Wishram Railyard Sediment Feasibility Study

Ecology Site Name: BNSF Wishram Track Switching Facility
Ecology Facility/ Site ID: 1625461
Cleanup Site ID: 230
Version: Draft

BNSF Railway Company
BNSF Wishram Railyard, Wishram, Washington

Wishram Railyard Sediment Feasibility Study
November 8, 2024

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Project name:	Wishram Railyard Sediment Feasibility Study		
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Executive Summary

This Sediment Feasibility Study (FS) was prepared by Jacobs on behalf of BNSF Railway Company (BNSF) for the BNSF Wishram Railyard (aka BNSF Track Switching Facility, "site") located in Wishram, Washington (Figure ES-1). Initial investigations were conducted in 2018 to investigate the potential presence of non-aqueous phase liquid (NAPL) in sediment in the nearshore area, characterize the nature and extent of NAPL if present, and evaluate nearshore sediment against applicable sediment cleanup standards (CH2M 2018). The Initial Investigation Work Plan was approved by the Washington State Department of Ecology (Ecology) on February 7, 2018, and field work was performed in June and August 2018. Following the initial work, the Sediment Remedial Investigation (RI) Work Plan (RI Work Plan) (Jacobs 2021) was developed to further characterize and delineate the area of impacted sediment. The RI Work Plan was approved by Ecology in 2021, and the RI field effort was conducted in two mobilizations between April and November 2022. A revision to the RI Work Plan was requested by Ecology on October 3, 2022, and BNSF submitted the Sediment Remedial Investigation Work Plan Revision 1 (Jacobs 2022) on October 25, which was subsequently approved by Ecology on October 27, 2022.

The remedial investigation was conducted in 2023 and identified a zone of NAPL impacts within approximately 140 feet of the shoreline which consisted of localized saturated or coated sediments and NAPL-coated woody debris with odors. No bedding structure was visible, and the abundance of mixed organic debris in the NAPL-impacted intervals suggest that these materials represent a layer of material that was in place before the land was inundated by the filling of Lake Celilo.

The RI identified this area as the source of the intermittent sheens at the site based on its location (adjacent to historically observed intermittent sheens), depth, peak Tar-specific Green Optical Screening Tool (TarGOST) responses, and consistent observations of saturated NAPL conditions (Jacobs 2024). The sheen-generating NAPL is between approximately 40 and 140 feet south of the shoreline and is present at thicknesses of up to 6 feet and at depths ranging from 0.5 foot below sediment surface (bss) to the south and 9.5 feet bss to the north (Figure ES-2). To the south, the NAPL-impacted interval thins and is closer to the sediment surface, as the sediment surface slopes downward. When the sediment bathymetry drops below the base of the impacted interval to the south (~141 feet above mean sea level), NAPL is no longer found. This is consistent with a historical surface release from the uplands that was controlled by the site topography before Lake Celilo was filled (Jacobs 2024). The main NAPL body, shown on Figure ES-2, represents the area targeted for remediation.

The purpose of this FS is to develop and evaluate remedial alternatives for the sheen-producing area in sediment at the site and the surface sediment locations resulting in risk to ecological receptors and human health, as described in the Sediment Remedial Investigation Report (Jacobs 2024).

Washington Administrative Code (WAC)173-340-351 and WAC 173-204-550 detail the requirements for the development of remedial alternatives. The regulations recommend a number and types of alternatives taking into account the characteristics and complexity of the facility, including current site conditions and physical constraints and the threats posed by the site to ecological receptors, human health and the environment.

The alternatives were evaluated to ensure that they met the threshold criteria: protection of human health and the environment, compliance with cleanup standards and applicable state and federal laws, provide for compliance monitoring, and complete restoration in a reasonable timeframe. Those alternatives that do not meet the threshold criteria were not considered further.

Based on the evaluation, six alternatives were developed, including the No Action alternative as required by Sediment Cleanup User's Manual Section 12.4.4 (Ecology 2021):

- Alternative 1 – No Action
- Alternative 2 – Removal, Backfill and Offsite Disposal
- Alternative 3 – Capping and Institutional Controls
  - Alternative 3A – Capping with AquaGate + Organoclay™ and Institutional Controls
  - Alternative 3B – Capping with a Reactive Core Mat (RCM) and Institutional Controls
  - Alternative 3C – Capping with RCM and a Marine Armor Mat (MAM) and Institutional Controls
- Alternative 4 – In-Situ Stabilization (ISS), Backfill and Institutional Controls

Retained alternatives were then compared using the disproportionate cost analysis (DCA), a Washington State Model Toxics Control Act procedure to evaluate tradeoffs, including costs, among technologies. As part of the DCA, the following categories are considered:

- **Protectiveness.** The overall protectiveness of human health and the environment.
- **Permanence.** The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances. Consider treatment capability, reduction of releases, management of the sources of release, degree of irreversibility of treatment, and the quantity and quality of treatment wastes.
- **Effectiveness Over the Long-Term.** The degree of certainty for cleanup success, long-term reliability, magnitude of residual risk, management of treatment wastes, and management of wastes left untreated. The criteria also considers the potential impacts to vulnerable populations and overburdened communities, including tribal nations.
- **Management of Implementation Risks.** The risk to human health and the environment associated with the alternative during construction and implementation.
- **Technical and Administrative Implementability.** The ability to be implemented including consideration of whether the alternative is technically and administratively possible.
- **Cost.** The cost to implement the alternative. Includes present capital costs, future capital costs, indirect costs, and operation and maintenance costs.

The relative benefits and costs of each alternative were compared to Alternative 2 in the DCA. Alternative 2 (removal) represents the most permanent cleanup action alternative (baseline alternative) against which the other alternatives are evaluated for the purpose of determining whether the cleanup action selected is permanent to the maximum extent practicable. It therefore provides the benchmark against which the relationship between incremental remedy benefits and incremental costs of other remedial alternatives are evaluated. This analysis was used to determine whether the proposed cleanup actions are permanent to the maximum extent practicable.

The total benefits for the remedial alternatives range from5.4 to 7.5, and present-worth costs range from $3.16M to $7.02M. The following conclusions were drawn from the DCA:

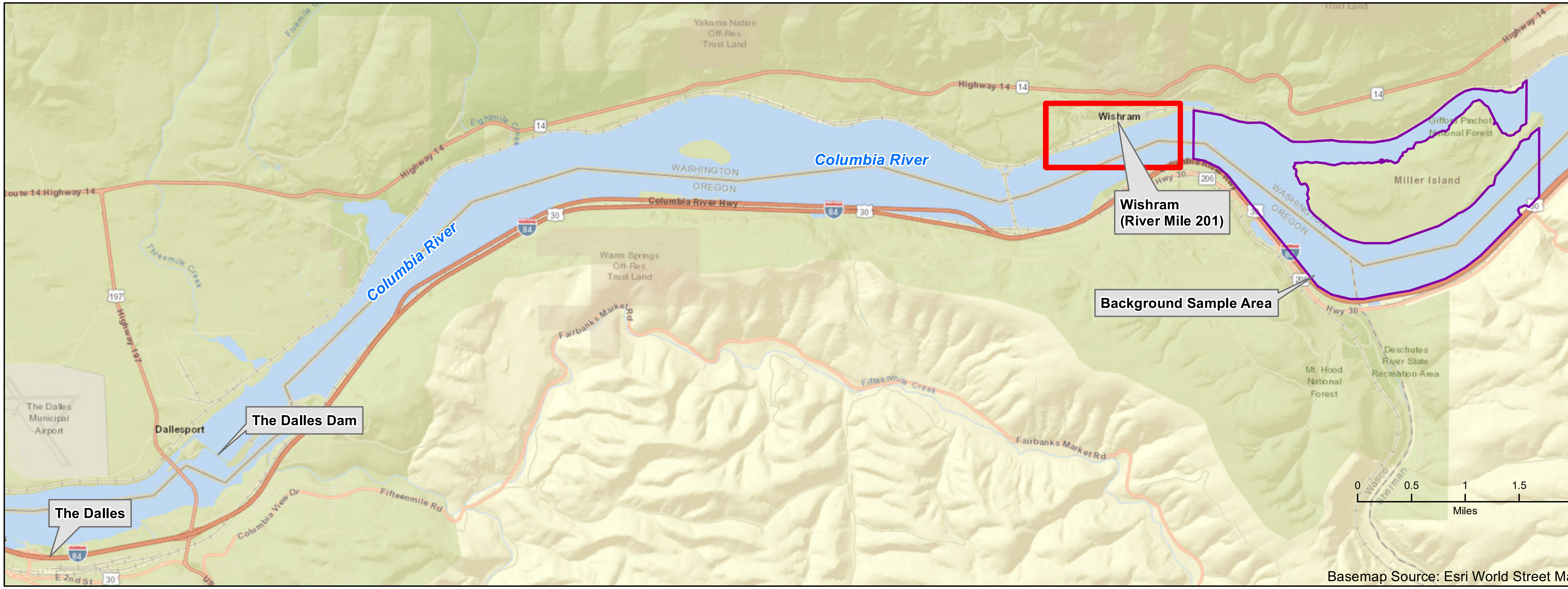
- Higher cost alternatives do not necessarily show proportional increases in overall benefit, especially when comparing capping alternatives (Alternatives 3A, 3B, and 3C) against Alternatives 2 and 4.
- The total benefit scores indicate that removal of sediments with NAPL-impacts results in a higher overall score, with scores highest in protectiveness, permanence, and effectiveness over the long-term

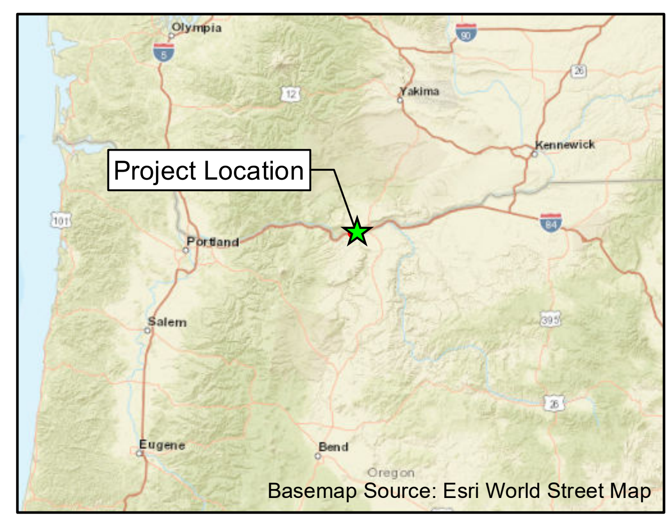
criteria. The lowest overall score is for Alternative 4 – ISS, due to the low scores for implementation risks, effectiveness over the long-term (which considers impacts to vulnerable populations and overburdened communities, including tribal nations), and technical and administrative feasibility.

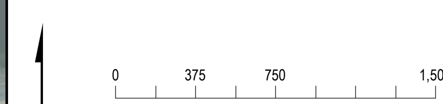
- Costs range from $3.16M (Alternative 3A) to $7.02M (Alternative 2) while the cost per benefit ranges from $0.45M to $0.94M for Alternatives 3A and 2, respectively. Remedial Alternative 3A has the lowest cost of $0.45M per benefit gained and remedial Alternative 2 has the highest cost of $0.94M per benefit gained.
- The three capping alternatives – Alternatives 3A, 3B, and 3C – scored similarly with the highest overall rating for Alternative 3C due to the potential long-term benefits of using a more aggressive approach to erosion by installing the MAM (which due to the nature of the river in that area is not considered necessary); however, the additional benefit is not proportionate relative to Alternative 3A and 3B. Remedial alternative 3A has the lowest cost of $0.45M per benefit gained.
- Alternative 3 - Capping (all three options) has other benefits that result in higher or similar scores with respect to Alternative 2 (Removal), especially for management of short-term risk and technical and administrative implementability. This method also reduces negative impacts to the environment and potential for tribal and/or related artifact removal or disturbances.
- Because the cost of Alternative 2 ($7.02M) is substantially higher than that of Alternative 3A ($3.16M), while the level of benefit is marginally greater (7.5 vs. 7.1, respectively), the incremental cost of Alternative 2 is considered disproportionate.
- In addition, for Alternative 3A, the level of benefit is marginally lower with a substantially lower incremental cost to benefits ratio compared to Alternative 2, thus the incremental cost of Alternative 2 is considered disproportionate.
- The level of benefits for Alternative 4 is substantially lower than that of Alternative 3A (5.4 vs. 7.1, respectively), and the ratio of cost to benefits is considerably higher ($0.91M vs. $0.45M). Therefore, the incremental cost of Alternative 4 is considered disproportionate.

The results of the DCA indicate that, at a minimum, Alternative 2 and Alternative 4 are disproportionately costly compared to their respective benefits in relation to Alternatives 3A, 3B, and 3C. Among the three capping alternatives, Alternative 3A has the lowest cost of $0. 45M per benefit gained as compared to Alternatives 3B and 3C ($0.54M and $0.61M, respectively). Thus, Alternative 3A was identified as the most appropriate alternative for the site.

The final identification of the remedial alternative would be stipulated in the cleanup action plan (CAP), which documents the selected cleanup action and specifies the cleanup standards and other requirements that the cleanup action must meet.







Notes:
Lake Celilo extends from The Dalles Dam 24 miles upstream

Figure ES-1. Site Location Map
BNSF Track Switching Facility
Wishram, Washington

Jacobs

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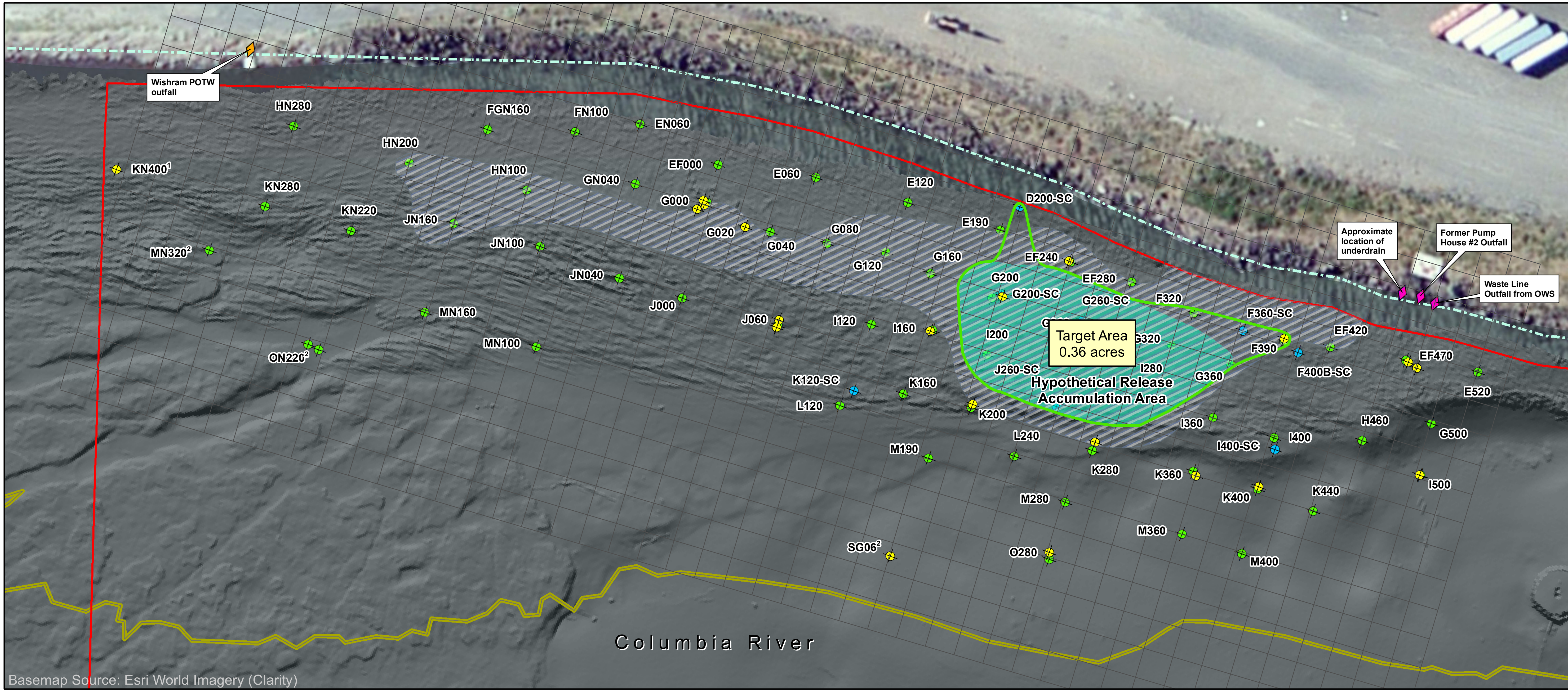

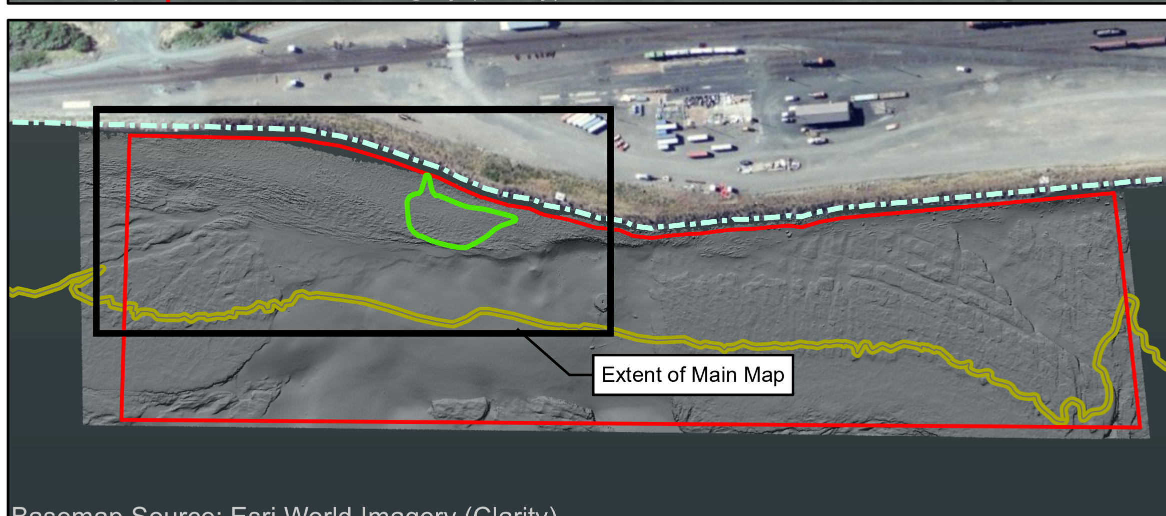

LEGEND

- Target Area (0.36 acres)
- Extent of NAPL-affected Area
- Approximate Extent of Sheen-Generating NAPL Impacts
- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

0 25 50 100
Feet

Note: Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution. Remedial Action and long-term monitoring will only be conducted in the hatched area.

Figure ES-2. Target Area
BNSF Track Switching Facility
Wishram, Washington

Jacobs

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Acronyms and Abbreviations

AO	Agreed Order
ARAR	applicable or relevant and appropriate requirement
BAZ	biologically active zone
BNSF	BNSF Railway Company
bss	below sediment surface
CAP	cleanup action plan
COC	constituent of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level
CSM	conceptual site model
CUL	cleanup level
DCA	disproportionate cost analysis
Ecology	Washington State Department of Ecology
FS	feasibility study
IC	institutional control
MAM	marine armor mat
mg/kg	milligram(s) per kilogram
MTCA	*Model Toxics Control Act*
NAPL	nonaqueous phase liquid
NAVD88	North American Vertical Datum of 1988
ng/kg	nanogram(s) per kilogram
OM&M	long-term operation, monitoring and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
RAO	remedial action objective
RCM	reactive core mat
RI	remedial investigation

SCO	sediment cleanup objective
SCUM	Sediment Cleanup User's Manual
SMS	Sediment Management Standards
SP&S	Spokane, Portland, and Seattle Railway
SWAC	surface weighted average concentration
SPA	Sediment Processing Area
TarGOST	Tar-specific Green Optical Screening Tool
TPH	total petroleum hydrocarbons
TPH-DRO	total petroleum hydrocarbons as diesel range organics
TPH-RRO	total petroleum hydrocarbons as residual range organics
USACE	U.S. Army Corps of Engineers
WAC	Washington Administrative Code
yd^3	cubic yard(s)
YNF	Yakama Nation Fisheries

1. Introduction

This Sediment Feasibility Study (FS) was prepared by Jacobs on behalf of BNSF Railway Company (BNSF) for the BNSF Wishram Railyard (aka BNSF Track Switching Facility, “site”) in Wishram, Washington (Figure 1-1). This FS is based on historical data collected during the 2018 Initial Investigation and the 2022 Remedial Investigation (RI). The in-water area investigated during the RI is referred to herein as “the site” for the purposes of this FS.

Petroleum sheening and nonaqueous phase liquid (NAPL) droplets have been observed on occasion along an approximately 350-foot-long stretch of the Columbia River adjacent to the BNSF Wishram Railyard (Washington State Department of Ecology (Ecology) 2017). This stretch of the Columbia River is separated from the uplands area by a berm armored with riprap. The area where the sheening has been observed was inundated in 1957 when the area behind The Dalles Dam was flooded, creating Lake Celilo. Initial investigation activities conducted in 2018 in the vicinity of the observed sheen identified a NAPL impacted organic-rich fill layer approximately 0.5 to 2.5 feet below the sediment surface (bss) between 40 and 140 feet south (offshore) of the current riprap shoreline. The sheen intermittently observed along the shoreline is the result of ebullition-driven transport of NAPL (bubbles) from the NAPL body to the water column, as described in the Initial Investigation Report (Jacobs 2019). Initial investigation sample results from the surface sediment overlying the NAPL body were found to exceed the Sediment Management Standards Sediment Cleanup Objectives (SCOs) for sulfides in one surface sample, and results exceed the Cleanup Screening Levels (CSLs) for TPH-DRO and TPH-RRO in two surface sediment samples (Washington Administrative Code [WAC] 173-204-563). The RI results show that sediment concentrations that exceed SMS criteria do not exist outside of the NAPL impacted area.

As required by Ecology in its letter dated August 13, 2020, BNSF collected additional data to meet the requirements of an RI during 2022. Figure 1-2 shows the area of the 2018 Initial Investigation, the railyard features, current and former shorelines, and the area investigated during the 2022 RI. Activities conducted during the sediment RI included collecting 16 sediment cores (of which select intervals from 13 cores were submitted for analysis) and 60 Tar-specific Green Optical Screening Tool (TarGOST) locations. These activities are described in the *Sediment Remedial Investigation Report* (Sediment RI Report) (Jacobs 2024).

The RI results identified an area adjacent to the BNSF Wishram Railyard within the Columbia River where the presence of NAPL in sediment is potentially resulting in periodic sheens via ebullition (Figure 1-3). This area of NAPL-impacted sediment is found at depths ranging from 0.5 foot bss to the south and 9.5 feet bss to the north (Figures 1-4 and 1-5) (Jacobs 2024). The NAPL is non-mobile based on data collected during the Initial Investigation and the RI, but occasional visible sheens on the water’s surface are generated as a result of ebullition (described in Section 1.9). To the west of the sheen generating area, lesser thicknesses of NAPL impacts have been identified. NAPL impacts identified in this western zone are not affecting surface sediment and are not known to produce sheen as they are buried by a minimum existing cover of 4.5 feet of sediment. The sheen-generating NAPL area, shown on Figure 1-3, represents the majority of the NAPL impacts at the site, and is the area targeted for active cleanup.

The ecological risk screening evaluated potential risk based on benthic criteria and bioaccumulative criteria as recommended by the Sediment Cleanup User’s Manual (SCUM) guidance. The results of the ecological risk screening evaluation indicated that constituents found in site surface sediment (driven by two 2018 samples with total petroleum hydrocarbons [TPH] as diesel range organics [TPH-DRO] exceedances) pose risk to the benthic community. The evaluation of potential risk from bioaccumulative compounds indicated that low concentrations of polycyclic aromatic hydrocarbons (PAHs) and TPH-DRO in a limited number of surface samples exceeded preliminary natural background values. However, when considering the concentration and detection frequency of PAHs and TPH-DRO in site sediment and the low potential for bioaccumulation, further ecological risk evaluation of these compounds is not warranted and are not evaluated in this FS. Human health screening results were similar to ecological screening, with some exceedances of risk criteria at a few sampling stations associated with the shellfish/fish consumption exposure scenario. Additional details on the risk screening are presented in the Sediment RI Report (Jacobs 2024).

1.1 Purpose and Organization

The purpose of this FS is to develop and evaluate remedial alternatives for the Wishram railyard sheen-producing area in sediment at the site and the surface sediment locations resulting in risk to ecological receptors and human health.

The FS has been prepared in accordance with the Ecology *Model Toxics Control Act* (MTCA) regulation WAC 173-340-351, WAC 173-340-730(5)(d), the applicable requirements of WAC 173-204-550, and the SCUM guidance (Ecology 2021). The FS was also prepared following the "Feasibility Study Checklist," which is FS guidance published by the Ecology Toxic Cleanup Program (Ecology 2016).

The report is organized into the following sections:

1. Introduction. This section briefly describes the FS purpose and organization, regulatory framework and chronology, site history and use, presents the site setting, summarizes the results of the RI, and presents a conceptual site model (CSM).

2. Identification and Screening of Remedial Technologies. Presents the remedial action objectives (RAOs) and remediation goals; summarizes the potential applicable or relevant and appropriate requirements (ARARs); identifies the preliminary remediation goals and general response actions; and identifies the area and depth of the sediment to be targeted by remediation.

3. Development of Alternatives. Identifies and describes a range of remedial approaches, technologies, and process options that could be used to address the sheens, and screens them based on effectiveness, implementability, and cost.

4. Detailed Evaluation and Selection of Alternatives. This section presents the development of the remedial alternatives for addressing the sheens by combining the remedial approaches, technologies, and process options that were retained after the screening described in Section 3. Evaluation of assembled remedial alternatives based on threshold requirements and disproportionate cost analysis (DCA) ranking criteria (WAC 173-340-360) is included in this section. The degree to which alternatives reduce risk, the amount of time needed to meet cleanup standards, and risks associated with implementing the cleanup are considered.

5. Remedy Selection. Details the rationale behind the selection of the preferred alternative. Includes description of how the alternative meets the expectations in WAC 173-340-370 and addresses public concerns.

6. References. Provides the references cited in the report.

1.2 General Site Information

The BNSF railyard is in the town of Wishram in Klickitat County, Washington, approximately 13 miles northeast of The Dalles, Oregon, and 0.75 mile south of Washington State Route 14, within the southwestern quarter of Section 17, Township 2 north, Range 15, east of the Willamette Meridian (Figure 1-1).

The BNSF railyard occupies a flat bench along the northern side of the Columbia River at the eastern edge of the Columbia River Gorge. The railyard is approximately 5,000 feet long (from northeast to southwest) and ranges from 150 to 720 feet wide (from northwest to southeast). The portion of the railyard where historical industrial activities (e.g., fuel storage, engine refueling, engine maintenance) occurred and the focus of the upland investigation is at the western end (approximately 1,100 feet) of the yard, covering an area of approximately 6 to 10 acres (KJ 2020). Existing structures on the railyard include storage buildings, a maintenance shop (office and tool storage), two mainline tracks, and active yard tracks (Figure 1-6). Current railyard operations on the uplands include an Amtrak passenger service Depot and a railcar switching track spur located just south of the Depot. Railcar fueling and maintenance activities are no longer performed at the railyard.

The railyard is located on the shore of the Columbia River within a treaty and accustomed fishing area of the Confederated Tribes and Bands of the Yakama Nation. Tribal members still exercise treaty reserved fishing rights on the shores of and in the Columbia River in the vicinity of the railyard. This fishing activity is regulated under tribal laws through off-reservation enforcement authority. The Celilo Treaty Fishing Access Site, a tribal fishing boat launch area regulated by the Bureau of Indian Affairs, is situated across the Columbia River on the Oregon shore. The Columbia River adjacent to the railyard is also used for vessel traffic, sailing, fishing, and various recreational uses.

1.3 Regulatory Framework and Chronology

Corrective action activities on the uplands portion of the railyard are being performed pursuant to an Agreed Order (AO) (No. DE 12897) between Ecology and BNSF, dated October 7, 2015 (BNSF 2017). The scope of work in the AO includes an upland RI, an FS, and a Draft Cleanup Action Plan, and is mainly focused on the upland area, with limited requirements related to shoreline conditions.

On March 3, 2017, Ecology directed BNSF to complete an investigation of the inundated lands area. In response to Ecology's 2017 letter, BNSF developed an Initial Investigation Work Plan to investigate the potential presence of NAPL in the identified nearshore area, characterize the nature and extent of NAPL if present, and evaluate nearshore sediment against applicable sediment cleanup standards (CH2M 2018). The Initial Investigation Work Plan (CH2M 2018) was approved by Ecology on February 7, 2018, and field work was performed in June and August 2018.

Subsequent work at the site included development of a Sediment RI Work Plan (RI Work Plan), which included a phased approach to the investigation. The final RI Work Plan (Jacobs 2021) was submitted to Ecology on November 19, 2021, incorporating Ecology comments on the draft RI Work Plan. On November 30, 2021, Ecology's letter approving the RI Work Plan (dated November 19, 2021) was received by BNSF.

Field work for Step 1, consisting of determining the biologically active zone and surface sediment sampling, was conducted in April 2022, and the results were discussed with Ecology and presented to Ecology and Yakama Nation Fisheries (YNF) in September 2022. Ecology and YNF requested modification to the approved RI Work Plan related to Step 2 field activities on October 3, 2022. In response, the RI Work Plan was revised on October 25, 2022, and the revision (RI Work Plan Revision 1) was approved by Ecology via email on October 27, 2022 (Jacobs 2022). The Step 2 work, consisting of the TarGOST investigation and subsurface coring, was conducted in November 2022.

Following completion of the RI, the Draft Sediment Remedial Investigation Report (Draft RI Report) was submitted to Ecology on May 30, 2023. On July 14, 2023, BNSF received comments from Ecology. In response, the comments were discussed with Ecology and the YNF on August 16, 2023, and a revised Draft RI Report was prepared and submitted to Ecology on October 16, 2023. Subsequent comments on the revised Draft RI Report were received from Ecology on November 28, 2023, and from the YNF on

December 8, 2023. A revision 2 of the Draft RI Report addressing comments from both Ecology and the YNF was prepared and submitted to Ecology on January 8, 2024 (Jacobs 2024), with a revision 3 submitted on April 22, 2024. Ecology approved the Draft RI Report via email on May 30, 2024 and the Final Sediment Remedial Investigation Report was submitted on June 10, 2024 (Jacobs 2024).

1.4 Site History and Use

The railyard was developed by the Spokane, Portland, and Seattle Railway (SP&S) between 1910 and 1912. SP&S merged with other railroads in 1970 to become the Burlington Northern Railroad, which merged with the Santa Fe Railroad in 1995 to become what is now BNSF Railway Company. Historically, locomotive operations involving fueling/watering and repairs also occurred within the western portion of the Wishram Railyard. Oil and diesel were the primary fuels historically used to fuel locomotives at this yard. Most track spurs, early structures, and infrastructure no longer remain.

Prominent historical railyard features present during some portion of the time between 1910 and the present, included a pump house and infrastructure (including a 24-foot-diameter structure) to obtain water from the Columbia River for railyard processes and drinking water from the Columbia River, various storage tanks (above and below ground), and an oil water separator; these structures are shown on Figure 1-7. Water use from the Columbia River was discontinued after water supply wells were installed within the railyard; the river water supply piping, which extended from a pump shaft on the railyard to the pump house, well, and river intake lines, was removed or abandoned in place in 1920. Historical features were identified using past reports, historical maps and aerial photographs, and historical documents (e.g., NWOR 2014), and correspondences between SP&S personnel, including design plans and drawings for former railyard features (BNSF 2017).

At the time the railyard was constructed, the Columbia River was free-flowing and occupied a channel approximately 300 feet south of and 40 to 50 feet lower than the current railyard. Construction of The Dalles Dam in 1957 impounded the Columbia River to create Lake Celilo. The southern portion of the railyard, now under water, was inundated during the filling of Lake Celilo in 1957. Areas to the south of the current railyard that are now underwater consisted of vegetated areas and bedrock outcrops with some areas of sandy beachfront. According to correspondence between SP&S personnel in the 1950s (SP&S 1950), numerous small shacks occupied by employees of SP&S were also located south of the current railyard.

1.5 Conceptual Site Model

This section describes the CSM based on the SCUM guidance and includes the following information:

- Physical characteristics of the inundated lands that have the potential to affect distribution and transport of constituents of concern (COCs). This includes the historical uplands use of the facility including associated outfalls and drainage patterns from railyard operations documented in the Ecology-approved Uplands RI Report (KJ 2020).
- Potential release and transport mechanisms (for example, erosion and stormwater runoff and direct discharges) going from the uplands to the sediment; thus, the Uplands RI results help inform the sediment CSM.
- Historical photos and drawings of the railyard before the formation of Lake Celilo, and bathymetry data collected by the U.S. Army Corps of Engineers (USACE) in 2008, by Solmar Hydro, Inc. in 2017 (CH2M 2018), and across a larger area by Solmar Hydro, Inc. in 2022. Combining the historical aerial photographs with bathymetry shows the current bathymetry aligns closely with the shoreline before inundation and identifies historical drainage pathways and low-lying areas.

- Investigation results include NAPL screening, coring, and surface sediment analytical data from the portion of the inundated lands near where sheens have been observed, both before and during the Initial Investigation and during the RI. The investigations identified the presence of submerged NAPL within the inundated lands and informed the potential NAPL transport mechanisms.

1.6 Site Setting and Physical Characteristics

The site is approximately 1,850 feet by 500 feet located at River Mile (RM) 201 along the Washington side of Lake Celilo (Figure 1-1). Lake Celilo is 24 miles long with primary tributaries including the Deschutes River and Fifteen Mile Creek. Background samples were collected between RM202 and RM206, upstream of the site near Miller Island and the confluence of the Columbia and Deschutes Rivers (Figure 1-1). This portion of the river is noted to be one of the driest and warmest portions within the Columbia River basin (USACE et.al. 2020).

1.6.1 Physical Characteristics

The physical characteristics that may affect COC distribution and transport are described in the following sections.

1.6.1.1 General Hydrology

The Columbia River basin is 258,000 square miles (670,000 kilometers [km]^2) in size. The river itself originates in Canada, entering the United States (U.S.) near the northeastern corner of Washington State and discharging at the Pacific Ocean near Astoria, Oregon, approximately 1,243 miles (2,000 km) from its origin. With an average flow at the mouth of about 265,000 cubic feet per second (cfs), the Columbia River is the fourth largest river in the U.S. by volume, and it has the largest discharge of any river in North America to the Pacific Ocean. The Deschutes River, with an average discharge of 5,824 cfs, joins the Columbia River just upstream of Wishram. Overall river flows along this reach of the Columbia River are controlled by operations of The Dalles Dam, located approximately 9 river miles downstream of the site, and the John Day Dam upstream approximately 14 river miles, resulting in daily and seasonal fluctuations in surface water elevations.

1.6.1.2 Geologic and Hydrogeologic Conditions

The local geology at the site, as determined by soil borings completed in the uplands area, consists of varying thickness of surface fill (sand and gravel reportedly sourced from nearby sand dunes and river deposits), followed by 10- to 95-foot-thick sequences of glaciofluvial sediment (and silt) deposited on eroded Columbia River Basalt Group bedrock during ice-age floods.

The uppermost hydrogeologic unit at the railyard is the glaciofluvial unconfined aquifer, consisting of unconsolidated sand and silt with gravel lenses deposited during the Missoula Floods. Numerous monitoring wells have been installed at the railyard and screened in the sand/silt deposits. These sand and silt deposits can be up to 95 feet thick in the western section of the railyard where locomotive operations involving fueling/watering and repairs occurred and a glaciofluvial sediment-filled erosional feature in the basalt bedrock is believed to be present. The glaciofluvial deposits are generally homogeneous, and in some areas the sand and silt overlie a thin layer of gravel just above bedrock (KJ 2016). Given the presence of exposed bedrock surfaces east and west of the initial 2018 sediment study, the glaciofluvial aquifer likely pinches out to the south just beyond the former shoreline of the Columbia River, approximately 350 feet from the current shoreline (CH2M 2018, Jacobs 2024).

Local topography and historical aerial photographs taken before the creation of Lake Celilo show exposed bedrock along some portions of the historical Columbia River shoreline adjacent to the railyard. Sampling conducted during the sediment RI has confirmed a limited area with sediment adjacent to the railyard. Bedrock was encountered at the surface in the area to the west of the planned sediment RI (Jacobs 2024).

Groundwater occurs in the unconfined sand/silt alluvial aquifer at 10 to 12 feet below grade at the railyard. Before construction of the dam and creation of Lake Celilo, the unconfined water table was at least 30 to 40 feet deeper. While groundwater flow beneath the central portion of the railyard is generally south toward the lake at a very shallow gradient, during 10 months of the year, Lake Celilo in the vicinity of the railyard is a losing water body where flow direction is to the north, toward the railyard (KJ 2020). Daily oscillations in the Columbia River stage (typically 1 to 2 feet) occur because of variable discharge rates from The Dalles Dam (KJ 2020, USGS water data website https://waterdata.usgs.gov/monitoring-location/14105700/#parameterCode=00065&period=P7D, accessed March 2023, USACE https://www.nwd-wc.usace.army.mil/dd/common/projects/www/tda.html, accessed March 2023).

Historical aerial photographs indicate the former shoreline of the river was approximately 300 feet south of where it is today and consisted primarily of bedrock, with the exception of an 800-foot sandy section where the bedrock erosional feature is believed to extend. Overlying the glaciofluvial deposits within the river and beyond the toe of the riprap embankment, are surface sediment consisting of micaceous fine sand to silty fine sand with varying amounts of organics that have been observed at thicknesses of up to approximately 5 feet. In select locations farther from the current shoreline, a 2- to 3.5-foot interval of highly plastic silty sand fill containing wood, roots, and limited amounts of miscellaneous litter is present (Jacobs 2024).

1.6.1.3 Bathymetry

A detailed bathymetric survey of the inundated lands adjacent to the railyard and around the Initial Investigation area was completed in 2017 and a second survey was conducted in 2022 in preparation for the RI (Jacobs 2024). The bathymetric survey indicates that within approximately 100 feet of the current shoreline, surface water depths are up to 15 feet as the riverbed dips to the south at a slope of approximately 8 percent (Figure 1-8). As shown on Cross Section BB-BB’, water depths of up to 20 feet are present in that area with a steep drop off near 100 feet from shore at a 52 percent slope that levels off abruptly. Water depths in the eastern and western portions of the site increase more gradually, reaching about 25 feet depth at 250 feet from shore in the east (Cross Section CC-CC’) and 30 to 35 feet at a distance of 500 feet from shore in the west (Cross Section AA-AA’). Slopes in Cross Section AA-AA’ are generally at less than 10 percent, with slopes in Cross Section CC-CC’ ranging from 19 to 2 percent.

Elevation of the sediment surface ranged from approximately 150 feet North American Vertical Datum of 1988 (NAVD88) to 120 feet NAVD88 within the study area. The elevation of The Dalles Dam forebay ranged from 157.74 to 158.72 feet NAVD88 during Step 1 (Columbia River Operational Hydrometeorological Management System, (https://pweb.crohms.org/dd/nwdp/project_hourly/webexec/rep?r=tda&date=04%2F12%2F2022) and ranged from 157.76 to 159.67 feet NAVD88 during Step 2, (https://pweb.crohms.org/dd/nwdp/project_hourly/webexec/rep?r=tda&date=11/14/2022). The survey confirmed the conditions on the surface identified from the historic aerial photographs of the area, with rocky outcrops present in several areas as shown by a jagged contour line. No unexpected features were identified.

1.7 Nature and Extent of Impacts

This subsection describes the nature and extent of impacts to sediment identified in the RI.

1.7.1 Estimated Extent of NAPL

The extent of NAPL at the site was delineated using multiple lines of evidence including TarGOST locations/intervals where NAPL-related waveforms were observed and where NAPL impacts in sediment cores advanced in 2018 and 2022 were observed. The estimated lateral and vertical extent of NAPL across the site is shown in Figures 1-3, 1-4, and 1-5, respectively. Cross section Figures 1-4 and 1-5 plot the TarGOST responses and the intervals of observed NAPL from the sediment cores and subsurface sediment analytical data.

The NAPL-affected area extends approximately 650 feet east-to-west, approximately 140 feet of the shoreline, and is as shown as the hatched area on Figure 1-3 (Jacobs 2024). The NAPL that is resulting in intermittent sheens is less extensive and is shown as the teal-colored area on Figure 1-3. The RI identified this area as the source of the intermittent sheens at the site based on its location (adjacent to historically observed intermittent sheens), depth, peak TarGOST responses, and consistent observations of saturated NAPL conditions (Jacobs 2024). The sheen-generating NAPL is between approximately 40 and 140 feet south of the shoreline and is present at thicknesses of up to 6 feet and at depths ranging from 0.5 foot bss to the south and 9.5 feet bss to the north (Figure 1-4). To the south, the NAPL-impacted interval thins and is closer to the sediment surface, as the sediment surface slopes downward. When the sediment bathymetry drops below the base of the impacted interval to the south (~141 feet above mean sea level) (Figure 1-5), NAPL is no longer found. This is consistent with a historical surface release from the uplands that was controlled by the site topography before Lake Celilo was filled (Jacobs 2024).

NAPL impacts diminish to the north and east towards the shoreline and are found at lesser thicknesses and relatively lower peak and average TarGOST responses. To the west all NAPL impacts are well below the biologically active zone and are generally found below 5 feet bss. Peak and average TarGOST responses also decline with distance to the west, and the impacted intervals are 2 feet or less, and often less than 1 foot. These thinner affected zones continue to deepen to the west to a depth of between 7 and 8 feet bss (Figure 1-4). Unimpacted TarGOST profiles collected during the 2022 RI bound the extent of all NAPL impacts (Jacobs 2024). The analytical data results from the subsurface sediment cores were also used to confirm the lateral and vertical extents of NAPL as illustrated in Figures 1-3 through 1-5 (Jacobs 2024).

1.7.2 Surface Sediment Conditions

Analytical results from the Step 1 investigation indicated the presence of total sulfides above the Freshwater Benthic dry weight sediment cleanup objective (SCO) in both site and background surface sediment samples. In addition, a single compound, 3 & 4-Methylphenol (m- & p-Cresols) was identified above the SCO in one background sample (BG17). TPH-DRO and TPH-RRO were not reported above their respective SCOs in site surface sediment samples collected during the 2022 RI (Jacobs 2024). Results of the 2018 Initial Investigation (Jacobs 2019) indicated exceedances of TPH-DRO and/or TPH-RRO in surface sediment at locations D200 and J260 (Figure 1-9).

Based on the lack of sediment in the investigation area, the biologically active zone (BAZ) was determined by Ecology as the top 10 cm of sediment (Ecology 2022), which is therefore the proposed BAZ.

In addition, surface weighted average concentrations (SWACs) were calculated for bioaccumulative chemicals, carcinogenic PAHs (cPAHs), and polychlorinated biphenyls (PCBs). The resulting Thiessen polygons are presented on Figure 1-10, with the calculation presented in Tables 1-1 and 1-2 for cPAHs and PCBs, respectively. Due to the low levels of detected concentrations for cPAHs and PCBs, the pre-remedy SWAC results are below the SCOs.

1.8 Risk Assessment Summary

Human health and ecological screening risk evaluations were conducted in accordance with SCUM guidance (Ecology 2021) and presented in the Sediment RI Report (Jacobs 2024).

The ecological risk screening evaluated potential risk based on benthic criteria and bioaccumulative criteria using the step-wise processes and the SMS rule recommended by the SCUM guidance (Ecology 2021). The SMS rule process for identifying a cleanup site based on benthic criteria is if the average of three stations exceeds the cleanup screening level (CSL) benthic criteria, which is not limited to "surface" sediment samples. The following exceedances are noted:

- Average of stations J260, D200, and D240:
  - greater than 8 times the benthic CSL for TPH-DRO
  - approximately 2.5 times the benthic CSL for TPH-RRO
- The 2022 investigation showed one station exceeding the SCO benthic criteria for sulfides.

These results show potential toxicity to the benthic community from surface sediment exceedances and the NAPL at depth to be a potential source of toxicity to the benthic community and impairment of surface water quality.

The evaluation based on bioaccumulative criteria defaulted to screening site sediment results against preliminary natural background values as the presumed SCO for bioaccumulative chemicals. Based on both the 2018 and 2022 investigations the presence of PAHs and TPH-DRO is localized and generally corresponds to the NAPL footprint. TPH-DRO is known to be subject to weathering and biodegradation in the aquatic environment and its components are not considered bioaccumulative. Evaluating risks from PAHs to higher trophic receptors (i.e., food web exposures) is uncertain because PAHs are not expected to significantly bioaccumulate in the tissues of fish or crustaceans. Therefore, further ecological risk evaluation of TPH-DRO or total PAHs is not warranted, and the presumed SCO set at preliminary natural background is considered protective.

The human health risk screening conducted in the Sediment RI Report (Jacobs 2024) evaluated the following potential exposure scenarios using exposure parameters, toxicity values, and calculated exposure point concentrations (EPCs) recommended in SCUM guidance. The results of the risk screening are summarized as follows:

- **Shellfish Consumption.** With the exception of 2,3,7,8-TCDD TEQ and benzo(g,h,i)perylene, the EPCs of constituents detected in sediment are below the preliminary natural background values used to evaluate the fish/shellfish consumption exposure scenario. The following summarizes the EPCs for these two constituents:
  - The EPC of 2,3,7,8-TCDD TEQ (0.78 nanogram per kilogram [ng/kg]) exceeds the preliminary background concentration (0.532 ng/kg). Three of the 13 samples analyzed for dioxin-like substances had 2,3,7,8-TCDD TEQ concentrations exceeding background. Because the majority of dioxin-like compounds included in the EPC calculation were not detected in sediment samples the EPC may be biased high.
  - The EPC of benzo(g,h,i)perylene (0.24 milligram per kilogram [mg/kg]) exceeds the preliminary natural background value (0.22 mg/kg). Because there were only two samples with detectable concentrations out of 21 samples collected, the EPC is the maximum detected concentration which is biased high. Because the mean of the two detected concentrations (0.13 mg/kg) is less than the preliminary natural background value and the 19 non-detected values range from 0.0076 mg/kg to

0.086 mg/kg, benzo(g,h,i)perylene concentrations are below or similar to the preliminary natural background value.

- **Beach Play**. Risks from exposure to sediment through the beach play exposure scenario meet the SMS and SCUM guidance human health criteria.
- **Clam Digging**. Risks from exposure to sediment through the clam digging exposure scenario meet the SMS and SCUM guidance human health criteria
- **Net Fishing**. Risks from exposure to sediment through the net fishing exposure scenario meet the SMS and SCUM guidance human health criteria.

1.9 Fate and Transport

As discussed in the Sediment RI Report (Jacobs 2024), NAPL at the site is not advectively mobile or migrating. The intermittent sheens are the result of gas ebullition-facilitated transport of NAPL from sediment to surface water. Ebullition occurs throughout the inundated lands as gases develop from the decaying organic matter associated with the former upland areas. Gas ebullition potential in sediment samples collected from across the study area was evaluated in the 2018 Initial Investigation. Ebullition rates estimated at the site ranged between 6.5 and 6.8 liters per square meter per day with little spatial variability (Jacobs 2019). These rates are indicative of high gas production resulting from the abundance of total organic carbon observed in deeper sediment and variable carbon substrate observed at shallow depths. This is further validated by field observations of ebullition during the 2018 sediment sampling event. Consistent with the ebullition process, gas bubble generation and the presence of sheens has only been observed during the warmer months and during periods of lower water.

The depth of the NAPL occurrence offshore coincides with the ebullition active zone of 0 to 5 feet bss (Viana et al. 2012; Costello and Talsma 2003), suggesting that gas ebullition is responsible for the mobilization of NAPL and contributes to NAPL transport to the water column. The intermittent sheening observed is the result of ebullition in the buried NAPL. Due to the hydrophobic characteristics of NAPL, it preferentially sorbs to the hydrophobic bubble surface. NAPL that attaches to a gas bubble is transported to the surface of the water, often spreading when the gas bubble breaks at the water surface and forming a sheen blossom. (ASTM E-3282-22 NAPL Mobility and Migration in Sediment – Evaluating Ebullition and Associated NAPL/Contaminant Transport 2022).

A greater abundance of gas bubbles and sheening occurs during periods of low water when the pressure from overlying water column is reduced, and during hot periods when the temperature of the sediment rises. A combination of the winds and current carry the sheens toward the shoreline where they are seen most often from the shoreline and where globules have been observed accumulating during relatively warm and calm weather conditions.

Figures 1-11 and 1-12 identify the source area for the ebullition causing sheens, buried NAPL in the inundated lands extending between approximately 40 and 140 feet south of the shoreline, extending between approximately 180 by 90 feet in the easterly to westerly direction. It should be noted that the grid presented on Figures 1-11 and 1-12 are 20 feet by 20 feet in size. As shown on Figures 1-11 and 1-12, offshore NAPL impacted sediment is generally overlain by approximately 5 to 10 feet of sediment with some isolated areas having less than 2 feet of overlying sediment. NAPL impacted sediment is not present below a break in the sediment slope. This area could be subject to erosion under high flow conditions prior to inundation. Under current submerged conditions, there is no evidence of erosion of NAPL-impacted sediment via scouring. As noted in Section 1.7.1, NAPL impacts diminish to the north and east towards the shoreline and are found at lesser thicknesses and relatively lower peak and average TarGOST responses. To the west all NAPL impacts are well below the biologically active zone and are generally found below 5 feet bss.

Bathymetry and sediment coring data indicate that in general the portions of the inundated lands affected by the NAPL represents a depositional environment, with deposition being limited to areas with gentle slopes. This is consistent with the work done by Moody et al. 2003, which found that hydrologic dam alterations trapped sediment, therefore filling riverbeds and sand bars and causing riffles to disappear. The bathymetry in this area shows a steep drop off to the south and the absence of sediment.

2. Identification and Screening of Technologies

This section presents the approach and results of the remedial technology screening. The technologies retained following the screening described in this section are then assembled into remedial action alternatives that are described in Section 3 and evaluated in Section 4 to assist in identifying a recommended alternative (Section 5). The remedial technology screening is preceded by the development of RAOs and preliminary remediation goals (PRGs) defining remediation and compliance with ARARs.

2.1 Remedial Action Objectives

As described in *Rules of Thumb for Superfund Remedy Selection* (EPA 1997), RAOs provide a general description of what the remedy is expected to accomplish. RAOs are site-specific and serve as the design basis for the remedial alternatives considered for the site. RAOs are influenced by the nature and extent of chemical exceedances, ARARs, and potential human and environmental exposure. The RAOs for the project are as follows:

- **RAO 1 –** Reduce risk to benthic organisms from direct contact with and ingestion of COCs in sediment and reduce risk to biota from ingestion of COCs in prey.
- **RAO 2 –** Reduce risk to humans from ingestion of COCs in fish and shellfish.
- **RAO 3 –** Prevent the generation of sheen emanating from known areas of buried NAPL-impacted sediment on the site through the ebullition pathway.
- **RAO 4 –** Protect cultural resources at the site.

RAOs are narrative statements that describe what the remedial action is intended to accomplish.

2.2 Target Area

Based on the RAOs as stated above and results of the RI, which include the 2018 data set, a Target Area for remediation has been established at the site (Figure 2-1), which depicts the proposed sediment cleanup unit boundary. This area includes:

1. The extent of the sheen-generating NAPL observed in TarGOST and sediment cores; and
2. Areas where SCO or CSL values are exceeded and are causing an ecological and human health exposure risk.
    a. TPH-DRO and TPH-RRO, Stations J260, D200, and D240 are within the target area (see Section 1.8 above)
    b. Station E320 for sulfide, however, sulfide is not contributing to risk.

In addition to the areas described above, the Target Area includes offsets, which are intended to accommodate constructability factors such as slope stability, means and methods of construction, and necessary overdredge and buffer beyond the assumed target area limits to account for a complete remedial process. Assumed offsets are different for each alternative as a result of the varied technologies and would be refined during the remedial design process. The Target Area plus the additional area included for the above considerations comprise what is referred to as the “remedial footprint,” which is discussed in Section 3 in more detail for each Alternative.

2.3 Applicable Laws and Relevant and Appropriate Requirements

Applicable laws are defined in WAC 173-204-505(2) as "all legally applicable requirements specified in WAC 173-340-710(3) and those requirements that the department determines, based on the criteria in WAC 173-340-710(4), are relevant and appropriate requirements". Other relevant and appropriate requirements may include state, federal, local or tribal laws that meet the criteria in WAC 173-340-710(4). These are regulatory requirements that may not be legally applicable but address problems or situations sufficiently similar to those encountered at a particular site and are therefore well suited to use at the site. These relevant and appropriate requirements must be considered when selecting and implementing cleanup actions to meet the minimum requirements of WAC 173-204-570(3). Once a requirement is determined to be relevant and appropriate it must be complied with as an applicable law.

The requirements determined to be applicable or "relevant and appropriate" are commonly referred to as ARARs. ARARs are identified based on site-specific factors, including the chemicals at the site that are being addressed in the remedial action, the physical characteristics of the site, and the remedial action alternatives being evaluated. ARARs are usually divided into three categories, described as follows:

- Chemical-specific ARARs include state and federal requirements that regulate constituent levels in various media, including the presence of sheen. These ARARs are usually health- or risk-based numerical values or methodologies used to determine the acceptable amount or concentrations of chemicals that may remain in the environment.
- Location-specific ARARs are requirements for constituent concentrations or remedial activities that apply based on a site's physical location.
- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes, or requirements to conduct certain actions to address particular circumstances at a site.

Appendix A presents the ARARs for the site by type.

2.4 Preliminary Remediation Goals

The preliminary remediation goals (proposed cleanup standards) for this site are:

- To prevent ebullition-facilitated transport of NAPL resulting in visible sheen.
- To prevent ecological and human exposure to COCs exceeding SCOs and CSLs and causing risk at the sediment surface.

Section 2.2 above and Figure 2-1 describe the locations and areas being addressed by the proposed sediment remediation. Figure 2-1 indicates that the nominal area proposed for cleanup is 0.36 areas (note that this footprint is slightly larger for each remedial alternative (discussed in Section 4) due to constructability factors.

2.5 Remedial Technology Screening

Prospective remedial technologies were identified and initially screened. Remedial alternatives for cleanup of sediment include the following three components (EPA 2005):

- General Response Actions (GRAs) – major categories of response activities such as institutional controls, Monitored Natural Recovery (MNR), containment, removal, or treatment.

- Potentially Applicable Remedial Technologies – general categories of technologies such as different in situ containment options (e.g., sediment capping/vertical containment) or removal methods (e.g., dredging).
- Process Options – technology implementation details, such as mechanical or hydraulic dredging methods.

2.6 General Response Actions

Several media-specific technology types are presented below to represent each GRA, apart from the No Action alternative, that can be expected to accomplish the RAOs and are grouped into nine categories. The GRAs may be used as standalone or in combination with one another. The No Action alternative is included as required by SCUM Section 12.4.4 (Ecology 2021), and the most permanent cleanup action will serve as a baseline alternative against which other alternatives are compared. The following provides a list of those applicable technologies which are detailed in Table 2-1.

- No Action
- Institutional Controls
- Natural Recovery
- Removal
- In-Place Containment
- Treatment
- Dewatering
- Transportation
- Disposal

2.7 Identification and Screening Technologies and Process Options

This section presents and screens the remedial technologies for impacted sediment in the treatment area as required by WAC 173-204-550(7)(c). Potentially applicable technologies are identified based on available site characterization data and known physical site conditions. Technologies identified are then either retained for further consideration or screened out based on an evaluation of their ability to effectively address site concerns. The technologies that are retained for further consideration are then assembled into remedial action alternatives to address the site-specific RAOs (see Section 3). The following subsections describe the technology screening criteria, and present the technologies retained for further assessment as components of the remedial alternatives for the site.

2.7.1 Technology Screening Criteria and Methodology

Technology screening was conducted and is included in this FS as required by WAC 173-204-550(7)(c). The technology screening was conducted consistent with the Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005). Potential remedial technologies and process options were screened according to the following established criteria:

- Technical effectiveness
- Implementability
- Cost

2.7.1.1 Technical Effectiveness

The technical effectiveness evaluation considers each technology and the ability to achieve the following: (1) reduce the toxicity or mobility of the COCs, (2) comply with applicable laws and meet RAOs, (3) limit potential impacts to human health and the environment during construction and implementation, and (4) determine whether the process is proven and reliable with respect to the COCs and conditions at the site.

Technologies that offer significantly less effectiveness than other proposed technologies may be eliminated from the alternative development process. Likewise, options that do not provide adequate protection of human health and the environment are eliminated from further consideration.

2.7.1.2 Implementability

Implementability is a measure of the technical or administrative feasibility of implementing a technology at the site. Options that are technically or administratively infeasible, are not compatible with site-specific conditions, or are difficult to construct may be eliminated from further consideration. Administrative feasibility includes consideration of the ease of obtaining land permits and agreements with various property owners and agencies.

2.7.1.3 Relative Cost

Qualitative and relative costs for implementing the remedy are considered in this criterion. At this stage in the process, the cost analysis is evaluated as to whether costs are low, medium, or high relative to other process options for the same technology. The cost ranges are based on a review of the literature, quotations, professional or engineering judgment, or data prepared for other studies and sites. Technologies of higher cost but with no additional benefit in effectiveness or implementability over other technologies may be eliminated from further consideration.

2.7.2 Retained Technologies

Individual remedial technologies and their associated process options were screened based on considerations of effectiveness, implementability, and relative cost. The screening step is designed to narrow the list of remedial technologies to identify the most viable candidates for use in assembling remedial action alternatives. The technology screening and screening results are summarized in Table 2-2. Where appropriate, the technology screening also provides the justification for retaining or not retaining a technology for further consideration. The overall goal is to retain representative process options within the GRA categories to form remedial alternatives. The remedial technologies and process options eliminated from further consideration based on lack of effectiveness, implementability, and/or cost are highlighted in gray shading in Table 2-2.

3. Development of Alternatives

This section describes the development of comprehensive alternatives from the technologies screened in Section 2. The results of the screening identified remedial technologies that are potentially applicable for implementation within the Target Area. This section presents the integration of the retained technologies into a range of potentially viable remedial alternatives. Although specific technologies are identified as part of each alternative, there may be modifications to the identified technologies during the design and implementation phases due to engineering considerations and/or local conditions. The modifications would be made to improve the implementability, effectiveness, or cost of the selected approach, without changing the outcome of the evaluation of the alternatives.

3.1 Development of Alternatives

The WAC 173-340-351 and WAC 173-204-550 detail the requirements for the development of remedial alternatives. The regulations recommend a number and types of alternatives taking into account the characteristics and complexity of the facility, including current site conditions and physical constraints and the threats posed by the site to ecological receptors, human health and the environment. At least one permanent alternative, an alternative with a standard point of compliance, and a no action alternative, if applicable, should be included; the alternatives below bracket the range of alternatives (see SCUM Section 12.4.4). Alternatives that clearly do not meet the minimum requirements in WAC 173-204-570(3) should not be included.

Six alternatives have been developed, including the No Action alternative as required by SCUM Section 12.4.4 (Ecology 2021):

- Alternative 1 – No Action
- Alternative 2 – Removal, Backfill and Offsite Disposal
- Alternative 3 – Capping and Institutional Controls
  - Alternative 3A – Capping with AquaGate + Organoclay™ and Institutional Controls
  - Alternative 3B – Capping with a Reactive Core Mat (RCM) and Institutional Controls
  - Alternative 3C – Capping with a RCM and a Marine Armor Mat (MAM) and Institutional Controls
- Alternative 4 – In-Situ Stabilization (ISS), Backfill and Institutional Controls

Per SCUM Section 12.4, the alternatives were evaluated against the most permanent solution, Alternative 2. This evaluation is conducted in Section 4.

3.2 Description of Remedial Alternatives

This section includes a description of each remedial alternative. The primary components of each of the remedial alternatives are summarized in Table 3-1 including the volumes, areas, and other pertinent information utilized in the descriptions provided below. Figure 3-1 depicts the location of the proposed staging area for the alternatives. Figures 3-2 through 3-4 depict the Target Area and remedial footprint (primary remedy component) for each of the action alternatives.

3.2.1 Common Elements

There are several elements and assumptions that are common to each of the alternatives described below in Section 3.2.2. Those common elements include the following: preconstruction activities, site preparation, debris removal, backfill, site restoration, institutional controls (ICs), and long-term operation, monitoring, and maintenance.

These common elements for the alternatives are listed in Table 3-2 and described below.

3.2.1.1 Pre-Construction Activities

These common elements are associated with Alternatives 2, 3A, 3B, 3C, and 4 and include the following activities:

- Pre-design investigation – These data may be necessary to refine specific aspects of the selected remedial alternative. Data needs will be evaluated prior to the outset of the design phase.
- Remedial design – The remedial design would be developed in a phased approach (e.g., a preliminary, intermediate, and final design, or some combination thereof) incorporating a design report, associated calculations, and specifications and drawings. The final specifications and drawings would be a component of the request for proposal to select a contractor to perform the construction work. For the purposes of this FS, alternatives 2, 3A, 3B, 3C, and 4 assume active remediation in the Target Area. Additionally, an evaluation would be performed to identify a list of applicable permits that would be required for construction. Coordination and consultations would be performed with the governing agencies and tribes. The parties responsible for permit acquisition would be determined after remedy selection.
- Contractor Work Plans - The contractor would be required to prepare work plans detailing means and methods, operational parameters for equipment to be used, quality assurance and quality control procedures, construction schedules, health and safety procedures, work schedules, and other items.
- Mobilization and Demobilization– Prior to commencement and following completion of work; equipment, labor and materials would be moved to and from the staging area and site.
- Preparing the site and conducting a property survey.
- Developing remedial design, construction management, and project management costs.

The above details on approach and implementation for the common elements are assumptions for FS purposes only. Although preliminary details on approach and implementation for the common elements are provided, the specifications for implementation and construction of the selected remedy would be identified during design and means and methods for implementation identified by the selected contractor.

3.2.1.2 Site Preparation

Site preparation activities would be conducted before implementation of remedial work associated with Alternatives 2, 3A, 3B, 3C, and 4. Such activities include the construction of material and equipment staging and handling areas (staging areas, approximately 1 acre), infrastructure installation and improvement, construction of the Sediment Processing Area (SPA) (Alternative 2), security measures and potentially clearing of vegetation and riprap along the shoreline to provide equipment and personnel access to the river and offloading/onloading facilities. Erosion and sediment, and stormwater controls would be installed around the upland support areas. Perimeter and in-water monitoring stations (for example, water quality and dust) would be installed at pre-determined locations. Siting of remedy elements would be assessed and approved by Ecology prior to remedial action.

Resuspension control systems (for example, silt curtains) would be required and installed prior to commencement of remedial activities to minimize potential migration of suspended material to surrounding areas during operations. Design of the resuspension control system would be completed during the design phase of the project upon further evaluation of site characteristics; however, for purposes of this evaluation, turbidity curtains are assumed to be installed around the perimeter where remedial activities would be conducted.

Monitoring would be performed to verify compliance with applicable regulations and permits. Water quality monitoring data (for example, turbidity) would be collected from fixed locations near the active work area. Ambient air monitoring for dust and noise monitoring would be conducted at upland areas during remedial operations. Mitigation for action level exceedances would be implemented, as appropriate. The monitoring program would be developed during the design phase.

3.2.1.3 Debris Removal

Debris such as metallic material, wood, concrete and subaquatic vegetation may be present in the Target Area. It is anticipated that debris would be removed prior to or concurrently with dredging operations (Alternative 2) and prior to capping (Alternatives 3A, 3B and 3C) and ISS (Alternative 4). Material would be segregated appropriately to the extent practicable to facilitate processing and disposal operations. Debris would be processed, loaded into trucks, and transported to a local landfill or recycling center for disposal. Additional investigations (e.g., magnetometer, side scan sonar, sub-bottom profiling) and evaluations would be performed to further refine the estimated debris quantity and final disposal locations as a component of future design evaluations and based on additional debris surveys.

3.2.1.4 Backfill

Following acceptance of the post-dredge survey (Alternative 2) and ISS (Alternative 4), backfill would be placed in the Target Area to manage residual impacts and to provide suitable substrate for benthic restoration. Backfill assumes the placement of a 6-inch thick layer, plus a 25 percent overplacement allowance and 25 percent material loss factor. The overplacement allowance provides for the potential loss due to consolidation, a placement tolerance for the contractor and to account for the accuracy of verification methods (for example, bathymetric surveys). Additionally, loss factors are included to account for material that is misplaced or lost due to site characteristics (for example, river hydrodynamics, water depths, etc.). As a basis for this FS, it is assumed that the backfill would be amended with a combination of organoclay (5 percent by weight) and granular activated carbon (GAC) (3 percent by weight) to address dredge residuals that may have the potential to generate sheen. This component would be assessed during design activities. Backfill would be placed using barge-based mechanical means. Following backfill placement, hydrographic surveys would be performed to verify the desired footprint and thickness have been achieved. Approximate backfill volumes are detailed in Table 3-1.

3.2.1.5 Site Restoration

Site restoration activities would be performed for Alternatives 2, 3A, 3B, 3C and 4, and all activities would be coordinated with applicable regulatory agencies. Restoration would be conducted where disturbances to the existing environment and natural habitats occurred within the upland and river bank areas due to the construction of support facilities and implementation of remedial activities.

Following construction, temporary facilities and controls would be removed and the site would be restored to pre-construction conditions. Specifically, infrastructure (including staging areas, the SPA, utilities, the water treatment system (WTS) equipment (Alternative 2), temporary security fencing, office trailers, flood containment structures) would be removed. The upland areas would be restored to original grade.

3.2.1.6 Institutional Controls

ICs may include physical access restrictions and covenants, with signage (such as "limit vessel wake" or "no anchorage") limiting potential disruption of constructed remedial facilities (for example, caps). ICs would be implemented following construction, determined during design and in coordination with applicable agencies. The ICs would be applicable to Alternatives 3A, 3B, 3C and 4. ICs are not required for Alternative 2 since the sheen generating sediment would be addressed through removal. Upland areas and banks would be restored to pre-construction conditions.

3.2.1.7 Long-term Operation, Monitoring, and Maintenance

Following implementation of each of the alternatives, a long-term operation, monitoring and maintenance (OM&M) plan would be developed. Monitoring would be performed to assess attainment of short-term (1 to 5 years) metrics focusing on remedy implementation success and confirmation of the conceptual site model through collection and analysis of data. Long-term (5 or more years) metrics would be informed by the results of the short-term evaluations. As a basis for this FS, long-term monitoring (LTM) will consist of visual assessments for sheen generation from the target area (Alternative 2; at years 1 through 3) and bathymetric surveys (Alternatives 2, 3A, 3B, 3C, and 4; at year 5 and every 5 years until year 30) for comparisons and other metrics similar to the short-term data collection efforts that consider long term sustainable conditions at the site. The exact components of the LTM would be developed during the design phase.

3.2.2 Remedial Alternatives

This section provides a general description of the various remedial alternatives developed. Section 4 provides the location and estimated amount of material to be removed or treated (which includes capping) for each alternative, consistent with WAC 173-204-550.

3.2.2.1 Alternative 1 – No Action

As required by SCUM Section 12.4.4 (Ecology 2021), the No Action alternative is required to be included unless the permanent alternative is chosen. The No Action alternative is not being considered for implementation at the site. Under No Action, no remedial action is implemented and therefore the existing conditions at the site would not change, except for those undergoing natural processes, if present. The No Action alternative is generally appropriate in situations where impacts at a site present no current or potential threat to human health or the environment, where the State does not provide the authority to take remedial action, or where a previous response action has eliminated the need for additional remedial action at a site. COCs would remain in place and be subject to environmental influences.

3.2.2.2 Alternative 2 – Removal, Backfill and Offsite Disposal

Alternative 2 includes the common elements detailed in Section 3.2.1, removal of sediment with NAPL impacts, placement of backfill (amended with organoclay and GAC to manage residual impacts) and transport and disposal of processed dredge material. Figure 3-2 depicts the primary Target Area and total remedial footprint of Alternative 2. The remedial footprint expands the Target Area by a distance of approximately 21 feet on each side to account for 3 to 1 (3:1) side-slopes based on an approximate dredge depth of 7.1 feet.

The approximate removal volumes, areas and primary alternative components associated with Alternative 2 are presented in Table 3-1. The removal volumes include the neatline prism (the estimated volume of impacted material with no other factors incorporated), a 0.5 foot overdredge allowance (typical of dredge projects to ensure depths or bathymetric targets are reached with a certain level of confidence), 5 percent bulking by volume (to account for density changes of the material when it is disturbed and removed, also referred to sometimes as “fluff factor”), 3:1 side-slopes (a typical assumption for slope stability for dredge projects at this level of project definition) and a 30 percent volume contingency factor (to account for potential underestimates of volume given the level of project definition at the FS stage). The neatline prism is defined as an exact three-dimensional geometric shape corresponding to the volume of sediment targeted for removal.

Alternative 2 has a total removal volume of approximately 8,200 cubic yards (yd^3) and an average dredge cut depth of 7.1 feet bss (plus 0.5 feet overdredge). The sheen producing NAPL is located at depth below an overlying sediment veneer and therefore the dredge prism has been divided into two distinct zones, the overlying sediment and the NAPL impacted sediment. The overlying sediment would be removed first to access the NAPL impacted sediment. The overlying sediment has an average dredge cut depth of 3.4 feet bss and an estimated volume of 4,150 yd^3. The NAPL impacted sediment has an average dredge cut thickness of 3.8 feet and ranges from 3.4 to 7.1 feet bss with an estimated volume of 4,050 yd^3. Dredge volume estimates would be revised during the design phase to account for constructability considerations including stable sidewall cuts, overdredge, and dredge prism configuration.

Figure 3-2 depicts the primary Target Area and total remedial footprint of Alternative 2. For purposes of this FS and based on sediment removals performed at other similar sites, removal would be conducted using barge-mounted mechanical means (such as an excavator equipped with a clamshell bucket). Excavation from the shoreline and hydraulic dredging were eliminated from further consideration as detailed in Table 2-2.

Real-Time Kinematic Digital Global Positioning System mounted on the dredge equipment and bathymetric surveys would be used to verify the specified removal depths are achieved. The surveys would be conducted before and after removal activities to confirm achievement of the horizontal and vertical (required dredge depth) limits of dredging.

Dredged sediment would require management and disposal following removal. The proposed approach involves transporting the dredged sediment in scows to an offloading facility at the shoreline. Spill plates would be constructed to support offloading and to mitigate releases of dredged material. The dredged material would be offloaded from scows and placed directly into a lined and bermed SPA. Sediment processing operations would be performed, as necessary, following offloading to meet transport and disposal requirements. For purposes of this FS, it has been assumed that dredged sediment would require processing and inspection at the SPA following dredging and placement there. An initial processing through a series of screens would be required to evaluate cultural resources followed by a combination of passive (e.g., gravity drainage) and active processing (e.g., mechanical mixing). In addition, a visual inspection screening process would be conducted to inspect for potential cultural artifacts. These requirements would be defined following remedy selection. The assumed productivity of dredging has been adjusted to account for these activities.

The active processing component is assumed to incorporate a solidification agent (Portland cement) as needed, to solidify the material to meet transport and disposal requirements. As a basis, it is assumed that 50 percent of the overlying sediment and 100 percent of the NAPL impacted sediment would require active processing. The processed dredged material would then be loaded into trucks for transport to the disposal facility. Additional infrastructure (such as loading platforms, decontamination stations and spill plates) may be required to facilitate the loading of trucks.

Treatability testing would be performed to determine the amendment and dosage required to pass paint filter testing and disposal facility requirements (for example, a minimum strength may be required by the receiving facility). Management of dredged material would require that the SPA be appropriately sloped to collect stormwater and water that drains from dredged materials (supernatant), which would then be conveyed to an on-site water treatment system (WTS). Treated water would be discharged back to the Columbia River or to a publicly owned treatment works (POTW) in accordance with regulatory requirements (Clean Water Act, see Appendix A).

Following confirmation of dredging operations, an amended backfill layer would be placed in the Target Area to manage residual impacts and to provide suitable substrate for benthic repopulation. This layer is sometimes referred to as a "residual management layer" or RML, the purpose of which is to mitigate potential impacts from target materials that are not removed due to the inherent challenges associated with dredging. See Section 3.2.1.4 for additional detail. Approximate backfill volumes are detailed in Table 3-1.

Debris is expected to be encountered and would be removed prior to or concurrently with dredging operations. See Section 3.2.1.3 for additional detail.

The total duration of construction is estimated at 5 months. During implementation of Alternative 2, monitoring would be conducted to verify compliance with applicable regulations and permits. Turbidity data would be collected from fixed locations upstream and downstream of the active work area. Ambient air monitoring for dust would be conducted at upland areas during construction. Mitigation for turbidity, sheen, and NAPL releases to surface water, as well as dust releases to air, would be implemented as necessary.

An OM&M plan would be developed to detail LTM to verify the remedy is functioning as designed. For purposes of the FS, it has been assumed that visual monitoring would be performed for a period of three years following completion of the remedial action to verify that sheens are no longer emanating from the target area as detailed in Appendix B. The OM&M plan would be further evaluated with regulatory agencies and refined during the design phase.

3.2.2.3 Alternative 3 – Capping and Institutional Controls

Alternative 3 includes the installation of a reactive cap over the Target Area and the common elements detailed in Section 3.2.1. Table 3-1 includes the quantities for the various quantities of materials and areas to be treated. Impacted sediments would remain on the site. Alternative 3 has been subdivided into three distinct capping alternatives: Alternatives 3A, 3B, and 3C. The differences between the alternatives are depicted in Exhibit 3-1 and are based on the reactive and armoring components of the caps, as further detailed below.

In general, cap thicknesses can vary significantly from as little as 12 inches up to several feet or more for different sites depending on the constituents, their concentrations, remedial objectives, and erosion potential, among other factors. Even within a site, multiple cap configurations can be appropriate due to variable site conditions.

Prior to the placement of cap materials, debris removal (see Section 3.2.1.3) would be conducted to prepare the subgrade followed by the placement of a leveling layer. This layer is typically a granular material such as sand and provides a more stable and even surface for placement of the first layer of cap materials, which need to be placed within required thickness tolerances.

In some capping projects, pre-dredging must first be completed to accommodate the thickness of the cap so that upon completion, there is no net elevation gain of the bathymetry. This is often required to comply with FEMA and USACE permitting requirements to reduce the potential for flooding or to maintain draft for vessels, among other possible reasons. The site is not within the navigational channel and therefore not regulated by USACE. The area within the Columbia that would be capped is less than an acre in size, located within the dam-controlled area of Lake Celilo and within the FEMA Zone A (FEMA FIRMette Map

5300990550B). For Flood Zone A, up to one foot of elevation is allowed under FEMA (44 Code of Federal Regulations 60.3(b)). The volume of Lake Celilo, which is 277,000 acre-feet (Ecology 2023), compared to the volume of material for the cap (based on 2 feet over 0.66 acres) of 3.03 acre-ft is 0.0000001%. Therefore, no measurable increase in water level is expected and cap layers for the proposed options in this FS are assumed to be placed on the existing sediment surface.

Next, the base layer (i.e., chemical isolation layer) would be placed in contact with the leveling layer and may include a reactive material, such as organic carbon, organoclay, and GAC, among other amendments, that may be mixed into the granular capping materials (for example, sand) or incorporated into a pre-fabricated manufactured cap system (for example, a RCM) to isolate and prevent migration of NAPL and sheens.

The upper layer of the cap would armor the cap, preventing erosion of the middle and base cap layers which may include stone or a prefabricated system such as a MAM. Above the armor layer, a habitat restoration layer (typically sand) would be placed to facilitate the reestablishment of the benthic community.

In some capping applications, a filter stone or material is needed between different capping layers. The filter layer serves as a stable base for materials such as armor stone placed above the reactive layers and to provide a transition between layers of significantly different grain sizes to prevent mixing and consolidation between the layers.

For purposes of this FS, as depicted in Exhibit 3-1, the cap for Alternatives 3A, 3B, and 3C is assumed to consist of the following (from bottom to top):

- an initial 6-inch-thick layer of leveling sand (3A, 3B, and 3C)
- a reactive layer:
  - 3A: a 3-inch layer of AquaGate plus organoclay™
  - 3B: a 0.25 to 0.5-inch nominally thick RCM
  - 3C: a 0.25-inch nominally thick RCM
- an erosion protection layer: a 6-inch-thick MAM (Alternative 3C only), and
- benthic restoration layer (12-inches for Alternatives 3A and 3B and 6-inches for Alternative 3C).

For Alternatives 3A and 3B, the thickness of the benthic restoration layer has been increased relative to Alternative 3C to provide a suitable option without the installation of a MAM.

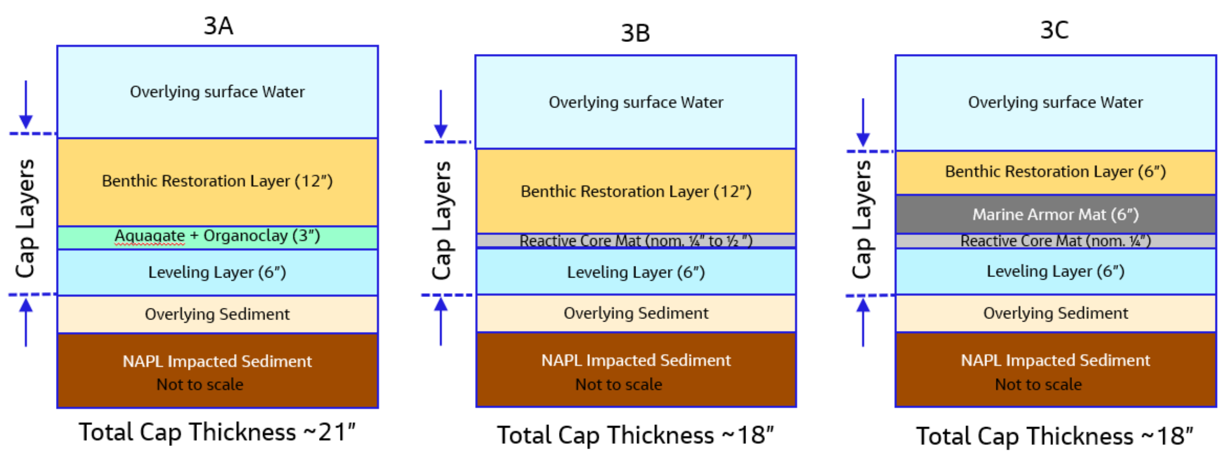

Exhibit 3-1. Typical Cross Section of Caps for Alternative 3A, 3B, and 3C

The initial 6-inch layer of sand would be placed to facilitate “leveling” of the current bathymetric surface to provide initial stability to prevent lateral movement of the cap and provide an even surface for placement of reactive elements.

Alternatives 3A, 3B, and 3C provide three different configurations for the reactive and erosion protection layers of the cap. The following describes the differences in more detail:

- Alternative 3A. A layer of AquaGate and organoclay™ (assumed thickness of 3 inches) would be placed above the leveling layer in an even thickness. A separate erosion protection layer would not be included; however, an enhanced thickness of twelve inches is assumed for the benthic restoration layer.
- Alternative 3B. A RCM, with a nominal thickness of ¼ to ½-inch would be placed above the leveling layer, and similar to Alternative 3A, a 12 inch layer of benthic restoration material would be placed over the RCM.
- Alternative 3C. A RCM with a nominal thickness of ¼-inch would be placed above the leveling layer following by the installation of a MAM and a 6-inch layer of benthic restoration material over the MAM.

Alternatives 3B and 3C have assumed an RCM in lieu of a granular chemical isolation layer to account for potential constructability considerations related to the steeply sloped site bathymetry. The RCM would provide a continuous thickness and layer which would avoid differential settlement common to granular materials. In addition, the RCM could be attached directly to the MAM and placed in a single lift as opposed to two separate lifts, simplifying constructability.

A filter layer is not included in the current cap configurations because the typical grain size distributions for the leveling layer, the AquaGate + organoclay layer™, and the benthic restoration layer are similar enough in grain size such that a filter layer is likely not necessary (Alternative 3A and 3B). For Alternative 3c, the MAM will distribute the load of the armor layer and the armor stone is contained within the geosynthetic meshing of the MAM; therefore, the filter layer (typically needed between layers of a cap when the grain size distributions differ substantially) would not be necessary.

The benthic restoration layer would be placed as a final layer above the reactive layers or MAM to promote benthic recolonization.

Table 3-1 provides estimated volumes for each cap component. The AquaGate + Organoclay™, and leveling and restoration layer include a 25 percent overplacement allowance and a 25 percent material loss factor, which are commonly included for subaqueous cap installations.

Figure 3-3 depicts the primary Target Area and total remedial footprint of Alternative 3 (3A, 3B, and 3C are the same). The remedial footprint expands the Target Area by a distance of 20 feet along the perimeter to account for inherent uncertainties in the location of the sheen producing NAPL impacted sediment and likely subsurface irregularities that affect ebullition. For purposes of this FS and based on sediment capping remedies performed at other similar sites, capping would be conducted using barge-mounted mechanical means (such as an excavator/crane equipped with a clamshell bucket).

Active cap simulations and modeling have not been conducted to evaluate the efficacy of various cap configurations and compositions to minimize the transport of NAPL impacted sediment or sheens into the overlying water column and to physical conditions that correlate to overall erosive forces present at the site (for example, wind, waves, velocity, seismic activity). Additionally, as the cap would be constructed over the existing sediment bed, hydraulic assessments would be performed to determine whether the cap placement would affect flooding elevations and be compliant with ARARs.

The estimated duration of construction for each of the capping alternatives are as follows: Alternative 3A: 2.0 months, Alternative 3B: 2.0 months and Alternative 3C: 2.5 months. An OM&M plan would be developed to detail LTM to verify the caps remain in place over time, and periodic monitoring (surveying) and maintenance would be conducted, as necessary, to maintain integrity of the cap to verify it is functioning as designed. The LTM would be further evaluated with regulatory agencies and refined during the design phase. In addition, ICs would be implemented as NAPL laden sediment would remain under the caps.

3.2.2.4 Alternative 4 – In-Situ Stabilization (ISS), Backfill and Institutional Controls

Alternative 4 includes the ISS of NAPL impacted sediment and the common elements detailed in Section 3.21. For this alternative, the ISS would be conducted over an approximate area of 0.44 acres as detailed in Table 3-1. Impacted materials would not be removed from the site under Alternative 4.

Under Alternative 4, NAPL-impacted sediment in the Target Area would be treated in situ by immobilizing the NAPL in a cement-type matrix. Figure 3-4 depicts the primary Target Area and total remedial footprint of Alternative 4. The remedial footprint expands the Target Area by a distance of approximately 6 feet (one diameter width of the auger) to account for additional in-situ stabilization around the perimeter of the Target Area that will ensure complete treatment.

In the remedial footprint, the ISS auger rigs (for example, crane mounted or hydraulic drill operating from a barge) would mechanically mix reagent into the overlying sediment and the NAPL impacted sediment, creating an array of overlapping, cement-like columns extending from the surface to below the bottom of the NAPL impacted sediment. For the purposes of this FS, ISS is assumed to a depth of 10 feet bss based on an average impacted depth of 7.1 feet plus a buffer below to account for dragdown and uncertainties in the impacted depth. Reagent for the ISS would be delivered to the site by truck and mixed on site in a batch plant. Based on experience at other similar sites, the mix design for Alternative 4 is assumed to be 10 percent Portland cement. Conducting ISS will result in a solid subsurface material that may include cultural resources. While the cultural resources would not be removed, the process may cause disturbance and will result in any such resources being solidified.

ISS implementation typically causes “swell” of the target material, which occurs when reagents are added and mixed due to the sheer volume increase of the material, the mixing process itself, and the curing process. Swell can vary significantly from site to site based on various factors including the target material itself. For purposes of the FS, it has been assumed that swell would be approximately 20 percent, or given the target depth of 10 feet, a 2-foot increase in sediment surface could be anticipated. Similar to Alternative 2 (see above Subsection 3.2.2.2), pre-dredging or post treatment swell removal is sometimes implemented to maintain bathymetric elevations; however, for this FS it has been assumed that swell removal or pre-dredging to accommodate swell is not necessary since it has been assumed there would be no net rise is surface water elevation. Near the edge of the bench, some build up of material may be needed to control swell.

Following confirmation of ISS operations, a 6-inch thick backfill layer would be placed in the Target Area above the treated material to provide suitable substrate for benthic repopulation. See Section 3.2.1.4 for additional detail. Approximate backfill volumes are detailed in Table 3-1.

Debris is expected to be encountered and would be removed prior to ISS operations. See Section 3-2.1.3 for additional detail. Note that this is not considered pre-dredging.

Bench-scale testing would be performed during remedial design to determine the optimum reagents, mix ratios, and reagent addition rates. The mix design would be evaluated by measuring and optimizing the hydraulic conductivity, unconfined compressive strength, and leaching reduction in a series of tests prepared using NAPL-impacted sediment obtained from the site.

A field demonstration test would also be performed to verify the bench-scale results, evaluate full-scale equipment options, establish productivity rates, and identify site-wide implementation considerations. Due to logistical limitations associated with mobilizing ISS equipment to the site for a field scale pilot test, a demonstration test would occur at the start of full-scale remediation.

The duration of construction is estimated at 3 months. An OM&M plan would be developed to detail LTM to verify the remedy is functioning as designed. Periodic surveying is assumed as a basis for this FS. The LTM would be further evaluated with regulatory agencies and refined during the design phase. In addition, ICs would be implemented and maintained following construction.

4. Detailed Evaluation and Selection of Alternatives

This section provides a description of the evaluation criteria, analysis of each alternative against the criteria and a comparative analysis.

4.1 Description of MTCA Evaluation Criteria

This section of the FS evaluates the remedial alternatives under the MTCA requirements for conducting a FS. As stated in the WAC 173-340-351, the purpose of the FS is to develop and evaluate remedial alternatives that will enable remedial action to be selected for the site that meets the requirements in WAC 173-340-360 and conforms, as appropriate, to the expectations in WAC 173-340-370. Under MTCA, remedial alternatives are evaluated within the framework of minimum requirements, including threshold requirements and DCA ranking criteria, as specified in WAC 173-340-360 and as presented in the FS Checklist (Ecology 2016). The remedial alternatives are screened against minimum requirements and then compared using a DCA.

4.1.1 Threshold Requirements

The requirements, as per WAC 173-340-360(3) and as presented in the FS Checklist (Ecology 2016), must be met by a remedial alternative to be considered further in the evaluations. For sediment sites, threshold requirements also address applicable requirements in WAC 173-204-570, see Section 4.3.7. In addition, these remedial alternatives should consider permanent solutions to the maximum extent practicable (WAC 173-340-360[3][a][x] and WAC 173-204-570[3][d]). If an alternative does not meet these criteria, it should be eliminated from further consideration. The threshold requirements are as follows:

- **Protect Human Health and the Environment**. This criterion considers to what degree the alternative reduces risk, how much time it will take to meet cleanup standards, and any on-site or off-site risks related to implementing the cleanup. (WAC 173-340-360[3][a][i] and WAC 173-204-570[3][a]).
- **Comply with Cleanup Standards**. For remedial alternatives to be considered viable, the alternatives must comply with cleanup standards. Cleanup standards in MTCA have three components: cleanup levels (CULs), points of compliance, and ARARs. (WAC 173-340-360[3][a][ii] and WAC 173-204-570[3][c]). Cleanup standards are finalized in the Cleanup Action Plan (CAP). For this FS, preliminary CULs for this site are described in Section 2.4.
- **Comply with Applicable State and Federal Laws**. For remedial alternatives to be considered viable, the alternatives must comply with applicable state and federal laws. (WAC 173-340-360[3][a][iii] and WAC 173-204-570[3][b]). For this FS, applicable state and federal laws are presented in Section 2.3 and Appendix A for the site by type (i.e., chemical, location, and action-specific).
- **Provide for Compliance Monitoring**. Compliance monitoring is required for all cleanup actions and unless otherwise directed by the department, a compliance monitoring plan shall be prepared. MTCA specifies three types of monitoring requirements for site cleanup and monitoring: protection, performance, and confirmation monitoring (see Subsection 4.2.4). (WAC 173-340-360[3][a][vi] and WAC 173-204-570[3][j]).
- **Reasonable Restoration Time Frame**. Describe the estimated restoration time frame for each alternative and the basis for this estimate. Discuss the reasonableness of this time frame using the evaluation factors in WAC 173-340-360(4) and WAC 173-204-570(5). The evaluation also considers public concerns identified under WAC 173-340-600(13) and (14) and Tribal rights and interests identified under WAC 173-340-620.

4.2 Disproportionate Cost Analysis Ranking Criteria

MTCA requires that remedial alternatives use permanent solutions to the maximum extent practicable. For example, alternatives that include dredging to remove sediment with NAPL impacts from the site, which provides a more permanent solution than alternatives that would not remove sediment with NAPL impacts, such as capping or ISS. However, dredging, in general, is more expensive than capping or ISS. The disproportionate cost analysis (DCA) is a MTCA procedure to evaluate tradeoffs, including costs, among technologies. It was specifically created to weigh incremental environmental benefits against the incremental cost of such benefits. This determination is made based on the DCA process in which:

- The most practicable, permanent remedial alternative serves as the baseline; and
- The benefits of the remedial alternatives to human health and the environment are evaluated and compared to the costs.

As required under MTCA, this analysis compares and contrasts each remedial alternative for each of the criteria listed below in accordance with [WAC 173-340-360(5)(d) and the FS checklist (Ecology 2016). Both quantitative measures and more qualitative best professional judgments are used in assessing benefits.

- **Protectiveness.** Overall protectiveness of human health and the environment.
- **Permanence.** The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances. Consider treatment capability, reduction of releases, management of the sources of release, degree of irreversibility of treatment, and the quantity and quality of treatment wastes.
- **Effectiveness Over the Long-Term.** Consider the degree of certainty for cleanup success, long-term reliability, magnitude of residual risk, management of treatment wastes, and management of wastes left untreated. In addition, long term effectiveness considers impacts to vulnerable populations and overburdened communities, including tribal nations.
- **Management of Implementation Risks.** Assess the risk to human health and the environment associated with the alternative during construction and implementation.
- **Technical and Administrative Implementability.** Ability to be implemented including consideration of whether the alternative is technically and administratively possible.
- **Cost.** The cost to implement the alternative. Includes present capital costs, future capital costs, indirect costs, and operation and maintenance costs.

4.3 Evaluation of Remedial Alternatives against Threshold Requirements

This section evaluates each remedial alternative with respect to the threshold requirements, as described above. For any remedial alternative, the five threshold requirements must be achieved to be considered viable as a remedial alternative for the site and be carried forward in the evaluation. Ultimately, remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 are designed to satisfy the five threshold requirements with critical differences in degree of certainty, reliance on institutional controls, and remediation time frames.

Remedial alternative 1 (No Action) would not mitigate the occurrence of sheen on the water surface caused by ebullition from NAPL containing sediments or mitigate exposure risk to the benthic community or human health. This alternative fails to achieve RAO 1 (reduce risk to benthic organisms), RAO 2 (reduce risk to humans), and RAO 3 (prevent the generation of sheen emanating from known areas of buried NAPL-impacted sediments through ebullition) in a reasonable time frame but would achieve RAO 4 (protect cultural resources) since no further action is taken. In addition, this alternative fails to comply with cleanup standards and chemical-specific state and federal laws. Since remedial alternative 1 (No Action) does not meet or fully satisfy the threshold requirements, it is eliminated from further consideration.

4.3.1 Protect Human Health and the Environment

Protection of human health and the environment is measured by each alternative's ability to achieve MTCA cleanup standards while considering factors such as:

- The comparative permanence derived from removing impacted sediment from the site that would otherwise have to be managed and/or potentially addressed in the future, and
- Short-term impacts on human health and the environment (e.g., benthic community and habitat loss, increased sediment load during dredging, community impacts from traffic, noise, and emissions) that may result from active remediation to achieve greater permanence.

As described in Section 1.8, the RI indicates human health screening results are similar to ecological screening with some exceedances of risk criteria at a few sampling stations associated with the shellfish/fish consumption exposure scenario, thus the site presents potential threat to human health or the environment. As identified in the FS, sediments with NAPL-impacts are non-mobile and are identified between approximately 3.4 to 7.1 feet bss. This area or the extent of sediments with NAPL-impacts are identified as a Target Area for remediation, as defined in Section 2.2. The sediments with NAPL-impacts produce occasionally visible sheens on the water surface through ebullition. While there is no current evidence of NAPL-impacted sediment erosion occurring at the site, the potential for future near-surface sediment erosion does exist (Jacobs 2024).

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 are expected to mitigate the occurrence of sheen on the water surface through ebullition. Remedial alternatives 3 (3A, 3B, and 3C) and 4 would rely on institutional controls to be protective in the long-term. ICs are not required for Alternative 2, since the sheen generating areas would be addressed through removal. Since institutional controls should be relied upon to the minimum extent practicable, the less reliant an alternative is on institutional controls the more protective the alternative. Remedy construction can result in elevated short-term environmental risks (e.g., adverse impacts to water quality) from dredging activities that remove sediments with NAPL-impacts from the site while providing greater long-term protectiveness and permanence. It is anticipated that in situ mixing of reagents for ISS using auger rigs would have higher short-term impacts on the water quality than dredging or capping due to the degree of mixing and likely disturbance. Some short-term risks can be reduced through prudent design practices and best management practices (BMPs) during construction.

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 would be protective of human health and the environment and would achieve RAO 1 (reduce risk to benthic organisms) and RAO 2 (reduce risk to humans), through removal and off-site disposal, capping or in-place containment, and in-situ stabilization of sediments with NAPL-impacts. Remedial Alternative 2 would achieve RAO 3 (prevent the generation of sheen through ebullition of NAPL) in a reasonable time frame through the complete removal of sediments with NAPL-impacts. Remedial alternatives 3 and 4 would also achieve RAO 3 (prevent the generation of sheen through ebullition of NAPL) but would rely on institutional controls to provide continued protection in the long-term. For each remedial alternatives 2 and 3 (3A, 3B, and 3C), RAO 4 (protect cultural resources) would also be achieved through pre-design cultural resources survey. Engineering controls during remedy implementation would limit the disturbance within the Target Area. Remedial Alternative 4 will result in a solid subsurface material that may include cultural resources. While the cultural resources would not be removed, the process may cause disturbance and will result in any such resources being solidified.

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 achieve the threshold criteria of protecting human health and the environment although the alternatives accomplish protectiveness by different means. Long-term risks and short-term (i.e., construction-related) risks are further evaluated as part of the DCA in Section 4.4.

4.3.2 Comply with Cleanup Standards

For remedial alternatives to be considered viable, the alternatives must comply with cleanup standards. Cleanup standards in MTCA have three components: cleanup levels, points of compliance, and ARARs. Cleanup standards are finalized in the CAP. For this FS, the PRGs for this site are described in Section 2.4. PRGs are generally concentration-based goals for individual chemicals for a specific medium and are typically based on RAOs, the current and reasonably anticipated future land uses, and the potential ARARs in consideration of background concentrations of the COCs. The remediation goals for this site are to prevent potential threat/risk to human health or the environment (RAO 1 and RAO 2) and to prevent the ebullition of NAPL resulting in a visible sheen on the water surface (RAO 3).

WAC 173-340-730(5)(d) (*adjustments to cleanup levels for nonaqueous phase liquid limitation*) states that; "for organic hazardous substances and petroleum hydrocarbons, the cleanup level shall not exceed a concentration that would result in nonaqueous phase liquid being present in or on the surface water. Physical observations of surface water at or above the cleanup level, such as the lack of a film, sheen, discoloration, sludge or emulsion in the surface water or adjoining shoreline, may be used to determine compliance with this requirement".

Thus, for all remedial alternatives 2, 3 (3A, 3B, and 3C), and 4, the PRG of preventing the ebullition of NAPL resulting in a visible sheen on the water surface is predicted to be achieved upon completion of remedial construction.

4.3.3 Comply with Applicable State and Federal Laws

Remedial action implemented under all Remedial Alternatives 2, 3 (3A, 3B, and 3C), and 4 would comply with or meet the applicable chemical-, location-, and action-specific state and federal laws identified for the site.

Chemical-specific state and federal laws mainly pertain to the protection of surface water quality. Sediments with NAPL-impact could be released to the Columbia River during in-water construction activities such as during sediment dredging, in-situ stabilization, and/or capping activities. Compliance with chemical-specific state and federal laws could be attained through the implementation of monitoring programs, BMPs, and engineering controls including silt and erosion control measures installed during construction.

Location-specific state and federal laws for all remedial alternatives would be addressed during the implementation of the remedial action. These primarily relate to work affecting threatened or endangered species, fish and wildlife habitat, national historic preservation, archaeological and Native American grave protection, and work performed within or adjacent to floodplains and shorelines. Consultation with respective agencies would be performed before implementing any remedial action. In addition, substantive requirements of various acts and implementing regulations identified would be met and addressed including measures to minimize disturbances on a location-specific basis.

Action-specific state and federal laws for Alternatives 2, 3 (3A, 3B, and 3C), and 4 would be addressed during the implementation of the remedial action. Activities under each alternative would be conducted in a manner that would comply with the substantive requirements of various acts and implementing regulations identified.

4.3.4 Provide for Compliance Monitoring

Compliance monitoring is a key criterion and a key assessment technology for sediment remediation. MTCA (WAC 173-340-410) specifies three types of monitoring requirements for site cleanup: protection, performance, and confirmation monitoring.

- **Protection Monitoring.** This confirms that human health and the environment are adequately protected during the construction phase of the remedial action.
- **Performance Monitoring.** Performance monitoring or post-construction performance monitoring is used to confirm that remedial actions have achieved the cleanup standards or other performance standards.
- **Confirmational Monitoring.** Confirmational monitoring or OM&M is used to confirm the long-term effectiveness of a remedial action after the performance standards or remediation levels have been achieved. This would include monitoring of disposal, isolation, or containment sites to ensure long-term protection.

The monitoring program(s) are included as part of Alternatives 2, 3 (3A, 3B, and 3C), and 4 allowing progress toward achieving cleanup standards to be assessed periodically. Remedial Alternatives 2, 3 (3A, 3B, and 3C), and 4 would include compliance monitoring through the implementation of a site-specific monitoring plan/program which would be developed during the design phase. The site-specific monitoring plan/program would include protective measures and monitoring to ensure the protection of human health and the environment during remedy construction. Monitoring would also be performed to evaluate the post-construction performance of the remedy and as part of the long-term monitoring. Because Alternative 2 includes removal of NAPL-impacted sediments causing ebullition, its monitoring period is assumed to be a short duration (3 years vs. 30 years for Alternatives 3A, 3B, 3C and 4).

4.3.5 Reasonable Restoration Time Frame

WAC 173-340-360(4) and WAC 173-204-570(5) specify several “factors” to consider when determining whether a remedial alternative has a reasonable restoration time frame. The values for the restoration time frame are identical to the values for time to achieve cleanup objectives or RAOs.

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 are predicted to achieve cleanup objectives or the RAOs as soon as the remedial action is completed, i.e., preventing the ebullition of NAPL resulting in a visible sheen on the water surface is predicted to be achieved at the end of remedial construction. Based on remedial action cost estimates, the estimated restoration time frame is estimated to be approximately 5 months for Alternative 2, 2 months for Alternatives 3A and 3B, and 2.5 months for Alternatives 3C, and 3 months for Alternative 4. For Alternative 2, the timeframe includes approximately 3 to 4 months of required time to complete the process of cultural screening of the dredged material at the on-site staging area prior to off-site disposal.

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 are assumed to provide for reasonable restoration time frames based on the ten factors in WAC 173-204-570(5)(c). However, long-term effectiveness and permanence of remedial alternatives 3 and 4 would rely on institutional controls thus, compliance monitoring, and maintenance would be required until the site no longer poses potential risks of non-compliance to address the long-term integrity of the remedy.

4.3.6 Threshold Requirements Summary

Based on the above evaluation, remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 comply with the MTCA threshold requirements. Therefore, these three remedial alternatives are carried forward to the next stage of further evaluation. In addition, based on the above evaluation, remedial Alternative 2 presents a more permanent solution than remedial alternatives 3 (3A, 3B, and 3C) and 4. Thus, remedial Alternative 2 is the baseline alternative against which the other alternatives are evaluated for the purpose of determining whether the cleanup action selected is permanent to the maximum extent practicable as presented in Section 4.3.

4.3.7 Minimum Requirements for Sediment Cleanup Actions

In addition to the above requirements, the minimum requirements that must be met for sediment cleanup actions are outlined in WAC 173-204-570(3) or it will not be further evaluated in the DCA. The minimum requirements and screening of cleanup action alternatives against minimum requirements are presented below:

- Protection of human health and the environment.
- Compliance with all applicable laws.
- Compliance with sediment cleanup standards.
- Use of permanent solutions to the maximum extent practicable.
- Reasonable restoration timeframe.
- Source control measures, if applicable.
- Issuance of a sediment recovery zone, if applicable.
- Compliance with institutional controls.
- Public review and comment provided.
- Compliance monitoring.
- Periodic review, if applicable.

<table>
<tr><th>Minimum Requirements</th><th>Alternative 2</th><th>Alternative 3 (3A, 3B, 3C)</th><th>Alternative 4</th></tr>
<tr><td>Protection of human health and the environment</td><td>Yes. Alternative will protect human health and the environment without site use restrictions. See above Section 4.3.1.</td><td colspan="2">Yes. Alternative will protect human health and the environment with minimal site use restrictions. See above Section 4.3.1.</td></tr>
<tr><td>Compliance with all applicable laws</td><td colspan="3">Yes. Alternative complies with applicable state and federal regulations.
See above Section 4.3.3.</td></tr>
<tr><td>Compliance with sediment cleanup standards</td><td colspan="3">Yes. Alternative is expected to comply with cleanup standards to be selected by Ecology. See above Section 4.3.2.</td></tr>
<tr><td>Use of permanent solutions to the maximum extent practicable</td><td>Yes. See below Section 4.4.</td><td>Yes. See below Section 4.4.</td><td>Yes. See below Section 4.4.</td></tr>
<tr><td>Reasonable restoration timeframe</td><td>Yes. See above Section 4.3.5.</td><td>Yes. See above Section 4.3.5.</td><td>Yes. See above Section 4.3.5.</td></tr>
</table>

Minimum Requirements	Alternative 2	Alternative 3 (3A, 3B, 3C)	Alternative 4
Source control measures, if applicable	Yes. Alternative includes most effective source control measures necessary.		
Issuance of a sediment recovery zone, if applicable	Not necessary. Cleanup standards will be met within a reasonable restoration timeframe.		
Compliance with institutional controls	Yes	Yes	Yes
Public review and comment provided	Yes	Yes	Yes[a]
Compliance monitoring	Yes. Alternative includes provisions for compliance monitoring. See above Section 4.3.4.		
Periodic review, if applicable	Yes	Yes	Yes

Notes:

a. Cultural resources would be disturbed but would remain in place.

Remedial alternatives 2, 3 (3A, 3B, and 3C), and 4 met these minimum requirements and are further evaluated for: a) permanent solutions to the maximum extent practicable; b) relative benefit ranking; and c) scoring, as presented below.

4.4 Evaluation of Remedial Alternatives using Disproportionate Cost Analysis Ranking Criteria

The DCA is an MTCA procedure to evaluate tradeoffs, including costs, among technologies. It was specifically created to weigh incremental environmental benefits against the incremental cost of such benefits. Remedial alternatives that meet the minimum requirements are further evaluated for permanent solutions to the maximum extent practicable, relative benefit ranking, and scoring. As discussed above, the active remedial alternatives meet the minimum requirements and are further evaluated below.

For this FS, weighted numeric scores are used to quantify the benefits of the remedial alternatives. The following benefits criteria are used for this evaluation, per WAC 173-340-360(5)(d) and WAC 173-204-570(4):

- Protectiveness
- Permanence
- Effectiveness Over the Long-Term
- Management of Implementation Risks
- Technical and Administrative Implementability
- Cost (cost is not scored nor is it a weighted benefit, but is used in the DCA to evaluate the benefit of each alternative relative to its present value)

An evaluation of the remedial alternatives relative to these six criteria is provided in Table 4-1. The evaluation is used to rank the remedial alternatives on a scale from 1 to 10 for each MTCA criterion and is used as a basis to calculate the numerical ratings in the DCA. These ratings are then weighted and summed for an overall measure of the benefits achieved by the remedial alternatives, presented in Table 4-2, along with the cost estimates (as net present value) for each remedial alternative. In general, a score of 1 represents a poorly-performing remedial alternative for that criterion, and a score of 10 represents an optimally-performing remedial alternative for that criterion or indicates the remedial alternative substantially meets the criterion. It should be noted that each aspect of the DCA scoring and weighting factors requires a degree of best professional judgment. Quantitative measures were used where possible.

4.4.1 Weighting Evaluation of Benefits Criteria

The evaluation criteria presented in WAC 173-204-570(4) and WAC 173-340-360(5) are weighted using the following considerations and are presented in Table 4-2. The weightings emphasize the core purpose of protecting human health and the environment and reflect site-specific considerations, such as the size, complexity, uncertainty, and potential restoration time frames involved in the remedial alternatives. Weighting factors for each of the benefits criteria reflect site-specific conditions and remedial objectives, but protectiveness, permanence, and long-term effectiveness benefits criteria are typically weighted more since they are core to protecting human health and the environment. The weightings, which add up to 100 percent, for each of the criteria are provided in the following:

- “Protectiveness” criterion is weighted at 30 percent. It represents the ultimate objective of implementing a remedial alternative and represents the greatest value of the six categories.
- “Permanence” criterion is weighted at 25 percent. In evaluating the alternatives under this criterion, the focus is on the degree to which the toxicity, mobility, or volume of hazardous substances is reduced, and considers the extent to which sediments with NAPL-impacts are removed from the site rather than leaving them buried in place. A high level of certainty must accompany the final environmental cleanup so that future actions will not be necessary. This criterion is closely associated with overall protectiveness but incorporates a greater factor of time.
- “Effectiveness over the long term” criterion is weighted at 25 percent. This weighting factor is associated with a measure of certainty related to the robustness of the action, as well as confidence in the technology used for the protection of human health and the environment. The criteria also considers the potential impacts to vulnerable populations and overburdened communities, including tribal nations. It is an important requirement because it addresses how well the remedy reduces risks, for example, whether sediments with NAPL-impacts are removed or left in place to be managed over the long term, and whether controls are adequate to maintain protection against potential ebullition of NAPL in the long term.
- “Management of implementation risks” criterion is weighted at 10 percent. This lower weighting is based upon the limited temporal aspect associated with the short-term risks at this site. Each remedial alternative is anticipated to have relatively shorter time frames with a smaller active remediation footprint, thus reducing the overall short-term risks to workers, the community, and the environment. At this site, short-term risks can be effectively managed through proper implementation of BMPs and engineering and administrative controls. Short-term risks are actively monitored (i.e., Protectiveness Monitoring) during the period of implementation.
- “Technical and administrative implementability” criterion is weighted at 10 percent. This weighting reflects the fact that implementability is less associated with environmental concerns than with the relative difficulty and uncertainty of implementing the project. It includes both technical factors and administrative factors associated with permitting and completing the cleanup.
- “Cost” is not a weighted benefit but is used in the DCA to evaluate the benefit of each alternative relative to its cost i.e., costs are evaluated against remedy benefits to assess cost-effectiveness and remedy practicability.

4.4.2 Disproportionate Cost Analysis and Discussion

The costs and benefits are summarized in Table 4-2 and Figure 4-1. The overall benefits associated with each alternative are summarized using a composite "benefits score." This score includes the rankings for individual evaluation criteria, which are multiplied by the weighting within that category and summed to reach the "total benefits score". The estimated costs are expressed in the total present worth which is adjusted for future costs (Appendix B). Cost estimates for each remedial alternative are expected to have an accuracy between -30 percent to +50 percent of actual costs, based on the assumed scope and project definition at the FS stage. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes. The summary of DCA is presented in Exhibit 4-1.

Exhibit 4-1. Summary of Disproportionate Cost Analysis

Remedial Alternative	Total Benefits Score	Estimated Present-Worth Cost [1] ($M)	Ratio of Cost to Benefits[2]
Alternative 2 – Removal, Backfill and Offsite Disposal	7.5	$7.02	$0.94M per Benefit
Alternative 3A – Capping w/ AquaGate+ organoclay™, and ICs	7.1	$3.16	$0.45M per Benefit
Alternative 3B - Capping w/ RCM, and ICs	7.1	$3.79	$0.54M per Benefit
Alternative 3C – Capping w/ RCM, MAM, and ICs	7.1	$4.23	$0.61M per Benefit
Alternative 4 – ISS, Backfill and ICs	5.4	$4.91	$0.91M per Benefit

[1] Remedial alternative cost estimates are presented in Appendix B.
[2] Ratio of Cost to Benefits, example for RA 2 = $7.02M/8.0 = $0.94 M per benefit
$M: Dollars in Millions
ISS = In-Situ Stabilization

The relative benefits and costs of each alternative are compared to Alternative 2, which represents the most permanent cleanup action alternative (the baseline alternative) against which the other alternatives are evaluated. The baseline alternative therefore provides the benchmark against which the relationship between incremental remedy benefits and incremental costs of each of the other remedial alternatives are evaluated. This analysis is used to determine whether the proposed cleanup actions are permanent to the maximum extent practicable.

The total benefits for the remedial alternatives range from 5.4 to 7.5, and present-worth costs range from $3.16 to $7.02M (see Appendix B for cost details). Figure 4-1 details the weighted benefits score for each alternative with an overlay of cost in graphical format. The following conclusions are drawn from the DCA presented above:

- Higher cost alternatives do not necessarily show proportional increases in overall benefit, especially when comparing capping alternatives (Alternatives 3A, 3B, and 3C) against Alternatives 2 and 4.
- The total benefit scores indicate that removal of sediments with NAPL-impacts results in a higher overall score, with scores highest in protectiveness, permanence, and effectiveness over the long-term criteria. The lowest overall score is for Alternative 4 – ISS, due to the low scores for implementation risks, effectiveness over the long-term (which considers impacts to vulnerable populations and overburdened communities, including tribal nations), and technical and administrative feasibility.

- Costs range from $3.16M to $7.02M while the cost per benefit ranges from $0.45M to $0.94M. Remedial alternative 3A has the lowest cost of $0.45M per benefit gained and remedial alternative 2 has the highest cost per benefit gained of $0.94M per Benefit.
- The three capping alternatives – Alternative 3A, 3B, and 3C – scored similarly with the highest overall rating for Alternative 3C due to the potential long-term benefits of using a more aggressive approach to erosion by installing the MAM (which due to the nature of the river in that area is not considered necessary); however, the additional benefit is not proportionate relative to Alternatives 3A and 3B. Remedial alternative 3A has the lowest cost of $0.45M per benefit gained.
- Alternative 3 - Capping (all three options) has other benefits that result in higher or similar scores with respect to Alternative 2 (Removal), especially for management of short-term risk and technical and administrative implementability. This method also reduces negative impacts to the environment and potential for tribal and/or related artifact removal or disturbances.
- Because the cost of Alternative 2 ($7.02M) is substantially higher than that of Alternative 3A ($3.16M), while the level of benefit is marginally greater (7.5 vs. 7.1, respectively), the incremental cost of Alternative 2 is considered disproportionate.
- In addition, for Alternative 3A, the level of benefit is marginally lower with a substantially lower incremental cost to benefits ratio compared to Alternative 2, thus the incremental cost of Alternative 2 is considered disproportionate.
- The level of benefits for Alternative 4 is substantially lower than that of Alternative 3A (5.4 vs. 7.1, respectively); and the ratio of cost to benefits is considerably higher ($0.91M vs. $0.45M); therefore, the incremental cost of Alternative 4 is considered disproportionate.

The results of the DCA indicates that, at a minimum, Alternative 2 and Alternative 4 are disproportionately costly compared to their respective benefits in relation to Alternatives 3A, 3B, and 3C. Among the three capping alternatives, Alternative 3A has the lowest cost of $0.45M per benefit gained as compared to Alternatives 3B and 3C. Thus, Alternative 3A was identified as the most appropriate alternative for the site.

The analysis presented in this section is intended to support participating parties in their evaluations of the remedial alternatives relative to MTCA. The final identification of the remedial alternative that includes a "permanent solution to the maximum extent practicable" would be stipulated in the cleanup action plan (CAP). The purpose of a CAP is to document the selected cleanup action and to specify the cleanup standards and other requirements the cleanup action must meet.

5. Remedy Selection

Alternative 3A (Capping with AquaGate and organoclay™ and Institutional Controls) has been identified as the recommended permanent solution to the maximum extent practicable under MTCA based upon its highest overall ranking in the DCA presented in Table 4-2. This alternative makes the greatest use of high-preference technologies, minimizes short-term impacts to the environment and cultural resources while remaining practicable and protective, in addition to having the lowest cost per benefit gained as compared to other remedial alternatives. Alternatives 3B and 3C (alternate capping configurations) also scored well in the DCA with having the next lowest cost per benefit and provide similar levels of protectiveness.

Alternative 4 received the lowest total benefits score which is significantly lower compared to remedial alternatives 2 and 3 (3A, 3B, and 3C). The proportion of costs for Alternative 4 compared to the benefits gained is higher as compared to Alternative 3A ($0.91M vs. $0.45M, respectively) and is lower compared to Alternative 2 ($0.91M per benefit vs. $0.94M per benefit, respectively); therefore, it is considered disproportionate. However, due to uncertainties in implementability and having the highest potential short-term impacts with relatively lower long-term protectiveness and permanence, Alternative 4 is considered not practicable. Thus, Alternative 4 received the lowest overall alternative ranking.

Alternative 2 received the highest total benefits score; however, the proportion of costs compared to the benefits gained ($0.94M per benefit) is highest compared to other remedial alternatives and is therefore considered disproportionate but remains practicable. Thus, Alternative 2 received the second-lowest overall remedial alternative ranking, as presented in Table 4-2.

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Tables

Table 1-1. Estimated Pre-Remedy Surface-Weighted Average Concentrations of cPAHs

Wishram Feasibility Study Report

Wishram Railyard, Wishram, Washington

Station_ID	Total cPAH (mg/kg)	Polygon Area (SF)	Area % of total	Existing Condition Area-Adjusted Concentration (mg/kg)	Notes
D160	0.34985	10,197	**3.54%**	0.0124	
E320	0.40250	5,408	**1.88%**	0.0076	
E380	0.03279	8,368	**2.91%**	0.0010	
E460	0.34755	13,742	**4.77%**	0.0166	
H360	0.03184	20,130	**6.99%**	0.0022	
I120	0.03306	10,116	**3.51%**	0.0012	
L320	0.06165	29,440	**10.23%**	0.0063	
SG01	0.05521	21,515	**7.48%**	0.0041	
SG02	0.09800	24,941	**8.67%**	0.0085	
SG03	2.15380	29,183	**10.14%**	0.2184	
SG11	0.03791	20,554	**7.14%**	0.0027	
SG13	0.03109	46,085	**16.01%**	0.0050	
SG23	0.03127	48,136	**16.72%**	0.0052	
	Totals	*287,814*			
			SWAC	**0.2911**	

Notes

The SWAC values are the sum of the area-adjusted concentration for each polygon. The area adjusted concentration is the product of the cPAH concentration for a given polygon and the percentage of total area represented by that polygon.

One half of the reporting limit was used in the calculation where the analyte was not detected.

Table 1-2. Estimated Pre-Remedy Surface-Weighted Average Concentrations of PCBs
Wishram Feasibility Study Report
Wishram Railyard, Wishram, Washington

Station_ID	Total PCBs (µg/kg)	Polygon Area (SF)	Area % of total	Existing Condition Area-Adjusted Concentration (µg/kg)	Notes
D160	0.04647	10,197	**3.54%**	0.00165	
E320	0.05102	5,408	**1.88%**	0.00096	
E380	0.01012	8,368	**2.91%**	0.00029	
E460	0.02503	13,742	**4.77%**	0.00120	
H360	0.07036	20,130	**6.99%**	0.00492	
I120	0.02339	10,116	**3.51%**	0.00082	
L320	0.01571	29,440	**10.23%**	0.00161	
SG01	0.01970	21,515	**7.48%**	0.00147	
SG02	0.09530	24,941	**8.67%**	0.00826	
SG03	0.01444	29,183	**10.14%**	0.00146	
SG11	0.01725	20,554	**7.14%**	0.00123	
SG13	0.01415	46,085	**16.01%**	0.00227	
SG23	0.03163	48,136	**16.72%**	0.00529	
	Totals	*287,814*			
			SWAC	**0.0314**	

Notes

The SWAC values are the sum of the area-adjusted concentration for each polygon. The area adjusted concentration is the product of the PCB concentration for a given polygon and the percentage of total area represented by that polygon.
One half of the reporting limit was used in the calculation where the analyte was not detected.

Table 2-1. Description of Potentially Applicable Technologies

General Response Action	Technology	Process Options	Description
No Action	None	N/A	No remedial measures or monitoring conducted. Required by SCUM Section 12.4.4
Institutional Controls	Institutional Controls	Institutional Controls	Institutional Controls (ICs) are non-engineered instruments, such as administrative and legal controls, that minimize the potential for human health or ecological exposure to contamination and ensure the long-term integrity of the remedy (EPA 2005). ICs may include land use restrictions, natural resource use restrictions, groundwater use restrictions or management areas, property deed notices, declaration of environmental restrictions, access controls (digging and/or drilling permits), surveillance, information posting or distribution, restrictive covenants, and federal, state, county, and/or local registries.
Natural Recovery	Monitoring Natural Recovery	Long-term Monitoring	No treatment actions are taken, but this option considers the natural processes that may reduce or degrade chemical constituents: dispersion, dilution, transformation, sorption, and deposition of cleaner sediment, resulting in a reduction in mass, toxicity, mobility, volume, or concentration of COCs. Long-term monitoring would be required.
	Enhanced Natural Recovery	Thin-layer Placement	Enhanced natural recovery involves placing a thin layer (a few inches) of clean sediment material (with the potential to include amendments) over the impacted sediment to provide a reduction of COC concentrations in the biologically active zone and to accelerate natural recovery. Long-term monitoring would be required.
Removal	Dredging	Mechanical Dredging	Mechanical dredging involves excavating sediment using conventional earthmoving equipment (for example, excavators, and cranes) from a barge. This involves working on the water and moving the barge as needed to remove the contaminated material.
		Hydraulic Dredging	Hydraulic dredging involves removal and transport in a slurry form. The hydraulic dredges typically have a suction device fixed to a movable arm (or ladder) that is raised or lowered to facilitate sediment removal. Hydraulically dredged materials are transported via piping directly to a staging/processing area. Booster pumps may be required to transport the materials as the distance and elevation increase between the dredge and processing areas. The suction end of the dredge is often equipped with a mechanical or hydraulic device to loosen the sediment before being drawn into the dredge suction line. Common hydraulic dredges include plain suction, conventional round cutterhead, horizontal auger, open suction, dustpan, high-solids pumps, and diver-assisted suction dredges.
		Specialty Dredging	Specialty Dredging includes vacuum dredging, pneumatic dredging, and other mechanical and hydraulic equipment/approach combinations. Vacuum dredging removes material via the use of vacuum trucks and requires carriage water to transport the dredged material. Dry dredges typically utilize a clamshell bucket on a fixed boom and use a pump to transport the dredged material. Pneumatic dredges use an air-operated submersible pump and a pipeline for transport of dredged material.
	Excavation (in the dry)	Excavation (in the dry)	This involves excavating sediment using conventional earthmoving equipment (for example, excavators, cranes) from the shore (removal in the wet) or isolating the target dredge material from the overlying water body by pumping or diverting water from the area (for example, sheet piling) (removal in dewatered conditions).
Containment	Capping	Engineered Capping	An engineered cap is composed of a single or layered materials (for example, sand, gravel, cobbles, geotextile) placed over in situ sediment to physically isolate and protect contaminated sediment from erosion and to mitigate the transport of dissolved and colloidally bound contaminants into the water column. An engineered cap can be composed of multiple materials, each with a specific purpose (for example, cobble for erosion protection overlying sand for chemical isolation) or the same material that can function as both erosion protection and chemical isolation. Where necessary, materials may include physical barriers such as engineered clay aggregate materials (for example, bentonite pellets, AquaBlok™). Geosynthetics are also commercially available and may be used to contain chemical isolation barrier material or erosion control material (for example, marine armor mat). Engineering/capping can be combined with another GRA (for example, removal) to increase the effectiveness of the alternative.
		Active Capping	An active cap is similar in design to an engineered cap (that is, physically isolates sediments and protects from erosion); however, it reduces the flux of contaminants from underlying sediment to the water column through the adsorption of contaminants onto the cap material. Reactive materials can be placed within the contaminant isolation layer of the cap (an "active" cap) to supplement this adsorption process or to provide some other physical/containment processes that reduce the mobility of the contaminants. Use of reactive materials may be warranted where evaluations of engineered capping show that a sufficiently thick cap cannot be created to adequately reduce the flux of contaminants over time. This condition may be due to a variety of reasons singly or in combination, such as the presence of highly mobile contaminants, high rates of groundwater advection, and/or the need to maintain certain water depths for navigation or habitat purposes. As described in EPA (2005), examples of materials used in active caps include reactive/adsorptive materials such as activated carbon, apatite, coke, organoclay, zero-valent iron, and zeolite. Composite geotextile mats containing one or more of these materials (for example, reactive core mats) and geosynthetics (for example, marine armor mat) are available commercially. Active capping can be combined with another GRA (for example, removal) to increase the effectiveness of the alternative.
Treatment	In Situ Treatment	Stabilization	In situ treatment stabilization includes mixing and fixating reactive admixtures into the sediment using amendments such as cement and slag to fixate or entrain contaminants. The process would be combined with a destructive approach when using chemical amendments to oxidize or reduce contaminant concentrations.
		Thermal Destruction	Thermal treatment involves the application of steam or hot air injection, or the use of electrical resistance, conductive, electromagnetic, or radio frequency heating. The processes increase the volatility of contaminants such that they can be removed (separated) from the solid matrix. The volatilized contaminants are then either collected or thermally destroyed.

Table 2-1. Description of Potentially Applicable Technologies

General Response Action	Technology	Process Options	Description
		Chemical Destruction	Chemical oxidants are injected into the subsurface sediments to oxidize organic contaminants.
		Biological Degradation	Biological degradation uses natural microbiological processes to degrade or transform organic chemicals in the sediment environment. Nutrients and potential electron donors/acceptors are provided while controlling temperature and pH to stimulate existing microorganisms to grow and use chemicals as a source of food and energy.
	Ex Situ Treatment	Stabilization	Ex situ treatment stabilization includes mixing the removed materials ex situ with Portland cement, fly ash, lime, kiln dust, or other stabilization agents. This process may be used for active dewatering only to reduce the leachability (that is, mobility) of the COCs or modifying the material's structural properties.
		Soil Washing	In soil washing, soil or sediment is put in contact with an aqueous solution to remove contaminants from the soil particles. The suspension is often also used to separate fine particles from coarser particles, allowing beneficial use of the coarser fraction (if sufficiently clean) at the site.
Dewatering	Active Dewatering	Plate and Frame Filter Press	Sediment slurry is pumped into cavities formed by a series of plates covered by a filter cloth. Liquids are forced through filter cloth and dewatered solids are collected in the filter cavities.
		Belt Filter Press	Sediment slurry drops onto a perforated belt where gravity drainage takes place. Thickened solids are pressed between a series of rollers to dewater solids further.
		Hydrocyclone	Sediment slurry is fed tangentially into a funnel-shaped unit to facilitate the centrifugal forces necessary to separate solids from liquids. Dewatered solids are collected, and overflow liquid is discharged.
		Stabilization	See Treatment, Ex Situ Treatment, Stabilization.
	Passive Dewatering	Geotextile Tubes	Hydraulically dredged or rehandled sediments are pumped into the geotextile tubes and excess water flows through the pores in the geotextiles, resulting in effective dewatering and volume reduction of the contaminated materials.
		Gravity Settling and Drainage	Mechanically dredged materials are placed on a lined pad and allowed to drain and air dry. Hydraulic sediment slurry enters a settling basin and is allowed to settle, drain, and consolidate in the bottom of a basin. Pretreatment with chemical addition may be used to enhance settling.
Transportation	Barge	Barge	Sediment is removed and transported to the appropriate treatment/disposal facility via barge. Barge may require stabilization or dewatering before transportation and requires an offloading facility to transfer material from water-based operations to land-based operations.
	Truck	Truck	Sediment is removed and transported to the appropriate treatment/disposal facility via truck. Truck may require stabilization or dewatering before transportation. Additional infrastructure, such as upgrading transport routes, loading docks and stockpile areas, and spill plates for loading, among others, may be required for transportation.
	Pipeline	Pipeline	Hydraulically dredged sediment is transported to the appropriate treatment/disposal facility via pipeline. Additional infrastructure, such as booster pumps and pipe racks, and site upgrades may be required for transportation.
	Rail	Rail	Sediment is removed and transported to the appropriate treatment/disposal facility via rail. Sediment placed in the rail cars (for example, gondolas) may require stabilization or dewatering before transportation. Existing rail facilities are present at the site, however, may require additional infrastructure, such as loading docks and stockpile areas, and spill plates for loading, among others.
Disposal	Onsite Disposal	Confined Disposal Facility	Sediment is placed in a disposal facility constructed onsite consisting of sheet piling and/or earthen dikes or caissons adjacent to or within a waterbody.
		Confined Aquatic Disposal	Sediment is placed through the water column into a bathymetric low area to form a confined aquatic disposal cell. Bathymetric low areas may be naturally occurring or may be constructed by dredging sediment to create low bathymetry artificially. After the placement of dredged material, the area is capped. Cap material may include the material dredged to create the low bathymetry.
	Offsite Disposal	Permitted Landfill	Sediment is disposed of in existing offsite permitted solid waste landfill.

Notes:

COC = chemical of concern

EPA = U.S. Environmental Protection Agency

GRA = general response action

N/A = not applicable

site = BNSF Wishram Railyard

Table 2-2. Technology Screening

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Status
No Action	None	N/A	Current and future risks would remain the same. Does not provide controls for reduction of exposure, long-term management, or monitoring measures. Does not meet RAOs.	N/A	None	Retained; Required by SCUM Section 12.4.4
Institutional Controls	Institutional Controls	Covenants	Minimizes potential human exposure to COCs in sediment. The site-specific IC's will be determined at a future date and may include land use restrictions, natural resource use restrictions, property deed notices, declaration of environmental restrictions, access controls (digging and/or drilling permits), surveillance, information posting or distribution, restrictive covenants, and federal, state, county, and/or local registries.	Technically and administratively implementable.	Low	Retained
Natural Recovery	Monitored Natural Recovery (MNR)	None	MNR would not be effective in the short term as no active remedial activities would be performed and sheens would continue to be present. However, deposition may occur in the long-term thereby reducing the potential for sheens, although the time to achieve is currently not quantified. Does not pose any additional risk to the community, workers, or the environment. Requires long-term monitoring. Does not meet RAOs.	Readily implementable and minimally intrusive. Activities would be limited to long-term monitoring and sampling from a boat and/or shoreline. Access, materials, personnel, and equipment are readily available.	Low	Not Retained. Effectiveness
	Enhanced Natural Recovery	Placement of Thin Layer of Clean Material	Reduces potential for sheens in sediment over time. Effectiveness depends on hydraulic conditions created, loading rates, and the quality of sediment deposited. Effective in low-energy aquatic environments. Requires long-term monitoring. Meets RAOs.	Technically implementable but could alter local habitat. Implementability considerations for specific areas would include impacts on surface water elevations, impacts on channel depth, and stability of added sediment layers. Activities would be limited to long-term monitoring and sampling from a boat and/or shoreline. Access, materials, personnel, and equipment are readily available.	Low	Retained
Removal	Dredging	Mechanical Dredging	Reduces potential long-term generation of sheens through the removal of NAPL-containing sediments. This may increase short-term exposure due to resuspension or release of COCs during dredging. Due to dredging technology limitations, management of post-dredging residuals may be necessary (for example, through the placement of post-dredging cover materials).. . Cultural resources may be dredged during remedial activities. Additional processing and resources would need to be implemented to ensure the preservation of cultural resources. Meets RAOs.	Technically and administratively implementable at the site and proven technology that has been implemented at other similar sites. Equipment, materials, and personnel are readily available. Would need to meet substantive requirements of applicable regulations. Damage or loss of sensitive habitats is expected, however, the placement of a habitat layer as part of backfill would provide an environment conducive to benthic recolonization. This may occur where dredging would impact shoreline areas significantly.	Medium	Retained
		Hydraulic Dredging	Reduces potential long-term generation of sheens through the removal of NAPL-containing sediments. This may increase short-term exposure due to resuspension or release of COCs during dredging. Effectiveness could be limited by the presence of debris and other coarse material; thus, mechanical removal of debris prior to hydraulic dredging would be required as an initial step. Due to dredging technology limitations, management of post-dredging residuals may be necessary (for example, through the placement of post-dredging cover materials). Cultural resources may be dredged during remedial activities. Additional processing and resources would need to be implemented to ensure the preservation of cultural resources to meet RAO 4. Meets RAOs.	Technically and administratively implementable at the site and proven technology that has been implemented at other similar sites. There are challenges based on the nature of COCs (NAPL) and bedrock outcroppings. NAPL has the potential to impact equipment (cutterheads) and transport (pipelines). Equipment, materials, and personnel are readily available. Conditions, such as the presence of boulders or debris, may cause implementability concerns. Would need to meet substantive requirements of applicable regulations. Damage or loss of sensitive habitats is expected, however, the placement of a habitat layer as part of backfill would provide an environment conducive to benthic recolonization. Not suitable for small projects, the cost of removing sediment is more than mechanical. An open area is needed to build a settling basin, stage geotextile tubes, or set up mechanical equipment for dewatering of material. Mobilization costs lend hydraulic dredging to projects with a larger scope.	High	Not Retained. Implementability and Cost

Table 2-2. Technology Screening

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Status
Removal (continued)	Dredging (continued)	Specialty Dredging	Reduces potential long-term generation of sheens through the removal of NAPL-containing sediments. This may increase short-term exposure due to resuspension or release of COCs during dredging. Effectiveness could be limited by the presence of debris and other coarse material; thus, mechanical removal of debris prior to specialty dredging would be required as an initial step. Due to dredging technology limitations, management of post-dredging residuals may be necessary (for example, through the placement of post-dredging cover materials). Cultural resources may be dredged during remedial activities. Additional processing and resources would need to be implemented to ensure the preservation of cultural resources to meet RAO 4. Meets RAOs.	Administratively implementable at the site and proven technology that has been implemented at other sediment remediation sites. Site characteristics such as water depths, debris, cultural resources, and depth of dredge cuts pose technical challenges. NAPL has the potential to impact equipment and transport pipelines. Equipment, materials, and personnel are readily available. Would need to meet substantive requirements of applicable regulations. Damage or loss of sensitive habitats is expected, however, the placement of a habitat layer as part of backfill would provide an environment conducive to benthic recolonization.	High	Not Retained. Effectiveness, Implementability, and Cost
	Excavation	Excavation (from shoreline or in dewatered conditions)	Reduces potential long-term general of sheens through the removal of NAPL-containing sediments. If conducted in dewatered conditions, provides greater removal precision than dredging through the water column and less potential for resuspension and offsite release of COCs. If conducted from the shoreline in the wet, may increase short-term exposure due to resuspension or release of COCs during excavation. Due to excavation technology limitations, management of post-excavation residuals may be necessary (for example, through the placement of post-dredging cover materials). Cultural resources may be excavated during remedial activities. Additional processing and resources would need to be implemented to ensure the preservation of cultural resources to meet RAO 4. Meets RAOs.	Technically and administratively implementable in areas where site conditions are favorable (for example, the excavation area can be contained or dewatered and access to sediments is feasible using land-based equipment or equipment in dewatered area). Facilitating dewater conditions (for example, installing sheetpile cofferdams) presents implementability challenges. Equipment, materials, and personnel are readily available. Would need to meet substantive requirements of applicable regulations. Damage or loss of sensitive habitats is expected, however, the placement of backfill will provide an environment conducive to benthic recolonization.	High	Not Retained. Effectiveness, Implementability, and Cost
Containment	Capping	Active Capping	Reduces long-term potential for sheen generation by containment and providing a cover over the NAPL-containing sediments. Requires post-construction maintenance and monitoring. Meets RAOs 1, 2, and 3 through containment and provides for treatment of the impacted surface material if a sorptive media (for example, organic carbon, organoclay, biochar) is included. Meets RAO 4 as no intrusive remediation would be performed. Can be combined with another GRA (for example, removal) to increase the effectiveness of the alternative.	Technically and administratively implementable. Capping by itself is most readily implementable in deeper, lower-energy environments. Implementation in shallower, higher-energy environments may require some sediment removal before capping to address flood storage and navigation concerns. Equipment, materials, and qualified personnel are available. Debris (e.g., metallic material, wood, concrete, subaquatic vegetation) removal would be required prior to cap placement. Would need to meet substantive requirements of applicable regulations. In situ caps have been successfully placed at other sites, but consideration must be given to the geotechnical characteristics (slope stability and seismic activity) of existing sediments to support the cap during design and construction.	Medium	Retained
		Isolation Capping	Reduces long-term potential for sheen generation through isolation of NAPL-impacted material achieving RAO 1, 2 and 3. May include a physical barrier (for example, an impermeable geofabric, clay, AquaBlok) sufficient to isolate and reduce sheens to the water column. Meets RAO 4 as no intrusive remediation would be performed. Requires post-construction maintenance and monitoring. Meets RAOs. Can be combined with another GRA (for example, removal) to increase the effectiveness of the alternative.	Technically and administratively implementable. Capping by itself is most readily implementable in deeper, lower-energy environments. Implementation in shallower, higher-energy environments may require some sediment removal before capping to address flood storage and navigation concerns. Equipment, materials, and qualified personnel are available. Debris (e.g., metallic material, wood, concrete, subaquatic vegetation) removal would be required prior to cap placement. Would need to meet substantive requirements of applicable regulations. In situ caps have been successfully placed at other sites, but consideration must be given to the geotechnical characteristics (slope stability and seismic activity) of existing sediments to support the cap during design and construction.	Medium	Retained

Table 2-2. Technology Screening

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Status
Treatment	In Situ treatment	Stabilization	Meets RAO1, 2, and 3 by immobilizing NAPL-impacts mitigating long-term potential for sheen generation. The process yields a solidified stable mass with high structural strength and low leaching potential. Does not meet RAO 4 as cultural resources would be solidified in place. Can be combined with another GRA (for example, removal) to increase effectiveness.	Technically and administratively implementable. The application is a proven technology that has been implemented at other similar sites. Specialized equipment, materials, and personnel are available. Specialty mixing equipment (augers) can be impeded at sites with debris or coarse granular material (cobbles). Implementation difficulty increases with depth. Implementation would also need to consider the anticipated swell of surface sediments often resulting during ISS and whether that might reduce water depths and inhibit future navigation and therefore swell removal may be required. Would need to meet substantive requirements of applicable regulations.	Medium	Retained
		Chemical Destruction	The injection of chemical oxidants into the NAPL impacted sediment would treat contaminants mitigating the generation of sheens, however, the added reagent would remain in-situ. NAPL may be mobilized due to the large quantities of reagents that may be required. May impact cultural resources through chemical interactions. Does not meet RAOs..	Administratively implementable. Would encounter technical implementability issues due to limited site precedence with NAPL impacts. Chemical destruction/oxidation would require the injection of significant quantities of oxidants to reduce concentrations and the mass of NAPL. It would be difficult to inject these large quantities to the depths where contamination is found. An increase in NAPL mobility may also occur during implementation of this process. May require additional study (both bench-scale to assess project-specifics regarding COCs, appropriate delivery systems, among others; and a pilot scale phase to demonstrate implementability in this setting) including an in-depth understanding of bedrock outcropping characteristics (e.g., bedding planes, fractures). The availability of qualified personnel, materials, and equipment would likely be limited. May be difficult to meet the substantive permit requirements.	High	Not Retained. Implementability, Cost
		Biological Degradation	Bioremediation has not been proven to be effective in the treatment of NAPL-impacted sediment. This technology has not been shown to be effective under the conditions observed at the site. Does not meet RAOs.	Administratively implementable. Would encounter technical implementability issues due to limited site precedence with NAPL impacts.. May require additional study (both bench-scale to assess project-specifics regarding COCs, appropriate delivery systems, among others; and a pilot scale to demonstrate implementability in this setting) including an in-depth understanding of bedrock outcropping characteristics (e.g., bedding planes, fractures). The availability of qualified personnel, materials, and equipment would likely be limited. May be difficult to meet the substantive permit requirements.	Medium	Not Retained. Effectiveness, Implementability
		Thermal Destruction	Thermal treatment may be used to heat NAPL into a less viscous state where it can be recovered via active extraction wells or trenches. Thermal treatment above the boiling point of water would decrease the viscosity of coal tar NAPL, which may be combined with another technology to remove or extract the NAPL. Increases in temperature have been shown to increase the solubility of site COCs. Increased subsurface temperatures increase the concentration of COC in the dissolved phase and increase the availability of these compounds thereby having a short-term effect on the benthic community and damage or loss of habitat in the target area. The dissolution of site COCs increases the viability of COCs to migrate outside of the target area. Does not meet RAOs.	Administratively implementable. Not technically implementable due to the location of NAPL impacts (sediment at depth) and hydrodynamic conditions. Limited site precedence and few methods are currently commercially available. May require additional study (both bench-scale to assess project-specific thermodynamics regarding COCs, appropriate delivery and extraction systems, among others; and a pilot scale to demonstrate implementability in this setting) including an in-depth understanding of bedrock outcropping characteristics (e.g., bedding planes, fractures). The availability of qualified personnel, materials, and equipment would likely be limited. Energy consumption and cost would be expected to be high relative to the expected implementation outcome. There may be implementability concerns with potential air emissions. May be difficult to meet the substantive permit requirements.	High	Not Retained. Effectiveness, Implementability, and Cost

Table 2-2. Technology Screening

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Status
Treatment (continued)	Ex Situ treatment	Stabilization	Effective at dewatering sediment to meet transport and disposal requirements. Meets RAOs. Can be combined with another GRA (for example, removal) to increase effectiveness.	Readily implementable and proven at other similar sediment sites. Equipment, materials, and personnel are readily available.	High	Retained
		Soil Washing	In general, effective on coarse sand and gravel but effectiveness decreases when clay and silt are present. The presence of NAPL decreases the overall effectiveness and may require additional processing. Would need to be combined with a removal technology. Meets RAOs.	Administratively implementable. Comprises technical implementability due to limited site precedence and few methods are currently commercially available. May require additional study (both bench-scale and a pilot scale to demonstrate implementability in this setting). The availability of qualified personnel, materials, and equipment would likely be limited. Produces a large amount of wastewater that requires treatment and requires large energy consumption. There may be implementability concerns with potential air emissions. May be difficult to meet the substantive permit requirements.	High	Not Retained. Implementability, and Cost
Dewatering	Active dewatering	Plate and Frame Filter Press	Effective at dewatering sediment to meet transport and disposal requirements and proven at other sediment sites. Meets RAOs if combined with another GRA.	Difficult to implement because of infrastructure requirements and the presence of NAPL. May require a large upland area to accommodate equipment. Equipment, materials, and personnel are readily available. May require monitoring and engineering controls for dust.	High	Not Retained. Implementability and Cost
		Belt Filter Press	Effective at dewatering sediment to meet transport and disposal requirements and proven at other sediment sites. Meets RAOs if combined with another GRA.	Difficult to implement because of infrastructure requirements and the presence of NAPL. May require a large upland area to accommodate equipment. Equipment, materials, and personnel are readily available. May require monitoring and engineering controls for dust.	High	Not Retained. Implementability and Cost
		Hydrocyclone	Effective at dewatering sediment to meet transport and disposal requirements. Meets RAOs if combined with another GRA.	Difficult to implement because of infrastructure requirements and the presence of NAPL. May require a large upland area to accommodate equipment. Equipment, materials, and personnel are readily available. May require monitoring and engineering controls for dust.	High	Not Retained. Implementability and Cost
	Passive dewatering	Geotextile Tubes	Effective at dewatering sediment to meet transport and disposal requirements and proven at other sediment sites. Meets RAOs if combined with another GRA (for example, removal).	Administratively and technically implementable and no additional infrastructure is needed to implement. Equipment, materials, and personnel are readily available.	Medium	Retained
		Gravity Settling and Drainage	Effective at dewatering sediment to meet transport and disposal requirements and proven at other sediment sites. Meets RAOs if combined with another GRA (for example, removal).	Administratively and technically implementable and no additional infrastructure is needed to implement. Equipment, materials, and personnel are readily available.	Low	Retained
Disposal	Onsite repository	Confined Disposal Facility	Meets RAOs if combined with other GRAs (for example, removal and ex-situ treatment.	Administratively and technically implementable, however, additional infrastructure would be required depending on the location of the repository. May require a large area to accommodate dredged material based on volume. Equipment, materials, and personnel are readily available.	High	Retained
		Confined Aquatic Disposal	Meets RAO if combined with other GRAs (for example, removal and ex-situ treatment).	Implementability concerns because of potential future sheen generation and meeting substantive permit requirements. May require a large area to accommodate dredged material based on volume. Equipment, materials, and personnel are readily available.	High	Not Retained. Implementability and Cost
	Offsite disposal	Permitted Landfill	Meets RAOs if combined with another GRA (for example, removal)	Requires an upland area to accommodate dredged material staging and processing. Equipment, materials, and personnel are readily available.	High	Retained

Table 2-2. Technology Screening

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Status

Notes:

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or cost. Remaining (unshaded) remedial technologies/process options have been retained for consideration in remedial action alternatives.

COC = chemical of concern

GRA = general response action

MNR = monitored natural recovery

N/A = not applicable

NCP = National Oil and Hazardous Substances Pollution Contingency Plan

RAO = remedial action objective

site = BNSF Wishram Railyard

Table 3-1. Remedial Alternative Quantities

Remedial Alternative	Description	Remedial Footprint[a] (acres)	Removal or Treatment Depth (feet bss)	Total Removal or Treatment Volume (yd^3)[b]	Total Backfill or Benthic Restoration Layer Volume (yd^3)[c, d, e]	Capping Leveling Layer (yd^3)	Capping RCM (ft^2)/CIL[i] (yd^3)	Capping MAM (ft^2)
1	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Removal, Backfill, and Offsite Disposal	0.70	7.1 (neat)/ 7.6 (OD)	8,200 removed	1,050[g]	N/A	N/A	N/A
3A	Capping – Aquagate + Organoclay and Institutional Controls	0.66	N/A	N/A	1,650	825	410 (CIL)	N/A
3B	Capping – RCM and Institutional Controls	0.66	NA	NA	1,650	825	32,900	N/A
3C	Capping – RCM, MAM, and Institutional Controls	0.66	N/A	N/A	825	825	32,900	32,900
4	In-Situ Stabilization, Backfill and Institutional Controls	0.44	10[f]	7,100 treated in situ	65[[h]	N/A	N/A	N/A

[a] For each alternative, the areal footprint of the target area material is 0.36 acre. The total remedial footprint (entirety of areal extents of treatment or removal area plus necessary buffers due to constructability concerns specific to each option) varies for each alternative. For Alternative 2, the remedial footprint includes 0.34 acre due to side slope excavation at a 3:1 slope. For Alternative 3, the remedial footprint of 0.66 acre includes 0.3 acre of cap area to account for a 20-foot horizontal buffer zone around perimeter. For Alternative 4, the total footprint is 0.44 acre including 0.08 acre to account for a one auger diameter width buffer zone around the perimeter of the target zone (6 feet).

[b] Dredge quantities include a 3 horizontal to 1 vertical (3:1) side slope for Alternatives 2 and 4.

[c] Backfill will be placed as a component of Alternatives 2 and 4. Volumes includes a 0.5-foot thick layer, plus a 25% overplacement allowance, 25% material loss factor and combination of organoclay (5% by weight) and GAC (3% by weight).

[d] A benthic restoration layer will be placed as a component of Alternative 3. Volume includes a 0.5-foot thick layer, plus a 25% overplacement allowance and a 25% material loss factor.

[e] Capping quantities for Alternatives 3A, 3B, and 3C include a 20-foot offset from the remedial footprint.

[f] The target material for treatment for Alternative 4 includes an average of 2.9-foot treatment zone beneath the target material, which, for constructability purposes, is assumed to result in a total depth of treatment of 10 feet. This will ensure overlap of assumed non-impacted material beneath the target zone, and accounts for auger size and sloped bathymetry and dragdown. No dredge cut is assumed, and swell can express above existing sediment surface.

[g] Backfill will be placed as a component of Alternatives 2 and 4 and will serve as a residual management layer and benthic restoration layer. Volumes includes a 0.5-foot-thick layer, plus a 25% overplacement allowance, 25% material loss factor and organoclay (5% by weight) and GAC (3% by weight). Alternative 2 volumes: 710 yd^3 (0.5 foot and 25% overplacement), 180 yd^3 (25% material loss), 78 yd^3 (organoclay) and 82 yd^3 (GAC).

[h] Alternative 4 volumes: 445 yd^3 (0.5 foot and 25% overplacement), and 110 yd^3 (25% material loss) 49 yd^3 (organoclay) and 51 yd^3 (GAC).

[i] Only relevant to Alternative 3A

Notes:
The actual areas and volumes of contaminated sediment removal, backfill, and capping will be refined during the design phase. Quantities shown are conservative estimates based on spatial analysis of previously collected samples.
bss = below sediment surface
CIL = chemical isolation layer
ft^2 = square foot (feet)
GAC = granular activated carbon
MAM = marine armor mat
N/A = not applicable
OD = over dredge
RCM = reactive core mat
yd^3 = cubic yard(s)

Table 3-2. Common Elements of Remedial Alternatives

Element	Alternative 2 – Removal, Backfill and Offsite Disposal	Alternative 3 - Capping and Institutional Controls	Alternative 4 – In-Situ Stabilization, Backfill and Institutional Controls
Pre-Construction Activities	X	X	X
Site Preparation	X	X	X
Debris Removal	X	X	X
Backfill	X		X
Institutional Controls		X	X
Long-term Monitoring	X	X	X

Table 4-1. Detailed Analyses of Retained Remedial Alternatives 2, 3 (3A, 3B, and 3C), and 4.

Evaluation of remedial alternatives for Disproportionate Cost Analysis is presented below.

Table 4-1a. Protectiveness

Evaluation Factors for Protectiveness	Remedial Alternative 2 Full Removal, Backfill and Offsite Disposal	Remedial Alternative 3 (3A, 3B, and 3C) [a, b, c] Capping and Institutional Controls	Remedial Alternative 4 In-Situ Stabilization, Backfill and Institutional Controls
Adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site	▪ This alternative is expected to be protective or would mitigate the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Complete removal of sediments with NAPL-impacts through dredging activities from the site would eliminate the occurrence of sheen on the water surface through the ebullition of NAPL. Due to the nature and location of the impacts, it is recognized that not all material may be removed. ▪ Provides greater long-term protectiveness but will have relatively higher short-term risk of adverse water quality. ▪ This alternative would achieve RAO 1 (reduce risk to benthic organisms) and RAO 2 (reduce risk to humans) in a reasonable time frame through the complete removal of sediments with NAPL-impacts. ▪ This alternative would achieve RAO 3 (prevent the generation of sheen through ebullition of NAPL) in a reasonable time frame through the complete removal of sediments with NAPL-impacts. ▪ For all remedial alternatives, RAO 4 (protect cultural resources) would also be achieved through pre-design cultural resources survey. ▪ Engineering controls during remedy implementation would limit the disturbance within the construction footprint.	▪ This alternative is expected to be protective or would mitigate the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Sediments with NAPL-impacts would be capped in place with a cap designed to prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Minimizes the potential for short-term adverse water quality impacts. ▪ Long-term protectiveness is dependent on the implementation and maintenance of institutional controls and cap maintenance, as necessary. ▪ This alternative would achieve RAO 1 (reduce risk to benthic organisms) and RAO 2 (reduce risk to humans) through in-place containment of sediments with NAPL-impacts. ▪ This alternative would achieve RAO 3 (prevent the generation of sheen through ebullition of NAPL) but would rely on institutional controls to be protective in long-term and cap maintenance, as necessary. ▪ For all remedial alternatives, RAO 4 (protect cultural resources) would also be achieved through pre-design cultural resources surveys. ▪ Engineering controls during remedy implementation would limit the disturbance within the construction footprint.	▪ This alternative is expected to be protective or would mitigate the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Sediments with NAPL-impacts would be stabilized in situ through auger mixing of stabilization reagents and would prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Long-term protectiveness is dependent on the implementation and maintenance of institutional controls. ▪ It is anticipated that in situ mixing of reagents for ISS using auger rigs would have higher short-term impacts on the water quality as compared to dredging and capping due to in-situ mixing of stabilizing agents into sediments with NAPL-impacts. ▪ This alternative would achieve RAO 1 (reduce risk to benthic organisms) and RAO 2 (reduce risk to humans) through in-situ stabilization of sediments with NAPL-impacts. ▪ This alternative would achieve RAO 3 (prevent the generation of sheen through ebullition of NAPL) but would rely on institutional controls to be protective in long-term. ▪ For all remedial alternatives, RAO 4 (protect cultural resources) would also be achieved through pre-design cultural resources survey. ▪ Engineering controls during remedy implementation would limit the disturbance within the construction footprint.
Overall Rating/Score:	8	7 [a,b,c]	6
Weighting Factor	30%		
Overall Rating/Score (Weighted):	**2.4**	**2.1** [a, b, c]	**1.8**

[a] Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls

[b] Alternative 3B – Capping with RCM and Institutional Controls

[c] Alternative 3C – Capping with RCM, MAM, and Institutional Controls

Notes:

ISS = In-Situ Stabilization

MAM = marine armor mat

NAPL = nonaqueous phase liquid

RAO = remedial action objective

RCM = reactive core mat

Table 4-1b. Permanence

Evaluation Factors for Permanence	Remedial Alternative 2 Full Removal, Backfill and Offsite Disposal	Remedial Alternative 3 (3A, 3B, and 3C)[a, b, c] Capping and Institutional Controls	Remedial Alternative 4 In-Situ Stabilization, Backfill and Institutional Controls
Reduction of Mobility or Volume	▪ Complete removal and offsite disposal of sediments with NAPL-impacts (sheen producing NAPL) through dredging activities from the site would eliminate the mobility and volume of NAPL.	▪ Sediments with NAPL-impacts would be capped in place which would prevent the mobility of NAPL sheen on the water surface. ▪ Volume of sediments with NAPL-impacts will remain the same.	▪ Sediments with NAPL-impacts would be stabilized in situ through auger mixing of stabilization reagents and would prevent the mobility of NAPL sheen on the water surface. ▪ In situ mixing of stabilizing agent may considerably increase the overall volume of stabilized NAPL-impacted sediments. ▪ There is a low risk of areas/volume of sediments with NAPL-impacts that remain unstabilized which would continue the mobility of NAPL sheen on the water surface.
The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated	▪ Hazardous substances would not be destroyed. Complete removal (i.e., approximately 8,200 yd^3) of sediments with NAPL-impacts would be dredged, processed, and transported for disposal at an offsite repository/facility. Total area of removal is approximately 0.7 acre.	▪ Sediments with NAPL-impact would not be destroyed or treated but would be capped in place to prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ The entire volume of the target area would be capped in place. ▪ Approximately 0.66 acre of sediments with NAPL-impacts would be capped in place.	▪ Sediments with NAPL-impacts would not be destroyed or treated but would be stabilized in situ to prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Approximately 0.44 acre of sediments with NAPL-impacts within the Target Area would undergo in situ treatment.
Degree of irreversibility of processes	▪ Removal of sediments with NAPL-impacts and disposal at an offsite repository/facility would be irreversible. ▪ Cultural artifacts would be disturbed from their original locations.	▪ Sediments with NAPL-impacts would be capped in place but the permanence would rely on the implementation and maintenance of institutional controls. ▪ Long-term permanence is not entirely addressed since sediments with NAPL-impacts potentially posing a risk are left in place beneath a cap. ▪ Capping is reversible since it is non-intrusive and a surficial application of treatment media only. ▪ Remedial alternative 3C includes placement of prefabricated system such as a MAM which would preventing erosion of the middle and base cap layers, thus providing relatively higher degree of permanence as compared to remedial alternatives 3A and 3B, which will be topped with 12 inches of sand.	▪ Stabilization amendments used are considered irreversible if the environment of stabilized sediments with NAPL-impacts is controlled through implementation and maintenance of institutional controls. ▪ Long-term permanence is a concern because erosion and diffusion could eventually release contaminants. ▪ Cultural artifacts would be disturbed irreversibly.
Overall Rating/Score:	9	6 [a, b, c]	7
Weighting Factor	25%		
Overall Rating/Score (Weighted):	**2.3**	**1.5** [a, b, c]	**1.8**

[a] Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls

[b] Alternative 3B – Capping with RCM and Institutional Controls

[c] Alternative 3C – Capping with RCM, MAM, and Institutional Controls

Notes:

MAM = marine armor mat

NAPL = nonaqueous phase liquid

RAO = remedial action objective

RCM = reactive core mat

yd^3 = cubic yard(s)

Table 4-1c. Effectiveness Over the Long Term

Evaluation Factors for Effectiveness Over the Long Term	Remedial Alternative 2	Remedial Alternative 3 (3A, 3B, and 3C) [a, b, c]	Remedial Alternative 4
	Full Removal, Backfill and Offsite Disposal	Capping and Institutional Controls	In-Situ Stabilization, Backfill and Institutional Controls
Magnitude of residual risk remaining at the conclusion of the remedial activities	▪ Residual risk is eliminated within the site through removal of sediments with NAPL-impacts (sheen producing NAPL). ▪ Eliminates the occurrence of sheen on the water surface through ebullition of NAPL by the removal of sediments with NAPL-impacts. ▪ Long-term effectiveness would be addressed since sediments with NAPL-impacts potentially posing a risk would be removed and disposed of at an offsite repository.	▪ Magnitude of residual risk would be reduced within the site but could increase if the containment/capping system is breached. Sediments with NAPL-impacts (sheen producing NAPL) at the site would be capped in-place under a containment system. ▪ Approximately 0.66 acre of engineered in-place containment/capping system would be constructed to contain approximately 8,200 yd^3 of overlying sediment and NAPL-impacted sediment.	▪ Magnitude of residual risk would be reduced within the site but could increase if the stabilized material/sediments are breached. Sediments with NAPL-impacts at the site would be stabilized in situ. ▪ Approximately 0.44 acre and 7,116 yd^3 of overlying sediment and NAPL-impacted sediment would undergo in situ treatment.
Degree of certainty that the remedial alternative will be successful	▪ This alternative has the highest degree of certainty that the remedial action will be successful through the elimination of the occurrence of sheen on the water surface through the ebullition of NAPL.	▪ Placement of cap is a reliable long-term remedial action to prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Long-term effectiveness is dependent on the design of the reactive core mat to isolate NAPL impacts and understanding the overall site-specific erosive forces present at the site (e.g., wind, waves, velocity, and seismic activity to design erosion protection). ▪ Remedial alternative 3A utilizes AquaGate with Organoclay™ which has a higher adsorptive capacity than of Organoclay delivered in a single layer of RCM. ▪ Remedial alternative 3C includes placement of prefabricated system such as a MAM which would prevent erosion of the middle and base cap layers, thus providing relatively higher degree of long-term effectiveness as compared to remedial alternatives 3A and 3B. ▪ Additionally, hydraulic assessments would be required to determine whether the cap placement would affect flooding elevations and be compliant with ARARs.	▪ In situ stabilization is a reliable long-term remedial action to prevent the occurrence of sheen on the water surface through the ebullition of NAPL. ▪ Long-term effectiveness is dependent on bench-scale testing and field demonstrations of the technology. ▪ In addition, understanding the overall site-specific erosive forces present at the site (e.g., wind, waves, velocity, and seismic activity would be required for a long-term successful remedial action). ▪ Mixing conditions and curing temperature influence solidified sediment strength. Since mixing and temperature are difficult to control in situ, in-situ solidification may be more limited and even more challenging in a dynamic river environment. ▪ Due to a possible considerable increase in the overall volume of stabilized sediments, a detailed hydraulic assessment would be required to determine the effect of flooding elevations and be compliant with ARARs.
Adequacy and reliability of remedial action/controls	▪ Removal and disposal of sediments with NAPL-impacts is a reliable control as disposal occurs offsite in a permitted facility. ▪ Removed sediments with NAPL-impacts would be disposed of at an offsite existing permitted facility; thus, containment or in situ stabilization-related periodic inspection, post-construction monitoring, and maintenance would not be required.	▪ This alternative would provide reliable control of sediments with NAPL-impacts if remedial components (cap) are properly designed, constructed, and maintained in the long-term. ▪ A maintenance and monitoring program would be implemented to confirm that the in-place containment system remains effective over time. ▪ Long-term effectiveness of the in-place containment system is dependent on the integrity of the cap, periodic inspection, and post-construction monitoring and maintenance. ▪ Long-term effectiveness of institutional controls would depend on the administrative and legal enforcement of the controls. ▪ Institutional Controls could be ignored by human receptors. This possibility could be mitigated through regular monitoring and risk communication programs.	▪ This alternative would provide reliable control of sediments with NAPL-impacts if remedial components (in situ stabilization) are properly designed, constructed, and maintained in the long-term. ▪ In situ solidification may not change the toxicity of the contaminants. Long-term performance is a concern because erosion and diffusion could eventually release contaminants. ▪ A maintenance and monitoring program would be implemented to confirm that the stabilized sediment remains effective over time. ▪ Long-term effectiveness of the stabilized sediment is dependent on periodic inspection, and post-construction monitoring. ▪ Long-term effectiveness of institutional controls would depend on the administrative and legal enforcement of the controls. ▪ Institutional Controls could be ignored by human receptors. This possibility could be mitigated through regular monitoring and risk communication programs.

Table 4-1c. Effectiveness Over the Long Term

Evaluation Factors for Effectiveness Over the Long Term	Remedial Alternative 2	Remedial Alternative 3 (3A, 3B, and 3C)[a, b, c]	Remedial Alternative 4
	Full Removal, Backfill and Offsite Disposal	Capping and Institutional Controls	In-Situ Stabilization, Backfill and Institutional Controls
Overall Rating/Score:	7	7[a, b, c]	5
Weighting Factor	25%		
Overall Rating/Score (Weighted):	**1.8**	**1.8**[a, b, c]	**1.3**

[a] Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls
[b] Alternative 3B – Capping with RCM and Institutional Controls
[c] Alternative 3C – Capping with RCM, MAM, and Institutional Controls
Notes:
ARAR = applicable or relevant and appropriate requirement
MAM = marine armor mat
NAPL = nonaqueous phase liquid
RCM = reactive core mat
yd^3 = cubic yard(s)

Table 4-1d. Management of Implementation Risks

Evaluation Factors for Management of Short-Term Risk	Remedial Alternative 2	Remedial Alternative 3 (3A, 3B, and 3C) [a, b, c]	Remedial Alternative 4
	Full Removal, Backfill and Offsite Disposal	Capping and Institutional Controls	In-Situ Stabilization, Backfill and Institutional Controls
Short-term risks that might be posed to the community during implementation of an alternative	▪ The site is located within a secured BNSF Railway Company (BNSF facility), but trespassers present at work areas (through the Columbia River) during implementation could pose short-term risks. Use of work zone security practices would be implemented to minimize safety risks. ▪ Local property owners could be present at work areas during implementation. Risk is anticipated to be minimal. Risk communication and access controls would minimize risk. ▪ Truck traffic for the transport of backfill and amendment material could impact the surrounding community. Other transportation modes (e.g., barge) could be evaluated during the remedial design phase. ▪ Transportation of dredged sediments with NAPL-impacts to the disposal facility is assumed to be via railcars which would have minimal impacts on the surrounding community.	▪ The site is located within a secured BNSF facility, but trespassers present at work areas (through the Columbia River) during implementation could pose short-term risks. Use of work zone security practices would be implemented to minimize safety risks. ▪ Local property owners could be present at work areas during implementation. Risk is anticipated to be minimal. Risk communication and access controls would minimize risk. ▪ Truck traffic for the transport of cap material could impact the surrounding community. For this alternative, the impacts are anticipated to be higher than other alternatives. Other transportation modes (e.g., barge) could be evaluated during the remedial design phase.	▪ The site is located within a secured BNSF facility, but trespassers present at work areas (through the Columbia River) during implementation could pose short-term risks. Use of work zone security practices would be implemented to minimize safety risks. ▪ Local property owners could be present at work areas during implementation. Risk is anticipated to be minimal. Risk communication and access controls would minimize risk. ▪ Truck traffic for the transport of backfill and amendment material could impact the surrounding community. Other transportation modes (e.g., barge) could be evaluated during the remedial design phase.
Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures	▪ Short-term impacts to workers due to remedial activities performed on a barge in a river environment such as working on a vessel, near heavy and mobile equipment in and around working docks. ▪ Direct contact with NAPL in dredged sediment during dredging, processing, and transportation. ▪ Safety measures and BMPs would be used to minimize the impacts.	▪ Short-term impacts to workers due to remedial activities performed on a barge in a river environment such as working on a vessel, near heavy and mobile equipment in and around working docks. ▪ Transport of cap materials and amendments for cap construction. ▪ Safety measures and BMPs would be used to minimize the impacts	▪ Short-term impacts to workers due to remedial activities performed on a barge in a river environment such as working on a vessel, near heavy and mobile equipment in and around working docks. ▪ Placing amendments in in-situ treatment areas. ▪ Safety measures and BMPs would be used to minimize the impacts.
Potential adverse environmental impacts resulting from construction and implementation of an alternative	▪ Sediment removal may result in short-term adverse impacts to the river. ▪ Exposure of fish and other biota to suspended sediments with NAPL-impacts in the water column. ▪ Temporary loss of benthos and habitat for the ecological community in remedial areas. ▪ Short-term risks of potential adverse environmental impacts resulting from construction and implementation of an alternative can be reduced through prudent design practices and BMPs during construction.	▪ Sediment capping may result in short-term adverse impacts to the river. ▪ Exposure of fish and other biota to suspended sediments with NAPL-impacts in the water column. ▪ Temporary loss of benthos and habitat for the ecological community in remedial areas. ▪ Short-term risks of potential adverse environmental impacts resulting from construction and implementation of an alternative can be reduced through prudent design practices and BMPs during construction.	▪ In situ sediment stabilization may result in short-term adverse impacts to the river. ▪ Exposure of fish and other biota to suspended sediments with NAPL-impacts in the water column. ▪ Temporary loss of benthos and habitat for the ecological community in remedial areas. ▪ It is anticipated that in situ mixing of reagents for ISS using auger rigs would have higher short-term impacts on the water quality as compared to dredging and capping. ▪ It is anticipated that there would be disruption of cultural resources during ISS, although materials will remain in place. ▪ Need to control ISS swell at the break in slope and/or to remove some ISS mass to return to original bathymetry. ▪ Short-term risks of potential adverse environmental impacts resulting from construction and implementation of an alternative can be reduced through prudent design practices and BMPs during construction.
Time until protection is achieved	▪ The duration of the short-term risks would be the time required for construction, which is estimated to be approximately 5 months.	▪ The duration of the short-term risks would be the time required for construction, which is estimated to be approximately 2 months for Alternatives 3A and 3B, and 2.5 months for Alternatives 3C.	▪ The duration of the short-term risks would be the time required for construction, which is estimated to be approximately 3 months.
Overall Rating/Score:	5	8 [a, b, c]	2

Table 4-1d. Management of Implementation Risks

Evaluation Factors for Management of Short-Term Risk	Remedial Alternative 2	Remedial Alternative 3 (3A, 3B, and 3C) [a, b, c]	Remedial Alternative 4
	Full Removal, Backfill and Offsite Disposal	Capping and Institutional Controls	In-Situ Stabilization, Backfill and Institutional Controls
Weighting Factor	10%		
Overall Rating/Score (Weighted):	**0.5**	**0.8** [a, b, c]	**0.2**

[a] Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls

[b] Alternative 3B – Capping with RCM and Institutional Controls

[c] Alternative 3C – Capping with RCM, MAM, and Institutional Controls

Notes:

BMP = best management practice

ISS = In-Situ Stabilization

MAM = marine armor mat

NAPL = nonaqueous phase liquid

RCM = reactive core mat

Table 4-1e. Technical and Administrative Implementability

Evaluation Factors for Technical and Administrative Implementability		Remedial Alternative 2 Full Removal, Backfill and Offsite Disposal	Remedial Alternative 3 (3A, 3B, and 3C) [a, b, c] Capping and Institutional Controls	Remedial Alternative 4 In-Situ Stabilization, Backfill and Institutional Controls
Technical Implementability	▪ Technical difficulties and unknowns associated with the construction and operation of a technology	▪ Dredging of sediments with NAPL-impacts is a proven technology that has been implemented at other similar sites; however, seasonal conditions such as inclement weather events and flood levels could affect operations. ▪ It may be difficult to control sediment resuspension and migration during inclement weather, but it can be reduced through BMPs. ▪ It may be difficult to preserve and screen for cultural resources during dredging operations.	▪ Capping of sediments with NAPL-impact is a proven technology that has been implemented at other similar sites; however, seasonal conditions such as inclement weather events and flood levels could affect operations. ▪ It may be difficult to control sediment resuspension and migration during inclement weather, but it can be reduced through BMPs.	▪ In-Situ stabilization of sediments with NAPL-impact is a proven technology that has been implemented at other similar sites but could be challenging due to site characteristics (riverine conditions, water depths, depth of NAPL). In addition, seasonal conditions such as inclement weather and flood levels could affect operations. ▪ Mixing conditions and curing temperature are principal factors that can influence solidified sediment strength. Since mixing and temperature are difficult to control in situ, in-situ solidification may be more limited. ▪ It may be difficult to control sediment resuspension and migration during inclement weather, but it can be reduced through BMPs.
	▪ Ease of undertaking additional remedial actions including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions	▪ Increasing the extent of dredging/excavation, capping, or in-situ treatment could be implemented. Additional remedial actions within the Columbia River could be more problematic due to factors such as adjacent land use, structures, bathymetry, bedrock outcroppings, use of the adjacent waterways, and community concerns.		
	▪ Ability to monitor the effectiveness of the remedy	▪ Limited short-term monitoring would be required for this alternative and can be performed using standard practices and technologies.	▪ Short- and long-term monitoring would be required for this alternative and can be performed using standard practices and technologies. ▪ Sediments with NAPL-impacts at the site would be capped in-place under a containment system. For this reason, some additional remedial actions are predicted to control or prevent the occurrence of sheen on the water surface through the ebullition of NAPL.	▪ Short- and long-term monitoring would be required for this alternative and can be performed using standard practices and technologies. ▪ If sediments with NAPL-impacts remain unstabilized, additional remedial actions are predicted to control or prevent the occurrence of sheen on the water surface through the ebullition of NAPL.
Administrative Implementability	▪ Activities needed to coordinate with other offices and agencies	▪ Coordination with Ecology, Yakama Nation, YNF, NMFS, and USFWS would need to be conducted during construction to protect migratory fish in the Columbia River.	▪ Coordination with Ecology, Yakama Nation, YNF, NMFS, and USFWS would need to be conducted during construction to protect migratory fish in the Columbia River. ▪ Coordination with BNSF and/or other property owners would need to be conducted to manage sediments with NAPL-impacts left in place and implement land use restrictions, Institutional Controls, if needed.	▪ Coordination with Ecology, Yakama Nation, YNF, NMFS, and USFWS would need to be conducted during construction to protect migrating fish in the Columbia River. ▪ Coordination with BNSF and/or other property owners would need to be conducted to manage stabilized sediments with NAPL-impacts left in place and implement land use restrictions, Institutional Controls, if needed.
	▪ Ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)	▪ Regulatory and facility approval for offsite disposal at an existing permitted facility should be obtainable. This was confirmed during the request for disposal pricing from offsite disposal facilities.	▪ No offsite remedial activities would be conducted under this alternative. Thus, there is no need to obtain approvals from regulatory agencies.	▪ No offsite remedial activities would be conducted under this alternative. Thus, there is no need to obtain approvals from regulatory agencies.
	▪ Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources ▪ Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies	▪ Services, equipment, and materials are locally or regionally available. ▪ Experienced environmental equipment operators (e.g., dredge, excavator, barge-mounted crane/auger) and material placement specialists would be required. ▪ Technologies specific to dredging, capping, and in-situ treatment are available and have been implemented at other similar sites.		
Overall Rating/Score:		6	9 [a, b, c]	4
Weighting Factor		10%		
Overall Rating/Score (Weighted):		**0.6**	**0.9** [a, b, c]	**0.4**

[a] Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls
[b] Alternative 3B – Capping with RCM and Institutional Controls
[c] Alternative 3C – Capping with RCM, MAM, and Institutional Controls

Notes:

BMP = best management practice
Ecology = Washington State Department of Ecology
MAM = marine armor mat
NAPL = nonaqueous phase liquid
NMFS = National Marine Fisheries Service
RCM = reactive core mat
USFWS = U.S. Fish and Wildlife Service
YNF = Yakama Nation Fisheries

Table 4-2. Summary of Disproportionate Cost Analysis – Alternative Benefits Metrics and Scores

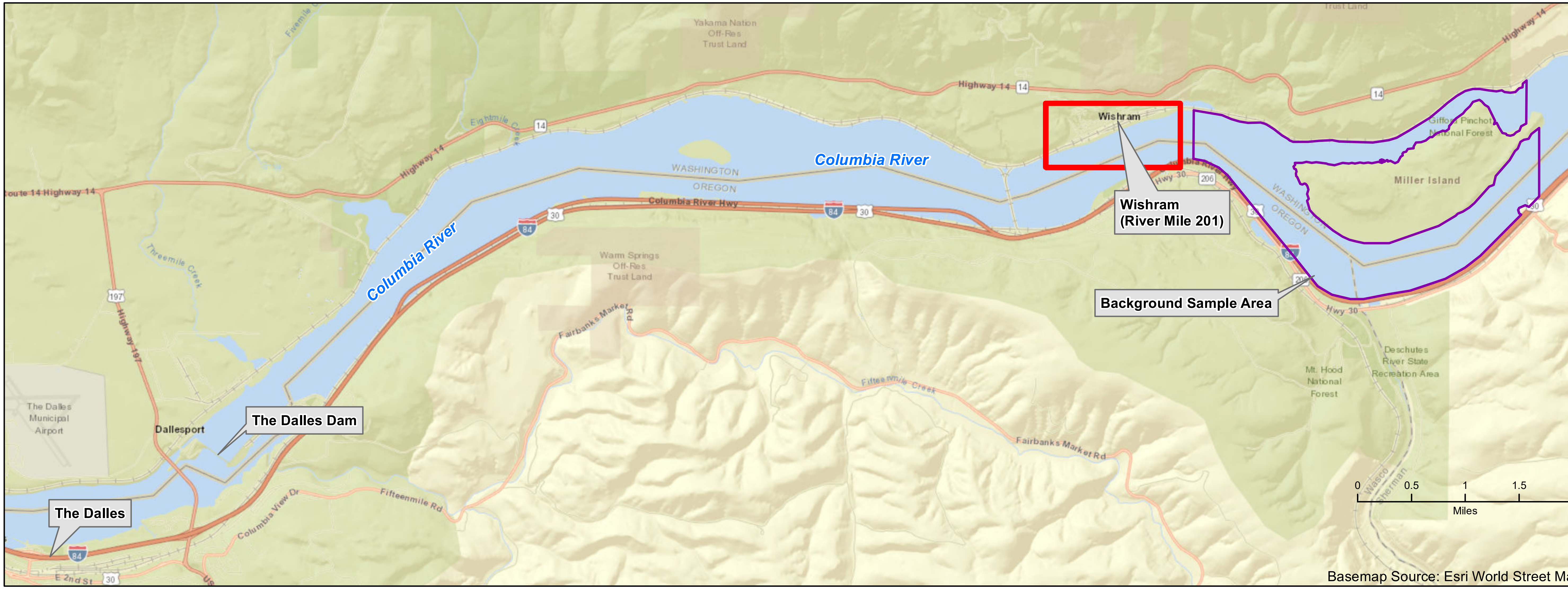
DCA Evaluation Criteria[a]	Remedial Alternatives' Benefits Scores[b]					Weighting Factor (Total 100%)	Remedial Alternatives' Weighted Benefits Scores[c]				
	RA 2	RA 3A	RA 3B	RA 3C	RA 4		RA 2	RA 3A	RA 3B	RA 3C	RA 4
Satisfy Threshold Requirements[d]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	–	–			–	–
Protectiveness	8	7	7	7	6	30%	2.4	2.1	2.1	2.1	1.8
Permanence	9	6	6	6	7	25%	2.3	1.5	1.5	1.5	1.8
Effectiveness Over the Long Term	7	7	7	7	5	25%	1.8	1.8	1.8	1.8	1.3
Management of Implementation Risks	5	8	8	8	2	10%	0.5	0.8	0.8	0.8	0.2
Technical and Administrative Implementability	6	9	9	9	4	10%	0.6	0.9	0.9	0.9	0.4
						Total Benefits Score	**7.5**	**7.1**	**7.1**	**7.1**	**5.4**
						Estimated Cost ($M Net Present Value)[e]	$7.02	$3.16	$3.79	$4.23	$4.91
						Ratio of Cost to Benefits ($M per Benefit)[f]	**$0.94 M per Benefit**	**$0.45 M per Benefit**	**$0.54 M per Benefit**	**$0.58 M per Benefit**	**$0.91 M per Benefit**
						Cost Disproportionate to Incremental Benefits	**Yes**	**No**	**No**	**No**	**Yes**
						RA Permanent (Maximum Extent Practicable)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
						Practicability of Remedy	**Yes**	**Yes**	**Yes**	**Yes**	**No**
						Overall RA Ranking	**5th**	**1st**	**2nd**	**3rd**	**4th**

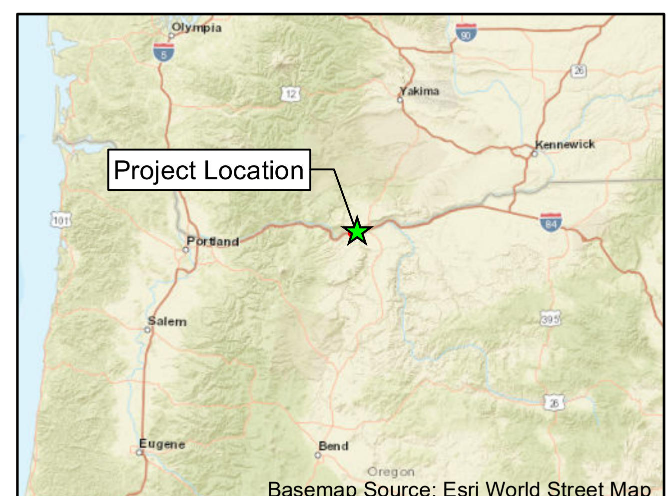
[a] Evaluation of remedial alternatives using disproportionate cost analysis ranking criteria are presented in Section 4.3 and Table 4-1.
[b] A score of 1 represents a poor-performing remedial alternative for that criterion, and a score of 10 represents an optimal-performing remedial alternative for that criterion or indicates the remedial alternative meets the criterion significantly well. It should be noted that each aspect of the DCA scoring and weighting factors requires a degree of best professional judgment.
[c] For RA 2, Protectiveness Score = 8 X 30% (weighting factor) = 2.4
[d] The threshold requirements are presented in Sections 4.1.1 and 4.2.
[e] Remedial alternative cost estimates are presented in Appendix B.
[f.] Ratio of Cost to Benefits, For RA 2 = $7.02 M / 7.5 = $0.94 M per benefit

Notes:
Remedial Alternative 2: Removal, Backfill, and Offsite Disposal
Remedial Alternative 3A: Capping with Aquagate + Organoclay, benthic restoration layer, and Institutional Controls
Remedial Alternative 3B: Capping with RCM, benthic restoration layer, and Institutional Controls
Remedial Alternative 3C: Capping with RCM, MAM, benthic restoration layer, and Institutional Controls
Remedial Alternative 4: In-Situ Stabilization, Backfill and Institutional Controls

$M = dollars in millions
DCA = disproportionate cost analysis
MAM = marine armor mat
RA = remedial alternative
RAM = reactive core mat

Figures





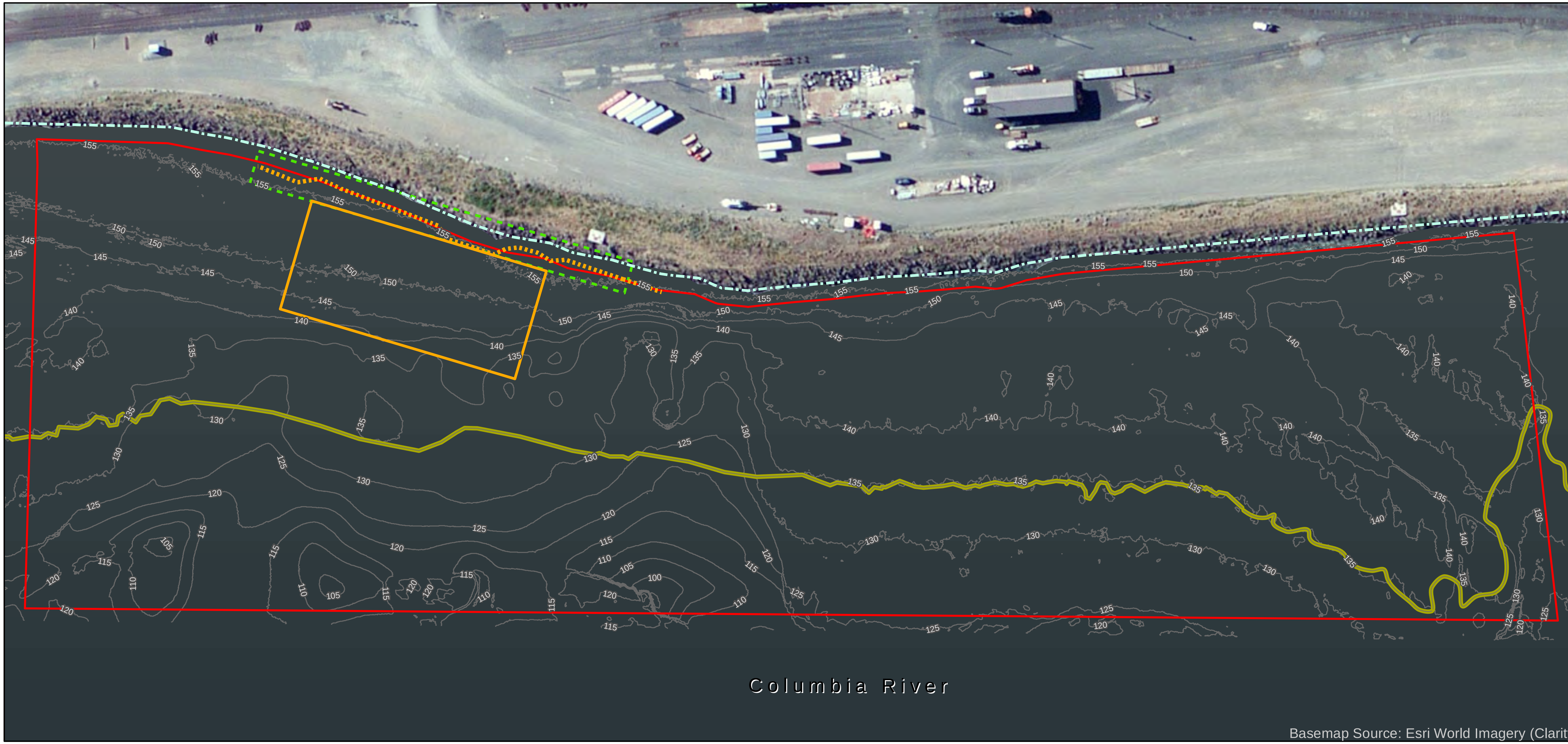
0 375 750 1,500
Feet

Notes:
Lake Celilo extends from The Dalles Dam 24 miles upstream

Figure 1-1. Site Location Map
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-1_SITEMAP.MXD STOLZRC 5/7/2024 16:04:33



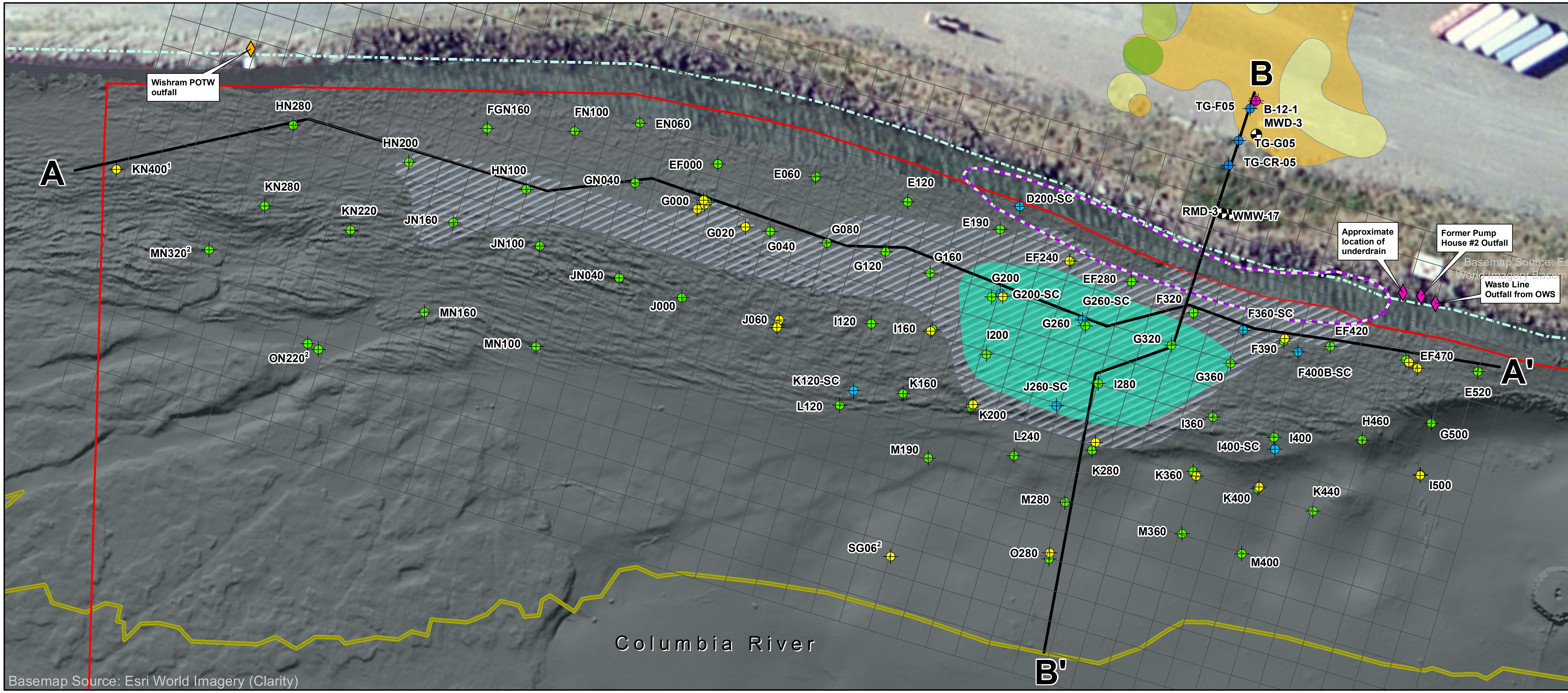
LEGEND

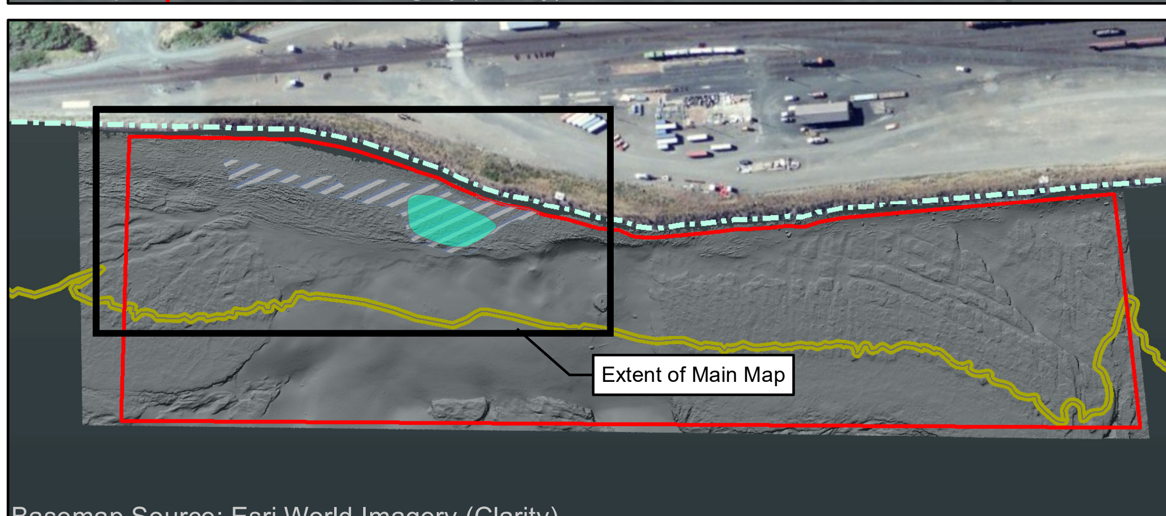
- Remedial Investigation Area
- WA Ecology Initial Investigation Area
- 2018 Initial Investigation Area
- Current Shoreline
- Former Shoreline
- Toe of Exposed Riprap observed within 2018 Sampling Investigation Area
- 2022 Bathymetric Contour (ft NAVD88, 5 ft Contour Interval)

0 100 200 400
Feet

Figure 1-2. Area Features
BNSF Track Switching Facility
Wishram, Washington

Jacobs





\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-3_NAPLIMPACTS.MXD GGEE 6/19/2024 09:51:27

LEGEND

- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Upland RI TarGOST Location
- Upland Boring
- Groundwater Monitoring Well
- Extent of NAPL-affected Area
- Approximate Extent of Sheen-Generating NAPL Impacts
- Small-extent NAPL Sheens Observed (Ecology, 2017)
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline
- Cross Section Location
- Inferred Lateral Extent of Smear Zone Diesel Impacts
- Inferred Lateral Extent of Submerged Diesel Impacts
- Inferred Lateral Extent of Smear Zone Oil Impacts
- Inferred Lateral Extent of Submerged Oil Impacts

0 25 50 100
Feet

Notes:
OWS = oil/water separator; POTW = publicly owned treatment works
[1]Changed station name from HN300 to KN400 post sample collection based on actual X,Y. (No target X,Y available at the time of collection. Station was estimated.)
[2]Refusal at surface.

Figure 1-3. Extent of NAPL Impacts
BNSF Track Switching Facility
Wishram, Washington

Jacobs

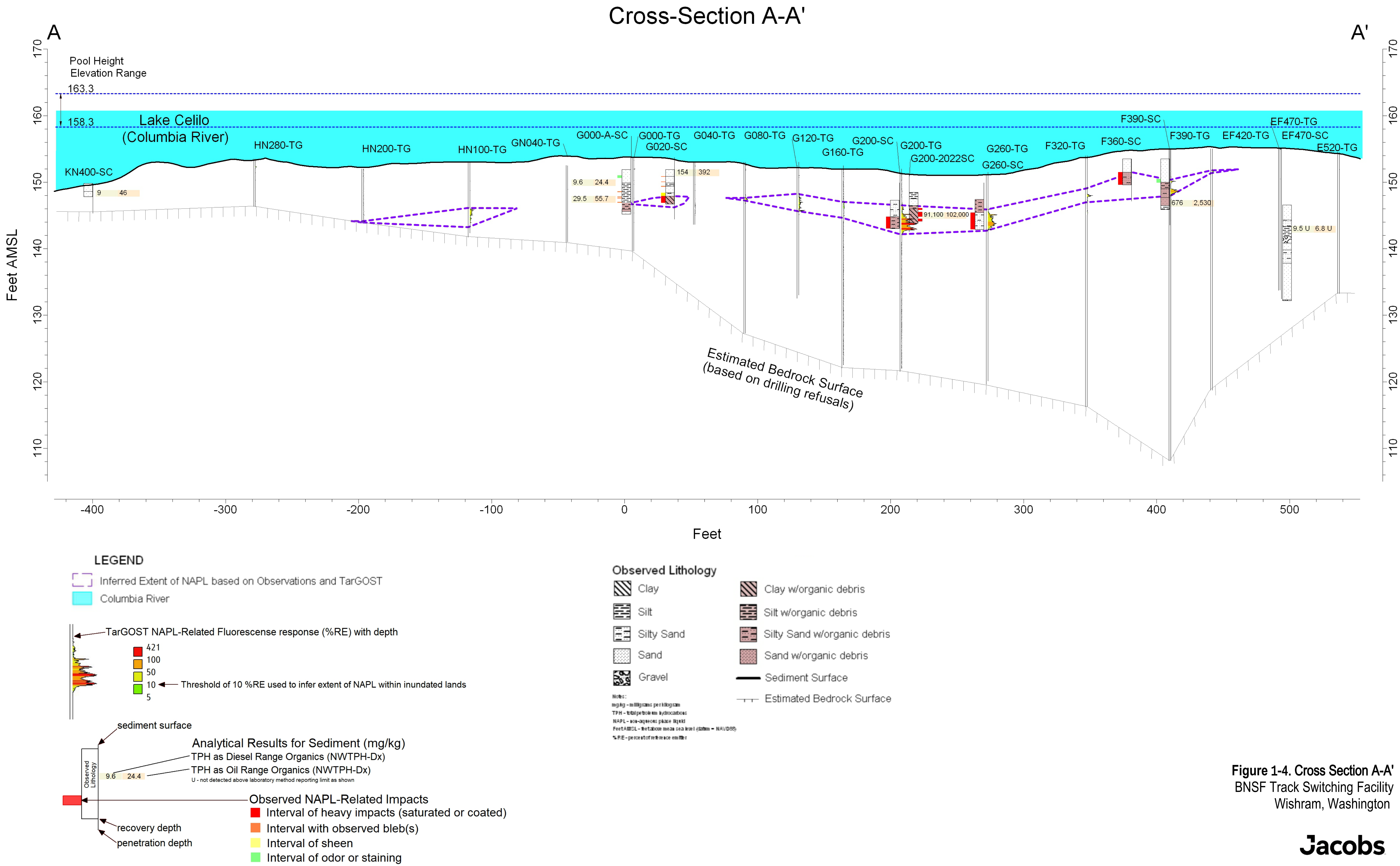
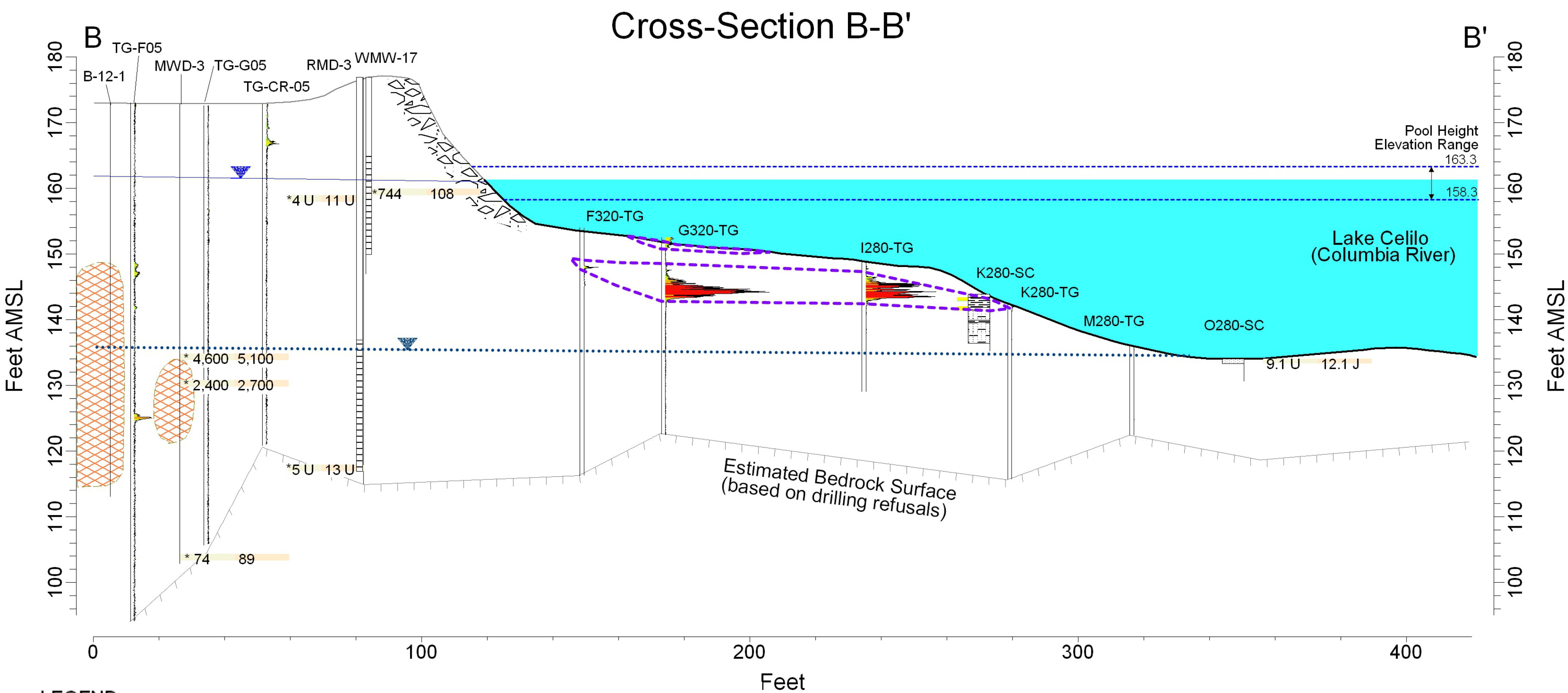


Figure 1-4. Cross Section A-A'
BNSF Track Switching Facility
Wishram, Washington

Jacobs



LEGEND

- Approximate current water table
- Approximate pre-1957 water table
- Columbia River
- Inferred Extent of NAPL based on Observations and TarGOST
- Inferred Upland Zone of Oil-like LNAPL from Upland RI
- Rip Rap

TarGOST NAPL-Related Fluorescense response (%RE) with depth

421
100
50
10 ← Threshold of 10 %RE used to infer extent of NAPL within inundated lands
5

sediment surface

Observed Lithology

9.6 24.4

recovery depth

penetration depth

Analytical Results for Upland Subsurface Soil(*) and Sediment (mg/kg)

TPH as Diesel Range Organics (NWTPH-Dx)
TPH as Oil Range Organics (NWTPH-Dx)
U - not detected above laboratory method reporting limit as shown
J - laboratory estimated concentration

Observed NAPL-Related Impacts

- Interval of heavy impacts (saturated or coated)
- Interval with observed bleb(s)
- Interval of sheen
- Interval of odor or staining

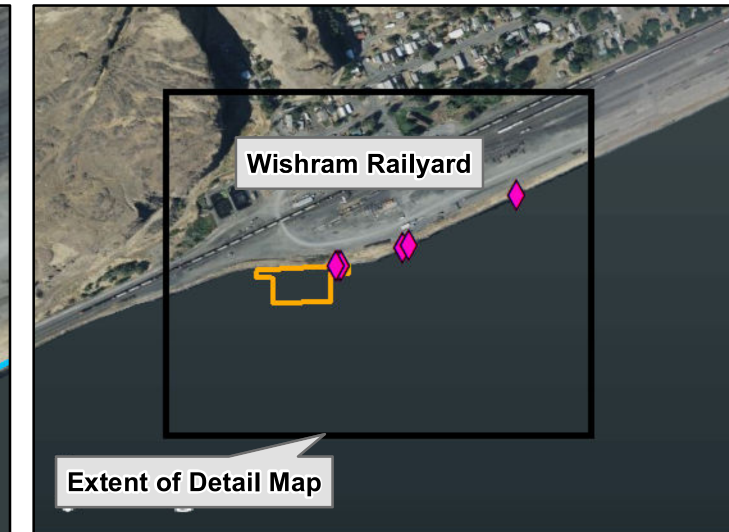
Observed Lithology

- Clay
- Silt
- Silty Sand
- Sand
- Gravel
- Clay w/organic debris
- Silt w/organic debris
- Silty Sand w/organic debris
- Sand w/organic debris
- Ground Surface
- Sediment Surface
- Estimated Bedrock Surface

Notes:
mg/kg - milligrams per kilogram
TPH - total petroleum hydrocarbons
NAPL - non-aqueous phase liquid
LNAPL - light non-aqueous phase liquid
Feet AMSL - feet above mean sea level (datum = NAVD88)
%RE - percent of reference emitter

Figure 1-5. Cross Section B-B'
BNSF Track Switching Facility
Wishram, Washington

Jacobs



SLC \\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-2_CURRENT_SITE_FEATURES.MXD STOLZRC 5/7/2024 16:04:54

LEGEND

- Former Outfall Location
- Stormwater Underdrain (A portion removed from service circa 1960)
- Stormwater Underdrain (Rerouted portion circa 1960)
- Current Shoreline
- Initial Investigation Area (Jacobs. 2019. Inundated Lands Initial Investigation Report Draft. BNSF Wishram Railyard, Wishram, Washington. May.)

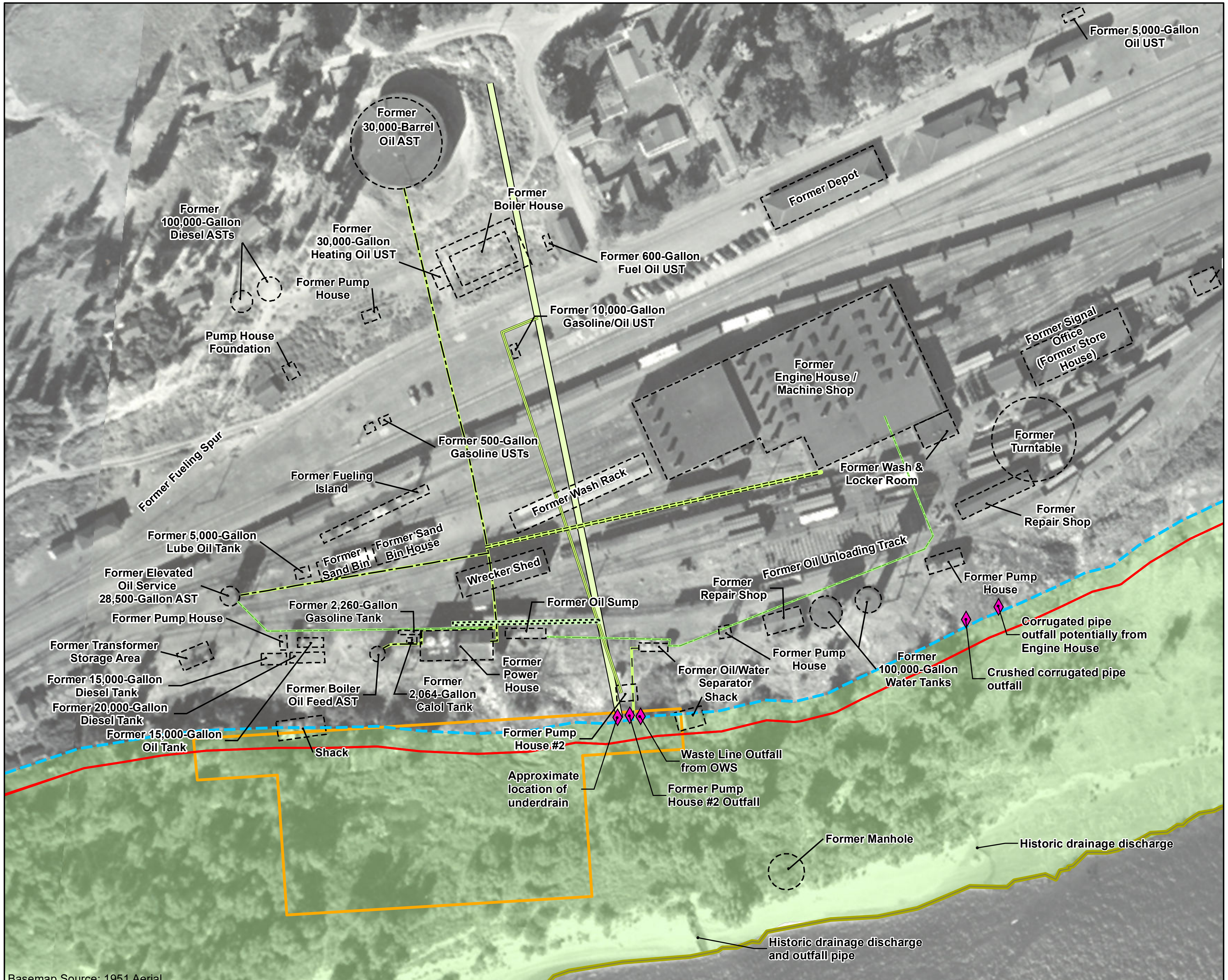
Notes:
OWS = oil/water separator

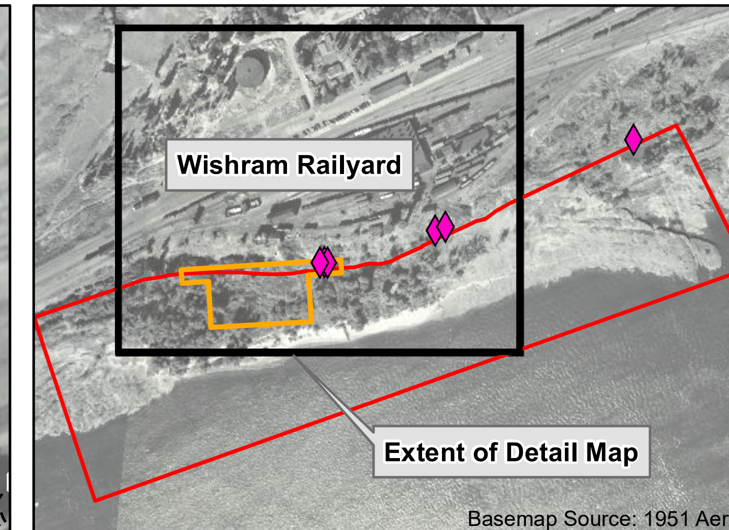
N

0 150 300 600
Feet

Figure 1-6. Current Site Features
BNSF Track Switching Facility
Wishram, Washington

Jacobs





LEGEND

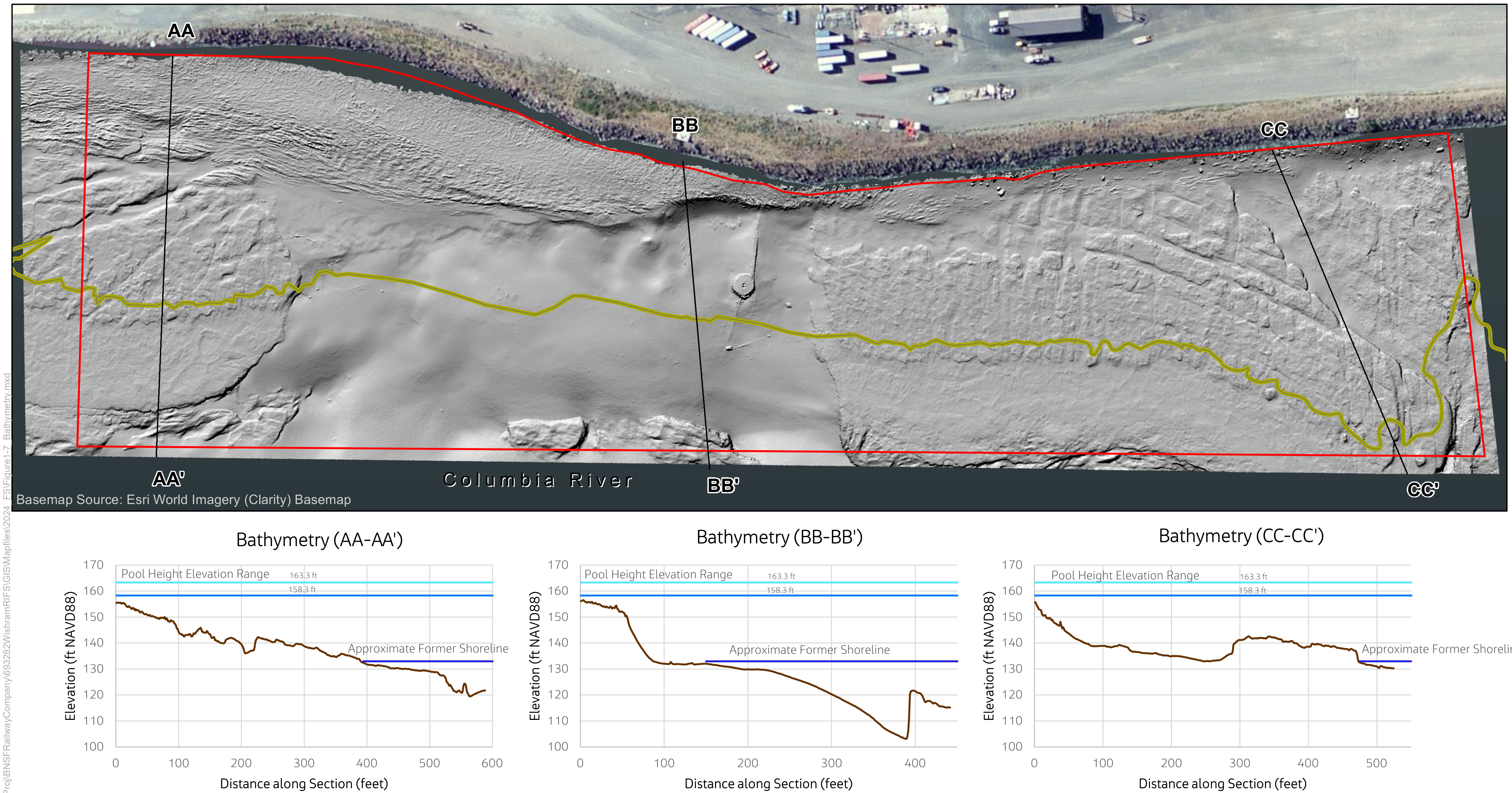
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Steam Line
- Former Bunker Fuel / Oil Pipeline
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain (A portion removed from service circa 1960)
- Stormwater Underdrain (Rerouted portion circa 1960)
- Initial Investigation Area (Jacobs. 2019. Inundated Lands Initial Investigation Report Draft. BNSF Wishram Railyard, Wishram, Washington. May.)
- Former Shoreline
- Inundated Lands

0 75 150 300
Feet

Figure 1-7. Former Site Features Shown on 1951 Aerial
BNSF Track Switching Facility
Wishram, Washington

Jacobs

SLC \\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-6_HISTORICAL_SITE_FEATURES.MXD STOLZRC 5/7/2024 16:05:44



LEGEND

Remedial Investigation Area

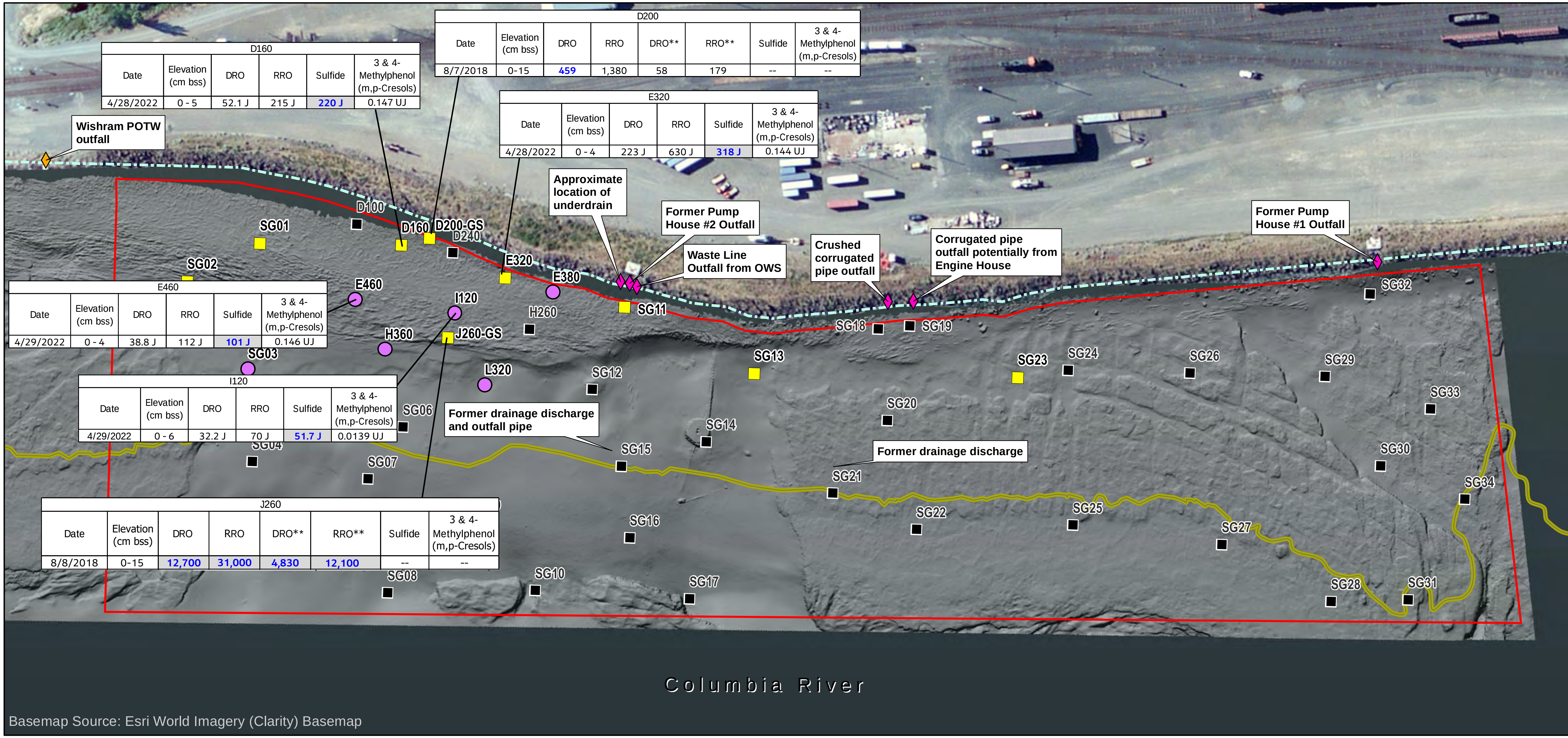
Former Shoreline

Note: Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.

N

0 100 200 Feet

Figure 1-8. Site Bathymetry with Cross Sections
BNSF Track Switching Facility
Wishram, Washington



D160

Date	Elevation (cm bss)	DRO	RRO	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
4/28/2022	0 - 5	52.1 J	215 J	**220 J**	0.147 UJ

D200

Date	Elevation (cm bss)	DRO	RRO	DRO**	RRO**	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
8/7/2018	0-15	**459**	1,380	58	179	--	--

E320

Date	Elevation (cm bss)	DRO	RRO	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
4/28/2022	0 - 4	223 J	630 J	**318 J**	0.144 UJ

E460

Date	Elevation (cm bss)	DRO	RRO	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
4/29/2022	0 - 4	38.8 J	112 J	**101 J**	0.146 UJ

I120

Date	Elevation (cm bss)	DRO	RRO	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
4/29/2022	0 - 6	32.2 J	70 J	**51.7 J**	0.0139 UJ

J260

Date	Elevation (cm bss)	DRO	RRO	DRO**	RRO**	Sulfide	3 & 4-Methylphenol (m,p-Cresols)
8/8/2018	0-15	**12,700**	**31,000**	**4,830**	**12,100**	--	--

LEGEND

- Composite Grab Sample (6 locations)
- Grab Sample (9 locations)
- No Sample* (31 locations)
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

Note: Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.

Sample locations portrayed at centroid of locations with multiple attempts.

Notes:
*No recovery due to the presence of bedrock, cobbles, boulders, grass, or shells.
OWS = oil/water separator
POTW = publicly owned treatment works

Analyte	Units	SCO[1]	CSL[2]
Sulfide	mg/kg	39	61
3 & 4-Methylphenol (m,p-Cresols)[3]	mg/kg	0.26	2
DRO	mg/kg	340	510
RRO	mg/kg	3600	4400

Table Notes:
[1] Washington Freshwater Sediment Cleanup Objectives (SCO)
[2] Washington Freshwater Sediment Screening Levels (CSL)
[3] 3-methylphenol and 4-methylphenol may not be able to be separated. In this case 4-methylphenol may be reported as the sum of the 3- and 4-methylphenol isomers

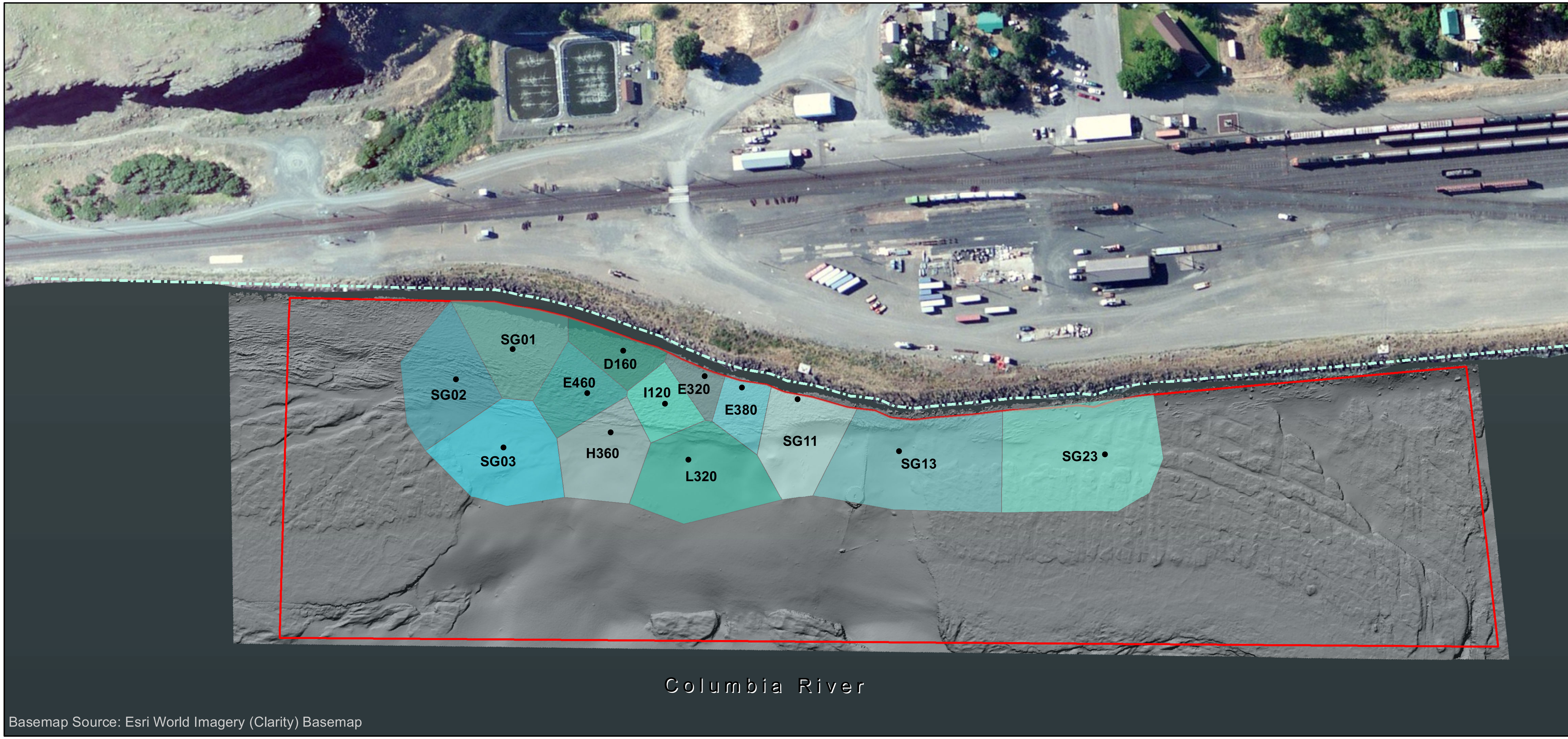
** - Analyzed with silica gel cleanup. Limited to samples collected during the 2018 Initial Investigation.
Values in blue bold are in excess of the SCO
Shaded values are in excess of the CSL
Results are presented in mg/kg
bss – below sediment surface
cm – centimeters
DRO – Diesel range organics
J – Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value. mg/kg – milligram per kilogram
RRO – Residual range organics
U - not detected above the practical quantitation limit

0 100 200 400
Feet

Figure 1-9 Grab Sample Locations with Analytical Results Exceeding one or more Screening Levels or Cleanup Objectives - Surface
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2022_REMEDIALINVESTIGATION\RI REPORT 2023\FIGURE2-2_GRABLOCATIONS.MXD GGEE 4/14/2023 14:40:16



LEGEND

- Sample Location
- Remedial Investigation Area

note - coloring of polygons is for visualization only

0 100 200 400
Feet

Figure 1-10. Thiessen Polygons for Sample Locations with Analytical Data - For Surface Weighted Average Concentration Calculation
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\THIESSENPOLYS.MXD GGEE 6/21/2024 15:00:06

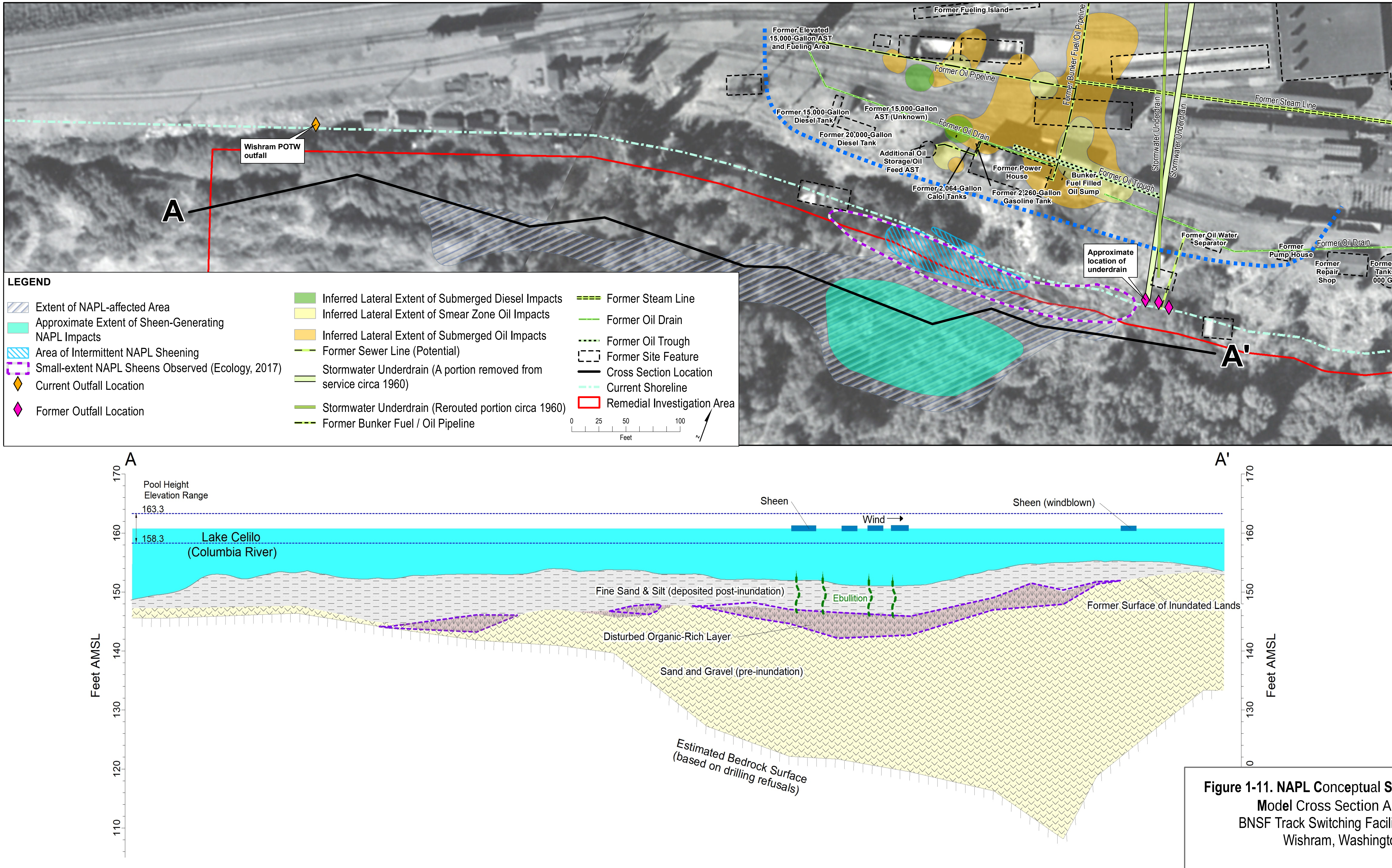
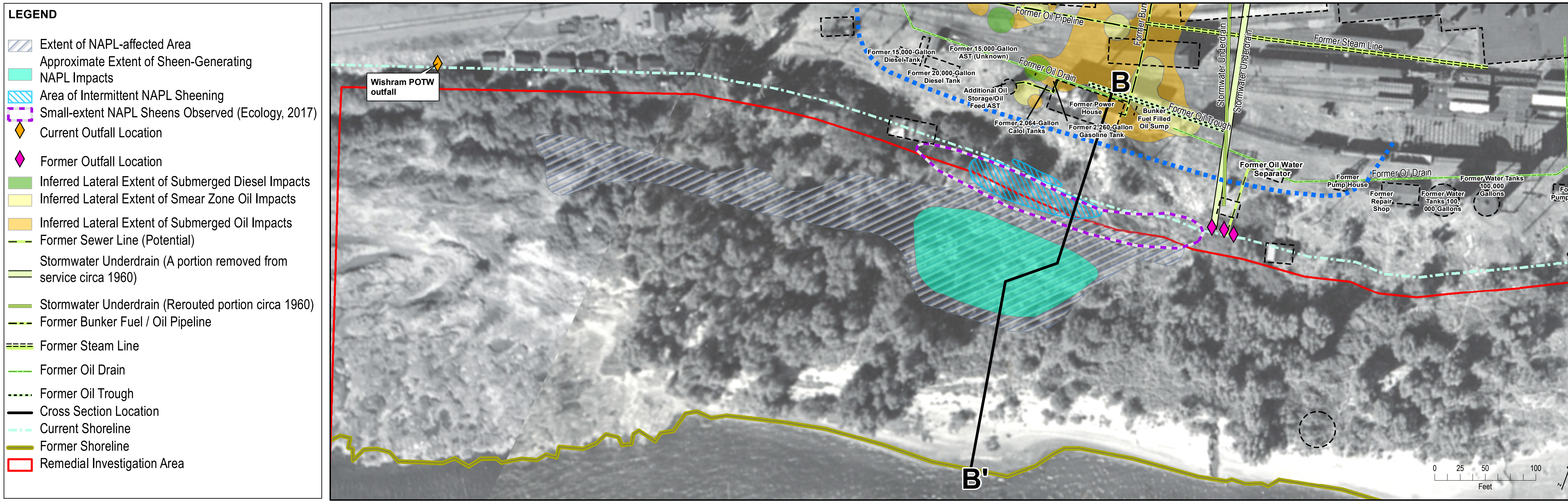
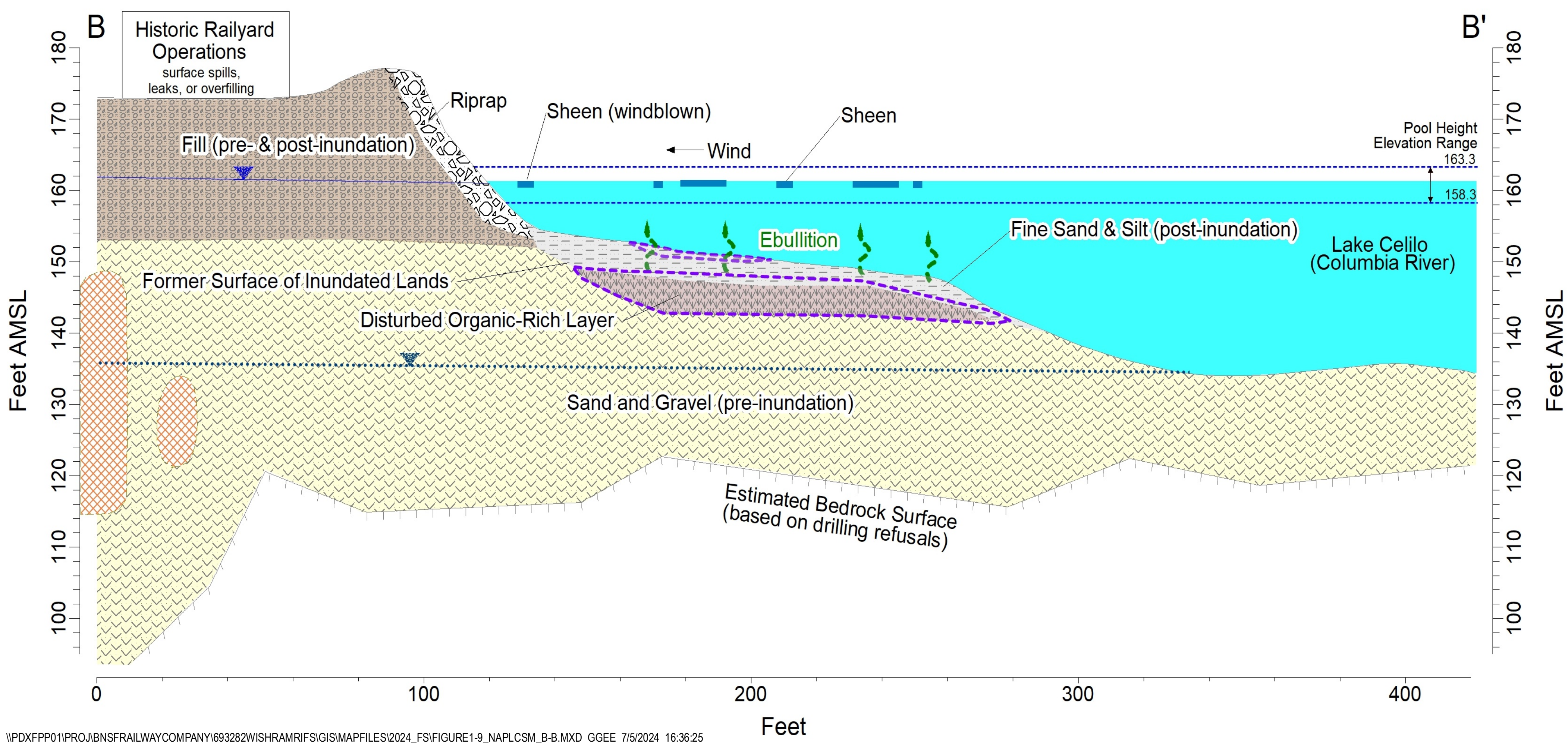


Figure 1-11. NAPL Conceptual Site Model Cross Section A-A'
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-8_NAPLCSM_A-A.MXD GGEE 7/5/2024 16:37:20





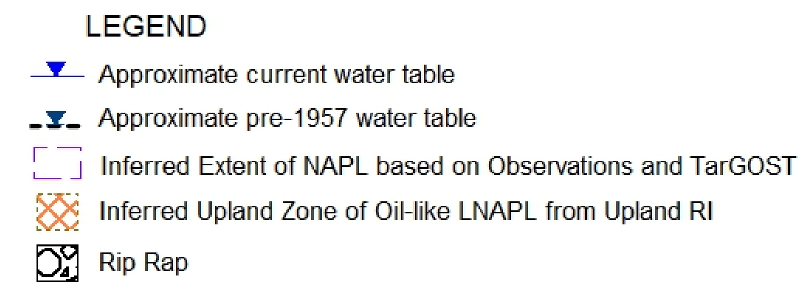
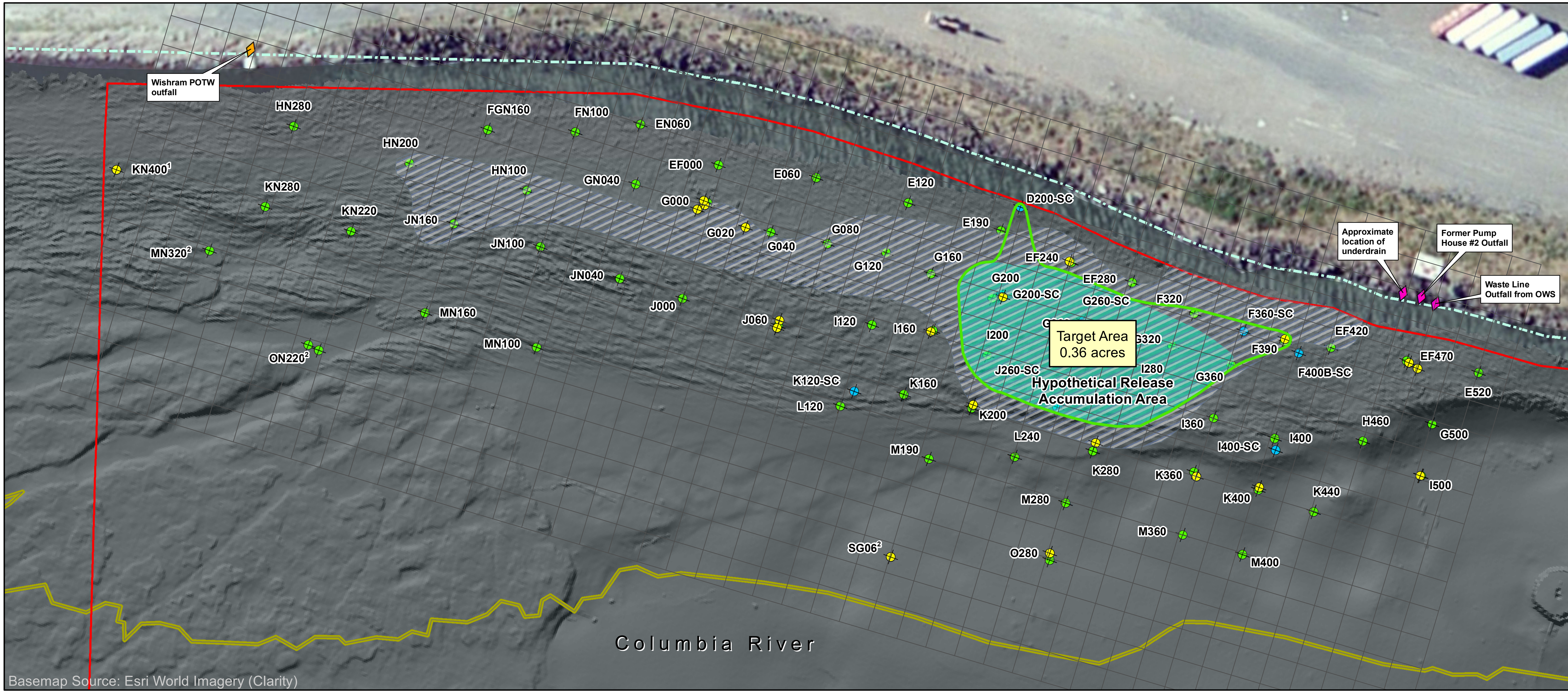
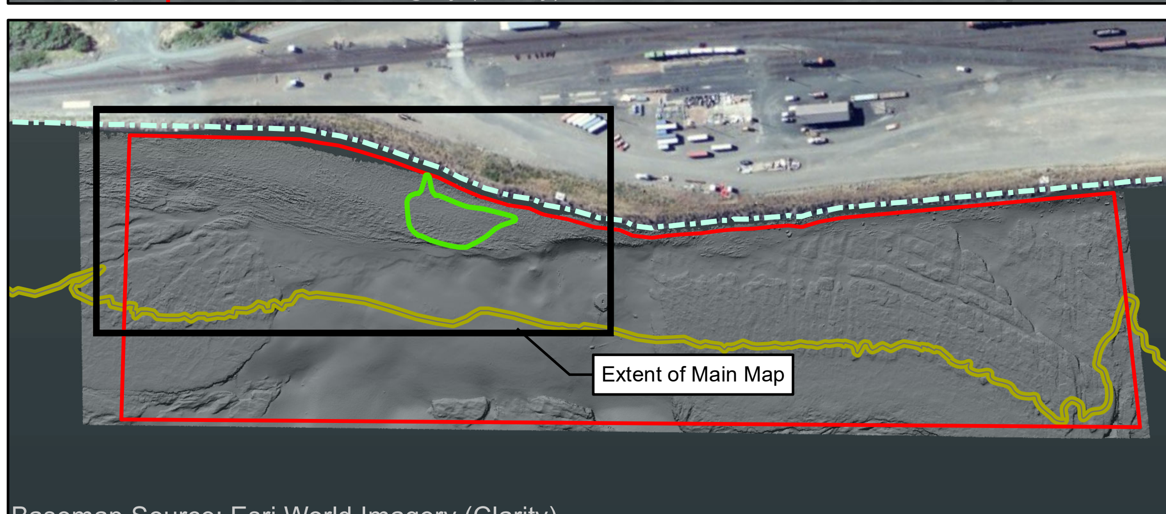


Figure 1-12. NAPL Conceptual Site Model Cross Section B-B'
BNSF Track Switching Facility Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE1-9_NAPLCSM_B-B.MXD GGEE 7/5/2024 16:36:25





LEGEND

- Target Area (0.36 acres)
- Extent of NAPL-affected Area
- Approximate Extent of Sheen-Generating NAPL Impacts
- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

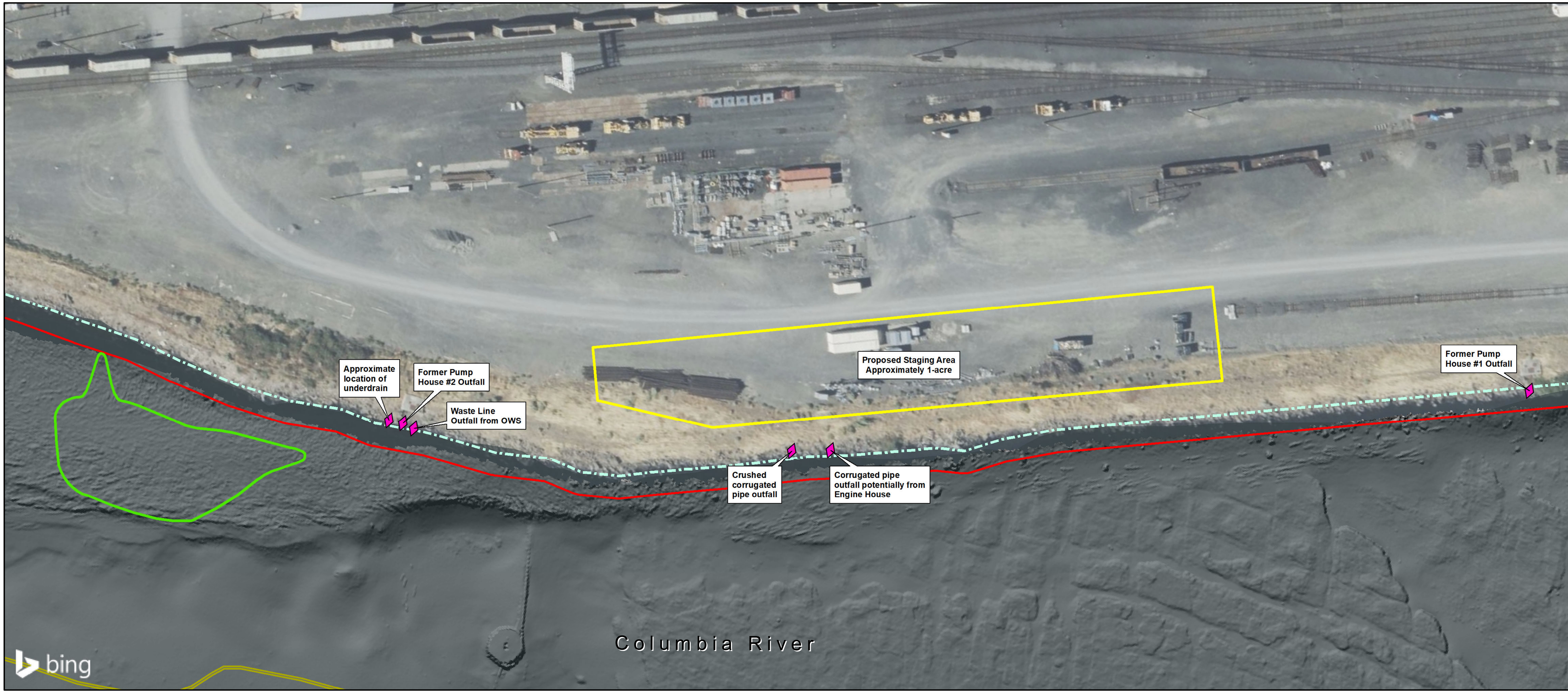
0 25 50 100
Feet

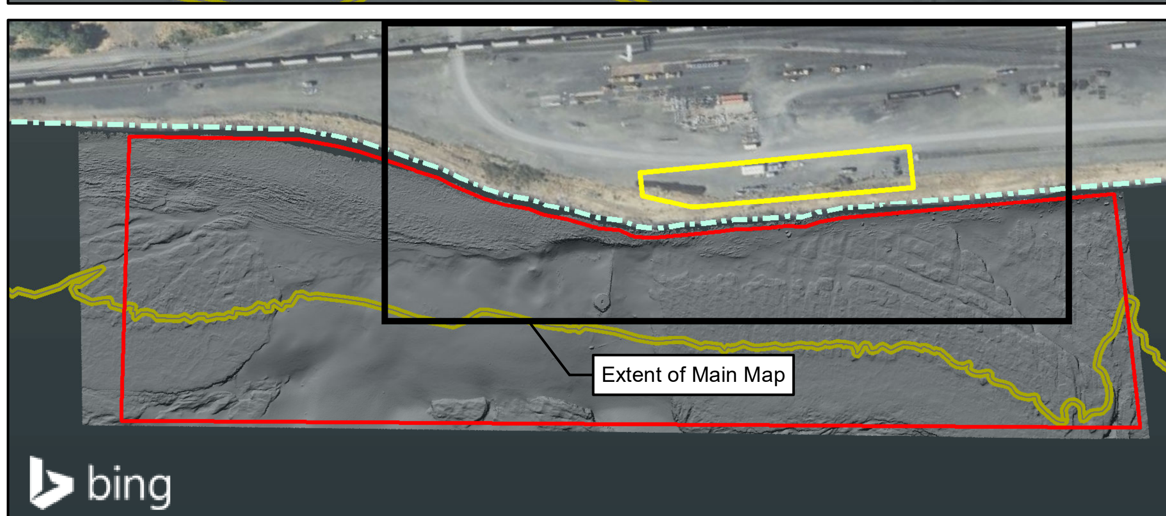
Note: Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution. Remedial Action and long-term monitoring will only be conducted in the hatched area.

Figure 2-1. Target Area
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE2-1_TARGET AREA.MXD GGEE 10/7/2024 14:09:40





LEGEND

- Proposed Staging Area
- Target Area
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

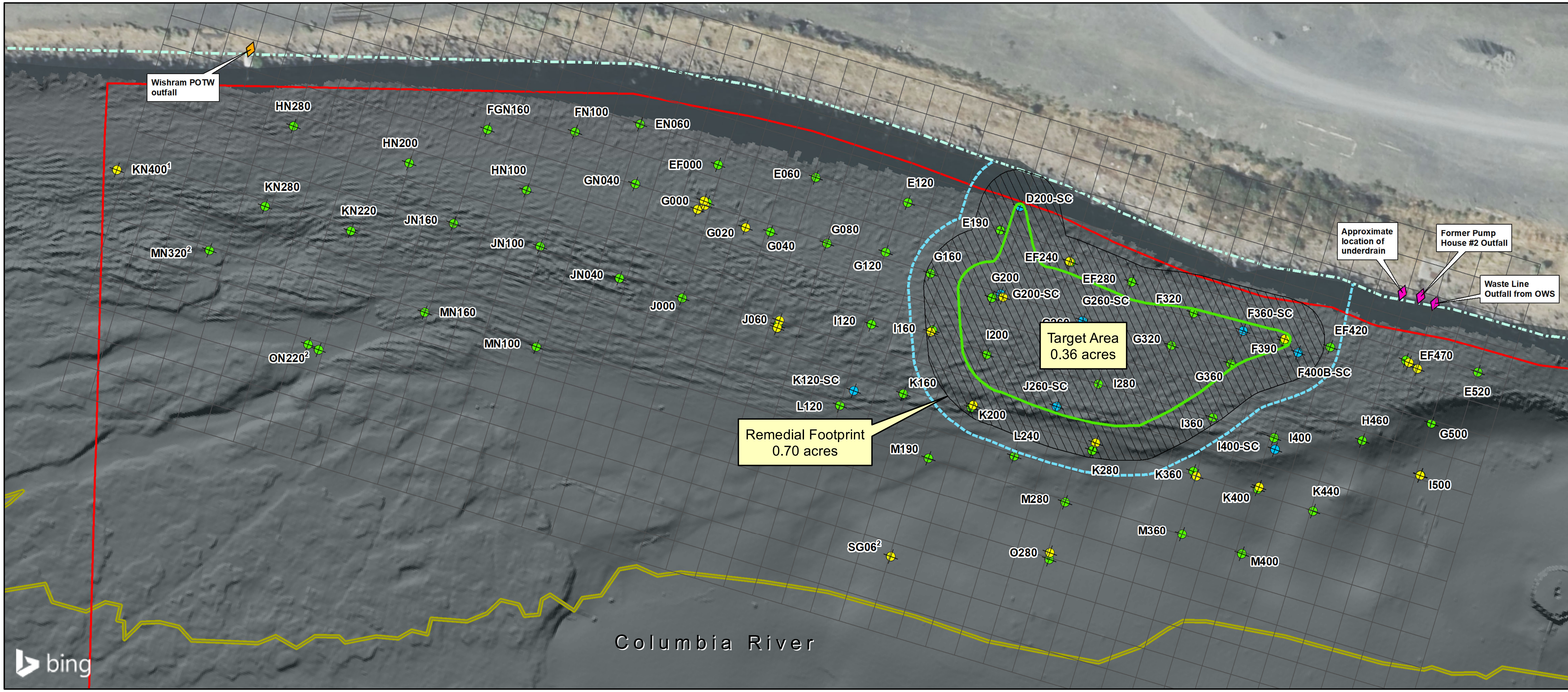
0 25 50 100
Feet

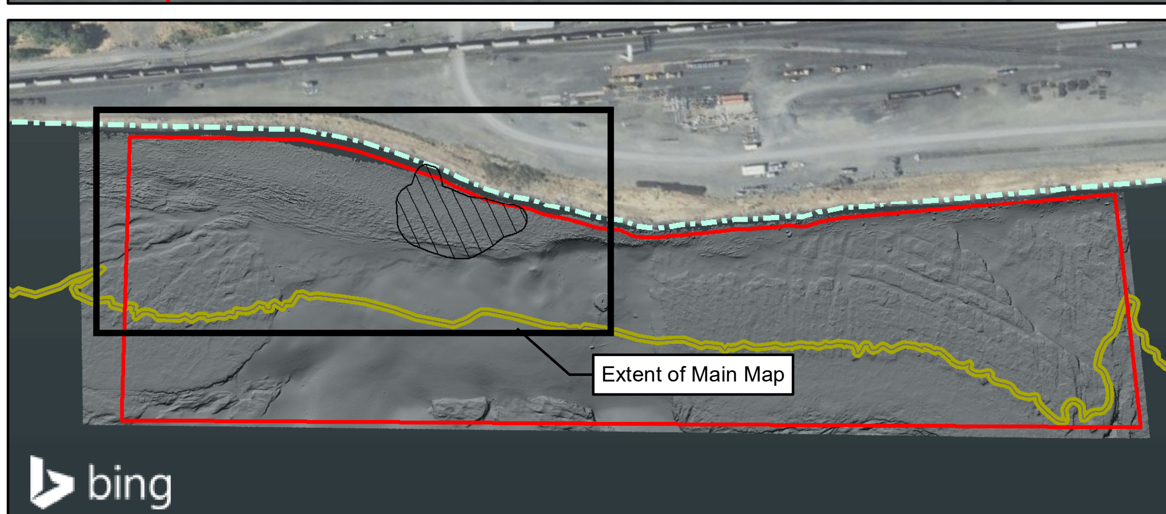
Notes:
1. Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.
2. Aerial Imagery Source: Bing Maps Aerial. Accessed 9/11/2024

Figure 3-1. Proposed Staging Area,
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE3-1_PROPOSEDSTAGINGAREA.MXD GGEE 9/11/2024 16:20:23





LEGEND

- Target Area (0.36 acres)
- Removal and Backfill Remedial Footprint (0.70 acres)
- Silt Curtain
- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

0 25 50 100
Feet

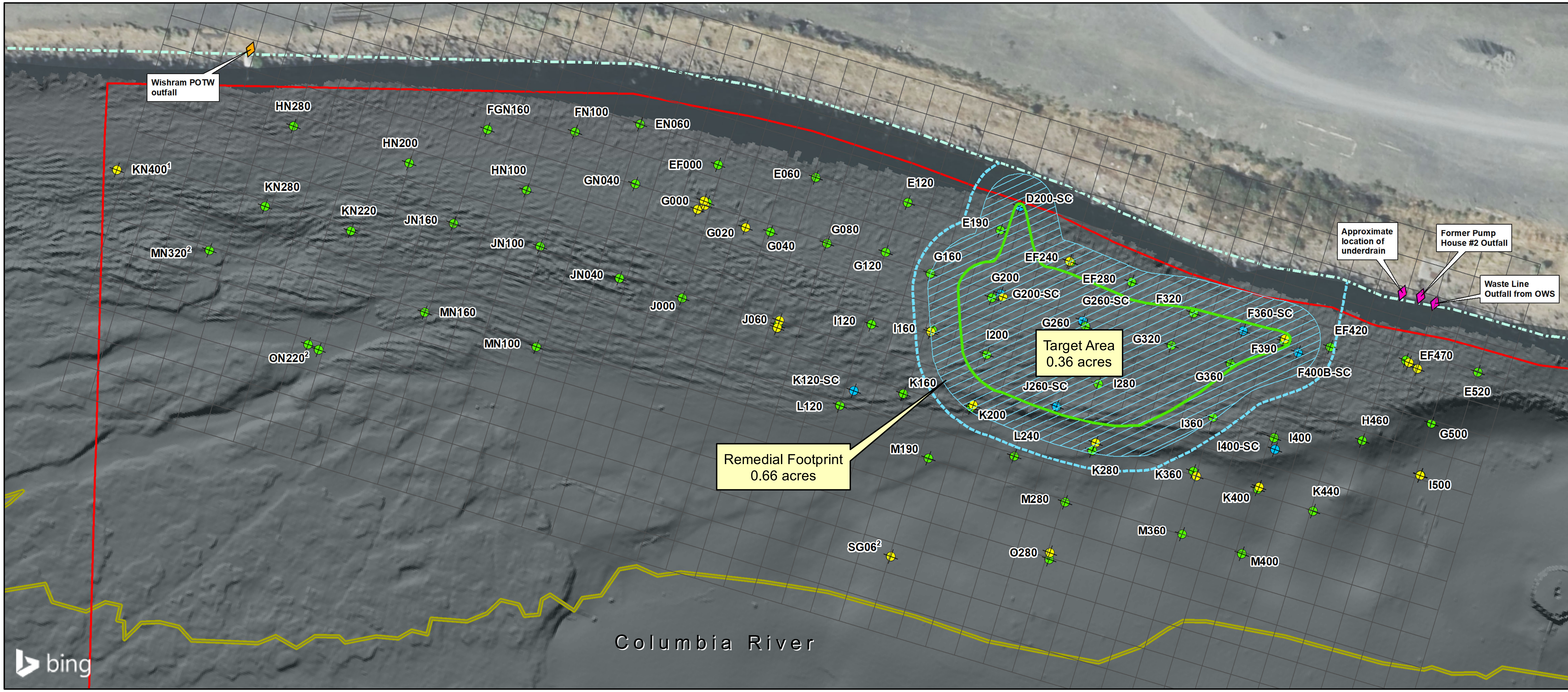
N

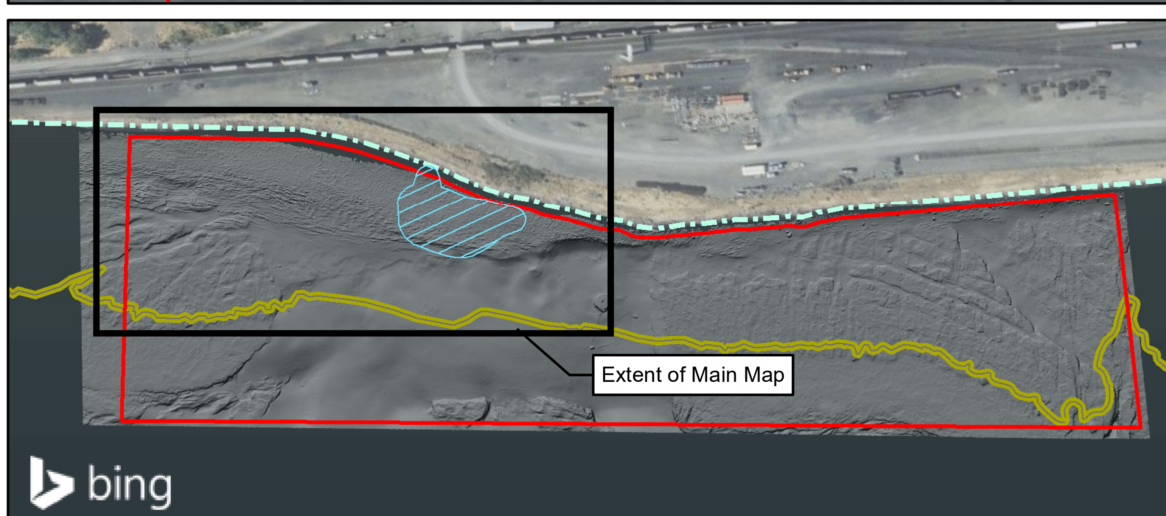
Notes:
1. Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.
2. Remedial Action and long-term monitoring will only be conducted in the hatched area.
3. Aerial Imagery Source: Bing Maps Aerial. Accessed 9/12/2024

Figure 3-2. Alternative 2 – Removal, Backfill and Offsite Disposal
BNSF Track Switching Facility
Wishram, Washington

Jacobs

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE3-2_ALT2.MXD GGEE 9/12/2024 11:56:51





LEGEND

- Target Area (0.36 acres)
- Capping Remedial Footprint (0.66 acres)
- Silt Curtain
- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

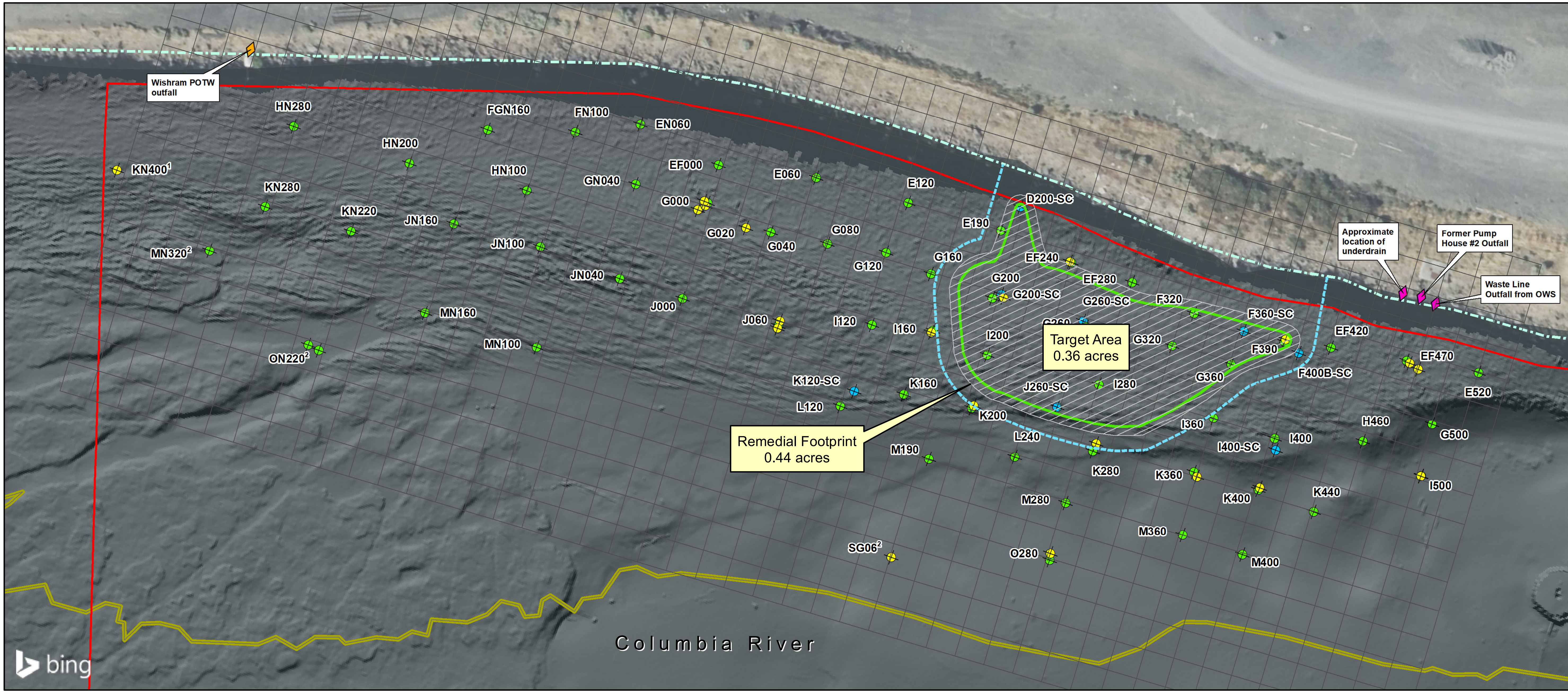
0 25 50 100
Feet

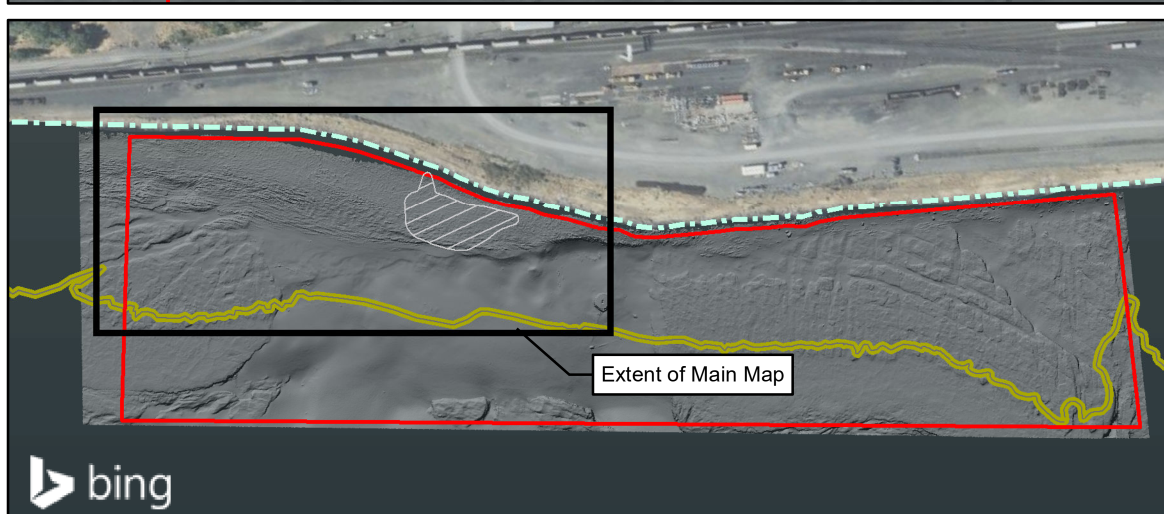
N

Notes:
1. Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.
2. Remedial Action and long-term monitoring will only be conducted in the hatched area.
3. Aerial Imagery Source: Bing Maps Aerial. Accessed 9/11/2024

Figure 3-3. Alternatives 3A, 3B and 3C – Capping and Institutional Controls
BNSF Track Switching Facility
Wishram, Washington

Jacobs





\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\2024_FS\FIGURE3-4_ALT4.MXD GGEE 9/12/2024 12:19:28

LEGEND

- Target Area (0.36 acres)
- In-Situ Stabilization Remedial Footprint (0.44 acres)
- Silt Curtain
- 2022 TarGOST Location
- 2022 Sediment Core
- 2018 Sediment Core
- Current Outfall Location
- Former Outfall Location
- Remedial Investigation Area
- Current Shoreline
- Former Shoreline

0 25 50 100
Feet

Notes:
1. Bathymetry shown presents results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.on January 12, 2022. Bathymetric data were collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013). Survey data are represented at a 1-foot grid resolution.
2. Remedial Action and long-term monitoring will only be conducted in the hatched area.
3. Aerial Imagery Source: Bing Maps Aerial. Accessed 9/12/2024

Figure 3-4. Alternative 4 – In-Situ Stabilization and Institutional Controls
BNSF Track Switching Facility
Wishram, Washington

Jacobs

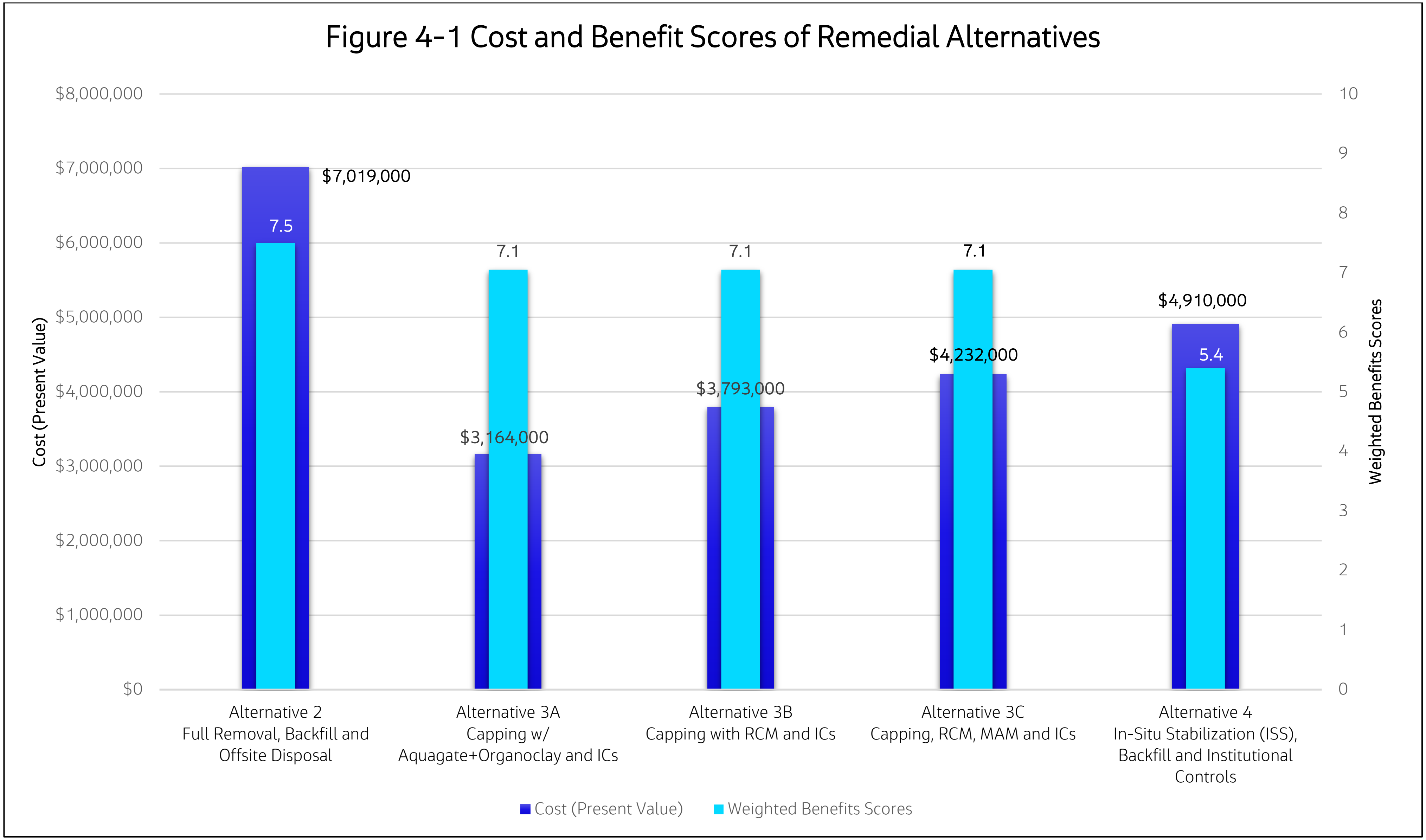


Figure 4-1 Cost and Benefit Scores of Remedial Alternatives
Cost (Present Value)
Weighted Benefits Scores
$8,000,000
$7,000,000
$6,000,000
$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
10
9
8
7
6
5
4
3
2
1
0
$7,019,000
7.5
7.1
$3,164,000
7.1
$3,793,000
7.1
$4,232,000
$4,910,000
5.4
Alternative 2 Full Removal, Backfill and Offsite Disposal
Alternative 3A Capping w/ Aquagate+Organoclay and ICs
Alternative 3B Capping with RCM and ICs
Alternative 3C Capping, RCM, MAM and ICs
Alternative 4 In-Situ Stabilization (ISS), Backfill and Institutional Controls
Cost (Present Value)
Weighted Benefits Scores

Appendix A
Applicable or Relevant and Appropriate Requirement

Table A-1. Chemical-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Medium	Regulation/Citation	Criterion/Standard	Rationale for Including	Action to Comply/Permit
Protection of surface water	Clean Water Act, 33 USC 1313 and 1314 (Sections 303 and 304). Most recent 304(a) list of recommended water quality criteria, as updated	Under CWA Section 304(a), EPA develops recommended water quality criteria for water quality programs established by states. Two kinds of water quality criteria are developed: one for protection of human health, and one for protection of aquatic life. CWA §303 requires States to develop water quality standards based on Federal water quality criteria to protect existing and attainable use or uses (e.g., recreation, public water supply) of the receiving waters.	The most recent 304(a) recommended water quality criteria are Relevant and Appropriate as criterion to apply to short-term impacts from dredging, in-situ stabilization, and/or capping if more stringent than promulgated state criteria. Contaminants could be released to the Columbia River during in-water construction activities such as during the sediment dredging, in-situ stabilization, and/or capping activities.	401 Water Quality Certification
Protection of surface water	Water Quality Standards for Surface Waters of the State of Washington, WAC 173-201A-240(5)	Establishes chemical water quality standards for surface waters of the State of Washington for protection of aquatic life.	State standards that are more stringent than federal standards are Relevant and Appropriate as criterion to short-term impacts during construction that may occur in implementing the remedy. Contaminants could be released to the Columbia River during in-water construction activities such as during the sediment dredging, in-situ stabilization, and/or capping activities.	401 Water Quality Certification
Protection of surface water	40 CFR 131.36(b)(1) Toxics Criteria for Those States Not Complying with Clean Water Act as applied to Washington, 40 CFR 131.45, Revision of certain Federal water quality criteria applicable to Washington	Establishes numeric water quality criteria for priority toxic pollutants for the protection of human health and aquatic organisms which supersede criteria adopted by the state, except where the state criteria are more stringent than the federal criteria.	Applicable requirement for any discharge of water generated during construction. Would apply to any discharges of water during construction. For example, if porewater drained from dredged sediments is discharged to the Columbia River.	401 Water Quality Certification

Table A-2. Action-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Action	Regulation/Citation	Description of Regulatory Requirement	Rational for Including	Action to Comply/Permit
Actions that discharge dredged or fill material into navigable waters	Clean Water Act, Section 404, 33 USC 1344 and Section 404(b)(1) Guidelines, 40 CFR Part 230 (Guidelines for Specification of Disposal Sites for Dredged or Fill Material)	CWA Section 404 regulates the discharge of dredged or fill material into waters of the U.S, including return flows from such activity. This program is implemented through regulations set forth in the 404(b)(1) guidelines, 40 CFR Part 230. The guidelines specify: - the restrictions on discharge (40 CFR 230.10); - the factual determinations on short-term and long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment (40 CFR 230.11) in light of Subparts C through F of the guidelines; and - the findings of compliance on the restrictions (40 CFR 230.12). Subpart J of the guidelines provide the standards and criteria for the use of compensatory mitigation when the response action will result in unavoidable impacts to the aquatic environment.	CWA Section 404 requirements are Applicable. Provides criteria and guidelines for evaluating impacts to the aquatic environment from dredging contaminated sediment, placement of capping material and enhanced monitored natural recovery material, and in-situ treatment of sediments that may occur in implementing the remedy.	Section 404 Permit, USACE Portland District More detailed remedial design information will be required to assess impacts and specify the requirements and controls to be placed on dredging and placement of capping or other materials in the river to minimize impacts. Compensatory mitigation for unavoidable loss of aquatic habitat will be determined and mitigation plans developed if necessary.
Actions that discharge pollutants to waters of U.S.	Clean Water Act, 33 USC 1341, (Section 401), 40 CFR Section, 121.2(a)(3), (4) and (5) See also WAC 173-225 Federal Water Pollution Control Act – Establishment of Implementation Procedures of Application of Certification.	Any activity which may result in any discharge into navigable waters requires reasonable assurances that the activity will be conducted in a manner which will not violate applicable water quality standards by the imposing effluent limitations, other limitations, and monitoring requirements needed so that the discharge will meet the applicable provisions of sections 1311, 1312, 1313, 1316, and 1317 of the Clean Water Act.	Relevant and Appropriate CWA 401 requirement, if more stringent than state implementation regulations, that in-water response actions that result in a discharge of pollutants comply with water quality standards through the placement of water quality-based conditions and other requirements on the discharge as needed. The Applicable state regulations require reasonable assurance that discharge to state waters will comply with state water quality standards. Actions to implement the remedial action that may result in discharges to state waters include, but may not be limited to, dredging, capping, riverbank remediation, or de-watering sediments.	401 Water Quality Certification Conditions and other requirements as needed so that state water quality standards are not violated will be placed on any such discharge.
Actions resulting in discharges to waters of the State of Washington	WAC-173-201A-510 and 520, Implementation of Water Quality Standards for Surface Waters of the State of Washington	Establishes water quality standards for the state of Washington, consistent with public health and enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife. For non-point sources and stormwater pollution, requires Best Management Practices to prevent quarter quality violations caused by stormwater.	All state-wide water quality standards, including numeric, narrative, and designated uses, are Applicable for any discharges to surface water from remedial activities that may result in discharges to waters of the state, such as, dredge and fill, capping, riverbank remediation, and or dewatering sediments. These regulations are Relevant and Appropriate for managing stormwater generated during construction, if the area disturbed is less than 1 acre.	401 Water Quality Certification NPDES and State Waste Discharge General Permit for Stormwater Discharges Associated with Construction Activity requirements are relevant and appropriate for remedies that include use of a concrete batch plant.
Actions involving sediment cleanup	WAC 173-204-570, Selection of Cleanup Actions	Sediment cleanup actions must comply with the sediment cleanup standards, use permanent solutions to the maximum extent practicable, provide for a reasonable restoration time frame, and shall not rely exclusively on MNR or ICs and monitoring where implementing a more permanent cleanup action is possible.	Washington Sediment Management Standards (SMS) are Applicable.	The proposed remedies include full removal and backfill, capping or in-situ stabilization but some proposed remedies rely on institutional controls to achieve remedial goals.
Actions involving sediment cleanup	WAC-220-660 Hydraulic Code Rules Subsections 220-660-110 Authorized work times in freshwater areas, 220-660-120 Common freshwater construction provisions, 220-660-130 Stream bank protection and lake shoreline stabilization, and 220-660-170 Dredging in freshwater areas	Places restrictions on construction projects in marine and freshwater environments to protect and restore fish habitat	Applicable to cleanup actions in sediments. The selected remedy will comply to the extent feasible and will include measures to mitigate unavoidable impacts to freshwater habitat as necessary.	Hydraulic Project Authorization (HPA) issued by the Washington Department of Fisheries (WDFW) Construction activities will avoid where feasible unnecessary disturbance to fish, shellfish, and wildlife.
Actions in federal navigation channels	River and Harbors Act of 1899, Section 10, 33 USC Section 403 and implementing regulations at 33 CFR Sections 322(e), 323.3, 323.4(b)-(c) and 329	The creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable	Applicable requirement for construction in the navigation channel so as not to create an obstruction to the navigable capacity. Applicable to the use of aids to navigation as institutional controls for maintaining the integrity of the cap. Applicable to the discharge of dredged	Section 404 Permit, USACE Portland District

Table A-2. Action-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Action	Regulation/Citation	Description of Regulatory Requirement	Rational for Including	Action to Comply/Permit
		river, or other water of the United States, outside established harbor lines. 33 CFR 322.5(e) addresses placing of aids to navigation in navigable water is under the purview of Section 10 and must meet requirements of the U.S. Coast Guard (33 CFR 330.5(a)(l)). 33 CFR Section 323.4(b) and (c) provide if any discharge of dredged or fill material contains any toxic pollutant listed under section 307 of the CWA such discharge shall require compliance with Section 404 of the CWA. Placement of pilings, or discharge of dredged material that where the flow or circulation of waters of the United States may be impaired or the reach of such waters reduced must comply with Section 10. 33 CFR 329.4 defines the terms "navigable water of the United States" for purposes of the USACE regulations, including those addressing the discharge of dredged or fill material.	material that may impair the flow or circulation of waters or reach of waters the United States.	
Actions generating air emissions	General Standards for Maximum Emissions, WAC-173-400-040	All sources and emissions units are required to meet the general emission standards unless a specific source standard is available. General standards apply to visible emissions, fallout, fugitive emissions, odors, emissions detrimental to persons and property, sulfur dioxide, concealment and masking, and fugitive dust	State regulations defining methods of control to be employed to minimize the release of contaminants associated with fugitive emissions are Applicable to remedial actions that may generate fugitive emissions. For example, if an on-site concrete batch plant is used for in-situ stabilization. These regulations could apply to earth-moving equipment, dust from vehicle traffic, and mobile-source exhaust.	Ecology General Order Permit for the potential on-site concrete batch plant Remedial actions that have the potential to release air emissions will meet standards
Actions generating noise	Maximum environmental noise levels, WAC 173-60 Incorporated by reference in Klickitat County Municipal Code 9.15.050 – Noise Level	Regulations contain specific requirements that pertain to noise levels and limitations	These regulations are Applicable to noise generated during remedial action.	Noise levels will need to be controlled if noise reaches nuisance levels.
Actions that involve generating, handling, and disposal of waste	Identifying Solid Waste, WAC-173-303-016	This regulation identifies those materials that are and are not solid wastes when recycled.	Solid waste identification requirements are Applicable to solid wastes generated during remedial actions.	Standards will be met for remediation activities.
Actions generating wastes for off-site disposal	Designation of Dangerous Waste, WAC 173-303-070	This regulation establishes the requirements for determining if a solid waste is a dangerous waste.	Dangerous waste characterization and determination is Applicable to wastes generated during remedial actions that will be disposed offsite.	A waste determination will be made for wastes prior to offsite disposal.
Actions generating a dangerous waste	Requirements for Generators of Dangerous Waste, WAC 173-303-170	This regulation establishes the requirements for dangerous waste generators.	This regulation is Applicable to remedial actions that may generate dangerous wastes.	Management of remediation wastes that are dangerous waste will comply with these requirements.
Actions generating a dangerous waste	Accumulating Dangerous Waste On Site, WAC 173-303-200	This regulation establishes the requirements for accumulating dangerous wastes on site.	State rules establishing requirements for accumulating dangerous waste on site are Applicable for managing dangerous wastes generated at the site, such as contaminated debris, personal protective equipment, and treatment chemicals.	If dangerous waste is found, then the waste will be managed to meet these requirements.
Actions generating a dangerous waste	Use and Management of Containers, WAC 173-303-630, General Requirements, WAC 173-303-280(6), and Closure, WAC 173-303-610(2), (4), and (5)	This regulation establishes requirements for management of dangerous waste in containers	This standard is Applicable to remedial actions that involve management of dangerous waste in containers that are subject to this standard.	Remedial actions that produce or manage containers of dangerous waste will be managed to meet standards.
Actions managing remediation wastes in staging piles	Staging Piles, WAC-173-303-64690	This regulation establishes the requirements for temporary storage of nonflowing remediation waste during remedial operations (incorporates 40 CFR 264.544 by reference)	This rule is Relevant and Appropriate for management of remediation wastes including contaminated soil/sediment piles that may be generated and accumulated during construction.	Standards will be met for remediation waste.
Actions cleaning up dangerous waste	General requirements for cleanup-only dangerous waste facilities, WAC 173-303-280(6)	This regulation establishes requirements for the protection of public safety and worker safety at dangerous waste cleanup sites, including measures to prevent exposure to members of the public, worker safety training, accident prevention, management of surface impoundments and waste piles, and construction quality assurance planning.	This rule is Relevant and Appropriate to construction activities including sediment dredging, capping, and in-situ stabilization and to handling prior to offsite transport.	Cleanup activities will comply with these standards.
Actions generating, handling, and disposal of solid waste	Owner Responsibilities for Solid Waste, WAC 173-350-025, Performance Standards, WAC 173-350-040, On-Site Storage,	This regulation establishes minimum functional performance standards for the proper handling and disposal of solid waste, not otherwise excluded. Provides requirements for the proper handling of solid waste ,	Requirements are Applicable for solid waste generated during implementation of remedial actions.	Remedial actions that generate solid waste will meet standards.

Table A-2. Action-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Action	Regulation/Citation	Description of Regulatory Requirement	Rational for Including	Action to Comply/Permit
	Collection and Transportation Standards, WAC 173-350-300, and Remedial Action, WAC 173-350-900	and identifies those functions necessary to ensure effective solid waste handling programs at both the state and local level.		
Actions generating dredged material dangerous waste	Excluded Categories of Waste, WAC 173-303-071(3)(ll)(i)	Dredged material that is subject to the requirements of Section 404 of the CWA is excluded as a dangerous waste.	The exemption is Applicable to the dredging, in-situ treatment, handling, storage, or other on-site activities of dredged materials that are being managed in accordance with Section 404 analysis and approvals.	Section 404 Permit, USACE Portland District

Table A-3. Location-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Location	Regulation/Citation	Criterion/Standard	Rationale for Including	Permit/Action
Presence of archaeologically or historically sensitive area	Native American Graves Protection and Reparation Act, 25 USC 3001-3013, 43 CFR 10 See also Protection of Indiana Graves - Penalty, RCW 22.44.040 and Skeletal Human Remains, Duty to Notify – Ground Disturbing Activities- Coroner Determination – Definitions, RCW 27.44.055	Requires Federal agencies and museums which have possession of or control over Native American cultural items (including human remains, associated and unassociated funerary items, sacred objects and objects of cultural patrimony) to compile an inventory of such items. Prescribes when such Federal agencies and museums must return Native American cultural items. "Museums" are defined as any institution or State or local government agency that receives Federal funds and has possession of, or control over, Native American cultural items.	If Native American human remains or cultural items associated with human remains are present and discovered during the course of remedial construction, this requirement is **Relevant and Appropriate**. Such a discovery at the BNSF Wishram Track Switching Facility is unlikely but possible given the long use of the area by the by the Confederated Tribes and Bands of the Yakama Nation.	BNSF will coordinate with DAHP (Department of Archaeology and Historic Preservation) and local tribal nations regarding the level of training or oversight needed during different phases of construction. This consultation is typically triggered by applying for a CWA Section 404 permit.
Presence of archaeologically or historically sensitive area	Archaeological and Historic Preservation Act. 16 USC 469a-1	Provides for the preservation of historical and archaeological data that may be irreparably lost due to a federally-approved project and mandates only preservation of the data.	**Relevant and Appropriate** if historical and archaeological data may be irreparably lost by implementation of the remedial activities.	BNSF will consult with the DAHP, and the local tribal nations prior to the start of remedial construction and will work to avoid, minimize, or mitigate the impacts of construction. This consultation is typically triggered by applying for a CWA Section 404 permit.
Presence of a floodplain	Requirements for Flood Plain Management Regulations, 44 CFR 60.3(a) Floodplain management, WAC-173-158	Prohibits encroachments that would result in any increase in flood levels during occurrence of base flood discharge.	FEMA flood rise requirements are considered **Relevant and Appropriate** requirements for remedial actions that involve capping or other placement of material in the river or on riverbanks that may increase flood levels.	Capping or other placement of material in the Columbia River or on riverbanks will not increase flood levels.
Presence of federally or state-listed endangered or threatened species	Interagency Cooperation for the Endangered Species Act, 50 CFR 402 Subpart B, Consultation Procedures Wildlife Classified as Protected Shall Not be Hunted or Fished, WAC 220-200-100 Wildlife Classified as Endangered Species, WAC 220-610-010	Actions authorized, funded, or carried out by federal agencies may not jeopardize the continued existence of endangered or threatened species or result in the adverse modification of species' critical habitat. Agencies are to avoid jeopardy or take appropriate mitigation measures to avoid jeopardy.	**Applicable** to remedial actions that may impact endangered or threatened species that are present at the site. Listed species, such as salmonids, may be present at the Site.	BNSF will consult with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) regarding actions to be taken, their impacts on listed species, and measures (applicable mitigation and/or best management practices) that will be taken to reduce, minimize, or avoid such impacts so as not to jeopardize the continued existence or adversely modify critical habitat. If take cannot be avoided, take permission from the Services will be obtained prior to construction and mitigation measures identified. Consultation with NMFS and USFWS, typically triggered by application CWA Section 404 Permit
Presence of essential fish habitat	Magnuson-Stevens Fishery Conservation and Management Act. 50 CFR Part.600.920	Requires consultation with NMFS on actions that may adversely affect Essential Fish Habitat (EFH), defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."	**Applicable** because the NMFS has designated the Middle Columbia-Hood Watershed as EFH for Coho and Chinook Salmon.	BNSF will consult with the NMFS regarding actions to be taken, their impact on EFH, and measures that will be implemented to minimize impacts on essential habitat. Consultation with NMFS and USFWS is typically triggered by an application for a Section 404 Permit.
Presence of fish and wildlife habitat	Fish and Wildlife Coordination Act. 16 USC 662 and 663, 50 CFR 6.302(g)	Requires federal agencies to consider effects on fish and wildlife from projects that may alter a body of water and mitigate or compensate for project-related losses, which includes discharges of pollutants to water bodies.	**Relevant and Appropriate** to determining impacts and appropriate mitigation, if necessary, for effects on fish and wildlife from filling activities, in-situ stabilization, or discharges from point sources.	BNSF will consult with the NMFS and USFWS regarding actions to be taken and measures that will be implemented to minimize impacts on essential habitat. Consultation with NMFS and USFWS is typically triggered by an application for a Section 404 Permit.
Presence of migratory birds	Migratory Bird Treaty Act. 16 USC §703 SO CFR §10.12	Makes it unlawful to take any migratory bird. "Take" is defined as pursuing, hunting, wounding, killing, capturing, trapping and collecting.	**Applicable** to response actions that could harm migratory birds using the Columbia River and may require use of best management practices for observing and avoiding contact with such species during construction of the remedy.	BNSF will consult with USFWS regarding actions to be taken and measures that will be implemented to avoid take of any migratory bird. If a take is unavoidable, a migratory bird permit is required.
Presence of Bald and Golden Eagles	Bald and Golden Eagle Protection Act. 16 USC 668, 50 CFR Part 22	Protects bald and golden eagles from take, possession, or transportation without a permit.	**Applicable** to remedial actions that would disturb bald or golden eagles, if present.	BNSF will consult with USFWS regarding actions to be taken and measures that will be implemented to avoid disturbance of bald and golden eagles, if present. If needed, remedial action work plans will include measures to minimize disturbances to bald or golden eagles. If a take is unavoidable, a permit is required.

Table A-3. Location-Specific ARARs for Remedial Action at the BNSF Wishram Track Switching Facility

Location	Regulation/Citation	Criterion/Standard	Rationale for Including	Permit/Action
Presence of Bald Eagles	Bald Eagle Protection Rules, WAC 220-610-100	Protects eagle habitat to maintain eagle populations so the species are not classified as threatened, endangered, or sensitive in Washington State	**Applicable** to remedial actions that would impact eagle habitat if present.	BNSF will consult with WDFW regarding bald eagles and their habitat, if present. If needed, remedial action work plans will include measures to protect bald eagle habitat.
Presence of shorelines	Shoreline Management Act of 1971, RCW 90.58 and WAC 173-24 Klickitat County Shorelines Master Program	Establishes regulations, enforcement procedures, and policies for protecting and developing Klickitat County shorelines areas. The Klickitat County SMP was approved by Ecology on August 7, 1998, and amended in 2007.	Policies and regulations for the shorelines of Klickitat County are **Relevant and Appropriate** for construction within 200 feet of the river shoreline and for dredging.	Design and construction will comply with the Shoreline Master Program requirements and will include mitigation for unavoidable impacts to shoreline resources. BNSF will consult with the Klickitat County Planning Department and apply for a Shoreline Development Permit via the Joint Aquatic Resources Permit Application (JARPA) as needed.

Appendix B
Costs

Basis of Estimate
Feasibility Study – Wishram Railyard Sediment
BNSF Wishram Track Switching Facility
Wishram, Washington

1. Introduction

Jacobs Engineering Group, Inc. (Jacobs) prepared detailed analysis cost estimates for remedial alternatives as part of the feasibility study (FS) report for the BNSF Wishram Track Switching Facility (BNSF Wishram Railyard) in Wishram, Washington. Detailed cost estimates were prepared for each of the remedial alternatives addressing impacted sediments in the Columbia River adjacent to the site.

This basis of estimate (BoE) memorandum focuses on the approach used specifically for the detailed analysis cost estimates for remedial alternatives in the FS.

2. Purpose and Intended Uses

This BoE constitutes the estimated construction costs to execute the activities as described in FS. The purpose of this BoE is to establish a rough order of magnitude (ROM) opinion of probable costs (Table 1) for implementation of the remedial alternatives and long-term operation, monitoring and maintenance (OM&M) for the purpose of comparing remedial alternatives to inform the remedy selection process. The ROM opinion of probable costs is not intended to be used as a forecasting tool to establish project budgets or negotiating enforcement settlements. The FS remedial alternative cost estimates are subject to change due to fluctuations in general economic and business conditions, rates of escalation and inflation, potential supply chain disruptions and market volatility with respect to labor, equipment and materials, future changes in site conditions, regulatory or enforcement policy changes, scope changes and delays in performance, among other factors. As such, the ROM opinion of probable costs is subject to change and may need to be revised.

Table 1. Estimate Information

Estimate Classification	Class 4
Estimate Use	Feasibility Study Comparative Evaluation
Requested By	BNSF
Estimated By	Jacobs Engineering Group, Inc.
Estimate Date	September 2024

3. Cost Guidance and Estimate Methodology

The approach to the development of the cost estimates is based on the methodology as described in the following cost guidance documents, as applicable:

- AACE International 2021 - 107R-19: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Environmental Remediation Industries. AACE International, October 5, 2021.

- (EPA 2000) - A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, July 2000.
- (USACE 2016) - Engineering and Design Environmental Remediation and Removal Programs Cost Engineering, U.S. Army Corps of Engineers (USACE) Engineer Regulation 1110-3-1301, December 30, 2016.

The estimate was developed using HCSS Heavy Bid software (HCSS) and the cost estimate is considered a bottom rolled up type estimate with individual cost items developed using labor, materials, subcontractors, and equipment. No binding quotations were obtained for contractors or materials at this stage; however, vendor quotes were obtained for project critical contractors and equipment for estimating purposes only.

Unit costs for various remedial activities were developed for the detailed analysis cost estimates for each of the remedial alternatives, as presented in Section 4 of the FS report. Unit costs generated from the HCSS software platform were used to present cost estimate summary and present value analysis in Microsoft Excel for each of the remedial alternatives. Detailed, unit-cost, or activity-based cost estimates are the most definitive of the estimating techniques and use information down to the lowest level of detail available at the time the estimates were generated.

4. Remedial Alternatives and Overall Costs

- The following are the remedial alternatives for detailed analysis as presented in Section 3 of the FS:
  - Alternative 1 – No Action
  - Alternative 2 – Removal, Backfill and Offsite Disposal
  - Alternative 3A – Capping with Aquagate + Organoclay and Institutional Controls
  - Alternative 3B – Capping with a Reactive Core Mat (RCM) and Institutional Controls
  - Alternative 3C – Capping with RCM and a Marine Armor Mat and Institutional Controls
  - Alternative 4 – Removal, In-Situ Stabilization, Backfill and Institutional Controls

Table CS-1 summarizes the overall costs associated with the remedial alternatives. The estimated total cost represents the total costs for construction and 30 years of long-term OM&M for each remedial alternative. The estimated total present worth presents the net present value of each remedial alternative. The total costs and total present worth costs were developed in 2024 U.S. dollars and do not include escalation.

5. Key Assumptions – HCSS Heavy Bid Cost Estimate Preparation

The basis for the cost estimates includes the following:

- Unit costs for various remedial activities were developed for the detailed analysis cost estimates for each of the remedial alternatives using HCSS Heavy Bid software platform.
- The cost estimate assumes specialized and heavy equipment, like dredging equipment, long-reach excavators, barges, screening plants, etc., that would require mobilization to the site.
- It is assumed that project-dedicated supervisory staff and specialty laborers/equipment operators will be hired from outside the local labor market and will receive per diem for the duration of the remedial action.

- The estimate was prepared using local market conditions to the degree practicable:
  - Wage rates based on January 2024 Davis-Bacon Act (DBA) wage determinations (WDs) from Klickitat County, Washington for craft laborers and equipment operators.
  - Equipment rates are based on 80 percent of Blue Book value.
  - Material costs have been obtained primarily via current vendor quotes, internet vendor searches, and Jacobs' estimator experience and are representative of current pricing.
- The provided labor rate database also includes the contractor and subcontractor burden markups for labor:
  - Federal/State Unemployment Taxes: 4.5 percent (%) (0.8% federal/3.7% state)
  - Social Security Taxes: 7.65%
  - Workmen's Compensation: Varies by contractor class (as applied in HCSS Heavy Bid)
- The following Prime Contractor overhead and profit were assumed:
  - General and Administrative Expense (G&A) = 5%
  - General Conditions = 15%
  - Profit = 10%
- The prime contractor also applies their markups on work performed by subcontractors. The following prime contractor markups on subcontractors are assumed:
  - G&A = 5%
  - Profit = 10%
- Escalation is not assumed for this cost estimate per EPA cost guidance *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000).

6. Key Assumptions - Backup Calculations

- The quantities used in the detailed analysis cost estimates for remedial alternatives were determined from the FS report and descriptions for each remedial alternative in Section 3. Engineering judgment or assumptions were also used as necessary in developing unit costs.
- Productivity determination for activities such as dredging, excavation, in-situ stabilization, loading, hauling, etc. were calculated, based on engineer experience, or vendor information, and adjusted to site-specific conditions or equipment driving the productivity for an activity.
- Quantities used for calculating the unit costs for the detailed analysis cost estimates for each of the remedial alternatives are presented in Table 3-1 of the FS report.
- The estimated duration of each remedial alternative is calculated based on major work activities such as site preparation, dredging/excavation, backfill, capping, in-situ stabilization and site restoration as follows:
  - Alternative 2 – 5 Months
  - Alternative 3A – 2 Months
  - Alternative 3B – 2 Months
  - Alternative 3C – 2.5 Months
  - Alternative 4 – 3 Months

7. Key Assumptions – Cost Summary and PV Analyses for FS Alternative Cost Estimates

- The contingency includes a combined scope (10%) and bid (10%) contingency of 20%. The contingency was applied and is presented on "Detailed Cost Estimate Summary" sheets per EPA's 2000 cost guidance. Scope contingency covers unknown costs that may occur during remedial design. Bid contingency represents costs, unforeseeable at the time of estimate preparation, which is likely to become known as the remedial action construction or as OM&M proceeds.
- Professional/technical services costs (i.e., project management, remedial design, construction management, and technical support) were included as a percentage of the capital cost and/or annual OM&M/periodic costs as recommended in Section 5.5 of EPA's cost guidance (EPA 2000).
- Types of costs (capital costs, annual OM&M costs, periodic costs, and present value of capital) assessed during the detailed analysis of each retained alternative and assumptions regarding discount rate, period of analysis, etc. are presented in Section 4 of the FS.

8. Estimate Accuracy

This cost estimate, as prepared, is considered Class 4, as defined by 107R-19: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Environmental Remediation Industries (AACE International 2021). This Class 4 cost estimate is assumed to represent the actual total installed cost within the range of -30 percent to +50 percent of the cost indicated. These are prepared solely to facilitate relative comparisons between remedial alternatives for FS evaluation purposes. The information in these cost estimates is based on the best available information regarding the anticipated scope of the remedial alternative at the time of development. Future changes in the cost estimates are likely to occur. This cost estimate is not an offer for either construction or project execution and should be evaluated for market changes after 90 days of the issue date.

9. References

AACE International 2021. Recommended Practice No. 107R-19: Cost Estimate Classification System As Applied in Engineering, Procurement, and Construction for the Environmental Remediation Industries. October.

U.S. Environmental Protection Agency (EPA). 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. EPA 540-R-00-002. July.

U.S. Army Corps of Engineers (USACE). 2016. *Engineering and Design Environmental Remediation and Removal Programs Cost Engineering.* (USACE Engineer Regulation 1110-3-1301. December.

TABLE CS-1

ALTERNATIVE COST SUMMARY

Site: BNSF Wishram Railyard
Location: Wishram, Washington
Phase: Feasibility Study
Base Year: 2024

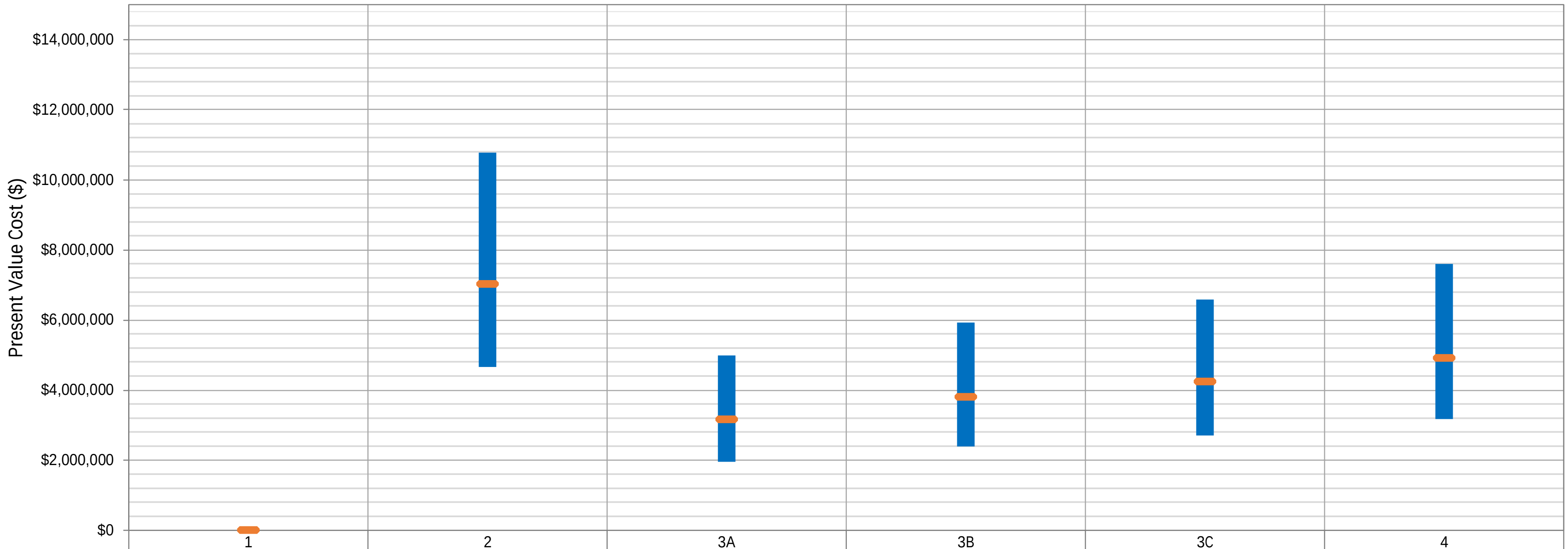
Alternative	Total Capital Cost	Total Annual Cost	Total Periodic Cost	Total Non-Discounted Cost	Present Value Cost
1	$0	$0	$0	$0	$0
2	$6,932,000	$0	$90,000	$7,022,000	$7,019,000
3A	$2,750,000	$0	$610,000	$3,360,000	$3,164,000
3B	$3,313,000	$0	$712,000	$4,025,000	$3,793,000
3C	$3,707,000	$0	$782,000	$4,489,000	$4,232,000
4	$4,722,000	$0	$269,000	$4,991,000	$4,910,000

Notes:

1. Capital costs, annual costs, and periodic costs are presented on Tables CS-2 through CS-4.
2. Estimated remedial timeframes and associated present value analysis for each remedial alternative are provided on Tables PV-2 through PV-4.
3. The non-discounted total cost demonstrates the impact of a discount rate on the total present value cost and the relative amount of future annual expenditures. Non-discounted costs are presented for comparison purposes only and should not be used in place of present value costs in the remedy selection process in accordance with FS guidance.
4. Costs presented for these alternatives are considered to have an accuracy between -30% to +50% of actual costs, based on the scope presented. Costs are prepared solely to facilitate relative comparisons between these alternatives for feasibility study level evaluation purposes.

Alternative 1: No Action
Alternative 2: Removal, Backfill and Offsite Disposal
Alternative 3A: Capping with Aquagate + Organoclay and Institutional Controls
Alternative 3B: Capping with a Reactive Core Mat (RCM) and Institutional Controls
Alternative 3C: Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls
Alternative 4: In-Situ Stabilization (ISS), Backfill and Institutional Controls

Alternative Cost Estimate Accuracy Ranges



	1	2	3A	3B	3C	4
PV (+50%)	$0	$10,529,000	$4,746,000	$5,690,000	$6,348,000	$7,365,000
PV	$0	$7,019,000	$3,164,000	$3,793,000	$4,232,000	$4,910,000
PV (-30%)	$0	$4,914,000	$2,215,000	$2,656,000	$2,963,000	$3,437,000

Remedial Alternative

Notes:

Alternative 1: No Action

Alternative 2: Removal, Backfill and Offsite Disposal

Alternative 3A: Capping with Aquagate + Organoclay and Institutional Controls

Alternative 3B: Capping with a Reactive Core Mat (RCM) and Institutional Controls

Alternative 3C: Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls

Alternative 4: In-Situ Stabilization (ISS), Backfill and Institutional Controls

TABLE PV-2

PRESENT VALUE ANALYSIS

Alternative 2

Removal, Backfill and Offsite Disposal

Site: BNSF Wishram Railyard

Location: Wishram, Washington

Phase: Feasibility Study

Base Year: 2024 Discount Rate[6] 2.0%

Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs	Total Annual Expenditure[3]	Discount Factor (2.0%)	Present Value[4]
0	$6,932,000	$0	$0	$6,932,000	1.0000	$6,932,000
1	$0	$0	$30,000	$30,000	0.9804	$29,412
2	$0	$0	$30,000	$30,000	0.9612	$28,835
3	$0	$0	$30,000	$30,000	0.9423	$28,270
4	$0	$0	$0	$0	0.9238	$0
5	$0	$0	$0	$0	0.9057	$0
6	$0	$0	$0	$0	0.8880	$0
7	$0	$0	$0	$0	0.8706	$0
8	$0	$0	$0	$0	0.8535	$0
9	$0	$0	$0	$0	0.8368	$0
10	$0	$0	$0	$0	0.8203	$0
11	$0	$0	$0	$0	0.8043	$0
12	$0	$0	$0	$0	0.7885	$0
13	$0	$0	$0	$0	0.7730	$0
14	$0	$0	$0	$0	0.7579	$0
15	$0	$0	$0	$0	0.7430	$0
16	$0	$0	$0	$0	0.7284	$0
17	$0	$0	$0	$0	0.7142	$0
18	$0	$0	$0	$0	0.7002	$0
19	$0	$0	$0	$0	0.6864	$0
20	$0	$0	$0	$0	0.6730	$0
21	$0	$0	$0	$0	0.6598	$0
22	$0	$0	$0	$0	0.6468	$0
23	$0	$0	$0	$0	0.6342	$0
24	$0	$0	$0	$0	0.6217	$0
25	$0	$0	$0	$0	0.6095	$0
26	$0	$0	$0	$0	0.5976	$0
27	$0	$0	$0	$0	0.5859	$0
28	$0	$0	$0	$0	0.5744	$0
29	$0	$0	$0	$0	0.5631	$0
30	$0	$0	$0	$0	0.5521	$0
TOTALS:	$6,932,000	$0	$90,000	$7,022,000		$7,018,517
TOTAL PRESENT VALUE OF ALTERNATIVE 2[5]						$7,019,000

Notes:

1. Period of analysis and long-term monitoring was assumed to be 3 years beyond the construction in Year 0.
2. Capital costs, for purposes of this analysis are assumed to occur in "year zero" of the project.
3. Total annual expenditure is the total cost per year with no discounting.
4. Present value is the total cost per year including a 2.0% discount factor for that year. See Table PV-ADRFT for details.
5. Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.
6. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
7. Costs are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
8. For federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94 (OMB 2023). This rate represents the "real" discount rate that approximates the marginal pretax rate of return on an average investment.

TABLE CS-2

Alternative 2
Removal, Backfill and Offsite Disposal

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal of debris and overlying and NAPL-impacted sediment in the Target Area followed by placement of backfill (amended with organoclay and GAC), water treatment and transport and disposal of processed debris and dredged material.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Capital Costs (Assumed to be Incurred During Year 0)						
1	Mobilization	LS	1	$217,000	$217,000	Includes mobilization of labor, equipment, and materials, which were assumed to be approximately 5 percent of the total direct construction costs.
2	Site Preparation					
2.1	Staging Area Development	LS	1	$411,000	$411,000	Includes the construction of a 1.0-acre staging area including the placement of a 4-inch layer of gravel/DGA, installation of geotextile, geogrid and a high-density polyethylene (HDPE) liner, 4 inches of asphalt over 0.5 acre, bin blocks (around the perimeter for secondary containment), decontamination station, personnel river access/docking and spill plates (2 total) for river offloading facility and for loading of dump trucks.
2.2	Erosion and Sediment Control	LF	960	$10	$9,601	Includes the installation and maintenance of upland erosion and sediment controls around the staging area during construction.
2.3	Resuspension Control System	LF	1,019	$130	$132,450	Includes the installation of turbidity curtains, oil booms, and anchors. Quantities assume the placement encompassing the perimeter of the remedial footprint with anchors installed every 50 feet and attached to the shoreline.
3	Temporary Facilities and Utilities	MO	4.8	$9,900	$47,252	Includes temporary facilities and utilities including on-site office trailers and supplies, jobsite sanitation, portable power, and potable water.
4	Debris Removal, Management and Disposal					
4.1	Debris Removal and Processing	AC	0.70	$72,000	$50,623	Includes the mechanical removal of surface debris, transport via tugs and scows to the offloading facility and debris offloading into the staging area for processing. Debris removal is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Debris removal operations are assumed to occur concurrently with dredging operations. Water generated from debris processing operations will be processed at the temporary onsite water treatment system. Estimated quantities assume 5 tons per acre. Engineering and administrative best management practices will be employed to control turbidity during debris removal activities.
5	Dredging					
5.1	Mechanical Dredging	CY	8,195	$96	$786,695	Includes mechanical dredging, sediment transport via tugs and scows to the offloading facility, and sediment offloading into the sediment processing area for processing. Dredging is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Dredging is assumed at a production rate of 350 cy per day. Estimated dredge quantities include the target area, 3:1 side slopes, a 0.5-foot allowable overdredge and 0.5 percent bulking factor. Water generated from sediment processing operations will be processed at the temporary onsite water treatment system. Engineering and administrative best management practices will be employed to control turbidity during all dredging activities.
5.2	Solidification Agent Procurement and Transport	TON	925	$190	$175,686	Includes the procurement, transport, and delivery of Portland cement to the Site.
5.3	Solidification of Dredged Material	TON	10,171	$36	$366,166	Includes the mixing of Portland cement and dredged sediments using mechanical means to reduce water content to meet transport and disposal requirements. Solidification of sediment is assumed with 10 percent Portland cement by weight. Solidification of dredged material is assumed at a production rate of 350 cy per day.
5.4	Solidified Dredged Material Loading	CY	6,892	$6	$41,355	Includes the loading of processed dredged material for transport to the disposal facility.
5.5	Cultural Resource Screening	DAY	82	$8,297	$679,953	Includes an initial mechanical separation of dredged material using a shaker and spray system followed by the manual screening of dredged material for cultural resources. Screening is assumed at a production of 100 cy per day.

TABLE CS-2

Alternative 2
Removal, Backfill and Offsite Disposal

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal of debris and overlying and NAPL-impacted sediment in the Target Area followed by placement of backfill (amended with organoclay and GAC), water treatment and transport and disposal of processed debris and dredged material.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
6	Water Treatment					
6.1	Water Treatment System	MTH	3.2	$73,000	$230,260	Assumes the installation and operation of a temporary water treatment system for the treatment of water resulting from scow dewatering and sediment processing. Costs include water treatment system rental and labor for operations. Water treatment system is assumed for the duration of dredged material processing and includes all appurtenances, controls and sensors, an oil-water separator, sand filters and GAC filtration. Water treatment system size was developed based on assumptions of approximately 50 gallons of water per in-situ cy of sediment. Treated effluent is assumed to be discharged back to the Columbia River in accordance with applicable discharge requirements.
7	Transportation and Disposal (T&D)					
7.1	Dredged Material Offsite Transport and Disposal (NAPL Impacted Sediment)	TONS	6,821	$45	$306,955	Includes T&D of processed dredged sediment via dump trucks to the Republic facility located in Roosevelt, WA.
7.2	Dredged Material Offsite Transport and Disposal (Overlying Sediment)	TONS	3,350	$45	$150,752	Includes T&D of processed dredged sediment via dump trucks to the Republic facility located in Roosevelt, WA. Assume 50% qualifies as daily cover (no disposal cost).
7.3	Debris and Construction Material, and General Refuse	TON	1,643	$45	$73,921	Includes T&D of debris and construction material, and general refuse via dump trucks to the Republic facility located in Roosevelt, WA.
8	Backfill					
8.1	Sand Procurement and Transport	TON	1,241	$41	$50,868	Includes the procurement, transport, and delivery of sand to the Site.
8.2	Organoclay Procurement and Transport	TON	62	$7,400	$459,050	Includes procurement, transport, and delivery of organoclay to the Site.
8.3	GAC Procurement and Transport	TON	37	$3,000	$111,661	Includes procurement, transport, and delivery of GAC to the Site.
8.4	Backfill Blending Operations	CY	1,046	$30	$31,366	Includes the on-site blending of sand, organoclay and GAC in the staging area.
8.5	Backfill Placement	CY	1,046	$120	$125,465	Includes the transfer of backfill material from the staging area to on-water scows, transport of the backfill material to the location of placement and placement of the backfill. Placement operations would be conducted following the successful confirmation of dredging activities. Backfill placement is assumed to be conducted using in-water mechanical methods utilizing from a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a minimum 6-inch-thick layer of sand/GAC/organoclay with 25 percent allowable overplacement with an assumed 25 percent material loss factor. Backfill amendment assumes a combination of organoclay (5 percent by weight) and GAC (3 percent by weight) to address residual remaining concerns of sheen generating NAPL.
9	Site Surveying	DY	5	$6,300	$31,500	Includes pre-construction and post-construction upland topographic and bathymetric surveys and reporting. Confirmation surveying will be conducted prior to and during dredging and backfill placement. Pre- and post-processed survey data will be compared to evaluate the successful completion of remedial activities.
10	Site Restoration	LS	1	$60,000	$60,000	Includes removal of upland staging area and restoration of the area to pre-construction conditions.
11	Demobilization	LS	1	$217,000	$217,000	Includes demobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
				Subtotal:	$4,768,278	

TABLE CS-2

Alternative 2
Removal, Backfill and Offsite Disposal

Description: Removal of debris and overlying and NAPL-impacted sediment in the Target Area followed by placement of backfill (amended with organoclay and GAC), water treatment and transport and disposal of processed debris and dredged material.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
	Contingency (Scope [10%] and Bid [10%]):			20%	$953,656	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$5,721,934	
12	Project Management:			5%	$286,097	Project Management includes planning and reporting, community relations support during construction, bid or contract administration, and legal services. Percentage based multiplier were used from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
13	Remedial Design:			8%	$457,755	Remedial design includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
14	Construction Management:			6%	$343,316	Construction management includes services to manage construction or installation of the remedial action from mobilization through to demobilization. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				TOTAL:	$6,809,101	
	Washington State Gross Receipts Tax (1.8%):				$122,564	
	TOTAL DIRECT AND INDIRECT CAPITAL COSTS:				$6,932,000	

TABLE CS-2

Alternative 2
Removal, Backfill and Offsite Disposal

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description:	Removal of debris and overlying and NAPL-impacted sediment in the Target Area followed by placement of backfill (amended with organoclay and GAC), water treatment and transport and disposal of processed debris and dredged material.
Site:	BNSF Wishram Railyard
Location:	Wishram, Washington
Base Year:	2024
Date:	September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Long-term operation, monitoring and maintenance (OM&M) - Periodic Costs						
15	Long-Term Monitoring - Survey (Years 1, 2 and 3)	EA	3	$20,000	$60,000	Assumes post-construction visual monitoring and installation of time-lapse cameras to evaluate the presence of sheen following construction. The estimated cost was calculated using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
				Subtotal:	$60,000	
	Contingency (Scope [10%] and Bid [10%]):			20%	$12,000	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$72,000	
16	Project Management:			10%	$7,200	Project Management includes planning and reporting, community relations support during O&M. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
17	Technical Support:			15%	$10,800	Technical support during O&M includes services to monitor, evaluate, and report progress of the remedial action. This includes oversight of O&M activities, update of O&M manual, and progress reporting. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July. Middle value of the recommended range in EPA 540-R-00-002 was used.
				TOTAL:	$90,000	

TOTAL NON-DISCOUNTED PERIODIC COST:	$90,000
TOTAL NON-DISCOUNTED PROJECT COST:	$7,022,000
TOTAL DISCOUNTED PROJECT COST:	$7,019,000

TABLE CS-2

Alternative 2
Removal, Backfill and Offsite Disposal

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal of debris and overlying and NAPL-impacted sediment in the Target Area followed by placement of backfill (amended with organoclay and GAC), water treatment and transport and disposal of processed debris and dredged material.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES

Notes:
CY - cubic yard DGA - dense graded aggregate EA - each EPA - U.S. Environmental Protection Agency GAC - granular activated carbon LF - linear foot LS - lump sum POWT- publicly owned treatment works SF - square feet TON - tons

General Notes:
1. Percentages used for indirect costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
2. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
3. Cost details provided in this estimate are based on professional judgment, similar project experience, knowledge of the existing conditions at the site, and costs from similar project estimates. Costs were not developed from the ground up and are instead estimated through unit costs, production and schedule assumptions, and associated project durations.
4. All assumptions, quantities, and unit prices used in this cost estimate are preliminary for the purposes of the FS and cost estimate. Cost estimates will be refined during future remedial design development efforts.
5. Remedial operations are assumed 12 hours per day, 6 days per week.
6. All costs include labor, equipment and materials, overhead and profit, general and administrative expenses and are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
7. These costs have been developed using currently available information regarding site characteristics such as site bathymetry, potential debris, physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
8. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Jacobs is not licensed as an accountant or securities attorney and, therefore, makes no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

TABLE PV-3A						
PRESENT VALUE ANALYSIS						
Alternative	3A					
Capping with Aquagate + Organoclay and Institutional Controls						
Site:	BNSF Wishram Railyard					
Location:	Wishram, Washington					
Phase:	Feasibility Study					
Base Year:	2024	Discount Rate[6]	2.0%			
Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs	Total Annual Expenditure[3]	Discount Factor (2.0%)	Present Value[4]
0	$2,750,000	$0	$0	$2,750,000	1.0000	$2,750,000
1	$0	$0	$0	$0	0.9804	$0
2	$0	$0	$0	$0	0.9612	$0
3	$0	$0	$0	$0	0.9423	$0
4	$0	$0	$0	$0	0.9238	$0
5	$0	$0	$44,039	$44,039	0.9057	$39,888
6	$0	$0	$0	$0	0.8880	$0
7	$0	$0	$0	$0	0.8706	$0
8	$0	$0	$0	$0	0.8535	$0
9	$0	$0	$0	$0	0.8368	$0
10	$0	$0	$44,039	$44,039	0.8203	$36,127
11	$0	$0	$0	$0	0.8043	$0
12	$0	$0	$0	$0	0.7885	$0
13	$0	$0	$0	$0	0.7730	$0
14	$0	$0	$0	$0	0.7579	$0
15	$0	$0	$217,159	$217,159	0.7430	$161,352
16	$0	$0	$0	$0	0.7284	$0
17	$0	$0	$0	$0	0.7142	$0
18	$0	$0	$0	$0	0.7002	$0
19	$0	$0	$0	$0	0.6864	$0
20	$0	$0	$44,039	$44,039	0.6730	$29,637
21	$0	$0	$0	$0	0.6598	$0
22	$0	$0	$0	$0	0.6468	$0
23	$0	$0	$0	$0	0.6342	$0
24	$0	$0	$0	$0	0.6217	$0
25	$0	$0	$44,039	$44,039	0.6095	$26,843
26	$0	$0	$0	$0	0.5976	$0
27	$0	$0	$0	$0	0.5859	$0
28	$0	$0	$0	$0	0.5744	$0
29	$0	$0	$0	$0	0.5631	$0
30	$0	$0	$217,159	$217,159	0.5521	$119,887
TOTALS:	$2,750,000	$0	$610,000	$3,360,000		$3,163,734
TOTAL PRESENT VALUE OF ALTERNATIVE 3 [5]						$3,164,000

Notes:

1. Period of analysis and long-term monitoring was assumed to be 30 years beyond the construction in Year 0.
2. Capital costs, for purposes of this analysis are assumed to occur in "year zero" of the project.
3. Total annual expenditure is the total cost per year with no discounting.
4. Present value is the total cost per year including a 2.0% discount factor for that year. See Table PV-ADRFT for details.
5. Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.
6. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
7. Costs are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
8. For federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94 (OMB 2023). This rate represents the "real" discount rate that approximates the marginal pretax rate of return on an average investment.

TABLE CS-3A

Alternative 3A
Capping with Aquagate + Organoclay and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 3 -inch layer of Aquate+Organoclay and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Capital Costs (Assumed to be Incurred During Year 0)						
1	Mobilization	LS	1	$86,000	$86,000	Includes mobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
2	Site Preparation					
2.1	Staging Area Development and Water Access	LS	1	$203,000	$203,000	Includes the construction of a 1.0-acre staging area including the placement of a 4-inch layer of gravel/DGA and a geogrid and personnel river access/docking.
2.2	Erosion and Sediment (E&S) Control	LF	960	$10.00	$9,601	Includes the installation and maintenance of upland erosion and sediment controls around the staging area during construction.
2.3	Resuspension Control System	LF	999	$130	$129,878	Includes the installation of turbidity curtains, oil booms, and anchors. Quantities assume the placement encompassing the perimeter of the remedial footprint with anchors installed every 50 feet and attached to the shoreline.
3	Temporary Facilities and Utilities	MO	1.5	$9,900	$14,480	Includes temporary facilities and utilities including on-site office trailers and supplies, jobsite sanitation, portable power, and potable water.
4	Debris Removal, Management and Disposal					
4.1	Debris Removal and Processing	AC	0.66	$72,000	$47,244	Includes the mechanical removal of surface debris and transport via tugs and scows to the offloading facility and debris offloading into the staging area for processing . Debris removal is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Debris removal operations are assumed to occur prior to cap placement. Water generated from debris processing operations is expected to be minimal and will be containerized and transported to the local POTW. Estimated quantities assume 5 tons per acre. Engineering and administrative best management practices will be employed to control turbidity during debris removal activities.
5	Cap Installation					
5.1	Sand Leveling Layer Procurement and Transport	TON	1,158	$41	$47,473	Includes procurement, transport, and delivery of sand to the Site.
5.2	Sand Leveling Layer Placement	CY	827	$94	$77,743	Includes the placement of a sand leveling layer to provide initial stability to prevent lateral movement of the cap. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods utilizing a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 6 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.
5.3	Aquagate + Organclay Procurement and Transport	TON	447	$1,650	$736,903	Includes procurement, transport, and delivery of Aquagate + Organoclay to the Site.
5.4	Aquagate + Organclay Layer Installation	CY	414	$94	$38,871	Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods utilizing a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target, placement of 3 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.
5.5	Benthic Restoration Layer Procurement and Transport	TON	2,316	$41	$94,946	Includes procurement, transport, and delivery of sand to the Site.
5.6	Benthic Restoration Layer Placement	CY	1,650	$119	$196,350	Includes the placement of a benthic restoration layer (sand) to promote benthic recolonization. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods using general construction equipment from a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 12 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.

TABLE CS-3A

Alternative 3A
Capping with Aquagate + Organoclay and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 3 -inch layer of Aquate+Organoclay and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
6	Transportation and Disposal					
6.1	Debris and Construction Material, and General Refuse	TON	890	$45	$40,045	Includes T&D of debris and construction material, and general refuse via dump trucks to the Republic facility located in Roosevelt, WA.
7	Site Surveying	DY	6	$5,900	$35,400	Includes pre-construction and post-construction upland topographic and bathymetric surveys and reporting. Confirmation surveying will be conducted prior to and during capping placement. Pre- and post-processed survey data will be compared to evaluate the successful completion of remedial activities.
8	Site Restoration	LS	1	$30,000	$30,000	Includes removal of upland staging area and restoration of the area to pre-construction conditions.
9	Site Institutional Controls (ICs)	LS	1	$15,810	$15,810	Includes development and maintenance of institutional controls and community awareness activities.
10	Demobilization	LS	1	$86,000	$86,000	Includes demobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
				Subtotal:	$1,891,445	
	Contingency (Scope [10%] and Bid [10%]):			20%	$378,289	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$2,269,734	
11	Project Management:			5%	$113,487	Project Management includes planning and reporting, community relations support during construction, bid or contract administration, and legal services. Percentage based multiplier were used from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
12	Remedial Design:			8%	$181,579	Remedial design includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
13	Construction Management:			6%	$136,184	Construction management includes services to manage construction or installation of the remedial action from mobilization through to demobilization. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				TOTAL:	$2,700,984	
	Washington State Gross Receipts Tax (1.8%):				$48,618	
	TOTAL DIRECT AND INDIRECT CAPITAL COSTS:				$2,750,000	

TABLE CS-3A

Alternative 3A
Capping with Aquagate + Organoclay and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 3 -inch layer of Aquate+Organoclay and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Long-term operation, monitoring and maintenance (OM&M) - Periodic Costs						
14	Long-Term Monitoring - Survey (Years 5, 10, 15, 20, 25, 30)	EA	6	$30,330	$181,980	Assumes bathymetric surveying will be conducted every 5 years for a duration of 30 years using multi-beam bathymetric survey techniques. Data will be evaluated, and the results will be included in a report. The estimated cost was calculated using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
15	Maintenance Program (Year 15, 30)	EA	2	$119,229	$238,457	The cap maintenance program is assumed to include cap maintenance activities at years 15 and 30. The cap maintenance program was calculated assuming a 10 percent multiplier of cap total direct construction costs for each maintenance event. The estimated cost for the long-term cap maintenance program was calculated and using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
				Subtotal:	$420,437	
	Contingency (Scope [10%] and Bid [10%]):			20%	$84,087	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$504,525	
16	Project Management:			6%	$30,271	Project Management includes planning and reporting, community relations support during O&M. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
17	Technical Support:			15%	$75,679	Technical support during O&M includes services to monitor, evaluate, and report progress of the remedial action. This includes oversight of O&M activities, update of O&M manual, and progress reporting. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July. Middle value of the recommended range in EPA 540-R-00-002 was used.
				TOTAL:	$610,475	

TOTAL NON-DISCOUNTED PERIODIC COST:	$610,000
TOTAL NON-DISCOUNTED PROJECT COST:	$3,360,000
TOTAL DISCOUNTED PROJECT COST:	$3,164,000

TABLE CS-3A

Alternative 3A
Capping with Aquagate + Organoclay and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description:	Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 3 -inch layer of Aquate+Organoclay and a 12-inch thick benthic restoration layer.
Site:	BNSF Wishram Railyard
Location:	Wishram, Washington
Base Year:	2024
Date:	September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES

Notes:
CY - cubic yard DGA - dense graded aggregate EA - each EPA - United States Environmental Protection Agency GAC - granular activated carbon LF - linear foot LS - lump sum MAM - marine armor mat POWT- publicly owned treatment works SF - square feet TON - Tons RCM - reactive core mat

General Notes:
1. Percentages used for indirect costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
2. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
3. Cost details provided in this estimate are based on professional judgment, similar project experience, knowledge of the existing conditions at the site, and costs from similar project estimates. Costs were not developed from the ground up and are instead estimated through unit costs, production and schedule assumptions, and associated project durations.
4. All assumptions, quantities, and unit prices used in this cost estimate are preliminary for the purposes of the FS and cost estimate. Cost estimates will be refined during future remedial design development efforts.
5. Remedial operations are assumed 12 hours per day, 6 days per week.
6. All costs include labor, equipment and materials, overhead and profit, general and administrative expenses and are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
7. These costs have been developed using currently available information regarding site characteristics such as site bathymetry, potential debris, physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
8. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Jacobs is not licensed as an accountant or securities attorney and, therefore, makes no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

TABLE PV-3B						
PRESENT VALUE ANALYSIS						
Alternative	3B					
Capping with a Reactive Core Mat (RCM) and Institutional Controls						
Site:	BNSF Wishram Railyard					
Location:	Wishram, Washington					
Phase:	Feasibility Study					
Base Year:	2024	Discount Rate[6]		2.0%		
Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs	Total Annual Expenditure[3]	Discount Factor (2.0%)	Present Value[4]
0	$3,313,000	$0	$0	$3,313,000	1.0000	$3,313,000
1	$0	$0	$0	$0	0.9804	$0
2	$0	$0	$0	$0	0.9612	$0
3	$0	$0	$0	$0	0.9423	$0
4	$0	$0	$0	$0	0.9238	$0
5	$0	$0	$44,039	$44,039	0.9057	$39,888
6	$0	$0	$0	$0	0.8880	$0
7	$0	$0	$0	$0	0.8706	$0
8	$0	$0	$0	$0	0.8535	$0
9	$0	$0	$0	$0	0.8368	$0
10	$0	$0	$44,039	$44,039	0.8203	$36,127
11	$0	$0	$0	$0	0.8043	$0
12	$0	$0	$0	$0	0.7885	$0
13	$0	$0	$0	$0	0.7730	$0
14	$0	$0	$0	$0	0.7579	$0
15	$0	$0	$268,055	$268,055	0.7430	$199,169
16	$0	$0	$0	$0	0.7284	$0
17	$0	$0	$0	$0	0.7142	$0
18	$0	$0	$0	$0	0.7002	$0
19	$0	$0	$0	$0	0.6864	$0
20	$0	$0	$44,039	$44,039	0.6730	$29,637
21	$0	$0	$0	$0	0.6598	$0
22	$0	$0	$0	$0	0.6468	$0
23	$0	$0	$0	$0	0.6342	$0
24	$0	$0	$0	$0	0.6217	$0
25	$0	$0	$44,039	$44,039	0.6095	$26,843
26	$0	$0	$0	$0	0.5976	$0
27	$0	$0	$0	$0	0.5859	$0
28	$0	$0	$0	$0	0.5744	$0
29	$0	$0	$0	$0	0.5631	$0
30	$0	$0	$268,055	$268,055	0.5521	$147,985
TOTALS:	$3,313,000	$0	$712,000	$4,025,000		$3,792,649
TOTAL PRESENT VALUE OF ALTERNATIVE 3 [5]						$3,793,000

Notes:

1. Period of analysis and long-term monitoring was assumed to be 30 years beyond the construction in Year 0.
2. Capital costs, for purposes of this analysis are assumed to occur in "year zero" of the project.
3. Total annual expenditure is the total cost per year with no discounting.
4. Present value is the total cost per year including a 2.0% discount factor for that year. See Table PV-ADRFT for details.
5. Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.
6. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
7. Costs are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
8. For federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94 (OMB 2023). This rate represents the "real" discount rate that approximates the marginal pretax rate of return on an average investment.

TABLE CS-3B

Alternative 3B
Capping with a Reactive Core Mat (RCM) and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25 to 0.5-inch RCM, and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Capital Costs (Assumed to be Incurred During Year 0)						
1	Mobilization	LS	1	$104,000	$104,000	Includes mobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
2	Site Preparation					
2.1	Staging Area Development and Water Access	LS	1	$203,000	$203,000	Includes the construction of a 1.0-acre staging area including the placement of a 4-inch layer of gravel/DGA and a geogrid and personnel river access/docking.
2.2	Erosion and Sediment (E&S) Control	LF	960	$10.00	$9,601	Includes the installation and maintenance of upland erosion and sediment controls around the staging area during construction.
2.3	Resuspension Control System	LF	999	$130	$129,878	Includes the installation of turbidity curtains, oil booms, and anchors. Quantities assume the placement encompassing the perimeter of the remedial footprint with anchors installed every 50 feet and attached to the shoreline.
3	Temporary Facilities and Utilities	MO	1.5	$9,900	$15,242	Includes temporary facilities and utilities including on-site office trailers and supplies, jobsite sanitation, portable power, and potable water.
4	Debris Removal, Management and Disposal					
4.1	Debris Removal and Processing	AC	0.66	$72,000	$47,244	Includes the mechanical removal of surface debris and transport via tugs and scows to the offloading facility and debris offloading into the staging area for processing . Debris removal is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Debris removal operations are assumed to occur prior to cap placement. Water generated from debris processing operations is expected to be minimal and will be containerized and transported to the local POTW. Estimated quantities assume 5 tons per acre. Engineering and administrative best management practices will be employed to control turbidity during debris removal activities.
5	Cap Installation					
5.1	Sand Leveling Layer Procurement and Transport	TON	1,158	$41	$47,473	Includes procurement, transport, and delivery of sand to the Site.
5.2	Sand Leveling Layer Placement	CY	827	$94	$77,743	Includes the placement of a sand leveling layer to provide initial stability to prevent lateral movement of the cap. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods utilizing a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 6 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.
5.3	Organoclay RCM Procurement and Transport	SF	32,870	$26	$862,847	Includes procurement, transport and delivery of prefabricated RCM containing organoclay at a thickness of 3 to 6 inches. The final thickness will be determined during the design phase.
5.4	Organoclay RCM Installation	SF	32,870	$8	$262,963	Includes the transfer of the RCM from the staging area to on-water barge platform, transport of the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods with general construction equipment using roll bars from two platforms assisted by divers with an assumed 20-foot offset from the Target Area and production rate of approximately 8,500 sf per day.
5.5	Benthic Restoration Layer Procurement and Transport	TON	2,316	$41	$94,946	Includes procurement, transport, and delivery of sand to the Site.
5.6	Benthic Restoration Layer Placement	CY	1,654	$119	$196,838	Includes the placement of a benthic restoration layer (sand) to promote benthic recolonization. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods using general construction equipment from a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 12 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.

TABLE CS-3B

Alternative 3B
Capping with a Reactive Core Mat (RCM) and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25 to 0.5-inch RCM, and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
6	Transportation and Disposal					
6.1	Debris and Construction Material, and General Refuse	TON	890	$45	$40,045	Includes T&D of debris and construction material, and general refuse via dump trucks to the Republic facility located in Roosevelt, WA.
7	Site Surveying	DY	6	$5,900	$35,400	Includes pre-construction and post-construction upland topographic and bathymetric surveys and reporting. Confirmation surveying will be conducted prior to and during capping placement. Pre- and post-processed survey data will be compared to evaluate the successful completion of remedial activities.
8	Site Restoration	LS	1	$30,000	$30,000	Includes removal of upland staging area and restoration of the area to pre-construction conditions.
9	Site Institutional Controls (ICs)	LS	1	$15,810	$15,810	Includes development and maintenance of institutional controls and community awareness activities.
10	Demobilization	LS	1	$104,000	$104,000	Includes demobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
				Subtotal:	$2,278,731	
	Contingency (Scope [10%] and Bid [10%]):			20%	$455,746	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$2,734,477	
11	Project Management:			5%	$136,724	Project Management includes planning and reporting, community relations support during construction, bid or contract administration, and legal services. Percentage based multiplier were used from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
12	Remedial Design:			8%	$218,758	Remedial design includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
13	Construction Management:			6%	$164,069	Construction management includes services to manage construction or installation of the remedial action from mobilization through to demobilization. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				TOTAL:	$3,254,028	
	Washington State Gross Receipts Tax (1.8%):				$58,572	
	TOTAL DIRECT AND INDIRECT CAPITAL COSTS:				$3,313,000	

TABLE CS-3B

Alternative 3B
Capping with a Reactive Core Mat (RCM) and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25 to 0.5-inch RCM, and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Long-term operation, monitoring and maintenance (OM&M) - Periodic Costs						
14	Long-Term Monitoring - Survey (Years 5, 10, 15, 20, 25, 30)	EA	6	$30,330	$181,980	Assumes bathymetric surveying will be conducted every 5 years for a duration of 30 years using multi-beam bathymetric survey techniques. Data will be evaluated, and the results will be included in a report. The estimated cost was calculated using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
15	Maintenance Program (Year 15, 30)	EA	2	$154,281	$308,562	The cap maintenance program is assumed to include cap maintenance activities at years 15 and 30. The cap maintenance program was calculated assuming a 10 percent multiplier of cap total direct construction costs for each maintenance event. The estimated cost for the long-term cap maintenance program was calculated and using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
				Subtotal:	$490,542	
			Contingency (Scope [10%] and Bid [10%]):	20%	$98,108	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$588,650	
16			Project Management:	6%	$35,319	Project Management includes planning and reporting, community relations support during O&M. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
17			Technical Support:	15%	$88,298	Technical support during O&M includes services to monitor, evaluate, and report progress of the remedial action. This includes oversight of O&M activities, update of O&M manual, and progress reporting. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July. Middle value of the recommended range in EPA 540-R-00-002 was used.
				TOTAL:	$712,267	
				TOTAL NON-DISCOUNTED PERIODIC COST:	$712,000	
				TOTAL NON-DISCOUNTED PROJECT COST:	$4,025,000	
				TOTAL DISCOUNTED PROJECT COST:	$3,793,000	

TABLE CS-3B

Alternative 3B
Capping with a Reactive Core Mat (RCM) and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25 to 0.5-inch RCM, and a 12-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES

Notes:
CY - cubic yard   DGA - dense graded aggregate   EA - each   EPA - United States Environmental Protection Agency   GAC - granular activated carbon   LF - linear foot   LS - lump sum   POWT- publicly owned treatment works   SF - square feet   TON - Tons

General Notes:
1. Percentages used for indirect costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
2. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
3. Cost details provided in this estimate are based on professional judgment, similar project experience, knowledge of the existing conditions at the site, and costs from similar project estimates. Costs were not developed from the ground up and are instead estimated through unit costs, production and schedule assumptions, and associated project durations.
4. All assumptions, quantities, and unit prices used in this cost estimate are preliminary for the purposes of the FS and cost estimate. Cost estimates will be refined during future remedial design development efforts.
5. Remedial operations are assumed 12 hours per day, 6 days per week.
6. All costs include labor, equipment and materials, overhead and profit, general and administrative expenses and are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
7. These costs have been developed using currently available information regarding site characteristics such as site bathymetry, potential debris, physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
8. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Jacobs is not licensed as an accountant or securities attorney and, therefore, makes no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

TABLE PV-3C						
PRESENT VALUE ANALYSIS						
Alternative	3C					
Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls						
Site:	BNSF Wishram Railyard					
Location:	Wishram, Washington					
Phase:	Feasibility Study					
Base Year:	2024	Discount Rate[6]		2.0%		
Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs	Total Annual Expenditure[3]	Discount Factor (2.0%)	Present Value[4]
0	$3,707,000	$0	$0	$3,707,000	1.0000	$3,707,000
1	$0	$0	$0	$0	0.9804	$0
2	$0	$0	$0	$0	0.9612	$0
3	$0	$0	$0	$0	0.9423	$0
4	$0	$0	$0	$0	0.9238	$0
5	$0	$0	$44,039	$44,039	0.9057	$39,888
6	$0	$0	$0	$0	0.8880	$0
7	$0	$0	$0	$0	0.8706	$0
8	$0	$0	$0	$0	0.8535	$0
9	$0	$0	$0	$0	0.8368	$0
10	$0	$0	$44,039	$44,039	0.8203	$36,127
11	$0	$0	$0	$0	0.8043	$0
12	$0	$0	$0	$0	0.7885	$0
13	$0	$0	$0	$0	0.7730	$0
14	$0	$0	$0	$0	0.7579	$0
15	$0	$0	$302,952	$302,952	0.7430	$225,098
16	$0	$0	$0	$0	0.7284	$0
17	$0	$0	$0	$0	0.7142	$0
18	$0	$0	$0	$0	0.7002	$0
19	$0	$0	$0	$0	0.6864	$0
20	$0	$0	$44,039	$44,039	0.6730	$29,637
21	$0	$0	$0	$0	0.6598	$0
22	$0	$0	$0	$0	0.6468	$0
23	$0	$0	$0	$0	0.6342	$0
24	$0	$0	$0	$0	0.6217	$0
25	$0	$0	$44,039	$44,039	0.6095	$26,843
26	$0	$0	$0	$0	0.5976	$0
27	$0	$0	$0	$0	0.5859	$0
28	$0	$0	$0	$0	0.5744	$0
29	$0	$0	$0	$0	0.5631	$0
30	$0	$0	$302,952	$302,952	0.5521	$167,251
TOTALS:	$3,707,000	$0	$782,000	$4,489,000		$4,231,844
TOTAL PRESENT VALUE OF ALTERNATIVE 3 [5]						$4,232,000

Notes:

1. Period of analysis and long-term monitoring was assumed to be 30 years beyond the construction in Year 0.
2. Capital costs, for purposes of this analysis are assumed to occur in "year zero" of the project.
3. Total annual expenditure is the total cost per year with no discounting.
4. Present value is the total cost per year including a 2.0% discount factor for that year. See Table PV-ADRFT for details.
5. Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.
6. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
7. Costs are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
8. For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94 (OMB 2023). This rate represents the "real" discount rate that approximates the marginal pretax rate of return on an average investment.

TABLE CS-3

Alternative 3C
Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25-inch RCM, 6-inch-thick MAM and a 6-inch thick benthic restoration layer.

Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Capital Costs (Assumed to be Incurred During Year 0)						
1	Mobilization	LS	1	$116,000	$116,000	Includes mobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
2	Site Preparation					
2.1	Staging Area Development and Water Access	LS	1	$203,000	$203,000	Includes the construction of a 1.0-acre staging area including the placement of a 4-inch layer of gravel/DGA and a geogrid and personnel river access/docking.
2.2	Erosion and Sediment (E&S) Control	LF	960	$10.00	$9,601	Includes the installation and maintenance of upland erosion and sediment controls around the staging area during construction.
2.3	Resuspension Control System	LF	999	$130	$129,878	Includes the installation of turbidity curtains, oil booms, and anchors. Quantities assume the placement encompassing the perimeter of the remedial footprint with anchors installed every 50 feet and attached to the shoreline.
3	Temporary Facilities and Utilities	MO	2.3	$9,900	$22,483	Includes temporary facilities and utilities including on-site office trailers and supplies, jobsite sanitation, portable power, and potable water.
4	Debris Removal, Management and Disposal					
4.1	Debris Removal and Processing	AC	0.66	$72,000	$47,244	Includes the mechanical removal of surface debris and transport via tugs and scows to the offloading facility and debris offloading into the staging area for processing. Debris removal is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Debris removal operations are assumed to occur prior to cap placement. Water generated from debris processing operations is expected to be minimal and will be containerized and transported to the local POTW. Estimated quantities assume 5 tons per acre. Engineering and administrative best management practices will be employed to control turbidity during debris removal activities.
5	Cap Installation					
5.1	Sand Leveling Layer Procurement and Transport	TON	1,158	$41	$47,473	Includes procurement, transport, and delivery of sand to the Site.
5.2	Sand Leveling Layer Placement	CY	827	$94	$77,743	Includes the placement of a sand leveling layer to provide initial stability to prevent lateral movement of the cap. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods utilizing a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 6 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.
5.3	Organoclay RCM Procurement and Transport	SF	32,870	$15	$493,055	Includes procurement, transport and delivery of prefabricated RCM containing organoclay at a thickness of 3 inches. The final thickness will be determined during the design phase.
5.4	Organoclay RCM Installation	SF	32,870	$8	$262,963	Includes the transfer of the RCM from the staging area to on-water barge platform, transport of the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods with general construction equipment using roll bars from two platforms assisted by divers with an assumed 20-foot offset from the Target Area and production rate of approximately 8,500 sf per day.
5.5	6-inch MAM Procurement and Transport	SF	32,870	$15	$493,055	Includes procurement, transport, and delivery of 6-inch MAM and onsite installation of armor stone into MAMs.
5.6	6-inch MAM Installation	SF	32,870	$8	$262,963	Includes the transfer of the MAM from the staging area to on-water barge platform, transport of the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods with a crane from a single platform assisted by divers with an assumed 20-foot offset from the Target Area and production rate of approximately 1,500 sf per day.
5.7	Benthic Restoration Layer Procurement and Transport	TON	1,158	$41	$47,473	Includes procurement, transport, and delivery of sand to the Site.
5.8	Benthic Restoration Layer Placement	CY	827	$119	$98,419	Includes the placement of a benthic restoration layer (sand) to promote benthic recolonization. Includes the transfer of material from the staging area to on-water scows, transport of the material to the location of placement and in-water placement. Placement is expected to be conducted using in-water mechanical methods using general construction equipment from a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a 20-foot offset from the Target Area, placement of 6 inches of sand with a 25 percent allowable overplacement with an assumed 25 percent material loss factor.

TABLE CS-3

Alternative 3C
Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25-inch RCM, 6-inch-thick MAM and a 6-inch thick benthic restoration layer.

Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
6	Transportation and Disposal					
6.1	Debris and Construction Material, and General Refuse	TON	890	$45	$40,045	Includes T&D of debris and construction material, and general refuse via dump trucks to the Republic facility located in Roosevelt, WA.
7	Site Surveying	DY	6	$5,900	$35,400	Includes pre-construction and post-construction upland topographic and bathymetric surveys and reporting. Confirmation surveying will be conducted prior to and during capping placement. Pre- and post-processed survey data will be compared to evaluate the successful completion of remedial activities.
8	Site Restoration	LS	1	$30,000	$30,000	Includes removal of upland staging area and restoration of the area to pre-construction conditions.
9	Site Institutional Controls (ICs)	LS	1	$15,810	$15,810	Includes development and maintenance of institutional controls and community awareness activities.
10	Demobilization	LS	1	$116,000	$116,000	Includes demobilization of labor, equipment, and materials, which were assumed to be 5 percent of the total direct construction costs.
				Subtotal:	$2,550,306	
	Contingency (Scope [10%] and Bid [10%]):			20%	$510,061	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$3,060,367	
11	Project Management:			5%	$153,018	Project Management includes planning and reporting, community relations support during construction, bid or contract administration, and legal services. Percentage based multiplier were used from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
12	Remedial Design:			8%	$244,829	Remedial design includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
13	Construction Management:			6%	$183,622	Construction management includes services to manage construction or installation of the remedial action from mobilization through to demobilization. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				TOTAL:	$3,641,836	

Washington State Gross Receipts Tax (1.8%): $65,553

TOTAL DIRECT AND INDIRECT CAPITAL COSTS: $3,707,000

TABLE CS-3

Alternative 3C
Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25-inch RCM, 6-inch-thick MAM and a 6-inch thick benthic restoration layer.
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Long-term operation, monitoring and maintenance (OM&M) - Periodic Costs						
14	Long-Term Monitoring - Survey (Years 5, 10, 15, 20, 25, 30)	EA	6	$30,330	$181,980	Assumes bathymetric surveying will be conducted every 5 years for a duration of 30 years using multi-beam bathymetric survey techniques. Data will be evaluated, and the results will be included in a report. The estimated cost was calculated using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
15	Maintenance Program (Year 15, 30)	EA	2	$178,314	$356,629	The cap maintenance program is assumed to include cap maintenance activities at years 15 and 30. The cap maintenance program was calculated assuming a 10 percent multiplier of cap total direct construction costs for each maintenance event. The estimated cost for the long-term cap maintenance program was calculated and using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
				Subtotal:	$538,609	
	Contingency (Scope [10%] and Bid [10%]):			20%	$107,722	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$646,331	
16	Project Management:			6%	$38,780	Project Management includes planning and reporting, community relations support during O&M. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
17	Technical Support:			15%	$96,950	Technical support during O&M includes services to monitor, evaluate, and report progress of the remedial action. This includes oversight of O&M activities, update of O&M manual, and progress reporting. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July. Middle value of the recommended range in EPA 540-R-00-002 was used.
				TOTAL:	$782,060	

TOTAL NON-DISCOUNTED PERIODIC COST: $782,000

TOTAL NON-DISCOUNTED PROJECT COST: $4,489,000

TOTAL DISCOUNTED PROJECT COST: $4,232,000

TABLE CS-3						
Alternative 3C Capping with Reactive Core Mat (RCM) and a Marine Armor Mat (MAM) and Institutional Controls Description: Removal and transport and disposal of debris, and Installation of an active cap over the Target Area. The cap consists of the following (from bottom to top): an initial 6-inch-thick layer of sand, 0.25-inch RCM, 6-inch-thick MAM and a 6-inch thick benthic restoration layer. Site: BNSF Wishram Railyard Location: Wishram, Washington Base Year: 2024 Date: September-24						FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY
ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES

Notes:
CY - cubic yard DGA - dense graded aggregate EA - each EPA - U.S. Environmental Protection Agency GAC - granular activated carbon GON - Gondaola LF - linear foot LS - lump sum MAM - marine armor mat POWT- publicly owned treatment works SF - square feet TON - Tons RCM - reactive core mat

General Notes:
1. Percentages used for indirect costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
2. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
3. Cost details provided in this estimate are based on professional judgment, similar project experience, knowledge of the existing conditions at the site, and costs from similar project estimates. Costs were not developed from the ground up and are instead estimated through unit costs, production and schedule assumptions, and associated project durations.
4. All assumptions, quantities, and unit prices used in this cost estimate are preliminary for the purposes of the FS and cost estimate. Cost estimates will be refined during future remedial design development efforts.
5. Remedial operations are assumed 12 hours per day, 6 days per week.
6. All costs include labor, equipment and materials, overhead and profit, general and administrative expenses and are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
7. These costs have been developed using currently available information regarding site characteristics such as site bathymetry, potential debris, physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
8. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Jacobs is not licensed as an accountant or securities attorney and, therefore, makes no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

TABLE PV-4

PRESENT VALUE ANALYSIS

Alternative 4

In-Situ Stabilization (ISS), Backfill and Institutional Controls

Site: BNSF Wishram Railyard

Location: Wishram, Washington

Phase: Feasibility Study

Base Year: 2024 Discount Rate[6] 2.0%

Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs	Total Annual Expenditure[3]	Discount Factor (2.0%)	Present Value[4]
0	$4,722,000	$0	$0	$4,722,000	1.0000	$4,722,000
1	$0	$0	$0	$0	0.9804	$0
2	$0	$0	$0	$0	0.9612	$0
3	$0	$0	$0	$0	0.9423	$0
4	$0	$0	$0	$0	0.9238	$0
5	$0	$0	$44,767	$44,767	0.9057	$40,547
6	$0	$0	$0	$0	0.8880	$0
7	$0	$0	$0	$0	0.8706	$0
8	$0	$0	$0	$0	0.8535	$0
9	$0	$0	$0	$0	0.8368	$0
10	$0	$0	$44,767	$44,767	0.8203	$36,725
11	$0	$0	$0	$0	0.8043	$0
12	$0	$0	$0	$0	0.7885	$0
13	$0	$0	$0	$0	0.7730	$0
14	$0	$0	$0	$0	0.7579	$0
15	$0	$0	$44,767	$44,767	0.7430	$33,263
16	$0	$0	$0	$0	0.7284	$0
17	$0	$0	$0	$0	0.7142	$0
18	$0	$0	$0	$0	0.7002	$0
19	$0	$0	$0	$0	0.6864	$0
20	$0	$0	$44,767	$44,767	0.6730	$30,127
21	$0	$0	$0	$0	0.6598	$0
22	$0	$0	$0	$0	0.6468	$0
23	$0	$0	$0	$0	0.6342	$0
24	$0	$0	$0	$0	0.6217	$0
25	$0	$0	$44,767	$44,767	0.6095	$27,287
26	$0	$0	$0	$0	0.5976	$0
27	$0	$0	$0	$0	0.5859	$0
28	$0	$0	$0	$0	0.5744	$0
29	$0	$0	$0	$0	0.5631	$0
30	$0	$0	$44,767	$44,767	0.5521	$24,715
TOTALS:	$4,722,000	$0	$269,000	$4,991,000		$4,914,664
TOTAL PRESENT VALUE OF ALTERNATIVE 4[5]						$4,910,000

Notes:

1. Period of analysis and long-term monitoring was assumed to be 30 years beyond the construction in Year 0.
2. Capital costs, for purposes of this analysis are assumed to occur in "year zero" of the project.
3. Total annual expenditure is the total cost per year with no discounting.
4. Present value is the total cost per year including a 2.0% discount factor for that year. See Table PV-ADRFT for details.
5. Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.
6. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
7. Costs are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
8. For Federal facility sites, it is generally appropriate to apply the "real" discount rates found in Appendix C of OMB Circular A-94 (OMB 2023). This rate represents the "real" discount rate that approximates the marginal pretax rate of return on an average investment.

TABLE CS-4

Alternative 4
In-Situ Stabilization (ISS), Backfill and Institutional Controls

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

Description: Removal and transport and disposal of debris in the Target Area followed by in-situ stabilization and placement of backfill (amended with organoclay and GAC).
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Capital Costs (Assumed to be Incurred During Year 0)						
1	Mobilization	LS	1	$271,000	$271,000	Includes mobilization of labor, equipment, and materials, which were assumed to be 10 percent of the total direct construction costs.
2	Site Preparation					
2.1	Staging Area Development	LS	1	$201,750	$201,750	Includes the construction of a 1.0-acre staging area including the placement of a 4-inch layer of gravel/DGA and a geogrid and personnel river access/docking.
2.2	Erosion and Sediment (E&S) Control	LF	960	$10	$9,601	Includes the installation and maintenance of upland erosion and sediment controls around the staging area during construction.
2.3	Resuspension Control System	LF	854	$130	$111,080	Includes the installation of turbidity curtains, oil booms, and anchors. Quantities assume the placement encompassing the perimeter of the remedial footprint with anchors installed every 50 feet and attached to the shoreline.
3	Temporary Facilities and Utilities	MO	2.7	$9,900	$26,293	Includes temporary facilities and utilities including on-site office trailers and supplies, jobsite sanitation, portable power, and potable water.
4	Debris Removal, Management and Disposal					
4.1	Debris Removal and Processing	AC	0.44	$72,000	$31,759	Includes the mechanical removal of surface and subsurface debris, transport via tugs and scows to the offloading facility and debris offloading into the staging area for processing. Debris removal is assumed to be conducted using in-water mechanical methods utilizing a single barge platform. Debris removal operations are assumed to occur prior to in-situ stabilization operations. Water generated from debris processing operations will be containerized and transported to the local POTW. Estimated quantities assume 5 tons per acre. Engineering and administrative best management practices will be employed to control turbidity during debris removal activities.
5	In-Situ Stabilization					
5.1	Field Demonstration Stabilization Agent Procurement and Trans	TON	313	$192	$60,000	Includes procurement, transport, and delivery of Portland cement to the Site to conduct the field demonstration. Quantity assumes a footprint of 5,625 sf with an in-situ sediment stabilization volume of 2,100 cy. Portland cement is assumed at 10 percent by weight of the in-situ stabilization volume.
5.2	Field Demonstration In-situ Stabilization Operations	CY	2,329	$188	$437,927	Includes In-situ stabilization using auger rigs on a single barge platform to mechanically mix reagent into the overlying sediment and the NAPL impacted sediment, creating an array of overlapping, cement-like columns extending from the surface to 10 feet bss.
5.3	Full-Scale Stabilization Agent Procurement and Transport	TON	755	$192	$144,952	Includes procurement, transport, and delivery of Portland cement to the Site to conduct the full scale in-situ stabilization. Quantity assumes a footprint of approximately 13,590 sf with an in-situ sediment stabilization volume of 5,050 cy. Portland cement is assumed at 10 percent by weight of the in-situ stabilization volume.
5.4	Full-Scale In-situ Stabilization Operations	CY	5,627	$188	$1,057,970	Includes In-situ stabilization using auger rigs on a single barge platform to mechanically mix reagent into the overlying sediment and the NAPL impacted sediment, creating an array of overlapping, cement-like columns extending from the surface to 10 feet bss. Grout plants and mixing equipment is assumed on the platform.
6	Transportation and Disposal (T&D)					
6.1	Debris and Construction Material, and General Refuse	TON	885	$45	$39,834	Includes T&D of debris and construction material, and general refuse via dump trucks to the Republic facility located in Roosevelt, WA.
7	Backfill					
7.1	Sand Procurement and Transport	TON	778	$41	$31,913	Includes the procurement, transport, and delivery of sand to the Site.
7.2	Organoclay Procurement and Transport	TON	39	$7,400	$287,991	Includes procurement, transport, and delivery of organoclay to the Site.
7.3	GAC Procurement and Transport	TON	23	$3,000	$70,052	Includes procurement, transport, and delivery of GAC to the Site.
7.4	Backfill Blending Operations	CY	656	$30	$19,678	Includes the on-site blending of sand, organoclay and GAC in the staging area.

TABLE CS-4

Alternative 4
In-Situ Stabilization (ISS), Backfill and Institutional Controls

Description: Removal and transport and disposal of debris in the Target Area followed by in-situ stabilization and placement of backfill (amended with organoclay and GAC).
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
7.5	Backfill Placement	CY	656	$120	$78,712	Includes the transfer of backfill material from the staging area to on-water scows, transport of the backfill material to the location of placement and placement of the backfill. Placement operations would be conducted following the successful confirmation of in-situ stabilization operation. Backfill placement is assumed to be conducted using in-water mechanical methods utilizing from a single platform with an assumed production rate of approximately 250 cy per day. Estimated quantities assume a minimum 6-inch-thick layer of sand/GAC/organoclay with 25 percent allowable overplacement with an assumed 25 percent material loss factor. Backfill amendment assumes a combination of organoclay (5 percent by weight) and GAC (3 percent by weight) to address residual remaining concerns of sheen generating NAPL.
8	Site Surveying	DY	5	$5,900	$29,500	Includes pre-construction and post-construction upland topographic and bathymetric surveys and reporting. Pre- and post-processed survey data will be compared to evaluate the successful completion of remedial activities.
9	Site Restoration	LS	1	$50,000	$50,000	Includes removal of upland staging area and restoration of the area to pre-construction conditions.
10	Site Institutional Controls (ICs)	LS	1	$15,810	$15,810	Includes development and maintenance of institutional controls and community awareness activities.
11	Demobilization	LS	1	$271,000	$271,000	Includes demobilization of labor, equipment, and materials, which were assumed to be 10 percent of the total direct construction costs.
				Subtotal:	$3,248,521	
	Contingency (Scope [10%] and Bid [10%]):			20%	$649,704	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$3,898,225	
12	Project Management:			5%	$194,911	Project Management includes planning and reporting, community relations support during construction, bid or contract administration, and legal services. Percentage based multiplier were used from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
13	Remedial Design:			8%	$311,858	Remedial design includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
14	Construction Management:			6%	$233,893	Construction management includes services to manage construction or installation of the remedial action from mobilization through to demobilization. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				TOTAL:	$4,638,887	
	Washington State Gross Receipts Tax (1.8%):				$83,500	
	TOTAL DIRECT AND INDIRECT CAPITAL COSTS:				$4,722,000	

TABLE CS-4

Alternative 4
In-Situ Stabilization (ISS), Backfill and Institutional Controls

Description: Removal and transport and disposal of debris in the Target Area followed by in-situ stabilization and placement of backfill (amended with organoclay and GAC).
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
Date: September-24

FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES
Long-term operation, monitoring and maintenance (OM&M) - Periodic Costs						
15	Long-Term Monitoring - Survey (Years 5, 10, 15, 20, 25, 30)	EA	6	$30,330	$181,980	Assumes bathymetric surveying will be conducted every 5 years for a duration of 30 years using multi-beam bathymetric survey techniques. Data will be evaluated, and the results will be included in a report. The estimated cost was calculated using the present worth analysis process outlined by the U.S. Environmental Protection Agency (USEPA, July 2000) using a discount rate of 2.0 percent.
				Subtotal:	$181,980	
	Contingency (Scope [10%] and Bid [10%]):			20%	$36,396	A contingency allowance has been included to account for unforeseen circumstances or variability such as quantities, labor, material costs, construction modifications, change orders and claims to cover bid and scope contingency. Due to the high levels of uncertainty at the feasibility stage, a 20 percent multiplier has been assumed on total project costs. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
				Subtotal:	$218,376	
16	Project Management:			8%	$17,470	Project Management includes planning and reporting, community relations support during O&M. Percentage based multiplier from Exhibit 5-8 detailed in the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July.
17	Technical Support:			15%	$32,756	Technical support during O&M includes services to monitor, evaluate, and report progress of the remedial action. This includes oversight of O&M activities, update of O&M manual, and progress reporting. Percentage based multiplier from the following reference: EPA 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002. July. Middle value of the recommended range in EPA 540-R-00-002 was used.
				TOTAL:	$268,602	

TOTAL NON-DISCOUNTED PERIODIC COST:	$269,000
TOTAL NON-DISCOUNTED PROJECT COST:	$4,991,000
TOTAL DISCOUNTED PROJECT COST:	$4,910,000

TABLE CS-4

Alternative 4
In-Situ Stabilization (ISS), Backfill and Institutional Controls

Description: Removal and transport and disposal of debris in the Target Area followed by in-situ stabilization and placement of backfill (amended with organoclay and GAC).
Site: BNSF Wishram Railyard
Location: Wishram, Washington
Base Year: 2024
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FEASIBILITY STUDY DETAILED COST ESTIMATE SUMMARY

ITEM NO.	DESCRIPTION	UNIT	NO. OF UNITS	UNIT COST	ESTIMATED COST	NOTES

Notes:

bss - below sediment surface CY - cubic yard DGA - dense graded aggregate EA - each EPA - United States Environmental Protection Agency GAC - granular activated carbon LF - linear foot LS - lump sum SF - square feet TON - Tons

General Notes:

1. Percentages used for indirect costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
2. Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.
3. Cost details provided in this estimate are based on professional judgment, similar project experience, knowledge of the existing conditions at the site, and costs from similar project estimates. Costs were not developed from the ground up and are instead estimated through unit costs, production and schedule assumptions, and associated project durations.
4. All assumptions, quantities, and unit prices used in this cost estimate are preliminary for the purposes of the FS and cost estimate. Cost estimates will be refined during future remedial design development efforts.
5. Remedial operations are assumed 12 hours per day, 6 days per week.
6. All costs include labor, equipment and materials, overhead and profit, general and administrative expenses and are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
7. These costs have been developed using currently available information regarding site characteristics such as site bathymetry, potential debris, physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
8. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Jacobs is not licensed as an accountant or securities attorney and, therefore, makes no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.