January 2015

**FORMER REYNOLDS METALS REDUCTION PLANT – LONGVIEW**

ANCHOR QEA

# Executive Summary

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

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**PLATE ES-1-1. VICINITY MAP OF REYNOLDS METALS REDUCTION PLANT**


Section 1:

# INTRODUCTION

Millennium Bulk Terminals – Longview, LLC (MBTL) and Northwest Alloys, Inc. (Northwest Alloys) are performing a Remedial Investigation/Feasibility Study (RI/FS) under the Model Toxics Control Act (MTCA) for the former Reynolds Metals Reduction Plant (Former Reynolds Plant) in Longview, Washington. This former aluminum manufacturing facility is located at 4029 Industrial Way, as shown in Plate ES-1-1.

The physical plant, buildings, and other improvements are owned by MBTL, while the upland property is owned by 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. The RI/FS was performed under the supervision of the Department of Ecology (Ecology) under Agreed Order No. DE-8940.

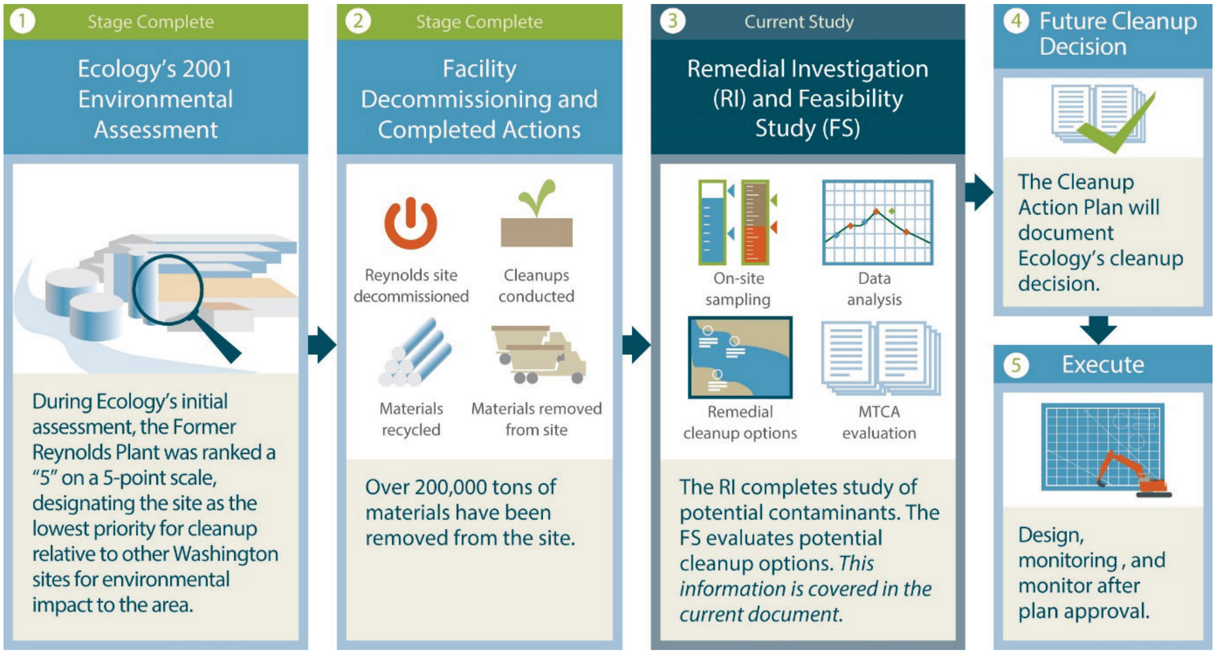
As described in Section 2 of the RI/FS, the Former Reynolds Plant was formerly used for the manufacture of aluminum. Aluminum manufacturing operations ended in 2001, and portions of the Former Reynolds Plant have since been decommissioned. MBTL currently operates a bulk products terminal on the site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

## RI/FS Evaluations Based on MTCA Requirements

The purpose of the RI/FS is to evaluate the nature and extent of contamination and potential cleanup options based on the Model Toxics Control Act (MTCA) regulations (Washington Administrative Code [WAC] Chapter 173-340). These regulations are implemented by Ecology to address the cleanup of contaminated soils, groundwater, or other media within the state of Washington.

As shown in Plate ES-1-2, the RI/FS is one of several steps in the MTCA cleanup process. 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.

**PLATE ES-1-2. ROLE OF THE RI/FS IN THE MTCA CLEANUP PROCESS**




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 the MTCA cleanup requirements. The RI/FS includes identification of a preferred remedial action alternative based on the MTCA requirements and criteria.

Final cleanup decisions are to be specified in a MTCA Cleanup Action Plan. The Cleanup Action Plan is a separate document from this RI/FS and will be made available for public review by Ecology during a future public comment opportunity. 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 No. DE-8940. The Agreed Order is a formal agreement that was entered into by Ecology, Northwest Alloys (as the property owner), and MBTL (as the owner of the site improvements, property tenant, and terminal operator).

## RI/FS Is Separate from Property Redevelopment Proposals

The RI/FS is not part of any current or future land use proposal for the Northwest Alloys property. Consistent with the MTCA requirements, all RI/FS documents and final cleanup decisions consider the general land use (i.e., industrial, commercial, or residential) occurring 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 of the RI/FS. Therefore, the RI/FS considers potential exposure risks and cleanup requirements within the context of ongoing industrial uses.

The MTCA process and cleanup decisions and its implementation are separate actions independent of any particular reuse plan for the Former Reynolds Plant. Although MBTL has initiated environmental review processes in support of a proposed new bulk commodity terminal on portions of the Former Reynolds Plant property, MBTL's proposal is not related to the RI/FS and will be the subject of separate environmental reviews and permitting under applicable regulatory requirements.

**PLATE ES-2-1. FORMER REYNOLDS PLANT CURRENT CONDITIONS**

## Section 2:

# RI/FS STUDY AREA BACKGROUND

Section 2 of the RI/FS summarizes background information for the Former Reynolds Plant (see Plate ES-2-1) and the RI/FS Study Area in which it is located. This includes a discussion of current land uses, a detailed summary of the facility's history, and a discussion of previous facility decommissioning, investigation, and cleanup activities that have been completed in coordination with Ecology to return the facility to productive reuse. These completed actions included numerous studies that provide environmental and geologic information regarding the RI/FS Study Area. 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 the MTCA regulations.

## Current Operations

The Former Reynolds Plant is located within an industrial land use corridor located along Industrial Way (Highway 432) and the Columbia River navigation channel. The Former Reynolds Plant and the adjacent properties are zoned for industrial uses.

Northwest Alloys owns a total of approximately 536 acres of property. 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. Only the southern portion of this property (approximately 436 acres located south of Industrial Way) was included in the historical aluminum manufacturing operations. The southern portion of the property is referred to as the Former Reynolds Plant.

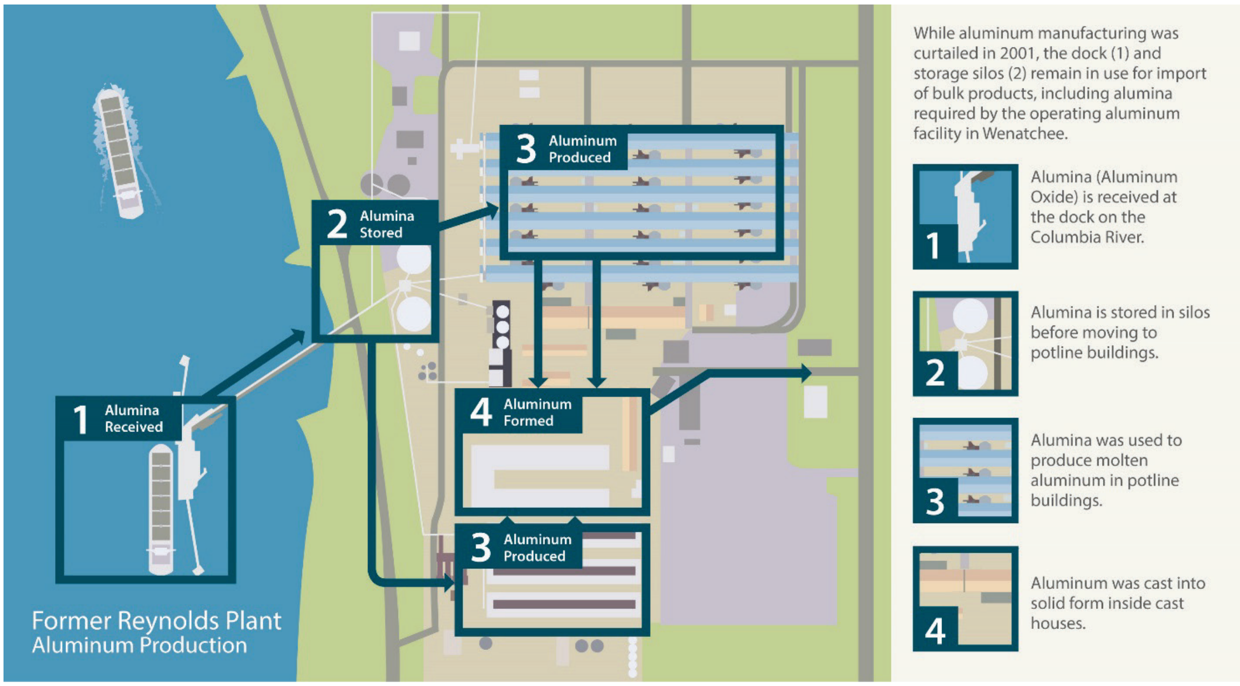
The Northwest Alloys-owned property extends to the extreme low water mark of the Columbia River. The aquatic lands located offshore of this point are owned by the state of Washington and are managed by the Washington State Department of Natural Resources (WDNR). Portions of the dock and outfalls are located on land leased to Northwest Alloys by WDNR.

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., 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.

Alumina is received by ship, stored, and is transloaded into railcars for shipment to an operating aluminum manufacturing facility, Alcoa Wenatchee Works, 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.

**PLATE ES-2-2. HISTORICAL ALUMINUM MANUFACTURING FACILITIES**




## Historical Operations

Aluminum production by Reynolds Metal Company began in in 1941 with the development of the aluminum production operations by Reynolds Metals Company. The manufacturing capabilities were expanded in the 1960s to include additional primary aluminum production, cast houses, and cable plant facilities. The facility focused on primary aluminum production, without extensive downstream product manufacturing facilities. 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 aluminum manufacturing processes historically conducted at the Former Reynolds Plant are well understood for the following reasons (see Plates ES-2-2 and ES-2-3):

- The manufacturing process was invented in 1882 and is largely unchanged since that time.
- No other industrial manufacturing has occurred at the Former Reynolds Plant.
- Extensive documentation of facility operations exists.

Historical facility operations are well documented and include the following:

- **Aluminum Production Facilities.** Plate ES-2-3 illustrates the main 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.
  - 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. The potline buildings included an extensive series of pots (see Plate ES-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 (Söderberg design) and a cathode (potliner), producing molten aluminum. Both the anodes and the cathodes were made on site from carbonaceous materials, including calcined petroleum coke, coal tar pitch, and anthracite coal.
  - Electricity used in the aluminum production process was obtained from the off-property Bonneville Power Administration electrical yards. This electricity was routed through two rectifier yards owned by Reynolds Metals Company (the north and south yards). The rectifiers were used to convert the alternating current electricity received from Bonneville Power Administration to direct current required in the aluminum production process.
  - The molten aluminum was cast into solid form in the two on-site cast houses.

**PLATE ES-2-3. THE ALUMINUM REDUCTION PROCESS**

This photograph from the late 1960s shows one of the Reynolds "potlines" (the A-line in Room 51) during Longview plant operations.

- **Former Cable Plant Operations.** The Cable Plant is located in the northwestern portion of the Former Reynolds Plant. It received molten aluminum from the aluminum production facilities and processed it in three furnaces—a continuous ingot caster, a rolling mill, and wire drawers.

- **Former On-site Recycling Processes.** At the Former Reynolds Plant, a recycling process was operated to recover reusable materials from the carbon lining of the pots in which the molten aluminum is produced and from other plant byproducts. This recycling process was conducted in the former Cryolite Recovery Plant located in the East Plant area. Recovered cryolite was used within the facility or was sold for use at other aluminum production facilities.
  - During operations, spent lime was generated and was initially segregated and managed in Fill Deposit A, located in the northeast portion of the facility.
  - The residual carbon from the on-site recycling process was disposed of in several fill deposits constructed within the Former Reynolds Plant. 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. 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 in accordance with an Ecology-approved closure plan meeting the requirements of WAC Chapter 173-303 (closure included the construction of a landfill cap, the filing of restrictive covenants, and implementation of a long-term operation and monitoring plan). The closed facility has continued to meet the requirements of the operation and monitoring plan. Federal rules 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.
  - The cryolite recovery operations were discontinued in 1990, and the Cryolite Recovery Plant structures have since been removed.
- **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) was used for the dry materials swept from the floors in the potline buildings. These materials included alumina, bath, cryolite, and aluminum fluoride.
  - Landfill #2 (industrial landfill) 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) contains concrete debris and other inert plant wastes similar to those in the industrial landfill (Landfill #2).
- **Other Operations Associated with Reynolds Metals Company.** 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 operations associated with Reynolds Metals Company included the following:
  - Maintenance facilities
  - Water supply wells
  - Wastewater treatment systems

## Historical Uses After Closure of the Former Reynolds Plant

In 2000, Alcoa purchased Reynolds Metals Company as a wholly owned subsidiary. As a requirement of this transaction, Reynolds Metals Company was required to divest the Longview smelter. To fulfill this obligation, Reynolds Metals Company sold the facility to Longview Aluminum in 2001 but retained ownership of the land. Longview Aluminum immediately closed the aluminum production operations, and the facility has not produced aluminum since that date.

Longview Aluminum declared bankruptcy in 2003. Following the bankruptcy, Reynolds Metals Company continued to retain ownership of the land, and in September 2005, ownership of the land transferred from Reynolds Metals Company to Northwest Alloys, both wholly owned subsidiaries of Alcoa.

In December 2004, Chinook Ventures purchased the Longview assets from the bankruptcy trustee. Chinook Ventures was the sole operator of the facility between 2004 and 2011. Chinook Ventures operated a terminal for the import, handling, and/or export of dry bulk materials, such as alumina, coal, green petroleum coke, cement, fly ash, slag, scrap metal, thin stillage (an agricultural byproduct of corn-based ethanol manufacturing) and other materials. Some of the aluminum manufacturing products were handled using existing facilities, but a number of these products were handled in new equipment and facilities developed by Chinook Ventures.

During its occupancy, Chinook Ventures decommissioned the majority of the facilities associated with aluminum manufacturing operations and brought materials from smelters being decommissioned throughout the northwest region to the site for recycling.

## Previous Decommissioning and Cleanup Activities

Extensive decommissioning, demolition, waste removal, and investigation and cleanup activities have been conducted to date at the Former Reynolds Plant. These actions have been conducted in coordination with Ecology.

To date, as part of facility decommissioning and cleanup, close to 300,000 tons 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. The following summarizes the facility decommissioning and cleanup activities:

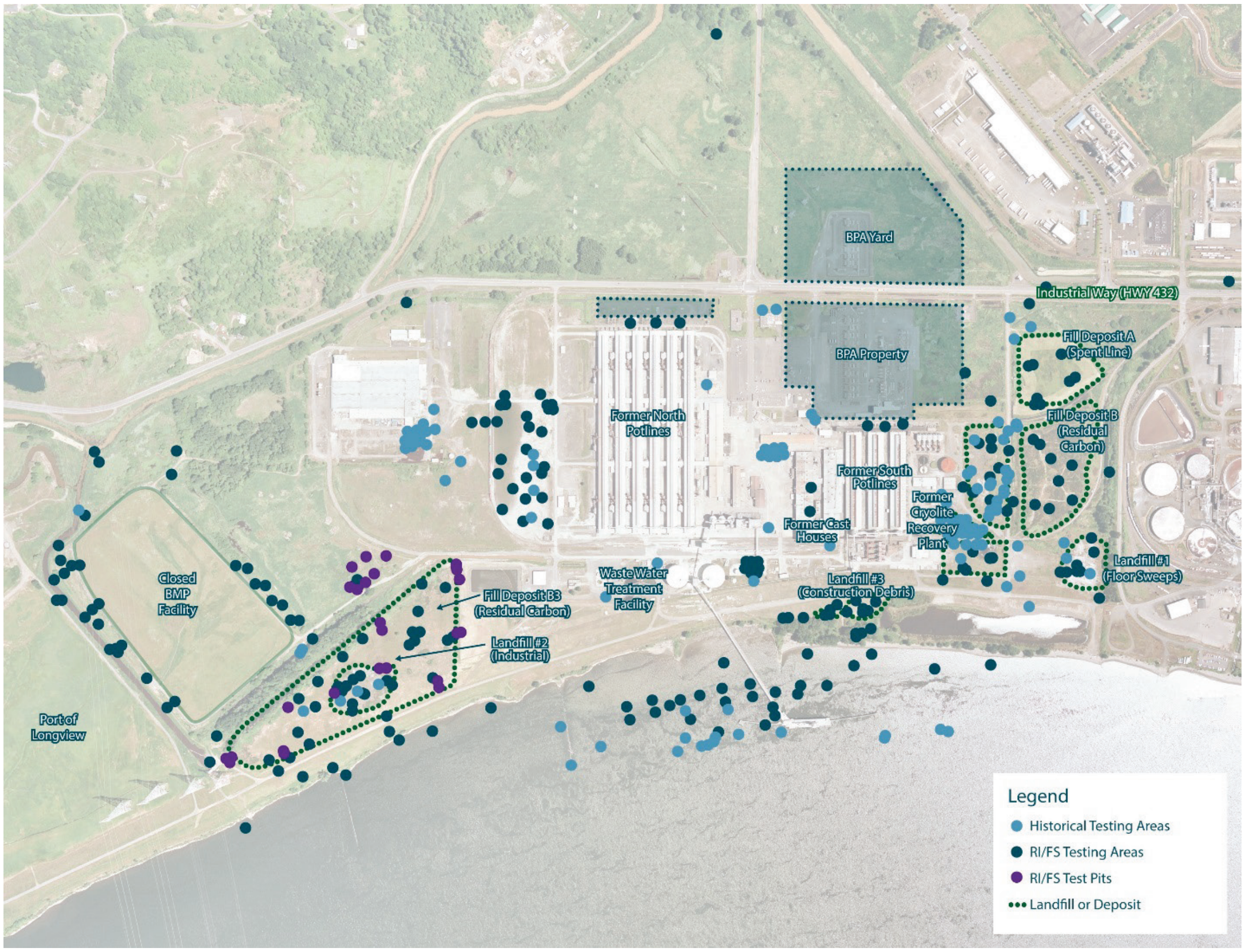
- **Decommissioning of the Former Reynolds Plant.** In May 2004, Reynolds Metals Company hired a firm to demolish the Cryolite Recovery Plant. Materials removed during that project included approximately 800 tons of metals, 150 tons of concrete, 161 tons of construction debris, 132 tons of brick/refractory and 850 tons of underflow solids. A total of 40 potroom transformers were sold by the bankruptcy trustee to a recycler that recycled the transformer metals and transformer oil.
- **Materials Removed by Chinook Ventures.** Over the period that Chinook Ventures owned the plant, the following materials were removed and recycled or appropriately disposed at permitted off-site facilities:
  - 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)

- **Materials Removed by MBTL.** Following the sale of the Chinook Ventures assets in January 2011, MBTL has continued to remove the remaining aluminum smelting equipment, materials, and wastes from the property, as well as materials that remained from Chinook Ventures' operations. Materials removed from the property include the following:
  - 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)
  - Approximately 68 tons of flooring from the machine shop
  - More than 100,000 tons of green petroleum coke
  - More than 21,000 tons of cement
  - Approximately 1,000 tons of solids from the Stormwater Retention Basin
  - More than 14,000 tons of debris removed from the on-site ditch system (disposed off site)
- **Interim Cleanup Work.** In coordination with Ecology, MBTL has taken a number of removal actions at discrete areas, including the removal of contaminated soil and areas impacted by historical spills. MBTL has also removed the following:
  - Scrap yard soil cleanup
  - Cable Plant underground storage tank cleanup
  - Warehouse underground storage tank and fuel island cleanup
  - Soil removal from the former cryolite area ditches
  - Soil cleanup at the diesel aboveground storage tank
  - Cleanup of other reported spills to soil
  - Partial soil removal in the heat transfer media oil area
- **Other Activities.** In addition to the actions previously listed, MBTL has accomplished the following additional facility repairs and upgrades since acquiring the facility assets in 2011 from Chinook Ventures:
  - Removal of unpermitted structures and equipment
  - Repairs to the dock and associated fire control systems
  - Upgrades to the facility water supply and wastewater management systems
  - Repairs to the cover of the Closed Black Mud Pond Facility
  - Repairs to the Consolidated Diking Improvement District (CDID) levee

## Summary of Site Conditions Prior to the RI/FS

The previous environmental investigations provide extensive baseline information for the RI/FS Study Area. Results document the locations of landfill and fill deposits at the site. Chemicals present on site from former aluminum production operations include fluoride, cyanide, total petroleum hydrocarbons (TPH), and polycyclic aromatic hydrocarbons (PAHs). Previous cleanup actions have been performed to address localized areas of petroleum-impacted soil. Section 3 of the RI/FS describes the additional testing performed as part of the RI/FS.

**PLATE ES-3-1. OVERVIEW OF REMEDIAL INVESTIGATION TESTING LOCATIONS**




Section 3:

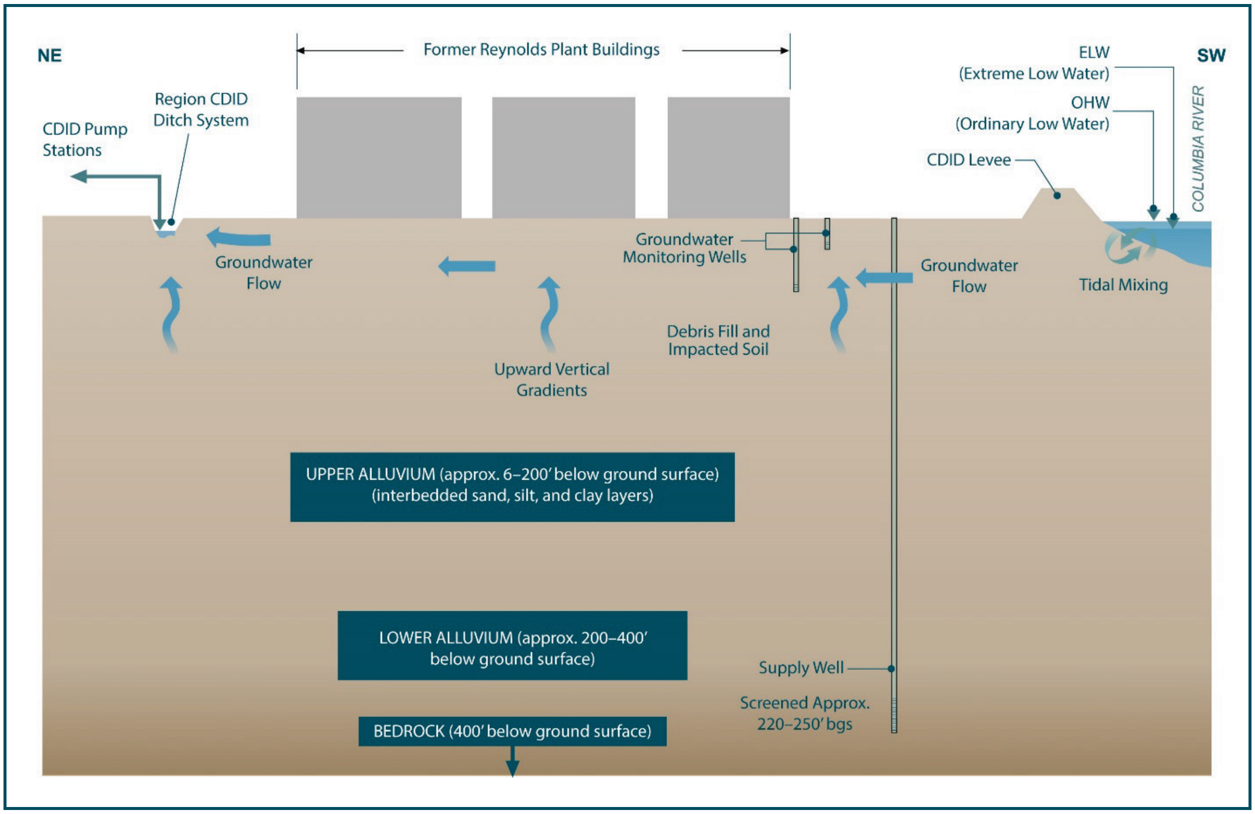
# REMEDIAL INVESTIGATION METHODS

Prior to developing the current RI/FS, extensive environmental testing information was available for the Former Reynolds Plant from previous investigations, cleanup, and closure activities, as described in Section 2 of the RI/FS. Ecology reviewed this information and then defined specific data gaps and testing requirements for the RI/FS.

These requirements were documented in a series of work plans and addenda. The testing defined by Ecology included both targeted testing to assess the nature and extent of chemicals associated with historical aluminum production, and also comprehensive testing to rule out other potential chemical impacts.

Plate ES-3-1 shows the combined locations of soils, fill deposits, landfills, groundwater, surface water, and sediment testing over the course of 8 years of investigations.

**PLATE ES-4-1. GROUNDWATER CONCEPTUAL SITE MODEL**




Section 4:

# GEOLOGIC AND HYDROGEOLOGIC SETTING

Section 4 of the RI/FS summarizes the regional geologic setting of the Former Reynolds Plant and RI/FS Study Area. This section includes detailed description of facility and regional soil stratigraphy, facility and regional hydrogeologic conditions, and the influences of the Columbia River, the CDID ditch and levee system, and the facility drainage ditches on groundwater conditions. Section 4 includes information derived from previous studies performed at the facility, testing performed during the RI/FS, and regional studies conducted within the Longview area.

## Geologic Conditions

The RI/FS Study Area is located within the Longview/Kelso basin, a topographic and structural depression formed by the Cascadia subduction zone. Soils within this area consist primarily of two layers of floodplain-deposited soils known as alluvium. This two-layer alluvial system is illustrated in the groundwater conceptual site model graphic (see Plate ES-4-1) and is summarized as follows:

- **Upper Alluvium.** In the RI/FS Study Area, the Upper Alluvium consists of fine-grained silt and clay deposits. Analysis of 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.

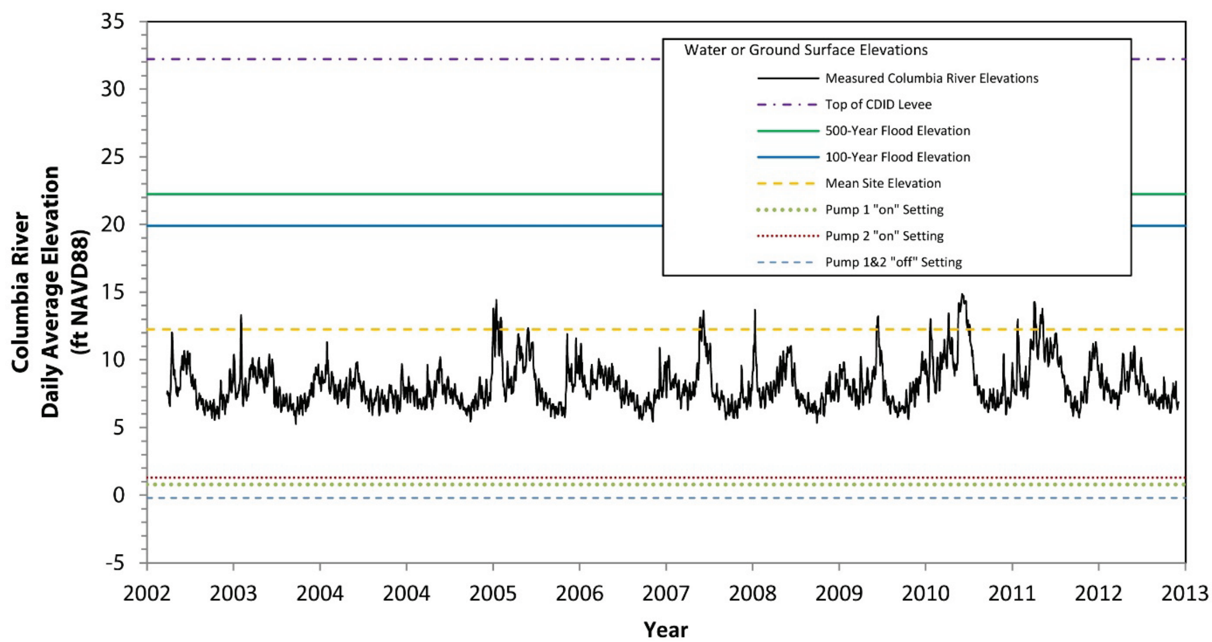
Vertical gradients between the Lower Alluvium and Upper Alluvium were assessed as part of the City of Longview's preliminary design studies for the Mint Farm Regional Water Treatment Plant. During June and November 2009, vertical gradients in well pairs completed in each alluvium layer showed the presence of an upward gradient from the Lower Alluvium to the Upper Alluvium.

## Hydrologic Influences

The behavior of groundwater within the RI/FS Study Area is influenced by the surface ditches of the regional CDID ditch system, the on-site National Pollutant Discharge Elimination System (NPDES) permit ditch system, and the Columbia River. The following provides a summary of these hydrologic influences:

- **Consolidated Diking Improvement District Ditch System.** The Columbia River is located along the southern side of the Former Reynolds Plant. The CDID ditched levee system adjacent to the Former Reynolds Plant is part of a larger (35 miles) network of dikes and levees originally constructed by U.S. Army Corps of Engineers 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 mean sea level. The CDID also operates a network (approximately 35 miles) of drainage ditches throughout the Longview/Kelso basin. The water levels in these drainage ditches are maintained by pumping at a level below that of the Columbia River, resulting in movement of shallow groundwater in the silt/clay soils of the Upper Alluvium away from the Columbia River and toward the lower-elevation CDID ditches.
- **On-site Ditch System.** In addition to the CDID ditches, numerous on-site ditches collect stormwater runoff and are part of the site's NPDES permit. Like the CDID ditch system, these ditches can also influence or extract shallow groundwater.
- **Columbia River.** The water elevations within the Columbia River vary both seasonally and daily. Seasonal variations are associated with precipitation rates, snow melt and operation of upstream dams, and associated irrigation/flood control systems. Daily elevations vary with the tides, with daily variations of up to 5 feet between high and low tide. Plate ES-4-2 compares the elevation of the Columbia River to that in the CDID ditches north and west of the Former Reynolds Plant. The CDID levee near the Former Reynolds Plant extends to an elevation significantly above the 100-year and 500-year flood elevations for the Columbia River.

**PLATE ES-4-2. CDID DITCHES MAINTAINED AT WATER LEVELS BELOW THOSE OF THE COLUMBIA RIVER**




# Study Area Hydrogeology

Shallow groundwater within the Former Reynolds Plant typically flows north and west, away from the Columbia River toward the CDID ditches. The on-site drainage ditches 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).

The elevations of shallow groundwater vary both seasonally and with tides in areas near the Columbia River. Seasonal variations in groundwater elevations were noted in shallow groundwater. Groundwater elevations were higher (with variation up to 2 feet) in the wet season than during the dry season. Tidal influences were noted and quantified in wells located within approximately 200 feet of the Columbia River shoreline.

Vertical groundwater gradients between the Lower Alluvium and the Upper Alluvium are upward. These upward gradients, combined with the thick sequences of silt and clay soil in the Upper Alluvium restrict potential downward migration of groundwater.

Section 5:

# REMEDIAL INVESTIGATION FINDINGS

Section 5 of the RI/FS describes the findings of the RI, including presentation of the results of chemical and biological testing of different media. Results of testing for each medium are compared against appropriate screening levels established under the MTCA or under other Applicable or Relevant and Appropriate Requirements (ARARs).

## Testing Results for Soils, Landfills, and Fill Deposits

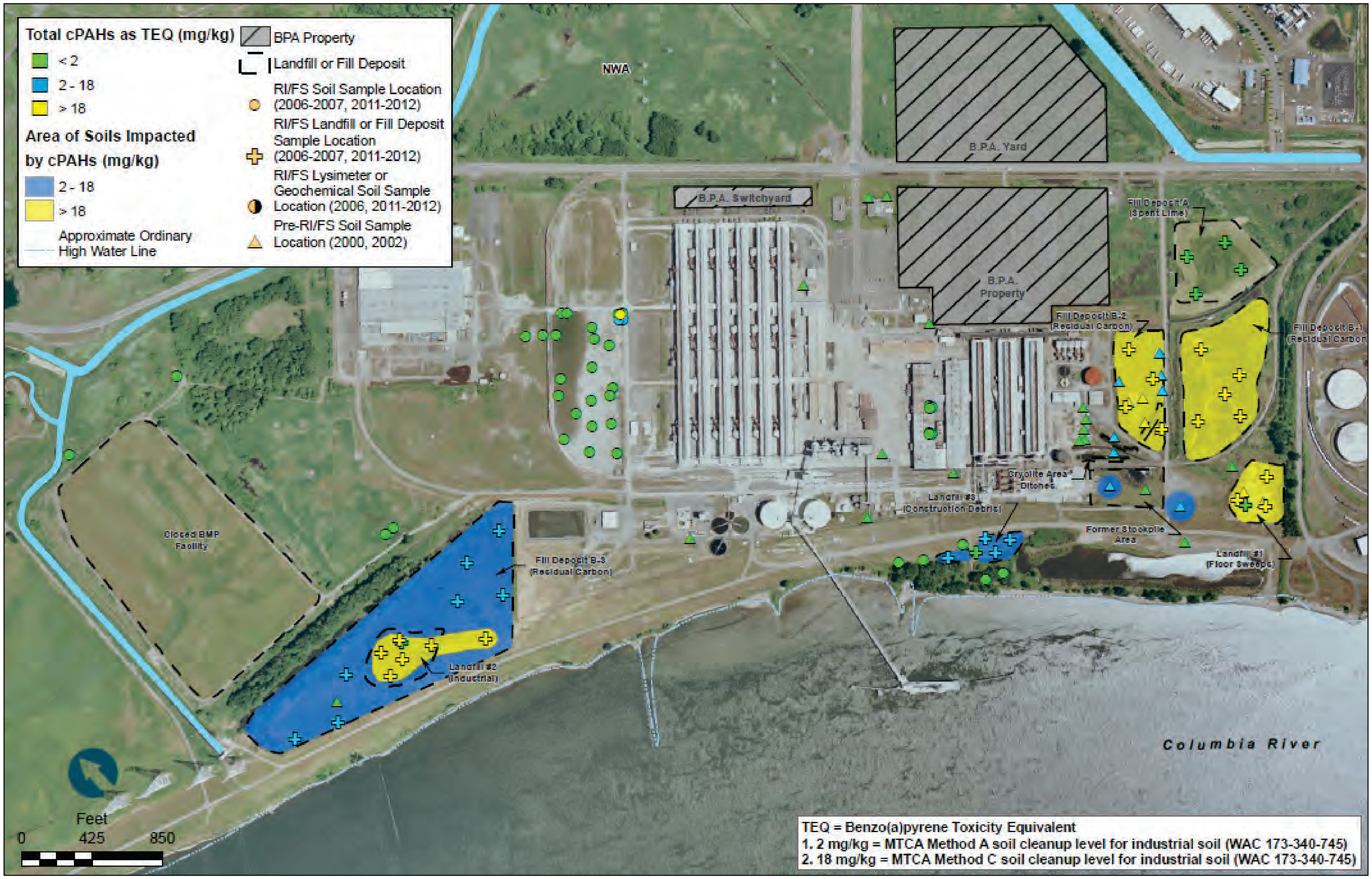
Surface soil quality throughout the majority of the Former Reynolds Plant is protective of industrial workers, and soil quality outside of the landfills and fill deposits is protective of terrestrial exposures. Landfills and fill deposits contain fluoride at levels that may leach to groundwater. This exposure pathway is addressed in the FS. Chemical impacts exceeding applicable screening levels were identified in a small number of locations within the Former Reynolds Plant.

One surface sample location from the northeast corner of the Flat Storage Area exceeded screening levels for PAH compounds in industrial soil (see Plate ES-5-1). The extent of this area was bounded by RI/FS sampling. The management of this area is addressed in the FS.

Several of the closed landfills and fill deposits at the facility also contain materials with elevated concentrations of PAH compounds (see Plate ES-5-2). However, these materials are contained and are 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.

Fluoride levels in soil, landfills, and fill deposits are consistently below industrial soil screening levels protective of industrial workers. Outside of the landfill and fill deposits, the fluoride concentrations in soil comply with screening levels for residential soil (see Plate ES-5-2).

There were no exceedances of soil screening levels for mercury, polychlorinated biphenyls (PCBs), solvents, or pesticides.




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.

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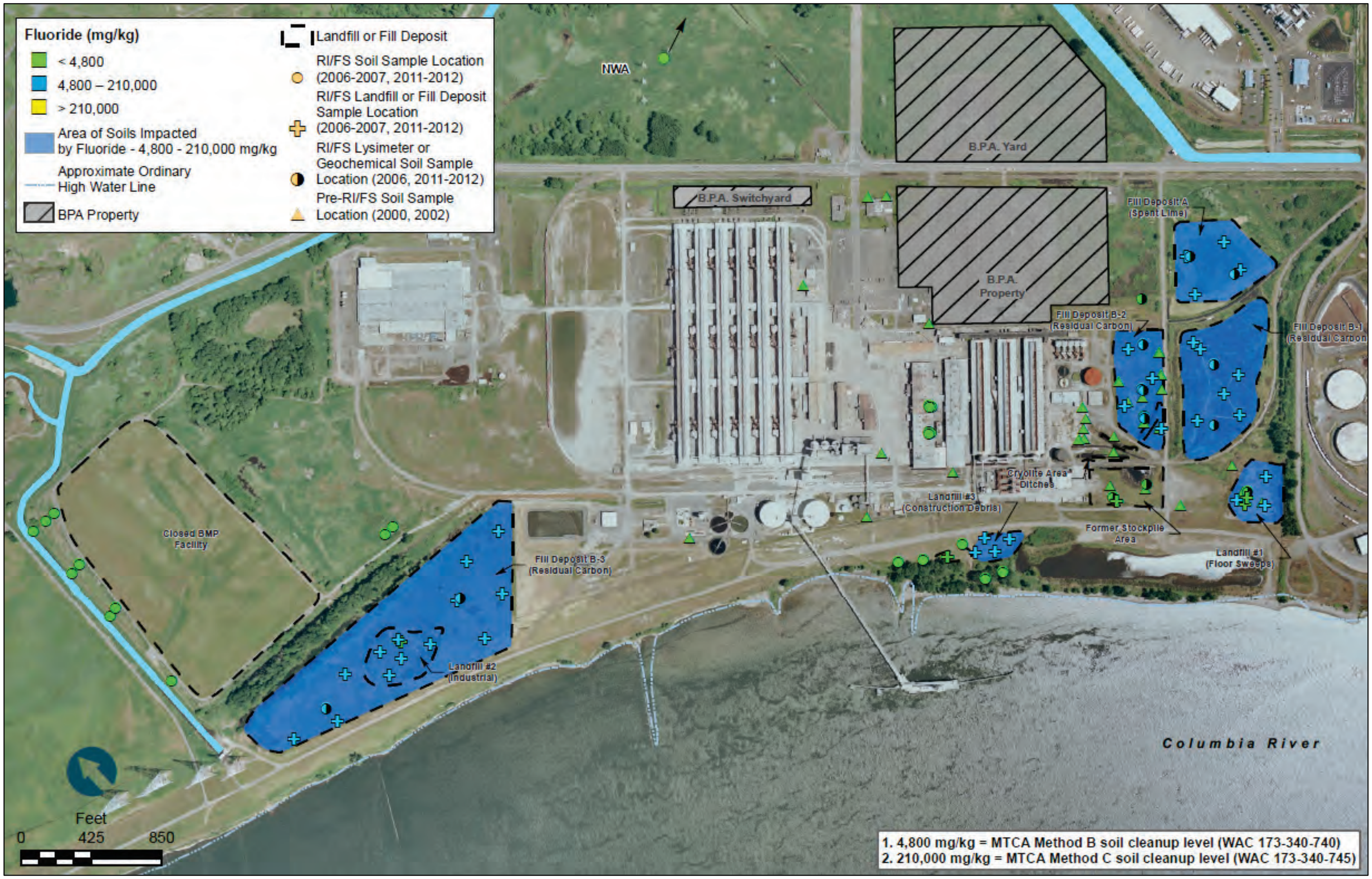
**Plate ES-5-1**

Summary of Soil and Fill Deposits Containing Elevated cPAH Concentrations

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview




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 ES-5-2**

Summary of Soil and Fill Areas Containing Elevated Fluoride Concentrations

Remedial Investigation/Feasibility Study

Former Reynolds Metals Reduction Plant – Longview

## Testing Results for Groundwater

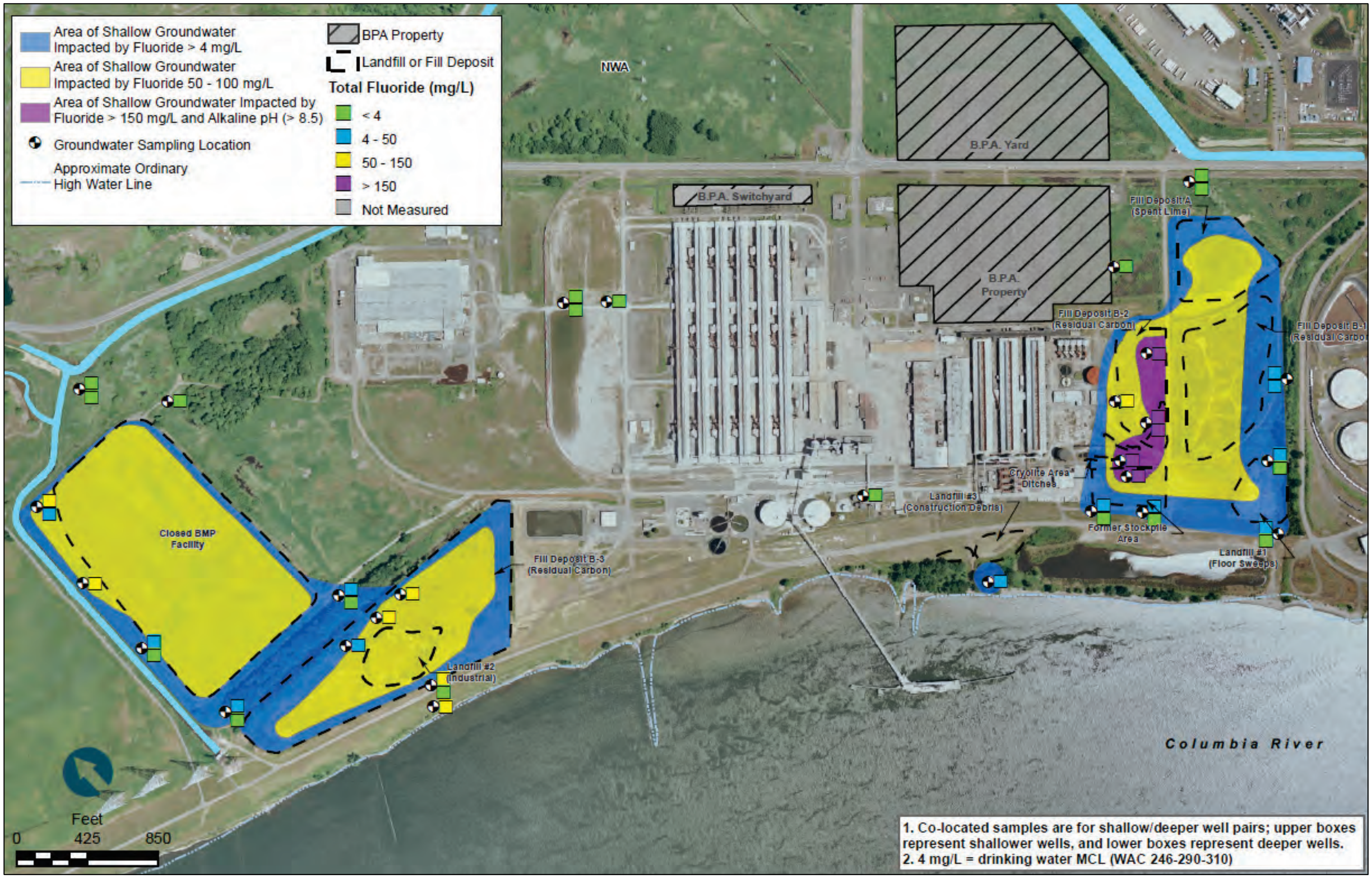
Groundwater testing for the RI/FS included multiple rounds of testing over 8 years. Groundwater monitoring has been conducted at the site for over 30 years.

No solvents or PCBs were detected in groundwater. Cyanide levels are below drinking water standards throughout the facility. Though PAH compounds were detected in some groundwater samples in the top portion of the Upper Alluvium, specifically the fill and silt/clay soils immediately within or adjacent to the landfill and fill deposits, these compounds were not detected in deeper portions of the Upper Alluvium or in any locations further away from the fill materials.

Fluoride is the chemical of greatest interest with respect to groundwater quality. Fluoride concentrations are elevated in groundwater present in the upper fill and silt/clay soils immediately within or adjacent to the landfill and fill deposits (see Plate ES-5-3). Monitoring shows that fluoride has limited mobility, and its movement appears to be controlled by geochemical processes in the soil. Section 6 of the RI/FS includes a detailed discussion of the natural processes occurring at the Former Reynolds Plant that limit the movement of fluoride in shallow soils and groundwater.

## Testing Results for Consolidated Diking Improvement District Ditches and Surface Water

Surface water quality within the Columbia River and CDID ditches was evaluated during the RI/FS. Surface water sampling results from the CDID ditches and Columbia River were consistently below screening levels.




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.

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**Plate ES-5-3**

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

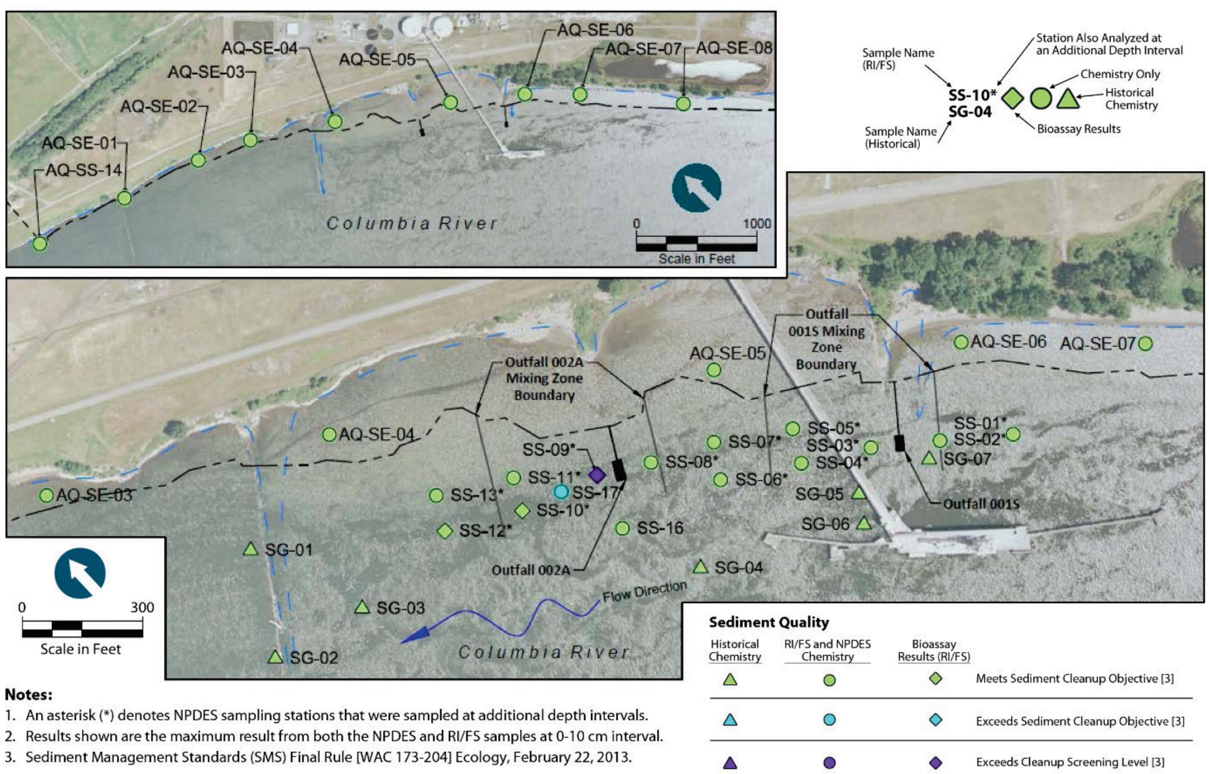
# Testing Results for Sediments

Columbia River sediments were tested extensively during coordinated RI/FS and NPDES permit monitoring events. These studies included resampling of areas tested previously during the 1990s by Ecology, as well as numerous other areas. Sampling locations are shown in Plate ES-5-4.

No impacts to nearshore or offshore sediments were noted except for a localized area immediately adjacent to Outfall 002A. A human health risk evaluation confirmed that concentrations of bioaccumulative chemicals complied with levels developed under the Sediment Management Standards to be protective of people that eat seafood from the site. However, one sample at that location exceeded the cleanup screening level based on the results of site-specific bioassay testing.

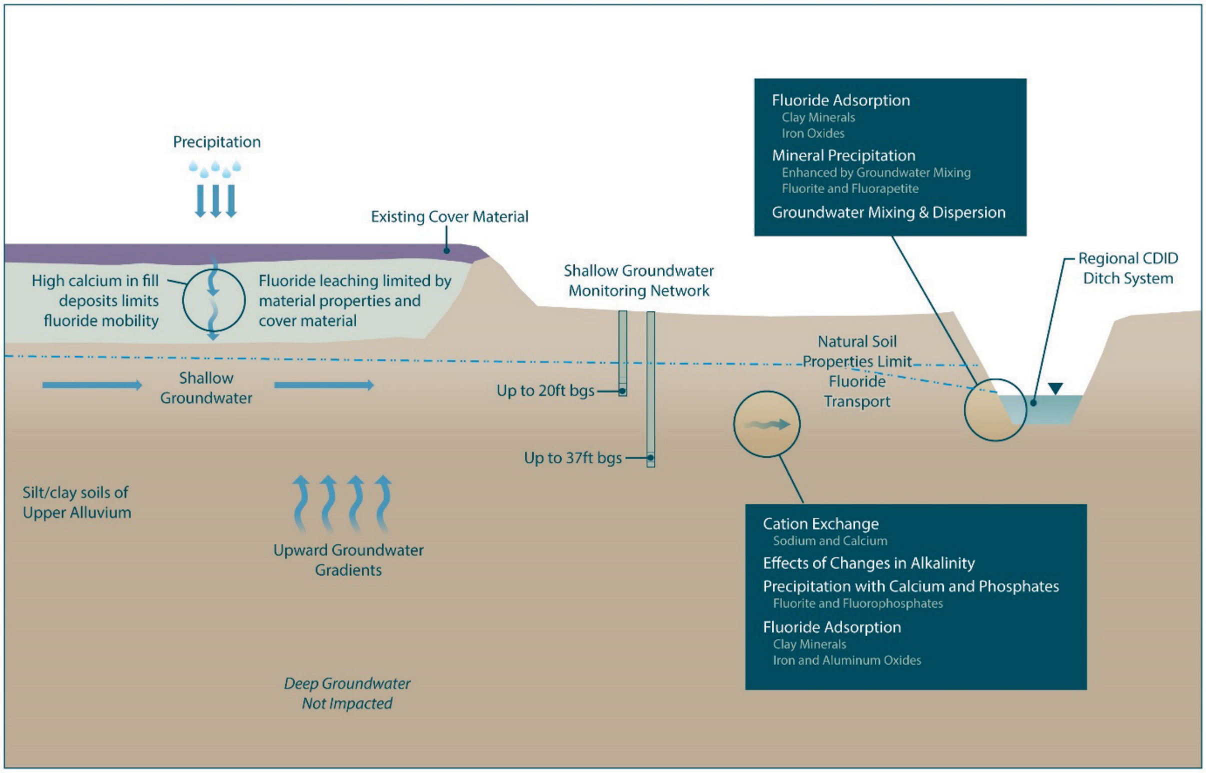
The area near Outfall 002A is monitored under the NPDES permit. Trend analysis indicates that sediments in this localized area are recovering over time. This recovery demonstrates that the source control actions completed by MBTL have been effective and the source of the impacts is not ongoing. However, despite the findings that the area is localized and is recovering naturally, Ecology requested that the area adjacent to Outfall 002A be carried forward into the FS.

**PLATE ES-5-4. SUMMARY OF RECENT SEDIMENT SAMPLING DATA**




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

**PLATE ES-6-1. KEY GEOCHEMICAL PROCESSES LIMITING MOBILITY OF FLUORIDE**




## Section 6:

# FATE AND TRANSPORT EVALUATION

Section 6 of the RI/FS 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 of the RI/FS, fluoride is the primary chemical of concern 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 (see Plate ES-6-1):

- **Limitations on Source Area Leaching.** Geochemical factors limit the leaching of fluoride from source areas (areas of elevated fluoride concentrations) to groundwater. Within the fill deposits, testing was performed to evaluate the factors controlling the leaching of fluoride from remaining source areas.
- **Limitations on Transport in Soil and Groundwater.** Natural geochemical and hydrogeologic processes limit the transport of fluoride in saturated soils and groundwater downgradient of source areas. These processes include the following:
  - Fluorite precipitation
  - Fluorophosphate precipitation

  - Adsorption (anion exchange) on clays
  - Adsorption on aluminum and iron oxides
- **Geochemical Processes in Nearshore Areas.** Geochemical and other interactions occurring at the point of exchange between groundwater and ditch water and between groundwater and surface water in the Columbia River were evaluated. In addition to the processes listed above, mixing of shallow groundwaters over a depth interval of 8 to 30 feet below ground surface (due to convergence of groundwater flow near ditch boundaries) can lead to precipitation of fluorite or fluorapatite minerals in the aquifer adjacent to the ditch. 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.
- **Fluoride Fate and Transport Modeling.** Groundwater fate and transport modeling was performed to quantitatively evaluate the reliability of these naturally occurring geochemical processes in attenuating fluoride in groundwater and preventing potential surface water quality impacts over the long-term. The following presents a summary of the fate and transport modeling:
  - Reactive transport simulations show an abundance of available calcium in the Upper Alluvium soils and sediments as necessary to arrest in place the dissolved alkaline fluoride plume in the former cryolite area. This 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 made available from site soils 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.
  - Modeling of these processes shows quantitatively that they provide sufficient in situ treatment to be protective of surface water quality in the Columbia River and CDID ditches.

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 fill deposits, such as the Closed Black Mud Pond Facility. These data empirically demonstrate 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.

**PLATE ES-7-1. CONCEPTUAL SITE MODEL—PLAN VIEW**


# Section 7:

# CONCEPTUAL SITE MODEL

Section 7 of the RI/FS provides a summary of the conceptual side model for the Former Reynolds Plant and adjacent portions of the RI/FS Study Area. The Former Reynolds Plant 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 NPDES-permitted on-site drainage system.

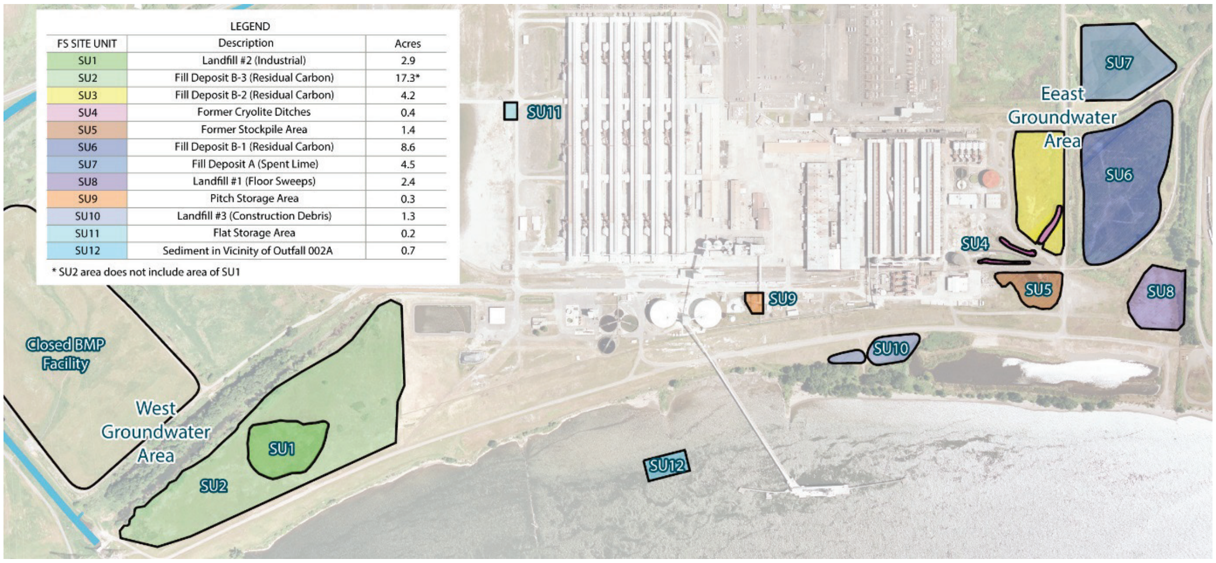
Plate ES-7-1 shows the defined areas of impacted soil and sediment, the locations of on-site landfills, and fill deposits. The nature and extent of impacted soil and fill materials within the facility has been determined. Impacted soils are largely localized to the on-site landfills and fill deposits.

Plate ES-7-1 also shows groundwater gradients in the shallow silt/clay soils of the Upper Alluvium. Groundwater at the site has been extensively monitored, and hydrogeologic and geochemical processes have been evaluated, as described in Section 6 of the RI/FS. Fluoride mobility has been found to be limited due to the function of natural processes.

The final cleanup action for the Former Reynolds Plant must ensure protection of relevant exposure pathways and receptors, including the following:

- **Soil Direct Contact—Industrial Workers.** Fluoride and cyanide, two of the principal chemicals of concern 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 petroleum concentrations) have already been isolated from direct contact as part of previous soil cover placement or cleanup actions. However, localized areas of shallow impacted soil remain on site. Further actions are appropriate to address these localized soil areas and to provide long-term protection against direct contact exposures at the landfills and fill deposits.
- **Protection of Groundwater Quality.** Plate ES-7-1 also shows groundwater gradients in the shallow silt/clay soils of the Upper Alluvium. Groundwater at the site has been extensively monitored, and hydrogeologic and geochemical processes have been evaluated, as described in Section 6 of the RI/FS. Fluoride mobility has been found to be limited due to the function of natural processes. Direct protection of groundwater quality in the Lower Alluvium (located beneath approximately 200 feet of silt/clay soils) from fluoride transport is currently achieved by both site hydrogeologic conditions (i.e., upward hydraulic gradients) and also by the geochemical processes occurring in site soils and groundwater that limit the 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 exceedances of screening levels have been observed. Results of geochemical modeling 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 National Pollutant Discharge Elimination System monitoring events. No impacts to nearshore or offshore sediments were noted except for a localized area immediately adjacent to Outfall 002A. Trend analysis indicates that sediments in this localized area are recovering over time, and existing concentrations are protective of human health. However, at Ecology's request, the sediments in the localized area adjacent to Outfall 002A will be addressed in the FS to maximize protection of benthic organisms that live in the river sediment.

**PLATE ES-8-1. FEASIBILITY STUDY SITE UNITS**




Section 8:

# CLEANUP ACTION REQUIREMENTS

Site units carried forward into the FS are illustrated in Plate ES-8-1. Section 8 of the RI/FS describes the cleanup standards and other regulatory requirements for the cleanup of the Former Reynolds Plant.

Remedial action objectives are general goals to be accomplished by the cleanup action. Remedial action objectives defined for the Former Reynolds Plant include the following:

- 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.
- Protection of human health and the environment by limiting direct contact with impacted media (i.e., soil, residual carbon, spent lime, and groundwater) based on an industrial use scenario.
- Protection of human health and the environment by reducing or controlling migration of fluoride-impacted groundwater.
- Protection of terrestrial ecological receptors.
- Protection of aquatic and benthic ecological receptors.

The cleanup action must also comply with elements of other applicable environmental reviews and permitting requirements. 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 permitting requirements, the action must nevertheless comply with the substantive requirements of such laws (Revised Code of Washington 70.105D.090 and WAC 173-340-710). Potential ARARs are discussed in Section 8.3 of the RI/FS.

Cleanup levels for the chemicals of concern at the Former Reynolds Plant are presented in Section 8.5 of the RI/FS. The presence of a cleanup level does not necessarily mean that MTCA cleanup standards are currently being exceeded. Chemicals of concern identified for the Former Reynolds Plant include the following:

- Fluoride and cyanide in surface water
- Fluoride, cyanide, carcinogenic PAHs, and petroleum in groundwater
- Fluoride, carcinogenic PAHs, PCBs, and petroleum in soil
- Bioassay impacts in bioactive zone sediments near Outfall 002A

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 (WAC 173-340-745). Thus, industrial use is the appropriate basis for development of site-specific soil cleanup levels under the MTCA. As described in Section 8 of the RI/FS, soil cleanup levels are also set to ensure protection of groundwater, indoor air quality, and terrestrial ecological receptors. Cleanup levels that meet these requirements are described in Section 8.5. Also discussed in that section are the points of compliance at which compliance with the cleanup levels will be measured.

The MTCA includes provisions for the use of remediation levels. Remediation levels are concentrations of a chemical that trigger a particular cleanup action or institutional control in an environmental medium. Remediation levels are relevant to the cleanup for fluoride in groundwater. Due to the natural geochemical processes at the site that restrict fluoride mobility, a single groundwater remediation level protective of surface water is not appropriate for the site. Remediation levels for groundwater vary by location (as discussed in Section 8.5) to ensure protection of surface water and groundwater quality.

**PLATE ES-9-1. 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

## Section 9:
# SCREENING OF CLEANUP TECHNOLOGIES

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; a facility still in operation in Ferndale, Washington; and at various other facilities in the United States, with some cleanup actions currently still in progress. There is a wealth of experience from similar facilities that can be applied to determine the best cleanup approach at this site.

Section 9 of the RI/FS screens potential cleanup technologies based on effectiveness, implementability, cost, and a consideration of what technologies have proven successful in remediation of other aluminum production sites. The technologies retained for use in developing cleanup alternatives fall into the following categories:

- **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.
- **Monitored Natural Attenuation.** Natural attenuation is the reduction in concentrations of chemicals in soil, groundwater, and surface water through a combination of naturally occurring physical, chemical, and biological processes.
- **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. Examples include soil or low-permeability caps. Evaluation of containment technologies considered site-specific conditions, including potential seismic and flood hazards.
- **In Situ Treatment.** In situ treatment involves in-place treatment of soil or groundwater. In situ treatments relevant for this project include direct injection of chemical reagents to stabilize or solidify soil, permeable reactive barriers, and backfill amended with reactive agents. Permeable reactive barriers can be very effective for treatment of fluoride in groundwater, using trenches backfilled with limestone and bone meal, which control fluoride through fluorite precipitation and other processes.
- **Removal with On-site Consolidation/Containment or Off-site Disposal.** Removal of impacted soil and residual materials has been widely applied at remediation sites. Excavators, backhoes, and other conventional earth-moving equipment are commonly used to remove contaminated soil from upland areas. Below the water table, shoring and dewatering may be required. Removed impacted materials are either contained on site or are shipped to an off-site permitted treatment or disposal facility. Dredging can be used to remove sediments for containment or off-site disposal.
- **Ex Situ Treatment.** Ex situ treatment (e.g., bioremediation) may be appropriate for on-site management of contaminants (e.g., petroleum-impacted soils).

### PLATE ES-9-1. CROSS SECTIONS OF ALTERNATIVE CAP DESIGNS

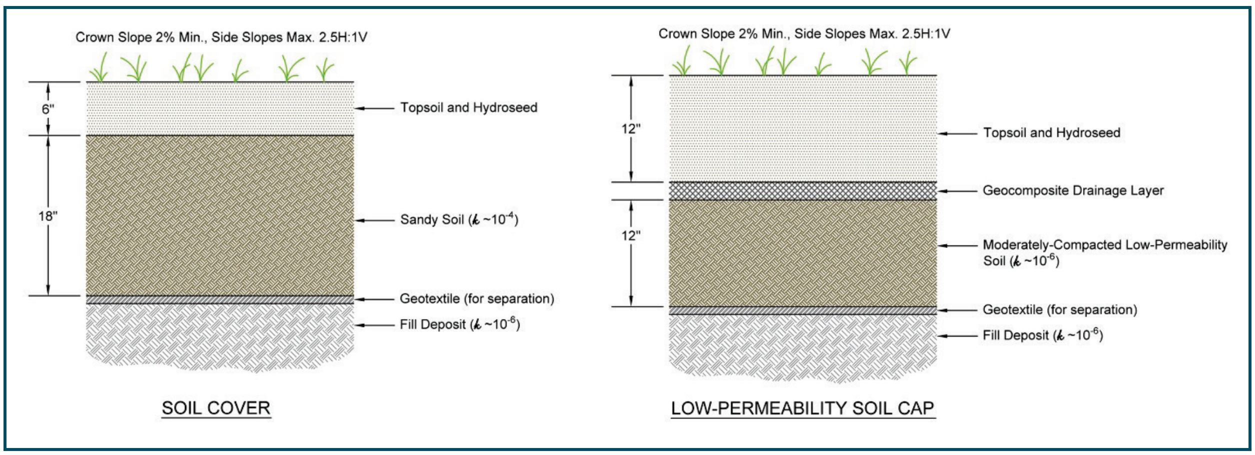
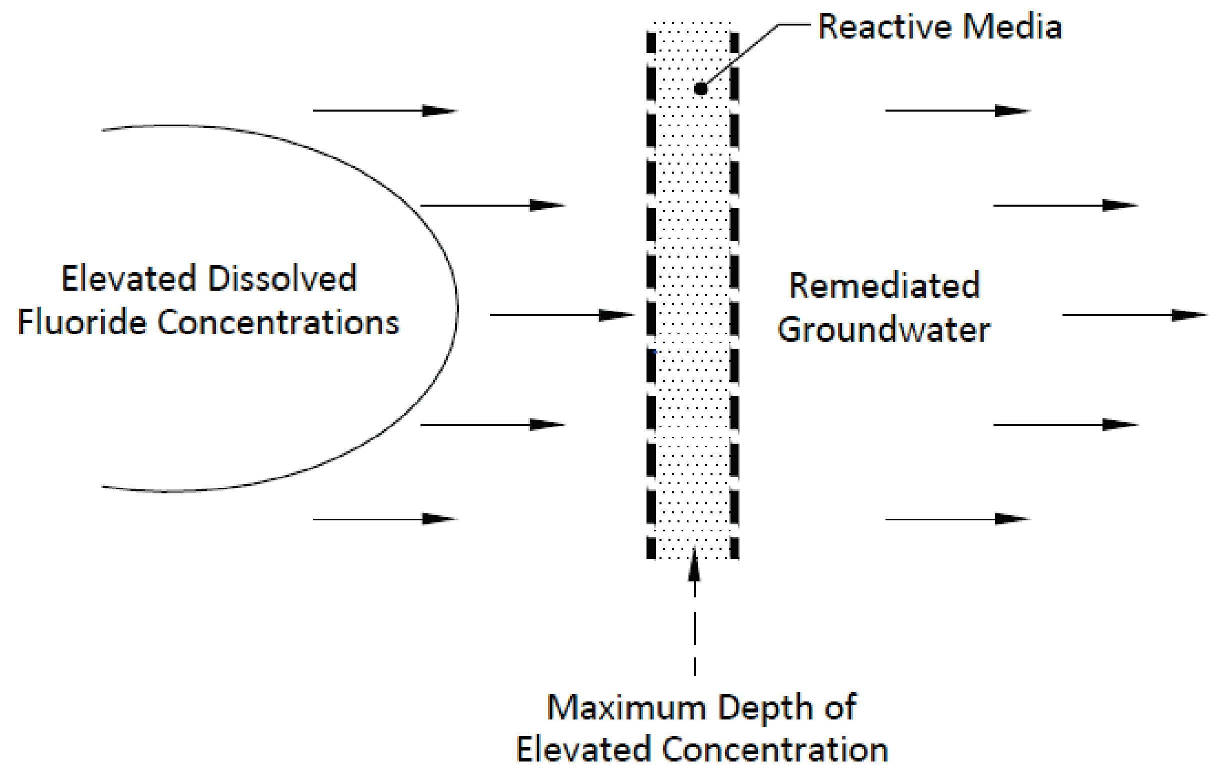


**PLATE ES-9-2. SCHEMATIC ILLUSTRATION OF PERMEABLE REACTIVE BARRIER**




A permeable reactive barrier is a continuous, in situ permeable treatment zone designed to intercept and remediate a contaminant plume. 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 ES-10-1. SUMMARY OF UPLAND REMEDIAL ALTERNATIVE COMPONENTS**

| Remedial Alternative | Cost (millions) | Institutional Controls | Natural Attenuation | In Situ Treatment | Fill Consolidation | On-site Containment | Off-site Disposal |
|---|---|---|---|---|---|---|---|
| 1 | $2.3 | Yes | Yes | No | No | Yes | No |
| 2 | $11.2 | Yes | Yes | No | No | Yes | Yes |
| 3 | $18.9 | Yes | Yes | Yes | Yes | Yes | Yes |
| 4 | $27.7 | Yes | Yes | Yes | Yes | Yes | Yes |
| 5 | $74.8 | Yes | Yes | Yes | Yes | Yes | Yes |
| 6 | $344.4 | Yes | Yes | Yes | No | No | Yes |

Note:
Refer to Plate 10-3 in the RI/FS for cost details.

## Section 10:
# DESCRIPTION OF CLEANUP ALTERNATIVES

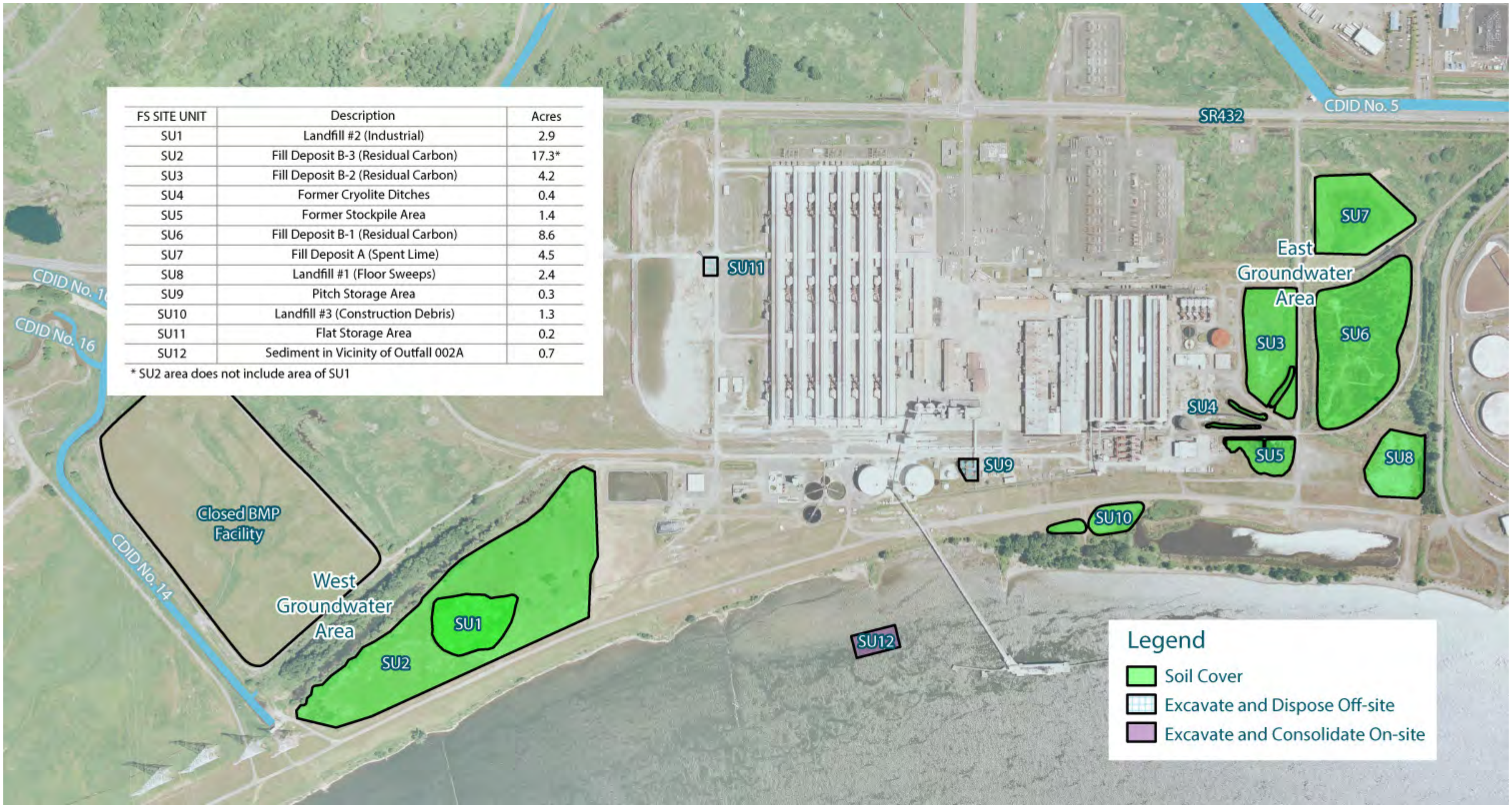
Section 10 of the RI/FS describes six alternatives that were developed and carried forward into the detailed FS evaluation. The six alternatives (see Plate ES-10-1) illustrate the range of approaches that can be used to conduct the final cleanup of the facility, using the suite of technologies retained during the technology screening in Section 9. The alternatives are arranged in general order of the MTCA preference and in order of increasing costs.

The following six remedial alternatives were developed for consideration at the site:

- **Alternative 1 – Institutional Controls and Natural Attenuation/Sediment Removal.** Under this alternative, there would not be additional removal or containment of landfills or impacted soil and no monitoring beyond current activities required by existing regulatory permits and orders. However, an environmental covenant would be filed to limit consumption of shallow groundwater as drinking water and to prohibit activities potentially encountering or disturbing hazardous materials. An environmental covenant or other equivalent institutional control would also be executed to ensure implementation of appropriate construction methods for future land use development, as needed, including use of appropriate installation methods for subsurface utilities and structural piling. Sediments near Outfall 002A would be dredged and contained at an upland, on-site location. 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.
- **Alternative 2 – Localized Removal and Off-site Disposal, Soil Capping, Natural Attenuation, and Institutional Controls/Sediment Removal (see Plate ES-10-2).** Alternative 2 focuses on use of enhanced containment, using physical barriers in addition to institutional controls to prevent direct contact with affected media. The physical barriers would be used to prevent contact with fill deposit and landfill materials as well as impacted soils and groundwater. Containment technologies would be used to achieve compliance with cleanup standards at the site, including placement of enhanced soil cover over areas of concern, and backfilling selected on-site ditches that intercept groundwater. Sediments near Outfall 002A would be dredged and contained at an upland, on-site location.

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.

- **Alternative 3 – Localized Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Soil Capping, Natural Attenuation, and Institutional Controls/Sediment Removal (see Plate ES-10-3).** Alternative 3 includes all of the remedial technologies identified in Alternative 2 with the addition of on-site consolidation to reduce the footprint of SU2 (Fill Deposit B-3) and to move SU10 (Landfill #3) to the inside of the CDID levee. Sediments near Outfall 002A would be dredged and contained in upland, on-site areas. Alternative 3 also includes the construction of two permeable reactive barriers and the use of reactive backfill in selected areas. The consolidation of fill deposit, sediments, 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 point of compliance. 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.
- **Alternative 4 – Localized Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Low-permeability Capping, Natural Attenuation, and Institutional Controls/Sediment Removal (see Plate ES-10-4).** Under this alternative, SU3 (Fill Deposit #2), SU5 (Former Stockpile Area) and SU8 (Landfill #1) would be excavated and consolidated on site. Reactive backfill would be placed in SU3 and SU5. Areas of remaining or consolidated fill landfills or deposits would be capped with a low-permeability soil cap to reduce infiltration and further isolate affected media. A permeable reactive barrier would be added to the northwest corner of the site to reduce the groundwater restoration timeframe in that area. Sediments near Outfall 002A would be dredged and contained at an upland, on-site location. 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.
- **Alternative 5 – Expanded Removal and Off-site Disposal, Excavation and Consolidation, Groundwater Treatment, Low-permeability Capping, Natural Attenuation, and Institutional Controls/Sediment Removal (see Plate ES-10-5).** Alternative 5 is similar to Alternative 4, but off-site disposal would be used for soils and fill materials excavated from SU3 (Fill Deposit B-2), SU5 (Former Stockpile Area ), SU8 (Landfill #1) and SU10 (Landfill #3) rather than on-site consolidation. Additional permeable reactive barriers would also be installed in the eastern portion of the facility.
- **Alternative 6 – Aggressive Removal and Off-site Disposal, Natural Attenuation, and Institutional Controls/Sediment Removal (see Plate ES-10-6).** Alternative 6 expands the use of removal and off-site disposal to soils and fill materials from SU1 and SU2 (Fill Deposit B-3 and Landfill #2), SU6 (Fill Deposit B-1), and SU7 (Fill Deposit A). A permeable reactive barrier would be added to the northwest corner of the site to reduce the groundwater restoration timeframe in that area. Sediments removed from the area around Outfall 002A (SU-12) would also be managed by off-site disposal. This alternative would minimize the footprint of capped soil areas on site. However, long-term monitoring would be conducted as under other alternatives to verify remedy effectiveness, natural attenuation and stability of groundwater conditions, and continued protection of surface water resources at the points of compliance.



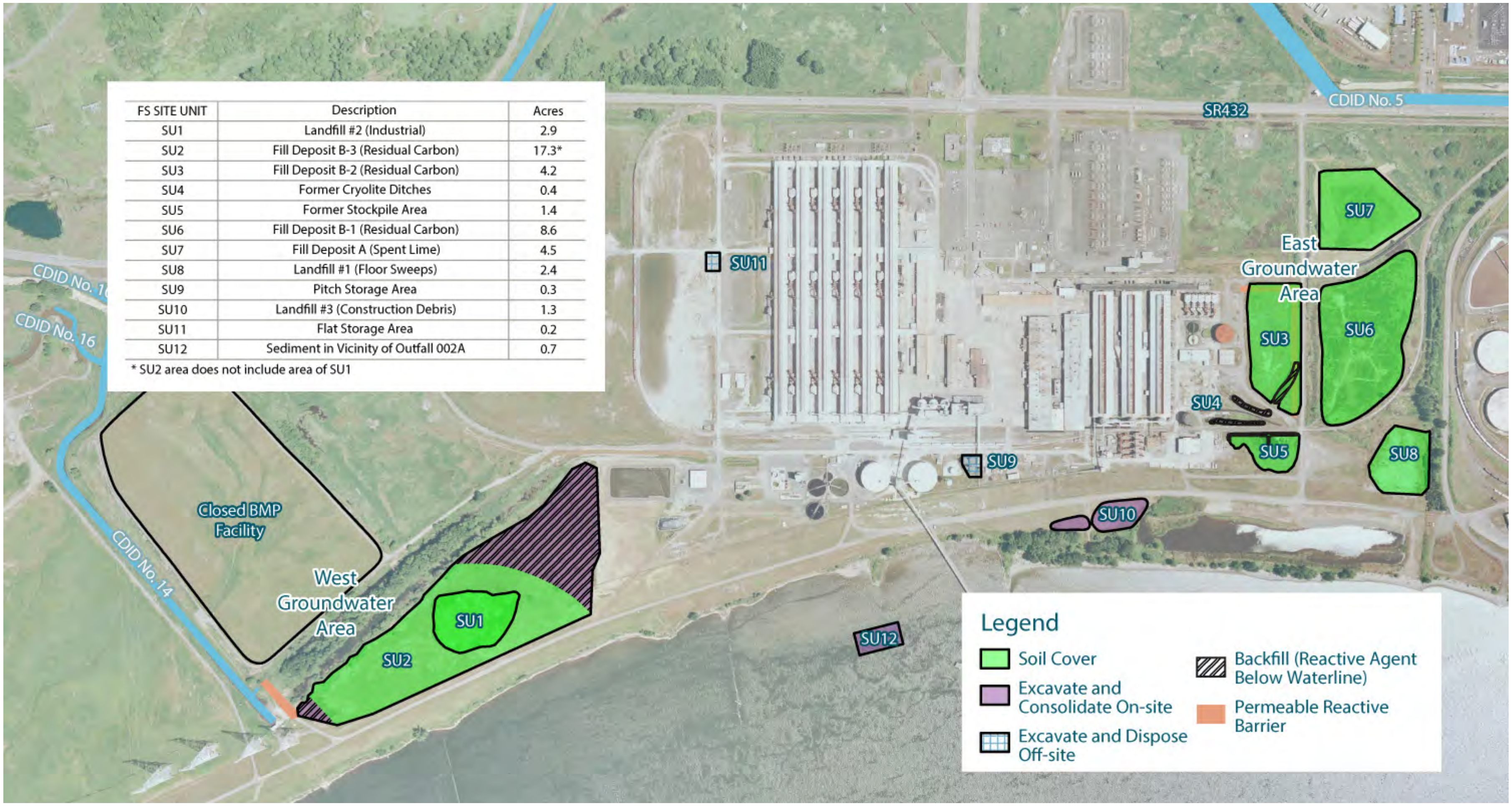

| FS SITE UNIT | Description | Acres |
|---|---|---|
| SU1 | Landfill #2 (Industrial) | 2.9 |
| SU2 | Fill Deposit B-3 (Residual Carbon) | 17.3* |
| SU3 | Fill Deposit B-2 (Residual Carbon) | 4.2 |
| SU4 | Former Cryolite Ditches | 0.4 |
| SU5 | Former Stockpile Area | 1.4 |
| SU6 | Fill Deposit B-1 (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.

ANCHOR QEA

**Plate ES-10-2**
Alternative 2
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



| 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 |

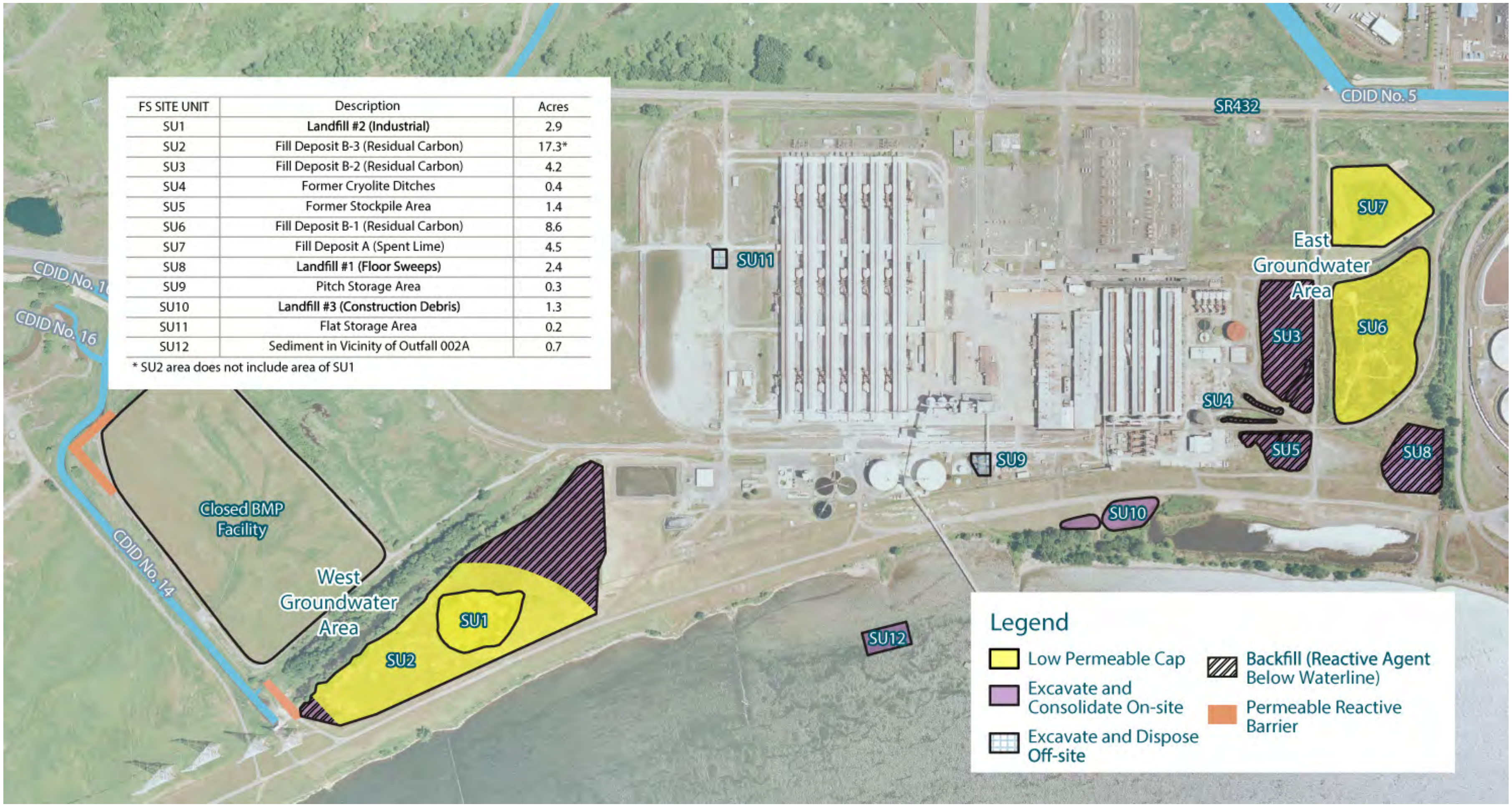
* SU2 area does not include area of SU1



**SOURCE**: Drawing prepared from Alta Survey (Minister & Glaeser Surveying, Inc.) by November 11, 2010. Aerial image from Aerometric dated June 2013.

ANCHOR QEA

**Plate ES-10-3**
Alternative 3
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



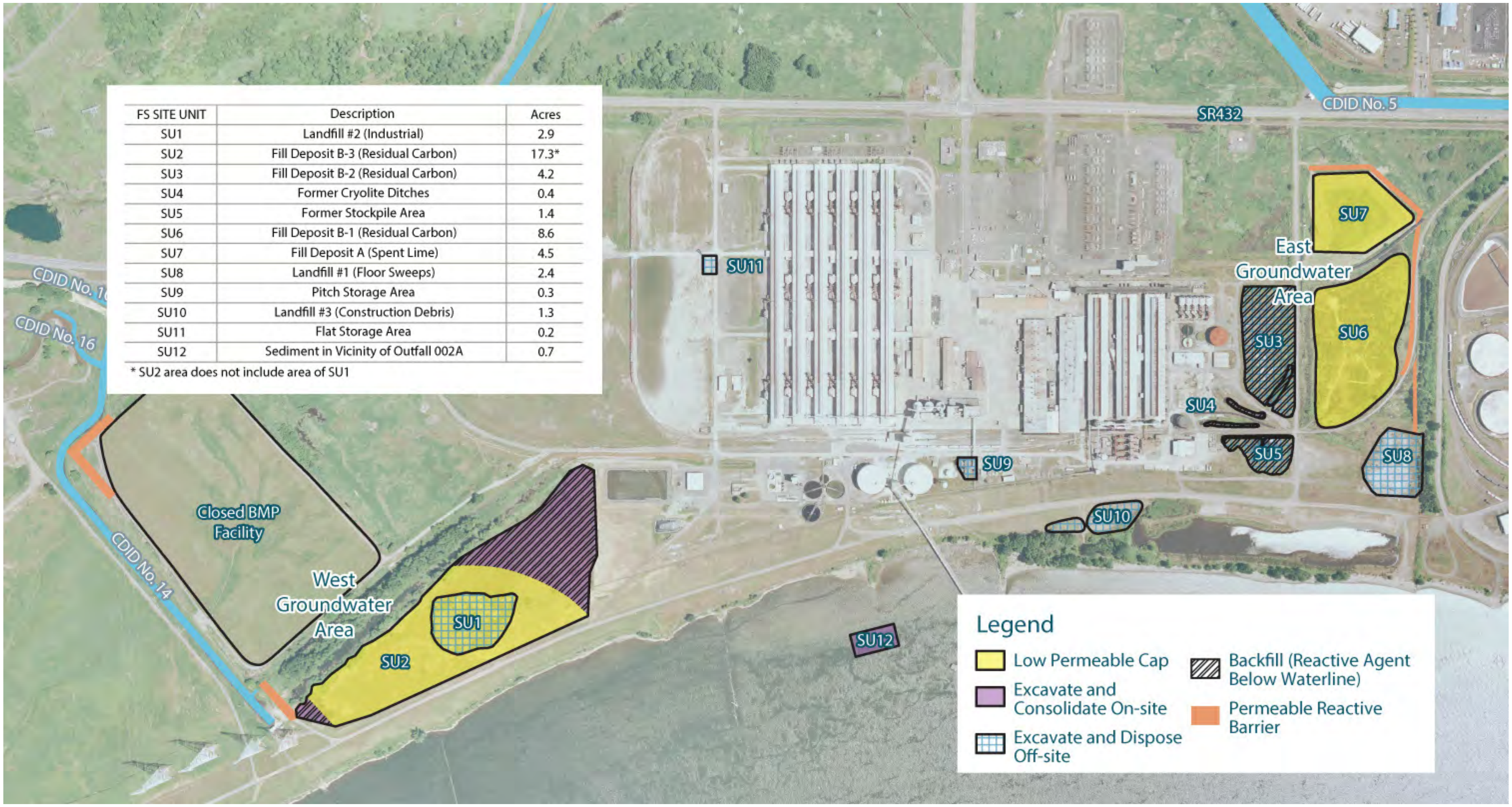

| FS SITE UNIT | Description | Acres |
|---|---|---|
| SU1 | **Landfill #2 (Industrial)** | 2.9 |
| SU2 | Fill Deposit B-3 (Residual Carbon) | 17.3* |
| SU3 | Fill Deposit B-2 (Residual Carbon) | 4.2 |
| SU4 | Former Cryolite Ditches | 0.4 |
| SU5 | Former Stockpile Area | 1.4 |
| SU6 | Fill Deposit 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.

ANCHOR QEA

**Plate ES-10-4**
Alternative 4
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview



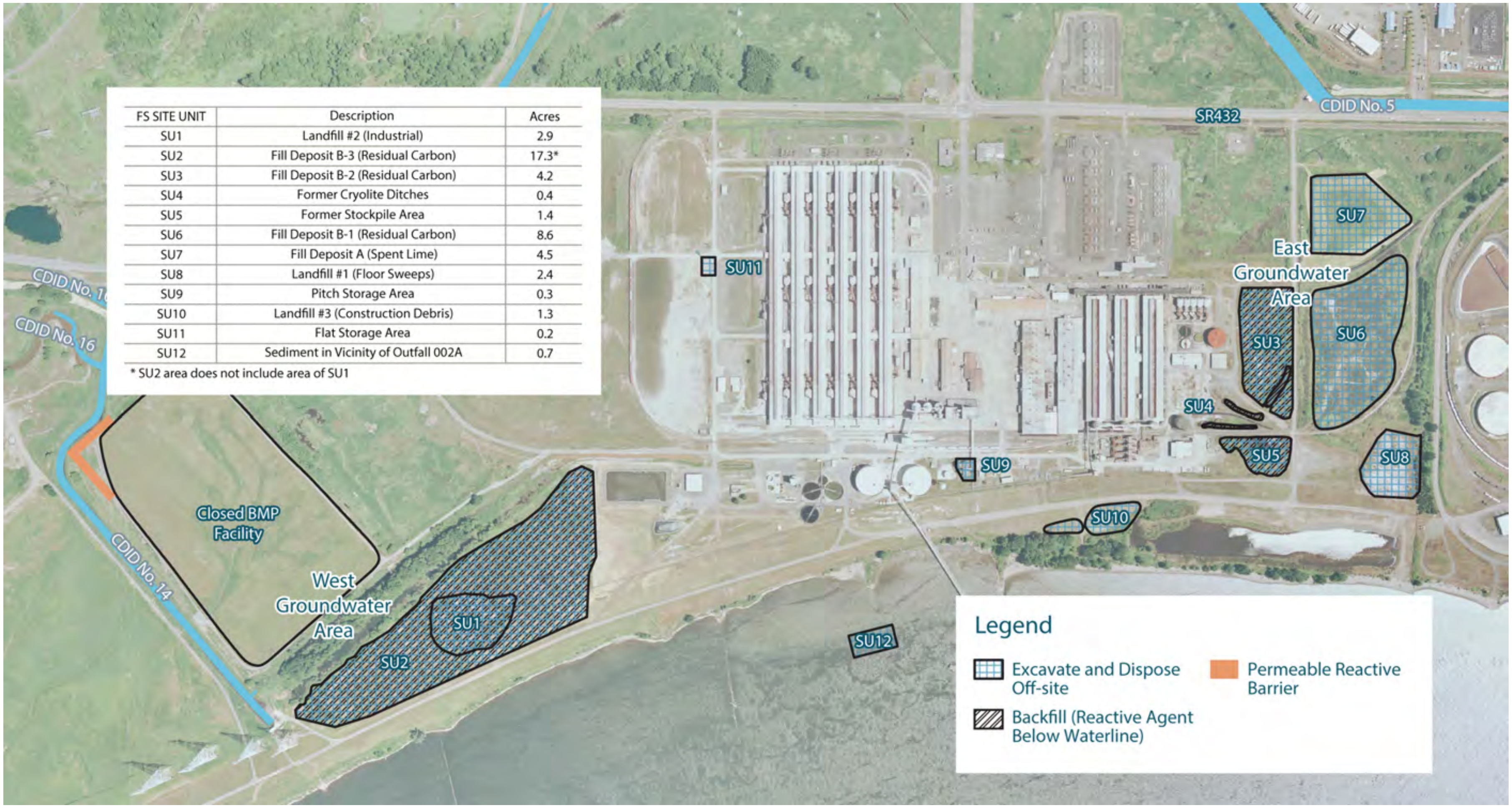

| FS SITE UNIT | Description | Acres |
|---|---|---|
| SU1 | Landfill #2 (Industrial) | 2.9 |
| SU2 | Fill Deposit B-3 (Residual Carbon) | 17.3* |
| SU3 | Fill Deposit B-2 (Residual Carbon) | 4.2 |
| SU4 | Former Cryolite Ditches | 0.4 |
| SU5 | Former Stockpile Area | 1.4 |
| SU6 | Fill Deposit B-1 (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.

ANCHOR QEA

**Plate ES-10-5**
Alternative 5
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview




| 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.

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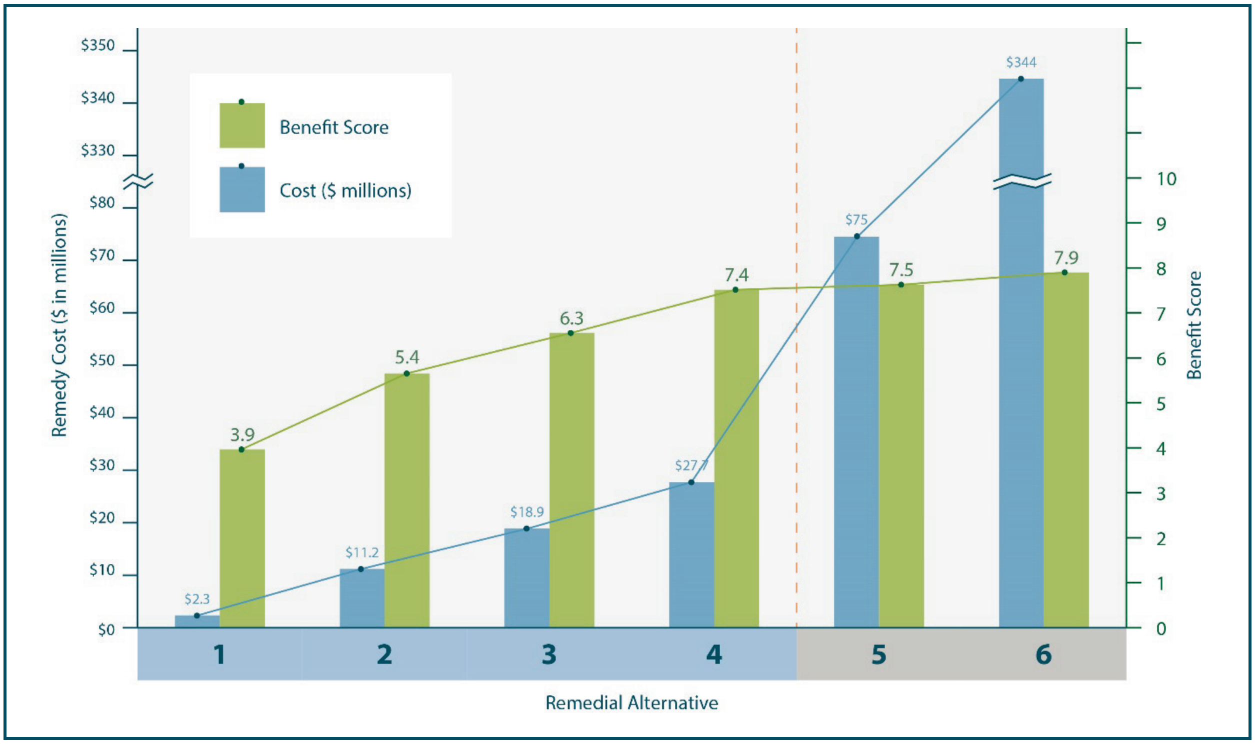
**Plate ES-10-6**
Alternative 6
Remedial Investigation/Feasibility Study
Former Reynolds Metals Reduction Plant – Longview

**PLATE ES-11-1. SUMMARY OF THE MTCA DISPROPORTIONATE COST ANALYSIS**




Section 11:

# EVALUATION OF CLEANUP ALTERNATIVES

The MTCA regulations identify specific criteria against which alternatives are to be evaluated. All cleanup actions must at a minimum meet the requirements of the threshold criteria. Additional MTCA criteria are considered when selecting from among the alternatives that fulfill the threshold requirements.

The six remedial alternatives all meet the threshold criteria, including the following:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws
- Provide for compliance monitoring

Other MTCA requirements for evaluating remedial alternatives for the selection of a cleanup action include the following:

- **Provide for a Reasonable Restoration Timeframe (WAC 173-340-360(4)).** The MTCA places a preference on those alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. The 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 raised during public review of the RI/FS (this document) and Ecology's cleanup decision (the Cleanup Action Plan).

- **Use of Permanent Solutions to the Maximum Extent Practicable (WAC 173-340-360(3)).** The 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 and practicability is to be conducted. Specifically, the regulations require that the costs and benefits of each of the project alternatives be balanced using a disproportionate cost analysis. That analysis considers the following seven MTCA criteria included in WAC 173-340-360(3)(e):
  - **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; on- and off-site risks that would occur from implementing the alternative; and the overall improvement of environmental quality.
  - **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 the MTCA to be more permanent than containment actions (which only reduce the mobility).
  - **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.
  - **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. This considers potential risks of implementing each alternative and the potential effectiveness of best management practices at controlling short-term risks.
  - **Technical and Administrative Implementability.** Evaluating an alternative's technical and administrative implementability includes consideration of factors, such as availability of necessary facilities, services, and materials; administrative and regulatory requirements; size and complexity of the alternative; and other factors.
  - **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. Ecology determined that the MTCA evaluation should be modified to reflect public input in this final FS. Specifically, "Public Concerns" was added as a criterion to the disproportionate cost analysis.
  - **Cost.** In the disproportionate cost analysis, the benefits of the alternatives are compared to the costs. Estimated costs for each remedial alternative 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).

Plate ES-11-2 provides a summary of how each alternative was scored against these MTCA benefits criteria. This analysis was performed with input from Ecology. The benefits score for each alternative includes 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 includes Ecology-specified weightings that favor remedy permanence.

**PLATE ES-11-2. SUMMARY OF UPLAND REMEDIAL ALTERNATIVE COMPONENTS**

| Alternative (Cost in millions) | Model Toxics Control Act Benefits Criteria[1] (Weighting) | | | | | | Composite Benefits Score[1,2,3] |
|---|---|---|---|---|---|---|---|
| | Protectiveness (25%) | Permanence (20%) | Long-term Effectiveness (20%) | Short-term Risk Management (15%) | Technical and Administrative Implementability (10%) | Consideration of Public Concerns (10%) | |
| Alternative 1 ($2.3) | 2 | 2 | 2 | 10 | 10 | 1 | 3.9 |
| Alternative 2 ($11.2) | 5 | 4 | 5 | 9 | 9 | 1 | 5.4 |
| Alternative 3 ($18.9) | 6 | 6 | 6.5 | 8 | 8.5 | 2 | 6.3 |
| Alternative 4 ($27.7) | 7.5 | 8 | 7.5 | 7.5 | 8 | 5 | 7.4 |
| Alternative 5 ($74.8) | 8 | 8 | 8 | 6 | 7 | 7 | 7.5 |
| Alternative 6 ($344.4) | 9 | 9 | 9 | 4 | 5 | 9 | 7.9 |

Notes:
1 = Benefits criteria evaluated in the disproportionate cost analysis are specified under Model Toxics Control Act (WAC 173-340-360(3). Weightings are as specified by Ecology.
2 = Refer to Section 11 and Plate 11-1 in the RI/FS for a detailed discussion of factors influencing the ranking of each alternative.
3 = Consideration of public concerns was evaluated by Ecology based on input received during the comment period.

The environmental benefits scores for each alternative ranged from 3.9 (Alternative 1) to 7.9 (Alternative 6). The breakpoint at which incremental costs outweigh incremental environmental benefits is clearly visible in Plate ES-11-1. Alternative 3 has a relatively high benefit score, offers a high degree of protection, and is cost effective. However, Alternative 4 is more permanent and provides additional source control, reduction in infiltration in capped areas, and may provide a more reasonable restoration timeframe. This results in an increase in the benefits score of 17 percent between Alternative 3 and Alternative 4, but benefits scores for the next two alternatives increase 1 percent and 5 percent, respectively.

In contrast to the benefits scores that reach a plateau after Alternative 4, the costs increase dramatically between Alternatives 4 and Alternatives 5. Though the costs increase by 250 percent between alternatives 4 and 5, the benefits scores do not change. The costs increase dramatically between Alternatives 5 and 6, increasing by more than 450 percent, while the environmental benefits increase by a mere 5 percent. As shown in Plate ES-11-1 the incremental costs outweigh the incremental benefits by a large margin beyond Alternative 4.

Based on the MTCA disproportionate cost analysis, Alternative 4 is the alternative considered permanent to the maximum extent practicable per WAC 173-340-360(3)(e).

**PLATE ES-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 permeable reactive barriers to intercept and treat groundwater |
| | Backfilling on-site ditches that intercept groundwater, with an upgrade to reactive backfill within select site units |
| Waste and Sediment Consolidation | Focused remedial excavation and on-site consolidation of six site units, 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 site units, where chemicals of concern exceed cleanup levels |
| Other | Long-term monitoring of surface water and groundwater at points of compliance |

# Section 12:
# PREFERRED REMEDIAL ALTERNATIVE

## Description of the Preferred Alternative

Under the disproportionate cost analysis (see Section 11), this alternative was evaluated and found to be the alternative that was permanent to the maximum extent practicable. This alternative, which is defined as the preferred alternative in the draft RI/FS, blends a number of remedial technologies, including removal, consolidation, capping, groundwater treatment, and monitored natural attenuation, resulting in a robust remedy that addresses all identified site conditions.

Plates ES-12-1 and ES-12-2 describe how Alternative 4 applies different remedial technologies to accomplish the final cleanup of the Former Reynolds Plant. The preferred alternative is shown in Plate ES-10-4. Key elements of the alternative include the following:

- **Consolidation of Landfills and Fill Deposits.** Alternative 4 includes the excavation and consolidation of materials from several site units to minimize the footprint of areas requiring long-term containment. The landfill (Landfill #3 – SU10) currently located outside of the levee will be removed and consolidated with other materials within the main facility.
- **Construction of Low-permeability Caps and Reactive Backfill.** Landfills and fill deposits to remain on site will be contained with low-permeability caps to further reduce infiltration and optimize containment of fluoride in shallow groundwater within the silt/clay soils near the deposits.
- **Soil Removal and Off-site Disposal.** The impacted portions of the pitch and former Flat Storage Areas (SUs 9 and 11) are isolated and comparatively small in volume. Under Alternative 4, these impacted soils will be addressed by excavation and off-site disposal.

- **Treatment of Fluoride with Permeable Reactive Barriers and Reactive Backfill.** Natural geochemical processes occurring at the site limit the migration of fluoride laterally and vertically and the silt/clay soils and groundwater beneath the landfill and fill deposits. In addition, the upward groundwater gradients beneath the site protect deep groundwater resources in the Lower Alluvium. Alternative 4 includes construction of permeable reactive barriers (vertical trenches backfilled with limestone and bone meal) to bolster the natural processes and to further isolate fluoride in groundwater. Alternative 4 also includes the use of reactive backfill for the former cryolite area ditches and selected excavation areas created during the removal and consolidation of soil and fill deposits.
- **Sediment Removal.** Alternative 4 includes the removal of sediment located near Outfall 002A and consolidation of that sediment in the uplands beneath a low-permeability cap.
- **Institutional Controls and Monitoring.** Alternative 4 includes institutional controls and monitoring to verify remedy effectiveness and natural attenuation of groundwater and surface water resources at the points of compliance.

## Basis for Identification of the 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 the MTCA and with other applicable or relevant and appropriate standards and laws
- Achieves human health and environmental protection in a relatively rapid timeframe 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 and solid media remaining on site to the extent practicable, consistent with Ecology expectations for remedial alternatives, as defined under the MTCA
- 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 and has historically been used; land use is consistent with the uses at surrounding properties
- Is cost effective relative to the range of alternatives evaluated

## PLATE ES-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] | | | |
| 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

## Next Steps

The following outlines the next steps in the cleanup process:

- Ecology requested that the sediment removal component of the cleanup be expedited as an interim action. Ecology amended the existing Agreed Order to cover this work, and an interim action work plan was prepared.
- Ecology solicited public comments on the draft RI/FS and sediment cleanup action work plan and associated Agreed Order amendment in June to July 2014.
- After reviewing the comments, Ecology decided the sediment removal should move forward as proposed. Permitting for this action is in progress, and the work is scheduled to be performed during the next allowable in-water work window, contingent on permitting.
- Ecology has finalized this RI/FS after considering public comments.
- Ecology will now begin work to develop its proposed cleanup decision and document that decision in a draft Cleanup Action Plan. Ecology will also develop a draft Consent Decree (a legally binding agreement to implement the cleanup action) and will evaluate potential environmental impacts of the proposed cleanup actions in accordance with the State Environmental Policy Act.
- Ecology will solicit public comments on the draft Cleanup Action Plan, draft Consent Decree, and State Environmental Policy Act determination.
- After considering comments received on the draft Cleanup Action Plan, Ecology will then finalize the document and execute the Consent Decree with Northwest Alloys and MBTL.
- The cleanup action will then be implemented, including completion of design, permitting, and construction.
- Long-term care of the site will include implementation of institutional controls, completion of long-term monitoring, and periodic review of the cleanup by Ecology during its 5-year reviews.

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