OPTIMIZATION REVIEW

BRADFORD ISLAND UPLAND AND RIVER OPERABLE UNITS

CASCADE LOCKS, OREGON

FINAL REPORT
September 30, 2021

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NOTICE AND DISCLAIMER

Work described herein, including preparation of this report, was performed by HydroGeoLogic, Inc. (HGL) and the US Army Corps of Engineers (USACE) Environmental and Munitions Center of Expertise (EM CX). Work conducted by HGL was performed under contract #W912DW21P0013 between HGL and USACE Seattle District.

This optimization review is a third-party review of work conducted at the Bradford Island Upland and River Operable Units (OUs) (the Site) under USACE CERCLA authority. The purpose is to provide recommendations aimed to increase remedy effectiveness, improve technical performance, reduce costs, and move the Site to completion. Recommendations are based on an independent evaluation of existing Site information and represent the technical views of the optimization review team. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by any party.

PREFACE

This report regarding the Bradford Island Upland and River OUs was prepared to provide recommendations aimed to increase remedy effectiveness, improve technical performance, reduce costs, and move the site to completion. The project contacts are as follows:

ORGANIZATION	CONTACT	CONTACT INFORMATION
USACE Portland District	Chris Budai, Project Manager	christine.m.budai@usace.army.mil
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USACE EM CX	Dave Becker, Hydrogeologist	Dave.J.Becker@usace.army.mil
HGL (contractor to USACE Seattle District)	Rob Greenwald, Principal Hydrogeologist Shane Cherry, Principal Scientist	rgreenwald@hgl.com scherry@hgl.com

LIST OF ACRONYMS AND ABBREVIATIONS

μg/L	micrograms per liter
μg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
amsl	above mean sea level
AOPC	area of potential concern
AST	aboveground storage tank
bgs	below ground surface
BPA	Bonneville Power Authority
CB	catch basin
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFD	Computational Fluid Dynamics
cfs	cubic feet per second
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbons
CPEC	Contaminant of Potential Ecological Concern
CSM	conceptual site model
cy	cubic yards
DEQ	Oregon Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
DU	Decision Unit
ECSI	Oregon DEQ Environmental Cleanup Site Information
EM CX	Environmental and Munitions Center of Expertise
EPA	United States Environmental Protection Agency
FS	Feasibility Study
ft	feet
ft^2	square feet
ft/d	feet per day
ft/s	feet per second
FWS	United States Fish and Wildlife Service
gpm	gallons per minute
HGL	HydroGeoLogic, Inc.
HMSA	Hazardous Material Storage Area
HPAH	high molecular weight polycyclic aromatic hydrocarbons
ISCO	in-situ chemical oxidation
ISM	Incremental Sampling Methodology

MNA	Monitored Natural Attenuation
MNR	monitored natural recovery
NAPL	non-aqueous phase liquid
NPL	National Priorities List
O&M	operation and maintenance
OCP	organochlorine pesticide
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SMA	sediment management area
SVOC	semivolatile organic compound
TAG	Technical Advisory Group
TCE	trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	total petroleum hydrocarbons
TPH-DRO	total petroleum hydrocarbons – diesel range organics
USACE	United States Army Corps of Engineers
VCP	Voluntary Cleanup Program
VOC	volatile organic compound

1.0 OBJECTIVES OF THE OPTIMIZATION REVIEW

This optimization review is a third-party review of work conducted at the Bradford Island Upland and River Operable Units (OUs) (the Site). The purpose is to provide recommendations aimed to increase remedy effectiveness, improve technical performance, reduce costs, and move the Site to completion. Recommendations are based on an independent evaluation of existing Site information and represent the technical views of the optimization review team.

The US Army Corps of Engineers (USACE) completed a remedial investigation (RI) in 2012 for the Upland and River OUs (URS, 2012). A feasibility study (FS) for the Upland OU (USACE, 2017a) was completed in 2017 and is currently being updated. A draft FS for the River OU (USACE, 2017b) was also prepared in 2017, and additional data collection is ongoing to revise the conceptual site model (CSM) to better inform the alternatives development for the River OU before that FS is finalized.

The optimization review included review of Site documents and data, a site visit, review of the CSM, a listening session with the Technical Advisory Group (TAG), and identification/review of technical issues (including data gaps evaluation and recommendations for alternative technologies and/or approaches to facilitate and expedite Site closure). The evaluation of data included a brief review of data collection and management methods, the consistency of the data with other Site data, and the potential use of the data in the optimization review. Data that were of suspect quality were either not used as part of the optimization review or were used with quality concerns noted. Where appropriate, this report provides recommendations made to improve data quality.

The scope of this optimization review pertains to the four areas of potential concern (AOPCs) on Bradford Island investigated in the 2012 RI, and potential impacts to the River OU from those AOPCs and from equipment previously disposed offshore. Background contaminant concentrations in the river considered in this optimization evaluation could possibly include impacts from other sources near the dam complex or further upstream, but detailed consideration of specific sources other than those noted above is not within the scope of this optimization review.

Documents reviewed for the optimization effort are listed in Section 6 (References).

2.0 OPTIMIZATION REVIEW TEAM

The optimization review team consists of the independent, third-party participants listed in **Table 2-1**.

TABLE 2-1. Optimization Review Team

NAME	ORGANIZATION	TELEPHONE	EMAIL
Rob Greenwald	HGL	732-239-6407	rgreenwald@hgl.com
Shane Cherry	HGL	239-313-7495	scherry@hgl.com
Dave Becker	USACE EM CX	402-697-2655	Dave.J.Becker@usace.army.mil

EM CX = Environmental and Munitions Center of Expertise; HGL = HydroGeoLogic, Inc.

The optimization team was represented at site visit on 20 April 2021 by Rob Greenwald (in person) and Dave Becker (via phone). **Table 2-2** lists other individuals in attendance at the optimization review site visit on 20 April 2021.

TABLE 2-2. Other Individual in Attendance at Site Visit on 20 April 2021.

NAME	ORGANIZATION	TITLE/ROLE
Chris Budai	USACE Portland District	Project Manager
Bill Gardiner	USACE Seattle District	Technical Lead
Kristen Kerns	USACE Seattle District	Risk Assessment
Missy Mcbain	USACE - Bonneville Dam	Facility Environmental Coordinator
Josh Carpenter	USACE - Bonneville Dam	Intern at Bonneville Dam

Table 2-3 lists participants of a “Listening Session” conducted with the TAG on 27 May 2021 to provide the optimization team additional site background and perspective.

TABLE 2-3. Participated in “Listening Session” on 27 May 2021

NAME	ORGANIZATION
Stacy Webster-Wharton	Bonneville Power Authority (BPA)
Jeremy Buck	U.S. Fish and Wildlife Service (FWS)
Robert Tan	U.S. Environmental Protection Agency (EPA)
Elizabeth Allen	EPA
Todd Hudson	Oregon Health Authority
Heidi Nelson	Oregon Department of Environmental Quality (DEQ)
Jennifer Peterson	Oregon DEQ
Mike Poulsen	Oregon DEQ
Andy Smith	Washington Department of Ecology (Ecology)
Marissa Merker	Nez Perce Tribe
Julie Atwood	Confederated Tribes and Bands of the Yakama Nation
Bob Dexter	Confederated Tribes and Bands of the Yakama Nation

NAME	ORGANIZATION
Rose Longoria	Confederated Tribes and Bands of the Yakama Nation
Laura Shira	Confederated Tribes and Bands of the Yakama Nation
Kim Magruder Carlton	Carlton Environmental (On Behalf of Yakama Nation)
Sherrie Duncan	Sky Environmental (On Behalf of Yakama Nation)
Teresa Michelsen	Avocet Consulting (On Behalf of Yakama Nation)
Carl Merkle	Confederated Tribes of the Umatilla Indian Reservation
James Gordon	Cowlitz Indian Tribe
Seth Russell	Cowlitz Indian Tribe
Jo Ben Walker	Cowlitz Indian Tribe
Chris Budai	USACE Portland District
Daniel Carlson	USACE Seattle District
Karah Haskins	USACE
Craig Johnson	USACE
John Morgan	USACE
Kristin Scheidt	USACE
Shane Cherry	HGL (Optimization Review Team)
Rob Greenwald	HGL (Optimization Review Team)
Dave Becker	USACE EM CX (Optimization Review Team)

3.0 SITE BACKGROUND

3.1 LOCATION AND SITE DESCRIPTION

Bradford Island is located within the Columbia River and is part of the Bonneville Dam complex at Cascade Locks, Oregon. The spatial relationship of Bradford Island to Bonneville Dam features is illustrated on **Figure 3-1**. The dam is located approximately 40 miles east of Portland, Oregon and approximately 145 miles upstream of the Columbia River mouth. The dam is located near the upper limit of tidal influence from the Pacific Ocean. Bonneville Pool is a 48-mile reservoir that extends upstream from the Bonneville Dam to The Dalles Dam. The pool is up to 100 feet (ft) deep within the spillway forebay near the Bonneville Dam (USACE, 2017a). The current navigation channel and locks are located between the south shore of Robins Island (located south of Bradford Island) and the Oregon Shore.

Construction of Bonneville Dam began in 1933, and operations began in 1938. The Second Powerhouse was constructed adjacent to the Washington State shore between 1974 and 1981. The current navigation lock was constructed on the Oregon side between 1989 and 1993, and soils from that excavation were placed to form Goose Island approximately 0.5 mile upstream near the Oregon shore (**Figure 3-1**).

Bradford Island includes a visitor center, fish ladders, a service center building, and an equipment building. A sandblast building was demolished in 2012 after being previously damaged in a storm. The Upland OU includes four AOPCs located on Bradford Island (**Figure 3-2**):

- Landfill AOPC, a former waste disposal site on the northeast tip of Bradford Island.
- Sandblast Area AOPC, near the former sandblast building on the north-central part of Bradford Island.
- Pistol Range AOPC, formerly used for small arms target practice on the south-central portion of Bradford Island.
- Bulb Slope AOPC, a fan-shaped accumulation of glass and electrical light bulb debris in a steeply sloped area on the north side of Bradford Island between the landfill access road and the Columbia River.

The River OU was identified in 2000, when electrical equipment and other solid waste were discovered in the Columbia River along the north shore of Bradford Island.

3.2 BRIEF SITE CHRONOLOGY

Table 3-1 briefly summarizes site chronology. Removal and remedial actions are being performed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The site is a federal facility and is not listed on the National Priorities List (NPL). CERCLA authority for Bradford Island is delegated to USACE.

TABLE 3-1. Brief Site Chronology

Date	Action
1996	Landfill on Bradford Island identified to EPA Region 10 and Oregon DEQ, and EPA requested sampling of Columbia River sediments and groundwater seeps.
1997	Landfill on Bradford Island added to Oregon DEQ ECSI database.
1998	Landfill on Bradford Island enters Oregon VCP for investigation and remediation. Investigation begins at Landfill AOPC.
2000	Underwater dive surveys were conducted due to the discovery of ballasts from fluorescent lights onshore on the north side of the island adjacent to the landfill, and three distinct piles of electrical waste-related items submerged in the Columbia River were identified just offshore of the landfill. Approximately 60 electrical items were removed from Debris Pile #1 and several sediment samples were collected.
2001	USACE cleaned sediment from the stormwater system, replaced the filter fabric socks that line each catch basin, and characterized and disposed of the waste generated during the cleaning process. USACE developed and implemented a regular inspection and maintenance program to prevent discharge of sediment into the storm drain system (i.e., replacement of the filter socks on a periodic basis).
2001	In-water investigation concluded that the remaining offshore electrical equipment in the river may represent an ongoing human or ecological risk and should be removed as soon as possible.
2002	Waste-related items were removed from off-shore debris piles including additional removal at Pile #1 and removal at Piles #2 and #3.
2002 to 2003	Additional investigation of sediments off-shore to determine extent of sediment impacts.
2004	USACE elects to continue investigation and remediation of Bradford Island under the CERCLA process.
2006	Additional surface water and sediment data collected.
2007	The most highly impacted sediments along the north shore of Bradford Island were removed via diver-directed dredging.
2008	Sampling conducted subsequent to sediment removal (sediment, clams, fish).
2011	"Pre-FS" sampling in river (sediment, clams, fish) – these data were collected subsequent to the dataset considered in the RI.
2012	RI Report for Upland and River OUs.
2017	FS for Upland OU and Draft FS for River OU.
2018	Sampling of solids from catch basins, and implementation of sampling program for liquids in catch basins.
2020	Passive sampling study offshore, including temperature sensors.
2020	Bass, crayfish, and clam tissue collection and chemical analysis (results of these efforts still being compiled and not yet available for review by the optimization team); Bass tracking study.

ECSI = Environmental Cleanup Site Information; VCP = Voluntary Cleanup Program.

3.3 Remedial Actions Previously Implemented

3.3.1 Upland OU

Other than characterization efforts, and soil cover placed at the Landfill AOPC in the 1980s, there have been no remedial actions at the Landfill AOPC, the Bulb Slope AOPC, or Pistol Range AOPC. There has been prior action near the Sandblast Area AOPC limited to sediment removal from the stormwater collection system. Solid materials from the stormwater catch basins and near the stormwater system outfalls on the northern perimeter of the Sandblast Area AOPC were sampled in May 2001. Based on the results of the catch basin and stormwater system outfall sampling, the stormwater system was identified as a potential pathway for conveying contaminants from the Sandblast Area AOPC to the river. In October 2001, USACE cleaned the sediment from the stormwater system, replaced the filter fabric socks that line each catch basin, and characterized and disposed of the waste generated during the cleaning process (URS, 2012). USACE has developed and implemented a regular inspection and maintenance program to prevent discharge of sediment into the storm drain system that included replacement of the filter socks on a periodic basis (URS, 2012). According to Oregon DEQ (including photographs Oregon DEQ provided), some overflow and bypass of the media meant to trap solids before discharge to the river may have occurred over time. Sediments were again removed from the catch basins and associated piping after a 2018 sampling event of accumulated solids, and no additional solids have subsequently accumulated (personal communication during optimization review site visit).

3.3.2 River OU

Removal of equipment from three debris piles offshore of Bradford Island occurred in 2000 and 2002. The locations of the three debris piles are indicated on **Figure 3-3**. Approximately 60 electrical items were removed from Debris Pile #1 and four sediment samples were collected during recovery activities in December 2000. Additional waste-related items were removed from all three debris piles in February and March 2002, including electrical items and other solid waste (URS, 2004). Electrical equipment removed from the debris piles included lightening arrestors, lighting ballasts, coupling capacitors, Inerteen capacitors, and switches. Some of the equipment recovered from the river contained either liquid or solid polychlorinated biphenyls (PCBs) and sheens were observed near some capacitors as they were removed from the riverbed (USACE, 2017b).

Incidental sediment removal occurred during the debris pile removal activities in 2000 and 2002. A more directed sediment removal event occurred in 2007 (CERCLA Non-time Critical Removal). Removal of the most highly impacted sediments along the north shore of Bradford Island was performed via diver-directed dredging in the 2007 removal event. Locations of sediment removal in 2007 are indicated on **Figure 3-4**.

In addition to in-river sampling conducted prior to the 2007 sediment removal, sampling was performed in-river after the 2007 sediment removal in 2008 (sediment, clams, fish) and again in 2011 (sediment, clams, fish). A summary of these sampling locations relative to the 2007 sediment removal locations is illustrated on **Figure 3-5**. The 2008 data were considered in the 2012 RI, and both the 2008 and the 2011 data were considered in the draft FS for the River OU.

3.4 Remedial Action Objectives (From FS Documents)

3.4.1 Upland OU

The Upland OU FS (USACE, 2017a) had the following remedial action objectives (RAOs):

- RAO-1: Reduce to acceptable levels the exposure risk of the fishing platform user to soils contaminated with carcinogenic polycyclic aromatic hydrocarbons (cPAHs).
- RAO-2: Reduce to acceptable levels the exposure risk of ecological receptors to soils contaminated with chromium, copper, lead, mercury, nickel, and total high molecular weight polycyclic aromatic hydrocarbons (HPAHs).

These RAOs did not address potential for unacceptable impacts to the River OU resulting from the Upland OU. The risk assessment results that were the basis of the FS evaluation for the Upland OU considered human and ecological exposures within the Upland OU, and not potential impacts to the River OU from the Upland OU. Based on that approach, the FS for the Upland OU (USACE, 2017a) did not develop or evaluate remedial alternatives for the Sandblast AOPC or include an RAO for potential impacts from the Upland OU to the River OU.

Recent discussions with the USACE team (personal communication, Chris Budai [USACE], Summer 2021) indicate that the Upland OU FS is being re-written to evaluate remedial alternatives for the Sandblast AOPC and include an RAO for potential impacts to the River OU from the Upland OU (including the Landfill, Sandblast, and Bulb Slope AOPCs). The inclusion of this third RAO provides a comprehensive approach that links the two OUs and is consistent with the principles of CERCLA, and this optimization review has been performed based on that perspective (i.e., RAOs for the Upland OU should include eliminating the potential for the Upland OU to cause ongoing or future impacts to the River OU).

3.4.2 River OU

The Draft FS for the River OU (USACE, 2017b) Section 4.1.1 identified the following RAOs:

- RAO-1: Reduce to acceptable levels the human health risks from indirect exposures to total PCBs as congeners through ingestion of fish and shellfish that occur via bioaccumulation pathways from surface sediment.
- RAO-2: Reduce to acceptable levels the risks to ecological receptors from indirect exposures through ingestion of prey via bioaccumulation pathways from sediment contaminated with total PCBs as congeners.

The draft FS for the River OU (USACE, 2017b) identified PCBs as the primary risk driver for human health and the primary driver for ecological risk for the River OU. HPAHs were also identified as an ecological risk driver specifically for the benthic community. The two RAOs refer only to PCBs and not to other contaminants.

The draft FS for the River OU concluded that remaining contaminants of concern (COCs), including polycyclic aromatic hydrocarbons (PAHs) and metals, would be addressed by remediation of PCBs because elevated concentrations of those COCs coincide with areas needing remediation for PCBs, and because PAHs and metals are not widely distributed within the River OU compared to the distribution of PCBs. This interpretation was consistent with and supported by the spatial distribution of COCs within the River OU illustrated in Figures 3-1 through 3-5 of the Data Evaluation Technical Memorandum, River Operable Unit (URS, 2014). The spatial correlation of PCBs and other COCs was strong, but other COCs may have a small influence on delineation of sediment management areas (SMAs). Delineation of cleanup polygons will occur initially during the preparation of an FS, and that delineation should focus on PCBs but consider minor adjustments to SMA boundaries to address other COCs from areas adjacent to PCB cleanup polygons (if any). SMA delineation would then be further refined during a future remedial design process.

3.5 Tribal and Stakeholder Concerns

Minutes from the Listening Session held on 27 May 2021 are included in Appendix A. The optimization team heard from representatives of tribal nations and regulatory agencies regarding their perspectives and concerns about the project, as well as past project history and visions for the future of the Site. A number of the concerns expressed involved larger issues than the human and ecological impacts of releases at or near Bradford Island. A recurring issue raised during the listening session was the potential for upland sources to impact the River OU through storm water discharge, mass wasting processes, or groundwater discharge. The linkage of the upland and the river is therefore a key consideration for the optimization team. Another key issue discussed during the listening session was the protection of individuals that use the island and the surrounding waters for fishing and other purposes now and in the future, and this issue is also a key consideration for the optimization team. Some of the concerns discussed during the Listening Session pertained to issues outside the scope of this optimization review but are represented in the notes included in Appendix A.

4.0 FINDINGS

4.1 WORKING CONCEPTUAL SITE MODEL

The optimization team's working CSM based on investigation efforts to date is presented below.

4.1.1 History and Potential Sources of Contamination

Potential sources of contamination discussed below include:

- Landfill AOPC
- Sandblast Area AOPC
- Pistol Range AOPC
- Bulb Slope AOPC
- River OU (Previous Disposal of Electrical Equipment Offshore)

Descriptions presented below are based on information in the RI (URS, 2012) unless otherwise noted. Relative locations of the AOPCs located on Bradford Island are indicated on **Figure 3-2**, and the debris piles where equipment was previously disposed offshore are indicated on **Figure 3-3**. Detailed consideration of other potential sources of contamination associated with the Bradford Dam complex or upstream of Bradford Island (including Goose Island) is not within the scope of this optimization review.

<u>Landfill AOPC</u>

Air photos indicated that landfill use began around 1942, was in heavy use by 1952, and was intermittently used until the early 1980s. The approximate extent of landfill debris is indicated by the purple dashed line on **Figure 4-1**. The Landfill AOPC is not a conventional landfill, rather it consisted of randomly located pits filled in with waste items. The volume of landfilled material was estimated to be between 7,500 and 9,900 cubic yards (cy) to a maximum depth of 15 ft below ground surface (bgs). Based on the extent of landfill debris on **Figure 4-1** the disposal occurred within an area approximately 300 ft long and 150 ft wide, similar in size to a football field. However, the area where actual disposal occurred was not rectangular and therefore represents a somewhat smaller area, estimated to be approximately 28,000 ft^2 (URS, 2004; URS, 2012).

The waste buried in the discrete pits included household waste, project-related wastes (grease, light bulbs, sandblast grit), electrical debris, up to 50 ballasts, broken glass, rubber tires, metal debris, wood debris, metal cables, asbestos containing building materials, burned debris, ceramic insulators, and mercury vapor lamps. Some exposed material observed on the northern edge and the surface of the landfill has included concrete rubble, steel cables, a few empty buckets and drums, plastic planter buckets, empty cans and paint solids, metallic slag, partially-burned construction debris, and miscellaneous trash. Pesticide/herbicide mixing and rinsing of pesticide/herbicide application equipment also occurred in the pesticide/herbicide wash area near the south side of the landfill (indicated on **Figure 4-1**). Soil cover was placed by 1982, and approximately 8 inches of additional soil cover was placed in 1989.

<u>Sandblast Area AOPC</u>

The Sandblast Area AOPC (**Figure 4-2**) includes subareas associated with different sources of contamination:

- A former disposal area for spent sandblast blast grit was located east of the former sandblast building. Equipment painted with metallic (e.g., lead and zinc chromate systems) and organometallic compounds was periodically stripped and repainted in the former sandblast building from approximately 1958 to 1988 (after 1988 sandblasting and painting operations moved to the service center building). Application of lead-based paints ceased in the early 1980s. Although records of on-Site spreading of sandblast grit are not available, sandblast grit observed adjacent to the former sandblast building indicates that spent sandblast grit was historically spread onsite for an unknown period prior to 1994; records available starting in 1994 indicate disposal to a Resource Conservation and Recovery Act (RCRA) hazardous waste facility in 1994 and thereafter. Previous investigations concluded that the primary source of soil contamination in the Sandblast Area AOPC is from the open disposal of sandblast grit.

- A former transformer disassembly area was located east of the former sandblast building. In 1995, PCB-containing transformers were disassembled at the paved parking area on the east side of the former sandblast building (not illustrated on **Figure 4-2**; see Figure 3-3 of the 2012 RI), and in November 1995 approximately 1 quart of PCB-containing oil was released and spread northward with stormwater runoff and into the stormwater drainage system, which has two outfalls to the Columbia River Outfalls that are indicated by dashed blue lines on **Figure 4-2**. A sheen of oil on the Columbia River was observed, and booms and absorbent pads were placed on the upland areas of the release and below the storm drain outfall in the river. At the time of the release samples were not collected from the stormwater system.

- A former Hazardous Material Storage Area (HMSA) was located about 200 feet south of the sandblast building. Prior to 1993/1994, hazardous waste generated at the Bonneville Dam complex was stored at the former HMSA, which has been referred to as the "former drum storage area". The former HMSA pad was constructed of wood and metal and did not have a secondary containment system or berms.

- An aboveground storage tank (AST) was historically located in the vicinity of the current HMSA, southeast of the sandblast building. Prior to the construction of the current HMSA, the approximately 300-gallon AST temporarily stored waste paints until the late 1990s when the tank was removed. A solvent odor was noted in a historical soil sample collected adjacent to the current HMSA and based on the analytical results it has been inferred that there was a historical release from the AST.

- A laydown area used for current storage of industrial equipment and materials is located in the northern portion of the Sandblast Area AOPC, along the north and south sides of the landfill access road. Soils may have become contaminated with oil, metallic debris, or other contaminants due to this equipment storage.

A former septic system serviced a bathroom located in the painting (western) portion of the former sandblast building. Floor drains in the former sandblast building may have also discharged into the septic system. The septic tank and the drain field are located near the north-central side of the former sandblast building. Investigation of the septic tank determined that it had not been backfilled with sandblast grit and was not a source of contamination at the Sandblast Area AOPC.

<u>Pistol Range AOPC</u>

The pistol range (**Figure 4-3**), located on the south side of Bradford Island, was used for small arms target practice beginning sometime in the 1940s or 1950s and ending in the late 1960s or early 1970s. No other land use has been identified in that area. The pistol range included an approximately 20-ft by 20-ft firing shed and a backstop constructed of treated lumber. Soils immediately adjacent to the firing shed, backstop, and areas down gradient of the shed and backstop have been impacted with metals associated with firing range activities. The firing shed fell into disrepair and was knocked down in the 1990s, though the wood from the structure was not removed following demolition. During the optimization review site visit the area was observed to be overgrown with vegetation.

Bulb Slope AOPC

The Bulb Slope AOPC (**Figure 4-4**) is a fan-shaped accumulation of glass and electrical light bulb debris on the north side of Bradford Island that includes approximately 1,900 ft^2 of a steep slope between the landfill access road and the Columbia River. The base of the bulb slope may be partially submerged during some periods. The debris is concentrated in the center of the slope and includes internal/external light bulbs, fluorescent light bulbs, automobile light bulbs, 1- to 1.5-inch diameter glass tubes, clear window-pane glass, white-colored molded glass (possibly light covers), and miscellaneous glass beverage containers.

River OU (Previous Disposal of Electrical Equipment Offshore)

Electrical equipment debris was disposed of directly in the Columbia River on the north side of the Landfill AOPC. Former debris piles (#1 through #3) are illustrated on **Figure 3-3**. The electrical equipment debris included light ballasts, electrical insulators, lightning arresters, electrical switches, rocker switches, a breaker box, and electrical capacitors.

In addition to these former disposal piles within the river, potential historical and/or future sources of impacts to the river considered during this optimization review include: 1) discharges via stormwater outfalls near the Sandblast Area AOPC; 2) sloughing of waste material and/or impacted soil into the river; 3) discharge of impacted groundwater to the river; and 4) transport of soil impacts to the river via overland water flow or wind. Determining if there are other potential sources of impacts to the river from other portions of the Bonneville Dam complex and/or upstream sources was beyond the scope of this optimization review.

4.1.2 Geology and Hydrogeology

The description of geology and hydrogeology is summarized herein based on the RI (URS, 2012) unless otherwise noted. The Site is located in the Columbia River Gorge within the Cascade Range physiographic province. The Columbia River has eroded through the following bedrock formations near the Site, from top to bottom:

- Columbia River Basalt Group - Flood basalts uplifted several hundred feet above the current river level, Miocene in age, that originated from a series of fissures in eastern Washington, Oregon, and Idaho.
- The Eagle Creek Formation - Primarily sandstones and conglomerates, with individual units of sedimentary tuffs, with nearly horizontal bedding and crops out close to current river elevation.
- Ohanapecosh Formation (also referred to as the Weigle Formation) - Volcaniclastic siltstones and sandstones with minor conglomerates, late Oligocene in age, that have been subject to folding and faulting. As much as two-thirds of the clasts consist of glass fragments that have been altered to a dominantly clay mineral assemblage, greatly weakening the formation. Bedding generally strikes northeast and north, with a dip near the Site of 5 to 20 degrees to the east and southeast. No outcrops of the Ohanapecosh formation are found at the Site.

Faulting and shearing features observed in the Ohanapecosh Formation do not continue into the overlying Eagle Creek Formation, indicating that faulting ended before the Eagle Creek sediments were deposited.

Two large landslides have contributed to the current topography near the Site:

- The Tooth Rock Landslide was a large rotational block failure that originated south of Bradford Island on the Oregon side of the Columbia River. This slide contributed to the formation of Bradford Island. Large slide blocks of the Eagle Creek Formation form the bedrock surface beneath Bradford Island. The river bottom in the immediate vicinity of Bradford Island consists of submerged Eagle Creek Formation resulting from the Tooth Rock Landslide, overlain by a thin layer of sands and silts deposited in lower velocity areas. Although the slide blocks of the Eagle Creek are relatively undisturbed, the uppermost 2 to 5 ft of this unit is fractured.
- The Bonneville (Cascade) slide is a younger slide that originated on the Washington side of the Columbia River. The toe of the landslide forms the northern abutment of the Second Powerhouse, and debris from the slide overlies the Tooth Rock Landslide on portions of Bradford Island.

Up to 30 ft of alluvium overlies the Eagle Creek Formation bedrock on Bradford Island. The alluvium is associated with Holocene to recent flooding of the Columbia River and consists of silty sands and gravels that include increasing amounts of Eagle Creek Formation clasts with depth. The alluvium pinches out near the northern shore of Bradford Island. In some locations there is weathered slide block below the alluvium and above the competent slide block (Eagle Creek Formation). Where present, the weathered slide block includes silty sand and clayey sand, with angular gravel in some locations (URS, 2004).

A cross-section from south to north through the landfill AOPC (URS, 2004) is presented on **Figure 4-5**. This figure indicates the stratigraphic units and their elevations relative to the typical forebay pool elevation. Based on Table D-1 in Appendix D of the RI (URS, 2012) the pool elevation between 1999 and 2009 ranged from 71.80 ft above mean sea level (amsl) to 76.10 ft amsl, with most values approximately 75 ft amsl. The water table on Bradford Island is generally within the alluvium and appears to be largely perched above the less-permeable Eagle Creek slide block material. Where the fractured bedrock crops out on the north shore of the island, seeps form in the winter months (URS, 2012; URS 2004).

The RI (URS, 2012) describes groundwater flow and hydraulic conductivity estimates for the Landfill AOPC and the Sandblast Area AOPC, as follows:

- Landfill APOC:
  - The direction of groundwater flow at the Landfill AOPC is from south to the north (RI Appendix D, Figures D-1 through D-4). The groundwater elevation contour maps in Appendix D of the RI were for April 2008 (wet season), July 2008 (dry season), October 2008 (dry season), and January 2009 (wet season), and within the footprint of the landfill and utilized water levels from the wells with the shallowest screens (MW-2 to MW-7 and MW-9).
  - Hydraulic gradients between MW-2 in the south part of landfill and MW-5 in the north part of the landfill ranged from 0.10 to 0.13 foot per foot (RI Appendix D, Table D-2).
  - As noted above, per the 2012 RI, the forebay pool elevation between 1999 and 2009 ranged from 71.80 ft amsl to 76.10 ft amsl, with most values approximately 75 ft amsl. Based on comparison of the top of competent slide block elevation (URS, 2004) to the forebay pool elevation, the top of the competent slide block at the Landfill AOPC is generally above the forebay pool elevation. This is illustrated on the cross-section depicted in **Figure 4-5** and indicates that the alluvium and weathered slide block are not in direct contact with the river. For water to get to the river it would need to seep out along the bank (consistent with seeps that have been observed) and/or migrate down into the competent slide block and be transported to the river within the slide block (possible

but less likely).

- One of the monitoring wells (MW-8) within the Landfill AOPC is completed relatively deep within the competent slide block.
    - The screen interval of MW-8 based on the well log (RI Appendix B), in conjunction with ground surface elevation of 112.49 ft amsl (RI Appendix D, Table D-1), is approximately 59.5 to 54.5 ft amsl. Therefore, the screen interval for this well is approximately 15 to 20 ft below the typical forebay pool elevation of 75 ft amsl.
    - In May 2002, the groundwater elevation at MW-8 was 58.68 ft msl and April 2008 it was 73.66 ft amsl, both below pool elevation (RI Appendix D, Table D-1). However, results from three later events in 2008 and 2009 all had groundwater elevation 88.5 to 90 ft amsl which is far above pool elevation.
    - It is not clear why the two earlier events had water levels below pool elevation, but the results from the later events suggest that under those conditions, if water migrates downward into the competent slide block, there is potential for subsequent flow from the competent slide block (higher elevation) to the river (lower elevation).
    - As illustrated on **Figure 4-1**, MW-8 is near well MW-5, which is screened much shallower than MW-8. The approximate screen elevation of MW-5 is 102.5 to 77.5 ft amsl, compared to the approximate screen elevation of 59.5 to 54.5 ft amsl at MW-8. The screen interval of MW-5 is within the landfill materials, fill/alluvium, and weathered slide block (URS, 2004), whereas the screen interval of MW-8 is within the competent slide block. Based on comparison of groundwater elevations between MW-5 and MW-8 measured in July 2008 to January 2009 (RI Appendix D, Table D-1), there was a downward head difference of approximately 5 to 7 ft between the shallower units and the competent slide block.
        - The downward vertical head difference indicates potential for downward flow from the alluvium and weathered slide block to the deeper competent slide block.
        - However, the relatively large magnitude of the head difference indicates poor hydraulic connection between the shallower units (alluvium and weathered slide block) and the deeper competent slide block.
    - Taken together, these data suggest that groundwater discharge via seepage along the bank adjacent to the river at the Landfill AOPC is likely to be the more significant component of groundwater discharge. Vertical migration of groundwater into the competent slide block, and subsequent groundwater migration to the river within the competent slide block, is likely to be a less significant (and perhaps negligible) component of groundwater discharge at the Landfill AOPC.
- Measured hydraulic conductivities in the fill/alluvium based on slug tests conducted in 2002 range from approximately 14 to 317 feet per day (ft/d), whereas in the weathered slide block and competent slide block the hydraulic conductivity is much lower, ranging from approximately 0.001 to 0.2 ft/d (URS 2004). A subsequent slug test at MW-10 in

2008, screened in the competent slide block and located in the “reference area” south of the Landfill AOPC, also indicated a low hydraulic conductivity of 0.033 ft/d in the competent slide block (URS, 2008). The low hydraulic conductivity in the weathered slide block and competent slide block also suggests limited potential for groundwater migration in the slide block relative to groundwater migration potential in the alluvium.

- Sandblast Area AOPC:
  - The direction of groundwater flow at the Sandblast Area AOPC is to the north and northwest (RI Appendix D, Figure D-5 through D-8). Water level maps for the Sandblast AOPC are based on water levels at MW-11 to MW-15 and the groundwater elevation contour maps in Appendix D of the RI were for April 2008 (wet season), July 2008 (dry season), October 2008 (dry season), and January 2009 (wet season).
    - Based on well logs (RI, Appendix B), the monitoring wells at the Landfill AOPC are generally screened in the weathered slide block. However, the upper portion of screen interval for three of the five wells (MW-12, MW-14, and MW-15) appears to be in alluvium.
    - The well log for MW-14 indicates the portion of the screened interval below alluvium is within the “slide block”, but the description of weathering within that interval suggests it is actually “weathered slide block”.
    - Groundwater levels in the Sandblast AOPC are just above the contact between the alluvium and the weathered slide block in most areas.
    - The contact between the alluvium and the slide block is close to the normal forebay pool level (approximately 75 ft amsl) at the northern edge of the Sandblast AOPC. At MW-14 the bottom of alluvium is 15 ft bgs based on the well log, which corresponds to an elevation of approximately 72 ft amsl. At MW-15 the bottom of alluvium is 13 ft bgs based on the well log, which corresponds to an elevation of approximately 74 ft amsl.
    - Unlike at the Landfill AOPC, the groundwater elevation near the river (e.g., MW-14 and MW-15) is similar to the forebay pool elevation (~75 ft NGVD), indicating relatively good connection between the groundwater (alluvium) and the river at the Sandblast AOPC.
    - The discussion regarding the connection between the alluvium and the slide block/bedrock materials at the Landfill AOPC would be applicable to the Sandblast Area as well.
  - Horizontal hydraulic gradients between MW-11 in the south portion of the Sandblast AOPC and MW-15 in the north portion of the Sandblast APOC range from 0.10 to 0.11 foot per foot, and horizontal hydraulic gradients between MW-11 in the south portion of the Sandblast AOPC and MW-14 in the north portion of the Sandblast APOC range from 0.07 to 0.08 foot per foot (RI Appendix D, Table D-2).
  - Measured hydraulic conductivities beneath the Sandblast Area AOPC based on slug tests conducted in 2008 range from 0.01 to 285 feet per day. These slug tests are described in the Groundwater Monitoring Well Installation Report (URS, 2008).

  - MW-11 had hydraulic conductivity of 0.011 to 0.027 ft/d and represents weathered slide block.
  - MW-13 had weathered hydraulic conductivity of 0.18 ft/d and represents weathered slide block.
  - MW-14 had a much higher hydraulic of 170 to 285 ft/d, and since this well has the top portion of the screen interval in alluvium (described on well log as silty clay with gravel), it appears there is highly conductive saturated zone (gravel) near the top of the well screen that is likely in hydraulic connection to the Columbia River. This is consistent with the observation that groundwater elevation at MW-14 is similar to the forebay pool elevation (i.e., in good hydraulic connection). It is also possible that the good hydraulic connection to the river at this well results from a highly permeable zone within the weathered slide block, since a portion of the screen interval at MW-14 within the weathered slide block is described as "sandy well-graded gravel with loose coarse sand" and that interval is also likely in contact with the river.

- Pistol Range and Bulb Slope AOPCs:
  - There are no monitoring wells at the Pistol Range AOPC or the Bulb Slope AOPC.
  - At the Pistol Range AOPC, located on the southern side of Bradford Island, topographic elevation is approximately 94 ft amsl and topography slopes south. It is therefore expected that shallow groundwater near the Pistol Range AOPC, if present, would flow south and likely discharge as seeps above the shoreline and/or to the river.
  - At the Bulb Slope AOPC, which is adjacent to the Columbia River on the north side of Bradford Island, the RI (URS, 2012) states that the substrate below the waste consists of a mixture of soils, rock that may have been placed in some areas, and what appear to be natural rock outcrops, all of which is underlain by siltstone bedrock. In this area, rainfall directly into the waste material could leach contaminants and discharge to the river.

The study area that encompasses all four AOPCs east of the dam on Bradford Island is approximately 1,400 ft by 600 ft equals 840,000 ft^2. North Bonneville, WA gets 71 inches of precipitation per year (North Bonneville, Washington Climate (www.bestplaces.net)). Conservatively assuming 50% of the precipitation recharges groundwater, the annual volume of water recharging the study area is 35.5 inches (2.95 ft) multiplied by 840,000 ft^2 equals 2.485 x 10^6 cubic feet per year, or approximately 35 gallons per minute (gpm). This would be the total approximate groundwater flow into the surrounding river (via seeps or groundwater discharge) from this recharge area; however, only a fraction of the island perimeter would potentially be contaminated by AOPCs. The total perimeter is about 3,300 feet, and about 1,300 feet of that is potentially downslope from the site AOPCs. Therefore, the potentially contaminated flow to the river (to the extent groundwater is actually impacted) would be approximately 35 gpm *1,300 / 3,300 which is approximately 14 gpm. This is an approximation but indicates the amount of groundwater flow is extremely small relative to the flow in adjacent river. Each AOPC makes up a component of the 14 gpm total estimated above. For example, Landfill AOPC represents about a third of the perimeter included in the calculation above, so groundwater flow from the Landfill AOPC to the norther towards the river is likely on the order of 5 gpm.

4.1.3 Hydrology and Hydraulics (Columbia River and Bonneville Dam)

The Columbia River watershed is approximately 259,000 square miles within the U.S. and Canada. The watershed is regulated by a coordinated system of dams operated to manage flooding, generate electricity, and facilitate fish migration. The Bonneville Dam supports navigation and generates electricity. The dam is operated as a run-of-river project such that the outflow is adjusted as the inflow changes, and the water surface elevation upstream of the dam typically varies over an elevation range of 3 to 5 feet. While flows are regulated by the operation of dams within the river system, flows at the Bonneville Dam vary over a wide range from 70,000 cubic feet per second (cfs) to 660,000 cfs.

The proximity of the dam and variable flow conditions related to spillway and powerhouse operations produce complex hydrodynamic conditions within the River OU. Over the range of possible conditions, flows move upstream (west to east) along the northern shoreline of Bradford Island due to the formation of a large eddy north of the Island. The Draft FS for the River OU (USACE, 2017b) reported that hydrodynamic conditions in the vicinity of the River OU were evaluated using Computational Fluid Dynamics modeling (CFD). Model-predicted flow velocities within the River OU range from 0 to 3 feet per second (ft/s) with lowest velocities occurring at the west side of the OU and highest velocities occurring at the east (upstream) end of the Island. Velocities within the River OU are highest during periods of moderate to high flow when the spillway is open and both powerhouses are operating at capacity. Flow velocities are slower at the shoreline and increase away from shore. Hydrodynamic conditions affect sediment dynamics including deposition and accumulation of sand and gravel among the boulders and cobbles as well as mobilization and transport of sand and gravel exposed at the riverbed surface.

4.1.4 Riverbed Characteristics

The riverbed along the northern shore of Bradford Island is dominated by coarse sediments including boulders, cobble, and gravel with fine-grained sand and silt filling in voids among the larger rocks. Appendix B includes photos of the riverbed taken during an underwater survey conducted in January 2020 as part of the passive sampling at the River OU (USACE 2020a; USACE 2020b). The riverbed composition varies widely within the River OU. Shallow bedrock forms a hard base with bedrock exposure in some places within the OU. Sediment deposited on the bedrock is dominated by coarse material including boulders, cobbles, and gravel. Sand and finer material is deposited within the void spaces among the larger rocks. The boulders and cobbles appear to be immobile and effective at preventing mobilization and transport of fine-grained sediments deposited within the void spaces. Sand and finer gravel materials at the riverbed surface may be mobilized and transported, however most of that material is coarse enough to move as bed load and would deposit within available nearby void spaces.

The River OU is not a conventional contaminated sediment site. The riverbed composition within the OU is dominated by boulders, cobbles, and shallow bedrock. Hydrodynamics and sediment dynamics are complicated by the proximity of the dam and the effects of variable operations. The nature and extent of residual contamination within the riverbed is not well characterized due to the challenges of sampling sediment within a riverbed dominated by boulders, cobbles, and bedrock.

Conventional remedial technologies for contaminated sediments may not be feasible within the River OU because of the coarse composition of the riverbed and the complex hydrodynamic conditions. Adaptations to dredging and capping technologies would be necessary to account for these site-specific challenges. Dredging using a smaller scale hydraulic dredge with divers may be feasible for removing contaminated finer sediments (sand and silt) from the voids among the cobbles and boulders. This type of dredging approach was previously used in 2008, but EPA and some stakeholders raised concerns at that time that this technology was not effective in removing PCBs from the riverbed. That criticism is supported by subsequent sampling and monitoring data that demonstrate residual PCBs are present in the riverbed at the locations of the former debris piles in the River OU. Hydraulic dredging should be considered and evaluated in the updated FS as a component of at least one remedial alternative. That evaluation should focus on determining whether sediment capping would be feasible and effective without dredging. Sediment capping may be adapted to target filling the void spaces with a combination of clean sand and carbon treatment amendment. A sand cap would not remain in place throughout the River OU unless the surface was armored with coarser material (e.g., gravel, cobble, rock) that would remain in place under modeled near bed flow velocities up to 3 ft/sec. Any capping approach would have to ensure that (1) the finished post-remedy sediment surface is able to remain in place reliably over the range of anticipated hydrodynamic conditions, and (2) the thickness of the cap is sufficient to prevent breakthrough and effectively isolate contaminants in place.

Upland source control regarding transport pathways to River OU is another important consideration. The CSM may be evaluated and, if appropriate, expanded to show transport pathways between upland AOPC sources and the River OU. Sufficient control of potential Upland OU sources to the river is essential to prevent future recontamination of the River OU.

4.1.5 Stormwater (Catch Basins and Outfalls)

Figure 4-2 identifies catch basins (CBs) located within the Sandblast Area AOPC, and two outfalls to the Columbia River (blue dashed lines on **Figure 4-2**). Catch basin CB-5 is located just north of CB-2 across a road but is not indicated on **Figure 4-2**. During optimization review site visit it was discussed that storm water flow in the parking lot between the Service Center Building and Equipment Building flows northward in the parking lot and into a small ditch that subsequently flows into Catch Basin #2. Three of the catch basins (CB-1, CB-3, and CB-4) drain to Outfall #1 (eastern outfall) and two of the catch basins (CB-2 and CB-5) drain to Outfall #2 (western outfall).

In October 2001, the USACE cleaned the sediment from the stormwater system, and replaced the filter fabric socks that line each catch basin (URS, 2012). Starting in 2001 the filter fabric socks were changed periodically. The catch basins are surrounded by straw waddles and there is also a black filter mat just below the grate. In 2018 a sampling event was conducted at the catch basins, which reflected accumulated sediments from 2001 to 2018 (USACE, 2018). There was cleaning of the solids at that time and a subsequent sampling program was implemented on liquids at the outfall (or just upstream of the outfall) to evaluate effluent quality (personal communication during optimization review site visit). Observations by Oregon DEQ staff suggest that the controls for the release of solids during precipitation events may have been overwhelmed during high intensity precipitation events. Black filter mats are now changed quarterly, and solids have not accumulated since 2018 (personal communication during optimization review site visit).

4.1.6 Contaminants of Concern and Summary of Contaminant Distribution

The discussion below qualitatively (and in some cases quantitatively) describes contaminant distribution relative to RI screening levels. No attempt is made as part of the optimization evaluation to redefine screening levels which is outside the scope and expertise of the optimization study, and definition of screening levels and/or cleanup levels is left to the USACE project team in consultation with tribes and stakeholders.

Landfill AOPC

Contaminants exceeding screening levels in soil at the Landfill AOPC include metals, PAHs, pesticides, herbicides, PCBs, and total petroleum hydrocarbons (TPH) (URS, 2012, Figures 9-1a to 9-3d). Metals with widespread concentrations above soil screening levels include antimony, arsenic, cadmium, lead, mercury, and/or zinc. In the Landfill AOPC many of these metals constituents have similar concentrations in surficial soil and deeper soil. Detection of PAHs above soil screening levels were also widespread. For other constituents (e.g., pesticides, herbicides, PCBs, TPH) concentrations exceeding soil screening levels were much less widespread.

Because sloughing of the waste material and soil into the river is a concern in the Landfill AOPC, the RI also compared the soil concentrations at perimeter locations near the river to the screening concentrations for sediments. Soils concentrations for many constituents (including metals, pesticides, PCBs, PAHs, and semivolatile organic compounds [SVOCs]) were detected in the Landfill AOPC perimeter soil samples at concentrations exceeding screening levels for sediment.

Groundwater is generally impacted above screening levels by the same constituents that impact the soil, as well as by relatively low concentrations of selected volatile organic compounds (VOCs) such as tetrachloroethylene (PCE), vinyl chloride, and chloroform. Seep samples at several locations along the northern extent of the island indicate some very mild impacts from TPH-diesel range organics (TPH-DRO) and VOCs at concentrations slightly exceeding the surface water screening levels, indicating that those relatively mobile constituents have migrated in groundwater to the seeps. As discussed above in Section 4.1.2, a small amount of groundwater (on the order of 5 gpm) is likely available in the Landfill AOPC, such that dilution of seep water upon entering the surface water of the Columbia River would be overwhelming. Constituents that are expected to not be mobile (e.g., PCBs, pesticides, PAHs, metals) were not detected at seeps, consistent with expectations.

Sandblast Area AOPC

The primary contaminants in the Sandblast Area AOPC are metals related to the sandblast grit that is found surrounding the former location of the sandblast building. Metals of concern based on soil sampling include lead, chromium, cadmium, nickel, and zinc, among others. Metals that impact soils across much of the Sandblast Area AOPC and were also observed in 2018 samples of sediment recovered from stormwater catch basins downslope of the area impacted by sandblast grit (discussed below under "Stormwater Catch Basins and Outfalls"). Based on figures from the RI (URS, 2012, Figures 9-5a to 9-5e) the substantially elevated metals concentrations in soil are generally restricted to the top approximately 1 ft of soil, with much lower concentrations at depths of 2 ft or more. For example, at LD-02 in the Laydown Area the cadmium concentration declines from approximately 8 milligrams per kilogram (mg/kg) at 0-1 ft to approximately 0.2 mg/kg (below screening level) at 1-3 ft, and chromium declines from approximately 50 mg/kg from 0-1 ft to approximately 17 mg/kg (below screening level) at 1-3 ft. Near the current HMSA at SBB17 chromium concentration declines from approximately 625 mg/kg from 0-0.5 ft to approximately 53 mg/kg at 3 ft, and lead concentration declines from approximately 516 mg/kg from 0-0.5 ft to approximately 32 mg/kg at 3 ft. Similar attenuation with depth occurs for other metals constituents and at other locations. For soil samples 10 ft or lower, the only metals exceeding screening levels were arsenic at concentrations just slightly above reference area levels, and chromium at only one location.

Metals including arsenic, iron, manganese, and vanadium have also exceeded screening levels in groundwater samples from monitoring wells and direct-push sampling locations (UR2, 2012, Figure 9-7a), although samples from groundwater monitoring wells only had screening level exceedances for arsenic, iron, and vanadium (other metals were apparently not analyzed in monitoring well samples). Only one monitoring well sample (from MW-11) contained vanadium above screening levels in the RI and subsequent samples from the same well did not have exceedances for this metal. Note that monitoring wells MW-11 to MW-13 are screened deeper than the nearby direct-push point sampling depths and monitoring wells likely have lower turbidity in the samples than direct-push samples. Both factors may explain why observed metals concentrations are much lower in the monitoring wells versus direct push samples (for metals constituents analyzed in monitoring wells and direct push samples). Turbidity in the direct push samples is likely the predominant reason. For example, at the 5 monitoring wells in this area (MW-11 to MW-15) iron was generally below the screening level of 300 micrograms per liter (µg/L) in multiple samples over time at all 5 wells, though one sample at MW-13 was 312 µg/L and one sample at MW-11 was 1,500 µg/L. In contrast, at direct-push locations much higher iron concentrations were observed (e.g., 9,820 µg/L at DP-10; 15,900 µg/L at DP-11; 16,500 at DP-1), likely due to iron bound to solids in more turbid samples.

According to the 2012 RI (Appendix I, Table I-13), samples collected with the direct-push sampling program were analyzed for a wide range of metals. However, monitoring well samples for the Sandblast AOPC were apparently only analyzed for selected metals limited to arsenic, iron, vanadium, and common cations (potassium, calcium, sodium, and magnesium). This limits the ability to compare monitoring well sample results to direct push sample results for a larger set of metals constituents.

With respect to contaminants other than metals at the Sandblast Area AOPC (URS, 2012, Figures 9-5f to 9-5k and 9-7b):

- There are PCBs in surface soil associated with the transformer disassembly area in the far northeast part of the Sandblast AOPC (and at one location downslope to the north in the Laydown Area). However, no PCBs were detected in soil above screening levels below a depth of 1 foot, and no PCBs were detected in groundwater.
- VOCs, particularly PCE and trichloroethylene (TCE), were observed in soil samples in the immediate vicinity of the current HMSA. Relatively low concentrations of PCE, TCE, and their daughter products were observed in groundwater throughout the Sandblast Area AOPC, with maximum concentrations in groundwater (PCE 54.5 µg/L and TCE 43.7 µg/L) at direct-push location DP11 (7 to 17 ft bgs) in 2004 near the apparent source area. All other measured PCE and TCE concentrations were much lower (generally 5 µg/L or less). VOC concentrations in soil and groundwater have very likely attenuated since sampling performed for the RI more than a decade ago.
- Pesticides, particularly DDT and Endrin, have been found above screening levels in the shallow soils in the northeastern portion of the Sandblast Area AOPC (including DDT in the Laydown Area north of the landfill access road). There was no sampling for pesticides in groundwater in those areas.
- HPAHs are found in soil above screening levels over much of the same area, along with a few locations near the current and former HMSA. A number of PAHs were detected in direct-push groundwater samples but not in groundwater samples from monitoring wells. Based on the tables in the 2012 RI it appears that only a selected set of SVOCs (phenanthrene, benzo[b]fluoranthene, and benzo[k]fluoranthene) were analyzed for in monitoring well samples. Similar to metals (e.g., iron), lower PAH concentrations in monitoring well samples versus direct push samples for constituents analyzed in both types of samples (such as phenanthrene) suggests concentrations in direct-push samples may be due to PAHs entrained on solids and does not represent dissolved (migrating) impacts, and/or could be due to the different depth for the samples.

As with metals, most contaminants in soil appear to be confined to the shallow soils. As with metals, the limited list of analytes for SVOCs limits the ability to compare monitoring well sample results to direct push sample results for a larger set of PAH constituents.

Based on discussion during the optimization review site visit, additional surficial soil sampling is currently being planned for multiple areas within the Sandblast Area AOPC, including some areas previously sampled and other areas not previously sampled. One area to be sampled for the first time is a vegetated area up-slope (south) of the current HMSA, due to concerns that wind could have transported sandblast grit to that higher elevation area. Another area that will be included is an area of disturbed soil just east of the current HMSA where sampling in the RI detected elevated concentrations of metals including lead, nickel, chromium, and other metals. The current plan, still being refined, is to use

Incremental Sampling Methodology (ISM) for surficial soil (depths discussed below) and discrete sampling in specific areas for deeper samples (down to 3 ft). ISM involves collection of numerous increments of soil with specific Decision Units (DUs). The samples within each DU are then combined according to specific procedures to provide a representative result for the DU, as opposed to a wide range of results at specific locations obtained from discrete sampling in a heterogenous setting.

USACE indicated to the optimization review team that there are ongoing discussions with the TAG about the number of ISM increments to be collected in each DU, the specific depth intervals to be sampled, and how to address ISM sampling in areas where "hot spots" have previously been identified.

- With respect to ISM sampling depth, USACE indicated that the US Fish and Wildlife Service suggested an ISM interval for surficial soil from ground surface to a depth of 2 inches to best characterize ground surface, and a deeper interval for discrete samples from 2 inches to 3 ft. ODEQ requested that the original surface interval of 0 to 12 inches bgs used in the RI be used during the ISM sampling. USACE expressed concern that 2 inches for surficial soil requested by US Fish and Wildlife Service is too shallow since some scraping of forest detritus is planned, and USACE believes intervals of 0-0.5 ft for ISM and 0.5-3 ft for the deeper discrete samples are preferable. The optimization team concurs with that logic.
- With respect to "hot-spots" in soil defined by previous sampling, USACE indicated that the TAG suggests pre-defining certain areas as "impacted" (based on previous sampling) and limiting the ISM to the remainder of the DU to determine if the remainder of the DU is impacted. This approach assumes that the pre-defined areas would be carried forward for remedial action, regardless of the ISM results in the remainder of the DU. The optimization team also concurs with that logic.

The optimization team notes that pre-defined areas carried forward for remedial action, and/or areas carried forward based on ISM results, can potentially be further refined by future sampling during pre-design activities to optimize (reduce) the area where actual remediation is implemented.

Pistol Range AOPC

Sampling for the RI was conducted for selected metals based on the previous use of the area as a firing range. The primary contaminant at the Pistol Range AOPC is lead in soil. (URS, 2012, Figure 9-11). The highest concentrations of lead in soil are near the firing shed (southwest portion of the AOPC) and near the backstop (northeast part of the AOPC). The maximum lead concentration in soil near the firing shed was 758 mg/kg, and the next highest lead concentration was 269 mg/kg, compared to the screening level of 25.5 mg/kg. The maximum lead concentration in soil near the backstop was 915 mg/kg, with multiple other locations above 500 mg/kg. Shallow soil between the firing shed and the backstop area generally have lead concentrations that exceed the lead screening level of 25.5 mg/kg but are below 100 mg/kg (i.e., much closer to the screening level). In groundwater, lead was below screening levels at both direct-push sampling locations in the Pistol Range AOPC. In sediments sampled from the lagoon located to the southeast of the Pistol Range AOPC lead was below the sediment screening level at each location.

Zinc is also detected above screening levels in soil at the Pistol Range AOPC near the firing shed (URS, 2012, Figure 9-11). The maximum zinc concentration in soil near the firing shed was 199 mg/kg, and several other nearby locations had zinc greater than 100 mg/kg, compared to the screening level of 71.7 mg/kg. There were no samples analyzed for zinc in other parts of the AOPC, including near the backstop area. In groundwater, zinc was below screening levels at both direct-push sampling locations. In sediments from the lagoon (located to the southeast) zinc was slightly above the screening level of 123 mg/kg at all four locations where zinc analysis was performed, with a maximum zinc concentration of 171 mg/kg. When the Pistol Range AOPC was in use as a firing range the ground surface may have been less vegetated compared to current conditions and there may have been historical runoff to the Columbia River, potentially explaining those sediment results.

USACE indicated to the optimization review site team there is general agreement to remove 1 to 3 ft of soil at the Pistol Range. One of the ecological issues is lead fragments that are encountered by birds, and there may be consideration of sieving the soil for lead fragments rather than soil removal from the site.

Bulb Slope AOPC

The RI sampling included 12 surface soil samples from within the area visibly impacted by glass and light bulb debris, with analysis for lead, mercury, and PCBs (as Aroclor 1260) (URS, 2012, Figure 9-12). Lead was detected above the soil screening level of 25.5 mg/kg in 11 of 12 locations, with maximum concentration of 597 mg/kg. Of the 12 locations, 9 had lead concentration in soil exceeding 100 mg/kg. Mercury was detected above the soil screening level of 0.066 mg/kg in 10 of 12 locations, with maximum concentration of 1.54 mg/kg. Of the 12 locations, 6 had mercury concentration in soil exceeding 0.25 mg/kg. PCBs were detected at several locations below soil screening levels.

Because sloughing of the waste material and soil into the river is a concern in the Bulb Slope AOPC, the RI also compared the soil concentrations discussed above to the screening concentrations for sediments. For lead, the soil concentrations exceeded the sediment screening level of 35 mg/kg at 11 of 12 locations. For mercury, the soil concentrations exceeded the sediment screening level of 0.214 mg/kg at 6 of 12 locations. For PCBs, the soil concentrations exceeded the sediment screening level of 0.048 mg/kg at 8 of 12 locations (i.e., every location where PCBs were detected); at the other 4 locations PCBs were not detected but the reporting level was above the very low sediment screening level of 0.048 micrograms per kilogram (µg/kg).

Stormwater Catch Basins and Outfalls

Solids were sampled from the catch basins in 2018 prior to being removed, with analysis for metals, PAHs, PCBs, pesticides, and total organic carbon (USACE, 2018). Elevated concentrations were detected in these sediments for metals (e.g., chromium, lead, nickel, zinc), PAHs, and several pesticides (e.g., DDT, endrin ketone). Some of the catch basins also had detections of PCB aroclor 1260 (e.g., CB-3 at 2.5 µg/kg and CB-4 at 3.1 µg/kg). In general, CB-3 and CB-4 had the highest constituent concentrations on sediments, followed by CB-1 and CB-5. CB-2, which is upslope of CB-5, generally had the lowest concentrations. When grouped by outfalls, the catch basins that drain to Outfall 1 (CB-1, CB-3, and CB-4) showed generally greater concentrations than the catch basins that drain to Outfall 2 (CB-2 and CB-5).

Stormwater was sampled in late 2018 at Outfalls 1 and 2 (leaving the storm drain system) and at CB-2 (prior to the filter), prior to clean-out of solids, with analysis for metals, PAHs, PCBs, pesticides, hardness, and total organic carbon (USACE, 2019). Stormwater at Outfalls 1 and 2 were subsequently sampled several more times after cleanout of solids, with samples collected after storms in 2019 and 2020 (spreadsheets provided by USACE after cleanout of solids). This sampling has indicated the concentrations of some contaminants in the stormwater exceeds screening “benchmark” levels. There were exceedances of the benchmark levels for select PAHs and dissolved and total copper during the sampling events in June 2019, October 2019, November 2019, and March 2020. Detections of individual congeners of PCBs up to the level of tens of µg/L were observed in stormwater. The detections of COCs are relatively low and expected to be easily diluted by flow in the river (discussed further in Section 4.2).

River OU

The three former electrical debris piles placed in the river, and potentially historical stormwater outfall discharges, impacted the surrounding riverbed with PCBs, PAHs, and metals. Electrical equipment and associated debris were removed from the three in-river debris piles in 2000 and 2002 (see **Figure 3-3** for locations), and PCB-impacted sediment was removed by diver-directed dredging in 2007 (see **Figure 3-4** for locations). Residual impacts in the riverbed include PCBs, PAHs, and selected metals.

Contaminants of Potential Ecological Concern (CPECs) within the River OU identified in the draft FS for the River OU (USACE, 2017b) included the following:

- PCBs (PCBs as Aroclors, PCBs as congeners, and PCB toxic equivalents)
- Metals
- PAHs
- Butyltins (direct toxicity only)
- Organochlorine pesticides (OCPs)
- SVOCs

The draft FS for the River OU (USACE, 2017b) reported that the findings of the human health and ecological risk assessments identified PCBs as the primary driver for human health risk and ecological risk for the River OU. HPAHs were also identified as an ecological risk driver specifically for the benthic community. The two RAOs identified in Section 4.1.1 of the draft FS for the River OU refer only to PCBs.

The draft FS for the River OU concluded that remaining COCs (PAHs and metals) would be addressed by remediation of PCBs because elevated concentrations of those COCs coincide with areas needing remediation for PCBs, and because PAHs and metals are not widely distributed within the River OU compared to the distribution of PCBs. The RI (Table 6-8a, URS, 2012) also identified TPH as detected in forebay sediment during post-removal sampling in 2008, which was not specifically addressed in the FS; however, the same logic would apply (i.e., impacts from TPH, to the extent present, would be assumed to be addressed by PCB remediation). With respect to the OCPs, Section 3.4 of the FS for River OU states: "*Maximum concentrations of OCPs were co-located with PCBs along the north shore of Bradford Island, adjacent to former underwater debris piles that were removed in 2000 and 2002, and also in one isolated detection on the northeastern tip of Goose Island. OCP compounds are not infrequently confounded with PCB congeners during laboratory analyses due to similarity of structure and overlapping mass ratios. There is no supporting site evidence to suggest that OCPs were disposed at the former debris piles in the north shore of Bradford Island. However, co-location with elevated PCBs in tissue, lack of uniform levels of OCPs throughout the River OU, and lack of OCP detections above the sediment [risk-based threshold concentrations] creates an uncertainty as to whether OCPs are site-related*." The optimization review team concurs with the interpretation in the FS for the River OU that this is most likely an issue of laboratory analysis confounding OCPs with PCBs for the reasons cited in the FS. However, the uncertainty as to whether OCPs are site-related may be alternately characterized as a data gap that may be addressed during future preparation of the FS for the River OU.

Sediment and tissue samples were collected in 2011 (URS, 2014). Smallmouth bass were collected from within the forebay and the reference area and highest concentrations of PCBs were observed in samples collected along the north shore of Bradford Island. Clam samples collocated with sediment samples were collected from seven 50 x 50 feet sample stations within the footprint of the 2007 sediment removal action. Sampling locations are illustrated on **Figure 3-5**. The 2014 Data Evaluation Technical Memorandum (URS, 2014) presented data displays mapping the spatial distribution of COC concentrations within the River OU for PCBs (total Aroclor concentrations), HPAHs, arsenic, mercury, and nickel with respect to screening level values. Results showed that locally elevated PCB concentrations coincided with the footprints of the three debris piles removed in 2000 and 2002 and the area just offshore from stormwater outfalls at the west end of the River OU. The footprints of the metals and HPAHs overlap with and are generally encompassed by the footprint of the PCBs. Similarly, maximum concentrations of OCPs were co-located with PCBs along the north shore of Bradford Island, adjacent to former underwater debris piles that were removed in 2000 and 2002, as previously noted.

A passive sampling study was conducted starting in January 2020. The purpose of the study was to identify locations that are ongoing sources of PCBs at Bradford Island. The passive samplers were deployed in a grid within the River OU to measure polyethylene concentrations and calculate freely dissolved PCBs in water at the sediment-water interface (USACE, 2020). Results, summarized on **Figure 4-6**, showed that the highest concentrations of PCBs coincided with the footprints of the three debris piles removed in 2000 and 2002 and the area just offshore from the stormwater outfalls at the west end of the River OU where sediments were previously removed in 2007.

It is not clear whether residual PCBs remaining within the River OU are present as dense non-aqueous phase liquid (DNAPL), bound to sediments, includes solid PCBs, or all of the above. The nature and extent of residual contamination is broadly defined by previous in-river sampling in various media (including the recent passive sampling study) but there are still some uncertainties particularly in the riverbed subsurface. Sediment characterization is greatly complicated by the boulder/cobble dominated riverbed composition within much of the River OU.

4.1.7 Contaminant Fate and Transport

Although the debris piles and impacted sediments in these key areas were previously removed, the results of passive sampling conducted in 2020 indicates ongoing PCB impacts at the sediment-water interface in these same general areas. This suggests that there is residual PCB contamination in the riverbed that partitions from sediments into the surface water at detectable levels. As noted above, it is not clear if that residual contamination is in the form of DNAPL in riverbed crevices, or in the form of contaminants bound to sediments in riverbed crevices, or both.

Further spreading of the PCB contamination historically released directly into the river seems unlikely. Based on evaluation of removal documentation and post-removal surveys, the optimization team presumes all equipment historically disposed in the river was removed during previous investigation and remediation efforts. Any oils that were historically released into the riverbed materials would be expected to have reached residual saturation long ago (i.e., residual DNAPL would be trapped in the subsurface crevices and pores with no remaining pool with sufficient head to be mobile). The modeled current velocities of 0 – 3 ft/s within the River OU are not sufficient to mobilize the gravel, cobble and boulders that make up the riverbed. The sand and silt, while mobile when exposed to flow velocities greater than approximately 2 ft/s, cannot be mobilized when they are sheltered in the crevices among the cobbles and boulders (i.e., below the riverbed surface). The general lack of fine-grained sediments at the riverbed surface observed in this area indicates relatively low potential for spreading via sediment transport. The correlation of the highest impacts observed in the 2020 passive sampling to areas of previous debris and sediment removal is consistent with a CSM with little ongoing spreading of these historical impacts. Contaminants other than PCBs (e.g., PAHs and metals) are subject to the same limitations regarding fate and transport in association with sediment dynamics.

There are several potential mechanisms that could result in future impacts to the river due to migration from the Upland OU. These include: 1) sloughing of waste and or soil into the river (e.g., from the Bulb Slope AOPC and/or Landfill AOPC) into the river; 2) groundwater transport of contaminants into the river via seeps along the riverbank and/or direct discharge of groundwater into surface water; 3) transport of impacted soil into the river via overland runoff or wind; and 4) future discharges to the river from stormwater.

Of these four potential transport mechanisms from the Upland OU to the river, the optimization review team believes sloughing is the most significant risk to the river in the near term. The reason is that sloughing due to erosion (an ongoing process) and/or due to an earthquake will almost certainly occur at some point in time and could result in direct release of waste and/or impacted soil into the river. Unless impacted material in these areas is removed or otherwise prevented from sloughing into the river via engineering controls, the potential for contaminant migration to the river via sloughing will persist. Minor transport of contaminated solids via site runoff, either via overwhelmed protections for the outfalls or via direct overland flow to the river, may occur particularly during high intensity precipitation events. Removal of contaminated soil would also eliminate this pathway.

The likelihood for significant impacts to the river via groundwater migration from the Upland OU appears to be relatively low.

- As discussed in Section 4.1.2, the amount of groundwater flow is limited.
- Additionally, most of the COCs (e.g., PCBs, PAHs, pesticides) are expected to be relatively immobile in groundwater (unless mobilized by co-solvency, but TPH is not observed in high enough concentrations in groundwater that co-solvency issues would be expected).
- At the Landfill APOC, groundwater migration is expected to primarily be in the alluvium and discharge as groundwater seeps (see Section 4.1.2). As discussed in Section 4.1.6, seep samples at several locations along the northern extent of the island at the Landfill AOPC indicated only mild impacts from relatively mobile constituents (TPH-DRO and VOCs) at concentrations slightly exceeding the surface water screening levels, whereas constituents that are expected to not be mobile (e.g., PCBs, pesticides, PAHs, metals) were not detected at the seeps.
- At the Sandblast AOPC, where direct discharge of groundwater from alluvium to the river is possible (see Section 4.1.2), the two monitoring wells closest to the river (MW-14 and MW-15) had only minor VOC impacts and nearly no impacts from metals (though analysis of metals in monitoring wells was limited to arsenic, iron, and vanadium). Other direct-push groundwater samples nearby indicated some metals impacts that are likely due to turbid samples (i.e., not dissolved contamination that is migrating).

In the Landfill AOPC, the Sandblast AOPC, and in the Pistol Range AOPC (where no groundwater impacts have been identified), future soil remediation will further reduce the current (relatively low) potential for impacts to the river via contaminant migration in groundwater.

Potential for overland water flow to carry contaminants into the river is generally expected to be low, but it is possible in areas immediately adjacent to the river including the Bulb Slope AOPC, portions of the Landfill AOPC, and portions of the Sandblast AOPC (such as the Laydown Area). In general (except in the Bulb Slope AOPC) infiltration is expected before reaching the river (i.e., contributing to potential impacts in groundwater or seeps). Specifically with respect to overland flow, those areas might nevertheless be considered high priority areas for excavation or engineering controls to mitigate any potential for impacts to the river from this mechanism. Potential for wind transport to the river under current conditions appears to be low. Potential for overland flow and/or wind transport to impact the river could be exacerbated under future conditions during soil remediation without adequate controls. Potential for stormwater to impact the river under current conditions is considered low based on modeling performed by USACE (discussed further in Section 4.2).

4.1.8 Potential Human and Ecological Exposure Pathways

Based on information in historical documents, primarily the RI (URS, 2012) past assessments of potential human exposure have included occupational exposures (both indoors and outdoors, including potential for vapor intrusion), exposures due to intrusive activities, the use of groundwater for potable supply for site workers, and consumption of fish from the impacted portions of the river around Bradford Island. Other exposure scenarios for the upland areas could also be considered under hypothetical unrestricted future conditions, and these were qualitatively considered in the development of optimization recommendations. Ecological exposures were considered for upland site soils (from the surface to as much as 3 feet) and for aquatic species in the river and species that may feed on them. Currently there is a fish advisory in the vicinity of Bradford Island to mitigate human exposure. Note that the assessment of the exposure assumptions was not within the scope or expertise for the optimization team.

4.1.9 Institutional and Engineering Controls

Access to this portion of the Bonneville Dam complex is controlled and only USACE employees, authorized contractors, and approved visitors can access the eastern portion of Bradford Island. Land use decisions are controlled by the USACE. No other institutional or engineering controls are in place for the upland areas. According to the Oregon Health Authority website, there is a restriction to not eat any resident fish (including bass, bluegill, carp, catfish, crappie, sucker, sturgeon, walleye and yellow perch) extending from Bonneville Dam to Ruckel Creek (approximately one mile upstream). Migratory fish (including Salmon, steelhead, lamprey and shad) are not included in the restriction.

4.1.10 Groundwater Monitoring

The existing monitoring wells that comprise the groundwater monitoring network are illustrated on **Figure 4-7**. This Site is in the RI/FS stage so the sampling to date has been investigative as opposed to long-term monitoring. Groundwater sampling (and measurement of water levels to determine groundwater elevations) has not been conducted since sampling performed for the RI, so the data are over ten years old. The CSM would be improved with more recent sampling of groundwater concentrations and measurement of water levels.

It is expected that a long-term groundwater monitoring program will be developed as a component of the remedy. Those details would be determined as part of remedial design. It is possible that many of the existing monitoring wells could be destroyed by remedial actions that include excavation or capping.

4.2 EFFECTIVENESS OF REMEDIAL ACTIONS PREVIOUSLY IMPLEMENTED

At the Landfill AOPC soil cover was placed in the 1980s and the area is highly vegetated. Details on the soil cover were not included in the documents reviewed by the optimization team, so effectiveness is hard to establish. The soil cover at the Landfill AOPC does not represent a permanent remedy and does not address potential for sloughing of waste and/or impacted soil into the river.

At the Sandblast AOPC previous remedial action has been limited to sediment removal from the stormwater catch basins in 2001 and 2018, and placement straw wattles and filters in the stormwater catch basins after 2001 that are maintained and periodically replaced. As noted previously, Oregon DEQ believes some overflow and bypass of the media meant to trap solids before discharge to the river may have occurred over time. USACE indicates that solids have not collected in the catch basins since the last cleanout in 2018, which suggests the straw wattles and filters are effectively impeding solids from entering the catch basins.

Water sampling from the two outfalls since 2018 has indicated the concentrations of some contaminants in the stormwater exceeds screening “benchmark” levels. There were exceedances of the benchmark levels for select PAHs and dissolved and total copper during the sampling events in June 2019, October 2019, November 2019, and March 2020. Detections of congeners of PCBs up to the level of tens of µg/L were observed in stormwater. There is some disagreement among the parties about the appropriate criteria. Note that the optimization team believes it is possible the concentrations of the PCBs in the stormwater may be affected by transport on suspended solids (most likely through partitioning onto organic carbon) that may pass through the filters in the catch basins, which would then be widely dispersed upon entering the river. Co-solvency of pesticides and PCBs into residual petroleum is also conceptually possible since some TPH has been detected in storm water, though at very low concentrations. TPH-gasoline was not detected at either outfall in four sampling events, and TPH-diesel and TPH-motor oil were detected no higher than 0.28 μg/L at either outfall.

Recent modeling of the transport of contaminants from the outfall within the river (USACE Engineer Research and Development Center, 2021 [Internal Draft]) suggests there would be large dilution effects. The modeling (the results of which are still undergoing internal USACE review) conservatively used the flow measured in only the one spillbay (18) at the dam that would be closest to the island along with the measured flow in the outfall to assess the dilution, and not the entire flow in this segment of the river channel. Dissolved concentrations of all constituents would be well below typical analytical methods (in the range of 10^{-6} to 10^{-8} μg/L).

In the river, previously implemented remedial actions included removal of three debris piles (**Figure 3-3**) in 2000 and 2002, and removal of sediment in 2007 (**Figure 3-4**) by diver-directed dredging. Sediment and tissue samples were collected from within the River OU in 2011 after the removal of the debris piles in 2000, 2002, and the removal of sediments in 2007 (URS, 2014). Passive sampling of free dissolved PCBs at or near the sediment water interface was conducted in 2020 (USACE, 2020). Sampling results (discussed in Section 4.1.6) showed that residual PCBs above screening level values remained in the sediments within the River OU after the remedial actions. The locations of highest PCB levels coincided closely with the footprints of the debris and sediment removal areas for both the 2011 and 2020 results.

Large PCB concentrations were observed in some organism samples in 2011 after previous dredging efforts. The optimization team believes this most likely reflects the fact that, until remediation is completed with a cap (as recommended in Section 5.2.2), there is potential for small benthic organisms (such as crayfish) to come in contact with PCBs associated with contamination (including residual NAPL containing PCBs) that may remain in the riverbed (especially in the crevices among coarse sediment) despite previous dredging efforts. Such impacts can impact the associated food chain.

4.3 Alternatives Previously Considered for Upland OU

The FS for the Upland OU (USACE, 2017a) stated that the Baseline Human Health and Ecological Risk Assessments concluded there were unacceptable levels of risk for human health in the Landfill AOPC due to the presence of cPAHs, and unacceptable risk to ecological receptors in the Landfill and Pistol Range AOPCs due primarily to the presence of metals. Therefore, the FS evaluated alternatives for remedial action at the Landfill AOPC and the Pistol Range AOPC.

The 2017 FS evaluation for the Upland OU considered human exposures within the Upland OU but did not address ecological risks within the Upland OU based on interpretation of Army guidance, and also did not fully address potential impacts to the River OU from the Upland OU. The FS for the Upland OU did not develop or evaluate remedial alternatives for the Sandblast AOPC. However, recent discussions with USACE (personal communication, Chris Budai [USACE], Summer 2021) have indicated the Sandblast Area AOPC will be included in an updated FS (in process) based on reinterpretation of Army guidance regarding ecological risk. The updated FS will also include addition of a third RAO for potential sources to the River OU, addressing linkage between Upland OU AOPCs (including the Landfill, Sandblast, and Bulb Slope APOCs) and potential impacts to the River OU.

As a result of this history, the summary of alternatives previously considered for the Upland OU presented below is limited to the alternatives previously considered for the Landfill AOPC and the Pistol Range AOPC.

Landfill AOPC

The FS for the Upland OU (USACE, 2017a) considered five remedial alternatives for the Landfill AOPC (estimated costs with 2019 price levels[1] for the alternative in parentheses):

- L1 – No action ($0)
- L2 – Landfill cutback and land use controls ($1,350,055)
- L3 – Landfill cutback, additional shallow excavation, and land use controls ($1,998,483)
- L4 – Landfill cutback, capping, and land use controls ($1,596,528)
- L5 – Landfill cutback, complete landfill excavation and backfill (5,856,355)

Each of the active alternatives included landfill cutback, which would include full excavation north of a specific line ("Landfill Setback" area on **Figure 4-8**) and grading to a second line further south ("2H:1V Graded Area" on **Figure 4-8**). Estimated removal is 1,988 cy. The cutback excavation would mitigate potential for waste or impacted soil to be subject erosion or mass wasting. In alternative L2 this cutback would be the extent of the active remediation. Land use controls would be applicable since some contaminated material would be left in place.

Areas for additional excavation and/or capping for Alternatives L3 and L4 are indicated on **Figure 4-8**. Alternative L3 includes shallow excavation (0 to 3 ft) in specific areas in addition to the cutback, primarily to address high concentrations of cPAHs. The additional excavation relative to Alternative L2 is estimated at 9,937 ft^2 in area and 3,092 cy of excavated material. Alternative L4 includes some excavation in sloped areas (1,675 ft^2) in addition to the cutback, plus capping with 3 ft of clean material in specific areas (8,262 ft^2) corresponding to areas that would have shallow excavation in Alternative L3. Alternatives L3 and L4 would also require land use controls since some contaminated material would be left in place.

Alternative L5 would include complete excavation of the landfill footprint (**Figure 4-9**) to an assumed depth of 10 ft. The additional excavation relative to Alternative L2 is estimated at 25,565 ft^2 in area and 10,841 cy of excavated material. Due to complete excavation no land use controls would be required for this alternative since no potential future exposures of any type would be expected.

Prior to excavation or capping, additional pre-design samples would be taken to further delineate/refine the excavation or capping footprint. Estimated costs for soil disposal assumed excavated waste would require disposal at a subtitle C landfill. Excavated areas would be backfilled with clean material.

Pistol Range AOPC

The FS for the Upland OU (USACE, 2017a) considered three remedial alternatives for the Pistol Range AOPC (estimated costs with 2019 price levels[1] in parentheses):

- PR1 – No action ($0)
- PR2 – Shallow excavation and backfill ($85,911)
- PR3 – Capping and land use controls ($133,872)

The areas targeted for either excavation or capping are shown on **Figure 4-10** and correspond to the locations with highest observed impacts near the former firing shed and backstop. Prior to excavation or capping, additional pre-design samples would be taken to further delineate/refine the excavation or

[1] These updated cost estimated based on 2019 price levels were provided by USACE and differ from costs presented in the 2017 FS.

capping footprint. Estimated costs for soil disposal assumed excavated waste would require disposal at a subtitle C landfill due to lead.

The excavation alternative included clearing existing vegetation, removal of 3 ft of soil from approximately 840 ft^2 (for a total of approximately 90 to 100 cy), backfilling with clean materials, and reseeding with native vegetation. Estimated costs for soil disposal assumed excavated waste would require disposal at a subtitle C landfill. The 3-ft depth of excavation was considered conservative due to the nature of the release and the limited mobility of lead in soils at near-neutral pH.

The capping alternative would be intended to prevent human exposure through the placement of a minimum of 3 ft of clean materials and reseeding with native vegetation.

4.4 Alternatives Previously Considered for River OU

The Draft FS for the River OU (USACE, 2017b) considered eight remedial alternatives for the River OU. The estimated costs of these alternatives ranged from $0 for Alternative 1 (no action) to nearly $21M for Alternative 8 (combination of capping, dredging, and monitored natural recovery [MNR] over the rest of the River OU with enhanced MNR (addition of some clean material) in certain areas.

The FS approach was based on the concept that PCBs are the primary risk driver, and other constituents (metals, PAHs) have only minor contribution to risk and have limited distribution and/or overlap with PCB impacts. Alternatives 2 through 8 incorporated different assumptions to determine the areas to be addressed via capping, dredging, enhanced MNR, and/or MNR, based on levels of PCB concentrations in sediments targeted for remediation. For example, Alternative 3 including capping for total PCBs in sediment greater than 29 µg/kg, Alternative 4 included capping for total PCBs in sediment greater than 15 µg/kg, Alternatives 5 and 6 included capping for total PCBs in sediment greater than 2.1 µg/kg, Alternative 7 included capping or dredging for total PCBs in sediment greater than 1.3 µg/kg, and Alternative 8 included capping for total PCBs in sediment greater than 0.97 µg/kg.

These remedial alternatives were developed according to a CSM that focused on sediment impacts. The FS is currently being updated to more rigorously account for a CSM where little sediment is present and residual material within the riverbed appears to be the predominant continuing source of PCB impacts.

4.5 Technical Issues and Data Gaps

Key technical issues and data gaps include the following:

- The River OU is not a conventional contaminated sediment site. The riverbed composition within the OU is dominated by boulders, cobbles, and shallow bedrock. Hydrodynamics and sediment dynamics are complicated by the proximity of the dam and the effects of variable operations. The nature and extent of residual contamination within the riverbed is not well characterized due to the challenges of sampling sediment within a riverbed dominated by boulders, cobbles, and bedrock. These issues are discussed below:
    - ***Complex riverbed composition*** – The riverbed composition varies widely within the River OU and includes boulders, cobbles, and gravel that is difficult to characterize.
    - ***Nature of contaminants in the riverbed*** – It is not clear whether PCBs remaining within the River OU are DNAPL, bound to sediments, or both. Results of the 2020 passive sampling study indicated continued impacts near the three former debris piles. The nature and extent of residual contamination is broadly defined by previous in-river sampling in

various media (including the recent passive sampling study) but there are still some uncertainties particularly in the riverbed subsurface where the coarse riverbed composition (e.g., cobble and boulders) complicates sediment sampling and characterization.

- ***Complex hydrodynamics*** –The proximity of the dam and variable flow conditions related to operation of the spillway and powerhouses produce complex hydrodynamic conditions within the River OU.

- ***Contaminant fate and transport*** – As noted previously, it is not known if PCBs in the riverbed are present as DNAPL, bound to sediments, or both. If any of the contamination is DNAPL, the potential for lateral migration needs to be evaluated and addressed as part of any remedy that leaves contamination in place. Specifically, if a sediment cap is used to isolate subsurface contamination from surface biota exposure, the lateral extent of the cap may need to be expanded to address previous contaminant migration (and related uncertainty) and any potential future lateral migration of contaminants. As discussed in Section 4.1.7, the optimization team believes oils historically released into the riverbed materials would be expected to have reached residual saturation long ago. The coarse riverbed sediment (e.g., cobbles) in portions of the River OU creates a situation in which residual PCBs present in the riverbed as DNAPL may not be physically mobile but may still be accessible to small benthic organisms, such as crayfish, within crevices among the cobbles below the sediment surface. Thus, while DNAPL may not be mobile, it could still be a viable exposure pathway for benthic organisms where it is present in coarse sediment locations.

- ***Feasibility of conventional remedial technologies*** – Conventional remedial technologies for contaminated sediments may not be feasible within the River OU because of the coarse composition of the riverbed and the complex hydrodynamic conditions. Adaptations to dredging and capping technologies would be necessary to account for these site-specific challenges.

- ***Upland source control and transport pathways to River OU*** – The CSM may be evaluated and, if appropriate, expanded to show transport pathways between upland AOPC sources and the River OU. Sufficient control of potential Upland OU sources to the river is essential to prevent future recontamination of the River OU.

- Upland OU

  - ***Vertical and lateral extent of soil contamination***. For several of the upland AOPCs, the vertical and lateral extent of contamination is not completely defined. Additional work being conducted in the summer of 2021 in the Sandblast APOC is intended to provide additional data in that AOPC. Though impacts are common for soil concentrations in the upper foot of soil or waste material (grit) in the Sandblast AOPC, the vertical extent of impacts is not well constrained, and this may affect the uncertainty in the projections of remedial costs. Similarly, horizontal impacts are in some cased not well defined. For example, at the Pistol Range AOPC the horizontal extent of contamination is not well constrained particularly to the northeast and northwest, and at the Sandblast Area AOPC the horizontal extent of contamination is not well constrained in the eastern portion.

- ***Current groundwater conditions***. Sampling for groundwater contaminants has not occurred for over 10 years and recent water level measurements are not available. These are data gaps that could affect the certainty in the evaluation of alternatives presented in an updated FS. Additionally, these older data are sub-ideal for documenting baseline conditions prior to any remedial actions.
- ***Geotechnical properties of the soils at sites immediately adjacent to the river***. The geotechnical properties of the soils at the site are not known adequately to assess the potential for slope instability. This is particularly relevant for the AOPCs near the river (e.g., Bulb Slope AOPC) and at the tree-covered slope north of the former sandblast building.
- ***Soil disposal at Subtitle C versus Subtitle D landfill***. It is not known if surficial soil and/or deeper soil in each AOPC will be hazardous and require disposal at a Subtitle C landfill. An assumption that all excavated soil will require disposal at a Subtitle C landfill, as previously assumed, may be overly conservative and bias evaluation against alternatives that include extensive excavation.
- ***VOC impacts near Current HMSA***. It is possible that VOC impacts to soil and groundwater that is suspected to have originated near a former AST impacts have substantially dissipated since the RI sampling, but updated sampling is needed to determine if these impacts remain (which could impact evaluation of remedy alternatives such as vapor intrusion impacts to future receptors).

5.0 RECOMMENDATIONS

Site-specific recommendations are provided below for the Upland OU and River OU, with recognition that impacts in the Upland OU could potentially result in future impacts to the River OU. These recommendations do not address specific concentration thresholds for screening or cleanup, which are an ongoing matter of discussion between USACE, tribes, and stakeholders. Rather, these recommendations are intended to be more conceptual in nature. Specific cost estimates are not provided with the recommendations given the conceptual nature of this optimization review within the RI/FS stage of the project.

5.1 UPLAND OU

5.1.1 Evaluate Alternatives Allowing for Unrestricted Use in the FS (and Select Where Feasible)

Implementing remedial measures that eliminate risk at the site to allow unrestricted future use typically requires additional up-front investment but subsequently avoids ongoing long-term costs for operations and maintenance (O&M), monitoring, five-year reviews, and enforcement of land-use controls. Additionally, it will avoid the potential need to re-evaluate the implemented remedy in later years if the land use of the dam complex changes in the future.

It is recommended that the updated FS for the Upland OU evaluate as rigorously as possible the additional costs and benefits of remediation to unrestricted use. For example, this alternative was not included for the Pistol Range AOPC in the FS for the Upland OU (USACE, 2017a), which only considered excavation and capping for areas with the highest impacts to surficial soils. For those excavation and capping alternatives, the FS noted that “because contamination is left in place above acceptable levels, land use controls are necessary.” Given the relatively small extent of the entire Pistol Range AOPC, and expected shallow depth of the impacts, the additional cost of complete excavation to allow for unrestricted use may not be prohibitive. Therefore (as an example) it would be beneficial for FS include an alternative for the Pistol Range that includes complete excavation to allow for unrestricted use.

Additionally, it is the general experience of the optimization team based on other sites that ongoing costs of contamination left in place are often not accurately or comprehensively incorporated into FS cost estimates. In such cases, a past decision to leave waste in place is later regretted. To avoid this outcome, it is also recommended that long-term costs for alternatives that leave waste in place be estimated conservatively (e.g., sufficiently high) in the updated FS, so those costs can be compared to the costs of remediation to unrestricted use. This will allow better consideration, and more likely selection (to the extent feasible), of alternatives that allow for unrestricted use.

5.1.2 Refine Excavation/Capping Extents During Pre-Design Sampling

The alternatives evaluated in the FS for the Upland OU (USACE, 2017a) were based on existing data to estimate areas and volumes to be remediated. The FS assumed that additional pre-design samples would be taken subsequent to the remedy selection to further delineate/refine the excavation footprint and depth (or capping footprint) before final design. The optimization team concurs with that general approach and recommends it be applied in the project (including the forthcoming FS update) in conjunction with an adaptive approach to excavation and associated contracting (discuss below). The optimization team believes this general approach allows the FS process and subsequent decisions to move forward in the most expeditious manner.

5.1.3 Adaptive Approaches for Excavation and Associated Contracting

It appears likely that excavation will ultimately occur in one or more AOPCs (and potentially in all four AOPCs). Even if the designed extent of excavation (horizontal and vertical) is refined during pre-design sampling as recommended above, there will still be some uncertainty about the final extent of excavation that will ultimately be needed.

The optimization team has observed other sites where restrictive contracting has resulted in an inflexible excavation strategy that cannot adequately adapt to field observations during the excavation. In some cases, the result is contamination left in place and associated negative impacts to long-term costs and/or the environment. In other cases, the result is excavation of more material than is actually necessary. It is therefore recommended that long-term planning for potential excavation incorporate an adaptive approach to excavation and associated contracting. In general, an adaptive approach could include the following:

- Removal and restoration of areas could be phased to allow temporary relocations of site functions, as needed (e.g., for the Sandblast Area AOPC, excavation of impacted soil will be complicated by the normal activities within the footprint of the AOPC).
- The excavation area within an AOPC would be divided into cells based on area size and current understanding of the contaminant distribution.
- Within a cell, excavation could target an initial thickness.
    - In The Pistol Range OPOC the initial thickness might be 1 ft.
    - In the Sandblast AOPC, the initial thickness might be observed thickness of sandblast grit plus 1 foot where grit is present, or the top 1 ft of soil where sandblast grit is not present or present at thicknesses of less than a foot.
    - In the Landfill AOPC, the initial thickness might be 5 ft.
- Based on confirmation testing, additional volumes of soil either below the excavated area or adjacent to it (if not already slated for removal) would be excavated.
- The contract could have a base item for excavation based on a best current estimate of volumes, with options for additional volumes (up to a specific limit) to address the uncertainty in actual depth and extent of the contamination.
- If additional volumes appear to require excavation upon reaching a contract limit, additional characterization could be conducted prior to a second phase of excavation.

Specific depth intervals included above are for purposes of example only, the specific depths for initial excavation would be developed by the project team.

5.1.4 TCLP Sampling for Refining Cost Estimates for Off-Site Disposal

The FS for the Upland OU (USACE, 2017a) assumed all excavated soil would require disposal as hazardous waste at a RCRA Subtitle C landfill. It is understandable that conservative assumptions may be employed in cost estimates for funding purposes. However, the optimization team believes this assumption could be overly conservative, and during the FS process for this project could bias against consideration/selection of alternatives with large amounts of excavation. For instance, as discussed in

Section 4.1.6 soils in the Sandblast AOPC below approximately 1 or 2 ft appear to be much less impacted than surficial soils. It is not certain that all surficial soils are hazardous, and likely much of the subsurface soil is non-hazardous and could go a Subtitle D landfill.

USACE indicated to the optimization review team that it plans to conduct preliminary Toxicity Characteristic Leaching Procedure (TCLP) sampling to evaluate if soil is hazardous or non-hazardous. It is recommended that this type of preliminary TCLP be performed early enough to allow for an improved estimate of the percentage of hazardous versus non-hazardous soil in each AOPC to be incorporated within the updated FS (rather than assuming 100 percent hazardous).

It is further recommended that the preliminary TCLP sampling evaluate surficial and subsurface soil separately, given potential for much lower subsurface concentrations. If surficial soil is not hazardous, then subsurface soil is likely not hazardous. If surficial soil is hazardous and subsurface is not hazardous, then the cost-benefit of segregating soil for hazardous versus non-hazardous disposal should be considered (would likely save a substantial amount on disposal costs). An incremental sampling approach for TCLP sampling to mimic actual removal/disposal operations, with representative sampling units randomly distributed throughout the areas, would also support decision-making. Some initial biased incremental sampling for TCLP in “hot spot” areas based on past discrete soil sampling would provide insight as to the degree to which waste material and impacted soil may need disposal in a Subtitle C landfill. If these “hot spot” soils do not display a toxicity characteristic, then it is likely that other soils will not as well.

5.1.5 Stormwater System Management

The excavation of all contaminated materials in the Sandblast AOPC displaying concentrations above a screening level that is protective of ecological receptors both in the upland area and in the river should be carefully considered as it would avoid the need for on-going monitoring, catch-basin filtration, or five-year reviews and would support any future land-use scenario. The Sandblast AOPC had been previously determined to not pose an unacceptable human health risk, but based on re-evaluation, potential ecological risks and/or impacts to the river such as via the stormwater management system are identified as concerns. At a minimum, it is recommended that sandblast grit be removed to the extent possible, with clean fill placed at the surface. Excavation of surficial materials with placement of clean fill (or capping) in additional areas, such as the Laydown Area near the river and the former hazardous materials storage area, should also be considered given the elevated concentrations of various contaminants there.

In the interim, current efforts to minimize transport of solids to the river via the outfalls using straw waddles and filters should continue. The optimization team does not currently recommend further efforts to treat stormwater by various means if actions are planned to address the upslope sources of the contaminants as discussed above. The very low concentrations in the river expected to result from stormwater discharges, accounting for a reasonable mixing scenario, would suggest that short-term actions such as treatment/sorption cartridges in the catch basins are not necessary. Oregon DEQ has expressed concerns about potential facilitated transport of PBCs by co-solvency in petroleum globules. Stormwater sampling conducted by USACE during the period 2018 to 2020 included analysis for TPH, and the TPH concentrations were very low. TPH-gasoline was not detected at either outfall in four sampling events, and TPH-diesel and TPH-motor oil were detected no higher than 0.28 µg/L at either outfall. To further address Oregon DEQ concerns regarding possible co-solvency, if further outfall sampling is conducted, it is recommended that the sampling continue to include TPH and PCBs and that sampling be conducted in a manner likely to capture any buoyant hydrocarbon globules (if any).

5.1.6 Updated Measurement of Groundwater Concentrations and Water Levels

The optimization team recommends the existing groundwater monitoring wells be sampled to assess current conditions (water quality and water levels). It is recommended that analysis include the complete target analyte list for metals to avoid issues with only sampling for a subset of metals that might be of concern. Analysis should also include pesticides, VOCs, PAHs (full scan), butyltin, PCBs, and both diesel and gasoline-range hydrocarbons. The optimization team is not recommending the risk assessments be redone based on the newly collected data, assuming the concentrations are reasonably consistent with (or lower than) results from the RI on a qualitative basis. However, this sampling would indicate if (qualitatively) there is some new observation that is vastly different from the previous groundwater data and/or is of sufficient concern such that a revised CSM is appropriate before the remedy decision is made. These data would also establish an updated baseline concentration dataset against which samples taken during and following any remedial action for waste and contaminated soils can be compared.

5.1.7 VOC Impacts Near Current HMSA (Sandblast Area AOPC)

Elevated VOCs in soil, and some associated groundwater impacts, were identified in the RI near the current HMSA, suspected to have resulted from a former AST. It is recommended that soil in that vicinity be sampled for VOCs, in conjunction with updated groundwater sampling recommended above (Section 5.1.6), to assess the current conditions regarding these VOCs impacts. It is possible that these impacts have substantially dissipated since the RI sampling. However, if contaminants originally identified in the RI, such as PCE, TCE, and DCE are found to still be above appropriate cleanup standards, additional characterization may be appropriate to assess the presence of an on-going source in the vadose zone and to further characterize the distribution within the alluvium and the bedrock. Remedial options should be considered if the concentrations represent a risk for either human or ecological receptors (including potential future receptors). Risks should consider both ingestion and vapor intrusion pathways (for both commercial/maintenance workers and hypothetic future residents). This sampling and associated evaluation of results can then be factored into development of remedial alternatives for the Sandblast AOPC considered in the updated FS.

Remedial options for the VOC contamination (if determined to be needed) could include excavation and soil vapor extraction for the vadose zone, and in-situ bioremediation, in-situ chemical oxidation (ISCO), and groundwater extraction for the aquifer. A potential risk of in-situ bioremediation or ISCO would be the mobilization of inorganics such as arsenic or chromium that may reach the river before re-precipitating. Remediation of any source mass in the vadose zone may allow a monitored natural attenuation remedy for groundwater without significant risks. The small groundwater flux to the river over the width of the impacted aquifer and the very large dilution from the river flow aided by the volatilization of the contaminants to the atmosphere would suggest a monitored natural attenuation (MNA) remedy for VOCs could still be protective.

5.1.8 Planned ISM Sampling in Sandblast Area AOPC

The ISM sampling planned for the summer of 2021 in the Sandblast Area AOPC includes a number of sampling units (that also correspond to DUs) in the areas east and south of the former Sandblast building. During the optimization review site visit USACE indicated concern about remediation deeper than shallow depths (i.e., 0-1 feet) among mature trees in the area as that may damage the trees. Although the need to define the potential for wind-deposited contamination in these areas is clear, the conceptual site model would suggest any impacts will likely be shallow. The optimization team verbally recommended to

USACE (in advance of this report) that the results of the shallow sampling be considered prior to performing the deeper samples. If the shallow ISM results indicate no impacts for the DU, then no deeper samples would be needed within that DU.

The incremental sampling units as proposed are perhaps reasonable for the assessment of risk in broader areas but will not fully support design decisions if risk assessment indicates the sampling/decision unit requires remedial action. A refined approach considering smaller sampling/decision units would be required to assess the extent of remediation at an adequate scale to be cost effective and protective. This could be done as a pre-design investigation.

5.1.9 Bulb Slope AOPC Considerations

The steep slope directly adjacent to the river at the Bulb Slope AOPC poses a challenge for any excavation undertaken to remove the debris and contamination, if required. The disturbance of the slope could trigger a slope failure and the transport of contamination directly to the river which would be unacceptable, as would any associated damage to the road that runs at the top of the slope. Planned investigations in the summer of 2021 should provide some information on soil properties that would support calculations of slope stability.

If it appears there is a slope stability issue at the Bulb Slope, either during excavation of debris or under natural conditions, steps could be taken to mitigate the risk. These steps could include the placement of a slope toe buttress in the river adjacent to the bank which would require placement of stable material in the river, extending the bank to the north into the river. Alternatively, the road at the top of the slope could be relocated to the south, and the slope flattened with excavation of material starting at the top of the slope and proceeding downward. The road relocation may have unacceptable impacts to habitat or other resources. The optimization team would tentatively favor the placement of the toe buttress, but further geotechnical assessment is required. As there may be waste from the slope that has fallen into the river, the placement of the toe buttress could be integrated with in-river capping design. Such an integrated approach would ensure remedy effectiveness and avoid design conflicts between upland and in-water components of the remedy.

5.1.10 Existing Monitoring Wells and Future Remediation Efforts

It is likely that future remediation efforts at the Landfill AOPC and Sandblast Area AOPC could damage or destroy existing monitoring wells as part of future remedial action. It is recommended that remedial design include a cost-benefit analysis of preserving wells versus replacing wells. If monitoring wells are destroyed during remediation, it may not be necessary to replace those wells one-for-one; rather, a revised groundwater monitoring network could be designed with potentially more wells or potentially fewer wells, as long as groundwater conditions after the active remediation can be effectively monitored. Furthermore, additional wells may be appropriate, particularly in the Sandblast Area, to target the interface between the alluvium and bedrock to better characterize this zone that may play a significant role in groundwater transport to the river.

5.2 River OU

5.2.1 Include COCs Other Than PCBs in RAOs

The two RAOs included in the draft FS for the River OU (USACE, 2017b) only address PCBs as congeners, and no other COCs. The draft FS supports the focus on PCBs using arguments that other COCs observed in riverbed sediments (e.g., PAHs, metals) would be addressed by remediation of the PCBs because they are collocated and generally not widespread. The optimization team recommends modifying the RAOs to include the other COCs found in sediments within the River OU. The logic of focusing on PCBs as an effective way to inform remedial decisions appears sound and consistent with the data that show the spatial distribution of COCs within the River OU. However, the objectives of the remedial action include addressing each of the COCs observed within the sediments in the River OU.

5.2.2 Recommendations for Adapting In-River Remedial Technologies to Site Conditions

Conventional remedial technologies for contaminated sediments may not be feasible within the River OU because of the coarse composition of the riverbed and the complex hydrodynamic conditions. The optimization team recommends adapting dredging and capping technologies to account for these site-specific challenges.

Diver-directed dredging was used in a targeted remedial action in 2007, and that approach may be used again in portions of the River OU with contaminated fine-grained surface sediments. EPA and some stakeholders raised concerns about the effectiveness of those dredging efforts. Those concerns are somewhat supported by subsequent monitoring that documented elevated residual PCB concentrations that coincided with the three former debris pile locations. The three former debris pile locations would be primary target areas, and possibly an area just offshore from the two outfalls that discharge to the west end of the River OU. The optimization team recommends minimizing dredging and relying more heavily on capping. Dredging may be minimized by focusing on removal of fine-grained (e.g., sand and silt) sediment from surface voids and crevices among the cobbles and boulders while leaving the boulder and cobble matrix intact. Dredging would use a smaller scale vacuum dredge with divers rather than a mechanical dredge that would not be effective with cobbles and boulders. The effectiveness of such dredging should be evaluated in the FS for the River OU and compared to one or more remedial alternatives that would apply capping without dredging. The impetus for dredging in addition to capping would be to minimize the amount of contamination that remains in the riverbed.

Sediment capping may be adapted to work most effectively with the riverbed composition and hydrodynamics. The optimization team recommends a capping approach that includes three or four integrated components that may be used with or without antecedent dredging:

1. Place a mixture of sand and reactive agent to fill the void spaces among the boulders and cobbles within areas designated for capping.
2. Place a second layer of mixed sand and reactive agent on the riverbed surface within areas designated for capping. The thickness of this cap layer should be determined using established cap effectiveness modeling tools to prevent breakthrough.
3. Place an armor layer on top of the sand layer using stone or riprap sized appropriately to prevent erosion of the cap surface. Modeled current velocities within the River OU ranged from 0 to 3 ft/s, which is fast enough to erode sandy material within areas of the River OU. Riprap sized 4 –

6-inch diameter would be effective (to be confirmed or adjusted by engineering analysis during remedial design).

4. As an alternative to riprap, the surface of the cap may be armored using a mixture of gravel and cobbles to mimic the existing composition of the riverbed and support similar post-remedy habitat conditions.

This recommended approach would have to ensure that the finished post-remedy sediment cap is able to remain in place without eroding and the thickness of the cap is sufficient to effectively isolate subsurface contaminants in place. The results of the modeling indicating velocities of 0 to 3 ft/s would require field measurements and calibration/validation to be sufficient for remedial design.

5.2.3 Refinements to the CSM

As discussed throughout this report, the optimization team recommends refining the CSM to encompass a comprehensive view of the site including meaningful linkages between the upland areas and the River OU. The CSM may be expanded to identify and describe transport pathways between upland AOPC sources and the River OU. There should be an assessment of whether upland sources are sufficiently controlled to prevent recontamination of the River OU. This is further discussed in Section 5.3.1. The CSM should also be refined with respect to the nature and extent of contamination within the riverbed and the potential for migration of those contaminants by sediment transport or other mechanisms.

5.2.4 Recommendations for Monitoring In-River Remedy

Post-remedy monitoring will be needed to confirm remedy effectiveness, but that monitoring will face the same challenges that limited the site characterization process. The optimization team recommends a multi-faceted post-remedy monitoring approach that aligns with the effective monitoring efforts conducted during remedial planning. Specific components of a post-remedy monitoring program may include fish tissue sampling, sampling of benthic biota, and performing a passive sampling study similar to the study completed in early 2020, which was an effective approach to highlight areas with the highest residual PCB impacts. One advantage of the passive sampling approach is rapid results compared to tissue sampling, which may yield delayed results related to organism lifetimes and the effects of COC bioaccumulation prior to remediation. Those studies would be designed in alignment with the selected remedy and the spatial distribution of remedial technologies within the River OU.

5.3 SEQUENCING OF REMEDIAL ACTIVITIES

5.3.1 Remedial Actions to Prioritize in Upland OU Prior to In-River Remedy

The highest cost remedy component for the overall project is anticipated to be the in-river remediation. Although the optimization team believes the predominant impacts to the River OU are from previous releases directly to the river, and not due to ongoing impacts from the Upland OU, it is prudent to address items in the Upland OU that could contribute future impacts to the River OU before implementing the in-river remedy, to avoid any subsequent in-river recontamination.

It is recommended that implementation of active remedial actions in the Upland OU with greatest potential to mitigate future impacts to the river be prioritized (in addition to steps to minimize any future spills or releases in locations such as the Laydown Area). The optimization team believes the highest priority remedial actions in the Upland OU in this regard are as follows:

- Eliminating potential for sloughing (and potentially overland flow) from the perimeter of the Landfill AOPC into the river.
- Eliminating potential for sloughing (and potentially overland flow) from Bulb Slope AOPC to the river.
- Removing impacted surficial soil from the Sandblast AOPC that has the greatest potential to impact stormwater that discharges to the river (and potentially overland flow from the Laydown Area adjacent to the river).

This recommendation is offered from a technical perspective only. The optimization team does not have specific recommendations regarding the best approach to accomplish this administratively (e.g., Non-time Critical Removal, Interim ROD, or simply getting to a Final ROD for the Upland OU as expeditiously as possible).

6.0 REFERENCES

Oregon Health Authority (website) with fish consumption recommnedations for Bonneville Dam:. https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/FISHCONSUMPTION/Pages/Bonneville.aspx#:~:text=Bonneville%20Dam%20Fish%20Advisory%20Due%20to%20high%20levels,and%20do%20not%20migrate%20out%20to%20the%20ocean.

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USACE, 2020a. *Final Quality Assurance Project Plan for Passive Sampling at River Operable Unit, Bradford Island, Cascade Locks, Oregon*. January.

USACE, 2020b. *Field Report, Passive Sampling Deployment and Retrieval, River Operable Unit, Bradford Island, Cascade Locks, OR*. June.

USACE Engineer Research and Development Center, 2021 (DRAFT*). Draft Memorandum on Contribution of Bradford Island Outfall 2 to Columbia River Contaminant Concentrations*. February.

Additionally, the optimization review team referred to spreadsheets provided by USACE including the following:

- *Spreadsheets for stormwater sampling results (liquid) for sampling in June 2019, October 2019, November 2019, and March 2020.*

- *Spreadsheet summarizing PCB results from in-river passive sampling conducted in 2020.*

FIGURES

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JOB No. 25696528	DESIGNED: LSM	PROJ. ENGINEER: LSM
	DRAWN BY: SB	APPROVED BY: MP
	CHECKED BY: SB	DATE: JULY 2010

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BRADFORD ISLAND

CASCADE LOCKS, OREGON

BONNEVILLE DAM COMPLEX

DRAWING NUMBER: FIGURE 2-1
GIS FILE NUMBER: FIG 2-1
SHEET:
REV.

Figure 3-1. Site Location Map and Relationship of Bradford Island to Bonneville Dam Complex

From Figure 2-1 of FS for Upland OU (USACE, 2017a)

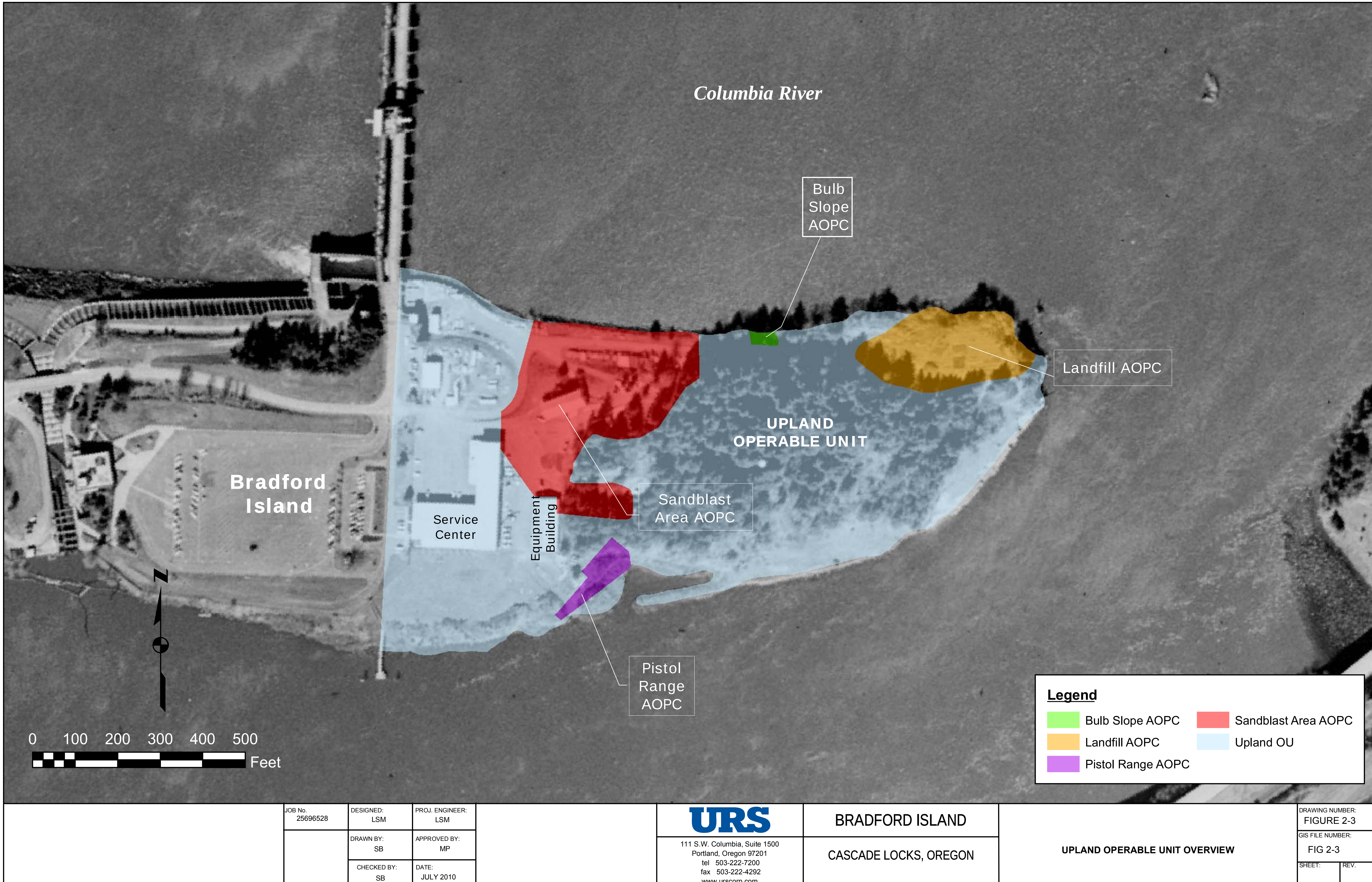

Figure 3-2. Areas of Potential Concern for the Upland OU

From Figure 2-3 of FS for Upland OU (USACE, 2017a)

JOB No.	DESIGNED:	PROJ. ENGINEER:
25696528	LSM	LSM
	DRAWN BY: SB	APPROVED BY: MP
	CHECKED BY: SB	DATE: JULY 2010

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BRADFORD ISLAND

CASCADE LOCKS, OREGON

RIVER OPERABLE UNIT

RIVER OU DEBRIS PILES

DRAWING NUMBER: FIGURE 2-7
GIS FILE NUMBER: FIG 2-7
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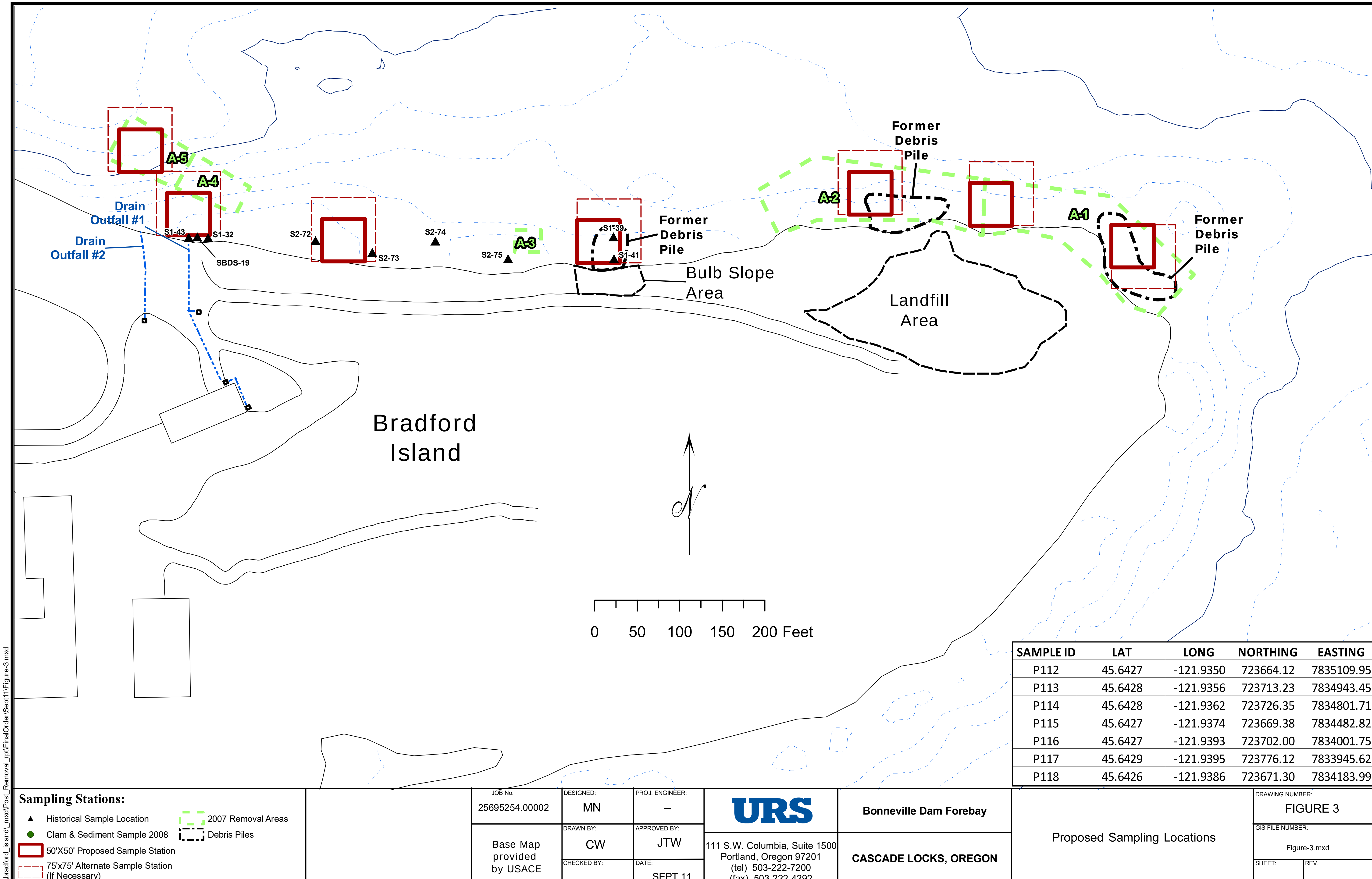
O:\25692709 USACE\53-F0072173.00 Brdford1\Ft.Worth DT-02\RI Report Working Folder\RI Text\Figures\FIG 3-5.mxd

Figure 3-3. Former Off-Shore Debris Piles Removed in 2000 and 2002

From Figure 2-7 of Draft FS for River OU (USACE, 2017b)



SAMPLE ID	LAT	LONG	NORTHING	EASTING
P112	45.6427	-121.9350	723664.12	7835109.95
P113	45.6428	-121.9356	723713.23	7834943.45
P114	45.6428	-121.9362	723726.35	7834801.71
P115	45.6427	-121.9374	723669.38	7834482.82
P116	45.6427	-121.9393	723702.00	7834001.75
P117	45.6429	-121.9395	723776.12	7833945.62
P118	45.6426	-121.9386	723671.30	7834183.99

Figure 3-4. Areas of Sediment Removal in 2007 (Green Dashed Lines)

From Figure 3 of FINAL Analytical Results for Sediment, Clams and Bass collected from Forebay, September/October 2011 and Bass collected from Reference Area August 2011, Bradford Island Pre-Feasibility Study (URS, 2013)

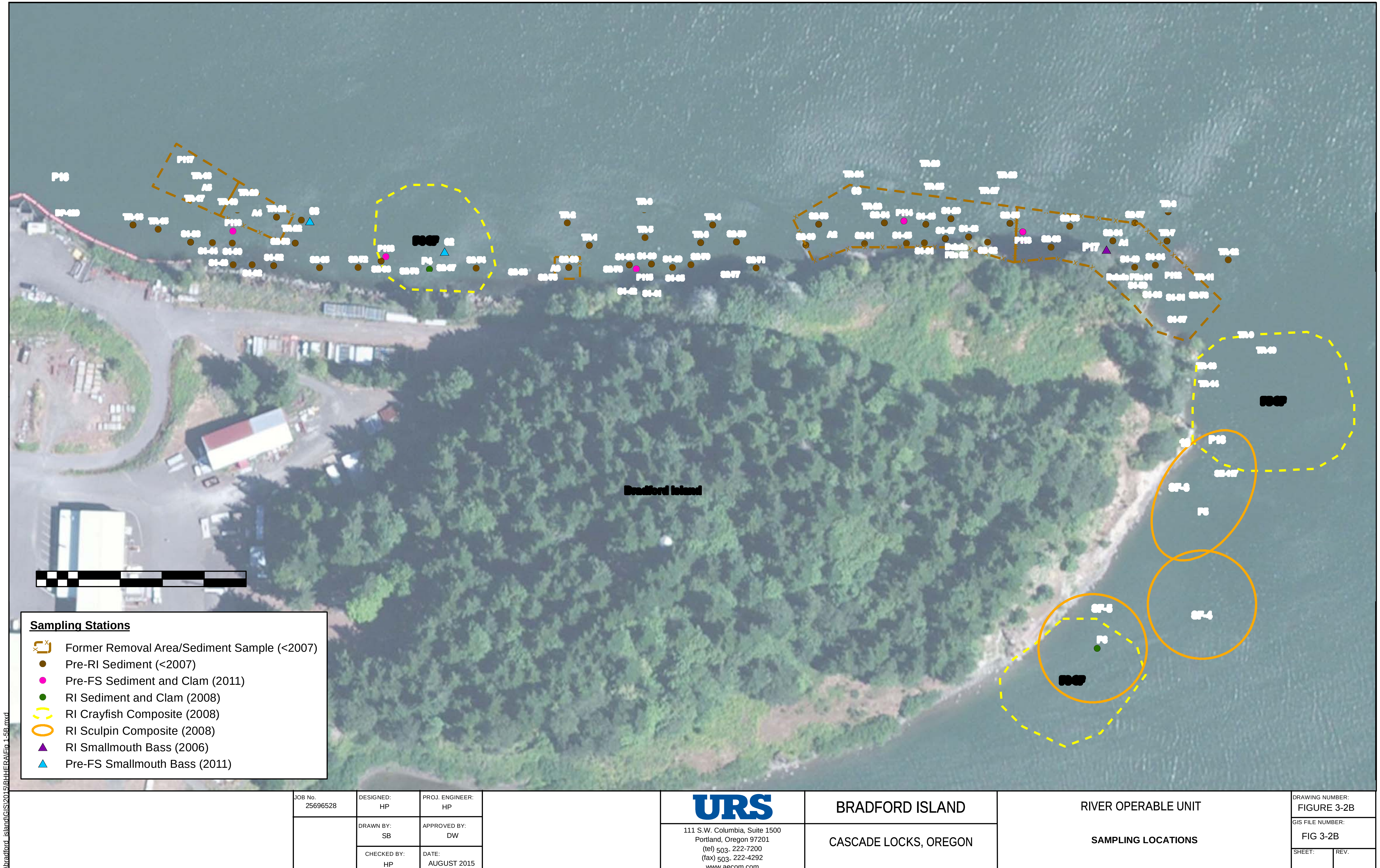


Figure 3-5. Locations for Sampling (Sediment, Clams, Fish) in 2008 and 2011, Collected After 2007 Sediment Removal

From Figure 3-2B of Draft FS for River OU (USACE, 2017b)

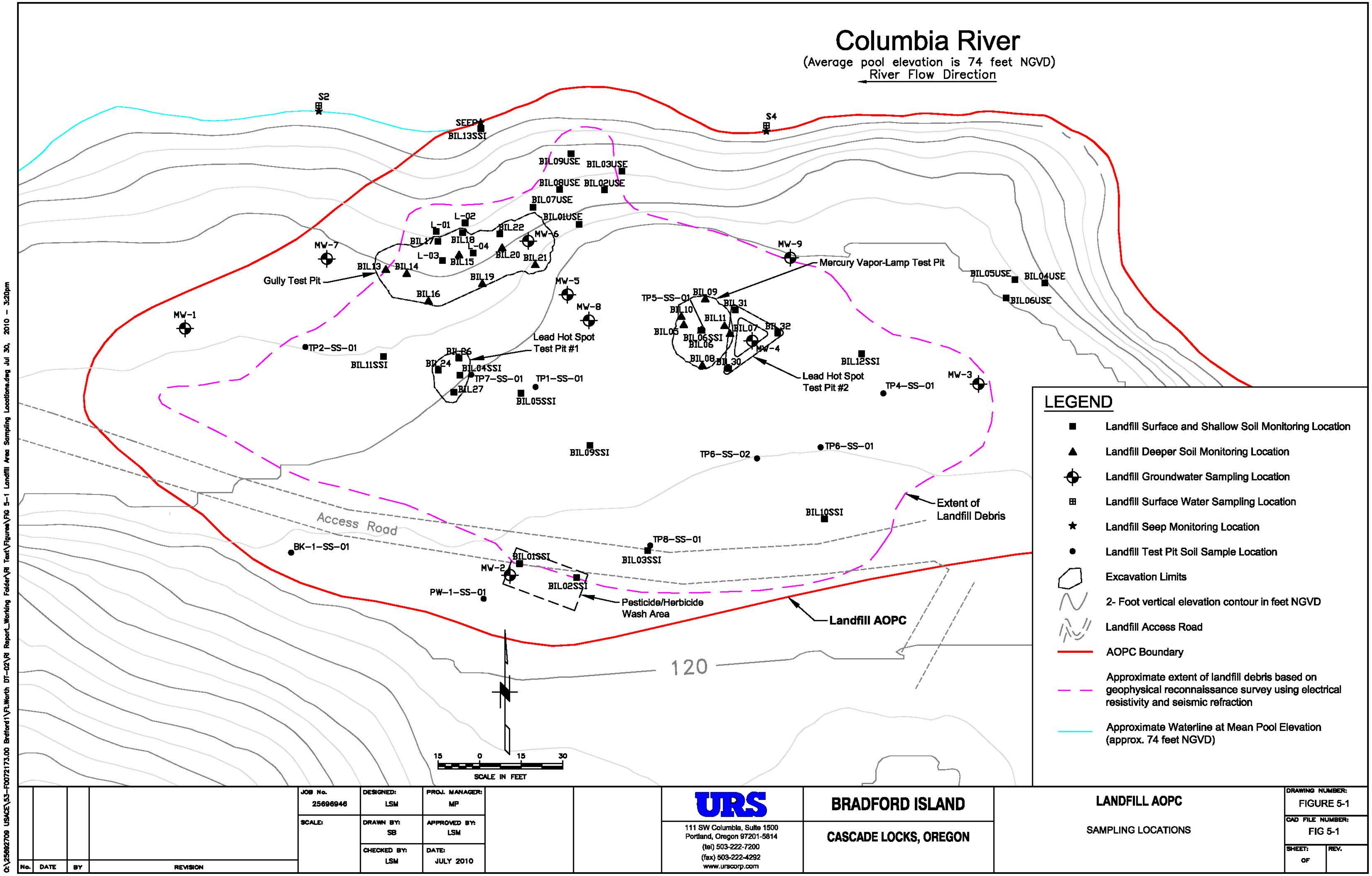


Figure 4-1. Landfill AOPC and RI Sample Locations

From Figure 5-1 of RI (URS, 2012)

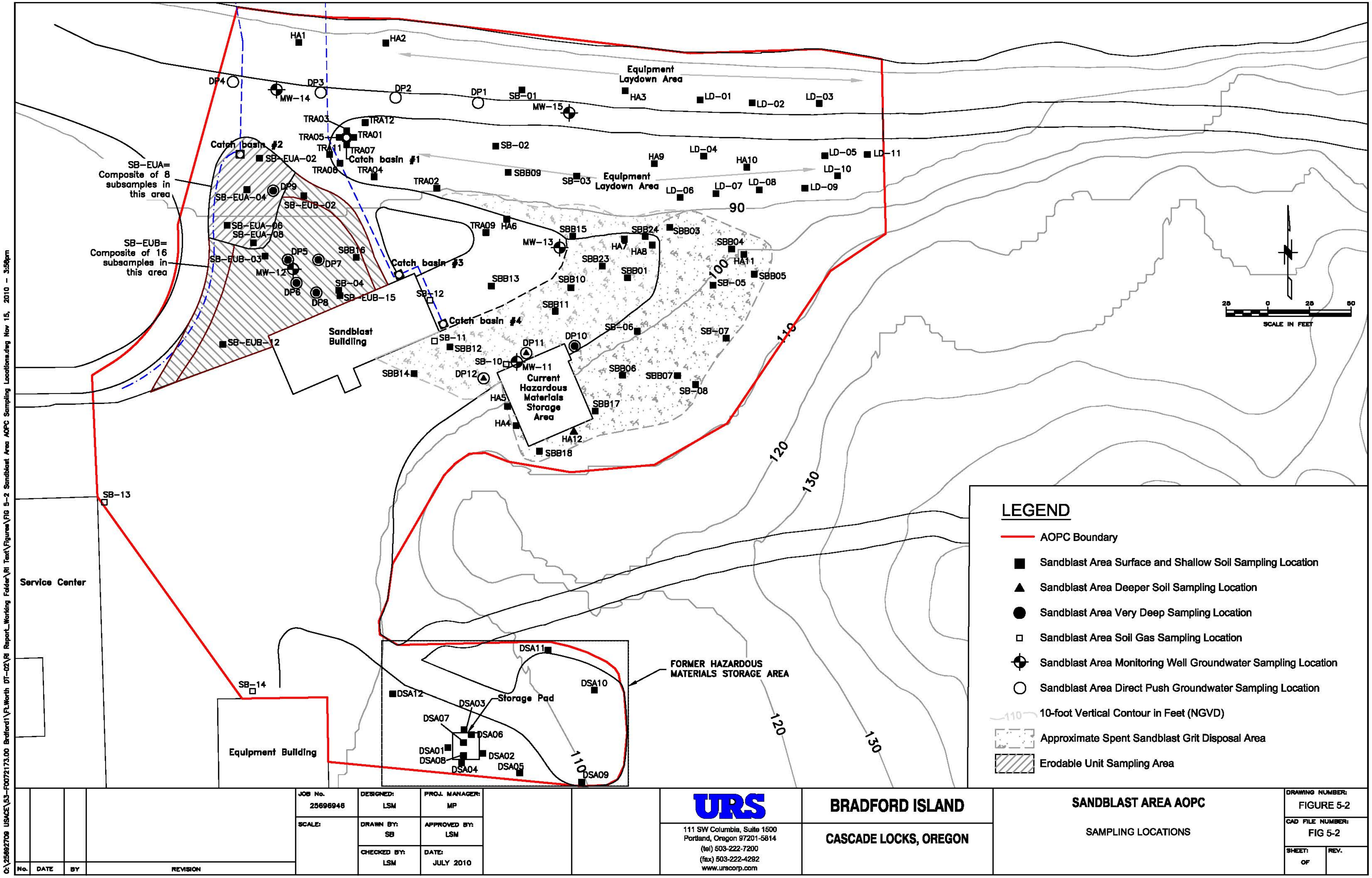


Figure 4-2. Sandblast Area AOPC and RI Sample Locations

From Figure 5-2 of RI (URS, 2012)

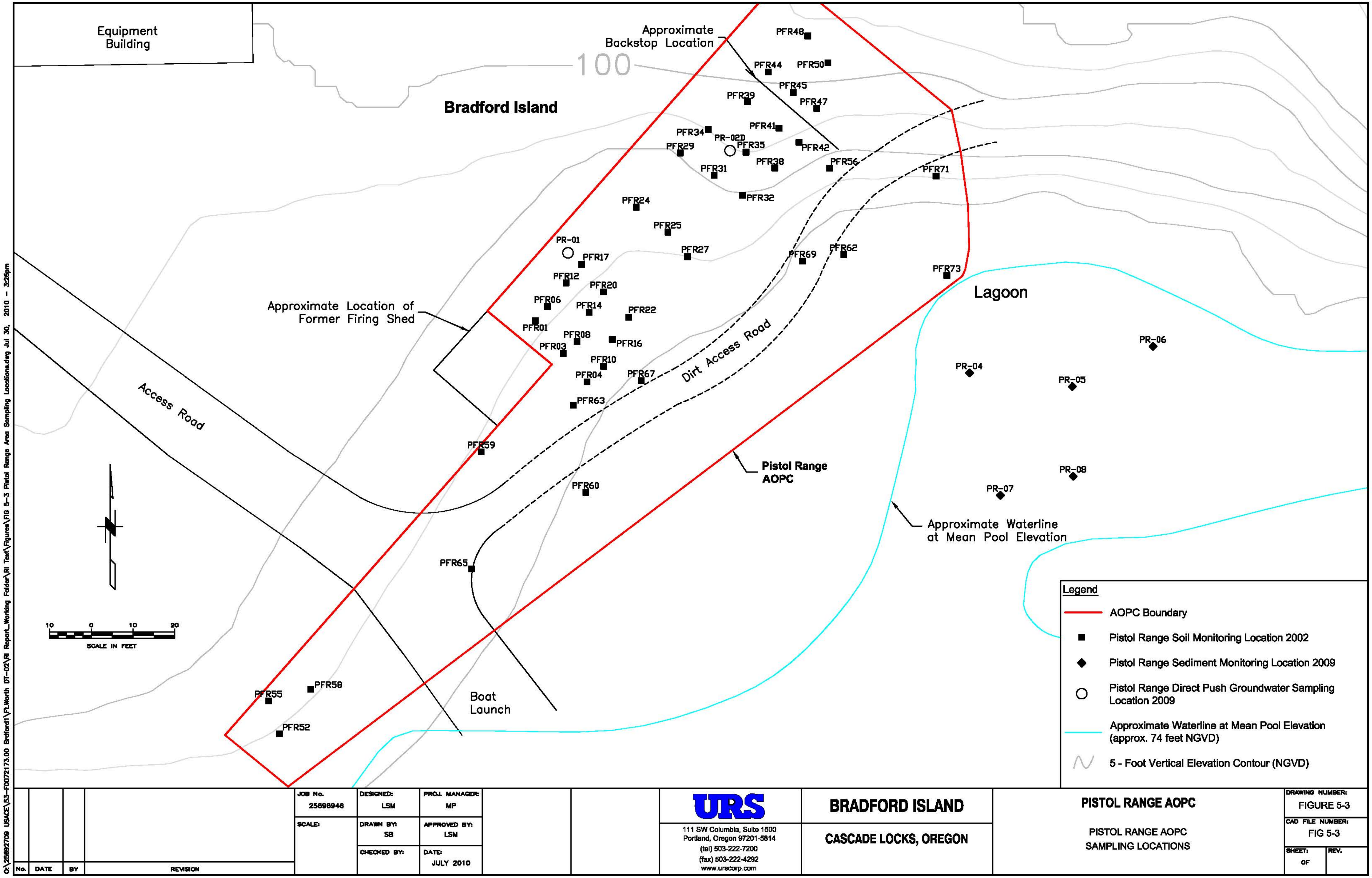


Figure 4-3. Pistol Range AOPC and RI Sample Locations

From Figure 5-3 of RI (URS, 2012)

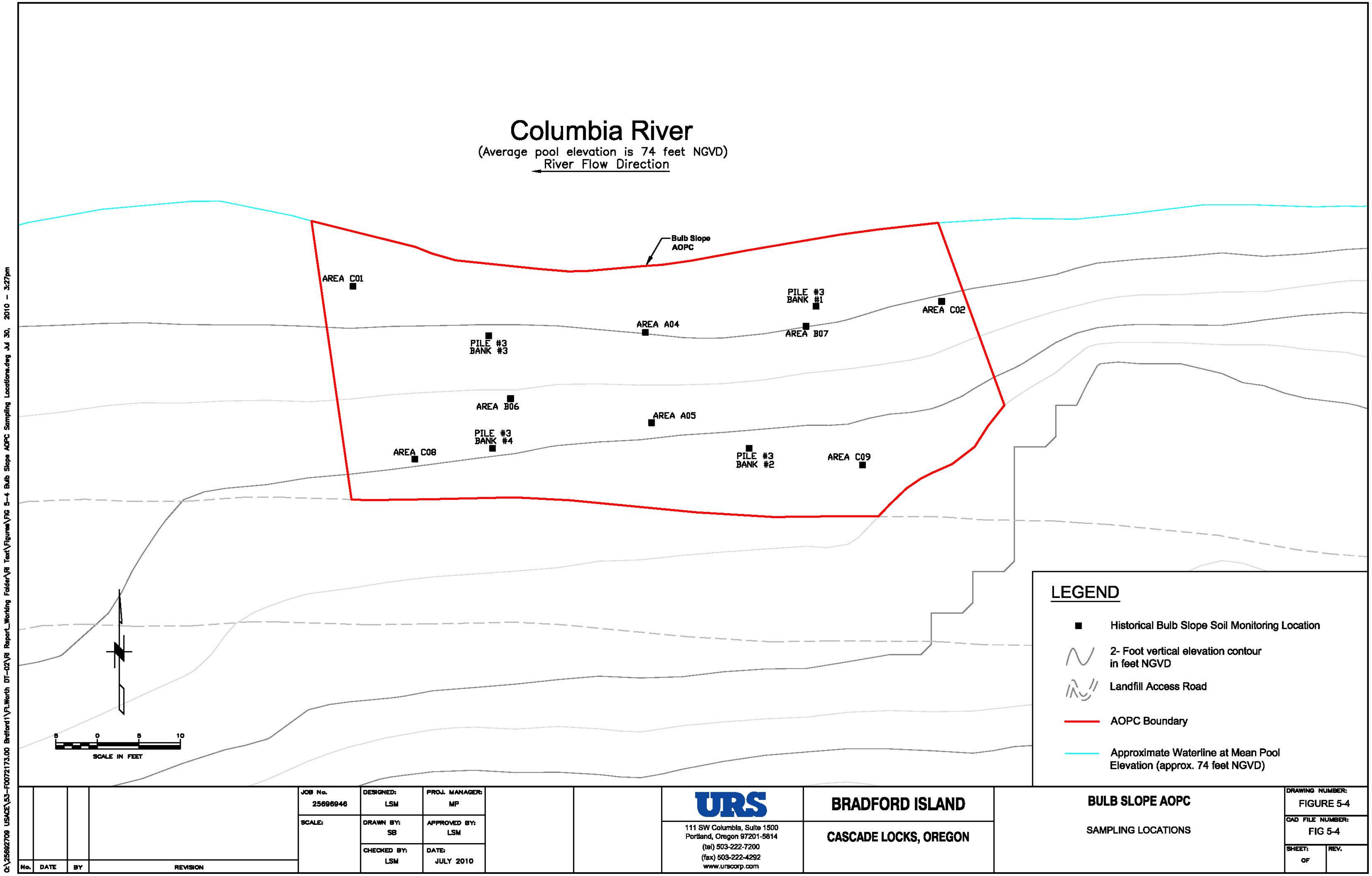


Figure 4-4. Bulb Slope AOPC and RI Sample Locations

From Figure 5-4 of RI (URS, 2012)

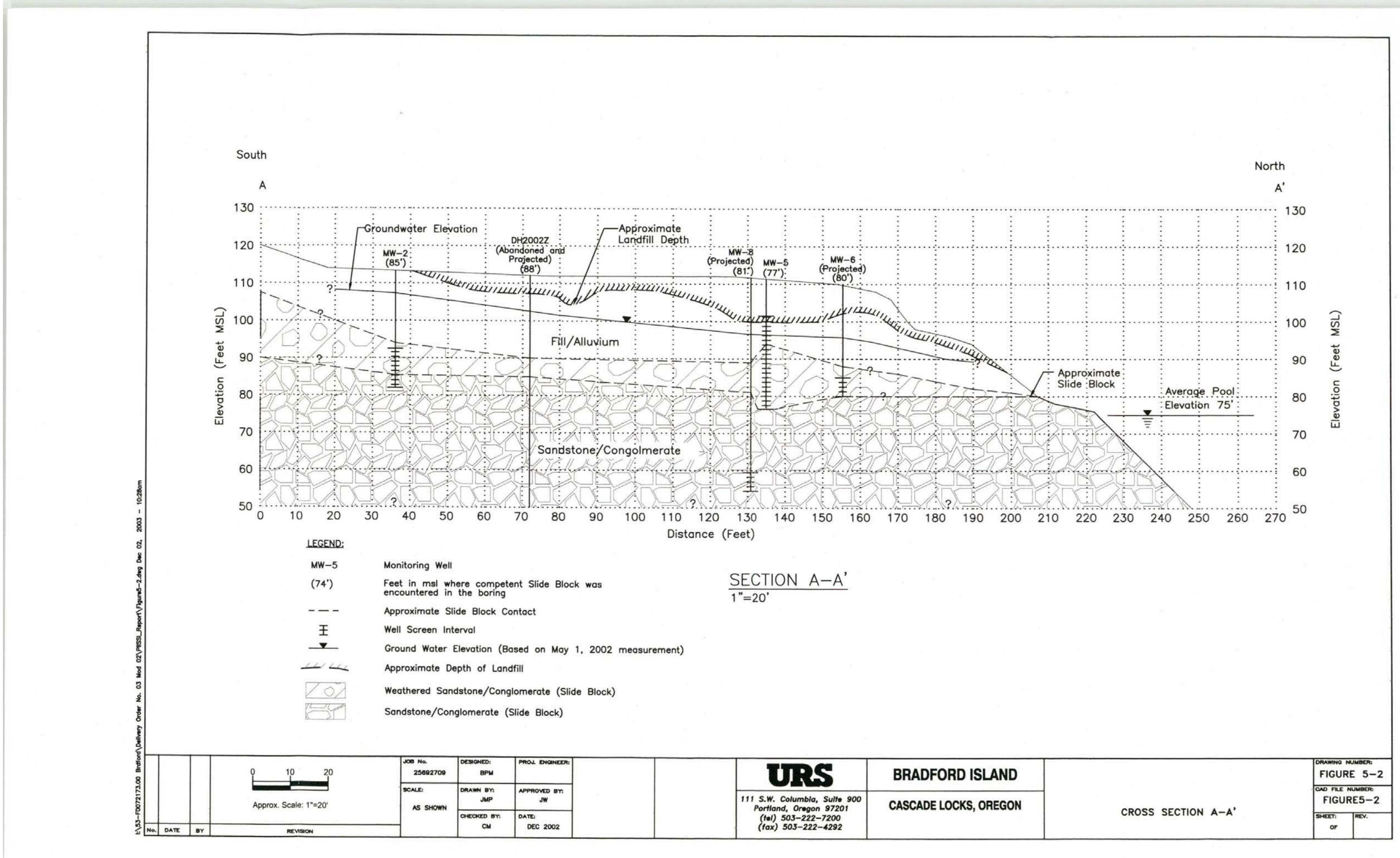
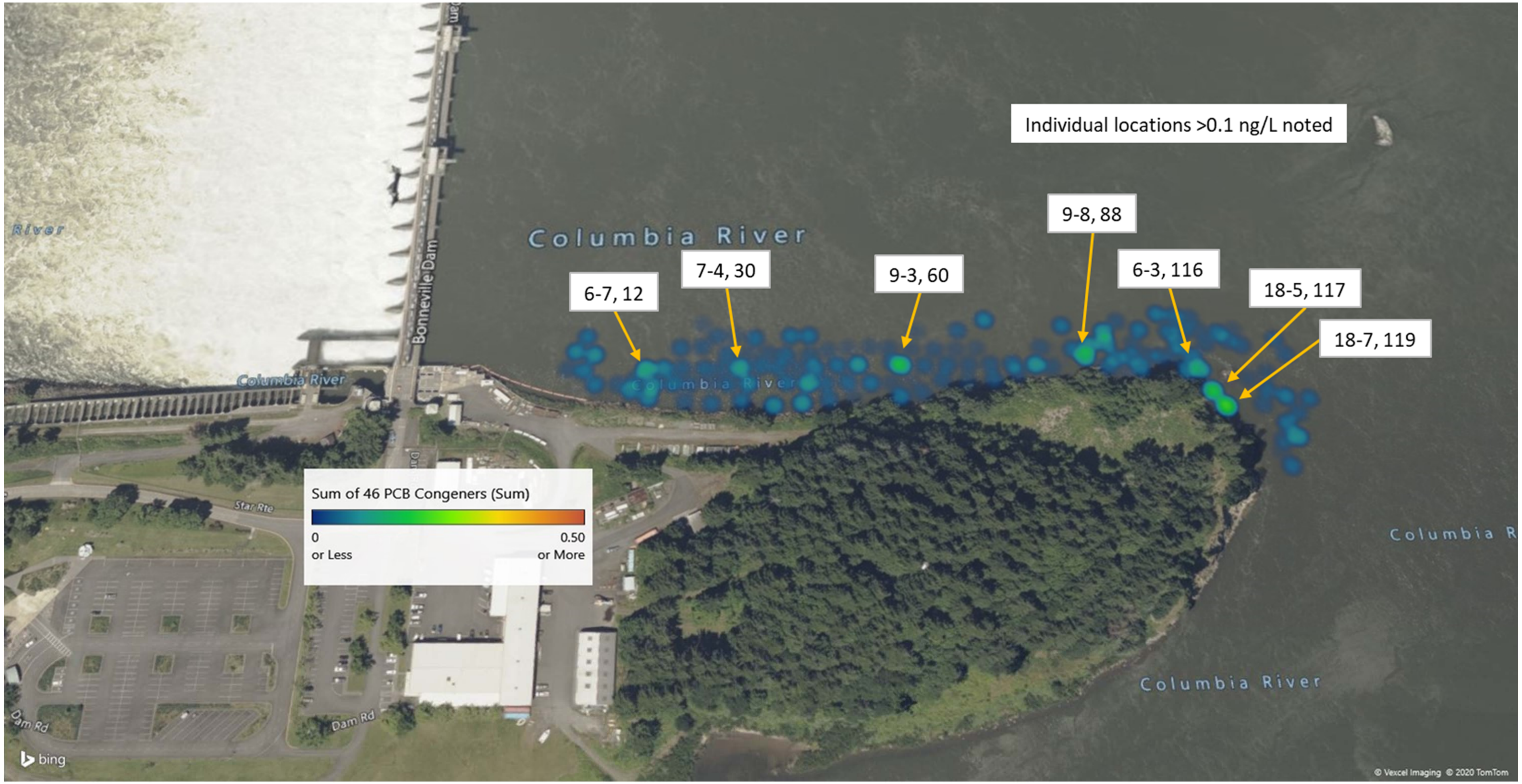


Figure 4-5. Cross-Section from South to North at Landfill AOPC

From Figure 5-2 of Landfill Site Characterization Report (URS, 2004)



USACE Sample ID	Lab ID	Total 46 Congeners (ng/L)
12	6-7	0.115
30	7-4	0.104
60	9-3	0.143

USACE Sample ID	Lab ID	Total 46 Congeners (ng/L)
88	9-8	0.135
116	6-3	0.109
117	18-5	0.154
119	18-7	0.207

Figure 4-6. Summary of Results from 2020 Passive Sampling Within the River (Sum of 46 PCB Congeners)

From spreadsheet with PCB concentrations provided by USACE

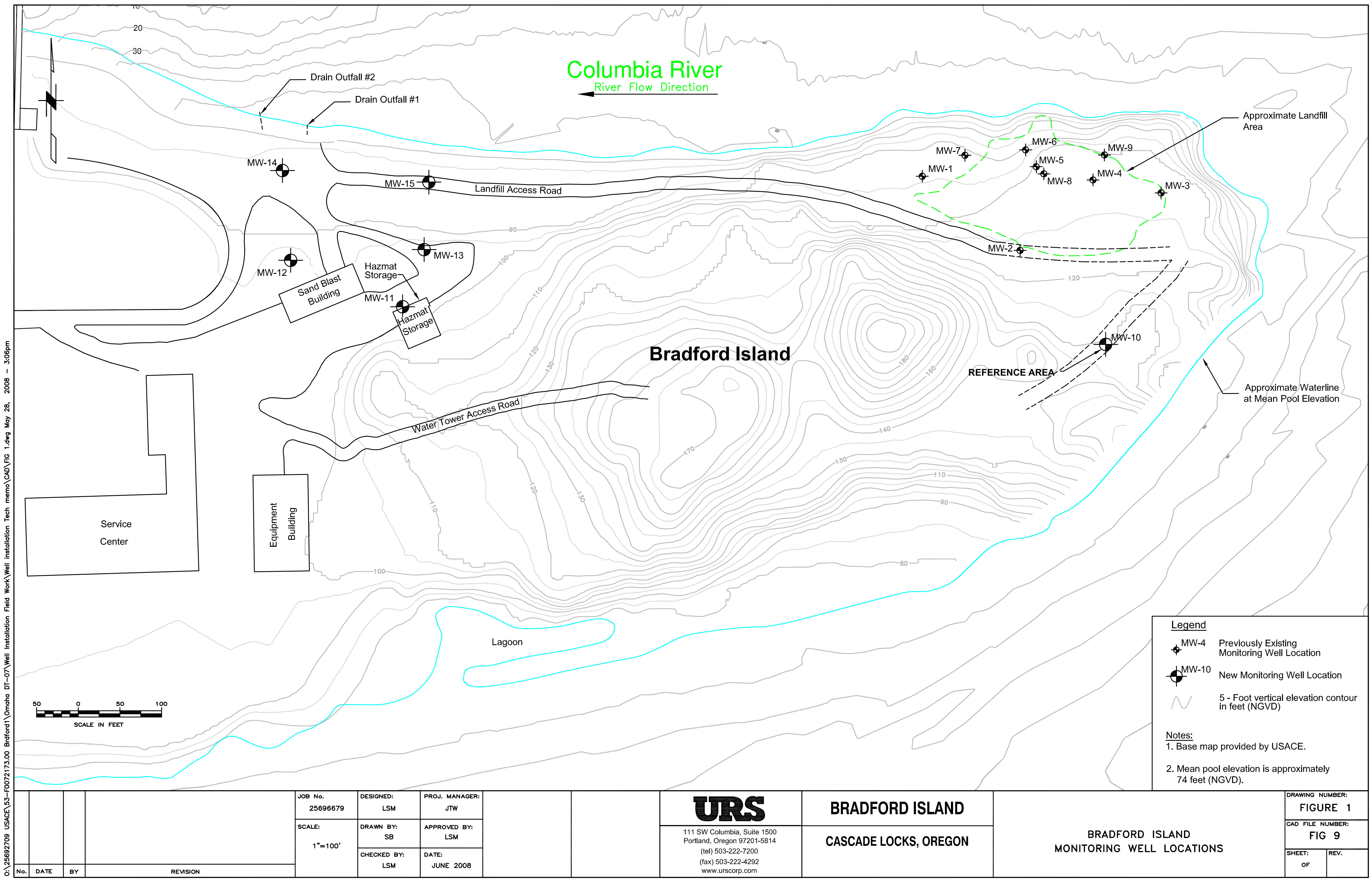


Figure 4-7. Locations of Existing Groundwater Monitoring Wells

From Figure 1 Groundwater Monitoring Well Installation Report (URS, 2008)

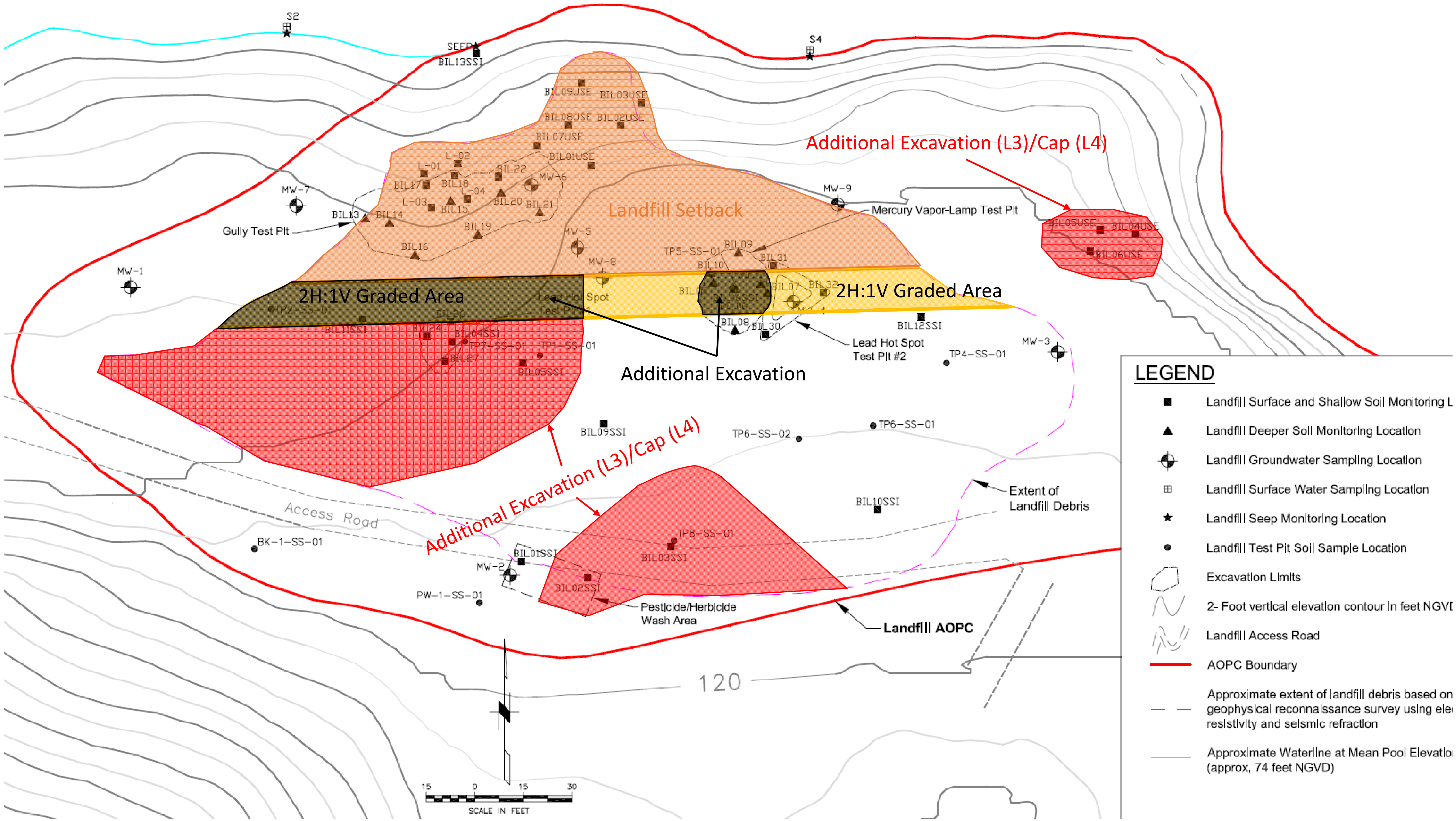


Figure 6-3. Alternative L3 and L4 Remedial Footprints

Figure 4-8. Landfill AOPC Previous FS Alternatives: Cutback and Slope Areas (Alternative L2) and Additional Areas for Excavation or Capping (Alternatives L3 and L4) *From Figure 6-3 of FS for Upland OU (USACE, 2017a)*

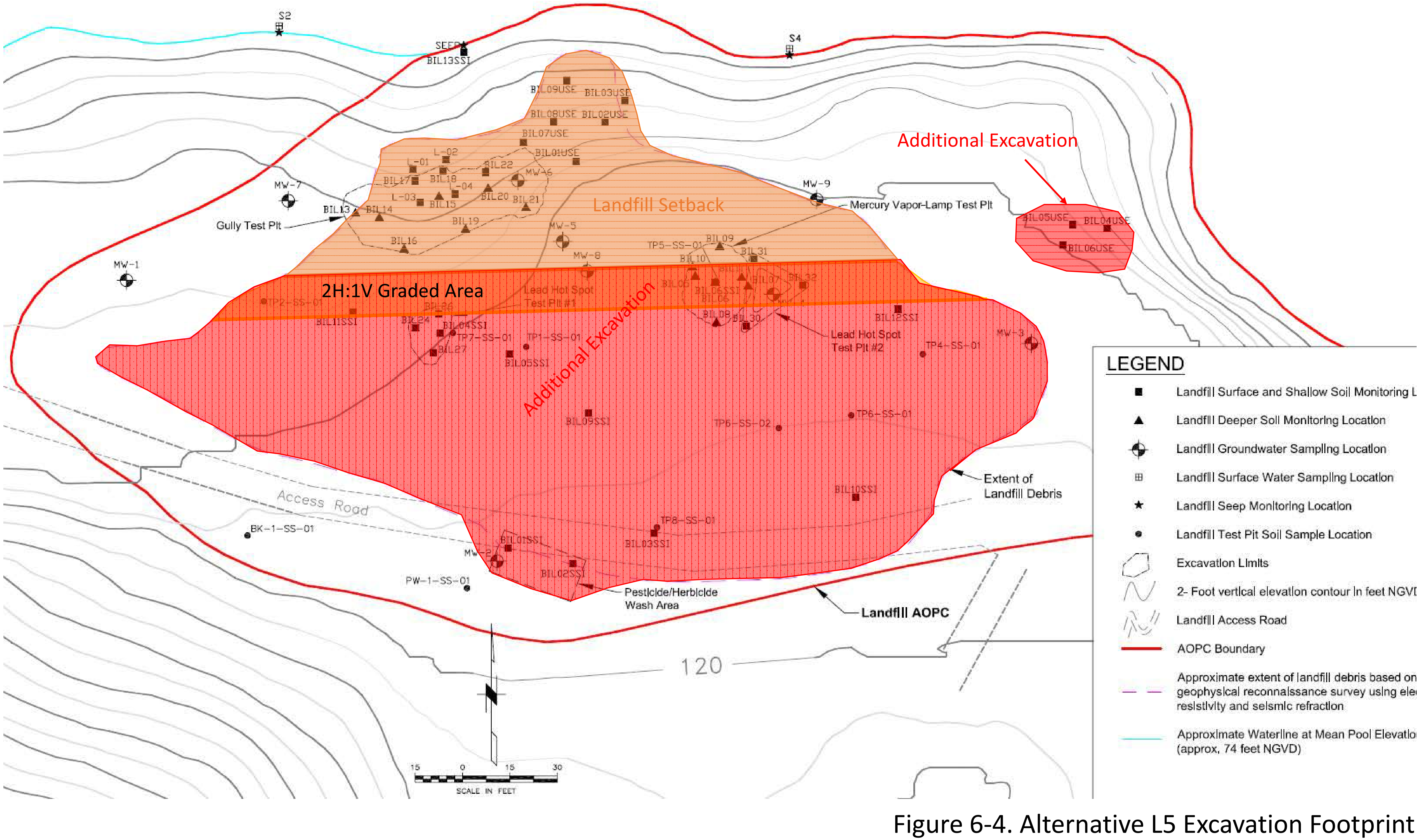


Figure 4-9. Landfill AOPC Previous FS Alternatives: Excavation Area for Alternative L5

From Figure 6-4 of FS for Upland OU (USACE, 2017a)

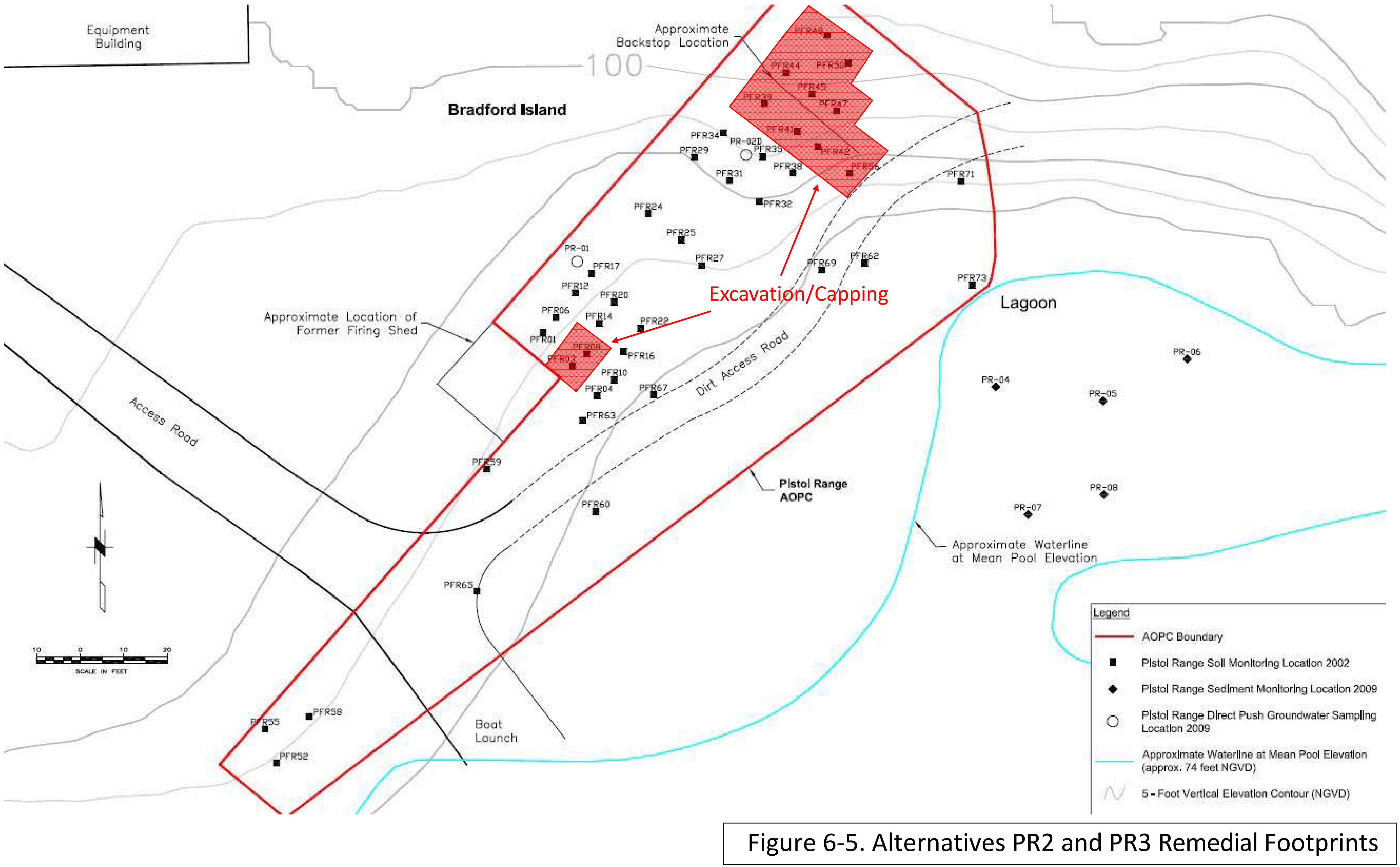


Figure 4-10. Pistol Range AOPC Previous FS Alternatives: Excavation Areas (Alternative PR2) or Capping Areas (Alternative PR3)

From Figure 6-5 of FS for Upland OU (USACE, 2017a)

APPENDIX A:

Minutes from Listening Session with TAG on 27 May 2021

TO: Bradford Island Technical Advisory Group

FROM: Rob Greenwald, HGL
Shane Cherry, HGL
Dave Becker, USACE EM CX

DATE: 7 June 2021

SUBJECT: Minutes from Optimization Review Listening Session, 27 May 2021, 10:00 to 11:40

Invited participants are listed below, and an "x" indicates participants who attended the meeting which was via WebEx.

	Email	Person
X	Rob.greenwald@hgl.com	Rob Greenwald (HGL)
X	Shane.cherry@hgl.com	Shane Cherry (HGL)
X	Dave.J.Becker@usace.army.mil	Dave Becker (USACE EX CX)
	USACE	
	Nicholas.A.Barbato@usace.army.mil	Nicholas Barbato
X	Christine.M.Budai@usace.army.mil	Chris Budai
	Kenneth.D.Duncan@usace.army.mil	Kenneth Duncan
	William.W.Gardiner@usace.army.mil	Bill Gardiner
X	Craig.J.Johnson@usace.army.mil	Craig Johnson
	Kristen.Kerns@usace.army.mil	Kristen Kerns
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A summary of the discussion is as follows:

- Roll call was taken by Daniel Carlson and attendees are noted above.

- Introduction of optimization review team
  - Rob Greenwald (HGL)
    - Hydrogeologist, 30+ years of experience, BA in Geology and MS in Applied Hydrogeology. Optimization reviews at over 100 GW contamination sites, primarily performed for EPA at Superfund sites. Approximately 15 reviews in Region 10 and approximately 10 of the reviews in Region 10 have included Kira Lynch (EPA) in some capacity.
  - Shane Cherry (HGL)
    - Fluvial Geomorphologist, Superfund sediment remediation sites around the country (large and small scale). BS in Earth Science and MS in Geography and Environmental Engineering. Worked in this region back to 1998 and up to the present, including work on Columbia and Willamette Rivers.
  - Dave Becker (USACE EM CX)
    - Geologist, 37+ years of experience including more than 75 optimization reviews for federal agencies including many for EPA. BS in Geology and MS in Geophysics. No direct involvement in Bradford Island project prior to this study.

- What is the goal of this optimization review?
  - Independent holistic technical evaluation at a high level intended to facilitate progress towards project goals.
  - The general approach to optimization reviews is to review documents, understand perspectives, re-evaluate the CSM, consider alternative approaches, and provide recommendations that provide cost-effective solutions for site characterization and/or remediation.
  - This review is being paid for by USACE at the suggestion of EPA Region 10 based on EPA's past experience with this optimization team. However, nobody on the optimization team has any direct past involvement at Bradford Island, and the nature of this type of optimization review is that the findings and recommendations will be the independent thoughts of the optimization review team for the consideration of all parties involved with Bradford Island.

    - Most of the optimization reviews performed by this group are for Superfund sites within the CERCLA process. The understanding of the optimization review team is that this site is progressing within the CERCLA process even though the site is not listed. The optimization review will therefore be performed within the context of the CERCLA process.

- Current status of the optimization review
    - The optimization team has reviewed documents, had a site visit by Rob Greenwald (who then did a briefing with Shane and Dave), and has had internal discussions about initial impressions.
    - The optimization team has not formulated findings and recommendations yet – that is reserved until after this Listening Session, so the team understands perspectives and concerns of people on this call before formulating findings and recommendations.

- Schedule and review of draft report
    - Goal is to have a draft report by approximately June 30.
    - The report is intended to be a high level report that is independent in nature, will likely be on the order of 25 pages.
    - The optimization team plans to provide the TAG with the draft report to receive feedback to correct any factual matters, improve wording, and incorporate other suggestions that the optimization team agrees with.
    - The optimization team may not agree with or implement every comment. Typically, in these types of reviews, all comments on the draft are considered in finalizing the report. However, a detailed response to comments (or a loop of comments and responses) is not performed. The comments can be included as an appendix, and if there are general themes about comments that were not implemented, a summary of those themes may be included at the beginning of that appendix.
    - The planned period for review of the draft report is 3 weeks, with the report finalized within another 2-3 weeks (by early to mid-August)

- Moved on to presentation of perspectives and concerns by organizations that requested time.

- Yakama Nation (YN) - Laura Shira
    - Working on Bradford for years, other YN individuals have worked on the site for decades.
    - USFW recently shared info with a government team doing an optimization study at another site which was followed by an all-day meeting, and Laura believes having opportunities for that type of feedback is valuable.
    - This site is a major concern for YN. Laura showed a slide indicating PCB concentrations in fish tissue around WA state and at other major PCB sites in other states. Slide noted a screening value of 0.57 ppb, and a maximum concentration of 183,140 ppb at Bradford Island which she noted was from a smallmouth bass collected in a 2011 sampling event after the removal actions. Laura noted this is much higher than 0.57 ppb, and also

higher than maximums at the other national sites with the next highest at Hudson River (20,000 ppb) and Fox River (14,000 ppb).

- Laura showed another slide that showed fishing platforms (i.e., the area is actively used for subsistence fishing.
- YN favors adding the site to the NPL and believes state cleanup laws should be recognized, and that cleanup should result in fish that are safe to eat.
- YN expects to use island when dam is gone in the future because it is within the YN tribe's designated usual and accustomed areas. They do not consider themselves as a "stakeholder" but rather they expect government to government dialogue. The relationship of YN and USACE has been "different" on this project compared to other projects with federal agencies, and YN feels their comments have been dismissed.
- Laura stated USACE does not acknowledge future use by YN in the planning horizon or cleanup plan. She requests that heritage fish consumption rates be considered, which are very high (1,000 grams per day) to accurately represent human health risks to tribal members.
- Laura stated that USACE is using Cascade Locks using as a background reference for risk-based contaminant levels, and she does not believe that approach meets the definition of background based on Washington or Oregon requirements.
- Laura stated there has been inadequate consideration of restoration efforts and no consideration of Natural Resource Damage Assessment (NRDA), and that Bonneville Dam has been a significant source of PCBs resulting in significant injury to the fishery. YN has experienced loss of resources and service and intends to pursue resource damages. YN also notes that delaying the remedial action will continue to increase those damages. YN wants the optimization to consider future use, habitat mitigation, and environmental damages (natural resource damages).
- YN believes there has been incomplete sampling and analysis; the work has been budget-driven rather than science-driven. Example - Bulb Slope AOPC and Sandblast AOPC contamination not fully characterized even though there is potential to erode into river (and for Bulb Slope AOPC there is no further plan to characterize other than test pits for road stability). YN believes Sandblast AOPC sampling has been piecemeal.
- YN has concerns about erosion as a transport pathway between the uplands and the river, and that there are signs that sloughing into the river has happened.
- YN is very concerned that the Upland area was "disconnected" from river in the FS process and that it was inappropriate to eliminate the Sandblast AOPC and Bulb Slope AOPC from the Upland FS given potential to impact the river. YN questions if they will be able to stand by the ROD. YN wants optimization to consider connectivity of Upland and River OUs.
- YN believes other parts of the dam complex are not properly characterized and wants the optimization to identify the history of other types of potential releases other than the four AOPCs currently considered.
- Summary of key YN concerns:
    - Have all sources of PCBs been identified (sloughing, stormwater, groundwater)?

        - Did DNAPL fluids from equipment dumped in the river migrate into cracks in the bedrock and/or downslope deeper into the forebay (no such investigations down gradient from river AOPC to look for that)?
        - Sandblast AOPC – grit as an ongoing source.
        - Bulb Slope AOPC - incomplete delineation.
        - Landfill AOPC – groundwater (GW) as a contaminant migration pathway.
        - Disconnect between Upland and River OUs.
        - River background reference concentrations.
        - Chemical uses on other parts of island and potential source areas not adequately delineated (e.g., septic system).
        - Potential that accumulated sediments in Forebay that were dredged at Bradford Island and placed at Goose Island resulted in contamination at Goose Island.

- U.S. Fish and Wildlife Service (USFWS) – Jeremy Buck
    - Contaminant specialist, working on site since late 1990s.
    - Site has small footprint, but some of the highest PCB concentrations observed in biota relative to other sites nationwide.
    - Primary sources are identified but do not know the specific PCB migration pathways which is a primary issue regarding risk. How are PCBs released from the source, and how do they get into the receptors? Hard to develop a remedy until that migration pathway is fully evaluated.
    - Because of how site is funded, there have been problems with good systematic planning efforts, sometimes things are fast tracked due to funding or schedule and TAG does not get full input which leads to issues. Jeremy indicated there was good systematic planning for recent passive design and for biota sampling, however, Sandblast AOPC study recently done was fast tracked and did not get full TAG participation, which may lead to problem with the results.
    - Jeremy thinks Sandblast AOPC should be straightforward, except for the issue about how to get grit out of forested areas and how much grit to leave behind.
    - DQOs used for study designs are at times not specific enough to help in answering questions for the site. Asking the questions differently, but still following DQO guidance and selecting certain phrasing of the questions, may alleviate later disagreement. This includes questions such as what are appropriate risk-based levels, and how will background concentrations be determined? He believes these questions should be resolved before data are collected and remediation options are considered.
    - Jeremy also stated that addressing what actions should be taken if specific concentration or risk levels are exceeded would be helpful.
    - Jeremy stated the approach to evaluating ecological risk is different between USACE, EPA, Oregon , and WA and that causes confusion. He believes Oregon has really useful risk guidance that should be considered.

- Oregon Department of Environmental Quality (ODEQ) – Mike Poulsen
    - Toxicologist, now PM for ODEQ, on project since 2002.

- Need for comprehensive, holistic view that considers the connections between Upland and River OUs. Source control in Upland OU is related to River OU. Mike noted, as an example, that Portland Harbor has an artificial split between upland source control (regulated by ODEQ) and in-water remediation (regulated by EPA), and he thinks that is not best approach. The need to comprehensively consider the Upland and River OUs is an ongoing theme with ODEQ comments (i.e., screening levels for the Upland OU need to consider the river). Mike suggested development of a holistic conceptual site model (CSM) that considers and describes these linkages.
- Mike indicated that ODEQ has a lack of authority at this site, and that he is not aware of other sites where a responsible party essentially regulates itself.
- At the Sandblast AOPC and Bulb Slope AOPC the USACE is now agreeing to do source control, which he agrees with, but that is still outside of a typical Superfund process.
- ODEQ has concerns that groundwater is a potential source to the river.
- The recent passive sampling and biota sampling is a positive, but ODEQ believes there should be more effort with PCB “full congener analysis”. Additionally, ODEQ continues to have concerns about other contaminants including pesticides and mercury.
- Mike stated that the PCB water screening level (for stormwater) of 2,000 ng/L that USACE is applying is an acute level from Oregon, but not something ODEQ would apply. Rather, ODEQ would use 14 ng/L (ambient chronic level) or even lower (0.064 ng/L for source control of chronic cumulative for human exposure).
- ODEQ believes ecological risk assessment should be done across AOPCs for receptors that access all (or multiple) areas on site, to determine cumulative exposure effect on those receptors.
- ODEQ believes that TPH should be more rigorously considered since petroleum is a hazardous substance under Oregon rules. Mike indicated TPH is being evaluated at Portland Harbor but not really at Bradford Island.
- ODEQ is concerned that funding limitations drive the work. For example, not using a full PCB congener analysis can then then lead to further discussion and delay.

- Next there was open discussion about perspectives and concerns from other participants/organizations who had not yet presented, and/or additional comments from any participant/organization.

- Shane Cherry asked for more details about the high PCB concentration in fish tissue that Laura Shira presented earlier.
    - Mike Paulsen said original river remediation (pile removal) was in 2002 and sediment removal was in 2007, and the post-remediation fish sampling (2011) is when they got the really high level Laura mentioned. Before the removal action one of the crayfish was sampled and lab had to dispose of it as hazardous waste, was likely PCB oil on the crayfish and not a tissue sample result based on orders of magnitude lower tissue concentrations that cause mortality in crayfish. Suspicion is there is some free product PCB oil remaining at large in the riverbed within the gravel and cobbles where it may be accessible to crayfish and other benthic organisms that causes such high levels. The

hope is that the passive sampling results help to identify those general areas. Could be very localized and related to the locations of previous debris piles in the river or could be due to groundwater flow/discharge through fractured bedrock discharging at discrete locations. These details may be important considerations for CSM refinements to help define and investigate transport and exposure pathways within the river.

  - Laura Shira indicated she is grateful for USACE working with the TAG on the passive samplers. Currents are high and there may be dilution so there was an attempt to get samplers as close to bottom as possible. Laura says passive sampling not as helpful as wanted because not all PCB congeners were evaluated and because currents cause dilution. Fractured rock below the river causes issues, do not really know the nature and extent of contamination remaining in the riverbed. Laura indicated currents run fast around the tip of island and carry sediments to the southeast corner, and she thinks sediments that were dredged and moved up to Goose Island could have caused impacts there. Laura said that alternatively it is possible that fish could feed at Bradford where there are impacts and then spawn at Goose Island.
  - Jeremy Buck indicated the high concentration fish sample Laura presented was a smallmouth bass and he suspects it could have been direct exposure to PCB oil or resulting from ingestion of crayfish that had PCB oil on it, because if was in tissue it would have killed the fish.
  - Teresa Michelsen said she would never see a concentration that high in fish tissue from ingestion exposure. They have seen crayfish exposed to PCB oil, such as observed at McCormick and Baxter. However, not much oiled sediment has been observed at Bradford Island. She indicated that the CSM and transport paths need to be understood, and then how to remediate can be more effectively addressed.

- Shane Cherry indicated a transformer was dropped on a dock at the Duwamish in 1975 where there is much smoother river bottom, and it migrated “downhill” on the riverbed. At Bradford Island there is a rough bottom with lots of crevices. Where would it, go, where would it stop and accumulate, and what could that expose? Shane noted some of his experience with the Housatonic River with similar river bottom characteristics as Bradford Island may be pertinent. Shane indicated river remediation will be tricky given the complex and varied river bottom.

- Rob Greenwald asked about perspectives regarding potential tradeoff of contaminant removal versus removing trees.
  - Jennifer Peterson said that the tradeoff has to consider the magnitude of contamination. Generally, tree removal is preferred over leaving long-term exposure, but all-else-equal saving trees when possible is obviously preferred.
  - Jeremy Buck said there is a desire to not mess up habitats, particularly the types of habitats that are “not unlimited”. On the other hand, there is less concern about lowest risk habitats, and many types of trees (like alders) could be removed. Habitat mitigation is also an option if habitat is damaged during remediation.
  - Teresa Michelsen added that this tradeoff may depend on risk assumptions and will be different if looking at industrial use (USACE approach) versus future residential use

(tribal approach).

- Shane Cherry asked if there is adequate discussion about future transition to residential use? He noted that one consideration is to develop recommendations that are "forward compatible" to future residential use when possible, or to create future milestones when future actions could be taken to address remining risks to allow residential use.
    - Laura Shira indicate the River OU had a 50-year horizon and does not think future transition to residential use is being fully or adequately considered since the dam is expected by USACE to remain in place past the 50-year milestone.

- Shane Cherry asked about concerns regarding not looking at a big enough area for potential sources of impacts to the river and asked if there are specific deficiencies in that aspect of the CSM anyone might want to chime in on.
    - Laura Shira indicated a community member showed her a map with an "X" at Cascade Island and said that area was a PCB use area. Laura said that's the kind of thing that needs to be pursued regarding the entire dam complex.
    - Jennifer Peterson said a majority of the in-water project did not analyze for pesticides. Early data did show pesticides. Wanted pesticide data in fish – but it is difficult to find adequate pesticide data in the Upland OU and specifically in the Sandblast AOPC (i.e., is there an upland source area such as the laydown area). High resolution pesticide results have not been available, and the data that are available are old.

- Shane asked if there were specific ecological receptors that were of concern that could be exposed in multiple places on the site (upland and/or river).
    - Jennifer Peterson said mink is one example. She said the Sandblast AOPC is an important driver for the upland area but wasn't considered in the FS. The Pistol Range was considered in that FS and Sandblast AOPC was not, even though the Sandblast AOPC likely drives sitewide ecological risk when all areas are considered together. She reiterated the need for comprehensively integrating in-water and upland exposure.

- Rob Greenwald noted the RI data set is relatively old and the site has been investigated for a very long period. He asked about perspectives regarding further extending the RI/FS timeframe to get a more comprehensive data set, versus the benefits of moving forward with some initial remediation for some of the items where there is general agreement and/or items that would substantially reduce risk (relative to short-term inaction on remediation while characterization continues).
    - Jeremy Buck said some of those decisions could be made more quickly if DQOs are better defined. He said it is very difficult at this point to develop a remedy approach for the river bottom since all exposure pathways are not well characterized. He thinks there are ongoing contributions into the river. He also does not foresee a remedy in the river that eliminates all PCBs in fish.
    - Jennifer Peterson indicated ODEQ supports removing the landfill, and also removing Sandblast AOPC grit (though how much of that to remove is an issue).

- Laura Shira agrees with removing the Landfill AOPC and Pistol Range AOPC, but thinks the previous lack of consideration of the Sandblast AOPC and Bulb Slope AOPC were more cost driven rather than fully considering risk and O&M. She thinks Bulb Slope AOPC and Sandblast AOPC should also have removal.
- Jennifer Peterson reiterate the need to consider upland exposure plus the pathway to from the Upland OU to the river.
- Mike Poulsen said that some disagreements about risks are due to difference in ARARs considered by different entities. USACE may not consider something is a risk but ODEQ does. Shane Cherry asked if that would change if this was under CERCLA (i.e., listed on NPL), and Mike said maybe.

* Dave Becker asked if there is a willingness to take some remedial action sooner rather than first trying to fully complete characterization, perhaps including additional characterization as remediation proceeds (i.e., use an initial phase of remediation as a next phase of characterization).
    - Teresa Michelsen is concerned if USACE funding could limit that after it begins. She said there needs to be trust and thinks there is lack of trust and lack of legal instruments requiring follow-through.
    - Jeremy Buck agreed with Teresa about trust issues between TAG and USACE, with USACE concerned that this is a never-ending loop of “how clean is clean enough” while TAG members may be concerned about adequate follow through on the decisions.
    - Rob Greenwald noted that many sites have this trade-off, and one way to build trust is to start moving forward and performing some of the remediation and making progress towards risk reduction.

* The optimization team expressed thanks for all information and feedback.

* The meeting adjourned at approximately 11:40 AM.

APPENDIX B:

Riverbed Photos from Passive Sampler Deployment January 28 to 31, 2020)

Appendix B – Riverbed Photos

Photos are from:

> USACE, 2020b. *Field Report, Passive Sampling Deployment and Retrieval, River Operable Unit, Bradford Island, Cascade Locks, OR*. June.

Locations identified on the photos can be identified on the sample locations maps, which are from:

> USACE, 2020a. *Final Quality Assurance Project Plan for Passive Sampling at River Operable Unit, Bradford Island, Cascade Locks, Oregon*. January.

All field notes and photos from the sampling deployment and retrieval are provided in Appendices B and C, respectively.

5.0 Significant Observations

Fine sandy sediment was noted to be most abundant at the northwestern corner of the site (Photo 5). The more eastern portions of the site were dominated by cobbles and gravel of various sizes (Photo 6, 7, and 8). Boulders were most common at the eastern portion of the site, especially near the eastern tip of the island (Photos 9 and 10). Clams and crayfish were visible at many deployment locations (Photos 11 and 12). The depths displayed in the below photos are inaccurate; the actual depths for each location are listed on the table within Appendix B.

Photo 5. Sandy sediment at river bottom in northwestern corner of the site (sample location 12)

Photo 6. Heterogeneous gravel mixture at river bottom (sample location 108)

Photo 7. Cobbles and gravel at river bottom (sample location 110)

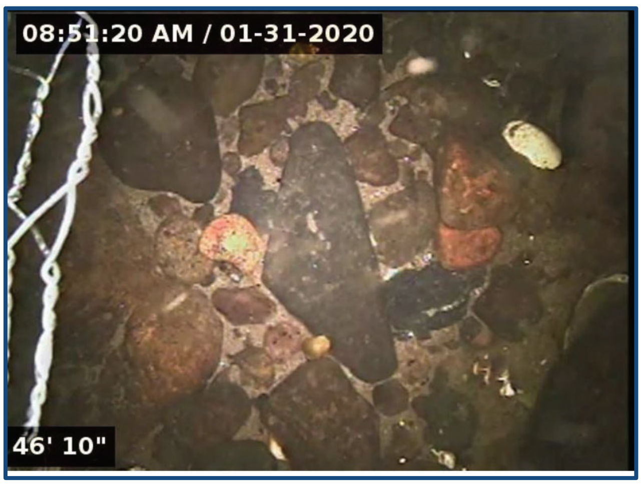


Photo 8. Cobbles and gravel at river bottom (general area near sample location 225)

Photo 9. Large cobbles and boulders at river bottom (general area near sample location 225)

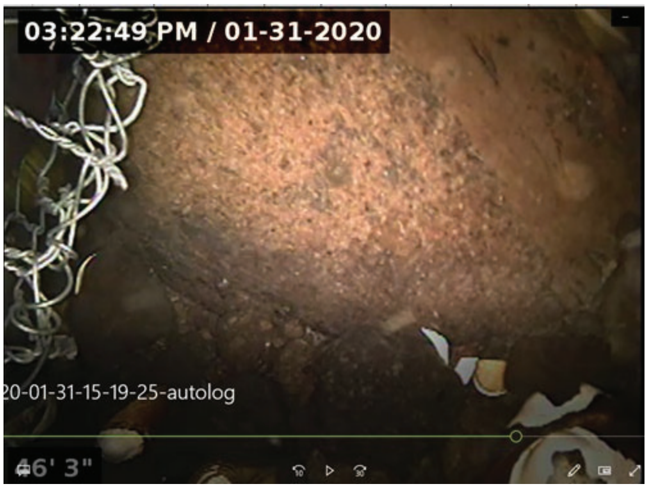
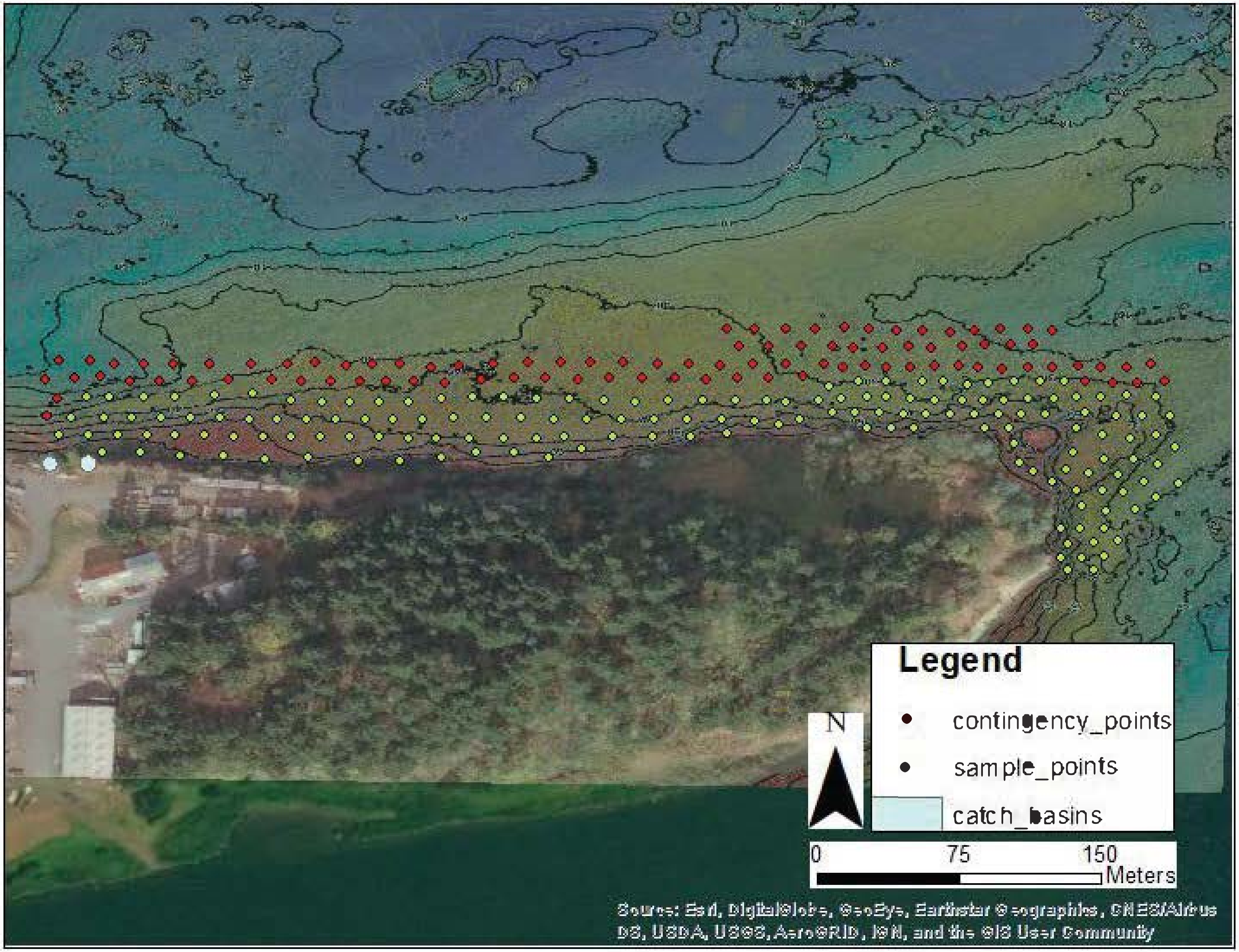


Photo 10. Boulder and gravel at river bottom (sample location 148)

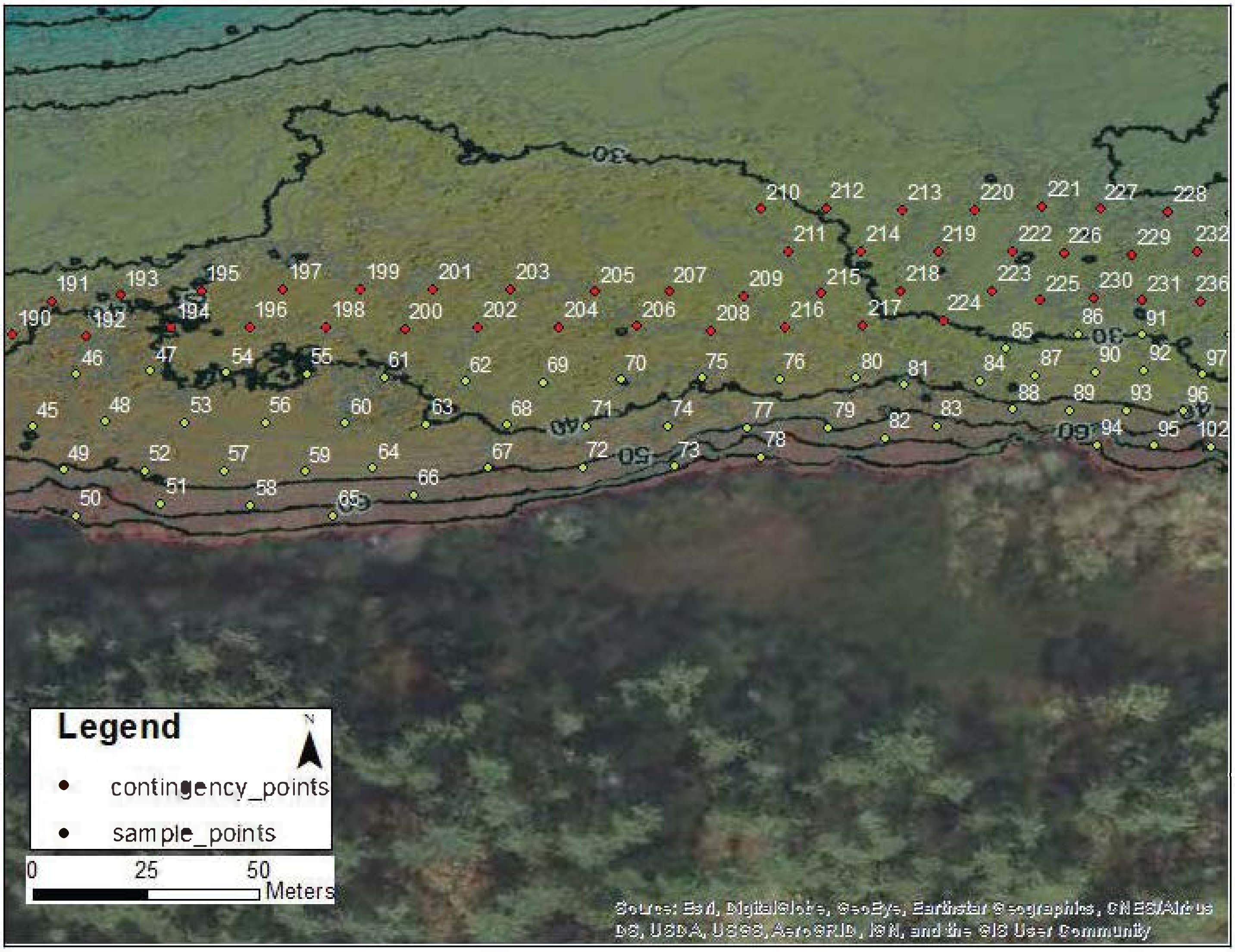
Photo 11. Clams visible throughout the site (sample location 135)

Photo 12. A crayfish at river bottom (adjacent to sample location 121)

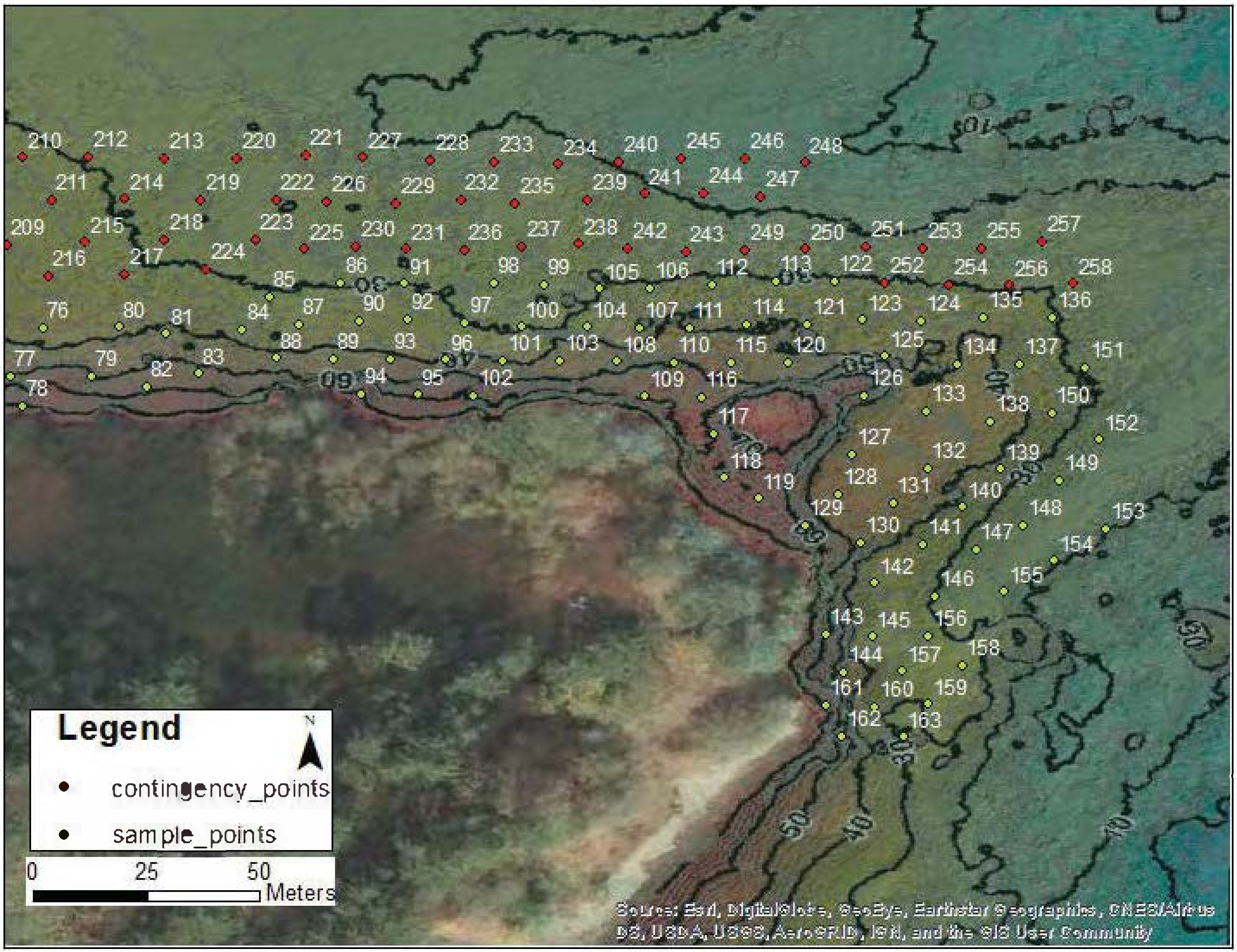
Bradford Island Sampling Location



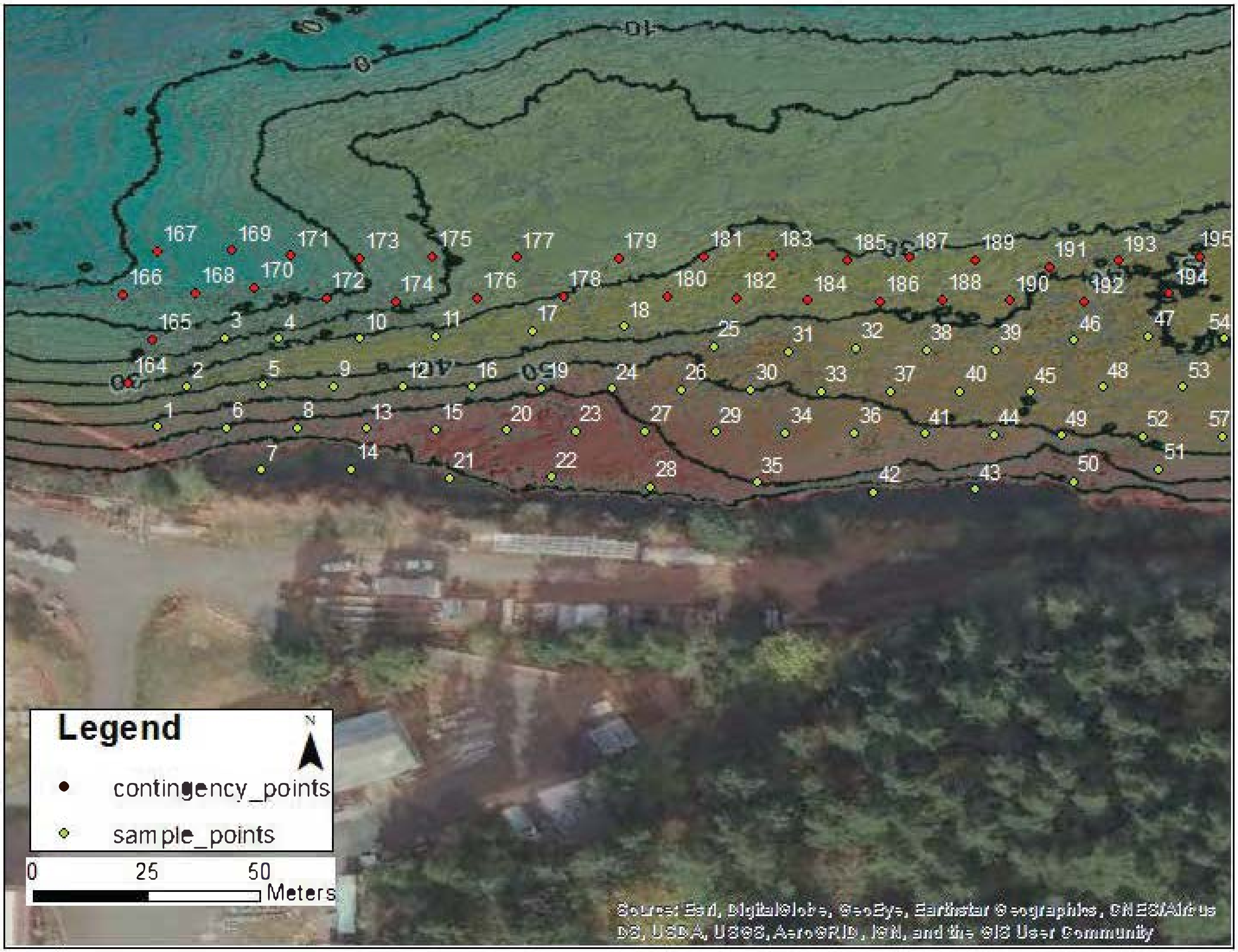
Bradford Island Sampling Location- Central



Bradford Island Sampling Location- East



Bradford Island Sampling Location- West



APPENDIX C:

TAG Comments on Draft Optimization Report and Discussion Regarding Comments Not Implemented or Partially Implemented

Appendix C:

TAG Comments on Draft Optimization Report and Discussion Regarding Comments Not Implemented

A draft version of this optimization report was provided to the Technical Advisory Group (TAG) on July 16, 2021. Comments were received from the following organizations:

- US Environmental Protection Agency (EPA) Region 10
- U.S. Fish and Wildlife Service
- Yakama Nation Fisheries
- Oregon Department of Environmental Quality (DEQ)

Those comments are provided on the following pages. The vast majority of the comments were addressed/implemented in the final optimization report. Some of the comments were not addressed or implemented (or were only partially addressed), as described below:

- There was a comment suggesting the report identify outdated methods and science, such as updates to risk assessment approach. The optimization evaluation did not focus on the type of consideration mentioned in the comment, and rather focused on big-picture conceptual items. For instance, as noted at the beginning of Section 5, the optimization evaluation did not address specific concentration thresholds for screening or cleanup, which are an ongoing matter of discussion between USACE, tribes, and stakeholders.
- There was a comment requesting additional critical evaluation of the substantial completeness of previous investigations. The draft optimization report already identified multiple items where completeness of data could be improved (e.g., delineation of impacts in specific areas, lack of recent data regarding current groundwater conditions, lack of recent characterization of VOC impacts near a former AST). The comment was partially addressed in the final report by adding additional discussion regarding completeness for specific items (e.g., identifying there was a limited number of metals and PAH analytes in groundwater samples from monitoring wells in the Sandblast AOPC). However, this comment is quite broad, and it is difficult to say if it has been fully addressed.
- There was a comment to provide additional critical evaluation of the interpretations and conclusions of the Administrative Record, rather than repeating text from previous documents. The optimization team uses information from existing documents to provide context for the findings and recommendations of the optimization evaluation. When the optimization team believes interpretations and conclusions from those documents (for issues pertinent to the review) may be incomplete or subject to question, the optimization report includes such discussion. As one example, the optimization report adds analysis beyond what was in the documents reviewed to determine that vertical migration of groundwater into the competent slide block (and subsequent groundwater migration to the river within the competent slide block) is likely to be a less significant (and perhaps negligible) component of groundwater discharge at the Landfill AOPC. As another example, the optimization report questions why

COCs other than PCBs were not included in the RAOs for the River OU and recommends modifying the RAOs to include the other COCs found in sediments within the River OU.

- There was a comment suggesting the report indicate that the past diver-assisted dredging resulted in dramatic increases in concentrations of PCBs in aquatic tissue. The optimization team does not believe that the 2007 dredging made conditions worse. Large PCB concentrations were observed in some organism samples in 2011 after previous dredging efforts. The optimization team believes this most likely reflects the fact that, until remediation is completed with a cap (as recommended in Section 5.2.2 of the optimization report), there is potential for small benthic organisms (e.g., crayfish) to come into contact with PCBs associated with contamination (including residual NAPL containing PCBs) that may remain in the riverbed (especially in the crevices among coarse sediment) despite previous dredging efforts. Such exposure can impact the associated food chain. These items have been more clearly stated in Section 4.2 ("Effectiveness of Remedial Actions Previously Implemented") in the final optimization report.
- There was a comment requesting more specific recommendations regarding the river cleanup. As noted in the introduction to Section 5, the optimization evaluation focused on big-picture conceptual items. The optimization report recommends a capping approach with up to four components (identified in the report) that can be used with or without dredging, and the report recommends that the updated FS for the River OU compare alternatives with and without dredging. Detailed comparison of alternatives and subsequent design are beyond the scope of the optimization review. Similarly, the optimization report recommends a multi-faceted post-remedy monitoring approach for the River OU that includes passive sampling (similar to the study completed in early 2020) to provide relatively rapid results, and sampling of fish tissue and benthic organisms to provide longer-term results that will be delayed due to organism lifetime. Again, more specific design of the monitoring is beyond the scope of this optimization review and would require more information regarding the remedy ultimately designed and implemented.
- There was a comment pertaining to a statement in the optimization report regarding the Landfill AOPC that, for constituents other than metals and PAHS (e.g., pesticides, herbicides, PCBs, TPH), concentrations exceeding soil screening levels were much less widespread. The comment requested a statement adding there are data gaps for these chemicals. The optimization team believes there are enough data at the Landfill AOPC to support the wording in the report.
- One comment indicates that the RI report discusses modeling of water velocities, and not measurements to confirm the modeling results. The comment further states that many passive samplers weighted with lead were lost, and the comment then states that it appears there is possible movement of materials such as gravel and cobbles. Based on discussion with USACE the weights were actually steel, and what was actually lost were the sampling material sheets and in some cases the steel balls that were initially within chicken wire. The sampling material sheets were contained within thin wire mesh with two metal grommets at opposite corners. Zip ties went through those grommets and attached to the bottom of chicken wire that was wired together to contain the steel balls for weight. The chicken wire appeared to have corroded and broken at areas of contact between the zip ties and wire. USACE hypothesized that electrolysis

between the metal of the weighted bags and the grommets resulted in corrosion and subsequent loss of the sampling material sheets. Based on the USACE account of the passive samplers, none of the samplers was dislodged and transported away by flows. Therefore, the comment about "loss" of samplers is not evidence that actual currents are strong enough to mobilize cobbles and boulders. The optimization team agrees that the flow velocity range of 0 to 3 ft/sec was the result of a hydrodynamic model and not confirmed by direct field measurements of flow velocities. However, the potential for flows to mobilize cobbles embedded in the riverbed is a physically different process compared to mobilizing a sampling instrument suspended above the riverbed and tethered to a steel anchor. The flow velocity is slowest at the boundary with the riverbed, and velocity increases progressively up through the water column. Passive samplers would experience higher velocities compared to the velocities applied directly to the riverbed. Additionally, the shape and size of the sampler would yield a higher drag force compared to a partially exposed cobble on the riverbed. Again, the loss of passive samplers does not necessarily imply cobbles and gravel could be mobilized. These factors notwithstanding, riverbed sediment mobility is a critical determination for the design of any kind of engineered sediment cap to ensure the cap remains in place under the range of expected flow conditions. The results of the hydrodynamic modeling would require field measurements and calibration/validation to be sufficient for remedial design (added to the recommendation in Section 5.2.2).

Greenwald, Robert

From: Tan, Robert <Tan.Robert@epa.gov>
Sent: Tuesday, August 17, 2021 9:49 AM
To: Greenwald, Robert
Cc: christine.m.budai@usace.army.mil; Kira LYNCH; Blocker, Shawn; Allen, Elizabeth
Subject: [EXTERNAL] RE: Bradford Island - Draft Optimization Report

Hi Rob and Chris,

EPA has completed its review of the draft HGL Optimization and does not have any further comments. We found that the report provides a fair and accurate summary of site conditions, and look forward to having further discussion among the TAG on plans to act on the recommendations.

Thank you,

Robert Tan

Greenwald, Robert

From: Buck, Jeremy <jeremy_buck@fws.gov>
Sent: Wednesday, August 18, 2021 4:31 PM
To: Greenwald, Robert
Subject: RE: [EXTERNAL] RE: Bradford Island - Draft Optimization Report

Hi Rob-

I only had two comments on the Draft Optimization Report, as follows:

1) Page 18 states that "With respect to ISM sampling depth, USACE indicated that the TAG suggested an ISM interval for surficial soil from ground surface to a depth of 2 inches to best characterize ground surface, and a deeper interval for discrete samples from 2 inches to 3 ft."

It should be noted that in this case, the TAG was not suggesting sampling to 2 inches, but rather this was specifically a US Fish and Wildlife Service recommendation. The Service (i.e., me, prior to any discussion with the TAG) primarily requested this so it would be easier for the COE to collect a much higher number of increments from each decision unit (DU) than was initially proposed (i.e., the COE proposed 30 increments per DU and the Service recommended at least 50 to 100 increments be collected, to be in better alignment with recommendations from the Hawaii guidance on incremental sampling when paint chips or PCBs are present). The Hawaii guidance indicates in Section 4.4.9 their manual (http://www.hawaiidoh.org/tgm.aspx): *"Field studies carried out by HDOH indicate that the concentration of a contaminant can vary by an order of magnitude or more in replicate samples collected from the same DU, even when an MI sample consists of greater than 50 increments (HDOH 2015, b). Under some circumstances even the higher recommended default of 75 increments per sample could be inadequate to demonstrate a representative mean contaminant concentration in a DU, such as when contaminants are distributed in a very heterogenic "nugget" form (e.g. lead pellets, or lead paint chips)."* The COE eventually agreed to collect 50 increments per DU and the TAG (especially DEQ) indicated support for a 0 to 12 inch surface sample. Recommended change: Indicate that it was the US Fish and Wildlife Service that suggested the ISM interval of 2 inches rather than the entire TAG.

2) In Section 5.1.8 *Planned ISM Sampling in Sandblast Area AOPC* on page 32 it states "A refined approach considering smaller sampling/decision units, or a subsequent round with discrete sampling, would be required to assess the extent of remediation at an adequate scale to be cost effective and protective." I would recommend against using discrete sampling to identify specific areas for remediation or action within a decision unit that has already been sampled using incremental sampling. Once a decision unit fails criteria, the entire decision unit should be remediated, or areas within the DU can be remediated followed by confirmation sampling with incremental sampling, or smaller decision units can be made within the decision unit and sampled with incremental sampling to better identify areas needing remediation. Allowing for discrete samples to be collected to make decisions following an incremental sampling event on a decision unit defeats the purpose of using incremental sampling, and is counter to Sampling Theory (which provides the basis for incremental sampling as described in Hawaii guidance Section 4.1) and is also counter to other guidance documents/training describing incremental sampling. Recommended change: Revise sentence and delete "…, or a subsequent round with discrete sampling,…". Additional information could also be added here about the benefits of using incremental sampling to describe a decision unit, conducting a remediation (typically a removal in this case), and then conducting confirmation sampling using incremental sampling over the same decision unit with a shallow 0 to 2 inch or 0 to 6 inch surface to provide confidence that remediation was successful.

Thanks for all your work in completing the draft report and providing the opportunity to comment.

Jeremy

Jeremy A. Buck
Senior Environmental Contaminant Specialist
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
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jeremy_buck@fws.gov
http://www.fws.gov/oregonfwo/Contaminants/FieldStudies/

Greenwald, Robert

From: Laura Shira <shil@yakamafish-nsn.gov>
Sent: Thursday, August 19, 2021 11:47 AM
To: Greenwald, Robert
Cc: Julie Atwood; swan@yakamafish-nsn.gov; rose@yakamafish-nsn.gov; Robert Dexter; Davis Washines; Eric Buer L.G., L.H.G., P.G.; Teresa Michelsen; Kim Carlton; Carlson, Daniel J CIV USARMY CENWS (USA); BUDAI, Christine M (Chris) CIV USARMY CENWP (USA); PE Andy Smith; POULSEN Mike; PETERSON Jenn L * DEQ; Bob Schwarz; Jeremy_Buck@fws.gov; Marissa Merker; Kira LYNCH; Tan.Robert@epa.gov; Sherrie Duncan
Subject: [EXTERNAL]
Attachments: 2021-08-19_BI_Optimization Rpt_YN Comments BD.pdf

Hi Robert.

Attached please find the Yakama Nation's comments on the Bradford Island Optimization Report.

Regards,

Laura Klasner Shira, P.E.
Environmental Engineer
Yakama Nation Fisheries
PO Box 151, Toppenish, WA 98948
509.985.3561 mobile

COLUMBIA RIVER - Honor.Protect.Restore

Established by the
Treaty of June 9, 1855

August 19, 2021

Via Electronic Mail – rgreenwald@hgl.com

HydroGeoLogic, Inc.
c/o Rob Greenwald, Principal Hydrogeologist
3709 SE Glenwood St.
Portland, Oregon 97202

RE: Yakama Nation comments on the Draft Optimization Review Report, Bradford Island Upland and River Operable Units

Dear Mr. Greenwald:

The Yakama Nation (YN) submits the following comments regarding the July 16, 2021, Draft Optimization Review Report for Bradford Island Upland and River Operable Units, Cascade Locks, Oregon (Draft Report) prepared by Hydrogeologic, Inc for the U.S. Army Corps of Engineers (USACE).

The purpose of the work documented in the Draft Report was to "provide recommendations aimed to increase remedy effectiveness, improve technical performance, reduce costs, and move the Site to completion." Overall, we are grateful to see additional review of site information and agree with the majority of the content, analysis, and conclusions of the Draft Report. However, the review of work completed to date appears to have several crucial deficiencies and offers relatively mild suggestions regarding changes that USACE should make. We offer the following suggestions for improving the Draft Report with the ultimate goal of a cleanup protective of the resources.

The Draft Report does correctly identify some deficiencies in the work performed to date, data gaps, and make reasonable recommendations including:

- Identifying the failure by USACE to adequately consider the link between the Upland and River operable units and the lack of a remedial action objective to protect the River Operable Unit from the Upland Operable Unit;

- Identifying that contaminants of concern addressed in each Operable Unit do not take the other Unit into consideration, and therefore are incomplete listings;
- Identifying the incomplete characterization of both Operable Units, although additional detail should be provided;
- Identifying the failure to fully identify the nature and extent of contaminants present (e.g. the form of PCB contamination in the River Operable Unit; lack of vertical and lateral characterization of soil contamination in the Upland Operable Unit);
- Recommending Upland Operable Unit remediation rely on removal of contaminated media to the maximum extent practicable and be performed to a level that is protective of ecologic receptors in both Operable Units;
- Recommending that cleanup and/or removal actions do not rely on institutional controls and long-term monitoring as both are likely to be more expensive and less effective than the Feasibility Study assessment would suggest.

In light of the relatively short reference list in Section 6.0 of the Draft Report and the concerns identified below, we question whether the review team was provided adequate budget or access to site documentation. Overall, the Draft Report requires substantive revision to reflect the current status of the Bradford Island cleanup. The Draft Report needs inclusion of the following technical issues that are either missing or not adequately addressed:

- Identification of outdated methods and science. For example, risks at the site must be based on current risk assessment approaches.
- Additional critical evaluation of the substantial completeness of investigative work, especially in cases where it is clearly deficient. This information is vital for informing the data gap evaluation and update the conceptual site model.
- Additional critical evaluation of the interpretations and conclusions of the Administrative Record. In some instances the Draft Report's review of previous work does not appear to have been particularly rigorous given that portions of the document repeat, in many cases nearly verbatim, text and conclusions previously presented in the RI and FS without critically evaluating whether they make sense, remain consistent with current regulations, or have been addressed by later work. For example, the discussion of geotechnical properties of soils at sites immediately adjacent to the Columbia River seems completely unaware of the Memorandum for Record regarding Slope Stability Analysis at Bradford Island prepared by USACE dated January 20, 2015. The memorandum concluded that north bank slopes were likely to fail in the future.
- Acknowledgement of unresolved data quality issues. We were surprised that the analysis of the passive samplers included in the report presented such firm conclusions regarding the distribution of PCBs in the river. The data used for that analysis are still under review and this section needs to be softened, e.g., "based on preliminary information," or removed, as well as any suggestions for future action based on that analysis.
- Evaluation of the efficacy of past cleanup efforts. For example, based on the available sampling results, past diver-assisted vacuum dredging has made conditions in the River Operable Unit

measurably worse and resulted in dramatic increases in concentrations of polychlorinated biphenyls in aquatic tissue.

- Recommendations on river cleanup. We had also anticipated that this review would include more specific recommendations for the river cleanup. With the breadth of experience on the review team, input on technology options and perspectives to consider would be extremely helpful.

We acknowledge that this technical review scope does not include identifying legal deficiencies in how well USACE has followed CERCLA and ARARs requirements (ex. recognition of state cleanup criteria); however, these deficiencies do negatively impact technical aspects of cleanup especially with respect to the ultimate protectiveness of the selected remedy. It is important to note that the Yakama Nation and both States consider this an unresolved issue that affects remedial design.

Correcting these deficiencies in a revised report would provide more meaningful guidance on improving the Bradford Island cleanup process. The Bradford Island cleanup has dragged on for more than two decades. Recommended total bans on resident fish consumption, first enacted by the states of Oregon and Washington in 2013 remain in place and there is no foreseeable date in the future when they will be lifted.

Please do not hesitate to contact me with questions. I can be reached at shil@yakamafish-nsn.gov or 509.985.3561.

Sincerely,

Laura K. Shira

Laura Shira, P.E.
Yakama Nation Fisheries

Greenwald, Robert

From: POULSEN Mike * DEQ <mike.poulsen@deq.state.or.us>
Sent: Monday, August 16, 2021 4:03 PM
To: Greenwald, Robert
Cc: BUDAI, Christine M (Chris) CIV USARMY CENWP (USA); SCHWARZ Bob DEQ; PETERSON Jenn L * DEQ
Subject: [EXTERNAL] RE: Bradford Island - Draft Optimization Report
Attachments: BradfordIslandDraftOptimizationReport-16Jul21-DEQcomments.docx

Rob –

DEQ appreciated the opportunity to participate in the optimization review listening session. We agree with many of the recommendations of the optimization report. Our comments on the report are included in the attached Word file.

Mike Poulsen
Oregon Department of Environmental Quality
700 NE Multnomah St., Suite 600
Portland, OR 97232-4100
503 229-6773

Note - the DEQ comments on subsequent pages are extracted from comments provided in a marked-up MS-Word file

Main document changes and comments

Page 5: Commented [A1] Author

As discussed in our comments below, our understanding is that the maintenance program was not implemented as planned.

Page 6: Commented [A2] Author

As discussed in our comments below, our understanding is that the maintenance program was not implemented as planned.

Page 11: Commented [A3] Author

It would be helpful to show the range of water elevations in the Bonneville pool for reference. The RI reports an average of 74 ft. above msl, ranging from 71.5 ft. to 76.6 ft.

Page 16: Commented [A4] Author

For perspective, add a statement that there are data gaps for these chemicals.

Page 17: Commented [A5] Author

Not analyzed in monitoring wells

Page 17: Commented [A6] Author

It is important to discuss data gaps relative to summaries of risk exceedances in groundwater. Groundwater samples from monitoring wells in the Sandblast Area were only analyzed for total and dissolved concentrations of arsenic, iron and vanadium, dissolved concentrations of calcium, magnesium, potassium, and sodium, TPH, monobutyltin, phenathrene, benzo b)fluoranthene, benzo(k)fluoranthene, and general chemistry parameters (dissolved bromide, chloride, fluoride, sulfate, ammonia, nitrate+nitrite, TOC and carbonate as $CaCO_3$), and VOCs (Table 6-3 h-i of 2012 RI). Many of the metals discussed above as exceeding hot spot and screening levels were not analyzed, nor were pesticides or PCBs.

Page 17: Commented [A7] Author

The direct-push samples were analyzed for a larger list of metals, but shallower. DP samples were analyzed for total and dissolved aluminum, antimony, arsenic, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc; total concentrations of tributyltin, monobutyltin, Lindane, methoxychlor, TPH-Dx, TPH-Gx; dissolved and total concentrations of 2-methylnaphthalene, acenaphthene, acenaphthylene, benzo(a)pyrene, benzoic acid, butyl benzyl phthalate, dibenz(a,h)anthracene, diethyl phthalate, di-n-butylphthalate, fluorene, indeno(1,2,3-cd pyrene, isophrone, naphthalene, phenanthrene, phenol; VOCs.

Page 18: Commented [A8] Author

Phenanthrene, benzo b)fluoranthene, benzo k)fluoranthene were the only PAHs analyzed in monitoring wells

Page 18: Commented [A9] Author

Metals were found at hot spot levels in soil, but were not analyzed in direct push samples (except limited nickel, chromium data), or monitoring well samples.

Page 21: Commented [A10] Author

The RI report includes additional information about TPH that should be discussed here.

Page 21: Commented [A11] Author

This statement regarding “lack of uniform levels” of OCP detections must be interpreted in the context of data gaps. Pesticides were not analyzed as a part of the larger forebay “random” sediment dataset to support the RI, and data for all contaminants from the shore of Bradford Island were excluded from the RI (See Appendix G of the RI entitled “data not used in the RI”). Pesticides were analyzed as a part of the 2011 limited sediment, clams and bass collected from the shore of north shore of Bradford Island as a result of DEQ comments See RI Appendix P) on this data gap. DEQ stated that although removal actions had occurred, all samples from the shores of Bradford Island should not be removed from the RI without re-characterization of non-removal and removal areas.

Page 21: Commented [A12] Author

It would be helpful to include a discussion of pesticides in this section.

Page 21: Inserted Author

measure polyethylene concentrations and calculate

Page 21: Deleted Author

measure

Page 21: Commented [A13] Author

Polyethylene concentrations are measured; freely dissolved concentrations are calculated.

Page 21: Inserted Author

or solid

Page 22: Commented [A14] Author

It would be prudent to mention uncertainties in locating all of the equipment that was historically disposed in the river.

Page 22: Commented [A15] Author

The RI report discusses modeling of water velocities, not measurements to confirm the modeling results. Given that many passive samplers weighted with lead were lost, it appears that there is possible movement of materials such as gravel and cobbles.

Page 22: Commented [A16] Author

Consider co-solvency as discussed below.

Page 22: Commented [A17] Author

There are few data for metals.

Page 23: Commented [A18] Author

Data gaps in groundwater for this area are significant. See comments below.

Page 23: Commented [A19] Author

DEQ agrees that new sampling of groundwater with a full analyte list would improve the CSM and address datagaps.

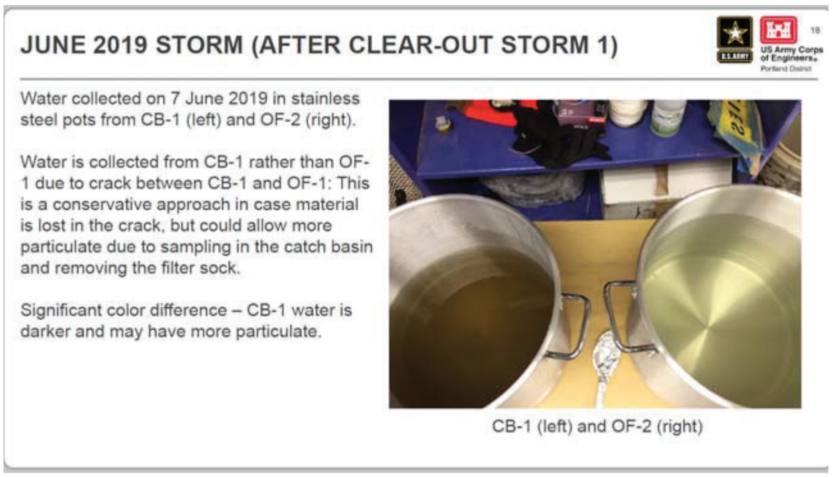
Page 24: Commented [A20] Author

USACE has presented findings at TAG meetings that these controls were insufficient due to water overflowing the catch basin wattles and filters. This material likely went directly to the river. This is shown in the two attached photographs from an October 20, 2016 site visit. It is unclear how much material current controls are capturing. There were also significant breaks in the stormwater lines and clogging of pipes with debris that prevented the retention of stormwater and resulted in overflow of stormwater lines. It is therefore highly uncertain if and how much was impeded by the system. This section should be updated with the information presented by the USACE to the TAG.

Page 24: Commented [A21] **Author**

The USACE also noted dark stained water from CB-1, and the potential that PAHs are associated with particulates. DEQ agrees that stormwater contains TPH, and asks that TPH and VOCs, phthalates) should be discussed relative to co-solvency transport of PCBs and pesticides in stormwater. In addition, these compounds may cause direct toxicity. TPH was also identified above risk levels, but was dropped because USACE states TPH is not a CERCLA contaminant. See September 2019 TAG Meeting Slides "Stormwater Best Management Practices Evaluation Update", included below.

1	Analysis	Drains to Outfall 1																	
2		CB-1						CB-3						CB-4					
6	Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)																		
7	Analyte	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac
8	Di-n-butylbenzylphthalate	310		150	25	µg/kg-dw	1	390		280	48	µg/kg-dw	1	320	J-	180	30	µg/kg-dw	1
9	Bis(2-ethylhexyl)phthalate	23000		15000	4700	µg/kg-dw	100	150000	J	280000	91000	µg/kg-dw	1000	21000		18000	5800	µg/kg-dw	100
10	Butylbenzylphthalate	73	UJ	150	5.9	µg/kg-dw	1	140	UJ	280	11	µg/kg-dw	1	90	UJ	180	7.2	µg/kg-dw	1
11	Carbazole	100		29	1.9	µg/kg-dw	1	500		57	3.7	µg/kg-dw	1	18	U	36	2.3	µg/kg-dw	1
12	Phenol	73	U	150	8.9	µg/kg-dw	1	40	J	280	17	µg/kg-dw	1	90	U	180	11	µg/kg-dw	1
13	Method: 8270D SIM - Polycyclic Aromatic Hydrocarbons (PAHs) by GC/MS SIM																		
14	Analyte	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac
15	Naphthalene	6.6	J	29	3.8	µg/kg-dw	1	37	J	57	7.4	µg/kg-dw	1	18	U	36	4.7	µg/kg-dw	1
16	2-Methylnaphthalene	7.8	J	29	3.2	µg/kg-dw	1	24	J	57	6.3	µg/kg-dw	1	18	U	36	4.0	µg/kg-dw	1
17	Acenaphthylene	15	U	29	1.8	µg/kg-dw	1	9.3	J	57	3.4	µg/kg-dw	1	18	U	36	2.2	µg/kg-dw	1
18	Acenaphthene	84		29	2.2	µg/kg-dw	1	220		57	4.3	µg/kg-dw	1	19	J	36	2.7	µg/kg-dw	1
19	Fluorene	58		29	4.7	µg/kg-dw	1	260		57	9.1	µg/kg-dw	1	11	J	36	5.8	µg/kg-dw	1
20	Phenanthrene	720		29	2.6	µg/kg-dw	1	4500		570	51	µg/kg-dw	10	18	U	36	3.2	µg/kg-dw	1
21	Anthracene	120		29	1.8	µg/kg-dw	1	750		57	3.4	µg/kg-dw	1	18	U	36	2.2	µg/kg-dw	1
22	Pyrene	1100		59	6.2	µg/kg-dw	2	9700		570	60	µg/kg-dw	10	670		36	3.8	µg/kg-dw	1
40	Method: NWTPH-Gx - Gasoline-Range Petroleum Products (GC)																		
41	Analyte	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac
42	Gasoline	6.6	J	13	6.1	mg/kg	1	30	UJ	33	15	mg/kg	1	12	UJ	13	6.1	mg/kg	1
43	Method: NWTPH-Dx - Diesel-Range Petroleum Products (GC)																		
44	Analyte	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac	Result	Qualifier	LOQ	MDL	Unit	Dil Fac
45	#2 Diesel (C10-C24)	500	U	840	210	mg/kg	10	1100	U	1900	460	mg/kg	10	520	U	860	210	mg/kg	10
46	Motor oil (>C24-C36)	1000		840	290	mg/kg	10	4200		1900	650	mg/kg	10	1400	J+	860	300	mg/kg	10



Page 24: Commented [A22] Author

Please provide a reference for this re-interpretation.

Page 27: Inserted Author

or solid

Page 27: Commented [A23] Author

This may not matter for benthic receptors, such as crayfish, coming into direct physical contact with contamination. PCBs could be present as DNAPL or solids. The high levels of PCBs measured in biota imply that there is still a concentration PCB source that has not been identified).

Page 31: Commented [A24] Author

DEQ agrees.

Page 31: Commented [A25] Author

Stormwater should be sampled for TPH and solvents because PCBs and pesticides could be transported by co-solvency effects.

Page 31: Commented [A26] Author

Any new data should include a full list of contaminants of interest.