UPLANDS CLEANUP ACTION PLAN

BNSF Wishram Railyard
(Ecology Site Name: BNSF Track Switching Facility)
Facility Site 1625461, Cleanup Site 230

November 2024

Prepared by Kennedy Jenks Consultants
Under Agreed Order DE 12897

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List of Acronyms

Acronym	Description
%/day	Percent per day
8 metals	arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver
amsl	above mean sea level
AO	Agreed Order
API	American Petroleum Institute
ARAR	applicable, relevant, and appropriate requirement
AS/SVE	air sparge/soil vapor extraction
AST	aboveground storage tank
bgs	below ground surface
BNSF	BNSF Railway Company
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Cleanup Action Plan
CCH	Center for Contaminant Hydrology
CH_4	methane
CLARC	Cleanup Levels and Risk Calculation
CMP	Compliance Monitoring Plan
CO_2	Carbon dioxide
COC	constituent of concern
cP	centipoise
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CPOC	conditional point of compliance
CRMP	cultural resources management plan
CSM	conceptual site model
CUL	cleanup level
CWA	Clean Water Act
DAHP	Washington State Department of Archaeology and Historic Preservation
DCAP	draft Cleanup Action Plan
DO	dissolved oxygen
DQO	data quality objective
DRO	diesel-range organics
ECs	engineering controls
Ecology	Washington State Department of Ecology

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Acronym	Description
EDB	ethylene dibromide
EDC	1,2-dichloroethane
EDR	Engineering Design Report
ENB	Eastern LNAPL Body
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
ERH	electrical resistive heating
Fire District #11	Klickitat County Fire Protection District #11
FS	feasibility study
ft/day	feet per day
GRO	gasoline-range organics
ICs	institutional controls
IRM	interim remedial measure
JARPA	Joint Aquatic Resources Permit Application
KJ	Kennedy/Jenks Consultants, Inc.
LDRM	LNAPL Distribution and Recovery Model
LIF	laser-induced fluorescence
LNAPL	light non-aqueous phase liquid
LTTR	Low-Temperature Thermal Removal
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NA	natural attenuation
NSZD	natural source zone depletion
O&M	Operations and Maintenance
O_2	Atmospheric oxygen
OHM	oil head monitoring
ORO	oil-range organics
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PLC	programmable logic controller
PLP	Potentially Liable Person
POTW	Publicly Owned Treatment Works

Acronym	Description
PQL	practical quantitation limit
PVC	polyvinyl chloride
PVI	petroleum vapor intrusion
QA/QC	Quality assurance/quality control
RAIS	Risk Assessment Information System
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
REL	Remediation Level
RGW	reconnaissance groundwater
RI	remedial investigation
SAP	Sampling and Analysis Plan
SCEM	site conceptual exposure model
site	Ecology Site Name: BNSF Track Switching Facility
SP&S	Spokane, Portland, and Seattle Railway
SVOCs	semi-volatile organic compounds
TCLP	toxicity characteristic leaching procedure
TEAs	Terminal Electron receptors
TEE	terrestrial ecological evaluation
TPH	Total Petroleum Hydrocarbons
TPH-Dx	Total Petroleum Hydrocarbons as Diesel and Oil Extended
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code
WNB	Western LNAPL Body (WNB)

Section 1: Introduction

This Cleanup Action Plan (CAP) presents the Washington State Department of Ecology's (Ecology) proposed cleanup action for the uplands portion of the BNSF Railway Company (BNSF) Wishram Railyard (Ecology Site Name: BNSF Track Switching Facility) (site) (Facility Site #1625461, Cleanup Site #230), generally located at 500 Main Street in Wishram, Klickitat County, Washington (Figure 1-1). This CAP is required as part of the site cleanup process under the Model Toxics Control Act (MTCA), Ch. 70.105D Revised Code of Washington (RCW), implemented by Ecology.

The cleanup action decision is based on the *Uplands Remedial Investigation Report, BNSF Wishram Railyard (Ecology Site Name BNSF Track Switching Facility) Wishram, Washington* (Uplands RI Report) (Kennedy/Jenks Consultants, Inc. [KJ] 2020) and the *Uplands Feasibility Study Report, BNSF Wishram Railyard (Ecology Site Name BNSF Track Switching Facility) Wishram, Washington* (Uplands FS Report) (KJ 2022) in the administrative record. The BNSF has been named as a potentially liable person (PLP) by Ecology. The PLP completed site investigation activities under Agreed Order No. 12897.

Washington Administrative Code (WAC) 173-340-380 in the MTCA regulation describes the required elements of a CAP. In compliance with these requirements, this CAP:

- Describes the site.
- Summarizes current site conditions.
- Summarizes the cleanup action alternatives considered in the remedy selection process.
- Describes the selected cleanup action for the site and the rationale for selecting this alternative.
- Identifies site-specific cleanup levels (CULs) and points of compliance (POCs) for each site-related constituent of concern (COC) and medium of concern for the proposed cleanup action.
- Identifies applicable state and federal laws for the proposed cleanup action.
- Identifies residual impacts remaining on the site after cleanup and restrictions on future uses and activities at the site to protect of human health and the environment.
- Discusses compliance monitoring requirements.
- Presents the schedule for implementing the CAP.

1.1 Declaration

Ecology has made a preliminary determination that a cleanup conducted in conformance with this CAP will comply with the requirements for selection of a remedy under WAC 173-340-360.

1.2 Applicability

Cleanup standards specified in this CAP are applicable only to the BNSF Wishram Railyard. They were developed as a part of an overall remediation process under Ecology oversight using the authority of MTCA and should not be considered as setting precedents for other sites.

1.3 Administrative Record

The documents used to make the decisions presented in this CAP are on file in the administrative record for the site. Major documents are listed in the reference section. The entire administrative record for the site is available for public review by appointment at Ecology's Central Regional Office, located at 250 West Alder Street, Union Gap, WA 98903-0009. Results from applicable studies and reports are summarized to provide background information pertinent to the CAP. These studies and reports include:

- Uplands RI Report (KJ 2020)
- Uplands FS Report (KJ 2022)

1.4 Cleanup Process

Cleanup conducted under the MTCA process requires the PLP(s) or Ecology to prepare specific documents. These procedural tasks and resulting documents, along with the MTCA section requiring their completion, are listed below with a brief description of each task.

- Public Participation Plan (WAC 173-340-600) — summarizes the methods that will be implemented to encourage coordinated and effective public involvement. Ecology prepares this document.
- Remedial Investigation and Feasibility Study (WAC 173-340-350) — documents the investigations and evaluations conducted at the site from the discovery phase to the RI/FS document. The RI collects and presents information on the nature and extent of site-related constituent impacts and the risks posed by the impacts. The FS presents and evaluates site cleanup alternatives and may propose a preferred cleanup alternative. The documents are usually prepared by the PLP(s), accepted by Ecology, and undergo public comment.
- Cleanup Action Plan (CAP) (WAC 173-340-380) — sets cleanup standards for the site and selects the cleanup actions intended to achieve the cleanup standards. Ecology issues the document, and it undergoes public comment.
- Engineering Design Report, Construction Plans and Specifications (WAC 173-340-400) – outlines details of the selected cleanup action, including engineered systems and design components from the CAP. These may include construction plans and specifications with technical drawings. The PLP(s) usually prepare the document, and Ecology approves it. Public comment is optional.
- Operation and Maintenance Plan(s) (WAC 173-340-400) — summarizes the requirements for inspection and maintenance of remediation operations. They include actions required to operate and maintain equipment, structures, or other remedial

systems. The PLP(s) usually prepare the document, and Ecology approves it.

- Cleanup Action Report (WAC 173-340-400) — provides details on the cleanup activities along with documentation of adherence to or variance from the CAP following implementation of the cleanup action. The PLP(s) usually prepare the document, and Ecology approves it.
- Compliance Monitoring Plan (WAC 173-340-410) — details the monitoring activities required to confirm the cleanup action is performing as intended. The PLP(s) usually prepare the document, and Ecology approves it.

Section 2: Site Description

2.1 Physical Site Characteristics

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 where RI activities are focused (i.e., the “site”), is located at the western end (approximately 1,100 feet) of the yard, covering an area of approximately 6 to 10 acres. The site location is shown on Figure 1-1. Current onsite structures include storage buildings, a maintenance shop (office and tool storage), two mainline tracks, and active rail spurs. Current and historical site features are shown on Figures 2-1 and 2-2.

The site is bounded by the town of Wishram to the north, the classification portion of the railyard to the east, the Columbia River to the south and southwest, and railroad right-of-way to the west. The size of the railyard and the location of the Columbia River, which is the southern boundary of the railyard, have changed over time. In 1957, the U.S. Army Corps of Engineers (USACE) completed construction of The Dalles Dam, a hydroelectric dam just upstream of The Dalles, Oregon. Construction of the dam created Lake Celilo, a 24-mile-long reservoir on the Columbia River. In the vicinity of the railyard, the surface water elevation rose by approximately 40 feet in just a few days, inundating formerly dry land for more than 250 feet perpendicular to the former riverbank. Therefore, historical railyard upland was inundated by the formation of Lake Celilo.

The rising water elevation that created Lake Celilo also significantly altered groundwater elevations and flow conditions beneath the railyard. Operation of the hydroelectric dam results in daily fluctuations in the surface water elevation, influencing groundwater flow beneath the site.

The site is relatively flat, with a surface elevation of approximately 175 feet above mean sea level (amsl), ranging from 171 feet amsl just north of the berm area to 180 feet amsl near the location of the former 30,000-barrel oil aboveground storage tank (AST). The surface elevation changes approximately 1 to 2 feet from east to west across the site. North of the railyard, beyond the site boundary, surface elevations increase steeply to highway 14 at approximately 600 feet amsl.

The region is semi-arid, receiving a 30-year normal annual precipitation of 12 to 16 inches (PRISM 2021). The majority of the precipitation occurs in late fall through early spring; precipitation is mostly in the form of rain. Summers are warm and dry. The annual mean temperature is between 61 and 64˚F (PRISM 2021).

2.2 Site History

The Wishram Railyard was originally developed by the Spokane, Portland, and Seattle (SP&S) Railway between 1910 and 1912. Existing and historical site features are shown on Figures 2-1 and 2-2. The primary use of the railyard was, and remains, railcar switching. Historically, industrial activities (locomotive fueling and watering, fuel storage, and engine and car repairs) occurred in the westernmost portion of the railyard (i.e., the site) including the Mainline Track Area, South of Mainline Track Area, and Former Engine House/Machine Shop Area, and Berm Area, covering an area of approximately 6 to 10 acres, as shown on Figure 2-1. The eastern portion of the site refers to the area east of the former Signal Office and former Oil House and near a former septic drainage field, as shown on Figure 2-2. A detailed history of the Wishram Railyard was included in the Uplands RI Report (KJ 2020) and is summarized below.

Historical Fueling Operations

Steam locomotive fueling using oil was conducted at the site from approximately 1912 through 1956. Fueling facilities included a 30,000-barrel oil AST located north of the mainline tracks, an Elevated Oil Service 28,000-gallon AST located south of the mainline tracks, an oil unloading trough east of the Power House, a concrete sump, as well as associated appurtenances and piping (Figures 2-1 and 2-2). The oil ASTs and appurtenances were removed circa-1957 after the transition to diesel-fueled locomotives in the early 1950s.

Diesel locomotives were fueled at the site from the early 1950s to the late 1970s. Diesel fueling was performed along a fueling spur and at a concrete fueling island (installed in 1949), located north and south, respectively, of the mainline tracks. The diesel fuel was initially stored in one 15,000 gallon and one 20,000-gallon underground storage tanks (USTs). In the late 1950s, diesel was stored in two 100,000-gallon ASTs (constructed in or after 1955) located northwest of the Maintenance Shop. Diesel fuel was transferred to and from the tanks by underground piping. The 100,000-gallon diesel ASTs were removed and fueling ceased at the site during the late 1970s. Based on available records in BNSF's internal UST database, the majority of the remaining tanks were removed in or prior to 1988.

Historical Maintenance Operations

Locomotives underwent maintenance and repairs in the former Engine House/Machine Shop. The former Engine House was constructed in 1911 as a rectangular run-through style building and underwent multiple additions until reaching its maximum footprint size in the 1940s (Figure 2-1). The former Engine House was demolished in the 1980s after it was no longer needed. Railcar repairs were performed in an area consisting of three tracks and the former (Car) Repair Shop, located to the southeast of the former Engine House/Machine Shop. The car repair shop building was removed in 1960.

Septic Drainage Field

A former septic drainage (leach) field and five septic tanks, located approximately 600 feet to the northeast of the former Engine House (Figure 2-2), was identified on a station layout map from 1959. Historical maps indicate that the septic system and drainage field treated and discharged wastewater generated on the railyard, as well as wastewater generated by the City of Wishram (single-family homes, a hotel, restaurant, etc.) starting sometime before 1962 and ceasing prior to 1996.

2.3 Cultural Resources Monitoring

The site is situated within the Columbia Hills Archaeological District as designated by the Washington State Department of Archaeology and Historic Preservation (DAHP), in a culturally significant area due to its proximity to Celilo Falls. The Geoarchaeological Monitoring of Additional Remedial Investigations report (Jacobs 2018) provides a detailed description of the historical background of the site and its potential cultural resources. A cultural resources management plan (CRMP) (AECOM 2016) was developed to establish protocols for managing cultural resources. The CRMP was submitted to the DAHP and the Confederated Tribes and Bands of the Yakama Nation. Subsurface investigative activities conducted in 2016 and 2018 were completed in accordance with the CRMP. Intrusive activities were performed under permit from DAHP.

The upland site is adjacent to Lake Celilo, which is part of a Treaty Indian Fishery. The Treaties of 1855 between the United States and the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, and the Nez Perce Tribe reserve and guarantee the fishing rights of these entities within Zone 6 of the Columbia River.

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 directly across the Columbia River on the Oregon shore. Fisheries in this area of the main stem Columbia River (designated “Zone 6”) are comanaged among the Yakama Nation and the states of Washington and Oregon under a 2008 U.S. District Court order (Ecology and BNSF, 2015).

Section 3: Uplands Remedial Investigations and Interim Remedial Actions

This section presents a summary of investigation activities, site geology and hydrogeology, sampling, field and laboratory analyses, and methodologies conducted between 2002 and 2020. A complete description of current site conditions is included in the Uplands RI Report (KJ 2020). Site conditions are briefly summarized below.

3.1 Field Investigations

Investigation activities were initiated onsite in 2002 to evaluate potential impacts to subsurface soils and groundwater from historical railyard activities. BNSF performed voluntary independent investigative and remedial actions through 2015. Site investigation and interim remedial activities included excavating and disposing soil containing petroleum hydrocarbons, removing and disposing former USTs, collecting soil and groundwater samples, conducting a laser-induced fluorescence (LIF) survey, and investigating light non-aqueous phase liquid (LNAPL) mobility in the vicinity of the former Power House. An air sparge/soil vapor extraction system was installed in early 2012, and was converted to a bioventing system in June 2012, to address residual hydrocarbon impacts in soil north and west of the Maintenance Shop. Operation of the bioventing system continued through July 2019. Areas where interim remedial actions were completed are shown on Figure 3-1.

BNSF and Ecology entered into an Agreed Order (AO) (No. 12897) in 2015 to complete the RI and FS. Field activities performed under the AO were substantially conducted between August 2016 and August 2020 and included collection of soil and groundwater samples, installation of groundwater monitoring wells, installation of four oil head monitoring (OHM) wells, collection of LNAPL samples for mobility testing, monthly inspections of the nearshore Columbia River surface from the bank, collection of oil sheen/oil droplet samples from the surface of the Columbia River, and investigation of the presence and extent of LNAPL impacts in the nearshore inundated lands bordering the site. Soil borings and groundwater monitoring from 2002 through 2020 are shown on Figures 3-2 and 3-3. Additional field activities to aid in the feasibility evaluation of remediation alternatives were conducted between July and September 2019 and reported in the Uplands RI Report (KJ 2020) and Uplands FS Report (KJ 2022). Evaluations of groundwater flow conditions beneath and in the vicinity of the site, as well as the potential migration of dissolved hydrocarbons from the site to the Columbia River were also conducted as part of the RI activities and are summarized in the Uplands RI Report (KJ 2020).

3.2 Site Geology

The site lies on the northern bank of the Columbia River. Prior to damming of the river in 1957 (The Dalles Dam), significant erosion and deposition of sediments occurred along the Columbia River associated with seasonal flow conditions. The majority of soils beneath the site were imported from other areas along the Columbia River (Grande 1992; Austin and Dill 1996) during development of the railyard. Fill material, comprised primarily of poorly graded fine to medium sand and gravel, is commonly encountered from ground surface to approximately 28 feet below ground surface (bgs). Native fine to medium sands and silts are generally encountered from

28 feet bgs to the top of bedrock, which can be encountered as deep as 80 feet bgs. Based on available references and surrounding geologic outcroppings, bedrock beneath the site is composed of flood basalts of the Columbia River Plateau.

3.3 Site Hydrogeology

Hydrogeologic conditions at the site are controlled by seasonal variation in groundwater recharge and short-term (hourly to daily) variations in the adjacent Columbia River stage. Daily oscillations in the Columbia River stage (typically 1 to 2 feet) occur due to variable discharge rates from The Dalles Dam, located downstream of the site. Both seasonal and daily stage variations can result in temporal reversals in the groundwater flow regime. During groundwater level monitoring events conducted in site wells prior to the RI, conditions of groundwater flowing toward the Columbia River and, during times of lower groundwater recharge, groundwater flowing away from the river toward the upland were observed.

A study of groundwater flow conditions on the site was performed based on approximately 45 months (3.75 years) of groundwater elevation data (collected from December 2016 to April 2017 and from March 2019 to August 2021) recorded every 2 hours using pressure transducers installed in select monitoring wells and the Columbia River. The results of these studies suggest a losing stream condition (i.e., net flux of water from the Columbia River to the site) occurs during the summer, fall, and winter months across the site, and a gaining stream condition (i.e., net flux of groundwater from the site to the Columbia River) occurs in the spring months for a majority of the wells. Over the two monitoring periods, a losing stream condition is observed more than 80 percent of the time in wells along the river berm. Site groundwater discharges to surface water in the Columbia River during a very limited portion of the year. Therefore, transport of site-related constituents offsite to the river is limited.

Groundwater level gauging has been conducted since 2003. The depth to water across the site is typically 10 to 12 feet bgs in the railyard and 14 to 16 feet bgs on the berm. Based on the long-term continuous monitoring data set, daily fluctuations in groundwater levels in berm wells are typically 0.3 to 0.4 feet, with a maximum range in groundwater elevations of 2 to 4 feet overall. The effect of oscillating Columbia River water levels on groundwater levels is dampened further upland in the railyard, with typical daily fluctuations of 0.05 foot per day and a maximum range in groundwater elevations of 1 to 2 feet.

Rising and falling head slug tests were conducted in 12 shallow and 3 deep monitoring wells to assess the hydraulic conductivity of the saturated zone. Slug test data were analyzed with AQTESOLV processing software using standard solution methods for unconsolidated water-table aquifers. Estimated horizontal hydraulic conductivity values for the site wells ranged between 0.2 feet per day (ft/day) at well WMW-26 to 652.5 ft/day at well WMW-22. The site geometric mean hydraulic conductivity was 6.39 ft/day.

3.4 Laboratory Analytical Methods

Soil and groundwater samples collected between 2002 and 2020 were typically submitted for one or more of the following analyses to evaluate the presence of site-related constituents: petroleum hydrocarbons as gasoline-, diesel- and oil-range organics (GRO, DRO, and ORO), benzene, toluene, ethylbenzene and total xylenes (BTEX), volatile organic compounds (VOCs), Resource Conservation and Recovery Act (RCRA) 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs). Total petroleum hydrocarbons – diesel range fraction (TPH-Dx) concentrations were calculated from the sum of DRO and ORO results.

Ten soil samples were also analyzed for extractable petroleum hydrocarbons (EPH) and four soil samples were submitted for analysis of select metals by the toxicity characteristic leaching procedure (TCLP) for waste profiling purposes.

Soil core samples were collected in 2013 and 2016 for LNAPL mobility analyses including initial pore fluid saturations, total porosity, air-filled porosity, grain density, dry bulk density, moisture content, air/water drainage capillarity, air permeability, hydraulic conductivity, free product mobility testing, residual saturation estimation, and effective porosity.

Monitoring well groundwater samples were also analyzed for general chemistry and natural attenuation parameters including nitrate/nitrite, ammonia, sulfate, sulfide, dissolved iron and manganese, alkalinity, and methane. Field groundwater quality parameters including dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, pH, and specific conductance were measured during well purging activities.

LNAPL samples collected from temporary wells and OHM wells were submitted for one or more of the following chemical analyses: DRO and ORO, VOCs, total metals (RCRA 8 plus copper, nickel, and zinc), PCBs, and EPH. Samples of LNAPL were also submitted for physical properties including dynamic viscosity, fluid density, and specific gravity at three temperatures and surface and interfacial tensions.

3.5 Soil Investigations

A total of 375 soil samples and seven field duplicate samples were collected from a combination of 175 soil borings advanced on site between 2002 and 2018 (311 samples) and discrete excavation confirmation samples collected between 2002 and 2010 (71 samples). Soil boring locations are shown on Figures 3-2 and 3-3.

Independent investigation activities conducted between 2002 and 2015 included advancing 92 soil borings and collecting 148 soil samples. These investigations were generally focused on delineating soil impacts and guiding interim remedial actions (e.g., excavations of impacted vadose zone soil) in the vicinity of former refueling or industrial activities in the Mainline Track Area (former Boiler House and Maintenance Shop) and South of Mainline Track Area (former fueling areas, diesel and oil pipelines, and petroleum ASTs and USTs, and former Power House). Thirteen of the soil samples were collected from nine soil borings advanced at locations where soil was subsequently excavated during interim remedial actions.

Soil investigations completed for the RI between 2016 and 2018 included advancing 83 soil borings and collecting 163 soil samples, including 7 field duplicate samples. The RI soil investigation objective was to evaluate data gaps in areas of the site where petroleum hydrocarbon compounds or other constituents were potentially used, stored, or distributed to assess potential impacts to site media. These areas included the former Transformer Storage

Area (for potential presence of PCBs in soil), former UST areas, former AST areas including the former 30,000-barrel Oil AST, two former Oil Houses used for oil storage, two former Repair Shops, the former Wash Rack, around the former Engine House/Machine Shop, along the berm, and the former septic drainage field.

Soil Sampling Results

Soil samples were analyzed for one or more of the analyses listed in Section 3.4. MTCA Method A and Method B Cancer and Noncancer CULs were used as screening values for chemicals reported in soil samples during the RI.

Site-related constituents of concern in soil include benzene, GRO, DRO, ORO, total petroleum hydrocarbons – diesel range fraction (sum of DRO and ORO results) expressed as TPH-Dx, and PAHs, based on reported concentrations above applicable CULs.

GRO was reported at concentrations above its MTCA Method A CUL in 12 out of 53 samples, localized near two former 500-gallon gasoline USTs (southwest of the Maintenance Shop) and a former gasoline UST near the former Power House. Benzene was reported infrequently (in two out of 177 samples) at concentrations above MTCA Method A CULs and is considered a site-related constituent of concern associated with GRO.

VOCs typically associated with gasoline (BTEX compounds), which typically pose the greatest potential risk to receptors, are present above MTCA Method A CULs in only two of 177 soil samples (benzene only). Fuel additives 1,2-dibromoethane [ethylene dibromide (EDB)] and 1,2-dichloroethane (EDC) were not reported above laboratory reporting limits in 128 soil samples collected and analyzed for these constituents. Chlorinated solvents and other VOCs were not reported at concentrations above MTCA Method A CULs in 177 soil samples tested. The relative absence of VOCs and the lack of buildings in or near impacted areas indicates vapor intrusion is an incomplete exposure pathway under current site conditions.

DRO and/or ORO and TPH-Dx were reported in unsaturated soils at concentrations above the MTCA Method A CUL at a single sample location in the footprint of the former Engine House/Machine Shop, samples from seven locations near the Maintenance Shop and former Boiler House, and three locations south of the mainline tracks. Soil with DRO and ORO at concentrations above the MTCA Method A CUL were reported in a sample from boring B-16-01 in 2016, DRO and/or ORO and TPH-Dx were reported in saturated soils at concentrations above the MTCA Method A CULs in the vicinity of the Maintenance Shop, south and east of former diesel and oil fueling operations, in the vicinity of former underground oil pipelines, and in the vicinity of the former Power House.

PAHs, including carcinogenic PAHs (cPAHs) which were used to calculate Total cPAHs, were reported above applicable MTCA Method A or B CULs in less than 10 percent of soil samples. PAHs above MTCA Method A CULs are associated with samples that contained DRO and ORO above MTCA Method A CULs.

Lead was reported below its MTCA Method A CULs in 125 soil samples and above the CUL in one sample collected in 2003. Lead was not reported above the CUL in two soil samples collected from a 2018 boring located adjacent to the 2003 sample location. Lead is not considered a site-related constituent of concern in soil. The other RCRA metals (arsenic, barium, cadmium, chromium, mercury, selenium, and silver) were not detected above CULs in soil samples.

3.6 Groundwater Investigations

A total of 525 groundwater samples including 59 field duplicates were collected from monitoring wells and temporary wells [reconnaissance groundwater (RGW) samples] between 2003 and 2020. The total includes 400 groundwater samples and 56 field duplicates from 37 monitoring wells and 66 RGW samples and 3 field duplicates from 62 temporary wells (Figures 3-2 and 3-3).

The permanent and temporary monitoring wells were installed to further define the nature and extent of dissolved-phase constituents, understand site hydrogeologic conditions, and to evaluate potential for submerged LNAPL to accumulate in the new wells. The shallow and deep wells along the berm area were installed to monitor the potential advancement of LNAPL towards the river.

Monitoring Wells

There are currently 28 shallow and 6 deep monitoring wells at the site. The shallow wells are constructed with 10- to 15-foot-long well screens placed to screen the upper 7 to 15 feet of the saturated zone. The deep wells are constructed with 15- to 20-foot-long screens with the bottom of the screen set at depths of approximately 45 to 65 feet bgs, near the contact with bedrock beneath the site.

Eleven shallow monitoring wells (WMW-1 through WMW-11) were installed between 2003 and 2012 in the main portion of the railyard. Three of the wells (WMW-2, WMW-4, and WMW-6) were subsequently removed during interim remedial actions. Between 2003 and 2015, a total of 91 groundwater samples (and 30 field duplicates) were collected from theses shallow monitoring wells during 19 groundwater sampling events.

Twenty additional shallow monitoring wells (WMW-12 through WMW-24 and WMW-26 through WMW-32) and six deep monitoring wells (RMD-01 to RMD-06) were installed during the RI between 2016 and 2018. Ten of the shallow wells (WMW-14 to WMW-23) and the six deep wells were installed along the berm area; the other 10 shallow wells were installed in the main and eastern portions of the railyard (Figures 3-2 and 3-3). Between 2016 and 2020, a total of 309 groundwater samples and 26 field duplicates were collected from the existing 28 shallow and 6 deep monitoring wells during 13 sampling events.

Groundwater and LNAPL (if present) levels were measured in site groundwater monitoring wells on a semiannual basis prior to 2017, a quarterly basis during the RI between 2017 and 2019, and semiannually in 2020.

Reconnaissance Groundwater Samples

Between 2004 and 2014, 21 RGW samples (and one field duplicate) were collected from 21 temporary wells. Between 2016 and 2018, an additional 45 RGW samples (and two field duplicates) were collected from 44 temporary wells. The temporary wells were typically constructed to sample the upper 5 to 10 feet of the saturated zone. During the RI, RGW samples were collected from soil boring B-16-24 at two depth intervals, one at the water table (10 to 15 feet bgs) and one at the top of bedrock surface (25 to 30 feet bgs).

Groundwater Sampling Results

Groundwater samples were analyzed for one or more of the analyses listed in Section 3.4. MTCA Method A and Method B Cancer and Noncancer CULs were used as screening values for chemicals reported in groundwater samples during the RI. Site-related constituents of concern in groundwater include DRO, ORO, PAHs, and metals.

DRO, ORO, and TPH-Dx concentrations reported above their CULs typically occur in the southern and central portions of the site in the wells near the former oil pipelines, western portion of the berm, and the former Engine House, and in wells west of the Maintenance Shop. PAHs (primarily 1-methylnaphthalene) were identified in the southern part of the site and in the vicinity of the former Engine House at concentrations above screening levels, in areas where DRO and/or ORO are also present.

Metals reported in monitoring well groundwater samples above applicable MTCA Method A or B CULs were limited to dissolved and total arsenic, total barium (one sample only), dissolved iron, and dissolved manganese. Iron, manganese, and arsenic are present in groundwater in locations where petroleum hydrocarbons and residual organics affect groundwater geochemistry and liberate naturally occurring metals in soil into groundwater.

Total barium, cadmium, chromium, and lead were reported above their respective MTCA Method A CULs in screening level RGW samples collected from 2004 and 2016; however, these metals are not site-related constituents of concern based on sampling results from site monitoring wells located in the vicinity of the RGW sample locations.

Benzene and GRO have not been reported at concentrations above MTCA Method A CULs in groundwater samples since 2004. The fuel additives EDB and EDC were not reported above laboratory reporting limits in 64 monitoring well samples and 46 RGW samples collected and analyzed for these constituents. Chlorinated solvents and other VOCs were not reported at concentrations above MTCA Method A CULs in groundwater samples. No evidence of LNAPL associated with gasoline has been observed at the site.

Natural Attenuation Evaluation

From 2016 to 2020, groundwater samples were collected semiannually to quarterly (depending on well screen interval and location) for field and laboratory-analyzed natural attenuation parameters. Aerobic hydrocarbon degradation processes are generally limited to the fringes of a dissolved-phase petroleum hydrocarbon footprint, where DO is present. In the absence of DO, anaerobic processes support biodegradation of petroleum hydrocarbons. Anaerobic processes use sequential terminal electron receptors (TEAs) such as nitrate, manganese, ferric iron, sulfate, and carbon dioxide. Concentration trends of TEAs associated with anaerobic biodegradation include decreases in nitrate and sulfate and increases in ammonia and sulfide, and increases in dissolved manganese, iron, methane, and alkalinity.

Natural attenuation parameter results collected during the RI indicate that biodegradation of dissolved-phase hydrocarbons is occurring at the site. In the central dissolved-phase hydrocarbon area (Mainline and South of Mainline Track Areas shown in Figure 3-4), aerobic groundwater conditions, as indicated by comparatively higher DO concentrations, are generally present around the edges of the dissolved-phase hydrocarbon extent (shallow wells WMW-05, WMW-10, WMW-12, WMW-13, and WMW-14). Anaerobic conditions are present within the dissolved-phase hydrocarbon extent (shallow wells WMW-15 through WMW-17, WMW-1, WMW-3, WMW-9, and WMW-11, and deep wells RMD-1 through RMD-3) with data indicating use of manganese, ferric iron, and carbon dioxide as TEAs.

3.7 LNAPL Investigations

The vertical and lateral extent of LNAPL beneath the site was delineated by conventional methods (advancing borings and installing monitoring wells) and the LIF survey conducted in 2013. Soil core samples and LNAPL samples from temporary wells and monitoring wells were submitted for laboratory analyses for physical properties and to evaluate LNAPL mobility. The results of these investigation activities are summarized in the following sections.

3.7.1 LNAPL Extent

The LIF survey was conducted using the TarGOST® LIF system, developed specifically for identifying long-chain petroleum hydrocarbons (e.g., oil, Bunker C, coal tar) in the subsurface (Dakota 2013). The LIF survey included 102 locations (Figure 3-2) advanced on approximately 12.5- to 50-foot centers (commonly 30- to 40 foot on-center). The LIF tooling was advanced to refusal (the top of bedrock surface) using a Geoprobe direct-push rig. Total boring depths ranged between approximately 12 bgs (near the Maintenance Shop) and 93 feet bgs (near the former Wrecker Shed).

The LIF data were qualitatively evaluated with respect to field observations of the presence of LNAPL in soil borings, occurrence of measurable LNAPL thicknesses in monitoring wells, and interpretation of the LIF logs for fuel types(s) (e.g., diesel-like and Bunker C/oil-like). The data were quantitatively evaluated with respect to soil laboratory analytical results for petroleum hydrocarbons, LNAPL mobility tests in soil cores, and estimates of residual LNAPL concentrations. These data were reviewed to assess the potential presence of LNAPL in the subsurface and to estimate LNAPL mobility. LNAPL mobility relates to the potential for LNAPL to flow from one location to another under an existing gradient. “Residual LNAPL” is present at or below LNAPL residual saturation and will not accumulate in a well or migrate across an area. “Mobile LNAPL” is present above the residual saturation and will accumulate in a well, but not migrate across an area. “Migrating LNAPL” is present above the residual saturation level and will migrate across an area if sufficient hydraulic forces are present.

Four OHM wells were installed in 2016. These wells were installed to measure apparent LNAPL thickness; evaluate the composition and level of saturation of LNAPL identified at the site; assess the potential LNAPL migration pathway through the sand aquifer; and assess the potential for migration into the bedrock unit. LIF survey results were used to locate the OHM wells in areas where the LNAPL appeared to be in contact with bedrock. Wells OHM-1, OHM-2, and OHM-3 were installed in the eastern LNAPL area and well OHM-4 was installed in the western LNAPL area (Figures 3-2 and 3-4). OHM wells were completed with variable screen lengths: 65-foot (OHM-1), 35-foot (OHM-2), 25-foot (OHM-3), or 5-foot (OHM-4).

LNAPL with properties consistent with both diesel and Bunker-C oil is present south of the mainline tracks near the former underground oil pipelines and the former Power House (Figure 3-4). Diesel LNAPL is present at the groundwater surface and in the periodically saturated vadose zone. Diesel and Bunker-C LNAPL is submerged at depths between the groundwater surface and up to 60 feet below the top of groundwater as a result of the formation of Lake Celilo. With the impoundment of Lake Celilo, the groundwater table rose rapidly, trapping LNAPL in the subsurface at depths similar to the pre-impoundment depth of groundwater. Submerged LNAPL is estimated to be greater than 60 years old based on known facility operations and the formation of Lake Celilo. LNAPL observed south of the mainline is classified as potentially recoverable, as evidenced by observations of measurable LNAPL in three of the four OHM wells and by laboratory measurements of LNAPL physical properties. LNAPL beneath the uplands area does not extend to the Columbia River. LNAPL was not observed in the southernmost row of LIF borings bordering the berm separating the site from the Columbia River, nor in the monitoring wells installed along the berm during the RI (berm monitoring wells). No evidence has been observed that the LNAPL body is migrating.

LNAPL with properties consistent with a weathered diesel fuel was historically present north of the mainline track in the vicinity of the Maintenance Shop. LNAPL in this area was located at the elevation of the pre-impoundment groundwater surface and in the periodically saturated vadose zone. Prior to January 2016, LNAPL was frequently observed in wells WMW 7 and WMW-8, located near the Maintenance Shop. Bioventing was implemented in this area as an IRM between 2012 and 2019 (See Section 3.9). Except for a single event in November 2016 (0.10 foot measured in WMW-8), LNAPL has not been measured in either well since January 2016.

3.7.2 LNAPL Properties

LNAPL samples collected from temporary wells (2013) and OHM wells in 2016 and 2019 were submitted for laboratory analysis of physical properties including dynamic viscosity, fluid density, and specific gravity at three temperatures. Soil core samples were also collected in 2013 and 2016 from borings within the eastern and western LNAPL area for a series of laboratory analyses for soil physical properties and to evaluate LNAPL mobility.

At 70°F, LNAPL density measurements ranged from 0.9494 to 0.9708 grams per cubic centimeter (g/cc), and LNAPL specific gravity measurements ranged from 0.9496 to 0.9728 (unitless). As the maximum density measurement is less than that of water (1 g/cc), the NAPL is classified as an LNAPL. Dynamic viscosity measurements decreased with increasing temperature, for example, ranging from 7,210 centipoise (cP) at 50°F to 141 cP at 130°F. While the LNAPL density is less than water, the majority of LNAPL beneath the site is submerged below the water table because of its high viscosity at site temperatures and the rapid change in groundwater levels due to the increase in surface water elevation of the Columbia River after completion of The Dalles Dam.

LNAPL mobility analyses indicated that LNAPL in soil cores collected from the eastern LNAPL area is mobile (e.g., soil cores from OHM-1 and OHM-2) or potentially mobile (e.g., soil core from OHM-3). The LNAPL mobility soil core testing results for OHM-1, OHM-2, and OHM-3 have been confirmed by measured apparent LNAPL thicknesses up to approximately 37 feet (July 2019), 14 feet (July 2019), and 12 feet (August 2018), respectively in the three wells. The presence of measurable LNAPL in these wells indicates the LNAPL in the vicinity of each well is mobile. The apparent LNAPL thicknesses continued to increase in these wells since installation through July 2019 due to high viscosity of the LNAPL slowing entry into the well.

LNAPL mobility analyses conducted on the soil core sample from well OHM-4 collected in 2016 indicated that LNAPL in the western LNAPL area is immobile. Though visible LNAPL was observed in the soil boring for OHM-4, the LNAPL mobility soil core testing results for OHM-4 as 'immobile' have been confirmed by absence of measurable apparent LNAPL thicknesses in the well since its installation in December 2016 (KJ 2020).

3.8 Interim Remedial Actions

Suspected legacy sources of petroleum hydrocarbons have been decommissioned and removed from the site and impacted soil has been removed as part of interim remedial measure (IRM) activities. Where implemented, IRMs successfully removed petroleum hydrocarbons down to the water table or bedrock such that soil samples collected from all but 11 of 145 soil borings/excavation confirmation sampling locations in site areas in the unsaturated zone do not contain residual petroleum hydrocarbons above MTCA Method A CULs. A limited area of residual hydrocarbons is present near the berm (based on one sample) but does not significantly contribute to the overall presence of dissolved phase hydrocarbons in other areas of the site. Horizontal migration of vadose zone soil impacts is not expected because lateral gradients or geologic features that would result in horizontal movement are not present.

3.8.1 Soil Excavations

Between 2002 and 2010, interim remedial actions included the excavation of approximately 5,000 tons of petroleum impacted surface soils and collection of 71 excavation confirmation soil samples. Figure 3-1 shows the approximate lateral extent of the excavation areas described below.

In 2002, a 30,000-gallon UST formerly used for storage of heating oil was discovered adjacent to the western side of the former Boiler House (Figure 2-1). Confirmation soil samples were collected and analyzed for DRO and ORO. The UST and approximately 750 tons of petroleum hydrocarbon-impacted soil were removed in April 2002.

In 2005, remediation activities were conducted at the site resulting in the removal and offsite disposal of approximately 3,600 tons of petroleum hydrocarbon-impacted soil and debris; removal and recycling of approximately 1,800 gallons of petroleum from the former 5,000-gallon Lube Oil UST and associated piping; and removal and recycling of 10 tons of metal. Excavations were performed in multiple areas of the site including the former Pump House Foundation near the Maintenance Shop, former Fueling Island (south of mainline tracks), former Lube Oil UST Area, and former Power House Area.

In 2007, in response to a diesel spill adjacent to a spur track south of the railyard depot building, approximately 9 tons of soil were excavated and disposed offsite.

In 2010, further soil excavation was performed in association with removal of a concrete structure believed to be the foundation for the Former Elevated 28,500-gallon Oil Service AST. As part of the concrete structure removal, an additional 628 tons of soil, concrete, and wood debris were excavated and disposed offsite.

3.8.2 Bioventing System

LNAPL with properties consistent with a weathered diesel fuel was historically present north of the mainline track in the vicinity of the Maintenance Shop. LNAPL in this area was located at the elevation of the pre-impoundment groundwater surface and in the periodically saturated vadose zone. Prior to January 2016, LNAPL was frequently observed in wells WMW-7 and WMW-8, located near the Maintenance Shop. Bioventing was implemented in this area as an IRM between 2012 and 2019. An air sparge/soil vapor extraction (AS/SVE) system installed in early 2012 was converted in June 2012 to a bioventing system with ambient air injection through the four SVE wells (Figure 3-1). The bioventing system operated until July 2019, with the system down for maintenance between April 2017 and November 2017. Except for a single event in November 2016 (0.10 foot measured in WMW-8), LNAPL has not been measured in either WMW-7 or WMW-8 since January 2016. A hydrocarbon sheen is inconsistently observed at the groundwater interface in both wells.

The bioventing system was shut down in July 2019 for feasibility study related field activities (see Section 3.9). Soil gas measurements collected during the 2019 field activities showed that oxygen was at near-atmospheric concentrations and little to no carbon dioxide was present in this area, indicating that air exchange rates in the vadose zone are sufficient to sustain aerobic degradation of the petroleum hydrocarbons. Based on the field data collected, the bioventing system was not restarted.

3.9 Feasibility Study Field Activities

Between July and September 2019, additional field activities to aid in the feasibility evaluation of remediation alternatives were conducted. The objectives of the field activities were to 1) evaluate the feasibility of removing LNAPL from site wells, 2) assess the performance of the existing bioventing system operating in the vicinity of the Maintenance Shop, 3) assess potential for bioventing in the vicinity of the submerged LNAPL south of the mainline, and 4) evaluate occurrence of natural source zone depletion (NSZD) at the site. The field activities were conducted in accordance with the *LNAPL Transmissivity, Bioventing Respirometry, and NSZD Testing Work Plan BNSF Wishram Railyard, Wishram, Washington* (FS Work Plan) (KJ 2019). The results of these activities were reported in the Uplands RI Report (KJ 2020) and Uplands FS Report (KJ 2022).

3.9.1 LNAPL Removal Testing

Between 22 and 23 July 2019 LNAPL was removed from wells OHM-1, OHM-2, and OHM-3 using high vacuum extraction techniques: a stinger tube, connected via flexible hose to a mobile vacuum truck was lowered into the well until it was submerged beneath the LNAPL surface. Fluids in the well were then evacuated until LNAPL was no longer observed through the flexible hose. The volume of total fluids (including LNAPL and water) recovered from each well was estimated based on fluid levels in the vacuum truck. Approximately 40 gallons of fluid were recovered from well OHM-1, approximately 15 gallons were recovered from well OHM-2, and approximately 18 gallons were recovered from well OHM-3.

Following LNAPL removal, recharge into each well was monitored using a level logging pressure transducer to record the potentiometric surface and an oil/water interface probe to gauge the depth to the top of the fluid column. The pressure transducers were suspended in each well below the initial (prior to evacuation) LNAPL/groundwater interface. Depth to LNAPL/air and LNAPL/water interfaces were measured with an oil/water interface probe intermittently while field personnel were on site, and at increasing time intervals through September 2019.

Field data from the LNAPL removal tests, along with laboratory-analyzed physical properties results from soil core and LNAPL samples, were used to calibrate the American Petroleum Institute's (API's) LNAPL Distribution and Recovery Model (LDRM) (API 2007) to estimate the percentages of recoverable LNAPL and total LNAPL that could potentially be removed from the subsurface in the eastern LNAPL area, and the amount of residual LNAPL that would remain. Model results showed that the estimated percentages of recoverable submerged LNAPL removed were similar for the physical removal (21 °C) scenario (20 percent removed after 10 years) and the low temperature (55 °C) thermal scenario (21 percent removed after 1 year). Because the LNAPL is not migrating, the additional time estimated for physical removal does not result in an increased risk to the environment.

3.9.2 Bioventing System Evaluation

The evaluation of LNAPL remediation at many sites has demonstrated the importance of NSZD and enhanced biological degradation by introducing atmospheric air into the subsurface to increase subsurface oxygen concentrations (i.e., bioventing). Two bioventing evaluations were performed: 1) a respirometry test of the existing bioventing system near the maintenance shop, and 2) an air injection and respirometry test in an area located south of the mainline tracks, near submerged LNAPL areas.

Existing Bioventing System – Respirometry Test

A respirometry test in the vicinity of the existing bioventing system near the Maintenance Shop (north of the mainline tracks) was performed to compare conditions during and following operation and to evaluate performance. The respirometry test included collecting soil gas (oxygen, carbon dioxide, hydrogen sulfide, and methane) and VOCs measurements in bioventing and monitoring wells during system operation (immediately before shutdown) and at increasing time intervals following system shutdown to assess oxygen consumption. Test results were analyzed to estimate biodegradation rates based on oxygen utilization rates.

According to U.S. Environmental Protection Agency (EPA) (1995) bioventing design guidance documents, oxygen utilization rates greater than 1.0 percent per day (%/day) indicate bioventing may be feasible at a given site. The calculated oxygen utilization rate of 0.082 %/day for the existing bioventing system was more than an order of magnitude less than 1.0 %/day, indicating the subsurface environment is sufficiently oxygenated for aerobic biodegradation to occur, and bioventing is no longer necessary in this area. The bioventing system remained off following the respirometry testing in July 2019.

Submerged LNAPL Area Bioventing Injection and Respirometry Tests

A bioventing injection test was performed south of the mainline tracks, between submerged LNAPL areas and the berm area in August 2019. Test activities included an initial soil gas survey of select monitoring wells, an air injection test at well WMW-11, and a respirometry test (following the injection test). Initial (baseline) soil gas oxygen concentrations measured prior to the air injection test were high (19 to 20% oxygen) and carbon dioxide concentrations were low (less than 1%). After 30 hours of continuous air injection, respirometry test results did not show a significant change in soil gas concentrations in monitored wells. The calculated oxygen utilization rate was 0.06 %/day, which is significantly lower than the 1.0 %/day criteria mentioned above. The results of the baseline soil gas oxygen concentrations and respirometry test indicated that bioventing does not enhance biological degradation in the tested area.

3.9.3 NSZD Evaluation

At sites impacted with petroleum hydrocarbons, LNAPL losses can occur through natural biodegradation processes such as methanogenesis, in which carbon dioxide (CO_2) and methane (CH_4) are generated by an anaerobic process during natural degradation of organic materials such as petroleum hydrocarbons. As both these gases are transported from the LNAPL source toward the atmosphere, CH_4 encounters atmospheric oxygen (O_2) and, through aerobic processes, generates CO_2 in the shallow surface soil layer and the vadose zone.

CO_2 flux was measured by trapping CO_2 and storing it for laboratory analysis, using the E-Flux method, developed at Colorado State University Center for Contaminant Hydrology (CCH). The E-Flux method measures carbon (to estimate total CO_2 flux) and carbon isotopes to estimate the contribution of petroleum hydrocarbon degradation to the total carbon flux from the soil to the ground surface (Zimbron et al. 2011). This process was used to assess and estimate natural LNAPL losses from biodegradation (i.e., NSZD).

Carbon traps were deployed in 11 locations in the Maintenance Shop, Submerged LNAPL, and former Engine House/ Machine Shop areas on 12 and 13 August 2019 and retrieved on 21 August 2019. The estimated CO_2 flux was calculated as described in the Uplands FS Report (KJ 2020) and then converted to an estimated equivalent LNAPL NSZD biodegradation rate.

Lower calculated equivalent NSZD rates (between not detected and 147 gallons/acre/year) were observed in areas with dissolved phase petroleum impacts only or no dissolved phase or LNAPL impacts. The higher calculated equivalent NSZD rates (between 364 and 6,146 gallons/acre/year) were measured in areas near or above the inferred extents of smear zone and/or submerged LNAPL. The carbon trap results provided evidence of biological activity (production of CO_2) from both petroleum hydrocarbon and natural sources; and showed that biodegradation of petroleum hydrocarbons (i.e., NSZD) is occurring in areas where significant petroleum hydrocarbon mass exists in the subsurface.

3.10 Site-Related Constituents and Locations

Based on historical railroad operations and previous investigations, COCs identified for the site include Total Petroleum Hydrocarbons (TPH) expressed as DRO, ORO, and TPH-Dx (sum of DRO and ORO results) in soil and groundwater, and, TPH as GRO in soil and 1-

methylnaphthalene in groundwater. Dissolved and total arsenic, dissolved iron, and dissolved manganese are also present as secondary COCs in site groundwater as a result of reducing conditions caused by the natural degradation of DRO and ORO in groundwater.

General areas within the present upland remediation investigation areas where petroleum hydrocarbon-related constituents have been identified (and the associated impacted media) include the following (see Figure 3-4):

- Mainline Track Area (dissolved phase) – vicinity of the former Boiler House and associated UST, former Pump House associated with former diesel ASTs, and the current Maintenance Shop.
- South of Mainline Track Area (eastern and western LNAPL areas, dissolved phase, shallow soil) – vicinity of former diesel and oil fueling areas and underground piping, former Oil Unloading Track, former Oil Trough, and former Power House. Shallow soil impacts are located at the south end of this area, on the northern side of the berm, south of the former Power House.
- Berm Area South of Power House (dissolved phase) – South of the former Engine House/Machine Shop area, south of the South of Mainline Track Area.
- Former Engine House/Machine Shop Area (dissolved phase), including the Former Oil House east of the former Signal Office/former Store House.

Potential operational sources of petroleum hydrocarbon-related constituents in these areas (historical oil and diesel fueling operations and steam power production, storage of oil and diesel fuel in multiple ASTs and USTs onsite, transport of oil in associated underground piping systems) are no longer present. Current site conditions are the result of historical impacts.

Section 4: Cleanup Standards

MTCA requires the establishment of cleanup standards for individual sites. The two primary components of cleanup standards are CULs and POCs. CULs identify the concentration at which a substance does not significantly threaten human health or the environment. COCs exceeding their respective CULs in a given media are addressed through a cleanup remedy that minimizes or restricts uncontrolled exposure to the impacted material. POCs represent the locations on the site where CULs must be met.

4.1 Overview

The process for establishing CULs involves the following:

- Identifying if MTCA methods A, B, or C are applicable;
- Developing CULs for individual constituents in each media;
- Identifying which constituents contribute most of the overall risk in each media (indicators); and
- Adjusting the CULs downward, if necessary, for carcinogenic substances, based on a total site risk of one in one hundred thousand ($1x10^{-5}$), and for non-carcinogenic substances based on a hazard index of 1.0.

MTCA provides three options for establishing CULs: Methods A, B, and C.

- Method A may be used to establish CULs at routine sites or sites with relatively few hazardous substances.
- Method B is the standard method for establishing CULs and may be used to establish CULs at any site.
- Method C is a conditional method that can be applied to qualifying industrial properties. Method C can also be used when a cleanup level under Method A or B is technically impossible to achieve or may cause significantly greater environmental harm.

MTCA defines the factors used to identify whether a substance should be retained as an indicator for the site. When defining CULs at a site impacted by several hazardous substances, Ecology may eliminate from consideration those substances contributing a small percentage of the overall threat to human health and the environment. WAC 173-340-703(2) provides that a substance may be eliminated from further consideration based on:

- The toxicological characteristics of the substance that govern its ability to adversely affect human health or the environment relative to the concentration of the substance;
- The chemical and physical characteristics of the substance that govern its tendency to persist in the environment;
- The chemical and physical characteristics of the substance that govern its tendency to move into and through the environment;
- The natural background concentration of the substance;
- The thoroughness of testing for the substance;
- The frequency of detection; and
- The degradation by-products of the substance.

4.2 Site Use

The evaluation of both human health CULs and ecological exposures depends on the use of the site, including future land use. Land use options under MTCA are as either an unrestricted property or an industrial property.

4.2.1 BNSF Wishram Railyard Property

Industrial properties are defined in WAC 173-340-200; the definition includes properties characterized by transportation areas and facilities zoned for industrial use. Industrial properties are further described in WAC 173-340-745(1).

The railyard portion of the site is zoned Industrial Park, which allows for the location of industrial manufacturing and processing type activities as well as conditional uses including railroad facilities. Current and foreseeable use of the railyard portion of the site is as an active railyard with storage of related items and a passenger train stop utilized by Amtrak, which is commensurate with industrial property use. The railyard and areas north of the mainline track area (e.g., the maintenance shop and bullpen) have controlled access measures to limit access by the general public, including fencing between the existing depot and maintenance shop, a fenced-in bullpen north of the maintenance shop, and are patrolled by railroad police.

The site is fully developed as an industrial railyard where buildings, pavement, rail, track structure, and surfaces (comprising approximately 94 percent of the land area) are designed and managed per federal regulations to remove and control vegetation, limit the potential for vegetation with deep root zones and use by wildlife. The railyard surface areas, covered by gravel, asphalt, or other impervious structures (e.g., buildings) minimize potential exposure to the soil. Along the Columbia River, engineered embankments (forming the berm area) composed of large riprap protect the banks from erosion and restrict potential deeper soil contact by occupants and wildlife. Foreseeable future use of the site is anticipated to remain the same, with railyard operations including railcar switching on tracks located just south of the Depot.

4.2.2 Off-Railyard Property

The off-railyard portion of the site is zoned Rural Center. The Rural Center zoning designation allows for agriculture, small business and commercial services, eating/drinking establishments, and residential use, among others. Areas zoned as Rural Center allow for access by the general public and therefore do not qualify as industrial properties.

Off-railyard properties with potential site-related constituent impacts to soil and groundwater are limited to two properties in the vicinity of the former boiler house and former heating oil UST located to the north of the maintenance shop area (Figure 2-1). The two properties in this area are owned by the Klickitat County Fire Protection District #11 (Fire District #11). Current features on the properties include compacted gravel parking areas and roadways paved with gravel, two warehouse storage-type buildings used by Fire District #11 to store and maintain critical fire equipment (eastern property), and a U.S. Post Office (western property).

4.3 Terrestrial Ecological Evaluation

WAC 173-340-7490 requires an assessment to determine if a terrestrial ecological evaluation (TEE) can be excluded from further assessment following WAC 173-340-7491, or if a simplified (WAC 173-340-7492) or site-specific (WAC 173-340-1793) TEE is needed to assess the potential effects of soil impacts to ecological receptors.

As stated in WAC 173-340-7491(1), no further evaluation is required if it is determined that a site meets any of the criteria in (a) through (d) of that section. The exclusion under 173-340-7491(1)(b), states "All soil contaminated with hazardous substances is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination. To qualify for this exclusion, an institutional control (IC) shall be required by the department under WAC 173-340-440." Based on site features, RI analytical data, interim remedial actions, and the selected remedial alternative actions presented in Section 6, the railyard property and off-railyard properties with site-related constituent impacts to soil will meet the TEE exclusion criteria under WAC 173-340-7491(1)(b), as summarized below. Based on the results of this evaluation, further TEE is not required.

The selected remedial alternative presented in Section 6 includes implementing engineering controls (ECs), including removal and destruction technologies, implementing a compliance groundwater monitoring program, and establishing institutional controls (ICs) and environmental covenants to control site uses that could potentially expose receptors to impacted media, including soil and groundwater. Based on site features information, RI analytical data, interim remedial actions, and the selected remedial alternative actions, the railyard property and off-railyard properties with site-related constituent impacts to soil will meet the barriers to exposure TEE exclusion criteria under WAC 173-340-7491(1)(b), as summarized below. Based on the results of this evaluation, further TEE is not required.

BNSF Wishram Railroad Property TEE

The railyard surface is primarily covered by buildings, pavement, rail, track structure, and paved gravel areas that are designed and managed per federal regulations to remove and control vegetation, limit the potential for vegetation with deep root zones and provide a physical barrier limiting exposure to subsurface soil. Along the Columbia River, engineered embankments (forming the berm area) composed of large riprap protect the banks from erosion and restrict potential contact with deeper soil by wildlife.

The soil excavation interim remedial measures conducted on the site between 2002 and 2010 removed much of the petroleum hydrocarbon-impacted soil in the vadose zone (Section 3.8). Site-related constituent impacts to soil remaining between ground surface and 15 feet bgs (standard POC) are limited to concentrations of GRO, DRO, ORO, and/or TPH-Dx above MTCA Method A CULs for industrial properties. These subsurface soil impacts are located near the Maintenance Shop beneath areas paved with gravel and asphalt, and near the former Engine House, former diesel and oil fueling operations, and former underground oil pipelines beneath areas paved with gravel.

The selected remedial actions include excavation and offsite disposal of petroleum hydrocarbon-impacted shallow soil on the northern side of the berm near soil boring B-16-01 (Figure 3-4). The other remaining subsurface soil impacts are located near the Maintenance

Shop beneath areas paved with gravel and asphalt, and near the former Engine House, former diesel and oil fueling operations, and former underground oil pipelines beneath areas paved with gravel.

Following implementation of the selected cleanup action alternative presented under Section 6, which includes establishment of ICs in the form of an environmental covenant to control site uses that could potentially expose receptors to impacted media combined with the existing ground surface coverings providing physical barriers to soil, the railroad property will meet the barriers to exposure TEE exclusion criteria in WAC 173-340-7491(1)(b).

Off-Railyard Property TEE

Off-railyard areas with potential petroleum hydrocarbon impacts to soil related to the railyard are limited to the vicinity of the former boiler house and former heating oil UST and a former pump house foundation located northwest of the maintenance shop. In 2002, the heating oil UST was removed, and petroleum hydrocarbon-impacted soil was excavated to the top of the bedrock surface (to the extent practicable) at a depth of approximately 16 feet bgs. The pump house foundation was removed in 2005 along with associated piping and impacted soil was excavated to depths ranging 5 to 15 feet bgs.

Remaining site-related constituent impacts to soil between ground surface and 15 feet bgs in these off-railyard properties are limited to concentrations of DRO, ORO, and TPH-Dx above MTCA Method A CULs for unrestricted land use near the former boiler house, and a concentration of GRO above the MTCA Method A CUL for unrestricted land use in one saturated zone soil sample near the former pump house. The areas of these soil sample locations are covered by physical barriers at the ground surface including compacted gravel surface areas, parking areas, and roadways paved with gravel.

With establishment of ICs in the form of an environmental covenant to control site uses that could potentially expose receptors to impacted media, combined with the existing ground surface coverings providing physical barriers to soil, the off-railyard property will meet the barriers to exposure TEE exclusion criteria in WAC 173-340-7491(1)(b).

4.4 Site Conceptual Exposure Model

Potentially complete exposure pathways for human and ecological receptors at the site include direct contact and/or incidental ingestion by construction workers and railyard workers of affected media (soil and groundwater). The vapor intrusion pathway is an incomplete exposure pathway due to lack of VOCs reported in soil and groundwater and the limited number of buildings (e.g., Maintenance Shop) onsite. A petroleum vapor intrusion (PVI) initial assessment presented in the Uplands RI Report (KJ 2020) concluded that PVI is not a risk in the Maintenance Shop. Although shallow groundwater at the site is not a current source of drinking water nor is it identified as a future drinking water source (potable water is supplied to the site by the City of Wishram and former water supply wells [Well #2 and Well #3] were decommissioned between 22 March and 19 April 2022) in accordance with WAC 173-340-720, groundwater at the site is considered potable for current and future uses. Therefore, human consumption of shallow site groundwater is a potential exposure pathway.

A site conceptual exposure model (SCEM) diagram is presented in Figure 4-1. The following exposure pathways are considered potentially complete for human receptors based on the existing site conditions and uses:

- Surface and subsurface soil direct contact and/or incidental ingestion by site, construction, and utility workers.
- Groundwater direct contact and/or incidental ingestion by site, construction, and utility workers [saturated conditions exist within approximately 10 to 15 feet below ground surface (bgs)].
- Consumption of groundwater by site, construction, and utility workers.
- Surface water direct contact and/or incidental ingestion by site, construction, and utility workers, recreational users, and tribal fishers and harvesters including children and adults.
- Consumption of aquatic organisms by recreational users.
- Consumption of natural resources by their intended community for subsistence purpose and collected by tribal fishers and harvesters. This includes children and adult consumers.

Direct contact and/or incidental ingestion exposure pathways for soil and groundwater can be controlled by institutional controls (ICs) and soil management/construction plans. The ICs would be put in place to protect onsite receptors.

Ecological exposures to site-related constituents in uplands area are negligible, as gravel and asphalt cover render ecological exposure routes incomplete across much of the site. Ecological receptors may occupy the sparsely vegetated areas along the berm separating the site from the Columbia River. Potential exposure risks along the berm are negligible given the existing analytical data characterizing berm surface soil (i.e., no known impacts) and delineated depth of subsurface impacts beyond anticipated receptor exposure depth.

LNAPL beneath the uplands area does not extend to the Columbia River and is not migrating, therefore, potential exposure to upland LNAPL by ecological receptors beneath the berm or in the river represents an incomplete pathway. Groundwater to surface water interaction along the bank area adjacent to the Columbia River is expected to be minimal as the river is a losing stream approximately 10 months a year. Investigation of environmental conditions in the adjacent reach of the Columbia River is ongoing.

4.5 Site Cleanup Levels

The RI and previous investigations have documented the presence of site-related chemical constituent impacts to soil and groundwater at the site. Based on the detection frequency and constituent concentrations exceeding screening levels for soil and groundwater, CULs were developed for soil and groundwater. As the site is located adjacent to the Columbia River, CULs were also developed for surface water. Available and applicable MTCA Methods A, B, and C cleanup levels and screening levels were obtained from Ecology's Cleanup Levels and Risk Calculation (CLARC) master data table (updated in July 2024) (Ecology 2024).

4.5.1 Soil

Site CULs for soil were established based on the industrial property site use of the railyard property and the Rural Center zoning designation for the off-railyard property. Soil CULs were established based on the following:

- MTCA Method A and C CULs for industrial properties for the railyard property,
- MTCA Method A and B CULs for unrestricted land uses for the off-railyard property,
- The fixed parameter 3-phase partitioning model described in WAC 173-340-747(4), and MTCA Equation 747-1 for the vadose or saturated (as applicable) zone that are protective of groundwater and the groundwater to surface water pathway,
- Background concentrations, and
- Laboratory practical quantitation limits (PQLs).

Additionally, for petroleum hydrocarbons, the CUL shall not result in the accumulation of LNAPL on or in groundwater (173-340-747(3)(g)).

Table 4-1 lists the final CULs for soil COCs.

4.5.2 Groundwater

Beneficial use designations for the groundwater beneath the site include use as a potential drinking water source. Groundwater CULs protective of drinking water were established based on:

- MTCA Method B cancer and noncancer CULs, and
- Other applicable, relevant, and appropriate requirements (ARARs) including state and federal Maximum Contaminant Levels (MCLs),
- MTCA Method A CULs for select constituents (DRO, ORO, and TPH-Dx),
- Background concentrations for arsenic, and
- Laboratory PQLs.

Additionally, for petroleum hydrocarbons, the CUL may not exceed a concentration that would result in LNAPL being present in or on the groundwater. Physical observations of groundwater at or above the cleanup level, such as the lack of a film, sheen, or discoloration of the groundwater or lack of sludge or emulsion in the groundwater, may be used to evaluate compliance with this requirement (WAC 173-340-720(7)(d)).

Based on localized groundwater flow conditions (Section 3.5.3) and the capacity for ICs to control direct contact and incidental ingestion pathways for groundwater beneath the site, contact within the Columbia River is the only potentially complete unrestricted exposure pathway for site groundwater. Therefore, for those groundwater COCs that have individual surface water compliance levels, the surface water screening levels will be applied to site groundwater with the potential to enter the Columbia River. For those groundwater COCs that do not have individual surface water compliance levels, the groundwater CULs will be used to determine compliance.

Table 4-1 lists the final CULs for groundwater COCs.

4.5.3 Surface Water

Surface water will be protected by remediating groundwater in the vicinity of the berm to applicable CULs. Surface water COCs are those constituents in site groundwater that exceed applicable surface water criteria as groundwater is in direct communication with the river. Beneficial use designations for the Columbia River near the site include potential drinking water supply, tribal fishing and harvesting of aquatic resources, spawning and rearing aquatic life, wildlife, and miscellaneous uses such as recreation, aesthetics, hydroelectric power generation, and commercial navigation and transportation.

Proposed surface water CULs protective of drinking water and aquatic life were established based on:

- Surface water MTCA Method B cancer and noncancer cleanup levels,
- ARARs including fresh surface water concentrations that are protective of human health and aquatic life under acute and chronic exposure conditions, as established under state (WAC 173-201A-240) and federal laws [Section 304 of the Clean Water Act (CWA)],
- Aquatic Life Protective Values for Freshwater, from Implementation Memo No. 23 (Ecology 2021) for petroleum hydrocarbons (e.g., weathered diesel) and as presented in the CLARC master data table (updated July 2022),
- Risk Assessment Information System (RAIS) concentrations,
- U.S. EPA Region 4 Ecological Risk Assessment Supplemental Guidance values,
- MTCA Method A for select constituents for beneficial use as potable water,
- Background concentrations, and
- Laboratory PQLs.

Table 4-1 lists the final CULs for COCs in surface water.

4.6 Site Cleanup Objectives for LNAPL

The cleanup objectives for LNAPL are based on the ability to remove LNAPL to the maximum extent practicable through normally accepted engineering practices [WAC 173-340-360(2)(c)(ii)(A)]. Cleanup objectives include remediation levels (REL) that will be used to identify when to transition from active to passive treatment of LNAPL. The LNAPL REL is not the same as the applicable petroleum hydrocarbon CUL (Table 4-1). The screening level is set higher for the REL and is used to focus more aggressive cleanup technologies on areas having the highest accumulations of mobile LNAPL.

The LNAPL REL, to indicate when to transition away from active removal, is based on the mobility of the LNAPL and potential for the LNAPL to migrate. Currently, LNAPL is not migrating. Mobile LNAPL will be physically removed from wells until:

- Ambient-temperature transmissivity is below 0.8 feet squared per day (ITRC 2018),
- Apparent maximum in-well thickness is equal to or less than 1 foot over a 12-month monitoring period, or
- Removal rates reach asymptotic conditions.

Once one of the above metrics is achieved, remediation will switch from physical removal to NSZD monitoring. NSZD monitoring will continue until LNAPL is no longer present at a measurable thickness in the monitoring wells. If monitoring shows that NSZD will not achieve RELs in a reasonable timeframe (see Section 5.5), biosparging will be implemented, and will continue until DO concentrations are sustained above 2 milligrams per liter (mg/L). Once DO is sustained above 2 mg/L, the LNAPL remedy will transition back to NSZD. During NSZD or other passive treatment, periodic evaluation will be performed to assess whether these conditions hold.

LIF investigation results and mobile LNAPL thickness data from the RI were used to approximate the area of mobile LNAPL (Figure 3-4). The area encompassing the primary source area and the historically highest accumulations of mobile LNAPL was identified as the Eastern LNAPL Body (ENB) in the FS. The mobile LNAPL in the ENB will undergo physical removal, followed by NSZD monitoring (and biosparging if necessary) (see Section 5). The area having mobile LNAPL thicknesses less than 1 foot was identified as the Western LNAPL Body (WNB) in the FS. The mobile LNAPL in the WNB will receive active remediation through biosparging, but no physical removal. Both the ENB and WNB areas will receive NSZD monitoring following cessation of the active remedy.

4.7 Point of Compliance

MTCA defines the POC as the point or points where CULs shall be attained. Once CULs are met at the POC, the site is no longer considered a threat to human health or the environment. As provided for in WAC 173-340-720(8)(c), where it can be demonstrated under WAC 173-340-350 through 173-340-390 that it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame, Ecology may approve a conditional point of compliance (CPOC) that shall be as close as practicable to the source of hazardous substances, and except as provided under WAC 173-340-720(8)(d), does not exceed the property boundary. MTCA defines CPOCs, including soil depths, for several potential receptor exposure pathways.

Soil. WAC 173-340-740(6) gives the POC requirements for soil. The standard POC for soil based on protection of human exposure via the direct contact pathway is sitewide to a depth of 15 feet bgs as the typical maximum depth of soil disturbing activities [WAC 173-340-740(6)(d)].

The unsaturated vadose zone within much of the railyard extends from the ground surface to 10 feet bgs and along the berm (due to raised ground surface topography) from the ground surface to approximately 15 feet bgs. The vadose zone within the two off-railyard properties owned by Fire District #11 extends from the ground surface to approximately 14 feet bgs. The CPOC for protection of human exposure via the direct contact pathway for soil in the unsaturated zone is the water table depth of 10 feet bgs within the railyard and the water table depth of 14 feet bgs for the two off-railyard properties.

The standard POC for soil CULs based on protection of groundwater is throughout the soil column. Potential impacts to groundwater from subsurface soil in the saturated zone will be evaluated based on direct measurement of groundwater conditions and remediation of soil in the saturated zone will be evaluated based on groundwater cleanup performance data.

Groundwater. WAC 173-340-720(8)(a) and (b) gives the POC requirements for groundwater. The standard POC for groundwater CULs will be beneath the site to the outer boundary of the impacted area, and from the top of the saturated zone to the lowest depth that could be affected by the site.

Surface Water. WAC 173-340-730(6)(a) gives the POC requirements for surface water. The standard POC for surface water CULs is the points at which hazardous substances are released to surface waters of the state, measured at a point immediately prior to discharge (i.e., no mixing zone allowed). The CPOC for monitoring groundwater at the interface with surface water is the line of existing shallow and deep monitoring wells installed on the berm bordering the Columbia River.

Section 5: Cleanup Action Selection

5.1 Remedial Action Objectives

The remedial action objectives (RAOs) are statements describing the actions necessary to protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route. They are developed considering the characteristics of the impacted media, the characteristics of the hazardous substances present, migration and exposure pathways, and potential receptor points.

The RAOs for the Uplands Area are based on the conceptual site model (Figure 4-1), which identified the potential receptors and exposure pathways present at the site. The RAOs include the following:

- Protect site, construction, and utility workers from direct contact with and incidental ingestion of soil containing COCs at concentrations above CULs during typical operations and soil excavations.
- Protect site, construction, and utility workers from direct contact with and ingestion of groundwater containing COCs at concentrations above CULs.
- Protect aquatic and recreational receptors immediately adjacent to the site from direct contact with and incidental ingestion of surface water containing COCs at concentrations above applicable surface water criteria discharging to the Columbia River.
- Protect recreational users and aquatic biota from ingestion of aquatic organisms containing COCs at concentrations above applicable standards.

Due to the depth of groundwater greater than 6 feet bgs, terrestrial ecological receptors are not expected to encounter groundwater in the uplands area of the site.

5.2 Cleanup Action Alternatives

Cleanup alternatives to meet these remedial action objectives were evaluated as part of the Uplands FS Report (KJ 2022). The FS evaluated five alternatives for addressing impacted media at the site. Alternatives included in the FS are described below and in Table 5-1.

Four cleanup action areas and three media types (soil, groundwater, and LNAPL) were identified based on exceedances of proposed CULs (Figures 3-4 and 3-5):

- Mainline Track Area – groundwater dissolved phase
- South of Mainline Track Area – groundwater dissolved phase and LNAPL
- Berm Area South of the Power House - subsurface soil (between 6 and 9 feet bgs near boring location B-16-01) and groundwater dissolved phase

- Former Engine House/Machine Shop Area – groundwater dissolved phase

The five remedial alternatives are summarized in Sections 5.2.1 to 5.2.5. The alternatives are presented as described in the FS. Estimated operation times (in years) for active remediation components of each alternative are provided for contextual discussion but are not definitive milestones for progressing to a passive operation. Refer to the Uplands FS Report (KJ 2022) for more detailed explanations of each remedial alternative.

5.2.1 Alternative 1 (A-1): Physical LNAPL Removal, Focused Biosparge, MNA, and Targeted Excavation

This was the baseline alternative presented in the FS. This alternative includes removing LNAPL periodically using a mobile vacuum unit in the ENB. Relatively thinner areas of LNAPL in the WNB will be treated through biosparging. After LNAPL RELs have been achieved, physical removal and biosparging will cease and NSZD monitoring will be initiated. While LNAPL is being physically removed, monitored natural attenuation (MNA) will be implemented for dissolved phase petroleum impacts in groundwater beneath the mainline track area, former Engine House, and south of the ENB and WNB areas. Elevated dissolved arsenic concentrations will be addressed by remediating petroleum hydrocarbons and the corresponding return of groundwater geochemical parameters to their ambient conditions. This alternative also includes excavating impacted soils in the vadose zone beneath the berm, establishing a groundwater covenant to restrict future use of site groundwater, and long-term groundwater compliance monitoring.

Periodic LNAPL removal is expected to be implemented in the ENB for up to 10 years. Focused biosparging in the WNB is expected to be implemented for up to 5 years. Once the focused biosparging and physical LNAPL removal cease, MNA and NSZD assessments will be conducted for a 3-year period, followed by compliance monitoring until CULs are achieved.

5.2.2 Alternative 2 (A-2): Institutional Controls and Environmental Covenants with Compliance Groundwater Monitoring

This alternative includes implementing a compliance groundwater monitoring program and establishing ICs and environmental covenants to control site uses that could potentially expose receptors to impacted media, including soil and groundwater. The nature of the ICs and environmental covenants described herein is part of each of the five alternatives. Active remediation to reduce adsorbed or dissolved impacts will not occur. Constituent concentrations will continue to be reduced through NSZD and natural attenuation. To limit exposures during construction activities, ICs will be implemented and maintained using an environmental covenant developed in accordance with Ecology procedures. Specifically, the environmental covenant will:

- Control activities that may result in the release of residual COCs, create a new exposure to residual COCs, or disturb the subsurface environment through plans and procedures approved by Ecology.

- Provide notification that residual COCs may be present and include deed restrictions that limit future development and use of the site.
- Prohibit the installation of wells for the purpose of water supply within the site boundary.
- Restrict the extraction of groundwater for purposes other than construction and hydraulic control dewatering, monitoring/investigation, or remediation.
- Require that groundwater extracted within the site boundary be evaluated via data review and testing and the discharge managed in accordance with state and federal regulations.
- Require that utilities or other subsurface infrastructure within the site boundary where the depth is greater than the highest measured groundwater be designed and constructed based on groundwater conditions.

ICs and environmental covenants will be managed in perpetuity or until CULs are met.

5.2.3 Alternative 3 (A-3): LNAPL Containment, MNA, and Targeted Excavation

Alternative A-3 includes containing the LNAPL in the ENB and WNB areas using a sheet pile wall on three sides (east, south, and west) and allowing the LNAPL body to naturally degrade (monitored NSZD). Groundwater beneath the mainline track area and the Engine House area will be assessed for MNA. Biosparging may be implemented in these two areas if DO concentrations are not sustained above 2 mg/L. Elevated dissolved arsenic concentrations will be addressed by remediating petroleum hydrocarbons and the corresponding return of groundwater geochemical parameters to their ambient conditions. This alternative also includes excavating impacted soils in the vadose zone beneath the berm, establishing a groundwater covenant to restrict future use of site groundwater, and long-term groundwater compliance monitoring.

NSZD monitoring will be conducted in the ENB and WNB areas for 3 years following installation of the containment wall. MNA will be conducted in the mainline track area and Engine House area for 3 years. Groundwater monitoring will then shift to a compliance monitoring strategy until CULs are achieved.

5.2.4 Alternative 4 (A-4): Physical LNAPL Removal, Biosparge, MNA, and Targeted Excavation

Similar to the baseline alternative (A-1), this alternative includes removing LNAPL periodically using a mobile vacuum unit in the ENB and remediating LNAPL in the WNB using biosparging. However, after LNAPL RELs have been achieved in the ENB area, biosparging may be implemented to enhance natural biological degradation and further reduce residual petroleum hydrocarbons in the ENB area. Additionally, dissolved phase petroleum hydrocarbons south of the ENB and WNB areas will be treated through biosparging. Once physical removal and biosparging have ceased in the ENB and WNB areas, NSZD monitoring will be initiated. While

LNAPL is being physically removed, groundwater beneath the mainline track area and the Engine House area will be assessed for MNA. Biosparging may be implemented in these two areas if DO concentrations are not sustained above 2 mg/L. Elevated dissolved arsenic concentrations will be addressed by remediating petroleum hydrocarbons and the corresponding return of groundwater geochemical parameters to their ambient conditions. This alternative also includes excavating impacted soils in the vadose zone beneath the berm, establishing a groundwater covenant to restrict future use of site groundwater, and long-term groundwater compliance monitoring.

Periodic LNAPL removal is expected to be implemented in the ENB for up to 10 years. If applied, biosparging to enhance natural biological degradation of LNAPL is expected to be implemented for up to 5 years. Focused biosparging in the WNB and south of the ENB is expected to be implemented for up to 5 years. Once biosparging and physical LNAPL removal ceases, MNA and NSZD assessments will be conducted for a 3-year period, followed by compliance monitoring until CULs are achieved.

5.2.5 Alternative 5 (A-5): Low-Temperature Thermal LNAPL Removal (LTTR), Biosparge, MNA, and Targeted Excavation

Alternative A-5 includes heating the subsurface in the ENB area to enhance physical removal of the LNAPL. The soil in the ENB area will be heated to approximately 50°C to 70°C using electrical resistive heating (ERH) to reduce LNAPL viscosity and increase mobility. ERH is the best way to control temperatures between wells and more uniformly distribute heat throughout the subsurface to alter LNAPL properties for efficient recovery. Removal and heating approaches will be adapted to target specific areas based on observations of improved LNAPL recovery, changes in thickness, and the effect of temperature. After physical removal has achieved practicable limits, biosparging will be implemented in the ENB area to further reduce residual petroleum hydrocarbons. Relatively thinner areas of LNAPL in the WNB and dissolved phase petroleum hydrocarbons south of the ENB will be treated through biosparging.

While LNAPL is being physically removed, groundwater beneath the mainline track area and the Engine House area will be assessed for MNA. Biosparging may be implemented in these two areas if DO concentrations are not sustained above 2 mg/L. Elevated dissolved arsenic concentrations will be addressed by remediating petroleum hydrocarbons and the corresponding return of groundwater geochemical parameters to their ambient conditions. This alternative also includes excavating impacted soils in the vadose zone beneath the berm, establishing a groundwater covenant to restrict future use of site groundwater, and long-term groundwater compliance monitoring.

Thermal treatment of the ENB area is anticipated to occur over a 1- to 2-year period, followed by up to 3 years of biosparging. Focused biosparging in the WNB and south of the ENB is expected to be implemented for up to 5 years. Once biosparging and physical LNAPL removal ceases, MNA and NSZD assessments will be conducted for a 3-year period, followed by compliance monitoring until CULs are achieved.

5.3 Regulatory Requirements

MTCA sets forth the minimum requirements and procedures for selecting a cleanup action. A cleanup action must meet each of the minimum requirements specified in WAC 173-340-360(2), including certain threshold and other requirements. These requirements are outlined below.

5.3.1 Threshold Requirements

A remedial action must meet certain threshold criteria to be considered under the MTCA [WAC 173-340-360 (2)(a)]. An alternative cannot be selected if it cannot meet the following threshold requirements:

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

A cleanup is presumed to be protective of human health and the environment if it achieves the CULs and/or mitigates exposure through controls. Compliance with cleanup standards involves achieving CULs at an appropriate POC, implementing ICs in those areas where remediation to CULs is not appropriate or feasible but RELs have been met. An alternative can comply with applicable federal and state laws by protecting human health and the environment through a combination of active and passive remedial measures and/or the implementation of ICs.

Compliance monitoring assesses the protection of human health and the environment during construction and the O&M period of a cleanup action. Compliance monitoring assesses whether a remedial action has met RELs and/or CULs and verifies its long-term effectiveness. Compliance with the threshold requirements does not imply untreated hazardous substances cannot remain onsite. MTCA recognizes non-treatment alternatives can comply with cleanup standards, provided compliance monitoring is included to confirm protection of human health and the environment.

Table 5-2 summarizes the evaluation of the alternatives in relation to MTCA's threshold criteria. Based on this evaluation, the five proposed alternatives met the threshold criteria - they can achieve CULs; have an acceptable POC; and provide for compliance monitoring.

5.3.2 Other Requirements

In addition, WAC 173-340-360(2)(b) states the cleanup action shall:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration timeframe; and
- Consider public concerns.

WAC 173-340-360(3) describes the specific requirements and procedures for evaluating whether a cleanup action uses permanent solutions to the maximum extent practicable. A permanent solution is defined as one where CULs can be met without further action being required at the site other than the disposal of residue from the treatment of hazardous substances. To evaluate whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis is conducted. This analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors, including:

- Protectiveness;
- Permanent reduction of toxicity, mobility, and volume;
- Cost;
- Long-term effectiveness;
- Short-term risk;
- Implementability; and
- Consideration of public concerns.

The comparison of benefits and costs may be quantitative but will often be qualitative and require the use of best professional judgment.

WAC 173-340-360(4) describes the specific requirements and procedures for evaluating whether a cleanup action provides for a reasonable restoration timeframe.

5.3.3 Groundwater Cleanup Action Requirements

Cleanup actions that address groundwater must meet the specific requirements described in WAC 173-340-360(2)(c). Assuming remedy effectiveness, all five alternatives (A-1 through A-5) meet the requirement for use of a permanent groundwater cleanup action.

5.3.4 Cleanup Action Expectations

WAC 173-340-370 sets forth the following expectations for the development of cleanup action alternatives and the selection of cleanup actions. These expectations represent the types of cleanup actions Ecology considers likely results of the remedy selection process; however, Ecology recognizes that there may be some sites where cleanup actions conforming to these expectations are not appropriate.

- Treatment technologies will be emphasized at sites with liquid wastes, areas with high concentrations of hazardous substances, or with highly mobile and/or highly treatable constituents;

- To minimize the need for long-term management of impacted materials, hazardous substances will be destroyed, detoxified, and/or removed to concentrations below CULs throughout sites with small volumes of hazardous substances;
- ECs, such as containment, may need to be used at sites with large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable;
- To minimize the potential for migration of hazardous substances, active measures will be taken to prevent precipitation and runoff from coming into contact with impacted soil or waste materials;
- When hazardous substances remain on-site at concentrations which exceed CULs, they will be consolidated to the maximum extent practicable where needed to minimize the potential for direct contact and/or migration;
- For sites adjacent to surface water, active measures will be taken to minimize or prevent releases to that water; dilution will not be the sole method for demonstrating compliance;
- Natural attenuation of hazardous substances may be appropriate at sites under certain specified conditions (see WAC 173-340-370(7)); and
- Cleanup actions will not result in a significantly greater overall threat to human health and the environment than other alternatives.

5.3.5 Applicable, Relevant, and Appropriate State and Federal Laws, and Local Requirements

WAC 173-340-710(1) requires that all cleanup actions comply with all applicable local, state, and federal law. It further states that the term "applicable state and federal laws" shall include legally applicable requirements and those requirements that Ecology determines "…are relevant and appropriate requirements." This section presents applicable state and federal law, relevant and appropriate requirements, and local permitting requirements, that were considered and were of primary importance in selecting cleanup requirements. If other requirements are identified at a later date, they will be applied to the cleanup actions at that time.

MTCA provides an exemption from the procedural requirements of several state laws and from any laws authorizing local government permits or approvals for remedial actions conducted under a consent decree, order, or agreed order (RCW 70A.305.110). However, the substantive requirements of a required permit must be met. The procedural requirements of the following state laws are exempted:

- Ch. 70A.15 RCW, Washington Clean Air Act;
- Ch. 70A.205 RCW, Solid Waste Management, Reduction, and Recycling;
- Ch. 70A.300 RCW, Hazardous Waste Management;
- Ch. 77.55 RCW, Construction Projects in State Waters;

- Ch. 90.48 RCW, Water Pollution Control; and
- Ch. 90.58 RCW, Shoreline Management Act of 1971.

WAC 173-340-710(4) sets forth the criteria Ecology evaluates when determining whether certain requirements are relevant and appropriate for a cleanup action. Table 5-3 lists the local, state, and federal laws containing the applicable or relevant and appropriate requirements that apply to the cleanup action at the site. Local laws, which may be more stringent than specified state and federal laws, will govern where applicable.

5.4 Evaluation of Cleanup Action Alternatives

The requirements and criteria outlined in Section 5.3 are used to conduct a comparative evaluation of the cleanup action alternatives and to select a cleanup action from those alternatives. Table 5-2 provides a summary of the ranking of the five alternatives (A-1, A-2, A-3, A-4, and A-5) against the various criteria. The comparative evaluation of the cleanup action alternatives against the requirements and criteria are summarized below.

5.4.1 Threshold Requirements

The following are the minimum requirements to be evaluated under WAC 173-340-360(2)(a) & (b).

5.4.1.1 Protection of Human Health and the Environment

Assuming the remedy is effective, each of the five alternatives is expected to achieve protection of human health and the environment, but over different restoration timeframes (see Section 5.5).

5.4.1.2 Compliance with Cleanup Standards

Assuming the remedy is effective, each of the five alternatives is expected to achieve compliance with cleanup standards, but over different restoration timeframes.

5.4.1.3 Compliance with Local, State, and Federal Laws

Each of the five alternatives is expected to be performed in compliance with applicable state and federal laws listed in Table 5-3. Local laws, which can be more stringent, will govern actions when they are applicable. These would be established during the design phase of the project.

5.4.1.4 Provision for Compliance Monitoring

There are three types of compliance monitoring: protection, performance, and confirmational. Protection monitoring is designed to protect human health and the environment during the construction and operation and maintenance phases of the cleanup action as described in the health and safety plan. Performance monitoring confirms that the cleanup action has met cleanup standards, remediation levels, and/or performance standards. Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been met or other performance standards have been attained.

Alternatives A-1, A-2, A-3, A-4, and A-5 would meet this provision as all would require varying levels of all three types of compliance monitoring.

5.4.2 Other Requirements

5.4.2.1 Use of Permanent Solutions to the Maximum Extent Practicable

To evaluate whether a cleanup action uses permanent solutions to the maximum extent practicable, the disproportionate cost analysis specified in the regulations is used. The analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors. The comparison of costs and benefits may be quantitative but will often be qualitative and require the use of best professional judgment.

Table 5-2 provides a summary of the relative ranking of each alternative in the decision process. The relative ranking of each alternative for each of the evaluation factors is summarized below.

- Protectiveness measures the degree to which existing risks are reduced, time required to reduce risk and attain cleanup standards, on- and off-site risks resulting from implementing the alternative, and improvement of overall environmental quality.

  A-2 and A-3 are protective, but do not actively remove LNAPL, leaving higher potential for future exposure. A-1 and A-4 will remove a fraction of the LNAPL mass, leaving residual mass for NSZD. A-5 will remove LNAPL faster than A-1 and A-4 but will still leave residual mass for NSZD. Active remediation via biosparging is included in A-1, A-4, and A-5 for the western LNAPL area and in A-3, A-4, and A-5 for dissolved phase impacts. Tradeoffs between timeframe and likelihood of effectiveness result in the differential scores among these alternatives. A-1, A-4, and A-5 are similar in intent to actively address LNAPL source and differ in timeframe and approach and are the most protective.

- Permanent reduction of toxicity, mobility, and volume measures the adequacy of the alternative in destroying the hazardous substance(s), the reduction or elimination of releases or sources of releases, the degree of irreversibility of any treatment process, and the characteristics and quantity of any treatment residuals.

  A-2 and A-3 do not provide permanent measures to address site conditions without long-term monitoring or ICs, though A-2 and A-3 provide long-term protection with ongoing maintenance. A-1, A-4, and A-5 would be more permanent than A-2 and A-3 include LNAPL removal to the extent practicable using different methods. Each option includes long-term monitoring.

- Long-term effectiveness measures the degree of success, the reliability of the alternative during the period that hazardous substances will remain above cleanup levels, the magnitude of residual risk after implementation, and the effectiveness of controls required to manage remaining wastes.

A-2 and A-3 provide effective long-term control but rely on controls to protect human health and the environment for a long period of time while hazardous substances remain on site, increasing uncertainty of future protection. A-1, A-4, and A-5 each remove LNAPL, significantly reducing the likelihood of exposure in the future. A-1 and A-4 remove LNAPL at ambient temperatures using simple and measurable methods; changes in LNAPL thickness and transmissivity can be measured over time and risks from unidentified isolated residuals or migration are limited. A-4 uses biosparging as a more active remedy to address dissolved phase impacts. A-5 uses heat to modify the physical properties of the LNAPL to shorten the extraction time; but is not expected to significantly increase the amount of LNAPL removed over the project lifecycle compared to A-1 and A-4.

- Short-term risk measures the risks related to an alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

  A-2 has little to no risk associated with implementation related to ICs and other planned activities are relatively limited in scale. A-3 includes the most invasive and significant construction elements. Installation of sealed interlocking sheet piles to the proposed depths is challenging work that involves the management of significant health and safety risks to workers and the most significant potential environmental impact of the activities in each of the alternatives. A-1 and A-4 include conventional drilling and LNAPL recovery methods that have relatively lower short-term risk ranking among the active remedial approaches. A-5 includes construction risks similar to A-4 with the addition of construction of treatment systems and increased risk from high voltage electrical connections, and the addition of heat to the subsurface system. Operational risks for A-5 include heating of the subsurface to moderate temperatures that pose limited thermal risks. Controlling the temperature to remain between 50 and 70°C limits LNAPL migration and vaporization risks.

- Implementability considers whether the alternative is technically possible, the availability of necessary off-site facilities, services, and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for operations and monitoring, and integrations with existing facility operations.

  A-2 is easily implemented. A-3 includes significant construction elements and is therefore, challenging to implement. Installation of sealed interlocking sheet piles to the proposed depths is challenging work. A-1 and A-4 include conventional drilling and LNAPL recovery methods that are relatively easy to implement. A-5 involves construction implementation methods similar to A-1 and A-4 with the addition of treatment system construction and high voltage electrical connections. For A-5, controlling the temperature to remain between 50 and 70°C is implementable using thermocouples throughout the wellfield.

- Cleanup costs are estimated based on specific design assumptions for each alternative. Although the costs are estimates based on design assumptions that might change, the relative costs can be used for this evaluation. For a detailed description of the costs involved with each alternative, please refer to the Uplands FS Report (KJ 2022).

Alternative	Total
A-1: Physical LNAPL Removal, Focused Biosparge, MNA, and Targeted Excavation	$ 5,067,000
A-2: Institutional Controls and Environmental Covenants with Compliance Groundwater Monitoring	$1,420,000
A-3: LNAPL Containment, Biosparge, MNA, and Targeted Excavation	$6,682,000
A-4: Physical LNAPL Removal, Biosparge, MNA, and Targeted Excavation	$6,983,000
A- 5: LTTR, Biosparge, MNA, and Targeted Excavation	$9,410,000

A-2 is the lowest cost alternative that includes measures to protect human health and the environment, which consist primarily of long-term monitoring and reporting once controls are in place. A-1, A-3, A-4, and A-5 have similar or identical costs for some project elements, including planning, biosparging, shallow excavation, groundwater monitoring, and reporting elements that scale based on the number of locations included or the duration of activities. A-3 and A-4 were ranked the same as their respective costs were within 5 percent. Costs for A-4 and A-5 include biosparge treatment in potentially five areas [western LNAPL area, eastern LNAPL area (after LNAPL removal), and dissolved phase in the southern end of eastern LNAPL area, mainline tracks area, and former Engine House] compared to one area for Alternative 1 (western LNAPL area) and two areas for A-3 (mainline tracks area and former Engine House). The most significant differences in conceptual scope and cost among these alternatives are for the LNAPL remedy. The cost to implement physical removal (A-1 and A-4) is significantly less than the cost to implement LTTR (A-5).

- Consider Public Concerns

  To understand and consider public concerns, Ecology presented the Uplands RI Report and Uplands FS Report for public review and comment. The public comments to the reports indicated a preference for permanent solutions to the maximum extent practicable, which is a requirement under MTCA. This CAP was also presented for public review and comment.

5.4.2.2 Disproportionate Cost Analysis Results

Costs are disproportionate to the benefits if the incremental costs of an alternative are disproportionate to the incremental benefits of that alternative. As described in the Uplands FS Report (KJ 2022), the overall ranking (i.e., the benefit) of each alternative was compared to its cost to provide a benefit/cost ratio. Based on the benefit/cost ratio evaluation, presented graphically in Table 5-4, A-2 is the best alternative for the site. However, as A-2 relies on the mitigation of the direct contact exposure pathway through institutional controls and does not actively remove the LNAPL to the maximum extent practicable, this alternative is eliminated from consideration. Alternatives A-1 and A-4 have similar benefit/cost ratios however A-4 ranks higher in its total weighted benefit. Alternatives A-4 and A-5 have similar benefit/cost ratios and total weighted benefits with A-4 scoring higher than A-5 for each category, however the estimated cost for A-5 is approximately $2.4 million higher than A-4 with no material benefit to cleanup timeframe. Based on the analysis of the factors listed above and as presented in Table 5-4, Ecology determined, following their review of the FS, that while the additional cost of alternative A-5 is disproportionate to its similar benefit to A-4, the additional cost of A-4 is not disproportionate to its incremental benefit over alternative A-1, and therefore A-4 is the best alternative.

5.5 Restoration Timeframe

According to WAC 173-340-360(4)(b), the specific requirements and procedures for assessing whether a cleanup action provides for a reasonable restoration timeframe include:

- Potential risks posed by the site to human health and the environment. As access to the site is strictly controlled, and activities resulting in exposing subsurface impacted materials will be conducted following appropriate ECs, the potential risk to human health and the environment is minimal.

- Practicability of achieving a shorter restoration timeframe. The limiting factor in achieving shorter restoration timeframes is the potential to remove LNAPL and residual petroleum hydrocarbons from below the water table. Alternatives A-1, A-4, and A-5 are estimated to have similar timeframes for LNAPL/petroleum hydrocarbon restoration. The restoration timeframe for alternative A-3 is expected to be longer as it does not include physical removal of the LNAPL.

- Current and potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site. The site is currently operated as a railyard and is expected to remain in that capacity for a long period of time. The surrounding areas are not impacted by the release from the site. Resources (e.g., recreational use of the river, drinking water supply) have not been significantly impacted, and are not expected to be impacted in the future, by the release from the site.

- Availability of alternative water supplies. Drinking water supplies for the City of Wishram have not been, and are not expected to be, impacted by the release from the site.

- Likely effectiveness and reliability of institutional controls. Institutional controls are expected to remain effective and in place for the foreseeable future.

- Ability to control and monitor migration of hazardous substances from the site. Four of the five cleanup alternatives (A-1, A-3, A-4, and A-5) present similar activities for control and monitoring migration of the site constituents. Cleanup alternative A-2 includes monitoring activities but does not include active remediation to reduce or control adsorbed or dissolved impacts.

- Toxicity of the hazardous substances at the site. Site constituents will naturally degrade and become less toxic over time.

- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions. There are numerous studies demonstrating that petroleum hydrocarbons will naturally degrade over time.

Additionally, WAC 173-340-360(4)(c) states that "*A longer period of time may be used for the restoration time frame for a site to achieve cleanup levels at the point of compliance if the cleanup action selected has a greater degree of long-term effectiveness than on-site or offsite disposal, isolation, or containment options.*" Alternatives A-1, A-4, and A-5 have shorter estimated restoration timeframes than Alternatives A-2 and A-3, as these three alternatives include removal of the LNAPL from the subsurface.

Based on the regulatory considerations, site-specific conditions (including data collected during RI and FS field activities for LNAPL physical properties, LNAPL removal, and estimated NSZD rates), literature biodegradation rate estimates (Hinchee and Ong 1992), and the assessment of the remedial technologies summarized in the FS, three of the five remedial alternatives (A-1, A-4, and A-5) are expected to have similar restoration timeframes (approximately 30 to 55 years). The initiation of the restoration timeframe starts following construction, start-up, and an initial period of shakedown for the selected cleanup action. For Alternative A-4, LNAPL removal is anticipated to be implemented for up to 10 years. Following LNAPL removal, biosparging will be implemented, if needed, to increase dissolved oxygen concentrations and further stimulate biodegradation of the residual petroleum hydrocarbons. Following physical LNAPL removal and biosparging (if needed), natural attenuation (NSZD) processes will be monitored to ensure destruction of the remaining residual petroleum hydrocarbons.

The proposed remedy includes ICs and ECs as part of the remedy. Accordingly, Ecology will perform a periodic review once every 5 years after initiation of the cleanup action as required under WAC 173-340-440 and as described in WAC 173-340-420.

Section 6: Selected Remedial Action

Based on the regulatory considerations, site-specific conditions, and the assessment of the remedial technologies summarized in the FS, alternative A-4 has been selected as the proposed remedial action for the site. Based on the available data, the timeframe to achieve restoration (time to reach CULs) is approximately 30 to 55 years. The initiation of the restoration timeframe starts following construction, start-up, and an initial period of shakedown for the selected cleanup action. The proposed remedy includes ICs and ECs as part of the remedy. Accordingly, Ecology will perform a periodic review once every 5 years after initiation of the cleanup action as required under WAC 173-340-440 and as described in WAC 173-340-420.

The selected remedy is protective of potential receptors and considers overall environmental impact and sustainability, while avoiding implementation challenges, performance uncertainty, and short-term impacts posed by alternative A-5. While LNAPL removal at ambient temperature results in a longer LNAPL remediation timeframe, the estimated restoration timeframe for the selected remedy is similar to alternatives A-1 and A-5. Because the LNAPL is not migrating towards the river, the additional time anticipated for physical removal does not represent an increased risk to the environment. As the site’s use as an active railyard is not expected to change for the foreseeable future, the remedy will not result in impacts to current or future use of the site, and ICs will be easily implemented and maintained.

The selected remedy involves physical removal of LNAPL in the ENB area, biosparging in the WNB area and at the southern end of the ENB area, MNA assessment in the mainline track area and beneath the former Engine House area, and excavation of shallow impacted soils in a portion of the berm area. Based on soil gas monitoring for NSZD parameters in the ENB area, biosparging may be implemented in the ENB after RELs for physical LNAPL recovery have been achieved. Biosparging is expected to enhance the attenuation of residual petroleum hydrocarbons and eliminate the transport of dissolved phase petroleum hydrocarbons towards the river during high groundwater conditions. Monitored NSZD in the ENB and WNB and MNA for dissolved impacts in the area south of the ENB and WNB areas, the mainline track area, and the Engine House area will be implemented once RELs for active remediation have been met. The selected remedial action uses ECs, including removal and destruction technologies, along with ICs, to control exposures to potential receptors (onsite workers, visitors, nearby residents, trespassers, and surface water).

The key components of the selected remedy are depicted on Figure 6-1.

6.1 Design and Permitting

An Engineering Design Report (EDR) and a Compliance Monitoring Plan (CMP) will be submitted for Ecology’s review and approval. The EDR will document the design-basis, civil/mechanical design, and permitting necessary for implementing the primary cleanup actions (i.e., installing wells, physical LNAPL removal, biosparging, and excavating shallow soils). The CMP will describe protection, performance, and confirmation monitoring to be conducted during and following implementation of the cleanup actions.

6.1.1 Engineering Design Report

In advance of and to support completion of the Draft EDR, additional data will need to be collected. Assessments are anticipated to include, but not be limited to, conducting LNAPL removal tests to evaluate extraction well spacing, conducting a biosparging pilot test, and baseline parameter monitoring data for LNAPL removal, biosparge, and MNA. The data will be evaluated to develop full-scale system design parameters as well as potential adaptive management and optimization concepts for LNAPL removal and the biosparging system. A work plan for obtaining the information will be prepared and executed as the first step in the remedial design process. The work plan will include a Health and Safety Plan detailing the potential project hazards and the actions to be taken to address and respond to hazards.

The following documents will be prepared in conjunction with the EDR under separate cover:

- Engineering Plans and Specifications: Prepared during the remedial design phase to provide details adequate to support the implementation of the cleanup action and to serve as a basis for contractor bidding.

- System Operations and Maintenance Plan: Details the practices and procedures necessary to operate and maintain the mechanical systems. The plan will provide information on process operating procedures, process data collection/reporting, and preventative maintenance.

6.1.2 Compliance Monitoring Plan

A CMP as specified in WAC 173-340-410 will be prepared as part of the remedial design phase to detail the scope, parameters, methods, and frequency to monitor remediation performance, inform system optimizations, and evaluate attainment of CULs. A Sampling and Analysis Plan (SAP) and a Quality Assurance Project Plan (QAPP) meeting the requirements of WAC 173-340-820 will be included in the CMP. The SAP will identify groundwater monitoring frequencies and analytical tests to be performed during cleanup activities (protection and performance monitoring) and for the duration of the compliance period (confirmational monitoring).

6.1.2.1 Protection Monitoring

Health and safety measures are required for those individuals working at and visiting the site who may reasonably be expected to come into contact with impacted media (1) during cleanup action construction (e.g., during excavation of petroleum-impacted soil and installation of LNAPL recovery and biosparge wells) or (2) during implementation of the remedial action (e.g., removing LNAPL from recovery wells). The remediation contractor(s) will prepare a site Health and Safety Plan. Health and safety measures, including protection monitoring to be implemented during construction activities, will be described in the Health and Safety Plan. A separate Health and Safety Plan will be prepared for use during remediation system Operations and Maintenance (O&M) activities.

6.1.2.2 Performance Monitoring

Performance monitoring will be conducted at startup of the biosparging systems, during LNAPL removal activities, and periodically during O&M. Performance monitoring will also include the MNA monitoring planned in areas with dissolved phase impacts and following shutdown of the active remediation systems.

Performance monitoring for physical LNAPL removal to evaluate when to transition away from active removal is based on the mobility of the LNAPL and potential for the LNAPL to migrate. Monitoring will include periodic measurements of ambient-temperature LNAPL transmissivity and apparent LNAPL thickness.

Performance groundwater monitoring will be performed to demonstrate conditions needed for biological degradation are present, natural attenuation is occurring, and the groundwater COC impacts are stable or decreasing. MNA includes periodically collecting groundwater samples for field water quality parameters [e.g., DO and ORP] and conducting specific laboratory analyses to confirm the natural processes are occurring. Groundwater sampling for COCs will also be collected in dissolved phase impacted areas to evaluate attainment of CULs.

Quality assurance/quality control (QA/QC) samples will be collected and analyzed during O&M activities and evaluated for conformance with the data quality objectives (DQOs).

6.1.2.3 Confirmation Monitoring

Groundwater confirmation monitoring will be conducted to evaluate groundwater cleanup progress until cleanup standards are met. The CMP will identify the specific requirements for future groundwater monitoring activities at the site. Monitoring well locations, sampling methods, analyses to be performed and sampling frequency will be identified in the CMP.

6.1.3 Permitting

A Joint Aquatic Resources Permit Application (JARPA) will be prepared for construction and excavation near the Columbia River. Permits will be obtained, including well permits for the LNAPL removal wells, biosparge wells, and associated monitoring wells; and building permits for the biosparge systems. Subsurface intrusive activities will include cultural resources monitoring completed in accordance with the CRMP under permit from DAHP. Because the biosparge systems will not result in discharges to the atmosphere, an air permit is not needed. Samples of the LNAPL and groundwater in the extraction wells will be collected and analyzed for waste profiling and to identify disposal methods. Discharge of wastewater to the local POTW, if necessary, will require submittal, and approval by the Klickitat County Public Utility District, of an industrial waste discharge permit. The permit will identify estimated discharge volumes, concentration limits, and monitoring requirements.

6.2 Site Preparation

Activities will include grading for equipment access, delineation of work zones and laydown areas, and identification of underground utilities within the footprint of the drilling and excavation areas. Utilities impacted by the remedial activities will be relocated, removed, or abandoned in-place as appropriate.

6.3 System Installation

In the ENB area, existing OHM wells and new recovery wells installed within the LNAPL extent will be used for LNAPL removal. Current estimates assume up to 15 new LNAPL recovery wells will be installed within the ENB area, on approximately 40-foot centers. New recovery wells will be constructed of 4- to 6-inch-diameter, stainless steel wire-wrapped screen connected to stainless steel or PVC blank risers.

Biosparge system installation includes constructing treatment pads/sheds, and furnishing air compressors, programmable logic controllers, distribution manifolds, values, sensors, and other appurtenances. System installation also includes trenching to place distribution piping, and well installation. In the WNB area, five shallow biosparge wells will be installed to depths between approximately 20 to 40 feet bgs; and three paired shallow (25 feet bgs) and deep (60 feet bgs) wells will be installed. At the south end of the ENB area, 10 paired shallow and deep biosparge wells will be installed (Figure 6-1). The number, location, and depth of biosparge wells in each area may change during preparation of the EDR, or at the time of installation, based on field conditions.

6.4 System Operation and Monitoring

LNAPL will be removed from wells by periodic high-vacuum extraction or other methods depending on field implementation testing and the results of future LDRM assessments. Adequate time will be allowed for LNAPL to recharge prior to subsequent extraction events. Between extraction events, the presence and apparent thickness of the LNAPL will be monitored. Physical removal will allow for an adaptive management strategy whereby the removal frequency is increased or decreased on a per well basis, based on observed site conditions. Once LNAPL removal in the ENB area has met its design objectives (i.e., RELs), active remediation will be discontinued and monitored NSZD will be assessed. Based on soil gas monitoring for NSZD parameters in the ENB area, biosparging may be implemented in the ENB area to further enhance biodegradation.

Biosparging will be implemented in the WNB and south of the ENB concurrent with LNAPL removal from ENB wells. MNA monitoring will be assessed in the mainline track and Engine House areas at the beginning of the active remediation program, to determine if biosparging will be implemented in these areas. MNA will be assessed in general accordance with Ecology's NA Guidance (Ecology 2005) and will include collecting groundwater samples for DRO, ORO, and NA parameters.

Where implemented, biosparging will continue until DO concentrations are sustained above 2 mg/L, at which time biosparging will be discontinued. MNA for dissolved impacts will then be assessed in the biosparge areas. A contingency for restarting the biosparge system(s) will be included in the EDR if future groundwater concentrations indicate NA will not achieve CULs within the restoration timeframe. The contingency plan will be based on decision criteria included in Ecology's NA guidance document. Compliance groundwater monitoring will be implemented following completion of the MNA assessment and will include monitoring for geochemical parameters and laboratory analysis for COCs.

6.5 Shallow Soil Excavation

Approximately 170 cubic yards of petroleum hydrocarbon-impacted soils on the northern side of the berm south of the former Power House (Figure 6-1) will be excavated and disposed offsite at a permitted facility. Impacted soils are anticipated to be encountered at depths between approximately 6 and 9 feet bgs. The vertical and lateral extents of soils exceeding the CULs will be confirmed in advance of conducting the physical removal to minimize the time the excavation near the riverbank remains open. The excavation extent will be confirmed by advancing soil borings using a direct push drill rig and collecting soil samples for laboratory analysis.

The excavation process will include removing and stockpiling soil from the upper 6 feet for testing for potential reuse as backfill material. The impacted soils estimated to be between 6 and 9 feet bgs will then be excavated, stockpiled separately, and characterized for disposal at an offsite licensed Subtitle D landfill facility as non-hazardous waste.

Excavation sidewalls will be sloped appropriately for safety; however, workers will not be allowed to enter the excavation. In situ confirmation samples will be collected in advance of performing the removal activities, therefore, no sampling is anticipated at the time of the excavation. The excavation will be backfilled with the overburden material, as well as clean fill material (imported from a local quarry) and compacted to existing grade. Dewatering is not expected to be needed based on the known depth of the impacted soils (9 feet bgs) and the average depth to groundwater (10 to 15 feet bgs beneath the berm).

6.6 Schedule

Implementation of the cleanup action will occur under a future Consent Decree. A detailed schedule for implementing the cleanup action will be provided as part of the EDR. Preparation of the EDR and a work plan to collect additional pre-design information will begin following issuance of the Consent Decree by Ecology. Documents to be provided following preparation of the EDR include:

- Engineering Plans and Specifications
- Operations and Maintenance Plan
- CMP including SAP/QAPP

6.7 Institutional Controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of a cleanup action or that may result in exposure to hazardous substances at a site (WAC 173-340-440). To limit exposures during construction activities, ICs in the form of an environmental covenant will be developed, implemented, and maintained in accordance with Ecology procedures.

Environmental covenants will be enacted on the railyard property and the two off-railyard properties owned by Fire District #11 to control activities that may result in the release of residual COCs, create a new exposure to residuals COCs, or disturb the subsurface environment through plans and procedures approved by Ecology; prohibit the installation of wells for the purpose of water supply; restrict the extraction of groundwater for purposes other than construction and hydraulic control dewatering, monitoring/investigation, or remediation; and require groundwater extracted within the site boundary be evaluated via data review and testing and the discharge managed in accordance with state and federal regulations. The enacted environmental covenants will be managed in perpetuity or until CULs are met.

As the proposed remedy includes ICs and ECs, Ecology will perform a periodic review once every 5 years after initiation of the cleanup action as required under WAC 173-340-440 and as described in WAC 173-340-420.

6.8 Public Participation

Ecology will coordinate with relevant federal, state, and local agencies regarding permits needed for the cleanup action. Public notice and participation will be provided in accordance with WAC 173-340-600. Ecology may require BNSF's assistance regarding permitting as provided under the agreement that will implement the cleanup.

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Tables

SUMMARY OF CLEANUP LEVELS (CULs)
BNSF Wishram Railyard, Wishram, Washington

Media / COCs	Units	CUL Value	CUL Value Source[a]
On-Railyard Property Soil - Vadose Zone			
Diesel-Range Organics	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
Oil-Range Organics	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
Total TPH-Dx	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
On-Railyard Property Soil - Saturated Zone			
Gasoline-Range Organics	mg/kg	30	Method A for Industrial Properties (Table 745-1)
Diesel-Range Organics	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
Oil-Range Organics	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
Total TPH-Dx	mg/kg	2,000	Method A for Industrial Properties (Table 745-1)
Groundwater			
Diesel-Range Organics	µg/L	500	Method A (Table 720-1)
Oil-Range Organics	µg/L	500	Method A (Table 720-1)
Total TPH-Dx	µg/L	500	Method A (Table 720-1)
1-Methylnaphthalene	µg/L	1.5	Method B Cancer
Arsenic, total	µg/L	5	Background
Barium, total	µg/L	2,000	Maximum Contaminant Level (WA State and Federal)
Iron, total	µg/L	11,000	Method B Noncancer
Manganese, total	µg/L	750	Method B Noncancer
Light Non-Aqueous Phase Liquid (LNAPL)			
LNAPL		No Detectable LNAPL	WAC 173-340-360(2)(c)(ii)
Surface Water			
Diesel-Range Organics	µg/L	500 / 3,000	Method A / Aquatic Life Protective Value
Oil-Range Organics	µg/L	500 / 3,000	Method A / Aquatic Life Protective Value
Total TPH-Dx	µg/L	500 / 3,000	Method A / Aquatic Life Protective Value
1-Methylnaphthalene	µg/L	2.1	Risk Assessment Information System (RAIS)
Arsenic, total	µg/L	5	Background
Barium, total	µg/L	220	USEPA Ecological Risk Assessment Supplemental Guidance
Lead, total	µg/L	2.5	Aquatic Life Water Quality Criteria (173-201A / CWA §304)
Iron, dissolved	µg/L	1,000	Aquatic Life Water Quality Criteria (CWA §304)
Manganese, dissolved	µg/L	50	Human Health Water Quality Criteria (CWA §304)

Media / COCs	Units	CUL Value	CUL Value Source[a]
Off-Railyard Property Soil - Vadose Zone			
Diesel-Range Organics	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)
Oil-Range Organics	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)
Total TPH-Dx	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)
Off-Railyard Property Soil - Saturated Zone			
Gasoline-Range Organics	mg/kg	30	Method A for Unrestricted Land Use (Table 740-1)
Diesel-Range Organics	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)
Oil-Range Organics	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)
Total TPH-Dx	mg/kg	2,000	Method A for Unrestricted Land Use (Table 740-1)

Notes:

CUL = Cleanup level. Refer to Appendix B to the Feasibility Study Report for more information.
Total TPH-Dx = Total TPH-Dx concentrations calculated by summing diesel-range organics (DRO) and oil-range organics (ORO) concentrations.
WAC = Washington Administrative Code
"µg/L" = micrograms per liter
"mg/kg" = milligrams per kilogram
COC = Constituents of concern

(a) Cleanup Level Value Sources:

Soil On BNSF Railyard Property - Restricted / Industrial CULs:
Soil Cleanup level values based on Ecology Model Toxics Control Act (MTCA) MTCA Method A for Industrial Properties (Table 745-1) values for soil based on WAC 173-340-745 from Cleanup Levels and Risk Calculation (CLARC) tables (updated July 2024).

Soil Off BNSF Railyard Property - Unrestricted CULs for soil in non-industrial use (zoned or otherwise) areas:
Cleanup level values based on Ecology MTCA Method A for Unrestricted Land Use (Table 740-1) values for soil based on WAC 173-340-740 from CLARC tables (updated July 2024).

Groundwater: Cleanup level values based on MTCA Method B values (B Cancer or B Non Cancer) and MTCA Method A values for groundwater (Table 720-1) based on Washington State Administrative Code (WAC) 173-340-720 from CLARC tables (updated July 2024), and Washington State (246-290 WAC) and Federal (40 CFR 141) Maximum Contaminant Levels (MCLs).

Surface Water: Cleanup level values based on Ecology MTCA Method B values (B Cancer or B Non Cancer), MTCA Method A values and other applicable, relevant, and appropriate requirements (ARARs) under applicable state (173-201A-240 WAC) and federal laws [Section 304 of the Clean Water Act (CWA); 40 CFR Subpart D 131.45] for surface water based on WAC 173-340-730 from CLARC tables (updated July 2024). Aquatic Life Protective Values, from Concentrations of Gasoline and Diesel Range Organics Predicted to be Protective of Aquatic Receptors in Surface Waters, Implementation Memorandum No. 23 (Ecology, August 25, 2021) and from CLARC tables (updated July 2024).
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TABLE 5-1

SUMMARY OF REMEDIAL ALTERNATIVES
BNSF Wishram Railyard

Remedial Alternative	Description
Alternative 1 - Physical LNAPL Removal, Focused Biosparge, MNA, and Targeted Excavation	
Excavate Shallow Impacted Soils	Excavate impacted soils in the vicinity of soil boring B-16-01, located to the south of the former power house. Total excavation volume of approximately 600 cubic yards. Laboratory testing to evaluate reuse of non-impacted soil on railyard and transport and offsite disposal of impacted soil, assumed to be non-hazardous waste.
Remove Mobile LNAPL in eastern LNAPL area	Periodically extract LNAPL from eastern portion of LNAPL body using approximately 15 new recovery wells and three existing OHM wells, allowing adequate time for recharge of LNAPL into extraction points between events. Monitor presence and amount of LNAPL. Offsite disposal of extracted fluids during implementation. NSZD of residual impacts in source area after drainable LNAPL is removed.
Focused biosparging in western LNAPL area.	Contingent on MNA assessment, install shallow and paired shallow and deep (between 20 and 40 feet bgs) biosparging wells in the western LNAPL area. Sparge air to stimulate biological degradation of LNAPL impacts in the western LNAPL area. Groundwater monitoring will be performed during operation of biosparging system. NSZD of residual impacts in western LNAPL area after cessation of biosparging.
Groundwater MNA and NSZD of Residual Petroleum Hydrocarbons	Conduct MNA assessment for dissolved phase petroleum in the mainline track area, beneath the former Engine House, and south of the eastern LNAPL area (just north of the river berm). Monitor groundwater for natural attenuation parameters to assess degradation of dissolved-phase petroleum hydrocarbons. MNA and NSZD used as polishing step following cessation of active treatment (biosparging and LNAPL removal). Compliance groundwater monitoring will be implemented at the site following MNA.
Alternative 2 - Institutional Controls (ICs) and Environmental Covenants (ECs) with Compliance Groundwater Monitoring	
Institutional Controls and Environmental Covenants	Develop institutional controls for the site and file environmental covenants to limit exposures to potential receptors (onsite workers, visitors, and nearby residents). Compliance groundwater monitoring will be implemented in selected wells. Constituent concentrations gradually decrease via natural source zone depletion and natural attenuation.
Alternative 3 - LNAPL Containment, Biosparge, MNA, and Targeted Excavation	
Excavate Shallow Impacted Soils	Excavate impacted soils in the vicinity of soil boring B-16-01, located to the south of the former power house. Total excavation volume of approximately 600 cubic yards. Laboratory testing to evaluate reuse of non-impacted soil on railyard and transport and offsite disposal of impacted soil, assumed to be non-hazardous waste.
Sheet Pile Wall	Install a sheet pile wall from ground surface to bedrock along three sides (eastern, southern, western) of the LNAPL areas to provide physical containment. No active treatment of source area. A Groundwater Covenant will be enacted to restrict future use of site groundwater.
Natural Source Zone Depletion (NSZD) of LNAPL	NSZD monitoring of residual petroleum hydrocarbons and LNAPL within contained area.
Biosparging mainline track area and former Engine House	Contingent on MNA assessment, install shallow (25 feet bgs) biosparging wells in the mainline track area and beneath the former Engine House, and sparge air to stimulate biological degradation of dissolved-phase petroleum hydrocarbons. Groundwater monitoring will be performed during operation of biosparging system.
Groundwater Monitored Natural Attenuation (MNA)	Following installation of the sheet pile containment wall, monitor groundwater for degradation of dissolved-phase petroleum hydrocarbons. MNA used as polishing step following cessation of active treatment (biosparging). Compliance groundwater monitoring will be implemented at the site following MNA.
Alternative 4 - Physical LNAPL Removal, Biosparge, MNA, and Targeted Excavation	
Excavate Shallow Impacted Soils	Excavate impacted soils in the vicinity of soil boring B-16-01, located to the south of the former power house. Total excavation volume of approximately 600 cubic yards. Laboratory testing to evaluate reuse of non-impacted soil on railyard and transport and offsite disposal of impacted soil, assumed to be non-hazardous waste.
Remove Mobile LNAPL in eastern LNAPL area	Periodically extract LNAPL from eastern portion of LNAPL body using approximately 15 new recovery wells and three existing OHM wells, allowing adequate time for recharge of LNAPL into extraction points between events. Monitor presence and amount of LNAPL. Offsite disposal of extracted fluids during implementation. NSZD of residual impacts in source area after drainable LNAPL is removed. Biosparging may be needed following cessation of LNAPL removal to stimulate further degradation of residual hydrocarbons, if groundwater remains impacted.
Biosparging mainline track area, former Engine House, western LNAPL area and south of eastern LNAPL area	Contingent on MNA assessment, install shallow (between 20 and 40 feet bgs) biosparging wells in the mainline track area, beneath the former Engine House and in the western LNAPL area, and install paired shallow (25 feet bgs) and deep (60 feet bgs) biosparging wells south of the eastern LNAPL area (just north of the river berm). Sparge air to stimulate biological degradation of LNAPL impacts (in the western LNAPL area) and dissolved-phase petroleum hydrocarbons. Groundwater monitoring will be performed during operation of biosparging system. NSZD of residual impacts in western LNAPL area after cessation of biosparging.
Groundwater MNA and NSZD of Residual Petroleum Hydrocarbons	Monitor groundwater for natural attenuation parameters to assess degradation of dissolved-phase petroleum hydrocarbons. MNA and NSZD used as polishing step following cessation of active treatment (biosparging and LNAPL removal). Compliance groundwater monitoring will be implemented at the site following MNA.
Alternative 5 - Low-Temperature Thermal Removal (LTTR), Biosparge, MNA, and Targeted Excavation	
Excavate Shallow Impacted Soils	Excavate impacted soils in the vicinity of soil boring B-16-01, located to the south of the former power house. Total excavation volume of approximately 600 cubic yards. Laboratory testing to evaluate reuse of non-impacted soil on railyard and transport and offsite disposal of impacted soil, assumed to be non-hazardous waste.
Low-Temperature Subsurface Heating and Mobile LNAPL Removal	Heat eastern portion of LNAPL body to approximately 50 to 70°C to reduce viscosity. Install stainless steel multiphase extraction wells for LNAPL recovery. Aboveground treatment of extracted fluids, off-site disposal of recovered LNAPL (or total fluids). Elevated subsurface temperatures will increase biological degradation through thermogenic bacteria. NSZD of residual impacts in source area after drainable LNAPL is removed and system cools to ambient temperatures. Biosparging may be used as a contingency remedy following cessation of LNAPL removal to increase oxygen concentrations in saturated interval and further stimulate degradation of residual hydrocarbons.
Biosparging mainline track area, former Engine House, western LNAPL area and south of eastern LNAPL area	Contingent on MNA assessment, install shallow (between 20 and 40 feet bgs) biosparging wells in the mainline track area, beneath the former Engine House and in the western LNAPL area, and install paired shallow (25 feet bgs) and deep (60 feet bgs) biosparging wells south of the eastern LNAPL area (just north of the river berm). Sparge air to stimulate biological degradation of LNAPL impacts (in the western LNAPL area) and dissolved-phase petroleum hydrocarbons. Groundwater monitoring will be performed during operation of biosparging system. NSZD of residual impacts in western LNAPL area after cessation of biosparging.
Groundwater MNA and NSZD of Residual Petroleum Hydrocarbons	Monitor groundwater for natural attenuation parameters to assess degradation of dissolved-phase petroleum hydrocarbons. MNA and NSZD used as polishing step following cessation of active treatment (biosparging and LNAPL removal). Compliance groundwater monitoring will be implemented at the site following MNA.

Notes: LNAPL = light non-aqueous phase liquid. NSZD = natural source zone depletion. MNA = monitored natural attenuation. OHM = oil-head monitoring. bgs = below ground surface.

TABLE 5-2

EVALUATION OF CLEANUP ACTION ALTERNATIVES
BNSF Wishram Railyard

Criteria		A-1 Physical LNAPL Removal, Focused Biosparge, MNA and Targeted Excavation	A-2 ICs and ECs with Compliance GWM	A-3 LNAPL Containment, Biosparge, MNA and Targeted Excavation	A-4 Physical LNAPL Removal, Biosparge, MNA and Targeted Excavation	A-5 LTTR, Biosparge, MNA and Targeted Excavation
Threshold Requirements						
Protection of human health & environment		yes	yes	yes	yes	yes
Compliant with cleanup standards		yes	yes	yes	yes	yes
Compliant with state & federal laws		yes	yes	yes	yes	yes
Provision for compliance monitoring		yes	yes	yes	yes	yes
Other Requirements						
Use of Permanent Solutions (disproportionate cost analysis - Relative Benefit/Cost Ratio) [(a)]	Weighting Factor	Rank #2	Rank #1	Rank #5	Rank #3	Rank #4
Protectiveness	30%	5	2	4	6	7
Permanent Reduction	20%	7	2	3	7	7
Long-term Effectiveness	20%	7	3	4	9	9
Short-term Risk	10%	8	9	3	8	4
Implementability	10%	8	9	5	8	6
Consider Public Concerns	10%	6	3	4	6	7
Cleanup Cost (rank)		6	9	5	5	1
Cleanup Cost (PLP-estimated)		$5,067,000	$1,420,000	$6,682,000	$6,983,000	$9,410,000
Total Relative Score (with cleanup cost rank)		76	61	44	80	67
Total Weighted Benefits		6.5	3.7	3.8	7.2	7.0
BENEFIT/COST RATIO		0.1	0.1	0.1	0.1	0.0
BENEFIT/COST RATIO Relative to Most Permanent Alternative (A-1)		1.0	2.1	0.4	0.8	0.6
Provide reasonable Restoration Time Frame		yes	yes	yes	yes	yes
Consider Public Comments		yes	yes	yes	yes	yes

Notes:
(a) Ranking order for Disproportionate Cost Analysis (DCA) based on the Benefit/Cost Ratio relative to the most permanent alternative (A-1). Further details on the DCA and weighting factors were provided in the Uplands FS Report (KJ 2022). A weighting factor was not applied to the Cleanup Cost (rank). Graphical representation of the DCA is provided in Table 5-4.

Abbreviations
PLP = potentially liable person per Revised Code of Washington (RCW) 70A.305.020(26).
ICs and ECs with Compliance GWM = Institutional Controls and Environmental Covenants with Compliance Groundwater Monitoring
LNAPL = light non-aqueous phase liquid
MNA = Monitored Natural Attenuation
LTTR = Low-Temperature Thermal Removal

TABLE 5-3

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE CLEANUP ACTION
BNSF Wishram Railyard, Wishram, Washington

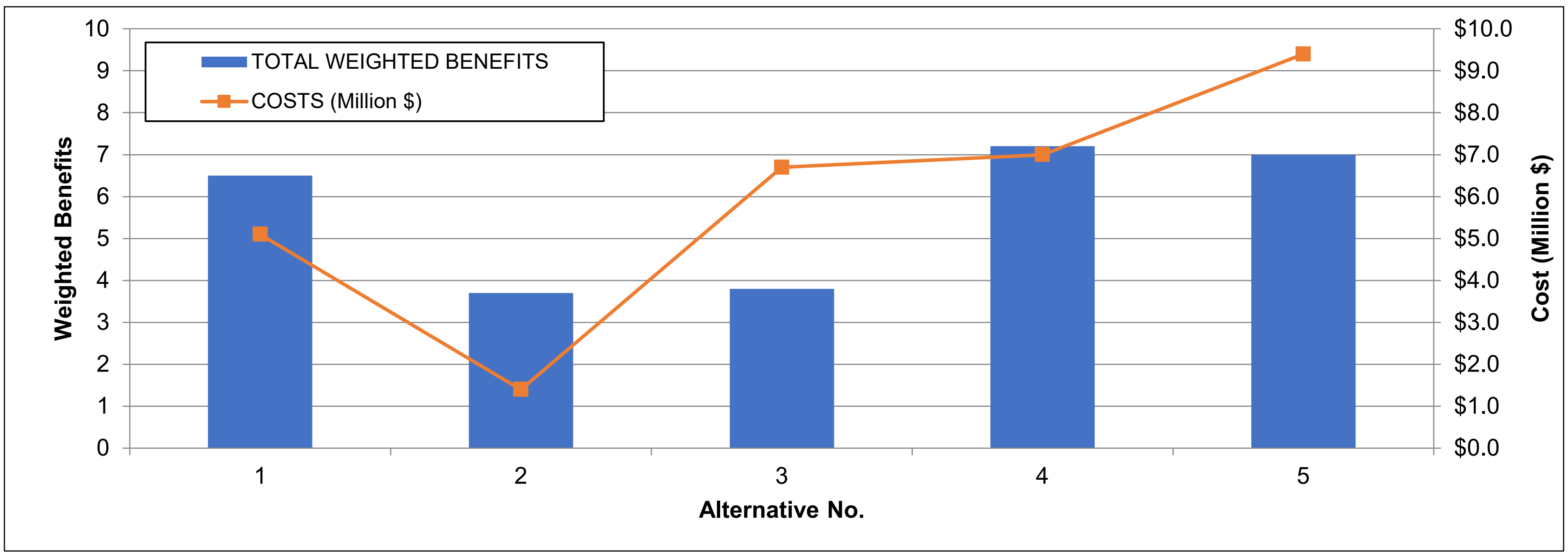
Jurisdiction	Summary of ARARs		Applicability of ARARs
Klickitat County Regulations	Ch. 13.12 KCMC	Sewer Administrative Code	Applicable for discharge to POTW
	Ch. 20 KCMC	Environmental impact	Applicable for planning phase of project
State of Washington Regulations	Ch. 173-18 WAC	Shoreline Management Act—Streams and rivers constituting shorelines of the state	Applicable for activities near the banks of the Columbia River
	Ch. 173-27 WAC	Shoreline management permit and enforcement procedures	Applicable for activities near the banks of the Columbia River
	Ch. 173-160 WAC	Minimum standards for construction and maintenance of wells	Applies to the construction of new wells on site and ongoing use of existing wells
	Ch. 173-162 WAC	Regulation and licensing of well contractors and operators	Applies to the installation and decommissioning of wells
	Ch. 173-201A WAC	Water quality standards for surface waters	Applies to clean-up levels established for site
	Ch. 173-216 WAC	State waste discharge permit program	Applies to the discharge of wastes generated during the remedial action
	Ch. 173-218 WAC	Underground injection control program	Applies to injection activities
	Ch. 173-303 WAC	Dangerous waste regulations	May apply to waste generated during the project
	Ch. 173-304 WAC	Minimum functional standards for solid waste handling	Applies to solid wastes generated during the remedial action
	Ch. 173-340 WAC	Model Toxics Control Act—Cleanup	Applies to all on-site work
	Ch. 173-350 WAC	Solid waste handling standards	Applies to solid wastes generated during the remedial action
	Ch. 197-11 WAC	SEPA rules	Applies to all on-site work
	Ch. 18.104 RCW	Water well construction	Applies to the construction of new wells on site
	Ch. 70.105D RCW	Hazardous Waste Cleanup - Model Toxics Control Act	Applies to all on-site work
	Ch. 90.48 RCW	Water pollution control	Applies to all on-site work
	Ch. 90.58 RCW	Shoreline Management Act of 1971	Applies to work performed along the shoreline of the Columbia River
Federal Regulations	29 CFR 1910	Occupational Safety and Health Standards	Applies to all on-site work
	42 USC 7401	Clean Air Act of 1977	Applies to all on-site work
	40 CFR 50	National Ambient Air Quality Standards	Applies to all on-site work
	40 CFR 141	Drinking Water Regulations	Applies to clean-up levels established for site
	CWA §304	Clean Water Act	Applies to clean-up levels established for site
	40 CFR 260-268	Hazardous Waste Regulations	Applies to all on-site work that generates hazardous waste

ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CWA = Clean Water Act
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
TESC = Temporary Erosion and Sediment Control
USC = U.S. Code
WAC = Washington Administrative Code
KCMC = Klickitat County Municipal Code

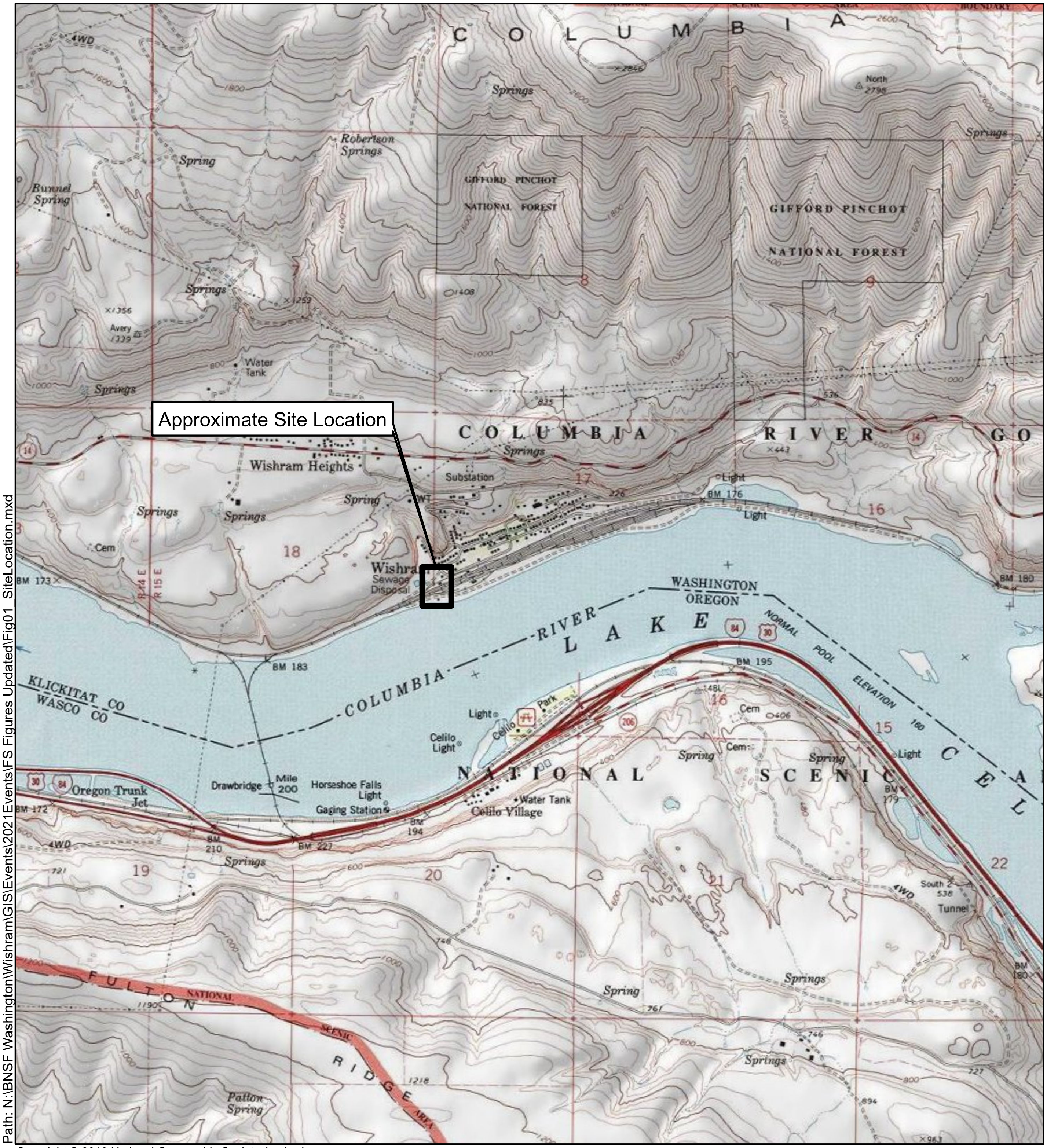
TABLE 5-4

BENEFIT/COST ANALYSIS
BNSF Wishram Railyard

		Disproportionate Cost Analysis				
BENEFITS	**Weighting Factor**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**
Protectiveness	30%	5	2	4	6	7
Permanence	20%	7	2	3	7	7
Long-Term Effectiveness	20%	7	3	4	9	9
Short-term Risk	10%	8	9	3	8	4
Ability to Implement	10%	8	9	5	8	6
Consideration of public concerns	10%	6	3	4	6	7
TOTAL WEIGHTED BENEFITS	**100%**	**6.5**	**3.7**	**3.8**	**7.2**	**7.0**
COSTS (Million $)	**--**	**$5.1**	**$1.4**	**$6.7**	**$7.0**	**$9.4**
BENEFIT/COST RATIO		1.3	2.6	0.6	1.0	0.7
BENEFIT/COST RATIO Relative to Most Permanent Alternative (Alternative 1)		1.0	2.1	0.4	0.8	0.6



Figures



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Note:
1. Locations are approximate.

Kennedy/Jenks Consultants

BNSF Wishram Railyard
Wishram, Washington

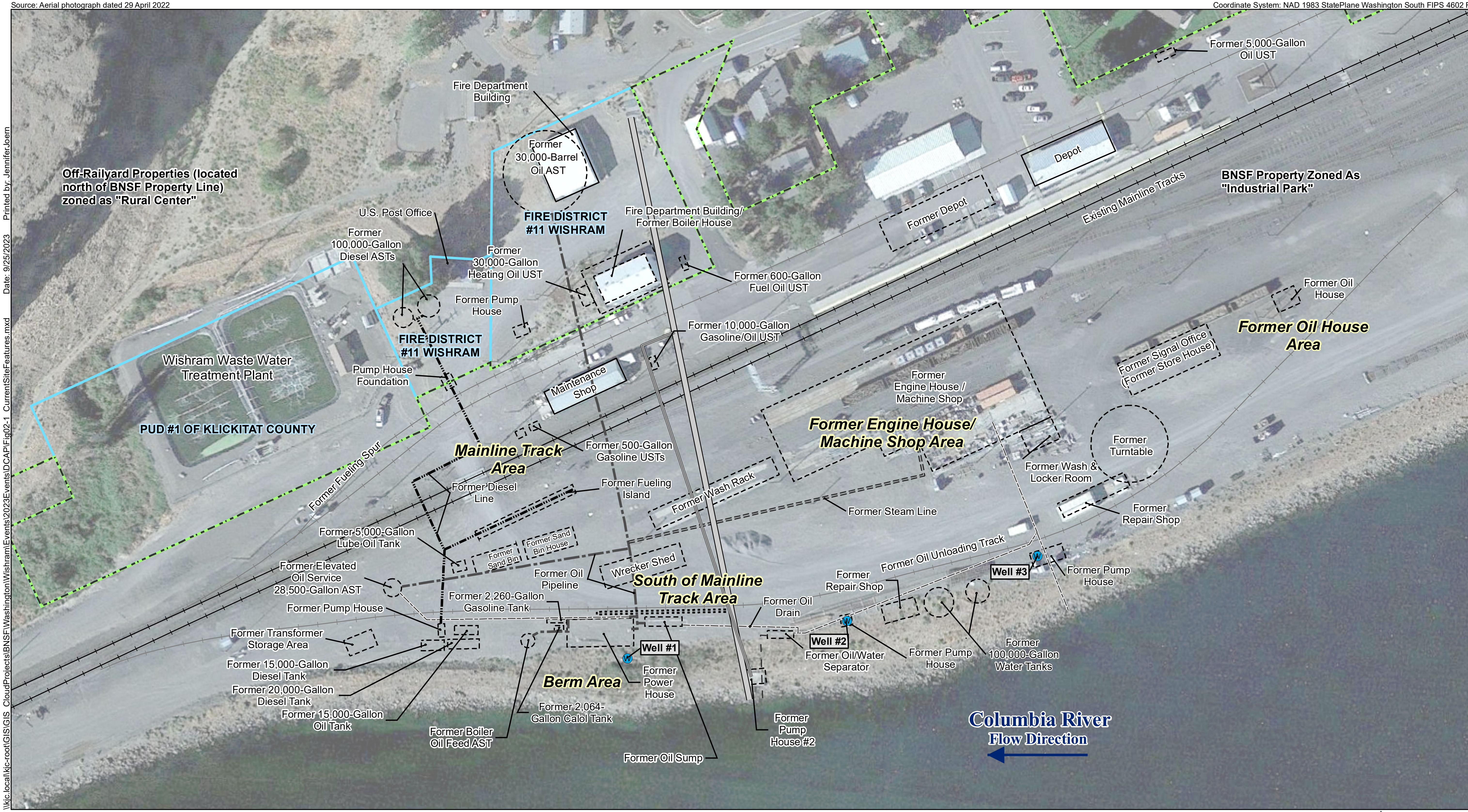
Site Location Map

2196120*06
December 2021

Figure 1-1

Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet



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Legend

- Former Water Supply Well (Approximate)
- Approximate BNSF Property Line
- Existing Site Feature
- Former Site Feature
- 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)
- Former Diesel Line
- Former Steam Line
- Off-Railyard Parcel Boundaries

Note:
1. Locations are approximate.
2. Selected parcel boundaries and property owners (shown) based on review of Klickitat County zoning maps through Interactive Mapping Program, accessed 27 April 2022.

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Scale: Feet

Kennedy Jenks

BNSF Wishram Railyard
Wishram, Washington

Current and Historical Site Features - Main Area

Figure 2-1

Source: Aerial photograph dated 28 September 2020

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

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Legend

- Approximate BNSF Property Line
- Former Bunker Fuel / Oil Pipeline
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain
- Stormwater Underdrain
- Existing Site Feature
- Former Site Feature

Note:
1. Locations are approximate.

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Scale: Feet

Kennedy Jenks

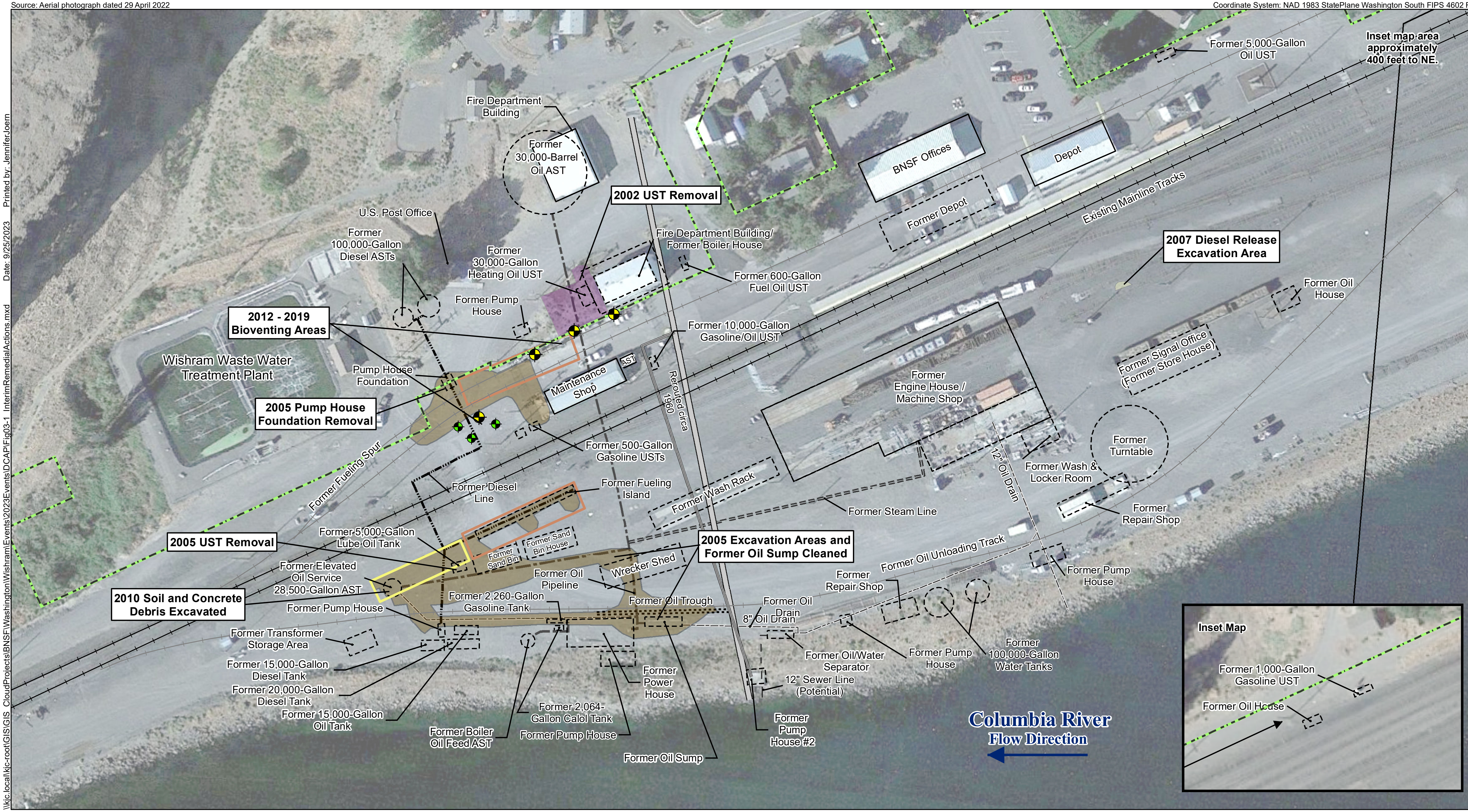
BNSF Wishram Railyard
Wishram, Washington

Current and Historical Site Features - East Area

Figure 2-2

Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- Bioventing Injection Well
- Air Sparge (AS) Well
- Approximate BNSF Property 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)
- Former Diesel Line
- Former Steam Line
- Suspected Diesel Fueling Area
- Suspected Oil Fueling Area
- Approximate Previous Excavation Area
- Approximate Previous Excavation Area
- Approximate Previous Excavation Area
- Existing Site Feature
- Former Site Feature

Note:
1. Locations are approximate.

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Scale: Feet

Kennedy Jenks

BNSF Wishram Railyard
Wishram, Washington

Previous Interim Remedial Actions

Figure 3-1

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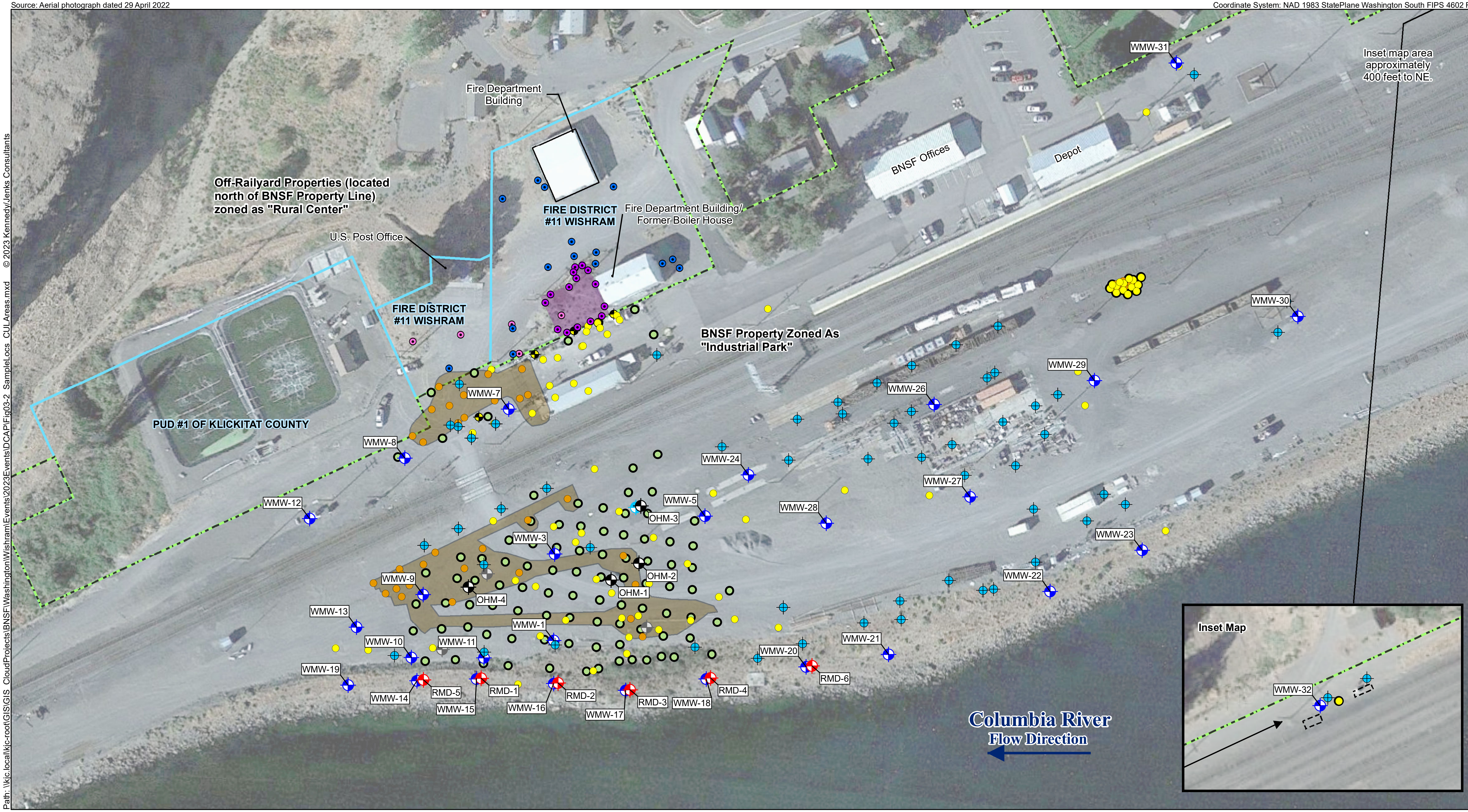
Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- Approximate BNSF Property Line
- LIF Location - Within BNSF Property Boundary
- LIF Location - North of BNSF Property Boundary

Location North of BNSF Property Boundary

- Excavation Soil Sample
- Soil Boring Location
- Off-Railyard Parcel Boundaries
- Approximate 2002 Excavation
- Approximate 2005/2010 Excavation

Location Within BNSF Property Boundary

- Abandoned Monitoring Well
- Air Sparge
- Soil Vapor Extraction
- Excavation Soil Sample
- OHM-3R
- OHM Well
- Shallow Monitoring Well
- Deep Monitoring Well
- Soil Boring Location
- Soil Boring and Recon GW Location

Notes:
1. Selected parcel boundaries and property owners (shown) based on review of Klickitat County zoning maps through Interactive Mapping Program, accessed 27 April 2022.
2. Recon GW Location = Reconnaissance Groundwater Sample Location (2004-2018).

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Scale: Feet

Kennedy Jenks

BNSF Wishram Railyard
Wishram, Washington

Soil Boring and Monitoring Well Locations - Main Area

Figure 3-2

Source: Aerial photograph dated 28 September 2020

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

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Legend

- Approximate BNSF Property Line
- Shallow Monitoring Well
- Soil Boring Location
- Soil Boring and Recon GW Location
- Existing Site Feature
- Former Site Feature

Notes:
1. Selected parcel boundaries and property owners (shown) based on review of Klickitat County zoning maps through Interactive Mapping Program, accessed 27 April 2022.
2. Recon GW Location = Reconnaissance Groundwater Sample Location.

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Scale: Feet

Kennedy Jenks

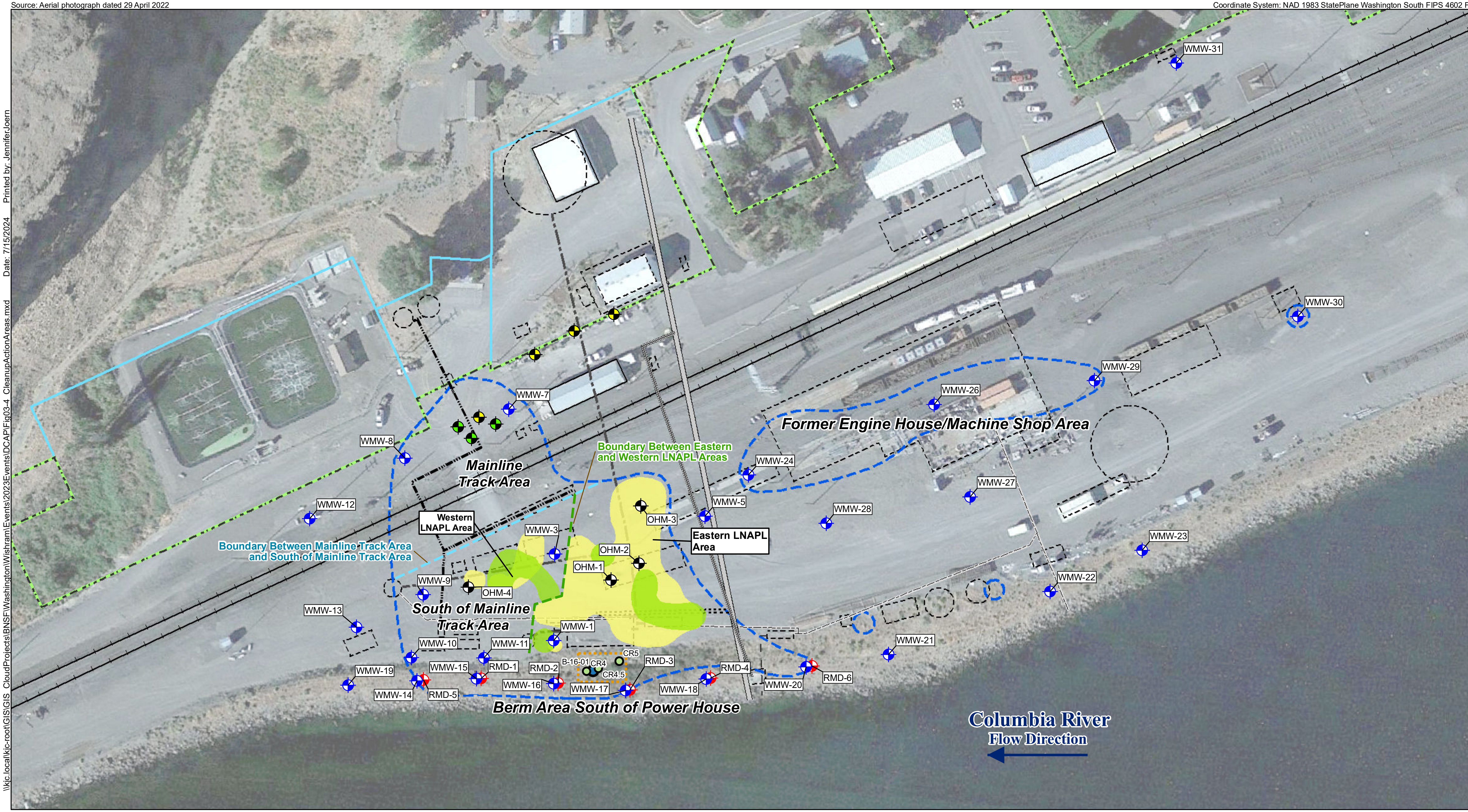
BNSF Wishram Railyard
Wishram, Washington

Soil Boring and Monitoring Well Location - East Area

Figure 3-3

Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- Approximate BNSF Property Line
- Shallow Monitoring Well
- Deep Monitoring Well
- Oil Head Monitoring Well
- Bioventing Injection Well
- Air Sparge (AS) Well
- Off-Railyard Parcel Boundaries
- Former Bunker Fuel / Oil Pipeline
- Former Diesel Line
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain
- Stormwater Underdrain
- Existing Site Feature
- Former Site Feature
- Approximate Lateral Extent of Dissolved Phase Diesel and/or Oil Impacts Above MTCA Method A CUL
- Inferred Lateral Extent of Submerged Diesel and/or Oil Impacts
- Inferred Lateral Extent of Smear Zone Diesel and/or Oil Impacts
- Shallow Berm Excavation
- Soil Boring
- LIF Location

Notes:
1. Locations are approximate.

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Scale: Feet

Kennedy Jenks

BNSF Wishram Railyard
Wishram, Washington

Cleanup Action Areas

Figure 3-4

Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

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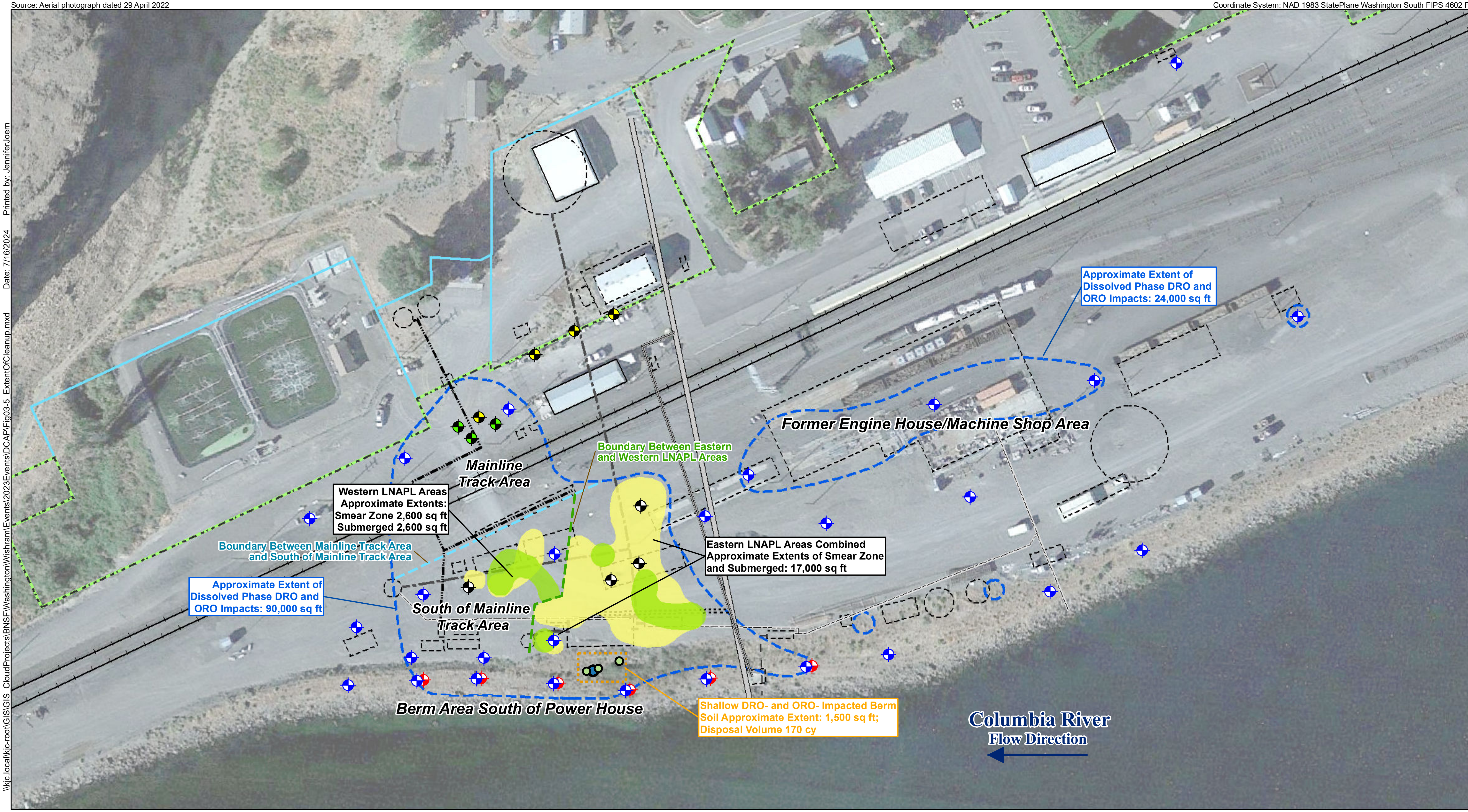

Legend

- Approximate BNSF Property Line
- Shallow Monitoring Well
- Deep Monitoring Well
- Oil Head Monitoring Well
- Bioventing Injection Well
- Air Sparge (AS) Well
- Off-Railyard Parcel Boundaries
- Former Bunker Fuel / Oil Pipeline
- Former Diesel Line
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain
- Stormwater Underdrain
- Existing Site Feature
- Former Site Feature
- Approximate Lateral Extent of Dissolved Phase Diesel and/or Oil Impacts Above MTCA Method A CUL
- Inferred Lateral Extent of Submerged Diesel and/or Oil Impacts
- Inferred Lateral Extent of Smear Zone Diesel and/or Oil Impacts
- Shallow Berm Excavation
- Soil Boring
- LIF Location

Notes:
1. Locations are approximate.
2. sq ft = square feet
3. cy = cubic yards
4. DRO = diesel-range organics
5. ORO = oil-range organics

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Scale: Feet

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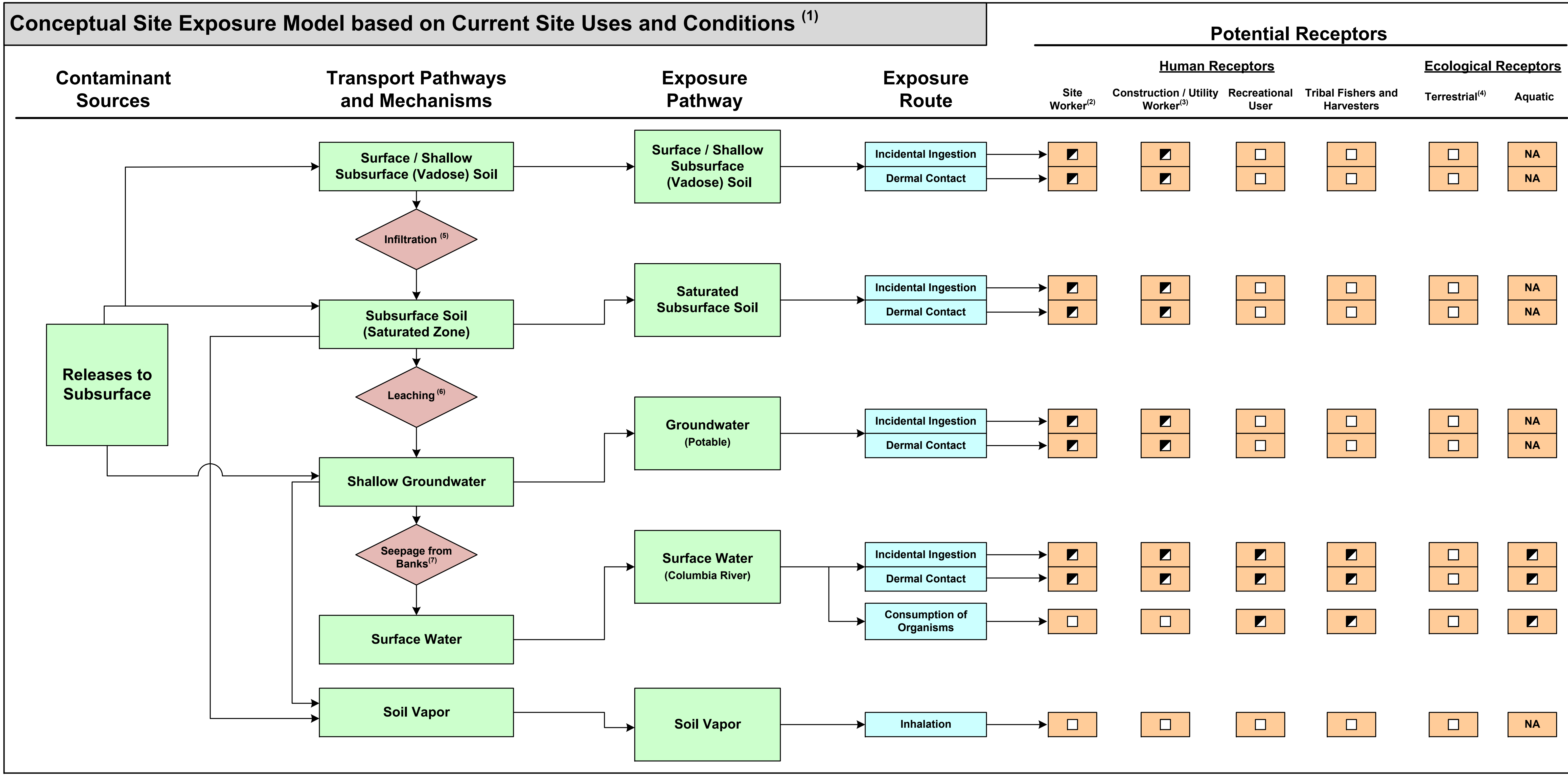
BNSF Wishram Railyard
Wishram, Washington

Approximate Extents of Cleanup Action Areas

Figure 3-5



Legend:

- Complete exposure pathway.
- Incomplete exposure pathway.
- Potentially complete exposure pathway or insufficient information.
- NA — Exposure pathway considered not applicable for the listed receptors.

Notes:

1. Potential exposure pathways may differ after remediation and/or redevelopment of the site.
2. Onsite employees performing routine tasks.
3. Onsite construction and/or utility workers performing invasive activities; workers performing environmental investigation or sampling activities.
4. Based on the Terrestrial Ecological Evaluation performed for the site.
5. Precipitation and infiltration through vadose soil to shallow groundwater.
6. Leaching of contaminants in soil to groundwater and downgradient dissolved-phase transport in shallow groundwater.
7. Seepage from groundwater to surface water along bank area adjacent to the Columbia River. This is expected to be minimal as the river is a losing stream approximately 10 months a year.

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BNSF Wishram Railyard
Wishram, Washington

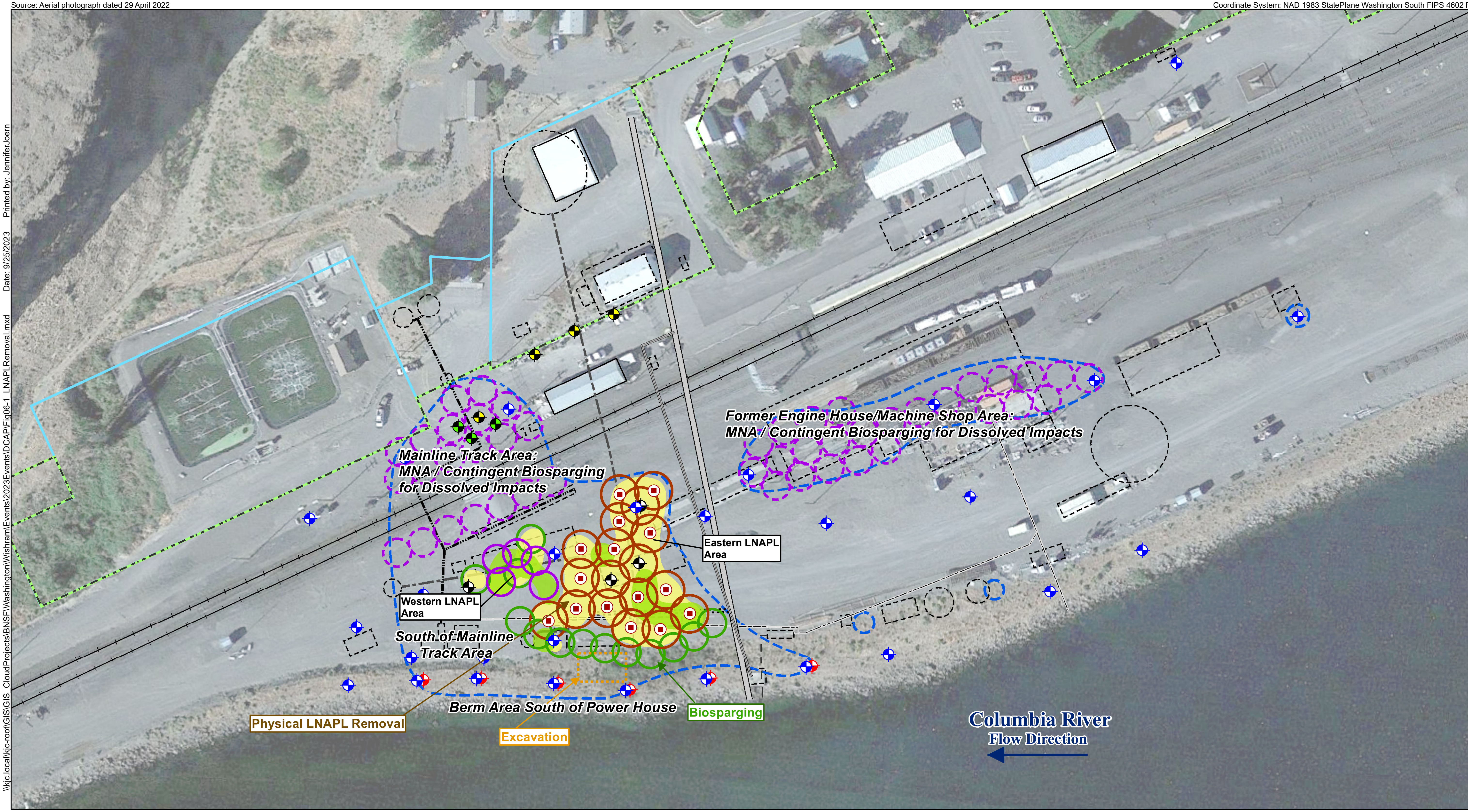
Conceptual Site Exposure Model Diagram

2496120.00
August 2024

Figure 4-1

Source: Aerial photograph dated 29 April 2022

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- Approximate BNSF Property Line
- Shallow Monitoring Well
- Deep Monitoring Well
- Oil Head Monitoring Well
- Bioventing Injection Well
- Air Sparge (AS) Well
- Off-Railyard Parcel Boundaries
- Former Bunker Fuel / Oil Pipeline
- Former Diesel Line
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain
- Stormwater Underdrain
- Existing Site Feature
- Former Site Feature
- Approximate Lateral Extent of Dissolved Phase Diesel and/or Oil Impacts Above MTCA Method A CUL
- Inferred Lateral Extent of Submerged Diesel and/or Oil Impacts
- Inferred Lateral Extent of Smear Zone Diesel and/or Oil Impacts
- Shallow Berm Excavation
- Proposed LNAPL Removal Well
- Shallow Biosparge Well: 15 foot ROI
- Paired Shallow and Deep Biosparge Well: 15 foot ROI
- LNAPL Removal Well: 20 foot ROI
- Contingent Shallow Biosparge Well Following MNA Assessment

Notes:
1. Locations are approximate.
2. MNA = monitored natural attenuation; LNAPL = light non-aqueous phase liquid.

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0 50 100

Scale: Feet

Kennedy Jenks

BNSF Wishram Railyard
Wishram, Washington

Alternative 4:
Physical LNAPL Removal, Biosparge, MNA, and Targeted Excavation

Figure 6-1

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