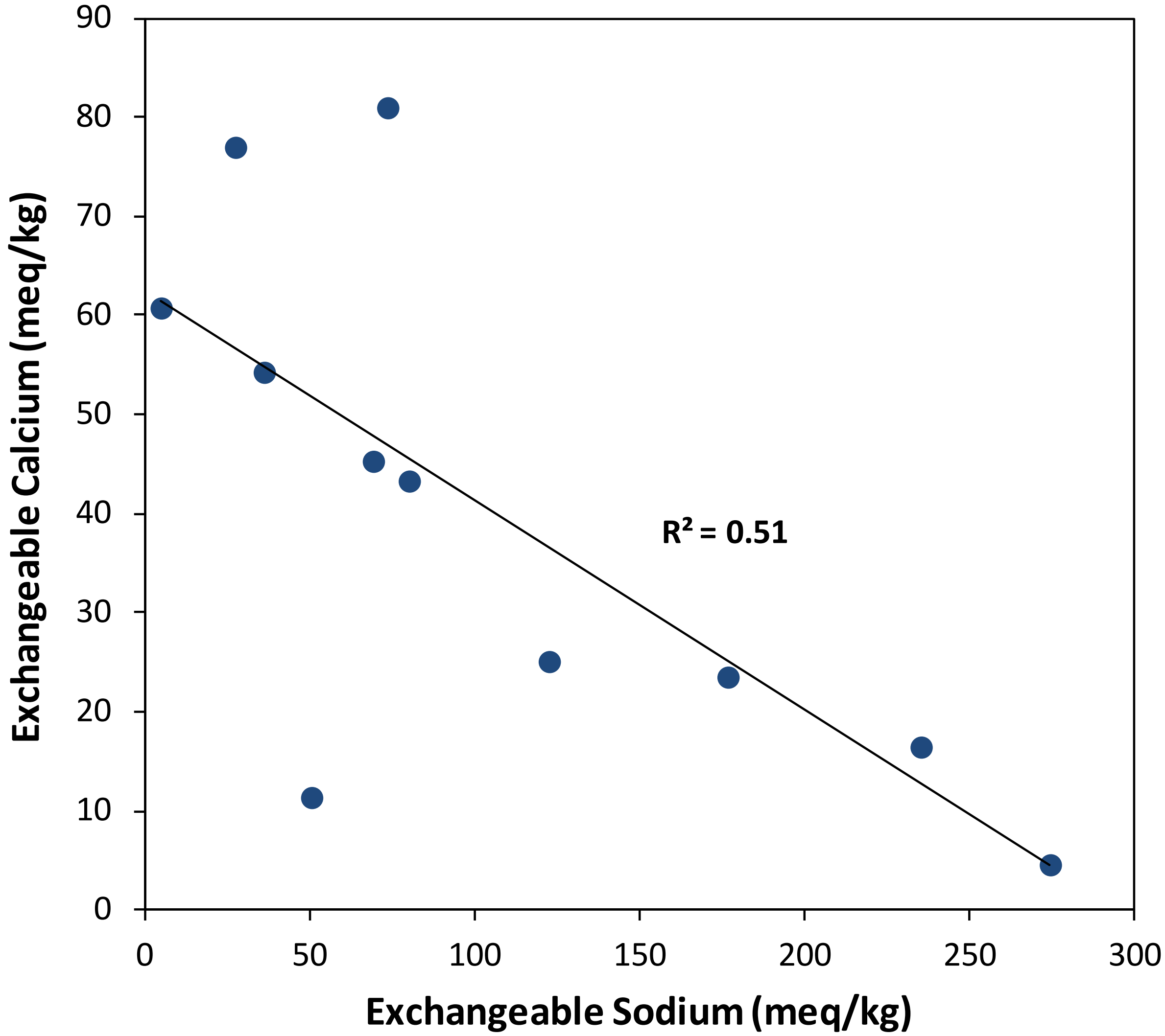
Plate 6-2
Scanning Electron Micrograph Showing Fluorite Crystals Formed In Situ
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



The inverse relationship between exchangeable calcium and exchangeable sodium in soil is direct evidence of the effect of past infiltration of alkaline sodium fluoride solutions into the native soils within portions of the test area. Cation exchange reactions of sodium in alkaline groundwater with calcium on smectite clay release calcium to groundwater to react with fluoride.

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Plate 6-3

Relationship Between Exchangeable Calcium and Sodium in Soil

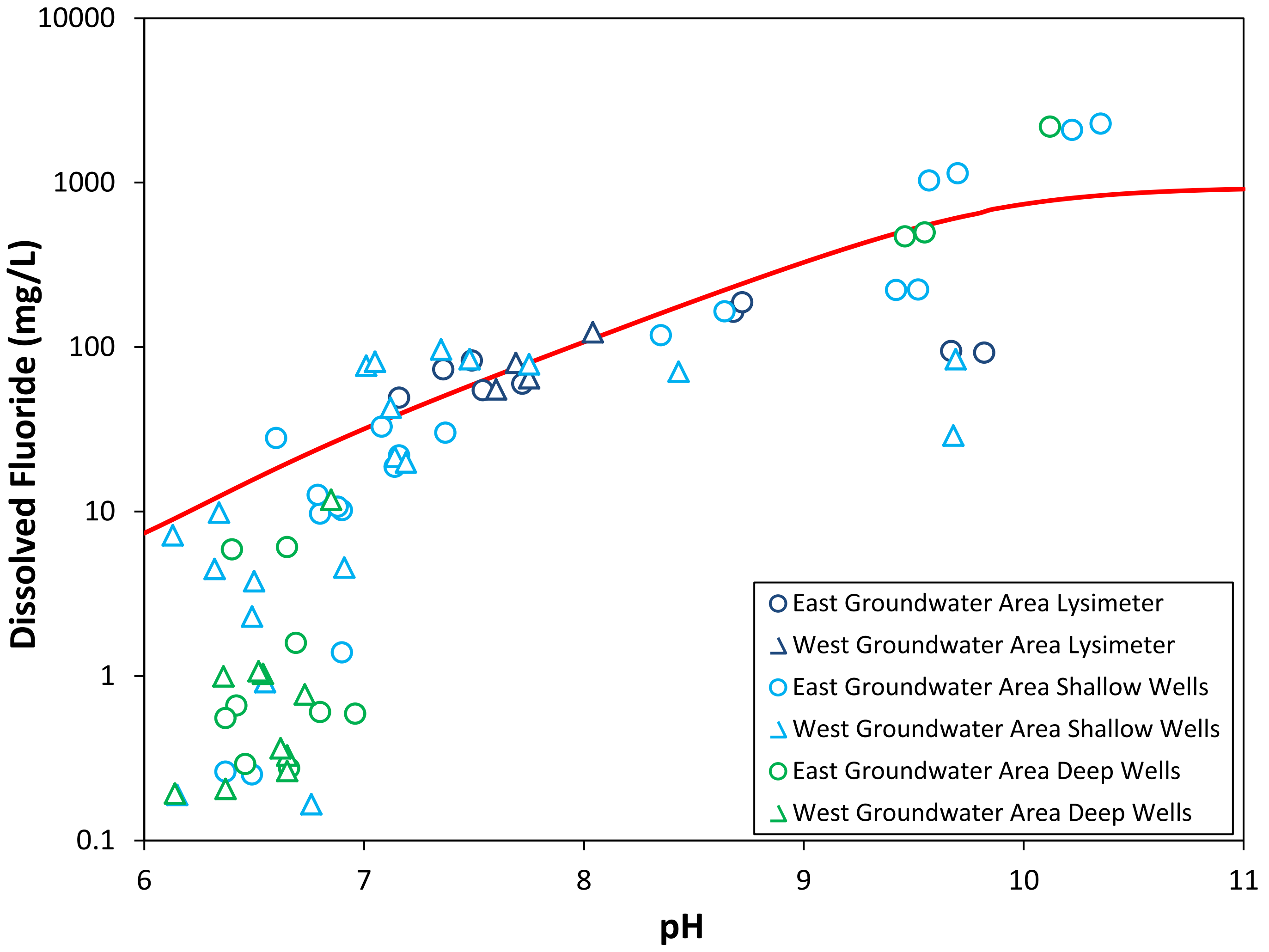
The elevated sodium in groundwater also drives a dissolution-precipitation reaction in which calcium-rich plagioclase feldspar is progressively replaced by albite (sodium feldspar), whereby dissolved calcium is released to groundwater:

$$CaAl_2Si_2O_{8(s)}\ (plagiocalse) + 2Na^+ + 4SiO_2 \rightleftharpoons 2NaAlSi_3O_{8(s)}\ (albite)\ + Ca^{2+} \quad (6\text{-}5)$$

This process, known as albitization, occurs naturally in sodium-rich environments, such as during the diagenesis of marine sediments. Mineralogical data indicate that only albite is present at depths shallower than 7.5 feet in GC-SB-01, -02, and -03, where it has apparently completely replaced plagioclase. Albite coexists with plagioclase at depths below 7.5 feet in GC-SB-01 and -02. In GC-SB-03, only plagioclase is detected below 10 feet.

Geochemical speciation modeling indicates that groundwater in wells PZ-5, R-3, PZ-2, PZ-1, PZ-3, PZ-4, and R-2 is undersaturated with respect to Ca-rich feldspar but is consistently supersaturated with respect to albite and fluorite, signifying a spontaneous tendency for Ca-rich feldspar to dissolve and albite and fluorite to precipitate from these groundwaters.

The spatial distribution of fluorite, albite, and plagioclase in the subsurface demonstrates the occurrence of natural attenuation of dissolved fluoride concentrations both vertically and laterally as groundwater flows from the southern area near the cryolite area ditches northward across the test area. The soil mass of calcium present in plagioclase feldspar and smectite is much greater than the total mass of fluoride in the alkaline groundwater such that fluorite precipitation represents a self-sustaining process controlling downgradient dissolved fluoride concentrations essentially preventing migration of fluoride and arresting plume movement. The variability in fluoride concentrations across the site is due in part to the pH dependence of calcium solubility, which in turn results in a direct correlation between pH and fluoride concentrations in equilibrium with fluorite (see Plate 6-4). For pH values of 8 or less, fluorite solubility effectively limits dissolved fluoride concentrations to fewer than 100 mg/L. Geochemical modeling results for East Groundwater Area wells indicates that fluorite precipitation may be controlling dissolved concentrations to values as low as 10 mg/L.



The fluoride concentrations in groundwater and porewater across the site are controlled in large part by the solubility of the mineral fluorite (calcium fluoride). The pH dependence of calcium solubility results in a direct correlation between pH and fluoride concentrations in equilibrium with fluorite. The red line represents the calculated solubility curve for fluorite. For groundwater pH values of 8 or less, fluorite solubility effectively limits dissolved fluoride concentrations to less than 100 mg/L. In some areas, fluorite precipitation may be controlling dissolved concentrations to values as low as 10 mg/L.

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Plate 6-4

Relationship Between Groundwater Fluoride Concentrations and pH

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

The alkalinity of groundwater within the central portion of the test area promotes desorption of phosphate from native soil, increasing dissolved phosphorus concentrations in groundwater (see Plate 6-5).

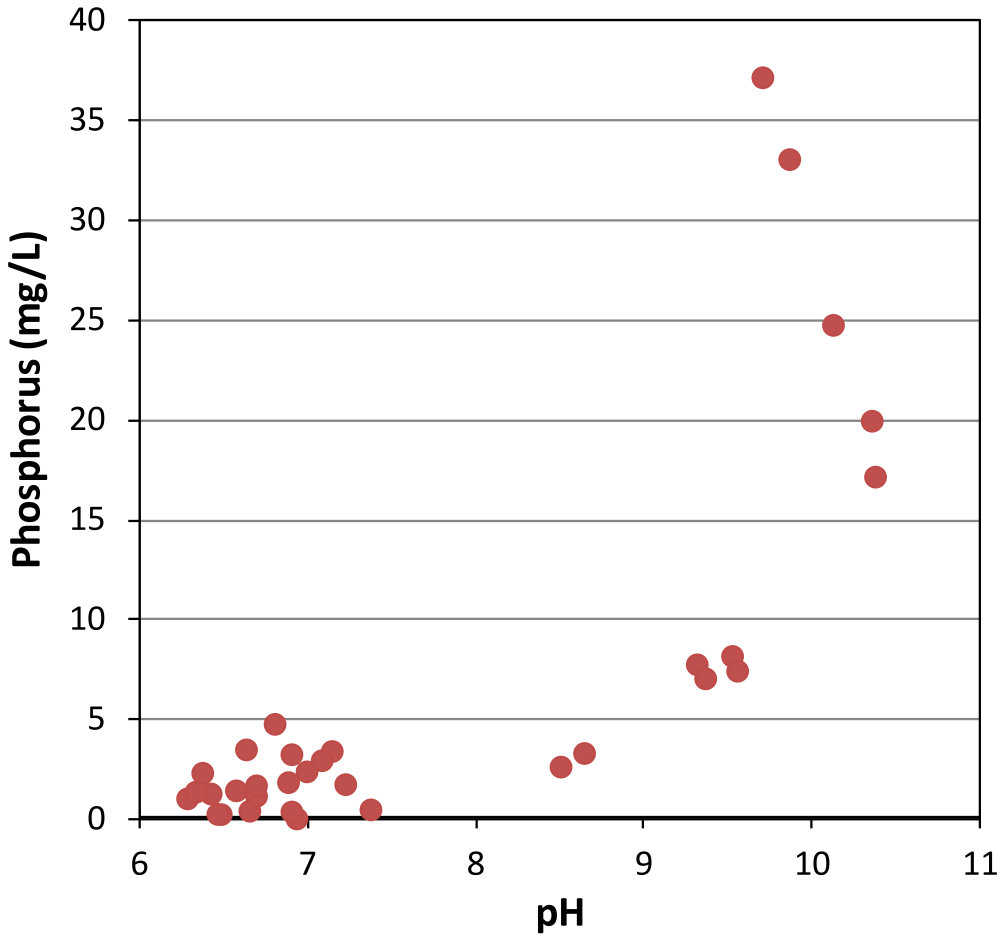
Geochemical speciation modeling results show that groundwater in wells PZ-5, R-3, PZ-2, PZ-1, PZ-3, PZ-4, and R-2 is supersaturated with respect to several fluoride-containing phosphate solid phases including fluorapatite, carbonate fluorapatite, and monofluorophosphate (MFP) apatite and indicating the possibility for fluoride removal from groundwater by the following reactions:

$$5Ca^{2+} + 3HPO_4^{2-} + F^- \rightleftharpoons Ca_5(PO_4)_3F_{(s)}(fluorapatite) + 3H^+ \tag{6-6}$$

$$\begin{aligned}&10Ca^{2+} + 5HPO_4^{2-} + 1.5CO_3^{2-} + 2F^-\\&\rightleftharpoons Ca_{10}(PO_4)_5(CO_3)_{1.5}F_{2(s)}(carbonate\ fluorapatite) + 5H^+\end{aligned} \tag{6-7}$$

$$\begin{aligned}&6Ca^{2+} + 4Na^+ + 6HPO_4^{2-} + 6F^- + 2H^+\\&\rightleftharpoons Ca_6Na_4(PO_3F)_6O_{2(s)}(MFP\ apatite) + 4H_2\end{aligned} \tag{6-8}$$

The relatively low concentrations of phosphate in comparison with fluoride concentrations in groundwater suggest that precipitation of fluorophosphates would be more effective as a fluoride removal mechanism at relatively low dissolved fluoride concentrations because the stoichiometric ratios of fluoride to phosphorus in these solids range from 1:3 in fluorapatite to 1:1 in MFP apatite. These phases might be expected to form at the fringes of the fluoride plume and would be very difficult to detect by powder XRD methods due to their low abundance. MFP apatite was tentatively identified by XRD in one sample from the farthest downgradient boring (GC-SB-04, 15 to 17.5 feet bgs).



The elevated pH of groundwater within the central portion of the former cryolite area promotes desorption of phosphate from native soils, increasing dissolved phosphorus concentrations in groundwater, as shown in the above graph. Geochemical speciation modeling results show that groundwater in wells PZ-5, R-3, PZ-2, PZ-1, PZ-3, PZ-4, and R-2 is supersaturated with respect to several fluoride-containing phosphate solid phases including fluorapatite, carbonate fluorapatite, and monofluorophosphate (MFP) apatite, indicating the potential for fluoride removal from groundwater by the precipitation of fluorophosphates. These phases are most likely to control fluoride concentrations at the fringes of the fluoride plume.

Plate 6-5

Dissolved Phosphorus as a Function of pH in East Groundwater Area Wells

6.2.3 Anion Exchange on Clays

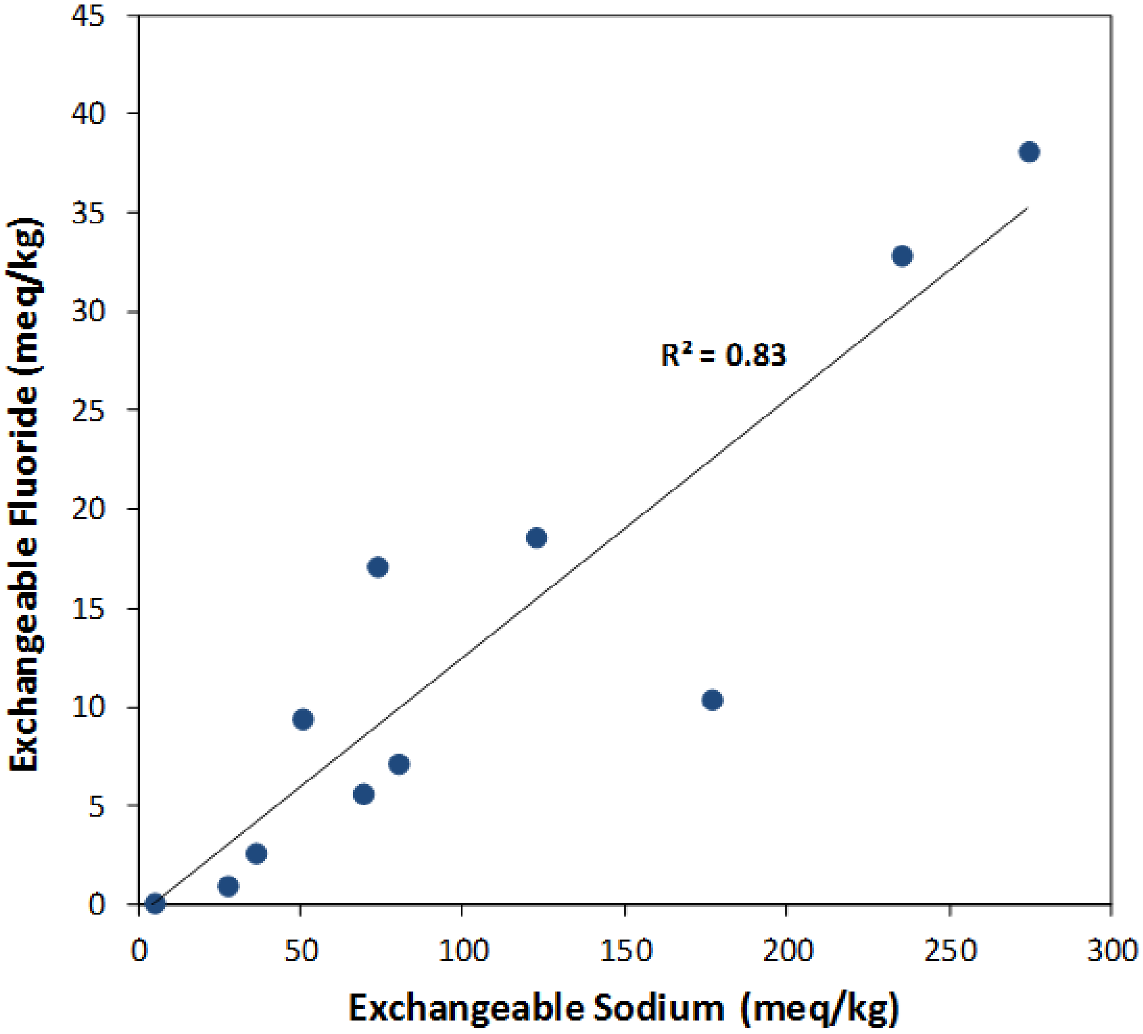
Evidence for the uptake of fluoride from groundwater by anion exchange reactions on clay is provided by direct analysis of AEC and exchangeable fluoride concentrations (see Appendix H). AEC ranges from 6 to 28 milli-equivalents per kilogram (meq/kg) soil (average 16 meq/kg). Exchangeable fluoride ranges from a maximum of 38 meq/kg in the higher-fluoride soils in GC-SB-02 to a minimum of 0.13 meq/kg in the furthest downgradient boring GC-SB-04. Exchangeable fluoride is strongly correlated with exchangeable sodium, indicating a common source (see Plate 6-6).

Exchangeable fluoride also shows a strong correlation with total fluoride concentrations up to approximately 500 mg/kg (see Plate 6-7), demonstrating anion exchange as an important mechanism regulating dissolved fluoride concentrations at the fringes and leading edge of the groundwater plume characterized by lower groundwater fluoride concentrations. Comparison of exchangeable fluoride concentrations to AEC of individual samples indicate that while the solid media is fully fluoride exchanged at GC-SB-01 and GC-SB-02 within the source area, significant AEC is still available for fluoride uptake in the solid media at the two downgradient locations (average of 44 percent of AEC at GC-SB-03 and 92 percent at GC-SB-04).

6.2.4 Adsorption on Aluminum and Iron Oxides

Aluminum and iron oxides provide additional capacity for uptake of dissolved fluoride through adsorption reactions. Fluoride, in particular, has a strong affinity for aluminum oxide surfaces. Soil fluoride concentrations show a good correlation with aluminum oxide content (see Plate 6-8).

Fluoride adsorption on aluminum and iron oxides is pH dependent. Fluoride, being a negatively charged ion, is adsorbed much more readily at near-neutral and acidic pH than in basic conditions, due to the negative charge which develops on oxide mineral surfaces as pH increases. Sorption reactions are, therefore, a more important factor in limiting fluoride migration at the leading edge of the groundwater plume, where the groundwater exhibits a near-neutral pH.



Fluoride uptake from groundwater by anion exchange reactions on clays is evidenced by direct analysis of anion exchange capacity and exchangeable fluoride concentrations (see Appendix H). Exchangeable fluoride is strongly correlated with exchangeable sodium, indicating a common source of sodium and fluoride (i.e., shallow groundwater).

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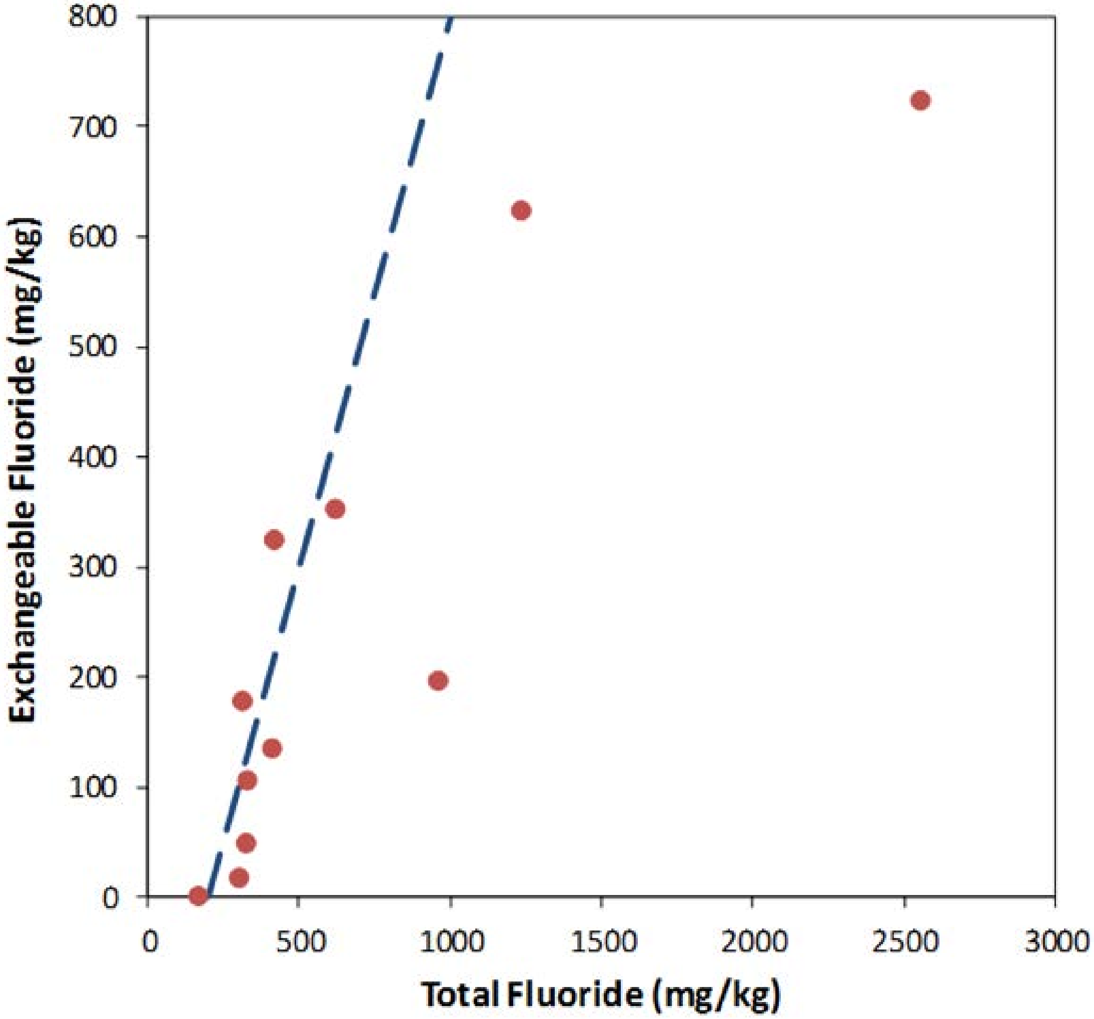
Plate 6-6
Correlation of Exchangeable Fluoride with Exchangeable Sodium Concentrations in Solid Media
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



The strong correlation between exchangeable and total fluoride concentrations in soil up to approximately 500 mg/kg total fluoride indicates that anion exchange is an important mechanism regulating dissolved fluoride concentrations at the fringes and leading edge of the groundwater plume characterized by lower groundwater fluoride concentrations.

Plate 6-7

Variation of Exchangeable Fluoride with Total Fluoride Concentrations in Solid Media
Remedial Investigation/Feasibility Study
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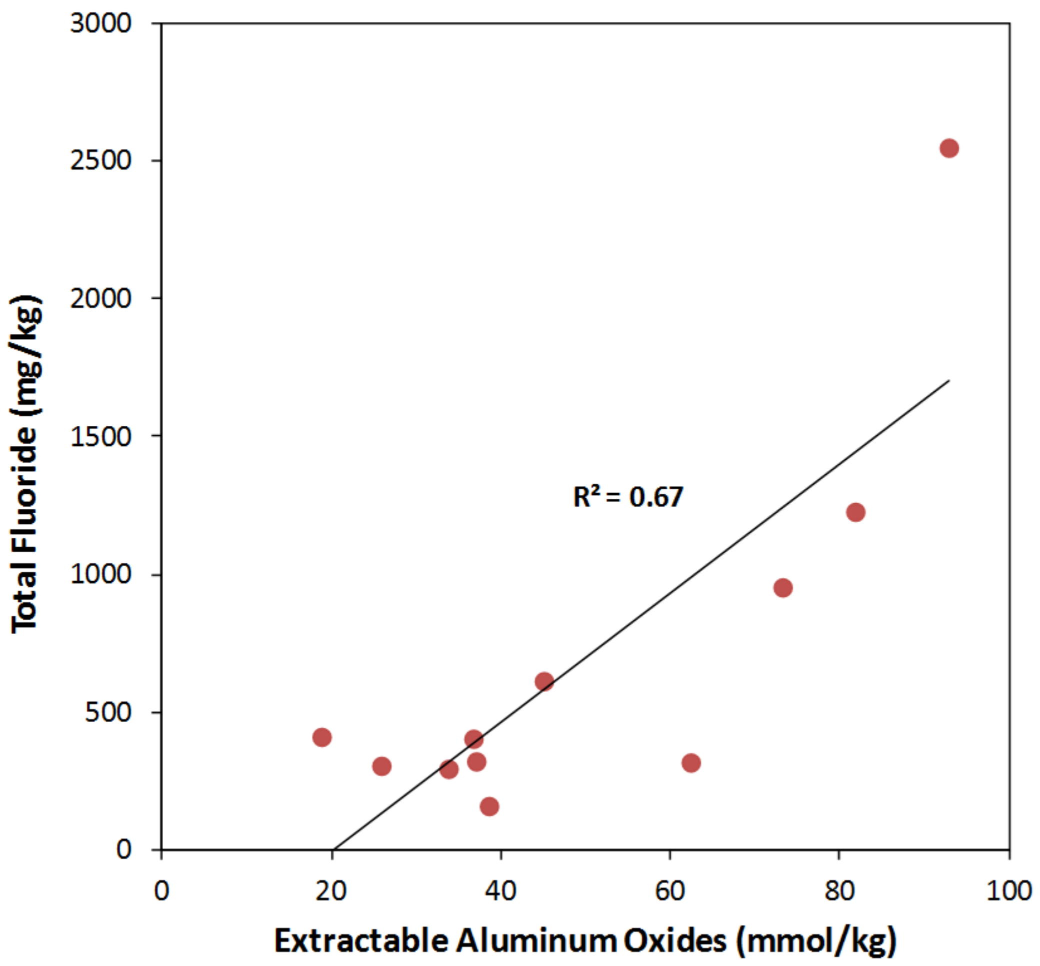


Adsorption on aluminum and iron oxides in soil provides additional capacity for attenuation of dissolved fluoride. Fluoride has a strong affinity for aluminum oxide surfaces. In the above graph, soil fluoride concentrations show a good correlation with extractable aluminum oxides. Fluoride adsorption on aluminum and iron oxides is pH dependent. Fluoride, being a negatively charged ion, is adsorbed much more readily at near-neutral and acidic pH than in basic conditions, due to the negative charge which develops on oxide mineral surfaces as pH increases. Sorption reactions are, therefore, a more important factor in limiting fluoride migration at the leading edge of the groundwater plume, where the groundwater exhibits a near-neutral pH.

Plate 6-8

Correlation of Soil Fluoride Concentrations with Extractable Aluminum Oxide Content

6.2.5 Summary of Findings from East Groundwater Area Geochemical Study

Plate 6-9 provides a synopsis of the processes occurring within the groundwater of the test area and how they affect groundwater fluoride concentrations. These processes are applicable to other site areas, though the conditions present in those areas will affect the impact of these processes on groundwater fluoride concentrations.

6.3 Geochemical Interactions at Ditch Water Boundaries

This section discusses processes occurring at the site that limit fluoride concentrations discharging to surface water in the numerous ditches in and surrounding the study area. As discussed in Section 4.3 and shown on Figures 4-1 and 4-2, shallow groundwater in the shallow alluvium WBZ beneath the site generally flows away from the Columbia River toward the CDID ditches. The only exception is riverward of the CDID levee, where flow can be toward the river. Fate and transport processes in areas near the Columbia River shoreline are discussed in more detail in Section 6.4.

Sampling results for surface water, including the CDID ditches, presented in Section 5.4 and Figures 5-14a and 5-14b show that dissolved fluoride concentrations are either non-detect or below the surface water screening level of 4 mg/L.

Groundwater near the CDID ditches is characterized by upward vertical hydraulic gradients, indicating both shallow and slightly deeper (approximately 30 feet bgs) groundwater in the upper alluvium WBZ discharge to the CDID ditches surrounding the study area. Shallow monitoring wells in the upper alluvium WBZ located adjacent to the ditches show a range of concentrations, depending on location, from less than 1 mg/L to a maximum of 84.5 mg/L at PZ-6. In contrast, slightly deeper (approximately 30 feet bgs) monitoring wells in the upper alluvium WBZ show much lower fluoride concentrations, generally less than or up to 1 mg/L, with only one exception (RL-2D). Mixing of shallow groundwater with slightly deeper low-fluoride groundwater within the upper alluvium WBZ in the vicinity of ditches can partly explain the empirical observation of very low fluoride detections in ditch water. Based on the understanding of geochemical processes affecting fluoride fate and transport at the site, as documented in Section 6.2, lines of evidence indicating the potential role of specific geochemical processes in attenuating fluoride concentrations discharging to the ditch system were evaluated.

Process Description	Location within Test Area	Impact on Fluoride in Groundwater	Applicability to Other Site Areas
Fluoride leaching from residual carbon and associated source materials	Upper solid media (1 to 7.5 feet below ground surface)	Concentrations are generally limited to less than 100 mg/L by fluorite solubility.	Extent of leaching depends in part on groundwater alkalinity. See Section 6.1 for leaching data.
Fluorite precipitation	Upper solid media and shallow groundwater	Reduces dissolved fluoride to 10 to 100 mg/L depending on pH and calcium.	Shallow groundwater in the West Groundwater Area
Fluorophosphate precipitation	Fringes of groundwater plume where fluoride concentrations are comparable to phosphate concentrations	Controls dissolved fluoride to low levels when sufficient phosphate is available.	Throughout the site in the unsaturated and saturated zones, depending on dissolved phosphate to fluoride concentrations. Groundwater-surface water transition zone at ditch and river boundaries.
Adsorption (anion exchange) on clays	Solid media and groundwater in the saturated and unsaturated zones	Retards fluoride movement. Uptake is more effective for lower dissolved fluoride concentrations.	Throughout the site in the unsaturated and saturated zones. Groundwater-surface water transition zone at ditch and river boundaries.
Adsorption on aluminum and iron oxides	Solid media and groundwater in the saturated and unsaturated zones	Retards fluoride movement. Uptake is more effective for lower dissolved fluoride concentrations and at near-neutral pH.	Throughout site in the unsaturated and saturated zones. Groundwater-surface water transition zone at ditch and river boundaries.

Note:
mg/L = milligram per liter

This plate provides a synopsis of the processes documented to be occurring within the East Groundwater Area and how these processes affect groundwater fluoride concentrations. These processes are applicable to other site areas, though the specific conditions present in those areas will affect the impact of these processes on groundwater fluoride concentrations.

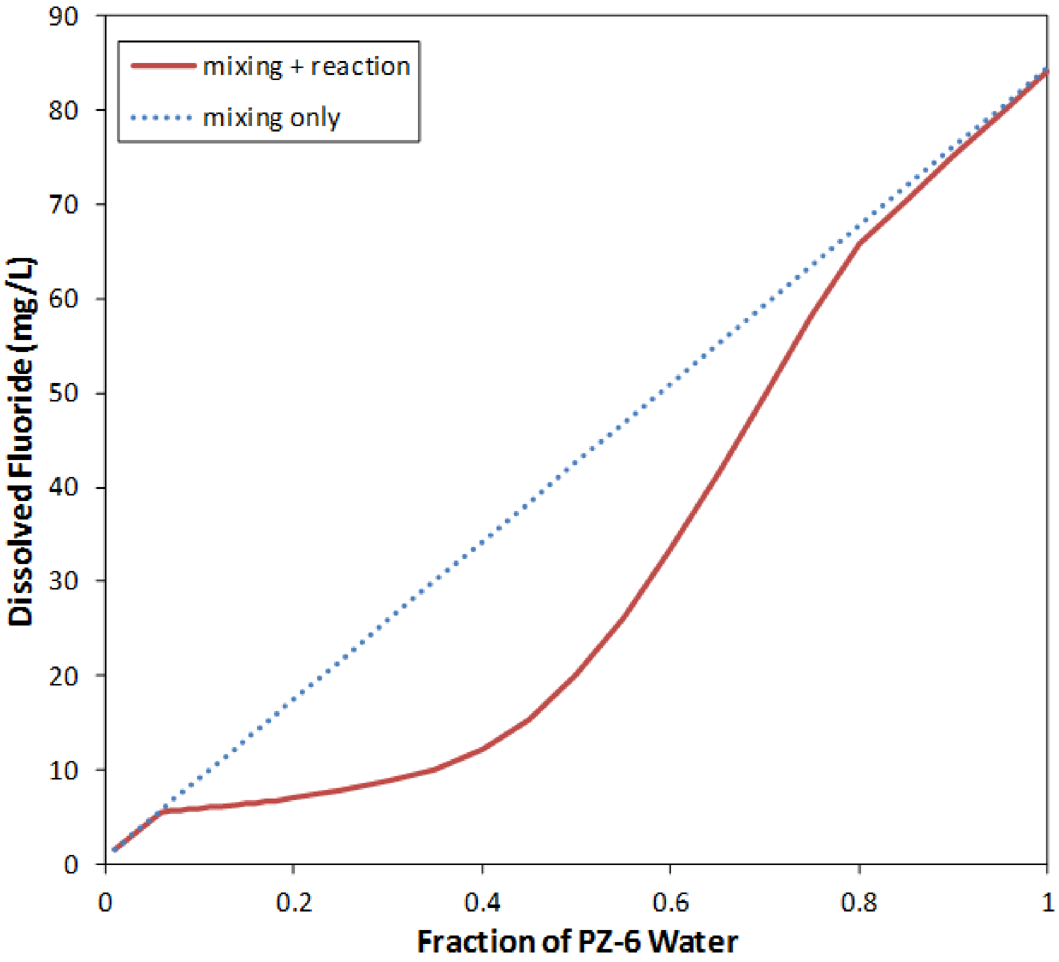
Plate 6-9

Summary of Geochemical Processes Identified Within the East Groundwater Area
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

Geochemical modeling was conducted to evaluate potential reactions affecting fluoride during the subsurface mixing of shallow groundwater over variable depths (8 to 30 feet bgs) as flow paths converge near ditches. Geochemical mixing models were developed for selected variable-depth groundwater sample pairs, including PZ-7 and G7-D, and PZ-6 and G7-D, using the geochemical modeling software PHREEQC (Parkhurst and Appelo 1999). Briefly, the shallow (8 to 18 feet bgs) and deep (20 to 30 feet bgs) end-members were mixed over a range of proportions from 0 to 100 percent, and minerals such as fluorite and fluorapatite were allowed to precipitate to equilibrium if they became supersaturated.

Modeling results for one example (PZ-6 mixing with G7-D) are shown on Plate 6-10. These results indicate that, while these waters are not supersaturated with respect to fluoride-bearing minerals, mixtures of the two waters can be supersaturated. Mixing of shallow groundwaters over a depth interval of 8 to 30 feet bgs (due to convergence of groundwater flow near ditch boundaries) can, therefore, lead to precipitation of fluorite or fluorapatite minerals in the aquifer adjacent to the ditch. The calculations indicate, furthermore that, depending on the samples selected as end-members in the mixing calculations, fluoride concentrations can be reduced by up to a factor of three relative to the concentrations calculated for simple conservative mixing alone. These results demonstrate the relative importance of fluoride mineral precipitation reactions in regulating groundwater fluoride concentrations in near-ditch environments and in reducing the dissolved concentrations that could ultimately discharge to surface water.

Adsorption on iron and aluminum oxides and clay minerals provides an additional mechanism for fluoride removal from groundwater prior to discharge to surface water. These mineral sorbents are ubiquitous in the environment and were documented in site soils in Section 6.2. Iron and aluminum oxides and clay minerals are typically abundant in the fine sediment that accumulates in the bottom of ditches over time. The presence of these materials provides an adsorptive barrier to fluoride migration from groundwater to surface water.



Subsurface mixing of shallow groundwater from variable depths (up to 30 feet bgs) as flow paths converge near ditches can result in precipitation of fluorite and/or fluorapatite minerals in the aquifer adjacent to the ditch. Geochemical modeling results for one subsurface mixing example (PZ-6 shallow groundwater from 8 to 18 feet bgs mixing with G7-D deeper groundwater from 20 to 30 feet bgs) indicate that while these waters are not supersaturated with respect to fluoride-bearing minerals, groundwater can become supersaturated as a result of mixing. This calculation indicates that fluoride concentrations can be reduced by up to a factor of three relative to the concentrations calculated for simple conservative mixing alone.

Plate 6-10

Modeled Dissolved Fluoride Concentrations During Subsurface Mixing of Shallow (PZ-6) and Deep (G7-D) Groundwater
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

The overall very low fluoride concentrations detected in water in ditches surrounding the site results largely from geochemical factors, including mixing-induced precipitation of insoluble fluoride minerals such as fluorite and fluorapatite and adsorption on clays and iron and aluminum oxides in the aquifer.

6.4 Processes Occurring at River Boundary

This section discusses processes occurring on-site at locations where groundwater may discharge to the surface waters of the Columbia River. Fluoride concentrations in the Columbia River adjacent to the site are low (approximately 0.2 mg/L) and statistically similar to concentrations measured upstream of the site. The surface water sampling results show empirically that groundwater discharging from the site does not have a measurable impact on fluoride concentrations in the river.

Groundwater in the upper alluvium WBZ generally flows from the Columbia River toward upland areas due to hydraulic control by pumping of the CDID ditch system, except in areas on the riverward side of the CDID levee, where groundwater gradients can sometimes be south and west toward the Columbia River (see Figures 4-1 and 4-2), depending on river stage. Vertical hydraulic gradients are generally downward in nearshore areas along the river.

Monitoring wells located in these areas include G1-S, G1-D, R-1S, R-1D, R-4S, R-4D, and SSA7-MW-01 in the eastern part of the site and G6-S, G6-D, and RLSW-4 in the western part. Fluoride concentrations are typically less than 2 mg/L in the deeper wells, while higher concentrations are found in the shallower wells, with a maximum of 96.8 mg/L at RLSW-4.

Water levels in three of the wells located near the crest of the CDID levee (G6-S, RLSW-4, and G1-S) are persistently several feet higher than the stage of the Columbia River, without any obvious source of recharge other than precipitation. A review of well logs and the absence of tidal influence on water levels (see Sections 4.3.1 and 4.3.2 and Plates 4-7 and 4-8) indicate that these wells are likely monitoring groundwater that is perched above low permeability horizons within the CDID levee or adjacent to the river bank. The persistence of these anomalously high water levels indicates a perched condition, with recharge due to local precipitation and slow drainage characteristics.

The elevated fluoride concentrations at RLSW-4 and G6-S (96.8 and 78.7 mg/L, respectively) also appear to be localized. The fluoride in the perched zone appears to have very limited if any impact on slightly deeper groundwater, as evidenced by the very low fluoride concentrations detected in monitoring well G6-D (approximately 1 mg/L).

The observed limited vertical migration of fluoride described above, despite the strong downward vertical gradients and absence of detectable water quality impacts in river water, is strong evidence that attenuation of fluoride concentrations in groundwater is occurring prior to discharge to surface water. In this setting, characterized by relatively low fluoride concentrations (typically 10 mg/L or less in areas where hydraulic gradients are toward the river), adsorption on clays, iron, and aluminum oxides present in overbank deposits is the primary attenuation mechanism.

Geochemical speciation modeling results indicate that upper alluvium WBZ groundwater adjacent to the Columbia River is supersaturated with respect to fluorapatite and other fluorophosphate minerals, although fluoride concentrations are generally too low to allow precipitation of fluorite. Precipitation of fluorophosphates is thus another important attenuation mechanism for fluoride in this setting.

In addition, tidal mixing in nearshore areas of the upper alluvial WBZ provides further reduction of the relatively low groundwater fluoride concentrations prior to discharge at the interface with the river. As described in Appendix H, tidal attenuation modeling was performed, using data obtained from the tidal study discussed in Section 4.3.2, to evaluate the attenuation that occurs in nearshore groundwater discharging to the Columbia River. Based on this modeling, the calculated attenuation factor for non-perched groundwater located at the shoreline discharging to the river is 0.3. This means that groundwater fluoride concentrations at the shoreline would be reduced by a factor of 0.3 due to tidal mixing (i.e., physical attenuation).

Collectively, these near shore processes are shown quantitatively to provide sufficient in situ attenuation of fluoride concentrations to be protective of surface water quality in the Columbia River.

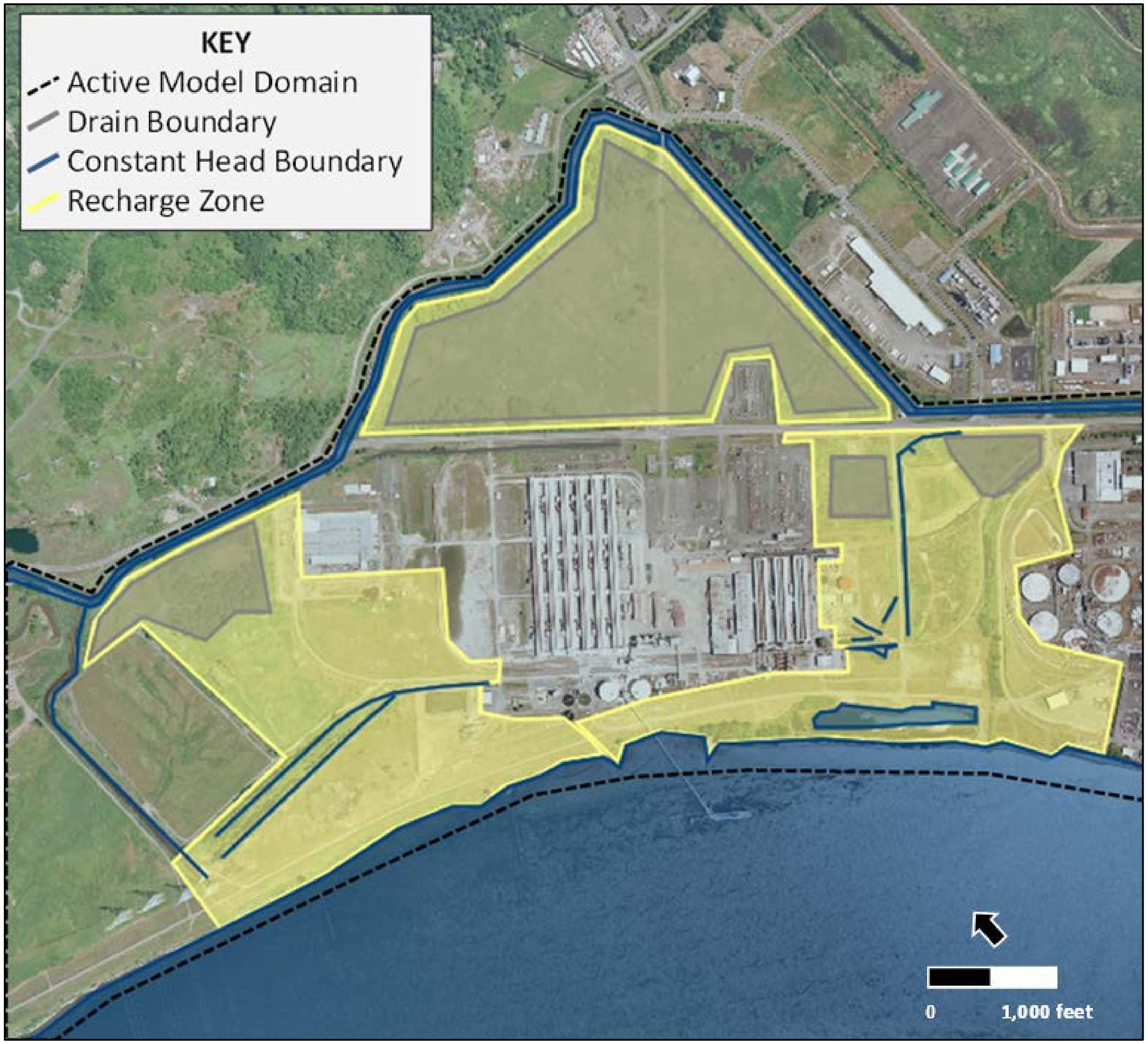
6.5 Fluoride Fate and Transport Modeling

Groundwater flow and transport modeling was performed to quantitatively evaluate the long-term effectiveness and reliability of geochemical processes in attenuating fluoride in groundwater and preventing potential surface water quality impacts. This section briefly describes the flow and geochemical reactive transport models and key simulation results. Details of model development, calibration, and application are provided in Appendix H.

6.5.1 Groundwater Flow Model

A three-dimensional numerical groundwater flow model was developed for the entire site using MODFLOW. The model domain boundaries include the Columbia River to the south, and the CDID ditches to the north and west (see Plate 6-11). Additional features included in the model are the various on-site ditches and definition of recharge areas within the site. The model was calibrated to observed heads. The calibrated model was used to simulate groundwater flow and evaluate flow patterns across the site.

The simulated flow patterns in the upper alluvium WBZ for the dry season, wet season, and long-term average conditions are illustrated on Plates 6-12 through 6-14, respectively. In the West Groundwater Area, patterns are generally consistent with flow from the Columbia River toward the U-ditch and, ultimately, the CDID ditches. In the East Groundwater Area, groundwater flows toward the Columbia River within a narrow band along the shore. A divide, approximately coincident with the levee road, separates this zone from upland areas where groundwater flow is toward the on-site ditches and CDID. The average groundwater discharge to the Columbia River is calculated at 27.2 million gallons per year (MGY), while 64 MGY are discharged to the CDID system and 47.6 MGY are captured by the on-site ditches (U-ditch in the West Groundwater Area and 004 Pump Station in the East Groundwater Area). Note that these flow rates represent all water, whether or not it contains fluoride. As discussed in Section 5, water quality in the CDID ditches is not impacted. Internal ditches are managed in accordance with the facility's NPDES permit.



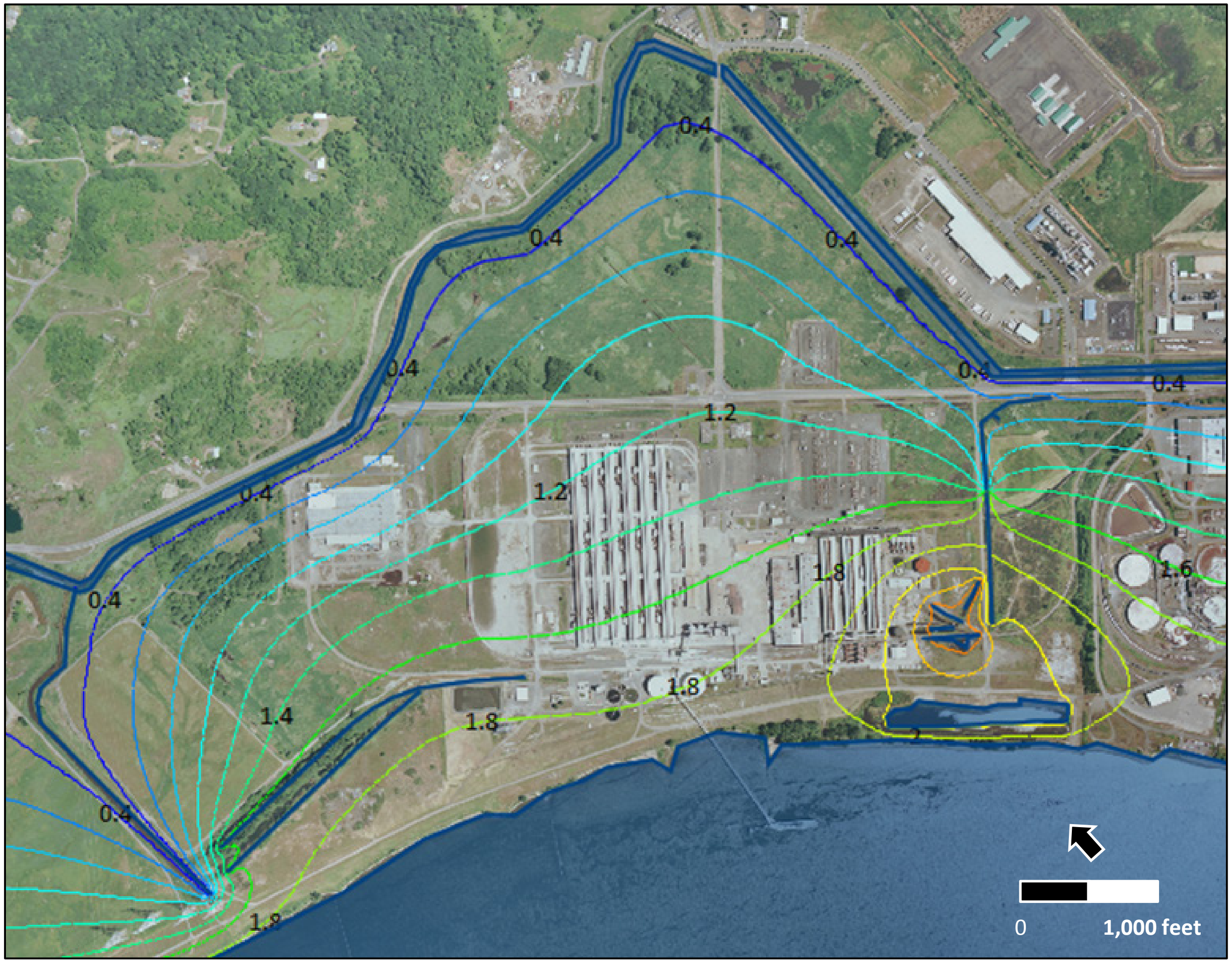
The groundwater flow model domain boundaries include the Columbia River to the south and the CDID ditches to the north and west. Additional model features include the on-site ditches (i.e., U-ditch, cryolite area ditches, and the ditch adjacent to Fill Deposits A, B-1, and B-2 [discharging to 004 Pump Station]) and recharge areas defined within the site. The groundwater flow model also incorporates a drain feature in order to keep water from ponding on the simulated ground surface.

Plate 6-11

Groundwater Flow Model Domain and Boundaries

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview



Note: Groundwater elevations are shown in meters above Mean Sea Level. The contour interval is 0.2 meter.

This plate shows the simulated groundwater flow pattern in the upper alluvium WBZ during the dry weather season. The model was calibrated to observed heads measured at the site in October 2012. In the West Groundwater Area, groundwater flows from the Columbia River towards the U-ditch and, ultimately, the CDID ditches. In the East Groundwater Area, groundwater flows towards the Columbia River within a narrow band along the shore. A divide, approximately coincident with the levee road, separates this zone from upland areas where groundwater flow is towards the on-site ditches and CDID ditches.

Plate 6-12

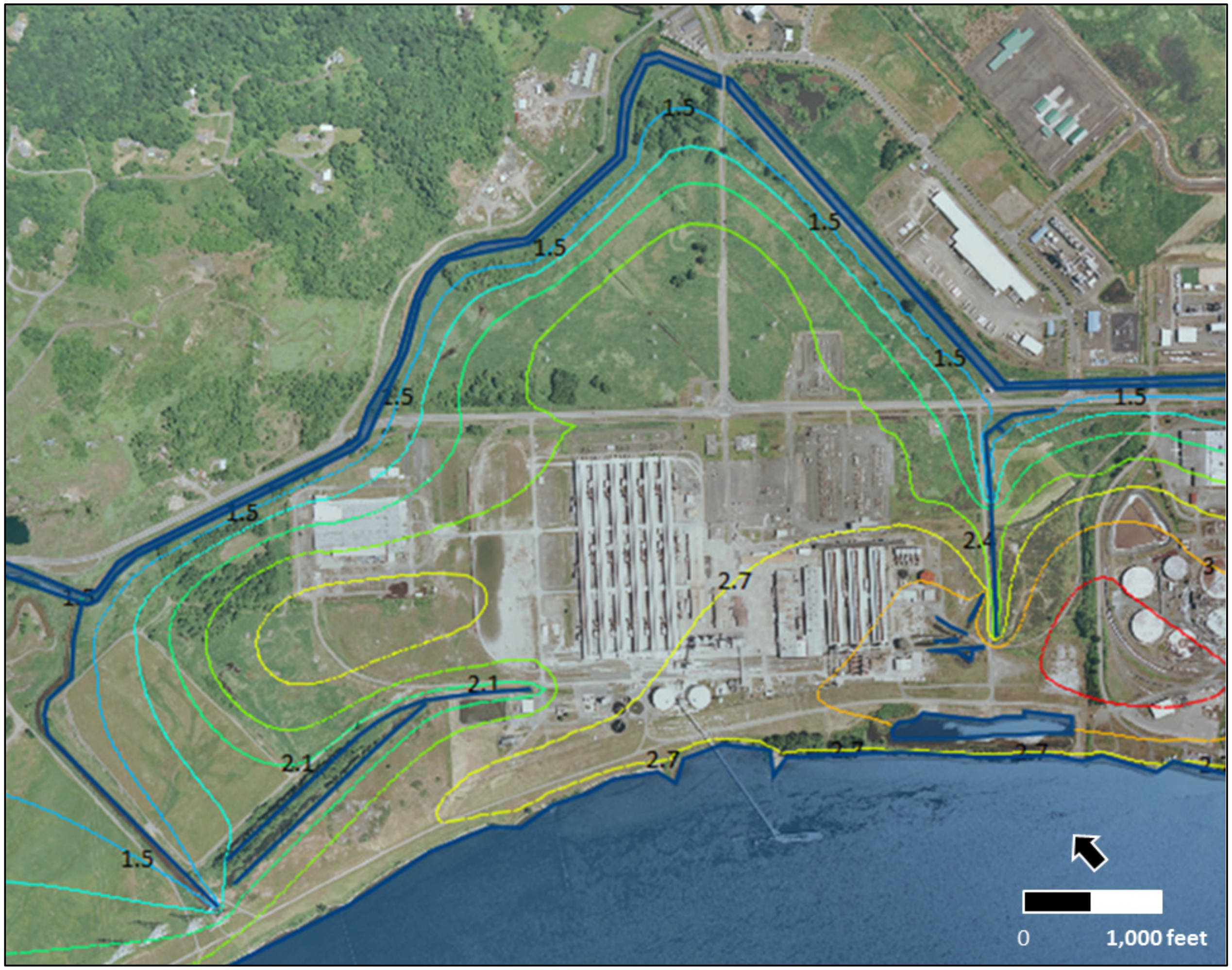
Groundwater Flow Pattern for the Dry Season Model
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

Note: Groundwater elevations are shown in meters above Mean Sea Level. The contour interval is 0.3 meter.

This plate shows the simulated groundwater flow pattern in the upper alluvium WBZ during the wet weather season. The model was calibrated to observed heads measured at the site in December 2012. In the West Groundwater Area, groundwater flows from the Columbia River towards the U-ditch and, ultimately, the CDID ditches. In the East Groundwater Area, groundwater flows towards the Columbia River within a narrow band along the shore. A divide, approximately coincident with the levee road, separates this zone from upland areas where groundwater flow is towards the on-site ditches and CDID ditches.

Plate 6-13

Groundwater Flow Pattern for the Wet Season Model
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: Groundwater elevations are shown in meters above Mean Sea Level. The contour interval is 0.3 meter.

This plate illustrates the simulated long-term average groundwater flow pattern in the upper alluvium WBZ. In the West Groundwater Area, groundwater generally flows from the Columbia River towards the U-ditch and, ultimately, the CDID ditches, with the exception of a narrow band along the shore in the south-central portion of the site. In the East Groundwater Area, groundwater flows towards the Columbia River within a narrow band along the shore. A divide, approximately coincident with the levee road, separates this zone from upland areas where groundwater flow is towards the on-site ditches and CDID ditches.

Plate 6-14

Groundwater Flow Pattern for the Long-term Average Model
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

6.5.2 Reactive Transport Model

Multi-component reactive transport models were developed for the East and West Groundwater Areas using the reactive transport simulator PHAST. The calibrated MODFLOW model provided the basis for the flow component of the models. In addition to groundwater flow, geochemical processes regulating fluoride concentrations and movement in groundwater are simulated by PHAST. These processes include aqueous speciation, mineral dissolution and precipitation, cation exchange on clays, and surface complexation on oxide surfaces. The chemical components simulated included aluminum, calcium, sodium, chloride, fluoride, phosphate, silica, inorganic carbon, and pH. The initial and boundary water and solid phase chemical compositions vary spatially according to the distribution of different geochemical zones, as identified on Plate 6-15. This includes definitions for background groundwater, Columbia River water, and precipitation (recharge) chemistry. In addition, several fluoride source zones were defined, including fill (residual carbon) deposits and a landfill deposit in the East Groundwater Area and a fill deposit in the West Groundwater Area. Concentrations of specific minerals, the ion exchange complex, and adsorbing surfaces were assigned based on site-specific data obtained from the geochemical study. Particularly important to fluoride transport, initial conditions throughout the model domain included exchangeable calcium concentrations based on site-specific data (see Appendix H). In the model, exchangeable calcium represents the calcium available in soil/solid media to react with and remove fluoride from groundwater. Further details of the setup and preparation of the PHAST models can be found in Appendix H.

Simulations were performed to evaluate fluoride transport and attenuation. The objective of these simulations was specifically to identify portions of the site where the documented natural attenuation processes will be sufficient to provide long-term protection of surface water quality and, conversely, to pinpoint locations where the effectiveness may be limited, for example, due to insufficient buffer zone or other site-specific factors. The reactive transport models were run for a total simulation time of 2,000 years. During the course of the simulations, fluorite was allowed to precipitate in a grid cell if the groundwater became supersaturated or dissolve if undersaturated groundwater entered a grid cell containing fluorite. Additionally, the adsorption-desorption of fluoride was modeled as a surface complexation reaction.

Parameter		Units	East and West Groundwater Areas			East Groundwater Area								West Groundwater Area		
			Background Aquifer[1]	Columbia River[2]	Precipitation[3]	Fill Deposit B-2 and Former Stockpile Area[5]	Fill Deposit A[6]	Fill Deposit B-1[7]	Impacted Shallow GW Area[8]	Landfill #1[9]	Fill Deposit B-2[10]	Area Surrounding PZ-4[11]	Former Stockpile Area[12]	Fill Deposit B-3[13]	Fill Deposit B-3[4]	Closed BMP Facility[14]
			Initial Condition	Constant Head	Recharge	Recharge	Recharge and Source Zone	Recharge and Source Zone	Source Zone	Recharge and Source Zone	Source Zone	Recharge and Source Zone	Recharge and Source Zone	Source Zone	Recharge	Source Zone
Solution Chemistry	Temperature	°C	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	pH	-	6.50	7.09	5.60	8.06	10.46	7.54	6.95	6.95	9.36	9.70	10.25	7.03	7.70	9.90
	Dissolved Inorganic Carbon	mg/L	45	54	0.2	95	75	75	120	120	195	700	1100	96	75	525
	Aluminum	mg/L	0.019	6.73 x 10^{-3}	-	3.16	15.14	4.05	0.10	0.10	0.19	0.6	0.22	1.25	2.3	0.75
	Calcium	mg/L	40	14.57	0.34	6.01	0.85	11.5	54.7	54.7	4.17	4.1	1.0	14	7.47	15
	Sodium	mg/L	23	6.75	0.141	557	378	327	400	400	1000	4250	6750	449	400	3500
	Chloride	mg/L	6	4.38	0.36	8.58	7.95	3.41	49.5	49.5	25.6	110	63.5	6.14	2.73	10
	Fluoride	mg/L	0.15	0.13	0.13	123.4	94.35	54.7	21	21	222	1080	2280	80	80	500
	Phosphorus	mg/L	1.47	0.029	0.05	0.046	0.021	0.012	1.9	1.9	7.48	36.5	21.1	0.93	0.042	10
	Silica	mg/L	31.1	4.62	-	11.21	3.75	17.2	22	22	11.8	15.3	26.5	18.25	14.21	10
Equilibrium Mineral Phases	Calcite	moles/kg$_w$	0	NA		NA	0	0	0	0	0	1	1	0	NA	0
	Cryolite	moles/kg$_w$	-				-	-	-	-	-	1000	1000	-		-
	Gibbsite	moles/kg$_w$	0				1	1	0	0	1	1	1	0		0
	Fluorite	moles/kg$_w$	0				1	1	0	1	1	1	1	1		1
	Amorphous Silica	moles/kg$_w$	1				0	1	1	1	0	0	0	1		1
Cation Exchanger[15] (CaX_2)		moles/kg$_w$	0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1
Aluminum Oxide (≡AlOH Adsorbing Surface)[16]		grams/kg$_w$	2				2	2	2	2	2	2	2	2		2

Notes:

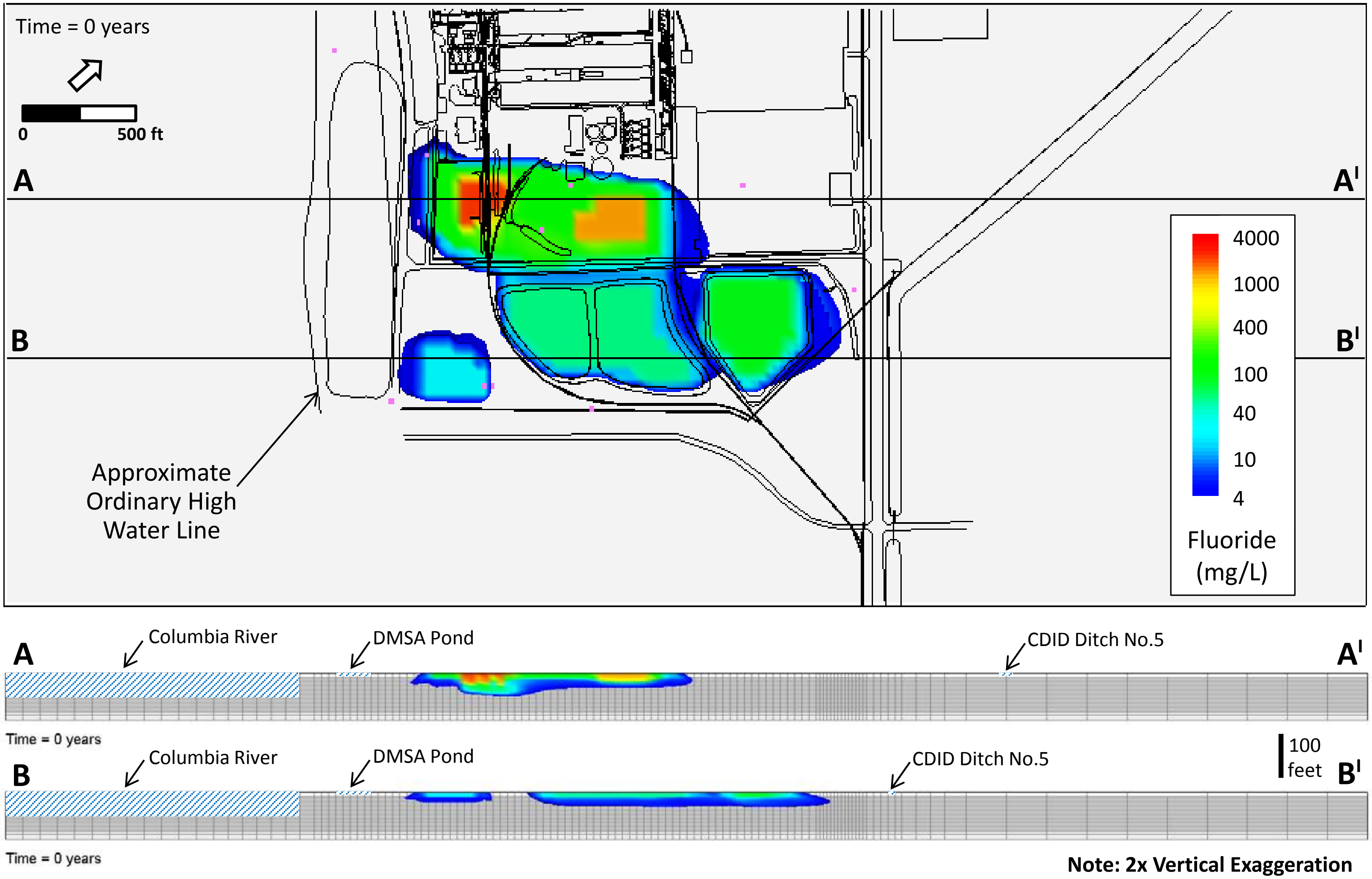
1. Average site-wide background chemistry (based on monitoring wells G4-S, G4-D, G5-S, G5-D, R-2, RL-4S, and RL-4D 2011/2012 data)
2. Average Columbia River water chemistry (based on surface water sampling location W5 2006/2011 data)
3. Site-wide non-source zone recharge chemistry (modified rainwater chemistry provided in PHREEQC manual [example 4])
4. Average recharge chemistry for the West Groundwater Area Fill Deposit B-3 and Landfill #2 (based on lysimeters GC-LY-07 and GC-LY-08 2012 data)
5. Average recharge chemistry for the Fill Deposit B-2 and the Former Stockpile Area (based on lysimeters GC-LY-05 and GC-LY-06 2012 data)
6. Average recharge and initial source zone chemistry for the East Groundwater Area Fill Deposit A (based on lysimeters GC-LY-01 and GC-LY-02 2012 data); Recharge: solution chemistry only
7. Average recharge and initial source zone chemistry for the East Groundwater Area Fill Deposit B-1 (based on lysimeters GC-LY-03 and GC-LY-04 2012 data); Recharge: solution chemistry only
8. Average initial source zone chemistry for the East Groundwater Area encompassing Fill Deposits A, B-1, and B-2, the Former Stockpile Area, and Landfill #1 (based on monitoring wells G1-S, G2-S, G3-S, R-1S, and R-4S 2011/2012 data)
9. Contains the same geochemical parameters as the impacted shallow groundwater area, with the exception of Landfill #1 being supersaturated with Fluorite; Recharge: solution chemistry only
10. Average initial source zone chemistry for Fill Deposit B-2 and Cryolite Area Ditches (based on monitoring wells PZ-1S, PZ-2D, PZ-3, and soil borings GC-SB-01, GC-SB-02, and GC-SB-03 2011/2012 data)
11. Average initial recharge and source zone chemistry for the area surrounding monitoring well PZ-4 and soil borings GC-SB-02 and GC-SB-03 (based on monitoring well PZ-4 and soil borings GC-SB-01, GC-SB-02, and GC-SB-03 2011/2012 data)
12. Average initial recharge and source zone chemistry for the area surrounding monitoring wells R-3 and PZ-5 [i.e., Former Stockpile Area] (based on monitoring wells R-3, PZ-5, and soil borings GC-SB-01, GC-SB-02, and GC-SB-03 2011/2012 data)
13. Average initial source zone chemistry for the West Groundwater Area Fill Deposit B-3 and Landfill #2 (based on RLSW-2 2011/2012 data)
14. Average initial source zone chemistry for the West Groundwater Area Closed BMP Facility [including pre-closure recharge] (based on monitoring well RL-2S historical data, as well as site source zones containing residual carbon)
15. Calculated from the CEC and exchangeable calcium data discussed in Section 1.4
16. Amount of aluminum oxides determined based on the extractable oxide data discussed in Section 1.5

Plate 6-15
Summary of Geochemical Initial and Boundary Conditions for the Reactive Transport Model
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

In the East Groundwater Area base case model, the maximum groundwater fluoride concentrations (in the vicinity of Fill Deposit B-2) decreased by a factor of approximately four from 2,350 mg/L to 600 mg/L over the 2,000-year simulation period. The footprint of the plume (in the vicinity of Fill Deposit B-2) exceeding 4 mg/L, however, did not change appreciably (see Plates 6-16 through 6-19). This is largely explained by the pH dependence of dissolved calcium concentrations (increasing with decreasing pH) and the fact that the available exchangeable calcium exceeds dissolved fluoride at the leading edge of the plume. As alkaline-, sodium-, and fluoride-rich groundwater migrates from the former cryolite area downgradient toward the CDID ditch, the pH is gradually neutralized by reactions with soil minerals. Sodium exchanges for soil calcium, which is more soluble at lower pH and becomes available to react with fluoride and precipitate fluorite. In this way, the rate of advance of dissolved fluoride is negligible compared to groundwater flow, and the fluoride plume is essentially arrested in both time and space. High fluoride concentrations can only be sustained as long as groundwater pH is elevated. Over the 2,000-year simulation period in the vicinity of the Former Stockpile Area and Landfill #1, the model predicts riverward transport of fluoride concentrations in excess of 4 mg/L, as shown in Plates 6-16 through 6-19. This is due to the fact that these deposits lie across the groundwater divide discussed in Section 6.5.1.

Concentrations downgradient of the fluoride plume also remain relatively stable. For example, the fluoride concentration in well G4-S remains below 1 mg/L over the entire simulation period. As a result, fluoride concentrations in groundwater downgradient of the East Groundwater Area plume are predicted to remain low into the foreseeable future. This result indicates that natural attenuation processes in the East Groundwater Area are and will continue to provide sufficient treatment to be protective of surface water in the CDID ditches.

In the West Groundwater Area, maximum groundwater fluoride concentrations are generally lower than in the East Groundwater Area (less than 200 mg/L) and primarily the result of past loading to groundwater beneath the Closed BMP Facility prior to its closure in 1990 and the leaching of fluoride containing materials in Fill Deposit B-3 (see Plate 6-20). Over the course of the 2,000-year base case simulation, the relic fluoride plume beneath the Closed BMP Facility is slowly flushed and concentrations are predicted to decline to levels below 10 mg/L beneath most of the footprint of the Closed BMP Facility. Concentrations beneath Fill Deposit B-3 are predicted to remain relatively stable since the residual carbon, which contains fluorite, is in direct contact with groundwater in places (see Plates 6-21 through 6-23).



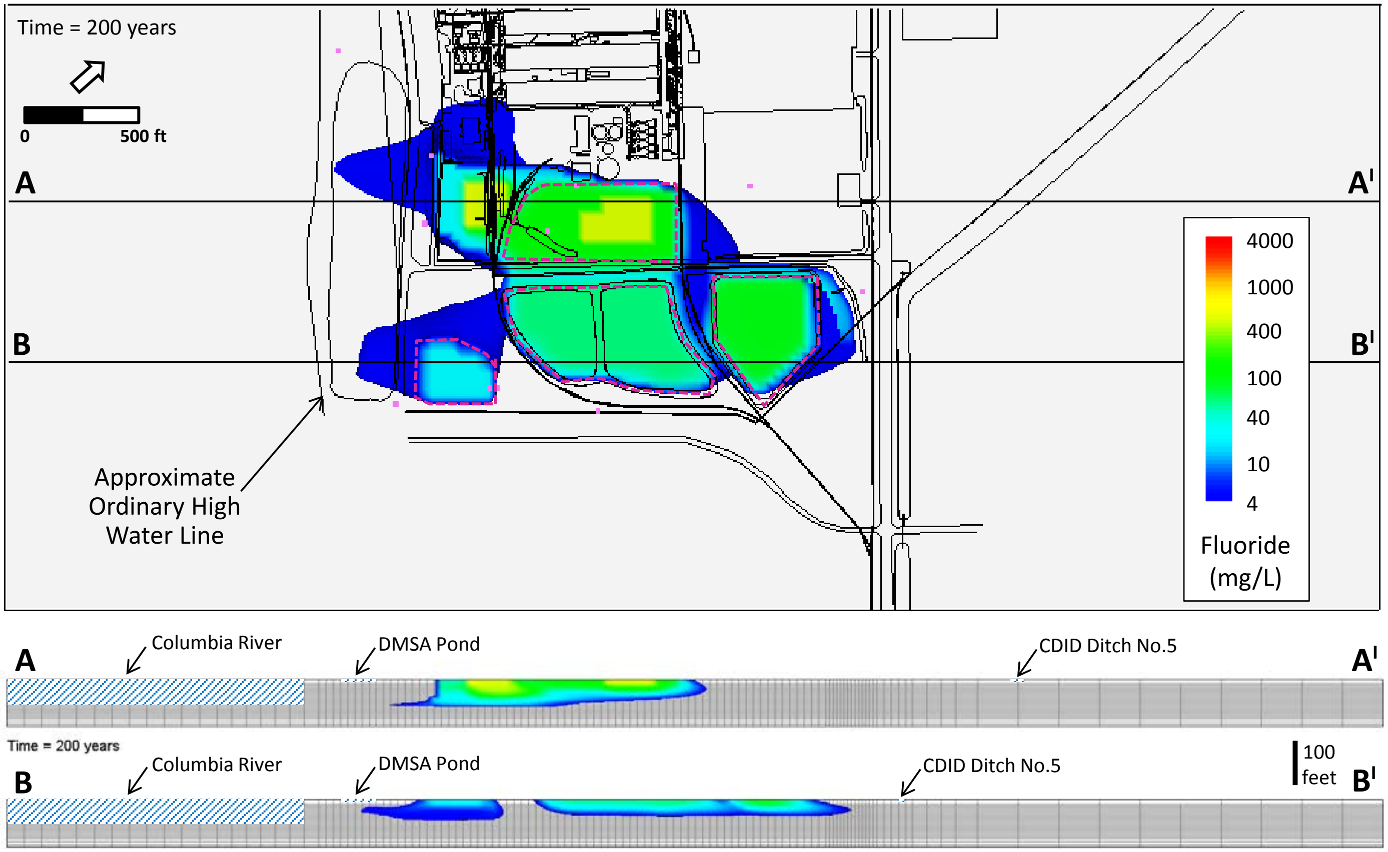
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations.

This plate illustrates the footprint of the East Groundwater Area fluoride plume exceeding 4 milligrams per liter (mg/L), representing current site conditions. The maximum simulated groundwater fluoride concentration under current site conditions is 2,350 mg/L near the Former Stockpile Area and southernmost cryolite area ditches.

Plate 6-16

Plan View and Vertical X-sections of the Simulated East Groundwater Area Fluoride Plume for Current Site Conditions



Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote the Fill Deposit and Landfill boundaries.

This plate illustrates the simulated East Groundwater Area fluoride plume after 200 years with no reduction in infiltration. The footprint of the simulated plume (in the vicinity of Fill Deposits A, B-1, and B-2) exceeding 4 milligrams per liter (mg/L) does not change appreciably over the course of 200 years. This is largely explained by the pH dependence of dissolved calcium concentrations (increasing with decreasing pH) and the fact that the available exchangeable calcium exceeds dissolved fluoride at the leading edge of the plume. As alkaline-, sodium-, and fluoride-rich groundwater migrates from Fill Deposit B-2 downgradient towards the CDID ditch, the pH is gradually neutralized by reactions with soil minerals. Sodium exchanges for soil calcium, which becomes available to react with fluoride and precipitate fluorite. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume is essentially arrested in both time and space. High fluoride concentrations can only be sustained as long as groundwater pH is elevated. The 4 mg/L fluoride plume in the vicinity of the Former Stockpile Area and Landfill #1 shows a certain degree of riverward migration, which is because these deposits lie on or are adjacent to the groundwater divide discussed in Section 6.5.1.

Plate 6-17

Plan View and Vertical X-sections of the Simulated East Groundwater Area Fluoride Plume
after 200 Years with No Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

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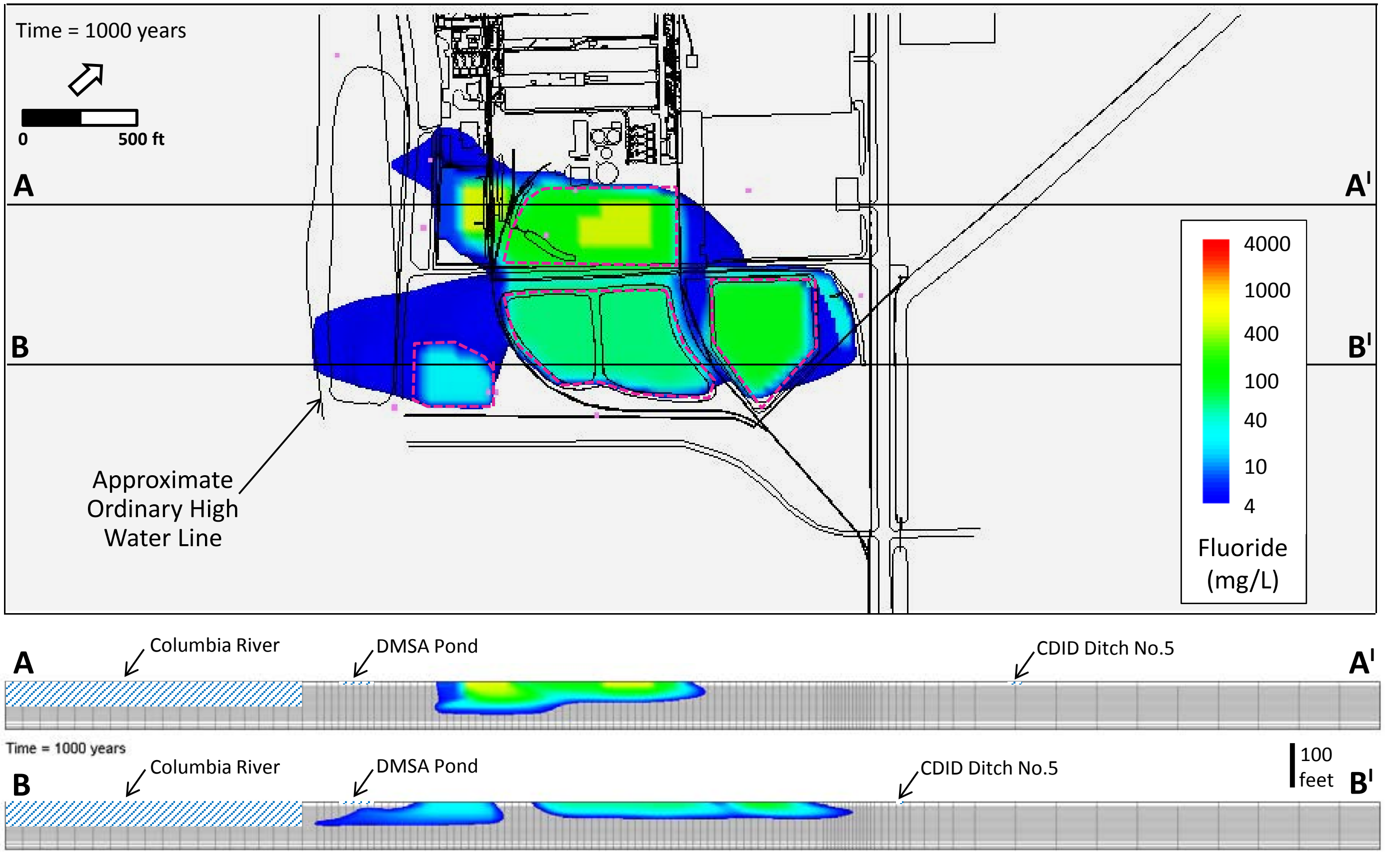


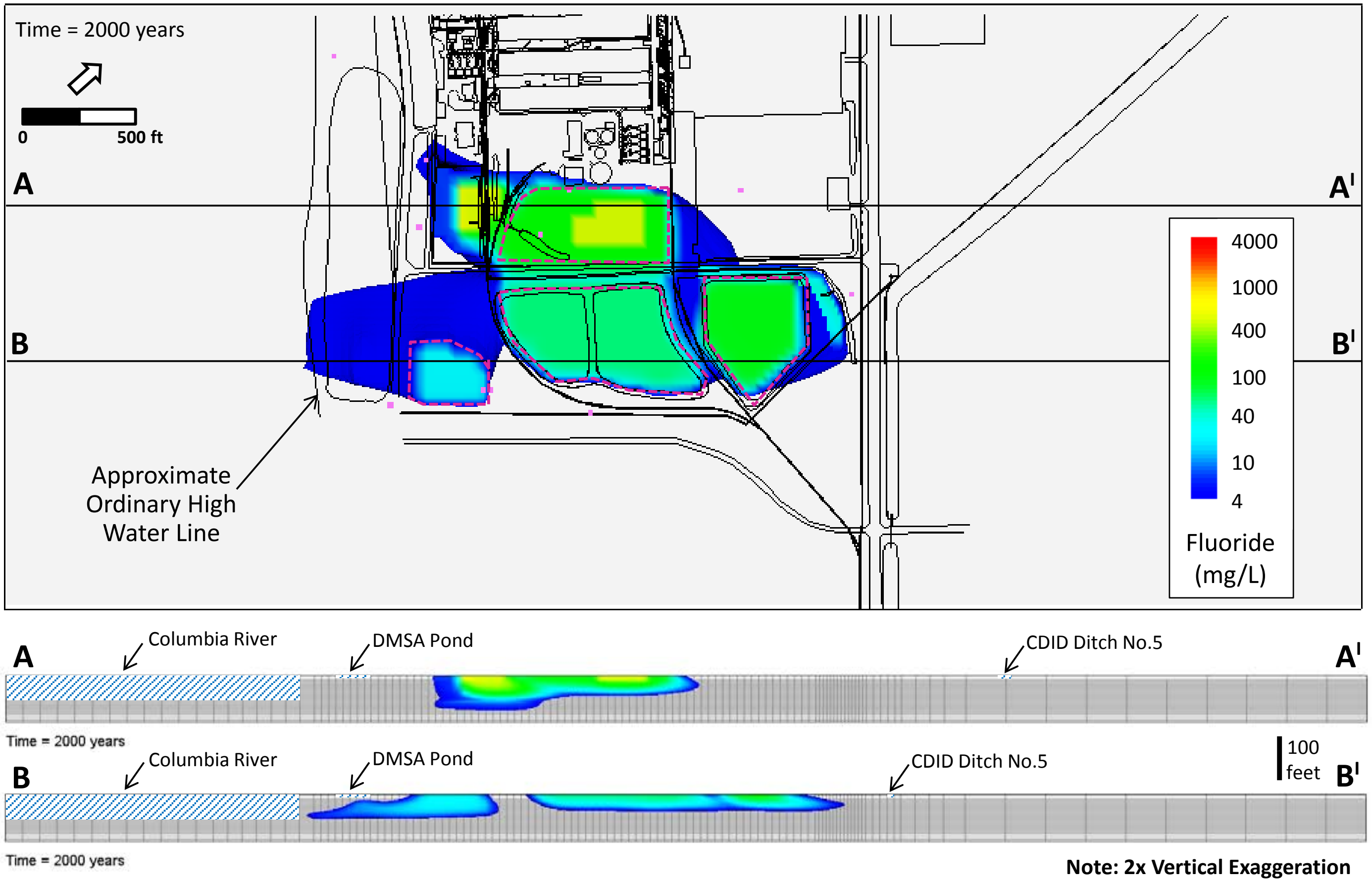
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote the extent of fluoride source areas.

This plate illustrates the simulated East Groundwater Area fluoride plume after 1,000 years with no reduction in infiltration. The footprint of the simulated plume (in the vicinity of Fill Deposits A, B-1, and B-2) exceeding 4 milligrams per liter (mg/L) does not change appreciably over the course of 1,000 years. This is largely explained by the pH dependence of dissolved calcium concentrations (increasing with decreasing pH) and the fact that the available exchangeable calcium exceeds dissolved fluoride at the leading edge of the plume. As alkaline-, sodium-, and fluoride-rich groundwater migrates from Fill Deposit B-2 downgradient towards the CDID ditch, the pH is gradually neutralized by reactions with soil minerals. Sodium exchanges for soil calcium which becomes available to react with fluoride and precipitate fluorite. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume is essentially arrested in both time and space. High fluoride concentrations can only be sustained as long as groundwater pH is elevated. The 4 mg/L fluoride plume in the vicinity of the Former Stockpile Area and Landfill #1 shows a certain degree of riverward migration, which is due to the fact that these deposits lie on or are adjacent to the groundwater divide discussed in Section 6.5.1.

Plate 6-18

Plan View and Vertical X-sections of the Simulated East Groundwater Area Fluoride Plume
after 1,000 Years with No Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



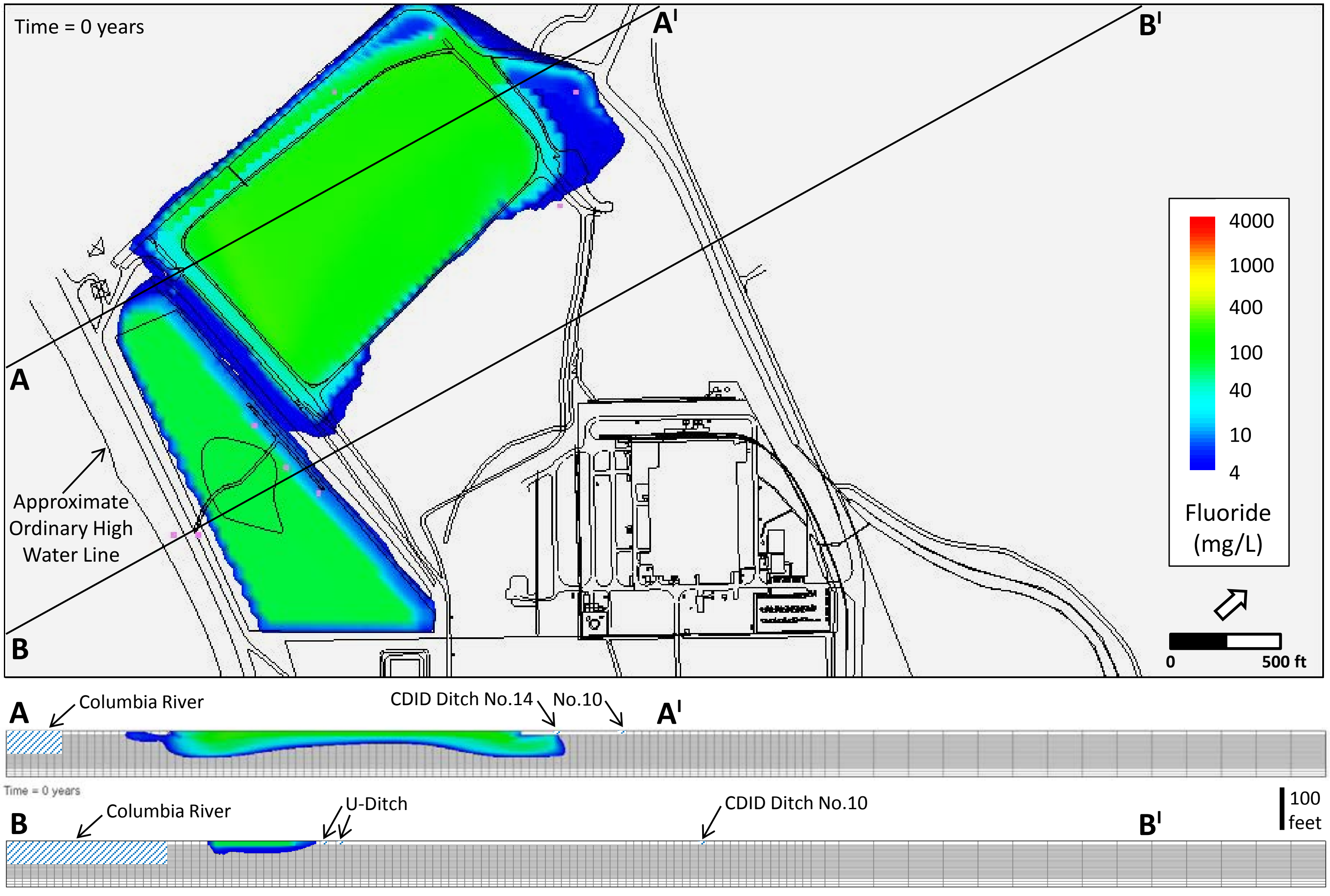
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate illustrates the simulated East Groundwater Area fluoride plume after 2,000 years with no reduction in infiltration. The footprint of the simulated plume (in the vicinity of Fill Deposits A, B-1, and B-2) exceeding 4 milligrams per liter (mg/L) does not change appreciably over the course of 2,000 years. This is largely explained by the pH dependence of dissolved calcium concentrations (increasing with decreasing pH) and the fact that the available exchangeable calcium exceeds dissolved fluoride at the leading edge of the plume. As alkaline-, sodium-, and fluoride-rich groundwater migrates from Fill Deposit B-2 downgradient towards the CDID ditch, the pH is gradually neutralized by reactions with soil minerals. Sodium exchanges for soil calcium, which becomes available to react with fluoride and precipitate fluorite. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume is essentially arrested in both time and space. High fluoride concentrations can only be sustained as long as groundwater pH is elevated. The 4 mg/L fluoride plume in the vicinity of the Former Stockpile Area and Landfill #1 shows a certain degree of riverward migration, which is due to the fact that these deposits lie on or are adjacent to the groundwater divide discussed in Section 6.5.1.

Plate 6-19

Plan View and Vertical X-sections of the Simulated East Groundwater Area Fluoride Plume
after 2,000 Years with No Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



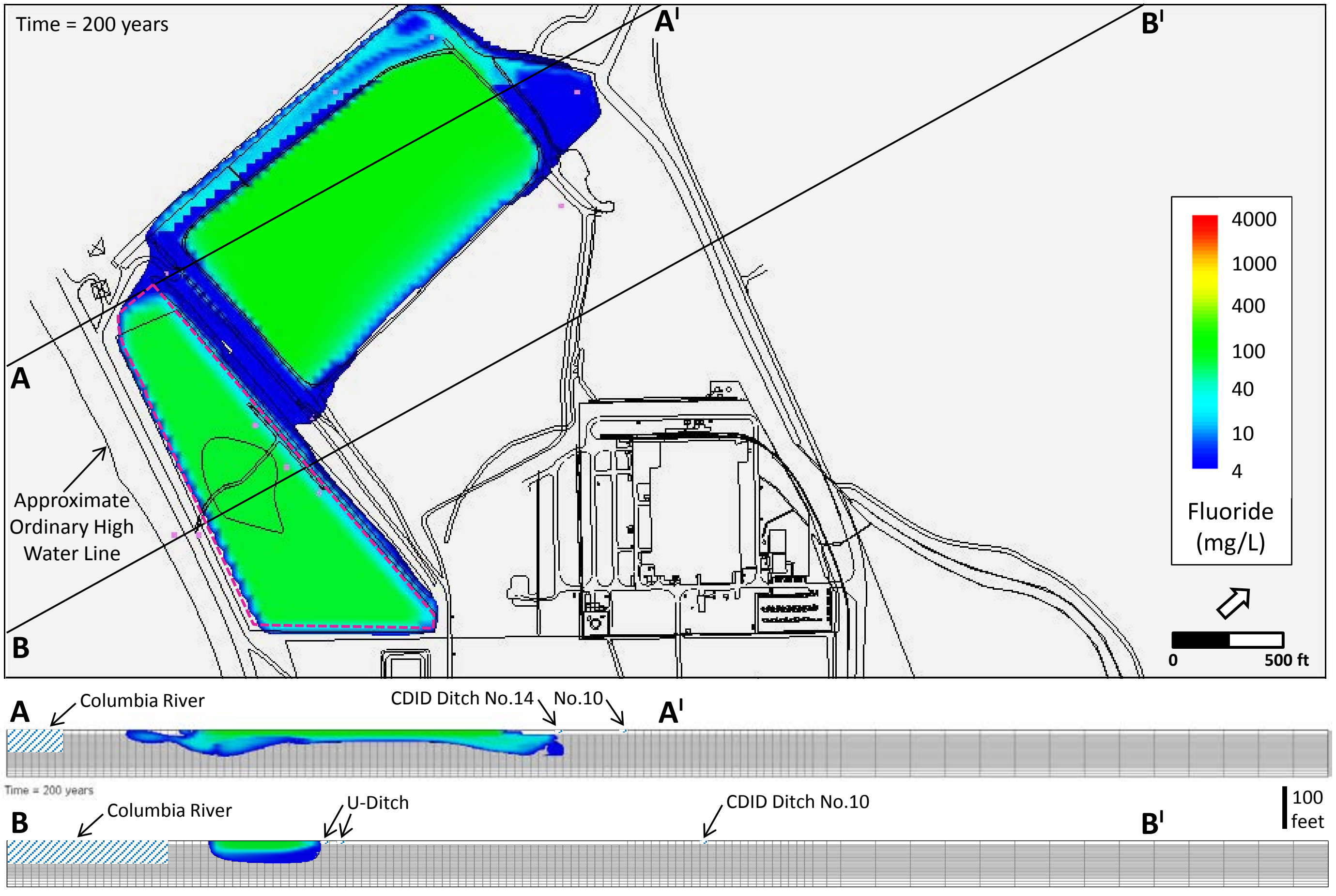
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations.

This plate illustrates the simulated West Groundwater Area fluoride plume exceeding 4 milligrams per liter, representing current site conditions. Elevated groundwater fluoride concentrations are primarily the result of past loading to groundwater beneath the Closed BMP Facility prior to its closure in 1990 and leaching of Fill Deposit B-3.

Plate 6-20

Plan View and Vertical X-sections of the Simulated West Groundwater Area Fluoride Plume under Current Site Conditions
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes Fill Deposit boundary.

This plate illustrates the simulated West Groundwater Area fluoride plume (exceeding 4 milligrams per liter [mg/L]) after 200 years with no reduction in infiltration. Over the course of 200 years, the relic fluoride plume beneath the Closed BMP Facility is slowly flushed and concentrations are predicted to decline to levels below 100 mg/L beneath most of the footprint of the Closed BMP Facility. Concentrations beneath Fill Deposit B-3 are predicted to remain relatively stable since the residual carbon, which contains fluorite, is in direct contact with groundwater in places. Fluoride concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time as they have been doing since closure of the BMP Facility.

Plate 6-21

Plan View and Vertical X-sections of the Simulated West Groundwater Area Fluoride Plume
after 200 Years with No Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

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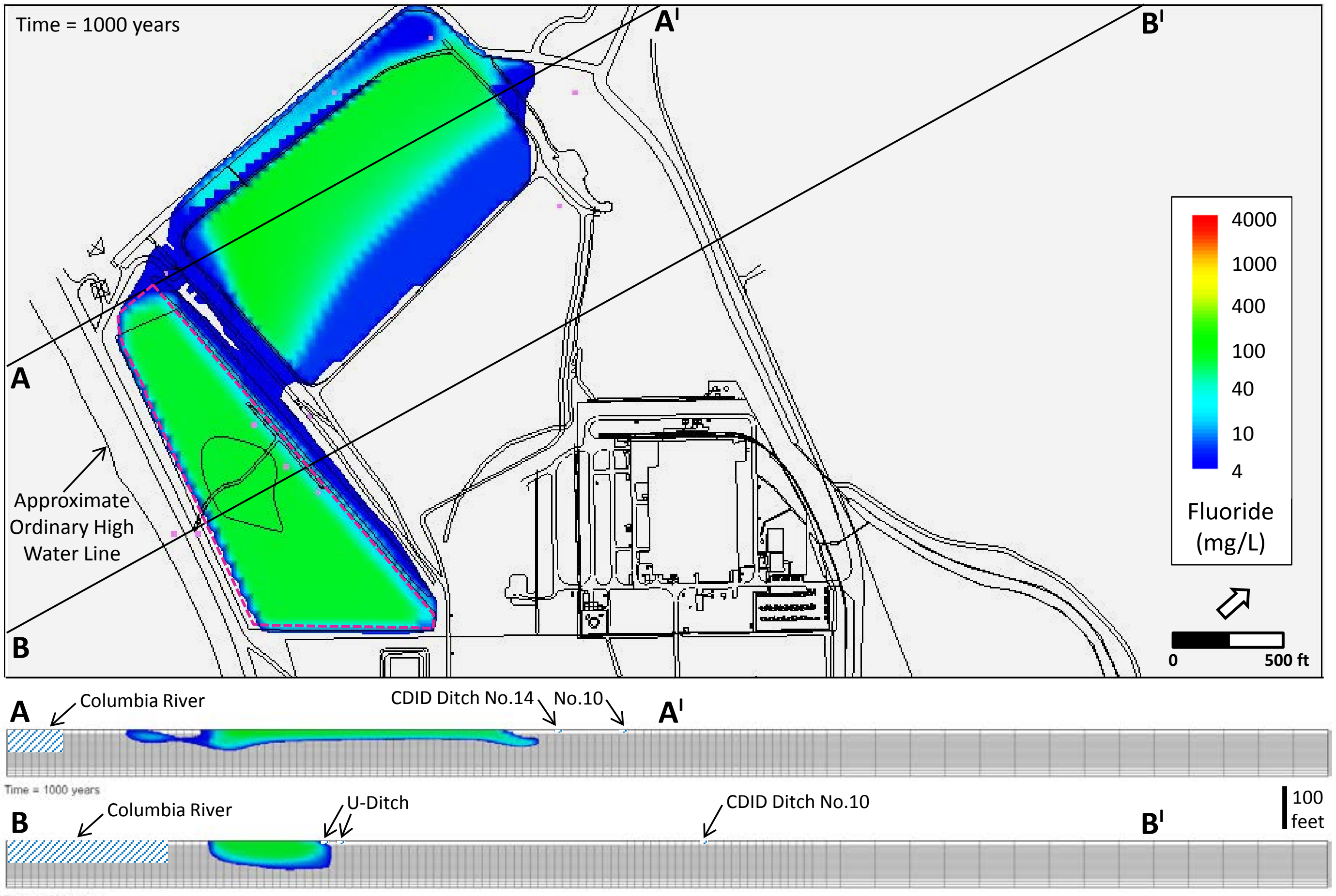


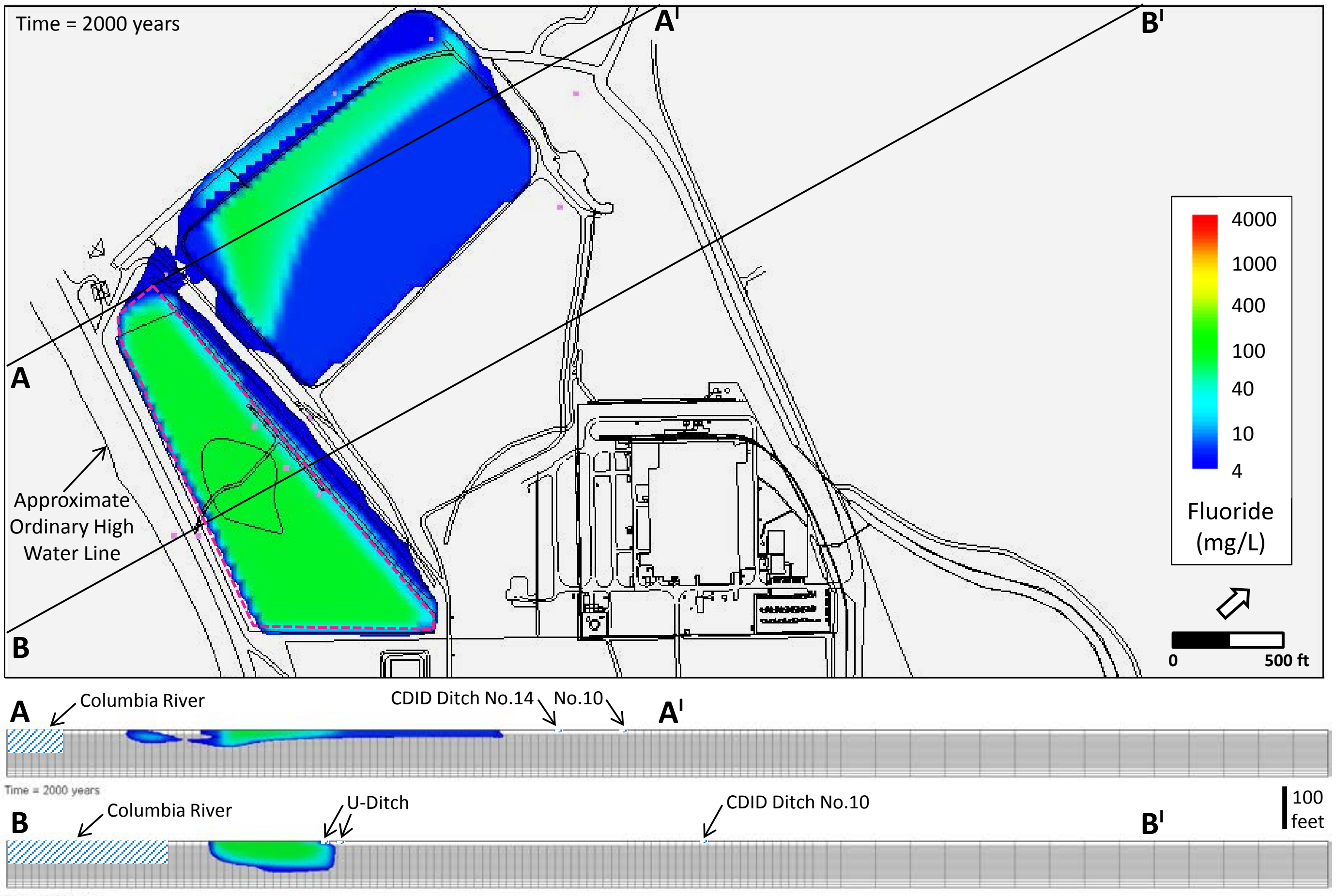
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes Fill Deposit boundary.

This plate illustrates the simulated West Groundwater Area fluoride plume (exceeding 4 milligrams per liter [mg/L]) after 1,000 years with no reduction in infiltration. Over the course of 1,000 years, the relic fluoride plume beneath the Closed BMP Facility is slowly flushed and concentrations are predicted to decline to levels below 50 mg/L beneath most of the footprint of the Closed BMP Facility. Concentrations beneath Fill Deposit B-3 are predicted to remain relatively stable since the residual carbon, which contains fluorite, is in direct contact with groundwater in places. Fluoride concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time as they have been doing since closure of the BMP Facility.

Plate 6-22

Plan View and Vertical X-sections of the Simulated West Groundwater Area Fluoride Plume
after 1,000 Years with No Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes the Fill Deposit boundary.

This plate illustrates the simulated West Groundwater Area fluoride plume (exceeding 4 milligrams per liter [mg/L]) after 2,000 years with no reduction in infiltration. Over the course of the 2,000-year simulation, the relic fluoride plume beneath the Closed BMP Facility is slowly flushed and concentrations are predicted to decline to levels below 10 mg/L beneath most of the footprint of the Closed BMP Facility. Concentrations beneath Fill Deposit B-3 are predicted to remain relatively stable since the residual carbon, which contains fluorite, is in direct contact with groundwater in places. Fluoride concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time as they have been doing since closure of the BMP Facility.

Plate 6-23

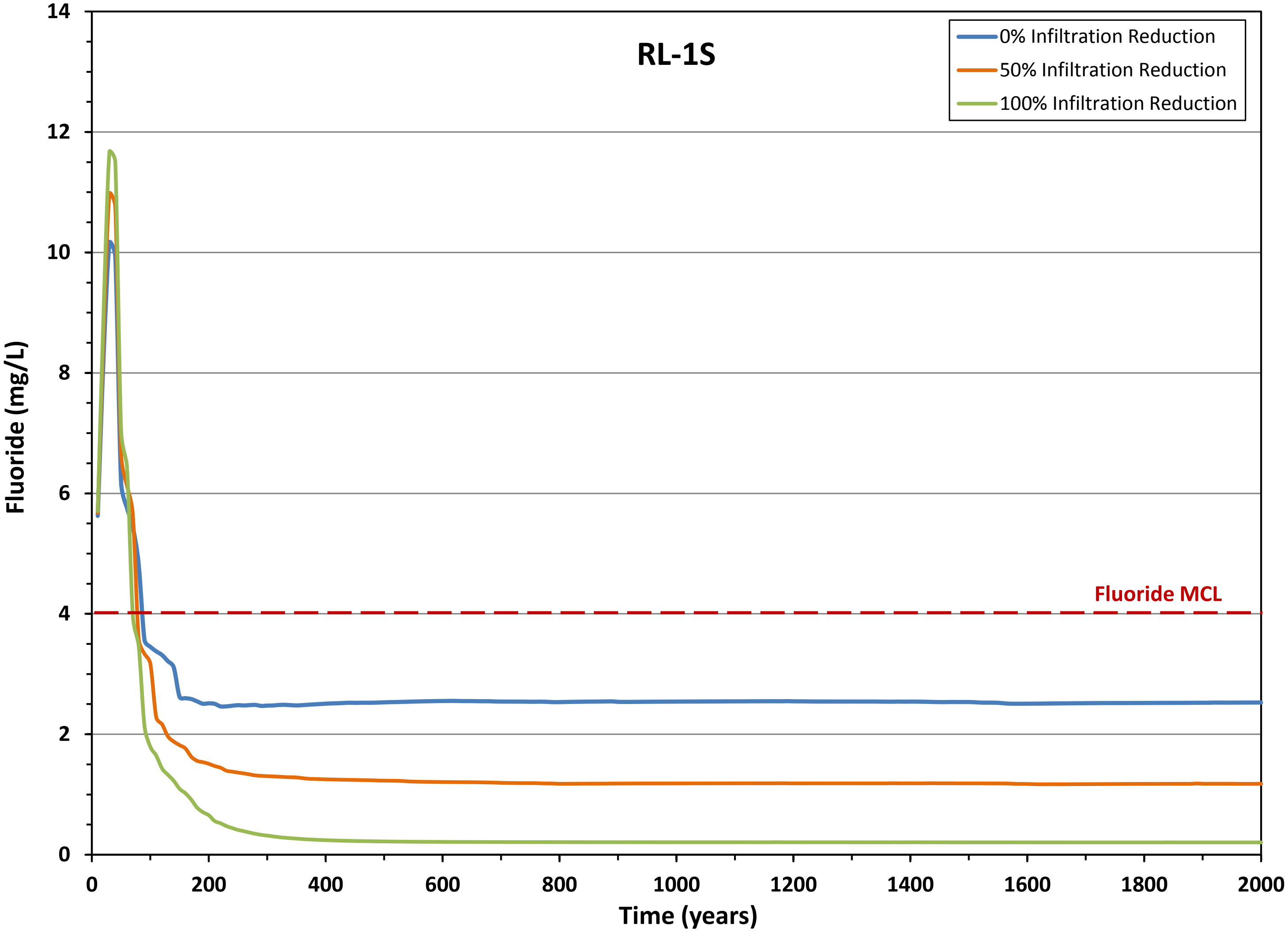
Plan View and Vertical X-sections of the Simulated West Groundwater Area Fluoride Plume after 2,000 Years with No Reduction in Infiltration

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

Concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time as they have been doing since closure of the BMP Facility. For example, the fluoride concentration in well RL-1S, currently close to 8 mg/L, is predicted to decrease below 4 mg/L over approximately 100 years (see Plate 6-24). The fluoride concentration in the nearby CDID ditch (at surface water Station W4) has been measured recently at less than 1 mg/L; therefore, the current fluoride concentration at RL-1S is protective of surface water quality and is expected to continue to be protective into the foreseeable future (see Plate 6-25). In another example, fluoride concentrations in RL-2S are currently near 50 mg/L and have decreased by approximately an order of magnitude since the Closed BMP Facility was in operation (see Plate 6-26). Concentrations in nearby CDID ditch (at surface water Station W3) are on the order of 1 mg/L; therefore, the measured concentration in RL-2S is protective of surface water quality. The 50-fold difference between shallow groundwater and surface water and the lack of measurable impact on surface water quality is likely due to a combination of processes including the mixing of shallow and slightly deeper (low fluoride) groundwater as groundwater flow converges toward the CDID ditches, precipitation of fluorite due to mixing or reaction with calcium in the aquifer, and adsorption on clays and oxides in soils and solid media.

The model predicts that concentrations will continue to decline to less than 20 mg/L within 200 years, as most of the dissolved fluoride mass beneath the Closed BMP Facility is flushed out, then more gradually as fluoride continues to leach from Fill Deposit B-3. In this case, the model predicts that fluoride concentrations in RL-2S will still be marginally greater than 4 mg/L after 2,000 years (see Plate 6-27). Because current concentrations, which are approximately an order of magnitude higher, are shown to be protective of surface water quality, decreasing fluoride concentrations in RL-2S will also continue to be protective of surface water quality.



Fluoride concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time as they have been doing since closure of the BMP Facility. In the southwestern corner of the site near the U-ditch and CDID (Reynolds) pump station, the fluoride concentration in well RL-1S, currently close to 8 milligrams per liter (mg/L), is predicted to decrease below 4 mg/L over the course of approximately 100 years for the 50 and 100 percent infiltration reduction scenarios, as well as the base case involving no reduction in infiltration over Fill Deposit B-3 and Landfill #2.

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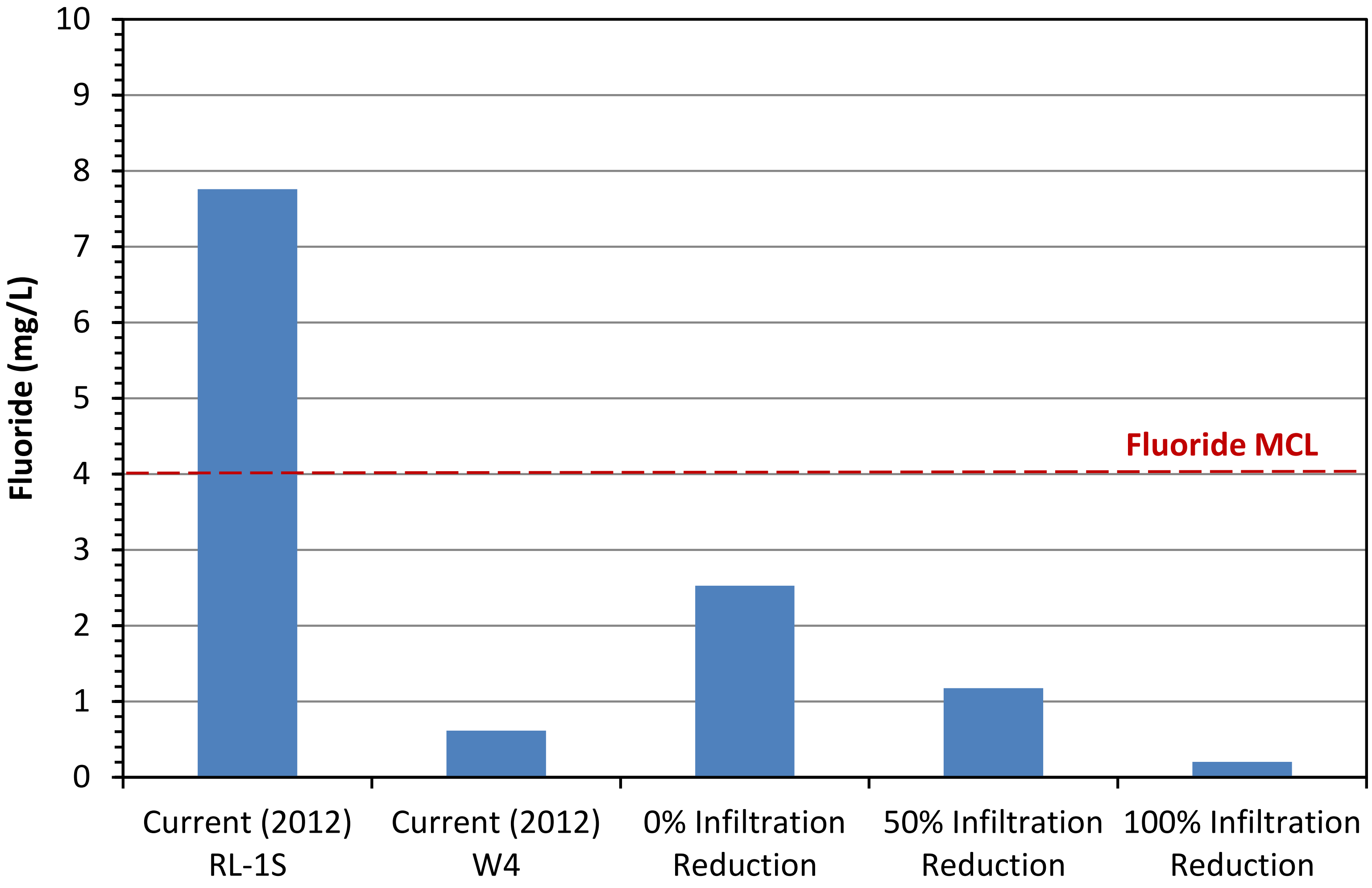
Plate 6-24

Simulated Fluoride Breakthrough Curves at Monitoring Well RL-1S

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview



Current fluoride concentrations measured at RL-1S are protective of surface water quality. The fluoride concentration in CDID Ditch No. 14 (at surface water Station W4), proximal to monitoring well RL-1S, has been measured recently at less than 1 milligram per liter. Concentrations in groundwater adjacent to the CDID ditches are predicted to continue to decrease over time (as shown in Plate 6-24); therefore, continued protection of surface water quality in the future is ensured, regardless of whether or not infiltration is reduced.

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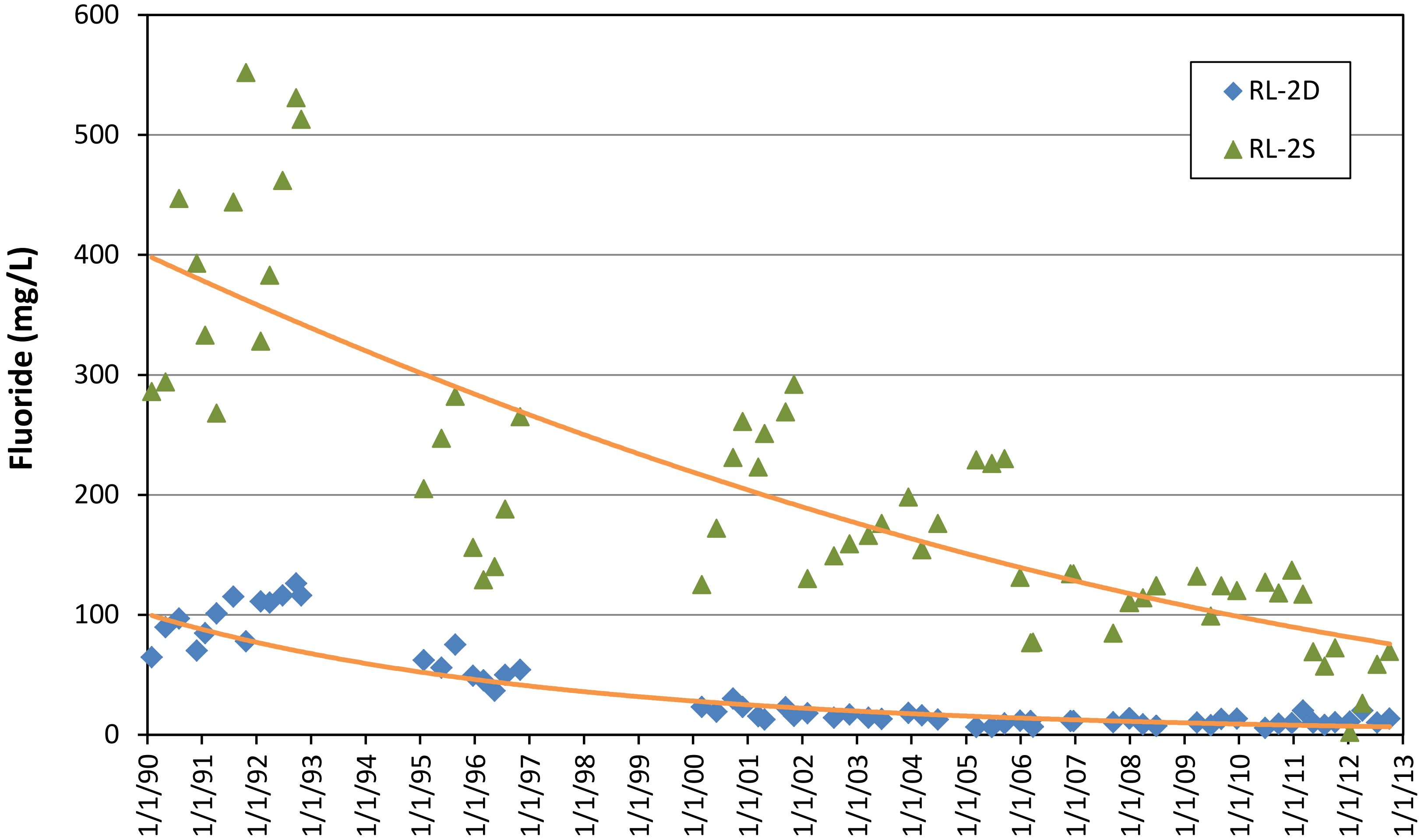
Plate 6-25
Measured and Simulated Future (2,000 years) Fluoride Concentrations at Well RL-1S and Surface Water Station W4
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Groundwater and ditch water quality surrounding the Closed BMP Facility has been monitored since the early 1990s as part of the Ecology-approved closure and post-closure monitoring program. Results of monitoring have shown that the closure and dewatering of the facility have been effective. As described in Section 5 of the Remedial Investigation, there are no impacts to water quality in the adjacent CDID ditches for cyanide or fluoride. Cyanide levels in the shallow groundwater within the silt/clay soils immediately adjacent to the Closed BMP Facility are protective of both drinking water and surface water quality. As shown in this plate, fluoride concentrations in shallow groundwater have been on a decreasing trend since facility closure. Fluoride concentrations in wells RL-2S (shallower well, green symbols above) and RL-2D (slightly deeper well, blue symbols) continue to decrease, reflecting the attenuation of fluoride by native soils.

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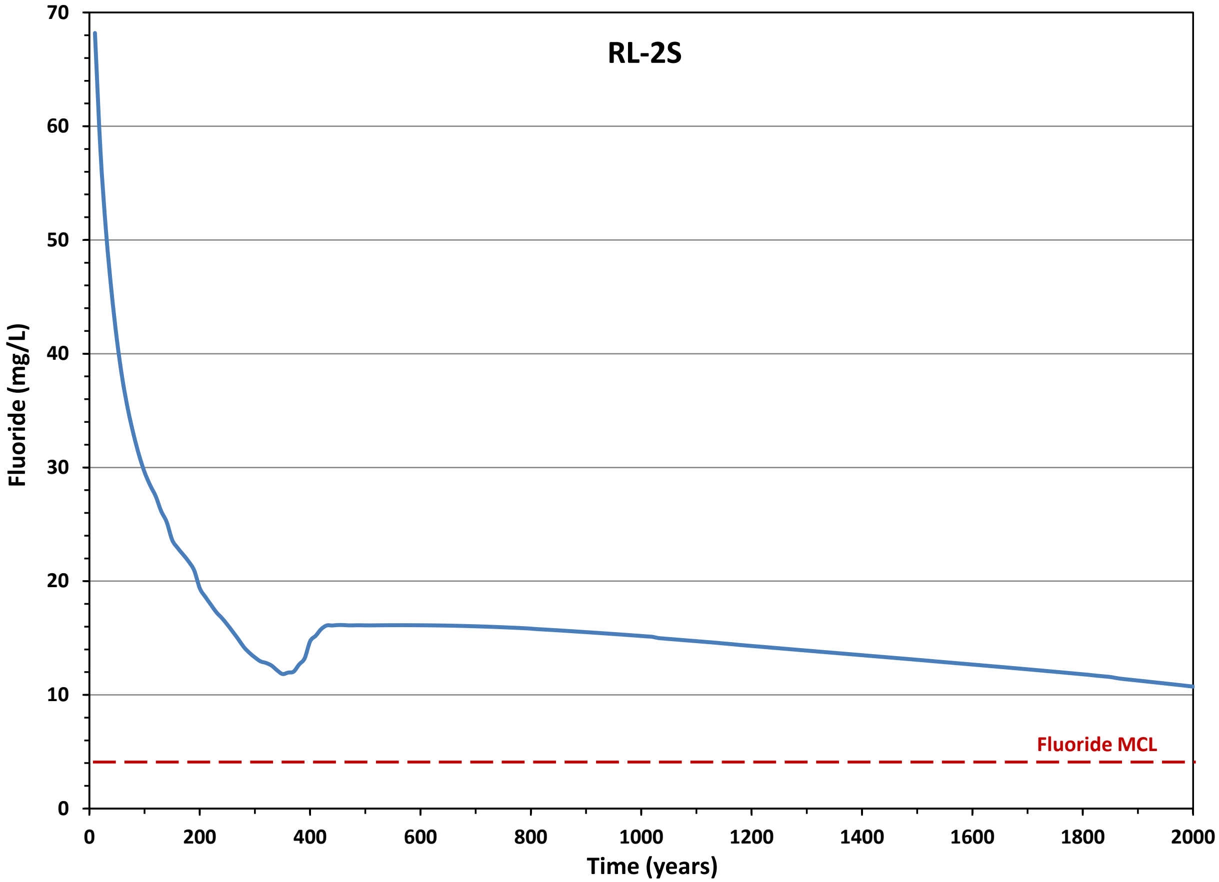
Plate 6-26
Reduction in Groundwater Fluoride Concentrations Since Closed BMP Facility Closure
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Measured fluoride concentrations in RL-2S are currently near 50 milligrams per liter (mg/L) and have decreased by approximately an order of magnitude since the Closed BMP Facility was in operation (see Plate 6-26). The model predicts that concentrations will continue to decline to less than 20 mg/L within 200 years (illustrated in the above graph), as most of the dissolved fluoride mass beneath the Closed BMP Facility is flushed out. In 2,000 years, the model predicts that fluoride concentrations in RL-2S will still be marginally greater than 4 mg/L. Current measured concentrations in the nearby CDID ditch (at surface water Station W3) are on the order of 1 mg/L. Since current concentrations in RL-2S are empirically demonstrated to be protective of surface water quality, decreasing fluoride concentrations in groundwater in the future will ensure continued protection of surface water quality. The 50-fold difference between shallow groundwater and surface water and the lack of measurable impact on surface water quality is likely to be due in part to the mixing of shallow groundwater from variable depths (lower fluoride at greater depths) as groundwater flow converges towards the CDID ditches, precipitation of fluorite due to mixing or reaction with calcium in the aquifer, and adsorption on clays and oxides in soils and solid media.

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Plate 6-27

Simulated Fluoride Breakthrough Curve for Monitoring Well RL-2S

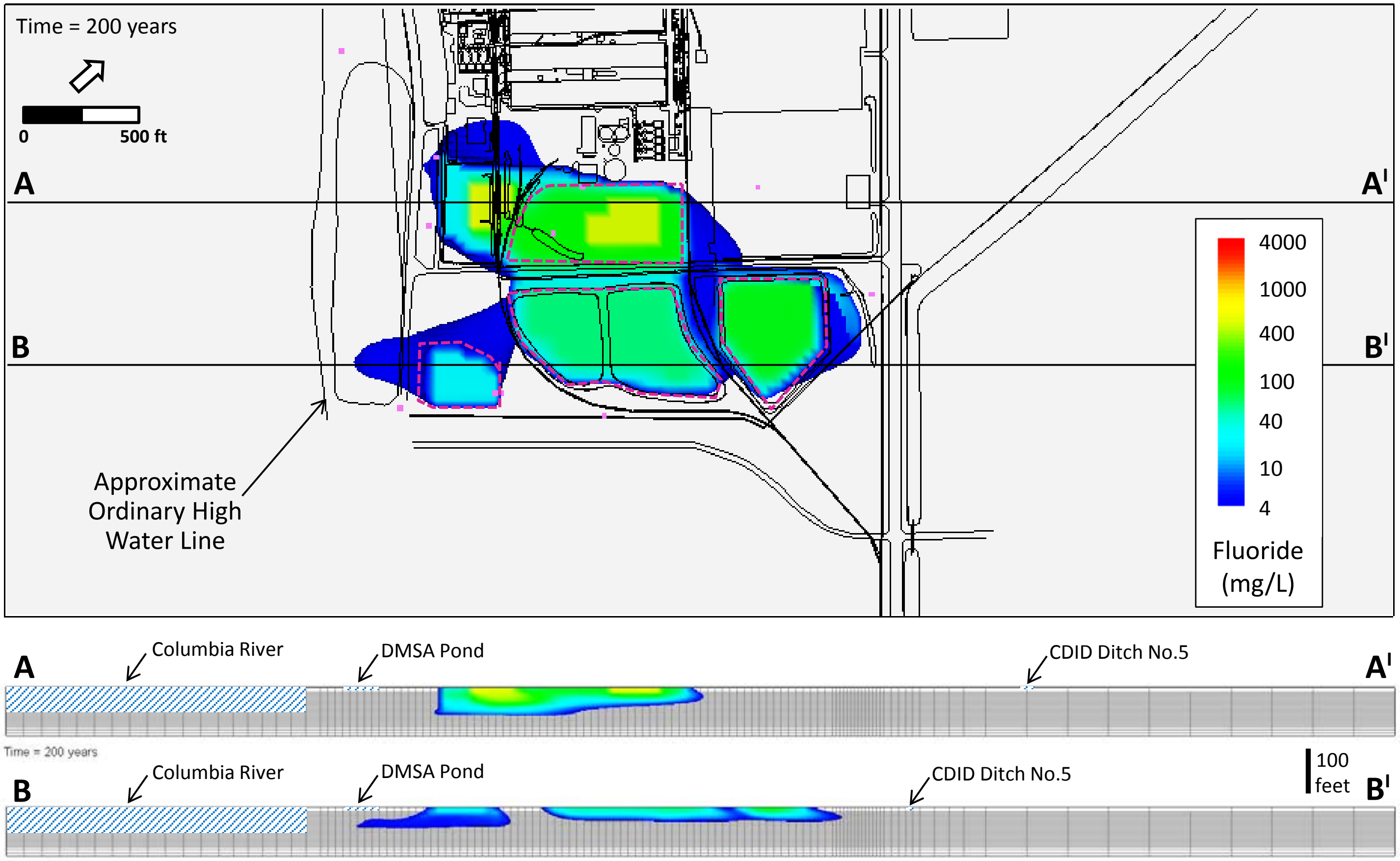
Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

A series of simulations were also performed to evaluate the potential benefit of reducing infiltration on fluoride source zones on the rate of attenuation of the fluoride plume. The source zones included Fill Deposits A, B-1, B-2, and Landfill #1 in the East Groundwater Area and Fill Deposit B-3 and Landfill #2 in the West Groundwater Area. The base case model results were compared to results for the following scenarios:

1. Infiltration in the source zones is reduced by 50 percent
2. Infiltration in the source zones is reduced by 100 percent

Plates 6-17, 6-18, and 6-19 show the base case simulated East Groundwater Area fluoride plume after 200, 1,000, and 2,000 years, respectively. Plates 6-28, 6-29, and 6-30 show the simulated East Groundwater Area fluoride plume after 200, 1,000, and 2,000 years, respectively, assuming 50 percent reduction in infiltration through the deposits/landfill. Plates 6-31, 6-32, and 6-33 show the simulated East Groundwater Area fluoride plume after 200, 1,000, and 2,000 years, respectively, assuming 100 percent reduction in infiltration, respectively. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the three simulation scenarios, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. After a simulation time of 2,000 years, the fluoride plume at the southern edge of Landfill #1 (floor sweeps) is predicted to have retreated somewhat for the 50 percent infiltration reduction scenario, while for the 100 percent infiltration reduction scenario, no riverward migration of the 4 mg/L fluoride plume is predicted; overall concentrations beneath this landfill are predicted to decrease by about a factor of 3 for the 100 percent infiltration reduction scenario. Also, there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposits A and B-1 after 2,000 years with 100 percent reduction in infiltration. However, the fluoride concentration in shallow groundwater immediately downgradient of the East Groundwater Area is currently less than 1 mg/L, well below the MCL, and remains below 1 mg/L in all three of the infiltration simulations (see Plates 6-34 and 6-35). Based on these results, there does not appear to be an appreciable improvement in groundwater quality downgradient of the East Groundwater Area as a result of significant (50 to 100 percent) reduction in infiltration through the East Groundwater Area fill and landfill deposits.



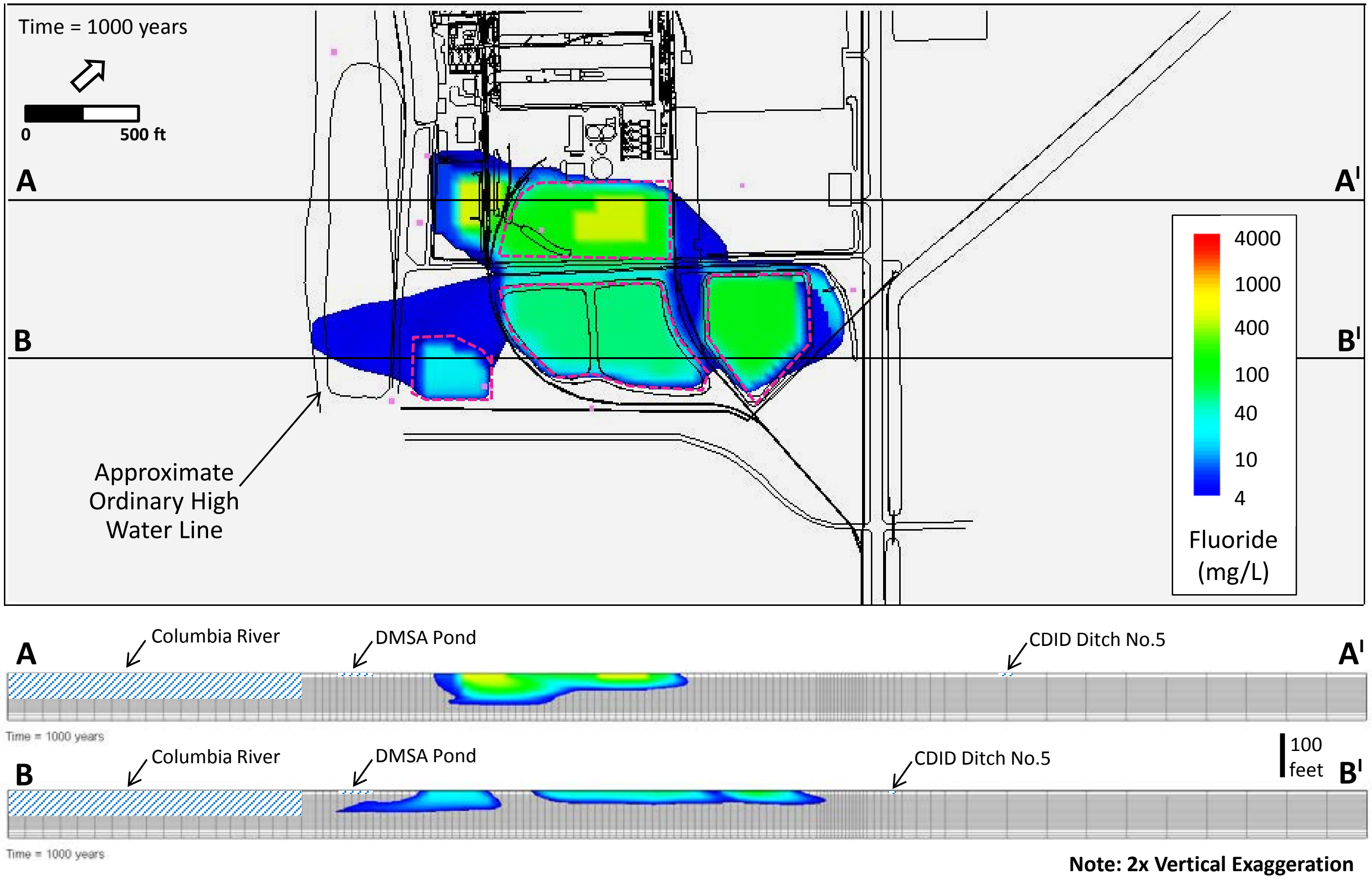
Note: 2x Vertical Exaggeration

Note:
Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 200 years assuming 50 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario after 200 years (no reduction in infiltration [see Plate 6-17]) compared to 50 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume (in the vicinity of Fill Deposits A, B-1, and B-2) is essentially arrested in both time and space. There is, however, a decrease in the downgradient footprint of the fluoride plume at the southern edges of the Former Stockpile Area and Landfill #1 (floor sweeps) with 50 percent reduction in infiltration as compared to the base case model.

Plate 6-28

Simulated East Groundwater Area Fluoride Plume after 200 Years with 50 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

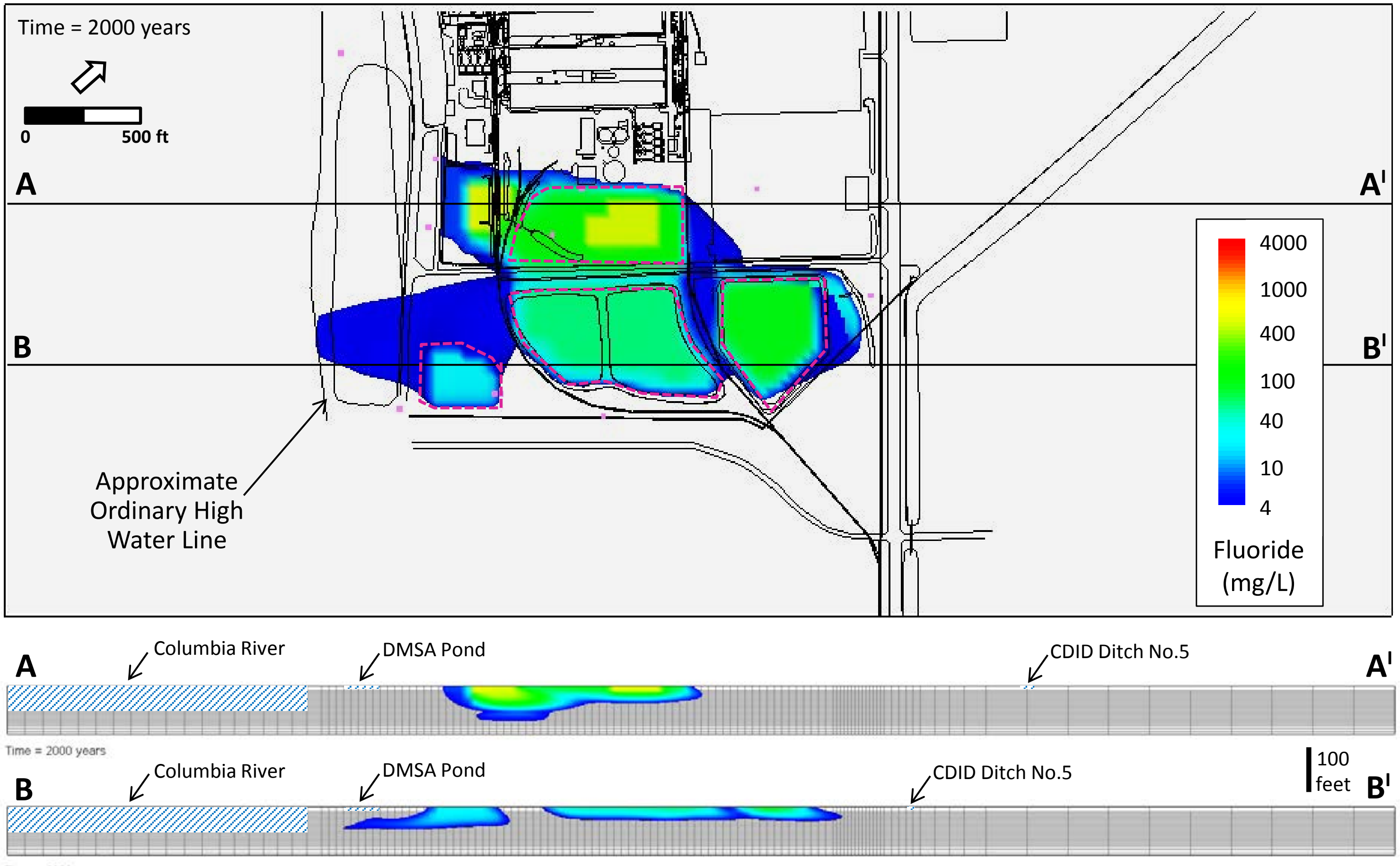


Note: Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 1,000 years assuming 50 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario after 1,000 years (no reduction in infiltration [see Plate 6-18]) compared to 50 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume (in the vicinity of Fill Deposits A, B-1, and B-2) is essentially arrested in both time and space. There is, however, a decrease in the downgradient footprint of the fluoride plume at the southern edges of the Former Stockpile Area and Landfill #1 (floor sweeps) with 50 percent reduction in infiltration as compared to the base case model.

Plate 6-29

Simulated East Groundwater Area Fluoride Plume after 1,000 Years with 50 Percent Reduction in Infiltration



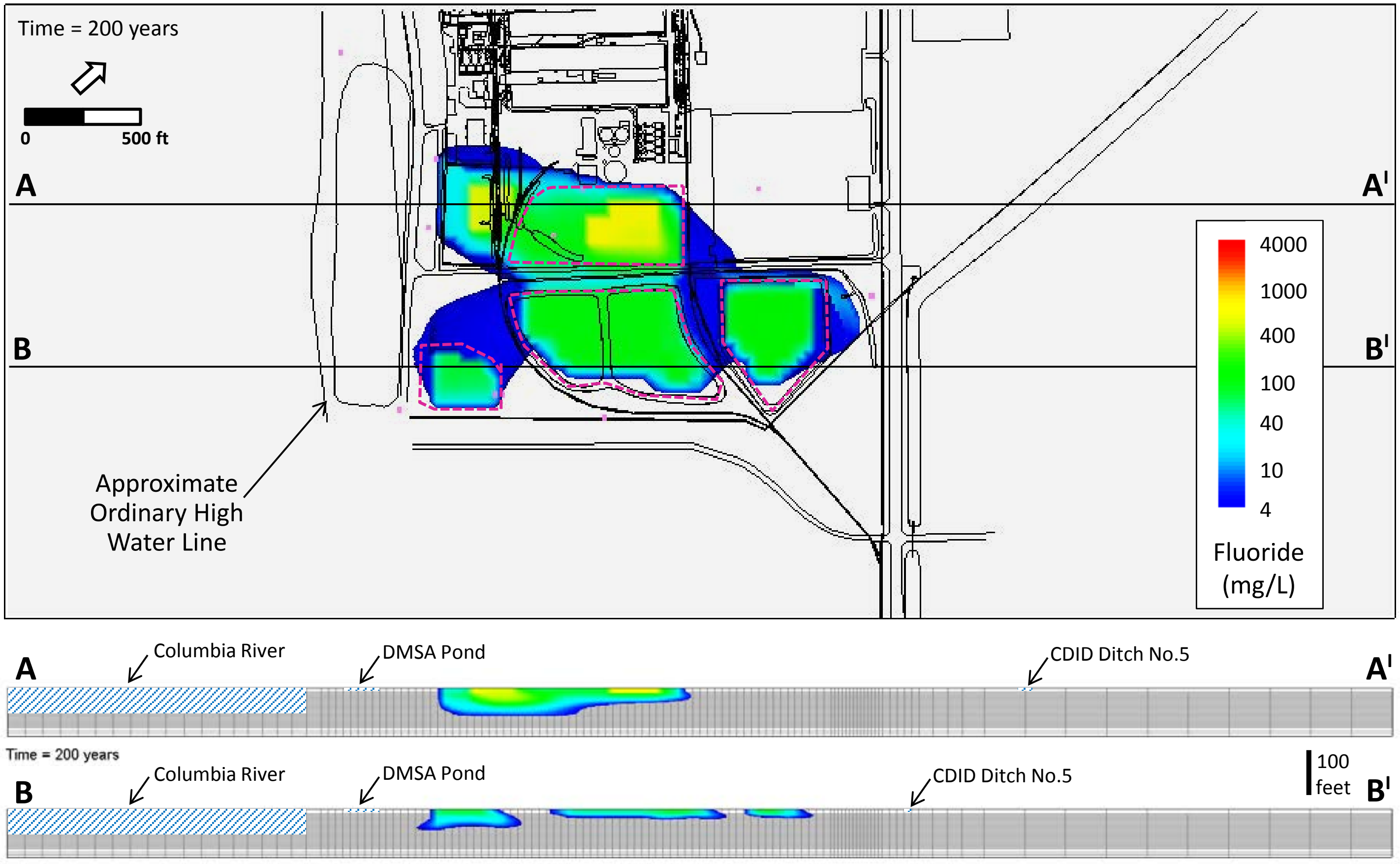
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 2,000 years assuming 50 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario (no reduction in infiltration [see Plate 6-19]) compared to 50 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. The rate of advance of dissolved fluoride is negligible compared to groundwater flow towards the internal site and CDID ditches, and the fluoride plume is essentially arrested in both time and space. There is, however, a decrease in the downgradient extent of the fluoride plume at the southern edge of Landfill #1 (floor sweeps) with 50 percent reduction in infiltration as compared to the base case model.

Plate 6-30

Simulated East Groundwater Area Fluoride Plume after 2,000 Years with 50 Percent Reduction in Infiltration



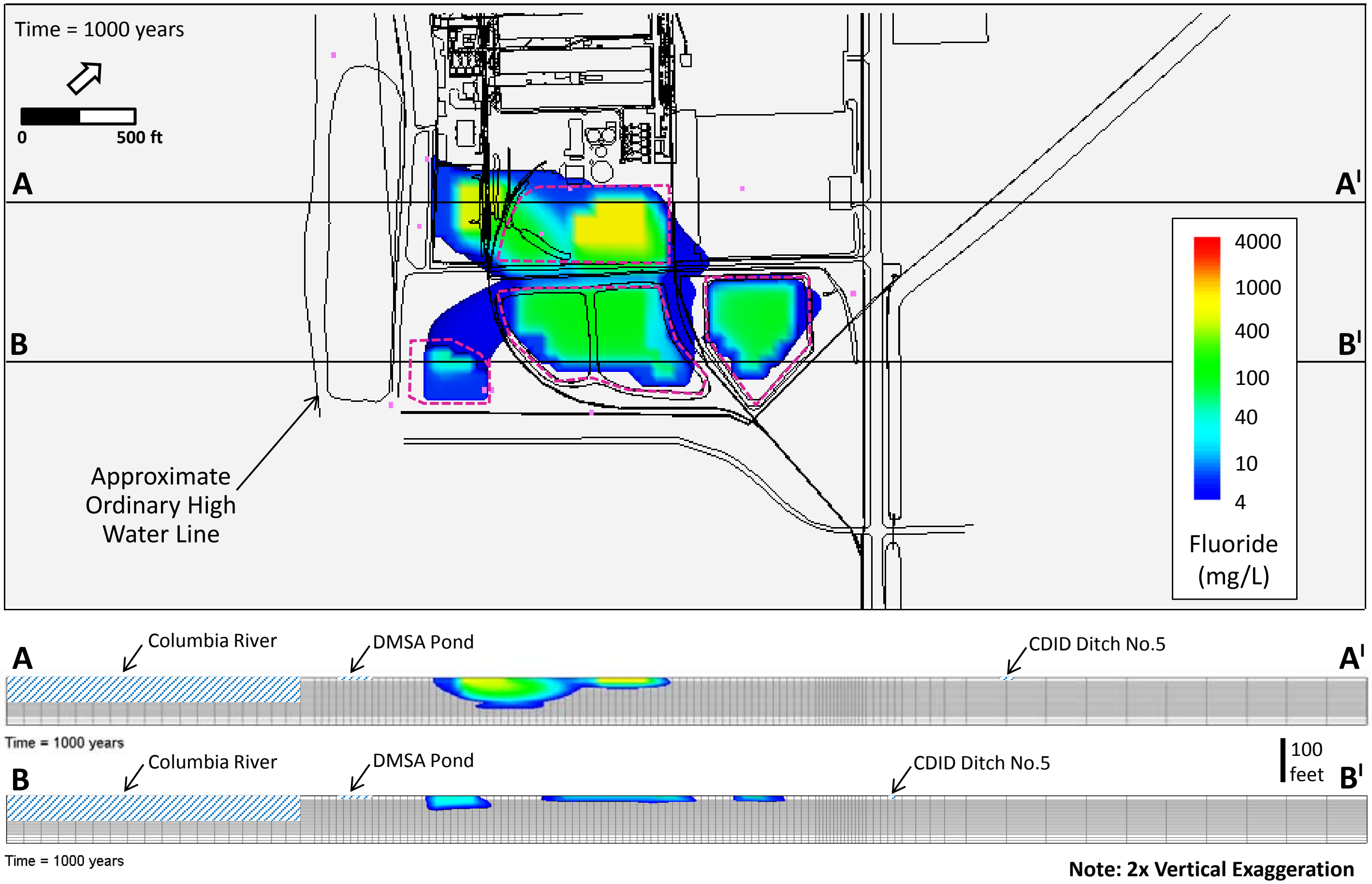
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 200 years assuming 100 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario at 200 years (no reduction in infiltration [see Plate 6-17]) compared to 100 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. With 100 percent reduction in infiltration, there is no riverward migration of the 4 milligrams per liter fluoride plume from the southern edge of the Former Stockpile Area and negligible riverward migration from the southern edge of Landfill #1, as compared to the base case scenario. Also, there is a decrease in the fluoride concentrations at the edges of Fill Deposits A and B-1 after 200 years with 100 percent reduction in infiltration. Ultimately, the rate of advance of dissolved fluoride is negligible compared to groundwater flow, and the fluoride plume is essentially arrested in both time and space.

Plate 6-31

Simulated East Groundwater Area Fluoride Plume after 200 Years with 100 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 1,000 years assuming 100 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario at 1,000 years (no reduction in infiltration [see Plate 6-18]) compared to 100 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. With 100 percent reduction in infiltration, there is no riverward migration of the 4 milligrams per liter fluoride plume from the southern edge of Landfill #1, as compared to the base case scenario after 1,000 years. Also, there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposits A and B-1 after 1,000 years with 100 percent reduction in infiltration. Ultimately, the rate of advance of dissolved fluoride is negligible compared to groundwater flow, and the fluoride plume is essentially arrested in both time and space.

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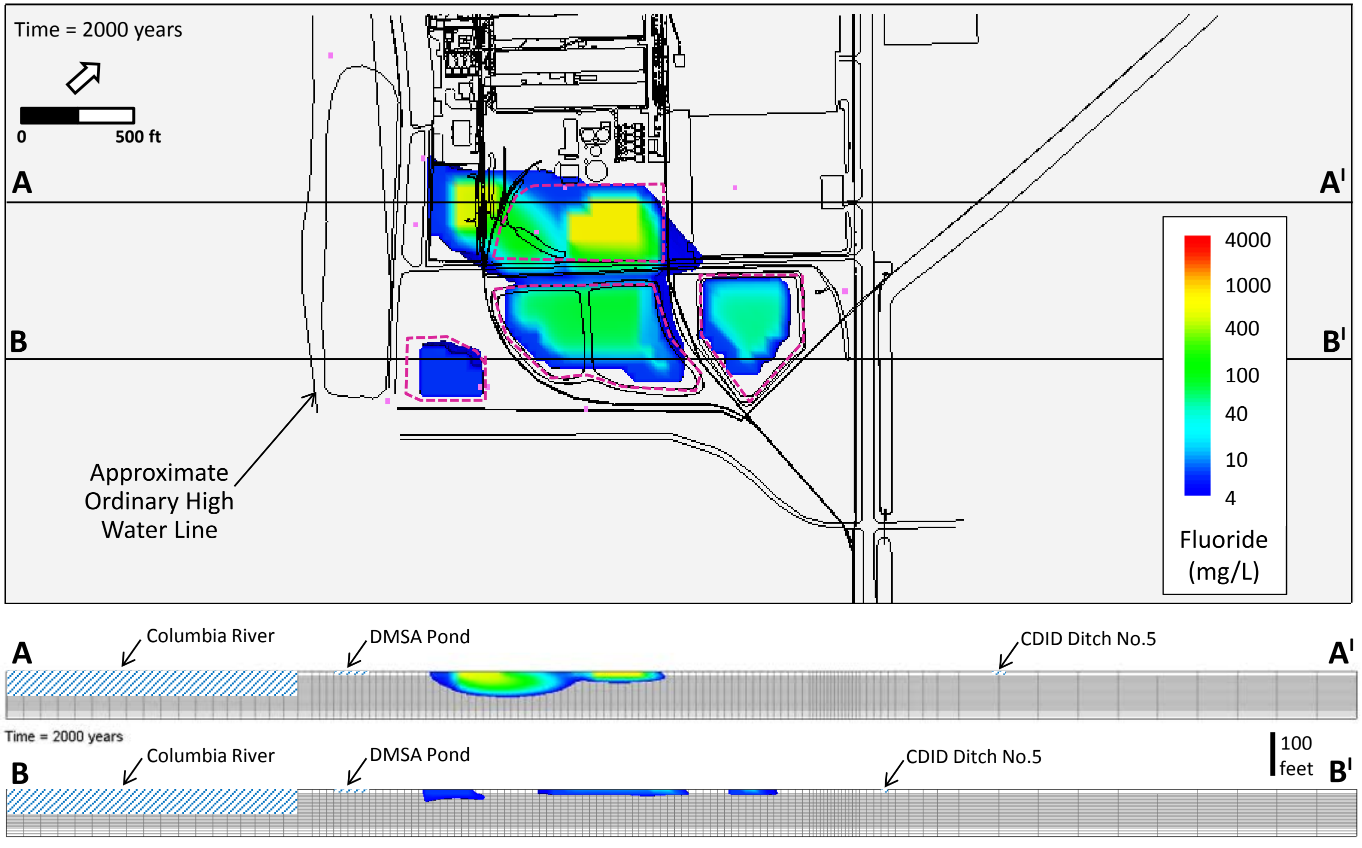
Plate 6-32

Simulated East Groundwater Area Fluoride Plume after 1,000 Years with 100 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



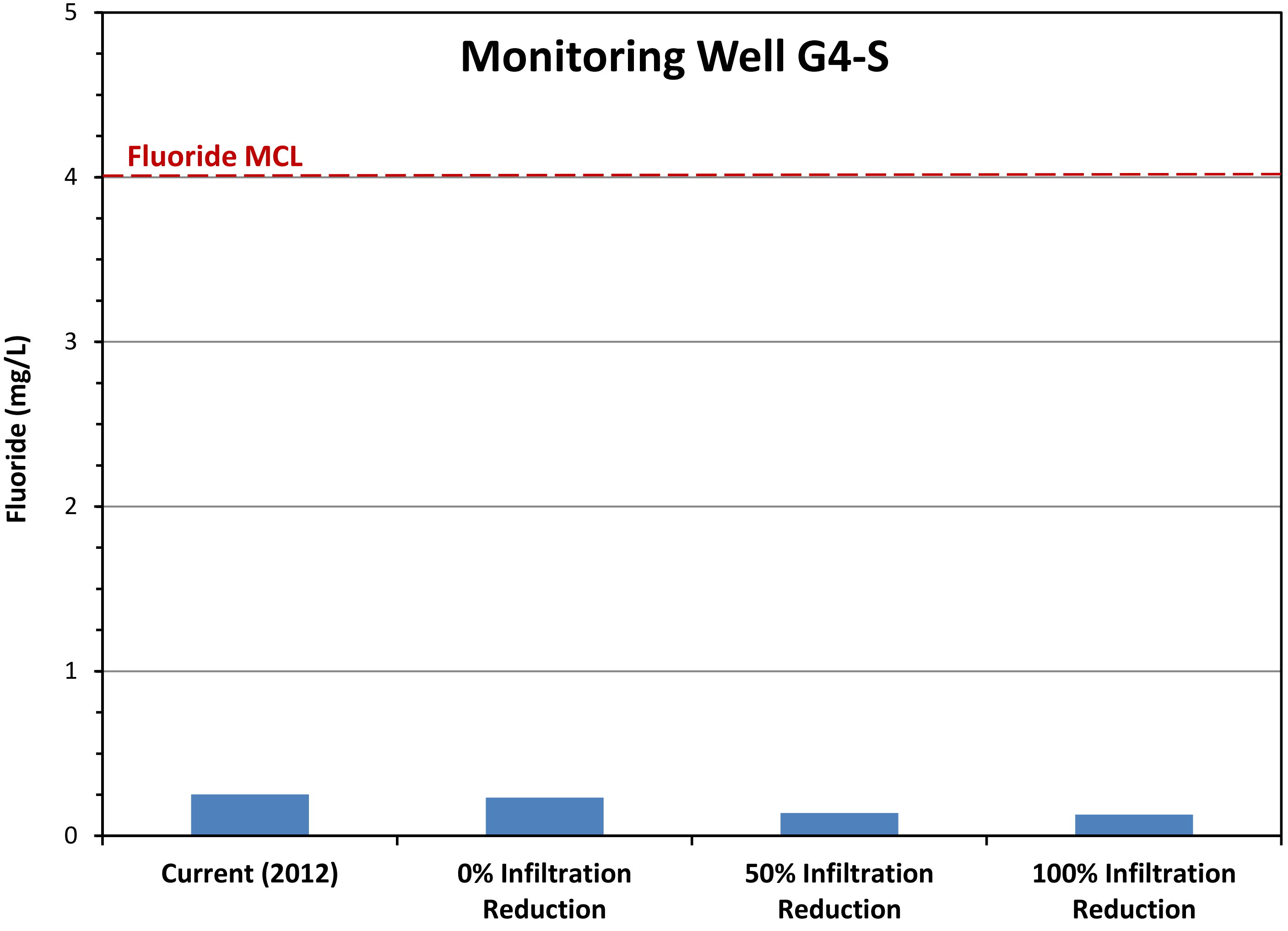
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed lines denote the Fill Deposit and Landfill boundaries.

This plate shows the East Groundwater Area fluoride plume after 2,000 years assuming 100 percent reduction in infiltration through Fill Deposits A, B-1 and B-2, and Landfill #1. There is little discernible change in maximum fluoride concentrations (shown in yellow) beneath Fill Deposit B-2 between the base case scenario (no reduction in infiltration [see Plate 6-19]) compared to 100 percent reduction in infiltration, as would be expected based on the fact that residual carbon and spent lime are in direct contact with groundwater in some places. Overall concentrations beneath Landfill #1 are predicted to decrease by approximately a factor of 3 with 100 percent reduction in infiltration, and there is no riverward migration of the 4 milligrams per liter fluoride plume, as compared to the base case scenario after 2,000 years. Also, there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposits A and B-1 after 2,000 years with 100 percent reduction in infiltration. Ultimately, the rate of advance of dissolved fluoride is negligible compared to groundwater flow, and the fluoride plume is essentially arrested in both time and space.

Plate 6-33

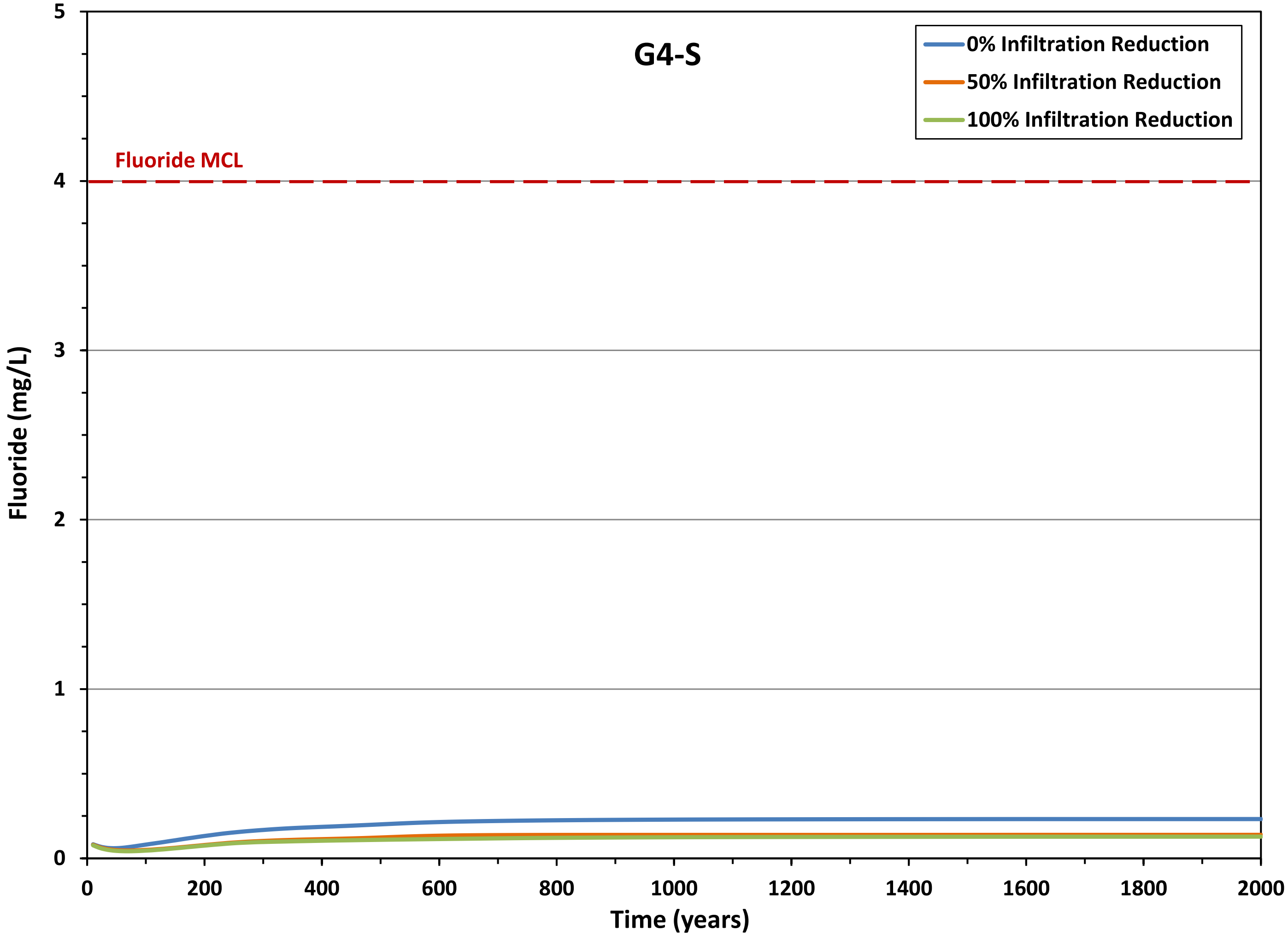
Simulated East Groundwater Area Fluoride Plume after 2,000 Years with 100 Percent Reduction in Infiltration



The fluoride concentration in shallow groundwater immediately downgradient of the East Groundwater Area, at monitoring well G4-S near CDID Ditch No.5, is currently less than 1 milligram per liter (mg/L), well below the MCL, and remains below 1 mg/L in all three of the infiltration reduction simulations, as shown in the above graph. Based on these results, significant reduction (50 to 100 percent) of infiltration through the East Groundwater Area landfill and fill deposits does not appreciably improve groundwater quality downgradient of the East Groundwater Area.

Plate 6-34

Measured and Simulated Future (2,000 Years) Fluoride Concentrations at Well G4-S
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



The fluoride concentration in shallow groundwater immediately downgradient of the East Groundwater Area is currently less than 1 milligram per liter (mg/L), well below the MCL, and is predicted to remain less than 1 mg/L in all of the infiltration reduction scenarios. Based on these results, reduction of infiltration through the East Groundwater Area landfill and fill deposits by 50 to 100 percent does not provide appreciable improvement in groundwater quality downgradient of the East Groundwater Area relative to no infiltration reduction.

Plate 6-35

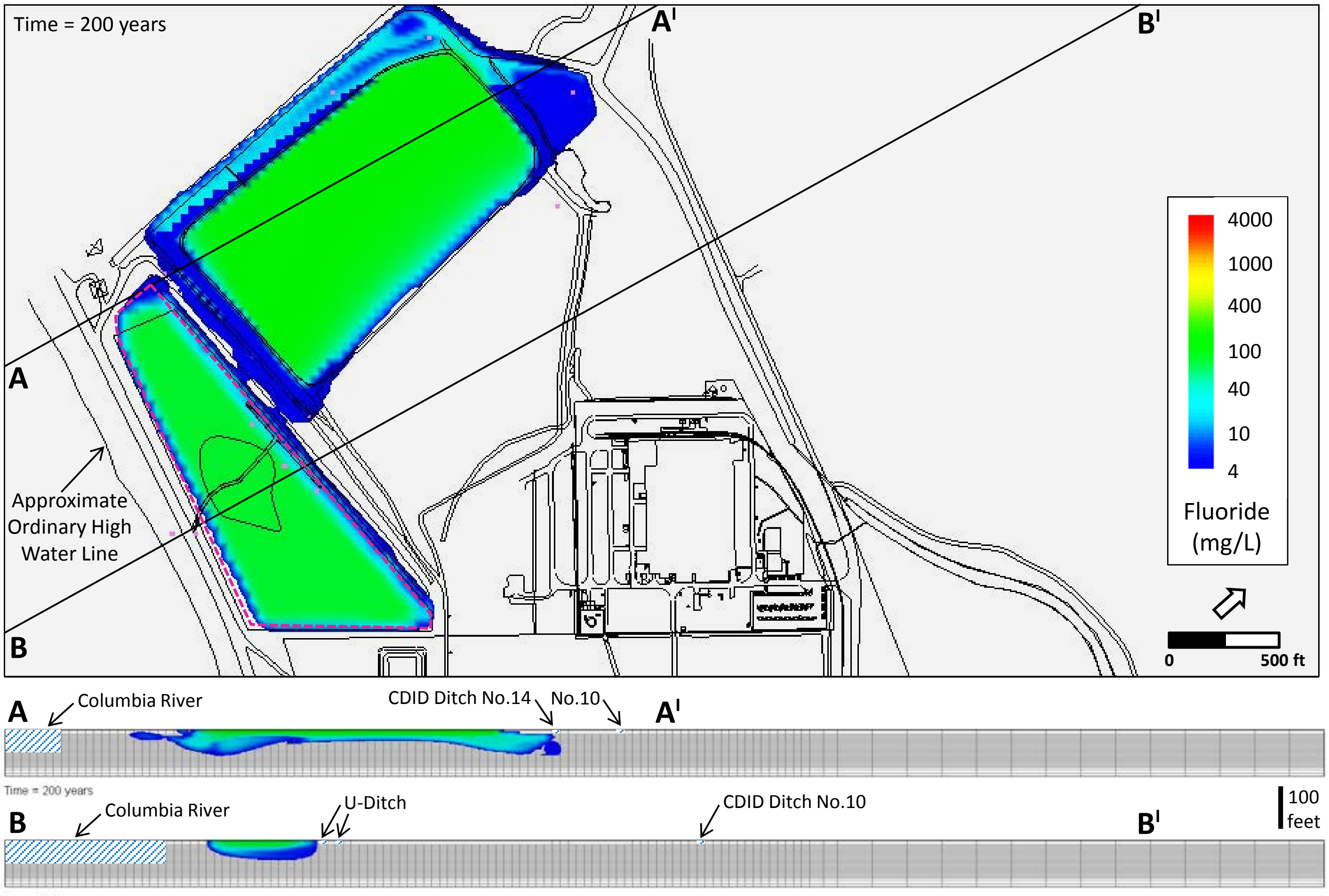
Simulated Fluoride Breakthrough Curves at Monitoring Well G4-S for the Different Infiltration Reduction Scenarios

Plates 6-21, 6-22, and 6-23 show the base case simulated West Groundwater Area fluoride plume after 200, 1,000, and 2,000 years, respectively. Plates 6-36, 6-37, and 6-38 show the simulated West Groundwater Area fluoride plume after 200, 1,000, and 2,000 years, respectively, assuming 50 percent reduction in infiltration through the fill and landfill deposits. Plates 6-39, 6-40, and 6-41 show the simulated West Groundwater Area fluoride plume after 200, 1,000, and 2,000 years assuming 100 percent reduction in infiltration, respectively. Similar to the East Groundwater Area simulations, reduction in infiltration through Fill Deposit B-3 does not result in a discernible decrease in the maximum groundwater concentrations (shown in green). There is, however, a notable decrease in fluoride concentrations in groundwater at the edges of Fill Deposit B-3 after 2,000 years with 100 percent reduction in infiltration. As shown on Plates 6-24 and 6-25, fluoride concentrations in shallow groundwater immediately downgradient of Fill Deposit B-3 are predicted to drop below the MCL within about 100 years, regardless of the level of infiltration reduction. Based on these results, there does not appear to be an appreciable improvement in groundwater quality as a result of significantly (50 to 100 percent) reducing infiltration through the West Groundwater Area fill deposit.

6.6 Fluoride Fate and Transport Summary

The following major processes are influencing the fate and transport of fluoride within soil, solid media, and groundwater in the study area:

- The leaching of fluoride from source areas is presently limited by the solubility of fluorite (calcium fluoride).
- Similarly, dissolved fluoride transport in groundwater from areas historically impacted by alkaline sodium fluoride solutions is limited by the solubility of fluorite (less than 100 mg/L for pH less than 8) and fluorophosphates, such as fluorapatite.
- Anion exchange and adsorption to soil aluminum oxides also serve to retard fluoride movement in groundwater at the leading edge of the plume. Testing indicates that natural AEC remains in areas outside of the source area deposits. This natural capacity is available for uptake of dissolved fluoride.
- In specific areas where relatively high groundwater pH and associated low soluble calcium concentrations permit elevated fluoride levels to persist, the abundance of available calcium in the upper alluvial soils ensures that fluoride concentrations are regulated by fluorite precipitation, which essentially arrests the plume in place and prevents downgradient migration.



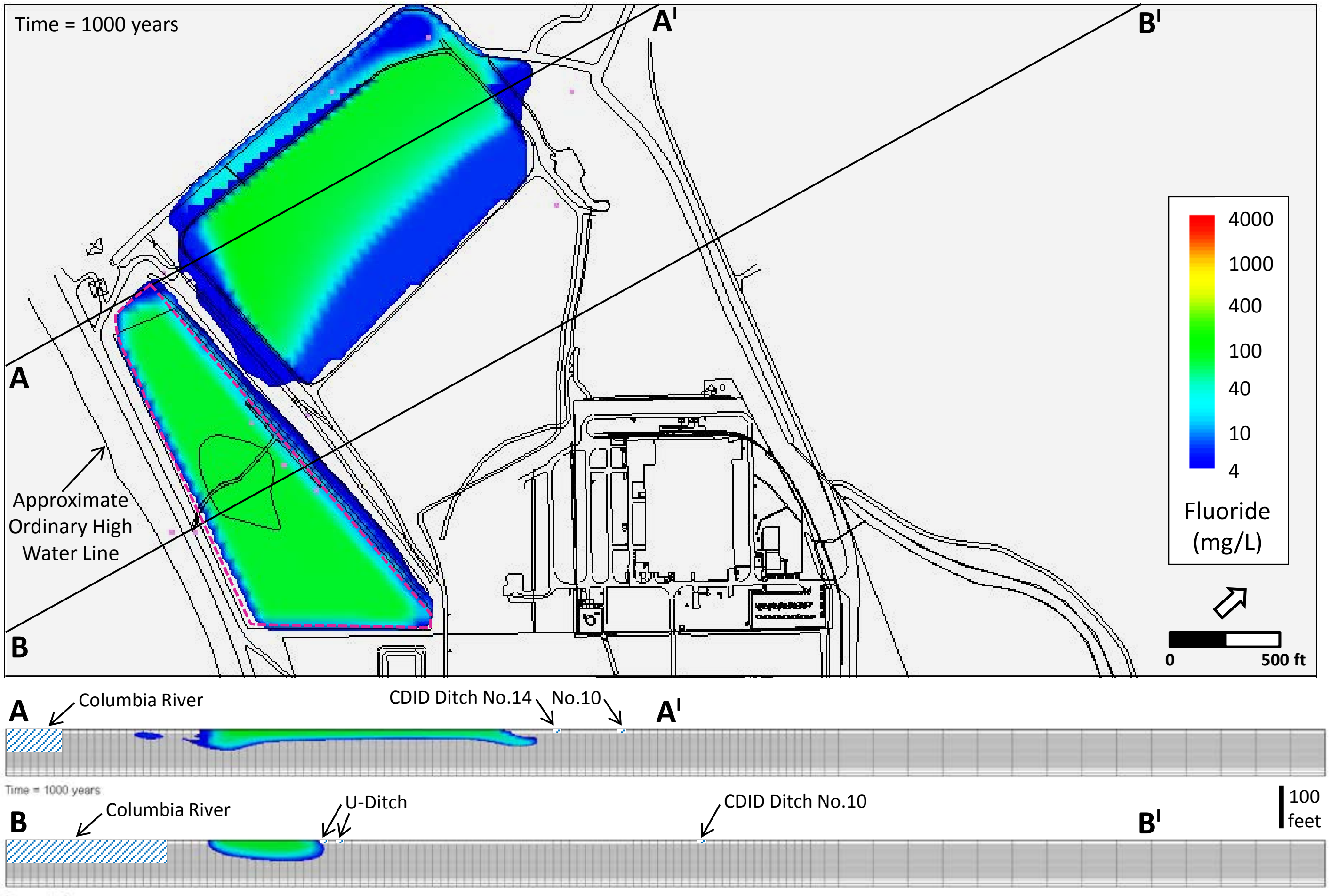
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes the Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 200 years assuming 50 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) or the overall extent of the plume, as compared to the base case scenario after 200 years (no reduction in infiltration [see Plate 6-21]).

Plate 6-36

Simulated West Groundwater Area Fluoride Plume after 200 Years with 50 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



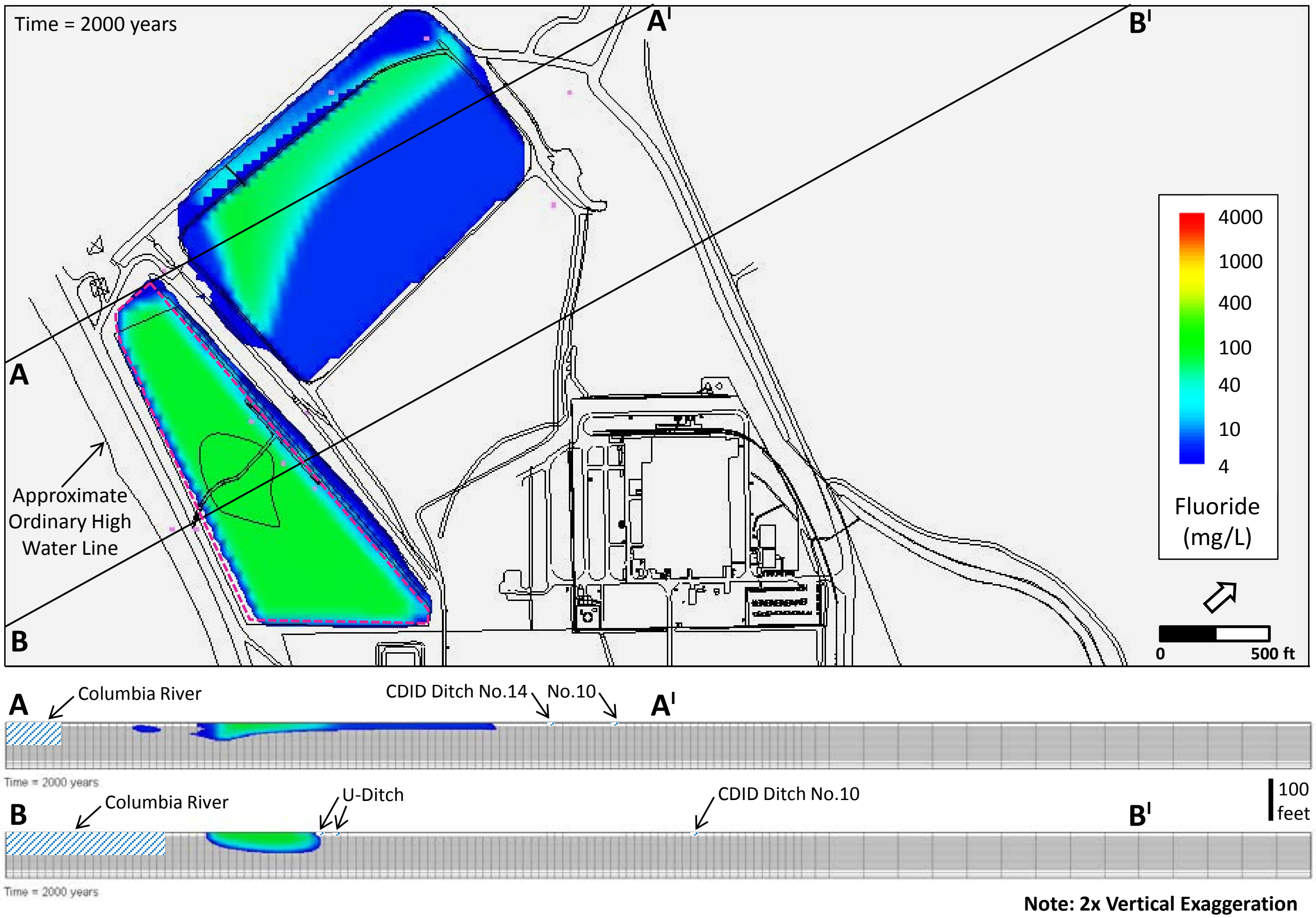
Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes the Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 1,000 years assuming 50 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) as compared to the base case scenario after 1,000 years (no reduction in infiltration [see Plate 6-22]).

Plate 6-37

Simulated West Groundwater Area Fluoride Plume after 1,000 Years with 50 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

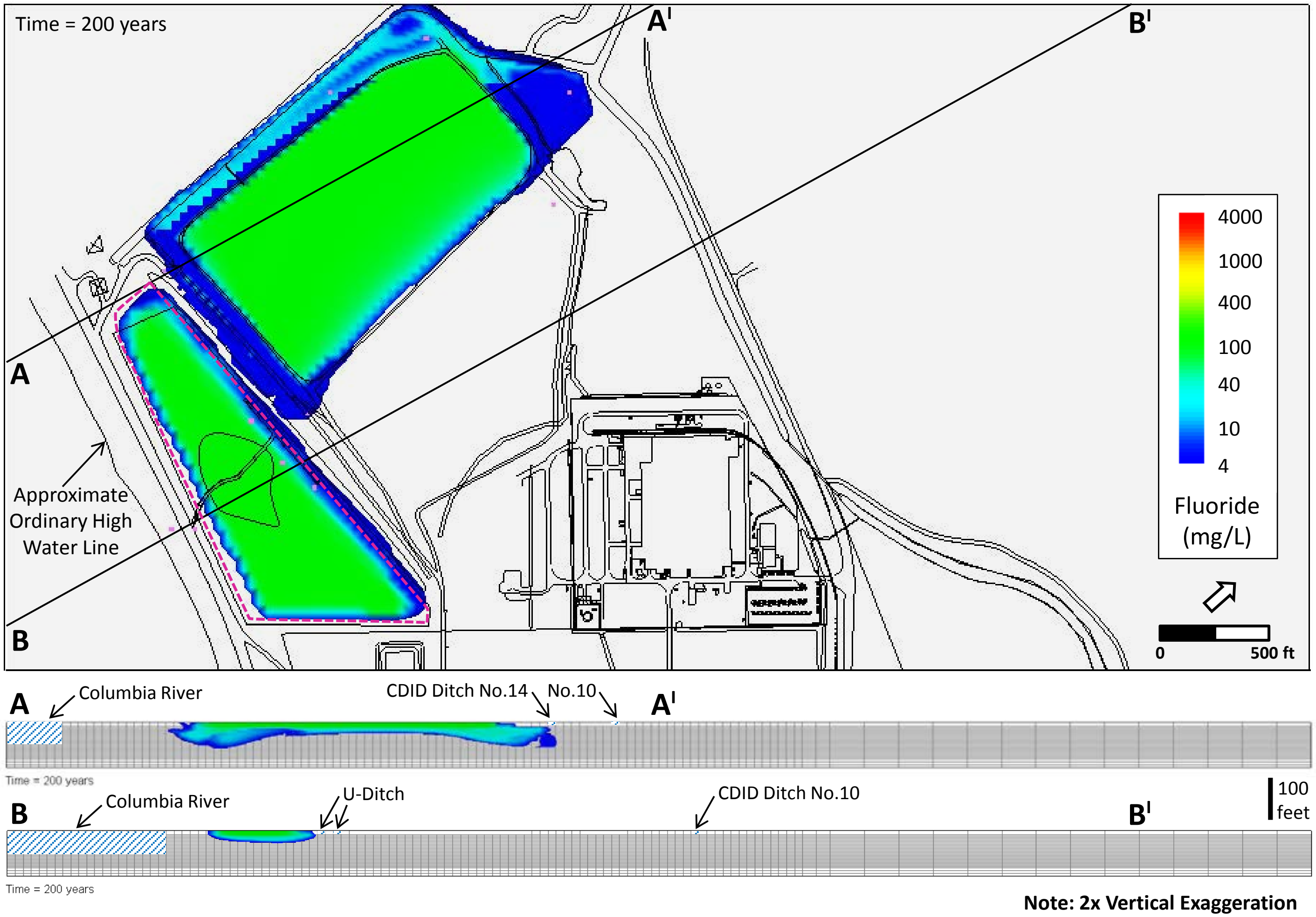


Note: Pink squares denote monitoring well locations; pink dashed line denotes the Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 2,000 years assuming 50 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) as compared to the base case scenario after 2,000 years (no reduction in infiltration [see Plate 6-23]).

Plate 6-38

Simulated West Groundwater Area Fluoride Plume after 2,000 Years with 50 Percent Reduction in Infiltration



Note: Pink squares denote monitoring well locations; pink dashed line denotes Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 200 years assuming 100 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) as compared to the base case scenario (no reduction in infiltration [see Plate 6-21]), but there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposit B-3 after 200 years with 100 percent reduction in infiltration.

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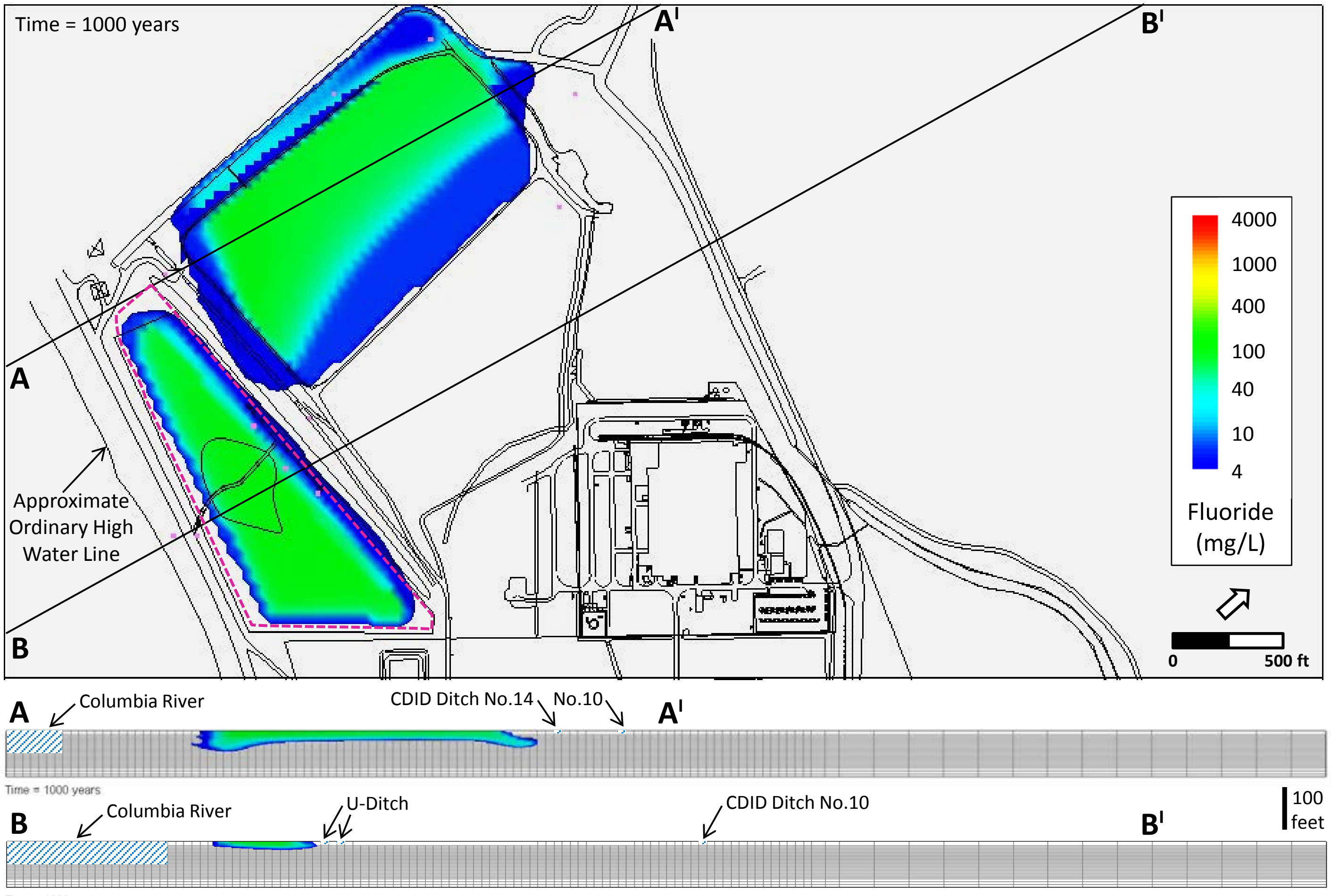
Plate 6-39

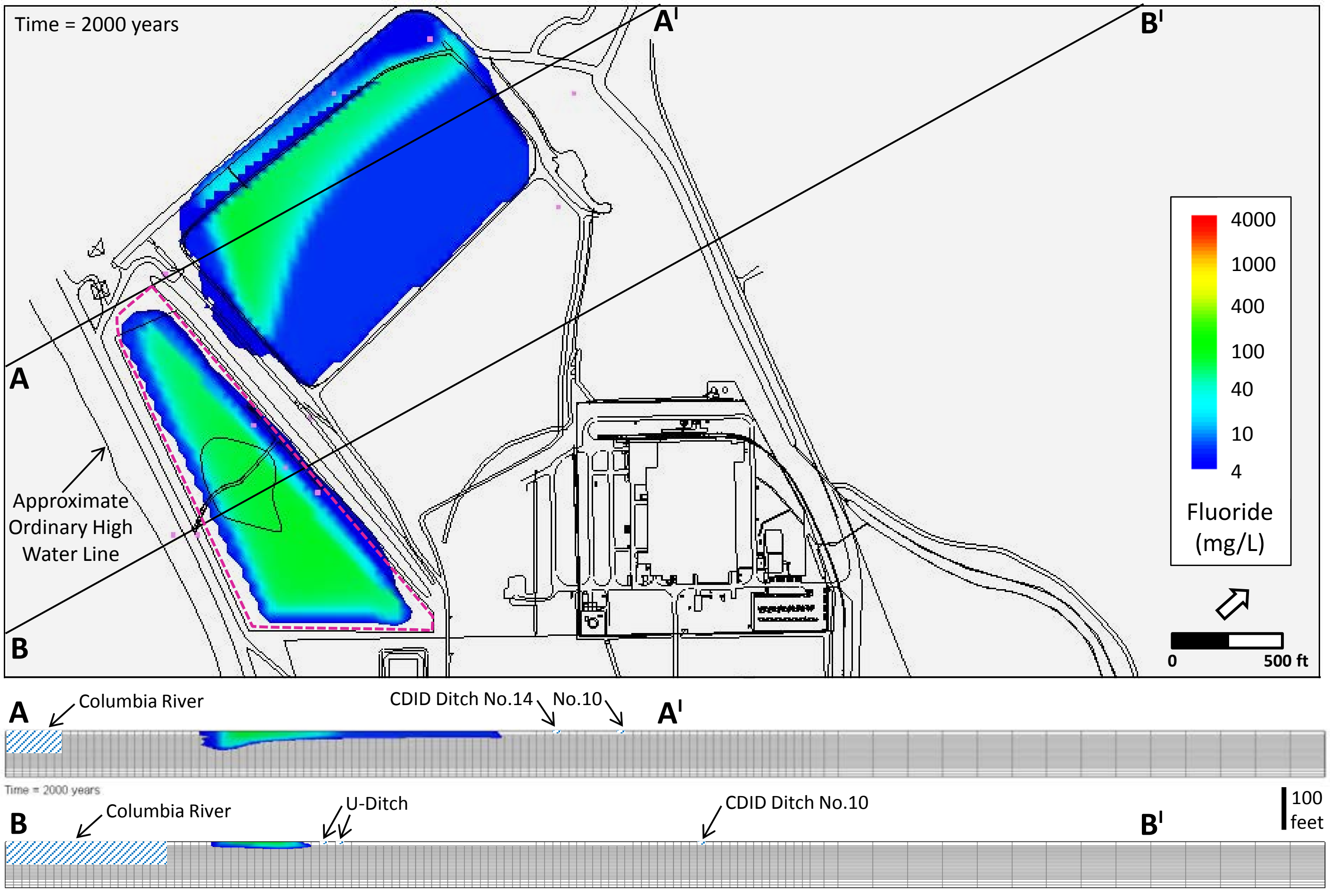
Simulated West Groundwater Area Fluoride Plume after 200 Years with 100 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: Pink squares denote monitoring well locations; pink dashed line denotes the Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 1,000 years assuming 100 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) as compared to the base case scenario (no reduction in infiltration [see Plate 6-22]), but there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposit B-3 after 1,000 years with 100 percent reduction in infiltration.

Plate 6-40
Simulated West Groundwater Area Fluoride Plume after 1,000 Years with 100 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



Note: 2x Vertical Exaggeration

Note: Pink squares denote monitoring well locations; pink dashed line denotes Fill Deposit boundary.

This plate shows the simulated West Groundwater Area fluoride plume after 2,000 years assuming 100 percent reduction in infiltration through Fill Deposit B-3 and Landfill #2. Reducing infiltration through Fill Deposit B-3 does not result in an appreciable decrease in the maximum groundwater fluoride concentrations (shown in green) as compared to the base case scenario after 2,000 years (no reduction in infiltration [see Plate 6-23]), but there is a noticeable decrease in the fluoride concentrations at the edges of Fill Deposit B-3 after 2,000 years with 100 percent reduction in infiltration.

Plate 6-41

Simulated West Groundwater Area Fluoride Plume after 2,000 Years with 100 Percent Reduction in Infiltration
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

Hydrogeologic conditions in the study area are influenced by the regional drainage networks of the CDID ditch system. These drainage networks generate a groundwater gradient flowing generally northward away from the Columbia River, with shallow groundwater discharging to the waters of the CDID ditch system. Fluoride that may be present in groundwater near the groundwater/ditch boundary is subject to a number of attenuation processes, including the precipitation of fluorophosphates, anion exchange, and adsorption reactions on soils present beneath the ditch bottom. Ditch water monitoring conducted as part of the RI has shown that these processes are capable of maintaining ditch water fluoride concentrations below 4 mg/L.

In the southernmost portions of the study area, groundwater gradients are at times toward the Columbia River. The portion of site groundwater that can flow toward the river is limited by site hydrogeologic gradients. Groundwater moving along this path is subject to dispersion, as well as tidally induced mixing in river nearshore areas. Geochemical processes applicable to the boundary between groundwater and the river include adsorption, exchange, and calcium fluorophosphate precipitation. Surface water concentrations measured within the Columbia River have been consistent with upriver background concentrations of approximately 0.2 mg/L or less.

Groundwater transport modeling analyses also provide support for the long-term effectiveness of the natural attenuation processes described above in regulating fluoride concentrations. Reactive transport simulations show that the abundance of available calcium in the upper alluvial WBZ soils and sediments is sufficient to guarantee that the dissolved alkaline fluoride plume in the former cryolite area is essentially arrested in place and will further attenuate downgradient as pH shifts to neutral and calcium becomes more soluble. Similarly, in areas of high fluoride groundwater with near-neutral pH, calcium provided by cation exchange and mineral dissolution reactions drives the precipitation of fluorite such that fluoride plumes associated with specific source areas appear to remain essentially stationary on timescales of centuries to millennia. These processes provide sufficient in situ treatment to be protective of surface water quality in the Columbia River and CDID ditches.

The results of the fate and transport evaluations have direct implications on remediation levels (RELs) for groundwater and soil. Empirical data demonstrate that current groundwater conditions are protective of surface water quality in CDID ditches and the Columbia River. Historical monitoring data documents decreasing concentration trends in downgradient groundwater post-closure of on-site disposal fill deposits, such as the Closed BMP Facility, demonstrating the effectiveness of natural attenuation processes in regulating fluoride over time. Reactive transport modeling further supports that these processes will continue to operate and be protective into the future. Setting RELs for groundwater that rely on continued stable or decreasing fluoride concentration trends will ensure continued protection of surface water quality.

Soil RELs for identifying soils suitable for reuse on site can be based on consideration of site-specific fluoride partitioning and unsaturated zone attenuation consistent with MTCA guidelines. Site-specific K_d values for fluoride leaching from soils containing fluoride residuals, based on leaching of the concentrated residual materials (see Table 6-1), can be combined with a soil attenuation factor to derive soil concentrations that would be protective of groundwater quality. By extension, soil RELs defined in this manner would also be protective of surface water quality.

The derivation of site-specific groundwater and soil RELs is discussed in detail in Section 8.

7 CONCEPTUAL SITE MODEL

This section provides a summary of the CSM developed for the study area based on the findings of the RI. The CSM includes a summary of environmental conditions at the site, fate and transport characteristics of principal site COCs, and an evaluation of potential exposure pathways and receptors. The CSM is illustrated on Figures 7-1 through 7-4.

7.1 Summary of Environmental Conditions

The environmental conditions at the site were initially evaluated through a series of investigation and cleanup actions conducted between the 1980s and 2007. These previous actions are described in Section 2.

After evaluating data gaps for the study area, the RI activities described in this report were initiated under Ecology direction to complete the assessment of current environmental conditions. These findings of the RI provide the information necessary to define the environmental conditions, develop the CSM, and support the development of cleanup alternatives in the FS consistent with MTCA requirements. The key findings of the RI include the following:

- Principal site COCs in soil/solid media are fluoride, cyanide, and PAH compounds. These compounds are associated primarily with former smelter operations and are generally present in localized areas where deposits of residual carbon and spent lime are currently managed on site. These localized areas include the landfills and fill deposits shown on Figure 7-1.
- Surface soil quality throughout the majority of the Former Reynolds Plant is protective of industrial workers. The exceptions to this are localized soil sampling locations within the northeast corner of the Flat Storage Area and impacted soils in Landfill #3 (construction debris). These areas are also shown on Figure 7-1, and management of these areas will be addressed in the FS.
- The contents of several of the closed landfills and fill deposits at the facility contain elevated concentrations of PAH compounds. Industrial workers are not exposed to these contained materials during normal, on-site work activities. The long-term management of the landfills and fill deposits is addressed as part of the FS.

- Columbia River sediments were tested extensively during coordinated RI/FS and NPDES monitoring events. No impacts to nearshore or offshore sediments were noted, except for a localized area immediately adjacent to Outfall 002A, which is monitored under the NPDES program. Trend analysis indicates that sediments in this extremely localized area are recovering over time. As described in Section 8, evaluation of detectable bioaccumulative concentrations confirms that existing concentrations are protective of human health and the environment. However, at Ecology's request, the limited area of benthic impacts to sediments will be addressed in the FS. The sediments near Outfall 002A are also subject to future monitoring under the NPDES program.
- Extensive testing has been performed in CDID ditch waters and surface waters of the Columbia River adjacent to the site. No exceedances of screening levels were noted in these ditch or surface water samples.
- No VOCs or PCBs were detected in groundwater. Cyanide levels are protective of drinking water and surface water quality. Fluoride and PAH concentrations are elevated only in the upper fill and silt/clay soils immediately within or adjacent to the landfill and fill deposits.

Fluoride is the principal COC for site groundwater. Groundwater concentrations of fluoride exceed MCLs in portions of the West Groundwater Area and East Groundwater Area and in a localized area adjacent to Landfill #3. The highest fluoride concentrations are located in the vicinity of Fill Deposit B-2. Fluoride concentrations in other portions of the East Groundwater Area and West Groundwater Area are more than ten-fold lower than this area. Concentrations of fluoride in groundwater adjacent to Landfill #3 are even lower, exceeding the MCL by only a narrow margin.

7.2 Fate and Transport Processes

Extensive testing has been conducted to evaluate the factors affecting the potential fate and transport of fluoride. Most site COCs are relatively immobile, as evidenced by the lack of groundwater impacts. Findings of the fate and transport evaluation are summarized in Section 6 and are illustrated in the CSM cross sections shown on Figures 7-2, 7-3, and 7-4. These principal fate and transport processes include the following:

- Leaching of fluoride from source areas is limited by the geochemical properties of the soils, solid media, and groundwater. A primary example of this is the calcium-mediated solubility of fluorite (calcium fluoride) in residual carbon and spent lime deposits.
- Certain conditions present in the vicinity of Fill Deposit B-2 (e.g., historical discharges of alkaline waters to this area) can enhance fluoride solubility in comparison to the conditions present in the other fill deposits. These conditions are localized to this area (i.e., Fill Deposit B-2) and only persist because of the elevated pH.
- Dissolved fluoride transport in groundwater away from areas historically impacted by alkaline sodium fluoride solutions is limited by the solubility of fluorite (less than 100 mg/L for pH less than 8) and fluorophosphates, such as fluorapatite.
- The supply of calcium available from soil minerals (feldspars, cation exchange sites on clays) far exceeds the amount of fluoride in groundwater. Because of this condition, the fluoride plume can be thought of as being arrested by the continued reaction with soil-derived calcium to precipitate fluorite.
- Anion exchange and adsorption to soil aluminum oxides also serve to retard fluoride movement in groundwater at the leading edge of the plume. Testing indicates that substantial adsorption capacity remains in soils outside of the source area deposits. This natural capacity is available for uptake of dissolved fluoride.
- These attenuation processes have limited the migration of fluoride both laterally and vertically under current hydrogeologic conditions present at the site.

Hydrogeologic conditions in the study area are influenced by the regional drainage networks of the CDID ditch system. These drainage networks generate a groundwater gradient flowing generally northward or westward away from the Columbia River, with shallow groundwater generally discharging to the waters of the regional CDID ditch system (see Figure 7-2). Fluoride that may be present in some groundwater near the groundwater/ditch boundary is subject to a number of attenuation processes, including the precipitation of fluorite and fluorophosphates, anion exchange, and adsorption reactions on soils present beneath the ditch bottom. Ditch water monitoring conducted as part of the RI has shown that these processes effectively maintain ditch water fluoride concentrations below site screening levels under existing pre-remediation conditions. Remediation measures would further protect water quality in the ditches.

In the southernmost portions of the site, groundwater gradients are at times toward the Columbia River (see Figures 7-3 and 7-4). The portion of site groundwater that can flow toward the river is limited by site hydrogeologic gradients. Groundwater moving along this path is subject to dispersion, as well as tidally induced mixing in river nearshore areas. Geochemical processes applicable to the boundary between groundwater and the river include adsorption, exchange, and calcium fluorophosphate precipitation. Surface water concentrations measured within the Columbia River have been consistent with upriver background concentrations of approximately 0.2 mg/L or less.

Results of geochemical reactive transport simulations for fluoride in groundwater show that the natural processes presently limiting fluoride transport at the site will continue to provide long-term protection of surface water quality in the river and CDID ditches on timescales of centuries.

7.3 Exposure Pathways and Receptors

The site is an industrial property surrounded by other industrial properties. Access to the site is controlled, consistent with its industrial land use. Surface drainage at the site is controlled by the on-site drainage system. Groundwater at the site has been extensively monitored, and hydrogeologic and geochemical processes have been evaluated. A series of cleanup actions have already been completed, as described in Section 2. Relevant exposure pathways and receptors for principal exposure pathways at the site include the following:

- **Soil direct contact – industrial workers**. Fluoride and cyanide, two of the principal COCs at the site, do not exceed industrial cleanup levels protective of direct contact exposures in any areas of the site. Most areas of impacted soils exceeding industrial screening levels (i.e., those soils containing elevated PAH and TPH concentrations) and present at the site have already been isolated from direct contact as part of previous soil cover placement or cleanup actions (e.g., partial cleanup of TPH-impacted soils at the 200,000-gallon fuel oil AST). However, localized areas of shallow impacted soil remain present on site. Further actions are appropriate to address these localized soil areas and to provide for long-term protection against direct contact exposures.

- **Protection of groundwater quality**. A key consideration at the site is the protection of groundwater quality in areas that serve as a current or potential future source of drinking water. The deep alluvium WBZ, the coarse aquifer unit present at 200 feet bgs and deeper, is used locally as a source of industrial and municipal water supply. Direct protection of the deep alluvium WBZ from fluoride transport is currently achieved by site hydrogeologic conditions (i.e., upward hydraulic gradients) in the shallow alluvium WBZ in the East Groundwater Area and West Groundwater Area and by the geochemical processes occurring in site soils and groundwater that prevent migration of fluoride.
- **Protection of ditch and surface waters**. Extensive testing of CDID ditch and surface waters at the site has been performed as part of the RI/FS, and no site-related impacts have been identified above applicable screening levels. Results of geochemical reactive transport simulations for fluoride in groundwater show that the natural processes presently limiting fluoride transport at the site will continue to provide long-term protection of surface water quality in the river and CDID ditches on timescales of centuries.
- **Protection of benthic organisms.** Columbia River sediments were tested extensively during coordinated RI/FS and NPDES monitoring events. No impacts to nearshore or offshore sediments were noted, except for a localized area immediately adjacent to Outfall 002A, which is monitored under the NPDES program. Trend analysis indicates that sediments in this extremely localized area are recovering over time. As described in Section 8, evaluation of detectable bioaccumulative concentrations confirms that existing concentrations are protective of human health and environment. However, at Ecology’s request, the area exceeding benthic criteria will be addressed in the FS.

8 CLEANUP ACTION REQUIREMENTS

A final cleanup action for the site must be protective of human health and the environment, meet state cleanup standards, and comply with other applicable state and federal laws. Cleanup standards will be consistent with the current and anticipated future land use. As discussed in Section 2.1, the Former Reynolds Plant is located within an industrial land use corridor, zoned for industrial use, and located adjacent to other industrial facilities. Therefore, cleanup standards will be based on industrial criteria. This section discusses site-specific requirements to be considered during alternative development. The assembly and evaluation of remedial alternatives are discussed in Sections 10 and 11.

8.1 Feasibility Study Site Units

Based on the results of the RI portion of this study, 12 distinct FS site units (SUs) and two areas of affected groundwater (i.e., the West Groundwater Area and the East Groundwater Area) have been identified for further evaluation, as shown on Figure 8-1. FS SUs were defined based on a combination of historical knowledge of site operations, historical aerial photographs, survey data, and visual observations. The boundaries of historical site landfill deposits (SUs 1 and 8) were defined using historical aerial photos (see Appendix D-3), land survey data (ALTA Survey; MGS 2010), and visual observations from RI field investigations (exploratory test pits; see Appendix D-4). The former cryolite ditches (SU4) and site fill deposits containing residual carbon (SUs 2, 3, and 6) or spent lime (SU7) were identified based on historical site use in these areas (e.g., former Cryolite Recovery Plant operations; see Section 2.2.3) and were delineated using site observations and the 2010 ALTA Survey. The boundary of the former SPL stockpile footprint (SU5) was identified using historical aerial photographs and Former Reynolds Plant maps. In addition, the boundaries of SUs 2, 3, and 5 were field-verified using visual observations from exploratory test pits conducted during February 2012 (see Plate 3-2). Based on historical site operations, visual observations during RI sampling activities, and RI chemical testing results, the former pitch storage area (SU9), landfill deposit containing construction debris (Landfill #3; SU10), and a portion of the former Flat Storage Area (SU11) were also identified as FS SUs for further evaluation. A small area of surficial sediments in the Columbia River in the vicinity of Outfall 002A was identified as SU12 based on an exceedance of benthic criteria. Surface and ditch waters are not identified as FS SUs; the RI concluded that surface water resources and ditch water are currently protected and that groundwater impacts are limited to confined, shallow zones.

8.2 Remedial Action Objectives

This section contains the following RAOs for the site:

- **RAO-1.** Continued protection of surface water adjacent to the site designated for potential future beneficial use as drinking water through enhancement of natural attenuation processes, where necessary.
- **RAO-2.** Protection of human health and the environment by limiting direct contact with COC-impacted media (i.e., soil, residual carbon, spent lime, and groundwater) based on an industrial use scenario.
- **RAO-3.** Protection of human health and the environment by reducing or controlling migration of fluoride-impacted groundwater from fill deposits, landfills, and impacted soil.
- **RAO-4.** Protection of terrestrial ecological receptors from exposure to COC-impacted soil.
- **RAO-5.** Protection of aquatic and benthic ecological receptors from exposure to COC-impacted media.

8.3 Applicable Federal, State, and Local Laws

Many environmental laws may apply to a cleanup action. In addition to meeting environmental standards set in applicable laws, the cleanup action must also comply with elements of other applicable environmental reviews and permitting requirements.

WAC 173-340-710 provides that MTCA cleanup actions must comply with applicable state and federal laws. Though a cleanup action performed under formal MTCA authorities (e.g., a Consent Decree) would be exempt from the procedural requirements of most state and all local environmental laws, the action must nevertheless comply with the substantive requirements of such laws (RCW 70.105D.090 and WAC 173-340-710). Potentially applicable federal, state, and local laws that may apply during the implementation of remedial actions at the site are summarized in the following sections. Potential federal requirements are specified in several statutes, codified in the United States Code (USC) and regulations promulgated in the CFR.

In general, ARARs are classified into the following three categories; some requirements, however, may not fall precisely into this classification system (EPA 1988):

- **Chemical-specific.** Ambient or chemical-specific requirements are usually health- or risk-based numerical values or methodologies, which when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment.
- **Action-specific.** Performance, design, or other action-specific requirements are usually technology- or activity-based requirements or limitations on cleanup actions. These requirements may include chemical-specific standards or criteria that must be met as the result of an action. For remedial actions at the site, these requirements are not necessarily triggered by the presence of specific impacts to site media but rather by the specific actions that occur at the site.
- **Location-specific.** Location-specific requirements are restrictions placed on the concentration of COCs or the conduct of activities solely because they occur in special locations. They are triggered based on the location of the remedial action to be undertaken. Location-specific ARARs may restrict or preclude certain remedial actions or may apply only to certain portions of the site.

Plate 8-1 presents ARARs that potentially apply to selection of chemical-specific cleanup levels at the site. Plate 8-2 presents action- or location-specific ARARs that may apply depending on the selected remedial activities. Each act/authority is described in Sections 8.3.1 and 8.3.2. Potential ARARs for caps are discussed separately in Section 8.3.3.

Plate 8-1 Chemical-specific ARARs for Remedial Action at the Site

Act/Authority	Criteria/Issue	Citation	Brief Description
Public Water Supply Regulations	State Drinking Water Regulations	Chapters 43.20 and 70.119A RCW, Chapter 246-290 WAC	Establishes MCLs for drinking water.
Safe Drinking Water Act	National Primary Drinking Water Regulations	42 USC 300f, 40 CFR 141	Establishes MCLs for drinking water.
Surface Water Quality Standards	State Ambient Water Quality Criteria	Chapter 90.48 RCW, Chapter 173-201A WAC	Establishes water quality standards for protection of human health and for protection of aquatic life (for both acute and chronic exposure durations).
Clean Water Act/National Toxics Rule	Federal Ambient Water Quality Criteria	33 USC 1251, 40 CFR 131	Requires the establishment of guidelines and standards to control the discharge of pollutants to waters of the United States. Two kinds of water quality criteria are developed—one for protection of human health and one for protection of aquatic life. The federal recommended water quality criteria are published on EPA's website: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm.
Sediment Management Standards	State Sediment Quality Criteria	Chapters 90.48 and 70.105D RCW, Chapter 173-204 WAC	Establishes numerical standards for the protection of benthic invertebrates in marine sediments. Ecology adopted amendments to the SMS rule on February 22, 2013, including freshwater SCOs protective of aquatic organisms. The new freshwater standards include chemical criteria and provisions for overriding the chemical criteria using bioassay tests. The amendments also establish methodology for assessing risks to human health. The revised SMS criteria became effective on September 1, 2013.

Notes:
CFR = Code of Federal Regulations
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
RCW = Revised Code of Washington
SMS = Sediment Management Standard
USC = United States Code
WAC = Washington Administrative Code

Plate 8-2 Action- or Location-specific ARARs for Remedial Action at the Site

Remedial Activity	Act/Authority	Criteria/Issue	Citation	Brief Description
Soil and/or Waste Excavation, Upland Filling and Disposal	Washington Water Pollution Control Act	Protects surface water; establishes mitigation policy for aquatic resources	Chapter 90.48 RCW, Chapter 173-201A WAC	Exempt from procedural requirements under WAC 173-340-710(9)(b).
	Clean Water Act (§ 401 and 404)	Discharges of pollutants or placement of fill into navigable waters and wetlands	33 USC 1341 and 1344, 40 CFR Part 230	Regulates the placement of fill material in waters of the United States, including fill placement below ordinary high water elevation or within navigable waters or wetlands.
	NPDES	Discharge of pollutants to waters of the United States	40 CFR Part 122, Chapter 90.48 RCW, Chapter 173-226 WAC	Permitting system for discharging pollutants into waters of the United States.
	Washington Hazardous Waste Management Act	State equivalent of RCRA requirements for designating certain solid wastes as "dangerous waste"; governs and establishes regulations for hazardous waste TSDFs	Chapter 70.105 RCW, Chapter 173-303 WAC	A "contained-out" determination has been received from Ecology allowing groundwater in contact with SPL and residual carbon to be managed as solid waste. Any dangerous waste transported from the site must be managed in accordance with these regulations. See also WAC 173-340-710(9)(b).
	RCRA	Generation and transportation of hazardous waste and waste management activities at TSDFs; off-site land disposal considerations	42 USC 6921-22; 40 CFR Parts 260, 261, and 268; Chapter 70.105 RCW	See previous description—this is a delegated state program under the Washington Hazardous Waste Management Act.
	TSCA	Tracks industrial chemicals in the United States and regulates intrastate and interstate commerce	15 USC s/s 2601 et seq. [1976]	Regulates PCBs, asbestos, indoor radon gas, and lead-based paint.

Remedial Activity	Act/Authority	Criteria/Issue	Citation	Brief Description
	Washington Hydraulics Code	Protection of fish and aquatic resources	Chapters 75.20 and 77.55 RCW, Chapter 220-110 WAC	Exempt from procedural requirements of Chapter 75.20/77.55 under WAC 173-340-710(9)(b).
	SEPA	Consideration and analysis of environmental impacts of major proposed actions	Chapter 43.21C RCW, Chapter 197-11 WAC	Construction activities associated with implementing a MTCA CAP.
	Washington Shoreline Management Act	Requirements for developments within water areas of the state or within 200 feet of the shoreline (based on ordinary high water mark of the Columbia River)	Chapter 90.58 RCW, Chapter 173-16 WAC	Exempt from procedural requirements under WAC 173-340-710(9)(b). Drainage ditches built to control flooding, to drain lands, and controlled by mechanical pumps are not "naturally occurring" streams and are not shorelines of the state.
Other Remedial Activities	National Historic Preservation Act	Protection of cultural or historic sites	30 CFR 800	In conjunction with the federal permitting process, the federal agency must consult with the State Historic Preservation Office and the federal Advisory Council on Historic Preservation to determine if the project would affect cultural or historic sites on, or eligible for, the National Register of Historic Places.
	Endangered Species Act	Effects on listed endangered or threatened species	16 USC 1531 et seq., 50 CFR Part 17	Actions authorized, funded, or carried out by federal agencies may not jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats.
	Federal Clean Air Act; Washington Clean Air Act; SWCAA	Protects air quality	42 USC §7401 et seq., Chapter 70.94 RCW, Chapter 173-400 WAC	Regulates air emission discharges, including fugitive dust. Exempt from procedural requirements of Chapter 70.94 RCW under WAC 173-340-710(9)(b).

Remedial Activity	Act/Authority	Criteria/Issue	Citation	Brief Description
	Minimum Standards for Construction and Maintenance of Wells	Water well construction	Chapter 18.104 RCW, Chapter 173-160 WAC	Establishes minimum standards for the construction and decommissioning of all wells in the state of Washington.

Notes:
CAP = Cleanup Action Plan
CFR = Code of Federal Regulations
MTCA = Model Toxics Control Act
NPDES = National Pollutant Discharge Elimination System
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
SPL = spent potliner
SWCAA = Southwest Clean Air Agency
TSCA = Toxic Substances Control Act
TSDF = treatment, storage, and disposal facility
USC = United States Code
WAC = Washington Administrative Code

8.3.1 Federal Requirements

Potential federal requirements are specified in several statutes, codified in the USC, and regulations promulgated in the CFR, as discussed in the following subsection.

The **Safe Drinking Water Act** (42 USC 300f; 40 CFR 141) establishes MCLs for drinking water. MCLs are ARARs for establishing cleanup levels for groundwater and surface water designated for use as drinking water. Designated beneficial uses of the Columbia River include public domestic water supply, and the highest beneficial use of groundwater at the site is for potable use. Therefore, these standards are relevant and appropriate for use as cleanup standards at the site (see Section 8.4).

The **Clean Water Act** (CWA; 33 USC Section 1251 et seq.) requires the establishment of guidelines and standards to control the discharge of pollutants to waters of the United States. Section 304 of the CWA (33 USC 1314) requires EPA to publish water quality criteria, which are developed for the protection of human health and aquatic life. Federal water quality criteria are published as they are developed, and many of them are included in Quality Criteria for Water 1986, EPA 440/5-86-001, May 1, 1986 (51 FR 43665), commonly known as the “Gold Book.” Publications of additional criteria established since the Gold Book was printed are announced in the Federal Register. Federal water quality criteria are used by states, including Washington, to set water quality standards for surface water. These standards are relevant and appropriate for possible actions at the site. Federal water quality criteria (along with related state standards) have been incorporated into the cleanup standards summarized in Section 8.4.

- **Discharges of pollutants into navigable waters** are regulated under Sections 401 and 404 of the CWA (33 USC 1341 and 1344), 40 CFR Part 230 (Section 404(b)(1) guidelines), 33 CFR Parts 320 (general policies), 323 and 325 (permit requirements), and 328 (definition of waters of the United States). These requirements regulate the placement of fill material below the ordinary high water elevation of waters of the United States or the placement of fill in navigable waters or wetlands. Cleanup activities may include disturbance of lands designated as wetlands by USACE. The CWA Section 404 regulations are implemented by the USACE. CWA Section 401 requires a water quality certification, which in Washington is implemented by Ecology.

- A **NPDES Waste Discharge Permit** is required for discharge of pollutants to waters of the United States pursuant to Section 402 of the CWA. NPDES permits are obtained from Ecology.

The Resource Conservation and Recovery Act addresses the generation and transportation of hazardous waste and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a "cradle to grave" management and permitting system for hazardous wastes. RCRA regulates "solid wastes" that are hazardous because they may cause or significantly contribute to an increase in mortality or serious illness or that pose a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by Ecology through regulations promulgated under the state's Hazardous Waste Management Act (also known as Dangerous Waste Regulations), Chapter 173-303 WAC (see Section 8.3.2).

The **Toxic Substances Control Act** (TSCA; 15 USC s/s 2601 et seq. [1976]) enables the EPA to require manufacturers and processors of chemicals to test and report potential health and environment hazards of chemicals, which might create an unreasonable environmental or public health hazard. The EPA also has the power to track industrial chemicals in the United States and regulate intrastate and interstate commerce under this act. Chemicals that the EPA deems to be an unreasonable risk may be prohibited from use in the United States. TSCA specifically regulates PCBs (Title I Section 6 (e)), asbestos (Title II), indoor radon gas (Title III), and lead-based paint (Title IV). Additionally, TSCA regulations supplement other federal statues, such as RCRA.

The **National Historic Preservation Act** (36 CFR 800) requires that when proponents seek a federal approval, the responsible federal agency must consult with the State Historic Preservation Officer and the federal Advisory Council on Historic Preservation to determine if the project would affect cultural or historic sites on, or eligible for, the National Register of Historic Places.

The **Endangered Species Act** (16 USC 1536 (a) – (d); 50 CFR Part 402) Section 7(a) requires federal agencies to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species.

The **Clean Air Act** (42 USC §7401 et seq.) regulates emissions of pollutants to the air, including fugitive dust. Controls for emissions are implemented through federal, state, and local programs.

8.3.2 Washington State and Local Requirements

Potential state and local requirements are specified in several statutes, codified in the WAC and RCW, and discussed in the following subsection.

Public Water Supply Regulations (Chapters 43.20 and 70.119A RCW; Chapter 246-290 WAC) establish MCLs for groundwater and surface water designated for use as drinking water.

Sediment Management Standards (Chapters 90.48 and 70.105D RCW; Chapter 173-204 WAC) are numerical standards established by the state for the protection of benthic invertebrates in marine sediments. Ecology adopted amendments to the SMS rule on February 22, 2013, including freshwater SCOs protective of aquatic organisms. The new freshwater standards include chemical criteria and provisions for overriding the chemical criteria using bioassay tests. The amendments also establish methodology for assessing risks to human health. The revised SMS became effective on September 1, 2013.

The **Washington Water Pollution Control Act** (Chapter 90.48 RCW; Chapter 173-201A WAC) provides for the protection of surface water quality. Chapter 173-201A WAC establishes water quality standards for surface waters of the state. Consistent with the requirements of Chapter 90.48 RCW, Ecology issues a water quality certification for any activity that may result in a discharge to state water.

The **Washington Hazardous Waste Management Act** (Chapter 70.105 RCW) and regulations promulgated thereunder (Chapter 173-303 WAC) are the state equivalent of RCRA and its implementing regulations. Washington's regulations use somewhat different terminology and designate certain solid wastes as "dangerous waste." This act governs and establishes regulations for hazardous waste treatment, storage, transfer, and disposal facilities. Under this act, materials designated as hazardous waste must be monitored until they are properly disposed of or undergo a process to become non-dangerous waste. Hazardous waste transported from the site must be tracked, sampled, and monitored under the regulations developed.

The **Washington Hydraulics Code** (Chapters 75.20 and 77.55 RCW; Chapter 220-110 WAC) establishes regulations for the construction of hydraulic projects or performance of other work that will use, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state and sets forth procedures for obtaining a hydraulic project approval. MTCA cleanups are exempt from the procedural requirements of these chapters under WAC 173-340-710(9)(b).

The **State Environmental Policy Act** (SEPA; Chapter 43.21C RCW; Chapter 197-11 WAC) is intended to ensure that state and local government officials consider environmental values when making decisions. The SEPA process begins when an application for a permit is submitted to an agency or when an agency proposes to take some official action, such as implementing a MTCA Cleanup Action Plan (CAP). Prior to taking any action on a proposal, agencies must follow specific procedures to ensure that appropriate consideration has been given to the environment. The severity of potential environmental impacts associated with a project determines whether an Environmental Impact Statement is required.

The **Washington Shoreline Management Act** (Chapter 90.58 RCW; Chapter 173-16 WAC) and regulations promulgated therein establish requirements for substantial developments occurring within water areas of the state or within 200 feet of the shoreline. Cowlitz County has set forth requirements based on local considerations. MTCA cleanups are exempt from the procedural requirements of Chapter 90.58 RCW under WAC 173-340-710(9)(b).

The **Washington Clean Air Act** (Chapter 70.94 RCW) provides for the preservation, protection, and enhancement of air quality for current and future generations. This act regulates air emission discharges, including fugitive dust. MTCA cleanups are exempt from the procedural requirements of Chapter 70.94 RCW under WAC 173-340-710(9)(b).

The **Minimum Standards for Construction and Maintenance of Wells** (Chapter 18.104 RCW; Chapter 173-160 WAC) establishes minimum standards for the construction and decommissioning of all wells in the state of Washington.

8.3.3 Potential ARARs for Caps to Be Considered in the Feasibility Study

Under state law, the requirements for closures involving caps apply to various types of wastes and landfills. WAC 173-340-710(7)(c) addresses this issue specifically.

Solid Waste Landfill Closure Requirements. Chapter 173-350 WAC provides minimum closure requirements for solid waste landfills created after its promulgation in 2003. Ecology may determine that the more stringent closure requirements in Chapters 173-351 or 173-303 WAC are relevant and appropriate to MTCA cleanup actions.

In general, current regulations that apply to newly created solid and dangerous waste units, including those specifically referenced in WAC 173-340-710(7)(c), do not apply to the site because placement of aluminum manufacturing process residuals ceased long before the applicable dates of the regulations. However, the regulations are considered even though they are not legally applicable to the site. The cap designs proposed for the site comply with WAC 173-340-710(7)(c) for the reasons subsequently discussed in this subsection.

Chapter 173-351 WAC applies only to new and existing municipal solid waste landfill units. These regulations specifically address design standards and closure requirements for municipal solid waste landfills. No municipal solid waste landfills are located at the site, and these regulations would not apply to the site based on dates of applicability.

Chapter 173-303 WAC is applicable to dangerous wastes managed after the effective dates of the regulations. With respect to cap design, these regulations are not applicable to

Landfill #1; Landfill #2; Landfill #3; and Fill Deposits A, B-1, B-2, and B-3. These areas were closed prior to the effective dates of the WAC 173-303 rules and associated waste listings. However, the Closed BMP Facility was closed under these regulations. Nonetheless, alternatives that consider off-site management of residual carbon would be developed consistent with provisions in WAC 173-303.

The Minimum Functional Standards for Solid Waste Handling (Chapter 173-304 WAC) were established in 1985, after closure of the fill deposits and Closed BMP Facility. Similarly, Chapter 173-350 WAC (promulgated in 2003) superseded Chapter 173-304 WAC for units created after its effective date, and its standards do not apply to units closed before 2003. Based on the dates of unit closures, these regulations are not applicable at the site. However, the provisions of the regulations in WAC 173-350 addressing cap design and evaluation for limited purpose landfills have been considered as ARARs in evaluating capping technologies for the two landfills and the fill deposits present on the site because the regulations address similar purposes, actions and activities, and media as those addressed by the cleanup action.

8.4 Area of Contamination Policy

Expectations for cleanup actions under WAC 173-340-370(5) include consolidation of hazardous substances that remain on site at concentrations that exceed cleanup levels "to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substance." On-site consolidation of residual carbon or spent lime in the fill deposits is included in select remedial alternatives developed in Section 10. Although residual carbon is classified as a listed dangerous waste if it is excavated and disposed of off site ("generated"), under EPA's Area of Contamination (AOC) policy, materials that would otherwise qualify as hazardous wastes may be moved within designated areas without triggering RCRA land disposal restrictions or minimum technology requirements. Although the AOC concept was initially discussed in the context of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program, it applies equally to RCRA corrective action sites, cleanups under state law, and voluntary cleanups.

EPA's AOC policy allows for certain broad AOCs to be considered RCRA landfills (EPA 1995). Certain discrete areas of generally dispersed contamination (AOCs) can be equated to a RCRA landfill, and movement of hazardous wastes within such areas is not considered land disposal and does not trigger the RCRA land disposal restrictions. The preamble to the National Contingency Plan (NCP; 55FR 8758-8760, March 8, 1990) also discusses using the concept of placement to determine which requirements might apply within an AOC. The concept of placement is important because placement of hazardous waste into a landfill or other land based unit is considered land disposal, which triggers the land disposal restrictions and may trigger other RCRA requirements, including permitting (at a non-CERCLA site), closure, and post-closure. In the NCP, EPA states "placement does not occur when waste is consolidated within an AOC, when it is treated in situ, or when it is left in place." Placement does occur, and additional RCRA requirements may be triggered when wastes are moved from one AOC to another (e.g., for consolidation) or when waste is actively managed (e.g., treated ex situ) within or outside the AOC and returned to the land.

Application of the AOC concept at the site is discussed in Section 10 in association with specific remedial alternatives that make use of this concept.

8.5 Cleanup Standards

A cleanup standard defines the point of compliance (POC) and concentration of a hazardous substance in media above which the impacted media may pose a risk to human health and the environment through a specified exposure pathway (i.e., the cleanup level). Ecology will select cleanup standards and points of compliance in the Cleanup Action Plan. This section evaluates applicable cleanup levels and POCs for purposes of evaluating cleanup alternatives.

8.5.1 Methodology

The MTCA Cleanup Regulations (Sections 173-340-720, -730, and -740 WAC) establish procedures to develop cleanup levels for surface water, groundwater, and soil. The MTCA Method A procedure is applicable to sites with relatively few hazardous substances and is applicable to the Former Reynolds Plant because fluoride is the primary COC in groundwater and there are obvious, reliable and proven remedial options for aluminum smelter sites. Cleanup levels based on this method are derived through selection of the most stringent concentration presented in the following sources:

- Concentrations listed in WAC Tables 173-720-1, -740-1, and -745-1 (for groundwater and soil)
- Concentrations established under ARARs
- Concentrations protective of the environment and surface water beneficial uses

Where numeric values were not available from these sources, Method C procedures were used to develop site-specific cleanup levels. MTCA Method C procedures employ a risk-based evaluation of potential human health and environmental exposures to site COCs and are applicable to all industrial sites. Therefore, cleanup levels for the Former Reynolds Plant are based on a combination of Method A and C procedures.

The Method C procedure also requires that a cleanup level for one medium must also be protective of the beneficial uses of other affected media. For example, site groundwater discharges into the CDID regional drainage ditches, which are periodically discharged into the Columbia River. Therefore, site-specific groundwater cleanup levels also considered surface water protection requirements. The procedures for developing cleanup levels for groundwater, surface water, and soil are outlined in the MTCA Cleanup Regulations, Sections 173-340-720, -730, and -740 WAC, respectively. Included in these sections are the specific rules for evaluating cross-media protectiveness. Where relevant to the site, cross-media protectiveness of cleanup levels is discussed in the following sections and incorporates the results of the fate and transport studies presented in previous sections of this report.

The SMSs establish procedures to develop cleanup levels for sediment.

8.5.2 Surface Water Cleanup Levels and Points of Compliance

In accordance with WAC 173-340-730, surface water cleanup levels must be at least as stringent as the criteria established under WAC 173-201A, Section 304 of the Federal CWA, and the National Toxics Rule (40 CFR Part 131). In addition, for surface water resources that may potentially be used as a drinking water source, criteria set forth in WAC 173-340-720 of MTCA must also be considered. As discussed in previous sections of this report, free cyanide and fluoride have been detected in groundwater adjacent to locations where groundwater discharges into the CDID regional drainage ditches. Free cyanide and fluoride have not been detected in Columbia River surface water adjacent to the site. For free cyanide, consistent numeric criteria are published in the state and federal regulations cited previously. These criteria are less than the state MCL (200 micrograms per liter [µg/L]) and are, therefore, also protective of drinking water resources. Applicable state and federal criteria do not include published numeric values for fluoride. The state and federal MCL for fluoride is 4 mg/L.

The POC for surface water cleanup levels is the point or points at which hazardous substances are released to surface waters of the state (WAC 173-340-730[6]). The CDID regional drainage ditches convey water from various locations within the cities of Kelso and Longview to the Columbia River to prevent flooding of the area. The water contained within the ditches is considered surface water of the state because it is released via permitted point discharges to the Columbia River. Although the CDID ditches themselves are not direct sources of drinking water, they are subject to the same surface water criteria as the river. The location where the reasonable maximum exposure associated with consumption of drinking water is the Columbia River; however, it is not practicable to monitor that location.

Therefore, a POC for surface water would be monitored in the CDID Ditch No. 14 water column at locations upgradient of the point of discharge to the Columbia River (i.e., the CDID pump station). It is important to note that establishment of a surface water monitoring station at the CDID ditch is more protective than monitoring at a POC located within the Columbia River because it provides a potentially more conservative measure of the conditions at the point of exposure. Surface water samples would be analyzed after filtering in accordance with the methodology established in WAC 173-201A applicable to free cyanide monitoring. In addition, because inert, non-bioavailable fluoride is abundant in the naturally formed soil, filtered samples are also appropriate to monitor fluoride concentrations in the surface water. Plate 8-3 summarizes the cleanup levels and POC for surface water.

Plate 8-3 Surface Water Cleanup Standards

Chemical of Potential Concern	Groundwater Cleanup Level	Protection Basis	Point of Compliance
Fluoride (dissolved)	4 mg/L	State Drinking Water MCL	Columbia River (measured upgradient in CDID Ditch No. 14)
Free Cyanide (dissolved)	5.2 µg/L	WAC 173-201A	

Notes:
µg/L = microgram per liter
CDID = Consolidated Diking Improvement District
MCL = maximum contaminant level
mg/L = milligram per liter
WAC = Washington Administrative Code

8.5.3 Groundwater Cleanup Levels and Points of Compliance

As previously discussed, future site uses will continue to be industrial; there are no plans to extract water for consumption from the shallow water-bearing layers, and existing water supply regulations effectively preclude this potential site exposure pathway within portions of the site. In addition, data collected during the RI indicates that the shallow water-bearing layers are isolated from the deeper production aquifer used for drinking water at the site. The City of Longview confirmed that impacted groundwater at the site will not impact the Mint Farm Wellfield installed in the deep aquifer primarily due to the presence of the silt/clay confining layer (Kennedy/Jenks Consultants 2012). However, consistent with MTCA, potential drinking water uses and surface water protection were considered in the initial development of groundwater cleanup levels. Because the site has few groundwater contaminants, Method A was used to develop cleanup levels for the site.

Final cleanup levels were selected as the most stringent values from the following sources:

- Method A WAC 173-720-1 table values
- Federal Drinking Water Standards and Health Advisories (EPA 2002)
- State Primary Drinking Water Regulations (Chapter 246-290 WAC).

For locations of the site where groundwater discharges to CDID drainage ditches, surface water criteria may also apply. As discussed in Section 6, fluoride is the primary COC for groundwater. The surface water cleanup level established in the previous section is based on the MCL; therefore, no adjustment to the initial groundwater cleanup level was necessary to protect surface water resources.

In accordance with WAC 173-720-7(C), natural background groundwater concentrations were considered when selecting screening levels (see Section 5.1) and cleanup levels. For example, naturally occurring arsenic has been observed at concentrations above MTCA Method A values and MCLs, 5 µg/L and 10 µg/L, respectively. Data available from the State Department of Health for Cowlitz County for the period 2001 to 2011 indicate an arsenic concentration range of up to 55 µg/L in groundwater. Per the guidelines in WAC 173-340-709(3), the 90th percentile of the background concentrations was calculated, and a screening level of 42 µg/L was established in Section 5.1. Site groundwater data were screened against this value, and no data were identified above the screening level; therefore, arsenic was not identified as a site COC, and no cleanup level is established in this section.

As defined in the MTCA regulations, the standard POC for groundwater extends from the uppermost level of the saturated zone to the lowest depth that could be potentially affected by site releases. For fluoride, it is anticipated that it would not be practicable[1] (as demonstrated in the disproportionate cost analysis [DCA] in Section 11) to meet groundwater cleanup levels throughout the site within a reasonable timeframe. According to WAC 173-340-720(8)(c), "Where it can be demonstrated under WAC 173-340-350 through 173-340-390 that it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame, Ecology may approve a conditional POC that shall be as close as practicable to the source of hazardous substances, and except as provided under (d) of this subsection, not to exceed the property boundary. Where a conditional POC is proposed, the person responsible for undertaking the cleanup action shall demonstrate that all practicable methods of treatment be used in the site cleanup."

As demonstrated in subsequent sections, the only alternative that could potentially achieve groundwater cleanup levels at the standard POC within a relatively short timeframe is Alternative 6, which consists of complete removal and off-site disposal of soil, landfill contents

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[1] Practicability is based on a determination that a more permanent cleanup action is not practicable based on the disproportionate cost analysis in WAC 173-340-360(3)(e).

and fill deposits with concentrations exceeding cleanup levels. However, as demonstrated in the DCA in Section 11, the costs are clearly disproportionate as little incremental environmental benefit (i.e., no additional protection) is achieved between Alternatives 5 and 6.

Based on this discussion and demonstrations in subsequent sections that it is not practicable to meet the standard POC in groundwater for fluoride, compliance with the fluoride groundwater cleanup level would be measured at conditional POC monitoring points located downgradient from the respective source areas prior to discharge to surface water, in accordance with WAC 173-340-720(8)(c). For all other constituents, compliance will be evaluated at wells located where remedial action occurs or adjacent to SUs. Plate 8-4 summarizes the cleanup levels and POC for groundwater.

Plate 8-4 Groundwater Cleanup Standards

Chemical of Potential Concern	Groundwater Cleanup Level	Protection Basis	Point of Compliance
Fluoride (dissolved)	4 mg/L	State Drinking Water MCL	Conditional POC at property line and Groundwater-Ditch Boundary
Free cyanide (dissolved)	200 µg/L	State Drinking Water MCL	Wells adjacent to applicable SUs
cPAHs	0.1 µg/L	MTCA Method A Standard Value	
TPH-Dx	500 µg/L	MTCA Method A Standard Value	
TPH-Ox	500 µg/L	MTCA Method A Standard Value	

Notes:
µg/L = microgram per liter
cPAH = carcinogenic polycyclic aromatic hydrocarbon
MCL = maximum contaminant level
mg/L = milligram per liter
MTCA = Model Toxics Control Act
POC = point of compliance
SU = site unit
TPH-Dx = total petroleum hydrocarbon – diesel range
TPH-Ox = total petroleum hydrocarbon – oil range

8.5.4 Soil Cleanup Levels

The site is zoned for industrial use, and there are no current or future plans to request a change in zoning; therefore, site operations meet the requirement of a “traditional industrial use” under the MTCA regulations (Section 173-340-745 WAC). Thus, industrial use is the appropriate basis for development of site-specific soil cleanup levels using MTCA Method A and C procedures. Soil cleanup levels were developed for fluoride, PAHs, TPH, and PCBs by considering the following potential exposure/risk pathways:

- Human health protection from direct soil contact
- Human health protection from soil-to-groundwater pathway exposure
- Human health protection from soil-to-air pathway exposure
- Terrestrial ecological protection

The final cleanup levels for site soils are summarized in Plate 8-5. Development of these cleanup levels is discussed in the following sections by pathway.

Plate 8-5 Soil Cleanup Levels

Chemical of Potential Concern	Soil Cleanup Level	Protection Basis
Fluoride[1]	210,000 mg/kg[1]	Method C
PAHs[2]	18 mg/kg	Method C
PCBs	10 mg/kg	Method A[3]
TPH Diesel Range	2,000 mg/kg	Method A
TPH Heavy Oil Range	2,000 mg/kg	Method A
TPH Mineral Oil	4,000 mg/kg	Method A
HTM Oil	10,000 mg/kg	Protective of Groundwater, Direct Contact, Soil Vapor, and Residual Saturation[4]

Notes:
1 = This cleanup level provides protection against direct-contact exposures for industrial workers. Refer to Section 8.5.4.2 for a discussion of groundwater protection. Described in that section, values protective of groundwater were determined to be 83,900 mg/kg for materials enriched with calcium or 3,100 mg/kg for other materials containing elevated fluoride.
2 = Cleanup level developed for potentially carcinogenic PAHs based on the approved MTCA TEF procedure.
3 = This is a total value for all PCBs. This value may be used only if the PCB contaminated soils are capped and the cap is maintained as required by 40 CFR 761.61. If this condition cannot be met, the value for unrestricted site use (1 mg/kg) must be used.
4 = As presented in Section 8.5.4, the soil to air pathway resulted in the most conservative cleanup level for HTM Oil. Therefore 10,000 mg/kg is selected as the soil cleanup level.
HTM = heat transfer media
mg/kg = milligram per kilogram
MTCA = Model Toxics Control Act
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
TEF = Toxicity Equivalency Factor
TPH = total petroleum hydrocarbon

8.5.4.1 Direct Soil Contact Pathway Exposure

Future development plans at the site include grading of the existing site with a minimum of 12 inches of clean fill and asphalt pavement; therefore, direct contact exposures to soil will be minimized. The primary potential pathway for direct contact would occur during earthwork operations and other activities required for site development. Accordingly, cleanup levels were initially derived using Method C WAC Equations 173-340-745-1, -745-2, and -745-3 for non-carcinogenic, carcinogenic, and petroleum COCs, respectively. No modifications were made to the standard parameters for these equations. However, because the TSCA regulation for PCBs lists more restrictive cleanup levels than those derived under Method C, the initial PCB cleanup level was adjusted downward from 66 to 10 mg/kg. This value is also consistent with the Method A concentration for Industrial Use scenarios.

8.5.4.2 Soil-to-Groundwater Pathway Exposure

Cleanup levels based on Method C direct contact must also consider the protection of groundwater resources. However, when empirical data exists that indicates that current groundwater impacts are not occurring and sufficient time has elapsed for migration from source areas to the point of measurement to reinforce that demonstration, then cleanup levels derived for direct contact would not require adjustment. Under some remedial scenarios and in some parts of the site, groundwater resource protection may be achieved by other means (e.g., groundwater remediation measures).

Section 5 discusses the groundwater monitoring performed to date. For cPAHs, concentrations were observed below 0.1 µg/L (Method A groundwater cleanup level for cPAHs), and source control work is planned in SU9 and SU11 to remove impacted soils above MTCA Method C Industrial cleanup levels to limit direct contact exposures. Concentrations of PAHs in groundwater have been observed slightly above 0.1 µg/L in wells PZ-1 and PZ-4 at SU3 and in well G2-D in the East Groundwater Area; however, concentrations at SU3 have reduced significantly since 2006 when cPAH concentrations were observed up to 1 µg/L in some wells. Therefore, the PAH soil cleanup level was not adjusted downward for protection of groundwater resources for these areas.

These source materials have percent level total fluoride concentrations (i.e., 2 to 7 percent); however, fluoride leachability is controlled by fluorite solubility. As discussed in Section 6.1 (summarized in Table 6.1), a range of K_d values was calculated for spent lime and residual carbon samples collected from Fill Deposits A, B-1, and B-3. While estimated K_d values range from 200 to 1640 L/kg, the fluoride leachate concentrations (18 to 94 mg/L) do not reflect the same level of variability as K_d values.

MTCA Equation 173-340-747-1 (the standard 3-phase partitioning model is presented subsequently) is the standard approach used by Ecology to determine soil constituent concentrations protective of groundwater resources. However, because the solubility of fluoride is limited by pH and the availability of other ions (such as calcium and phosphate), Equation 173-340-747-1 is not an accurate method for predicting the leachability of fluoride. For example, as discussed in Section 6.2, when a calcium source is mixed with groundwater containing dissolved fluoride under neutral pH conditions, fluoride will react with calcium to precipitate fluorite. After the reaction occurs—thus, reducing fluoride concentrations in groundwater, while increasing fluoride concentrations in soil—a new steady state is achieved, and the characteristic K_d value of the treated soil/groundwater matrix would be increased. Therefore, remedial alternatives that include in situ groundwater treatment are expected to result in increases of fluoride concentrations in soil and RELs based on simple K_d values would grossly under predict soil concentrations protective of groundwater resources. For this reason, adjustments to the fluoride soil cleanup level were not made based on a predicted soil concentration derived using Equation 173-340-747-1.

However, Equation 173-340-747-1 is a useful tool to evaluate order of magnitude source material and soil concentrations that would not adversely impact groundwater quality. Using an average K_d value of 1,049 L/kg, this equation results in a protective source material concentration of approximately 83,900 mg/kg. All source material located in the vadose zone at or below concentrations of 83,900 mg/kg would not be expected to result in exceedances of the groundwater cleanup level.

$$C_S = C_w(UCF)DF\left[K_d + \frac{(\theta_w + \theta_a H_{cc})}{\rho_b}\right] \tag{8-1}$$

where:

Variable		Value	Basis for Selection
C_S	Protective source material concentration (mg/kg)	83,900	Calculated
C_w	Groundwater cleanup level (µg/L)	4,000	Section 8.5.3
UCF	Unit conversion factor (1 mg/1,000 µg)	0.001	MTCA default value
DF	Dilution factor (unitless)	20	MTCA default value
K_d	Distribution coefficient (L/kg)	823	Site-specific[1]
θ_w	Water-filled soil porosity (mL water/mL soil)	0.3	MTCA default value
θ_a	Air-filled soil porosity (mL air/ml soil)	0.13	MTCA default value
H_{cc}	Henry's law constant (unitless)	0	MTCA default value
ρ_b	Dry soil bulk density (kg/L)	1.5	MTCA default value

1 = Refer to Table 6-1.
µg = microgram
kg = kilogram
L = liter
mL = milliliter
mg = milligram

In areas containing soil with elevated fluoride concentrations, but no residual carbon or spent lime (e.g., Landfills #1 and #3), the average calculated fluoride REL protective of groundwater is 3,100 mg/kg based on 2006 lysimeter data and 2007 SPLP data collected from Landfill #1 and the Former Stockpile Area, and an average K_d of 39 L/kg. Therefore an REL of 3,100 mg/kg fluoride in soil could be used as a conservative screening level to determine whether or not soil encountered/excavated as part of future industrial operations or redevelopment activities could be reused on site as fill. Alternatively, empirical data could be used to determine the protectiveness of reuse of soils with higher fluoride concentrations. It is important to note this value does not apply to calcium rich materials such as spent lime and residual carbon.

8.5.4.3 Soil-to-Air Pathway Exposure

For COCs that readily evaporate (such as diesel and solvents), the inhalation of vapors arising from impacted soil must be considered. Under Method C, the vapor pathway must be evaluated whenever a volatile substance is expected on site. On this site, diesel and oil range hydrocarbons are present; however, the pathway is considered incomplete whenever the TPH concentration is less than 10,000 mg/kg for diesel range constituents (see WAC 173-340-745(5)(iii)(C)(II)). For TPH (diesel and oil range), the pathway is considered incomplete when the existing concentrations are approximate to the cleanup level derived for protection of groundwater resources. The maximum TPH concentrations in SU9 and SU10 are less than 10,000 mg/kg. TPH cleanup levels for the site are protective of the soil-to-air pathway.

8.5.4.4 Terrestrial Ecological Protection

As part of a MTCA site RI/FS, Ecology requires a TEE to determine whether a release of hazardous substances to soil may pose a threat to the terrestrial environment through either a simplified or a site-specific TEE approach. Though the majority of the site area is covered by industrial infrastructure, landfills and fill deposits, the Former Reynolds Plant contains at least 10 acres of mixed native and invasive vegetation within 500 feet of areas where contamination is located, which triggered the need for a site-specific TEE in accordance with WAC 173-340-7490.

This section provides a summary of the site-specific TEE conducted using Ecology guidance (WAC 173-340-7493) and procedures provided via the TEE Interactive User's Guide (Ecology 2014); the detailed evaluation is provided as Appendix I-1. The site-specific TEE performed for the Former Reynolds Plant included the two key elements required under MTCA guidance: problem formulation and selection of evaluation method to characterize existing or potential threats to terrestrial plants or animals exposed to hazardous substances in soil. Per guidance, the problem formulation evaluated the site sources and history using existing site data to identify the issues to be addressed in the site-specific TEE, specifically the identification and toxicological assessment of chemicals of potential ecological concern (COPECs) and the development of a CSM as the basis for evaluating COPEC exposure to receptors of concern.

8.5.4.4.1 Problem Formulation

During the problem formulation step of the TEE, four COPECs (cyanide, fluoride, benzo(a)pyrene, and total PCB Aroclors) were identified through a conservative screening of all available soil data collected from 0 to 6 feet bgs at 147 locations across the site to ecological indicator concentrations (EICs). Because the site is industrial, under TEE guidance, only wildlife EICs were required. However, the screening also conservatively used other available EICs when wildlife EICs did not exist. COPECs benzo(a)pyrene and total PCB Aroclors were identified based on exceedances of wildlife EICs. Cyanide and fluoride were identified as COPECs using literature-based and plant EIC-based screening numbers, respectively. The problem formulation step concluded that further refinement of the evaluation of potential risk from exposure to cyanide and fluoride was a precautionary approach given the relative uncertainty in the use of screening values other than wildlife EICs. A site-specific TEE was therefore conducted to determine protective concentrations of fluoride and cyanide and to further characterize potential risk from exposure to benzo(a)pyrene and total PCB Aroclors using default TEE wildlife EICs.

8.5.4.4.2 Site-specific TEE

Several evaluation methods are available for application under site-specific TEE guidance to ensure that the goals of the ecological evaluation are fulfilled. Methods for conducting this site-specific TEE included a literature survey for cyanide and fluoride toxicity and bioaccumulation data and site-specific geochemical modeling to address fluoride bioaccessibility as well as further characterization of potential risks from benzo(a)pyrene and total PCB Aroclors. The site-specific TEE in Appendix I-1 describes the evaluation methods, details of the literature survey, the risk characterization, and the uncertainty evaluation.

For COPECs benzo(a)pyrene and total PCB Aroclors, potential risks were further characterized beyond the conservative screening conducted in the problem formulation step by determining the overall exposure concentration to wildlife foraging the site through calculation of a 95% upper confidence limit (UCL) using available soil data and comparison to default TEE wildlife EICs.

The literature survey was used to identify toxicity and bioaccumulation data needed to calculate protective fluoride and cyanide soil concentrations based on the TEE wildlife exposure models used to develop the wildlife EICs. The survey was conducted to locate applicable toxicity data for mammalian (short-tailed shrew and meadow vole) and avian (American robin) receptors, earthworm bioaccumulation factor values, and a plant uptake coefficient. These values were developed using sources including those used in TEE guidance for other chemicals, incorporating values from multiple studies for most parameters and including an evaluation of variability in the available earthworm bioaccumulation factors for fluoride. Additionally, for fluoride, the calculation of a protective soil concentration was also modified based on geochemical modeling taking into account the finite solubility of calcium fluoride given: 1) the chemical nature of site soils limiting dissolved fluoride and 2) fluoride being predominantly present in mineral forms that are unlikely to be bioaccessible or toxic to terrestrial biota. The geochemical model results were applied in the default TEE equations for both incidental soil ingestion and earthworm content to calculate fluoride wildlife protective concentrations in soil.

Protective soil concentrations of COPECs cyanide and fluoride were then calculated for the shrew, vole, and robin using these derived input values, and the lowest of the three receptors were compared to site soil data.

The site-specific TEE concluded that cyanide and fluoride are unlikely to pose a risk to terrestrial wildlife at the site. Cyanide concentrations in all site soil samples were below the calculated protective concentration. Fluoride concentrations in site soils exceeded the calculated protective concentration in areas of the site that are designated as remediation SUs. Outside of the designated SUs, only two samples in the U-Ditch area exceeded the protective fluoride soil concentration. The U-Ditch area 95% UCL is less than the protective soil fluoride concentration.

The site-specific TEE concluded that benzo(a)pyrene and total PCB Aroclors are also unlikely to pose a risk to terrestrial wildlife at the site. Benzo(a)pyrene and total PCB Aroclor concentrations in site soils exceeded the EICs only in areas of the site that have been designated as remediation SUs. When considered on a site-wide basis, the 95% UCLs for these chemicals are less than their respective protective concentrations. Therefore, soil cleanup levels were not further adjusted to protect terrestrial ecological resources.

8.5.4.5 *Soil Point of Compliance*

The standard POC for direct contact with soils extends from the ground surface throughout the site to 15 feet bgs (see WAC 173-340-740(6)(d)).

As set forth in WAC 173-340-740(6)(f), for MTCA cleanup actions that involve containment of hazardous substances, soil cleanup levels will typically not be met at the standard POC in soils shallower than 15 feet bgs. In these cases, the cleanup action consisting of engineered caps may be determined to comply with cleanup standards, provided that the following applies:

- The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360 (see Section 10).
- The cleanup action is protective of human health and the environment.
- The cleanup action is demonstrated to be protective of terrestrial ecological receptors.
- Institutional controls are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system (see Section 10).
- Compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system (see Section 10).
- The types, levels, and amount of hazardous substances remaining on site and the measures that will be used to prevent migration and contact with those substances are specified in the draft CAP.

8.5.5 Sediment Cleanup Standards

Under SMS, cleanup standards are developed based on protection of human health, higher trophic level species, and the benthic community.

Appendix I-2 performs the human health risk screening of sediment data for the site, finding that average concentrations in the study area are below the applicable risk-based threshold concentrations for all bioaccumulative chemicals (e.g., cPAHs and PCBs). Therefore, sediments are protective of human health at baseline conditions and cleanup standards were not developed for protection of human health. Similarly, cleanup standards were not developed for higher trophic level species because sediments are below applicable risk-based threshold concentrations at baseline conditions.

Cleanup standards were developed for the benthic community based on the chemical and biological (i.e., bioassay) criteria in WAC 173-204-563. WAC 173-204-563 provides two levels for potential use as cleanup standards for each contaminant: the SCO and the CSL. The SCO is set at a concentration at which no adverse effects have been shown to occur, including no acute or chronic adverse effects on biological resources. The CSL is a minor adverse effects level, which is the minimum level to be achieved in SMS cleanup actions. The more stringent SCO criteria were selected as cleanup levels for the site. The cleanup levels are applied to the biologically active zone, which is the upper 10 cm of sediment.

The area of impacted sediment is developed by considering both chemical criteria and bioassays, with bioassay criteria overriding chemical criteria. In addition, the presence of sheen in subsurface sediment is also considered in determining the area requiring remediation. However, the presence of sheen is not considered a cleanup level, per se.

9 SCREENING OF CLEANUP TECHNOLOGIES

As described in the introductory sections, the Former Reynolds Plant was used for aluminum smelting throughout its operational history. The aluminum smelting process, raw materials, and byproducts are well understood and documented. Many former aluminum smelter sites have been cleaned up in the United States and worldwide; Alcoa has performed similar cleanups at two former aluminum smelters in Washington and Oregon, as well as a facility still in operation in Ferndale and various cleanups in the United States, some currently in progress. Therefore, there is a wealth of experience from similar facilities that can be applied to determine the best cleanup approach at this site. Because the COCs are similar at aluminum smelter sites and because byproducts from the manufacturing process were typically deposited on site in large volumes, remedial technologies applied to the cleanup of former aluminum smelters are also well understood. On-site containment of residual carbon, spent lime, and construction debris is typically a component of cleanup at these sites because the materials are not very toxic, and containment technologies are effective in eliminating exposure to potential receptors and preventing migration of COCs. However, there are site-specific factors that must be considered in the cleanup of any site, including hydrogeology, geochemistry, physical setting, potential exposures, and receptors. This section evaluates cleanup technologies for the upland portions/media (groundwater, soil, and residual carbon) following MTCA guidance and in consideration of site-specific factors for possible implementation at the site. Potentially applicable technologies are identified and retained for assembly of site-specific alternatives in Section 10. Sediment cleanup technologies are evaluated separately in Appendix J.

Cleanup technologies are typically organized under General Response Actions that represent different conceptual approaches to remediation. The following six general response actions have been identified for the site:

- Institutional Controls
- Monitored Natural Attenuation
- In Situ Containment
- In Situ Treatment
- Removal with On-site Consolidation/Containment or Off-site Disposal
- Ex Situ Treatment

Technology screening begins by identifying available technologies that will not address site COCs or are not able to be implemented for technical reasons. These technologies are eliminated at this initial screening stage. Retained technologies are evaluated further and for each affected medium (soil, residual soil media, and groundwater). Cleanup technologies under the same general response action are evaluated relative to one another on the basis of the following three criteria:

- **Effectiveness.** The effectiveness criterion evaluates the technology for its protectiveness and reduction in chemical toxicity, mobility, or volume. Both short-term and long-term effectiveness are evaluated. Short-term effectiveness addresses the construction and implementation periods. Long-term effectiveness evaluates the technology after the action is in place.
- **Implementability.** The implementability criterion evaluates the technology for technical and administrative feasibility. Technical feasibility refers to the ability to construct, operate, maintain, and monitor the action during and after construction and meet technology-specific regulation during construction. Administrative feasibility refers to the ability to obtain permits for off-site actions and availability of specific equipment and technical specialists.
- **Cost.** The cost criterion is used to compare different technologies. In most cases, the full cost of a given technology cannot be determined at this screening level; however, typical technology costs obtained from vendors, cost-estimating guides, prior projects, and engineering judgment are used to determine the relative cost of a technology compared with similar technologies.

9.1 Institutional Controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with a cleanup action or result in exposure to hazardous substances. They may be physical restrictions, such as fences, or legal restrictions, such as use limitations recorded on the property deed.

Potentially applicable institutional controls include the following:

- Fences and warning signs to limit access to the site or specific areas on the site
- Deed restrictions addressing land use and soil excavation

- Deed restrictions to preclude drinking water use
- Use restrictions and monitoring requirements to prevent disturbance of caps or other engineered controls

All of these institutional controls are potentially effective at preventing exposure to hazardous substances, are easy to implement, and can be implemented at relatively low costs. Therefore, they have been retained for further consideration.

9.2 Natural Attenuation

Natural attenuation is the reduction in concentrations of COCs in soil, groundwater, and surface water through a combination of naturally occurring physical, chemical, and biological processes.

As a general response action, monitored natural attenuation provides data to document the presence and effectiveness of natural processes removing or containing site COCs. Measures to enhance natural processes are considered under the In Situ Treatment general response action. Natural attenuation is an important mechanism affecting contaminant fate and transport under any cleanup action involving contaminant mass left in place. Furthermore, the results of the groundwater fate and transport study presented in Section 6 indicate that natural attenuation processes are occurring and have effectively arrested movement of the groundwater fluoride plumes and are expected to do so for the foreseeable future. Residual groundwater impacts will persist upon waste and affected media removal due to the low permeability nature of the shallow aquifer materials and natural geochemistry. Enhanced natural attenuation, such as the addition of reactive materials to standard excavation backfill, may also be effective and is discussed in Section 9.4.2. As a stand-alone technology, monitored natural attenuation is highly implementable and cost effective. Therefore, monitoring of natural attenuation was carried forward for more detailed analysis in this FS.

9.3 In Situ Containment

In situ containment involves confining hazardous substances in situ through placement of physical or hydraulic barriers. Containment technologies are designed to prevent contact with and migration of the hazardous substances. Use of in situ containment technologies typically results in minimal short-term releases of hazardous substances during construction and can provide a relatively lower, cost effective method of reducing the potential for exposure.

Hydraulic controls can be effective methods for preventing the expansion of groundwater plumes. This technology is often paired with a treatment system designed to reduce COC concentrations in the extracted groundwater. Accordingly, the effectiveness and implementability of hydraulic controls are discussed in Section 9.5.4. The remainder of this section discusses various physical barriers (i.e., covers and caps) that may be effective to:

- Reduce the potential for direct contact exposure to COCs
- Reduce the potential for COC-impacted solid media to migrate beyond source areas
- Reduce the potential for COCs to migrate from solid media to groundwater

9.3.1 Physical Barriers

When properly designed for site-specific conditions, physical barriers are effective and reliable methods for preventing direct contact exposures and migration or erosion of impacted solid media. Long-term physical barrier integrity can be ensured through implementation of appropriate institutional controls and routine inspection and maintenance. The ability of a physical barrier to reduce the potential for groundwater impacts is dependent on the design of the barrier—the main purpose being the infiltration reduction of surface water through the isolated media. This is achieved through a balance of surface water conveyance (i.e., runoff) at the top of the barrier, water percolation or evaporation within the barrier, lateral water conveyance (i.e., drainage) within the barrier, and infiltration retardation (i.e., permeability reduction) at the base of the barrier. To evaluate the effectiveness of a range of physical barrier process options, a preliminary quantitative analysis was performed to evaluate the relative performance of the following three process options described below and shown on Figure 9-1:

- **Soil Cover.** Soil covers typically consist of a layer of clean soil overlain by a vegetative layer to prevent erosion and promote runoff of rain water from the top of the cover. They also prevent exposure to underlying soils. The primary cover layer prevents direct contact exposure to underlying impacted solid media and can be designed to reduce or promote infiltration. When designed to promote infiltration, the cover material is specified to allow infiltrating rainwater to drain away from the fill area to points where it can be captured and conveyed away from the impacted solid media. The soil cover included in the performance evaluation includes a 6-inch vegetation layer and an 18-inch sandy soil layer that work together to convey water away from the fill deposit or landfill. In areas where a more durable surface is preferred, the vegetative layer could be replaced with structural fill (e.g., compacted gravel).

- **Low-permeability Soil Cap.** Caps constructed of low-permeability soil, such as compacted sandy clay, prevent exposure to underlying soils and reduce surface water infiltration through contaminated materials by retarding the flow of water below the main barrier layer. They also reduce the mobility of contaminants located in the unsaturated soil zone and control erosion of contaminated material. The cap included in the performance evaluation includes a 12-inch vegetation layer and a 12-inch moderately compacted, low-permeability soil layer. To further enhance cap performance, a geocomposite drainage layer was modeled between the vegetative and barrier layers. Alternatively, semipermeable engineered materials (e.g., asphalt or soil-cement mixtures) or structural fill (e.g., compacted gravel) could also be used in areas requiring a durable surface, such as high-traffic areas in lieu of the vegetative layer. The replacement of the vegetative layer with such engineered materials would increase the conveyance of surface water away from the cap, thus increasing the overall performance of the cap if implemented.
- **Composite Cap.** A composite cap is constructed of various layers of soil and engineered materials, such as flexible membrane liners, geonets, or geosynthetic clay liners. The additional impermeable layer prevents infiltration to underlying soils from occurring as well as prevents direct exposure and controls erosion. This type of cap is the typical design employed in new landfill construction, which could be considered a more protective option under certain site conditions but is also a more expensive alternative. For the purposes of the comparative performance analysis, a standard multi-component cap, as shown on Figure 9-1, was included.

The quantitative analysis was performed using the Hydrologic Evaluation of Landfill Performance (HELP) model. Developed by the U.S. Army Engineer Waterways Experiment Station, the HELP computer program is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills (Schroeder et al. 1994). It accepts weather, soil, and design data and uses solution techniques to calculate items such as runoff volume (which is a function of material and slope), material permeability (*k*; saturated and unsaturated), and evaporation rate. Landfill systems with various types of designs may be modeled. The primary purpose of the model is to assist in the comparison of landfill design alternatives.

The HELP weather generator module was used to simulate two categories of rainfall events: 1) annual accumulations simulated over a theoretical 100-year period, and 2) during the 25-year, 24-hour design return period event. For both approaches, precipitation data from the nearest representative observation location (Longview, Washington) was input to the HELP model to develop a rainfall record. The standard simulation was then manually modified to include the 25-year, 24-hour precipitation event that is included in WAC 173-303-665 as design criteria.[2] This type of event is predicted to occur once every 25 years on average; in any given year, the probability of occurrence is 4 percent. Details of the analyses, including input parameters and graphics of results, are summarized in Appendix K.

Plate 9-1 summarizes the total rainfall and average predicted leakage for the existing site conditions (i.e., base case) and the three cap types during the 25-year return period event and over one year; calculated values include those on the day of the event and during the subsequent 5 days. The results determined that infiltration reductions of at least 11 and 37 percent could be achieved over the average annual accumulation period and during the 25-year event, respectively, for the soil cover. The low-permeability cap would be expected to reduce infiltration by at least 80 and 95% over the average annual accumulation period and during the 25-year event, respectively. The composite cap would expect to reduce infiltration by at least 99 percent for either precipitation event. As discussed in Section 6.5.2, infiltration reductions of 0, 50, and 100 percent were simulated with the groundwater model. The results indicated that the fate and transport of fluoride is not significantly affected by the reduction in infiltration. As a result, it is expected that a soil cover will perform as sufficiently as a low-permeability soil cap or composite cap to achieve an infiltration

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[2] The 25-year, 24-hour precipitation event was calculated from "Precipitation Intensity Cells for Washington State" available from the Oregon Climate Service as Geographic Information System shapefiles (Washington State Department of Transportation 2013). Cells overlaying the project site were queried using ArcView.

reduction that would prevent long-term migration of fluoride-impacted groundwater. However, the soil cap does not reduce infiltration to the maximum extent practicable as required by the ARARs applicable to cap design.

Capping costs vary with the design of the cap. Costs are associated with cap design, construction, institutional controls, and long-term monitoring. Low-permeability soil caps are more costly than soil covers, but the added protection may be appropriate under some conditions to reduce infiltration. Therefore, both of the soil cover and low-permeability soil cap technologies have been retained for further consideration of impacted soil containment. Composite caps are significantly more expensive to construct and maintain and do not provide an incremental benefit over the other physical barriers considered. Therefore, composite caps have not been retained for further consideration.

9.3.2 Site-specific Conditions

Site-specific conditions that warrant additional consideration when evaluating in situ containment technologies and designing landfill covers include potential seismic and flood hazards. Each of these potential hazards, and how they have been considered in this FS, is discussed as follows.

Much of the state of Washington, including Longview, is designated as a seismic impact zone by the United States Geological Survey. Seismic impact zones are defined as areas in which there is at least a 10 percent probability that horizontal seismic accelerations equal to or greater than 0.1 g (acceleration of gravity at the earth's surface) will occur within a 250-year period. In general, relatively flat earth structures, such as the landfills and fill deposits present at the site, are resistant to seismic motions and will move together with the surrounding ground in the event of an earthquake. Nonetheless, federal and state regulations require seismic analysis, based on a relatively severe earthquake event, for the design of landfill cover systems. For example, a slope stability and deformation analysis would be performed as part of the engineering design to verify that the cover system would remain serviceable after a 1 in 2,500-year seismic event and that the range of material displacement would be considered repairable and the costs associated with such maintenance acceptable over a given occurrence interval.

As discussed in Section 4.2.1, the Columbia River is located along the southern side of the Former Reynolds Plant. A CDID flood control levee is located along the shoreline, and protects the site from exposure to high current velocities (e.g., greater than 1 foot per second) during flood events that could cause scour or erosion of the landfills and fill deposits. Along the Former Reynolds Plant, the height of the levee averages approximately 32 feet above MSL, which protects the site from flood events with recurrence intervals of greater than 500 years. Based on the topography of the site, under extreme flood conditions, water could enter the site from the river at the downgradient end of the site around the levee and create a "backwater" condition in the upland portion of the site behind the levee. In this situation, fill deposits and landfills could be saturated for a relatively short time period, but the current velocities would not be sufficient to scour the engineered covers or ground surface. As demonstrated by the fate and transport analysis in Section 6, fluoride migration in groundwater is controlled at the site by the natural geochemistry, even in deposits that are in contact with groundwater. Therefore, short-term conditions whereby fill deposits and landfills are saturated do not pose any additional potential risk of contaminant migration.

Plate 9-1 Summary of Preliminary Physical Barrier Performance Evaluation

Model Run	Annual Summary Over a Theoretical 100-year Period		25-year Design Return Period Event	
	Average Rainfall or Estimated Infiltration (inches)	Percent Reduction in Infiltration from Base Case	Rainfall or Estimated Infiltration (inches) During Storm Event[1,2]	Percent Reduction in Infiltration from Base Case
Rainfall generated during storm event	36.25	N/A	4.22	N/A
Base Case – no change from current site conditions	23.29	N/A	3.424	N/A
Soil Cover	20.80	11%	2.170	37%
Low-permeability Cap	4.67	80%	0.184	95%
Composite Cap	0.08	Approximately 100%	2.27E-03	Approximately 100%

Notes:

1= The 25-year return period storm event represents a very high-intensity storm that is the standard for which new landfills are designed to consider.

2 = Value presented represents the 6-day accumulation of rainfall or simulated infiltration after the initiation of the storm event.

N/A = not-applicable

9.4 In Situ Treatment

A common approach to site remediation is the application of in situ technologies that address subsurface impacts without removing large volumes of impacted materials. In situ treatment technologies can potentially reduce the concentration, mobility, and toxicity of COCs. They can also minimize potential releases of hazardous substances and the amount of waste generated. The disadvantage of many in situ treatment technologies is that their effectiveness can be limited by subsurface conditions that create inefficiencies in treatment processes. In situ treatment can be applied to both soil and groundwater. In general, if source material is removed, in situ treatment can be applied to address residual groundwater impacts. In situ treatments relevant for this project include direct injection of chemical reagents to stabilize or solidify soil, permeable reactive barriers (PRBs), and backfill amended with reactive agents.

9.4.1 In Situ Soil Treatment

Stabilization. Depending on in situ conditions, chemical reagents can be injected or mixed directly into a potential source area to address elevated soil and groundwater conditions. Ideally, the chemical reagents would react with the soil or the COCs in the groundwater to reduce the concentration of COCs or decrease their mobility. The effectiveness of this technology can be limited in heterogeneous and low-permeability soils or where there is extensive debris due to poor distribution of the reagents. Because the SUs tend to contain variable, low-permeability soils and solid media, and due to the uncertainty of stabilization effectiveness for complete fluoride treatment, this technology has not been retained for further consideration.

Solidification. Soil is stabilized by adding amendments to immobilize contaminants resulting in a low-permeability, subsurface mass. Potential amendments include pozzolans and cement. Amendments can be mixed with soil in situ. This treatment method does not destroy contaminants and often increases the volume of impacted material. Due to the additional volume generated by this technology and the typically higher cost of in situ stabilization compared to more reliable, ex situ methods, this technology has not been retained for consideration.

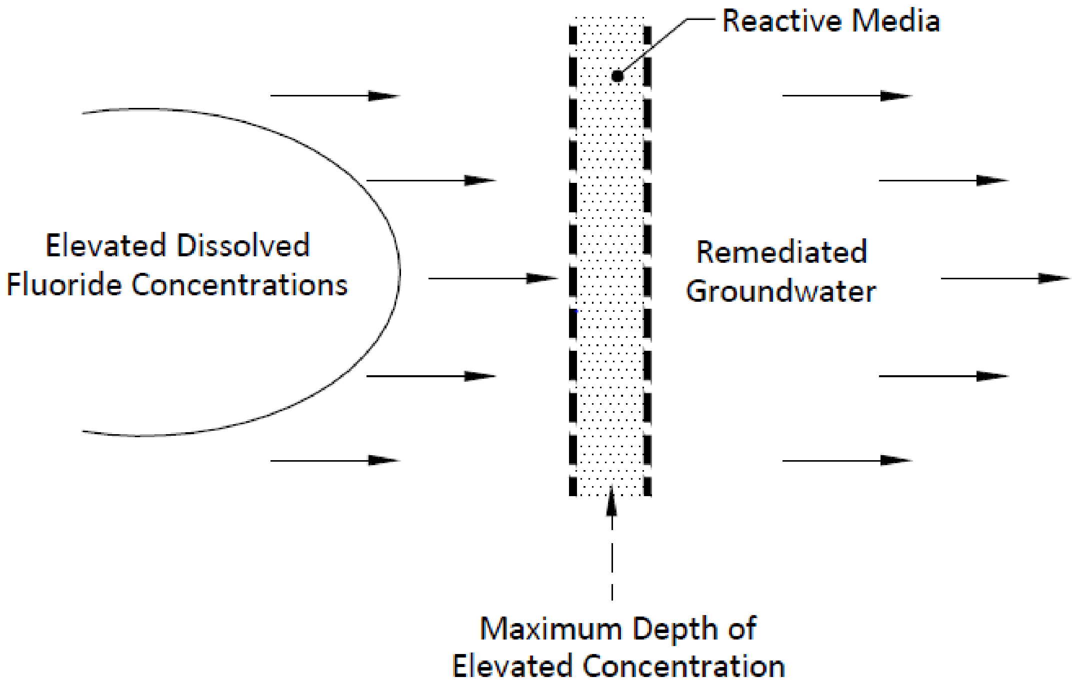
9.4.2 In Situ Groundwater Treatment

Permeable Reactive Barriers. A PRB is a "continuous, in situ permeable treatment zone designed to intercept and remediate a contaminant plume" (ITRC 2005). The general design is a vertical trench, perpendicular to movement of contaminated groundwater, which is backfilled with the selected reactive media (see Plate 9-2). Reactive media selection depends on the chemical(s) to be treated and site conditions. A PRB would require minimal maintenance and operational costs. This technology was retained for proven effectiveness, implementability, and relatively low cost. Effectiveness and implementability of this technology are discussed in greater detail in the following sections.

Soil Backfill Amendment. Areas excavated to a depth below the seasonal high water table may be backfilled with amended materials to promote long-term reduction of residual groundwater COC concentrations. The backfill would consist of typical soil backfill mixed on site with the same reactive agents used in the PRBs. The amended backfill would enhance natural attenuation processes and potentially reduce the groundwater restoration timeframe for the site. Amendment addition to the backfill is retained for consideration, as it would have minimal impact on cost and implementability of soil excavation and backfilling of excavated areas.

9.4.2.1 Literature-based PRB Implementation and Performance Summary

Scientific literature regarding fluoride treatment in drinking water, groundwater, and wastewater was reviewed to demonstrate the effectiveness and implementability of PRBs, as well as to identify the appropriate treatment media for application of PRBs to the site. The primary fluoride treatments identified include precipitation of fluorite (calcium fluoride) by addition of soluble calcium minerals; adsorption onto apatite (calcium phosphate mineral that can contain fluoride); adsorption of fluoride on multivalent metal oxides, especially alumina (aluminum oxide); and adsorption of fluoride onto clays and soils.



A PRB is a "continuous, in situ permeable treatment zone designed to intercept and remediate a contaminant plume" (ITRC 2005). The general design is a vertical trench, perpendicular to movement of contaminated groundwater, which is backfilled with selected reactive media. Reactive media selection depends on the chemical(s) to be treated and site conditions. For this Site, the reactive media would likely consist of gravel, crushed limestone, and bone meal for fluoride treatment. Bench scale testing would be performed during remedial design and prior to installation to finalize design details.

Plate 9-2

Schematic Illustration of Permeable Reactive Barrier Configuration (Elevation View)

Precipitation of the mineral fluorite (or other calcium/fluorine containing minerals such as brushite) by addition of soluble calcium minerals is effective for removal of high concentrations of fluoride from water. Addition of lime or calcium chloride is a common treatment method for industrial wastewaters with elevated fluoride concentrations but does not often achieve the desired final concentration. Adsorption onto apatite (rock phosphate, bone char, or bone meal) can remove fluoride from water to concentrations less than 1 mg/L; however, the limited amendment capacity limits this treatment to water with low initial fluoride concentrations. Adsorption onto alumina (aluminum oxide) and other multivalent metal oxides and hydroxides, can effectively remove high concentrations of fluoride and achieve final concentrations less than 1 mg/L. However, these treatments are only effective under acidic conditions, with optimal removal achieved in the pH range of 3 to 5. Adsorption to clays, zeolites, and soils may be effective at removing low levels of fluoride from groundwater and drinking water and has been observed to occur naturally at the site (see Section 7). The relevant studies are summarized in Appendix K.

9.4.2.2 PRB Conceptual Design

Based on the literature review summarized in the previous section, fluoride treatment PRB trenches would be backfilled with limestone, which consists of calcite ($CaCO_3$) that would dissolve in the groundwater as it flows through the PRB, increasing the calcium concentration in groundwater. Limestone is preferable to the more soluble calcium minerals (lime or calcium chloride), as the slower dissolution rate will ensure long-term performance of the PRB or amended backfill. If the remedial concentration goals for fluoride cannot be achieved through fluorite precipitation alone, bone meal may be incorporated into the PRB to remove the residual concentration. PRB amendment selection is discussed further in Appendix K. Bench scale testing would be performed during remedial design and prior to installation to finalize design details. A schematic illustration of PRB configuration is shown on Plate 9-2.

9.5 Removal and Ex Situ Treatment or Disposal

Removal of impacted soil and residual materials has been widely applied at remediation sites. Excavators, backhoes, and other conventional earth moving equipment are the most common equipment used to remove contaminated soil from upland areas. Below the water table, shoring and dewatering may be required. Removed impacted materials are treated and disposed of either on site or at an off-site permitted disposal facility. This general response action (where practicable) has the advantage of providing the greatest removal of contaminants from a site. The primary disadvantages include the potential for short-term releases of hazardous substances during removal operations and technical limitations to removing materials below the groundwater table, particularly near surface water bodies. Removal of impacted soil and sand media may not significantly reduce the restoration timeframe for groundwater. Additionally, this technology can become prohibitively expensive as material volumes increase and wastes, some potentially hazardous, are generated. Potentially applicable technologies for removal, ex situ treatment, and disposal of impacted media are presented in the following section.

9.5.1 Soil Removal Technologies

Impacted soils can be effectively removed by dry excavation or dredging (excavation below the groundwater elevation); however, some limitations exist, as noted in the following evaluation.

Dry Excavation. Excavators, backhoes, and other conventional earth-moving equipment are the most common equipment used to remove impacted soil and soil media from upland areas. Dry excavation of soil and soil media below the groundwater table may also be facilitated through the installation of temporary cofferdams or sheetpile walls and the subsequent lowering of the groundwater table. Dry excavation is a proven method; however, costs associated with dewatering and groundwater drawdown can be substantial, and dewatered fluids would require disposal or treatment prior to discharge. Therefore, dry excavation is only feasible for removal of soils above and just below the groundwater table.

Wet Excavation. Wet excavation is a method of excavation that allows the removal of soil and soil media below the groundwater table without the necessary dry conditions required of traditional methods. The major drawback of this method is that the excavated material has moisture contents up to 50 percent by volume. This material must be dewatered prior to transport for off-site disposal. Partial dewatering can also be accomplished by pumping overlying water into temporary containment prior to treatment and disposal. Costs associated with processing and disposal of this additional waste product can be high. Wet excavation is only feasible for limited areas where excavations are conducted at depths more than a few feet below the groundwater table.

9.5.2 Consolidation and Disposal

Excavated materials may either be disposed of directly or dewatered and then disposed. Disposal options for soil are described in the following paragraphs.

Beneficial Use of Residual Carbon. Excavated residual carbon has some commercial value and could be used beneficially for energy recovery if the appropriate approvals are granted by Ecology and EPA. At this time, however, this option has significant regulatory hurdles because once excavated and removed from the site, residual carbon is a listed hazardous waste. A recycling or energy recovery facility would have to be permitted as a hazardous waste TSDF or the operation would have to meet applicable requirements to be considered recycling. Due to these regulatory hurdles and the fact that a commercial market has not been identified for the material, beneficial use of residual carbon is not retained for remedial alternative development in Section 10. In the event a viable option to beneficially use this material becomes available, the Respondents will consult with Ecology and apply for the appropriate regulatory approvals.

On-site Consolidation. As discussed in Section 8.3, hazardous wastes may be moved within designated areas under the AOC policy without triggering RCRA land disposal restrictions or minimum technology requirements. Fill deposit materials, landfill materials and soil excavated in areas can be consolidated into one or more locations beneath covers or caps to minimize the potential for direct contact and migration of COCs to groundwater. On-site consolidation and containment is less costly than off-site landfill disposal but requires long-term, on-site management of impacted materials. The technology is cost-effective and reduces the overall footprint of impacted material. On-site consolidation is consistent with Ecology expectations in WAC 173-340-370(5) that when materials remain on site at concentrations in excess of cleanup levels, those materials shall be consolidated to the maximum extent practicable when needed to minimize the potential for direct contact and migration of COCs. Therefore, it is retained for use in alternative development in Section 10.

Off-site Landfill Disposal. Impacted materials from the site may be transported to an off-site, permitted disposal facility. This disposal method provides for secure, long-term containment of non-hazardous and hazardous solid wastes. While this can be cost prohibitive for larger volumes of material, the technology will be retained for further development in Section 10.

9.5.3 Ex Situ Soil Treatment

Because fluoride cannot be destroyed—only immobilized—screening of ex situ soil treatment technologies is focused on the treatment of organic COCs at the site, including PAHs and TPH.

Thermal Desorption. Low-temperature thermal desorption involves heating soils to temperatures between 200 and 600 degrees Fahrenheit until VOCs and SVOCs, such as benzene and naphthalene, evaporate. Exhaust gases produced by the process are typically combusted. This technology is generally effective for VOCs and SVOCs, achieving 90 to 99.7 percent destruction efficiencies for low-molecular-weight polycyclic aromatic hydrocarbons (LPAHs; EPA 1999), but is not effective for metals.

Thermal desorption systems can be designed to operate without producing liquid or solid secondary wastes, to meet clean air standards, and to achieve very low concentrations of residual constituents in soil. Limitations include high energy requirements for treating wet soils, difficulty in completely treating soils containing high levels of organics, and the need to obtain permits for treatment of off gas (typically via incineration) generated from an on-site thermal desorption system. Thermal desorption may be accomplished on site with a mobile treatment unit or off site at a permanent treatment facility; however, based on the relatively small volume of soils impacted with organic COCs at the site, on-site treatment would not be cost effective.

Compared to off-site landfill disposal, thermal desorption is typically more expensive than disposal at a Subtitle D (non-hazardous waste) landfill but has the advantage of providing contaminant treatment and destruction rather than containment. This technology is typically less expensive than disposal at a hazardous waste landfill (for medium to large quantities of soil). However, the water content of the waste material would result in high-energy requirements, and this technology is more expensive than other ex situ treatment options. Therefore, this technology has not been retained for further consideration.

Biological Treatment. Contaminant biodegradation by indigenous soil microbes can be enhanced by amending excavated soil with nutrients, moisture, and oxygen (typically provided by mixing). Process options for biological treatment include the following:

- **Landfarming/Composting.** Contaminated soil is spread out in a lined area and regularly tilled and amended with moisture and nutrients.
- **Biopiles.** Contaminated soil is amended with nutrients and stockpiled.

Ex situ biological treatment methods have limited effectiveness for high-molecular-weight polycyclic aromatic hydrocarbons (HPAHs), are slower than other treatment technologies, and require significant space to implement (EPA 1999). However, ex situ biological treatment has proven to be effective in treating low-mid molecular weight PAHs, as well as TPH, and space limitations are not an issue at this site. These technologies are effective for the organic COCs at the site with similar or lower costs than other treatment options. Therefore, ex situ bioremediation of site soils is retained for this FS for treatment of SU9.

9.5.4 Groundwater Pump and Treat Systems

Migration of contaminants dissolved in groundwater can be controlled by pumping groundwater from vertical wells or trenches, creating a capture zone within which groundwater flows toward the wells for extraction. The effectiveness of this technology to completely capture impacted groundwater is often limited at sites with heterogeneous soils and where fluoride mass removal is limited by solubility. Hydraulic containment of groundwater through pumping is also a proven technology, but potential groundwater extraction rates at the site are expected to be quite high because of the adjacent river and large impacted areas. Operational costs would also be very high due to the required number of extraction wells, large volume of water extracted, and required subsequent treatment prior to being discharged. For these reasons, groundwater pumping and treatment is not a practicable cleanup method at the site in lieu of other technologies that directly treat site COCs in situ. However, to document the rationale for not retaining this technology for development of cleanup alternatives in Section 10, implementability of this technology is evaluated in greater detail in the following sections.

9.5.4.1 Dewatering Scenario

One potential application of the groundwater pump-and-treat method at the site with the potential to meet a standard POC in groundwater is to fully dewater the fill deposits and landfills (i.e., fully depress groundwater levels to below the base of the deposits) to prevent groundwater contact with the materials that contain COCs. The implementability of this application of groundwater pump-and-treat was evaluated semi-quantitatively using the groundwater model (see Appendix H). A dewatering scenario was simulated to estimate groundwater extraction rates necessary to completely dewater the deposits and to determine the overall impacts to site hydrology.

In the model, well fields were represented by trenches surrounding the Fill deposit B-3 and Landfill #2 in the West Groundwater Area and surrounding Fill Deposits A, B-1 and B-2, Landfill #1 and the former stockpile area in the East Groundwater Area[3] (see Plate 9-3). The bottom elevations of the trenches were set to 3 feet below the elevation of the base of the deposits to maintain the water table below the depth of the deposits. Based on test pits excavated in the deposits/landfills, the average depth from ground surface elevation to native soil ranges from 6 to 15 feet. However, to ensure that groundwater levels would be maintained below the lowest potential elevation of residual materials, the trench elevation was set at -1 meter MSL or approximately 20 feet deep.

The analysis determined that: 1) 8 feet of drawdown would be needed; 2) the radius of influence of the extraction wells would be approximately 85 feet; and 3) approximately 80 to 100 wells spaced about 170 feet apart would be required. Installation of such a large number of wells and associated piping would be impractical. Moreover, extraction wells would need to be installed through the fill deposits to at least 30 feet bgs because installation of wells along the perimeter of the deposits would not have a sufficiently large radius of influence.

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[3] Trenches completely surrounding the deposits are not practicable or cost effective. Simulating them in the model, however, can be used to estimate well field extraction rates.

The average annual groundwater extraction rate predicted in this scenario was 360 gallons per minute (gpm); the wet season average extraction rate was 440 gpm. During peak flows, the rate would be higher. These extraction rates do not include groundwater flow to the internal ditches. In this scenario, half of the pumped water would come from the Columbia River based on its proximity (see groundwater contour map resulting from this simulation on Plate 9-3).

The average annual extraction rate to dewater deposits significantly exceeds the capacity of the existing treatment system. Currently, Facility 71 treats leachate from two sources: the cryolite area ditches and the Closed BMP Facility. Compared to the capacity of Facility 71, extraction rates to dewater the landfill and deposits would exceed the system capacity of 80 gpm by a factor of five to six (at predicted average and wet season extraction rates, respectively). Therefore, a new, dedicated water treatment facility would be needed to implement this scenario, which would cost approximately $8 million.

Plate 9-3 Dewatering Scenario

Note: Groundwater elevations are given in meters (MSL). The contour interval is 0.3 meters.

In addition to the high flow rates relative to existing water treatment capacity, large infrastructure needs (wells, piping, controls, and a new, dedicated water treatment system), and the fact that half of the extracted water would originate from the Columbia River, additional factors that negatively impact the implementability of this technology include the following:

- Construction of an extraction system would be incompatible with an engineered cap, an option being considered in several areas for this site.
- This option would require close monitoring of system performance due to seasonal and tidal fluctuations in groundwater levels (see Section 4.4).
- This option is less sustainable than other groundwater treatment and containment technologies because it would rely on continuous resources and power.
- There would be no backup during power outages beyond monitored natural attenuation and the natural geochemical conditions, and any improvements to groundwater quality would be eliminated.
- Operations and maintenance requirements would be higher for the pumps, pipes, and controls than other groundwater treatment technologies under consideration.
- As demonstrated in Section 6, fluoride concentrations in groundwater are currently controlled by fluorite that has precipitated in the areas of impacted groundwater. Accordingly, a pump-and-treat system will not be efficient for fluoride mass removal because of the limited solubility.

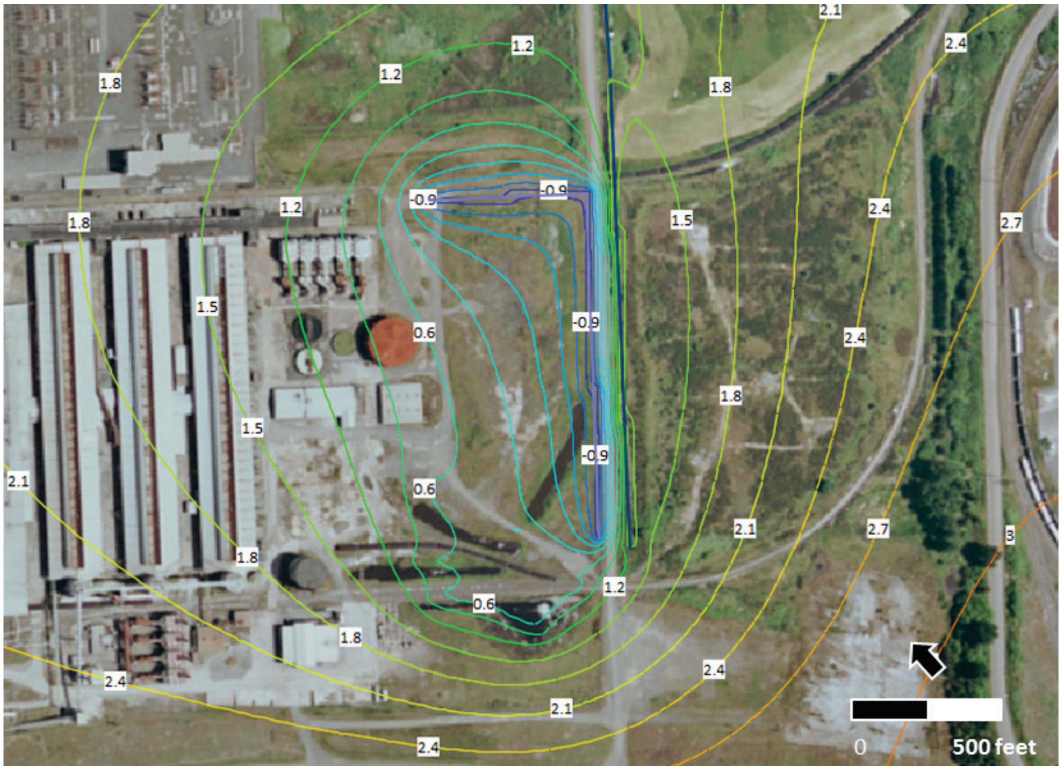
9.5.4.2 Containment Scenario

While Section 9.5.4.1 demonstrates that complete dewatering of the fill deposits and landfills deposits via groundwater pump-and-treat is impracticable, this section semi-quantitatively evaluates the implementability of groundwater pump-and-treat for hydraulic control or containment of a focused area at the site—Fill deposit B-2 (SU3). This section also compares order-of-magnitude costs for implementing a pump-and-treat system versus PRB technology to address this area.

Conceptually, to fully capture groundwater within SU3 and to prevent it from flowing into the internal stormwater ditch east of SU3 (the nearest discharge point), groundwater levels must be drawn down below the elevation of the bottom of the ditch. To determine extraction rates required to achieve this level of drawdown, a trench was simulated using the groundwater model as a surrogate for a row of extraction wells. The alignment for the trench extended 1,000 feet along the east and north sides of SU3, the same as the PRB alignment in Alternative 3 (see Section 10). The elevation of the bottom of the trench was set to -1 meter (MSL) to enable optimal dewatering of SU3, which would intercept groundwater that exceeds site cleanup levels.

In this scenario, the average annual groundwater extraction rate would be 110 gpm. The estimated average groundwater extraction rate during the wet season would be 135 gpm, and during the dry season it would be 60 gpm. These flows exceed the existing capacity to treat fluoride-impacted water on site by a factor of 1.6 during the wettest time of the year and comprise one-third to one-half of the extraction rates needed to dewater all mud and landfill deposits on site. Groundwater from the Fill Deposits A and B-1 east of the ditch would still flow into the ditch, as shown on the model-simulated groundwater potentiometric map (see Plate 9-4). Therefore, implementation of pump-and-treat for hydraulic control of the Fill Deposit B-2 would require a new, dedicated water treatment system.

Plate 9-4 Groundwater Pump-and-Treat Scenario for Fill Deposit B-2



Note: Groundwater elevations are given in meters (MSL). The contour interval is 0.3 meters.

In addition to a water treatment system, other infrastructure needed to implement pump-and-treat downgradient of Fill Deposit B-2 would include 27 groundwater extraction wells spaced at approximately 35 feet and installed to a depth of 30 feet, associated piping, controls and power supply. Costs to install a groundwater pump-and-treat system for Fill Deposit B-2 Area would cost approximately $2.5 million; present value of the operating costs is $1.5 million. These costs are disproportionately higher (five times the capital cost and eight times overall cost) than use of a PRB at this location for in situ groundwater treatment (approximate installation costs of $500,000 from Appendix L, Table L-1). Therefore, the groundwater pump-and-treat system is not a practicable cleanup method at the site in lieu of other technologies that directly treat site COCs in situ, and therefore has not been carried forward to alternatives development in Section 10.

9.6 Process Options for Development of Cleanup Alternatives

Plate 9-5 summarizes the technologies identified for screening, their effectiveness, implementability, cost, and whether or not they were retained for further consideration.

Based on the technology screening presented previously, the process options retained for further consideration in addressing each of the RAOs identified in Section 8 are summarized on Plate 9-6.

Plate 9-5 Preliminary Remedial Technology Screening

Medium	Response Action	Technology Identified for Screening	Applicability	Effective?	Implementable?	Cost	Retained for Further Consideration
Solid	Containment (Engineered Cap)	Soil Cover	All COCs	Yes	Yes	Low	Yes
		Low-permeability Cap	All COCs	Yes	Yes	Medium	Yes
		Composite Cap	All COCs	Yes	Yes	High	No
	In Situ Treatment	Stabilization	All COCs	Limited	Yes	High	No
		Solidification	All COCs	No	Yes	High	No
	Removal	Dry Excavation	All COCs	Yes	Yes	Medium	Yes[1]
		Wet Excavation	All COCs	Yes	Yes	High	Yes[2]
	Disposal	Beneficial Use of Residual Carbon	All COCs	Yes	No	Medium	No
		On-site Consolidation	All COCs	Yes	Yes	Low	Yes
		Commercial Landfill	All COCs	Yes	Yes	Med-High	Yes
	Ex Situ Treatment	Biological Treatment	Organic COCs	Yes	Yes	Low	Yes
		Thermal Treatment	Organic COCs	Yes	Yes	High	No
Aqueous	Containment	Hydraulic Controls	All COCs	Yes	No	High	No
	In Situ Treatment	Natural Attenuation	Fluoride	Yes	Yes	Low	Yes
		Permeable Reactive Barriers	Fluoride	Yes	Yes	Low	Yes
		Backfill Amended with Reactive Agents	Fluoride	Yes	Yes	Low	Yes
	Ex Situ Treatment	Pump-and-Treat	All COCs	Limited	No	High	No

Notes:

1 = Dry excavation is retained for removal of soils above or just below the groundwater table.

2 = Wet excavation is retained for limited areas where excavations are conducted at depths more than a few feet below the groundwater table.

COC = chemical of concern

Plate 9-6 Detailed Summary of Process Options

Response Action	Remedial Action Objective Addressed	Retained Technology	Process Option	Description
Institutional Controls	Direct contact	Proprietary controls (physical and legal restrictions of land/water use, access)	Security fencing for access	Fences and warning signs to control access to the site or specific areas on the site
			Deed restrictions	• Deed restrictions to address land use and soil excavation • Deed restrictions to preclude drinking water use • Use restrictions and monitoring requirements to prevent disturbance of caps or other engineered controls
Containment	• Direct contact • Migration to groundwater from solid media	Engineered capping	Soil cover	Maintain existing soil covers on fill/landfill deposits or enhancement with placement of clean soil on the surface
			Low-permeability cap	Upgrade of existing soil covers on select fill/landfill deposits with compacted sandy clay
In Situ Treatment	Groundwater migration	Physical, chemical, and biological	Monitored natural attenuation	Monitor to document the presence and effectiveness of natural processes removing or containing site COCs
		Chemical	Permeable reactive barriers	Selected reactive media is backfilled in a vertical trench, perpendicular to the movement of the contaminated groundwater
			Backfill amended with reactive agents	Mix typical soil backfill on site with the same reactive agents used in the PRBs
Ex Situ Treatment	• Direct contact • Migration to groundwater from solid media	Biological	Landfarming/composting	Contaminated soil is spread out in a lined area and regularly tilled and amended with moisture and nutrients
			Biopiling	Amend contaminated soil with nutrients and then stockpiled

Response Action	Remedial Action Objective Addressed	Retained Technology	Process Option	Description
Removal	• Direct contact • Migration to groundwater from solid media	Dry excavation	Excavators and backhoes	Remove soil and fill/landfill material above and just below the groundwater table, followed by an additional process[1]
		Wet excavation	Excavators and backhoes	Remove soil material below the groundwater table (dewatering is necessary), followed by an additional process[1]
Disposal	• Direct contact • Migration to groundwater from solid media	On-site disposal	On-site consolidation	Consolidate fill and landfill deposit materials and soil excavated in areas into one or more locations beneath covers or caps to minimize the potential for direct contact and migration of COCs to groundwater
		Off-site disposal	Commercial landfill	Transport impacted soils from the site to an off-site, permitted disposal facility

Notes:
1 = On-site consolidation, off-site disposal, or on-site biological treatment (organic COCs only) will be used after dry or wet excavation.
COC = chemical of concern
PRB = permeable reactive barrier
RAO = remedial action objective

10 DESCRIPTION OF CLEANUP ALTERNATIVES

The previous section describes potentially applicable remedial technologies and process options for the site and evaluates those technologies based on the MTCA criteria of relative effectiveness, implementability, and cost for application to the site. In this section, these retained technologies are combined to formulate a range of remedial action alternatives.

Numerous combinations of suitable cleanup technologies can be grouped to create alternatives to address the site COCs. The remedial alternatives have been limited to compatible cleanup technologies that are combined with the goal of protecting human health and the environment. The alternatives listed below include different combinations of natural attenuation, containment, removal, disposal, and treatment. The alternatives present a full range of potential remediation options available for the site and highlight tradeoffs associated with implementation of different remedial technologies, consistent with Ecology's expectations for cleanup actions and the objectives of the FS.

The following sections include descriptions of each of the six alternatives carried forward into the detailed FS evaluation. The alternatives are arranged in general order of MTCA preference with respect to degree of permanence as reflected in generally increasing removal/disposal/treatment volumes and costs. Section 11 presents a detailed MTCA evaluation of each alternative.

The following six upland remedial alternatives were developed for consideration at the site:

- **Alternative 1.** Institutional Controls and Natural Attenuation
- **Alternative 2.** Localized Removal and Off-site Disposal, Soil Capping, Natural Attenuation, and Institutional Controls
- **Alternative 3.** Localized Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Soil Capping, Natural Attenuation, and Institutional Controls
- **Alternative 4.** Localized Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Low-permeability Capping, Natural Attenuation, and Institutional Controls

- **Alternative 5.** Expanded Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Low-permeability Capping, Natural Attenuation, and Institutional Controls
- **Alternative 6.** Aggressive Removal and Off-site Disposal, Groundwater Treatment, Natural Attenuation, and Institutional Controls

All six upland alternatives include sediment removal from SU12 and consolidation in upland SU2 (see Appendix J for evaluation and selection of sediment alternatives to address SU12).

The remainder of this section summarizes MTCA expectations for cleanup action alternatives and describes the alternatives assembled to address these expectations and the SUs identified for further evaluation in the FS. Plate 10-1 provides a summary of the components used in each alternative.

Plate 10-1 Summary of Upland Remedial Alternative Components

Remedial Alternative	Institutional Controls	Natural Attenuation	In Situ Treatment	Waste Consolidation	On-site Containment	Off-site Disposal
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	No	No	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes
6	Yes	Yes	Yes	No	No	Yes

10.1 Expectations for Cleanup Action Alternatives (WAC 173-370)

WAC 173-340-370 sets forth Ecology's expectations for likely results of the remedy selection process, with the recognition that there may be sites where cleanup actions conforming to the expectations are not appropriate. Plate 10-2 evaluates the regulatory expectations against specific conditions at the Former Reynolds Plant.

Plate 10-2 Comparison of Expectations for Cleanup Action Alternatives in WAC 173-340-370 to Site Conditions

MTCA Subsection	Expectation	Site Conditions
1	Treatment technologies will be emphasized at sites containing liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile materials, and/or discrete areas of hazardous substances that lend themselves to treatment.	• Landfill and fill deposits do not contain liquid wastes • Fluoride concentrations in soil and groundwater at the site are relatively low • Natural geochemistry of the site limits fluoride mobility • Impacted areas are not “discrete” – areas are very large – and fluoride cannot be treated or destroyed, only immobilized
2	All hazardous substances will be destroyed, detoxified, and/or removed to cleanup levels throughout sites containing small volumes of hazardous substances.	• Fluoride cannot be destroyed or detoxified • The site contains large volumes of impacted media
3	Recognition of the need to use engineering controls, such as containment, for sites or portions of sites that contain large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable.	• The site contains large volumes of impacted media • Fluoride concentrations in soil and groundwater at the site are relatively low • Fluoride cannot be destroyed/treated
4	To minimize potential migration of hazardous substances, active measures will be taken to prevent precipitation and runoff from contacting contaminated soil and waste materials. When such measures are impracticable, runoff will be contained and treated.	• Existing soil and vegetative covers and structures limit contact of precipitation/runoff with contaminated soil and residual materials • Engineered caps are included in the range of alternatives considered in the FS • Natural geochemistry limits migration of hazardous substances
5	When hazardous substances remain on-site at concentrations exceeding cleanup levels, those hazardous substances will be consolidated to the maximum extent practicable where needed to minimize potential for direct contact and migration of hazardous substances.	• Fill deposit and landfill materials are already consolidated • Additional consolidation is not needed to minimize potential for direct contact and migration of hazardous substances • DCA in Section 11 evaluates if further consolidation is practicable
6	For facilities adjacent to surface water, active measures will be taken to prevent/minimize release to surface water via surface runoff and groundwater	• Nature and extent of contamination and CSM demonstrate releases to surface water exceeding cleanup levels are not occurring

MTCA Subsection	Expectation	Site Conditions
	discharges in excess of cleanup levels. Dilution will not be the sole method for demonstrating compliance with cleanup standards.	• Natural geochemistry of site controls migration of fluoride such that elevated dissolved fluoride concentrations are arrested in space and time by geochemical processes
7	Natural attenuation may be appropriate at sites where:	
7a	Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable	• Fluoride cannot be treated or destroyed, only immobilized • Ongoing fluoride immobilization is already occurring at the site through natural geochemical processes • Complete removal and off-site disposal of materials in landfills and fill deposits is not practicable (demonstrated by DCA) • Source control via removal is included in the range of alternatives evaluated in the FS
7b	Leaving contaminants on-site during the restoration time frame does not pose an unacceptable threat to human health or the environment	• Direct contact with fill deposit and landfill materials will be prevented via cover/cap in all alternatives evaluated in the FS • Soil concentrations are below industrial direct contact criteria and terrestrial ecological criteria • Natural geochemistry at the site limits migration of fluoride in groundwater to off-site receptors and has essentially arrested elevated dissolved fluoride concentrations in space and time
7c	There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate	• The natural geochemistry of the site controls migration of fluoride in groundwater • Documented declining trend of fluoride and cyanide concentrations in groundwater over 23 years
7d	Appropriate monitoring is conducted to ensure natural attenuation is taking place and human health and the environment are protected	• Long-term monitoring is included in the range of alternatives evaluated in the FS, in addition to data from previous and ongoing monitoring
8	Cleanup actions that meet the above expectations will not result in a significantly greater overall threat to human health and the environment than other alternatives	• Under current conditions, the site does not threaten human health and the environment. Existing soil covers and structures prevent direct contact with landfill and debris deposits. Soil concentrations are below industrial direct

MTCA Subsection	Expectation	Site Conditions
		contact criteria and terrestrial ecological criteria. - Natural geochemistry at the site limits migration of fluoride in groundwater to off-site receptors and has arrested elevated dissolved fluoride.

The range of the alternatives assembled in the following section for detailed evaluation in the FS meet the MTCA expectations for cleanup alternatives as described in Plate 10-2.

10.2 Alternative 1

Alternative 1 is a baseline alternative developed to provide an evaluation of existing site conditions. As demonstrated in Sections 6 and 7, naturally occurring geochemical processes have essentially arrested elevated fluoride concentrations in groundwater in time and space, and current conditions are protective of surface water receptors. Surface soil quality throughout the majority of the Former Reynolds Plant is protective of industrial workers. Under this alternative, there would be no additional removal or containment of waste and impacted soil or monitoring (beyond current activities required by existing regulatory orders). However, an environmental covenant would be recorded to limit consumption of site groundwater as drinking water and activities potentially encountering or disturbing hazardous materials. The site environmental covenant or other equivalent institutional control would also be ensure implementation of appropriate construction methods for future land use development as needed, including methods for subsurface utilities and structural piling. Long-term monitoring would be conducted to verify natural attenuation and stability of groundwater conditions, as well as to verify continued protection of surface water resources at the points of compliance (see Section 8.4).

10.3 Alternative 2

Alternative 2 emphasizes use of physical barriers rather than institutional controls to prevent direct contact with affected media, specifically remaining fill deposit and landfill materials and soils and groundwater with elevated COC concentrations. Containment technologies would be used to achieve compliance with cleanup levels at the site, including placement of soil cover over areas of concern and backfilling select on-site ditches that intercept groundwater. Upland soil covers would be constructed in most impacted areas. Long-term monitoring would be performed to verify natural attenuation and stability of groundwater conditions, as well as to verify continued protection of surface water resources at the points of compliance. Figure 10-1 displays the proposed remedial technologies associated with Alternative 2, and Plate 10-3 provides a summary list of the technologies and estimated costs separated by focused zones of treatment and the associated SUs.

Additional cost estimation details can be found in Appendix L. Specific components of Alternative 2 include the following:

- **Environmental Covenant**. An environmental covenant would be filed to limit consumption of site groundwater as drinking water, the disturbance of soil covers, and activities potentially encountering or disturbing hazardous materials. The environmental covenant would also be executed to ensure implementation of appropriate construction methods for future land use development as needed, including methods for subsurface utilities and structural piling.

Plate 10-3
Summary of Feasibility Study Alternatives and Costs

Feasibility Study Site Unit		**Alternative 1**		**Alternative 2**		**Alternative 3**		**Alternative 4**		**Alternative 5**		**Alternative 6**	
West Groundwater Area													
	Groundwater					Install Permeable Reactive Barrier at SU2	$191,000	Install Permeable Reactive Barrier at SU2 and NW corner	$588,000	Install Permeable Reactive Barrier at SU2 and NW corner	$588,000	Install Permeable Reactive Barrier at NW corner	$382,000
SU1	Landfill # 2 (Industrial) (SW Corner)	No Further Action	$0	Enhance Existing Soil Cover (Hydroseed Surface)	$175,000	Enhance Existing Soil Cover (Hydroseed Surface)	$175,000	Construct Low Permeability Cap (Hydroseed Surface)	$623,000	Excavate Waste and Dispose (Off-Site); Construct Low Permeability Cap (Hydroseed Surface)	$4,199,000	Excavate Waste and Dispose (Off-Site)	$3,634,000
SU2	Fill Deposit B-3 (Residual Carbon) (SW Corner)	No Further Action	$0	Enhance Existing Soil Cover (Hydroseed Surface)	$1,017,000	Excavate and Consolidate Waste within SU2; Construct Soil Cover (Hydroseed Surface); Backfill Excavated Areas with Reactive Material and General Fill	$3,537,000	Excavate and Consolidate Waste within SU2; Construct Low Permeability Cap (Hydroseed Surface; Backfill Excavated Areas with Reactive Material and General Fill (Hydroseed Surface)	$4,460,000	Excavate and Consolidate Waste within SU2; Construct Low Permeability Cap (Hydroseed Surface); Backfill Excavated Areas with Reactive Material and General Fill (Hydroseed Surface)	$5,114,000	Excavate Waste and Dispose (Off-Site); Backfill Excavated Areas with Reactive Material and General Fill (Hydroseed Surface)	$61,481,000
East Groundwater Area													
	Groundwater					Install Permeable Reactive Barrier at SU3	$547,000			Install Permeable Reactive Barrier at SU6/7	$1,012,000		
SU3	Fill Deposit B-2 (Residual Carbon)	No Further Action	$0	Construct Soil Cover (Gravel Surface)	$523,000	Construct Soil Cover (Gravel Surface)	$523,000	Excavate Waste and Affected Soil and Consolidate below SU6 Low-Permeability Cap; Backfill with Reactive Material and General Fill (Gravel Surface)	$2,055,000	Excavate Waste and Affected Soil and Dispose (Off-Site); Backfill with Reactive Material and General Fill (Gravel Surface)	$15,922,000	Excavate Waste and Affected Soil and Dispose (Off-Site); Backfill with Reactive Material and General Fill (Gravel Surface)	$15,922,000
SU4	Former Cryolite Plant Ditches	No Further Action	$0	Backfill Former Cryolite Ditch with General Fill; Construct Soil Cover (Gravel Surface); Place Residual Sand Cover in Angle and Railroad Ditches	$63,000	Backfill Former Cryolite Ditch with Reactive Material and General Fill; Construct Soil Cover (Gravel Surface); Place Residual Reactive Cover in Angle and Railroad Ditches	$93,000	Backfill Former Cryolite Ditch with Reactive Material and General Fill; Place Residual Reactive Cover in Angle and Railroad Ditches	$70,000	Backfill Former Cryolite Ditch with Reactive Material and General Fill; Place Residual Reactive Cover in Angle and Railroad Ditches	$70,000	Backfill Former Cryolite Ditch with Reactive Material and General Fill; Place Residual Reactive Cover in Angle and Railroad Ditches	$70,000
SU5	Former Stockpile Area (SE Side of Site)	No Further Action	$0	Backfill Former SPL Ditch with General Fill; Enhance Existing Soil Cover (Gravel Surface)	$114,000	Backfill Former SPL Ditch with Reactive Material and General Fill; Enhance Existing Soil Cover (Gravel Surface)	$127,000	Excavate Affected Soil and Consolidate with SU6; Backfill with Reactive Material and General Fill (Gravel Surface)	$373,000	Excavate Affected Soil and Dispose (Off-Site); Backfill with Reactive Material and-General Fill (Gravel Surface)	$702,000	Excavate Affected Soil and Dispose (Off-Site); Backfill with Reactive Material and General Fill (Gravel Surface)	$702,000
SU6	Fill Deposit B-1 (Residual Carbon) (East Side of Site)	No Further Action	$0	Enhance Existing Soil Cover (Hydroseed Surface)	$503,000	Enhance Existing Soil Cover (Hydroseed Surface)	$503,000	Incorporate SU3 and SU5 Material; Construct Low Permeability Cap (Hydroseed Surface)	$1,785,000	Construct Low Permeability Cap (Hydroseed Surface)	$1,785,000	Excavate Waste and Affected Soil and Dispose (Off-Site); Resurface Excavation with Topsoil and Hydroseed	$82,164,000

- **Soil Cover**. Areas with soils and fill deposit and landfill solid media exceeding cleanup levels would be covered with clean soil to prevent future exposure to the affected material. The design of the cover would consist of an approximate 2-foot layer of clean soil overlain by an operating surface. The thickness and composition of the operating surface would depend on the proposed use of the area. For light uses, a clean soil cap with topsoil and hydroseed would be sufficiently protective. For moderate uses, such as light vehicle traffic, compaction and a gravel surface or other engineered design may be appropriate. Grading of individual areas to be capped to achieve a minimum crown slope of 2 percent and maximum side slopes of 2.5 horizontal: 1 vertical (H:V) will be performed to facilitate post-construction drainage and achieve the desired cap performance. Some moderate consolidation is likely to occur to minimize the overall footprint of residual materials. SUs that would receive grading (as necessary) and enhancement of an existing soil cover include SU1 (Landfill #1), SU2 (Fill Deposit B-3, SU5 (Former Stockpile Area), SU6 (Fill Deposit B-1), and SU7 (Fill Deposit A). A new soil cover would be constructed at SU3 (Fill Deposit B-2), SU8 (Landfill #1), and SU10 (Landfill #3). SU4 (Former Cryolite Ditches) would receive a full soil cover and additional backfill to match the adjacent grade in the easternmost ditch (i.e., the cryolite area ditch) and an average 6-inch cover in the two westernmost ditches (i.e., the railroad and angle ditches). The former SPL ditch in SU5 (Former Stockpile Area) would also be backfilled to meet adjacent grades; 4 feet of fill was assumed for cost estimation purposes.
- **Soil Removal and Off-site Disposal.** For SUs where small volumes of material with COCs exceeding cleanup levels are present, specifically SU9 (Pitch Storage Area) and SU11 (Flat Storage Area), the material will be removed from the site and disposed of at an approved off-site disposal facility. This will minimize the need for long-term management of the impacted material on site and remove smaller source areas consistent with Ecology's expectations for cleanup action alternatives (see WAC 173-340-370(2)). Material from SU9 could potentially be designated as dangerous waste due to elevated PAH concentrations. If so, it would be transported to a Subtitle C facility, which was assumed for the purposes of preparing the alternative's cost estimate. Material from SU11 is expected to be designated as solid waste and would be transported to a Subtitle D facility. The SU9 excavation would be resurfaced with gravel, while the SU11 excavation would be backfilled with imported fill.

- **Monitoring**. The monitoring program would focus on COCs in groundwater downgradient of affected areas at the points of compliance established in Section 8.4 to document natural attenuation at the site. Depending on the alternative, existing monitoring well locations may be decommissioned if they are in the footprint of an excavation or cap, or additional wells may be installed to better capture a POC. The program would also include surface water monitoring. For cost estimating purposes, the following frequency of events was assumed to occur over a 30-year period: 10 quarterly and 20 annual events would be conducted within the West Groundwater Area, and 5 quarterly and 25 annual events would be conducted within the East Groundwater Area. Monitoring events would occur in a step-wise fashion with 5 to 10 years of quarterly events, followed by 20 to 25 years of annual events and by monitoring every 5 years thereafter throughout the restoration timeframe. These assumptions are for cost estimating purposes only. A long-term compliance monitoring plan will be developed in conjunction with the CAP, and the need for, scope, and frequency of monitoring would be reviewed and reassessed by Ecology in conjunction with 5-year reviews.

10.4 Alternative 3

Alternative 3 includes all of the remedial technologies identified in Alternative 2 with the addition of focused remedial excavation and on-site consolidation of two SUs (2 and 10; Fill Deposit B-3 and Landfill #3, respectively), the construction of two PRBs, and the upgrade to reactive backfill within select SUs. The consolidation of fill deposit and landfill materials would remove materials located on the riverward side of the CDID levee and would increase the areas of the site that would comply with the standard soil POC. Long-term monitoring would be conducted to verify remedy effectiveness, natural attenuation and stability of groundwater conditions, and continued protection of surface water resources at the points of compliance. Figure 10-2 displays the proposed remedial technologies associated with Alternative 3, and Plate 10-3 provides a summary list of the technologies and estimated costs separated by focused zones of treatment and the associated SUs; additional cost estimation details can be found in Appendix G. Specific components of Alternative 3 include the following:

- **Environmental Covenant**. See description under Alternative 2.

- **Permeable Reactive Barrier.** A PRB would be constructed along the western perimeter of SU2 (Fill Deposit B-3) to intercept groundwater that flows through the area and likely interacts with surface water in the adjacent CDID ditch. A second PRB would be constructed around SU3 (Fill Deposit B-2) at locations that intercept downgradient groundwater that flows towards on-site and CDID drainage ditches. As demonstrated by the empirical geochemical analysis and fate and transport modeling presented in Section 6, naturally occurring geochemical processes have essentially arrested elevated fluoride concentrations in groundwater, preventing fluoride plume migration well into the future under current conditions. Therefore, the addition of PRBs to this alternative simply enhances naturally occurring processes and overall protectiveness of this alternative. For cost estimating purposes, the PRBs were assumed to be 3-foot-wide by 20-foot-deep trenches filled with a mixture of 10 percent bone meal and 90 percent limestone, by weight.
- **Soil Cover**. SU1 (Landfill #2), SU2 (Fill Deposit B-3), SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area), SU6 (Fill Deposit B-1), SU7 (Fill Deposit A), and SU8 (Landfill #1) would be graded to achieve a minimum crown slope of 2 percent and maximum side slopes of 2.5H:1V and would receive additional clean soil to result in a 2-foot soil cover under this alternative. The cryolite ditch in SU4 would receive a full soil cover and additional backfill to match adjacent grade; the two westernmost ditches (i.e., the railroad and angle ditches) would receive a reactive cover. The former SPL ditch in SU5 (Former Stockpile Area) would also be backfilled to meet adjacent grades. All surfaces would be hydroseeded, except for SU3 and SU5, which would be surfaced with compacted gravel.
- **Waste Consolidation**. Construction debris from SU10 (Landfill #3) would be dry excavated, transported, and consolidated on top of the spent lime deposits at SU7 (Fill Deposit A). Consolidation of materials within the West Groundwater Area is consistent with the AOC policy described in Section 8.3. The consolidated unit would then be covered with soil cover to prevent exposure to affected media. The SU10 excavation would be backfilled with imported fill and resurfaced with topsoil and hydroseed. SU2 (Fill Deposit B-3) would also be excavated and consolidated; materials excavated would be consolidated within the same SU. The purpose of the SU2 consolidation is to simplify the construction of the soil cover and minimize the footprint

of the fill deposit, consistent with WAC 173-340-370(5). Consolidation of SU2 materials within the East Groundwater Area is also consistent with the AOC policy.

- **Reactive Backfill.** Backfill consisting of a mixture of bone meal, limestone, and sand would be placed in lieu of standard import backfill below the groundwater table in locations where fluoride concentrations exceed groundwater cleanup levels. The areas to receive reactive backfill would include portions of SU2 (Fill Deposit B-3) and the cryolite and former SPL ditches in SU4 (Former Cryolite Ditches) and SU5 (Former Stockpile Area), respectively. For cost estimation purposes, half of the fill volume was assumed to be below the water table; this half was assumed to contain 90 percent general fill and 10 percent reactive fill. In Alternative 2, the ditches would only receive soil cover, and this upgrade in Alternative 3 is intended to augment groundwater treatment. The 6-inch soil cover in the railroad and angle ditches as part of Alternative 2 would be replaced with 6 inches of reactive backfill in Alternative 3. The SU2 excavation would be resurfaced with topsoil and hydroseed.
- **Soil Removal and Off-site Disposal.** Material from SU9 (Pitch Storage Area) would be excavated and profiled for disposal. For cost estimating purposes, transport to a Subtitle C facility was assumed. Material from SU11 (Flat Storage Area) would be excavated and transported to a Subtitle D facility. The surface of SU9 would be resurfaced with gravel, while the SU11 excavation would be backfilled with imported fill.
- **Monitoring.** For cost estimating purposes, the following frequency of events was assumed to occur over a 30-year period: 10 quarterly and 20 annual events would be conducted within the West Groundwater Area, and 5 quarterly and 25 annual events would be conducted within the East Groundwater Area. Monitoring events would occur in a step-wise fashion with 5 to 10 years of quarterly events, followed by 20 to 25 years of annual events and by monitoring every 5 years thereafter throughout the restoration timeframe. These assumptions are for cost estimating purposes only. A long-term compliance monitoring plan will be developed in conjunction with the CAP, and the need for, scope, and frequency of monitoring would be reviewed and reassessed by Ecology in conjunction with 5-year reviews.

10.5 Alternative 4

Under this alternative, groundwater areas would be addressed by additional treatment measures in an effort to reduce the restoration timeframe. Additional areas of affected soils and waste would be managed by a combination of excavation, disposal, backfilling, and on-site consolidation. Areas of remaining or consolidated wastes would be capped with a low-permeability soil cap to reduce infiltration and further isolate affected media.
Figure 10-3 displays the proposed remedial technologies associated with Alternative 4, and Plate 10-3 provides a summary list of the technologies and estimated costs separated by focused zones of treatment and the associated SUs; additional cost estimation details can be found in Appendix L. Specific components of Alternative 4 include the following:

- **Environmental Covenant**. See description under Alternative 2.
- **Permeable Reactive Barrier.** One PRB would be constructed on the west side of SU2 (Fill Deposit B-3) to intercept groundwater that flows through the area and likely interacts with surface water in the adjacent CDID ditch. A second PRB would be constructed adjacent to the northwest corner of the Closed BMP Facility to provide further protection against groundwater COC migration. For cost estimating purposes, the PRBs were assumed to be 3-foot-wide by 20-foot-deep trenches filled with a mixture of 10 percent bone meal and 90 percent limestone, by weight.
- **Reactive Backfill.** The areas to receive reactive backfill would include portions of SU2 (Fill Deposit B-3), SU3 (Fill Deposit B-2), and the cryolite and former SPL ditches in SU4 (Former Cryolite Ditches) and SU5 (Former Stockpile Area), respectively. For cost estimation purposes, for SU2 and the ditches, half of the fill volume was assumed to be below the water table; this half was assumed to contain 90 percent general fill and 10 percent reactive fill. For SU3, the volume below the water table was assumed to be 90 percent general fill and 10 percent reactive fill. The 6-inch soil cover in the railroad and angle ditches as part of Alternative 2 would be replaced with 6 inches of reactive backfill. The excavations at SU2 would be resurfaced with topsoil and hydroseed. SU3 and SU5 would be resurfaced with gravel.
- **Waste Consolidation**. Deposits from SU3 (Fill Deposit B-2) and SU5 (Former Stockpile Area) would be dry-excavated using limited dewatering to the extent practicable. Wet excavation of SU3 (Fill Deposit B-2) may be required in some areas. Material from SU3 and SU5 would be consolidated on top of SU6 (Fill Deposit B-1) and covered with a

low-permeability soil cap. The remaining excavation would be backfilled to grade using sand and reactive material below the groundwater table. However, based on the fate and transport modeling presented in Section 6, removal of solid media from SU3 is not expected to significantly decrease the restoration timeframe for groundwater because fluoride concentrations are currently controlled by fluorite that has precipitated in the East Groundwater Area. Removing the shallow, impacted solid media will not affect this process. In other words, elevated dissolved groundwater concentrations are expected to remain in the current arrested, stable state for hundreds of years regardless of additional source removal in the area of SU3. SU8 (Landfill #1) would be dry-excavated and consolidated within SU7 (Fill Deposit A). The base of the SU8 excavation would be regraded to match surrounding grade and resurfaced with topsoil and hydroseed. Deposits from SU3 (Fill Deposit B-2) and SU5 (Former Stockpile Area) would be excavated, transported, and consolidated with residual carbon deposits at SU6 (Fill Deposit B-1). Consolidation of materials within the East Groundwater Area is consistent with the AOC policy and WAC 173-340-370(5). This consolidated media would then be capped to prevent exposure to affected media. Waste at SU2 (Fill Deposit B-3) and SU10 (Landfill #3) would be consolidated and backfilled and/or resurfaced in the same manner as in Alternative 3.

- **Low-Permeability Cap.** A low-permeability soil cap would be constructed over SU1 (Landfill #2), SU2 (Fill Deposit B-3), SU6 (Fill Deposit B-1), and SU7 (Fill Deposit A) with a surface consisting of a minimum 6-inch layer of topsoil and hydroseed.
- **Soil Removal and Off-site Disposal.** Material from SU9 (Pitch Storage Area) would be excavated and profiled for disposal. For cost estimating purposes, transport to a Subtitle C facility was assumed. Material from SU11 (Flat Storage Area) would be excavated and transported to a Subtitle D facility. The surface of SU9 would be resurfaced with gravel, while the SU11 excavation would be backfilled with imported fill.
- **Monitoring**. For cost estimating purposes, the following frequency of events was assumed to occur over a 30-year period: ten quarterly and four annual events would be conducted within the West Groundwater Area, and five quarterly and nine annual events would be conducted within the East Groundwater Area. Monitoring events would occur in a step-wise fashion with 5 to 10 years of quarterly events, followed by 4 to 9 years of annual events and by monitoring every 5 years thereafter throughout the restoration timeframe. These assumptions are for cost estimating purposes only.

A long-term compliance monitoring plan will be developed in conjunction with the CAP, and the need for, scope, and frequency of monitoring would be reviewed and reassessed by Ecology in conjunction with 5-year reviews.

10.6 Alternative 5

Alternative 5 is similar to Alternative 4, but with expanded groundwater treatment and significantly expanded removal and off-site disposal of source areas. Figure 10-4 displays the proposed remedial technologies associated with Alternative 5, and Plate 10-3 provides a summary list of the technologies and estimated costs separated by focused zones of treatment and the associated SUs; additional cost estimation details can be found in Appendix L. Specific components of Alternative 5 include the following:

- **Environmental Covenant**. See description under Alternative 2.
- **Permeable Reactive Barrier.** One PRB would be constructed on the west side of SU2 (Fill Deposit B-3) to intercept groundwater that flows through the area and likely interacts with surface water in the adjacent CDID ditch. A second PRB would be constructed adjacent to the northwest corner of the Closed BMP Facility to provide further protection against groundwater COC migration. A third PRB would be constructed around the northern and eastern perimeter of SU6 (Fill Deposit B-1) and SU7 (Fill Deposit A) to provide further protection against groundwater COC migration. These PRBs would be constructed to potentially reduce the restoration timeframe and to further reduce the potential for migration pathways at points of compliance. As shown in Section 6, the current fluoride plume boundary is expected to remain stable for the foreseeable future, and the PRBs serve to enhance the naturally occurring processes limiting fluoride migration at the site. For cost estimating purposes, the PRBs were assumed to be 3-foot-wide by 20-foot-deep trenches filled with a mixture of 10 percent bone meal and 90 percent limestone, by weight.
- **Waste Consolidation**. Waste at SU2 (Fill Deposit B-3) would be consolidated in the same manner as in Alternatives 3 and 4.
- **Reactive Backfill.** The areas to receive reactive backfill would include portions of SU2, SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area), and the cryolite and former SPL ditches in SU4 (Former Cryolite Ditches) and SU5 (Former Stockpile Area),

respectively. For cost estimation purposes, for SU2 and the ditches, half of the fill volume was assumed to be below the water table; this half was assumed to contain 90 percent general fill and 10 percent reactive fill. For SU3, the volume below the water table was assumed to be 90 percent general fill and 10 percent reactive fill. The 6-inch soil cover in the railroad and angle ditches as part of Alternative 2 would be replaced with 6 inches of reactive backfill. The excavations at SU2 would be resurfaced with topsoil and hydroseed. SU3 and SU5 would be resurfaced with gravel.

- **Low-Permeability Cap.** A low-permeability soil cap would be constructed over SU1 (Landfill #2), SU2 (Fill Deposit B-3), SU6 (Fill Deposit B-1), and SU7 (Fill Deposit A) with a surface consisting of a minimum 6-inch layer of topsoil and hydroseed.
- **Soil Removal and Off-site Disposal.** An expanded number of SUs where fill deposit and landfill material with COCs exceeding the cleanup level is present will be addressed by excavation and off-site disposal. Solid wastes from SU1 (Landfill #2), SU8 (Landfill #1), SU10 (Landfill #3), and SU11 (Flat Storage Area) would be excavated and disposed of at a Subtitle D facility. Soils and solid media from SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area), and SU9 (Pitch Storage Area) would be profiled, excavated, and disposed of at an appropriately permitted, off-site landfill facility. For cost estimating purposes, material from SU3, SU5, and SU9 were assumed to require Subtitle C disposal. SU8 would be resurfaced with topsoil and hydroseed. SU9 would be resurfaced with gravel. Excavations at SU10 and SU11 would be backfilled with imported fill.
- **Monitoring**. For cost estimating purposes, the following frequency of events was assumed to occur over a 30-year period: ten quarterly and four annual events would be conducted within the West Groundwater Area, and five quarterly and nine annual events would be conducted within the East Groundwater Area. Monitoring events would occur in a step-wise fashion with 5 to 10 years of quarterly events, followed by 4 to 9 years of annual events and by monitoring every 5 years thereafter throughout the restoration timeframe. These assumptions are for cost estimating purposes only. A long-term compliance monitoring plan will be developed in conjunction with the CAP and the need for, scope, and frequency of monitoring would be reviewed and reassessed by Ecology in conjunction with 5-year reviews.

10.7 Alternative 6

Alternative 6 consists of the removal of affected soils, fill deposit, and landfill materials to achieve cleanup levels as well as groundwater treatment measures in an effort to reduce the restoration timeframe. The goal of this alternative is to minimize the restrictions and institutional controls necessary at the site by removing and disposing of known residual materials off-site. Figure 10-5 displays the proposed remedial technologies associated with Alternative 6, and Plate 10-3 provides a summary list of the technologies and estimated costs separated by focused zones of treatment and the associated SUs; additional cost estimation details can be found in Appendix L. Specific components of Alternative 6 include the following:

- **Environmental Covenant**. See description under Alternative 2.
- **Permeable Reactive Barrier.** A PRB would be constructed adjacent to the northwest corner of the Closed BMP Facility to provide further protection against groundwater COC migration. For cost estimating purposes, the PRB was assumed to be 3-foot-wide by 20-foot-deep trench filled with a mixture of 10 percent bone meal and 90 percent limestone, by weight.
- **Reactive Backfill.** The areas to receive reactive backfill would include SU1 (Landfill #2), SU2 (Fill Deposit B-3), SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area), and the cryolite and former SPL ditches in SU3 and SU5, respectively. For cost estimation purposes, for ditches, half of the fill volume was assumed to be below the water table; this half was assumed to contain 90 percent general fill and 10 percent reactive fill. For SU1, the entire volume was assumed to be 90 percent general fill and 10 percent reactive backfill. For SU2 and SU3, the volumes below the water table were assumed to be 90 percent general fill and 10 percent reactive fill. The 6-inch soil cover in the railroad and angle ditches as part of Alternative 2 would be replaced in Alternative 6 with 6 inches of reactive backfill. The excavations at SU1 and SU2 would be resurfaced with topsoil and hydroseed. SU3 and SU5 would be resurfaced with gravel.
- **Soil Removal and Off-site Disposal.** Under this alternative, material from all SUs would be excavated and disposed of off-site. Solid wastes from SU1 (Landfill #1), SU7 (Fill Deposit A), SU8 (Landfill #1), SU10 (Landfill #3), and SU11 (Flat Storage Area) would be excavated and disposed of at a Subtitle D facility. Soils and solid media from

SU2 (Fill Deposit B-3), SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area), SU6 (Fill Deposit B-1), and SU9 (Pitch Storage Area) would be profiled, excavated, and disposed of at an appropriately permitted, off-site landfill facility. For cost estimating purposes, material from SU2, SU3, SU5, SU6, and SU9 were assumed to require Subtitle C disposal. Excavations at SU6, SU7, and SU8 would be resurfaced with topsoil and hydroseed. SU9 would be resurfaced with gravel. Excavations at SU10 and SU11 would be backfilled with imported fill.

- **Monitoring**. For cost estimating purposes, the following frequency of events was assumed to occur over a 30-year period: eight quarterly events would be conducted within the West Groundwater Area, and three quarterly would be conducted within the East Groundwater Area. Monitoring events would occur in a step-wise fashion with 3 to 8 years of quarterly events, followed by monitoring every 5 years thereafter throughout the restoration timeframe. These assumptions are for cost estimating purposes only. A long-term compliance monitoring plan will be developed in conjunction with the CAP and the need for, scope, and frequency of monitoring would be reviewed and reassessed by Ecology in conjunction with 5-year reviews.

11 EVALUATION OF CLEANUP ALTERNATIVES

This section provides a comparative evaluation of the six remedial alternatives described in Section 10, to support selection of a preferred cleanup action in accordance with MTCA requirements. MTCA identifies specific criteria against which alternatives are to be evaluated and categorizes them as either "threshold" or "other" requirements. All cleanup actions must at a minimum meet the threshold requirements. The other MTCA requirements are considered when selecting from among the alternatives that fulfill the threshold requirements. The six remedial alternatives are evaluated against the threshold criteria in Section 11.1 and against the other MTCA criteria in Section 11.2.

11.1 Minimum Requirements for Cleanup Actions

WAC 173-340-360(2) defines the minimum requirements that all remedial alternatives must achieve in order to be selected as a final cleanup action at a site. This section provides an overview of these regulatory criteria. The consistency of each alternative with these criteria is then discussed in the subsequent sections.

11.1.1 Threshold Requirements

The MTCA threshold requirements for a selected cleanup action are as follows:

- Protect human health and the environment
- Comply with cleanup standards (established in Section 8.4)
- Comply with applicable state and federal laws (identified in Section 8.2)
- Provide for compliance monitoring

The overall protectiveness that a cleanup alternative provides depends on its ability to meet cleanup standards for site COCs. Cleanup standards include a cleanup level and a location (i.e., POC) where compliance with the cleanup level must be demonstrated. Five of the six alternatives are expected to meet threshold criteria, although the estimated time required to achieve compliance with cleanup levels at the standard POC may vary among the alternatives. The exception is Alternative 1, which upon evaluation, may not meet threshold requirements because the alternative relies primarily upon institutional controls, monitored natural attenuation, and monitoring. Alternatives that rely primarily on institutional controls must include permanent solutions for all or a portion of the site, if possible, in accordance with WAC 173-340-440(6). Natural attenuation can be considered a permanent solution and active remedial measure when the requirements of WAC 173-370(7) are met, which include source control activities implemented to the maximum extent practicable. The process to evaluate whether or not alternatives use permanent solutions to the maximum extent practicable is a component of the "other MTCA requirements" discussed in the following section. Therefore, all alternatives developed in Section 10 are assumed to meet MTCA threshold criteria and will be evaluated with respect to restoration timeframes, and other relevant MTCA considerations, as part of the following DCA.

11.1.2 Other Model Toxics Control Act Requirements

Other requirements for evaluating remedial alternatives for the selection of a cleanup action include the following:

- Use of permanent solutions to the maximum extent practicable (WAC 173-340-360(3)). MTCA specifies that when selecting a cleanup action, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." The regulations specify the manner in which this analysis of permanence is to be conducted. Specifically, the regulations require that the costs and benefits of each of the project alternatives be balanced using a DCA.
- Provide for a reasonable restoration timeframe (WAC 173-340-360(4)). MTCA places a preference on those alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. MTCA includes a summary of factors that can be considered in evaluating whether a cleanup action provides for a reasonable restoration timeframe.
- Consider public concerns (WAC 173-340-360). Ecology considers public concerns by making draft copies of remedial decision documents available for review and comment.

11.2 Alternatives Evaluation

This section provides a qualitative evaluation of each alternative with respect to the seven MTCA criteria included in WAC 173-340-360(3)(e) as part of the DCA procedures. The following sections provide brief descriptions of how the particular alternative meets the objectives established by the DCA criteria. Alternatives are then compared to each other with respect to the criteria to determine which alternative would implement the most practicable permanent solution for the site. The analysis concludes with a reasonable restoration timeframe evaluation using consideration factors provided in WAC 173-340-360(4)(b). This analysis has been performed with input from Ecology.

11.2.1 Protectiveness

Protectiveness is defined as the degree to which overall protectiveness of human health and the environment is achieved by a given alternative. This includes the extent of reduction of existing risks; length of time required to meet cleanup standards at the site; risks, both on- and off-site, that would occur from implementing the alternative; and the overall improvement of environmental quality.

Alternative 1. Soil covers or existing structures currently isolate most impacted areas exceeding soil cleanup levels protective of direct contact pathways. Management of site groundwater exposure is achieved through institutional controls, and natural attenuation is the primary remedial action implemented to achieve cleanup levels. As described in Section 6, elevated fluoride concentrations in groundwater are arrested and not predicted to decrease below cleanup levels or migrate in 2000 years. The time to achieve groundwater cleanup levels throughout the site is expected to be long under this alternative (i.e., greater than 2000 years), although groundwater already meets cleanup levels within the site boundaries where a conditional POC could be established. No supplemental source control activities would be performed. Natural attenuation of groundwater along the migration pathway to surface water (i.e., the Columbia River and the CDID drainage ditches) is well demonstrated; therefore, no off-site risks are associated with this alternative.

Alternative 2. With respect to groundwater and surface water, Alternative 2 provides a similar level of protectiveness to Alternative 1. Alternative 2 provides an increased reduction in on-site risk as all areas which exceed soil cleanup levels would either be removed and disposed of off site or isolated by a minimum 2-foot soil cover. Therefore, soil cleanup standards would be met at the completion of construction. As discussed in Section 9, a 2-foot soil cover can be designed and constructed to achieve an 11- to 55-percent reduction in infiltration, which may result in a marginal decrease in maximum fluoride concentrations and the areal extent of the fluoride plumes over a timespan of hundreds of years. A negligible increase in off-site risk would result from the transport of excavated materials to off-site landfill facilities.

Alternative 3. Similar to Alternative 2, all material exceeding soil cleanup levels would be either removed and disposed of off site or isolated by a minimum 2-foot soil cover. In addition, approximately 6.3 acres of impacted soil fill deposit and landfill materials would be excavated and consolidated into existing on-site containment areas, resulting in a reduction of areas requiring institutional and engineering controls to limit exposure. As part of this alternative, excavated areas that originally contributed to groundwater cleanup level exceedances would be backfilled with reactive materials; as a result, these materials may reduce the timeframe needed to achieve groundwater cleanup levels. Within a portion of SU2 or Fill Deposit B-3 (i.e., at the standard POC), fluoride concentrations are also reduced and controlled by fluorite, which is precipitated in groundwater in this source area. Additional treatment of groundwater is achieved through the construction of a PRB adjacent to SU3 (Fill Deposit B-2), which enhances existing geochemical attenuation processes and will ensure source control along the groundwater to CDID ditch water pathway, further reducing potential off-site risk.

Alternative 4. Alternative 4 provides a marginal increase in the level of protectiveness in comparison to Alternative 3. An additional 8.2 acres of impacted soil and fill deposit and landfill materials would be excavated and consolidated into existing on-site containment areas. Excavated areas that contributed to groundwater cleanup level exceedances would be backfilled with reactive materials, possibly reducing the timeframe to achieve groundwater cleanup levels at the standard POC SU3 (Fill Deposit B-2). All soil covers limiting direct contact are upgraded to a low-permeability cap, thereby reducing infiltration through capped areas. As demonstrated by the fate and transport modeling presented in Section 6, reductions in infiltration of 50 to 100 percent do not appear to appreciably improve groundwater quality; however, added protection may be provided against migration of the fluoride plume toward the Columbia River in the East Groundwater Area. Although enhancements are made to further reduce rainwater infiltration and treat residual COCs in groundwater, a marginal reduction in the time to achieve groundwater cleanup levels at the standard POC is expected. Additional source control and groundwater treatment would be achieved through the construction of a second PRB adjacent to the northwest corner of the Closed BMP Facility.

Alternative 5. This alternative provides no incremental benefit with respect to reduction of risks associated with on-site exposures. Approximately 164,000 cubic yards of impacted soil fill deposit and landfill materials that were consolidated and contained on site under preceding alternatives is transported off site for disposal under Alternative 5. Transporting of this material increases potential short-term, off-site risks and does not reduce the length of time necessary to achieve soil cleanup levels at standard POCs. However, source control along the eastern property line adjacent to SU6 (Fill Deposit B-1) and SU7 (Fill Deposit A) and adjacent to the northwest corner of the Closed BMP Facility through PRB construction enhances existing geochemical processes that prevent off-site migration of COCs in groundwater.

Alternative 6. This alternative includes excavation and off-site disposal of all impacted soil and fill deposit and landfill materials above cleanup levels; therefore, upon completion of construction, compliance with soil cleanup levels would be attained throughout the soil column (i.e., the standard POC). No soil covers or low-permeability caps would be required. This alternative does pose the greatest potential short-term, off-site risk, as approximately 613,000 cubic yards of material would be transported to an off-site disposal facility. Additional source control and groundwater treatment would be achieved through the construction of a PRB adjacent to the northwest corner of the Closed BMP Facility.

With the exception of Alternative 1, all of the alternatives provide adequate degrees of protectiveness by removing direct contact with waste materials and including varying degrees of treatment for affected groundwater. The discussion presented in Plate 11-1, which provides numeric values for the alternatives, is intended to be relative to other alternatives and is based on the degree of overall protectiveness of the proposed technologies associated with each alternative. Given the importance of this criterion, the weighting is the maximum (30 percent) relative to other criteria in determining the overall environmental benefit of an alternative.

Plate 11-1

Summary of Remedial Alternative Disproportionate Cost Analysis

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score[3]	Probable Cost[4]
	Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.	*The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*	*Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.*	*The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*	*Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*	*Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.*		
Alternative 1	This alternative provides no significant increase in protectiveness of either human health or the environment from baseline conditions; however, natural attenuation has been demonstrated to control off-site risks. Restoration timeframe for groundwater is expected to be greater than 100 years. 2	This alternative does not enhance the natural attenuation processes that are occurring at the site, although the process does effectively control off-site migration and reduce toxicity of contaminants. No soil or waste removal is included under this alternative; therefore, no volume reduction would occur. 2	This alternative relies on natural attenuation to reduce COC concentrations below cleanup levels. The reliability of this as an action plan is moderately high given the observed trends in groundwater concentrations across the site. This alternative, however, relies on existing soil cover and institutional controls to address direct contact with waste materials. 2	This alternative results in the least disturbance of contaminants and accordingly poses the least short-term risk; therefore, the alternative meets the criteria to the highest degree. 10	This alternative is the most technically and administratively implementable alternative and consists of remedial action components that are regularly implemented at cleanup sites. 10	A low score is assigned to this alternative to reflect lack of support for the lower level of overall protectiveness, and lack of groundwater treatment, consolidation and off-site disposal relative to other alternatives. 1	3.9	$2.3M
Alternative 2	Similar protectiveness to Alternative 1; however, enhancements to existing soil covers increase the overall protectiveness of the alternative. 5	Alternative 2 provides a marginal increase in permanence in comparison to Alternative 1 through the removal of 395 cy of impacted soil and waste. 4	Given the natural attenuation processes at the site and the removal of fill deposit and landfill materials from direct contact by soil cover, this alternative scores relatively high on the long-term effectiveness. The potential for erosional or other natural forces that would degrade the cover is the greatest threat to effective long-term management of materials on-site under this scenario. 5	Minimal disturbance of site contaminants will occur as a result of this alternative. Minor grading will occur and any potential disturbances can be mitigated with standard erosion control best management practices. 9	This alternative is a technically and administratively implementable alternative and consists of remedial action components that are regularly implemented at cleanup sites. However, it is more complex than Alternative 1 and was assigned a lower score. 9	A low score is assigned to this alternative to reflect lack of support for the lower level of overall protectiveness, and lack of groundwater treatment, consolidation and off-site disposal relative to other alternatives. 1	5.4	$11.2M
Alternative 3	On-site risks are reduced with the use of reactive backfill materials to treat groundwater in situ resulting in potential reduction in the time required to achieve groundwater cleanup levels at the standard POC. Source control and natural attenuation is enhanced by treatment PRBs. 6	This alternative uses active solutions to reduce contaminant mobility and reduce contaminant toxicity. Groundwater treatment is used to reduce contaminants. Contaminant mobility is reduced by consolidating impacted soil, fill deposit and landfill materials to reduce the footprint in which rainwater can infiltrate. 6	Effectively, Alterative 3 is similar to the previous alternative, in that fill deposits and landfills will be managed by soil cover. The added groundwater treatment of this alternative will increase its overall effectiveness at containing affected groundwater. The treatment technology is relatively low-tech, and as such, its reliability over the long term should not be a source of concern. This will lead to detoxification of groundwater migrating towards surface water from the two focused zones of treatment. 6.5	This alternative has slightly elevated risks associated with construction due to the consolidation of soils and the associated transport. Given the relatively low toxicity of the source material and the short distances of travel between SUs the risks are not expected to be significant and can be easily mitigated with standard construction soil tracking and erosion control best management practices. 8	Similar to Alternative 2, this alternative consists of remedial action components that are regularly implemented at cleanup sites. It is likely that a bench scale study would be required to verify the backfill composition of the full-scale groundwater treatment portion of this alternative. This, along with the additional scope and complexity of material management of the individual SUs, is slightly elevated relative, and as such, the value assigned to it is lower. 8.5	Relative to Alternatives 1 and 2, Alternative 3 includes elements for which commenters expressed support: groundwater treatment, consolidation and off-site disposal. However, the relatively low score reflects lesser use of groundwater treatment, consolidation and off-site disposal relative to Alternatives 4, 5 and 6. 2	6.3	$18.9M
Alternative 4	Greater protectiveness than Alternative 3. All material contained on site would be isolated using low-permeability caps which is not expected to significantly reduce the groundwater restoration timeframe at standard POC in comparison to Alternative 3, but provides an added level of protection to surface water (the Columbia River). 7.5	Additional groundwater treatment options are added, as well as increased consolidation of fill deposit and landfill material and off-site disposal in comparison to Alternative 3. The inclusion of low-permeability capping as part of this alternative reduces the contaminant mobility. 8	The reliability of this alternative to effectively address site contaminants in the long term is incrementally greater than the previous alternative. This is due to the increased removal of source material (both off-site and consolidated on-site) and additional groundwater treatment (PRB in the northwest corner of the West Groundwater Area). The reduction in infiltration associated with the upgrade to low permeability caps offers greater protection against migration of fluoride toward the Columbia River. As such, this score reflects this additional environmental benefit. 7.5	This alternative has slightly elevated risks relative to Alternative 3, but overall potential risks to human health the environment as a result of construction and implementation are still not substantial. Again, risks associated with construction would result from consolidation or off-site disposal of soils and the associated transport. It assumed that the risks could be easily mitigated with standard construction soil tracking and erosion control best management practices. 7.5	This alternative consists of similar remedial action components as the previous alternative and has a similar scale of complexity and scope. However, because more material is removed by this alternative, schedule and logistical considerations are increased, along with the potential for impacts to current operations. 8	Multiple commenters expressed support for Alternative 4 due to the overall protectiveness of the remedy, the reduction of the footprint of the site requiring engineering controls over Alternative 3 and the balance of cost to benefits for the alternative. 5	7.4	$27.7M
Alternative 5	No incremental benefit is achieve with respect to reducing on-site risks in comparison to Alternative 4. Approximately 134,000 cy of impacted soil, fill deposit and landfill materials would be disposed of off site, which could increase potential off-site risks during transport. 8	Similar level of permanence as Alternative 4 with respect to mobility and toxicity. This alternative expands groundwater treatment aspects with the addition of a PRB in the East Cryolite Area. Although volume reduction is increased, material removed from the site is not treated, so toxicity would not decrease. 8	Again, the reliability of this alternative to effectively address site contaminants in the long term is incrementally greater than the previous alternative. This is due to the additional increased removal and disposal of source material off-site and the additional groundwater treatment. Therefore, this score reflects the additional environmental benefit. 8	This alternative has slightly elevated risks relative to the previous alternatives, but overall potential risks to human health the environment as a result of construction and implementation are still not substantial. With a greater volume of material transported off-site, this alternative warranted a lower valuation. 6	This alternative consists of similar remedial action components as the previous two alternatives and has a similar scale of complexity and scope, with the exception that a greater volume of soil will be excavated and disposed of off-site. Increased impacts to operations in comparison to Alternative 4 are expected. 7	This alternative includes removal of more contaminated material from the site than Alternatives 1, 2, 3 or 4, lessening concerns regarding potential impacts to site redevelopment associated with containment features. This also helps reduce concerns about natural disasters compromising the containment features. 7	7.5	$75M
Alternative 6	With respect to on-site risk, this alternative removes the most contaminant mass from the site which would result in the shortest restoration timeframe for soil and groundwater at standard POCs. However, the excavation and transport of approximately 587,000 cy would likely pose a temporary off-site risk during construction. 9	With respect to on-site hazardous substances toxicity, mobility, and volume, this alternative provides the greatest benefits within the shortest timeframe in comparison to the other alternatives. This is due to the overall removal of known site contaminants and the treatment associated with backfilling with reactive agent. The alternative has the potential to generate significant releases during construction. 9	This alternative includes more of the higher ranking cleanup action components as listed in the column heading above in comparison to the other alternatives because of the removal of known source material from the site. Therefore, this alternative ranks most preferred for this category. 9	This alternative has the greatest risks to human health and the environment relative to the other alternatives due to the largest volume of material to be excavated and transported off-site. In addition, groundwater treatment (primarily backfill with reactive agent) will be the most wide spread under this alternative. As such, the assigned value is lower than the previous alternatives. 4	This alternative relies on excavating and hauling source material off-site and as such, is a relatively simple alternative. However, the greatest schedule and logistical challenges exist for this alternative to minimize impacts to current operations. This alternative would also require several months to construct. 5	This alternative results in the least amount of contaminated materials remaining on-site and addresses concerns regarding the long-term integrity of containment features and their potential impacts to site redevelopment. 9	7.9	$344M

Notes:

1. Consideration of public concerns is not addressed in this table because the public has not yet had an opportunity to provide comments.
2. Each of the DCA criteria listed were weighted, so the overall DCA score would be influenced by criteria directly relating to protectiveness and effectiveness. A score of 10 represents an alternative that satisfies the criteria to the highest degree.
3. Although allowed, costs were not considered in the environmental benefit scoring.
4. Probable cost reflects the total estimated cost + 50% contingency (Table 10-3).

COC = chemical of concern

cy = cubic yards

POC = point of compliance

11.2.2 Permanence

The permanence of a cleanup action is measured by the degree to which it permanently reduces the toxicity, mobility, or volume of hazardous substances. For example, treatment actions that destroy contaminants (thereby reducing toxicity, mobility, and volume) are considered under MTCA to be more permanent than containment actions (which only reduce the mobility).

Alternative 1. This alternative relies upon natural attenuation to reduce the COC concentrations in groundwater. As discussed in Section 6, the mobility of fluoride is essentially prevented by a number of geochemical reactions, which results in the precipitation of various stable fluoride compounds such as fluorite and fluorapatite. Because no enhancement of natural attenuation processes occurs under Alternative 1, no reduction can be expected beyond baseline conditions. No excavation or consolidation of site soils or wastes occurs under this alternative; therefore, no volume reduction of hazardous substances would occur. However, previous sections of this RI/FS have demonstrated that current conditions at the site are protective to surface water and other potential off-site receptors.

Alternative 2. This alternative provides a marginal increase in permanence, compared to Alternative 1, with approximately 190 cubic yards of impacted soil and waste material permanently removed from the site. No further enhancements to reduce COC mobility or toxicity occur as part of Alternative 2.

Alternative 3. This alternative reduces contaminant mobility, and toxicity is permanently reduced using treatment methods such as the construction of two PRBs and placement of reactive backfill in SUs with groundwater exceeding site cleanup levels.

Alternative 4. This alternative includes low-permeability caps over all impacted soils and waste materials, which may marginally reduce the mobility of COCs managed on site. Excavation and consolidation of SU3 and SU5 includes backfilling with an additional 5.7 acres of reactive backfill as part of this alternative compared to Alternative 3, and a second PRB is added to the northwest corner of the Closed BMP Facility. The added source control, waste consolidation, and groundwater treatment associated with the Alternative 4 approach provides an increase in permanence because it targets a larger treatment area.

Alternative 5. This alternative provides a similar level of permanence with respect to COC mobility and toxicity reduction in comparison to Alternative 4, which is enhanced by the inclusion of a PRB along the eastern property line adjacent to SUs 6 and 7 (Fill Deposits B-1 and A, respectively). With respect to volume reduction, approximately 164,000 cubic yards of impacted soil and fill deposit and landfill materials would be permanently removed from the site. However, this material would not be treated, so no further reduction in toxicity would occur.

Alternative 6. This alternative removes all impacted soil and fill deposit and landfill materials (approximately 613,000 cubic yards) from the site. However, like Alternative 5, this material would not be treated so no further reduction in toxicity would occur. Approximately 26 acres of SUs with groundwater exceeding site cleanup levels would be backfilled with reactive materials, reducing the toxicity of COCs in groundwater to the highest degree. Like Alternative 5, a PRB in the northwest corner of the Closed BMP Facility provides additional groundwater treatment.

The toxicity and volume of contaminants that are addressed by containment will be reduced over the long term by natural attenuation, even though the time to reduce contaminant toxicity and volume may vary. Therefore, all alternatives provide a relatively high degree of permanence over the long term. Alternatives that would implement groundwater treatment further reduce the mobility of site contaminants, but only excavation and disposal off site will address the overall volume reduction of hazardous substances. The scoring of each alternative reflects these observations. To evaluate the relative permanence of these alternatives, a comparative analysis of the degree of permanence of the remedial alternatives over the short-term is presented in Plate 11-1.

11.2.3 Effectiveness over the Long Term

Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the restoration timeframe, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage remaining hazardous substances. MTCA ranks the following types of cleanup action components in descending order of relative long-term effectiveness:

- Reuse and recycling

- Destruction or detoxification
- Immobilization or solidification
- On-site or off-site disposal in an engineered, lined, and monitored facility
- On-site isolation or containment with attendant engineering controls
- Institutional controls and monitoring

Long-term effectiveness considerations applicable to each alternative include the following:

- **Alternative 1.** This alternative relies on natural attenuation (a form of COC destruction) to achieve groundwater cleanup levels. As discussed in Section 6, the chemical reactions that attenuate fluoride in groundwater are well documented at the site. The limitations on the processes are understood, and there is a high degree of confidence that the reactions will continue to occur for the foreseeable future as demonstrated by long-term simulations using the fate and transport model developed for the site. Under Alternative 1, the restoration timeframe to achieve groundwater cleanup levels at the standard POC of compliance is expected to be very long (i.e., hundreds of years). However, during this time, on-site isolation through existing soil covers (which cover most areas), institutional controls, and monitoring can be reliably used to manage other exposure pathways. Alternatively, a conditional POC could be established closer to impacted areas within the property boundaries, where groundwater cleanup levels would be met immediately.
- **Alternative 2.** This alternative provides similar long-term effectiveness in comparison to Alternative 1 with respect to groundwater. Alternative 2 provides additional long-term control of other exposure pathways through the limited removal of impacted soil and waste material and soil covers placed over all material managed on site.
- **Alternative 3**. The long-term effectiveness provided by this alternative with respect to groundwater is achieved through a combination of natural attenuation, consolidation and on-site containment of impacted soils and waste material, and in situ treatment of residual groundwater. Treatment of residual groundwater dissolved concentrations of fluoride would be enhanced through active attenuation on reactive backfill placed in excavations and the PRBs.
- **Alternative 4.** This alternative provides incrementally greater long-term effectiveness in comparison to Alternative 3 through the inclusion of additional groundwater

treatment options including an increase in residual groundwater treatment area by 5.6 acres (placement of reactive backfill in SU3 and SU5 after they are excavated and consolidated in SU6) and addition of a second PRB to the northwest corner of the Closed BMP Facility. Immobilization of site COCs is also enhanced by the substitution of a soil cover for a low-permeability cap over all areas where impacted soil and fill deposit and landfill materials are managed on site.

- **Alternative 5.** This alternative provides an increased level of long-term effectiveness over Alternative 4 by reducing the volume of impacted soil and fill deposit and landfill materials managed on site. No additional upgrades to the cleanup action components are included in Alternative 5 that would result in improved long-term effectiveness, with the exception of an additional PRB constructed adjacent to SU6 (Fill Deposit B-1) and SU7 (Fill Deposit A).
- **Alternative 6.** This alternative provides a high degree of long-term effectiveness through the removal of all impacted soil and fill deposit and landfill materials from the site and increased residual groundwater treatment in SU2 (Fill Deposit B-3). Low residual risk is expected to remain on site after construction; however, natural attenuation of site groundwater will likely still be required to achieve cleanup levels at the standard POC since fluorite that has precipitated in groundwater beneath sources areas will buffer dissolved fluoride concentrations for a very long time. The addition of a PRB in the northwest corner will reduce contaminant mobility.

Based on the fate and transport modeling that demonstrates suitable conditions exist to essentially arrest the elevated fluoride concentrations in time and space for hundreds, if not thousands of years, long-term effectiveness of each alternative will not be a concern. Additionally, all of the alternatives would use relatively low-tech solutions, so the degree of certainty and reliability of the alternatives is relatively constant. The rankings reflect the discussion above and are the basis for the values shown in Plate 11-1.

11.2.4 Management of Short-Term Risks

Management of short-term risks is the degree to which human health and the environment are protected during construction and implementation of the alternative. Potential risks of implementing each alternative and the potential effectiveness of best management practices at controlling short-term risks are discussed as follows:

- **Alternative 1.** No construction would occur as part of this alternative; therefore, potential short-term risks would be limited to potential exposures to a field crew during groundwater and surface water monitoring activities. Standard best management practices can be implemented to ensure worker health and safety.
- **Alternative 2.** Limited construction would occur as part of this alternative. Potential short-term risks would be limited to potential exposures to a field crew during groundwater and surface water monitoring activities and construction workers during grading and excavation of the small volume of material designated for off-site disposal. Standard best management practices can be implemented to ensure worker health and safety and minimize incidental releases to the environment (e.g., erosion control measures). Potential risks associated with off-site transport of excavated materials are expected to be negligible.
- **Alternative 3.** More excavation work is included in this alternative in comparison to Alternative 2; however, standard best management practices can be implemented to manage potential risks to human health and the environment. Potential risks associated with off-site transport of excavated materials are expected to be negligible.
- **Alternative 4.** Approximately 8.2 acres of additional excavation work is included in this alternative; however, the scale of the construction of this alternative is comparable to Alternative 3. Therefore, management of potential short-term risks is expected to be similar.
- **Alternative 5.** This alternative increases the off-site removal volume of impacted soil and fill deposit and landfill materials from approximately 190 to 164,000 cubic yards. Transport of this material for off-site disposal could require more than 5,200 truck and trailer trips across local roads and state highways. The nearest Subtitle C landfill is located in Arlington, Oregon, approximately 180 miles from the site. Best management practices can be implemented to prevent material releases; however, the short-term risk to the public and non-industrial environments is significantly increased under this alternative.
- **Alternative 6.** This alternative includes the off-site removal of approximately 613,000 cubic yards of impacted soil and fill deposit and landfill materials. Transport of this material for off-site disposal would require more than 19,300 truck and trailer

trips across local roads and state highways. The nearest Subtitle C landfill is located in Arlington, Oregon, approximately 180 miles from the site. Best management practices can be implemented to prevent material releases; however, the short-term risk to the public and non-industrial environments is significantly increased under this alternative.

Given the moderate toxicity of waste material at the site, short-term risks are relatively minimal for all of the alternatives. Alternatives with increased excavation have higher short-term risks, due to handling and disposal concerns and the risks associated with high volumes of off-site truck traffic, but best management practices are well established for these actions and are easy to implement. As with the other criteria, the values presented in Plate 11-1 are intended to be relative to the other alternatives.

11.2.5 Technical and Administrative Implementability

Evaluating an alternative's technical and administrative implementability includes consideration of the following:

- Potential for landowner cooperation
- Whether the alternative is technically possible
- Availability of necessary facilities, services, and materials
- Administrative and regulatory requirements
- Scheduling
- Size and complexity of the alternative
- Monitoring requirements
- Access for construction and monitoring
- Integration of existing operations with the remedial action

Implementability considerations applicable to the alternatives are described as follows:

- **Alternative 1.** This alternative is technically and administratively feasible to implement. This alternative would not interfere with existing site uses but would also not reduce the areas that may restrict potential future site uses.

- **Alternative 2.** This alternative is technically and administratively feasible to implement. This alternative would result in minimal interferences with existing site uses and would not reduce the areas that may restrict potential future site uses.
- **Alternative 3.** Although more complex than Alternative 2, this alternative is technically and administratively feasible to implement. This alternative would result in minimal interferences with existing site uses, and most construction work would occur in locations away from existing site operations. Alternative 3 reduces the overall area allocated to long-term management of impacted soil and fill deposit and landfill materials on site in comparison to Alternative 2, thereby expanding areas that could be used in the future.
- **Alternative 4.** This alternative is equally implementable in comparison to Alternative 3 and provides an additional reduction in the area allocated to managing impacted soil and fill deposit and landfill materials on site.
- **Alternative 5.** This alternative provides an equivalent reduction in the area allocated to long-term management of impacted soil and fill deposit and landfill materials on site in comparison to Alternative 4; however, it is less implementable because it is likely that the large volume of material being removed from the site would impact existing facility operations.
- **Alternative 6.** This alternative does not include long-term management of impacted soil and waste material on site; therefore, future limitations to site uses would be negligible. However, it is the least implementable alternative because it is likely that the large volume of material being removed from the site would impact existing facility operations.

In general, all of the alternatives use technologies that are commonly applied as part of remedial actions and, hence, the benefit values shown in Plate 11-1 are relative to the other alternatives. The general complexity is the most variable factor and the values presented have less to do with the remaining considerations because all of the remaining considerations are relatively constant between the alternatives.

11.2.6 Consideration of Public Concerns

The draft FS was made available for public review and comment during June and July 2014. The concerns expressed by the public and the degree to which each alternative addresses those concerns were evaluated by Ecology based on the public comments received during the public comment period. Ecology determined that the MTCA evaluation should be modified to reflect public input in this final FS. Specifically, at Ecology's direction, "Public Concerns" was added as a criterion to the DCA presented in Plate 11-1. Consideration of public concerns was assigned a weighting of 10 percent, and the weighting factors for the other criteria were adjusted downward to maintain a total weight of 100 percent. The factors weighed most heavily are protectiveness and permanence. The weighting for consideration of public concerns reflects that most public concerns are addressed by the other criteria of the DCA. In other words, the degree of risk reduction, the long-term reliability, and the community and environmental impacts during construction are all represented in the public comments and also in the other metrics of the DCA. Public concern rankings in the DCA provide a summary of these community concerns based on public comments received on the FS.

Many concerns raised during the comment period related to containing wastes on site. Some were concerned that wastes left on site would reduce redevelopment options. Others raised concerns that natural disasters such as earthquakes or floods could damage the containment structures. Concerns were also raised regarding the long-term impacts of sea level rise. Other commenters felt that the preferred alternative, Alternative 4, struck an appropriate balance between benefit and cost. Ecology's responses to the comments received can be found in the Responsiveness Summary.

11.2.7 Cost

Estimated costs for each remedial alternative are summarized in Plate 10-3 and Plate 11-1. Details regarding the assumptions and methodology used to develop the cost estimate are provided in Appendix L. Cost estimates include design, construction oversight, capital costs, and long-term operation and maintenance costs but do not include fees associated with RIs, Ecology oversight, or legal costs. The costs presented reflect FS-level design estimates and are presented with a range of contingency levels (+50/-30 percent).

11.2.8 Provision for a Reasonable Restoration Timeframe

The restoration timeframe analysis can consist of qualitative and relative estimates of the restoration timeframe for each alternative. Under MTCA, evaluation of a reasonable restoration timeframe includes the following factors to consider:

- Potential risks posed by the site to human health and the environment
- Practicability of achieving a shorter restoration time frame
- Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor migration of hazardous substances from the site
- Toxicity of the hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions

Under all alternatives, groundwater and surface water cleanup standards are currently met within ditch and surface waters of the Columbia River. Therefore, the restoration timeframe to protect ecological receptors is immediate. In addition, all alternatives (including Alternative 1 to a lesser extent) achieve soil cleanup standards immediately after construction of engineering controls (e.g., soil covers) and implementation of institutional controls (e.g., deed restrictions regarding disturbance of soil and groundwater). All alternatives will include long-term management of groundwater quality within the site, in a manner protective of groundwater and surface water resources, and meet groundwater cleanup levels at locations within the property where a conditional POC could be established. None of the alternatives is expected to meet the standard POC for groundwater in a relatively short restoration time frame because solid media impacting the entire groundwater plume would have to be excavated (to the depth of the deepest wells with fluoride concentrations exceeding the cleanup level), which is not practicable.

11.2.9 Summary

Plate 11-1 provides a summary of the qualitative DCA criteria evaluation for each alternative discussed in the preceding section. It also provides a numeric rating of the environmental benefits provided by each alternative, with 10 representing an alternative that satisfies the criteria to the highest degree and 0 representing the least. The final environmental benefit score is then compared to the estimated cost of each alternative to determine which alternative provides the incrementally greatest degree of environmental benefit while considering the most cost-effective use of technology—that is, which alternative uses permanent solutions to the maximum extent practicable. As noted, the alternatives were scored with Ecology's input, which emphasized the permanence of the remedy and consideration of public concerns.

Plate 11-2 provides a graphic summary of the DCA and compares environmental benefits and costs for each alternative. Environmental benefits ranged from 3.9 (Alternative 1) to 7.9 (Alternative 6). In general, the greatest environmental benefits were associated with higher cost alternatives. However, the breakpoint at which incremental costs begin to outweigh incremental environmental benefits is illustrated on Plate 11-2. A "plateau" in the benefits line graph is evident beginning with Alternative 4, indicating that incremental costs associated with Alternatives 5 and 6 are disproportionate for the little to no increase in benefits over Alternative 4. The chart also indicates the rate at which costs increase among alternatives. The point at which additional costs begin to outweigh additional benefits can be estimated as the point where the cost line graph becomes steeper and approaches a vertical asymptote (i.e., beginning at Alternative 4). While Alternative 3 has a relatively high benefit score, offers a high degree of protection, and is cost-effective, given site conditions (proximity to ecological receptors, protection of deep wells, and long restoration time frames) a more permanent solution is preferred. Alternative 4 is more permanent and provides additional source control, reduction in infiltration in capped areas, and may provide a more reasonable restoration timeframe. Therefore, the additional benefits and costs associated with Alternative 4 over Alternative 3 are not disproportionate, and one could conclude that Alternative 4 meets the definition of permanent to the maximum extent practicable per WAC 173-340-360(3)(e).

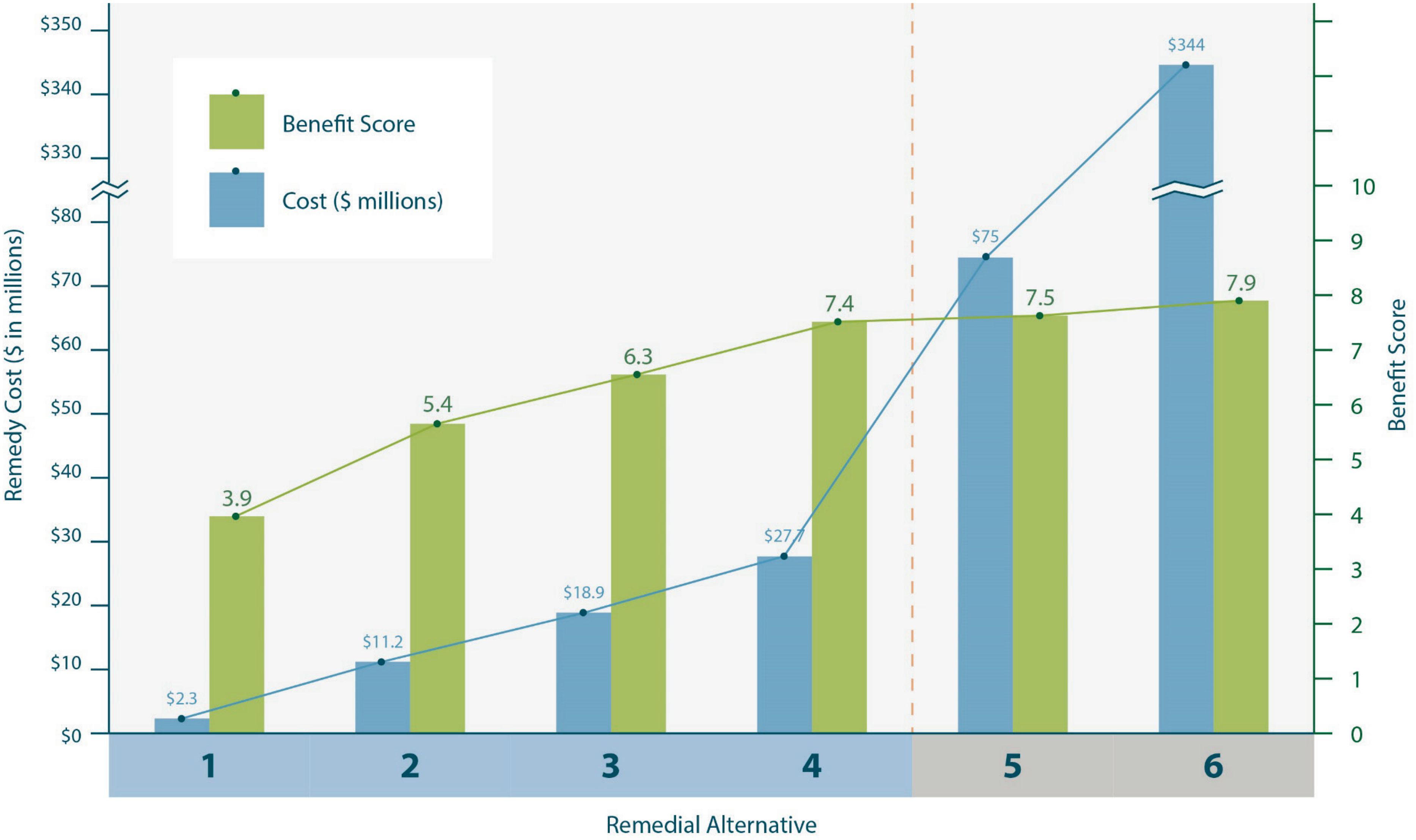


Plate 11-2
Summary of MTCA Disproportionate Cost Analysis
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

12 PREFERRED REMEDIAL ALTERNATIVE

The preceding sections present and evaluate six site-wide remedial alternatives that represent a range of remedial technologies and process options. This section identifies the recommended cleanup action alternative for the site, consistent with MTCA requirements and expectations for remedial actions. As discussed in Section 11.2.6, the community's comments will also be considered by Ecology when selecting the cleanup remedy for the site under MTCA. The final remedy selected by Ecology will include a schedule, Compliance Monitoring Plan, and financial assurance requirements; in addition, a "lead agency" is required to conduct a review for any proposal that involves government "action," as defined in SEPA rules (WAC 197-11-704), to consider the environmental consequences of a proposal before taking action.

12.1 Factors Influencing Recommended Alternative Identification

Several factors influenced the identification of the recommended remedial alternative, including the CSM (see Section 7), regulatory expectations and ARARs (see Section 8), and the alternatives evaluation (see Section 11.2), as summarized in the following subsections. The preferred alternative was selected with input from Ecology with an emphasis on the permanence of the remedy.

12.1.1 Conceptual Site Model Summary

Understanding the nature and extent of contamination, fate and transport characteristics, and potential exposure pathways and receptors for principal site COCs is important in identifying appropriate remedial actions for a site. Formulated based on knowledge gained through the RI (see Sections 1 to 6), the CSM describes each of these three components. The key elements of the CSM influencing identification of a recommended cleanup action alternative are as follows:

- **Limited Number of Well-Understood and Localized COCs.** Principal site COCs in soil/solid media are fluoride, cyanide, and PAH compounds. These compounds are typically encountered at aluminum smelter sites, and treatment technologies to address these COCs are well understood and documented. At the Former Reynolds Plant, these compounds are associated with former smelter operations and are generally present in localized areas, including the landfills and fill deposits. Consolidation and containment of residual materials in this manner is also typical for aluminum smelter site remediation and serves to limit potential exposure to COCs.

- **Current Site Conditions Are Protective to Potential Receptors.** The Former Reynolds Plant is located within an industrial land use corridor, zoned for industrial use, and located adjacent to other industrial facilities. Surface soil quality throughout the majority of the Former Reynolds Plant is protective of industrial workers and terrestrial organisms. Industrial workers are not exposed to materials contained in landfills and fill deposits during normal on-site work activities. Results from extensive testing of CDID ditch waters and surface waters of the Columbia River adjacent to the site verifies that current site conditions are not impacting these resources.
- **Natural Geochemistry of the Site Limits Migration of COCs.** Fluoride is the principal COC for site groundwater. Leaching of fluoride from source areas is limited by the geochemical properties of the soils, solid media, and groundwater. Multiple geochemical processes have been observed and documented at the site (see Section 6) that serve to limit fluoride mobility. These processes provide redundant levels of protection against the migration of fluoride. The primary attenuation mechanism is associated with the abundance of calcium available from soil minerals which far exceeds the amount of fluoride in groundwater. Because of this condition, the fluoride plume is essentially arrested in time and space, both now and for thousands of years into the future.

12.1.2 Summary of Regulatory Expectations and ARARs

A final cleanup action for the site must comply with applicable state and federal laws (see Section 8.3) and comply with cleanup standards (see Section 8.4). Additionally, where appropriate for the site in question, final cleanup actions must meet Ecology's general expectations for MTCA remedial actions (see Section 11). The key regulatory requirements and expectations influencing identification of a recommended cleanup action alternative are as follows:

- **Consistency with Capping ARARs.** Section 8.3.3 specifies ARARs that potentially apply to closures of fill deposits and landfills involving caps. These cap ARARs are performance-based and allow for different cap materials and construction and an evaluation of overall relative performance in design selection, with the overall goal of minimizing infiltration through contained materials. Site-specific performance of different types of caps was evaluated quantitatively in two sections of this report, as explained in the following:

  - Section 6 evaluates the effects of reducing infiltration in varying degrees through caps overlying fill deposits and landfills on fluoride concentrations and distribution in groundwater. Reductions in infiltration on the order of 50 to 100 percent do not appreciably improve groundwater quality over current conditions but may decrease the potential for riverward migration of the fluoride plume in the East Groundwater Area.
  - Section 9.3.1 presents a quantitative analysis of various cap designs and concludes that performance of a low-permeability soil cap and composite cap would be essentially the same, thereby eliminating more costly composite caps from further consideration. The cleanup action alternatives include either soil covers or low-permeability soil caps. While this analysis indicates that low-permeability soil caps reduce infiltration to a greater degree than soil covers, fate and transport modeling indicates there is very little resulting net benefit to groundwater quality achieved by this reduction in infiltration.

- **Application of Conditional Point of Compliance for Groundwater.** As discussed in Sections 8.5.3 and 9.5.4.1 and based on the DCA (see Section 11.2), it is not practicable to meet the standard POC in groundwater for fluoride within a reasonable restoration time frame. As discussed in Section 11.2.3, even implementation of Alternative 6, considered to be a permanent cleanup action, may require a very long restoration time frame due to the limited solubility of fluorite that has precipitated in groundwater beneath source areas. In other words, dissolved concentrations of fluoride are expected to persist for a long time following source area excavations. In accordance with WAC 173-340-720(8)(c), where a conditional POC is proposed, it must be demonstrated that the site cleanup will include all practical methods of treatment. Therefore, the inclusion of treatment technologies to address source areas and groundwater was considered in identifying a recommended cleanup action alternative for the site.

- **Expectations for Cleanup Action Alternatives.** Based on WAC 173-340-370 and as discussed in Plate 10-2, several expectations for cleanup action alternatives are relevant to the Former Reynolds Plant:
  - WAC 173-340-370(3). The need to use engineering controls, such as containment, is recognized for sites such as the Former Reynolds Plant that contain large volumes of material with relatively low levels of hazardous substances where treatment is impracticable.
  - WAC 173-340-370(4). Ecology expects that measures such as capping will be taken to prevent precipitation and subsequent runoff from coming into contact with contaminated materials.
  - WAC 173-340-370(5). When materials are left on site at concentrations above cleanup levels, it is expected they will be consolidated to the maximum extent practicable to minimize the potential for direct contact and migration of hazardous substances. Alternative 4 provides the greatest amount of consolidation of the alternatives considered.
  - WAC 173-340-370(6). For facilities adjacent to a surface water body, Ecology expects that active measures will be taken to minimize releases to surface water. Alternative 4 provides additional groundwater treatment to protect surface water bodies near the Closed BMP Facility with the inclusion of a PRB in the northwest corner of the West Groundwater Area.
  - WAC 173-340-370(7)(b). Sections 6 and 7 demonstrate that leaving COCs on-site during the restoration time frame does not pose an unacceptable threat to human health or the environment; all receptors including industrial workers and surface water are protected under current conditions, and fluoride in groundwater is not migrating. Any additional cleanup actions will reinforce and ensure longevity of this protection well into the future.
  - WAC 173-340-370(7)(c). Finally, natural geochemical attenuation processes are well documented at the site and expected to continue for the foreseeable future.
- **Minimum Requirements for Groundwater Cleanup Actions.** It has been demonstrated by the DCA that a permanent cleanup action is not practicable for the Former Reynolds Plant. WAC 173-340-360(2)(c)(ii) specifies requirements for nonpermanent groundwater cleanup actions including the following:

- Treatment or removal of the source of the release shall be conducted for liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile hazardous substances, or hazardous substances that cannot be reliably contained.
- Groundwater containment, including barriers or hydraulic control through groundwater pumping (or both), shall be implemented to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater volume affected by the hazardous substances.

COCs at the Former Reynolds Plant can be reliably contained; in fact, natural geochemical processes at the site are effectively doing so under current conditions before implementation of a final cleanup action. Any additional groundwater containment systems, such as PRBs, would serve to bolster the existing processes that are preventing migration of fluoride in groundwater.

12.1.3 Alternatives Evaluation Summary

Each of the six alternatives described in Section 10 were included in a disproportionate cost analysis (see Section 11.2), where they were evaluated using the following seven MTCA criteria as listed in WAC 173-340-360(3)(f): protectiveness, permanence, cost, effectiveness over the long term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. The evaluation also considered whether a cleanup action provides for a reasonable restoration timeframe (WAC 173-340-360(4)).

The results of the DCA indicate that Alternative 4 is permanent to the maximum extent practicable. Alternative 3 also meets the four MTCA threshold criteria[4] and achieves cleanup levels for all media at a conditional POC at the end of construction. The alternative makes use of treatment as a permanent groundwater remedial technology and includes consolidation of large waste volumes. However, Alternative 4 provides a somewhat more permanent remedy because low-permeability soil caps will substantially prevent

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[4] Listed in Section 11.1.1—protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring.

precipitation and subsequent runoff from coming into contact with contaminated materials. Given site conditions (proximity to ecological receptors, protection of deep wells, and long restoration time frames) a more permanent solution is warranted. Alternative 4 is more permanent and provides additional source control, reduction in infiltration in capped areas, and may reduce the restoration time frame in comparison to Alternative 3. Therefore, the additional costs associated with Alternative 4 in comparison to Alternative 3 are not disproportionate in comparison to the additional benefits provided.

The MTCA evaluation and DCA presented in the draft FS were revised to consider public concerns voiced during the public comment period. Using the criteria in MTCA, Alternative 4 is identified as the preferred alternative for the site because it is permanent to the maximum extent practicable. This alternative blends a number of remedial technologies, including removal, consolidation, capping, groundwater treatment, and monitored natural attenuation, resulting in a cost-effective approach for addressing site COCs. Alternatives 5 and 6 are much more costly and provide little or no incremental benefits in comparison to Alternative 4.

12.2 Description of Preferred Alternative

Components of the preferred remedial alternative are shown on Figure 12-1 and summarized in Plates 12-1 and 12-2. Details for the active components of the alternative are provided in the following subsections:

Plate 12-1 Components of the Preferred Remedial Alternative

Remedial Action Type	Preferred Alternative Component
Institutional Controls	Filing of environmental covenant to limit consumption of site groundwater as drinking water and activities potentially encountering or disturbing hazardous materials
Natural Attenuation	Natural geochemistry at the site limits migration of fluoride in groundwater to off-site receptors
In Situ Treatment	Construction of two PRBs to intercept and treat groundwater
	Backfilling on-site ditches that intercept groundwater, with an upgrade to reactive backfill within select SUs
Waste and Sediment Consolidation	Focused remedial excavation and on-site consolidation of six SUs, including two outside of the CDID levee
On-site Containment	Construction of low-permeability caps over areas with soils, landfills, and fill deposits exceeding cleanup levels
Off-site Disposal	Removal and disposal of materials from two SUs, where COCs exceed cleanup levels
Other	Long-term monitoring of surface water and groundwater at points of compliance

Notes:
CDID = Consolidated Diking Improvement District
COC = contaminant of concern
PRB = permeable reactive barrier
SU = site unit

Plate 12-2 Preferred Alternative: Proposed Remedial Actions by Site Unit

Site Unit	Description	Proposed Remedial Action				
		Excavate and Off-Site Disposal	Excavation and On-Site Consolidation	Reactive Backfill Below Water Line	Low-Permeability Soil Cap[2]	PRB
SU1	Landfill #2 (Industrial)				x	
SU2	Fill Deposit B-3 (Residual Carbon)		Eastern and western portions[1,6]		Center portion	
SU3	Fill Deposit B-2 (Residual Carbon)		x[1,3,8]	x		
SU4	Former Cryolite Ditches			x[5]		
SU5	Former Stockpile Area		x[1,3,8]	x		
SU6	Fill Deposit B-1 (Residual Carbon)				x	
SU7	Fill Deposit A (Spent Lime)				x	
SU8	Landfill #1 (Floor Sweeps)		x[4,7]			

Site Unit	Description	Proposed Remedial Action				
		Excavate and Off-Site Disposal	Excavation and On-Site Consolidation	Reactive Backfill Below Water Line	Low-Permeability Soil Cap[2]	PRB
SU9	Pitch Storage Area	x[3]				
SU10	Landfill #3 (Construction Debris)		x[1,7]			
SU11	Flat Storage Area	x[1]				
SU12	Vicinity of Outfall 002A		x[1,9]			
Other	PRB west of SU2; PRB northwest of Closed BMP Facility					x

Notes:
1 = Followed by backfill with general fill.
2 = Finished operating surface would be hydroseed.
3 = Finished operating surface would be gravel.
4 = Followed by new soil cover. Finished operating surface would be hydroseed.
5 = Railroad and angle ditches would receive a 6-inch reactive cover. Cryolite ditches would receive reactive fill below the water line and general fill above.
6 = Excavated material would be consolidated within the same SU.
7 = Excavated material would be transferred to SU7 prior to capping of SU7.
8 = Excavated material would be transferred to SU6 prior to capping of SU6.
9 = Excavated material would be transferred to SU2 prior to capping of SU2.
BMP = Black Mud Pond
PRB = permeable reactive barrier
SU = site unit

12.2.1 Landfill and Fill Deposits

Due to natural site conditions (e.g., geochemistry and upward hydraulic gradients) and limited off-site impacts to surface water and groundwater, several of the landfill and fill deposit areas for this site are suitable candidates for remedial actions with the goal of long-term containment. Remedial actions would also include excavation, consolidation, and/or off-site disposal of specific SUs to minimize the potential for direct contact and migration of hazardous substances.

The site has several areas containing soils/solid media and waste with COC concentrations above cleanup levels:

- Three landfills: Landfill #2 (SU1), Landfill #1 (SU8), and Landfill #3(SU10)

- Several fill deposits: Fill Deposit B-3 (SU2), Fill Deposit B-2 (SU3), Fill Deposit B-1 (SU6), and Fill Deposit A (SU7)
- Three storage areas: Former Stockpile Area (SU5), Pitch Storage Area (SU9), Flat Storage Area (SU11)

Alternative 4 includes the excavation and consolidation of materials from select SUs to other areas prior to installation of low-permeability soil caps. Materials excavated from Landfill #1 (SU8) and Landfill #3 (SU10) would be consolidated within Fill Deposit A (SU7). Materials excavated from Fill Deposit B-2 (SU3) and Former Stockpile Area (SU5) would be consolidated within Fill Deposit B-2 (SU6). SU8 would receive a new soil cover and hydroseed, whereas SU10 would be backfilled with general fill. SU3 and SU5 would be backfilled with general fill and reactive fill (see Section 12.2.2) and resurfaced with gravel. The eastern and western portions of SU2 would be excavated and consolidated within the same SU to minimize the potential for direct contact and migration of hazardous substances; the excavated area would be filled with reactive fill (see Section 12.2.2) below the water line and general fill above the water line.

Post consolidation, three areas would be covered with a low permeability soil cap to prevent future exposure to the affected material. The design of the cap would consist of a 12-inch layer of moderately compacted low-permeability soil, overlain by a geocomposite drainage layer, overlain by a 12-inch operating surface, such as vegetative layer or structural fill (see Figure 9-1). Some moderate consolidation and grading of individual areas are likely to occur to facilitate post-construction drainage and to minimize the overall footprint of source material. SUs that would receive a low permeability cap are SUs 1, 2 (post partial excavation and consolidation of eastern and western portions and post transfer of materials from SU12 [see Section 12.2.3]), 6 (post transfer of materials from SUs 3 and 5), and 7 (post transfer of materials from SUs 8 and 10).

The Pitch and Flat Storage Areas (SUs 9 and 11) are isolated and comparatively small in volume; under Alternative 4, they would be addressed by excavation and off-site disposal (see Section 12.2.3).

12.2.2 Groundwater

As discussed in the CSM (see Sections 6 and 7), groundwater concentrations of fluoride exceed MCLs in portions of the West Groundwater Area and East Groundwater Area and in a localized area adjacent to the southeast debris fill area. Natural geochemical processes occurring in site soils and groundwater, however, limit the migration of fluoride both laterally and vertically; in addition, site hydrogeologic conditions (i.e., upward hydraulic gradients) protect deep groundwater from fluoride transport. Nevertheless, Alternative 4 includes groundwater treatment to provide continued protection of groundwater and surface water receptors from the migration of site COCs.

Alternative 4 includes the construction of two PRBs—vertical trenches, perpendicular to contaminated groundwater flow, that are backfilled with selected reactive media—to further limit the mobility of contaminants in groundwater and satisfy Ecology's requirements for groundwater cleanup actions. One 350-feet-long PRB would be located at the western perimeter of SU2, where groundwater flows from the site towards CDID Ditch No 14. The other 725-feet-long PRB would be "L-shaped" and located northwest of the Closed BMP Facility (see Figure 12-1). The PRBs would consist of mineral amendments such as calcite, in the form of limestone, to remove high concentrations of fluoride from water and apatite, in the form of bone meal, to reduce low fluoride concentrations further (see Appendix K). PRB width, depth, and composition will depend on a number of factors including treatment longevity, cost, and other design considerations (see Table K-2 of Appendix K) and will be determined after the CAP and Consent Decree are established for the site by Ecology.

As discussed in Section 9.5.4, other groundwater technologies, such as pump and treat systems, were considered but not deemed practical for this site due to the anticipated high number of extraction wells and large volume of water to be extracted and treated prior to being discharged. Moreover, a dewatering scenario using the groundwater model indicated that half of the pumped water would come from the Columbia River based on proximity to the extraction wells.

Alternative 4 also includes the use of reactive backfill for select areas. Similar to the PRB composition, the reactive backfill would have mineral amendments, such as calcite and apatite, to reduce fluoride concentrations in groundwater flowing through the backfill.

Below the water line, Fill Deposit B-3 (SU2 in the eastern and western areas), Fill Deposit B-2 (SU3), and the Former Stockpile Area (SU5) would receive reactive backfill post-excavation; the Former Cryolite Ditches (SU4) and Former Stockpile Area (SU5) would receive reactive backfill to augment the geochemical and other interactions occurring at the point of exchange between groundwater and ditch water. Above the water line, the areas would receive general fill.

Section 2.2.4 of Appendix H describes and presents the results of reactive transport model simulations of Alternative 4. The simulations assumed the excavation and capping elements of Alternative 4, but conservatively did not include emplacement of reactive backfill below the water line or PRBs. Figures 36, 37, and 38 of Appendix H illustrate the extent of simulated East Groundwater Area fluoride plume at 200, 1,000, and 2,000 years after implementation of Alternative 4, respectively. Figures 39, 40, and 41 of Appendix H illustrate the extent of the simulated West Groundwater Area fluoride plume 200, 1,000, and 2,000 years after implementation of Alternative 4, respectively.

12.2.3 Other Components

Other components of Alternative 4 include the excavation of sediment near an outfall to the Columbia River and consolidation of that sediment in SU2, removal and off-site disposal of isolated areas of contamination, institutional controls to restrict certain current and future site activities, and long-term monitoring to verify remedy effectiveness and natural attenuation of groundwater and surface water resources at the points of compliance.

Alternative 4 includes the wet-excavation and consolidation of sediment in the vicinity of Outfall 002A (SU12). Excavated material would be transferred to SU2 prior to the capping of SU2. SU12 would then be returned to grade with clean river sand.

Small, isolated areas of material with COCs exceeding cleanup levels are practicable to remove. Alternative 4 includes the excavation and off-site disposal of soil from the Pitch Storage (SU9) and Flat Storage Areas (SU11); SU9 would receive a gravel surface and SU11 would be backfilled with general fill. Excavation and off-site disposal will minimize the need for long-term management of the impacted material on-site and remove smaller source areas. Material from SU9 could potentially designate as dangerous waste due to elevated PAH concentrations. If so, it would be transported to a Subtitle C facility, which was assumed for the purposes of preparing the alternatives cost estimate. Material from SU11 is expected to designate as solid waste and would be transported to a Subtitle D facility. The finished operating surface of the Pitch Storage Area would be gravel, whereas the Flat Storage Area would be backfilled with general fill.

An environmental covenant would be filed to limit consumption of site groundwater as drinking water, the disturbance of soil covers, and activities potentially encountering or disturbing hazardous materials. An environmental covenant or other equivalent institutional control (e.g., Consent Decree requirement) would also be executed to ensure implementation of appropriate construction methods for future land use development as needed, including subsurface utilities and structural piling.

Long-term monitoring would be conducted to verify remedy effectiveness and natural attenuation of groundwater and surface water resources at the points of compliance. Existing monitoring well locations may be decommissioned if they are in the footprint of an excavation or cap, or additional wells may be installed to obtain samples closer to a POC.

12.3 Basis for Identification of Preferred Alternative

The preferred alternative was selected with input from Ecology with an emphasis on permanence. The following attributes contribute to the provisional identification of Alternative 4 as the preferred remedial alternative under MTCA remedy selection criteria (WAC 173-340-360):

- Complies with MTCA and with other applicable standards and laws
- Achieves human health and environmental protection in a relatively rapid time frame, compared with the range of alternatives evaluated and to the extent practicable with respect to groundwater restoration
- Reduces the volume of affected media and waste in the environment
- Includes protective, engineered in situ confinement of residual carbon fill deposits that are not practicable to remove

- Consolidates impacted soils/solid media remaining on site to the extent practicable, consistent with Ecology expectations for remedial alternatives (WAC-173-340-370)
- Has minimal and manageable short-term construction risks, compared with the range of alternatives evaluated
- Uses multiple technologies to provide maximum long-term effectiveness
- Is implementable
- Is protective under the industrial land uses for which the property is zoned as has historically been used; land use is consistent with the uses at surrounding properties
- Is cost effective, relative to the range of alternatives evaluated

When compared with the recommended alternative, the costs associated with implementing other alternatives with a potential for additional environmental benefit (i.e., Alternatives 5 and 6) are disproportionate and do not provide any significant incremental degree of increased environmental protectiveness (see Section 11.2.9).

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TABLES

Table 5-1
Screening Levels

Parameters	Surface Water			Groundwater			Soil, Landfill, and Fill Deposits		Sediment			
	Screening Level	Units	ARAR	Screening Level	Units	ARAR	Screening Level (mg/kg)	ARAR	SQV[5]		Units (Dry Weight)	ARAR
									SCO/SL1	CSL/SL2		
Inorganic Parameters												
Cyanide[1]	0.0052	mg/L	WAC 173-201A	0.2	mg/L	MCL	70,000 / 65.7	Method C Industrial / TEE[4]	--	--	--	--
Fluoride	4.0	mg/L	MCL	4.0	mg/L	MCL	210,000 / 2,110	Method C Industrial[8] / TEE[4]	1,900	--	mg/kg	Background[7]
Sulfate	250	mg/L	Secondary MCL	250	mg/L	Secondary MCL	None	--	--	--	--	--
Arsenic[2]	0.005	mg/L	Method A	0.005 / 0.042	mg/L	Method A / Background Groundwater	20/88	Method A Industrial/ Method C Industrial	14	120	mg/kg	WAC 173-204
Cadmium	0.00025	mg/L	USEPA CWA	0.005	mg/L	MTCA Method A	2	Method A Industrial	2.1	5.4	mg/kg	WAC 173-204
Chromium[3]	0.010	mg/L	WAC 173-201A	0.050	mg/L	MTCA Method A	19	Method A Industrial	72	88	mg/kg	WAC 173-204
Copper	0.0035	mg/L	WAC 173-201A	1.3	mg/L	MCL	140,000	Method C Industrial	400	1,200	mg/kg	WAC 173-204
Lead	0.00054	mg/L	WAC 173-201A	0.015	mg/L	MTCA Method A	1,000	Method A Industrial	360	1,300	mg/kg	WAC 173-204
Mercury	0.000012	mg/L	WAC 173-201A	0.002	mg/L	MTCA Method A	2	Method A Industrial	0.66	0.8	mg/kg	WAC 173-204
Nickel	0.052	mg/L	USEPA CWA	0.10	mg/L	MCL	38	Background Soil	26	110	mg/kg	WAC 173-204
Organic Parameters												
Benzo(a)pyrene	0.2 / 0.03	µg/L	MCL / MTCA Method B Surface Water	0.1	µg/L	MTCA Method A	2	Method A Industrial	--	--	--	--
Naphthalene	--	µg/L	--	160	µg/L	MTCA Method A	5	Method A Industrial	--	--	--	--
Total cPAHs TEQ	0.2 / 0.03	µg/L	MCL / MTCA Method B Surface Water	0.1	µg/L	MTCA Method A	2	Method A Industrial	--	--	--	--
Total PAHs[6]	--	µg/L	--	--	µg/L	--	--	--	17	30	mg/kg	WAC 173-204
Total PCB Aroclors	0.024	µg/L	WAC 173-201A	0.1	µg/L	MTCA Method A	10	Method A Industrial	0.11	2.5	mg/kg	WAC 173-204
TPH-Diesel	--	µg/L	--	500	µg/L	MTCA Method A	2,000	Method A Industrial	340.00	510.0	mg/kg	WAC 173-204
TPH-Heavy Oil	--	µg/L	--	500	µg/L	MTCA Method A	2,000	Method A Industrial	3,600.00	4,400.0	mg/kg	WAC 173-204
TPH-Mineral Oil	--	µg/L	--	500	µg/L	MTCA Method A	4,000	Method A Industrial	--	--	--	--

Notes:

Background Soil = Washington state-wide background values as estimated using 90th percentile concentrations in Ecology publication #94-115 (*Natural Background Soil Metals Concentrations in Washington State*)

Background Groundwater = Background estimated using the 90th percentile concentrations of Cowlitz County groundwater data available from the State Department of Health.

MTCA Method A = Groundwater and Soil Cleanup Levels presented in Tables 173-340-720-1 and 173-340-745-1

MTCA Method B = Surface Water Cleanup Levels as calculated according to WAC 173-340-730

Method C Industrial = MTCA Method C Industrial Soil Cleanup Levels (standard values, direct contact) [WAC 173-340-745]

MCL = State Drinking Water Maximum Contaminant Level [WAC 246-290-310]

Secondary MCL = State Drinking Water Secondary MCL [WAC 246-290-310]

1 = Surface Water and Groundwater samples are analyzed as free cyanide; Soil, Landfill, and Fill Deposit samples are analyzed as total cyanide.

2 = The site is located in an area of Cowlitz County known to contain elevated levels of naturally occurring arsenic, iron and manganese in groundwater. Data available from the State Department of Health for Cowlitz County for the period 2001-2011 indicate an arsenic concentration range of up to 55 µg/L in monitored water system wells, with a median value of 10 µg/L and a 90-percentile value of 42 µg/L. Consistent with MTCA provisions (WAC 173-340-709(3)), groundwater data were compared to the 90-percentile of the background concentrations.

3 = Surface Water and Soil are analyzed as Cr(VI); Groundwater is analyzed as Cr(Total)

4 = The TEE protective soil concentration is only applicable to soil in areas of the property exhibiting suitable habitat for wildlife receptors; all soil results are screened to both MTCA and TEE criteria. These values do not apply to developed portions of the property, to landfill or fill deposit contents, or to soils deeper than 6 feet.

5 = Sediment Quality Values (SQVs) from Table VI of WAC 173-204-563 as presented in *Sediment Management Standards Final Rule [WAC 173-204]* Ecology, February 22, 2013. Results from confirmatory bioassays may be used to demonstrate compliance with SCO and/or CSL criteria as defined in the rule.

6 = Total PAHs screening level = Sum of LPAH and HPAH concentrations (dry weight; freshwater total) per the *Sediment Management Standards Final Rule [WAC 173-204]* Ecology, February 22, 2013.

Table 5-1
Screening Levels

7 = The criteria listed for fluoride is 1,900 mg/kg, which is based on a range of background fluoride values for the Western US (USGS, 1974, 1984).
USGS (U.S. Geological Survey), 1974. Selenium, Fluorine, and Arsenic in Surficial Materials of the Conterminous United States. Geological Survey Circular 692.
USGS, 1984. *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States.* USGS Professional Paper 1270.

8 = MTCA Method C Industrial soil cleanup level for fluoride provides protection against direct-contact exposures for industrial workers. Refer to Section 8.3.4.2 for a discussion of groundwater protection. Described in that section values protective of groundwater were determined to be 83,900 mg/kg for values enriched with calcium or 3,100 mg/kg for other materials containing elevated fluoride.

-- = not available or not applicable
µg/L = micrograms per liter
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
ARAR = Applicable or Relevant and Appropriate Requirement
cPAH = carcinogenic polycyclic aromatic hydrocarbon
Cr = chromium
CSL/SL2 = Cleanup Screening Level/Screening Level 2
CWA = Clean Water Act
HPAH = high-molecular-weight polycyclic aromatic hydrocarbon
LPAH = low-molecular-weight polycyclic aromatic hydrocarbon
MCL = maximum contaminant level
MTCA = Model Toxics Control Act
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
TEE = Terrestrial Ecological Evaluation
TEQ = Benzo(a)pyrene toxicity equivalent concentration
TPH = total petroleum hydrocarbons
USEPA = U.S. Environmental Protection Agency
SQV = sediment quality value
SCO/SL1 = Sediment Cleanup Objective/Screening Level 1
WAC = Washington Administrative Code

Table 5-2
Fluoride and Cyanide Results: Landfill and Fill Deposits

		Analyte	Fluoride	Cyanide, total	Cyanide, Weak Acid Dissociable (WAD)
		Unit	mg/kg	mg/kg	mg/kg
		Soil SL	210,000	70,000	
Location	**Sample ID**	**Sample Depth**			
Landfill #2 (Industrial)					
	AQ-ILF-01-0-11	0 - 11 ft	**48,300**	**53.7**	**2.70**
	AQ-ILF-02-0-12	0 - 12 ft	**62,000**	**10.4**	**0.444 J**
	AQ-ILF-03-0-12	0 - 12 ft	**48,700**	**13.4**	0.289 U
	AQ-ILF-04-0-14	0 - 14 ft	**87,100**	**13.8**	**0.813**
	AQ-ILF-05-0-14	0 - 14 ft	**34,800**	**34.1**	**0.690**
	S3-A-022707	0.5 - 1 ft	**412**	**0.97**	0.32 U
Landfill #1 (Floor Sweeps)					
	AQ-FSL-01-0-12	0 - 12 ft	**91,600**	**64.2**	**7.28**
	AQ-FSL-02-0-16	0 - 16 ft	**75,600**	**102**	**2.11**
	AQ-FSL-03-1-8.5	1 - 8.5 ft	**23,800**	**23.6**	**2.22**
	S2-A-022707	0.5 - 1 ft	**436**	**3.0**	0.33 U
Fill Deposit B-2 (Residual Carbon)					
	AQ-ECA-01-2-5	2 - 5 ft	**30,900**	**90.5**	**48.6**
	AQ-ECA-02-1-5	1 - 5 ft	**46,200**	**26**	**1.13**
	AQ-ECA-03-1-7	1 - 7 ft	**34,300**	**5.36**	**4.3**
	AQ-ECA-04-2-8	2 - 8 ft	**40,200**	**18.4**	**2.75**
Fill Deposit B-3 (Residual Carbon)					
	AQ-BMD-01-2-5	2 - 5 ft	**35,700**	**2.85 J**	**0.344**
	AQ-BMD-02-1.5-5.5	1.5 - 5.5 ft	**41,500**	**2.7 J**	**0.857**
	AQ-BMD-03-2-8	2 - 8 ft	**44,500**	**4.42 J**	**2.56**
	AQ-BMD-04-1-7	1 - 7 ft	**31,900**	**34.2 J**	**5.89**
	AQ-BMD-05-1-6	1 - 6 ft	**46,000**	**10.8 J**	**7.09**
	AQ-BMD-06-1.5-5.5	1.5 - 5.5 ft	**42,500**	**4.29 J**	**3.39**
	AQ-BMD-07-1-3	1 - 3 ft	**47,000**	**25.9 J**	**8.86**
	AQ-BMD-08-2-4	2 - 4 ft	**40,600**	**16.2**	**4.6 J**
Fill Deposit B-1 (Residual Carbon)					
	AQ-BMP-01-2-16	2 - 16 ft	**53,200**	**2.57 J**	**1.79**
	AQ-BMP-02-1-15	1 - 15 ft	**43,700**	**2.35 J**	**0.311**
	AQ-BMP-03-2-16	2 - 16 ft	**55,800**	**15.5**	**1.8 J**
	AQ-BMP-04-1.5-13.5	1.5 - 13.5 ft	**69,900**	**12.8**	**9.65 J**
	AQ-BMP-05-1.5-15.5	1.5 - 15.5 ft	**47,100**	**9.67**	**1.31 J**
Fill Deposit A (Spent Lime)					
	AQ-WMP-01-2.5-7.5	2.5 - 7.5 ft	**76,000**	**4.64 J**	0.405 U
	AQ-WMP-02-2-8	2 - 8 ft	**47,000**	**86.3 J**	**0.864**
	AQ-WMP-03-2-6	2 - 6 ft	**52,000**	**2.04 J**	0.38 U
	AQ-WMP-04-2-8	2 - 8 ft	**31,400**	**51.2 J**	**1.26**

Table 5-2
Fluoride and Cyanide Results: Landfill and Fill Deposits

		Analyte	Fluoride	Cyanide, total	Cyanide, Weak Acid Dissociable (WAD)
		Unit	mg/kg	mg/kg	mg/kg
		Soil SL	210,000	70,000	
Location	**Sample ID**	**Sample Depth**			
Landfill #3 (Construction Debris)					
	AQ-SSA7-03-4-5	4 - 5 ft	**1,650**	**4.19**	--
	AQ-SSA7-03-11-12	11 - 12 ft	**170**	**-- R**	--
	AQ-SSA7-04-8-9	8 - 9 ft	**274**	0.307 UJ	--
	AQ-SSA7-04-1.5-2	1.5 - 2 ft	**21,900**	**12.9**	--
	AQ-SSA7-05-0-1	0 - 1 ft	**9,390**	**7.46**	--
	AQ-SSA7-05-2-3	2 - 3 ft	**31,700**	**10**	--
	AQ-SSA7-05-6-7	6 - 7 ft	**8,930**	**24.4**	--
	AQ-SSA7-05-12-13	12 - 13 ft	**2,020**	**2.6**	--
	AQ-SSA7-06-0-1	0 - 1 ft	**1,140**	**12.1**	--
	AQ-SSA7-06-4-5	4 - 5 ft	**16,600**	**1.66**	--
	AQ-SSA7-06-8-9	8 - 9 ft	**1,050**	**9.58**	--
	AQ-SSA7-07-0-1	0 - 1 ft	**23,500**	**3.8**	--
	AQ-SSA7-07-3-4	3 - 4 ft	**2,720**	**3.55**	--
	AQ-SSA7-07-6-7	6 - 7 ft	**191**	**1.58**	--
Other Soil Samples					
	SPLP1-S-022707	0.5 - 1 ft	**533**	**0.62**	--
	SPLP2-S-022707	0.5 - 1 ft	**732**	**0.745**	--
	SPLP3-S-022707	0.5 - 1 ft	**784**	**0.178**	--
	SPLP4-WM-022707	0.5 - 1 ft	**29,500**	--	--

Notes:

1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

2 = Results are reported in dry weight basis.

3 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than Soil screening level.

Underline = Non-detected concentration is above one or more identified screening levels

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

ft = feet

LDC = Laboratory Data Consultants

mg/kg = milligrams per kilogram

R = rejected result

SL = screening level

USEPA = U.S. Environmental Protection Agency

WAD = weak acid dissociable

Table 5-3
Metals Results: Landfill and Fill Deposits

	Location	**Fill Deposit B-2 (Residual Carbon)**				**Fill Deposit B-3 (Residual Carbon)**							
	Location ID	**AQ-ECA-01**	**AQ-ECA-02**	**AQ-ECA-03**	**AQ-ECA-04**	**AQ-BMD-01**	**AQ-BMD-02**	**AQ-BMD-03**	**AQ-BMD-04**	**AQ-BMD-05**	**AQ-BMD-06**	**AQ-BMD-07**	**AQ-BMD-08**
	Sample ID	**AQ-ECA-01-2-5**	**AQ-ECA-02-1-5**	**AQ-ECA-03-1-7**	**AQ-ECA-04-2-8**	**AQ-BMD-01-2-5**	**AQ-BMD-02-1.5-5.5**	**AQ-BMD-03-2-8**	**AQ-BMD-04-1-7**	**AQ-BMD-05-1-6**	**AQ-BMD-06-1.5-5.5**	**AQ-BMD-07-1-3**	**AQ-BMD-08-2-4**
	Sample Date	**10/19/2012**	**10/19/2012**	**10/19/2012**	**10/19/2012**	**10/22/2012**	**10/22/2012**	**10/22/2012**	**10/22/2012**	**10/22/2012**	**10/22/2012**	**10/22/2012**	**10/23/2012**
	Depth	**2 - 5 ft**	**1 - 5 ft**	**1 - 7 ft**	**2 - 8 ft**	**2 - 5 ft**	**1.5 - 5.5 ft**	**2 - 8 ft**	**1 - 7 ft**	**1 - 6 ft**	**1.5 - 5.5 ft**	**1 - 3 ft**	**2 - 4 ft**
	Sample Type	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Metals (mg/kg)	**Soil SL**												
Antimony	1,400	1.72 U	1.74 U	1.48 U	1.65 U	1.4 UJ	**0.864 J**	1.45 U	1.32 U	1.38 U	1.45 U	**0.962 J**	**1.63**
Arsenic	20/88	**3.67**	**2.37 J**	**2.33 J**	**5.57**	**3.71**	**4.09**	**3.63**	**2.29 J**	**2.79**	**3.3**	**5.95**	**5.27**
Barium	--	**144***	**122***	**117***	**167**	**105***	**120***	**132***	**119***	**115***	**126***	**136**	**156***
Beryllium	7,000	**11.9**	**12**	**12.4**	**6.99**	**8.58**	**12.6**	**10.5**	**8.9**	**11**	**11.3**	**15.3**	**14.9**
Cadmium	2	1.72 U	1.74 U	**0.857 J**	**0.972 J**	1.4 U	1.37 U	1.45 U	1.32 U	1.38 U	1.45 U	1.6 U	**0.913 J**
Chromium	19/2,000 (VI/III)	**16.5**	**15.5**	**13.4**	**23.9**	**15.2**	**21**	**22.1**	**11.9**	**16.6**	**18.7**	**24.4**	**23.8**
Copper	140,000	**132**	**218**	**208**	**111**	**134**	**257**	**143**	**140 J**	**135**	**171**	**244**	**171**
Lead	1,000	**12.3**	**12.6**	**9.26**	**16**	**11.3**	**15.7**	**13.6**	**10.3**	**11.7**	**14.5**	**17.6**	**17.5**
Mercury	2	0.137 U	0.139 U	0.118 U	0.132 U	0.112 U	0.11 U	**0.0707 J**	0.106 U	0.11 U	0.116 U	**0.07 J**	0.13 U
Nickel	--	**164**	**181**	**229**	**143**	**121**	**250**	**170**	**143 J**	**135**	**202**	**362**	**368**
Selenium	1,800	3.43 U	3.48 U	2.96 U	3.3 U	2.8 U	2.74 U	2.89 U	2.65 U	2.76 U	2.91 U	3.21 U	3.26 U
Silver	1,800	1.72 U	1.74 U	1.48 U	1.65 U	1.4 U	1.37 U	1.45 U	1.32 U	1.38 U	1.45 U	1.6 U	1.63 U
Thallium	--	1.72 U	1.74 U	1.48 U	1.65 U	1.4 U	1.37 U	1.45 U	1.32 U	1.38 U	1.45 U	1.6 U	1.63 U
Zinc	1,100,000	**27.1**	**22.5**	**20.1**	**37.2**	**30.2**	**36.1**	**39.2**	**21.6**	**19.8**	**23.6**	**43.6**	**25**

Table 5-3
Metals Results: Landfill and Fill Deposits

	Location	Fill Deposit B-1 (Residual Carbon)					Fill Deposit A (Spent Lime)			
	Location ID	AQ-BMP-01	AQ-BMP-02	AQ-BMP-03	AQ-BMP-04	AQ-BMP-05	AQ-WMP-01	AQ-WMP-02	AQ-WMP-03	AQ-WMP-04
	Sample ID	AQ-BMP-01-2-16	AQ-BMP-02-1-15	AQ-BMP-03-2-16	AQ-BMP-04-1.5-13.5	AQ-BMP-05-1.5-15.5	AQ-WMP-01-2.5-7.5	AQ-WMP-02-2-8	AQ-WMP-03-2-6	AQ-WMP-04-2-8
	Sample Date	10/24/2012	10/24/2012	10/23/2012	10/23/2012	10/23/2012	10/24/2012	10/24/2012	10/24/2012	10/24/2012
	Depth	2 - 16 ft	1 - 15 ft	2 - 16 ft	1.5 - 13.5 ft	1.5 - 15.5 ft	2.5 - 7.5 ft	2 - 8 ft	2 - 6 ft	2 - 8 ft
	Sample Type	C	C	C	C	C	C	C	C	C
Metals (mg/kg)	**Soil SL**									
Antimony	1,400	**1.48 J**	**0.852 J**	**1.65**	**1.79**	**1.07 J**	**1.11 J**	**1.59**	**1.51 J**	**1.13 J**
Arsenic	20/88	**10**	**4.55**	**7.47**	**11.3**	**5.84**	**9.87**	**14.1**	**11.4**	**6.94**
Barium	--	**58.8***	**93.2***	**218***	**116**	**100***	**17.7***	**34.2***	**19.5**	**24.2***
Beryllium	7,000	**14.4**	**13.9**	**22.1**	**22.2**	**19.6**	**3.94 J**	6.28 U	**2.19**	1.49 U
Cadmium	2	1.81 U	**1.14 J**	**0.904 J**	**1.29 J**	1.47 U	1.62 U	1.57 U	1.56 U	1.49 U
Chromium	19/2,000 (VI/III)	**16.9**	**43.1**	**30.4**	**30.2**	**36.3**	**2.42 J**	**2.37 J**	**3.59**	**3.54**
Copper	140,000	**124**	**248**	**128**	**128**	**303**	**76.3**	**68**	**133**	**107**
Lead	1,000	**15.5**	**16.6**	**22.2**	**33.2**	**17.6**	**0.824 J**	**0.957 J**	**1.03 J**	**0.836 J**
Mercury	2	0.144 U	**0.131**	**0.119 J**	**0.14**	**0.106 J**	0.129 U	0.126 U	0.125 U	0.119 U
Nickel	--	**375**	**251**	**502**	**890**	**388**	**31.7**	**37.7**	**42.7**	**39.2**
Selenium	1,800	3.61 U	2.71 U	3.23 U	3.44 U	2.94 U	3.23 U	**2.02 J**	**2.11 J**	**1.61 J**
Silver	1,800	1.81 U	1.35 U	1.61 U	1.72 U	1.47 U	1.62 U	1.57 U	1.56 U	1.49 U
Thallium	--	1.81 U	1.35 U	1.61 U	1.72 U	1.47 U	1.62 U	1.57 U	1.56 U	1.49 U
Zinc	1,100,000	**48**	**106**	**57.6**	**98.9**	**78.5**	**4.3 J**	6.28 U	6.24 U	**3.08 J**

Table 5-3
Metals Results: Landfill and Fill Deposits

	Location	**Landfill #2 (Industrial)**						**Landfill #1 (Floor Sweeps)**			
	Location ID	**S3**	**AQ-ILF-01**	**AQ-ILF-02**	**AQ-ILF-03**	**AQ-ILF-04**	**AQ-ILF-05**	**S2**	**AQ-FSL-01**	**AQ-FSL-02**	**AQ-FSL-03**
	Sample ID	**S3-A-022707**	**AQ-ILF-01-0-11**	**AQ-ILF-02-0-12**	**AQ-ILF-03-0-12**	**AQ-ILF-04-0-14**	**AQ-ILF-05-0-14**	**S2-A-022707**	**AQ-FSL-01-0-12**	**AQ-FSL-02-0-16**	**AQ-FSL-03-1-8.5**
	Sample Date	**2/27/2007**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/18/2012**	**2/27/2007**	**10/18/2012**	**10/18/2012**	**10/18/2012**
	Depth	**0.5 - 1 ft**	**0 - 11 ft**	**0 - 12 ft**	**0 - 12 ft**	**0 - 14 ft**	**0 - 14 ft**	**0.5 - 1 ft**	**0 - 12 ft**	**0 - 16 ft**	**1 - 8.5 ft**
	Sample Type	**D**	**C**	**C**	**C**	**C**	**C**	**D**	**C**	**C**	**C**
Metals (mg/kg)	**Soil SL**										
Antimony	1,400	6 U	**2.27**	**2.02**	**27.6**	**4.03**	**1.79**	6 U	**4.33**	**3.33**	**1.07 J**
Arsenic	20/88	6 U	**9.58**	**10**	**59.7**	**11.4**	**6.94**	6 U	**15.1**	**10.1**	**2.05 J**
Barium	--	--	**47.7**	**57.9**	**46.4**	**73**	**64.9**	--	**75.8**	**65.7**	**129**
Beryllium	7,000	**0.2**	**12.7**	**20.1**	**12.6**	**21.8**	**8**	**0.2**	**14.6**	**12.4**	**11.8**
Cadmium	2	0.3 U	**1.76**	**2.22**	**1.82**	**1.7**	**1.78**	0.2 U	**3.68**	**2.32**	1.38 U
Chromium	19/2,000 (VI/III)	**16.3**	**35.6**	**75.9**	**217**	**58.8**	**25**	**16.8**	**100**	**43**	**25.1**
Copper	140,000	**27.6**	**1,020**	**296**	**420**	**391**	**307**	**24**	**736**	**619**	**207**
Lead	1,000	**7**	**59.4**	**60.5**	**71.1**	**136**	**49.5**	**3**	**100**	**93.3**	**16.8**
Mercury	2	**0.06**	0.0965 U	0.0984 U	**0.132**	**0.0786 J**	**0.149**	0.06 U	**0.405**	**0.194**	**0.167**
Nickel	--	**16**	**222**	**201**	**213**	**302**	**185**	**14**	**265**	**193**	**43**
Selenium	1,800	6 U	2.41 U	2.46 U	2.41 U	**1.41 J**	2.44 U	6 U	**2.93**	2.69 U	2.75 U
Silver	1,800	--	1.21 U	1.23 U	1.21 U	1.28 U	1.22 U	--	1.33 U	1.35 U	1.38 U
Thallium	--	6 U	1.21 U	1.23 U	1.21 UJ	1.28 U	1.22 U	6 U	**0.826 J**	1.35 U	1.38 U
Zinc	1,100,000	**57**	**1,490**	**133**	**157**	**164**	**81.5**	**48**	**153**	**236**	**61.1**

Table 5-3
Metals Results: Landfill and Fill Deposits

Notes:
* = Results marked with an asterisk indicate that the it was dry weight corrected by the lab using a different % solids value.
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
C = Composite sample (of multiple discrete intervals)
D = Discrete sample
ft = feet
LDC = Laboratory Data Consultants
mg/kg = milligrams per kilogram
SL = screening level
USEPA = U.S. Environmental Protection Agency

FINAL VALIDATED DATA

Table 5-4
TCLP Metals Results: Landfill and Fill Deposits

Location		Fill Deposit B-2 (Residual Carbon)	Fill Deposit B-3 (Residual Carbon)	Fill Deposit B-1 (Residual Carbon)	Fill Deposit A (Spent Lime)	Landfill #2 (Industrial)					Landfill #1 (Floor Sweeps)		
Location ID		AQ-ECA-04	AQ-BMD-07	AQ-BMP-04	AQ-WMP-03	AQ-ILF-01	AQ-ILF-02	AQ-ILF-03	AQ-ILF-04	AQ-ILF-05	AQ-FSL-01	AQ-FSL-02	AQ-FSL-03
Sample Date		10/19/2012	10/22/2012	10/23/2012	10/24/2012	10/17/2012	10/17/2012	10/17/2012	10/17/2012	10/18/2012	10/18/2012	10/18/2012	10/18/2012
Sample ID		AQ-ECA-04-2-8	AQ-BMD-07-1-3	AQ-BMP-04-1.5-13.5	AQ-WMP-03-2-6	AQ-ILF-01-0-11	AQ-ILF-02-0-12	AQ-ILF-03-0-12	AQ-ILF-04-0-14	AQ-ILF-05-0-14	AQ-FSL-01-0-12	AQ-FSL-02-0-16	AQ-FSL-03-1-8.5
Depth		2 - 8 ft	1 - 3 ft	1.5 - 13.5 ft	2 - 6 ft	0 - 11 ft	0 - 12 ft	0 - 12 ft	0 - 14 ft	0 - 14 ft	0 - 12 ft	0 - 16 ft	1 - 8.5 ft
Sample Type		C	C	C	C	C	C	C	C	C	C	C	C
TCLP Metals (µg/L)	DW Threshold Value												
Antimony	--	50 U	--	50 U	--	50 U	50 U	**31.5 J**	**27.5 J**	**27.5 J**	50 U	50 U	50 U
Arsenic	**5,000**	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Barium	**100,000**	**569**	500 U	**304 J**	500 U	500 U	500 U	500 U	500 U	**256 J**	**297 J**	**386 J**	500 U
Beryllium	--	50 U	--	**72**	--	100 U	**63 J**	**54 J**	**154**	**96 J**	**129**	**98 J**	**67 J**
Cadmium	**1,000**	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	**27.5 J**	**29 J**	50 U	50 U
Chromium	**5,000**	100 U	100 U	100 U	100 U	100 U	100 U	100 U	**138**	100 U	**254**	**94.5 J**	100 U
Copper	--	**614**	--	**334**	--	**5,040**	**206 J**	**750**	**665**	**3,030**	**225 J**	**314**	**687**
Lead	**5,000**	50 U	50 U	50 U	50 U	50 U	50 U	**36.5 J**	**112**	50 U	**65.5**	50 U	50 U
Mercury	**200**	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Nickel	--	**104**	**--**	**274**	--	**447**	**562**	**847**	**2,060**	**1,700**	**1,440**	**1,000**	**166**
Selenium	**1,000**	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Silver	**5,000**	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Thallium	--	50 U	--	50 U	--	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Zinc	--	250 U	--	**146 J**	--	**17,200**	**704**	**682**	**2,190**	**746**	**1,450**	**2,860**	**290**

Notes:

1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

2 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than the DW Threshold Value (WAC 173-303-090(8)(c))

Underlined = Non-detected concentration is above one or more identified screening levels

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

-- = Results not reported or not applicable

µg/L = micrograms per liter

C = Composite sample (of multiple discrete intervals)

TCLP = Toxicity Characteristic Leaching Procedure

DW = dangerous waste

ft = feet

LDC = Laboratory Data Consultants

WAC = Washington Administrative Code

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		Landfill #1 (Floor Sweeps)	Landfill #2 (Industrial)	Landfill #3 (Construction Debris)				
Location ID		S2	S3	AQ-SSA7-03		AQ-SSA7-04		AQ-SSA7-05
Sample Date		S2-A-022707	S3-A-022707	10/27/2011	10/27/2011	10/27/2011	10/27/2011	10/27/2011
Sample ID		2/27/2007	2/27/2007	AQ-SSA7-03-4-5	AQ-SSA7-03-11-12	AQ-SSA7-04-8-9	AQ-SSA7-04-1.5-2	AQ-SSA7-05-0-1
Depth		0.5 - 1 ft	0.5 - 1 ft	4 - 5 ft	11 - 12 ft	8 - 9 ft	1.5 - 2 ft	0 - 1 ft
Sample Type		D	D	D	D	D	D	D
Conventional Parameters	**Soil SL**							
Total organic carbon	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (µg/kg)								
1-Methylnaphthalene	--	--	--	**17.5 J**	6.92 U	8.26 U	**24.6 J**	32.2 U
2-Methylnaphthalene	--	64 U	63 U	**30.1 J**	6.92 U	8.26 U	**37.9**	**19.4 J**
Acenaphthene	--	64 U	63 U	**67.9**	3.46 U	4.13 U	**28.4**	**129**
Acenaphthylene	--	64 U	63 U	**20.5**	3.46 U	4.13 U	**35.8**	**19.4**
Anthracene	--	64 U	63 U	**285**	3.46 U	4.13 U	**143**	**339**
Benzo(a)anthracene	--	64 U	**150**	**2,910**	**2.9 J**	**10.7**	**745**	**1,080**
Benzo(a)pyrene	2,000	64 U	**110**	**5,040**	3.46 U	**10.8**	**922**	**1,290**
Benzo(b)fluoranthene[1]	--	64 U	**300**	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	64 U	**110**	--	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	**12,000**	**4.7 J**	**12.8**	**3,200**	**4,110**
Benzo(g,h,i)perylene	--	64 U	**120**	**5,920**	**2.12 J**	**6.64**	**1,270**	**2,340**
Chrysene	--	64 U	**340**	**6,350**	**3.37 J**	**11.5**	**1,680**	**1,960**
Dibenzo(a,h)anthracene	--	64 U	63 U	**1,440**	3.46 U	4.13 U	**280**	**377**
Dibenzofuran	--	--	--	**67.6**	3.46 U	4.13 U	**35.4**	**89.2**
Fluoranthene	--	64 U	**500**	**3,650**	**7.3**	**14.3**	**1,600**	**2,620**
Fluorene	--	64 U	63 U	**63.6**	3.46 U	4.13 U	**34.9**	**97.2**
Indeno(1,2,3-c,d)pyrene	--	64 U	**90**	**4,580**	**2.3 J**	**5.78**	**1,040**	**1,710**
Naphthalene	5,000	--	--	**69.5**	6.92 U	8.26 U	**56.5**	**48.3**
Phenanthrene	--	64 U	**250**	**1,280**	**3.17 J**	**4.38**	**749**	**1,690**
Pyrene	--	64 U	**490**	**4,650**	**6.42**	**20.5**	**1,560**	**2,360**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--	--
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	64 U	**200**	**7,200**	**2.93 J**	**14**	**1,500**	**2,040**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		Landfill #3 (Construction Debris)						
Location ID		**AQ-SSA7-05**			**AQ-SSA7-06**			**AQ-SSA7-07**
Sample Date		**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/28/2011**
Sample ID		**AQ-SSA7-05-2-3**	**AQ-SSA7-05-6-7**	**AQ-SSA7-05-12-13**	**AQ-SSA7-06-0-1**	**AQ-SSA7-06-4-5**	**AQ-SSA7-06-8-9**	**AQ-SSA7-07-0-1**
Depth		**2 - 3 ft**	**6 - 7 ft**	**12 - 13 ft**	**0 - 1 ft**	**4 - 5 ft**	**8 - 9 ft**	**0 - 1 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**
Conventional Parameters	**Soil SL**							
Total organic carbon	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (µg/kg)								
1-Methylnaphthalene	--	**40.2 J**	**285**	7.19 U	31.5 U	**86.4**	6.8 U	**21.1 J**
2-Methylnaphthalene	--	**68.3**	**230**	7.19 U	31.5 U	**138**	6.8 U	**30.8 J**
Acenaphthene	--	**158**	**379**	3.59 U	**76.4**	**309**	3.4 U	**120**
Acenaphthylene	--	**68.2**	60.1 U	3.59 U	**29.9**	**118**	**2.22 J**	**48.8**
Anthracene	--	**596 J**	**980**	3.59 U	**191**	**970**	**5.07**	**407**
Benzo(a)anthracene	--	**3,590**	**2,620**	**1.96 J**	**1,050**	**2,700**	**4.97**	**1,340**
Benzo(a)pyrene	2,000	**8,640 J**	**2,400**	**1.88 J**	**1,810**	**3,230**	**9.22**	**1,540**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**19,000 J**	**8,520**	**4.89 J**	**5,640**	**8,220**	**48.4**	**4,040**
Benzo(g,h,i)perylene	--	**16,300 J**	**2,750**	**2.48 J**	**3,090**	**3,290**	**58.3**	**1,640**
Chrysene	--	**9,180**	**6,590**	**3.09 J**	**1,860**	**4,440**	**12**	**2,070**
Dibenzo(a,h)anthracene	--	**2,490 J**	**650**	3.59 U	**581**	**727**	**7.23**	**386**
Dibenzofuran	--	**143 J**	**213**	3.59 U	**32.6**	**309**	3.4 U	**85.6**
Fluoranthene	--	**6,890 J**	**8,680**	**1.95 J**	**1,630**	**6,640**	**6.76**	**3,240**
Fluorene	--	**96.7 J**	**275**	3.59 U	**45.5**	**256**	3.4 U	**117**
Indeno(1,2,3-c,d)pyrene	--	**9,790 J**	**2,320**	3.59 U	**2,440**	**2,850**	**39.3**	**1,500**
Naphthalene	5,000	**193**	**376 J**	7.19 U	**19.6 J**	**513**	6.8 U	**135**
Phenanthrene	--	**2,250 J**	**5,250**	**1.83 J**	**620**	**4,570**	**3.71**	**1,680**
Pyrene	--	**7,740**	**8,320**	**3.31 J**	**1,610**	**6,060**	**7.34**	**2,920**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--	--
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**12,000 J**	**3,900**	**2.95 J**	**2,800**	**4,700**	**19.3**	**2,300**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		**Landfill #3 (Construction Debris)**		**Landfill #2 (Industrial)**				
Location ID		**AQ-SSA7-07**		**AQ-ILF-01**	**AQ-ILF-02**	**AQ-ILF-02**	**AQ-ILF-03**	**AQ-ILF-04**
Sample Date		**10/28/2011**	**10/28/2011**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/17/2012**
Sample ID		**AQ-SSA7-07-3-4**	**AQ-SSA7-07-6-7**	**AQ-ILF-01-0-11**	**AQ-ILF-02-0-12**	**AQ-ILF-02-0-12SPLIT**	**AQ-ILF-03-0-12**	**AQ-ILF-04-0-14**
Depth		**3 - 4 ft**	**6 - 7 ft**	**0 - 11 ft**	**0 - 12 ft**	**0 - 12 ft**	**0 - 12 ft**	**0 - 14 ft**
Sample Type		**D**	**D**	**C**	**C**	**C**	**C**	**C**
Conventional Parameters	**Soil SL**							
Total organic carbon	--	--	--	**21 J**	**17 J**	--	**8.3 J**	**8 J**
Polycyclic Aromatic Hydrocarbons (µg/kg)								
1-Methylnaphthalene	--	47.6 U	7.96 U	**2,850**	**3,420**	**1,650 J**	1,420 U	3,100 U
2-Methylnaphthalene	--	**32.8 J**	7.96 U	**4,210**	**4,760**	**2,350 J**	1,420 U	3,100 U
Acenaphthene	--	**105**	3.98 U	**42,100**	**28,200**	**15,400 J**	**2,000**	**22,600**
Acenaphthylene	--	**22.8 J**	3.98 U	**638 J**	762 U	**344 J**	712 U	1,550 U
Anthracene	--	**247**	3.98 U	**30,000**	**31,900**	**21,000 J**	**6,520**	**17,800**
Benzo(a)anthracene	--	**807**	3.98 U	**149,000**	**167,000**	**181,000 J**	**113,000**	**64,400**
Benzo(a)pyrene	2,000	**1,030**	3.98 U	**212,000**	**227,000**	**271,000 J**	**114,000**	**113,000**
Benzo(b)fluoranthene[1]	--	--	3.98 U	**438,000**	**520,000**	--	**252,000**	**282,000**
Benzo(k)fluoranthene[1]	--	--	3.98 U	**105,000**	**112,000**	--	**73,100**	**73,700**
Benzo(b,k)fluoranthene	--	**2,710**	--	--	--	**690,000 J**	--	--
Benzo(g,h,i)perylene	--	**1,610**	3.98 U	**141,000**	**147,000**	**209,000 J**	**72,600**	**160,000**
Chrysene	--	**1,360**	3.98 U	**225,000**	**288,000**	**335,000 J**	**249,000**	**143,000**
Dibenzo(a,h)anthracene	--	**254**	3.98 U	**47,900**	**54,000**	**59,300 J**	**29,300**	**25,000**
Dibenzofuran	--	**53.5**	3.98 U	**10,800**	**15,100**	**8,190 J**	**1,190**	**5,840**
Fluoranthene	--	**1,890**	3.98 U	**229,000**	**243,000**	**288,000 J**	**177,000**	**153,000**
Fluorene	--	**78.9**	3.98 U	**12,700**	**17,100**	**9,340 J**	**1,720**	**5,940**
Indeno(1,2,3-c,d)pyrene	--	**1,170**	3.98 U	**178,000**	**186,000**	**208,000 J**	**82,100**	**127,000**
Naphthalene	5,000	**125**	7.96 U	**9,240**	**6,600**	**2,790 J**	**1,280 J**	**2,090 J**
Phenanthrene	--	**1,060**	3.98 U	**109,000**	**106,000**	**73,000 J**	**15,600**	**59,900**
Pyrene	--	**1,990**	3.98 U	**218,000**	**233,000**	**285,000 J**	**187,000**	**141,000**
Total PAHs (U = 1/2)[2,3]	--	--	--	**2,164,438 J**	**2,390,461**	**2,660,364 J**	**1,379,186 J**	**1,400,145 J**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**1,540**	3.98 U	**306,040**	**333,780**	**388,180 J**	**171,440**	**171,640**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		**Landfill #2 (Industrial)**	**Landfill #1 (Floor Sweeps)**				**Fill Deposit B-2 (Residual Carbon)**	
Location ID		**AQ-ILF-05**	**AQ-FSL-01**	**AQ-FSL-01**	**AQ-FSL-02**	**AQ-FSL-03**	**AQ-ECA-01**	**AQ-ECA-02**
Sample Date		**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/19/2012**	**10/19/2012**
Sample ID		**AQ-ILF-05-0-14**	**AQ-FSL-01-0-12**	**AQ-FSL-01-0-12SPLIT**	**AQ-FSL-02-0-16**	**AQ-FSL-03-1-8.5**	**AQ-ECA-01-2-5**	**AQ-ECA-02-1-5**
Depth		**0 - 14 ft**	**0 - 12 ft**	**0 - 12 ft**	**0 - 16 ft**	**1 - 8.5 ft**	**2 - 5 ft**	**1 - 5 ft**
Sample Type		**C**	**C**	**C**	**C**	**C**	**C**	**C**
Conventional Parameters	**Soil SL**							
Total organic carbon	--	**6.6 J**	**14 J**	--	**10 J**	**21 J**	**36 J**	**350 J**
Polycyclic Aromatic Hydrocarbons (µg/kg)								
1-Methylnaphthalene	--	3,460 U	**92,900**	**73,300 J**	**1,890 J**	**9,130**	**514**	2490 U
2-Methylnaphthalene	--	3,460 U	**133,000**	**95,700 J**	**2,680 J**	**15,700**	**671**	2490 U
Acenaphthene	--	**8,950**	**672,000**	**1,030,000 J**	**29,200**	**72,500**	**3,440**	**821 J**
Acenaphthylene	--	1,730 U	**5,360**	**9,830 J**	1,820 U	1,030 U	**447**	1,250 U
Anthracene	--	**14,500**	**288,000**	**604,000 J**	**29,200**	**266,000**	**155,000**	**27,600**
Benzo(a)anthracene	--	**81,800**	**239,000**	**247,000 J**	**60,000**	**116,000**	**68,500**	**40,100**
Benzo(a)pyrene	2,000	**155,000**	**231,000**	**189,000 J**	**76,700**	**104,000**	**10,500**	**10,000**
Benzo(b)fluoranthene[1]	--	**284,000**	**449,000**	--	**172,000**	**153,000**	--	--
Benzo(k)fluoranthene[1]	--	**81,500**	**125,000**	--	**46,300**	**50,300**	--	--
Benzo(b,k)fluoranthene	--	--	--	**561,000 J**	--	--	**65,300**	**62,200**
Benzo(g,h,i)perylene	--	**193,000**	**221,000**	**145,000 J**	**80,600**	**61,700**	**1,980**	**4,020**
Chrysene	--	**145,000**	**348,000**	**476,000 J**	**118,000**	**140,000**	**146,000**	**88,100**
Dibenzo(a,h)anthracene	--	**30,700**	**40,600**	**31,100 J**	**14,700**	**13,700**	**1,120**	**1,790**
Dibenzofuran	--	**3,710**	**272,000**	**352,000 J**	**10,500**	**91,500**	**15,600**	**2,390**
Fluoranthene	--	**135,000**	**1,420,000**	**1,500,000 J**	**199,000**	**310,000**	**803,000**	**247,000**
Fluorene	--	**5,170**	**384,000**	**550,000 J**	**14,800**	**222,000**	**969**	1,250 U
Indeno(1,2,3-c,d)pyrene	--	**159,000**	**199,000**	**142,000 J**	**64,800**	**65,900**	**2,150**	**4,620**
Naphthalene	5,000	3,460 U	**201,000**	**147,000 J**	**5,120**	**35,000**	**522**	2,490 U
Phenanthrene	--	**59,200**	**1,540,000**	**1,780,000 J**	**106,000**	**677,000**	**810,000 J**	**107,000**
Pyrene	--	**132,000**	**1,060,000**	**1,110,000 J**	**166,000**	**250,000**	**612,000**	**192,000**
Total PAHs (U = 1/2)[2,3]	--	**1,494,585**	**7,920,860**	**9,042,930 J**	**1,198,400 J**	**2,653,945**	**2,697,713 J**	**792,626 J**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**220,150**	**339,740**	**291,870 J**	**113,660**	**145,290**	**25,667**	**21,752**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		Fill Deposit B-2 (Residual Carbon)		Fill Deposit B-3 (Residual Carbon)				
Location ID		AQ-ECA-03	AQ-ECA-04	AQ-BMD-01	AQ-BMD-02	AQ-BMD-03	AQ-BMD-04	AQ-BMD-05
Sample Date		10/19/2012	10/19/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012
Sample ID		AQ-ECA-03-1-7	AQ-ECA-04-2-8	AQ-BMD-01-2-5	AQ-BMD-02-1.5-5.5	AQ-BMD-03-2-8	AQ-BMD-04-1-7	AQ-BMD-05-1-6
Depth		1 - 7 ft	2 - 8 ft	2 - 5 ft	1.5 - 5.5 ft	2 - 8 ft	1 - 7 ft	1 - 6 ft
Sample Type		C	C	C	C	C	C	C
Conventional Parameters	**Soil SL**							
Total organic carbon	--	**37 J**	**6.8 J**	**220 J**	**31 J**	**48 J**	**33 J**	**79 J**
Polycyclic Aromatic Hydrocarbons (µg/kg)								
1-Methylnaphthalene	--	**679 J**	2,500 U	2,040 U	1,980 U	2,090 U	5,070 U	2,070 U
2-Methylnaphthalene	--	**791 J**	2,500 U	2,040 U	1,980 U	2,090 U	5,070 U	2,070 U
Acenaphthene	--	**17,400**	1,250 U	1,020 U	989 U	1,040 U	**3,560**	1,040 U
Acenaphthylene	--	**527**	1,250 U	1,020 U	989 U	1,040 U	2,540 U	1,040 U
Anthracene	--	**112,000**	**7,530**	**1,070**	**1,950**	**3,020**	**98,400**	**4,600**
Benzo(a)anthracene	--	**53,700**	**31,000**	**1,890**	**9,870**	**9,260**	**42,200**	**7,520**
Benzo(a)pyrene	2,000	**12,400**	**16,700**	**1,670**	**8,810**	**7,340**	**7,730**	**1,510**
Benzo(b)fluoranthene[1]	--	**45,400**	--	--	--	**26,500 J**	--	--
Benzo(k)fluoranthene[1]	--	**9,400**	--	--	--	**6,630**	--	--
Benzo(b,k)fluoranthene	--	**--**	**66,800**	**9,720**	**57,200**	--	**62,300**	**23,600**
Benzo(g,h,i)perylene	--	**2,750**	**6,830**	**1,790**	**13,700**	**9,140**	**2,720**	**1,660**
Chrysene	--	**116,000**	**72,900**	**5,430**	**35,200**	**20,000 J**	**104,000**	**25,800**
Dibenzo(a,h)anthracene	--	**1,010**	**3,250**	**529 J**	**3,910**	**2,110**	2,540 U	**639 J**
Dibenzofuran	--	**9,270**	**655 J**	1,020 U	989 U	1,040 U	**8,090**	**796 J**
Fluoranthene	--	**553,000**	**145,000**	**7,050**	**21,900**	**35,100**	**411,000**	**56,700**
Fluorene	--	**6,330**	1,250 U	1,020 U	989 U	1,040 U	2,540 U	1,040 U
Indeno(1,2,3-c,d)pyrene	--	**2,550**	**8,120**	**2,070**	**14,200**	**8,500**	**3,220**	**2,000**
Naphthalene	5,000	1,050 U	2,500 U	2,040 U	1,980 U	2,090 U	5,070 U	2,070 U
Phenanthrene	--	**859,000**	**32,000**	5,360 U	**8,880**	**19,300**	**370,000**	**40,800**
Pyrene	--	**489,000**	**140,000**	**6,490**	**21,600**	**31,100**	**299,000**	**38,200**
Total PAHs (U = 1/2)[2,3]	--	**2,291,732 J**	**536,410 J**	**45,489 J**	**202,168**	**183,215 J**	**1,423,635**	**208,490 J**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**24,766**	**28,346**	**3,145.2 J**	**17,680**	**12,840 J**	**19,669**	**5,144 J**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		Fill Deposit B-3 (Residual Carbon)			Fill Deposit B-1 (Residual Carbon)				
Location ID		AQ-BMD-06	AQ-BMD-07	AQ-BMD-08	AQ-BMP-01	AQ-BMP-02	AQ-BMP-03	AQ-BMP-04	AQ-BMP-05
Sample Date		10/22/2012	10/22/2012	10/23/2012	10/24/2012	10/24/2012	10/23/2012	10/23/2012	10/23/2012
Sample ID		AQ-BMD-06-1.5-5.5	AQ-BMD-07-1-3	AQ-BMD-08-2-4	AQ-BMP-01-2-16	AQ-BMP-02-1-15	AQ-BMP-03-2-16	AQ-BMP-04-1.5-13.5	AQ-BMP-05-1.5-15.5
Depth		1.5 - 5.5 ft	1 - 3 ft	2 - 4 ft	2 - 16 ft	1 - 15 ft	2 - 16 ft	1.5 - 13.5 ft	1.5 - 15.5 ft
Sample Type		C	C	C	C	C	C	C	C
Conventional Parameters	**Soil SL**								
Total organic carbon	--	**290 J**	**430 J**	**310 J**	**13 J**	**13 J**	**24**	**8.9**	**52 J**
Polycyclic Aromatic Hydrocarbons (µg/kg)									
1-Methylnaphthalene	--	2,130 U	2,170 U	5,470 U	690 U	1,060 U	6,410 U	2,640 U	5,400 U
2-Methylnaphthalene	--	2,130 U	2,170 U	5,470 U	690 U	1,060 U	6,410 U	2,640 U	5,400 U
Acenaphthene	--	1,060 U	1,090 U	2,730 U	**6,300**	**4,690 J**	**10,300**	**4,010**	**16,200**
Acenaphthylene	--	1,060 U	1,090 U	2,730 U	345 U	531 U	3,200 U	1,320 U	2,700 U
Anthracene	--	**2,400**	**682 J**	**4,270**	**39,000**	**22,800 J**	**100,000**	**14,300**	**90,400**
Benzo(a)anthracene	--	**7,280**	**3,230**	**7,730**	**126,000**	**82,600**	**181,000**	**47,300**	**227,000**
Benzo(a)pyrene	2,000	**1,770**	**2,760**	**5,070**	**86,200**	**54,600**	**98,000**	**35,500**	**116,000**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--	**99,900**	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--	**24,200**	--
Benzo(b,k)fluoranthene	--	**37,200**	**22,100**	**42,100**	**327,000**	**236,000**	**384,000**	--	**457,000**
Benzo(g,h,i)perylene	--	**3,010**	**6,070**	**8,480**	**48,800**	**33,400**	**34,900**	**21,400**	**35,100**
Chrysene	--	**26,300**	**8,640**	**23,700**	**282,000**	**199,000**	**402,000**	**103,000**	**460,000**
Dibenzo(a,h)anthracene	--	**1,330**	**1,910**	**3,050**	**13,500**	**9,090**	**14,500**	**4,770**	**13,600**
Dibenzofuran	--	1,060 U	1,090 U	2,730 U	**2,090**	**1,340 J**	**4,230**	**756 J**	**4,050**
Fluoranthene	--	**21,800**	**8,330**	**38,900**	**772,000**	**490,000**	**1,240,000**	**270,000**	**1,480,000**
Fluorene	--	1,060 U	1,090 U	2,730 U	**4,100**	**2,040 J**	**6,320**	**2,670**	**9,450**
Indeno(1,2,3-c,d)pyrene	--	**3,690**	**7,050**	**9,940**	**48,100**	**32,700**	**41,100**	**20,100**	**40,900**
Naphthalene	5,000	2,130 U	2,170 U	5,470 U	690 U	1,060 U	6,410 U	2,640 U	5,400 U
Phenanthrene	--	**12,300**	2,950 U	**27,600**	**218,000**	**144,000**	**553,000**	**80,400**	**517,000**
Pyrene	--	**18,200**	**8,370**	**33,100**	**693,000**	**393,000**	**1,110,000**	**258,000**	**1,340,000**
Total PAHs (U = 1/2)[2,3]	--	**140,595**	**76,052 J**	**217,605**	**2,667,298**	**1707115.5 J**	**4,190,565**	**990926 J**	**4,816,150**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**6,983**	**6,275**	**11,589**	**140,480**	**92,629**	**164,080**	**56,157**	**194,450**

Table 5-5
PAH Results: Landfill and Fill Deposits

Location		Fill Deposit A (Spent Lime)			
Location ID		**AQ-WMP-01**	**AQ-WMP-02**	**AQ-WMP-03**	**AQ-WMP-04**
Sample Date		**10/24/2012**	**10/24/2012**	**10/24/2012**	**10/24/2012**
Sample ID		**AQ-WMP-01-2.5-7.5**	**AQ-WMP-02-2-8**	**AQ-WMP-03-2-6**	**AQ-WMP-04-2-8**
Depth		**2.5 - 7.5 ft**	**2 - 8 ft**	**2 - 6 ft**	**2 - 8 ft**
Sample Type		**C**	**C**	**C**	**C**
Conventional Parameters	**Soil SL**				
Total organic carbon	--	**0.084 J**	**0.12 J**	**0.092 J**	**0.14 J**
Polycyclic Aromatic Hydrocarbons (µg/kg)					
1-Methylnaphthalene	--	13.3 U	13.5 UJ	63.7 U	9.68 U
2-Methylnaphthalene	--	13.3 U	13.5 UJ	63.7 U	9.68 U
Acenaphthene	--	6.66 U	**4.93 J**	31.8 U	4.84 U
Acenaphthylene	--	6.66 U	6.75 UJ	31.8 U	4.84 U
Anthracene	--	**5.21 J**	28.7 UJ	31.8 U	**19**
Benzo(a)anthracene	--	**110**	**233 J**	**94**	**85**
Benzo(a)pyrene	2,000	**52**	**82.4 J**	**37**	**24**
Benzo(b)fluoranthene[1]	--	--	--	--	**114**
Benzo(k)fluoranthene[1]	--	--	--	--	**34**
Benzo(b,k)fluoranthene	--	**530**	**531 J**	**250**	--
Benzo(g,h,i)perylene	--	**115**	**74 J**	**40**	**16**
Chrysene	--	**469**	**539 J**	**243**	**211**
Dibenzo(a,h)anthracene	--	**28**	**21.4 J**	31.8 U	**3.79 J**
Dibenzofuran	--	6.66 U	**6.85 J**	31.8 U	4.84 U
Fluoranthene	--	**225**	**1,850 J**	**713**	**909**
Fluorene	--	6.66 U	6.75 UJ	31.8 U	4.84 U
Indeno(1,2,3-c,d)pyrene	--	**112**	**74.7 J**	**42**	**14**
Naphthalene	5,000	13.3 UJ	13.5 UJ	63.7 U	9.68 U
Phenanthrene	--	**11**	**372 J**	**16.5 J**	**295**
Pyrene	--	**301**	**1,760 J**	**727**	**840**
Total PAHs (U = 1/2)[2,3]	--	**1,990.28 J**	**5,590.63 J**	**2,353.7 J**	**2,587.79 J**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**134**	**174 J**	**79.8**	**51.0 J**

Table 5-5
PAH Results: Landfill and Fill Deposits

Notes:
1 = When no values are reported for both, see benzo(b+k)fluoranthene results.
2 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.
3 = Total PAHs is the sum of all PAHs listed on this table, if measured.
4 = Total cPAH minimum 7 analytes calculation includes benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene. Per MTCA cleanup regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)" under WAC 173-340-708(e).
5 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
6 = Results are reported in dry weight basis.
7 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Soil screening level
<u>Underlined = Non-detected concentration is above one or more identified screening levels</u>
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
µg/kg = microgram per kilogram
C = Composite sample (of multiple discrete intervals)
D = Discrete sample
cPAH = carcinogenic polycyclic aromatic hydrocarbon
ft = feet
USEPA = United States Environmental Protection Agency
MTCA = Model Toxics Control Act
SL = screening level
TEQ = toxic equivalency
WAC = Washington Administrative Code

Table 5-6
PCB Aroclors Results: Landfill and Fill Deposits

	Location	**Landfill #3 (Construction Debris)**									
	Location ID	**AQ-SSA7-03**		**AQ-SSA7-04**		**AQ-SSA7-05**				**AQ-SSA7-06**	
	Sample ID	**AQ-SSA7-03-4-5**	**AQ-SSA7-03-11-12**	**AQ-SSA7-04-8-9**	**AQ-SSA7-04-1.5-2**	**AQ-SSA7-05-0-1**	**AQ-SSA7-05-2-3**	**AQ-SSA7-05-6-7**	**AQ-SSA7-05-12-13**	**AQ-SSA7-06-0-1**	**AQ-SSA7-06-4-5**
	Sample Date	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**	**10/27/2011**
	Depth	**4 - 5 ft**	**11 - 12 ft**	**8 - 9 ft**	**1.5 - 2 ft**	**0 - 1 ft**	**2 - 3 ft**	**6 - 7 ft**	**12 - 13 ft**	**0 - 1 ft**	**4 - 5 ft**
	Sample Type	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
PCB Aroclors (mg/kg)	**Soil SL**										
Aroclor 1016	--	0.0516 U	0.0114 U	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	0.0105 U	0.012 U
Aroclor 1221	--	0.0516 U	0.0114 U	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	0.0105 U	0.012 U
Aroclor 1232	--	0.0516 U	0.0114 U	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	0.0105 U	0.012 U
Aroclor 1242	--	0.0516 U	0.0114 U	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	0.0105 U	0.012 U
Aroclor 1248	--	**1.61 J**	0.0114 U	0.0124 U	**0.0198 J**	**0.0227 J**	**0.492 J**	**0.168 J**	0.0104 U	0.0105 U	**0.0549 J**
Aroclor 1254	--	**359 J**	0.0114 U	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	**0.0517 J**	0.012 U
Aroclor 1260	--	0.0516 U	0.0114 U	0.0124 U	**0.0394 J**	**0.0576 J**	**0.128 J**	**0.066 J**	0.0104 U	**0.0706 J**	**0.0409 J**
Aroclor 1262	--	0.0103 U	--	0.0124 U	0.0125 U	0.0106 U	0.0123 U	0.0113 U	0.0104 U	0.0105 U	0.012 U
Aroclor 1268	--	**0.106 J**	--	0.0124 U	**0.0307 J**	**0.0335 J**	**0.201 J**	**0.0624 J**	0.0104 U	**0.0721 J**	**0.0427 J**
Total PCB Aroclors (U = 1/2)[4]	10	**2.21 J**	0.0114 U	0.0124 U	**0.127 J**	**0.146 J**	**0.858 J**	**0.330 J**	0.0104 U	**0.226 J**	**0.175 J**

Table 5-6
PCB Aroclors Results: Landfill and Fill Deposits

Location		**Landfill #3 (Construction Debris)**				**Landfill #2 (Industrial)**					
Location ID		**AQ-SSA7-06**	**AQ-SSA7-07**			**S3**	**AQ-ILF-01**	**AQ-ILF-02**	**AQ-ILF-03**	**AQ-ILF-04**	**AQ-ILF-05**
Sample ID		**AQ-SSA7-06-8-9**	**AQ-SSA7-07-0-1**	**AQ-SSA7-07-3-4**	**AQ-SSA7-07-6-7**	**S3-A-022707**	**AQ-ILF-01-0-11**	**AQ-ILF-02-0-12**	**AQ-ILF-03-0-12**	**AQ-ILF-04-0-14**	**AQ-ILF-05-0-14**
Sample Date		**10/27/2011**	**10/28/2011**	**10/28/2011**	**10/28/2011**	**2/27/2007**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/18/2012**
Depth		**8 - 9 ft**	**0 - 1 ft**	**3 - 4 ft**	**6 - 7 ft**	**0.5 - 1 ft**	**0 - 11 ft**	**0 - 12 ft**	**0 - 12 ft**	**0 - 14 ft**	**0 - 14 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**C**	**C**	**C**	**C**	**C**
PCB Aroclors (mg/kg)	**Soil SL**										
Aroclor 1016	--	0.0112 U	0.0118 U	0.0101 U	0.00815 U	0.032 U	0.114 U	0.119 U	0.107 U	0.115 U	0.108 U
Aroclor 1221	--	0.0112 U	0.0118 U	0.0101 U	0.00815 U	0.032 U	0.114 U	0.119 U	0.107 U	0.115 U	0.108 U
Aroclor 1232	--	0.0112 U	0.0118 U	0.0101 U	0.00815 U	0.032 U	0.114 U	0.119 U	0.107 U	0.115 U	0.108 U
Aroclor 1242	--	0.0112 U	0.0118 U	0.0101 U	0.00815 U	0.032 U	0.114 U	0.119 U	0.107 U	**0.0873 J**	**0.0861 J**
Aroclor 1248	--	0.0112 U	**0.152 J**	0.0101 U	0.00815 U	0.032 U	0.114 U	0.119 U	0.107 U	0.115 U	0.108 U
Aroclor 1254	--	**0.0645 J**	0.0118 U	**0.0137 J**	0.00815 U	0.032 U	**0.211**	**0.460**	**3.350**	**0.816**	**2.07**
Aroclor 1260	--	**0.0655 J**	**0.0588 J**	0.0101 U	0.00815 U	0.032 U	**0.162**	**0.394**	**0.443**	**0.287**	**0.686**
Aroclor 1262	--	0.0112 U	--	--	--	--	0.114 U	0.119 U	0.107 U	0.115 U	0.108 U
Aroclor 1268	--	**0.0867 J**	**0.0688 J**	**0.0696 J**	0.00815 U	--	**0.325**	**0.916**	0.107 U	0.115 U	**0.150**
Total PCB Aroclors (U = 1/2)[4]	10	**0.25 J**	**0.309 J**	**0.114 J**	0.00815 U	0.032 U	**1.040**	**2.127**	**4.168**	**1.535 J**	**3.26 J**

Table 5-6
PCB Aroclors Results: Landfill and Fill Deposits

	Location	Landfill #1 (Floor Sweeps)				Fill Deposit B-2 (Residual Carbon)	Fill Deposit B-3 (Residual Carbon)	Fill Deposit B-1 (Residual Carbon)	Fill Deposit A (Spent Lime)
	Location ID	**S2**	**AQ-FSL-01**	**AQ-FSL-02**	**AQ-FSL-03**	**AQ-ECA-03**	**AQ-BMD-03**	**AQ-BMP-04**	**AQ-WMP-04**
	Sample ID	**S2-A-022707**	**AQ-FSL-01-0-12**	**AQ-FSL-02-0-16**	**AQ-FSL-03-1-8.5**	**AQ-ECA-03-1-7**	**AQ-BMD-03-2-8**	**AQ-BMP-04-1.5-13.5**	**AQ-WMP-04-2-8**
	Sample Date	**2/27/2007**	**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/19/2012**	**10/22/2012**	**10/23/2012**	**10/24/2012**
	Depth	**0.5 - 1 ft**	**0 - 12 ft**	**0 - 16 ft**	**1 - 8.5 ft**	**1 - 7 ft**	**2 - 8 ft**	**1.5 - 13.5 ft**	**2 - 8 ft**
	Sample Type	**D**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
PCB Aroclors (mg/kg)	**Soil SL**								
Aroclor 1016	--	0.033 U	0.129 U	0.226 U	0.139 U	0.0342 U	0.0493 U	0.0655 U	0.00586 U
Aroclor 1221	--	0.033 U	0.129 U	0.226 U	0.139 U	0.0342 U	0.0493 U	0.0655 U	0.00586 U
Aroclor 1232	--	0.033 U	0.129 U	0.226 U	0.139 U	0.0377 U	0.0493 U	0.0655 U	0.00586 U
Aroclor 1242	--	0.033 U	**0.251**	**0.455**	0.139 U	0.0377 U	0.0493 U	**0.180**	0.00586 U
Aroclor 1248	--	0.033 U	0.129 U	0.226 U	**1.410**	0.0342 U	**0.172**	0.0655 U	0.00586 U
Aroclor 1254	--	0.033 U	**0.530**	**0.571**	**0.465**	0.0342 U	**0.162**	**0.703**	**0.00483 J**
Aroclor 1260	--	0.033 U	**0.390**	**0.711**	**0.229**	0.0342 U	**0.069**	**0.299**	0.00586 U
Aroclor 1262	--	--	0.129 U	0.226 U	0.139 U	0.0342 U	0.0493 U	0.0655 U	0.00586 U
Aroclor 1268	--	--	**1.130**	**4.730**	**0.455**	0.0342 U	0.0493 U	**0.0566 J**	0.00586 U
Total PCB Aroclors (U = 1/2)[4]	10	0.033 U	**2.624**	**7.032**	**2.907**	0.0377 U	**0.551**	**1.402 J**	**0.02827 J**

Table 5-6
PCB Aroclors Results: Landfill and Fill Deposits

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
4 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all non-detect, the highest reporting limit value is reported as the sum.
🟨 = Detected concentration is greater than Soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
C = Composite sample (of multiple discrete intervals)
D = Discrete sample
ft = feet
LDC = Laboratory Data Consultants
mg/kg = milligrams per kilogram
PCB = polychlorinated biphenyl
SL = screening level
USEPA = U.S. Environmental Protection Agency

Table 5-7
TPH Results: Landfill and Fill Deposits

	Location	**Landfill #3 (Construction Debris)**	
	Location ID	**AQ-SSA7-05**	
	Sample Date	**AQ-SSA7-05-2-3**	**AQ-SSA7-05-6-7**
	Sample ID	**10/27/2011**	**10/27/2011**
	Depth	**2 - 3 ft**	**6 - 7 ft**
	Sample Type	**D**	**D**
Total Petroleum Hydrocarbons (mg/kg)	**Soil SL**		
Diesel range hydrocarbons	2,000	**111**	**1,180**
Oil range hydrocarbons		**270**	**276**

Notes:

1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

2 = Results are reported in dry weight basis.

🟨 = Detected concentration is greater than soil screening level

Underlined = Non-detected concentration is above one or more identified screening levels

Bold = Detected result

D = Discrete sample

ft = feet

LDC = Laboratory Data Consultants

mg/kg = milligrams per kilogram

SL = screening level

TPH = total petroleum hydrocarbons

USEPA = U.S. Environmental Protection Agency

Table 5-8
VOC Results: Landfill and Fill Deposits

Location		Landfill #2 (Industrial)						Landfill #1 (Floor Sweeps)
Location ID		**S3**	**AQ-ILF-02**	**AQ-ILF-03**		**AQ-ILF-04**	**AQ-ILF-05**	**S2**
Sample ID		**S3-A-022707**	**AQ-ILF-02-6-8**	**AQ-ILF-03-8-10**	**AQ-ILF-03-8-10**	**AQ-ILF-04-12-14**	**AQ-ILF-05-10-12**	**S2-A-022707**
Sample Date		**2/27/2007**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/17/2012**	**10/18/2012**	**2/27/2007**
Depth		**0.5 - 1 ft**	**6 - 8 ft**	**8 - 10 ft**	**8 - 10 ft**	**12 - 14 ft**	**10 - 12 ft**	**0.5 - 1 ft**
Sample Type		**D**	**D**	**D**	**FD**	**D**	**D**	**D**
Volatile Organics (µg/kg)	**Soil SL**							
1,2,3-Trichlorobenzene	--	6.7 U	440 U	1,430 U	293 UJ	674 U	510 U	14 U
1,2,3-Trichloropropane	--	2.7 U	88.1 UJ	285 UJ	58.6 UJ	135 UJ	102 UJ	5.7 U
1,2,4-Trichlorobenzene	--	6.7 U	440 U	1,430 U	293 UJ	674 U	510 U	14 U
1,2,4-Trimethylbenzene	--	1.4 U	88.1 U	**151 J**	58.6 UJ	135 U	102 U	2.9 U
1,2-Dibromo-3-chloropropane	--	6.7 U	440 UJ	1,430 UJ	293 UJ	674 UJ	510 UJ	14 U
1,2-Dichlorobenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
1,2-Dichloroethane	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 UJ	2.9 U
1,2-Dichloroethene, cis-	--	1.4 U	44 UJ	143 UJ	29.3 UJ	67.4 UJ	51 U	2.9 U
1,2-Dichloroethene, trans-	--	1.4 U	44 UJ	143 UJ	29.3 UJ	67.4 UJ	51 U	2.9 U
1,2-Dichloropropane	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
1,3,5-Trimethylbenzene (Mesitylene)	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
1,3-Dichlorobenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
1,3-Dichloropropane	--	1.4 U	44 UJ	143 UJ	29.3 UJ	67.4 UJ	51 UJ	2.9 U
1,3-Dichloropropene, cis-	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
1,3-Dichloropropene, trans-	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
1,4-Dichlorobenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
2,2-Dichloropropane	--	1.4 U	88.1 UJ	285 UJ	58.6 UJ	135 UJ	102 UJ	2.9 U
2-Butanone (MEK)	--	**7.0**	881 UJ	2,850 UJ	586 UJ	1,350 UJ	1,020 UJ	**20**
2-Chlorotoluene	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
2-Hexanone (Methyl butyl ketone)	--	6.7 U	881 UJ	2,850 UJ	586 UJ	1,350 UJ	1,020 UJ	14 U
4-Chlorotoluene	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
4-Isopropyltoluene (4-Cymene)	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
Acetone	--	**44**	1,760 UJ	5,700 UJ	1170 UJ	2,690 UJ	2,040 UJ	**120**
Benzene	30	**1.4**	**13.2 J**	71.3 U	14.7 UJ	33.7 U	25.5 U	2.9 U
Bromobenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Bromochloromethane	--	1.4 U	44 UJ	143 UJ	29.3 UJ	67.4 UJ	51 UJ	2.9 U
Bromodichloromethane	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Bromoform (Tribromomethane)	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 UJ	2.9 U
Bromomethane (Methyl bromide)	--	1.4 U	881 U	2,850 U	586 UJ	1,350 U	1,020 U	2.9 U
Carbon disulfide	--	**3.8**	881 U	2,850 U	586 UJ	1,350 U	1,020 U	**4.0**
Carbon tetrachloride (Tetrachloromethane)	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Chlorobenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Chloroethane	--	1.4 U	881 U	2,850 U	586 UJ	1,350 U	1,020 U	2.9 U
Chloroform	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U

Table 5-8
VOC Results: Landfill and Fill Deposits

Location		Landfill #1 (Floor Sweeps)			Fill Deposit B-2 (Residual Carbon)	Fill Deposit B-1 (Residual Carbon)	Fill Deposit A (Spent Lime)	Fill Deposit B-3 (Residual Carbon)
Location ID		**AQ-FSL-01**	**AQ-FSL-02**	**AQ-FSL-03**	**AQ-ECA-03**	**AQ-BMP-02**	**AQ-WMP-02**	**AQ-BMD-01**
Sample ID		**AQ-FSL-01-4-6**	**AQ-FSL-02-14-16**	**AQ-FSL-03-5-7**	**AQ-ECA-03-5-7**	**AQ-BMP-02-11-13**	**AQ-WMP-02-6-8**	**AQ-BMD-01-4-5**
Sample Date		**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/19/2012**	**10/24/2012**	**10/24/2012**	**10/22/2012**
Depth		**4 - 6 ft**	**14 - 16 ft**	**5 - 7 ft**	**5 - 7 ft**	**11 - 13 ft**	**6 - 8 ft**	**4 - 5 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**
Volatile Organics (µg/kg)	**Soil SL**							
1,2,3-Trichlorobenzene	--	561 U	353 U	517 U	621 U	561 U	510 U	897 U
1,2,3-Trichloropropane	--	112 UJ	70.7 UJ	103 UJ	124 UJ	112 UJ	102 UJ	89.7 U
1,2,4-Trichlorobenzene	--	561 U	353 U	517 U	621 U	561 U	510 U	449 U
1,2,4-Trimethylbenzene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
1,2-Dibromo-3-chloropropane	--	561 UJ	353 UJ	517 UJ	621 UJ	561 UJ	510 UJ	449 U
1,2-Dichlorobenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
1,2-Dichloroethane	--	56.1 UJ	35.3 UJ	51.7 UJ	62.1 UJ	56.1 U	51 U	44.9 U
1,2-Dichloroethene, cis-	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
1,2-Dichloroethene, trans-	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
1,2-Dichloropropane	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
1,3,5-Trimethylbenzene (Mesitylene)	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
1,3-Dichlorobenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
1,3-Dichloropropane	--	56.1 UJ	35.3 UJ	51.7 UJ	62.1 UJ	56.1 UJ	51 U	44.9 U
1,3-Dichloropropene, cis-	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
1,3-Dichloropropene, trans-	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
1,4-Dichlorobenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
2,2-Dichloropropane	--	112 UJ	70.7 UJ	103 UJ	124 UJ	112 U	102 U	89.7 U
2-Butanone (MEK)	--	1,120 UJ	707 UJ	1,030 UJ	1,240 UJ	1,120 UJ	1,020 UJ	897 U
2-Chlorotoluene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
2-Hexanone (Methyl butyl ketone)	--	1,120 UJ	707 UJ	1,030 UJ	1,240 UJ	1,120 UJ	1,020 UJ	897 UJ
4-Chlorotoluene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
4-Isopropyltoluene (4-Cymene)	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Acetone	--	2,240 UJ	1,410 UJ	2,070 UJ	2,480 UJ	2,250 UJ	2,040 UJ	1,790 UJ
Benzene	30	28 U	17.7 U	25.9 U	31 U	28.1 U	25.5 U	22.4 U
Bromobenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Bromochloromethane	--	56.1 UJ	35.3 UJ	51.7 UJ	62.1 UJ	56.1 U	51 U	44.9 U
Bromodichloromethane	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Bromoform (Tribromomethane)	--	112 UJ	70.7 UJ	103 UJ	124 UJ	112 UJ	102 UJ	89.7 U
Bromomethane (Methyl bromide)	--	1120 U	707 U	1,030 U	1,240 U	1,120 U	1,020 U	897 U
Carbon disulfide	--	1,120 U	707 U	1,030 U	1,240 U	1,120 U	1,020 U	897 U
Carbon tetrachloride (Tetrachloromethane)	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Chlorobenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Chloroethane	--	1,120 U	707 U	1,030 U	1,240 U	1120 U	1,020 U	897 U
Chloroform	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U

Table 5-8
VOC Results: Landfill and Fill Deposits

Location		Fill Deposit B-3 (Residual Carbon)					
Location ID		AQ-BMD-02	AQ-BMD-03	AQ-BMD-04	AQ-BMD-05	AQ-BMD-06	AQ-BMD-07
Sample ID		AQ-BMD-02-3.5-5.5	AQ-BMD-03-4-6	AQ-BMD-04-3-5	AQ-BMD-05-3-5	AQ-BMD-06-3.5-5.5	AQ-BMD-07-1-3
Sample Date		10/22/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012
Depth		3.5 - 5.5 ft	4 - 6 ft	3 - 5 ft	3 - 5 ft	3.5 - 5.5 ft	1 - 3 ft
Sample Type		D	D	D	D	D	D
Volatile Organics (µg/kg)	**Soil SL**						
1,2,3-Trichlorobenzene	--	942 U	924 U	981 U	1140 U	946 U	1,070 U
1,2,3-Trichloropropane	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
1,2,4-Trichlorobenzene	--	471 U	462 U	490 U	569 U	473 U	534 U
1,2,4-Trimethylbenzene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
1,2-Dibromo-3-chloropropane	--	471 U	462 U	490 U	569 U	473 U	534 U
1,2-Dichlorobenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,2-Dichloroethane	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,2-Dichloroethene, cis-	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,2-Dichloroethene, trans-	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,2-Dichloropropane	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,3,5-Trimethylbenzene (Mesitylene)	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
1,3-Dichlorobenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,3-Dichloropropane	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
1,3-Dichloropropene, cis-	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
1,3-Dichloropropene, trans-	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
1,4-Dichlorobenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
2,2-Dichloropropane	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
2-Butanone (MEK)	--	942 U	924 U	981 U	1,140 U	946 U	1070 U
2-Chlorotoluene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
2-Hexanone (Methyl butyl ketone)	--	942 U	924 U	981 U	1,140 U	946 U	1070 U
4-Chlorotoluene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
4-Isopropyltoluene (4-Cymene)	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Acetone	--	1,880 U	1,850 U	1,960 U	2,280 U	1,890 U	2,140 U
Benzene	30	23.5 U	23.1 U	24.5 U	28.5 U	23.6 U	26.7 U
Bromobenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Bromochloromethane	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Bromodichloromethane	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Bromoform (Tribromomethane)	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Bromomethane (Methyl bromide)	--	942 U	924 U	981 U	1,140 U	946 U	1,070 U
Carbon disulfide	--	942 U	924 U	981 U	1,140 U	946 U	1,070 U
Carbon tetrachloride (Tetrachloromethane)	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Chlorobenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Chloroethane	--	942 U	924 U	981 U	1,140 U	946 U	1,070 U
Chloroform	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U

Table 5-8
VOC Results: Landfill and Fill Deposits

	Location	Landfill #2 (Industrial)						Landfill #1 (Floor Sweeps)
	Location ID	S3	AQ-ILF-02	AQ-ILF-03		AQ-ILF-04	AQ-ILF-05	S2
	Sample ID	S3-A-022707	AQ-ILF-02-6-8	AQ-ILF-03-8-10	AQ-ILF-03-8-10	AQ-ILF-04-12-14	AQ-ILF-05-10-12	S2-A-022707
	Sample Date	2/27/2007	10/17/2012	10/17/2012	10/17/2012	10/17/2012	10/18/2012	2/27/2007
	Depth	0.5 - 1 ft	6 - 8 ft	8 - 10 ft	8 - 10 ft	12 - 14 ft	10 - 12 ft	0.5 - 1 ft
	Sample Type	D	D	D	FD	D	D	D
Chloromethane	--	1.4 U	440 UJ	1,430 UJ	293 UJ	674 UJ	510 U	2.9 U
Dibromochloromethane	--	1.4 U	176 U	570 U	117 UJ	269 U	204 U	2.9 U
Dibromomethane	--	1.4 U	88.1 UJ	285 UJ	58.6 UJ	135 UJ	102 UJ	2.9 U
Dichlorodifluoromethane	--	--	176 U	570 U	117 UJ	269 U	204 U	--
Dichloromethane (Methylene chloride)	20	2.7 U	440 U	1430 U	293 UJ	674 U	510 U	5.7 U
Ethylbenzene	6,000	1.4 U	**29.1 J**	**388**	**27.6 J**	**220**	51 U	2.9 U
Ethylene dibromide (1,2-Dibromoethane)	5	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 UJ	2.9 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	1.4 U	176 U	570 U	117 UJ	269 U	204 UJ	2.9 U
Isopropylbenzene (Cumene)	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
m,p-Xylene	9,000	1.4 U	**59.9 J**	**2,260**	**101**	**471**	**57.1 J**	2.9 U
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	--	6.7 U	881 UJ	**1,790 J**	586 UJ	1,350 UJ	1,020 UJ	14 U
Methyl tert-butyl ether (MTBE)	--	--	88.1 U	285 U	58.6 UJ	135 U	102 U	--
Naphthalene	5,000	6.7 U	**1,130**	**13,200**	**72.7 J**	**379**	**1,000**	14 U
n-Butylbenzene	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
n-Propylbenzene	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
o-Xylene	9,000	1.4 U	**23.8 J**	**1,640**	**84.4**	**70**	51 U	2.9 U
sec-Butylbenzene	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
Styrene	--	1.4 U	88.1 U	285 U	58.6 UJ	135 U	102 U	2.9 U
tert-Butylbenzene	--	1.4 U	88.1 UJ	285 UJ	58.6 UJ	135 UJ	102 U	2.9 U
Tetrachloroethene (PCE)	50	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Toluene	7,000	1.4 U	**45.8 J**	285 U	58.6 UJ	**295**	**189**	2.9 U
Trichloroethene (TCE)	30	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U
Trichlorofluoromethane (Fluorotrichloromethane)	--	1.4 U	176 UJ	570 UJ	117 UJ	269 UJ	204 U	2.9 U
Vinyl chloride	--	1.4 U	44 U	143 U	29.3 UJ	67.4 U	51 U	2.9 U

Table 5-8
VOC Results: Landfill and Fill Deposits

	Location	Landfill #1 (Floor Sweeps)			Fill Deposit B-2 (Residual Carbon)	Fill Deposit B-1 (Residual Carbon)	Fill Deposit A (Spent Lime)	Fill Deposit B-3 (Residual Carbon)
	Location ID	**AQ-FSL-01**	**AQ-FSL-02**	**AQ-FSL-03**	**AQ-ECA-03**	**AQ-BMP-02**	**AQ-WMP-02**	**AQ-BMD-01**
	Sample ID	**AQ-FSL-01-4-6**	**AQ-FSL-02-14-16**	**AQ-FSL-03-5-7**	**AQ-ECA-03-5-7**	**AQ-BMP-02-11-13**	**AQ-WMP-02-6-8**	**AQ-BMD-01-4-5**
	Sample Date	**10/18/2012**	**10/18/2012**	**10/18/2012**	**10/19/2012**	**10/24/2012**	**10/24/2012**	**10/22/2012**
	Depth	**4 - 6 ft**	**14 - 16 ft**	**5 - 7 ft**	**5 - 7 ft**	**11 - 13 ft**	**6 - 8 ft**	**4 - 5 ft**
	Sample Type	**D**	**D**	**D**	**D**	**D**	**D**	**D**
Chloromethane	--	561 U	353 U	517 U	621 U	561 U	510 U	449 U
Dibromochloromethane	--	224 U	141 U	207 U	248 U	225 UJ	204 U	179 U
Dibromomethane	--	112 UJ	70.7 UJ	103 UJ	124 UJ	112 U	102 U	89.7 U
Dichlorodifluoromethane	--	224 U	141 U	207 U	248 U	225 UJ	204 UJ	179 U
Dichloromethane (Methylene chloride)	20	561 U	353 U	517 U	621 U	561 U	510 U	449 U
Ethylbenzene	6,000	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Ethylene dibromide (1,2-Dibromoethane)	5	56.1 UJ	35.3 UJ	51.7 UJ	62.1 UJ	56.1 UJ	51 U	44.9 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	224 UJ	141 UJ	207 UJ	248 UJ	225 UJ	204 U	179 U
Isopropylbenzene (Cumene)	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
m,p-Xylene	9,000	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	--	1,120 UJ	707 UJ	1,030 UJ	1,240 UJ	1,120 UJ	1,020 UJ	897 U
Methyl tert-butyl ether (MTBE)	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Naphthalene	5,000	224 U	**24,300**	**1290**	**452**	**203 J**	204 U	**198**
n-Butylbenzene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
n-Propylbenzene	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
o-Xylene	9,000	56.1 U	35.3 U	51.7 U	62.1 U	56.1 UJ	51 U	44.9 U
sec-Butylbenzene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Styrene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
tert-Butylbenzene	--	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Tetrachloroethene (PCE)	50	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Toluene	7,000	112 U	70.7 U	103 U	124 U	112 U	102 U	89.7 U
Trichloroethene (TCE)	30	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U
Trichlorofluoromethane (Fluorotrichloromethane)	--	224 U	141 U	207 U	248 U	225 U	204 U	179 U
Vinyl chloride	--	56.1 U	35.3 U	51.7 U	62.1 U	56.1 U	51 U	44.9 U

Table 5-8
VOC Results: Landfill and Fill Deposits

	Location	Fill Deposit B-3 (Residual Carbon)					
	Location ID	AQ-BMD-02	AQ-BMD-03	AQ-BMD-04	AQ-BMD-05	AQ-BMD-06	AQ-BMD-07
	Sample ID	AQ-BMD-02-3.5-5.5	AQ-BMD-03-4-6	AQ-BMD-04-3-5	AQ-BMD-05-3-5	AQ-BMD-06-3.5-5.5	AQ-BMD-07-1-3
	Sample Date	10/22/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012	10/22/2012
	Depth	3.5 - 5.5 ft	4 - 6 ft	3 - 5 ft	3 - 5 ft	3.5 - 5.5 ft	1 - 3 ft
	Sample Type	D	D	D	D	D	D
Chloromethane	--	471 U	462 U	490 U	569 U	473 U	534 U
Dibromochloromethane	--	188 U	185 U	196 U	228 U	189 U	214 U
Dibromomethane	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Dichlorodifluoromethane	--	188 U	185 U	196 U	228 U	189 U	214 U
Dichloromethane (Methylene chloride)	20	471 U	462 U	490 U	569 U	473 U	534 U
Ethylbenzene	6,000	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Ethylene dibromide (1,2-Dibromoethane)	5	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	188 U	185 U	196 U	228 U	189 U	214 U
Isopropylbenzene (Cumene)	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
m,p-Xylene	9,000	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	--	942 U	924 U	981 U	1,140 U	946 U	1,070 U
Methyl tert-butyl ether (MTBE)	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Naphthalene	5,000	188 U	185 U	**267 J**	228 U	189 U	214 U
n-Butylbenzene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
n-Propylbenzene	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
o-Xylene	9,000	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
sec-Butylbenzene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Styrene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
tert-Butylbenzene	--	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Tetrachloroethene (PCE)	50	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Toluene	7,000	94.2 U	92.4 U	98.1 U	114 U	94.6 U	107 U
Trichloroethene (TCE)	30	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U
Trichlorofluoromethane (Fluorotrichloromethane)	--	188 U	185 U	196 U	228 U	189 U	214 U
Vinyl chloride	--	47.1 U	46.2 U	49 U	56.9 U	47.3 U	53.4 U

Table 5-8
VOC Results: Landfill and Fill Deposits

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
µg/kg = microgram per kilogram
D = Discrete sample
FD = Field duplicate
ft = feet
MEK = 2-Butanone
MIBK = methyl isobutyl ketone (or 4-Methyl-2-pentanone)
MTBE = methyl tert-butyl ether
PCE = tetrachloroethene
SL = screening level
TCE = trichloroethene
USEPA = U.S. Environmental Protection Agency

Table 5-9
Other Soil Testing Results: Landfill and Fill Deposits

Analyte	Location ID Sample ID Sample Date Depth	SPLP1 SPLP1-S-022707 2/27/2007 0.5 - 1 ft	SPLP2 SPLP2-S-022707 2/27/2007 0.5 - 1 ft	SPLP3 SPLP3-S-022707 2/27/2007 0.5 - 1 ft	SPLP4 SPLP4-WM-022707 2/27/2007 0.5 - 1 ft
Conventional Parameters					
Total solids (%)		--	--	--	**60.2**
pH (SU)		**7.9**	**7.82**	**7.65**	--
Soil Concentrations (mg/kg)					
Cyanide, total		**0.62**	**0.745**	**0.178**	--
Fluoride		**533**	**732**	**784**	**29,500**
Laboratory Leachate Concentrations (mg/L)					
Total solids (preserved; %)		--	--	--	**75.9**
Cyanide, free		0.0005 U	0.0005 U	**0.0027**	--
Cyanide, weak acid dissociable (WAD)		0.005 UJ	0.005 UJ	0.005 UJ	--
Cyanide, total		**0.0171**	**0.016**	0.005 U	--
Fluoride		**12.7**	**11.3**	**9.1**	**18**

Notes:

1 = pH was measured for in situ groundwater from the nearest groundwater monitoring well during the October 2006 sampling event. SPLP 1/2 measured at G2S; SPLP 3 measured at PZ5.

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

ft = feet

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

SU = standard units

WAD = weak acid dissociable

Table 5-10
Lysimeter Testing Results

						Residual Carbon					
Target Waste Material	**Former Stockpile Area**		**Landfill #1 (Floor Sweeps)**	**Fill Deposit A (Spent Lime)**		**Fill Deposit B-1**		**Fill Deposit B-2**		**Fill Deposit B-3**	
Location ID	**LYS1**	**LYS2**	**LYS3**	**GC-LY-01**	**GC-LY-02**	**GC-LY-03**	**GC-LY-04**	**GC-LY-05**	**GC-LY-06**	**GC-LY-07**	**GC-LY-08**
Sample ID	**LY1-SO**	**LY2-SO**	**LY3-SO**	**GC-LY-01-2.5-3**	**GC-LY-02-2.5-3**	**GC-LY-03-4-4.6**	**GC-LY-04-3.6-4.3**	**GC-LY-05-1.4-2**	**GC-LY-06-2.7-3.3**	**GC-LY-07-3-3.5**	**GC-LY-08-2-2.5**
Sample Date	**10/4/2006**	**10/4/2006**	**10/4/2006**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/21/2011**	**12/20/2011**
Analyte **Depth**	**0.5 - 1 ft**	**0.5 - 1 ft**	**0.5 - 1 ft**	**2.5 - 3 ft**	**2.5 - 3 ft**	**4 - 4.6 ft**	**3.6 - 4.3 ft**	**1.4 - 2 ft**	**2.7 - 3.3 ft**	**3 - 3.5 ft**	**2 - 2.5 ft**
Conventional Parameters											
Total solids (%)	**85.6**	**83.4**	**83**	**58.9**	**61.4**	**70.9**	**56.4**	**69.8**	**83.4**	**70**	**71.8**
Soil Concentrations (mg/kg)											
Cyanide, weak acid dissociable (WAD)	**0.27**	**0.34**	0.1 U	--	--	--	--	--	--	--	--
Cyanide, total	**1.4**	**1.2**	**0.34**	--	--	--	--	--	--	--	--
Fluoride	**523 J**	**1,310 J**	**396 J**	**65,900 J**	**59,500 J**	**40,900 J**	**61,800 J**	**6,430 J**	**2,740 J**	**34,200 J**	**16,000 J**
Porewater Concentrations (mg/L)											
2006 Sampling Event 1											
Cyanide, Free	**0.00141 J**	**0.00822 J**	**0.000227 J**	--	--	--	--	--	--	--	--
Cyanide, WAD	**0.035**	**0.195**	**0.018**	--	--	--	--	--	--	--	--
Cyanide, Total	**0.146**	**0.775**	0.086	--	--	--	--	--	--	--	--
Fluoride	**34.1**	**58.6**	**124**	--	--	--	--	--	--	--	--
2006 Sampling Event 2											
Cyanide, Free	**0.000596**	**0.000552**	**0.000222 J**	--	--	--	--	--	--	--	--
Cyanide, WAD	**0.035**	**0.24**	**0.015**	--	--	--	--	--	--	--	--
Cyanide, Total	**0.165**	**0.925**	**0.092**	--	--	--	--	--	--	--	--
Fluoride	**34.1**	**60.9**	**127**	--	--	--	--	--	--	--	--
2006 Sampling Event 3											
Cyanide, Free	**0.000195 J**	0.0005 U	0.0005 U	--	--	--	--	--	--	--	--
Cyanide, WAD	**0.052**	**0.308**	**0.018**	--	--	--	--	--	--	--	--
Cyanide, Total	**0.188**	**0.905**	**0.075**	--	--	--	--	--	--	--	--
Fluoride	**35.6**	**59.0**	**136**	--	--	--	--	--	--	--	--
2012 Sampling Event 1											
Temperature (°C)	--	--	--	**20.3**	**22.6**	**22.3**	**20.5**	**21.1**	**20.8**	**22**	**22.1**
pH (SU)	--	--	--	**9.82**	**11.1**	**7.16**	**7.54**	**8.72**	**7.36**	**7.6**	**7.69**
Alkalinity, Bicarbonate as $CaCO_3$	--	--	--	**315**	**36.5**	**368**	**545**	**1,040**	**400**	**736**	**129**
Alkalinity, Carbonate as $CaCO_3$	--	--	--	**235**	**488**	20 U	20 U	**56**	20 U	20 U	20 U
Alkalinity, Hydroxide as $CaCO_3$	--	--	--	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Alkalinity, total as $CaCO_3$	--	--	--	**549**	**524**	**368**	**545**	**1,100**	**400**	**736**	**129**
Chloride (total)	--	--	--	**7.21**	**8.69**	**3.41**	**5.14**	**9.54**	**8.44**	**4.38**	**2.94**
Phosphate	--	--	--	0.02 U	0.02 U	**0.015 J**	0.02 U	0.02 U	**0.052**	**0.016 J**	0.02 U
Sulfate	--	--	--	**44.2**	**29.5**	**11.9**	**20.1**	**167**	**68.5**	**19.4**	**3.08**
Conventional Parameters, Dissolved (mg/L)											
Fluoride	--	--	--	**92.5**	**94**	**49.3**	**54.7**	**187**	**73.2**	**55.4**	**80**
Metals, Dissolved (µg/L)											
Aluminum	--	--	--	**3,970**	**26,300**	**6,190**	**2,900**	250 U	**6,060**	**1,390**	**3,130**
Calcium	--	--	--	**1,500 J**	**1,070 J**	**40,700**	**8,630**	**5,230**	**7,730**	**11,100**	**2,370**
Iron	--	--	--	**213**	**118**	**428**	**295**	**1,510**	**204**	**276**	100 U
Magnesium	--	--	--	**548**	**52.4 J**	**9,210**	**5,720**	**2,320**	**2,940**	**9,690**	**1,120**

Table 5-10
Lysimeter Testing Results

						Residual Carbon					
Target Waste Material	**Former Stockpile Area**		**Landfill #1 (Floor Sweeps)**	**Fill Deposit A (Spent Lime)**		**Fill Deposit B-1**		**Fill Deposit B-2**		**Fill Deposit B-3**	
Location ID	**LYS1**	**LYS2**	**LYS3**	**GC-LY-01**	**GC-LY-02**	**GC-LY-03**	**GC-LY-04**	**GC-LY-05**	**GC-LY-06**	**GC-LY-07**	**GC-LY-08**
Sample ID	**LY1-SO**	**LY2-SO**	**LY3-SO**	**GC-LY-01-2.5-3**	**GC-LY-02-2.5-3**	**GC-LY-03-4-4.6**	**GC-LY-04-3.6-4.3**	**GC-LY-05-1.4-2**	**GC-LY-06-2.7-3.3**	**GC-LY-07-3-3.5**	**GC-LY-08-2-2.5**
Sample Date	**10/4/2006**	**10/4/2006**	**10/4/2006**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/20/2011**	**12/21/2011**	**12/20/2011**
Analyte **Depth**	**0.5 - 1 ft**	**0.5 - 1 ft**	**0.5 - 1 ft**	**2.5 - 3 ft**	**2.5 - 3 ft**	**4 - 4.6 ft**	**3.6 - 4.3 ft**	**1.4 - 2 ft**	**2.7 - 3.3 ft**	**3 - 3.5 ft**	**2 - 2.5 ft**
Manganese	--	--	--	**1.28**	1 U	**9.33**	**11.6**	**241**	**239**	**8.01**	**10.6**
Potassium	--	--	--	**1,790**	**2,440**	**1,840**	**1,200**	**2,590**	**1,860**	**1,680**	**1,190**
Silicon	--	--	--	**3,200**	**4,040**	**17,900**	**16,200**	**5,130**	**15,100**	**14,000**	**10,700**
Sodium	--	--	--	**389,000**	**322,000**	**159,000**	**327,000**	**817,000**	**272,000**	**424,000**	**141,000**
2012 Sampling Event 2 (September 29 2012)											
Conventional Parameters (mg/L)											
Temperature (°C)	--	--	--	**21.1**	**20.5**	--	**20.5**	**22.4**	**23.1**	**22.1**	**23.0**
pH (SU)	--	--	--	**9.67**	**11.6**	--	**7.72**	**8.68**	**9.67**	**7.75**	**8.04**
Alkalinity, total (mg $CaCO_3$/L)	--	--	--	**540**	**738**	--	**706**	**1,060**	**454**	**979**	**508**
Chloride (total)	--	--	--	**6.11**	**8.87**	--	**1.17**	**8.72**	**2.71**	**2.19**	**2.51**
Phosphorous	--	--	--	**0.032 J**	**0.046 J**	--	**0.012 J**	**0.04 J**	**0.078 J**	**0.068 J**	**0.178 J**
Sulfate	--	--	--	**31.2**	**29.7**	--	**5.98**	**154**	**65.2**	**19.0**	**38.6**
Conventional Parameters (mg/L)											
Fluoride (total)	--	--	--	*Limited Volume - no result*		--	**53.8**	**163**	**79.8**	**62.4**	**119**
Conventional Parameters, Dissolved (mg/L)											
Fluoride	--	--	--	**94.7**	**107**	--	**59.9**	**164**	**82.9**	**64.6**	**123**
Metals, Dissolved (µg/L)											
Aluminum	--	--	--	**2,910**	**35,600**	--	**3,070**	**269 J**	**7,220**	**1,690**	**2,930**
Calcium	--	--	--	**631 J**	1,000 U	--	**11,500**	**1,050**	**6,970**	**15,000**	**3,840**
Iron	--	--	--	**225**	**122**	--	**186**	**1,130**	**384**	**245**	**139**
Magnesium	--	--	--	**298 J**	500 U	--	**6,150**	**1,600**	**2,960**	**13,200**	**3,170**
Manganese	--	--	--	**0.611 J**	**0.511 J**	--	**1.13**	**99.8**	**53.8**	**1.76**	**2**
Potassium	--	--	--	**2,090**	**3,930**	--	**1,550**	**2,810**	**2,630**	**2,680**	**2,310**
Silicon	--	--	--	**3.46**	**7.22**	--	**17.2**	**7.31**	**20.1**	**17.2**	**14.5**
Sodium	--	--	--	**383,000**	**374,000**	--	**346,000**	**833,000**	**298,000**	**485,000**	**390,000**

Notes:

Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
°C = degrees Celsius
µg/L = micrograms per liter

CaCO3 = calcium carbonate
ft = feet
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
SU = standard units

Table 5-11
Soil Geochemical Testing Results

Location ID	GC-SB-01						GC-SB-02					
Sample ID	010312_003	010312_002	010312_001	123011_004	123011_003	123011_002	010312_011	010312_010	010312_009	010312_008	010312_007	010312_006
Sample Date	1/3/2012	1/3/2012	1/3/2012	12/30/2011	12/30/2011	12/30/2011	1/3/2012	1/3/2012	1/3/2012	1/3/2012	1/3/2012	1/3/2012
Analyte Depth	2.5 - 5 ft	5 - 7.5 ft	7.5 - 10 ft	10 - 12.5 ft	12.5 - 15 ft	15 - 17.5 ft	2.5 - 5 ft	5 - 7.5 ft	7.5 - 10 ft	10 - 12.5 ft	12.5 - 15 ft	15 -17.5 ft
Conventional Parameters												
Temperature (°C)	--	**20.9**	--	--	--	--	**20.8**	**20.9**	--	--	--	--
pH (SU)	--	**8.57 J**	--	--	--	--	**8.6 J**	**8.88 J**	--	--	--	--
Total organic carbon (mg/kg)	**38,000 J**	**57,000 J**	**3,300 J**	**1,300 J**	**700 J**	**310 J**	**320,000 J**	**47,000 J**	**2,400 J**	**890 J**	**720 J**	**310 J**
Total solids (%)	**81.1**	**63.3**	**68.1**	**71.4**	**74.1**	**78.9**	**61.7**	**57.9**	**69.4**	**74.3**	**76.8**	**78.7**
Fluoride (mg/kg)	**1,610**	**46,400**	**2,610**	**956**	**630**	**309**	**-- R**	**12,600**	**2,550**	**1,230**	**616**	**414**

Location ID	GC-SB-03					GC-SB-04					
Sample ID	010512_001	010412_004	010412_003	010412_002	010412_001	010612_001	010512_006	010512_005	010512_004	010512_003	010912_001
Sample Date	1/5/2012	1/4/2012	1/4/2012	1/4/2012	1/4/2012	1/6/2012	1/5/2012	1/5/2012	1/5/2012	1/5/2012	1/9/2012
Analyte Depth	2.5 - 5 ft	5 - 7.5 ft	7.5 - 10 ft	10 - 12.5 ft	12.5 - 15 ft	2.5 - 5 ft	5 - 7.5 ft	7.5 - 10 ft	10 - 12.5 ft	12.5 - 15 ft	15 - 17.5 ft
Conventional Parameters											
Temperature (°C)	**20.7**	--	--	--	--	--	--	--	--	--	--
pH (SU)	**9.18 J**	--	--	--	--	--	--	--	--	--	--
Total organic carbon (mg/kg)	**360,000 J**	**220,000 J**	**28,000 J**	**7,700 J**	**9,000 J**	**30,000**	**36,000 J**	**4,000**	**49,000**	**22,000**	**11,000**
Total solids (%)	**57.8**	**45.1**	**57.6**	**65.6**	**71.6**	**61.9**	**43.8**	**66.9**	**49.2**	**58.6**	**66.7**
Fluoride (mg/kg)	**54,000**	**10,900**	**3,380**	**407**	**325**	**703**	**525**	**321**	**298**	**267**	**163**

Notes:

Bold = Detected result

-- = Results not reported or not applicable

R = rejected result

°C = degrees Celsius

ft = feet

mg/kg = milligrams per kilogram

SU = standard units

J = Estimated value

Table 5-12
Soil Testing Results: Fluoride and Cyanide

				Analyte	**Fluoride**	**Cyanide, total**	**Cyanide, weak acid dissociable (WAD)**
				Unit	**mg/kg**	**mg/kg**	**mg/kg**
				Soil SL	210,000 / 2,110	70,000 / 65.7	
Location	**Location ID**	**Sample ID**	**Sample Date**	**Depth**			
North Field Area							
	S1	S1-A-092806	9/28/2006	0.5 - 1 ft	**171 J**	**0.9**	0.45 U
		S1-B-092806	9/28/2006	1.5 - 2 ft	**99 J**	0.47 U	0.47 U
		S41-092806 (FD)	9/28/2006	1.5 - 2 ft	**118 J**	0.47 U	0.47 U
Field Southwest of the Cable Plant							
	AQ-SSA1-03	AQ-SSA1-03-3-4	3/15/2012	3 - 4 ft	**415 J**	**0.512**	--
	AQ-SSA1-06	AQ-SSA1-06-3-3.5	3/15/2012	3 - 3.5 ft	**267 J**	**0.302**	--
Northwest Site Area							
	AQ-SSA3-01	AQ-SSA3-01-2-3	10/13/2011	2 - 3 ft	**396 J**	0.273 U	0.297 U
	AQ-SSA3-02	AQ-SSA3-02-2-3	10/13/2011	2 - 3 ft	**302 J**	0.316 U	0.317 U
	AQ-SSA3-03	AQ-SSA3-03-2-3	10/13/2011	2 - 3 ft	**388 J**	**0.368**	0.306 U
	AQ-SSA3-04	AQ-SSA3-04-2-3	10/13/2011	2 - 3 ft	**864 J**	**8.8**	**0.518**
	AQ-SSA3-05	AQ-SSA3-05-2-3	10/13/2011	2 - 3 ft	**442 J**	0.359 U	0.372 U
	AQ-SSA3-06	AQ-SSA3-06-2-3	10/13/2011	2 - 3 ft	**301 J**	0.335 U	0.342 U
	AQ-SSA3-07	AQ-SSA3-07-2-3	10/13/2011	2 - 3 ft	**690 J**	0.29 U	0.313 U
	AQ-SSA3-08	AQ-SSA3-08-2-3	10/13/2011	2 - 3 ft	**497 J**	0.352 U	0.355 U
Casting Pit Fill Soils							
	AQ-SSA5-01	AQ-SSA5-01-8-10	8/31/2011	8 - 10 ft	**208**	--	--
		AQ-SSA5-01-14-16	8/31/2011	14 - 16 ft	**298 J**	--	--
	AQ-SSA5-02	AQ-SSA5-02-8-10	8/31/2011	8 - 10 ft	**190 J**	--	--
		AQ-SSA5-02-14-16	8/31/2011	14 - 16 ft	**176 J**	--	--
	AQ-SSA5-03	AQ-SSA5-03-8-10	8/31/2011	8 - 10 ft	**186**	--	--
		AQ-SSA5-03-14-16	8/31/2011	14 - 16 ft	**163**	--	--
	AQ-SSA5-04	AQ-SSA5-04-8-10	8/31/2011	8 - 10 ft	**250**	--	--
		AQ-SSA5-04-14-16	8/31/2011	14 - 16 ft	**194**	--	--
	AQ-SSA5-05	AQ-SSA5-05-5-7	8/31/2011	5 - 7 ft	**200**	--	--
		AQ-SSA5-05-14-16	8/31/2011	14 - 16 ft	**192**	--	--

Table 5-12
Soil Testing Results: Fluoride and Cyanide

				Analyte	Fluoride	Cyanide, total	Cyanide, weak acid dissociable (WAD)
				Unit	mg/kg	mg/kg	mg/kg
				Soil SL	210,000 / 2,110	70,000 / 65.7	
Location	**Location ID**	**Sample ID**	**Sample Date**	**Depth**			
	AQ-SSA5-06	AQ-SSA5-06-8-10	8/31/2011	8 - 10 ft	**181**	--	--
		AQ-SSA5-06-14-16	8/31/2011	14 - 16 ft	**194**	--	--
Soils Adjacent to Landfill No. 3 (Construction Debris)							
	AQ-SSA7-01	AQ-SSA7-01-3-4	10/27/2011	3 - 4 ft	**363**	**0.994 J**	--
	AQ-SSA7-02	AQ-SSA7-02-3-4	10/27/2011	3 - 4 ft	**253**	**0.287 J**	--
	AQ-SSA7-08	AQ-SSA7-08-3-4	10/28/2011	3 - 4 ft	**225**	0.268 U	--
	AQ-SSA7-09	AQ-SSA7-09-3-4	10/28/2011	3 - 4 ft	**303**	0.301 U	--
	AQ-SSA7-10	AQ-SSA7-10-3-4	10/28/2011	3 - 4 ft	**629**	0.657 U	--

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
FD = field duplicate
ft = feet
mg/kg = milligrams per kilogram
USEPA = U.S. Environmental Protection Agency
WAD = weak acid dissociable
SL = screening level

Table 5-13
Soil Testing Results: Metals

Location		Outfall 003 Drainage	Outfall 005 Drainage	Drainage Downstream of Outfall 005	Rectifier Yards Soils				
Location ID		**AQ-OF3**	**AQ-OF5**	**AQ-OF5D**	**RY1**	**RY2**	**RY3**	**RY5**	
Sample ID		**AQ-SO-OF3-0-10**	**AQ-SO-OF5-0-10**	**AQ-SO-OF5D-0-10**	**RY1-092806**	**RY2-092806**	**RY3-092806**	**RY5-092806**	**RY45-092806**
Sample Date		**10/25/2012**	**10/25/2012**	**10/25/2012**	**9/28/2006**	**9/28/2006**	**9/28/2006**	**9/28/2006**	**9/28/2006**
Depth		**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**	**FD**
Metals (mg/kg)	**Soil Screening Level**								
Antimony	1,400	2.91 U	2.58 U	9.27 U	--	--	--	--	--
Arsenic	20/88	**21.1**	**4.31 J**	**30.0**	--	--	--	--	--
Cadmium	2	2.91 U	2.58 U	9.27 U	--	--	--	--	--
Chromium	19	**15.3**	**12.8**	**18.7**	--	--	--	--	--
Copper	140,000	**38.7**	**36.7**	**70.1**	--	--	--	--	--
Lead	1,000	**11.6**	**7.56**	**16.9**	--	--	--	--	--
Mercury	2	0.233 U	0.206 U	0.742 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Nickel	--	**23.4**	**17.1**	**37.9**	--	--	--	--	--
Silver	1,800	2.91 U	2.58 U	9.27 U	--	--	--	--	--
Zinc	1,100,000	**109**	**73.9**	**182**	--	--	--	--	--

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
D = Discrete sample
FD = Field duplicate
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
cm = centimeters
ft = feet
LDC = Laboratory Data Consultants
mg/kg = milligrams per kilogram
USEPA = U.S. Environmental Protection Agency

Table 5-14
Soil Testing Results: PAHs

Location		**North Field Area**			**Field Southwest of the Cable Plant**		**Flat Storage Area**	
Location ID		**S1**			**AQ-SSA1-03**	**AQ-SSA1-06**	**AQ-SSA4-01**	
Sample Date		**9/28/2006**	**9/28/2006**	**9/28/2006**	**3/15/2012**	**3/15/2012**	**9/1/2011**	**9/1/2011**
Sample ID		**S1-A-092806**	**S1-B-092806**	**S41-092806**	**AQ-SSA1-03-3-4**	**AQ-SSA1-06-3-3.5**	**AQ-SSA4-01-0-1**	**AQ-SSA4-01-1-2**
Depth		**0.5 - 1 ft**	**1.5 - 2 ft**	**1.5 - 2 ft**	**3 - 4 ft**	**3 - 3.5 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**FD**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**							
1-Methylnaphthalene	--	--	--	--	39.3 U	44.5 U	7.7 U	7.28 U
2-Methylnaphthalene	--	65 U	66 U	65 U	39.3 U	44.5 U	7.7 U	7.28 U
Acenaphthene	--	65 UJ	66 U	65 U	19.7 U	22.2 U	3.85 U	3.64 U
Acenaphthylene	--	65 U	66 U	65 U	19.7 U	22.2 U	3.85 U	3.64 U
Anthracene	--	65 U	66 U	65 U	19.7 U	22.2 U	3.85 U	3.64 U
Benzo(a)anthracene	--	65 UJ	66 U	65 U	**33.1**	**29.5**	3.85 U	**1.99 J**
Benzo(a)pyrene	2,000	65 U	66 U	65 U	**40.2**	**35.0**	3.85 U	3.64 U
Benzo(b)fluoranthene[1]	--	**60 J**	66 U	65 U	--	--	**2.38 J**	--
Benzo(k)fluoranthene[1]	--	**88**	66 U	65 U	--	--	3.85 U	--
Benzo(b,k)fluoranthene	--	--	--	--	**208**	**173**	**--**	**3.96 J**
Benzo(g,h,i)perylene	--	65 U	66 U	65 U	**72.5**	**57.0**	3.85 U	3.64 U
Chrysene	--	**94**	66 U	65 U	**113**	**87.0**	3.85 U	3.64 U
Dibenzo(a,h)anthracene	--	65 U	66 U	65 U	**15.4 J**	**11.6 J**	3.85 U	3.64 U
Dibenzofuran	--	65 U	66 U	65 U	19.7 U	22.2 U	3.85 U	3.64 U
Fluoranthene	--	**65 J**	66 U	65 U	**48.8**	**40.0**	3.85 U	3.64 U
Fluorene	--	65 U	66 U	65 U	19.7 U	22.2 U	3.85 U	3.64 U
Indeno(1,2,3-c,d)pyrene	--	65 U	66 U	65 U	**63.3**	**49.9**	3.85 U	3.64 U
Naphthalene	5,000	65 UJ	66 U	65 U	39.3 U	44.5 U	7.7 U	7.28 U
Phenanthrene	--	65 U	66 U	65 U	**17.1 J**	**12.6 J**	3.85 U	3.64 U
Pyrene	--	65 U	66 U	65 U	**43.5**	**37.0**	3.85 U	3.64 U
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**60 J**	66 U	65 U	**73.3 J**	**62.3 J**	**2.95 J**	**2.8 J**

Table 5-14
Soil Testing Results: PAHs

Location		Flat Storage Area					
Location ID		**AQ-SSA4-02**		**AQ-SSA4-03**		**AQ-SSA4-04**	
Sample Date		**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**
Sample ID		**AQ-SSA4-02-0-1**	**AQ-SSA4-02-1-2**	**AQ-SSA4-03-0-1**	**AQ-SSA4-03-1-2**	**AQ-SSA4-04-0-1**	**AQ-SSA4-04-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	7.54 U	8.25 U	8.55 U	9.12 U	10.1 U	8.41 U
2-Methylnaphthalene	--	7.54 U	8.25 U	8.55 U	9.12 U	**5.54 J**	8.41 U
Acenaphthene	--	3.77 U	4.13 U	**2.56 J**	4.56 U	**12.3**	4.21 U
Acenaphthylene	--	3.77 U	4.13 U	4.27 U	4.56 U	5.07 U	4.21 U
Anthracene	--	3.77 U	4.13 U	**4.11 J**	4.56 U	**19.5**	**3.18 J**
Benzo(a)anthracene	--	**2.31 J**	4.13 U	**38.4**	**22.6**	**75.2**	**16.9**
Benzo(a)pyrene	2,000	3.77 U	4.13 U	**56.1**	**35**	**93.2**	**19.9**
Benzo(b)fluoranthene[1]	--	--	**3.72 J**	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	4.13 U	--	--	--	--
Benzo(b,k)fluoranthene	--	**5.87 J**	**--**	**174**	**157**	**169**	**46**
Benzo(g,h,i)perylene	--	**3.45 J**	4.13 U	**109**	**73.2**	**59**	**19.9**
Chrysene	--	**2.67 J**	**2.08 J**	**77.9**	**57**	**93.2**	**27.1**
Dibenzo(a,h)anthracene	--	3.77 U	4.13 U	**19.5**	**15.8**	**14.7**	**4.55**
Dibenzofuran	--	3.77 U	4.13 U	4.27 U	4.56 U	**5.42**	4.21 U
Fluoranthene	--	3.77 U	4.13 U	**54.8**	**31.5**	**128**	**28.8**
Fluorene	--	3.77 U	4.13 U	4.27 U	4.56 U	**8.21**	4.21 U
Indeno(1,2,3-c,d)pyrene	--	**2.74 J**	4.13 U	**88**	**63.8**	**62.6**	**18.8**
Naphthalene	5,000	7.54 U	8.25 U	8.55 U	9.12 U	**6.53 J**	8.41 U
Phenanthrene	--	3.77 U	4.13 U	**19.2**	**10.2**	**62.8**	**13.4**
Pyrene	--	3.77 U	4.13 U	**54.1**	**30.8**	**125**	**30.8**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**3.19 J**	**3.28 J**	**88.9**	**61.5**	**126**	**28.8**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-05**	**AQ-SSA4-05**			**AQ-SSA4-06**	
Sample Date		**9/1/2011**	**9/1/2011**	**9/3/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**
Sample ID		**AQ-SSA4-05-0-1**	**AQ-SSA4-05-1-2**	**AQ-SSA4-05-2-3**	**AQ-SSA4-05-3-4**	**AQ-SSA4-06-0-1**	**AQ-SSA4-06-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**2 - 3 ft**	**3 - 4 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	327 U	**63.8 J**	**23.5**	9.05 U	8.53 U	7.18 U
2-Methylnaphthalene	--	327 U	**63.8 J**	**28.8**	9.05 U	8.53 U	7.18 U
Acenaphthene	--	164 U	**31.9 J**	**71.3 J**	4.52 U	4.26 U	3.59 U
Acenaphthylene	--	164 U	**31.9 J**	**5.12**	4.52 U	4.26 U	3.59 U
Anthracene	--	**185**	**28.4 J**	**142 J**	4.52 U	4.26 U	**2.93 J**
Benzo(a)anthracene	--	**11,100**	**1450 J**	**173 J**	**2.98 J**	**4.54**	**15.6**
Benzo(a)pyrene	2,000	**15,100**	**2000 J**	**143 J**	**2.84 J**	**4.15 J**	**21.7**
Benzo(b)fluoranthene[1]	--	--	--	--	**5.41**	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	4.52 U	--	--
Benzo(b,k)fluoranthene	--	**52,600**	**7390 J**	**265 J**	--	**8.65**	**75.6**
Benzo(g,h,i)perylene	--	**25,600**	**4270 J**	**113 J**	**3.05 J**	**4.21 J**	**38.1**
Chrysene	--	**47,300**	**7,230 J**	**173 J**	**6.14**	**5.58**	**30.2**
Dibenzo(a,h)anthracene	--	**4,980**	**738 J**	**25.2 J**	4.52 U	4.26 U	**7.47**
Dibenzofuran	--	164 U	**31.9 J**	**46 J**	4.52 U	4.26 U	3.59 U
Fluoranthene	--	**5,540**	**688 J**	**476 J**	**8.63**	**9.06**	**28.3**
Fluorene	--	164 U	**31.9 J**	**71.5**	4.52 U	4.26 U	3.59 U
Indeno(1,2,3-c,d)pyrene	--	**19,300**	**3,090 J**	**105 J**	**2.99 J**	**3.95 J**	**34.3**
Naphthalene	5,000	327 U	**63.8 J**	**87 J**	**17.4**	8.53 U	7.18 U
Phenanthrene	--	**438**	**51.8 J**	**495 J**	**8.09**	**7.58**	**14.2**
Pyrene	--	**6,530**	**796 J**	**365 J**	**6.08**	**10.1**	**27.7**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**24,400**	**3,340 J**	**202 J**	**4.49 J**	**6.13 J**	**35.3**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-07**		**AQ-SSA4-08**		**AQ-SSA4-09**	
Sample Date		**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**
Sample ID		**AQ-SSA4-07-0-1**	**AQ-SSA4-07-1-2**	**AQ-SSA4-08-0-1**	**AQ-SSA4-08-1-2**	**AQ-SSA4-09-0-1**	**AQ-SSA4-09-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	9.82 U	**4.84 J**	7.13 U	6.28 U	8.68 U	8.65 U
2-Methylnaphthalene	--	9.82 U	8 U	7.13 U	6.28 U	8.68 U	8.65 U
Acenaphthene	--	4.91 U	**30.5**	**3.54 J**	**2.26 J**	**2.48 J**	4.33 U
Acenaphthylene	--	4.91 U	**90.5**	3.56 U	3.14 U	4.34 U	4.33 U
Anthracene	--	4.91 U	**164**	**3.71**	**2.87 J**	**4.81**	4.33 U
Benzo(a)anthracene	--	**6.92**	**290**	**17.5**	**12.6**	**18.4**	**17.5**
Benzo(a)pyrene	2,000	**5.69**	**270**	**19.7**	**14**	**17.9**	**25.6**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**12.9**	**406**	**62.2**	**46.1**	**57.1**	**103**
Benzo(g,h,i)perylene	--	**5.06**	**135**	**25.6**	**20.3**	**20.2**	**41**
Chrysene	--	**18.7**	**311**	**35.9**	**20.3**	**32.3**	**36.3**
Dibenzo(a,h)anthracene	--	4.91 U	**42.8**	**5.62**	**3.99**	**4.62**	**8.94**
Dibenzofuran	--	4.91 U	**11.3**	**2.17 J**	3.14 U	4.34 U	4.33 U
Fluoranthene	--	**6.76**	**701**	**37.3**	**21.1**	**36.7**	**25.5**
Fluorene	--	4.91 U	**46.9**	**2.13 J**	3.14 U	4.34 U	4.33 U
Indeno(1,2,3-c,d)pyrene	--	**5.19**	**158**	**23.9**	**17.9**	**19.6**	**36.6**
Naphthalene	5,000	9.82 U	8 U	7.13 U	6.28 U	8.68 U	8.65 U
Phenanthrene	--	**2.79 J**	**503**	**15.3**	**10.1**	**21.8**	**8.31**
Pyrene	--	**7.37**	**624**	**32**	**19.9**	**32.9**	**24.8**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**8.62**	**363**	**31**	**22.3**	**28.2**	**42.6**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-10**		**AQ-SSA4-11**	**AQ-SSA4-11**	**AQ-SSA4-12A**	
Sample Date		**9/1/2011**	**9/1/2011**	**9/1/2011**	**9/1/2011**	**11/8/2012**	**11/8/2012**
Sample ID		**AQ-SSA4-10-0-1**	**AQ-SSA4-10-1-2**	**AQ-SSA4-11-0-1**	**AQ-SSA4-11-1-2**	**AQ-SSA4-12A-0-1**	**AQ-SSA4-12A-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	6.39 U	6.36 U	6.83 U	6.73 U	9.64 U	8.06 U
2-Methylnaphthalene	--	6.39 U	6.36 U	6.83 U	6.73 U	9.64 U	8.06 U
Acenaphthene	--	3.2 U	3.18 U	**2.11 J**	**2.74 J**	4.82 U	4.03 U
Acenaphthylene	--	3.2 U	3.18 U	3.42 U	3.37 U	4.82 U	4.03 U
Anthracene	--	**5.27**	**3.47**	**5.46**	**4.66**	4.82 U	**3.19 J**
Benzo(a)anthracene	--	**22.2**	**16.9**	**29.2**	**15.4**	**5.93**	**29.3**
Benzo(a)pyrene	2,000	**47.7**	**25.3**	**41.8**	**17.1**	**6.46**	**40.9**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**120**	**59.4**	**99.6**	**42.7**	**28.5**	**138**
Benzo(g,h,i)perylene	--	**105**	**37.5**	**53.6**	**19.9**	**17.0**	**83.1**
Chrysene	--	**55.8**	**33.5**	**54.9**	**21.4**	**12.8**	**62.5**
Dibenzo(a,h)anthracene	--	**13.5**	**5.49**	**8.9**	**3.7**	**3.65 J**	**16.7**
Dibenzofuran	--	3.2 U	3.18 U	3.42 U	3.37 U	4.82 U	4.03 U
Fluoranthene	--	**42.3**	**33.1**	**54.1**	**26.8**	**9.73**	**46**
Fluorene	--	3.2 U	3.18 U	3.42 U	**1.78 J**	4.82 U	4.03 U
Indeno(1,2,3-c,d)pyrene	--	**77.9**	**29.7**	**44.5**	**17.7**	**15.7**	**71.5**
Naphthalene	5,000	6.39 U	6.36 U	6.83 U	6.73 U	9.64 U	**4.5 J**
Phenanthrene	--	**21.6**	**15.8**	**23.4**	**16.7**	**4.61 J**	**14.8**
Pyrene	--	**54.5**	**40.6**	**58.8**	**25**	**9.54**	**51.5**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	**140.43 J**	**578.11 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**71.6**	**36.8**	**60.6**	**25.3**	**11.97 J**	**67.1**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-12B**		**AQ-SSA4-13**		**AQ-SSA4-14**	
Sample Date		**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**
Sample ID		**AQ-SSA4-12B-0-1**	**AQ-SSA4-12B-1-2**	**AQ-SSA4-13-0-1**	**AQ-SSA4-13-1-2**	**AQ-SSA4-14-0-1**	**AQ-SSA4-14-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	7.51 U	7.8 U	7.19 U	9.43 U	8.73 U	8.03 U
2-Methylnaphthalene	--	7.51 U	7.8 U	7.19 U	9.43 U	8.73 U	8.03 U
Acenaphthene	--	3.76 U	3.9 U	3.59 U	4.71 U	4.36 U	4.02 U
Acenaphthylene	--	3.76 U	3.9 U	3.59 U	4.71 U	4.36 U	4.02 U
Anthracene	--	3.76 U	3.9 U	3.59 U	4.71 U	4.36 U	4.02 U
Benzo(a)anthracene	--	**4.59**	**13.3**	**5.37**	**2.88 J**	**9.35**	**5.72**
Benzo(a)pyrene	2,000	**4.37**	**15.4**	**6.01**	4.71 U	**12.5**	**6.59**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**10.7**	**73.4**	**25.4**	9.43 U	**50.4**	**26.3**
Benzo(g,h,i)perylene	--	**6.93**	**44.6**	**11.7**	4.71 U	**42.8**	**18.2**
Chrysene	--	**6.06**	**29.9**	**11**	**2.38 J**	**26.4**	**15.5**
Dibenzo(a,h)anthracene	--	3.76 U	**9.94**	**2.74 J**	4.71 U	**7.8**	**3.56 J**
Dibenzofuran	--	3.76 U	3.9 U	3.59 U	4.71 U	4.36 U	4.02 U
Fluoranthene	--	**7.29**	**20.2**	**5.66**	**3.92 J**	**11.9**	**7.91**
Fluorene	--	3.76 U	3.9 U	3.59 U	4.71 U	4.36 U	4.02 U
Indeno(1,2,3-c,d)pyrene	--	**6.38**	**39.5**	**10.4**	4.71 U	**34.5**	**15.7**
Naphthalene	5,000	7.51 U	7.8 U	7.19 U	9.43 U	8.73 U	8.03 U
Phenanthrene	--	**4.72**	**6.04**	3.59 U	**2.59 J**	**2.76 J**	4.02 U
Pyrene	--	**7.26**	**20.1**	**6.21**	**4.34 J**	**13.5**	**8.71**
Total PAHs (U = 1/2)[2,3]	--	**80.84**	**293.83**	**106.05 J**	**56.16 J**	**235.91 J**	**132.29 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**6.79**	**29.31**	**10.51 J**	**3.61 J**	**22.97**	**11.87 J**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-15**		**AQ-SSA4-16**		**AQ-SSA4-17**	**AQ-SSA4-17**
Sample Date		**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**	**11/8/2012**
Sample ID		**AQ-SSA4-15-0-1**	**AQ-SSA4-15-1-2**	**AQ-SSA4-16-0-1**	**AQ-SSA4-16-1-2**	**AQ-SSA4-17-0-1**	**AQ-SSA4-17-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	7.42 U	8.77 U	7.88 U	8.46 U	9.67 U	9.56 U
2-Methylnaphthalene	--	7.42 U	8.77 U	7.88 U	8.46 U	9.67 U	9.56 U
Acenaphthene	--	3.71 U	4.39 U	3.94 U	**2.64 J**	**18.7**	4.78 U
Acenaphthylene	--	3.71 U	4.39 U	3.94 U	4.23 U	4.83 U	4.78 U
Anthracene	--	3.71 U	4.39 U	**2.62 J**	**6.03**	**27.4**	4.78 U
Benzo(a)anthracene	--	3.71 U	4.39 U	**18.3**	**23.7**	**75.6**	4.78 U
Benzo(a)pyrene	2,000	3.71 U	4.39 U	**23.3**	**24.1**	**77**	4.78 U
Benzo(b)fluoranthene[1]	--	3.71 U	4.39 U	--	--	--	4.78 U
Benzo(k)fluoranthene[1]	--	3.71 U	4.39 U	--	--	--	4.78 U
Benzo(b,k)fluoranthene	--	--	--	**68.8**	**66.9**	**142**	**--**
Benzo(g,h,i)perylene	--	3.71 U	4.39 U	**40.6**	**31.3**	**79.5**	4.78 U
Chrysene	--	3.71 U	4.39 U	**34.7**	**39.8**	**91.6**	4.78 U
Dibenzo(a,h)anthracene	--	3.71 U	4.39 U	**8.2**	**6.88**	**16**	4.78 U
Dibenzofuran	--	3.71 U	4.39 U	3.94 U	4.23 U	**9.47**	4.78 U
Fluoranthene	--	3.71 U	4.39 U	**29.2**	**48.2**	**144**	4.78 U
Fluorene	--	3.71 U	4.39 U	3.94 U	**2.17 J**	**13.5**	4.78 U
Indeno(1,2,3-c,d)pyrene	--	3.71 U	4.39 U	**35**	**30.5**	**74.6**	4.78 U
Naphthalene	5,000	7.42 U	8.77 U	7.88 U	8.46 U	**7.99 J**	9.56 U
Phenanthrene	--	3.71 U	4.39 U	**12**	**28.2**	**99.9**	4.78 U
Pyrene	--	3.71 U	4.39 U	**30**	**44.9**	**134**	4.78 U
Total PAHs (U = 1/2)[2,3]	--	7.42 U	8.77 U	**322.42 J**	**372.24 J**	**1023.35 J**	9.56 U
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	3.71 U	4.39 U	**36.68**	**37.3**	**108.7**	4.78 U

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**					
Location ID		**AQ-SSA4-18**		**AQ-SSA4-19**			
Sample Date		**11/8/2012**	**11/8/2012**	**11/9/2012**	**11/9/2012**	**11/9/2012**	**11/9/2012**
Sample ID		**AQ-SSA4-18-0-1**	**AQ-SSA4-18-1-2**	**AQ-SSA4-19-0-1**	**AQ-SSA4-69-0-1**	**AQ-SSA4-19-1-2**	**AQ-SSA4-69-1-2**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**0 - 1 ft**	**1 - 2 ft**	**1 - 2 ft**
Sample Type		**D**	**D**	**D**	**FD**	**D**	**FD**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**						
1-Methylnaphthalene	--	8.88 U	8.68 U	7.74 U	8.03 U	8.77 U	8.73 U
2-Methylnaphthalene	--	8.88 U	8.68 U	7.74 U	8.03 U	8.77 U	8.73 U
Acenaphthene	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Acenaphthylene	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Anthracene	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Benzo(a)anthracene	--	**7.36**	**3.99 J**	**4.6**	**3.52 J**	**3.29 J**	**2.88 J**
Benzo(a)pyrene	2,000	**7.54**	**3.06 J**	**5.15**	**4.11**	**3.34 J**	4.36 U
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**19.4**	**9.51**	**13.7**	**12.7**	**9.22**	**5.65 J**
Benzo(g,h,i)perylene	--	**10**	**4.92**	**7.4**	**5.06**	**3.88 J**	**3.24 J**
Chrysene	--	**10.6**	**4 J**	**7.6**	**5.84**	**4.3 J**	**2.67 J**
Dibenzo(a,h)anthracene	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Dibenzofuran	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Fluoranthene	--	**10.6**	**3.94 J**	**6.82**	**4.64**	**4.67**	**2.95 J**
Fluorene	--	4.44 U	4.34 U	3.87 U	4.01 U	4.39 U	4.36 U
Indeno(1,2,3-c,d)pyrene	--	**9.55**	**4.43**	**6.78**	**4.63**	**3.71 J**	**3.03 J**
Naphthalene	5,000	8.88 U	**5.27 J**	7.74 U	8.03 U	8.77 U	8.73 U
Phenanthrene	--	**4.55**	4.34 U	**2.8 J**	4.01 U	4.39 U	4.36 U
Pyrene	--	**11**	**4.12 J**	**7.45**	**5.03**	**4.75**	**3.14 J**
Total PAHs (U = 1/2)[2,3]	--	**117.24**	**67.11 J**	**85.52 J**	**71.61 J**	**65.68 J**	**54.09 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**11.5**	**5.11 J**	**7.93**	**6.45 J**	**5.22 J**	**3.58 J**

Table 5-14
Soil Testing Results: PAHs

Location		**Flat Storage Area**						
Location ID		**AQ-SSA4-20**		**AQ-SSA4-24**		**AQ-SSA4-25**		**AQ-SSA4-26**
Sample Date		**11/8/2012**	**11/8/2012**	**1/11/2013**	**1/11/2013**	**1/11/2013**	**1/11/2013**	**1/11/2013**
Sample ID		**AQ-SSA4-20-0-1**	**AQ-SSA4-20-1-2**	**AQ-SSA4-24-0-1**	**AQ-SSA4-24-1-2**	**AQ-SSA4-25-0-1**	**AQ-SSA4-25-1-2**	**AQ-SSA4-26-0-1**
Depth		**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**0 - 1 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**							
1-Methylnaphthalene	--	7.87 U	9.32 U	8.31 U	9.25 U	40.6 U	9.42 U	8.1 U
2-Methylnaphthalene	--	7.87 U	9.32 U	8.31 U	9.25 U	40.6 U	9.42 U	8.1 U
Acenaphthene	--	3.94 U	4.66 U	4.16 U	4.63 U	**15.7 J**	4.71 U	**3.13 J**
Acenaphthylene	--	3.94 U	4.66 U	4.16 U	4.63 U	20.3 U	4.71 U	**3.48 J**
Anthracene	--	**3.39 J**	4.66 U	4.16 U	4.63 U	**69**	**3.29 J**	**11.8**
Benzo(a)anthracene	--	**19.3**	**3.38 J**	**9.23**	4.63 U	**3480**	**18.3**	**445**
Benzo(a)pyrene	2,000	**21.8**	**2.45 J**	**12.2**	4.63 U	**7120**	**27.4**	**913**
Benzo(b)fluoranthene[1]	--	--	--	--	4.63 U	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	4.63 U	--	--	--
Benzo(b,k)fluoranthene	--	**46.3**	**6.65 J**	**37.2**	**--**	**17600**	**72.4**	**2880**
Benzo(g,h,i)perylene	--	**30.3**	**3.64 J**	**36.1**	**8.07**	**8330**	**33.9**	**2330**
Chrysene	--	**27.6**	**3.33 J**	**22.7**	4.63 U	**7690**	**33.1**	**1470**
Dibenzo(a,h)anthracene	--	**5.32**	4.66 U	**4.03 J**	4.63 U	**2240**	**7.14**	**405**
Dibenzofuran	--	3.94 U	4.66 U	4.16 U	4.63 U	**16.4 J**	4.71 U	**2.65 J**
Fluoranthene	--	**34.7**	**3.8 J**	**14.1**	4.63 U	**3080**	**24.6**	**384**
Fluorene	--	3.94 U	4.66 U	4.16 U	4.63 U	-- U	4.71 U	**2.28 J**
Indeno(1,2,3-c,d)pyrene	--	**25.8**	**3.46 J**	**20.3**	**3.66 J**	**7090**	**28.9**	**1590**
Naphthalene	5,000	7.87 U	9.32 U	8.31 U	9.25 U	40.6 U	9.42 U	8.1 U
Phenanthrene	--	**15.2**	4.66 U	**4.83**	4.63 U	**399**	**9.75**	**54.2**
Pyrene	--	**36.8**	**4.04 J**	**16**	4.63 U	**3470**	**24.2**	**430**
Total PAHs (U = 1/2)[2,3]	--	**286.2 J**	**61.04 J**	**199.56 J**	**58.01 J**	**60671.2 J**	**306.53 J**	**10936.69 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**31.75**	**4.07 J**	**19.5 J**	**3.63 J**	**10237.9**	**40.41**	**1459.7**

Table 5-14
Soil Testing Results: PAHs

	Location	**Flat Storage Area**					**Casting Pit Fill Soils**	
	Location ID	**AQ-SSA4-26**			**AQ-SSA4-27**		**AQ-SSA5-01**	
	Sample Date	**1/11/2013**	**1/11/2013**	**1/11/2013**	**1/11/2013**	**1/11/2013**	**8/31/2011**	**8/31/2011**
	Sample ID	**AQ-SSA4-76-0-1**	**AQ-SSA4-26-1-2**	**AQ-SSA4-76-1-2**	**AQ-SSA4-27-0-1**	**AQ-SSA4-27-1-2**	**AQ-SSA5-01-8-10**	**AQ-SSA5-01-14-16**
	Depth	**0 - 1 ft**	**1 - 2 ft**	**1 - 2 ft**	**0 - 1 ft**	**1 - 2 ft**	**8 - 10 ft**	**14 - 16 ft**
	Sample Type	**FD**	**D**	**FD**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**							
1-Methylnaphthalene	--	8.63 U	8.66 U	9.34 U	8.61 U	36.8 U	6.23 U	6.28 U
2-Methylnaphthalene	--	8.63 U	8.66 U	9.34 U	8.61 U	36.8 U	6.23 U	6.28 U
Acenaphthene	--	**2.47 J**	4.33 U	4.67 U	4.3 U	**10.3 J**	3.11 U	**2.78 J**
Acenaphthylene	--	**2.92 J**	4.33 U	4.67 U	4.3 U	**23.9**	3.11 U	3.14 U
Anthracene	--	**8.53**	4.33 U	4.67 U	**3.24 J**	**67.9**	3.11 U	**3.6**
Benzo(a)anthracene	--	**320**	4.33 U	**2.57 J**	**61.1**	**3320**	**4.34**	**28**
Benzo(a)pyrene	2,000	**638**	4.33 U	**2.89 J**	**116**	**6200**	**5.09**	**37.9**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**2070**	**6.92 J**	**8.91 J**	**403**	**18400**	**12.7**	**123**
Benzo(g,h,i)perylene	--	**2290**	**7.92**	**15.5**	**262**	**11700**	**5.65**	**40.2**
Chrysene	--	**936**	**2.5 J**	**3.26 J**	**218**	**16600**	**6.81**	**55.6**
Dibenzo(a,h)anthracene	--	**294**	4.33 U	4.67 U	**45**	**2080**	3.11 U	**9.51**
Dibenzofuran	--	4.32 U	4.33 U	4.67 U	4.3 U	**11.3 J**	3.11 U	3.14 U
Fluoranthene	--	**274**	4.33 U	4.67 U	**51.7**	**1480**	**6.92**	**46.1**
Fluorene	--	4.32 U	4.33 U	4.67 U	4.3 U	**9.85 J**	3.11 U	3.14 U
Indeno(1,2,3-c,d)pyrene	--	**1230**	**4.97**	**7.84**	**197**	**8530**	**5.48**	**38.6**
Naphthalene	5,000	8.63 U	8.66 U	9.34 U	8.61 U	36.8 U	6.23 U	6.28 U
Phenanthrene	--	**39.2**	4.33 U	4.67 U	**11.8**	**150**	**2.99 J**	**17.2**
Pyrene	--	**310**	4.33 U	4.67 U	**57.1**	**1830**	**7.05**	**40.7**
Total PAHs (U = 1/2)[2,3]	--	**8432.39 J**	**59.11 J**	**75.99 J**	**1447.46 J**	**70468.45 J**	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**1038.76**	**3.81 J**	**5.09 J**	**188.8**	**9599**	**7.57**	**58.4**

Table 5-14
Soil Testing Results: PAHs

Location		**Casting Pit Fill Soils**						
Location ID		**AQ-SSA5-02**		**AQ-SSA5-03**		**AQ-SSA5-04**		**AQ-SSA5-05**
Sample Date		**8/31/2011**	**8/31/2011**	**8/31/2011**	**8/31/2011**	**8/31/2011**	**8/31/2011**	**8/31/2011**
Sample ID		**AQ-SSA5-02-8-10**	**AQ-SSA5-02-14-16**	**AQ-SSA5-03-8-10**	**AQ-SSA5-03-14-16**	**AQ-SSA5-04-8-10**	**AQ-SSA5-04-14-16**	**AQ-SSA5-05-5-7**
Depth		**8 - 10 ft**	**14 - 16 ft**	**8 - 10 ft**	**14 - 16 ft**	**8 - 10 ft**	**14 - 16 ft**	**5 - 7 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**							
1-Methylnaphthalene	--	6.59 U	7.39 U	6.99 U	6.74 U	7.4 U	7.2 U	6.65 U
2-Methylnaphthalene	--	6.59 U	7.39 U	6.99 U	6.74 U	7.4 U	7.2 U	6.65 U
Acenaphthene	--	3.29 U	3.7 U	3.5 U	3.37 U	3.7 U	**4.74**	3.32 U
Acenaphthylene	--	3.29 U	3.7 U	3.5 U	3.37 U	3.7 U	3.6 U	3.32 U
Anthracene	--	3.29 U	3.7 U	3.5 U	3.37 U	**3.95**	**7.9**	3.32 U
Benzo(a)anthracene	--	**5.37**	**7.43**	**5.26**	**6.48**	**10.8**	**18.4**	**6.76**
Benzo(a)pyrene	2,000	**6.3**	**9.17**	**5.92**	**8.27**	**10.2**	**20.5**	**8.52**
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**16.2**	**30.9**	**13.3**	**20.8**	**25.8**	**38.8**	**26.4**
Benzo(g,h,i)perylene	--	**6.96**	**11.7**	**6.18**	**9.51**	**11.8**	**16.2**	**10.7**
Chrysene	--	**8.07**	**14.3**	**6.61**	**11.2**	**16.7**	**21.9**	**14.2**
Dibenzo(a,h)anthracene	--	3.29 U	**2.56 J**	3.5 U	**1.91 J**	**2.06 J**	**3.33 J**	**2.36 J**
Dibenzofuran	--	3.29 U	3.7 U	3.5 U	3.37 U	**2.34 J**	**2.83 J**	3.32 U
Fluoranthene	--	**10.2**	**11**	**8**	**10.9**	**23**	**43**	**12.5**
Fluorene	--	3.29 U	3.7 U	3.5 U	3.37 U	3.7 U	**4.24**	3.32 U
Indeno(1,2,3-c,d)pyrene	--	**6.72**	**10.9**	**6.11**	**8.66**	**10.6**	**16.3**	**10.1**
Naphthalene	5,000	6.59 U	7.39 U	6.99 U	6.74 U	**3.98 J**	7.2 U	6.65 U
Phenanthrene	--	**5.42**	**5.06**	**3.76**	**5.31**	**16.9**	**31.8**	**5.37**
Pyrene	--	**9.63**	**11.1**	**7.63**	**11.3**	**25.6**	**37.8**	**11.8**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**9.37**	**14.5 J**	**8.63**	**12.2 J**	**15.3 J**	**28.4 J**	**13.2 J**

Table 5-14
Soil Testing Results: PAHs

Location		**Casting Pit Fill Soils**			**Soils Adjacent to Landfill No. 3 (Construction Debris)**			
Location ID		**AQ-SSA5-05**	**AQ-SSA5-06**		**AQ-SSA7-01**	**AQ-SSA7-02**	**AQ-SSA7-08**	**AQ-SSA7-09**
Sample Date		**8/31/2011**	**8/31/2011**	**8/31/2011**	**10/27/2011**	**10/27/2011**	**10/28/2011**	**10/28/2011**
Sample ID		**AQ-SSA5-05-14-16**	**AQ-SSA5-06-8-10**	**AQ-SSA5-06-14-16**	**AQ-SSA7-01-3-4**	**AQ-SSA7-02-3-4**	**AQ-SSA7-08-3-4**	**AQ-SSA7-09-3-4**
Depth		**14 - 16 ft**	**8 - 10 ft**	**14 - 16 ft**	**3 - 4 ft**	**3 - 4 ft**	**3 - 4 ft**	**3 - 4 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**							
1-Methylnaphthalene	--	6.41 U	7.05 U	7.34 U	6.97 U	6.97 U	7.84 U	9.37 U
2-Methylnaphthalene	--	6.41 U	7.05 U	7.34 U	6.97 U	6.97 U	7.84 U	9.37 U
Acenaphthene	--	**2.38 J**	3.53 U	**2.62 J**	**2.48 J**	3.49 U	3.92 U	4.68 U
Acenaphthylene	--	3.21 U	3.53 U	3.67 U	3.49 U	3.49 U	3.92 U	4.68 U
Anthracene	--	**3.8**	**1.91 J**	**4.71**	**5.77**	**5.1**	3.92 U	4.68 U
Benzo(a)anthracene	--	**14.9**	**8.72**	**14.2**	**11.7**	**10.9**	**5.84**	**2.69 J**
Benzo(a)pyrene	2,000	**18.3**	**7.2**	**17.9**	**10.4**	**12.3**	**5.75**	4.68 U
Benzo(b)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene[1]	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	**40.2**	**19.7**	**37.4**	**50.5**	**111**	**13.2**	9.37 U
Benzo(g,h,i)perylene	--	**17.5**	**9.29**	**18.6**	**19.2**	**89.5**	**7.61**	**2.36 J**
Chrysene	--	**21.7**	**18.8**	**20.6**	**33.8**	**28**	**7.42**	4.68 U
Dibenzo(a,h)anthracene	--	**3.63**	3.53 U	**3.49 J**	**3.96**	**12.2**	3.92 U	4.68 U
Dibenzofuran	--	**1.72 J**	3.53 U	**2.83 J**	**6.1**	3.49 U	3.92 U	4.68 U
Fluoranthene	--	**29.3**	**17.4**	**27.3**	**43.5**	**20.5**	**11.9**	**3.04 J**
Fluorene	--	**2.16 J**	3.53 U	**2.35 J**	**2.33 J**	3.49 U	3.92 U	4.68 U
Indeno(1,2,3-c,d)pyrene	--	**17.2**	**7.93**	**17**	**16.3**	**67.9**	**5.93**	4.68 U
Naphthalene	5,000	6.41 U	7.05 U	7.34 U	**4.03 J**	6.97 U	7.84 U	9.37 U
Phenanthrene	--	**18.2**	**7.83**	**16**	**25.1**	**9.03**	**5.27**	**3.73 J**
Pyrene	--	**27.2**	**16.2**	**25.1**	**43.1**	**21.7**	**11.8**	**3.12 J**
Total PAHs (U = 1/2)[2,3]	--	--	--	--	--	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	**26.1**	**11.2**	**25.3 J**	**19**	**32.8**	**8.52**	**3.57 J**

Table 5-14
Soil Testing Results: PAHs

Location		**Soils Adjacent to Landfill No. 3**	**Outfall 003 Drainage**	**Outfall 005 Drainage**	**Drainage Downstream of Outfall 005**
Location ID		**AQ-SSA7-10**	**Soil**	**AQ-OF5**	**AQ-OF5D**
Sample Date		**10/28/2011**	**10/25/2012**	**10/25/2012**	**10/25/2012**
Sample ID		**AQ-SSA7-10-3-4**	**AQ-SO-OF3-0-10**	**AQ-SO-OF5-0-10**	**AQ-SO-OF5D-0-10**
Depth		**3 - 4 ft**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**
Sample Type		**D**	**D**	**D**	**D**
Polycyclic Aromatic Hydrocarbons (µg/kg)	**Soil SL**				
1-Methylnaphthalene	--	7.94 U	61.7 U	14.1 U	51.5 U
2-Methylnaphthalene	--	7.94 U	61.7 U	**10.5 J**	51.5 U
Acenaphthene	--	3.97 U	30.9 U	**24.4**	25.8 U
Acenaphthylene	--	3.97 U	30.9 U	7.04 U	25.8 U
Anthracene	--	3.97 U	30.9 U	**40**	25.8 U
Benzo(a)anthracene	--	3.97 U	**117**	**126**	**28.9**
Benzo(a)pyrene	2,000	3.97 U	**200**	**337**	**55.2**
Benzo(b)fluoranthene[1]	--	3.97 U	**477**	**701**	**156**
Benzo(k)fluoranthene[1]	--	3.97 U	**138**	**179**	**41.4**
Benzo(b,k)fluoranthene	--	--	--	--	--
Benzo(g,h,i)perylene	--	3.97 U	**252**	**332**	**72.1**
Chrysene	--	3.97 U	**273**	**266**	**72.1**
Dibenzo(a,h)anthracene	--	3.97 U	**42.7**	**64.9**	25.8 U
Dibenzofuran	--	3.97 U	--	--	--
Fluoranthene	--	3.97 U	**178**	**217**	**44.9**
Fluorene	--	3.97 U	30.9 U	**25**	25.8 U
Indeno(1,2,3-c,d)pyrene	--	3.97 U	**213**	**281**	**65.7**
Naphthalene	5,000	7.94 U	61.7 U	**33.5**	51.5 U
Phenanthrene	--	3.97 U	**66.1**	**142**	**16.6 J**
Pyrene	--	3.97 U	**168**	**204**	**42.3**
Total PAHs (U = 1/2)[2,3]	--	--	**2294.6**	**3011.97 J**	**749.8 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,4]	2,000	3.97 U	**301.5**	**474.9**	**86.4**

Table 5-14
Soil Testing Results: PAHs

Notes:
1 = When no values are reported for both, see benzo(b+k)fluoranthene results.
2 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.
3 = Total PAHs is the sum of all PAHs listed on this table, if measured.
4 = Total cPAH minimum 7 analytes calculation includes benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene. Per MTCA cleanup regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)" under WAC 173-340-708(e).
5 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
6 = Results are reported in dry weight basis.
7 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Soil SL screening level (MTCA A Industrial Soil)
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
D = Discrete Sample
FD = Field Duplicate
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
µg/kg = microgram per kilogram
cm = centimeter
cPAH = carcinogenic polycyclic aromatic hydrocarbon
ft = feet
MTCA = Model Toxics Control Act
SL = screening level
TEQ = toxic equivalency
USEPA = U.S. Environmental Protection Agency
WAC = Washington Administrative Code

Table 5-15
Soil Testing Results: PCB Aroclors

	Location	**Outfall 003 Drainage**	**Outfall 005 Drainage**	**Drainage Downstream of Outfall 005**	**Soils Adjacent to Landfill No. 3 (Construction Debris)**					**Rectifier Yards Soils**				
	Location ID	**AQ-OF3**	**AQ-OF5**	**AQ-OF5D**	**SSA7-01**	**SSA7-02**	**SSA7-08**	**SSA7-09**	**SSA7-10**	**RY1**	**RY2**	**RY3**	**RY5**	
	Sample ID	**AQ-SO-OF3-0-10**	**AQ-SO-OF5-0-10**	**AQ-SO-OF5D-0-10**	**AQ-SSA7-01-3-4**	**AQ-SSA7-02-3-4**	**AQ-SSA7-08-3-4**	**AQ-SSA7-09-3-4**	**AQ-SSA7-10-3-4**	**RY1-092806**	**RY2-092806**	**RY3-092806**	**RY5-092806**	**RY45-092806**
	Sample Date	**10/25/2012**	**10/25/2012**	**10/25/2012**	**10/27/2011**	**10/27/2011**	**10/28/2011**	**10/28/2011**	**10/28/2011**	**9/28/2006**	**9/28/2006**	**9/28/2006**	**9/28/2006**	**9/28/2006**
	Depth	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**3 - 4 ft**	**3 - 4 ft**	**3 - 4 ft**	**3 - 4 ft**	**3 - 4 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**
Analyte	**Sample Type**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**FD**
PCB Aroclors (mg/kg)	**Soil SL**													
Aroclor 1016	--	0.0107 U	0.00979 U	0.0346 U	0.0117 U	0.011 U	0.00831 UJ	0.0118 U	0.00805 U	0.071 U	0.071 U	0.032 U	0.071 U	0.033 U
Aroclor 1221	--	0.0107 U	0.00979 U	0.0346 U	0.0117 U	0.011 U	0.00831 UJ	0.0118 U	0.00805 U	0.071 U	0.071 U	0.032 U	0.071 U	0.033 U
Aroclor 1232	--	0.0107 U	0.00979 U	0.0346 U	0.0117 U	0.011 U	0.00831 UJ	0.0118 U	0.00805 U	0.071 U	0.071 U	0.032 U	0.071 U	0.033 U
Aroclor 1242	--	**0.00576 J**	0.00979 U	0.0346 U	0.0117 U	0.011 U	0.00831 UJ	0.0118 U	0.00805 U	0.071 U	0.071 U	0.032 U	0.071 U	0.033 U
Aroclor 1248	--	0.0107 U	0.00979 U	0.0346 U	**0.013**	0.011 U	0.00831 U	0.0118 U	0.00805 U	0.071 U	0.071 U	0.032 U	0.071 U	0.033 U
Aroclor 1254	--	**0.0295**	**0.014**	**0.0445**	0.0117 U	0.011 U	0.00831 U	0.0118 U	0.00805 U	**0.30**	**0.18**	**0.07**	**0.17**	**0.032 J**
Aroclor 1260	--	**0.025**	**0.0202**	**0.050**	0.0117 U	0.011 U	0.00831 U	0.0118 U	0.00805 U	0.11 U	**0.086**	**0.037**	**0.19**	**0.05**
Aroclor 1262	--	0.0107 U	0.00979 U	0.0346 U	0.0117 U	0.011 U	--	--	--	--	--	--	--	--
Aroclor 1268	--	0.0107 U	0.00979 U	0.0346 U	0.0117 U	0.011 U	0.00831 U	0.0118 U	0.00805 U	--	--	--	--	--
Total PCB Aroclors (U = 1/2)[1]	10	**0.092 J**	**0.069**	**0.216**	**0.0598**	0.011 U	0.00831 UJ	0.0118 U	0.00805 U	**0.50**	**0.44**	**0.020**	**0.54**	**0.20 J**

Notes:

1 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.

🟨 = Detected concentration is greater than Soil screening level

Underlined = Non-detected concentration is above one or more identified screening levels

Bold = Detected result

D = Discrete sample

FD = Field duplicate

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

cm = centimeter

ft = feet

mg/kg = milligrams per kilogram

PCB = polychlorinated biphenyl

SL = screening level

Table 5-16
Soil Testing Results: TPH/EPH

Location		Rectifier Yards Soils							Field Southwest of the Cable Plant	
Location ID		RY1	RY2	RY3	RY4	RY5		RY6	AQ-SSA1-03	AQ-SSA1-06
Sample Date		RY1-092806	RY2-092806	RY3-092806	RY4-092806	RY5-092806	RY45-092806	RY6-092806	AQ-SSA1-03-3-4	AQ-SSA1-06-3-3.5
Sample ID		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	3/15/2012	3/15/2012
Depth		0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	3 - 4 ft	3 - 3.5 ft
Sample Type		D	D	D	D	D	FD	D	D	D
Total Petroleum Hydrocarbons (mg/kg)	**Soil SL**									
Diesel range hydrocarbons	2,000	**26**	**42**	5.3 U	**36**	**15**	**10**	**15**	79.2 U	36.2 U
Oil range hydrocarbons		**110**	**55**	**20**	**85**	**120**	**80**	**61**	**308**	**174**
Extractable Petroleum Hydrocarbons (µg/kg)										
C8-C10 Aliphatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aliphatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aliphatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aliphatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aliphatics	--	--	--	--	--	--	--	--	--	--
C8-C10 Aromatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aromatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aromatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aromatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aromatics	--	--	--	--	--	--	--	--	--	--

Table 5-16
Soil Testing Results: TPH/EPH

Location		HTM Oil Area								
Location ID		**AQ-SSA6-01**		**AQ-SSA6-02**			**AQ-SSA6-03**		**AQ-SSA6-04**	
Sample Date		**AQ-SSA6-01-3-4**	**AQ-SSA6-01-7-8**	**AQ-SSA6-02-3-4**	**AQ-SSA6-02-4-5**	**AQ-SSA6-02-5-6**	**AQ-SSA6-03-3-4**	**AQ-SSA6-03-6-7**	**AQ-SSA6-04-1-2**	**AQ-SSA6-04-3-4**
Sample ID		**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**
Depth		**3 - 4 ft**	**7 - 8 ft**	**3 - 4 ft**	**4 - 5 ft**	**5 - 6 ft**	**3 - 4 ft**	**6 - 7 ft**	**1 - 2 ft**	**3 - 4 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
Total Petroleum Hydrocarbons (mg/kg)	**Soil SL**									
Diesel range hydrocarbons	2,000	**6,580**[4]	**3,760**[4]	**144**	**105**	**64.4 J**	**338**	**450**	**18.6 J**	33.3 U
Oil range hydrocarbons		**3,090**[4]	**2,220**[4]	59.6 U	59.8 U	**68.1**	**163**	**219**	**52.8**	66.6 U
Extractable Petroleum Hydrocarbons (µg/kg)										
C8-C10 Aliphatics	--	14 U	13 U	--	--	--	16 U	--	--	--
C10-C12 Aliphatics	--	**47**	13 U	--	--	--	16 U	--	--	--
C12-C16 Aliphatics	--	**470**	**80**	--	--	--	16 U	--	--	--
C16-C21 Aliphatics	--	**2,800**	**2,000**	--	--	--	**130**	--	--	--
C21-C34 Aliphatics	--	**3,300**	**2,700**	--	--	--	**210**	--	--	--
C8-C10 Aromatics	--	14 U	13 U	--	--	--	16 U	--	--	--
C10-C12 Aromatics	--	14 U	13 U	--	--	--	16 U	--	--	--
C12-C16 Aromatics	--	**54**	13 U	--	--	--	16 U	--	--	--
C16-C21 Aromatics	--	**270**	**31**	--	--	--	16 U	--	--	--
C21-C34 Aromatics	--	**80**	**41**	--	--	--	**38**	--	--	--

Table 5-16
Soil Testing Results: TPH/EPH

Location		**HTM Oil Area**								
Location ID		**AQ-SSA6-05**			**AQ-SSA6-06**		**AQ-SSA6-07**		**AQ-SSA6-08**	
Sample Date		**AQ-SSA6-05-1-2**	**AQ-SSA6-05-3-4**	**AQ-SSA6-05-7-8**	**AQ-SSA6-06-1-2**	**AQ-SSA6-06-3-4**	**AQ-SSA6-07-1-2**	**AQ-SSA6-07-5-6**	**AQ-SSA6-08-4-5**	**AQ-SSA6-08-7-8**
Sample ID		**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**	**8/30/2011**
Depth		**1 - 2 ft**	**3 - 4 ft**	**7 - 8 ft**	**1 - 2 ft**	**3 - 4 ft**	**1 - 2 ft**	**5 - 6 ft**	**4 - 5 ft**	**7 - 8 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
Total Petroleum Hydrocarbons (mg/kg)	**Soil SL**									
Diesel range hydrocarbons	2,000	25 U	**25.6**	37.6 U	25 U	29.3 U	**79.4**	**247**	33.8 U	**99.4**
Oil range hydrocarbons		50 U	**105**	75.2 U	50 U	58.5 U	**140**	**126**	67.6 U	**42.9 J**
Extractable Petroleum Hydrocarbons (µg/kg)										
C8-C10 Aliphatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aliphatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aliphatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aliphatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aliphatics	--	--	--	--	--	--	--	--	--	--
C8-C10 Aromatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aromatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aromatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aromatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aromatics	--	--	--	--	--	--	--	--	--	--

Table 5-16
Soil Testing Results: TPH/EPH

Location		**HTM Oil Area**								
Location ID		**AQ-SSA6-09**				**AQ-SSA6-10**	**AQ-SSA6-10**		**AQ-SSA6-11**	
Sample Date		**AQ-SSA6-09-2-3**	**AQ-SSA6-09-4-5**	**AQ-SSA6-09-11-12**	**AQ-SSA6-09-13-14**	**AQ-SSA6-10-0-1**	**AQ-SSA6-10-1-2**	**AQ-SSA6-10-2-3**	**AQ-SSA6-11-2-3**	**AQ-SSA6-11-5-6**
Sample ID		**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**	**9/2/2011**
Depth		**2 - 3 ft**	**4 - 5 ft**	**11 - 12 ft**	**13 - 14 ft**	**0 - 1 ft**	**1 - 2 ft**	**2 - 3 ft**	**2 - 3 ft**	**5 - 6 ft**
Sample Type		**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
Total Petroleum Hydrocarbons (mg/kg)	**Soil SL**									
Diesel range hydrocarbons	2,000	25 U	**483**	25 U	25.1 U	**69.3**	**1,850**	**4,910** [4]	**31.5**	**514**
Oil range hydrocarbons		50 U	**1,710**	50 U	50.1 U	**93.6**	**2290** [4]	**4,510** [4]	**45.8 J**	**2,410** [4]
Extractable Petroleum Hydrocarbons (µg/kg)										
C8-C10 Aliphatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aliphatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aliphatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aliphatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aliphatics	--	--	--	--	--	--	--	--	--	--
C8-C10 Aromatics	--	--	--	--	--	--	--	--	--	--
C10-C12 Aromatics	--	--	--	--	--	--	--	--	--	--
C12-C16 Aromatics	--	--	--	--	--	--	--	--	--	--
C16-C21 Aromatics	--	--	--	--	--	--	--	--	--	--
C21-C34 Aromatics	--	--	--	--	--	--	--	--	--	--

Table 5-16
Soil Testing Results: TPH/EPH

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = Results are reported in dry weight basis.
3 = All non-detect results are reported at the reporting limit.
4 = Detected concentrations exceeded the screening level but did not exceed the site-specific petroleum cleanup level as calculated based on the EPH analysis and Ecology's 4-phase model (See Appendix G)
🟨 = Detected concentration is greater than Soil screening level
Underlined = Non-detected concentration is above one or more identified screening levels
Bold = Detected result
D = Discrete sample
FD = Field duplicate
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
µg/kg = micrograms per kilogram
EPH = extractable petroleum hydrocarbons
TPH = total petroleum hydrocarbons
ft = feet
mg/kg = milligrams per kilogram
SL = screening level
USEPA = U.S. Environmental Protection Agency

Table 5-17
Soil Testing Results: Nutrients

	Location	**Former Thin Stillage Application Areas**								**Reference Stations**	
	Location ID	**AQ-SSA2-01**	**AQ-SSA2-02**	**AQ-SSA2-03**	**AQ-SSA2-04**	**AQ-SSA2-05**	**AQ-SSA2-06**	**AQ-SSA2-07**	**AQ-SSA2-08**	**AQ-SSA2-REF-01**	**AQ-SSA2-REF-02**
	Sample ID	**AQ-SSA2-01-0-0.5**	**AQ-SSA2-02-0-0.5**	**AQ-SSA2-03-0-0.5**	**AQ-SSA2-04-0-0.5**	**AQ-SSA2-05-0-0.5**	**AQ-SSA2-06-2-3**	**AQ-SSA2-07-2-3**	**AQ-SSA2-08-0-0.5**	**AQ-SSA2-REF-01-0-0.5**	**AQ-SSA2-REF-02-0-0.5**
	Sample Date	**3/15/2012**	**3/16/2012**	**3/15/2012**	**3/16/2012**	**3/15/2012**	**3/16/2012**	**3/15/2012**	**3/16/2012**	**3/16/2012**	**3/16/2012**
Analyte	**Depth**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**	**0 - 0.5 ft**
Nutrients (mg/kg)	**Soil SL**										
Ammonia (as Nitrogen)	--	**3.21**	**6.41**	**4.84**	**4.44**	**5.08**	**7.17**	**5.2**	**3.22**	**3.83**	**2.66**
Nitrate-Nitrogen	--	3.57 U	3.44 U	3.17 U	11.3 U	9.33 U	4.01 U	11 U	9.42 U	9.98 U	3.43 U
Orthophosphate Phosphorous	--	**2.21 J**	**1.65 J**	**1.71 J**	**4.3 J**	**3.17 J**	**6.82 J**	**5.77 J**	**4.08 J**	**2.4 J**	**0.824 J**
Potassium	--	**1540**	**955**	**931**	**1080**	**235**	**1320**	**592**	**995**	**583**	**1130**
Total Phosphorous	--	**9.55**	**14.3**	**22.1**	**13.8**	**12.0**	**32.8**	**16.5**	**12.1**	**20.1**	**10.9**
Total Organic Carbon	--	**21,000**	**24,000**	**19,000**	**19,000**	**3,000**	**25,000**	**3,800**	**16,000**	**11,000**	**32,000**
Total Solids (%)	--	**68.8**	**69.1**	**75.9**	**63.3**	**78.7**	**59.7**	**66.0**	**78.8**	**72.3**	**70.8**
Total Kjeldahl Nitrogen (TKN)	--	**1,760**	**1,720**	**1,840**	**1,570**	**337**	**1,610**	**381**	**1,370**	**722**	**2,600**

Notes:
🟨 = Detected concentration is greater than soil screening level
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
-- = Results not reported or not applicable
mg/kg = milligrams per kilogram
SL = screening level
ft = feet

Table 5-18a
West Groundwater Area Geochemical Results

	Location ID	**G5-S**			**G5-D**			**G6-S**			
	Sample ID	**G5-S-072811**	**G5-S-100711**	**G5-S-100412**	**G5-D-072811**	**G5-D-100711**	**G5-D-100412**	**G6-S-072611**	**G6-S-072811**	**G6-S-101011**	**G6-S-100212**
	Sample Date	**7/28/2011**	**10/7/2011**	**10/4/2012**	**7/28/2011**	**10/7/2011**	**10/4/2012**	**7/26/2011**	**7/28/2011**	**10/10/2011**	**10/2/2012**
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**11.8**	**11.7**	**11.5**	**13.3**	**11.8**	**11.8**	**13.9**	**14.8**	**12.8**	**13.0**
pH (SU)	--	**6.71**	**6.76**	**6.15**	**5.86**	**6.37**	**6.14**	**7.35**	**7.35**	**7.75**	**7.48**
Dissolved oxygen (mg/L)	--	**0.56**	**1.13**	**0.1**	**0.27**	**0.47**	**0.09**	**1.07**	**1.67**	**0.85**	**0.35**
Oxidation Reduction Potential (mV)	--	**-72.3**	**-67.5**	**33.7**	**-41.0**	**-67.0**	**58.8**	**-95.0**	**-15.7**	**80.9**	**-65.6 N**
Turbidity (NTU)	--	**4.27**	**1.84**	**8.91**	**11.2**	**2.63**	**4.73**	**1.48**	--	**3.33**	**3.71**
Conductivity (µS/cm)	--	**623**	**626**	**523**	**489**	**464**	**436**	**2,027**	**1,699**	**2,843**	**2,552**
Sulfide (mg/L)	--	**0.03**	--	**0.04**	0.0	**0.03**	**0.07**	**0.1**	--	**0.05**	**0.14**
Ferrous Iron (Fe 2+) (mg/L)	--	**3.8**	**2.6**	**1.8**	**4.8**	**5.2**	--	**0.4**	--	**0.8**	**0.2**
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	**281**	**250**	--	**200**	**192**	--	**965**	--	**1,360**	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	20 U	--	20 U	20 U	--	20 U	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	20 U	--	20 U	20 U	--	20 U	--	20 U	--
Alkalinity, total as $CaCO_3$	--	**281**	**250**	**240**	**200**	**192**	**160**	**965**	--	**1,360**	**1,330**
Chloride (total)	--	**3.72**	**3.80**	**3.93**	**14.6**	**14.7**	**15.2**	**5.37**	--	**6.52**	**5.76 J**
Phosphorus	--	**1.07**	**0.24 J**	**1.49**	**1.42**	**1.26**	**1.47**	**2.30**	--	**7.5**	**8.81**
Sulfate	250	1 U	1 U	1 U	1 U	1 U	1 U	**44.8**	--	**57.2**	**50.6**
Total dissolved solids	--	**306**	**335**	**363**	**311**	**305**	**313**	**1,290**	--	**1,810**	**1,780**
Total suspended solids	--	**62.0**	**70.0**	**106**	**29.0**	**41.0**	**71.0**	**9.0**	--	5 U	**20.0**
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	**39 J**	--	--	**131**	--	--	--	**1,330**
Calcium	--	--	--	**53,900**	--	--	**37,800**	--	--	--	**19,300**
Iron	--	--	--	**67,400**	--	--	**46,500**	--	--	--	**3,130**
Magnesium	--	--	--	**19,800**	--	--	**14,200**	--	--	--	**5,660**
Manganese	--	--	--	**3,590**	--	--	**2,150**	--	--	--	**954**
Potassium	--	--	--	**2,550**	--	--	**2,260**	--	--	--	**6,580**
Silicon	--	--	--	**33,800**	--	--	**35,000**	--	--	--	**18,800**
Sodium	--	--	--	**10,500**	--	--	**8,240**	--	--	--	**683,000**
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	**4.51 J**	50 U	50 U	**5.0 J**	50 U	50 U	**971**	--	**343**	**318**
Calcium	--	**46,700**	**49,400**	**53,600**	**39,200**	**38,200**	**37,000**	**27,400**	--	**18,000**	**18,500**
Iron	--	**54,200**	**52,900**	**67,100**	**46,400**	**47,400**	**46,100**	**546**	--	**1,320**	**981 J**
Magnesium	--	**18,600**	**18,200**	**19,900**	**14,700**	**13,900**	**13,900**	**9,170**	--	**6,670**	**5,510**
Manganese	--	**3,580**	**3,680**	**3,510**	**2,010**	**2,130**	**2,120**	**521**	--	**967**	**863**
Potassium	--	**2,790**	**2,640**	**2,590**	**2,400**	**2,290**	**2,230**	**5,090**	--	**6,910**	**6,510**
Silicon	--	**30,100**	**30,600**	**33,500**	**34,000**	**33,200**	**34,300**	**18,900**	--	**17,700**	**18,300**
Sodium	--	**11,500**	**11,300**	**10,200**	**8,130**	**8,090**	**8,240**	**465,000**	--	**738,000**	**694,000**

Table 5-18a
West Groundwater Area Geochemical Results

	Location ID	G6-D				G7-D			PZ-6		
	Sample ID	G6-D-072611	G6-D-072811	G6-D-101011	G6-D-100212	G7-D-072811	G7-D-100711	G7-D-100512	PZ-6-072711	PZ-6-100711	PZ-6-100212
	Sample Date	7/26/2011	7/28/2011	10/10/2011	10/2/2012	7/28/2011	10/7/2011	10/5/2012	7/27/2011	10/7/2011	10/2/2012
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**14.7**	**15.6**	**12.8**	**12.7**	**13.0**	**12.7**	**12.8**	**12.7**	**14.2**	**14.4**
pH (SU)	--	**6.48**	**6.59**	**6.52**	**6.54**	**6.16**	**6.73**	**6.36**	**9.72**	**9.69**	**8.43**
Dissolved oxygen (mg/L)	--	**0.27**	**0.14**	**1.32**	**0.34**	**0.10**	**0.61**	**0.13**	**0.30**	**0.41**	**0.874**
Oxidation Reduction Potential (mV)	--	**-114**	**-99.8**	**-66.0**	**-47 N**	**-92.0**	**-108**	**19.3**	**-390**	**-75.2**	**-223 N**
Turbidity (NTU)	--	**766**	--	**1.64**	**2.85**	**15.1**	**21.9**	**55.4**	**39.2**	**354**	**80.9**
Conductivity (µS/cm)	--	**2,749**	**2,867**	**2,996**	**2,885**	**1,400**	**1,467**	**1,349**	**2,800**	**3,470**	**2,722**
Sulfide (mg/L)	--	**0.06**	--	**0.02**	**0.08**	0.0	**0.02**	**0.16**	**1.2**	**2.2**	**0.52**
Ferrous Iron (Fe 2+) (mg/L)	--	**6.5**	--	**4.0**	**2.4**	**5.4**	**6.2**	**1.2**	**0.8**	**1.6**	**1.2**
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	**2,080**	--	**1,690**	--	**715**	**653**	--	**820**	**1,340**	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	--	20 U	--	20 U	20 U	--	**800**	**670**	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	--	20 U	--	20 U	20 U	--	20 U	20 U	--
Alkalinity, total as $CaCO_3$	--	**2,080**	--	**1,690**	**1,800**	**715**	**653**	**760**	**1,620**	**2,010**	**1,510**
Chloride (total)	--	**66.1**	--	**62.5**	**56.0**	**14.1**	**12.8**	**11.7 J**	**23**	**29.1**	**15.2 J**
Phosphorus	--	0.18 U	--	**0.95**	**0.116**	**0.24**	**0.18**	**0.794**	**7.8**	**12.3**	**7.9**
Sulfate	250	**43.9**	--	**53.3**	**44.8**	1 U	**1.02**	1 UJ	**36.8**	**51.3**	**36.1**
Total dissolved solids	--	**1,750**	--	**2,000**	**2,090**	**746**	**686**	**806**	**2,230**	**2,950**	**2,120**
Total suspended solids	--	**126**	--	**41.0**	**41.0**	**46.0**	**34.0**	**197**	**9.0**	**68.0**	**42.0**
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	--	250 U	--	--	**571**	--	--	**3,550**
Calcium	--	--	--	--	**148,000**	--	--	--	--	--	**5,450**
Iron	--	--	--	--	**41,900**	--	--	**43,900**	--	--	**4,880**
Magnesium	--	--	--	--	**109,000**	--	--	--	--	--	**1,780**
Manganese	--	--	--	--	**4,020**	--	--	**3,480**	--	--	**381**
Potassium	--	--	--	--	**4,600**	--	--	**3,140**	--	--	**1,650**
Silicon	--	--	--	--	**31,400**	--	--	**30,100**	--	--	**35,100**
Sodium	--	--	--	--	**482,000**	--	--	**127,000**	--	--	**807,000**
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	6.11 U	--	250 U	250 U	**8.43 J**	50 U	50 U	**1,480**	**357**	**977**
Calcium	--	**134,000**	--	**137,000**	**153,000**	**79,700**	**85,700**	**96,900**	**6,000**	**6,310**	**5,530**
Iron	--	**47,900**	--	**45,400**	**41,200**	**27,300**	**17,800**	**43,500**	**2,310**	**1,730**	**2,640**
Magnesium	--	**102,000**	--	**97,300**	**98,100**	**39,100**	**37,900**	**44,300**	**457**	**924**	**1,370**
Manganese	--	**3,190**	--	**3,660**	**4,020**	**2,990**	**2,740**	**3,510**	**124**	**132**	**441**
Potassium	--	**4,960**	--	**4,590**	**4,680**	**3,220**	**3,030**	**3,210**	**1,120**	**1,360**	**1,070 J**
Silicon	--	**33,900**	--	**30,200**	**33,100**	**26,600**	**24,700**	**29,100**	**27,500**	**25,100**	**33,900**
Sodium	--	**406,000**	--	**523,000**	**485,000**	**122,000**	**96,800**	**122,000**	**815,000**	**1,080,000**	**895,000**

Table 5-18a
West Groundwater Area Geochemical Results

Location ID		PZ-7			RL-1S			RL-1D		
Sample ID		**PZ-7-072711**	**PZ-7-100711**	**PZ-7-100212**	**MBT-072711-15**	**RL-1S-100611**	**RL-1S-100412**	**MBT-072611-08**	**RL-1D-100611**	**BMP-100412-02**
Sample Date		**7/27/2011**	**10/7/2011**	**10/2/2012**	**7/27/2011**	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/6/2011**	**10/4/2012**
Geochemical - Field Parameters	**Screening Level**									
Temperature (°C)	--	**17.0**	**13.8**	**13.7**	**11.4**	**12.1**	**12.3**	**13.8**	**12.4**	**12.0**
pH (SU)	--	**7.09**	**7.14**	**7.19**	**5.48**	**6.34**	**6.4**	**6.46**	**6.65**	**7.23**
Dissolved oxygen (mg/L)	--	**0.18**	**0.59**	**0.60**	**0.33**	**0.48**	**0.24**	**0.79**	**6.60**	**0.81**
Oxidation Reduction Potential (mV)	--	**-252**	**-138**	**-144 N**	**-34.0**	**39.0**	**0.5**	**-87.0**	**-62.0**	**-119**
Turbidity (NTU)	--	**4.03**	**14.6**	**24.1**	**17.7**	**17.3**	--	**>1,000**	**61.9**	**67.9**
Conductivity (µS/cm)	--	**2,577**	**2,533**	**2,136**	**498**	**410**	**313**	**1,285**	**1,268**	**1,295**
Sulfide (mg/L)	--	**0.11**	**0.05**	**0.06**	**0.06**	**0.02**	--	0.0	0.0	--
Ferrous Iron (Fe 2+) (mg/L)	--	**2.2**	**2.0**	**2.2**	**3.0**	**4.3**	--	**4.5**	**4.4**	--
Geochemical - Conventional (mg/L)										
Alkalinity, Bicarbonate as $CaCO_3$	--	**1,410**	**1,340**	--	--	**358**	--	--	**698**	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	20 U	--	--	20 U	--	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	20 U	--	--	20 U	--	--	20 U	--
Alkalinity, total as $CaCO_3$	--	**1,410**	**1,340**	**1,390**	--	**358**	**230**	--	**698**	--
Chloride (total)	--	20 U	**13.8**	**16.2 J**	**3.05**	**3.75**	**3.74**	**2.74**	**2.85**	**2.86**
Phosphorus	--	**5.36**	**5.32**	**6.28**	--	**0.468**	**0.43**	--	**1.3**	--
Sulfate	250	20 U	1 U	**1.1**	**4.54**	**1.88**	**1.5**	1 U	1 U	1 U
Total dissolved solids	--	**1,830**	**1,840**	**1,780**	--	**490**	**392**	--	**667**	--
Total suspended solids	--	**5.0**	**8.0**	**1,160 J**	--	**8.0**	**15.0**	--	**193**	--
Geochemical Metals, Total (µg/L)										
Aluminum	--	--	--	**1,770**	--	--	**352**	--	--	--
Calcium	--	--	--	**29,000**	--	--	**14,900**	--	--	--
Iron	--	--	--	**19,500**	--	--	**11,800**	--	--	--
Magnesium	--	--	--	**12,100**	--	--	**6,960**	--	--	--
Manganese	--	--	--	**665**	--	--	**408**	--	--	--
Potassium	--	--	--	**2,440**	--	--	**657**	--	--	--
Silicon	--	--	--	**35,400**	--	--	**23,700**	--	--	--
Sodium	--	--	--	**547,000**	--	--	**79,300**	--	--	--
Geochemical Metals, Dissolved (µg/L)										
Aluminum	--	**141**	**183**	**188 J**	--	**214**	134	--	50 U	--
Calcium	--	**28,500**	**27,700**	**29,300**	**11,400**	**13,600**	**14,800**	**111,000**	**122,000**	**250,000**
Iron	--	**11,200**	**13,800**	**15,400**	--	**7,780**	**10,000**	--	**57,900**	--
Magnesium	--	**11,200**	**11,200**	**9,930**	**5,350**	**6390**	**6,940**	**58,900**	**58,900**	**122,000**
Manganese	--	**554**	**636**	**588**	--	**425**	**384**	--	**3,410**	--
Potassium	--	**2,470**	**2,570**	**2,220**	--	**756**	**654**	--	**2,100**	--
Silicon	--	**33,800**	**31,900**	**36,000**	--	**21,100**	**22,900**	--	**32,600**	--
Sodium	--	**602,000**	**596,000**	**528,000**	**83,100**	**100,000**	**82,900**	**23,900**	**24,000**	**24,500**

Table 5-18a
West Groundwater Area Geochemical Results

Location ID		RL-2S			RL-2D			RL-3S		
Sample ID		MBT-072711-16	RL-2S-100611	BMP-100412-05	MBT-072611-11	RL-2D-100611	BMP-100412-06	MBT-072611-12	RL-3S-100611	BMP-100412-09
Sample Date		7/27/2011	10/6/2011	10/4/2012	7/26/2011	10/6/2011	10/4/2012	7/26/2011	10/6/2011	10/4/2012
Geochemical - Field Parameters	**Screening Level**									
Temperature (°C)	--	**13.6**	**13.0**	**13.0**	**12.5**	**11.7**	**11.8**	**15.8**	**13.5**	**14.3**
pH (SU)	--	**9.74**	**9.68**	**9.37**	**6.49**	**6.85**	**6.80**	**6.64**	**6.91**	**6.3**
Dissolved oxygen (mg/L)	--	**0.05**	**0.61**	**0.37**	**0.30**	**0.24**	**0.65**	**0.27**	**0.41**	**0.42**
Oxidation Reduction Potential (mV)	--	**-213**	**-179**	**-138**	**-125**	**-147**	**-123**	**-131**	**-98.7**	**-159**
Turbidity (NTU)	--	**7.59**	**6.75**	**6.36**	**1.76**	**5.65**	**22.8**	**2.72**	**4.74**	**5.48**
Conductivity (µS/cm)	--	**6,116**	**547**	**3,250**	**2,339**	**2,596**	**2,740**	**1,583**	**1,661**	**1,224**
Sulfide (mg/L)	--	**1.6**	**2.7**	--	**0.6**	**0.07**	--	**0.05**	0.0	--
Ferrous Iron (Fe 2+) (mg/L)	--	**0.1**	**0.2**	--	**3.0**	**4.3**	--	**2.8**	**5.0**	--
Geochemical - Conventional (mg/L)										
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**2,360**	--	--	**1,410**	--	--	**738**	--
Alkalinity, Carbonate as $CaCO_3$	--	--	**1,840**	--	--	20 U	--	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	--	--	20 U	--	--	20 U	--
Alkalinity, total as $CaCO_3$	--	--	**4,200**	--	--	**1,410**	--	--	**738**	--
Chloride (total)	--	**31.8**	**39.4**	**33.2**	**28.5**	**35.2**	**32.5**	**14**	**10.5**	**11.5**
Phosphorus	--	--	**11.6**	--	--	**2.13**	--	--	**1.46**	--
Sulfate	250	**127**	**164**	**166**	**10.4**	**15.7**	**17.4**	1 U	**1.46**	1 U
Total dissolved solids	--	--	**5,570**	--	--	**1,680**	--	--	**892**	--
Total suspended solids	--	--	**12.0**	--	--	**81.0**	--	--	**118**	--
Geochemical Metals, Total (µg/L)										
Aluminum	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--
Silicon	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--
Geochemical Metals, Dissolved (µg/L)										
Aluminum	--	--	250 U	--	--	**44.3 J**	--	--	50 U	--
Calcium	--	**1,080**	**4,510**	--	**73,600**	**66,700**	--	**58,600**	**65,700**	--
Iron	--	--	**3,150**	--	--	**56,800**	--	--	**73,000**	--
Magnesium	--	**199**	**882**	--	**39,700**	**32,300**	--	**32,600**	**27,700**	--
Manganese	--	--	**25.1**	--	--	**1,560**	--	--	**6,460**	--
Potassium	--	--	**1,770**	--	--	**3,590**	--	--	**1,550**	--
Silicon	--	--	**15,600**	--	--	**37,000**	--	--	**27,900**	--
Sodium	--	**160,000**	**1,040,000**	--	**284,000**	**590,000**	--	**253,000**	**164,000**	--

Table 5-18a
West Groundwater Area Geochemical Results

	Location ID	RL-3D			RL-4S			RL-4D		
	Sample ID	**MBT-072711-17**	**RL-3D-100611**	**BMP-100412-08**	**MBT-072711-18**	**RL-4S-100611**	**BMP-100412-10**	**MBT-072611-14**	**RL-4D-100611**	**BMP-100412-11**
	Sample Date	**7/27/2011**	**10/6/2011**	**10/4/2012**	**7/27/2011**	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/6/2011**	**10/4/2012**
Geochemical - Field Parameters	**Screening Level**									
Temperature (°C)	--	**13.4**	**12.5**	**12.8**	**15.8**	**16.3**	**17.8**	**13.9**	**13.3**	**13.6**
pH (SU)	--	**6.18**	**6.65**	**7.29**	**6.23**	**6.55**	**7.48**	**6.24**	**6.62**	**6.76**
Dissolved oxygen (mg/L)	--	**0.78**	**0.25**	**0.33**	**0.62**	**0.37**	**0.65**	**0.24**	**0.55**	**0.45**
Oxidation Reduction Potential (mV)	--	**-68.0**	**-62.0**	**-55**	**-67.0**	**-54.0**	**-79**	**-90.0**	**-88.8**	**-68**
Turbidity (NTU)	--	**>1,000**	**64.5**	**602**	**131**	**147**	**35.4**	**15.3**	**1,676**	**>1,000**
Conductivity (µS/cm)	--	**1,214**	**1,165**	**1,130**	**537**	**506**	**476**	**653**	**674**	**633**
Sulfide (mg/L)	--	**0.03**	0.0	--	0.0	0.0	--	**0.04**	0.0	--
Ferrous Iron (Fe 2+) (mg/L)	--	**5.4**	**6.2**	--	**2.8**	**2.4**	--	**4.1**	**1.6**	--
Geochemical - Conventional (mg/L)										
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**693**	--	--	**258**	--	--	**283**	--
Alkalinity, Carbonate as $CaCO_3$	--	--	20 U	--	--	20 U	--	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	--	--	20 U	--	--	20 U	--
Alkalinity, total as $CaCO_3$	--	--	**693**	--	--	**258**	--	--	**283**	--
Chloride (total)	--	**3.33**	**3.63**	**3.87**	**11.1**	**12.0**	**12.0**	**10.0**	**10.2**	**12.1**
Phosphorus	--	--	**1.67**		--	**1.98**	--	--	**7.45**	--
Sulfate	250	1 U	1 U	1 U	**1.13**	1 U	1 U	**8.98**	**7.05**	**2.51**
Total dissolved solids	--	--	**652**	--	--	**406**	--	--	**414**	--
Total suspended solids	--	--	**119**	--	--	**41.0**	--	--	**3,760**	--
Geochemical Metals, Total (µg/L)										
Aluminum	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--
Silicon	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--
Geochemical Metals, Dissolved (µg/L)										
Aluminum	--	--	50 U	--	--	50 U	--	--	50 U	--
Calcium	--	**100,000**	**118,000**	--	**33,400**	**32,700**	--	**44,300**	**44,700**	--
Iron	--	--	**40,300**	--	--	**43,000**	--	--	**50,600**	--
Magnesium	--	**52,100**	**54,900**	--	**18,300**	**18,000**	--	**22,400**	**22,000**	--
Manganese	--	--	**1,830**	--	--	**3,050**	--	--	**2,820**	--
Potassium	--	--	**2,950**	--	--	**1,010**	--	--	**1,810**	--
Silicon	--	--	**32,400**	--	--	**28,900**	--	--	**33,500**	--
Sodium	--	**29,600**	**29,000**	--	**33,900**	**34,600**	--	**24,400**	**24,400**	--

Table 5-18a
West Groundwater Area Geochemical Results

	Location ID	**RL-5**			**RLSW-1**		**RLSW-2**		**RLSW-3**		
	Sample ID	**MBT-072611-13**	**RL-5-100711**	**BMP-100412-12**	**RLSW-1-101011**	**RLSW-1-100412**	**RLSW-2-101111**	**RLSW-2-100512**	**RLSW-3-101111**	**RLSW-3-100512**	**RLSW-3-120412**
	Sample Date	**7/26/2011**	**10/7/2011**	**10/4/2012**	**10/10/2011**	**10/4/2012**	**10/11/2011**	**10/5/2012**	**10/11/2011**	**10/5/2012**	**12/4/2012**
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**13.9**	**11.0**	**10.3**	**13.7**	**14.5**	**13.2**	**14.6**	**11.6**	**12.3**	**11.7**
pH (SU)	--	**5.90**	**6.49**	**6.1**	**7.12**	**7.2**	**7.01**	**7.05**	**6.13**	**6.3**	**6.92**
Dissolved oxygen (mg/L)	--	**0.22**	**1.03**	**0.35**	**0.40**	**0.09**	**0.54**	**1.74**	**1.46**	**0.31**	**0.20**
Oxidation Reduction Potential (mV)	--	**70.0**	**82.5**	**64.0**	**-118.1**	**-11**	**-23.3**	**34.2**	**-41.4**	**44.4**	**-49.3 N**
Turbidity (NTU)	--	**8.01**	**15.0**	**24.8**	**24.2**	**3.97**	**11.2**	**10.6**	**28.4**	**28.4**	**69.0**
Conductivity (µS/cm)	--	**638**	**628**	**609**	**2,436**	**2,155**	**1,519**	**1,407**	**2,099**	**1,815**	**1,769**
Sulfide (mg/L)	--	**0.03**	**0.02**	--	0.0	**0.09**	**0.02**	**0.02**	0.0	**0.02**	--
Ferrous Iron (Fe 2+) (mg/L)	--	**0.5**	**0.2**	--	**4.0**	**2.4**	**0.3**	**1.1**	**4.2**	**2.6**	--
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**265**	--	**1,290**	--	**910**	--	**1,160**	--	--
Alkalinity, Carbonate as $CaCO_3$	--	--	20 U	--	20 U	--	20 U	--	20 U	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	--	20 U	--	20 U	--	20 U	--	--
Alkalinity, total as $CaCO_3$	--	--	**265**	--	**1,310**	**1160**	**910**	**690**	**1,160**	**1,050**	--
Chloride (total)	--	**7.95**	**8.55**	**8.04**	**12.7**	**9.42**	**6.44**	**5.84**	**23.1**	**25.5**	--
Phosphorus	--	--	**0.09 J**	--	**6.2**	**3.62**	**1.06**	**0.80**	**0.84**	**0.46**	--
Sulfate	250	**76.7**	**78.2**	**77.5**	**10.0**	**20.9**	**70.5**	**64.4 J**	1 U	1 U	--
Total dissolved solids	--	--	**482**	--	**1,610**	**1,550**	**1,300**	**1,170**	**1,260**	**1,250**	--
Total suspended solids	--	--	**61.0**	--	**48.0**	5 U	5 U	5 U	**46.0**	**120**	--
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	--	--	**170**	--	**2,120**	--	**254**	--
Calcium	--	--	--	--	--	**21,100**	--	--	--	--	--
Iron	--	--	--	--	--	**8,220**	--	**1,230**	--	**37,900**	--
Magnesium	--	--	--	--	--	**11,500**	--	--	--	--	--
Manganese	--	--	--	--	--	**481**	--	**219**	--	**1,340**	--
Potassium	--	--	--	--	--	**1,910**	--	**1,830**	--	**4,400**	--
Silicon	--	--	--	--	--	**24,500**	--	**20,100**	--	**28,600**	--
Sodium	--	--	--	--	--	**561,000**	--	**374,000**	--	**296,000**	--
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	--	**224**	--	250 U	**144 J**	**1,180**	**1,310**	**176**	**188**	--
Calcium	--	**7,860**	**8,980**	--	**22,000 J**	**20,400**	**13,500**	**14,400**	**59,500**	**83,000**	--
Iron	--	--	**332**	--	**8,650**	**8,200**	**236 J**	**555**	**26,100**	**25,900**	--
Magnesium	--	**3,690**	**4,330**	--	**12,900 J**	**11,400**	**6,970**	**7,060**	**29,200**	**34,900**	--
Manganese	--	--	**79.4**	--	**468**	**485**	**347**	**164**	**1,360**	**1,270**	--
Potassium	--	--	**675**	--	**1,900**	**1,700**	**1,750**	**2,090**	**3,420**	**3,970**	--
Silicon	--	--	**11,900**	--	**25,600**	**24,800**	**17,400**	**19,100**	**26,100**	**27,500**	--
Sodium	--	**124,000**	**148,000**	--	**632,000**	**555,000**	**452,000**	**445,000**	**315,000**	**304,000**	--

Table 5-18a
West Groundwater Area Geochemical Results

	Location ID	RLSW-4		SSA4-MW-01
	Sample ID	RLSW-4-101011	RLSW-4-100212	SSA4-MW-01-100512
	Sample Date	10/10/2011	10/2/2012	10/5/2012
Geochemical - Field Parameters	**Screening Level**			
Temperature (°C)	--	**13.3**	**13.8**	**15.6**
pH (SU)	--	**7.35**	**7.38**	**6.5**
Dissolved oxygen (mg/L)	--	**0.27**	**0.19**	**0.51**
Oxidation Reduction Potential (mV)	--	**-96.0**	**-84.0**	**13.5**
Turbidity (NTU)	--	**8.67**	**2.41**	**6.94**
Conductivity (µS/cm)	--	**3,004**	**2,790**	**514**
Sulfide (mg/L)	--	**1.0**	**0.64**	**0.02**
Ferrous Iron (Fe 2+) (mg/L)	--	**1.6**	**1.3**	**2.0**
Geochemical - Conventional (mg/L)				
Alkalinity, Bicarbonate as $CaCO_3$	--	**1,510**	--	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	--	--
Alkalinity, total as $CaCO_3$	--	**1,510**	**1,570**	**200**
Chloride (total)	--	**7.66**	**6.64 J**	**6.62**
Phosphorus	--	**10.5**	**5.65**	**0.122**
Sulfate	250	**27.1**	**14.6**	**46.4 J**
Total dissolved solids	--	**2,060**	**2,000**	**386**
Total suspended solids	--	**32**	**7**	**103**
Geochemical Metals, Total (µg/L)				
Aluminum	--	--	**546**	**180**
Calcium	--	--	**23,600**	--
Iron	--	--	**2,880**	**2,110**
Magnesium	--	--	**8,650**	--
Manganese	--	--	**1,160**	**1,950**
Potassium	--	--	**7,480**	**1,620**
Silicon	--	--	**20,100**	**25,500**
Sodium	--	--	**766,000**	**41,400**
Geochemical Metals, Dissolved (µg/L)				
Aluminum	--	**399**	**405**	**119**
Calcium	--	**22,700 J**	**21,700**	**38,200**
Iron	--	**3,190**	**2,660**	**1,970**
Magnesium	--	**10,100 J**	**9,070**	**21,500**
Manganese	--	**1,190**	**1,170**	**1,970**
Potassium	--	**7,510**	**6,880**	**1,690**
Silicon	--	**20,200**	**22,200**	**25,500**
Sodium	--	**835,000**	**777,000**	**42,100**

Table 5-18a
West Groundwater Area Geochemical Results

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Groundwater screening level
Bold = Detected result
Underlined = Non-detected concentration is above one or more identified screening levels
J = Estimated value
N = Presumptive evidence
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
µg/L = micrograms per liter
µS/cm= microsiemens per centimeter
°C = degree Celsius
$CaCO_3$ = calcium carbonate
LDC = Laboratory Data Consultants
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
SU = standard unit
FD = field duplicate sample
USEPA = United States Environmental Protection Agency

Table 5-18b
West Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide	WAD Cyanide	Total Cyanide	Dissolved Free Cyanide	Dissolved WAD Cyanide	Dissolved Total Cyanide	Fluoride	Dissolved Fluoride
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Screening Level	**0.2**	--	--	**0.2**	--	--	**4.0**	**4.0**
West Groundwater Area Monitoring Wells										
G5S	G5-S-100412	10/4/2012	0.005 U	0.005 U	0.005 U	0.005 UJ	**0.0084**	0.005 U	**0.223**	**0.189**
	G5-S-100711	10/7/2011	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.159**	**0.166**
	G5-S-072811	7/28/2011	**0.0021 J**	0.005 U	0.005 U	--	--	--	0.153 UJ	--
	G5-S-091806	9/18/2006	**0.000452 J**	0.005 U	0.005 U	--	--	--	**0.2**	--
G5D	G5-D-100412	10/4/2012	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	**0.246**	**0.193**
	G5-D-100711	10/7/2011	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.01 U	**0.193**	**0.206**
	G5-D-072811	7/28/2011	**0.0025 J**	**0.0055**	0.005 U	--	--	--	0.184 UJ	--
	G5-D-091806	9/18/2006	**0.000269 J**	0.005 U	0.005 U	--	--	--	**0.2**	--
G6S	G6-S-100212	10/2/2012	0.0026 J	**0.0215**	**0.109**	0.005 U	**0.0168**	**0.108**	**86.4**	**84.4**
	G6-S-101011	10/10/2011	0.005 UJ	**0.016**	**0.0928**	0.005 UJ	**0.0134**	**0.0958**	**77.8**	**78.7**
	G6-S-072611	7/26/2011	0.0049 U	**0.017**	**0.0852**	--	--	--	**67.8**	--
	G6-S-091906	9/19/2006	**0.00267**	**0.0259**	**0.137**	--	--	--	**85.4**	--
G6D	G6-D-100212	10/2/2012	0.005 U	**0.0218**	**0.189**	0.005 U	**0.0184**	**0.145**	**1.77**	**1.03**
	G6-D-101011	10/10/2011	0.005 UJ	**0.0136**	**0.0652**	0.005 UJ	**0.0144**	**0.136**	**1.07**	**1.11**
	G6-D-072611	7/26/2011	0.004 U	**0.0059**	**0.121**	--	--	--	**0.484 J**	--
	G6-D-091906	9/19/2006	0.0005 U	**0.0592**	**3.05**	--	--	--	0.1 U	--
G7D	G7-D-100512	10/5/2012	0.005 U	**0.0113**	**0.0185**	0.005 U	0.005 U	**0.0136**	**1.07**	**0.995**
	G7-D-100711	10/7/2011	0.005 U	0.005 U	**0.0079**	0.005 U	0.005 U	**0.0052**	**0.797**	**0.773**
	G7-D-072811	7/28/2011	0.005 U	0.005 U	**0.0133**	--	--	--	**0.921 J**	--
	G7-D-091806	9/18/2006	**0.000531 J**	**0.0102**	**0.018**	--	--	--	**1.4**	--
RL-1S	RL-1S-100412	10/4/2012	0.005 U	**0.008**	**0.0144**	0.005 UJ	**0.0078**	**0.0151**	**7.82**	**7.35**
	RL-1S-100611	10/6/2011	0.005 UJ	0.005 U	**0.0154**	0.005 U	**0.0075**	**0.013**	**9.79**	**9.85**
	MBT-072711-15	7/27/2011	0.005 U	**0.0055**	**0.008**	--	--	--	**7.42**	--
	RL-1S-091906	9/19/2006	**0.000641**	**0.00719**	**0.0261**	--	--	--	**13**	--

Table 5-18b
West Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide mg/L	WAD Cyanide mg/L	Total Cyanide mg/L	Dissolved Free Cyanide mg/L	Dissolved WAD Cyanide mg/L	Dissolved Total Cyanide mg/L	Fluoride mg/L	Dissolved Fluoride mg/L
Screening Level			**0.2**	--	--	**0.2**	--	--	**4.0**	**4.0**
RL-1D	BMP-100412-02	10/4/2012	0.005 U	0.005 U	0.005 U	--	--	--	**0.357**	--
	RL-1D-100611	10/6/2011	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.333**	**0.329**
	MBT-072611-08	7/26/2011	0.005 UJ	0.015 U	0.015 U	--	--	--	0.177 UJ	--
	RL-1D-091906	9/19/2006	0.000503 U	**0.0127**	**0.00435 J**	--	--	--	**0.2**	--
RL-2S	BMP-100412-05	10/4/2012	0.005 U	**0.0248**	**19.2**	--	--	--	**69.4**	--
	RL-2S-100611	10/6/2011	**0.0322**	**0.106**	**21.3**	0.005 U	**0.0492**	**6.52**	**72.3**	**29**
	MBT-072711-16	7/27/2011	**0.0022 J**	**0.14**	**12.4**	--	--	--	**57.1**	--
	RL-2S-091806	9/18/2006	**0.0369 J**	**0.0744**	**15.8**	--	--	--	**94**	--
RL-2D	BMP-100412-06	10/4/2012	0.005 U	0.02 U	**0.112**	--	--	--	**13.3**	--
	RL-2D-100611	10/6/2011	0.005 UJ	**0.0205**	**0.562**	0.005 U	**0.0136**	**0.098**	**10.4**	**11.8**
	MBT-072611-11	7/26/2011	0.005 UJ	**0.0106**	**0.258**	--	--	--	**8.04**	--
	RL-2D-091806	9/18/2006	**0.000495 J**	**0.00971**	**0.0361**	--	--	--	**10.5**	--
RL-3S	BMP-100412-09	10/4/2012	0.005 U	**0.0096**	**0.0349**	--	--	--	**6.28**	--
	RL-3S-100611	10/6/2011	0.005 U	**0.0074**	**0.0271**	0.005 UJ	**0.0084**	**0.0244**	**4.12**	**4.56**
	MBT-072611-12	7/26/2011	0.005 UJ	**0.01**	**0.0422**	--	--	--	**6.09**	--
	RL-3S-091906	9/19/2006	**0.00104**	**0.0203**	**0.111**	--	--	--	**16.6**	--
RL-3D	BMP-100412-08	10/4/2012	0.005 U	0.005 U	0.005 U	--	--	--	**0.368**	--
	RL-3D-100611	10/6/2011	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	**0.005**	**0.267**	**0.264**
	MBT-072711-17	7/27/2011	**0.0035 J**	0.015 U	0.015 U	--	--	--	**0.223 J**	--
	RL-3D-091906	9/19/2006	0.0005 U	0.005 U	0.005 U	--	--	--	**0.2**	--
RL-4S	BMP-100412-10	10/4/2012	0.005 U	**0.0065**	0.005 U	--	--	--	**0.882**	--
	RL-4S-100611	10/6/2011	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.94**	**0.916**
	MBT-072711-18	7/27/2011	**0.0044 J**	0.005 U	0.005 U	--	--	--	**0.761 J**	--
	RL-4S-091906	9/19/2006	**0.000624**	0.005 U	0.005 U	--	--	--	**0.5**	--

Table 5-18b
West Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide	WAD Cyanide	Total Cyanide	Dissolved Free Cyanide	Dissolved WAD Cyanide	Dissolved Total Cyanide	Fluoride	Dissolved Fluoride
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Screening Level	**0.2**	--	--	**0.2**	--	--	**4.0**	**4.0**
RL-4D	BMP-100412-11	10/4/2012	0.005 U	**0.0076**	0.005 U	--	--	--	**0.406**	--
	RL-4D-100611	10/6/2011	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	**0.3**	**0.363**
	MBT-072611-14	7/26/2011	0.005 UJ	0.005 U	0.005 U	--	--	--	**0.296 J**	--
	RL-4D-091906	9/19/2006	**0.000581**	0.005 U	0.005 U	--	--	--	**0.3**	--
RL-5	BMP-100412-12	10/4/2012	0.005 U	**0.0099**	**0.0314**	--	--	--	**2.79**	--
	RL-5-100711	10/7/2011	0.005 U	**0.0064**	**0.0332**	0.005 U	**0.0061**	**0.0297**	**2.26**	**2.3**
	MBT-072611-13	7/26/2011	0.005 UJ	0.005 U	**0.0288**	--	--	--	**2.39**	--
	RL-5-091806	9/18/2006	**0.00407**	**0.00213 J**	**0.038**	--	--	--	**1.6**	--
PZ-6	PZ-6-100212	10/2/2012	0.005 U	**0.0218**	**0.62**	0.005 U	**0.0269**	**0.812**	**76.3**	**70.8**
	PZ-6-100711	10/7/2011	0.005 U	**0.0223**	**4.04**	0.005 U	**0.028**	**7.02**	**79.8**	**84.5**
	PZ-6-072711	7/27/2011	0.005 U	**0.13**	**1.9**	--	--	--	**76.9**	--
	PZ-6-091806	9/18/2006	**0.0107 J**	**0.145**	**5.43**	--	--	--	**94.4**	--
PZ-7	PZ-7-100212	10/2/2012	0.005 UJ	**0.014**	**0.0909**	0.005 UJ	**0.0093 J**	**0.0609**	**20.8**	**19.9**
	PZ-7-100711	10/7/2011	0.005 U	**0.0092**	**0.0542**	0.005 U	**0.0102**	**0.0479**	**21.3**	**21.5**
	PZ-7-072711	7/27/2011	0.005 U	**0.0378**	**0.0498**	--	--	--	**25**	--
	PZ-7-091806	9/18/2006	**0.00116 J**	**0.0229**	**0.0915**	--	--	--	**32.5**	--
RLSW-1	RLSW-1-100412	10/4/2012	0.005 U	**0.0137**	**0.121**	0.005 UJ	**0.0081**	**0.0875**	**56.9**	**50.7**
	RLSW-1-101011	10/10/2011	0.005 UJ	**0.0188**	**0.782 J**	0.005 UJ	**0.0097**	**0.155**	**43.1**	**42.8**
	RLSW-1-092706	9/27/2006	**0.000853**	**0.0239**	**0.0952**	--	--	--	**63.8**	--
RLSW-2	RLSW-2-100512	10/5/2012	0.005 U	0.01 U	**0.0324**	0.005 U	**0.007**	**0.0469**	**82.5**	**81.4**
	RLSW-2-101111	10/11/2011	0.005 UJ	**0.0079**	**0.041**	0.005 UJ	**0.0069**	**0.0419**	**81.3**	**77**
	RLSW-2-092706	9/27/2006	**0.000624**	**0.0188**	**0.0943**	--	--	--	**71.4**	--
RLSW-3	RLSW-3-100512	10/5/2012	0.005 U	**0.0371**	**0.449**	0.005 U	**0.0288**	**0.39**	**4.76**	**4.48**
	RLSW-3-101111	10/11/2011	0.005 UJ	**0.0345**	**0.41**	0.005 UJ	**0.0235**	**0.35**	**5.62**	**7.17**
	RLSW-3-092706	9/27/2006	**0.00138**	**0.0309**	**0.299**	--	--	--	**11.8**	--

Table 5-18b
West Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide mg/L	WAD Cyanide mg/L	Total Cyanide mg/L	Dissolved Free Cyanide mg/L	Dissolved WAD Cyanide mg/L	Dissolved Total Cyanide mg/L	Fluoride mg/L	Dissolved Fluoride mg/L
Screening Level			**0.2**	--	--	**0.2**	--	--	**4.0**	**4.0**
RLSW-4	RLSW-4-100212	10/2/2012	0.005 U	**0.0197**	**0.131**	0.005 U	**0.016**	**0.126**	**101**	**94.6**
	RLSW-4-101011	10/10/2011	0.005 UJ	**0.0198**	**0.122 J**	0.005 UJ	**0.0158**	**0.123**	**102**	**96.8**
	RLSW-4-091906	9/19/2006	0.0005 U	**0.0319**	**0.707**	--	--	--	**89.4**	--
SSA4-MW-01	SSA4-MW-01-011212	1/12/2012	--	--	--	--	--	--	--	--
	SSA4-MW-01-100512	10/5/2012	0.005 U	**0.0053**	0.005 U	0.005 U	**0.0058**	**0.0149**	**3.93**	**3.77**

Notes:

1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

2 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than Groundwater screening level

Bold = Detected result

Underlined = Non-detected concentration is above one or more identified screening levels

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

LDC = Laboratory Data Consultants

mg/L = milligrams per liter

WAD = weak acid dissociable

USEPA = U.S. Environmental Protection Agency

Table 5-18c
West Groundwater Area Total Metals Results

	Location ID	**RL-1S**	**RLSW-3**	**SSA4-MW-01**
	Sample ID	**RL-1S-100412**	**RLSW-3-100512**	**SSA4-MW-01-100512**
	Sample Date	**10/4/2012**	**10/5/2012**	**10/5/2012**
Metals (µg/L)	**Screening Level**			
Antimony	--	1 U	2 U	--
Arsenic	5/42[1]	1.51 U	**7.64**	**2.1**
Beryllium	--	1 U	2 U	--
Cadmium	5	1 U	2 U	--
Chromium	50	2 U	1.98 U	4 U
Copper	1,300	**2.4**	4 U	**1.37 J**
Lead	15	1 U	**5.22**	--
Mercury	2	0.08 U	0.16 U	--
Nickel	100	**3.17**	**4.73**	**6.63**
Selenium	--	2 U	4 U	--
Silver	--	1 U	2 U	--
Thallium	--	1 U	2 U	--
Zinc	--	**3.9 J**	**5.31 J**	--

Notes:

1 = The study area is located in an area of Cowlitz County known to contain elevated levels of naturally occurring arsenic, iron and manganese in groundwater. Data available from the State Department of Health for Cowlitz County for the period 2001-2011 indicate an arsenic concentration range of up to 55 µg/L in monitored water system wells, with a median value of 10 µg/L and a 90-percentile value of 42 µg/L. Consistent with MTCA provisions (WAC 173-340-709(3)), groundwater data were compared to the 90-percentile of the background concentrations.

2 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

3 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than Groundwater screening level

▨ = Detected concentration is greater than MTCA Method A Groundwater cleanup level but is below regional background[1]

Bold = Detected result

<u>Underlined = Non-detected concentration is above one or more identified screening levels</u>

J = Estimated value

U = Compound analyzed, but not detected above detection limit

-- = Results not reported or not applicable

µg/L = micrograms per liter

USEPA = U.S. Environmental Protection Agency

Table 5-18d
West Groundwater Area Dissolved Metals Results

	Location ID	**RL-1S**			**RL-1D**			**RL-2S**		
	Sample ID	**MBT-072711-15**	**RL-1S-100611**	**RL-1S-100412**	**MBT-072611-08**	**RL-1D-100611**	**BMP-100412-02**	**MBT-072711-16**	**RL-2S-100611**	**BMP-100412-05**
	Sample Date	**7/27/2011**	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/6/2011**	**10/4/2012**	**7/27/2011**	**10/6/2011**	**10/4/2012**
Metals, Dissolved (µg/L)	**Screening Level**									
Antimony	--	--	--	1 U	--	--	--	--	--	--
Arsenic	5/42[1]	**0.889 J**	**0.967 J**	**1.72 J**	**1.37 J**	**1.2 J**	**0.967 J**	**2.82**	**19.5**	**34**
Beryllium	--	--	--	1 U	--	--	--	--	--	
Cadmium	5	--	--	1 U	--	--	--	--	--	
Chromium	50	**1.7 J**	2.32 U	**1.94 J**	1.21 U	1.62 U	4 U	**5.97**	**35.8**	**66.7**
Copper	1,300	**2.51 J**	4 U	4 U	4 U	4 U	2 U	**1 J**	20 U	20 U
Lead	15	--	--	1 U	--	--	--	--	--	--
Mercury	2	--	--	0.08 U	--	--	--	--	--	--
Nickel	100	**5.04**	**2.71**	**2.94**	**0.9 J**	**1.09 J**	**1.73 J**	**4.5**	**26.1**	**65.9**
Selenium	--	--	--	2 U	--	--	--	--	--	--
Silver	--	--	--	1 U	--	--	--	--	--	--
Thallium	--	--	--	1 U	--	--	--	--	--	--
Zinc	--	--	--	**2.92 J**	--	--	--	--	--	--

Table 5-18d
West Groundwater Area Dissolved Metals Results

	Location ID	RL-2D			RL-3S			RL-3D			RL-4S
	Sample ID	**MBT-072611-11**	**RL-2D-100611**	**BMP-100412-06**	**MBT-072611-12**	**RL-3S-100611**	**BMP-100412-09**	**MBT-072711-17**	**RL-3D-100611**	**BMP-100412-08**	**MBT-072711-18**
	Sample Date	**7/26/2011**	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/6/2011**	**10/4/2012**	**7/27/2011**	**10/6/2011**	**10/4/2012**	**7/27/2011**
Metals, Dissolved (µg/L)	**Screening Level**										
Antimony	--	--	--	--	--	--	--	--	--	--	--
Arsenic	5/42[1]	**2.69**	**5.84**	**4.72 J**	**10.4**	**17.6**	**12.1**	**1.42 J**	**1.48 J**	**1.32 J**	**5.16**
Beryllium	--	--	--	--	--	--		--	--	--	--
Cadmium	5	--	--	--	--	--		--	--	--	--
Chromium	50	**2.64**	**9.97**	**4.56 J**	1.47 U	1.98 U	**0.933 J**	0.967 U	1.89 U	**0.589 J**	1.03 U
Copper	1,300	**0.322 J**	4 U	10 U	4 U	4 U	2 U	**0.511 J**	4 U	2 U	4 U
Lead	15	--	--	--	--	--	--	--	--	--	--
Mercury	2	--	--	--	--	--	--	--	--	--	--
Nickel	100	**2.71**	**6.63**	**10.5**	**1.77 J**	**1.84 J**	**3.04**	**0.767 J**	**1.4 J**	**1.87 J**	**1.14 J**
Selenium	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--

Table 5-18d
West Groundwater Area Dissolved Metals Results

	Location ID	RL-4S		RL-4D			RL-5			RLSW-3	SSA4-MW-01
	Sample ID	**RL-4S-100611**	**BMP-100412-10**	**MBT-072611-14**	**RL-4D-100611**	**BMP-100412-11**	**MBT-072611-13**	**RL-5-100711**	**BMP-100412-12**	**RLSW-3-100512**	**SSA4-MW-01-100512**
	Sample Date	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/6/2011**	**10/4/2012**	**7/26/2011**	**10/7/2011**	**10/4/2012**	**10/5/2012**	**10/5/2012**
Metals, Dissolved (µg/L)	**Screening Level**										
Antimony	--	--	--	--	--	--	--	--	--	2 U	--
Arsenic	5/42[1]	**3.14**	**4.34**	**1.52 J**	**1.39 J**	**1.3 J**	**1.33 J**	**1.32 J**	**1.5 J**	**6.04**	**2.27**
Beryllium	--	--	--	--	--	--	--	--	--	2 U	--
Cadmium	5	--	--	--	--	--	--	--	--	2 U	--
Chromium	50	1.69 U	**0.578 J**	0.822 U	1.49 U	**0.9 J**	0.989 U	2 U	**1.16 J**	**2.07 J**	4 U
Copper	1,300	4 U	2 U	4 U	4 U	2 U	**11.6**	**22.7**	**17.8**	4 U	**1.21 J**
Lead	15	--	--	--	--	--	--	--	--	2 U	--
Mercury	2	--	--	--	--	--	--	--	--	0.16 U	--
Nickel	100	**1.46 J**	**1.56 J**	**0.656 J**	**0.778 J**	**1.07 J**	**4.69**	**8.23**	**8.29**	**4.58**	**6.69**
Selenium	--	--	--	--	--	--	--	--	--	**2.04 J**	--
Silver	--	--	--	--	--	--	--	--	--	2 U	--
Thallium	--	--	--	--	--	--	--	--	--	2 U	--
Zinc	--	--	--	--	--	--	--	--	--	**6.82 J**	--

Table 5-18d
West Groundwater Area Dissolved Metals Results

Notes:

1 = The study area is located in an area of Cowlitz County known to contain elevated levels of naturally occurring arsenic, iron and manganese in groundwater. Data available from the State Department of Health for Cowlitz County for the period 2001-2011 indicate an arsenic concentration range of up to 55 µg/L in monitored water system wells, with a median value of 10 µg/L and a 90-percentile value of 42 µg/L. Consistent with MTCA provisions (WAC 173-340-709(3)), groundwater data were compared to the 90-percentile of the background concentrations.

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🟨 = Detected concentration is greater than Groundwater screening level

▨ = Detected concentration is greater than MTCA Method A Groundwater cleanup level but is below regional background[1]

Bold = Detected result

Underlined = Non-detected concentration is above one or more identified screening levels

J = Estimated value

U = Compound analyzed, but not detected above detection limit

-- = Results not reported or not applicable

MTCA = Model Toxics Control Act

µg/L = micrograms per liter

USEPA = U.S. Environmental Protection Agency

Table 5-18e
West Groundwater Area PAH Results

	Location ID	G6-S				G6-D		RL-1S	RL-4S		RLSW-2
	Sample ID	G6-S-010507	G6-S-010507-D	G6-S-072811	G6-S-101011	G6-D-072811	G6-D-101011	RL-1S-100412	RL-4S-072711	RL-4S-100611	RLSW-2-010507
	Sample Date	1/5/2007	1/5/2007	7/28/2011	10/10/2011	7/28/2011	10/10/2011	10/4/2012	7/27/2011	10/6/2011	1/5/2007
	Sample Type		FD								
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**										
1-Methylnaphthalene	--	--	--	0.0381 UJ	0.0381 U	0.0374 UJ	0.0374 U	0.0412 U	0.0377 U	0.0377 U	--
2-Methylnaphthalene	--	0.01 U	0.01 U	0.0381 UJ	0.0381 U	0.0374 UJ	0.0374 U	**0.0247 J**	0.0377 U	0.0377 U	0.01 U
Acenaphthene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Acenaphthylene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0122 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Anthracene	--	0.01 U	0.01 U	**0.0469**	**0.0571**	**0.0815**	**0.0884**	0.0206 U	**0.0169 J**	**0.0127 J**	0.01 U
Benzo(a)anthracene	--	0.01 U	0.01 U	**0.00977 J**	0.0124 U	**0.0136 J**	0.0187 U	0.0206 U	**0.0102 J**	0.0108 U	0.01 U
Benzo(a)pyrene	0.1	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0309 U	0.0189 U	0.0189 U	0.01 U
Benzo(b)fluoranthene	--	0.01 U	0.01 U	0.019 UJ	0.019 U	0.0187 UJ	0.0187 U	0.0309 U	0.0189 U	0.0189 U	0.01 U
Benzo(k)fluoranthene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0309 U	0.0189 U	0.0189 U	0.01 U
Benzo(g,h,i)perylene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Chrysene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Dibenzo(a,h)anthracene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Dibenzofuran	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	--	--	0.0189 U	0.01 U
Fluoranthene		**0.1**	**0.095**	**0.0572**	**0.12**	0.0187 U	0.0187 U	0.0206 U	**0.0153 J**	0.0189 U	0.01 U
Fluorene	--	**0.048**	**0.048**	0.019 U	**0.0161 J**	**0.0171 J**	**0.0272**	0.0206 U	0.0189 U	0.0189 U	0.01 U
Indeno(1,2,3-c,d)pyrene	--	0.01 U	0.01 U	0.019 U	0.019 U	0.0187 U	0.0187 U	0.0206 U	0.0189 U	0.0189 U	0.01 U
Naphthalene	160	0.01 U	0.01 U	0.0381 UJ	**0.0349 J**	0.0374 UJ	**0.0215 J**	**0.0218 J**	**0.0334 J**	**0.0214 J**	0.01 U
Phenanthrene	--	0.01 U	0.01 U	0.019 U	**0.01 J**	0.0187 U	0.0187 U	0.0206 U	**0.0165 J**	**0.0108 J**	0.01 U
Pyrene	--	**0.12**	**0.11**	**0.0902**	**0.207**	0.0187 U	0.0187 U	0.0206 U	**0.0171 J**	**0.0133 J**	0.01 U
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)^{1,2}	0.1	0.01 U	0.01 U	**0.0144 J**	0.019 U	**0.0145 J**	0.0187 U	0.0309 U	**0.0143 J**	0.0189 U	0.01 U

Table 5-18e
West Groundwater Area PAH Results

	Location ID	**RLSW-3**		**SSA4-MW-01**	
	Sample ID	**RLSW-3-100512**	**RLSW-3-120412**	**SSA4-MW-01-011212**	**SSA4-MW-01-100512**
	Sample Date	**10/5/2012**	**12/4/2012**	**1/12/2012**	**10/5/2012**
	Sample Type				
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**				
1-Methylnaphthalene	--	0.0374 U	0.0748 UJ	0.0374 U	0.0748 UJ
2-Methylnaphthalene	--	**0.0239 J**	0.0748 UJ	0.0374 U	0.0748 UJ
Acenaphthene	--	**0.013 J**	0.0374 U	0.0187 U	0.0374 U
Acenaphthylene	--	0.0187 U	0.0374 U	0.0187 U	0.0374 U
Anthracene	--	**0.0327**	**0.0405**	0.0187 U	0.0374 U
Benzo(a)anthracene	--	**0.0139 J**	0.0374 U	0.0187 U	0.0374 U
Benzo(a)pyrene	0.1	**0.0163 J**	0.0374 U	**0.0124 J**	0.0374 U
Benzo(b)fluoranthene	--	**0.0434**	0.0374 U	0.0187 U	0.0374 U
Benzo(k)fluoranthene	--	0.028 U	0.0374 U	0.0187 U	0.0374 U
Benzo(g,h,i)perylene	--	0.0187 U	0.0374 U	0.0187 U	0.0374 U
Chrysene	--	**0.0357**	0.0374 U	0.0187 U	0.0374 U
Dibenzo(a,h)anthracene	--	0.0187 U	0.0374 U	0.0187 U	0.0374 U
Dibenzofuran	--	--	0.0374 U	0.0187 U	0.0374 U
Fluoranthene		**0.0728**	**0.0428**	0.0187 U	0.0374 U
Fluorene	--	**0.0121 J**	0.0374 U	0.0187 U	0.0374 U
Indeno(1,2,3-c,d)pyrene	--	0.0187 U	0.0374 U	0.0187 U	0.0374 U
Naphthalene	160	**0.0288 J**	0.0748 UJ	**0.0212 J**	0.0748 UJ
Phenanthrene	--	**0.0295**	0.0374 U	**0.0106 J**	0.0374 U
Pyrene	--	**0.0422**	**0.0248 J**	0.0187 U	0.0374 U
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[1,2]	0.1	**0.0257 J**	0.0374 U	**0.0172 J**	0.0374 U

Table 5-18e
West Groundwater Area PAH Results

Notes:

1 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.

2 = Total cPAH minimum 7 analytes calculation includes benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene. Per MTCA cleanup regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)" under WAC 173-340-708(e).

3 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

4 = All non-detect results are reported at the reporting limit.

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

<u>Underlined = Non-detected concentration is above one or more identified screening levels</u>

µg/L = micrograms per liter

cPAHs = carcinogenic polycyclic aromatic hydrocarbons

FD = field duplicate sample

MTCA = Model Toxics Control Act

TEQ = toxic equivalency

USEPA = U.S. Environmental Protection Agency

WAC = Washington Administrative Code

Table 5-18f
West Groundwater Area PCB, VOC, and SVOC Results

	Location ID	RL-1S	RLSW-3
	Sample ID	RL-1S-100412	RLSW-3-100512
	Sample Date	10/4/2012	10/5/2012
PCB Aroclors (µg/L)	**Screening Level**		
Aroclor 1016	--	0.0189 U	0.0189 U
Aroclor 1221	--	0.0189 U	0.0189 U
Aroclor 1232	--	0.0189 U	0.0189 U
Aroclor 1242	--	0.0189 U	0.0189 U
Aroclor 1248	--	0.0189 U	0.0189 U
Aroclor 1254	--	0.0189 U	0.0189 U
Aroclor 1260	--	0.0189 U	0.0189 U
Aroclor 1262	--	0.0189 U	0.0189 U
Aroclor 1268	--	0.0189 U	0.0189 U
Total PCB Aroclors (U = 1/2)[1]	0.1	0.0189 U	0.0189 U
Volatile Organics (µg/L)			
1,1,1,2-Tetrachloroethane	--	0.5 U	0.5 U
1,1,1-Trichloroethane	--	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	--	0.5 U	0.5 U
1,1,2-Trichloroethane	--	0.5 U	0.5 U
1,1-Dichloroethane	--	0.5 U	0.5 U
1,1-Dichloroethene	--	0.5 U	0.5 U
1,1-Dichloropropene	--	1 U	1 U
1,2,3-Trichlorobenzene	--	2 U	2 U
1,2,3-Trichloropropane	--	1 U	1 U
1,2,4-Trichlorobenzene	--	2 U	2 U
1,2,4-Trimethylbenzene	--	1 U	1 U
1,2-Dibromo-3-chloropropane	--	5 U	5 U
1,2-Dichlorobenzene	--	0.5 U	0.5 U
1,2-Dichloroethane	--	0.5 U	0.5 U
1,2-Dichloroethene, cis-	--	0.5 U	0.5 U
1,2-Dichloroethene, trans-	--	0.5 U	0.5 U
1,2-Dichloropropane	--	0.5 U	1 U
1,3,5-Trimethylbenzene (Mesitylene)	--	1 U	1 U
1,3-Dichlorobenzene	--	0.5 U	0.5 U
1,3-Dichloropropane	--	1 U	1 U
1,3-Dichloropropene, cis-	--	1 U	1 U
1,3-Dichloropropene, trans-	--	1 U	1 U
1,4-Dichlorobenzene	--	0.5 U	0.5 U
2,2-Dichloropropane	--	1 U	1 U
2-Butanone (MEK)	--	10 U	10 UJ
2-Chlorotoluene	--	1 U	1 U
2-Hexanone (Methyl butyl ketone)	--	10 U	10 U
4-Chlorotoluene	--	1 U	1 U
4-Isopropyltoluene (4-Cymene)	--	1 U	1 U
Acetone	--	20 U	20 U
Benzene	--	0.25 U	0.25 U
bis(2-Ethylhexyl)adipate	--	0.155 U	0.14 U
Bromobenzene	--	0.5 U	0.5 U
Bromochloromethane	--	1 U	1 U
Bromodichloromethane	--	1 U	1 U
Bromoform (Tribromomethane)	--	1 U	1 U
Bromomethane (Methyl bromide)	--	5 UJ	5 U
Carbon disulfide	--	10 U	10 U
Carbon tetrachloride (Tetrachloromethane)	--	0.5 U	0.5 U
Chlorobenzene	--	0.5 U	0.5 U
Chloroethane	--	5 U	5 UJ
Chloroform	--	1 U	1 U
Chloromethane	--	5 UJ	5 U
Dibromochloromethane	--	1 U	1 U
Dibromomethane	--	1 U	1 U
Dichlorodifluoromethane	--	1 U	1 U
Dichloromethane (Methylene chloride)	--	5 U	5 U
Ethylbenzene	--	0.5 U	0.5 U
Ethylene dibromide (1,2-Dibromoethane)	--	0.5 U	0.5 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	5 U	5 U
Isopropylbenzene (Cumene)	--	1 U	1 U

Table 5-18f
West Groundwater Area PCB, VOC, and SVOC Results

	Location ID Sample ID Sample Date	RL-1S RL-1S-100412 10/4/2012	RLSW-3 RLSW-3-100512 10/5/2012
m,p-Xylene	--	1 U	1 U
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	--	10 UJ	10 U
Methyl tert-butyl ether (MTBE)	--	1 U	1 U
Naphthalene	--	2 U	2 U
n-Butylbenzene	--	1 U	1 U
n-Propylbenzene	--	0.5 U	0.5 U
o-Xylene	--	0.5 U	0.5 U
sec-Butylbenzene	--	1 U	1 U
Styrene	--	1 U	1 U
tert-Butylbenzene	--	1 U	1 U
Tetrachloroethene (PCE)	--	0.5 U	0.5 U
Toluene	--	1 U	1 U
Trichloroethene (TCE)	--	0.5 U	0.5 U
Trichlorofluoromethane (Fluorotrichloromethane)	--	2 U	2 U
Vinyl chloride	--	0.5 U	0.5 U
Semivolatile Organics (µg/L)			
1,2,4-Trichlorobenzene	--	0.0515 U	0.0467 U
1,2-Dichlorobenzene	--	0.0515 UJ	0.0467 UJ
1,2-Dinitrobenzene	--	0.515 U	0.467 U
1,3-Dichlorobenzene	--	0.0515 UJ	0.0467 UJ
1,3-Dinitrobenzene	--	0.515 U	0.467 U
1,4-Dichlorobenzene	--	0.0515 UJ	0.0467 UJ
1,4-Dinitrobenzene	--	0.515 U	0.467 U
2,3,4,6-Tetrachlorophenol	--	0.103 U	0.0935 U
2,3,5,6-Tetrachlorophenol	--	0.103 U	0.0935 U
2,4,5-Trichlorophenol	--	0.103 U	0.0935 U
2,4,6-Trichlorophenol	--	0.103 U	0.0935 U
2,4-Dichlorophenol	--	0.103 U	0.0935 U
2,4-Dimethylphenol	--	0.103 UJ	0.0935 UJ
2,4-Dinitrophenol	--	0.515 U	0.467 U
2,4-Dinitrotoluene	--	0.206 U	0.187 U
2,6-Dinitrotoluene	--	0.206 U	0.187 U
2-Chloronaphthalene	--	0.0206 U	0.0187 U
2-Chlorophenol	--	0.103 U	0.0935 U
2-Methylphenol (o-Cresol)	--	0.0515 U	0.0467 U
2-Nitroaniline	--	0.412 UJ	0.374 U
2-Nitrophenol	--	0.206 U	0.187 U
3,3'-Dichlorobenzidine	--	0.206 UJ	0.187 UJ
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	--	0.0515 U	0.0467 U
3-Nitroaniline	--	0.412 UJ	0.374 UJ
4-Bromophenyl-phenyl ether	--	0.0515 U	0.0467 U
4-Chloro-3-methylphenol	--	0.206 U	0.187 U
4-Chloroaniline	--	0.0515 UJ	0.0467 UJ
4-Chlorophenyl phenyl ether	--	0.0515 U	0.0467 U
4-Nitroaniline	--	0.412 UJ	0.374 UJ
4-Nitrophenol	--	0.206 UJ	0.187 UJ
Aniline	--	0.103 UJ	0.0935 UJ
Azobenzene	--	0.0515 U	0.0467 U
Benzidine	--	0.515 U	0.467 U
Benzoic acid	--	2.58 U	**1.61 J**
Benzyl alcohol	--	0.206 U	0.187 U
bis(2-Chloroethoxy)methane	--	0.0515 U	0.0467 U
bis(2-Chloroethyl)ether	--	0.0515 U	0.0467 U
bis(2-Chloroisopropyl)ether	--	0.0515 U	0.0467 U
bis(2-Ethylhexyl)phthalate	--	**1.95**	**0.981**
Butylbenzyl phthalate	--	1.03 U	0.935 U
Carbazole	--	0.0309 U	**0.0198 J**
Dibenzofuran	--	0.0206 U	**0.0123 J**
Diethyl phthalate	--	0.103 U	0.0935 U
Dimethyl phthalate	--	0.103 U	0.0935 U
Di-n-butyl phthalate	--	**0.26 J**	**0.277 J**
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	--	0.515 U	0.467 U
Di-n-octyl phthalate	--	0.515 U	0.467 U

Table 5-18f
West Groundwater Area PCB, VOC, and SVOC Results

	Location ID	RL-1S	RLSW-3
	Sample ID	RL-1S-100412	RLSW-3-100512
	Sample Date	10/4/2012	10/5/2012
Hexachlorobenzene	--	0.0206 U	0.0187 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	0.0515 UJ	0.0467 UJ
Hexachlorocyclopentadiene	--	0.103 U	0.0935 U
Hexachloroethane	--	0.0515 UJ	0.0467 UJ
Isophorone	--	0.0515 U	**0.0256 J**
Nitrobenzene	--	0.206 U	0.187 U
n-Nitrosodimethylamine	--	0.0515 UJ	0.0467 UJ
n-Nitrosodi-n-propylamine	--	0.0515 U	0.0467 U
n-Nitrosodiphenylamine	--	0.0515 U	0.0467 U
Pentachlorophenol	--	0.412 U	0.374 U
Phenol	--	0.412 UJ	0.374 UJ
Pyridine	--	0.206 UJ	**0.175 J**

Notes:

1 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.

2 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

3 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than Groundwater screening level

Bold = Detected result

Underlined = Non-detected concentration is above one or more identified screening levels

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

µg/L = micrograms per liter

FD = field duplicate sample

MTCA = Model Toxics Control Act

PCB = polychlorinated biphenyl

SVOC = semi volatile organic compound

TEQ = toxic equivalency

USEPA = U.S. Environmental Protection Agency

VOC = volatile organic compound

WAC = Washington Administrative Code

Table 5-19a
East Groundwater Area Geochemical Results

	Location ID	G1-S						G1-D			
	Sample ID	G1-S-072511	G1-S-D-072511	G1-S-101111	G1-S-101111	G1-S-100412	G1-S-120312	G1-D-072511	G1-D-101111	G1-D-100412	G1-D-120312
	Sample Date	7/25/2011	7/25/2011	10/11/2011	10/11/2011	10/4/2012	12/3/2012	7/25/2011	10/11/2011	10/4/2012	12/3/2012
	Sample Type		FD		FD						
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	13.3	13.3	13.7	13.7	12.8	13.5	14.0	15.5	13.0	12.0
pH (su)	--	6.9	6.9	6.9	6.9	6.8	7.1	6.3	6.42	6.37	6.57
Dissolved oxygen (mg/L)	--	0.6	0.6	0.24	0.24	0.12	0.18	0.54	0.34	0.19	0.2
Oxidation Reduction Potential (mV)	--	-74.5	-74.5	-30.0	-30.0	14.9	-82.3 N	-156	-81.7	-18.3 N	-84.3 N
Turbidity (NTU)	--	15.7	15.7	2.4	2.4	4	1.95	>1,000	15	6.2	8.34
Conductivity (µS/cm)	--	660	660	853	853	1,496	1,320	2,941	3,952	3,594	3,726
Sulfide (mg/L)	--	0.02	0.02	0.1	0.1	0.02	--	0.0	0.0	0.05	--
Ferrous Iron (Fe 2+) (mg/L)	--	1.8	1.8	2.2	2.2	2.4	--	5.0	7.2	4.8	--
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	315	314	281	240	--	--	838	1,240	--	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	20 U	20 U	20 U	--	--	20 U	20 U	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	20 U	20 U	20 U	--	--	20 U	20 U	--	--
Alkalinity, total as $CaCO_3$	--	315	314	281	240	569	--	838	1,240	962	--
Chloride (total)	--	4.54	4.52	7.28	8.34	15.7	--	332	525	431	--
Phosphorus	--	0.084 U	0.118	0.43 J	0.42 J	1.22	--	1.09	1.33	1.24	--
Sulfate	250	10.6	10.7	151	157	333	--	1 U	20 U	1 U	--
Total dissolved solids	--	395	386	569	559	1,110	--	1,740	2,310	1,910	--
Total suspended solids	--	5.0	6.0	5 U	7.0	9.0	--	87	149	244	--
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	--	--	465	--	--	--	61 J	--
Calcium	--	--	--	--	--	128,000	--	--	--	174,000	--
Iron	--	--	--	--	--	5,440	--	--	--	218,000	--
Magnesium	--	--	--	--	--	63,800	--	--	--	82,100	--
Manganese	--	--	--	--	--	681	--	--	--	5,420	--
Potassium	--	--	--	--	--	38,100	--	--	--	2,780	--
Silicon	--	--	--	--	--	15,300	--	--	--	37,300	--
Sodium	--	--	--	--	--	137,000	--	--	--	316,000	--
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	810	779	587	601	427	--	7.87 J	100 U	100 U	--
Calcium	--	32,900	33,100	46,500	47,400	124,000	--	157,000	170,000	167,000	--
Iron	--	2,410	2,120	2,690	2,670	4,830	--	241,000	221,000	220,000	--
Magnesium	--	16,900	16,600	23,500	24,800	61,100	--	77,800	85,800	81,800	--
Manganese	--	202	202	256	257	642	--	5,600	5,240	5,420	--
Potassium	--	14,600	14,500	20,200	20,500	36,900	--	1,930	3,500	2,750	--
Silicon	--	13,900	13,900	12,700	12,500	15,000	--	39,300	34,200	37,600	--
Sodium	--	73,200	71,700	87,700	89,300	133,000	--	218,000	419,000	277,000	--

Table 5-19a
East Groundwater Area Geochemical Results

Location ID		G2-S				G2-D				G3-S		G3-S
Sample ID		**G2-S-072511**	**G2-S-101111**	**G2-S-100312**	**G2-S-120312**	**G2-D-072511**	**G2-D-101111**	**G2-D-100312**	**G2-D-120312**	**G3-S-072811**	**G3-S-101111**	**G3-S-100412**
Sample Date		**7/25/2011**	**10/11/2011**	**10/3/2012**	**12/3/2012**	**7/25/2011**	**10/11/2011**	**10/3/2012**	**12/3/2012**	**7/28/2011**	**10/11/2011**	**10/4/2012**
Sample Type												
Geochemical - Field Parameters	**Screening Level**											
Temperature (°C)	--	**13.8**	**14.8**	**14.6**	**13.3**	**12.9**	**12.5**	**13.4**	**12.2**	**14.6**	**13.8**	**12.6**
pH (su)	--	**7.22**	**7.14**	**7.16**	**7.26**	**6.99**	**6.80**	**6.96**	**6.86**	**6.90**	**7.08**	**6.6**
Dissolved oxygen (mg/L)	--	**0.32**	**0.07**	**0.26**	**1.9**	**0.38**	**0.16**	**1.74**	**0.21**	**0.32**	**0.28**	**0.14**
Oxidation Reduction Potential (mV)	--	**-203**	**-135**	**-96.7 N**	**-140 N**	**-248**	**-51.0**	**-29 N**	**-102 N**	**-171**	**-134**	**-1.7 N**
Turbidity (NTU)	--	**105**	**31.4**	**3.74**	**32**	**32.8**	**518**	**63.5**	**1,000**	**37.3**	**6.37**	**1.98**
Conductivity (µS/cm)	--	**3,519**	**3,499**	**3,280**	**3,762**	**3,544**	**3,496**	**3,237**	**3,328**	**2,268**	**2,172**	**2,046**
Sulfide (mg/L)	--	0.0	**0.04**	**0.05**	--	**0.65**	**0.08**	**0.8**	--	0.0	**0.01**	**0.06**
Ferrous Iron (Fe 2+) (mg/L)	--	**2.9**	**2.0**	**2.8**	--	**2.6**	**2.6**	**2.5**	--	**3.2**	**5.0**	**2.2**
Geochemical - Conventional (mg/L)												
Alkalinity, Bicarbonate as $CaCO_3$	--	**1,990**	**1,980**	--	--	**1,870**	**1,820**	--	--	**1,050**	**1,010**	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	20 U	--	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	20 U	--	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, total as $CaCO_3$	--	**1,990**	**1,980**	**2,010**	--	**1,870**	**1,820**	**1,840**	--	**1,050**	**1,010**	**1,070**
Chloride (total)	--	**85.5**	**91**	**83.4**	--	**133**	**147**	**134**	--	**90.2**	**70.5**	**85**
Phosphorus	--	**1.8**	**3.46**	**2.88**	--	**2.44**	**4.82**	**0.78**	--	**3.3**	**3.0**	**2.65**
Sulfate	250	1 U	1 U	5 U	--	**100**	**110**	**67.1**	--	1 U	1 U	1 U
Total dissolved solids	--	**2,460**	**2,540**	**2,300 J**	--	**2,550**	**2,680**	**2,280 J**	--	**1,510**	**1,490**	**1,570**
Total suspended solids	--	**17.0**	**13.0**	**-- R**	--	**10**	**3,830**	**7,210 J**	--	**28**	5 U	**22**
Geochemical Metals, Total (µg/L)												
Aluminum	--	--	--	**126 J**	--	--	--	**51,100 J**	--	--	--	**155 J**
Calcium	--	--	--	**82,600**	--	--	--	**85,600**	--	--	--	**53,200**
Iron	--	--	--	**23,000**	--	--	--	**94,800**	--	--	--	**36,000**
Magnesium	--	--	--	**57,900**	--	--	--	**53,400**	--	--	--	**30,000**
Manganese	--	--	--	**2,910**	--	--	--	**2,360**	--	--	--	**3,000**
Potassium	--	--	--	**12,100**	--	--	--	**7,030**	--	--	--	**2,050**
Silicon	--	--	--	**23,900**	--	--	--	**72,800**	--	--	--	**27,400**
Sodium	--	--	--	**775,000**	--	--	--	**868,000**	--	--	--	**451,000**
Geochemical Metals, Dissolved (µg/L)												
Aluminum	--	**70.4 J**	250 U	250 U	--	**11.8 J**	250 U	250 U	--	**101**	**170**	250 U
Calcium	--	**77,800**	**78,200**	**78,700**	--	**60,400**	**67,700**	**65,100**	--	**52,500**	**42,300**	**54,700**
Iron	--	**22,100**	**23,900**	**22,100**	--	**6,460**	**8,840**	**5,370**	--	**36,400**	**30,300**	**35,600**
Magnesium	--	**54,900**	**56,700**	**55,700**	--	**32,500**	**35,600**	**33,900**	--	**30,800**	**26,600**	**30,800**
Manganese	--	**2,690**	**2,790**	**2,730**	--	**904**	**1,100**	**1,040**	--	**3,170**	**2,700**	**3,010**
Potassium	--	**9,330**	**10,000**	**11,400**	--	**3,810**	**4,710**	**4,330**	--	**2,170**	**2,350**	**2,250**
Silicon	--	**24,300**	**24,300**	**23,900**	--	**29,800**	**28,200**	**29,400**	--	**24,800**	**24,700**	**27,400**
Sodium	--	**790,000**	**830,000**	**788,000**	--	**854,000**	**867,000**	**835,000**	--	**450,000**	**489,000**	**452,000**

Table 5-19a
East Groundwater Area Geochemical Results

Location ID		G3-D			G4-S				G4-D		G4-D
Sample ID		G3-D-072811	G3-D-101111	G3-D-100412	G4-S-072611	G4-S-101011	G4-S-100312	G4-S-120412	G4-D-072811	G4-D-101111	G4-D-100512
Sample Date		7/28/2011	10/11/2011	10/4/2012	7/26/2011	10/10/2011	10/3/2012	12/4/2012	7/28/2011	10/11/2011	10/5/2012
Sample Type											
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**15.0**	**14.4**	**13.2**	**12.9**	**12.5**	**13.3**	**12.2**	**12.5**	**12.7**	**13.7**
pH (su)	--	**6.48**	**6.65**	**6.4**	**6.33**	**6.37**	**6.49**	**6.46**	**6.63**	**6.46**	**6.66**
Dissolved oxygen (mg/L)	--	**0.16**	**0.21**	**0.11**	**0.44**	**0.81**	**0.16**	**0.21**	**0.51**	**1.00**	**1.22**
Oxidation Reduction Potential (mV)	--	**-67.0**	**-44.0**	**11.4**	**-124**	**-79.0**	**-24.9 N**	**-105 N**	**-184**	**-78.0**	**7.4**
Turbidity (NTU)	--	**17.5**	**27.3**	**47.7**	**>1,000**	**167**	**77.2**	**238**	**372**	**43.2**	**59.7**
Conductivity (µS/cm)	--	**1,131**	**1,133**	**1,142**	**1,066**	**1,040**	**1,016**	**1,052**	**1,326**	**1,363**	**1,206**
Sulfide (mg/L)	--	0.0	0.0	**0.14**	0.0	0.0	**0.46**	--	0.0	**0.01**	**0.04**
Ferrous Iron (Fe 2+) (mg/L)	--	**3.4**	**5.6**	**--**	**4.2**	**4.8**	**2.0**	--	**2.6**	**4.5**	**3.8**
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	**517**	**528**	--	**509**	**520**	--	--	**728**	**743**	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	20 U	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	20 U	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, total as $CaCO_3$	--	**517**	**528**	**554**	**509**	**520**	**592**	--	**728**	**743**	**720**
Chloride (total)	--	**52.2**	**49.2**	**58**	**1.4**	**1.34**	**1.38**	--	**2.31**	**2.05**	**1.9**
Phosphorus	--	**0.3**	**0.47 J**	**0.592**	**1.42**	**2.37**	**1.88**	--	**3.54**	**0.31 J**	**0.48**
Sulfate	250	**15.6**	**13.7**	**3.38**	1 U	1 U	1 U	--	1 U	1 U	1 UJ
Total dissolved solids	--	**658**	**698**	**757**	**554**	**620**	**482 J**	--	**729**	**768**	**745**
Total suspended solids	--	**63**	**73**	**122**	**326**	**341**	**288 J**	--	**799**	**76**	**134**
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	**295**	--	--	**3,160**	--	--	--	**1,200**
Calcium	--	--	--	**73,100**	--	--	**95,800**	--	--	--	--
Iron	--	--	--	**33,500**	--	--	**82,100**	--	--	--	**41,600**
Magnesium	--	--	--	**38,400**	--	--	**44,400**	--	--	--	--
Manganese	--	--	--	**2,140**	--	--	**2,410**	--	--	--	**2,920**
Potassium	--	--	--	**5,730**	--	--	**2,440**	--	--	--	**4,270**
Silicon	--	--	--	**27,600**	--	--	**40,800**	--	--	--	**33,800**
Sodium	--	--	--	**137,000**	--	--	**23,200**	--	--	--	**38,600**
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	**16.1 J**	50 U	50 U	7.47 U	250 U	50 U	--	**7.0 J**	50 U	50 U
Calcium	--	**67,700**	**68,200**	**70,900**	**85,700**	**84,100**	**91,800**	--	**113,000**	**128,000**	**129,000**
Iron	--	**23,500**	**27,000**	**27,800**	**69,300**	**69,500**	**75,800**	--	**46,300**	**41,100**	**39,300**
Magnesium	--	**38,400**	**37,700**	**37,600**	**42,900**	**41,300**	**42,800**	--	**59,100**	**63,700**	**63,200**
Manganese	--	**1,980**	**2,120**	**2,070**	**2,220**	**2,300**	**2,400**	--	**2,750**	**3,050**	**2,830**
Potassium	--	**6,360**	**6,180**	**5,630**	**2,490**	**2,190**	**2,220**	--	**4,280**	**4,680**	**4,340**
Silicon	--	**25,100**	**23,800**	**26,500**	**36,600**	**32,600**	**35,500**	--	**30,000**	**29,500**	**31,100**
Sodium	--	**123,000**	**135,000**	**142,000**	**24,100**	**23,000**	**23,000**	--	**55,300**	**50,100**	**39,400**

Table 5-19a
East Groundwater Area Geochemical Results

	Location ID	**PZ-1**			**PZ-2**			**PZ-3**		**PZ-4**	
	Sample ID	**PZ-1-072611**	**PZ-1-072811**	**PZ-1-100711**	**PZ-2-072611**	**PZ-2-072811**	**PZ-2-100711**	**PZ-3-072711**	**PZ-3-100711**	**PZ-4-072711**	**PZ-4-101011**
	Sample Date	**7/26/2011**	**7/28/2011**	**10/7/2011**	**7/26/2011**	**7/28/2011**	**10/7/2011**	**7/27/2011**	**10/7/2011**	**7/27/2011**	**10/10/2011**
	Sample Type										
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**16.7**	**15.7**	**15.0**	**16.6**	**16.4**	**14.1**	**14.6**	**16.4**	**14.5**	**14.4**
pH (su)	--	**9.31**	**9.42**	**9.52**	**9.36**	**9.5**	**9.55**	**8.50**	**8.64**	**9.86**	**9.70**
Dissolved oxygen (mg/L)	--	**0.09**	**0.19**	**0.05**	**0.19**	**0.18**	**0.33**	**0.3**	**0.32**	**0.22**	**0.02**
Oxidation Reduction Potential (mV)	--	**-330**	**-23.0**	**-206**	**-361**	**-86.0**	**-161**	**-258**	**-158**	**-414**	**-274**
Turbidity (NTU)	--	**2.16**	--	**4.04**	**13.1**	--	**1.92**	**6.36**	**6.89**	**4.01**	**1.58**
Conductivity (µS/cm)	--	**3,228**	**3,088**	**3,374**	**8,352**	**8,673**	**7,863**	**3,605**	**5,125**	**13,798**	**14,230**
Sulfide (mg/L)	--	**0.5**	--	**0.4**	**5.0**	--	**3.5**	**0.28**	**0.2**	**2.3**	**2.7**
Ferrous Iron (Fe 2+) (mg/L)	--	**1.0**	--	**1.2**	**0.4**	--	**1.0**	**0.5**	**0.8**	**0.2**	**0.4**
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	**850**	--	**761**	**2,370**	--	**2,420**	**1,650**	**2,280**	**3,240**	**3,140**
Alkalinity, Carbonate as $CaCO_3$	--	**290**	--	**293**	**1,800**	--	**1,020**	20 U	**40**	**2,990**	**2,750**
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	--	20 U	20 U	--	20 U	20 U	20 U	20 U	20 U
Alkalinity, total as $CaCO_3$	--	**1,140**	--	**1,050**	**4,170**	--	**3,450**	**1,650**	**2,320**	**6,230**	**5,890**
Chloride (total)	--	20 U	--	**12.8**	**37.6**	--	**34.1**	**25.6**	**35.1**	**106**	**123**
Phosphorus	--	**7.8**	--	**8.22**	**7.1**	--	**7.48**	**2.68**	**3.36**	**33.1**	**37.2**
Sulfate	250	**80.5**	--	**101**	**65.8**	--	**77.4**	10 U	**1.37**	**108**	**121**
Total dissolved solids	--	**2,090**	--	**2,100**	**5,910**	--	**5,410**	**2,250**	**--**	**10,500**	**--**
Total suspended solids	--	5 U	--	5 U	5 U	--	**8.0**	5 U	**5.0**	**23**	**6.0**
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--
Silicon	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	**534**	--	**782**	**237 J**	--	**176 J**	**170**	**193 J**	**637**	**535 J**
Calcium	--	**3,540**	--	**4,170**	**2,290**	--	**2,210**	**5,920**	**7,000**	**3,850**	**4,000**
Iron	--	**3,130**	--	**1,920**	**12,100**	--	**8,470**	**629**	**812**	**31,200**	**35,100**
Magnesium	--	**373 J**	--	**395**	**1,150**	--	**1,060**	**2,550**	**3,240**	**2,180**	**2,120**
Manganese	--	**194**	--	**290**	**112**	--	**91.9**	**280**	**343**	**108**	**107**
Potassium	--	**1,470**	--	**1,700**	**5,260**	--	**5,010**	**3,080**	**4,020**	**6,220**	**6,380**
Silicon	--	**8,590**	--	**11,800**	**12,000**	--	**12,000**	**10,900**	**12,100**	**16,000**	**13,900**
Sodium	--	**793,000**	--	**803,000**	**2,470,000**	--	**2,180,000**	**915,000**	**1,310,000**	**4,170,000**	**4,420,000**

Table 5-19a
East Groundwater Area Geochemical Results

Location ID		PZ-5			R-1S			
Sample ID		PZ-5-072511	PZ-5-072811	PZ-5-101011	MBT-072511-02	R-1S-080211	R-1S-100511	SPL-100312-06
Sample Date		7/25/2011	7/28/2011	10/10/2011	7/25/2011	8/2/2011	10/5/2011	10/3/2012
Sample Type								
Geochemical - Field Parameters	**Screening Level**							
Temperature (°C)	--	**14.0**	**15.9**	**13.9**	**14.2**	**14.0**	**14.1**	**15.3**
pH (su)	--	**10.37**	**10.51**	**10.35**	**6.69**	**7.28**	**7.37**	**7.14**
Dissolved oxygen (mg/L)	--	**0.12**	**0.13**	**0.02**	**0.12**	**0.46**	**0.35**	**0.15**
Oxidation Reduction Potential (mV)	--	**-385**	**-293**	**-349**	**-139**	**-158**	**-146**	**-96**
Turbidity (NTU)	--	**2.53**	--	**0.99**	**1.99**	**1.96**	**1.92**	**2.28**
Conductivity (µS/cm)	--	**20,947**	**2,084**	**21,520**	**485**	**536**	**555**	**485**
Sulfide (mg/L)	--	**--**	--	**5.0**	--	**0.16**	**0.17**	--
Ferrous Iron (Fe 2+) (mg/L)	--	**1.0**	--	**0.4**	--	**3.0**	**3.4**	--
Geochemical - Conventional (mg/L)								
Alkalinity, Bicarbonate as $CaCO_3$	--	**540**	--	**1,370**	--	--	**233**	--
Alkalinity, Carbonate as $CaCO_3$	--	**7,960**	--	**7,430**	--	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	--	20 U	--	--	20 U	--
Alkalinity, total as $CaCO_3$	--	**8,500**	--	**8,800**	--	--	**233**	--
Chloride (total)	--	**51.9**	--	**73.1**	**2.24**	--	**2.38**	**2.86**
Phosphorus	--	**17.2**	--	**20**	--	--	**0.536**	--
Sulfate	250	**503**	--	**453**	--	--	1 U	--
Total dissolved solids	--	**15,200**	--	**16,000**	--	--	**308**	--
Total suspended solids	--	**10**	--	**10**	--	--	**11**	--
Geochemical Metals, Total (µg/L)								
Aluminum	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--
Silicon	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--
Geochemical Metals, Dissolved (µg/L)								
Aluminum	--	**228 J**	--	1,000 U	--	--	**189**	--
Calcium	--	**1,030 J**	--	2,000 U	--	--	**16,900**	--
Iron	--	**108,000**	--	**92,300**	--	--	**6,800**	--
Magnesium	--	**292 J**	--	1,000 U	--	--	**7,110**	--
Manganese	--	**36.0**	--	**29.0**	--	--	**1,180**	--
Potassium	--	**10,900**	--	**11,900**	--	--	**2,600**	--
Silicon	--	**37,100**	--	**18,800**	--	--	**26,300**	--
Sodium	--	**6,520,000**	--	**6,720,000**	--	--	**71,400**	--

Table 5-19a
East Groundwater Area Geochemical Results

	Location ID	R-1D				R-2				
	Sample ID	MBT-072511-04	R-1D-080211	R-1D-100511	SPL-100312-05	MBT-072511-07	R-2-080211	R-2-100511	R-2-100312	SPL-100312-01
	Sample Date	7/25/2011	8/2/2011	10/5/2011	10/3/2012	7/25/2011	8/2/2011	10/5/2011	10/3/2012	10/3/2012
	Sample Type									
Geochemical - Field Parameters	**Screening Level**									
Temperature (°C)	--	**15.2**	**14.0**	**12.6**	**13.6**	**12.1**	**11.4**	**11.7**	**11.5**	**11.5**
pH (su)	--	**6.21**	**5.94**	**6.57**	**6.71**	**5.12**	**5.71**	**6.69**	**6.74**	**6.74**
Dissolved oxygen (mg/L)	--	**0.81**	**1.0**	**0.61**	**0.93**	**0.12**	**0.62**	**0.31**	**1.0**	**1.0**
Oxidation Reduction Potential (mV)	--	**-95.0**	**-75.0**	**-188**	**-122**	**-25.1**	**-38.6**	**-106**	**-81 N**	**-81**
Turbidity (NTU)	--	**77.8**	**30.8**	**72.0**	**35.3**	**161**	**3.12**	**19.8**	**1.62**	**1.62**
Conductivity (µS/cm)	--	**2,005**	**1,985**	**2,012**	**1,965**	**413**	**414**	**510**	**418**	**418**
Sulfide (mg/L)	--	--	0.0	0.0	--	--	**0.07**	0.0	**0.01**	--
Ferrous Iron (Fe 2+) (mg/L)	--	--	**5.3**	**5.0**	--	--	**3.7**	**4.0**	**1.6**	--
Geochemical - Conventional (mg/L)										
Alkalinity, Bicarbonate as $CaCO_3$	--	--	--	**879**	--	--	--	**175**	--	--
Alkalinity, Carbonate as $CaCO_3$	--	--	--	20 U	--	--	--	20 U	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	--	20 U	--	--	--	20 U	--	--
Alkalinity, total as $CaCO_3$	--	--	--	**879**	--	--	--	**175**	**139**	--
Chloride (total)	--	**108**	--	**105**	**105**	**5.73**	--	**5.95**	**5.58**	**5.65**
Phosphorus	--	--	--	**1.49**	--	--	--	**1.74**	**3.74**	--
Sulfate	250	--	--	1 U	--	--	--	1 U	1 U	--
Total dissolved solids	--	--	--	**1,250**	--	--	--	**321**	**235 J**	--
Total suspended solids	--	--	--	**116**	--	--	--	**37**	**69 J**	--
Geochemical Metals, Total (µg/L)										
Aluminum	--	--	--	--	--	--	--	--	**110**	--
Calcium	--	--	--	--	--	--	--	--	**26,600**	--
Iron	--	--	--	--	--	--	--	--	**29,400**	--
Magnesium	--	--	--	--	--	--	--	--	**12,200**	--
Manganese	--	--	--	--	--	--	--	--	**1,870**	--
Potassium	--	--	--	--	--	--	--	--	**1,280**	--
Silicon	--	--	--	--	--	--	--	--	**32,200**	--
Sodium	--	--	--	--	--	--	--	--	**26,600**	--
Geochemical Metals, Dissolved (µg/L)										
Aluminum	--	--	--	250 U	--	--	--	250 U	50 U	--
Calcium	--	--	--	**123,000**	--	--	--	**26,000**	**26,500**	--
Iron	--	--	--	**145,000**	--	--	--	**33,800**	**29,400**	--
Magnesium	--	--	--	**60,900**	--	--	--	**12,500**	**12,100**	--
Manganese	--	--	--	**5,590**	--	--	--	**2,030**	**1,860**	--
Potassium	--	--	--	**1,950**	--	--	--	**1,170**	**1,300**	--
Silicon	--	--	--	**30,200**	--	--	--	**30,600**	**31,500**	--
Sodium	--	--	--	**136,000**	--	--	--	**25,200**	**26,700**	--

Table 5-19a
East Groundwater Area Geochemical Results

Location ID		R-3					R-4S				
Sample ID		**MBT-072511-03**	**R-3-080211**	**R-3-100511**	**R-53-100511**	**SPL-100312-07**	**MBT-072511-05**	**MBT-072511-06**	**R-4S-080211**	**R-4S-100511**	**SPL-100312-02**
Sample Date		**7/25/2011**	**8/2/2011**	**10/5/2011**	**10/5/2011**	**10/3/2012**	**7/25/2011**	**7/25/2011**	**8/2/2011**	**10/5/2011**	**10/3/2012**
Sample Type					**FD**			**FD**			
Geochemical - Field Parameters	**Screening Level**										
Temperature (°C)	--	**13.1**	**15.7**	**13.0**	**13.0**	**16.3**	**13.4**	**13.4**	**13.6**	**13.6**	**13.9**
pH (su)	--	**10.19**	**10.32**	**10.1**	**10.1**	**10.2**	**6.20**	**6.20**	**6.50**	**6.88**	**7.01**
Dissolved oxygen (mg/L)	--	**0.02**	**0.36**	**0.07**	**0.07**	**0.02**	**0.23**	**0.23**	**1.17**	**0.49**	**0.909**
Oxidation Reduction Potential (mV)	--	**-559**	**-423**	**-526**	**-526**	**-461**	**-105**	**-105**	**-103**	**-135**	**-163**
Turbidity (NTU)	--	**8.74**	**5.44**	**1.52**	**1.52**	**2.09**	**433**	**433**	**26.8**	**28.1**	**18.8**
Conductivity (µS/cm)	--	**2,292**	**22,635**	**22,330**	**22,330**	**22,084**	**1,724**	**1,724**	**1,708**	**1,755**	**1,686**
Sulfide (mg/L)	--	--	**34.65**	**3.2**	**3.2**	--	--	--	0.0	0.0	--
Ferrous Iron (Fe 2+) (mg/L)	--	--	**0.2**	**0.4**	**0.4**	--	--	--	**4.7**	**2.0**	--
Geochemical - Conventional (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	--	--	**2,740**	**2,730**	--	--	--	--	**1,050**	--
Alkalinity, Carbonate as $CaCO_3$	--	--	--	**8,420**	**8,620**	--	--	--	--	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	--	20 U	20 U	--	--	--	--	20 U	--
Alkalinity, total as $CaCO_3$	--	--	--	**11,200**	**11,400**	--	--	--	--	**1,050**	--
Chloride (total)	--	**47.6**	--	**74.7**	**75.0**	**61.0**	**8.66**	**8.66**	--	**9.49**	**8.32**
Phosphorus	--	--	--	**24.8**	**23.9**	--	--	--	--	**1.9**	--
Sulfate	250	--	--	**114**	**119**	--	--	--	--	1 U	--
Total dissolved solids	--	--	--	**17,800**	**17,900**	--	--	--	--	**1,450**	--
Total suspended solids	--	--	--	**17**	**9.0**	--	--	--	--	**14**	--
Geochemical Metals, Total (µg/L)											
Aluminum	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--
Silicon	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--
Geochemical Metals, Dissolved (µg/L)											
Aluminum	--	--	--	900 U	900 U	--	--	--	--	250 U	--
Calcium	--	--	--	**1,230 J**	**1,580 J**	--	--	--	--	**80,800**	--
Iron	--	--	--	**123,000**	**128,000**	--	--	--	--	**92,500**	--
Magnesium	--	--	--	900 U	900 U	--	--	--	--	**37,200**	--
Manganese	--	--	--	**15.8 J**	**15.8 J**	--	--	--	--	**5,300**	--
Potassium	--	--	--	**11,900**	**12,900**	--	--	--	--	**1,930**	--
Silicon	--	--	--	**29,200**	**32,000**	--	--	--	--	**27,600**	--
Sodium	--	--	--	**7,250,000**	**7,630,000**	--	--	--	--	**319,000**	--

Table 5-19a
East Groundwater Area Geochemical Results

Location ID		R-4D		R-4D			SSA6-MW-01	
Sample ID		MBT-072511-01	R-4D-080211	R-4D-100511	SPL-100312-03	SPL-100312-04	SSA6-MW-01-100512	SSA6-MW-01-120412
Sample Date		7/25/2011	8/2/2011	10/5/2011	10/3/2012	10/3/2012	10/5/2012	12/4/2012
Sample Type						FD		
Geochemical - Field Parameters	**Screening Level**							
Temperature (°C)	--	**13.2**	**13.3**	**12.8**	**14.0**	**14.0**	**12.9**	**12.6**
pH (su)	--	**6.35**	**6.33**	**6.69**	**6.8**	**6.8**	**6.9**	**6.57**
Dissolved oxygen (mg/L)	--	**0.68**	**0.98**	**1.03**	**0.031**	**0.031**	**0.67**	**0.2**
Oxidation Reduction Potential (mV)	--	**-129**	**-107**	**-100**	**-85**	**-85**	**-54 N**	**-27.4 N**
Turbidity (NTU)	--	**266**	**245**	**5.25**	**11.0**	**11.0**	**5.55**	**3.09**
Conductivity (µS/cm)	--	**1,292**	**1,299**	**1,159**	**1,280**	**1,280**	**492**	**380**
Sulfide (mg/L)	--	--	0.0	0.0	--	--	**0.07**	--
Ferrous Iron (Fe 2+) (mg/L)	--	--	**3.8**	**4.5**	--	--	**1.8**	--
Geochemical - Conventional (mg/L)								
Alkalinity, Bicarbonate as $CaCO_3$	--	--	--	**576**	--	--	--	--
Alkalinity, Carbonate as $CaCO_3$	--	--	--	20 U	--	--	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	--	20 U	--	--	--	--
Alkalinity, total as $CaCO_3$	--	--	--	**576**	--	--	**235**	--
Chloride (total)	--	**8.89**	--	**8.99**	**9.16**	**9.22**	**3.76**	--
Phosphorus	--	--	--	**1.22**	--	--	**1.86**	--
Sulfate	250	--	--	1 U	--	--	1 U	--
Total dissolved solids	--	--	--	**822**	--	--	**346**	--
Total suspended solids	--	--	--	**99**	--	--	**25**	--
Geochemical Metals, Total (µg/L)								
Aluminum	--	--	--	--	--	--	50 U	--
Calcium	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	**14,200**	--
Magnesium	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	**1,720**	--
Potassium	--	--	--	--	--	--	**2,430**	--
Silicon	--	--	--	--	--	--	**30,500**	--
Sodium	--	--	--	--	--	--	**32,600**	--
Geochemical Metals, Dissolved (µg/L)								
Aluminum	--	--	--	50 U	--	--	50 U	--
Calcium	--	--	--	**73,200**	--	--	**35,400**	--
Iron	--	--	--	**127,000**	--	--	**14,100**	--
Magnesium	--	--	--	**41,100**	--	--	**19,800**	--
Manganese	--	--	--	**4,770**	--	--	**1,750**	--
Potassium	--	--	--	**2,110**	--	--	**2,430**	--
Silicon	--	--	--	**33,000**	--	--	**29,700**	--
Sodium	--	--	--	**96,400**	--	--	**32,300**	--

Table 5-19a
East Groundwater Area Geochemical Results

	Location ID	SSA7-MW-01		
	Sample ID	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
	Sample Date	2/23/2012	10/5/2012	10/5/2012
	Sample Type			FD
Geochemical - Field Parameters	**Screening Level**			
Temperature (°C)	--	**9.97**	**12.1**	**12.1**
pH (su)	--	**6.3**	**6.79**	**6.79**
Dissolved oxygen (mg/L)	--	**1.39**	**0.11**	**0.11**
Oxidation Reduction Potential (mV)	--	**-36.9**	**29.2**	**29.2**
Turbidity (NTU)	--	**6.42**	**4.76**	**4.76**
Conductivity (µS/cm)	--	**448**	**1,161**	**1,161**
Sulfide (mg/L)	--	**0.03**	**0.02**	**0.02**
Ferrous Iron (Fe 2+) (mg/L)	--	**2.8**	**3.4**	**3.4**
Geochemical - Conventional (mg/L)				
Alkalinity, Bicarbonate as $CaCO_3$	--	**241**	--	--
Alkalinity, Carbonate as $CaCO_3$	--	20 U	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	20 U	--	--
Alkalinity, total as $CaCO_3$	--	**241**	**640**	**640**
Chloride (total)	--	**7.91**	**9.85**	**9.96**
Phosphorus	--	**0.198**	**1.51**	**1.51**
Sulfate	250	**7.49**	1 U	1 U
Total dissolved solids	--	**366**	**831**	**839**
Total suspended solids	--	5 U	**32**	**43**
Geochemical Metals, Total (µg/L)				
Aluminum	--	--	**71**	**67**
Calcium	--	--	--	--
Iron	--	--	**19,200**	**19,200**
Magnesium	--	--	--	--
Manganese	--	--	**4,410**	**4,440**
Potassium	--	--	**3,520**	**3,510**
Silicon	--	--	**22,600**	**22,900**
Sodium	--	--	**224,000**	**227,000**
Geochemical Metals, Dissolved (µg/L)				
Aluminum	--	**1,840**	**66**	**67**
Calcium	--	**25,300**	**38,300**	**38,200**
Iron	--	**11,800**	**18,900**	**19,200**
Magnesium	--	**10,200**	**15,700**	**15,800**
Manganese	--	**1,920 J**	**4,370**	**4,380**
Potassium	--	**1,560**	**3,550**	**3,540**
Silicon	--	**23,500**	**22,900**	**23,000**
Sodium	--	--	**221,000**	**222,000**

Table 5-19a
East Groundwater Area Geochemical Results

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Groundwater screening level
Bold = Detected result
J = Estimated value
N = Presumptive evidence
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
<u>Underlined = Non-detected concentration is above one or more identified screening levels</u>
µg/L = micrograms per liter
µS/cm= microsiemens per centimeter
°C = degree Celsius
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
su = standard unit
FD = field duplicate sample
USEPA = United States Environmental Protection Agency

Table 5-19b
East Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide mg/L	WAD Cyanide mg/L	Total Cyanide mg/L	Dissolved Free Cyanide mg/L	Dissolved WAD Cyanide mg/L	Dissolved Total Cyanide mg/L	Fluoride mg/L	Dissolved Fluoride mg/L
		Screening Level	**0.2**	**--**	**--**	**0.2**	**--**	**--**	**4.0**	**4.0**
East Groundwater Area Monitoring Wells										
G1-S	G1-S-120312	12/3/2012	0.005 U	**0.0088**	**0.0287**	0.005 U	**0.0052**	**0.0259**	--	--
	G1-S-100412	10/4/2012	0.005 U	0.005 U	**0.0062**	0.005 UJ	**0.0105**	0.005 U	**10.4**	**9.7**
	G1-S-101111	10/11/2011	0.005 U	0.005 U	0.01 UJ	0.005 UJ	0.005 U	0.005 U	**9.76**	**10.2**
	G51-S-101111	10/11/2011	0.005 U	0.005 U	0.005 UJ	0.005 UJ	0.005 U	0.005 U	**9.7**	**10.3**
	G1-S-072511	7/25/2011	0.005 UJ	0.005 U	0.005 U	--	--	--	**18.9**	--
	G1-S-D-072511	7/25/2011	0.005 UJ	0.005 U	0.005 U	--	--	--	**19.2**	--
	G-1S-100206	10/2/2006	**-- R**	0.005 U	0.005 U	--	--	--	**14.3**	--
G1-D	G1-D-120312	12/3/2012	**0.0048 J**	**0.0166**	**0.0764**	**0.0035 J**	**0.0154**	**0.0583**	--	--
	G1-D-120312-D	12/3/2012	**0.0051**	**0.0166**	**0.299**	**0.0066**	**0.0192**	**0.0686**	--	--
	G1-D-100412	10/4/2012	**0.0097**	**0.0428**	**0.105**	**0.0099 J**	**0.0354**	**0.0898**	**0.677**	**0.554**
	G1-D-101111	10/11/2011	0.005 U	**0.0108**	**0.0707 J**	**0.0025 J**	**0.0111**	**0.0704**	**0.67**	**0.66**
	G1-D-072511	7/25/2011	**0.0054 J**	**0.0288**	**0.0779**	--	--	--	**0.49 J**	--
	G-1D-100206	10/2/2006	**0.00335 J**	**0.00769**	**0.0479**	--	--	--	**6.2**	--
G2-S	G2-S-100312	10/3/2012	0.005 UJ	**0.0326**	**0.27**	0.005 U	**0.0298**	**0.261**	**22.4**	**21.9**
	G2-S-101111	10/11/2011	0.005 U	**0.037**	**0.276 J**	0.005 UJ	**0.0274**	**0.28**	**22.6**	**18.7**
	G2-S-072511	7/25/2011	0.005 UJ	**0.0324**	**0.245**	--	--	--	**23**	--
	G-2S-100206	10/2/2006	**-- R**	**0.0143**	**0.353**	--	--	--	**4.9**	--
G2-D	G2-D-100312	10/3/2012	0.005 UJ	**0.025**	**0.324**	0.005 U	**0.0292**	**0.314**	**0.597**	**0.59**
	G2-D-101111	10/11/2011	0.005 U	**0.0382**	**0.325 J**	0.005 UJ	**0.0267**	**0.308**	**0.594**	**0.603**
	G2-D-072511	7/25/2011	0.005 UJ	**0.0184**	**0.245**	--	--	--	**0.607 J**	--
	G-2D-100206	10/2/2006	**-- R**	**0.0193**	**0.368**	--	--	--	**2.4**	--
G3-S	G3-S-100412	10/4/2012	0.005 U	**0.0119**	**0.0522**	0.005 UJ	**0.0085**	**0.0527**	**30.2**	**28**
	G3-S-101111	10/11/2011	0.005 U	**0.0123**	**0.0758 J**	0.005 UJ	**0.007**	**0.0607**	**47.4**	**32.8**
	G3-S-072811	7/28/2011	**0.0034 J**	0.005 U	**0.0538**	--	--	--	**27.6**	--
	G-3S-100206	10/2/2006	**0.000883 J**	**0.0279**	**0.0825**	--	--	--	**18.7**	--
	G-43S-100206	10/2/2006	**0.000952 J**	**0.0229**	**0.0861**	--	--	--	**19.6**	--

Table 5-19b

East Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide	WAD Cyanide	Total Cyanide	Dissolved Free Cyanide	Dissolved WAD Cyanide	Dissolved Total Cyanide	Fluoride	Dissolved Fluoride
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Screening Level	**0.2**	**--**	**--**	**0.2**	**--**	**--**	**4.0**	**4.0**
G3-D	G3-D-100412	10/4/2012	0.005 U	**0.0129**	**0.0854**	0.005 UJ	**0.0152**	**0.0852**	**6.43**	**5.89**
	G3-D-101111	10/11/2011	0.005 U	**0.0141**	**0.0899 J**	0.005 UJ	**0.0114**	**0.0838**	**5.92**	**6.08**
	G3-D-072811	7/28/2011	**0.0031 J**	**0.0146**	**0.0788**	--	--	--	**5.58**	--
	G-3D-100206	10/2/2006	**0.0024**	**0.0456**	**0.106**	--	--	--	**6.6**	--
G4-S	G4-S-100312	10/3/2012	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	**0.0063**	**0.277**	**0.252**
	G4-S-101011	10/10/2011	0.005 UJ	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	**0.256**	**0.262**
	G4-S-072611	7/26/2011	0.005 U	0.005 U	0.005 U	--	--	--	1 U	--
	G-4S-091906	9/19/2006	0.000501 U	0.005 U	0.005 U	--	--	--	**0.3**	--
G4-D	G4-D-100512	10/5/2012	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.0074**	**0.304**	**0.275**
	G4-D-101111	10/11/2011	0.005 U	0.005 U	0.005 UJ	0.005 UJ	0.005 U	0.005 U	**0.287**	**0.291**
	G4-D-072811	7/28/2011	**0.0029 J**	0.005 U	0.01 U	--	--	--	**0.269 J**	--
	G-4D-091906	9/19/2006	**0.000625**	0.005 U	**0.147**	--	--	--	**0.4**	--
	G-44D-091906	9/19/2006	0.000513 U	**0.0117**	0.005 U	--	--	--	**0.3**	--
R-1S	SPL-100312-06	10/3/2012	0.005 U	**0.0111**	**0.0417**	--	--	--	**29.8**	--
	R-1S-100511	10/5/2011	0.005 U	**0.0123**	**0.0331**	0.005 U	**0.0098**	**0.0329**	**31**	**30.1**
	MBT-072511-02	7/25/2011	0.005 UJ	0.0178 U	**0.0199**	--	--	--	**32.5**	--
	R-1S-091906	9/19/2006	0.000527 U	**0.0213**	**0.067**	--	--	--	**20.6**	--
R-1D	SPL-100312-05	10/3/2012	**0.0029 J**	**0.0171**	**0.059**	--	--	--	**0.879**	--
	R-1D-100511	10/5/2011	**0.0036 J**	**0.0235**	**0.0537**	0.005 U	**0.0067**	**0.0266**	--	--
	MBT-072511-04	7/25/2011	**0.0066 J**	0.0501 U	**0.0432**	--	--	--	**0.586 J**	--
	R-1D-091906	9/19/2006	**0.00183**	**0.0107**	**0.0398**	--	--	--	1 U	--
R-2	R-2-100312	10/3/2012	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	**0.0057**	**0.509**	**0.465**
	SPL-100312-01	10/3/2012	0.005 U	0.005 U	**0.007**	--	--	--	**0.521**	--
	R-2-100511	10/5/2011	0.005 U	0.005 U	**0.0055**	0.005 U	0.005 U	**0.0058**	--	--
	MBT-072511-07	7/25/2011	0.005 UJ	0.005 U	0.005 U	--	--	--	**0.478 J**	--
	R-2-100206	10/2/2006	**0.00045 J**	**0.00213 J**	0.005 U	--	--	--	**0.4**	--

Table 5-19b
East Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide mg/L	WAD Cyanide mg/L	Total Cyanide mg/L	Dissolved Free Cyanide mg/L	Dissolved WAD Cyanide mg/L	Dissolved Total Cyanide mg/L	Fluoride mg/L	Dissolved Fluoride mg/L
		Screening Level	**0.2**	**--**	**--**	**0.2**	**--**	**--**	**4.0**	**4.0**
R-3	SPL-100312-07	10/3/2012	**0.0058**	**0.484**	**363**	--	--	--	**1,920**	--
	R-3-100511	10/5/2011	**0.0062**	**0.488**	**376**	**0.0038 J**	**0.521**	**372**	**2,180**	**2,190**
	R-53-100511	10/5/2011	**0.0049 J**	**0.518**	**391**	**0.0049 J**	**0.542**	**411**	**2,180**	**2,190**
	MBT-072511-03	7/25/2011	**0.0072 J**	**0.734**	**368**	--	--	--	**2,100**	--
	R-3-092706	9/27/2006	**0.0852**	**0.89**	**426**	--	--	--	**2,410**	--
	R-43-092706	9/27/2006	**0.13**	**0.724**	**414**	--	--	--	**2,380**	--
R4-S	SPL-100312-02	10/3/2012	0.005 U	**0.0086**	**0.031**	--	--	--	**14.5**	--
	R-4S-100511	10/5/2011	0.005 U	**0.0097**	**0.0238**	0.005 U	**0.0105**	**0.0245**	**11.4**	**10.7**
	MBT-072511-05	7/25/2011	0.005 UJ	0.0295 U	**0.025**	--	--	--	**8.25**	--
	MBT-072511-06	7/25/2011	0.005 UJ	0.0293 U	**0.0245**	--	--	--	**8.28**	--
	R-4S-092706	9/27/2006	**0.00202**	**0.00567**	**0.0534**	--	--	--	**10.1**	--
R-4D	SPL-100312-03	10/3/2012	0.005 U	**0.0066**	**0.0292**	--	--	--	**2.1**	--
	SPL-100312-04	10/3/2012	0.005 U	**0.0066**	**0.0299**	--	--	--	**2.09**	--
	R-4D-100511	10/5/2011	0.005 U	**0.0063**	**0.0259**	0.005 U	0.005 U	**0.0234**	**1.54**	**1.59**
	MBT-072511-01	7/25/2011	0.005 UJ	0.0175 U	**0.038**	--	--	--	**1.83**	--
	R-4D-092706	9/27/2006	**0.00161**	**0.0198**	**0.0271**	--	--	--	**1.1**	--
PZ-1	PZ-1-100212	10/2/2012	0.005 U	**0.0963**	**7.95**	0.005 U	**0.0549**	**7.72**	**239**	**222**
	PZ-1-100711	10/7/2011	0.005 U	**0.152**	**7.54**	0.005 U	**0.0573**	**7.16**	**218**	**224**
	PZ-1-072611	7/26/2011	0.0052 U	**0.217**	**7.48 J**	--	--	--	**221**	--
	PZ-1-092606	9/26/2006	**0.023 J**	**0.0956**	**7.48**	--	--	--	**234**	--
PZ-2	PZ-2-100212	10/2/2012	0.005 U	**0.027**	**26.4**	0.005 U	**0.123**	**32.6**	**496**	**471**
	PZ-2-100711	10/7/2011	0.005 U	**0.144**	**26.7**	0.005 U	**0.0954**	**29**	**484**	**497**
	PZ-2-072611	7/26/2011	0.0049 U	**0.249**	**35.3**	--	--	--	**504**	--
	PZ-2-092706	9/27/2006	**0.0732**	**0.137**	**34.7**	--	--	--	**539**	--
PZ-3	PZ-3-100212	10/2/2012	0.005 U	**0.0136**	**0.142**	0.005 U	**0.0159**	**0.138**	**125**	**118**
	PZ-3-100711	10/7/2011	0.005 U	**0.0227**	**0.383**	0.005 U	**0.0179**	**0.146**	**166**	**165**
	PZ-3-072711	7/27/2011	0.005 U	**0.0153**	**0.177**	--	--	--	**147**	--
	PZ-3-092606	9/26/2006	**0.00135 J**	**0.0264**	**0.434**	--	--	--	**213**	--

Table 5-19b
East Groundwater Area Cyanide and Fluoride Results

Location ID	Sample ID	Sample Date	Free Cyanide	WAD Cyanide	Total Cyanide	Dissolved Free Cyanide	Dissolved WAD Cyanide	Dissolved Total Cyanide	Fluoride	Dissolved Fluoride
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Screening Level	**0.2**	**--**	**--**	**0.2**	**--**	**--**	**4.0**	**4.0**
PZ-4	PZ-4-100212	10/2/2012	0.005 U	**0.182**	**106**	0.005 U	**0.354**	**97.3**	**1,220**	**1,030**
	PZ-4-101011	10/10/2011	0.005 UJ	**0.116**	**98.8**	0.005 UJ	**0.743**	**105**	**1,170**	**1,140**
	PZ-4-072711	7/27/2011	**0.0037 J**	**0.511**	**96**	--	--	--	**1,070**	--
	PZ-4-092606	9/26/2006	**0.189 J**	**0.0415**	**70.4**	--	--	--	**1,020**	--
PZ-5	PZ-5-100212	10/2/2012	**0.0061**	**0.0234**	**297**	**0.0061**	**0.122**	**267**	**2,180**	**2,090**
	PZ-5-101011	10/10/2011	**0.0124 J**	**0.227**	**147**	**0.0085 J**	**0.239**	**282**	**2,360**	**2,280**
	PZ-5-072511	7/25/2011	**0.007 J**	**0.898**	**347**	--	--	--	**2,560**	--
	PZ-5-100206	10/2/2006	**0.211 J**	**0.784**	**304**	--	--	--	**2,470**	--
	PZ-45-100206	10/2/2006	**0.336 J**	**1.04**	**354**	--	--	--	**2,440**	--
SSA6-MW-01	SSA6-MW-01-100512	10/5/2012	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.006**	**1.5**	**1.39**
SSA7-MW-01	SSA7-MW-01-100512	10/5/2012	0.005 U	**0.0121**	**0.0793**	0.005 U	**0.0105**	**0.08**	**12.9**	**12.6**
	SSA7-MW-51-100512	10/5/2012	0.005 U	**0.0112**	**0.0734**	0.005 U	**0.0114**	**0.08**	**12.6**	**12.3**
	SSA7-MW-01-GW-022312	2/23/2012	0.005 U	**0.0087**	**0.031**	0.005 U	**0.008**	**0.028**	**8.51**	**8.41**

Notes:

1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

2 = All non-detect results are reported at the reporting limit.

🟨 Detected concentration is greater than Groundwater screening level

Bold = Detected result

Underlined = Non-detected concentration is above one or more identified screening levels

J = Estimated value

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

-- = Results not reported or not applicable

mg/L = milligrams per liter

USEPA = Unites States Environmental Protection Agency

R = rejected result

WAD = weak acid dissociable

Table 5-19c
East Groundwater Area Metals Results

	Location ID	G2-S	G4-S	R-2	SSA6-MW-01-2012	SSA7-MW-01-2012	
	Sample ID	G2-S-100312	G4-S-100312	R-2-100312	SSA6-MW-01-100512	SSA7-MW-01-100512	SSA7-MW-51-100512
	Sample Date	10/3/2012	10/3/2012	10/3/2012	10/5/2012	10/5/2012	10/5/2012
	Sample Type						FD
Metals (µg/L)	**Screening Level**						
Antimony	--	5 U	1 U	1 U	--	--	--
Arsenic	5/42[1]	**30.9**	**5.43**	2.64 U	**8.46**	**4.11**	**3.92**
Beryllium	--	5 U	1 U	1 U	--	--	--
Cadmium	5	5 U	1 U	1 U	--	--	--
Chromium	50	20 U	4.24 U	1.13 U	4 U	4 U	4 U
Copper	1,300	10 U	**9.46**	**3.16**	2 U	2 U	2 U
Lead	15	5 U	**2.16**	1 U	--	--	--
Mercury	2	0.4 U	0.08 U	0.08 U	--	--	--
Nickel	100	**9.94 J**	**4.64**	**1.08 J**	**1.09 J**	**3.31**	**3.41**
Selenium	--	10 U	2 U	2 U	--	--	--
Silver	--	5 U	1 U	1 U	--	--	--
Thallium	--	5 U	1 U	1 U	--	--	--
Zinc	--	20 U	**19.7**	**2.88 J**	--	--	--
Metals, Dissolved (µg/L)							
Antimony	--	5 U	1 U	1 U	--	--	--
Arsenic	5/42[1]	**33.3**	**5.19**	**3.02**	**9.07**	**3.99**	**3.96**
Beryllium	--	5 U	1 U	1 U	--	--	--
Cadmium	5	5 U	1 U	1 U	--	--	--
Chromium	50	**3.22 J**	**0.611 J**	**1.32 J**	4 U	4 U	4 U
Copper	1,300	20 U	4 U	4 U	2 U	2 U	2 U
Lead	15	5 U	1 U	1 U	--	--	--
Mercury	2	0.4 U	0.08 U	0.08 U	--	--	--
Nickel	100	**8.78 J**	**1.66 J**	**1.03 J**	**1.08 J**	**3.43**	**3.29**
Selenium	--	10 U	**1.26 J**	2 U	--	--	--
Silver	--	5 U	1 U	1 U	--	--	--
Thallium	--	5 U	1 U	1 U	--	--	--
Zinc	--	20 U	4 U	**2.76 J**	--	--	--

Notes:

1 = The study area is located in an area of Cowlitz County known to contain elevated levels of naturally occurring arsenic, iron and manganese in groundwater. Data available from the State Department of Health for Cowlitz County for the period 2001-2011 indicate an arsenic concentration range of up to 55 µg/L in monitored water system wells, with a median value of 10 µg/L and a 90-percentile value of 42 µg/L. Consistent with MTCA provisions (WAC 173-340-709(3)), groundwater data were compared to the 90-percentile of the background concentrations.

2 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

3 = All non-detect results are reported at the reporting limit.

🟨 = Detected concentration is greater than Groundwater screening level

▒ = Detected concentration is greater than MTCA Method A Groundwater cleanup level but is below regional background[1]

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

-- = Results not reported or not applicable

Underlined = Non-detected concentration is above one or more identified screening levels

µg/L = micrograms per liter

FD = field duplicate sample

USEPA = U.S. Environmental Protection Agency

Table 5-19d
East Groundwater Area PAH Results

	Location ID	G1-S	G2-S			G2-D		G4-S	PZ-1		
	Sample ID	**G-1S-010507**	**G-2S-010507**	**G2-S-100312**	**G2-S-120312**	**G2-D-120312**	**G2-D-120312-D**	**G4-S-100312**	**PZ-1-022707**	**PZ-1-072811**	**PZ-1-100711**
	Sample Date	**1/5/2007**	**1/5/2007**	**10/3/2012**	**12/3/2012**	**12/3/2012**	**12/3/2012**	**10/3/2012**	**2/27/2007**	**7/28/2011**	**10/7/2011**
	Sample Type						**FD**				
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**										
1-Methylnaphthalene	--	--	--	0.187 U	0.0748 UJ	0.0748 UJ	0.0748 UJ	0.19 U	--	**0.329 J**	**0.498**
2-Methylnaphthalene	--	0.01 U	**0.013**	0.187 U	0.0748 UJ	0.0748 UJ	0.0748 UJ	0.19 U	**0.42**	**0.202 J**	**0.29**
Acenaphthene	--	**0.013**	**0.074**	**0.136**	**0.0734**	0.0374 U	0.0374 U	0.0952 U	**4.2**	**1.56**	**2.53**
Acenaphthylene	--	0.01 U	0.01 U	0.0935 U	**0.033 J**	0.0374 U	0.0374 U	0.0952 U	**0.02**	0.122 U	**0.0396**
Anthracene	--	0.01 U	**0.034**	**0.165**	**0.216**	**0.111**	**0.137**	0.0952 U	**3.6**	**1.76**	**1.9**
Benzo(a)anthracene	--	**0.012**	**0.019**	**0.102**	**0.071**	**0.0469**	**0.0509**	0.0952 U	**0.23**	**0.162**	**0.155**
Benzo(a)pyrene	0.1	0.01 U	**0.014**	**0.0927 J**	**0.019 J**	**0.0329 J**	**0.0287 J**	0.143 U	**0.023**	**0.0962**	**0.0222**
Benzo(b)fluoranthene[1]	--	**0.014**	**0.03**	**0.172**	--	--	--	0.143 U	**0.08 J**	--	--
Benzo(k)fluoranthene[1]	--	**0.014**	**0.03**	--	**0.0763**	--	--	--	**0.08 J**	--	--
Benzo(b,k)fluoranthene	--	--	--	**0.0651 J**	**0.0207 J**	**0.0892**	**0.0804**	0.0952 U	--	**0.195 J**	**0.159 J**
Benzo(g,h,i)perylene	--	**0.011**	**0.019**	0.14 U	--	**0.0307 J**	**0.0282 J**	0.143 U	**0.015**	**0.134**	**0.0165 J**
Chrysene	--	**0.046**	**0.086**	**0.115**	**0.0733**	**0.0421**	**0.0402**	0.0952 U	**0.39 J**	**0.212**	**0.267**
Dibenzo(a,h)anthracene	--	0.01 U	0.01 U	0.0935 U	0.0374 U	0.0374 U	0.0374 U	0.0952 U	0.011 U	0.0943 U	0.0187 U
Dibenzofuran	--	0.01 U	**0.021**	--	**0.0285 J**	0.0374 U	0.0374 U	--	**1.4**	**0.562**	**0.939**
Fluoranthene		**0.046**	**0.2**	**0.497**	**0.299**	**0.0633**	**0.0634**	**0.0604 J**	**4.6**	--	--
Fluorene	--	0.01 U	**0.041**	**0.105**	**0.0841**	**0.0281 J**	**0.0329 J**	0.0952 U	**12**	**3.36**	**5.25**
Indeno(1,2,3-c,d)pyrene	--	0.01 U	**0.011**	**0.0576 J**	**0.0193 J**	**0.0305 J**	**0.0276 J**	0.0952 U	0.011 U	**0.105**	**0.00978 J**
Naphthalene	160	0.01 U	0.024 U	0.187 U	**0.0764 J**	0.0748 UJ	0.0748 UJ	0.19 U	2.1 U	**1.99 J**	**2.45**
Phenanthrene	--	0.01 U	**0.14**	**0.26**	**0.119**	0.0374 U	0.0374 U	**0.0737 J**	**28**	**8.53**	**13.1**
Pyrene	--	**0.5**	**0.12**	**0.339**	**0.201**	**0.0559**	**0.0553**	0.0952 U	**3.4**	**0.996**	**1.51**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,3]	0.1	**0.01**	**0.024**	**0.1387 J**	**0.0383 J**	**0.0519 J**	**0.0469 J**	0.143 U	**0.067 J**	**0.149 J**	**0.0582 J**

Table 5-19d
East Groundwater Area PAH Results

	Location ID	PZ-2		PZ-3				PZ-4		
	Sample ID	**PZ-2-072811**	**PZ-2-100711**	**PZ-3-022707**	**PZ-53-022707**	**PZ-3-072711**	**PZ-3-100711**	**PZ-4-022707**	**PZ-4-072711**	**PZ-4-101011**
	Sample Date	**7/28/2011**	**10/7/2011**	**2/27/2007**	**2/27/2007**	**7/27/2011**	**10/7/2011**	**2/27/2007**	**7/27/2011**	**10/10/2011**
	Sample Type				**FD**					
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**									
1-Methylnaphthalene	--	**0.383 J**	**0.184**	--	--	**0.278**	**0.294**	--	**0.494**	0.388 UJ
2-Methylnaphthalene	--	**0.0806 J**	**0.119**	**0.067**	**0.075**	**0.14**	**0.138**	**0.24**	0.381 U	0.388 UJ
Acenaphthene	--	**0.559**	**0.904**	**1.1**	**1.1**	**2.55**	**3.14**	**1.2**	**0.818**	**0.385 J**
Acenaphthylene	--	0.0504 U	**0.0332**	0.011 U	0.011 U	**0.0291**	**0.0277**	0.011 U	0.19 U	0.194 UJ
Anthracene	--	**2.6**	**1.69**	**2.1**	**2**	**2.58**	**2.05**	**3**	**1.94**	**1.21 J**
Benzo(a)anthracene	--	**0.215**	**0.232**	**0.12**	**0.11**	**0.151**	**0.138**	**0.48**	**0.239**	**0.223 J**
Benzo(a)pyrene	0.1	**0.034 J**	**0.0314**	**0.018**	0.011 U	**0.0322**	**0.0258**	**0.048**	0.19 U	0.194 UJ
Benzo(b)fluoranthene[1]	--	--	--	**0.034 J**	**0.024 J**	--	--	**0.15 J**	**0.133 J**	--
Benzo(k)fluoranthene[1]	--	--	--	**0.034**	**0.024**	--	--	**0.15**	0.19 U	--
Benzo(b,k)fluoranthene	--	**0.23 J**	**0.259 J**	--	--	**0.081**	**0.0779 J**	--	--	0.388 UJ
Benzo(g,h,i)perylene	--	**0.0204 J**	**0.0199**	0.011 U	0.011 U	0.0189 U	0.0198 U	**0.016**	0.19 U	0.194 UJ
Chrysene	--	**0.328**	**0.38**	**0.27**	**0.25**	**0.221**	**0.22**	**1.1**	**0.377**	**0.319 J**
Dibenzo(a,h)anthracene	--	0.0377 U	0.019 U	0.011 U	0.011 U	0.0189 U	0.0198 U	0.011 U	0.19 U	0.194 UJ
Dibenzofuran	--	**0.0714**	**0.124**	**0.43**	**0.42**	**--**	**1.17**	**0.38**	--	0.194 UJ
Fluoranthene		--	--	**5.7**	**5.5**	**--**	**--**	**8.4**	--	--
Fluorene	--	**0.271**	**0.484**	**2.2**	**2**	**3.5**	**3.64**	**0.97**	**0.48**	**0.283 J**
Indeno(1,2,3-c,d)pyrene	--	0.0377 U	**0.018 J**	0.011 U	0.011 U	0.0189 U	0.0198 U	0.011 U	0.19 U	0.194 UJ
Naphthalene	160	**0.784 J**	**1.19**	**0.13**	**0.13**	**0.449 J**	**0.418**	**2.4**	**1.52 J**	**0.823 J**
Phenanthrene	--	**2.47**	**3.75**	**17**	**16**	**20.1**	**22.1**	**15**	**5.42**	**3.12 J**
Pyrene	--	**1.48**	**1.86**	**4**	**3.9**	**4.4**	**3.51**	**5.6**	**2.18**	**1.69 J**
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,3]	0.1	**0.0856 J**	**0.0871 J**	**0.041 J**	**0.025 J**	**0.0595**	**0.0516 J**	**0.14 J**	**0.164 J**	**0.161 J**

Table 5-19d
East Groundwater Area PAH Results

	Location ID	PZ-5			R1-S		R1-D	
	Sample ID	**PZ-5-022707**	**PZ-5-072811**	**PZ-5-101011**	**R-1S-080211**	**R-1S-100511**	**R-1D-080211**	**R-1D-100511**
	Sample Date	**2/27/2007**	**7/28/2011**	**10/10/2011**	**8/2/2011**	**10/5/2011**	**8/2/2011**	**10/5/2011**
	Sample Type							
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**							
1-Methylnaphthalene	--	--	0.189 UJ	**0.0203 J**	0.0374 U	0.0377 U	0.0377 U	0.0377 U
2-Methylnaphthalene	--	0.027 U	0.189 UJ	**0.0455 J**	0.0374 U	0.0377 U	0.0377 U	0.0377 U
Acenaphthene	--	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Acenaphthylene	--	0.011 U	**0.531**	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Anthracene	--	**0.045**	**0.332**	**0.345 J**	**0.0102 J**	0.0189 U	**0.0284**	**0.0173 J**
Benzo(a)anthracene	--	**0.016**	**0.112**	**0.107 J**	0.0187 U	0.0189 U	0.0189 U	0.0122 U
Benzo(a)pyrene	0.1	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	**0.0104 J**
Benzo(b)fluoranthene[1]	--	**0.012 J**	0.0943 UJ	--	0.0187 U	0.0189 U	0.0189 U	--
Benzo(k)fluoranthene[1]	--	**0.012**	0.0943 U	--	0.0187 U	0.0189 U	0.0189 U	--
Benzo(b,k)fluoranthene	--	--	--	0.0392 UJ	--	--	--	**0.0212 J**
Benzo(g,h,i)perylene	--	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Chrysene	--	**0.057**	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0146 U
Dibenzo(a,h)anthracene	--	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Dibenzofuran	--	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Fluoranthene		**0.12**	--	--	**0.0216**	0.0189 U	0.0189 U	0.0189 U
Fluorene	--	**0.02**	0.0943 U	**0.0566 J**	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Indeno(1,2,3-c,d)pyrene	--	0.011 U	0.0943 U	0.0196 UJ	0.0187 U	0.0189 U	0.0189 U	0.0189 U
Naphthalene	160	**0.7**	**0.535 J**	**0.531 J**	**0.0304 J**	0.0377 U	**0.0293 J**	**0.03 J**
Phenanthrene	--	**0.16**	0.0943 U	**0.0395 J**	**0.0158 J**	0.0189 U	0.0189 U	**0.0108 J**
Pyrene	--	**0.078**	0.0943 U	0.0196 UJ	**0.0108 J**	0.0189 U	0.0189 U	0.0189 U
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,3]	0.1	**0.011 J**	**0.0777 J**	**0.0245 J**	0.0187 U	0.0189 U	0.0189 U	**0.0151 J**

Table 5-19d
East Groundwater Area PAH Results

	Location ID	R-2			R-3		R-3	R4-S	
	Sample ID	**R-2-080211**	**R-2-100511**	**R-2-100312**	**R-3-080211**	**R-3-100511**	**R-53-100511**	**R-4S-080211**	**R-4S-100511**
	Sample Date	**8/2/2011**	**10/5/2011**	**10/3/2012**	**8/2/2011**	**10/5/2011**	**10/5/2011**	**8/2/2011**	**10/5/2011**
	Sample Type						**FD**		
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**								
1-Methylnaphthalene	--	0.0377 U	0.0385 U	0.189 U	0.135 UJ	**0.0595 J**	**0.0578 J**	0.0385 U	0.05 U
2-Methylnaphthalene	--	0.0377 U	0.0385 U	0.189 U	0.0962 UJ	**0.0992 J**	**0.108 J**	0.0385 U	0.05 U
Acenaphthene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.0381 UJ	0.0286 UJ	0.0192 U	0.025 U
Acenaphthylene	--	0.0189 U	0.0192 U	0.0943 U	2.12 UJ	1.05 UJ	1.14 UJ	0.0192 U	0.025 U
Anthracene	--	**0.012 J**	**0.0138 J**	0.0943 U	**1.02 J**	**0.949 J**	**0.853 J**	**0.114**	**0.0973**
Benzo(a)anthracene	--	0.0189 U	0.0192 U	0.0943 U	**0.282 J**	**0.305 J**	**0.26 J**	**0.0494**	0.0448 U
Benzo(a)pyrene	0.1	0.0189 U	0.0192 U	0.142 U	0.0385 UJ	0.019 UJ	0.019 UJ	0.0192 U	0.025 U
Benzo(b)fluoranthene[1]	--	0.0189 U	0.0192 U	0.142 U	0.0385 UJ	--	--	0.0192 U	0.025 U
Benzo(k)fluoranthene[1]	--	0.0189 U	0.0192 U	0.142 U	0.0385 UJ	--	--	0.0192 U	0.025 U
Benzo(b,k)fluoranthene	--	--	--	--	--	0.0381 UJ	0.0381 UJ	--	--
Benzo(g,h,i)perylene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	0.019 UJ	0.0192 U	0.025 U
Chrysene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	**0.284 J**	0.0192 U	0.025 U
Dibenzo(a,h)anthracene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	0.019 UJ	0.0192 U	0.025 U
Dibenzofuran	--	0.0189 U	0.0192 U	--	0.0385 UJ	**0.0388 J**	0.019 UJ	0.0192 U	0.025 U
Fluoranthene		0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	0.0286 UJ	0.0192 U	0.025 U
Fluorene	--	0.0189 U	0.0192 U	0.0943 U	**0.041 J**	**0.0621 J**	**0.0674 J**	**0.0172 J**	**0.0213 J**
Indeno(1,2,3-c,d)pyrene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	0.019 UJ	0.0192 U	0.025 U
Naphthalene	160	0.0377 U	0.0385 U	0.189 U	**0.105 J**	**0.157 J**	**0.146 J**	**0.0225 J**	**0.0304 J**
Phenanthrene	--	0.0189 U	**0.0104 J**	0.0943 U	**0.026 J**	**0.0184 J**	**0.0199 J**	**0.0124 J**	**0.0178 J**
Pyrene	--	0.0189 U	0.0192 U	0.0943 U	0.0385 UJ	0.019 UJ	0.019 UJ	0.0192 U	0.025 U
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,3]	0.1	0.0189 U	0.0192 U	0.142 U	**0.0553 J**	**0.0439 J**	**0.0421 J**	**0.0185**	0.025 U

Table 5-19d
East Groundwater Area PAH Results

	Location ID	R4-D		SSA7-MW-01-2012		
	Sample ID	R-4D-080211	R-4D-100511	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
	Sample Date	8/2/2011	10/5/2011	2/23/2012	10/5/2012	10/5/2012
	Sample Type					FD
Polycyclic Aromatic Hydrocarbons (µg/L)	**Screening Level**					
1-Methylnaphthalene	--	0.0374 U	0.0381 U	0.0381 U	0.0769 UJ	0.0762 UJ
2-Methylnaphthalene	--	0.0374 U	0.0381 U	0.0381 U	0.0769 UJ	0.0762 UJ
Acenaphthene	--	0.0187 U	0.019 U	0.019 U	0.0385 U	0.0381 U
Acenaphthylene	--	0.0187 U	0.019 U	0.019 U	0.0385 U	0.0381 U
Anthracene	--	**0.0676**	**0.0389**	0.019 U	**0.0246 J**	**0.028 J**
Benzo(a)anthracene	--	**0.0403**	0.0208 U	**0.00973 J**	0.0385 U	0.0381 U
Benzo(a)pyrene	0.1	**0.0209**	**0.0106 J**	0.019 U	0.0385 U	0.0381 U
Benzo(b)fluoranthene[1]	--	--	--	0.019 U	0.0385 U	0.0381 U
Benzo(k)fluoranthene[1]	--	--	--	0.019 U	0.0385 U	0.0381 U
Benzo(b,k)fluoranthene	--	**0.0623 J**	0.0381 U	--	--	--
Benzo(g,h,i)perylene	--	**0.014 J**	0.019 U	0.019 U	0.0385 U	0.0381 U
Chrysene	--	**0.0503**	0.0114 U	0.019 U	0.0385 U	0.0381 U
Dibenzo(a,h)anthracene	--	0.0187 U	0.019 U	0.019 U	0.0385 U	0.0381 U
Dibenzofuran	--	0.0187 U	0.019 U	0.019 U	0.0385 U	0.0381 U
Fluoranthene		**0.021**	0.011 U	**0.01 J**	0.0385 U	0.0381 U
Fluorene	--	0.0187 U	0.019 U	0.019 U	0.0385 U	0.0381 U
Indeno(1,2,3-c,d)pyrene	--	**0.0142 J**	0.019 U	0.019 U	0.0385 U	0.0381 U
Naphthalene	160	**0.0274 J**	0.0381 U	**0.0199 J**	**0.0549 J**	0.0762 UJ
Phenanthrene	--	**0.0212**	**0.0197**	**0.0138 J**	**0.0232 J**	0.0381 U
Pyrene	--	**0.0271**	**0.00975 J**	**0.00987 J**	0.0385 U	0.0381 U
Total cPAHs TEQ (7 minimum CAEPA 2005) (U = 1/2)[2,3]	0.1	**0.034 J**	**0.0155 J**	**0.01437 J**	0.0385 U	0.0381 U

Table 5-19d
East Groundwater Area PAH Results

Notes:
1 = When no values are reported for both, see benzo(b,k)fluoranthene results.
2 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.
3 = Total cPAH minimum 7 analytes calculation includes benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene. Per MTCA cleanup regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)" under WAC 173-340-708(e).
4 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
5 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Groundwater screening level
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
Underlined = Non-detected concentration is above one or more identified screening levels
µg/L = micrograms per liter
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
FD = field duplicate sample
USEPA = U.S. Environmental Protection Agency
TEQ = toxic equivalency
WAC = Washington Administrative Code
MTCA = Model Toxics Control Act

Table 5-19e
East Groundwater Area PCB, VOC, and SVOC Results

	Location ID	G2-S	G4-S	R-2	SSA7-MW-01-2012		
	Sample ID	G2-S-100312	G4-S-100312	R-2-100312	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
	Sample Date	10/3/2012	10/3/2012	10/3/2012	2/23/2012	10/5/2012	10/5/2012
	Sample Type						FD
PCB Aroclors (µg/L)	**Screening Level**						
Aroclor 1016	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1221	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1232	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1242	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1248	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1254	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1260	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1262	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Aroclor 1268	--	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Total PCB Aroclors (U = 1/2)	0.1	0.0192 U	0.0187 U	0.0187 U	0.0374 UJ	0.0189 U	0.0187 U
Volatile Organics (µg/L)							
1,1,1,2-Tetrachloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,1,1-Trichloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,1,2,2-Tetrachloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,1,2-Trichloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,1-Dichloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,1-Dichloroethene	--	5 U	0.5 U	0.5 U	--	--	--
1,1-Dichloropropene	--	10 U	1 U	1 U	--	--	--
1,2,3-Trichlorobenzene	--	20 U	2 U	2 U	--	--	--
1,2,3-Trichloropropane	--	10 U	1 U	1 U	--	--	--
1,2,4-Trichlorobenzene	--	20 U	2 U	2 U	--	--	--
1,2,4-Trimethylbenzene	--	10 U	1 U	1 U	--	--	--
1,2-Dibromo-3-chloropropane	--	50 U	5 U	5 U	--	--	--
1,2-Dichlorobenzene	--	5 U	0.5 U	0.5 U	--	--	--
1,2-Dichloroethane	--	5 U	0.5 U	0.5 U	--	--	--
1,2-Dichloroethene, cis-	--	5 U	0.5 U	0.5 U	--	--	--
1,2-Dichloroethene, trans-	--	5 U	0.5 U	0.5 U	--	--	--
1,2-Dichloropropane	--	5 U	0.5 U	0.5 U	--	--	--
1,3,5-Trimethylbenzene (Mesitylene)	--	10 U	1 U	1 U	--	--	--
1,3-Dichlorobenzene	--	5 U	0.5 U	0.5 U	--	--	--
1,3-Dichloropropane	--	10 U	1 U	1 U	--	--	--
1,3-Dichloropropene, cis-	--	10 U	1 U	1 U	--	--	--
1,3-Dichloropropene, trans-	--	10 U	1 U	1 U	--	--	--
1,4-Dichlorobenzene	--	5 U	0.5 U	0.5 U	--	--	--
2,2-Dichloropropane	--	10 U	1 U	1 U	--	--	--
2-Butanone (MEK)	--	100 U	10 U	10 U	--	--	--
2-Chlorotoluene	--	10 U	1 U	1 U	--	--	--
2-Hexanone (Methyl butyl ketone)	--	100 U	10 U	10 U	--	--	--
4-Chlorotoluene	--	10 U	1 U	1 U	--	--	--
4-Isopropyltoluene (4-Cymene)	--	10 U	1 U	1 U	--	--	--
Acetone	--	200 U	20 U	20 U	--	--	--

Table 5-19e
East Groundwater Area PCB, VOC, and SVOC Results

Location ID		G2-S	G4-S	R-2	SSA7-MW-01-2012		
Sample ID		G2-S-100312	G4-S-100312	R-2-100312	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
Sample Date		10/3/2012	10/3/2012	10/3/2012	2/23/2012	10/5/2012	10/5/2012
Sample Type							FD
Benzene	--	2.5 U	0.25 U	0.25 U	--	--	--
bis(2-Ethylhexyl)adipate	--	0.701 U	0.714 U	0.708 U	--	--	--
Bromobenzene	--	5 U	0.5 U	0.5 U	--	--	--
Bromochloromethane	--	10 U	1 U	1 U	--	--	--
Bromodichloromethane	--	10 U	1 U	1 U	--	--	--
Bromoform (Tribromomethane)	--	10 U	1 U	1 U	--	--	--
Bromomethane (Methyl bromide)	--	50 U	5 U	5 U	--	--	--
Carbon disulfide	--	100 U	10 U	10 U	--	--	--
Carbon tetrachloride (Tetrachloromethane)	--	5 U	0.5 U	0.5 U	--	--	--
Chlorobenzene	--	5 U	0.5 U	0.5 U	--	--	--
Chloroethane	--	50 U	5 U	5 U	--	--	--
Chloroform	--	10 U	1 U	1 U	--	--	--
Chloromethane	--	50 U	5 U	5 U	--	--	--
Dibromochloromethane	--	10 U	1 U	1 U	--	--	--
Dibromomethane	--	10 U	1 U	1 U	--	--	--
Dichlorodifluoromethane	--	10 U	1 U	1 U	--	--	--
Dichloromethane (Methylene chloride)	--	50 U	5 U	5 U	--	--	--
Ethylbenzene	--	5 U	0.5 U	0.5 U	--	--	--
Ethylene dibromide (1,2-Dibromoethane)	--	5 U	0.5 U	0.5 U	--	--	--
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	50 U	5 U	5 U	--	--	--
Isopropylbenzene (Cumene)	--	10 U	1 U	1 U	--	--	--
m,p-Xylene	--	10 U	1 U	1 U	--	--	--
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	--	100 U	10 UJ	10 UJ	--	--	--
Methyl tert-butyl ether (MTBE)	--	10 U	1 U	1 U	--	--	--
Naphthalene	--	20 U	2 U	2 U	--	--	--
n-Butylbenzene	--	10 U	1 U	1 U	--	--	--
n-Propylbenzene	--	5 U	0.5 U	0.5 U	--	--	--
o-Xylene	--	5 U	0.5 U	0.5 U	--	--	--
sec-Butylbenzene	--	10 U	1 U	1 U	--	--	--
Styrene	--	10 U	1 U	1 U	--	--	--
tert-Butylbenzene	--	10 U	1 U	1 U	--	--	--
Tetrachloroethene (PCE)	--	5 U	0.5 U	0.5 U	--	--	--
Toluene	--	10 U	1 U	1 U	--	--	--
Trichloroethene (TCE)	--	5 U	0.5 U	0.5 U	--	--	--
Trichlorofluoromethane (Fluorotrichloromethane)	--	20 U	2 U	2 U	--	--	--
Vinyl chloride	--	5 U	0.5 U	0.5 U	--	--	--

Table 5-19e
East Groundwater Area PCB, VOC, and SVOC Results

Location ID		G2-S	G4-S	R-2	SSA7-MW-01-2012		
Sample ID		G2-S-100312	G4-S-100312	R-2-100312	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
Sample Date		10/3/2012	10/3/2012	10/3/2012	2/23/2012	10/5/2012	10/5/2012
Sample Type							FD
Semivolatile Organics (µg/L)							
1,2,4-Trichlorobenzene	--	0.234 U	0.238 U	0.236 U	--	--	--
1,2-Dichlorobenzene	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
1,2-Dinitrobenzene	--	2.34 U	2.38 U	2.36 U	--	--	--
1,3-Dichlorobenzene	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
1,3-Dinitrobenzene	--	2.34 U	2.38 U	2.36 U	--	--	--
1,4-Dichlorobenzene	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
1,4-Dinitrobenzene	--	2.34 U	2.38 U	2.36 U	--	--	--
2,3,4,6-Tetrachlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2,3,5,6-Tetrachlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2,4,5-Trichlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2,4,6-Trichlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2,4-Dichlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2,4-Dimethylphenol	--	0.467 UJ	0.476 UJ	0.472 UJ	--	--	--
2,4-Dinitrophenol	--	2.34 U	2.38 U	2.36 U	--	--	--
2,4-Dinitrotoluene	--	0.935 U	0.952 U	0.943 U	--	--	--
2,6-Dinitrotoluene	--	0.935 U	0.952 U	0.943 U	--	--	--
2-Chloronaphthalene	--	0.0935 U	0.0952 U	0.0943 U	--	--	--
2-Chlorophenol	--	0.467 U	0.476 U	0.472 U	--	--	--
2-Methylphenol (o-Cresol)	--	0.234 U	0.238 U	0.236 U	--	--	--
2-Nitroaniline	--	1.87 U	1.9 U	1.89 U	--	--	--
2-Nitrophenol	--	0.935 U	0.952 U	0.943 U	--	--	--
3,3'-Dichlorobenzidine	--	0.935 UJ	0.952 UJ	0.943 UJ	--	--	--
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	--	0.234 U	0.238 U	0.236 U	--	--	--
3-Nitroaniline	--	1.87 UJ	1.9 UJ	1.89 UJ	--	--	--
4-Bromophenyl-phenyl ether	--	0.234 U	0.238 U	0.236 U	--	--	--
4-Chloro-3-methylphenol	--	0.935 U	0.952 U	0.943 U	--	--	--
4-Chloroaniline	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
4-Chlorophenyl phenyl ether	--	0.234 U	0.238 U	0.236 U	--	--	--
4-Nitroaniline	--	1.87 UJ	1.9 UJ	1.89 UJ	--	--	--
4-Nitrophenol	--	0.935 UJ	0.952 UJ	0.943 UJ	--	--	--
Aniline	--	0.467 UJ	0.476 UJ	0.472 UJ	--	--	--
Azobenzene	--	0.234 U	0.238 U	0.236 U	--	--	--
Benzidine	--	2.34 U	2.38 U	2.36 U	--	--	--
Benzoic acid	--	11.7 U	11.9 U	11.8 U	--	--	--
Benzyl alcohol	--	0.935 U	0.952 U	0.943 U	--	--	--
bis(2-Chloroethoxy)methane	--	0.234 U	0.238 U	0.236 U	--	--	--
bis(2-Chloroethyl)ether	--	0.234 U	0.238 U	0.236 U	--	--	--
bis(2-Chloroisopropyl)ether	--	0.234 U	0.238 U	0.236 U	--	--	--
bis(2-Ethylhexyl)phthalate	--	10.3 U	10.5 U	10.4 U	--	--	--

Table 5-19e
East Groundwater Area PCB, VOC, and SVOC Results

	Location ID	G2-S	G4-S	R-2	SSA7-MW-01-2012		
	Sample ID	G2-S-100312	G4-S-100312	R-2-100312	SSA7-MW-01-GW-022312	SSA7-MW-01-100512	SSA7-MW-51-100512
	Sample Date	10/3/2012	10/3/2012	10/3/2012	2/23/2012	10/5/2012	10/5/2012
	Sample Type						FD
Butylbenzyl phthalate	--	14 U	14.3 U	14.2 U	--	--	--
Carbazole	--	**0.0747 J**	0.143 U	0.142 U	--	--	--
Dibenzofuran	--	**0.0469 J**	0.0952 U	0.0943 U	--	--	--
Diethyl phthalate	--	14 U	14.3 U	14.2 U	--	--	--
Dimethyl phthalate	--	14 U	14.3 U	14.2 U	--	--	--
Di-n-butyl phthalate	--	14 U	14.3 U	14.2 U	--	--	--
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	--	2.34 U	2.38 U	2.36 U	--	--	--
Di-n-octyl phthalate	--	14 U	14.3 U	14.2 U	--	--	--
Hexachlorobenzene	--	0.0935 U	0.0952 U	0.0943 U	--	--	--
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
Hexachlorocyclopentadiene	--	0.467 U	0.476 U	0.472 U	--	--	--
Hexachloroethane	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
Isophorone	--	0.234 U	0.238 U	0.236 U	--	--	--
Nitrobenzene	--	0.935 U	0.952 U	0.943 U	--	--	--
n-Nitrosodimethylamine	--	0.234 UJ	0.238 UJ	0.236 UJ	--	--	--
n-Nitrosodi-n-propylamine	--	0.234 U	0.238 U	0.236 U	--	--	--
n-Nitrosodiphenylamine	--	0.234 U	0.238 U	0.236 U	--	--	--
Pentachlorophenol	--	1.87 U	1.9 U	1.89 U	--	--	--
Phenol	--	1.87 UJ	1.9 UJ	1.89 UJ	--	--	--
Pyridine	--	0.935 UJ	0.952 UJ	0.943 UJ	--	--	--

Table 5-19e
East Groundwater Area PCB, VOC, and SVOC Results

Notes:

1 = Totals are calculated as the sum of all detected results and half of the reporting limit of undetected results (U=1/2). If all results are not detected, the highest reporting limit value is reported as the sum.
2 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
3 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Groundwater screening level
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
-- = Results not reported or not applicable
Underlined = Non-detected concentration is above one or more identified screening levels
µg/L = micrograms per liter
PCB = polychlorinated biphenyl
VOC = volatile organic compound
SVOC = semivolatile organic compound
FD = field duplicate sample
USEPA = U.S. Environmental Protection Agency
TEQ = toxic equivalency
WAC = Washington Administrative Code
MTCA = Model Toxics Control Act

Table 5-19f
East Groundwater Area TPH and EPH Results

	Location ID	SSA6-MW-01-2012	SSA6-MW-01-2012	
	Sample ID	SSA6-MW-01-011212	SSA6-MW-01-100512	SSA6-MW-01-120412
	Sample Date	1/12/2012	10/5/2012	12/4/2012
	Sample Type			
Total Petroleum Hydrocarbons (mg/L)	**Screening Level**			
Diesel range hydrocarbons	0.5	--	**1.37**	**1.76**
Diesel range hydrocarbons (silica gel treated)	0.5	**0.0775**	--	0.234 U
Oil range hydrocarbons	0.5	--	**0.380**	**0.621**
Oil range hydrocarbons (silica gel treated)	0.5	**0.154**	--	0.467 U
Extractable Petroleum Hydrocarbons (µg/L)				
C8-C10 Aliphatics	--	40 U	**44 J**	--
C10-C12 Aliphatics	--	40 U	40 U	--
C12-C16 Aliphatics	--	40 U	40 U	--
C16-C21 Aliphatics	--	40 U	40 U	--
C21-C34 Aliphatics	--	40 U	40 U	--
C8-C10 Aromatics	--	40 U	40 U	--
C10-C12 Aromatics	--	40 U	40 U	--
C12-C16 Aromatics	--	40 U	40 U	--
C16-C21 Aromatics	--	40 U	40 U	--
C21-C34 Aromatics	--	40 U	40 U	--

Notes:

🟨 = Detected concentration is greater than Surface Water screening level

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

-- = Results not reported or not applicable

µg/L = micrograms per liter

mg/L = milligrams per liter

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	W1				W2					
	Sample ID	**W1-100406**	**W1-080111**	**W1-101211**	**W1-100112**	**W2-100306**	**W42-100306**	**W2-101211**	**W2-080111**	**W2-080111-D**	**W2-100112**
	Sample Date	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2006**	**10/3/2006**	**10/12/2011**	**8/1/2011**	**8/1/2011**	**10/1/2012**
Analyte	**Sample Type**						**FD**			**FD**	
Field Parameters (mg/L)	**Screening Level**										
Temperature (°C)	--	**15.5**	**18.5**	**14.8**	**19.2**	**14.5**	**14.5**	**13.7**	**21.1**	**21.1**	**18.1**
pH (su)	--	**6.71**	**6.51**	**6.22**	**6.84**	**7.22**	**7.22**	**6.34**	**6.75**	**6.75**	**6.73**
Dissolved Oxygen (mg/L)	--	**6.21**	**2.62**	**1.03**	--	**7.10**	**7.10**	**1.81**	**3.69**	**3.69**	**3.11**
Oxidation Reduction Potential (mV)	--	**-28.9**	**-12.4**	**44.6**	**9.3**	**16.5**	**16.5**	**108.5**	**55.4**	**55.4**	**33.5**
Turbidity (NTU)	--	--	**36.1**	**126**	**49.24**	--	--	**16.5**	**19.2**	**19.2**	**15.2**
Conductivity (µS/cm)	--	**197**	**233**	**170**	**203**	**234**	**234**	**206**	**235**	**235**	**201**
Sulfide (mg/L)	--	0.01 U	**0.06**	0.0	**0.01**	0.01 U	0.01 U	0.0	**0.6**	**0.6**	**0**
Ferrous Iron (Fe2+) (mg/L)		**2.9**	**2.8**	**2.5**	**2.2**	0.2 U	0.2 U	**0.02**	**0.4**	**0.4**	**0.4**
Fluoride (mg/L)											
Fluoride	4	**0.2**	0.168 UJ	--	**0.156**	**0.2**	**0.2**	--	0.186 UJ	0.187 UJ	**0.235**
Fluoride, Dissolved (mg/L)											
Fluoride	4	--	--	**0.149**	**0.158**	--	--	**0.307**	--	--	**0.173**
Cyanide (mg/L)											
Cyanide, free	0.0052	0.0005 U	0.005 U	--	0.005 U	0.0005 U	0.0005 U	--	0.005 U	0.005 U	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	0.005 U	0.005 U	--	0.005 U	0.005 U	0.005 U	--	0.005 U	0.005 U	0.005 U
Cyanide, total	--	**0.0788**	0.005 U	--	0.005 U	0.005 U	0.005 U	--	0.005 U	0.005 U	0.005 U
Cyanide, Dissolved (mg/L)											
Cyanide, free	0.0052	--	--	0.005 U	0.005 U	--	--	**0.0055 R**	--	--	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	--	--	0.005 U	0.005 U	--	--	0.005 U	--	--	0.005 U
Cyanide, total	--	--	--	0.005 U	0.005 U	--	--	0.005 U	--	--	0.005 U
Geochemical - Conventional Parameters (mg/L)											
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**101**	**72.4**	**83.4**	--	--	**94.2**	**106**	**105**	--
Alkalinity, Carbonate as $CaCO_3$	--	--	20 U	20 U	**6.47**	--	--	20 U	20 U	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	20 U	**0.178**	--	--	20 U	20 U	20 U	--
Alkalinity, total as $CaCO_3$	--	**94.1**	**101**	**72.4**	**83.4**	**105**	**102**	**94.2**	**106**	**105**	**89.4**
Chloride (total)		**8.7**	**6.92**	**5.76**	**6.47**	**9.3**	**9.4**	**8.98**	**9.45**	**9.46**	**8.14**
Phosphorus	--	0.016 U	**0.244**	**0.58**	**0.178**	**0.016**	**0.02**	**0.08 J**	**0.07 J**	**0.07 J**	**0.068 J**
Sulfate	250	**4.6**	**3.23**	**3.05**	**3.4**	**3.6**	**3.6**	**3**	**2.94**	**2.95**	**3**
Total dissolved solids	--	--	**166**	**151**	**139**	--	--	**179**	**164**	**158**	**129**
Total suspended solids	--	--	**15**	**111**	**10**	--	--	5 U	5 U	**6**	5 U
Density (g/mL)	--	**1.00**	--	--	--	**1.0002**	**1.0002**	--	--	--	--

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	W3				W4					W5			
	Sample ID	W3-100306	W3-080111	W3-101211	W3-100112	W4A-100306	W4B-100306	W4-080111	W4-101211	W4-100112	W5-100306	W5-080111	W5-101211	W5-100212
	Sample Date	10/3/2006	8/1/2011	10/12/2011	10/1/2012	10/3/2006	10/3/2006	8/1/2011	10/12/2011	10/1/2012	10/3/2006	8/1/2011	10/12/2011	10/2/2012
Analyte	Sample Type													
Field Parameters (mg/L)	Screening Level													
Temperature (°C)	--	**14.2**	**22.7**	**14.3**	**17.2**	**15.4**	**15.4**	**22.3**	**13.9**	**17.7**	**16.5**	**19.9**	**16.5**	**16.9**
pH (su)	--	**7.33**	**6.94**	**7.15**	**6.84**	**7.27**	**7.56**	**7.22**	**7.11**	**6.87**	**6.61**	**6.96**	**7.7**	**7.7**
Dissolved Oxygen (mg/L)	--	**7.70**	**2.27**	**2.17**	**1.74**	**7.54**	**5.58**	**1.79**	**2.31**	**2.36**	**11.9**	**8.36**	**8.83**	**5.38**
Oxidation Reduction Potential (mV)	--	**16.5**	**112.7**	**89.2**	**6.84**	**13**	**2.6**	**26.2**	**82.4**	**4**	**48.4**	**201**	**69.2**	**12.1**
Turbidity (NTU)	--	--	**22.8**	**16.4**	**17.4**	--	--	**13.6**	**13.1**	**5.52**	--	**4.43**	**5.23**	**2.18**
Conductivity (μS/cm)	--	**234**	**313**	**331**	**215**	**235**	**238**	**418**	**410**	**260**	**193**	**131**	**146**	**140**
Sulfide (mg/L)	--	0.01 U	**0.6**	**0.05**	**0.01**	0.01 U	0.01 U	**0.05**	**0.06**	**0**	0.01 U	**0.03**	0.0	**0**
Ferrous Iron (Fe2+) (mg/L)		0.2 U	**0.2**	**0.02**	**0.6**	0.2 U	0.2 U	**0.2**	**0.2**	**0.08**	0.2 U	**0.1**	**0.3**	**0.2**
Fluoride (mg/L)														
Fluoride	4	**0.2**	**1.23**	--	**0.183**	**0.2**	**0.2**	**2.64**	--	**0.696**	0.1 U	**-- R**	--	**0.127**
Fluoride, Dissolved (mg/L)														
Fluoride	4	--	--	**1.24**	**0.238**	--	--	--	**2.31**	**0.647**	--	--	**0.133**	0.1 U
Cyanide (mg/L)														
Cyanide, free	0.0052	0.0005 U	**0.0022 J**	--	0.005 U	**0.000741**	0.0005 U	0.005 U	--	**0.0049 J**	**0.00149**	0.0024 U	--	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	0.005 U	**0.0064**	--	**0.0052**	0.005 U	0.005 U	**0.0058**	--	**0.0054**	**0.0138**	0.005 U	--	0.005 U
Cyanide, total	--	0.005 U	**0.0056**	--	0.005 U	0.005 U	0.005 U	**0.0199**	--	**0.0052**	0.005 U	0.005 U	--	0.005 U
Cyanide, Dissolved (mg/L)														
Cyanide, free	0.0052	--	--	0.005 U	0.005 U	--	--	--	0.005 U	**0.0037 J**	--	--	0.005 U	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	--	--	**0.0066**	**0.0052**	--	--	--	**0.0064**	**0.0091**	--	--	0.005 U	0.005 U
Cyanide, total	--	--	--	**0.0123**	0.005 U	--	--	--	**0.0222**	0.005 U	--	--	0.005 U	0.005 U
Geochemical - Conventional Parameters (mg/L)														
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**154**	**114**	--	--	--	**210**	**196**	--	--	**50.4**	**56**	--
Alkalinity, Carbonate as $CaCO_3$	--	--	20 U	20 U	--	--	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	20 U	--	--	--	20 U	20 U	--	--	20 U	20 U	--
Alkalinity, total as $CaCO_3$	--	**103**	**154**	**114**	**94.8**	**104**	**105**	**210**	**196**	**112**	**55.6**	**50.4**	**56**	**45.2**
Chloride (total)		**8.8**	**7.79**	**10.2**	**8.35**	**9.5**	**9.5**	**6.86**	**10.3**	**8.66**	**4.4**	**3.82**	**4.91**	**7.08**
Phosphorus	--	**0.016**	**0.168**	**0.08 J**	**0.044 J**	0.016 U	**0.016**	**0.326**	**0.12**	**0.066 J**	**0.036**	0.038 U	**0.014 J**	**0.038 J**
Sulfate	250	**3.8**	**3.08**	**3.17**	**3.12**	**3.7**	**3.9**	**3.42**	**3.98**	**2.88**	**10.2**	**7.42**	**10.2**	**9.8**
Total dissolved solids	--	--	**213**	**251**	**149**	--	--	**265**	**313**	**173**	--	**70**	**104**	**71**
Total suspended solids	--	--	**12**	5 U	5 U	--	--	**19**	**6**	5 U	--	5 U	5 U	**7**
Density (g/mL)	--	**1.0001**	--	--	--	**1.0001**	**1.0001**	--	--	--	**1.0001**			

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	**W6**				**W7**				**W8**	**W9**		**W10**
	Sample ID	**W6-100406**	**W6-080111**	**W6-101211**	**W6-100112**	**W7-100406**	**W7-080111**	**W7-101211**	**W7-100112**	**W8-100312**	**W9-100212**	**W59-100212**	**W10-100212**
	Sample Date	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2012**	**10/2/2012**	**10/2/2012**	**10/2/2012**
Analyte	**Sample Type**											**FD**	
Field Parameters (mg/L)	**Screening Level**												
Temperature (°C)	--	**14.4**	**20.9**	**14.2**	**17.9**	**14.4**	**17.2**	**14.9**	**20.8**	**19.8**	**17.4**	**17.4**	**17.5**
pH (su)	--	**7.01**	**6.64**	**6.42**	**6.78**	**7.01**	**6.47**	**6.37**	**6.49**	**7.4**	**7.57**	**7.57**	**7.5**
Dissolved Oxygen (mg/L)	--	**6.01**	**1.76**	**0.76**	**33.0**	**8.48**	**2.95**	**1.40**	**5.37**	**7.22**	**6.31**	**6.31**	**7.00**
Oxidation Reduction Potential (mV)	--	**18**	**92.0**	**94.7**	**77.7**	**-53**	**-6.9**	**36.2**	**-7.4 N**	**56.6**	**27.4**	**27.4**	**29.2**
Turbidity (NTU)	--	--	**16.3**	**31.7**	**21.6**	--	**47.2**	**264**	**52.84**	**1.94**	**2.9**	**2.9**	**10.8**
Conductivity (µS/cm)	--	**243**	**230**	**229**	**235**	**203**	**236**	**175**	**206**	**146**	**140**	**140**	**148**
Sulfide (mg/L)	--	0.01 U	**0.08**	0.0	**0.01**	0.01 U	**0.08**	0.0	--	**0.02**	**0**	**0**	**0.03**
Ferrous Iron (Fe2+) (mg/L)		0.2 U	**0.2**	**0.4**	**0**	0.2 U	**2.6**	**2.6**	**2.9**	**0**	**0.1**	**0.1**	**0.2**
Fluoride (mg/L)													
Fluoride	4	**0.2**	0.165 UJ	--	**0.185**	**0.1**	0.15 UJ	--	**0.147**	**0.113**	**0.188**	**0.133**	**0.152**
Fluoride, Dissolved (mg/L)													
Fluoride	4	--	--	**0.176**	**0.180**	--	--	**0.144**	**0.146**	**0.106**	**0.109**	**0.107**	**0.108**
Cyanide (mg/L)													
Cyanide, free	0.0052	0.0005 U	0.005 U	--	**0.0046 J**	0.0005 U	0.005 U	--	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	0.005 U	0.005 U	--	0.005 U	0.005 U	0.005 U	--	**0.0071**	0.005 U	0.005 U	0.005 U	0.005 U
Cyanide, total	--	**0.0452**	0.005 U	--	0.005 U	**1.19**	0.005 U	--	0.005 U	0.005 U	0.005 U	0.005 U	**0.0055**
Cyanide, Dissolved (mg/L)													
Cyanide, free	0.0052	--	--	**0.004 J**	0.005 U	--	--	0.005 U	**0.005**	0.005 U	0.005 U	0.005 U	0.005 U
Cyanide, Weak acid dissociable (WAD)	--	--	--	0.005 U	0.005 U	--	--	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cyanide, total	--	--	--	0.005 U	0.005 U	--	--	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Geochemical - Conventional Parameters (mg/L)													
Alkalinity, Bicarbonate as $CaCO_3$	--	--	**101**	**97**	--	--	**115**	**70.6**	--	--	--	--	--
Alkalinity, Carbonate as $CaCO_3$	--	--	20 U	20 U	--	--	20 U	20 U	--	--	--	--	--
Alkalinity, Hydroxide as $CaCO_3$	--	--	20 U	20 U	--	--	20 U	20 U	--	--	--	--	--
Alkalinity, total as $CaCO_3$	--	**117**	**101**	**97**	**96.6**	**96.3**	**115**	**70.6**	**80.6**	**37**	**50.4**	**48.8**	**51.2**
Chloride (total)		**14.4**	**12.2**	**14.2**	**13.6**	**8.6**	**6.96**	**5.8**	**6.41**	**9.71**	**7.42**	**7.51**	**9.64**
Phosphorus	--	**0.016**	**0.072 J**	**0.072 J**	**0.056 J**	0.016 U	**0.302**	**1.75**	**0.206**	**0.05 J**	**0.054 J**	**0.04 J**	**0.074 J**
Sulfate	250	**1.4**	**2.1**	**2.2**	**1.64**	**4.4**	**3.21**	**3**	**3.45**	**10.3**	**9.97**	**9.75**	**10**
Total dissolved solids	--	--	**159**	**191**	**162**	--	**164**	**143**	**133**	**78 J**	**56**	**50**	**84**
Total suspended solids	--	--	5 U	5 U	5 U	--	**27**	**248**	**13**	**-- R**	**22**	5 U	**193**
Density (g/mL)	--	**0.9999**				**0.9997**							

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	**W1**				**W2**					
	Sample ID	**W1-100406**	**W1-080111**	**W1-101211**	**W1-100112**	**W2-100306**	**W42-100306**	**W2-101211**	**W2-080111**	**W2-080111-D**	**W2-100112**
	Sample Date	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2006**	**10/3/2006**	**10/12/2011**	**8/1/2011**	**8/1/2011**	**10/1/2012**
Analyte	**Sample Type**						**FD**			**FD**	
Geochemical - Metals, Total (µg/L)											
Aluminum	--	--	--	--	**38.8 J**	--	--	--	--	--	50 U
Calcium	--	--	--	--	**16,500**	--	--	--	--	--	**18,800**
Iron	--	--	--	--	**8,100**	--	--	--	--	--	**1,860**
Magnesium	--	--	--	--	**8,240**	--	--	--	--	--	**8,620**
Manganese	--	--	--	--	**822**	--	--	--	--	--	**407**
Potassium	--	--	--	--	**1,880**	--	--	--	--	--	**2,340**
Silicon	--	--	--	--	**21,600**	--	--	--	--	--	**19,700**
Sodium	--	--	--	--	**11,100**	--	--	--	--	--	**11,900**
Geochemical - Metals, Dissolved (µg/L)											
Aluminum	--	50 U	**4.08 J**	50 U	50 U	50 U	50 U	50 U	50 U	**6.94 J**	50 U
Calcium	--	**15,900**	**16,000**	**15,000**	**16,400**	**18,700**	**18,900**	**19,400**	**19,300**	**19,400**	**18,300**
Iron	--	**4,570 J**	**6,240**	**3,740**	**1,810**	50 U	50 U	**405**	**434**	**446**	**439**
Magnesium	--	**7,570**	**8,770**	**5,390**	**8,070**	**8,530**	**8,620**	**7,510**	**9,080**	**9,190**	**8,430**
Manganese	--	**859**	**968**	**560**	**808**	**228**	**206**	**237**	**670**	**673**	**393**
Potassium	--	**1,900**	**2,040**	**2,550**	**1,850**	**2,100**	**2,300**	**2,810**	**2,300**	**2,350**	**2,260**
Silicon	--	**23,300**	**23,000**	**14,500**	**21,100**	**20,600**	**20,800**	**17,500**	**20,500**	**20,500**	**19,100**
Sodium	--	**12,100**	**11,900**	**9,020**	**10,900**	**13,200**	**13,700**	**11,700**	**13,500**	**13,500**	**11,600**

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	**W3**				**W4**					**W5**			
	Sample ID	**W3-100306**	**W3-080111**	**W3-101211**	**W3-100112**	**W4A-100306**	**W4B-100306**	**W4-080111**	**W4-101211**	**W4-100112**	**W5-100306**	**W5-080111**	**W5-101211**	**W5-100212**
	Sample Date	**10/3/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2006**	**10/3/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2006**	**8/1/2011**	**10/12/2011**	**10/2/2012**
Analyte	**Sample Type**													
Geochemical - Metals, Total (µg/L)														
Aluminum	--	--	--	--	**95.1**	--	--	--	--	**45.1 J**	--	--	--	**47.4 J**
Calcium	--	--	--	--	**19,800**	--	--	--	--	**20,800**	--	--	--	**14,800**
Iron	--	--	--	--	**2,230**	--	--	--	--	**1,690**	--	--	--	**221**
Magnesium	--	--	--	--	**8,810**	--	--	--	--	**9,200**	--	--	--	**4,470**
Manganese	--	--	--	--	**471**	--	--	--	--	**828**	--	--	--	**8**
Potassium	--	--	--	--	**2,400**	--	--	--	--	**2,620**	--	--	--	**1,140**
Silicon	--	--	--	--	**19,000**	--	--	--	--	**19,100**	--	--	--	**4,480**
Sodium	--	--	--	--	**12,800**	--	--	--	--	**18,200**	--	--	--	**7,880**
Geochemical - Metals, Dissolved (µg/L)														
Aluminum	--	50 U	**5.93 J**	50 U	50 U	50 U	50 U	**5.02 J**	50 U	50 U	50 U	**6.73 J**	50 U	50 U
Calcium	--	**19,200**	**21,500**	**22,200**	**19,800**	**19,500**	**20,000**	**23,300**	**23,100**	**20,500**	**14,900**	**13,300**	**15,500**	**13,500**
Iron	--	50 U	**494**	**879**	**419**	50 U	90 U	**631**	**542**	**353**	50 U	**63.9**	**158**	**156**
Magnesium	--	**8,920**	**10,000**	**9,590**	**8,850**	**8,830**	**9,040**	**10,600**	**10,200**	**9,150**	**4,280**	**3,780**	**4,450**	**4,130**
Manganese	--	**573**	**1,000**	**711**	**447**	**471**	**498**	**677**	**556**	**283**	**4**	**2.98**	2 U	**1.81**
Potassium	--	**2,200**	**2,030**	**3,060**	**2,400**	**2,300**	**2,400**	**1,940**	**3,140**	**2,550**	**1,200**	**938**	**1,290**	**969**
Silicon	--	**21,200**	**17,500**	**16,400**	**18,700**	**19,900**	**20,900**	**16,400**	**15,800**	**18,800**	**5,100**	**4,150**	**4,600**	**4,580**
Sodium	--	**13,800**	**30,500**	**35,700**	**12,900**	**14,500**	**14,900**	**54,900**	**54,800**	**17,700**	**7,400**	**5,680**	**7,170**	**7,380**

Table 5-20
Surface Water and CDID Ditch Water Testing Results

	Location ID	**W6**				**W7**				**W8**	**W9**		**W10**
	Sample ID	**W6-100406**	**W6-080111**	**W6-101211**	**W6-100112**	**W7-100406**	**W7-080111**	**W7-101211**	**W7-100112**	**W8-100312**	**W9-100212**	**W59-100212**	**W10-100212**
	Sample Date	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/4/2006**	**8/1/2011**	**10/12/2011**	**10/1/2012**	**10/3/2012**	**10/2/2012**	**10/2/2012**	**10/2/2012**
Analyte	**Sample Type**											**FD**	
Geochemical - Metals, Total (µg/L)													
Aluminum	--	--	--	--	50 U	--	--	--	**62.2**	**47.9 J**	**206**	**139**	**752**
Calcium	--	--	--	--	**23,100**	--	--	--	**16,600**	**14,800**	**14,900**	**14,700**	**15,200**
Iron	--	--	--	--	**2,470**	--	--	--	**9,830**	**170 J**	**422**	**343**	**1,090**
Magnesium	--	--	--	--	**9,080**	--	--	--	**8,190**	**4,590**	**4,540**	**4,460**	**4,770**
Manganese	--	--	--	--	**315**	--	--	--	**851**	8.01 U	**17.7**	**13.2**	**43.2**
Potassium	--	--	--	--	**1,570**	--	--	--	**1,920**	**1,160**	**1,150**	**1,140**	**1,240**
Silicon	--	--	--	--	**19,700**	--	--	--	**22,000**	**4,820**	**4,720**	**4,570**	**5,320**
Sodium	--	--	--	--	**12,100**	--	--	--	**11,000**	**9,480**	**8,230**	**8,050**	**9,350**
Geochemical - Metals, Dissolved (µg/L)													
Aluminum	--	50 U	**8.8 J**	50 U	50 U	50 U	**6.11 J**	50 U	50 U	50 U	50 U	50 U	50 U
Calcium	--	**24,200**	**21,000**	**21,800**	**22,400**	**16,700**	**16,800**	**14,800**	**16,000**	**14,500**	**13,600**	**13,600**	**13,300**
Iron	--	**50 J**	**610**	**520**	**328**	**6,460 J**	**7,310**	**4,960**	**2,720**	115 U	**159**	**163**	**176**
Magnesium	--	**8,870**	**8,460**	**7,930**	**8,780**	**8,030**	**8,760**	**5,290**	**7,940**	**4,520**	**4,180**	**4,180**	**4,150**
Manganese	--	**486**	**358**	**511**	**248**	**917**	**986**	**516**	**797**	**3.78**	**2.44**	**2.51**	**27.1**
Potassium	--	**1,700**	**1,270**	**2,070**	**1,490**	**2,000**	**2,020**	**2,510**	**1,830**	**1,160**	**976**	**974**	**1,000**
Silicon	--	**20,000**	**16,500**	**16,800**	**19,200**	**22,400**	**23,300**	**14,500**	**20,600**	**4,710**	**4,660**	**4,630**	**4,760**
Sodium	--	**13,200**	**12,100**	**11,100**	**11,800**	**12,500**	**12,300**	**8,870**	**10,700**	**9,450**	**7,650**	**7,640**	**8,570**

Table 5-20
Surface Water and CDID Ditch Water Testing Results

Notes:
1 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).
2 = All non-detect results are reported at the reporting limit.
🟨 = Detected concentration is greater than Surface Water screening level
Bold = Detected result
J = Estimated value
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
R = Rejected due to hold time exceedance. Pre-validated result was 0.1 U mg/L.
-- = Results not reported or not applicable
<u>Underlined = Non-detected concentration is above one or more identified screening levels</u>
FD = field duplicate
µg/L = micrograms per liter
µS/cm = microsiemens per centimeter
°C = degree Celsius
$CaCO_3$ = calcium carbonate
g/mL = grams per milliliter
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
su = standard unit
USEPA = U.S. Environmental Protection Agency
WAD = weak acid dissociable

Table 5-21
NPDES Sediment Testing Results

			Location ID	**SS-01**	**SS-01**	**SS-02**	**SS-02**	**SS-03**	**SS-03**	**SS-03**
			Sample Date	**12/10/2012**	**12/11/2012**	**12/11/2012**	**12/11/2012**	**12/12/2012**	**12/12/2012**	**12/12/2012**
			Sample ID	**MBTL12-SS-01-02**	**MBTL12-SS-01-10**	**MBTL12-SS-02-02**	**MBTL12-SS-02-10**	**MBTL12-SS-03-02**	**MBTL12-SS-03-10**	**MBTL12-SS-03-10CONF**
			Depth	**0 - 2 cm**	**0 - 10 cm**	**0 - 2 cm**	**0 - 10 cm**	**0 - 2 cm**	**0 - 10 cm**	**0 - 10 cm**
			Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**V**
Analyte	**Other Reference Values**	**SQO**	**CSL**							
Conventional Parameters										
Total organic carbon (pct)	--	--	--	**0.22**	**1.60**	**0.27**	**2.30**	**0.82**	**2.10**	--
Total solids (pct)	--	--	--	**71.1**	**57.8**	**70.6**	**57.6**	**63.4 J**	**56.7 J**	**58.1**
Ammonia as nitrogen (mg/kg)	--	230	300	**1.80**	**21.6**	**0.74**	**27.3**	**1.96**	**66.2**	--
Sulfide (mg/kg)	--	--	--	**1.90**	**10.3**	1.52 U	1.8 U	1.78 U	**12.2**	--
Fluoride, Cyanide, and Aluminum (mg/kg)										
Fluoride	1,900*	--	--	**217 J**	**359 J**	**190 J**	**296 J**	**144**	**329**	--
Cyanide, total	--	--	--	0.31 U	0.375 U	0.309 U	0.426 U	0.355 U	0.428 U	--
Aluminum	58,030**	--	--	**3,130**	**14,000**	**4,080**	**14,400**	**6,310**	**19,000**	--
Grain Size (pct)										
Total Gravel (USCS)	--	--	--	**1.18**	**2.09**	**0.32**	**0.73**	**0.08**	**0.00**	--
Total Sand (USCS)	--	--	--	**73.8**	**27.2**	**75.1**	**43.6**	**56.8**	**10.4**	--
Silt	--	--	--	**22.1**	**53.2**	**21.1**	**35.3**	**32.1**	**41.7**	--
Clay	--	--	--	**2.90**	**17.5**	**3.60**	**20.4**	**11.1**	**47.8**	--
Total Fines (silt + clay)	--	--	--	**25.0**	**70.7**	**24.7**	**55.7**	**43.2**	**89.5**	--
Polycyclic Aromatic Hydrocarbons (µg/kg)										
1-Methylnaphthalene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
2-Methylnaphthalene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Acenaphthene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Acenaphthylene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Anthracene	--	--	--	13.2 U	16.8 U	**8.25 J**	16.6 U	14.6 U	17.2 U	--
Benzo(a)anthracene	--	--	--	13.2 U	16.8 U	**80.0**	16.6 U	14.6 U	17.2 U	--
Benzo(a)pyrene	--	--	--	13.2 U	16.8 U	**35.4**	16.6 U	14.6 U	17.2 U	--
Benzo(b)fluoranthene	--	--	--	13.2 U	16.8 U	--	16.6 U	14.6 U	17.2 U	--
Benzo(k)fluoranthene	--	--	--	13.2 U	16.8 U	--	16.6 U	14.6 U	17.2 U	--
Benzo(b,k)fluoranthene	--	--	--	--	--	**77.5**	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	13.2 U	16.8 U	**9.2 J**	16.6 U	14.6 U	17.2 U	--
Chrysene	--	--	--	13.2 U	16.8 U	**43.6**	16.6 U	14.6 U	17.2 U	--
Dibenzo(a,h)anthracene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Fluoranthene	--	--	--	**7.59 J**	16.8 U	**158**	16.6 U	14.6 U	17.2 U	--
Fluorene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Indeno(1,2,3-c,d)pyrene	--	--	--	13.2 U	16.8 U	**12.2 J**	16.6 U	14.6 U	17.2 U	--
Naphthalene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Phenanthrene	--	--	--	13.2 U	16.8 U	14.1 U	16.6 U	14.6 U	17.2 U	--
Pyrene	--	--	--	13.2 U	16.8 U	**136**	16.6 U	14.6 U	17.2 U	--
Total HPAH (9 of 15) (U = 0)	--	--	--	**7.59 J**	16.8 U	**551.9 J**	16.6 U	14.6 U	17.2 U	--
Total LPAH (6 of 15) (U = 0)	--	--	--	13.2 U	16.8 U	**8.25 J**	16.6 U	14.6 U	17.2 U	--
Total PAHs (SMS Freshwater 2013) (U = 0)	--	17,000	30,000	**7.59 J**	16.8 U	**560 J**	16.6 U	14.6 U	17.2 U	--

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-01	SS-01	SS-02	SS-02	SS-03	SS-03	SS-03
			Sample Date	12/10/2012	12/11/2012	12/11/2012	12/11/2012	12/12/2012	12/12/2012	12/12/2012
			Sample ID	MBTL12-SS-01-02	MBTL12-SS-01-10	MBTL12-SS-02-02	MBTL12-SS-02-10	MBTL12-SS-03-02	MBTL12-SS-03-10	MBTL12-SS-03-10CONF
			Depth	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm
			Sample Type	N	N	N	N	N	N	V
Analyte	**Other Reference Values**	**SQO**	**CSL**							
PCB Aroclors (µg/kg)										
Aroclor 1016	--	--	--	5.19 U	6.86 U	5.22 U	6.94 U	6.2 U	6.96 U	4.64 U
Aroclor 1221	--	--	--	5.19 U	6.86 U	5.22 U	6.94 U	6.2 U	6.96 U	4.64 U
Aroclor 1232	--	--	--	5.19 U	6.86 U	5.22 U	6.94 U	6.2 U	6.96 U	4.64 U
Aroclor 1242	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Aroclor 1248	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Aroclor 1254	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Aroclor 1260	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Aroclor 1262	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Aroclor 1268	--	--	--	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U
Total PCB Aroclors (U = 0)	--	110	2,500	5.19 U	6.86 U	5.22 U	6.94 UJ	6.2 U	6.96 U	4.64 U

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-04	SS-04	SS-04	SS-05	SS-05	SS-06	SS-06
			Sample Date	12/12/2012	12/12/2012	12/12/2012	12/13/2012	12/13/2012	12/12/2012	12/12/2012
			Sample ID	MBTL12-SS-04-02	MBTL12-SS-04-10	MBTL12-SS-54-10	MBTL12-SS-05-02	MBTL12-SS-05-10	MBTL12-SS-06-02	MBTL12-SS-06-10
			Depth	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm
			Sample Type	N	N	FD	N	N	N	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
Conventional Parameters										
Total organic carbon (pct)	--	--	--	**2.00**	**1.10**	**0.80**	**0.37**	**0.31**	**1.60**	**1.50**
Total solids (pct)	--	--	--	**53.8 J**	**64.1 J**	**65.9**	**67.0**	**68.4**	**55.3 J**	**59.7 J**
Ammonia as nitrogen (mg/kg)	--	230	300	**3.71**	**18.7**	**23.7**	**2.06**	**2.52**	**4.07**	**78.1**
Sulfide (mg/kg)	--	--	--	**2.55**	1.5 U	**1.94**	1.75 U	1.58 U	1.68 U	**21.1**
Fluoride, Cyanide, and Aluminum (mg/kg)										
Fluoride	1,900*	--	--	**306**	**187**	**182 J**	**129 J**	**132 J**	**255**	**322**
Cyanide, total	--	--	--	0.803 U	0.363 U	0.357 U	0.321 U	0.335 U	0.438 U	0.376 U
Aluminum	58,030**	--	--	**17,500**	**10,000**	**8,990**	**5,810**	**4,980**	**13,300**	**18,400**
Grain Size (pct)										
Total Gravel (USCS)	--	--	--	**0.84**	**0.28**	**0.04**	**0.17**	**0.52**	**0.06**	**0.00**
Total Sand (USCS)	--	--	--	**12.9**	**51.1**	**51.3**	**51.0**	**62.6**	**23.2**	**4.26**
Silt	--	--	--	**51.3**	**34.4**	**34.3**	**45.0**	**33**	**44.9**	**50.6**
Clay	--	--	--	**35.0**	**14.2**	**14.3**	**3.8**	**3.9**	**31.9**	**45.1**
Total Fines (silt + clay)	--	--	--	**86.3**	**48.6**	**48.6**	**48.8**	**36.9**	**76.8**	**95.7**
Polycyclic Aromatic Hydrocarbons (µg/kg)										
1-Methylnaphthalene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
2-Methylnaphthalene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Acenaphthene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Acenaphthylene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Anthracene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	**11.2 J**	17.9 U	16.3 U
Benzo(a)anthracene	--	--	--	18.4 U	15.4 U	**18.1**	**7.27 J**	**12.4 J**	17.9 U	16.3 U
Benzo(a)pyrene	--	--	--	18.4 U	15.4 U	**9.98 J**	14 U	14.2 U	17.9 U	16.3 U
Benzo(b)fluoranthene	--	--	--	18.4 U	15.4 U	--	14 U	--	17.9 U	16.3 U
Benzo(k)fluoranthene	--	--	--	18.4 U	15.4 U	--	14 U	--	17.9 U	16.3 U
Benzo(b,k)fluoranthene	--	--	--	--	--	**24.1 J**	--	**16.2 J**	--	--
Benzo(g,h,i)perylene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Chrysene	--	--	--	18.4 U	15.4 U	**17.4**	14 U	**24.7**	17.9 U	16.3 U
Dibenzo(a,h)anthracene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Fluoranthene	--	--	--	18.4 U	**9.86 J**	**14.4**	**10.8 J**	**65.3**	17.9 U	16.3 U
Fluorene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Indeno(1,2,3-c,d)pyrene	--	--	--	18.4 U	15.4 U	13.9 U	14 U	14.2 U	17.9 U	16.3 U
Naphthalene	--	--	--	18.4 U	15.4 U	**7.25 J**	14 U	14.2 U	17.9 U	16.3 U
Phenanthrene	--	--	--	18.4 U	15.4 U	**7.96 J**	**7.60 J**	**33.5**	17.9 U	16.3 U
Pyrene	--	--	--	18.4 U	**7.72 J**	**23.8**	**10.1 J**	**50.7**	17.9 U	16.3 U
Total HPAH (9 of 15) (U = 0)	--	--	--	18.4 U	**17.6 J**	**108 J**	**28.2 J**	**169 J**	17.9 U	16.3 U
Total LPAH (6 of 15) (U = 0)	--	--	--	18.4 U	15.4 U	**15.2 J**	**7.60 J**	**44.7 J**	17.9 U	16.3 U
Total PAHs (SMS Freshwater 2013) (U = 0)	--	17,000	30,000	18.4 U	**17.6 J**	**123 J**	**35.8 J**	**214 J**	17.9 U	16.3 U

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-04	SS-04	SS-04	SS-05	SS-05	SS-06	SS-06
			Sample Date	12/12/2012	12/12/2012	12/12/2012	12/13/2012	12/13/2012	12/12/2012	12/12/2012
			Sample ID	MBTL12-SS-04-02	MBTL12-SS-04-10	MBTL12-SS-54-10	MBTL12-SS-05-02	MBTL12-SS-05-10	MBTL12-SS-06-02	MBTL12-SS-06-10
			Depth	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm
			Sample Type	N	N	FD	N	N	N	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
PCB Aroclors (µg/kg)										
Aroclor 1016	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1221	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1232	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1242	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1248	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1254	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1260	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1262	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Aroclor 1268	--	--	--	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U
Total PCB Aroclors (U = 0)	--	110	2,500	7.35 UJ	8.0 U	8.57 U	5.54 U	5.85 U	6.92 U	6.69 U

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-07	SS-07	SS-08	SS-08	SS-09	SS-09	SS-09
			Sample Date	12/12/2012	12/12/2012	12/12/2012	12/12/2012	12/11/2012	12/11/2012	12/11/2012
			Sample ID	MBTL12-SS-07-02	MBTL12-SS-07-10	MBTL12-SS-08-02	MBTL12-SS-08-10	MBTL12-SS-09-02	MBTL12-SS-09-10	MBTL12-SS-09-10CONF
			Depth	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm
			Sample Type	N	N	N	N	N	N	V
Analyte	**Other Reference Values**	**SQO**	**CSL**							
Conventional Parameters										
Total organic carbon (pct)	--	--	--	**0.33**	**0.36**	**0.29**	**0.29**	**0.54**	**1.30**	--
Total solids (pct)	--	--	--	**63.1 J**	**67.6 J**	**69 J**	**70.0 J**	**67.9**	**69.5**	**69.7**
Ammonia as nitrogen (mg/kg)	--	230	300	**1.78**	**1.44**	**1.52**	**0.96**	**1.95**	**8.92**	--
Sulfide (mg/kg)	--	--	--	1.54 U	1.57 U	1.55 U	**2.35**	**1.93**	1.47 U	--
Fluoride, Cyanide, and Aluminum (mg/kg)										
Fluoride	1,900*	--	--	**134**	**138**	**126**	**117**	**365 J**	**890 J**	--
Cyanide, total	--	--	--	0.354 U	0.327 U	0.332 U	0.323 U	**0.499**	**2.20**	--
Aluminum	58,030**	--	--	**5,420**	**5,020**	**4,600**	**4,120**	**5,440**	**8,150**	--
Grain Size (pct)										
Total Gravel (USCS)	--	--	--	**0.25**	**0.05**	**0.06**	**0.16**	**0.35**	**0.90**	--
Total Sand (USCS)	--	--	--	**51.0**	**49.0**	**60.9**	**70.3**	**63.5**	**65.7**	--
Silt	--	--	--	**44.2**	**47.1**	**35.3**	**25.8**	**32.4**	**29.4**	--
Clay	--	--	--	**4.60**	**3.80**	**3.70**	**3.70**	**3.80**	**4.00**	--
Total Fines (silt + clay)	--	--	--	**48.8**	**50.9**	**39.0**	**29.5**	**36.2**	**33.4**	--
Polycyclic Aromatic Hydrocarbons (µg/kg)										
1-Methylnaphthalene	--	--	--	15.8 U	14.3 U	13.9 U	13.5 U	272 U	**427 J**	**344**
2-Methylnaphthalene	--	--	--	15.8 U	14.3 U	13.9 U	13.5 U	272 U	**445 J**	**343**
Acenaphthene	--	--	--	15.8 U	14.3 U	13.9 U	13.5 U	**3,260**	**19,000**	**14,500**
Acenaphthylene	--	--	--	15.8 U	14.3 U	13.9 U	13.5 U	272 U	686 U	**147 J**
Anthracene	--	--	--	**14.0 J**	**9.0 J**	13.9 U	**14.4**	**1,930**	**20,400**	**22,700**
Benzo(a)anthracene	--	--	--	**20.4**	**30.2**	**8.29 J**	**26.4**	**7,400**	**66,800**	**52,400**
Benzo(a)pyrene	--	--	--	**12.9 J**	**23.1**	13.9 U	**17.9**	**9,850**	**89,300**	**166,000**
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	**33.5**	**70.2**	**16.0 J**	**84.6**	**17,500**	**143,000**	**125,000**
Benzo(g,h,i)perylene	--	--	--	**12.0 J**	**19.7**	**8.75 J**	**11.0 J**	**6,610**	**57,000**	**45,700**
Chrysene	--	--	--	**33.1**	**114**	**40.8**	**57.9**	**10,900**	**83,800**	**65,200**
Dibenzo(a,h)anthracene	--	--	--	15.8 U	14.3 U	13.9 U	13.5 U	**1,390**	**12,300**	**10,300**
Fluoranthene	--	--	--	**65.0**	**116**	**13.5 J**	**50.3**	**14,100**	**130,000**	**324,000**
Fluorene	--	--	--	**8.03 J**	14.3 U	13.9 U	13.5 U	**969**	**7,500**	**8,310**
Indeno(1,2,3-c,d)pyrene	--	--	--	15.8 U	**20.4**	13.9 U	13.5 U	**6,690**	**59,800**	**49,800**
Naphthalene	--	--	--	**10.5 J**	14.3 U	13.9 U	13.5 U	272 U	**628 J**	**769**
Phenanthrene	--	--	--	**56.1**	**50.8**	**8.94 J**	**13.5**	**5,030**	**56,000**	**71,600**
Pyrene	--	--	--	**51.2**	**87.6**	**12.0 J**	**49.2**	**13,000**	**119,000**	**296,000**
Total HPAH (9 of 15) (U = 0)	--	--	--	**228 J**	**481**	**99.3 J**	**297 J**	**87,440**	**761,000**	**1,134,400**
Total LPAH (6 of 15) (U = 0)	--	--	--	**88.6 J**	**59.8 J**	**8.94 J**	**27.9**	**11,189**	**103,528 J**	**118,026 J**
Total PAHs (SMS Freshwater 2013) (U = 0)	--	17,000	30,000	**317 J**	**541 J**	**108 J**	**325 J**	**98,629**	**864,528 J**	**1,252,426 J**

Table 5-21
NPDES Sediment Testing Results

			Location ID	**SS-07**	**SS-07**	**SS-08**	**SS-08**	**SS-09**	**SS-09**	**SS-09**
			Sample Date	**12/12/2012**	**12/12/2012**	**12/12/2012**	**12/12/2012**	**12/11/2012**	**12/11/2012**	**12/11/2012**
			Sample ID	**MBTL12-SS-07-02**	**MBTL12-SS-07-10**	**MBTL12-SS-08-02**	**MBTL12-SS-08-10**	**MBTL12-SS-09-02**	**MBTL12-SS-09-10**	**MBTL12-SS-09-10CONF**
			Depth	**0 - 2 cm**	**0 - 10 cm**	**0 - 2 cm**	**0 - 10 cm**	**0 - 2 cm**	**0 - 10 cm**	**0 - 10 cm**
			Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**V**
Analyte	**Other Reference Values**	**SQO**	**CSL**							
PCB Aroclors (µg/kg)										
Aroclor 1016	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	38.6 U
Aroclor 1221	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	38.6 U
Aroclor 1232	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	38.6 U
Aroclor 1242	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	**502**
Aroclor 1248	--	--	--	**3.16 J**	5.62 U	5.64 U	**2.81 J**	**103**	**1,650**	38.6 U
Aroclor 1254	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	**105**	**577**	**528**
Aroclor 1260	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	**54.7**	**220**	**249**
Aroclor 1262	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	38.6 U
Aroclor 1268	--	--	--	6.27 U	5.62 U	5.64 U	5.44 U	5.87 U	56.9 U	38.6 U
Total PCB Aroclors (U = 0)	--	110	2,500	**3.16 J**	5.62 U	5.64 U	**2.81 J**	**263**	**2,447**	**1,279**

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-10	SS-10	SS-10	SS-11	SS-11	SS-11	SS-12
			Sample Date	12/11/2012	12/11/2012	12/11/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012
			Sample ID	MBTL12-SS-10-02	MBTL12-SS-10-10	MBTL12-SS-10-10CONF	MBTL12-SS-11-02	MBTL12-SS-11-10	MBTL12-SS-11-10CONF	MBTL12-SS-12-02
			Depth	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm
			Sample Type	N	N	V	N	N	V	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
Conventional Parameters										
Total organic carbon (pct)	--	--	--	**0.27**	**1.40**	--	**0.36**	**0.38**	--	**0.20**
Total solids (pct)	--	--	--	**75.3**	**70.6**	**75.6**	**71.8**	**69.2**	**72.5**	**71.9**
Ammonia as nitrogen (mg/kg)	--	230	300	**1.99**	**5.10**	--	**2.14**	**1.91**	--	**2.38**
Sulfide (mg/kg)	--	--	--	**11.1**	**3.30**	--	1.53 U	1.55 U	--	1.44 U
Fluoride, Cyanide, and Aluminum (mg/kg)										
Fluoride	1,900*	--	--	**194 J**	**311 J**	--	**119 J**	**121 J**	--	**148 J**
Cyanide, total	--	--	--	0.315 U	0.353 U	--	0.316 U	0.36 U	--	0.313 U
Aluminum	58,030**	--	--	**3,320**	**5,930**	--	**5,530**	**4,840**	--	**6,380**
Grain Size (pct)										
Total Gravel (USCS)	--	--	--	**3.16**	**1.89**	--	**0.06**	**0.40**	--	**0.31**
Total Sand (USCS)	--	--	--	**77.1**	**69.9**	--	**41.3**	**54.0**	--	**72.9**
Silt	--	--	--	**18**	**21.0**	--	**54.8**	**41.4**	--	**24.6**
Clay	--	--	--	**1.8**	**7.30**	--	**3.80**	**4.20**	--	**2.20**
Total Fines (silt + clay)	--	--	--	**19.8**	**28.3**	--	**58.6**	**45.6**	--	**26.8**
Polycyclic Aromatic Hydrocarbons (µg/kg)										
1-Methylnaphthalene	--	--	--	12.4 U	13.3 U	44.6 U	13.9 U	13.3 U	9.4 U	274 U
2-Methylnaphthalene	--	--	--	12.4 U	13.3 U	**33.8 J**	13.9 U	13.3 U	9.4 U	274 U
Acenaphthene	--	--	--	**12.7**	13.3 U	**509**	13.9 U	13.3 U	9.4 U	**750**
Acenaphthylene	--	--	--	12.4 U	13.3 U	44.6 U	13.9 U	13.3 U	9.4 U	274 U
Anthracene	--	--	--	**19.5**	13.3 U	**604**	**8.87 J**	13.3 U	**14.5**	**1,550**
Benzo(a)anthracene	--	--	--	**134**	**15.8**	**2,560**	**40.7**	**12.7 J**	**12.00**	**8,180**
Benzo(a)pyrene	--	--	--	**191**	**13.7**	**4,950**	**14.7**	**11.2 J**	**12.4**	**12,700**
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	**331**	**51.2**	**7,210**	**40.6**	**27.6**	**42.8**	**18,600**
Benzo(g,h,i)perylene	--	--	--	**135**	**12.9 J**	**3,130**	13.9 U	**8.97 J**	**9.68**	**8,310**
Chrysene	--	--	--	**160**	**35.0**	**4,030**	**51.8**	**29.0**	**34.9**	**9,620**
Dibenzo(a,h)anthracene	--	--	--	**26.8**	13.3 U	**662**	13.9 U	13.3 U	9.4 U	**1,470**
Fluoranthene	--	--	--	**158**	**19.7**	**4,750**	**161**	**18.4**	**29.2**	**13,200**
Fluorene	--	--	--	12.4 U	13.3 U	**202**	**8.55 J**	13.3 U	**4.87 J**	**400**
Indeno(1,2,3-c,d)pyrene	--	--	--	**131**	**13.1 J**	**3,390**	**7.64 J**	**9.05 J**	**10.1**	**8,580**
Naphthalene	--	--	--	12.4 U	13.3 U	**80.2**	13.9 U	13.3 U	**6.09 J**	274 U
Phenanthrene	--	--	--	**58.5**	13.3 U	**2,040**	**44.1**	**13 J**	**31.4 J**	**4,360**
Pyrene	--	--	--	**163**	**17.9**	**4,700**	**126**	**17.4**	**27.2**	**13,200**
Total HPAH (9 of 15) (U = 0)	--	--	--	**1,430**	**179 J**	**35,382**	**442 J**	**134 J**	**178**	**93,860**
Total LPAH (6 of 15) (U = 0)	--	--	--	**90.7**	13.3 U	**3,435.20**	**61.5 J**	**13 J**	**56.9 J**	**7,060**
Total PAHs (SMS Freshwater 2013) (U = 0)	--	17,000	30,000	**1,521**	**179 J**	**38,817**	**504 J**	**147 J**	**235 J**	**100,920**

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-10	SS-10	SS-10	SS-11	SS-11	SS-11	SS-12
			Sample Date	12/11/2012	12/11/2012	12/11/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012
			Sample ID	MBTL12-SS-10-02	MBTL12-SS-10-10	MBTL12-SS-10-10CONF	MBTL12-SS-11-02	MBTL12-SS-11-10	MBTL12-SS-11-10CONF	MBTL12-SS-12-02
			Depth	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 2 cm
			Sample Type	N	N	V	N	N	V	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
PCB Aroclors (µg/kg)										
Aroclor 1016	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1221	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1232	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1242	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1248	--	--	--	**8.85**	5.19 U	3.57 U	5.54 U	5.67 U	--	**3.75 J**
Aroclor 1254	--	--	--	**5.95**	5.19 U	3.57 U	5.54 U	5.67 U	--	**2.69 J**
Aroclor 1260	--	--	--	**7.88**	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1262	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Aroclor 1268	--	--	--	4.93 U	5.19 U	3.57 U	5.54 U	5.67 U	--	5.34 U
Total PCB Aroclors (U = 0)	--	110	2,500	**22.7**	5.19 U	3.57 U	5.54 U	5.67 U	--	**6.44 J**

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-12	SS-12	SS-13	SS-13	SS-13	SS-16	SS-17
			Sample Date	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012
			Sample ID	MBTL12-SS-12-10	MBTL12-SS-12-10CONF	MBTL12-SS-13-02	MBTL12-SS-13-10	MBTL12-SS-13-10CONF	SS-16-10	SS-17-10
			Depth	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
			Sample Type	N	V	N	N	V	N	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
Conventional Parameters										
Total organic carbon (pct)	--	--	--	**0.30**	--	**0.37**	**0.36**	--	--	--
Total solids (pct)	--	--	--	**72.8**	**78.2**	**66.6**	**68.8**	**72.4**	**76.5**	**60.3**
Ammonia as nitrogen (mg/kg)	--	230	300	**3.79**	--	**2.18**	**2.35**	--	--	--
Sulfide (mg/kg)	--	--	--	1.44 U	--	1.51 U	1.63 U	--	--	--
Fluoride, Cyanide, and Aluminum (mg/kg)										
Fluoride	1,900*	--	--	**145 J**	--	**137 J**	**129 J**	--	--	--
Cyanide, total	--	--	--	0.328 U	--	0.365 U	0.361 U	--	--	--
Aluminum	58,030**	--	--	**5,870**	--	**5,780**	**5,380**	--	--	--
Grain Size (pct)										
Total Gravel (USCS)	--	--	--	**0.57**	--	**0.00**	**0.00**	--	--	--
Total Sand (USCS)	--	--	--	**76.1**	--	**43.8**	**49.9**	--	--	--
Silt	--	--	--	**18.7**	--	**51.6**	**45.6**	--	--	--
Clay	--	--	--	**4.70**	--	**4.6**	**4.5**	--	--	--
Total Fines (silt + clay)	--	--	--	**23.4**	--	**56.2**	**50.1**	--	--	--
Polycyclic Aromatic Hydrocarbons (μg/kg)										
1-Methylnaphthalene	--	--	--	275 U	43.2 U	14.6 U	13.7 U	9.29 U	--	--
2-Methylnaphthalene	--	--	--	275 U	43.2 U	14.6 U	13.7 U	9.29 U	--	--
Acenaphthene	--	--	--	**521**	**167**	14.6 U	13.7 U	9.29 U	--	--
Acenaphthylene	--	--	--	275 U	43.2 U	14.6 U	13.7 U	9.29 U	--	--
Anthracene	--	--	--	**1,120**	**294**	14.6 U	13.7 U	9.29 U	--	--
Benzo(a)anthracene	--	--	--	**6,520**	**1,250**	**8.42 J**	**18.2**	**14.1**	--	--
Benzo(a)pyrene	--	--	--	**11,900**	**2,150**	14.6 U	**17.6**	**20.0**	--	--
Benzo(b)fluoranthene	--	--	--	--	--	14.6 U	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	14.6 U	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	**17,100**	**3,310**	--	**33.8**	**39.6**	--	--
Benzo(g,h,i)perylene	--	--	--	**7,680**	**1,340**	14.6 U	**13.1 J**	**16.5**	--	--
Chrysene	--	--	--	**7,560**	**1,550**	**7.42 J**	**28.6**	**22.6**	--	--
Dibenzo(a,h)anthracene	--	--	--	**1,470**	**267**	14.6 U	13.7 U	9.29 U	--	--
Fluoranthene	--	--	--	**8,890**	**2,790**	**18.6**	**36.0**	**31.2**	--	--
Fluorene	--	--	--	**268 J**	**82.1**	14.6 U	13.7 U	9.29 U	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	**8,190**	**1,470**	14.6 U	**13.1 J**	**15.0**	--	--
Naphthalene	--	--	--	275 U	43.2 U	14.6 U	13.7 U	9.29 U	--	--
Phenanthrene	--	--	--	**3,400**	**1,020**	**14.4 J**	**14.9**	**9.01 J**	--	--
Pyrene	--	--	--	**8,750**	**2,760**	**15.5**	**31.6**	**28.5**	--	--
Total HPAH (9 of 15) (U = 0)	--	--	--	**78,060**	**16,887**	**49.9 J**	**192 J**	**188**	--	--
Total LPAH (6 of 15) (U = 0)	--	--	--	**5,309 J**	**1,563**	**14.4 J**	**14.9**	**9.01 J**	--	--
Total PAHs (SMS Freshwater 2013) (U = 0)	--	17,000	30,000	**83,369 J**	**18,450**	**64.3 J**	**207 J**	**197 J**	--	--

Table 5-21
NPDES Sediment Testing Results

			Location ID	SS-12	SS-12	SS-13	SS-13	SS-13	SS-16	SS-17
			Sample Date	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012	12/13/2012
			Sample ID	MBTL12-SS-12-10	MBTL12-SS-12-10CONF	MBTL12-SS-13-02	MBTL12-SS-13-10	MBTL12-SS-13-10CONF	SS-16-10	SS-17-10
			Depth	0 - 10 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
			Sample Type	N	V	N	N	V	N	N
Analyte	**Other Reference Values**	**SQO**	**CSL**							
PCB Aroclors (µg/kg)										
Aroclor 1016	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 U	14.9 U
Aroclor 1221	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 U	14.9 U
Aroclor 1232	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 U	14.9 U
Aroclor 1242	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 U	14.9 UJ
Aroclor 1248	--	--	--	**17.8**	--	5.73 U	5.54 U	--	10.6 UJ	**88.5 J**
Aroclor 1254	--	--	--	**12.2**	--	5.73 U	**3.75 J**	--	10.6 UJ	14.9 UJ
Aroclor 1260	--	--	--	**8.97**	--	5.73 U	5.54 U	--	10.6 U	**67.5 J**
Aroclor 1262	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 UJ	14.9 UJ
Aroclor 1268	--	--	--	5.48 U	--	5.73 U	5.54 U	--	10.6 U	14.9 UJ
Total PCB Aroclors (U = 0)	--	110	2,500	**39.0**	--	5.73 U	**3.75 J**	--	10.6 UJ	**156 J**

Table 5-21
NPDES Sediment Testing Results

Notes:

1 = Totals are calculated as the sum of all detected results (non-detected results = 0; U=0). If all results are not detected, the highest reporting limit value is reported as the sum.

2 = Total PAHs is the total of 1-methynaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(x)fluoranthenes, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene.

3 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

4 = Results are reported in dry weight basis.

5 = All non-detect results are reported at the reporting limit.

🟦 = Detected concentration is greater than Freshwater Sediment Cleanup Objective (SCO) (WAC 173-204) February 2013.

🟨 = Detected concentration is greater than Freshwater Cleanup Screening Level (CSL)and the SCO (WAC 173-204) February 2013.

Bold = Detected result

-- = Results not reported or not applicable

J = Estimated value

UJ = Compound analyzed but not detected above estimated detection limit

U = Compound analyzed but not detected above detection limit

µg/kg = microgram per kilogram

cm = centimeter

CSL = Cleanup Screening Level (WAC 173-204, February 2013)

FD = field duplicate sample

mg/kg = milligram per kilogram

N = normal sample

HPAH = high molecular weight PAH

NPDES = National Pollutant Discharge Elimination System

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyl

pct = percent

SMS = Sediment Management Standards (WAC 173-204, February 2013)

SCO = Sediment Cleanup Objective (WAC 173-204, February 2013)

V = verification sample

LPAH = low molecular weight PAH

* The criterion listed for fluoride is 1,900 mg/kg, which is the upper bound of regional background fluoride values for the Western United States (USGS 1974, 1984).
USGS (U.S. Geological Survey), 1974. *Selenium, Fluorine, and Arsenic in Surficial Materials of the Conterminous United States* . Geological Survey Circular 692.
USGS, 1984. *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States* . USGS Professional Paper 1270.

** PEC = probable effects concentration
The aluminum PEC is the representative effect concentration selected from among the ER-M and PELs for Hyalella azteca and Chironomus riparius presented in USEPA (1996). The PEC is the geometric mean of the 50th percentile in the effects dataset and the 85th percentile in the no effects dataset. It represents the lower limit of the range of concentrations usually associated with adverse effects (USEPA Assessment and Remediation of Contaminated Sediments Program, ES/ER/TM-95/R4, November 1997).

Table 5-22
RI/FS Sediment Testing Results

Location			**Nearshore Sediments**								
Location ID			**AQ-SE-01**	**AQ-SE-02**	**AQ-SE-03**	**AQ-SE-04**	**AQ-SE-05**	**AQ-SE-06**	**AQ-SE-07**	**AQ-SE-07**	**AQ-SE-08**
Sample Date			**11/13/2012**	**11/13/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**
Sample ID			**AQ-SE-01-10**	**AQ-SE-02-10**	**AQ-SE-03-10**	**AQ-SE-04-10**	**AQ-SE-05-10**	**AQ-SE-06-10**	**AQ-SE-07-10**	**AQ-SE-57-10**	**AQ-SE-08-10**
Depth			**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**
Sample Type			**N**	**N**	**N**	**N**	**N**	**N**	**N**	**FD**	**N**
	SCO	**CSL**									
Conventional Parameters (pct)											
Total organic carbon	--	--	**0.58**	**0.21**	**0.22**	**0.4**	**0.3**	**0.23**	**0.21**	**0.21**	**0.20**
Total solids	--	--	**81.5**	**70.5**	**74**	**64.6**	**67**	**68.2**	**68**	**68.3**	**68.6**
Metals (mg/kg)											
Arsenic	14	120	**2.49**	**1.47**	**2.39**	**2.28**	**1.51 J**	**1.81**	**1.31 J**	**1.21 J**	**1.31 J**
Cadmium	2.1	5.4	0.603 U	0.701 U	0.697 U	0.813 U	0.791 U	0.782 U	0.797 U	0.726 U	0.704 U
Chromium	72	88	**6.65**	**4.73**	**4.40**	**6.76**	**5.03**	**6.20**	**5.35**	**5.68**	**3.70**
Copper	400	1,200	**25.4**	**13.8**	**12.9**	**17.8**	**15.4**	**14.9**	**14.2**	**14.7**	**12.0**
Lead	360	1,300	**13**	**1.74**	**2.96**	**3.55**	**2.67**	**2.52**	**2.34**	**2.25**	**1.80**
Mercury	0.66	0.8	**0.498**	**0.0397 J**	**0.105**	**0.0887**	**0.231**	0.0625 U	**0.537**	0.0581 U	0.0563 U
Silver	0.57	1.7	0.603 U	0.701 U	0.697 U	0.813 U	0.791 U	0.782 U	0.797 U	0.726 U	0.704 U
Zinc	3,200	4,200	**43.5**	**20.9**	**27.8**	**37.9**	**29.6**	**30.9**	**27.8**	**28.5**	**20.0**
Polycyclic Aromatic Hydrocarbons (µg/kg)											
1-Methylnaphthalene	--	--	74.2 U	**8.65 J**	8.25 U	9.51 U	**5.21 J**	8.87 U	9.05 U	8.92 U	8.96 U
2-Methylnaphthalene	--	--	74.2 U	**15.7**	8.25 U	9.51 U	**7.41 J**	**5.38 J**	9.05 U	8.92 U	8.96 U
Acenaphthene	--	--	37.1 U	4.36 U	**12.1**	**3.25 J**	**25.5**	**2.5 J**	4.52 U	4.46 U	4.48 U
Acenaphthylene	--	--	37.1 U	4.36 U	4.13 U	4.76 U	**16.6**	**2.39 J**	4.52 U	4.46 U	4.48 U
Anthracene	--	--	37.1 U	**3.01 J**	**33.2 J**	**5.71**	**36**	**4.39 J**	**4.31 J**	4.46 U	4.48 U
Benzo(a)anthracene	--	--	**43.6**	**6.13**	**106 J**	**10.1**	**84.9**	**2.96 J**	**12.4**	**3.05 J**	**3.47 J**
Benzo(a)pyrene	--	--	**61.3**	**8.63**	**136 J**	**10.1**	**71.6**	**5.48 J**	**15.4**	**6.38 J**	**5.3**
Benzo(b)fluoranthene	--	--	**97.5**	**17.3**	**180 J**	**17.7**	**261**	**7.92**	**19.9**	**6.79**	**7.16**
Benzo(k)fluoranthene	--	--	**25.9 J**	**3.96 J**	**59.9 J**	**5.84**	**71.6**	**3.88 J**	**7.24**	6.69 U	4.48 U
Benzo(g,h,i)perylene	--	--	**40.6**	**10.3**	**85.5 J**	**9.37**	**38.0**	**3.4 J**	**8.93**	**3.88 J**	4.48 U
Chrysene	--	--	**58.6**	**15.3**	**134 J**	**41.9**	**294**	**5.89**	**13.8**	**2.98 J**	**5.14**
Dibenzo(a,h)anthracene	--	--	37.1 U	4.36 U	**18.6 J**	4.76 U	**9.64**	4.43 U	4.52 U	4.46 U	4.48 U
Dibenzofuran	200	680	37.1 U	4.36 U	**7.21**	**3.09 J**	**34.3**	**6.21**	4.52 U	4.46 U	4.48 U
Fluoranthene	--	--	**69.2**	**12.9**	**240 J**	**18.8**	**954**	**12.1**	**30.3**	**5.59**	**10.3**
Fluorene	--	--	37.1 U	4.36 U	**11.5**	**4.41 J**	**37.8**	**3.72 J**	4.52 U	4.46 U	4.48 U
Indeno(1,2,3-c,d)pyrene	--	--	**38.0**	**7.73**	**87.1 J**	**7.23**	**38.4**	4.43 U	**7.82**	**2.29 J**	**2.76 J**
Naphthalene	--	--	74.2 U	8.73 U	8.25 U	9.51 U	**10.4**	8.87 U	9.05 U	8.92 U	8.96 U
Phenanthrene	--	--	**45.9**	**13.6**	**131 J**	**22.1**	**718**	**6.49**	**20.4**	**3.88 J**	**5.19**
Pyrene	--	--	**75.2**	**13.4**	**199 J**	**17.1**	**667**	**9.60**	**24.4**	**5.01**	**7.85**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)	--	--	**84.2 J**	**12.51 J**	**182.5 J**	**14.84**	**121.09**	**7.46 J**	**20.5**	**8.18 J**	**7.14 J**
Total HPAH (9 of 15) (U = 1/2)	--	--	**528.5 J**	**97.83 J**	**1,246.1 J**	**140.52**	**2,490.14**	**55.66 J**	**142.45**	**41.54 J**	**48.7 J**
Total LPAH (6 of 15) (U = 1/2)	--	--	**157.2**	**27.52 J**	**193.99 J**	**42.61 J**	**844.3**	**23.92 J**	**36.01 J**	**17.26 J**	**18.63**
Total PAH (15) (U = 1/2)	--	--	**685.6 J**	**125.35 J**	**1,440.09 J**	**183.12 J**	**3,334.44**	**79.59 J**	**178.46 J**	**58.8 J**	**67.33 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)	--	--	**82.4 J**	**12.3 J**	**182.5 J**	**14.61**	**121.09**	**7.01 J**	**20.27**	**7.62 J**	**6.69 J**
Total HPAH (9 of 15) (U = 0)	--	--	**510 J**	**95.7 J**	**1,246 J**	**138**	**2,490**	**51.2 J**	**140**	**36.0 J**	**42.0 J**
Total LPAH (6 of 15) (U = 0)	--	--	**45.9**	**16.6 J**	**189 J**	**35.5 J**	**844**	**19.5 J**	**24.7 J**	**3.88 J**	**5.19**
Total PAH (15) (U = 0)	17,000	30,000	**555.8 J**	**112.26 J**	**1,433.9 J**	**173.61 J**	**3,334.44**	**70.72 J**	**164.9 J**	**39.85 J**	**47.17 J**
Total PAH (SMS Freshwater 2013) (U = 0)	17,000	30,000	**556 J**	**137 J**	**1,434 J**	**174 J**	**3,347 J**	**76.1 J**	**165 J**	**39.9 J**	**47.2 J**

Table 5-22
RI/FS Sediment Testing Results

		Location	River Sediments						
		Location ID	**AQ-SS-03**	**AQ-SS-03**	**AQ-SS-04**	**AQ-SS-09**	**AQ-SS-09**	**AQ-SS-10**	**AQ-SS-14**
		Sample Date	**12/12/2012**	**12/12/2012**	**12/10/2012**	**12/10/2012**	**12/10/2012**	**12/10/2012**	**12/10/2012**
		Sample ID	**AQ-SS-03-10**	**AQ-SS-03-10CONF**	**AQ-SS-04-10**	**AQ-SS-09-10**	**AQ-SS-09-AB**	**AQ-SS-10-10**	**AQ-SS-14-10**
		Depth	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**18 - 24 cm**	**0 - 10 cm**	**0 - 10 cm**
		Sample Type	**N**	**V**	**N**	**N**	**N**	**N**	**N**
	SCO	**CSL**							
Conventional Parameters (pct)									
Total organic carbon	--	--	**2.40**	--	**0.14**	**1.40**	--	**0.84**	**0.30**
Total solids	--	--	**56.9**	--	**73.1**	**68.1**	**49.1**	**62.1**	**74.1**
Metals (mg/kg)									
Arsenic	14	120	**6.48**	--	**0.773 J**	**2.80**	--	**4.62**	**1.47**
Cadmium	2.1	5.4	**0.599 J**	--	0.729 U	0.762 U	--	**0.535 J**	0.672 U
Chromium	72	88	**25.2**	--	**6.99**	**14.0**	--	**22.5**	**6.07**
Copper	400	1,200	**35.6**	--	**14.8**	**33.6**	--	**154**	**12.3**
Lead	360	1,300	**7.63**	--	**1.41**	**14.7**	--	**5.73**	**1.92**
Mercury	0.66	0.8	**0.0593 J**	--	**0.105**	**0.281**	--	**0.202**	0.0538 U
Silver	0.57	1.7	0.921 U	--	0.729 U	0.762 U	--	0.81 U	0.672 U
Zinc	3,200	4,200	**63.3**	--	**26.7**	**60.0**	--	**61.8**	**26.7**
Polycyclic Aromatic Hydrocarbons (µg/kg)									
1-Methylnaphthalene	--	--	11.6 U	--	8.99 U	979 U	163 U	9.91 U	8.22 U
2-Methylnaphthalene	--	--	11.6 U	--	8.99 U	979 U	163 U	9.91 U	8.22 U
Acenaphthene	--	--	5.82 U	--	4.49 U	**4,690 J**	**3,340**	4.95 U	4.11 U
Acenaphthylene	--	--	5.82 U	--	4.49 U	489 U	81.4 U	4.95 U	4.11 U
Anthracene	--	--	5.82 U	--	4.49 U	**3,330 J**	**226**	4.95 U	4.11 U
Benzo(a)anthracene	--	--	5.82 U	--	**3.89 J**	**16,000 J**	81.4 U	**8.12**	**3.64 J**
Benzo(a)pyrene	--	--	5.82 U	--	**5.1**	**24,100 J**	81.4 U	**13.4**	**4.66**
Benzo(b)fluoranthene	--	--	5.82 U	--	**6.13**	**33,400 J**	81.4 U	**14.7**	**7.92**
Benzo(k)fluoranthene	--	--	5.82 U	--	4.49 U	**11,000 J**	81.4 U	**4.46 J**	4.11 U
Benzo(g,h,i)perylene	--	--	5.82 U	--	**2.28 J**	**17,400 J**	81.4 U	**6.95**	**2.68 J**
Chrysene	--	--	5.82 U	--	**4.06 J**	**25,800 J**	81.4 U	**8.50**	**9.75**
Dibenzo(a,h)anthracene	--	--	5.82 U	--	4.49 U	**2,960 J**	81.4 U	4.95 U	4.11 U
Dibenzofuran	200	680	5.82 U	--	4.49 U	**596**	**207**	4.95 U	4.11 U
Fluoranthene	--	--	5.82 U	--	**4.26 J**	**30,000 J**	**136**	**12.2**	**10.7**
Fluorene	--	--	5.82 U	--	4.49 U	**1,540 J**	**795**	4.95 U	4.11 U
Indeno(1,2,3-c,d)pyrene	--	--	5.82 U	--	**2.33 J**	**16,200 J**	81.4 U	**7.59**	**2.59 J**
Naphthalene	--	--	11.6 U	--	8.99 U	979 U	163 U	9.91 U	8.22 U
Phenanthrene	--	--	5.82 U	--	4.49 U	**11,900 J**	**1,450 J**	**5.07**	**5.35**
Pyrene	--	--	5.82 U	--	**3.93 J**	**28,200 J**	**85.8**	**11.6**	**9.67**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2)	--	--	5.82 U	--	**6.82 J**	**32,314 J**	81.4 U	**17.22 J**	**6.58 J**
Total HPAH (9 of 15) (U = 1/2)	--	--	5.82 U	--	**36.47 J**	**205,060 J**	**547.4**	**89.99 J**	**55.72 J**
Total LPAH (6 of 15) (U = 1/2)	--	--	11.6 U	--	8.99 U	**22,194 J**	**5,933.2 J**	**19.93**	**17.68**
Total PAH (15) (U = 1/2)	--	--	11.6 U	--	**52.19 J**	**227,254 J**	**6,480.6 J**	**109.92 J**	**73.4 J**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)	--	--	5.82 U	--	**6.38 J**	**32,314 J**	81.4 U	**16.97 J**	**6.17 J**
Total HPAH (9 of 15) (U = 0)	--	--	5.82 U	--	**32.0 J**	**205,060 J**	**222**	**87.5 J**	**51.6 J**
Total LPAH (6 of 15) (U = 0)	--	--	11.6 U	--	8.99 U	**21,460 J**	**5,811 J**	**5.07**	**5.35**
Total PAH (15) (U = 0)	17,000	30,000	11.6 U	--	**31.98 J**	**226,520 J**	**6,032.8 J**	**92.59 J**	**56.96 J**
Total PAH (SMS Freshwater 2013) (U = 0)	17,000	30,000	11.6 U	--	**32.0 J**	**226,520 J**	**6,033 J**	**92.6 J**	**57.0 J**

Table 5-22
RI/FS Sediment Testing Results

		Location	Nearshore Sediments								
		Location ID	**AQ-SE-01**	**AQ-SE-02**	**AQ-SE-03**	**AQ-SE-04**	**AQ-SE-05**	**AQ-SE-06**	**AQ-SE-07**	**AQ-SE-07**	**AQ-SE-08**
		Sample Date	**11/13/2012**	**11/13/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**
		Sample ID	**AQ-SE-01-10**	**AQ-SE-02-10**	**AQ-SE-03-10**	**AQ-SE-04-10**	**AQ-SE-05-10**	**AQ-SE-06-10**	**AQ-SE-07-10**	**AQ-SE-57-10**	**AQ-SE-08-10**
		Depth	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**
		Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**FD**	**N**
	SCO	**CSL**									
Semivolatile Organics (µg/kg)											
1,2,4-Trichlorobenzene	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
1,2-Dichlorobenzene	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
1,3-Dichlorobenzene	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
1,4-Dichlorobenzene	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	185 U	21.8 U	20.6 U	23.8 U	22.9 U	22.2 U	22.6 U	22.3 U	22.4 U
2,4-Dinitrophenol	--	--	927 U	109 U	103 U	119 U	115 U	111 U	113 U	112 U	112 U
2,4-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol (o-Cresol)	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	260	2,000	92.7 U	10.9 U	10.3 U	**31.4**	**87.4**	**64.5**	**80.8**	**91.8**	**18.5**
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenyl ether	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--
Aniline	--	--	--	--	--	--	--	--	--	--	--
Benzoic acid	--	--	4640 U	546 U	516 UJ	594 U	573 UJ	554 UJ	566 UJ	558 UJ	560 U
Benzyl alcohol	--	--	185 U	21.8 U	20.6 U	23.8 U	**20.9 J**	22.2 U	22.6 U	22.3 U	22.4 U
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroisopropyl)ether	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	742 U	87.3 U	82.5 U	95.1 U	91.7 U	88.7 U	90.5 U	89.2 U	89.6 U
Butylbenzyl phthalate	--	--	742 U	87.3 U	82.5 U	95.1 U	91.7 U	88.7 U	90.5 U	89.2 U	89.6 U
Carbazole	900	1,100	--	--	--	--	--	--	--	--	--
Diethyl phthalate	--	--	185 U	21.8 U	20.6 U	23.8 U	22.9 U	22.2 U	22.6 U	22.3 U	22.4 U
Dimethyl phthalate	--	--	185 U	21.8 U	20.6 U	23.8 U	22.9 U	22.2 U	22.6 U	22.3 U	22.4 U
Di-n-butyl phthalate	--	--	185 U	21.8 U	20.6 U	23.8 U	22.9 U	22.2 U	22.6 U	22.3 U	22.4 U
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	742 U	87.3 U	82.5 U	95.1 U	91.7 U	88.7 U	90.5 U	89.2 U	89.6 U

Table 5-22
RI/FS Sediment Testing Results

		Location	River Sediments						
		Location ID	AQ-SS-03	AQ-SS-03	AQ-SS-04	AQ-SS-09	AQ-SS-09	AQ-SS-10	AQ-SS-14
		Sample Date	12/12/2012	12/12/2012	12/10/2012	12/10/2012	12/10/2012	12/10/2012	12/10/2012
		Sample ID	AQ-SS-03-10	AQ-SS-03-10CONF	AQ-SS-04-10	AQ-SS-09-10	AQ-SS-09-AB	AQ-SS-10-10	AQ-SS-14-10
		Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	18 - 24 cm	0 - 10 cm	0 - 10 cm
		Sample Type	N	V	N	N	N	N	N
	SCO	CSL							
Semivolatile Organics (µg/kg)									
1,2,4-Trichlorobenzene	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
1,2-Dichlorobenzene	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
1,3-Dichlorobenzene	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
1,4-Dichlorobenzene	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
2,3,4,6-Tetrachlorophenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2,4,5-Trichlorophenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2,4,6-Trichlorophenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2,4-Dichlorophenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2,4-Dimethylphenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2,4-Dinitrophenol	--	--	145 U	--	112 U	12,200 U	--	124 U	103 U
2,4-Dinitrotoluene	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
2,6-Dinitrotoluene	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
2-Chloronaphthalene	--	--	5.82 U	--	4.49 U	489 U	--	4.95 U	4.11 U
2-Chlorophenol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
2-Methylphenol (o-Cresol)	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
2-Nitroaniline	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
2-Nitrophenol	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
3,3'-Dichlorobenzidine	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
3-Methylphenol & 4-Methylphenol (m&p-Cresol)	260	2,000	14.5 U	--	11.2 U	1,220 U	--	12.4 U	**64.7**
3-Nitroaniline	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
4-Bromophenyl-phenyl ether	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
4-Chloro-3-methylphenol	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
4-Chloroaniline	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
4-Chlorophenyl phenyl ether	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
4-Nitroaniline	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
4-Nitrophenol	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
Aniline	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
Benzoic acid	--	--	727 U	--	562 U	61,200 U	--	619 U	514 U
Benzyl alcohol	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
bis(2-Chloroethoxy)methane	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
bis(2-Chloroethyl)ether	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
bis(2-Chloroisopropyl)ether	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
bis(2-Ethylhexyl)phthalate	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
Butylbenzyl phthalate	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
Carbazole	900	1,100	8.73 U	--	6.74 U	**1,360 J**	--	7.43 U	6.17 U
Diethyl phthalate	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
Dimethyl phthalate	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
Di-n-butyl phthalate	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	--	--	145 U	--	112 U	12,200 U	--	124 U	103 U
Di-n-octyl phthalate	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U

Table 5-22
RI/FS Sediment Testing Results

Location			Nearshore Sediments								
Location ID			**AQ-SE-01**	**AQ-SE-02**	**AQ-SE-03**	**AQ-SE-04**	**AQ-SE-05**	**AQ-SE-06**	**AQ-SE-07**	**AQ-SE-07**	**AQ-SE-08**
Sample Date			**11/13/2012**	**11/13/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**	**11/12/2012**
Sample ID			**AQ-SE-01-10**	**AQ-SE-02-10**	**AQ-SE-03-10**	**AQ-SE-04-10**	**AQ-SE-05-10**	**AQ-SE-06-10**	**AQ-SE-07-10**	**AQ-SE-57-10**	**AQ-SE-08-10**
Depth			**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**	**0 - 10 cm**
Sample Type			**N**	**N**	**N**	**N**	**N**	**N**	**N**	**FD**	**N**
	SCO	**CSL**									
Hexachlorobenzene	--	--	37.1 U	4.36 U	4.13 U	4.76 U	4.59 U	**7.17**	4.52 U	4.46 U	4.48 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
Isophorone	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--
n-Nitrosodimethylamine	--	--	--	--	--	--	--	--	--	--	--
n-Nitrosodi-n-propylamine	--	--	--	--	--	--	--	--	--	--	--
n-Nitrosodiphenylamine	--	--	92.7 U	10.9 U	10.3 U	11.9 U	11.5 U	11.1 U	11.3 U	11.2 U	11.2 U
Pentachlorophenol	--	--	742 U	87.3 U	82.5 U	95.1 U	91.7 U	88.7 U	90.5 U	89.2 U	89.6 U
Phenol	120	210	74.2 U	**11.3**	**5.99 J**	**26.8**	**12.8**	**18.1**	**11.6**	**11.7**	**14.4**
PCB Aroclors (µg/kg)											
Aroclor 1016	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1221	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1232	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1242	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1260	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1262	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1268	--	--	--	--	--	--	--	--	--	--	--
Total PCB Aroclors (U = 1/2)	--	--	--	--	--	--	--	--	--	--	--
Total PCB Aroclors (U = 0)	110	2,500	--	--	--	--	--	--	--	--	--
PCB Congeners (ng/kg)											
PCB-077	--	--	**87.5**	**20.6**	**20.2**	**39.3**	**61.6**	**2.38**	**1.31**	**1.79**	**1.12**
PCB-081	--	--	**3.43**	**0.735 J**	**0.806 J**	**1.15**	**2.04**	0.131 U	0.0882 U	0.0853 U	0.0738 U
PCB-105	--	--	**517**	**50.6**	**47.5**	**82.1**	**144**	**14.0**	**5.83**	**36.8**	**4.49**
PCB-114	--	--	**33.2**	**3.15**	**2.51**	**5.02**	**8.39**	**0.807 J**	**0.327 J**	**2.31**	**0.212 J**
PCB-118	--	--	**1,180**	**109**	**89.5**	**181**	**290**	**31.5**	**12.9**	**92.1**	**10.9**
PCB-123	--	--	**28.2**	**2.62**	**3.00**	**3.67**	**6.74**	**0.682 J**	**0.364 J**	**1.38**	**0.211 J**
PCB-126	--	--	**3.52**	**0.495 J**	**0.399 J**	**0.737 J**	**1.36**	**0.111 J**	0.0961 U	**0.124 J**	0.0696 U
PCB-156/157	--	--	**172**	**61.9**	**7.38**	**8.40**	**19.4**	**4.13**	**1.69**	**14.2**	**1.25 J**
PCB-167	--	--	**53.1**	**16.3**	**2.78**	**2.70**	**6.02**	**1.23**	**0.55 J**	**4.06**	**0.356 J**
PCB-169	--	--	0.353 U	0.113 U	0.109 U	0.124 U	0.162 U	0.0815 U	0.0792 U	0.101 U	0.0682 U
PCB-189	--	--	**9.24**	**4.37**	**1.52**	**0.747 J**	**2.35**	**0.224 J**	**0.183 J**	**0.576 J**	**0.115 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 1/2, EMPC = 1)	--	--	**0.427**	**0.061 J**	**0.048 J**	**0.088 J**	**0.160**	**0.0142 J**	**0.0068 J**	**0.0186 J**	**0.0052 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 0, EMPC = 1)	--	--	**0.422**	**0.059 J**	**0.047 J**	**0.086 J**	**0.157**	**0.0129 J**	**0.0008 J**	**0.0171 J**	**0.0006 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 1/2, EMPC = 0)	--	--	**0.427**	**0.061 J**	**0.048 J**	**0.088 J**	**0.160**	**0.003 EMPCJ**	**0.0068 J**	**0.0186 J**	**0.0051 EMPCJ**
Total PCB Congener TEQ 2005 (Mammal) (U = 0, EMPC = 0)	--	--	**0.422**	**0.059 J**	**0.047 J**	**0.086 J**	**0.157**	**0.0018 EMPCJ**	**0.0008 J**	**0.0171 J**	**0.0006 EMPCJ**

Table 5-22
RI/FS Sediment Testing Results

Location			River Sediments						
Location ID			AQ-SS-03	AQ-SS-03	AQ-SS-04	AQ-SS-09	AQ-SS-09	AQ-SS-10	AQ-SS-14
Sample Date			12/12/2012	12/12/2012	12/10/2012	12/10/2012	12/10/2012	12/10/2012	12/10/2012
Sample ID			AQ-SS-03-10	AQ-SS-03-10CONF	AQ-SS-04-10	AQ-SS-09-10	AQ-SS-09-AB	AQ-SS-10-10	AQ-SS-14-10
Depth			0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	18 - 24 cm	0 - 10 cm	0 - 10 cm
Sample Type			N	V	N	N	N	N	N
	SCO	CSL							
Hexachlorobenzene	--	--	5.82 U	--	4.49 U	489 U	--	4.95 U	4.11 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
Hexachlorocyclopentadiene	--	--	29.1 U	--	22.5 U	2,450 U	--	24.8 U	20.6 U
Hexachloroethane	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
Isophorone	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
Nitrobenzene	--	--	58.2 U	--	44.9 U	4,890 U	--	49.5 U	41.1 U
n-Nitrosodimethylamine	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
n-Nitrosodi-n-propylamine	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
n-Nitrosodiphenylamine	--	--	14.5 U	--	11.2 U	1,220 U	--	12.4 U	10.3 U
Pentachlorophenol	--	--	116 U	--	89.9 U	9,790 U	--	99.1 U	82.2 U
Phenol	120	210	**6.75 J**	--	**5.95 J**	979 U	--	**7.16 J**	**15.5**
PCB Aroclors (µg/kg)									
Aroclor 1016	--	--	1.92 U	--	--	1.45 U	19.1 U	1.9 U	--
Aroclor 1221	--	--	4.34 U	--	--	3.28 U	19.1 U	4.3 U	--
Aroclor 1232	--	--	2.08 U	--	--	1.57 U	19.1 U	2.06 U	--
Aroclor 1242	--	--	1.75 U	--	--	1.32 U	19.1 U	1.73 U	--
Aroclor 1248	--	--	2.27 U	--	--	**124**	19.1 UJ	2.25 U	--
Aroclor 1254	--	--	3.35 U	--	--	**106**	19.1 UJ	3.32 U	--
Aroclor 1260	--	--	1.97 U	--	--	**55.6 J**	19.1 U	1.96 U	--
Aroclor 1262	--	--	1.43 U	--	--	1.08 U	19.1 UJ	1.42 U	--
Aroclor 1268	--	--	2.93 U	--	--	2.21 U	19.1 U	2.9 U	--
Total PCB Aroclors (U = 1/2)	--	--	4.34 U	--	--	**291 J**	19.1 UJ	4.3 U	--
Total PCB Aroclors (U = 0)	110	2,500	4.34 U	--	--	**286 J**	19.1 UJ	4.3 U	--
PCB Congeners (ng/kg)									
PCB-077	--	--	**0.779 J**	**0.88 J**	**2.20**	**1,380**	--	**2.23 J**	**5.91**
PCB-081	--	--	0.327 U	0.0953 U	0.639 U	20.3 U	--	0.327 U	0.382 U
PCB-105	--	--	**2.79**	**3.25**	**8.63**	**17,500 J**	--	**10.8**	**18.5**
PCB-114	--	--	0.342 U	**0.179 J**	0.504 U	**1,280**	--	**0.589 J**	**0.919 J**
PCB-118	--	--	**4.96**	**6.26**	**18.2**	**48,200 J**	--	**22.3**	**33.2**
PCB-123	--	--	0.328 U	0.0906 U	0.554 U	1.48 U	--	**0.367 J**	**1.14**
PCB-126	--	--	0.431 U	0.109 U	0.641 U	**47.5 J**	--	0.315 U	0.312 U
PCB-156/157	--	--	**0.694 J**	**0.705 J**	**2.49**	**10,200 J**	--	**4.10**	**3.35**
PCB-167	--	--	0.372 U	**0.31 J**	**0.869 J**	**2,760**	--	**1.25**	**1.26**
PCB-169	--	--	0.503 U	0.131 U	0.785 U	14 U	--	0.327 U	0.372 U
PCB-189	--	--	0.319 U	0.0933 U	0.587 U	**462**	--	0.272 U	**0.495 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 1/2, EMPC = 1)	--	--	**0.029 J**	**0.0078 J**	**0.045 J**	**7.51 J**	--	**0.022 J**	**0.024 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 0, EMPC = 1)	--	--	**0.0 J**	**0.0004 J**	**0.001 J**	**7.30 J**	--	**0.001 J**	**0.002 J**
Total PCB Congener TEQ 2005 (Mammal) (U = 1/2, EMPC = 0)	--	--	**0.029 J**	**0.0078 EMPCJ**	**0.045 J**	**2.76 EMPCJ**	--	**0.022 EMPCJ**	**0.024 EMPCJ**
Total PCB Congener TEQ 2005 (Mammal) (U = 0, EMPC = 0)	--	--	**0.0 J**	**0.0004 EMPCJ**	**0.001 J**	**2.55 EMPCJ**	--	**0.001 EMPCJ**	**0.002 EMPCJ**

Table 5-22
RI/FS Sediment Testing Results

Notes:

1 = Totals are calculated as the sum of all detected results (U=0). If all results are not detected, the highest reporting limit value is reported as the sum.

2 = EMPC-qualified values are incorporated into totals in two ways—all EMPC values, if present, are included in the totals as the full EMPC value (EMPC=1) or not included in the total (EMPC=0).

3 = Total PAH (SMS Freshwater 2013) is the total of 1-methynaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(x)fluoranthenes, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene.

4 = USEPA Stage 2B data validation was completed by Laboratory Data Consultants (LDC).

5 = Results are reported in dry weight basis.

6 = All non-detect results are reported at the reporting limit.

🟦 = Detected concentration is greater than Freshwater Sediment Cleanup Objective (SCO) (WAC 173-204) February 2013.

🟨 = Detected concentration is greater than Freshwater Cleanup Screening Level (CSL)and the SCO (WAC 173-204) February 2013.

Bold = Detected result

J = Estimated value
UJ = Compound analyzed but not detected above estimated detection limit
U = Compound analyzed but not detected above detection limit
-- = Results not reported or not applicable
µg/kg = microgram per kilogram
cm = centimeter
CSL = Cleanup Screening Level (WAC 173-204, February 2013)
SMS = Sediment Management Standards (WAC 173-204, February 2013)
SCO = Sediment Cleanup Objective (WAC 173-204, February 2013)
TEQ = toxic equivalency
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH

FD = field duplicate sample
FS = Feasibility Study
mg/kg = milligram per kilogram
N = normal sample
ng/kg = nanogram per kilogram
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
pct = percent
USEPA = U.S. Environmental Protection Agency
V = verification sample
RI = Remedial Investigation

EMPC = estimated maximum possible concentration (Totals with an EMPC qualifier indicates that at least one of the analytes is an EMPC value.)

Table 5-23
Results of Sediment Confirmational Bioassays

	Hyalella azteca		*Chironomus dilutus*			
	10-Day Mortality (%)		**20-Day Mortality (%)**		**20-Day Growth (mg/individual)**	
Control	0	Pass QA	16.3	Pass QA	1.4	Pass QA
SS-09	36.3	CSL Hit	100	CSL Hit	N/A	CSL Hit
SS-10	1.3	Pass	28.8	Pass	1.55	Pass
SS-12	3.8	Pass	21.3	Pass	1.36	Pass

Notes:

1. Bioassay results were screened using sediment cleanup objective (SCO) and/or cleanup screening level (CSL) criteria as defined in the *Sediment Management Standards Final Rule* [WAC 173-204-563; Ecology, February 22, 2013].

2. A summary of bioassay results, including all supporting laboratory reports and a QA summary, are included in Appendix F.

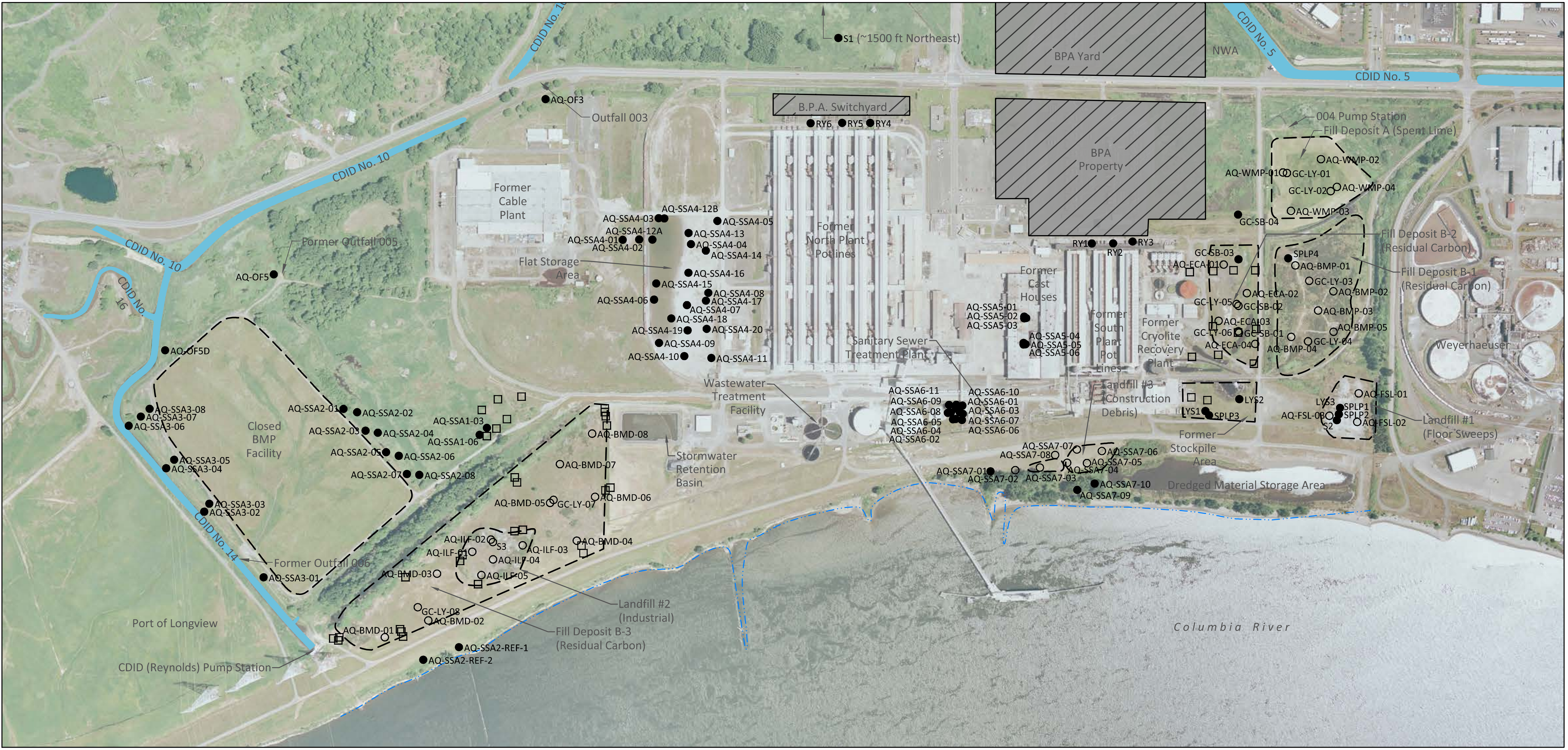
CSL = cleanup screening level
mg = milligram
N/A = not applicable
QA = quality assurance

Table 6-1
Summary of Lysimeter and SPLP Testing Data for Residual Carbon and Spent Lime Deposits

Area and Sample ID	Sample Type	Location	Data Source	Bulk Fluoride Concentration in Solid Media (%)	SPLP Test Leaching Data (mg/L)	Lysimeter Water Data: Fluoride (Dissolved; mg/L) Round 1	Lysimeter Water Data: Fluoride (Dissolved; mg/L) Round 2	Lysimeter Water Data: pH (SU) Round 1	Estimated Kd (L/kg)
Residual Carbon									
GC-LY-03	Lysimeter	East Plant	Table 5-10	4.09	--	49.3	47.8	7.16	842
GC-LY-04	Lysimeter	East Plant	Table 5-10	6.18	--	54.7	58.4	7.54	1093
SPLP4-WM-022707	SPLP Test	East Plant	Table 5-9	2.95	18	--	--	--	1639
GC-LY-07	Lysimeter	West Plant	Table 5-10	3.42	--	55.4	54.8	7.6	621
GC-LY-08	Lysimeter	West Plant	Table 5-10	1.60	--	80	77.2	7.69	204
								Average Kd for Residual Carbon	880
Spent Lime									
GC-LY-01	Lysimeter	East Plant	Table 5-10	6.59	--	92.5	88.5	9.82	728
GC-LY-02	Lysimeter	East Plant	Table 5-10	5.95	--	94	93.2	11.1	636
								Average Kd for Spent Lime	682
								Average Kd for Residual Carbon and Spent Lime	823

Notes:
1% fluoride in solid media = 10,000 mg/kg
Kd = soil/water partitioning coefficient
L/kg = liter per kilogram
mg/kg = milligram per kilogram
mg/L = milligram per liter
SPLP = synthetic precipitation leaching procedure
SU = standard unit

FIGURES



SOURCE: Aerial image from Aerometric dated June 2013.

NOTE:
1. Soil sample location S1 is located in the North Field approximately 2,000 feet NNE of RY4.
2. Some landfill or fill deposit sampling stations also included testing of underlying or overburden soils.

LEGEND:

-·-·-·-	Approximate Ordinary High Water Line
▨	BPA Property
– – – –	Landfill or Fill Deposit
●	RI/FS Soil Sample Location
○	RI/FS Landfill or Fill Deposit Sample Location [2]
☐	RI/FS Test Pit Observation Location

0 600
Scale in Feet

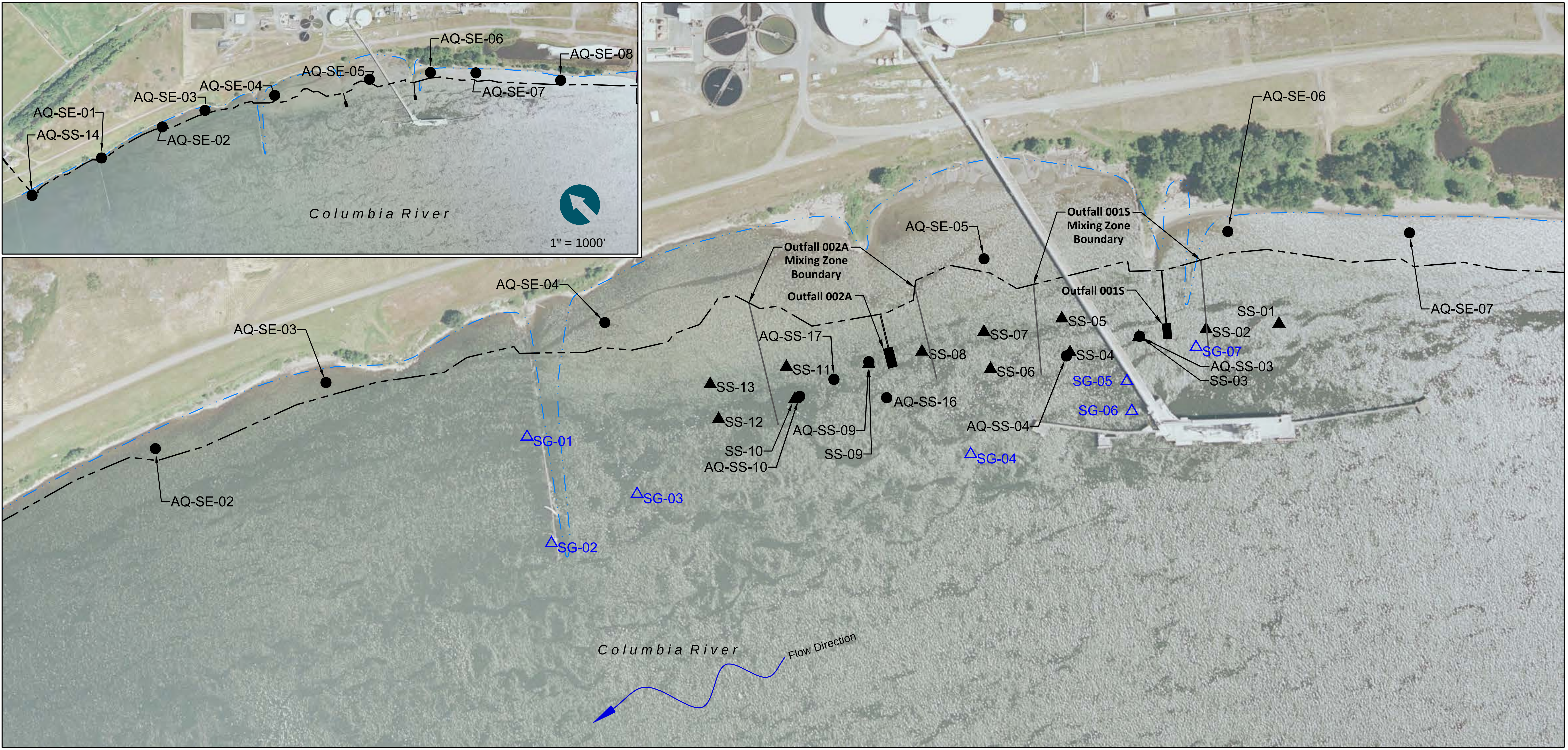
Figure 3-1

RI/FS Soil, SPLP, Landfill, and Fill Deposit Sampling Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 3-2.dwg Figure 3-1

Feb 27, 2014 2:03pm chewett



SOURCE: Aerial image from Aerometric dated June 2013.

NOTES:

1. Confirmational sediment bioassay tests were conducted at sampling stations SS-09, SS-10 and SS-12.

LEGEND:

- —— · · —— Approximate Ordinary High Water Line
- —— – – —— Property Line
- ▬ Approximate Outfall and Diffuser
- △ Recent Surface Sediment Sampling
- ● RI/FS Surface Sediment Sampling
- ▲ NPDES Surface Sediment Sampling

0 250
Scale in Feet

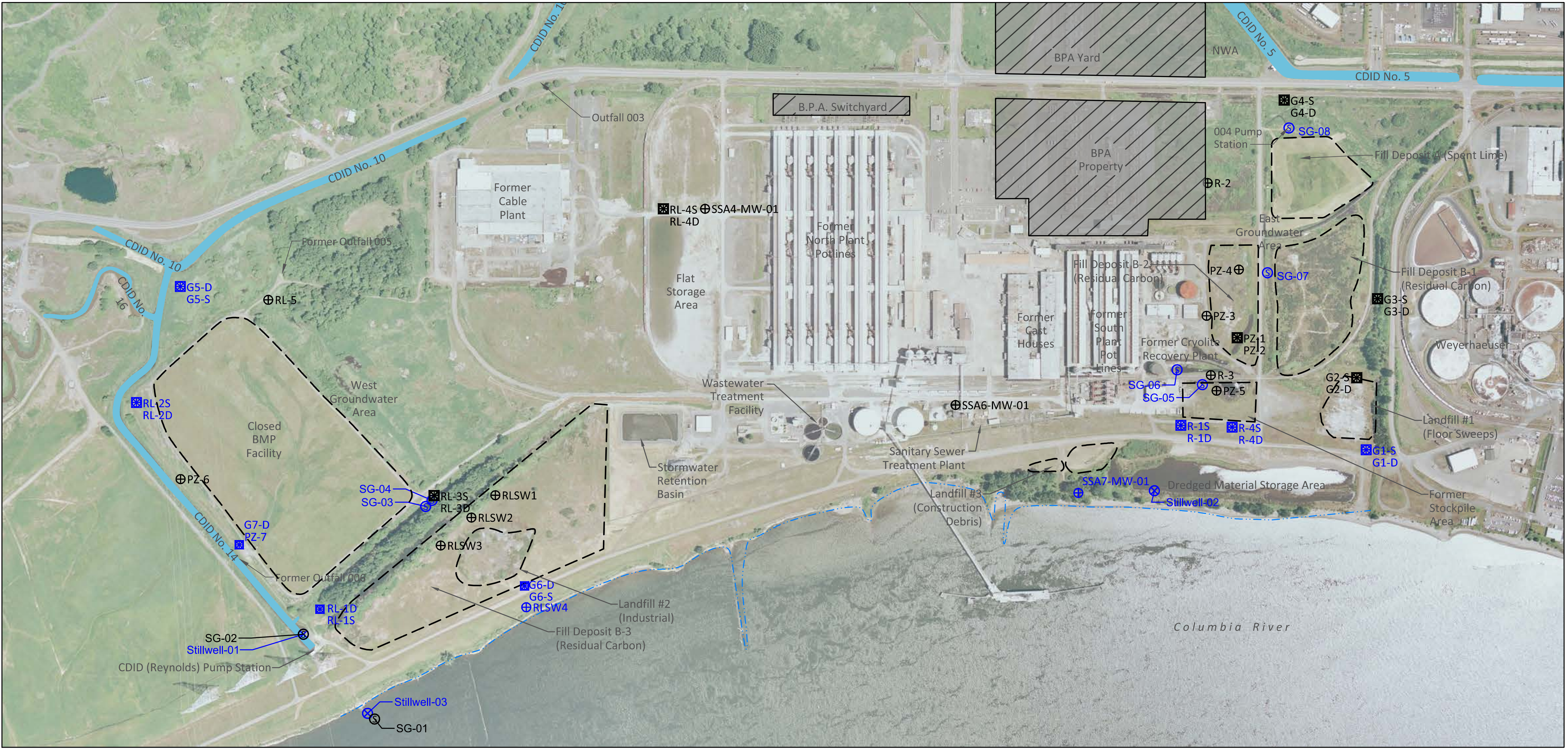
K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 3-5.dwg Combined PAH and PCB

Feb 27, 2014 2:03pm chewett

ANCHOR QEA

Figure 3-2

RI/FS and NPDES Sediment Sampling Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



SOURCE: Aerial image from Aerometric dated June 2013.
NOTE:
1. Stilling Well and Staff Gauge locations surveyed by Gibbs & Olson Engineering, September 2012.
2. Tidal study was completed September 25 through October 2, 2012.
3. Wells or gauges shown in blue were used during the tidal study.

LEGEND:

-·-·-·- Approximate Ordinary High Water Line
▨ BPA Property
- - - - Landfill or Fill Deposit
⊕ Groundwater Sampling Location
▣ Paired Shallow/Deeper Groundwater Sampling Location
⊗ Temporary Stilling Well Instrumented for Tidal Study
Ⓢ Permanent Staff Gauge

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 3-1.dwg F3-3
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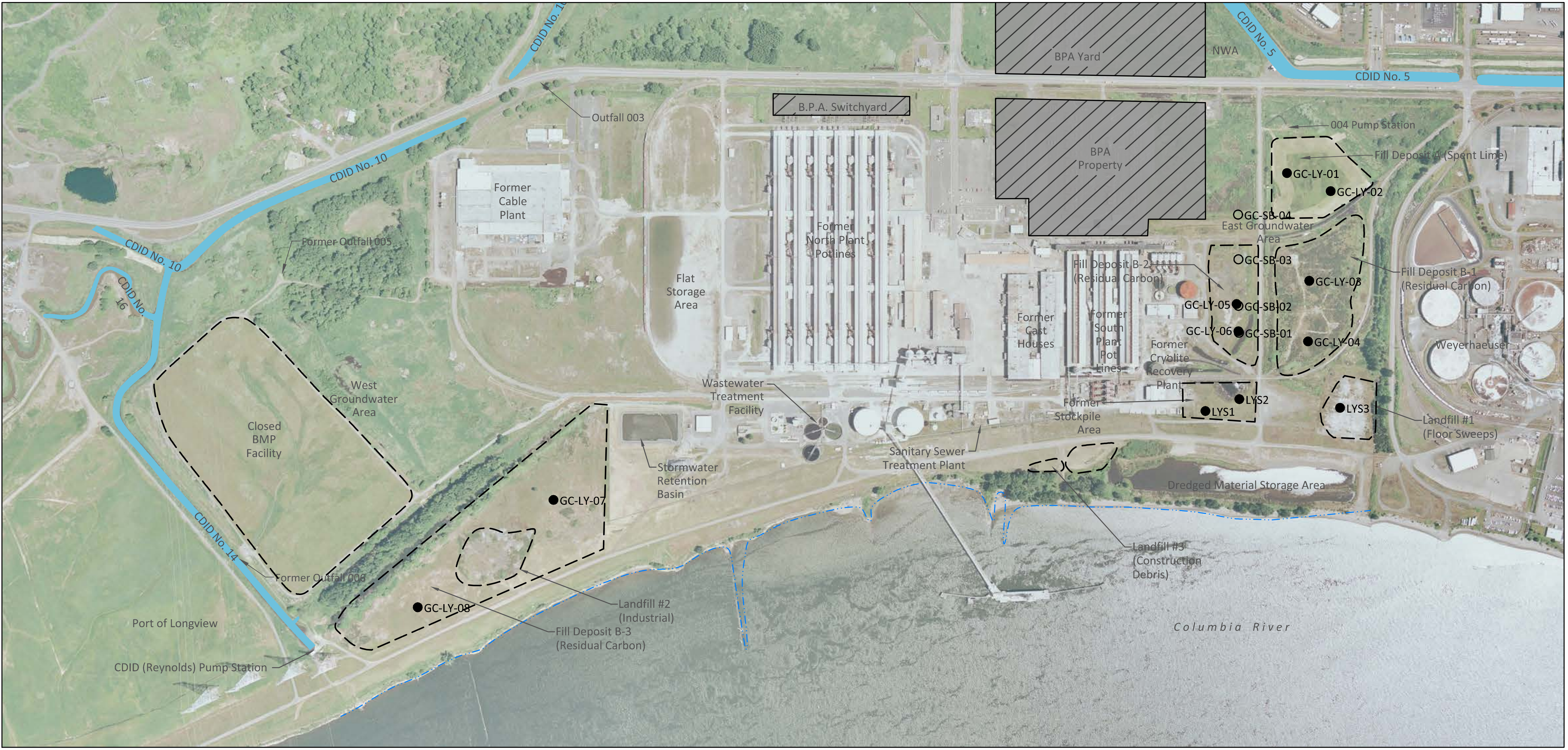
Figure 3-3
RI/FS Groundwater Sampling and Tidal Study Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA



SOURCE: Aerial image from Aerometric dated June 2013.

LEGEND:

–·–·–	Approximate Ordinary High Water Line
▨	BPA Property
- - - -	Landfill or Fill Deposit
●	Lysimeter Sampling Location
○	Geochemical Soil Boring Location

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 3-3.dwg F3-4

Feb 27, 2014 2:05pm chewett

Figure 3-4
RI/FS Lysimeter and Geochemical Sampling Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA

SOURCE: Aerial image from Aerometric dated June 2013.

LEGEND:

- - ·- - · Approximate Ordinary High Water Line
▨ BPA Property
ⓘW1 Surface Water or Ditch Water Sampling Location

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 3-4.dwg F3-5

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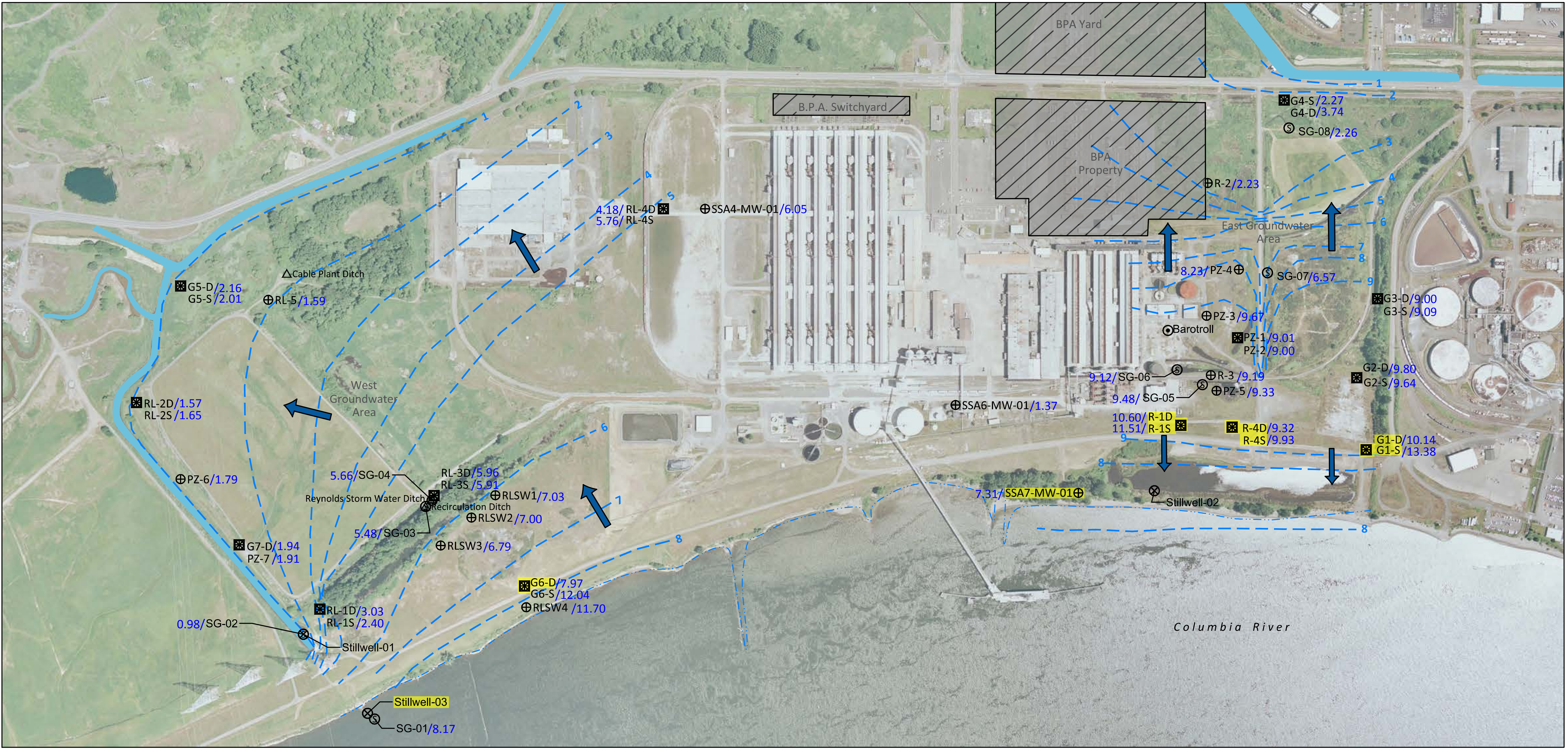
Figure 3-5

RI/FS Surface Water and Ditch Water Sampling Locations
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA



SOURCE: Aerial image from Aerometric dated June 2013.
VERTICAL DATUM: NAVD88, Feet.
NOTE:

1. Groundwater, surface water, and ditch water elevation measurements collected between 0918 and 1739 on October 1, 2012.
2. Over the course of the 96-hour tidal study conducted during the October Gauging Event, the Columbia River elevation fluctuated approximately 5 feet. During that same time period, the groundwater elevations in the tidally-influenced wells fluctuated up to 0.5 ft (SSA7-MW-01).

LEGEND:

-·-·-· Approximate Ordinary High Water Line
— — — Groundwater Elevation Contour in Feet
▨ BPA Property
➡ Inferred Groundwater Flow Direction

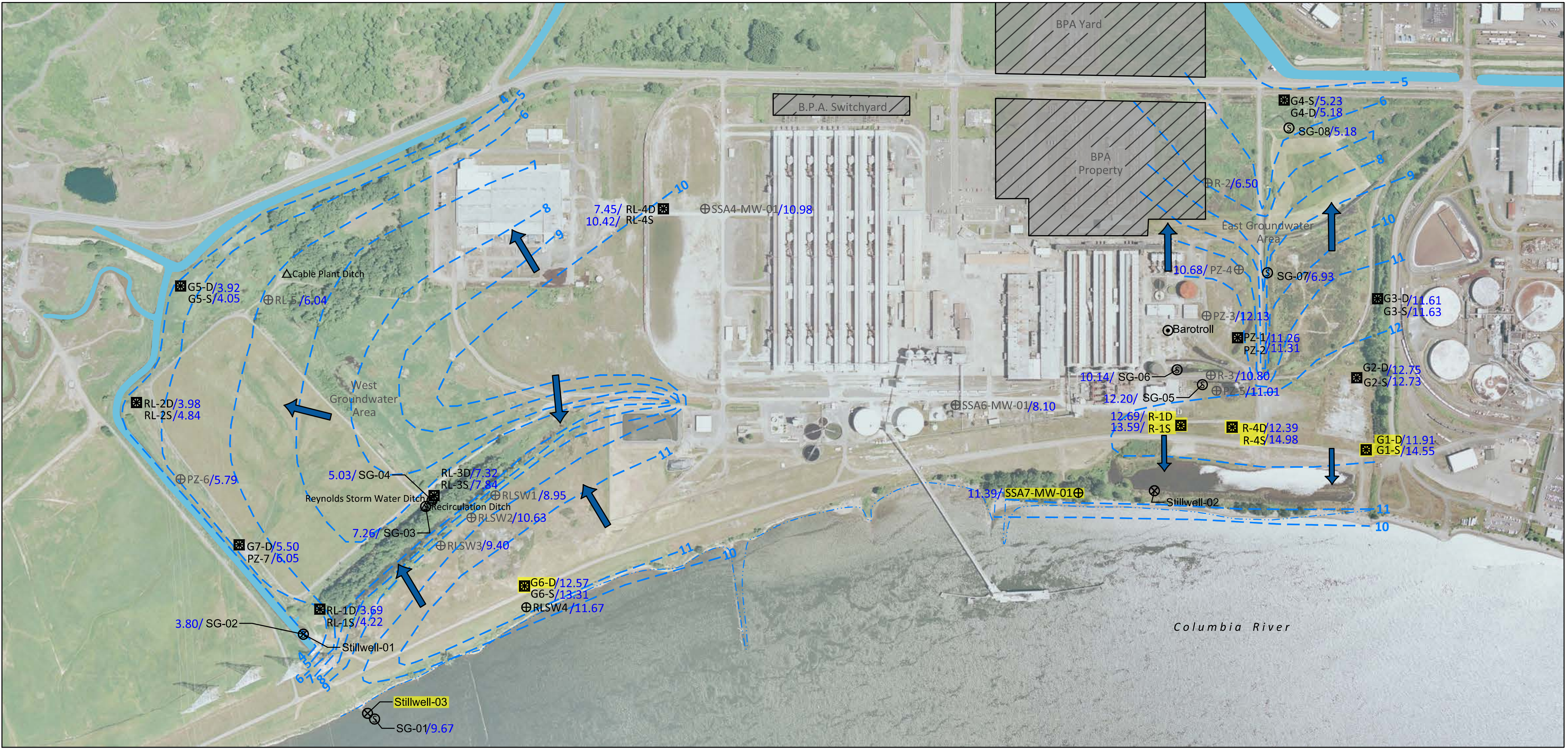
4.14 Groundwater or Surface Water Elevation (ft NAVD88)
G2-S ⊕ Groundwater Well
R-1S/R-1D ⊠ Paired Shallow/Deeper Groundwater Well
SG-02 Ⓢ Staff Gauge
🟨 Tidally-Influenced Well

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 4-5.dwg F4-1
Feb 27, 2014 2:06pm chewett

ANCHOR QEA

Figure 4-1
RI/FS Dry Weather Groundwater Elevation Contour Map
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



SOURCE: Aerial image from Aerometric dated June 2013.
VERTICAL DATUM: NAVD88, Feet.
NOTE:

1. Groundwater, surface water, and ditch water elevation measurements collected between 0825 and 1340 on December 18, 2012.
2. Over the course of the 96-hour tidal study conducted during the October Gauging Event, the Columbia River elevation fluctuated approximately 5 feet. During that same time period, the groundwater elevations in the tidally-influenced wells fluctuated up to 0.5 ft (SSA7-MW-01).

LEGEND:

—·—·—	Approximate Ordinary High Water Line
— — —	Groundwater Elevation Contour in Feet
▨	BPA Property
➡	Inferred Groundwater Flow Direction
4.14	Groundwater or Surface Water Elevation (ft NAVD88)
G2-S ⊕	Groundwater Well
R-1S/R-1D ⊠	Paired Shallow/Deeper Groundwater Well
SG-02 Ⓢ	Staff Gauge
🟨	Tidally-Influenced Well

0 600
Scale in Feet

Figure 4-2

RI/FS Wet Weather Groundwater Elevation Contour Map
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 4-5.dwg F4-2
Feb 27, 2014 2:06pm chewett

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-026 (Key Study Areas_GW_TP).dwg Figure 4-3

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

NOTES:

1. Test pit depths are summarized in Table D-6-1. Ground surface elevations from 2010 survey by Minister & Glaeser Surveying, Inc..
2. Groundwater, surface water, and ditch water elevation measurements collected during wet weather conditions in December, 2012.

LEGEND:

🟩	Landfill or Fill Deposit Present Predominantly Above the Groundwater Table
🟨	Landfill or Fill Deposit with Fill Material Below the Groundwater Table
— —	Groundwater Elevation Contour in Feet (NAVD88)
□25.8	Test Pit Location and Estimated Base of Fill Deposit Elevation in Feet (NAVD88)
△<23.1	Test Pit Location Where Base of Fill Deposit Was Not Reached - Estimated Maximum Elevation in Feet (NAVD88)

0 600
Scale in Feet

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Figure 4-3

Fill Material in Contact with Groundwater During Wet Weather Conditions
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Figure 4-4.dwg Figure 4-4

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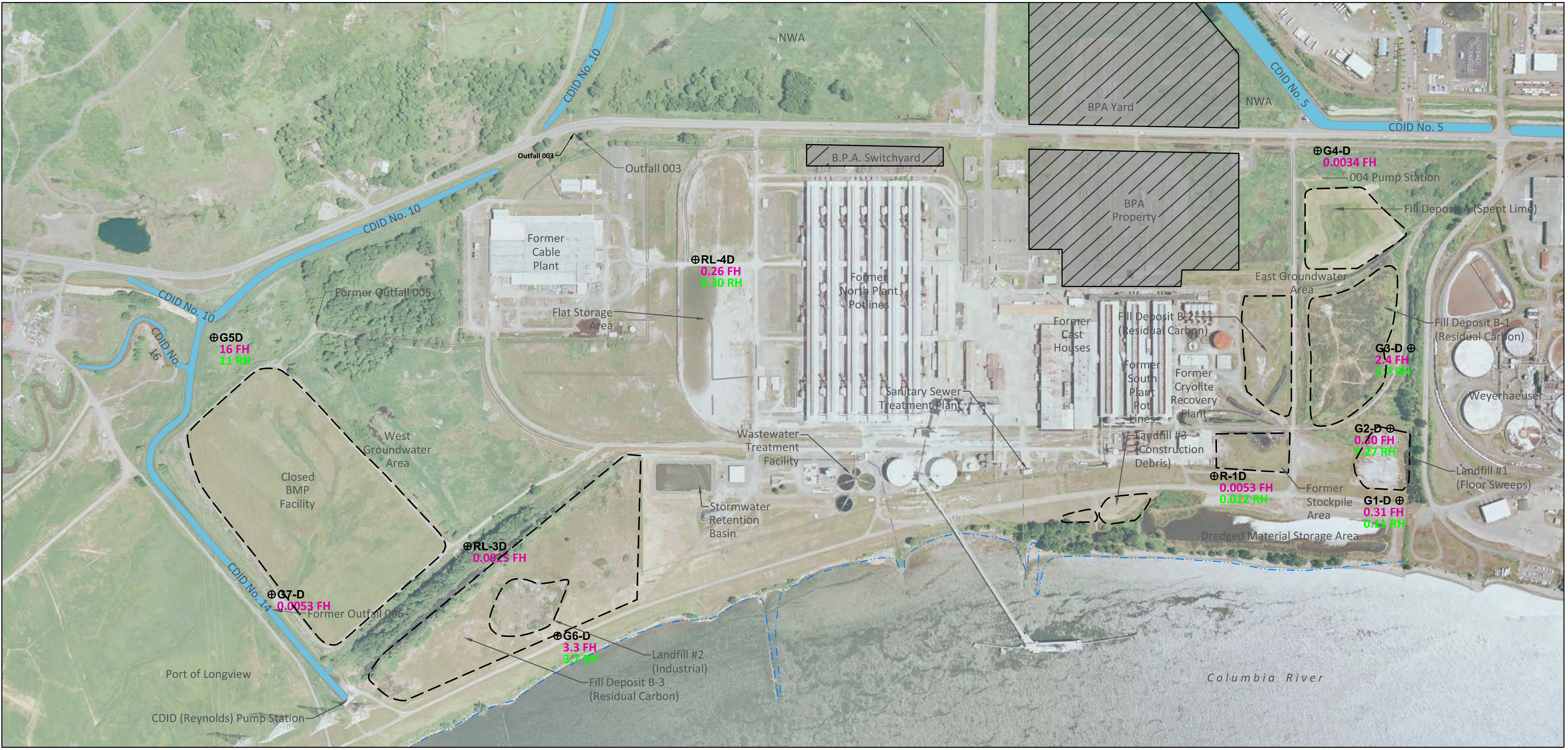

SOURCE: Aerial image from Aerometric dated June 2013.

NOTE: The geometric mean of the estimated horizontal hydraulic conductivity is 0.22 feet per day.

LEGEND:

— — — —	Landfill or Fill Deposit
—·—·—	Approximate Ordinary High Water Line
RL-3D ⊕	Groundwater Sampling Location
0.31 FH	Estimated Horizontal Hydraulic Conductivity (feet per day) Based on Falling Head Slug Test Completed in October 2006, Bouwer & Rice Method
0.11 RH	Estimated Horizontal Hydraulic Conductivity (feet per day) Based on Rising Head Slug Test Completed in October 2006, Bouwer & Rice Method

0 500
Scale in Feet

ANCHOR QEA

Figure 4-4
RI/FS Measurement of Hydraulic Conductivity Using Aquifer Slug Testing
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

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NOTES:
1. 1,600 mg/kg = MTCA Method B soil cleanup level; 70,000 mg/kg = MTCA Method C Industrial soil cleanup level (standard values, direct contact) [WAC 173-340-745].
2. For stations with multiple samples, the highest concentration is used.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)

✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)

◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)

△ Pre-RI/FS Soil Sample Location (2000, 2002)

Total Cyanide (mg/kg)

🟩 < 1,600

🟦 1,600 - 70,000

🟨 > 70,000

Approximate Ordinary High Water Line

Landfill or Fill Deposit

▨ BPA Property

Feet

0 300 600 900 1,200

Figure 5-1

RI/FS Soil, Landfill, and Fill Deposit Results: Total Cyanide

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. 4,800 mg/kg = MTCA Method B soil cleanup level; 210,000 mg/kg = MTCA Method C Industrial soil cleanup level (standard values, direct contact) [WAC 173-340-745].
2. For stations with multiple samples, the highest concentration is used.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)

✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)

◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)

△ Pre-RI/FS Soil Sample Location (2000, 2002)

Fluoride (mg/kg)

🟩 < 4,800

🟦 4,800 – 210,000

🟨 > 210,000

Approximate Ordinary High Water Line

Landfill or Fill Deposit

▨ BPA Property

Feet
0 300 600 900 1,200

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ANCHOR QEA

Figure 5-2
RI/FS Soil, Landfill, and Fill Deposit Results: Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. 20 mg/kg = MTCA Method A Industrial soil cleanup level [WAC 173-340-745]; 88 mg/kg MTCA Method C Industrial soil cleanup level (standard values, direct contact) [WAC 173-340-745].
2. For stations with multiple samples, the highest concentration is used.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

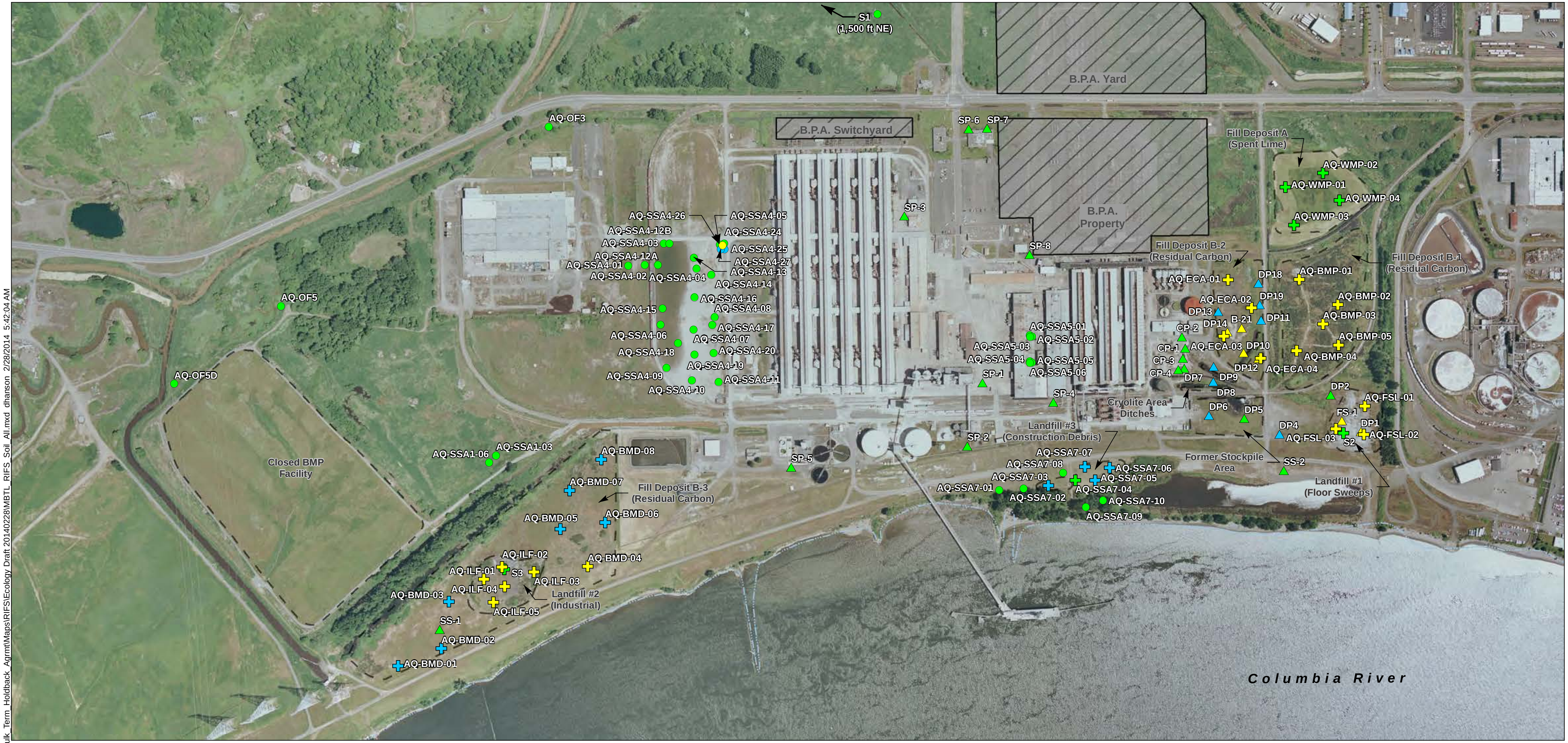
● RI/FS Soil Sample Location (2006-2007, 2011-2013)
✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)
◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)
△ Pre-RI/FS Soil Sample Location (2000, 2002)

Arsenic (mg/kg)
🟩 < 20
🟦 20 - 88
🟨 > 88

Approximate Ordinary High Water Line
Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

Figure 5-3
RI/FS Soil, Landfill, and Fill Deposit Results: Arsenic
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview



NOTES:

1. Total cPAHs calculated using the Toxic Equivalency Factors (TEF) in WAC 173-340 Table 708-2; non-detects were summed using one half of the lab reporting limit.
2. 2 mg/kg = MTCA Method A Industrial soil cleanup level [WAC 173-340-745]; 18 mg/kg = MTCA Method C Industrial soil cleanup level (standard values, direct contact) [WAC 173-340-745].
3. cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbons.
4. For stations with multiple samples, the highest concentration is used.
5. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)

✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)

◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)

△ Pre-RI/FS Soil Sample Location (2000, 2002)

Total cPAHs (mg/kg)

🟩 < 2

🟦 2 - 18

🟨 > 18

Approximate Ordinary High Water Line

Landfill or Fill Deposit

▨ BPA Property

Feet

0 300 600 900 1,200

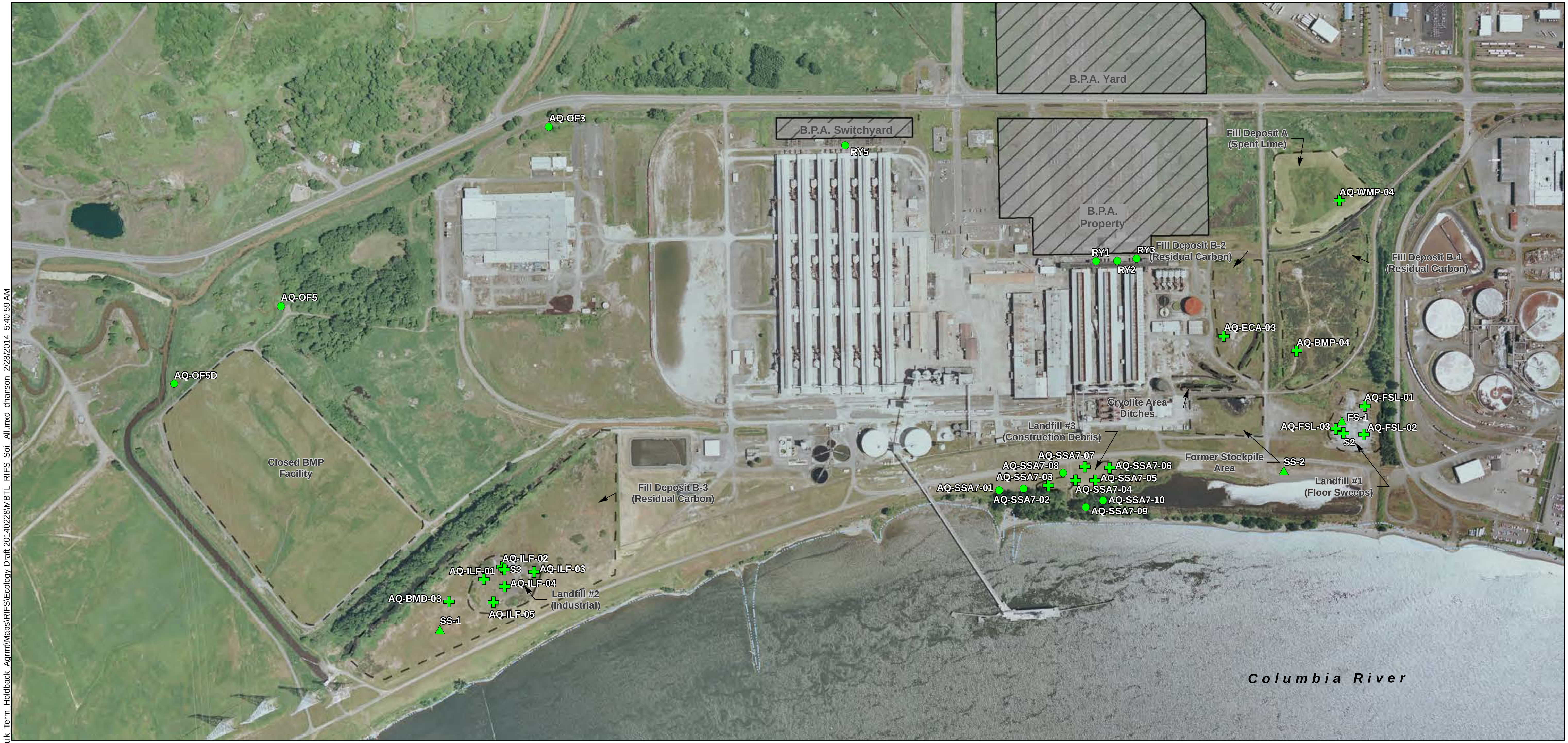
ANCHOR QEA

Figure 5-4

RI/FS Soil, Landfill, and Fill Deposit Results: Total cPAHs

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant - Longview



NOTES:
1. Total PCBs were summed using detected Aroclor concentrations; if an individual Aroclor was not detected, one half of the reporting limit was used.
2. 10 mg/kg = MTCA Method A Industrial soil cleanup level [WAC 173-340-745]; 50 mg/kg = PCB disposal criteria [40.CFR.§761].
3. PCB = Polychlorinated Biphenyls.
4. For stations with multiple samples, the highest concentration is used.
5. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)

✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)

◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)

△ Pre-RI/FS Soil Sample Location (2000, 2002)

Total PCBs (mg/kg)

🟩 < 10

🟦 10 - 50

🟨 > 50

Approximate Ordinary High Water Line

Landfill or Fill Deposit

▨ BPA Property

Feet
0 300 600 900 1,200

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ANCHOR QEA

Figure 5-5
RI/FS Soil, Landfill, and Fill Deposit Results: Total PCB (Aroclors)
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

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NOTES:
1. 5 mg/kg = MTCA Method A Industrial soil cleanup level [WAC 173-340-745]; 1,600 mg/kg = MTCA Method B Unrestricted soil cleanup level (standard values, direct contact) [173-340-745]; 70,000 mg/kg = MTCA Method C Industrial soil cleanup level (standard values, direct contact) [173-340-745].
2. For stations with multiple samples, the highest concentration is used.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)
✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)
◐ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)
△ Pre-RI/FS Soil Sample Location (2000, 2002)

Naphthalene (mg/kg)

🟩	< 5
🟦	5 - 1,600
🟨	1,600 - 70,000
🟪	> 70,000

Approximate Ordinary High Water Line
Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

Figure 5-6
RI/FS Soil, Landfill, and Fill Deposit Results: Naphthalene
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. For stations with multiple samples, the highest concentration is used.
2. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

● RI/FS Soil Sample Location (2006-2007, 2011-2013)

✚ RI/FS Landfill or Fill Deposit Sample Location (2006-2007, 2011-2012)

◑ RI/FS Lysimeter or Geochemical Soil Sample Location (2006, 2011-2012)

△ Pre-RI/FS Soil Sample Location (2000, 2002)

🟩 Chlorinated Solvents Not Detected

🟦 Chlorinated Solvents Detected

Approximate Ordinary High Water Line

Landfill or Fill Deposit

▨ BPA Property

Feet

0 300 600 900 1,200

Figure 5-7

RI/FS Soil, Landfill, and Fill Deposit Results: Chlorinated Solvents
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Total Free Cyanide only.
2. 0.0052 mg/L = WA state surface water criteria (freshwater, chronic) [WAC 173-201A-240];
0.2 mg/L = State Drinking Water Maximum Contaminant Level (MCL) [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. Results shown are from the October 2006 event.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ⊕ Groundwater Sampling Location

2006: Total Free Cyanide (mg/L)
- 🟩 < 0.0052
- 🟦 0.0052 - 0.2
- 🟨 > 0.2
- ◻ Not Measured
- R Result Rejected (QA/QC)

- Approximate Ordinary High Water Line
- ⬅ Groundwater Flow Direction
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

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ANCHOR QEA

Figure 5-8a
RI/FS 2006 Groundwater Results: Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

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NOTES:
1. Total Free Cyanide only.
2. 0.0052 mg/L = WA state surface water criteria (freshwater, chronic) [WAC 173-201A-240];
0.2 mg/L = State Drinking Water Maximum Contaminant Level (MCL) [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2011 sampling included July and October events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ● Groundwater Sampling Location

2011: Total Free Cyanide (mg/L)
🟩 < 0.0052
🟦 0.0052 - 0.2
🟨 > 0.2
⬜ Not Measured

Approximate Ordinary High Water Line
Groundwater Flow Direction
Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

ANCHOR QEA

Figure 5-8b
RI/FS 2011 Groundwater Results: Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Dissolved Free Cyanide only.
2. 0.0052 mg/L = WA state surface water criteria (freshwater, chronic) [WAC 173-201A-240]; 0.2 mg/L = State Drinking Water Maximum Contaminant Level (MCL) [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2011 sampling included July and October events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ● Groundwater Sampling Location

2011: Dissolved Free Cyanide (mg/L)
- 🟩 < 0.0052
- 🟦 0.0052 - 0.2
- 🟨 > 0.2
- ⬜ Not Measured

- Approximate Ordinary High Water Line
- ⬅ Groundwater Flow Direction
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

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ANCHOR QEA

Figure 5-8c
RI/FS 2011 Groundwater Results: Dissolved Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Total Free Cyanide only.
2. 0.0052 mg/L = WA state surface water criteria (freshwater, chronic) [WAC 173-201A-240]; 0.2 mg/L = State Drinking Water Maximum Contaminant Level (MCL) [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. The maximum free cyanide concentration at G1-D was detected in October 2012; resampling and testing of G1-D in December 2012 detected free cyanide < 0.0052 mg/L.
5. For stations with multiple samples, the highest concentration is used.
6. 2012 sampling included February, October, and December events.
7. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.

G6-S ⊕ Groundwater Sampling Location

2012: Total Free Cyanide (mg/L)

🟩 < 0.0052
🟦 0.0052 - 0.2
🟨 > 0.2
⬜ Not Measured

-·- Approximate Ordinary High Water Line
⬅ Groundwater Flow Direction
⌐ ¬ Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

Figure 5-8d
RI/FS 2012 Groundwater Results: Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Dissolved Free Cyanide only.
2. 0.0052 mg/L = WA state surface water criteria (freshwater, chronic) [WAC 173-201A-240]; 0.2 mg/L = State Drinking Water Maximum Contaminant Level (MCL) [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. The maximum dissolved free cyanide concentration at G1-D was detected in October, 2012; resampling and testing of G1-D in December, 2012 detected dissolved free cyanide < 0.0052 mg/L.
5. For stations with multiple samples, the highest concentration is used.
6. 2012 sampling included February, October, and December events.
7. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.

G6-S ◐ Groundwater Sampling Location

2012: Dissolved Free Cyanide (mg/L)
- 🟩 < 0.0052
- 🟦 0.0052 - 0.2
- 🟨 > 0.2
- ⬜ Not Measured

- Approximate Ordinary High Water Line
- Groundwater Flow Direction
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2012.mxd cgardner 2/28/2014 5:57:56 AM

Figure 5-8e
RI/FS 2012 Groundwater Results: Dissolved Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05 Millennium Bulk Term Holdback Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL RIFS GW 2006 2011.mxd cgardner 2/28/2014 5:35:03 AM

NOTES:

1. Total Fluoride only.
2. 4 mg/L = State drinking water MCL [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. Sampling results shown are from October 2006.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ◐ Groundwater Sampling Location

2006: Total Fluoride (mg/L)

- 🟩 < 4
- 🟦 4 - 50
- 🟨 50 - 150
- 🟪 > 150
- ⬜ Not Measured

- Approximate Ordinary High Water Line
- Groundwater Flow Direction
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

ANCHOR QEA

Figure 5-9a
RI/FS 2006 Groundwater Results: Total Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:

1. Total Fluoride only.
2. 4 mg/L = State drinking water MCL [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2011 sampling included July and October events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ◐ Groundwater Sampling Location

2011: Total Fluoride (mg/L)

🟩	< 4
🟦	4 - 50
🟨	50 - 150
🟪	> 150
⬜	Not Measured

-·-·-	Approximate Ordinary High Water Line
←	Groundwater Flow Direction
⌐ ¬	Landfill or Fill Deposit
▨	BPA Property

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2006_2011.mxd cgardner 2/28/2014 5:42:51 AM

ANCHOR QEA

Figure 5-9b

RI/FS 2011 Groundwater Results: Total Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:

1. Dissolved Fluoride only.
2. 4 mg/L = State drinking water MCL [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2011 sampling included July and October events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ● Groundwater Sampling Location

2011: Dissolved Fluoride (mg/L)

🟩 < 4
🟦 4 - 50
🟨 50 - 150
🟪 > 150
⬜ Not Measured

-·- Approximate Ordinary High Water Line
← Groundwater Flow Direction
⌐ ¬ Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2006_2011.mxd cgardner 2/28/2014 5:44:44 AM

ANCHOR QEA

Figure 5-9c
RI/FS 2011 Groundwater Results: Dissolved Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2012.mxd cgardner 2/28/2014 6:02:22 AM

NOTES:
1. Total Fluoride only.
2. 4 mg/L = State drinking water MCL [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2012 sampling included February, October, and December events.
6. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.

G6-S ◐ Groundwater Sampling Location

2012: Total Fluoride (mg/L)
🟩 < 4
🟦 4 - 50
🟨 50 - 150
🟪 > 150
⬜ Not Measured

┄ Approximate Ordinary High Water Line
⬅ Groundwater Flow Direction
⌐ ¬ Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

ANCHOR QEA

Figure 5-9d
RI/FS 2012 Groundwater Results: Total Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Dissolved Fluoride only.
2. 4 mg/L = State drinking water MCL [WAC 246-290-310].
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2012 sampling included February, October, and December events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ⊕ Groundwater Sampling Location

2012: Dissolved Fluoride (mg/L)
🟩 < 4
🟦 4 - 50
🟨 50 - 150
🟪 > 150
⬜ Not Measured

Approximate Ordinary High Water Line
← Groundwater Flow Direction
Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

ANCHOR QEA

Figure 5-9e
RI/FS 2012 Groundwater Results: Dissolved Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2012.mxd cgardner 2/28/2014 6:03:54 AM

NOTES:
1. 0.03 µg/L - MTCA Method B surface water cleanup level (WAC 173-340-730).
2. 0.1 ug/L = MTCA Method A groundwater cleanup level (WAC 173-340-720).
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. Sampling from January 2007.
6. cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbons.
7. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.
9. Total cPAHs calculated using the Toxic Equivalency Factors (TEF) in WAC 173-340 Table 708-2; non-detects were summed using one half of the lab reporting limit.

G6-S ⊕ Groundwater Sampling Location

2007: Groundwater Results cPAHs as TEQ (µg/L)
- 🟩 < 0.03
- 🟦 0.03 - 0.1
- 🟪 > 0.1
- ◻ Not Measured
- ▣ Sampled but Not Detected

- Approximate Ordinary High Water Line
- ⬅ Groundwater Flow Direction
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

Figure 5-10a
RI/FS 2007 Groundwater Results: Total cPAHs as TEQ
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. 0.03 µg/L - MTCA Method B surface water cleanup level (WAC 173-340-730).
2. 0.1 ug/L = MTCA Method A groundwater cleanup level (WAC 173-340-720).
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2011 sampling included July and October events.
6. cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbons.
7. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.
9. Total cPAHs calculated using the Toxic Equivalency Factors (TEF) in WAC 173-340 Table 708-2; non-detects were summed using one half of the lab reporting limit.

G6-S ◐ Groundwater Sampling Location

2011: Groundwater Results cPAHs as TEQ (µg/L)
- 🟩 < 0.03
- 🟦 0.03 - 0.1
- 🟪 > 0.1
- ■ Not Measured
- ▣ Sampled but Not Detected

- ‐·‐ Approximate Ordinary High Water Line
- ⬅ Groundwater Flow Direction
- ⌐ ¬ Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2006_2011.mxd cgardner 2/28/2014 5:49:27 AM

ANCHOR QEA

Figure 5-10b
RI/FS 2011 Groundwater Results: Total cPAHs as TEQ
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:

1. 0.03 µg/L - MTCA Method B surface water cleanup level (WAC 173-340-730).
2. 0.1 ug/L = MTCA Method A groundwater cleanup level (WAC 173-340-720).
3. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
4. For stations with multiple samples, the highest concentration is used.
5. 2012 sampling included October and December events.
6. cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbons.
7. Vertical Datum: NAVD88, Feet.
8. Aerial image from Aerometric dated June 2013.
9. Total cPAHs calculated using the Toxic Equivalency Factors (TEF) in WAC 173-340 Table 708-2; non-detects were summed using one half of the lab reporting limit.

G6-S ⊕ Groundwater Sampling Location

2012: Groundwater Results cPAHs as TEQ (µg/L)

🟩 < 0.03
🟦 0.03 - 0.1
🟪 > 0.1
⬜ Not Measured
▣ Sampled but Not Detected

-·-· Approximate Ordinary High Water Line
⬅ Groundwater Flow Direction
⌐ ¬ Landfill or Fill Deposit
▨ BPA Property

Feet
0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2012.mxd cgardner 2/28/2014 6:07:19 AM

Figure 5-10c
RI/FS 2012 Groundwater Results: Total cPAHs as TEQ
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:

1. Total PCBs were summed using detected Aroclor concentrations; if an individual Aroclor was not detected, one half of the reporting limit was used.
2. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
3. PCBs = Polychlorinated Biphenyls.
4. For stations with multiple samples, the highest concentration is used.
5. Results are from the February and October 2012 sampling events.
6. Vertical Datum: NAVD88, Feet.
7. Aerial image from Aerometric dated June 2013.

G6-S ⊕ Groundwater Sampling Location

🟩 PCBs Not Detected

🟦 PCBs Detected

⬜ Not Measured

Approximate Ordinary High Water Line

⬅ Groundwater Flow Direction

Landfill or Fill Deposit

▨ BPA Property

Feet

0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_GW_2012.mxd cgardner 2/28/2014 6:09:06 AM

ANCHOR QEA

Figure 5-11
RI/FS 2012 Groundwater Results: Total PCB (Aroclors)
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. VOCs = Volatile Organic Compounds.
2. Co-located shallow and deeper groundwater samples are represented as single symbol with two sampling designations (i.e., RL-1S and RL-1D). The shallow well concentration is represented by the adjacent upper box and the deeper concentration by the lower box.
3. For stations with multiple samples, the highest concentration is used.
4. Results are from the October 2012 sampling event.
5. Vertical Datum: NAVD88, Feet.
6. Aerial image from Aerometric dated June 2013.

G6-S ⊕ Groundwater Sampling Location

🟩 VOCs Not Detected
🟦 VOCs Detected
⬜ Not Measured

┄ Approximate Ordinary High Water Line
⬅ Groundwater Flow Direction
⌐¬ Landfill or Fill Deposit
▨ BPA Property

Q:\Jobs\110730-01.05 Millennium Bulk Term Holdback Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL RIFS GW 2012.mxd cgardner 2/28/2014 6:10:52 AM

ANCHOR QEA

Figure 5-12
RI/FS 2012 Groundwater Results: VOCs
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_SW_2006.mxd cgardner 2/28/2014 6:17:43 AM

NOTES:
1. Based on Total Free Cyanide results.
2. 0.0052 mg/L = State surface water criteria (freshwater, chronic) [WAC 173-201A-240].
3. Surface water sampling location W6 is outside of the Study Area Boundary and is not shown on this figure.
4. Vertical Datum: NAVD88, Feet.
5. Aerial image from Aerometric dated June 2013.

Total Free Cyanide (mg/L)

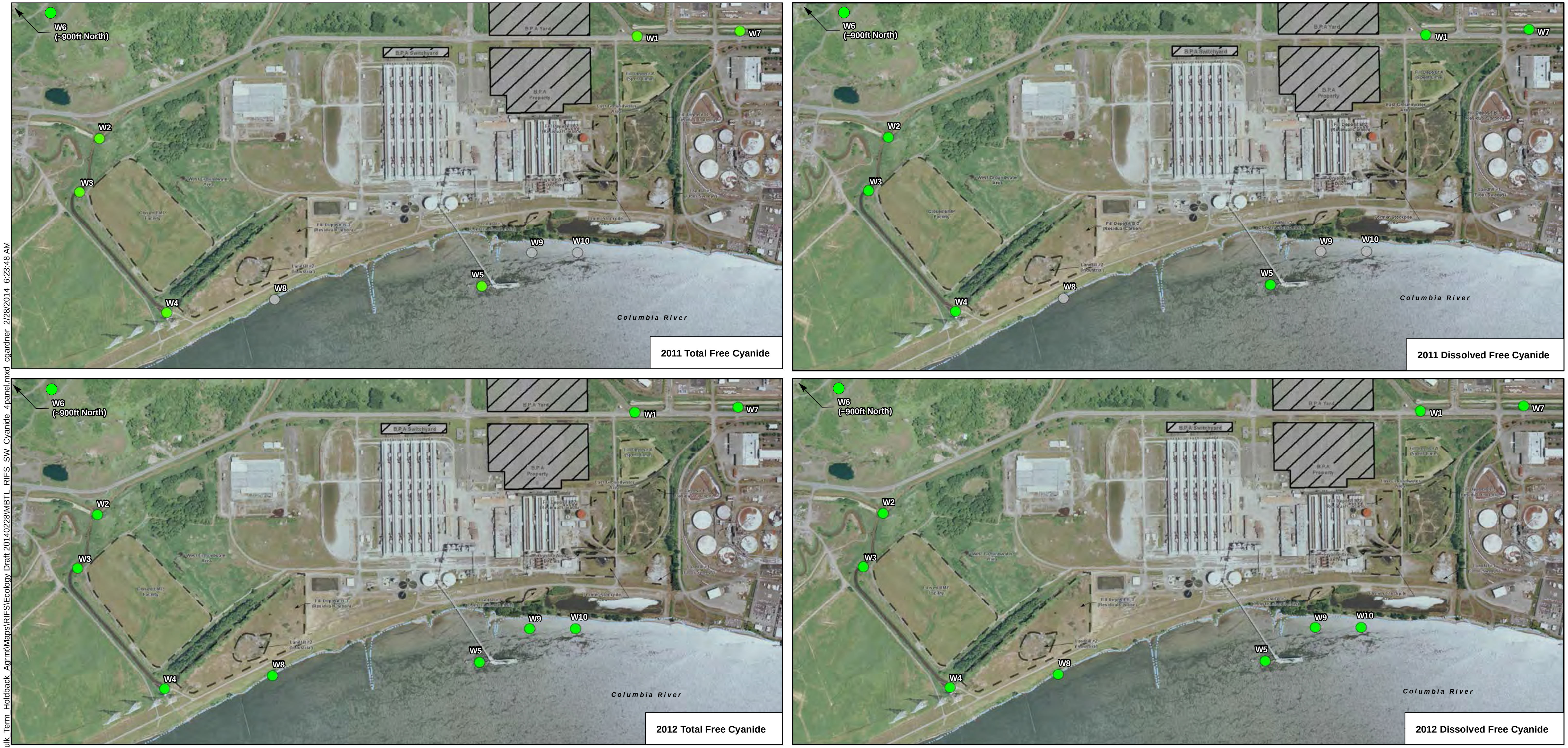
- 🟢 < 0.0052
- 🔵 > 0.0052
- ● Not Measured

- Approximate Ordinary High Water Line
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 300 600 900 1,200

Figure 5-13a
RI/FS 2006 Surface Water and Ditch Water Results: Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05 Millennium Bulk Term Holdback Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL RIFS SW Cyanide 4panel.mxd cgardner 2/28/2014 6:23:48 AM



NOTES:
1. 0.0052 mg/L = State surface water criteria (freshwater, chronic) [WAC 173-201A-240].
2. Surface water sampling location W6 is outside of the Study Area Boundary and is not shown on this figure.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

Free Cyanide (mg/L)
- ● < 0.0052
- ● > 0.0052
- ● Not Measured
- ® Rejected (QA/QC)

- Approximate Ordinary High Water Line
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 620 1,240 1,860 2,480

Figure 5-13b
RI/FS 2011 and 2012 Surface Water and Ditch Water Results: Total Free Cyanide
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

NOTES:
1. Based on Total Fluoride results.
2. 4 mg/L = WA state drinking water MCL (WAC 246-290-310).
3. Surface water sampling location W6 is outside of the Study Area Boundary and is not shown on this figure.
4. Vertical Datum: NAVD88, Feet.
5. Aerial image from Aerometric dated June 2013.

Total Fluoride (mg/L)
- 🟢 < 4
- 🔵 > 4
- ● Not Measured

- ⋯ Approximate Ordinary High Water Line
- ⌐¬ Landfill or Fill Deposit
- ▨ BPA Property

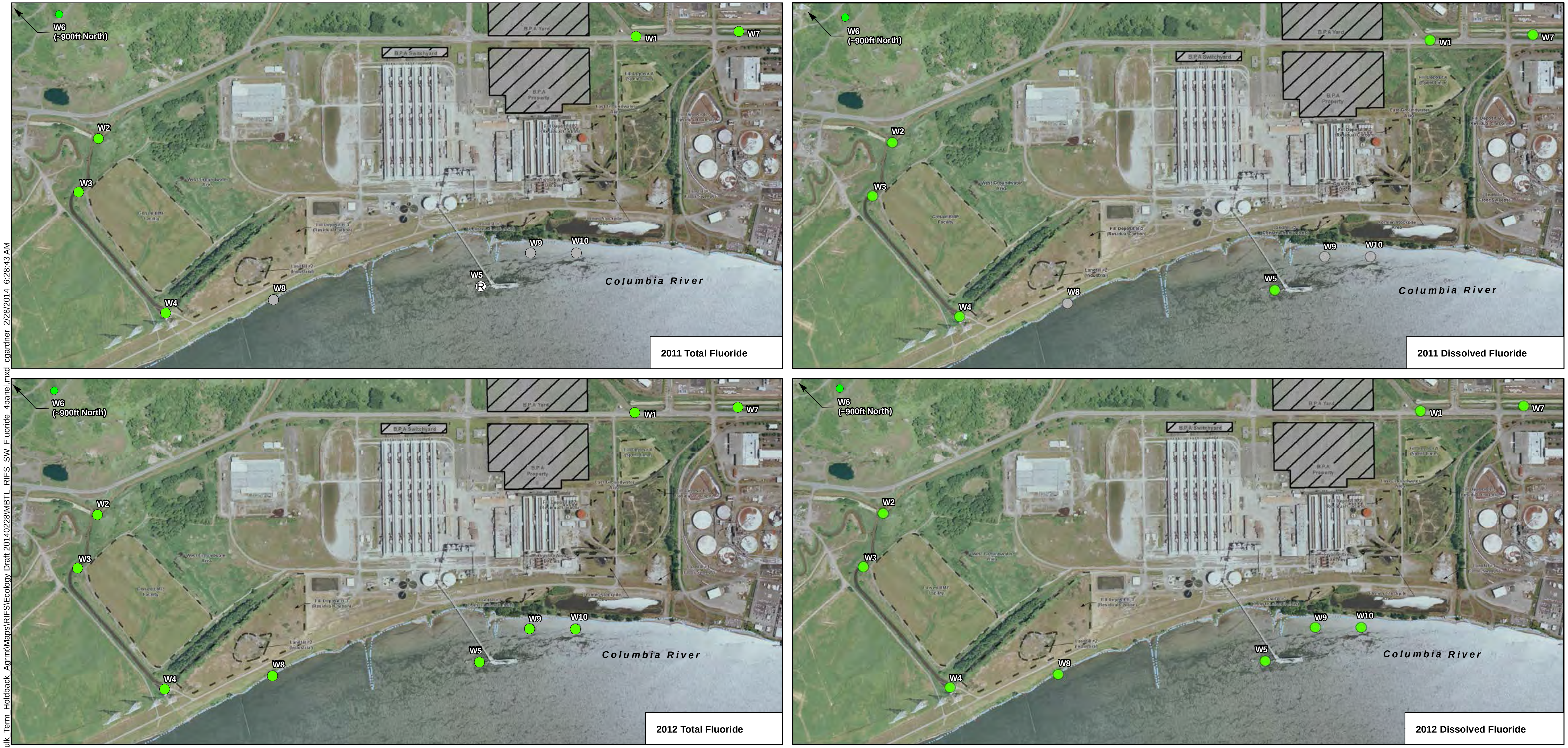
Feet
0 300 600 900 1,200

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_SW_2006.mxd cgardner 2/28/2014 6:19:26 AM

ANCHOR
QEA

Figure 5-14a
RI/FS 2006 Surface Water and Ditch Water Results: Total Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview

Q:\Jobs\110730-01.05_Millennium_Bulk_Term_Holdback_Agrmt\Maps\RIFS\Ecology Draft 20140228\MBTL_RIFS_SW_Fluoride_4panel.mxd cgardner 2/28/2014 6:28:43 AM



NOTES:
1. 4 mg/L = WA state drinking water MCL (WAC 246-290-310).
2. Surface water sampling location W6 is outside of the Study Area Boundary and is not shown on this figure.
3. Vertical Datum: NAVD88, Feet.
4. Aerial image from Aerometric dated June 2013.

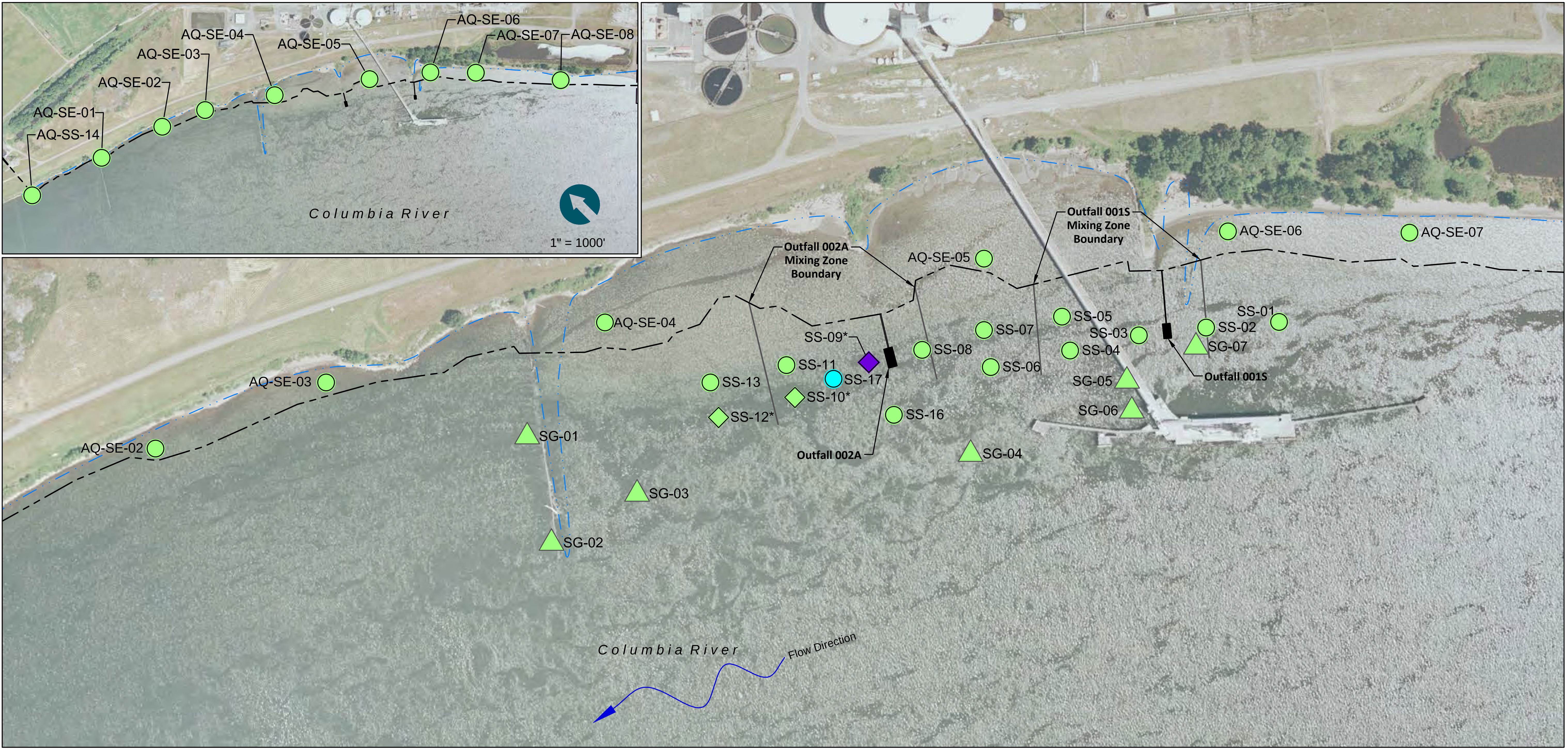
Fluoride (mg/L)
- ● < 4
- ● > 4
- ● Not Measured
- ® Rejected (QA/QC)

- Approximate Ordinary High Water Line
- Landfill or Fill Deposit
- ▨ BPA Property

Feet
0 620 1,240 1,860 2,480

ANCHOR QEA

Figure 5-14b
RI/FS 2011 and 2012 Surface Water and Ditch Water Results: Fluoride
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant - Longview



K:\Projects\0730-MBT-Longview\0730-RP-014.dwg Figure 5-15

Feb 27, 2014 1:47pm chewett

SOURCE: Aerial image from Aerometric dated June 2013.

NOTES:

1. Results shown are the maximum result from both the NPDES and RI/FS samples at the 0-10 cm interval.
2. Sediment Management Standards (SMS) Final Rule [WAC 173-204] Ecology, February 22, 2013

LEGEND:

Approximate Ordinary High Water Line

Property Line

Approximate Outfall and Diffuser

Sample Name (RI/FS)

Sample Name (Historical)

SS-10*
SG-04

Station Also Analyzed at an Additional Depth Interval

Chemistry Only

Historical Chemistry

Bioassay Results

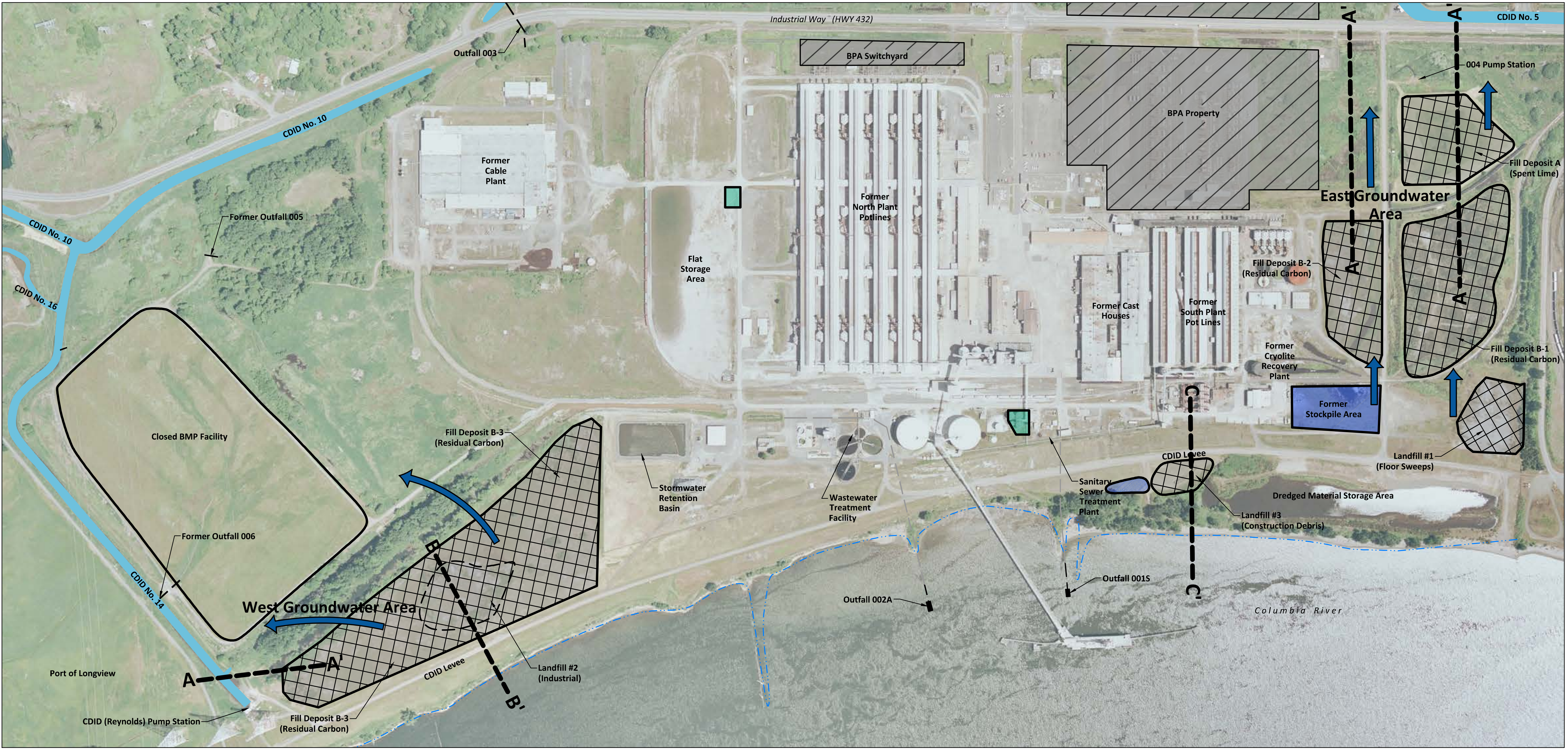
Sediment Quality

Historical Chemistry	RI/FS and NPDES Chemistry	Bioassay Results (RI/FS)	
△	●	◆	Meets Sediment Cleanup Objective [2]
△	●	◆	Exceeds Sediment Cleanup Objective [2]
▲	●	◆	Exceeds Cleanup Screening Level [2]

0 250
Scale in Feet

Figure 5-15

RI/FS and NPDES Sediment Sampling Results
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



SOURCE: Aerial image from Aerometric, dated June 2013.

NOTE: Refer to Figures 7-2 through 7-4 for conceptual site model sections A-A', B-B' and C-C'.

LEGEND:

- -·-·-· Approximate Ordinary High Water Line
- ← Direction of Groundwater Flow
- ▨ BPA Property
- ▩ Soil/fill Unit Containing Elevated (>1%) Fluoride Concentrations
- 🟩 Localized Soil/fill Unit - No Fluoride or Groundwater Impacts
- 🟦 Soil/fill Unit with Low-level Fluoride (<0.2% or 2,000 mg/kg)

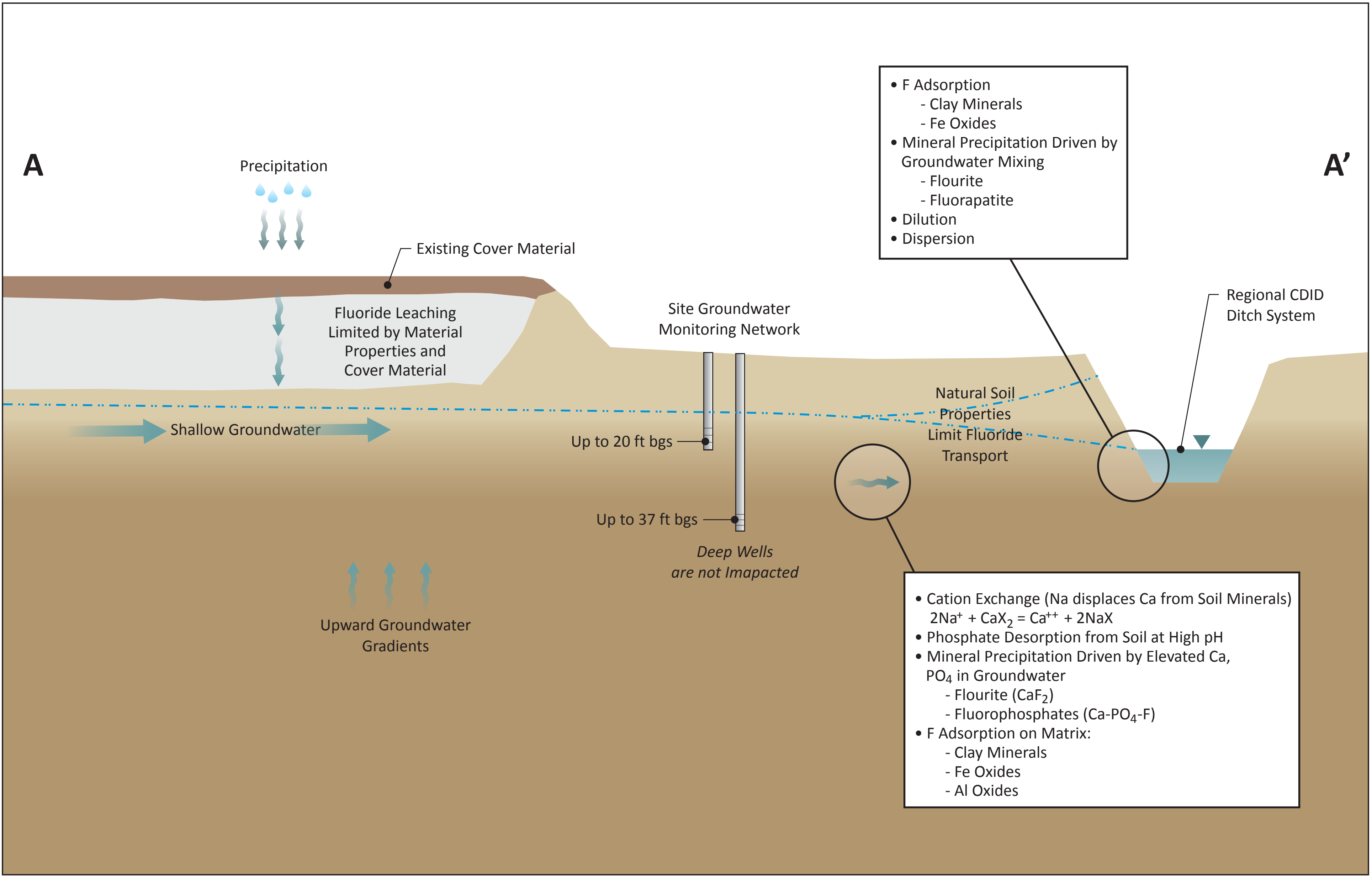
0 500
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\Section 1\0730-RP-005 (Existing features updated).dwg Figure 7-1

Mar 26, 2014 10:30am heriksen

ANCHOR QEA

Figure 7-1
Conceptual Site Model - Plan View
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



- F Adsorption
  - Clay Minerals
  - Fe Oxides
- Mineral Precipitation Driven by Groundwater Mixing
  - Flourite
  - Fluorapatite
- Dilution
- Dispersion

- Cation Exchange (Na displaces Ca from Soil Minerals) $2Na^{+} + CaX_2 = Ca^{++} + 2NaX$
- Phosphate Desorption from Soil at High pH
- Mineral Precipitation Driven by Elevated Ca, PO_4 in Groundwater
  - Flourite (CaF_2)
  - Fluorophosphates ($Ca\text{-}PO_4\text{-}F$)
- F Adsorption on Matrix:
  - Clay Minerals
  - Fe Oxides
  - Al Oxides

07/08/2013 heriksen K/Projects/0730-MBT-Longview/0730-RP-001.cdr

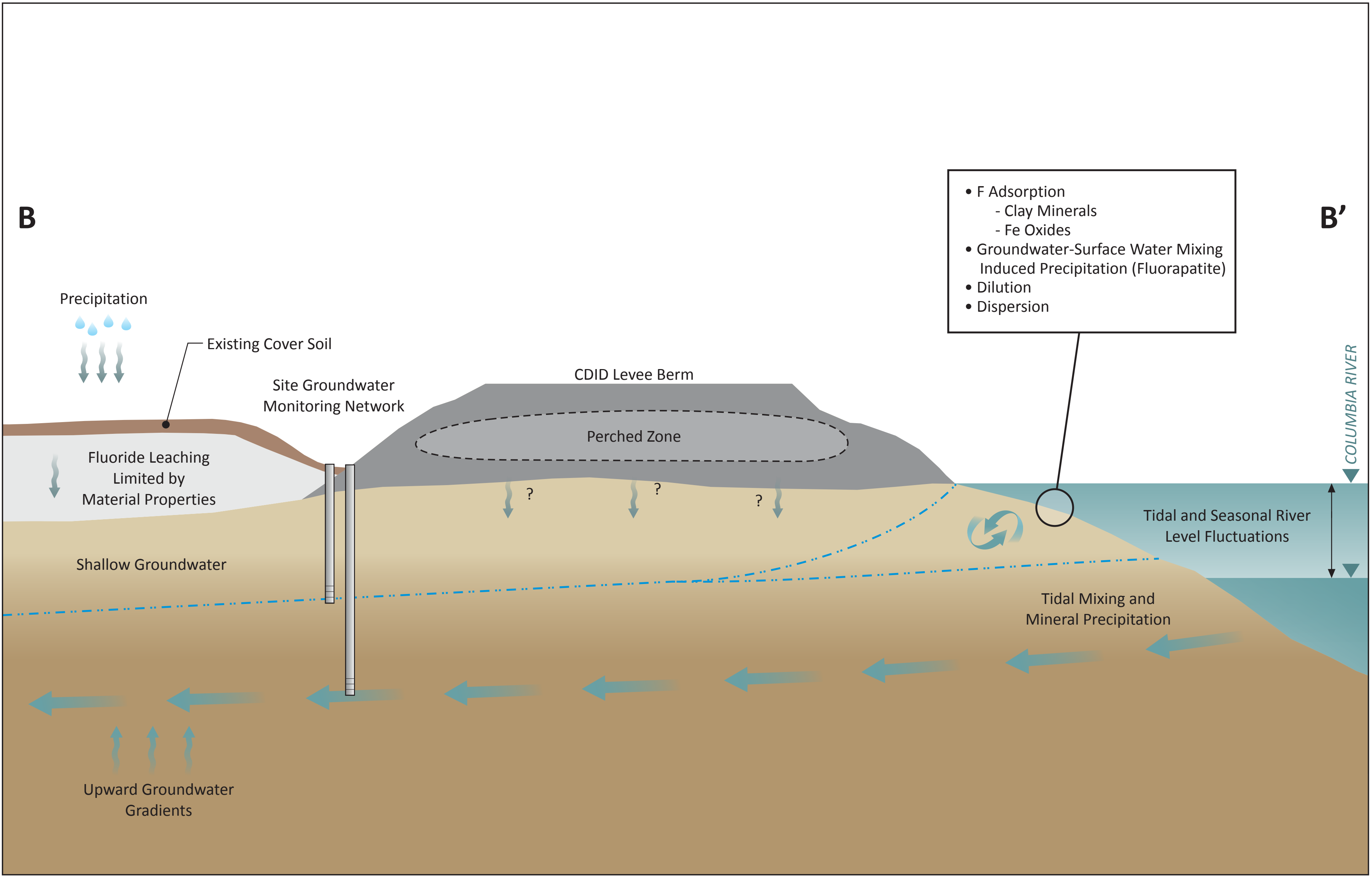
ANCHOR QEA

Figure 7-2

Conceptual Site Model - Cross Section A-A'

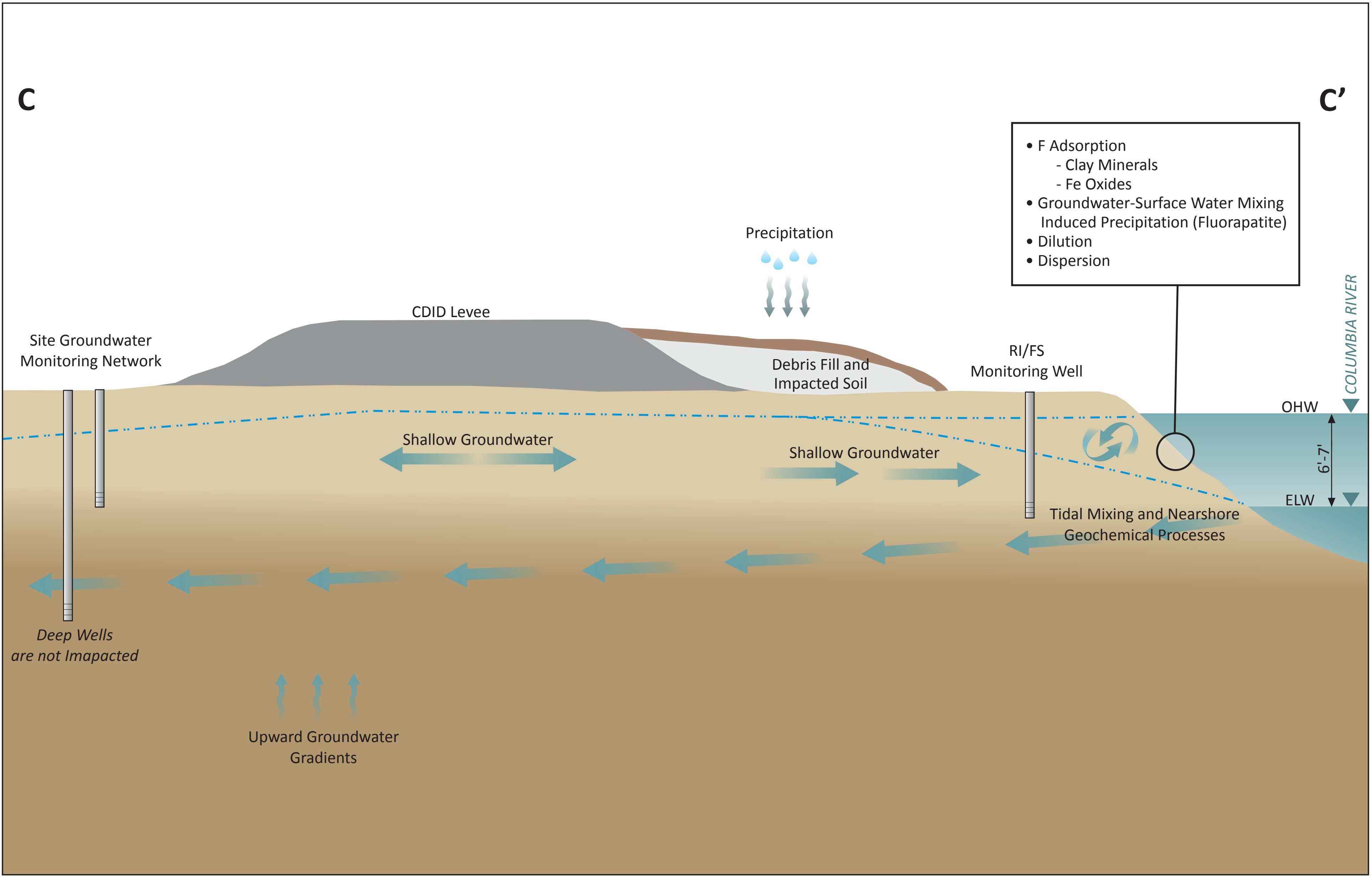
Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview



07/08/2013 heriksen K/Projects/0730-MBT-Longview/0730-RP-002.cdr

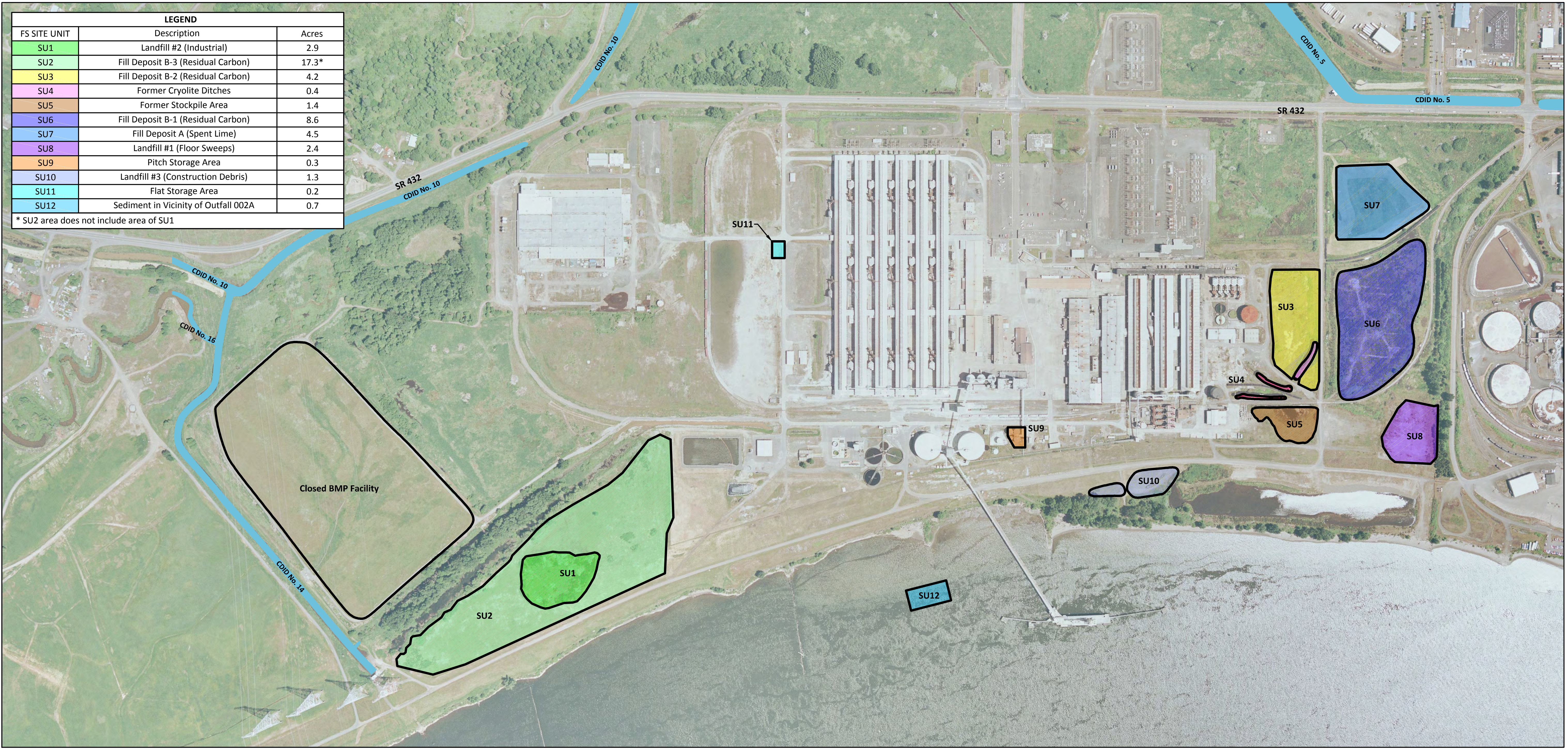
Figure 7-3
Conceptual Site Model - Cross Section B-B'
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



07/08/2013 heriksen K/Projects/0730-MBT-Longview/0730-RP-003.cdr

ANCHOR QEA

Figure 7-4
Conceptual Site Model - Cross Section C-C'
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

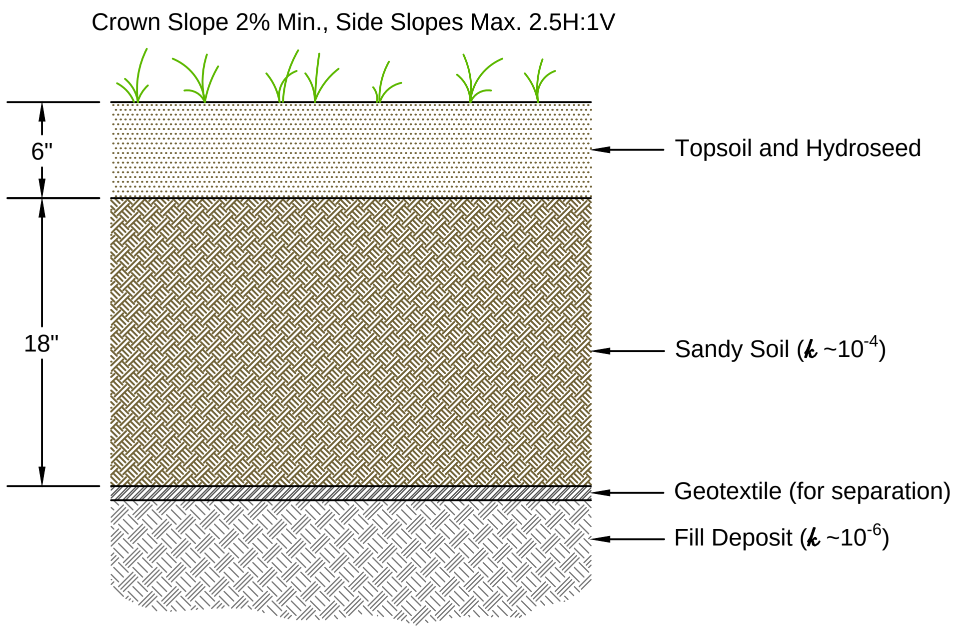
SOURCE: Aerial image from Aerometric dated June 2013.

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-018 (Alternatives).dwg Figure 8-1

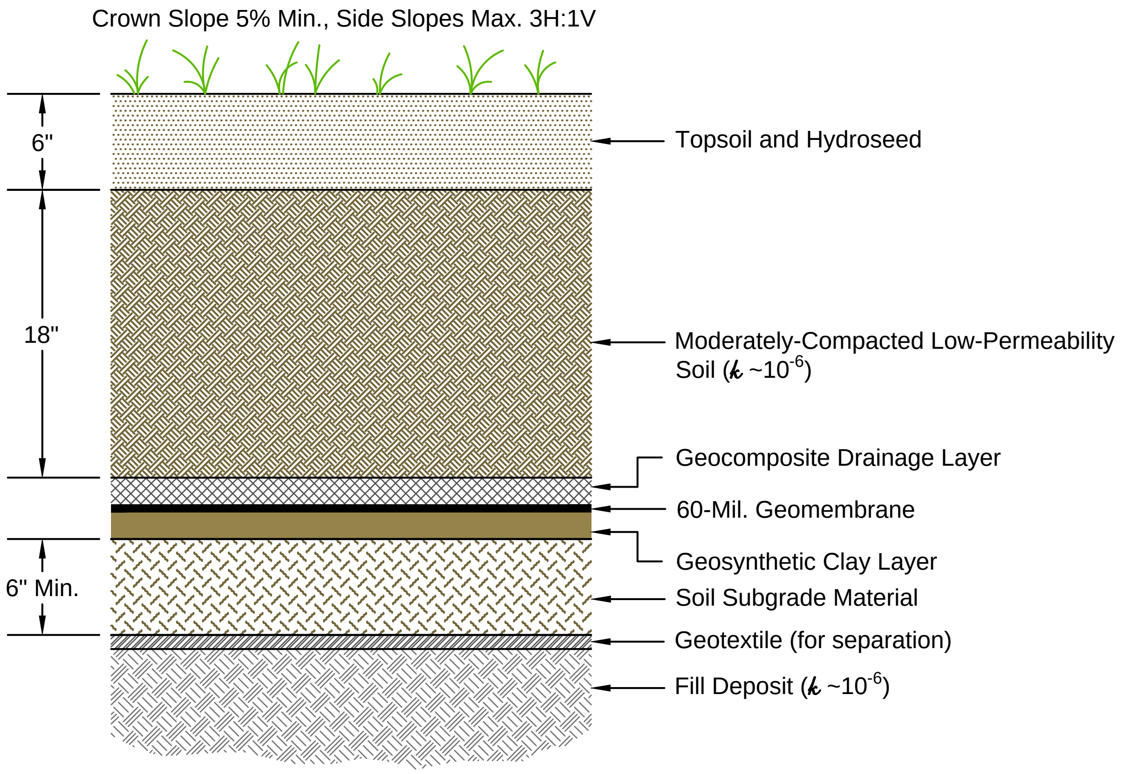
Mar 04, 2014 1:53pm chewett

Figure 8-1
FS Site Units
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

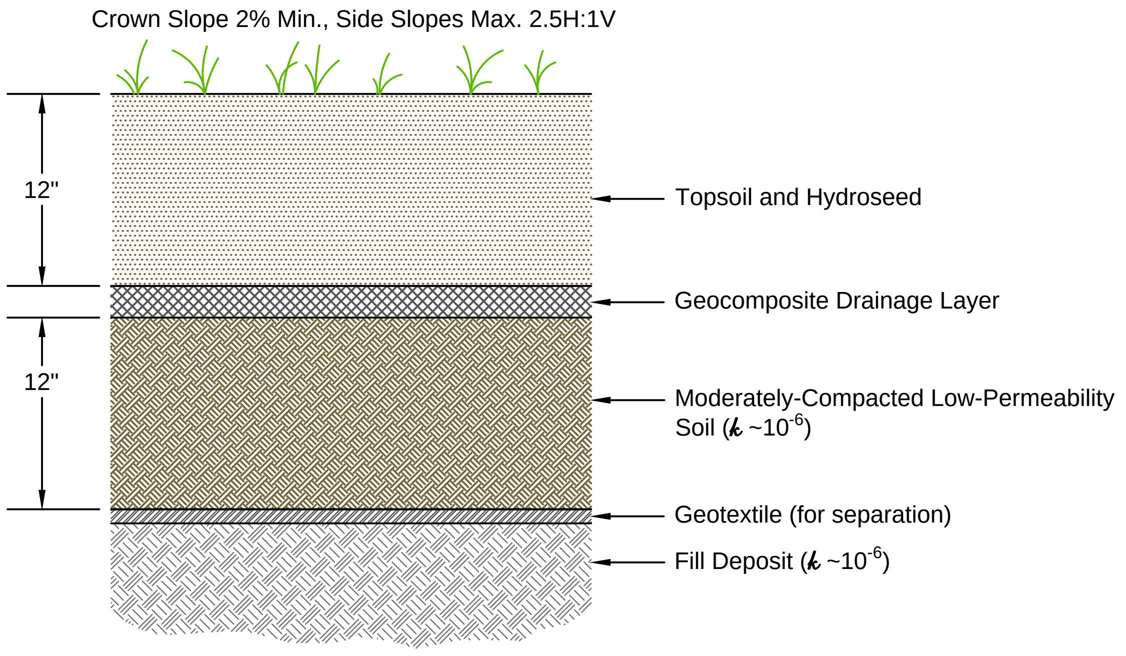
ANCHOR QEA



SOIL COVER



GEOCOMPOSITE CAP



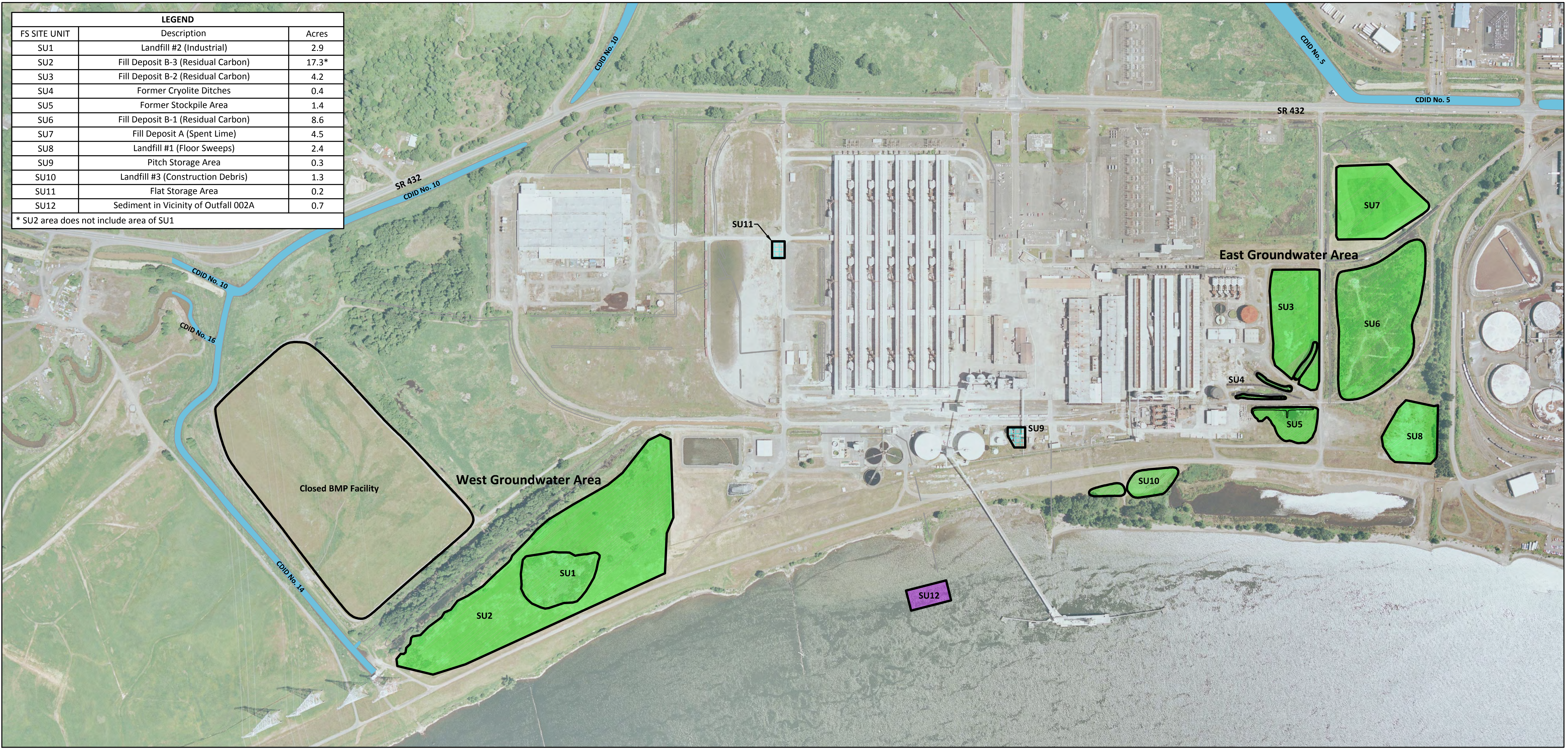
LOW-PERMEABILITY SOIL CAP

Not to Scale

NOTE:
k = permeability in centimeters per second

Mar 04, 2014 1:57pm chewett K:\Projects\0730-MBT-Longview\0730-RP-021.dwg 9-1

Figure 9-1
Cross Sections of Evaluated Physical Barriers
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

LEGEND:

- 🟩 Soil Cover
- ▦ Excavate and Dispose Off-site
- 🟪 Excavate and Consolidate On-site

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-018 (Alternatives).dwg Figure 10-1

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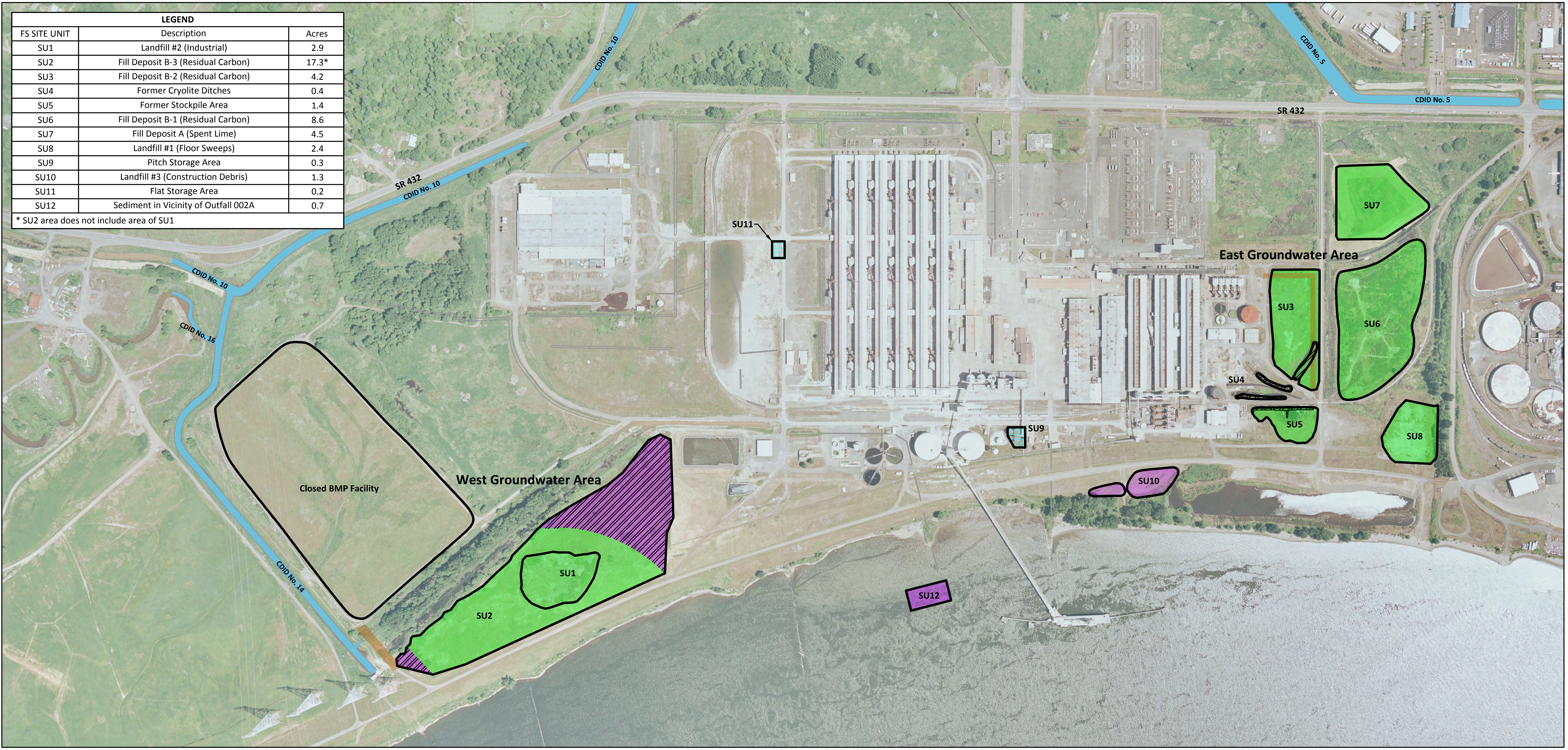
Figure 10-1
Alternative 2
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

LEGEND:

🟩	Soil Cover
🟪	Excavate and Consolidate On-site
▦	Excavate and Dispose Off-site
▨	Backfill (Reactive Agent Below Waterline)
🟫	Permeable Reactive Barrier

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-018 (Alternatives).dwg Figure 10-2

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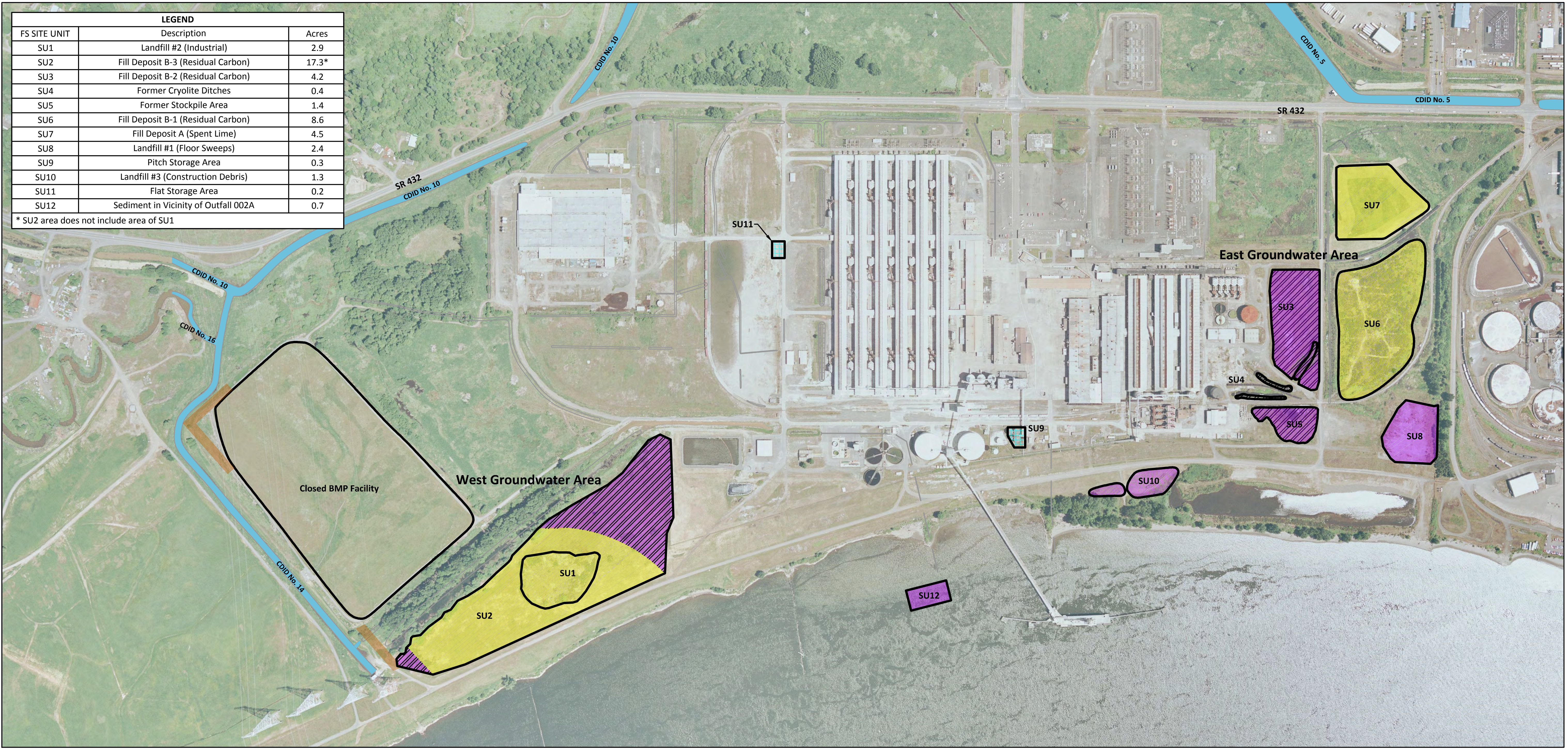
Figure 10-2

Alternative 3
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

LEGEND:

🟨	Low Permeable Cap	▨	Backfill (Reactive Agent Below Waterline)
🟪	Excavate and Consolidate On-site	🟫	Permeable Reactive Barrier
▦	Excavate and Dispose Off-site		

0 600
Scale in Feet

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-018 (Alternatives).dwg Figure 10-3

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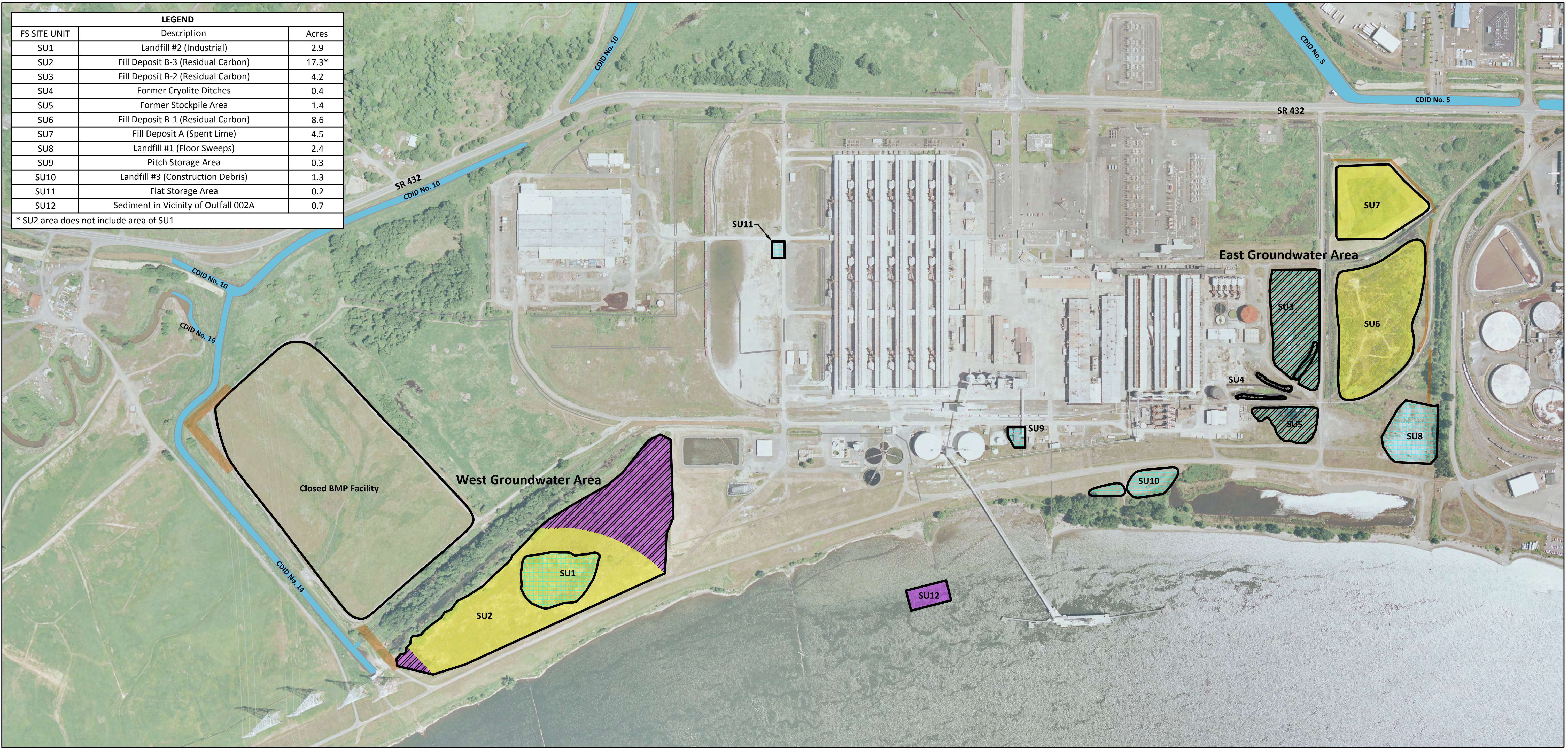
Figure 10-3
Alternative 4
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA



LEGEND

FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

K:\Projects\0730-MBT-Longview\MBT- 2011 Capex\RI-FS\0730-RP-018 (Alternatives).dwg Figure 10-4

May 05, 2014 1:57pm chewett

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

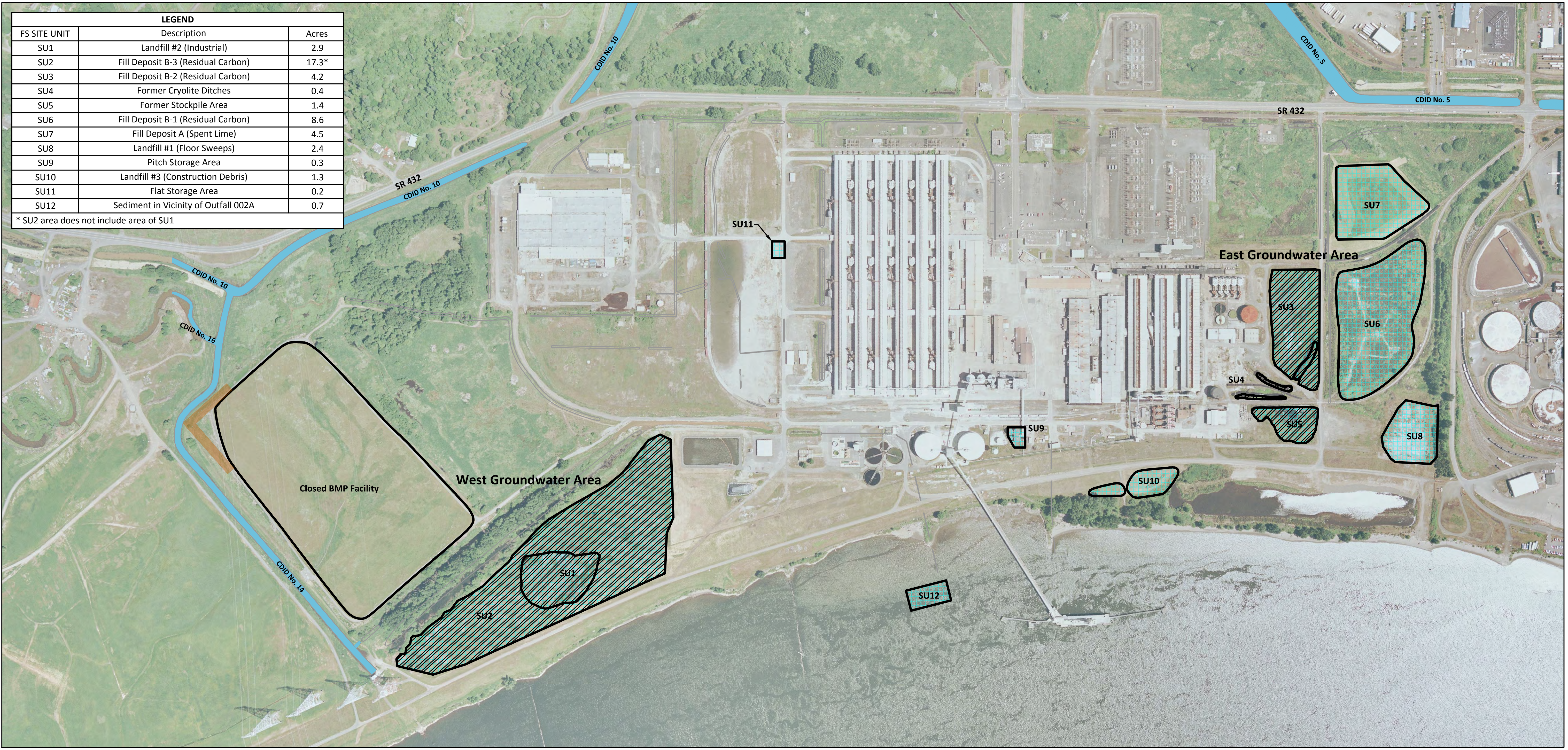
LEGEND:

- 🟨 Low Permeable Cap
- 🟪 Excavate and Consolidate On-site
- ▦ Excavate and Dispose Off-site
- ▨ Backfill (Reactive Agent Below Waterline)
- 🟫 Permeable Reactive Barrier

0 600
Scale in Feet

Figure 10-4
Alternative 5
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

LEGEND:

- ▦ Excavate and Dispose Off-site
- ▨ Backfill (Reactive Agent Below Waterline)
- 🟧 Permeable Reactive Barrier

0 600
Scale in Feet

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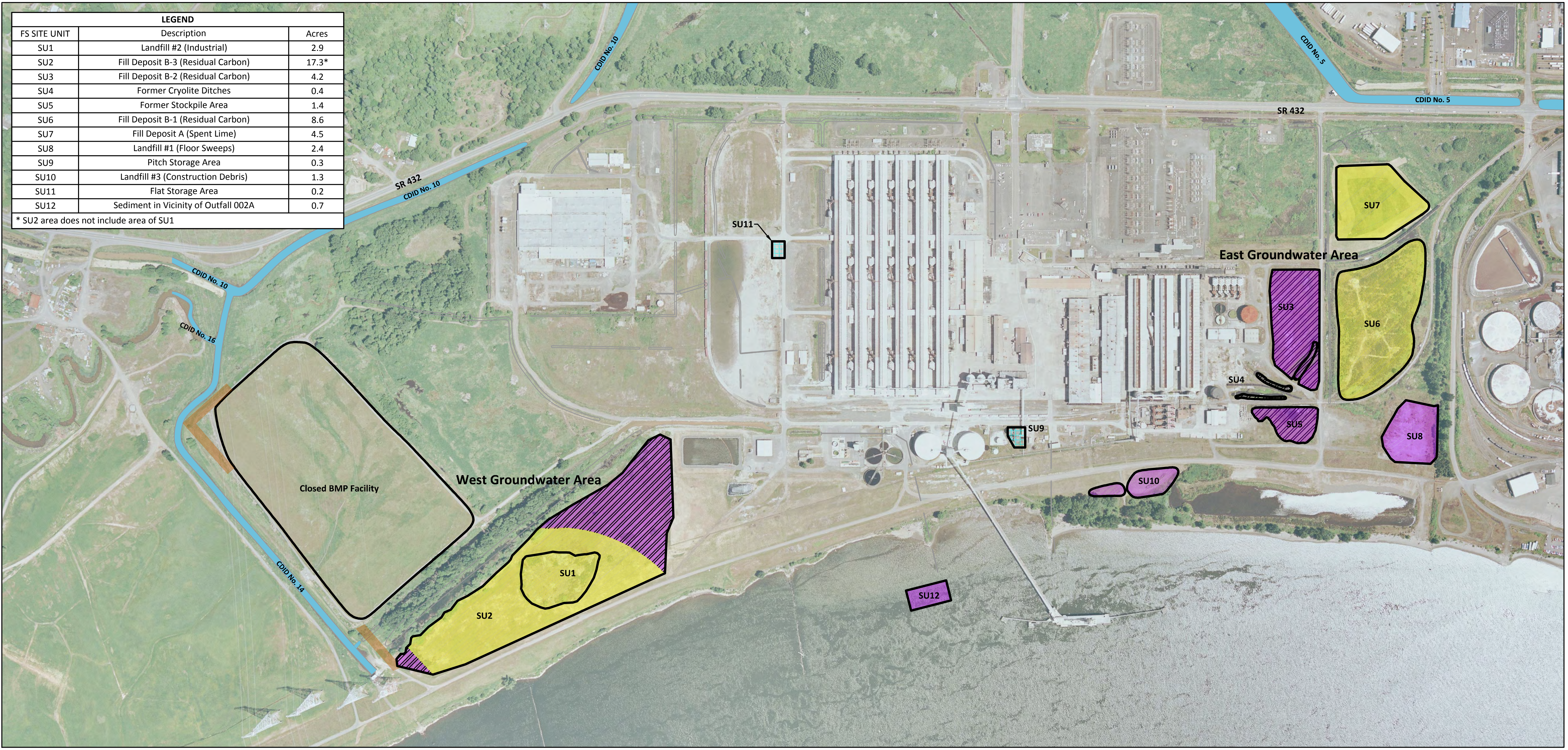
Figure 10-5
Alternative 6
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

ANCHOR QEA



LEGEND		
FS SITE UNIT	Description	Acres
SU1	Landfill #2 (Industrial)	2.9
SU2	Fill Deposit B-3 (Residual Carbon)	17.3*
SU3	Fill Deposit B-2 (Residual Carbon)	4.2
SU4	Former Cryolite Ditches	0.4
SU5	Former Stockpile Area	1.4
SU6	Fill Deposit B-1 (Residual Carbon)	8.6
SU7	Fill Deposit A (Spent Lime)	4.5
SU8	Landfill #1 (Floor Sweeps)	2.4
SU9	Pitch Storage Area	0.3
SU10	Landfill #3 (Construction Debris)	1.3
SU11	Flat Storage Area	0.2
SU12	Sediment in Vicinity of Outfall 002A	0.7

* SU2 area does not include area of SU1

SOURCE: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

LEGEND:

🟨	Low Permeable Cap
🟪	Excavate and Consolidate On-site
▦	Excavate and Dispose Off-site
▨	Backfill (Reactive Agent Below Waterline)
🟫	Permeable Reactive Barrier

0 600
Scale in Feet

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Figure 12-1

Preferred Remedial Alternative - Alternative 4
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

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