Remedial Design/Remedial Action Work Plan

Prepared for NW Natural
ECSI No. 1138
July 6, 2018
Former Portland Gas Manufacturing Site

Remedial Design/Remedial Action Work Plan

Prepared for
NW Natural
220 NW Second Avenue
Portland, Oregon 97209

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue
Portland, Oregon 97219
# TABLE OF CONTENTS

1 **Introduction** ................................................................. 1
   1.1 Purpose ................................................................................. 1
   1.2 Work Plan Organization......................................................... 1

2 **Site Background** ......................................................... 3
   2.1 Site Description ................................................................. 3
      2.1.1 Site History .................................................................. 3
      2.1.2 Current Site Uses .......................................................... 5
   2.2 Site Contaminants of Concern ............................................. 6
   2.3 Remedial Action Objectives ................................................ 6
   2.4 Description of Selected Remedial Action ............................... 6
   2.5 Design Adjustments Based on Pre-Design Investigation Results................................................... 8

3 **Project Roles, Responsibilities, and Qualifications** ............. 11
   3.1 Project Team Organization ............................................... 11
   3.2 Roles and Responsibilities of Key Personnel ....................... 11

4 **Remedy Implementation** ............................................... 14
   4.1 Design Criteria, Cleanup Levels, and Performance Criteria .................................................. 14
      4.1.1 Design Criteria ............................................................. 14
      4.1.2 PGM Performance Criteria ........................................... 14
      4.1.3 Comparison with Portland Harbor Cleanup Criteria .................................................. 15
   4.2 Remedial Design/Remedial Action Tasks ............................. 16
      4.2.1 Dredging ................................................................. 16
      4.2.2 Debris Removal ........................................................... 17
      4.2.3 Sediment Dewatering, Transport, and Disposal .................... 18
      4.2.4 Placement of Caps, Covers, and Armor Stone .................... 18
      4.2.5 Remedial Action Verification ...................................... 19
      4.2.6 Long-Term Monitoring Program .................................. 19
   4.3 Permitting and Regulatory Requirements ............................ 19
      4.3.1 Federal Approvals ....................................................... 20
      4.3.2 State and Local Approvals ......................................... 22
      4.3.3 Other Regulatory Considerations .................................. 23
      4.3.4 Work Window Requirements ...................................... 24
   4.4 Site Access and Easements ............................................... 24
4.5 Supplemental Design Investigations ................................................................. 24

5 Deliverables ............................................................................................................. 26
  5.1 Remedial Design Reports ......................................................................................... 26
      5.1.1 Preliminary Design Meeting .............................................................................. 26
      5.1.2 Pre-Final Design Report ................................................................................... 26
      5.1.3 Final Remedial Design Report ......................................................................... 27
  5.2 Sampling and Analysis Plan .................................................................................. 27
  5.3 Health and Safety Plan .......................................................................................... 27
  5.4 Construction Quality Assurance and Control Plan ............................................... 28
  5.5 Monitoring, Performance Evaluation, and Contingency Plan .................................. 28
  5.6 Project Completion Report ..................................................................................... 29

6 Project Schedule ..................................................................................................... 30

7 References ............................................................................................................... 31

TABLES
Table 1 Cleanup Levels
Table 2 Hot Spot Criteria
Table 3 Anticipated Construction Permitting Requirements

FIGURES
Figure 1 Site Vicinity Map
Figure 2 Existing and Pre-Design Sample Locations
Figure 3a Selected Remedial Alternative
Figure 3b Updated Remedial Design Based on Pre-Design Investigation Results
Figure 4 Project Team Organizational Chart
Figure 5 Project Schedule
### ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>µg/kg</td>
<td>micrograms per kilogram</td>
</tr>
<tr>
<td>BMP</td>
<td>best management practice</td>
</tr>
<tr>
<td>BSLV</td>
<td>Bioaccumulative Screening Level Value</td>
</tr>
<tr>
<td>BTEX</td>
<td>benzene, toluene, ethylbenzene, and xylene</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>COC</td>
<td>contaminant of concern</td>
</tr>
<tr>
<td>COP</td>
<td>City of Portland datum</td>
</tr>
<tr>
<td>CQACCP</td>
<td>Construction Quality Assurance and Control Plan</td>
</tr>
<tr>
<td>CRD</td>
<td>Columbia River Datum</td>
</tr>
<tr>
<td>CWA</td>
<td>Clean Water Act</td>
</tr>
<tr>
<td>DEQ</td>
<td>Oregon Department of Environmental Quality</td>
</tr>
<tr>
<td>DSL</td>
<td>Oregon Department of State Lands</td>
</tr>
<tr>
<td>ECSI</td>
<td>Environmental Cleanup Site Information</td>
</tr>
<tr>
<td>EMNR</td>
<td>enhanced monitored natural recovery</td>
</tr>
<tr>
<td>ESA</td>
<td>Endangered Species Act</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Act</td>
</tr>
<tr>
<td>FS</td>
<td>Feasibility Study</td>
</tr>
<tr>
<td>GAC</td>
<td>granular activated carbon</td>
</tr>
<tr>
<td>HASP</td>
<td>Health and Safety Plan</td>
</tr>
<tr>
<td>MGP</td>
<td>manufactured gas plant</td>
</tr>
<tr>
<td>MNR</td>
<td>monitored natural recovery</td>
</tr>
<tr>
<td>MPECP</td>
<td>Monitoring, Performance Evaluation, and Contingency Plan</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
</tr>
<tr>
<td>OAR</td>
<td>Oregon Administrative Rule</td>
</tr>
<tr>
<td>Order</td>
<td>Order on Consent No. LQVC NWR-09-02</td>
</tr>
<tr>
<td>PAH</td>
<td>polycyclic aromatic hydrocarbon</td>
</tr>
<tr>
<td>PCR</td>
<td>Project Completion Report</td>
</tr>
<tr>
<td>PDI</td>
<td>pre-design investigation</td>
</tr>
<tr>
<td>PEC</td>
<td>Probable Effects Concentration</td>
</tr>
<tr>
<td>PGM</td>
<td>Portland Gas Manufacturing</td>
</tr>
<tr>
<td>PTW</td>
<td>principal threat waste</td>
</tr>
<tr>
<td>RAL</td>
<td>remedial action level</td>
</tr>
<tr>
<td>RAO</td>
<td>remedial action objective</td>
</tr>
<tr>
<td>RD/RA</td>
<td>Remedial Design/Remedial Action</td>
</tr>
<tr>
<td>RHA</td>
<td>Rivers and Harbors Act</td>
</tr>
<tr>
<td>RM</td>
<td>river mile</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>ROD</td>
<td>Record of Decision</td>
</tr>
<tr>
<td>SDU</td>
<td>sediment decision unit</td>
</tr>
<tr>
<td>SES</td>
<td>Sevenson Environmental Services</td>
</tr>
<tr>
<td>SI/SCE</td>
<td>Integrated Sediment Investigation/Source Control Evaluation Report</td>
</tr>
<tr>
<td>SLV</td>
<td>Screening Level Value</td>
</tr>
<tr>
<td>TCLP</td>
<td>toxicity characteristic leaching procedure</td>
</tr>
<tr>
<td>TPH</td>
<td>total petroleum hydrocarbons</td>
</tr>
<tr>
<td>TZW</td>
<td>transition zone water</td>
</tr>
<tr>
<td>USACE</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>USEPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>USFWS</td>
<td>U.S. Fish and Wildlife Service</td>
</tr>
</tbody>
</table>
1 Introduction

This Remedial Design/Remedial Action (RD/RA) Work Plan was prepared to address the cleanup action selected in the Record of Decision (ROD) issued by the Oregon Department of Environmental Quality (DEQ) on July 3, 2017 (DEQ 2017), for contaminated sediments and groundwater at the former Portland Gas Manufacturing (PGM) site. The PGM site includes a river reach of approximately 800 feet along the western side of the Willamette River from approximately river mile (RM) 12.0 to RM 12.2 between the Burnside and Steel bridges in downtown Portland, Oregon (Figure 1).

1.1 Purpose

This RD/RA Work Plan was prepared per the requirements of the April 2009 Order on Consent signed by DEQ and NW Natural (Order on Consent No. LQVC-NWR-09-02 [Order]), as modified by Amendment No. 2 to the Order, executed on August 10, 2017. The PGM site contaminants of concern (COCs) are polycyclic aromatic hydrocarbons (PAHs); total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene, and xylene (BTEX); free cyanide; and target metals (lead, mercury, and zinc). The selected RA includes a blend of technologies, including dredging, in situ treatment with reactive caps and covers containing activated carbon, armoring to resist erosion in most areas, and monitored natural recovery (MNR) and enhanced monitored natural recovery (EMNR) in less impacted areas.

This work plan describes current site conditions, establishes RD objectives, describes the roles of the parties involved in site cleanup, outlines what measures are necessary to address contaminated sediments and reduce site risk, discusses deliverables to be developed to document the work, and presents the anticipated project schedule.

1.2 Work Plan Organization

This remainder of this work plan is organized as follows:

- **Section 2 – Site Background.** This section describes the current site conditions, site history, previous investigations, remedial action objectives (RAOs), and a description of the ROD-selected RA.
- **Section 3 – Project Roles, Responsibilities, and Qualifications.** This section identifies the duties, responsibilities, authorities, and qualifications of the personnel involved in the RD/RA process.
- **Section 4 – Remedy Implementation.** This section discusses the design objectives, proposed performance criteria, RD components to be implemented, permitting and regulatory requirements, site access and easements, and supplemental investigations and evaluations to support RD.
- **Section 5 – Deliverables.** This section provides an overview of the various deliverables that will be prepared as part of the RD/RA process.

- **Section 6 – Project Schedule.** This section outlines the schedule for RD/RA activities and deliverables.

- **Section 7 – References.**
2 Site Background

This section provides a site description, site history, RAOs, and a description of the selected RA. This work was informed by numerous studies and investigations performed under the PGM Order, including a site history review, four rounds of investigation of sediment, two rounds of investigation of surface water and transition zone water (TZW), a groundwater source control evaluation, and a Feasibility Study (FS). The results of these investigations are summarized in the Historical Summary Report (HAI and Anchor Environmental 2009), Integrated Sediment Investigation/Source Control Evaluation Report (SI/SCE; Anchor QEA 2013, 2014), and FS (Anchor QEA 2016). Additional pre-design investigation (PDI) was conducted in September and October of 2017, as outlined in the draft Pre-Design Investigation Data Report (Anchor QEA 2018 [currently in revision]). Existing SI/SCE, FS, and pre-design sample locations are shown in Figure 2.

2.1 Site Description

The former PGM site is located along the west bank of the Willamette River on a 0.2-mile reach between the Burnside Bridge and the Steel Bridge from approximately RM 12.1 to RM 12.3 (Figure 1). The former PGM site was a manufactured gas plant (MGP) that operated from 1860 to 1913. The former PGM site was approximately bounded by NW Davis Street to the south, NW Second Avenue to the west, NW Glisan Street (and the Steel Bridge) to the north, and the Willamette River to the east. Although historical MGP operations occupied several city blocks, the locus of historical MGP operations was on Block 5, the location of which is shown in Figure 2.

2.1.1 Site History

2.1.1.1 Former Portland Gas Manufacturing Operations

From 1860 until the early 1900s, the PGM gas manufacturing area was limited to one historical city block (Block 5), with office space and coal storage located on a second city block. A portion of the historical MGP operations within Block 5 was located on a river wharf that extended into the water, supported by a backfilled concrete retaining wall. The highest concentrations of COCs were detected in groundwater and sediments near this area. By 1913, the gasification operations had been expanded to include all or portions of three additional city blocks. In 1913, all operations were moved down river to the Gasco site (Environmental Cleanup Site Information [ECSI] No. 84), and the PGM plant was closed.

Gas at the PGM site was manufactured exclusively from coal until the late 1890s. In subsequent years, carbureted water gas processes and oil gas manufacturing were incorporated, and coal was gradually phased out in the early 1900s. From 1906 until the plant shutdown in 1913, the PGM site produced gas almost exclusively from oil, with carbureted water gas processes retained for emergency needs only.
2.1.1.2 Portland Seawall Construction
Construction of the Portland seawall began in 1927 and was completed in 1929. At that time, numerous former MGP plant structures were still present on Block 5, including the timber wharf, concrete retaining wall, and three buildings—a one-story brick building, a two-story brick building, and a one-story corrugated iron building.

Seawall Foundation Dredging. Work on the seawall began with preparation of the riverbed for placement of timber crib structures, which were set at a base elevation of -30.8 feet City of Portland datum (COP). The Block 5 area required dredging to achieve the proper base elevation for the seawall foundation and was generally over-excavated to a depth of 5 to 9 feet below the base of the timber crib structure. The excavated trench was backfilled with “select” sand and gravel dredged from the river (Laurgaard 1933).

Placement of Seawall Demolition Debris. In September 1928, dredging of the seawall foundation trench undermined the stability of the former PGM structures, and a large section of the two-story brick building, the timber wharf, the concrete retaining wall, and underlying riverbank soils slumped into the river (Laurgaard 1933). Rubble from the collapse of the former plant structures was evidently cleared from the seawall construction area and dumped approximately 150 to 250 feet offshore, where it remains on the surface of the riverbed today. A particularly large pile of debris (approximately 100 feet wide by 200 feet long and rising 5 to 10 feet above the surrounding riverbed) is present offshore from the PGM area, as shown in Figure 2. Diver observations confirm that this debris pile contains large sections of brick wall, concrete, lumber, and corrugated sheet metal that are likely from the demolished PGM structures.

Offshore Deposits of Tar-Like Material. A localized area with thin surficial deposits of solidified tar-like material is present on the offshore debris mound. This material was likely placed concurrently with the demolition debris when the contaminated sediments adjacent to Block 5 were cleared from the foundation trench. The extent of the surficial tar-like material is shown in Figure 2. The thickness of the tar-like material ranges from 2 to 13 inches, averaging about 7 inches, based on diver measurements. The extent of these deposits is currently being refined with additional diver surveys as part of the PDI.

2.1.1.3 Sanitary Sewer Utility
In the early 1950s, a sanitary pressure main was installed from the west side of the Willamette River at the Ankeny Pump House to the east side of the river, crossing near the upstream boundary of the PGM locality of the facility. The location of the sanitary sewer utility is shown in Figure 2. According to as-built drawings, the sewer utility consists of paired 30-inch and 42-inch force mains installed approximately 5 to 7 feet below the mudline on pile-supported brackets. The sanitary pressure mains are evidently still in service (www.portlandmaps.com). During the excavation of the sewer trench,
some buried contamination may have been side-cast onto the PGM site, especially in the vicinity of samples G783/C783 and PGM-23.

2.1.2 Current Site Uses

2.1.2.1 Adjacent Land Uses

Existing land uses adjacent to the PGM site are as follows:

- Waterfront Park (public open space)
- Naito Parkway (high-use traffic corridor)
- City streets and commercial properties
- Steel Bridge (a combined rail, light rail, and vehicle traffic corridor)

2.1.2.2 Willamette River Beneficial Uses

Per Oregon Administrative Rule (OAR) 340-041-0340, Table 340A, this reach of the Willamette River currently supports, or could support, the following beneficial uses:

- Industrial water supply
- Irrigation
- Fish and aquatic life, as well as a migration corridor for salmon and steelhead
- Wildlife
- Fishing
- Boating
- Water contact recreation
- Aesthetic quality
- Commercial navigation and transportation

Domestic water supply has not been identified as a current or reasonably likely future use of surface water in the Lower Willamette River within Portland Harbor (LWG 2012), and the City of Portland has reported that it has no plans to use the Willamette River as a municipal water supply (City of Portland 2010).

The primary navigation use for this portion of the river is for the berthing of U.S. Navy vessels in early June during the Rose Festival Fleet Week. The authorized navigation depth in the Willamette River channel between the Broadway and Ross Island bridges is -30 feet Columbia River Datum (CRD; USACE 1987). The Port of Portland is responsible for dredging this reach of the channel, whereas individual parties are responsible for maintaining their own berthing areas outside the channel (USACE 1987; Port of Portland 1988). The only known maintenance dredging event along this portion of the seawall was conducted by the City of Portland in response to the U.S. Navy’s concerns regarding the safe passage and berthing of their vessels during Fleet Week (City of Portland 1989). In
May 1989, 14,600 cubic yards of dredged material was removed to a target depth of -30 feet CRD in a 60-foot-wide strip along the seawall between the Burnside and Steel bridges.

2.2 Site Contaminants of Concern
Several rounds of remedial investigation were conducted to delineate the extent of contamination at the PGM site and assess potential risks to human health and the environment. Based on these investigations, the following COCs have been identified:

- PAHs
- TPH
- BTEX
- Cyanide
- Target metals (lead, mercury, and zinc)

2.3 Remedial Action Objectives
As specified in the ROD, the RAOs for the PGM site are as follows (DEQ 2017):

- Assure protection of ecological receptors (i.e., fish and invertebrates) and humans from risks associated with contaminated sediment, TZW, and surface water through the achievement of acceptable risk levels as defined in OAR 340-122-0115. The primary risk pathways that will be controlled as part of this RA include the following:
  - Direct risk to benthic organisms from surface sediment and TZW (via direct contact and ingestion) for PAHs, TPH, and, to a lesser degree, target metals and free cyanide
  - Bioaccumulation risk to fish from PAHs in sediment
  - Bioaccumulation risk to humans from PAHs in sediment and, to a lesser degree, surface water
- Prevent or minimize future releases and migration of COCs in subsurface sediment and groundwater into the zone of exposure for ecological and human receptors. TZW contamination derived from both local impacted sediments and from upland groundwater sources may be commingled and will be addressed at the point of discharge through the in-water remedy.
- Remove or treat hot spots of contamination if feasible.
- Ensure protection is maintained over time through long-term monitoring, maintenance, and periodic review as appropriate of the selected remedy elements.

2.4 Description of Selected Remedial Action
The RAOs described in Section 2.3 were addressed by the remedial action selected in the ROD (DEQ 2017), as depicted in Figure 3a. The preliminary remedial design was subsequently adjusted
based on the PDI results (as reported in Anchor QEA 2018 [currently in revision]) and is depicted in Figure 3b.

Including recent PDI design adjustments, the remedial action area is divided into 10 sediment decision units (SDU), which are designated Areas A through G (Figure 3b). The selected RA includes a tiered blend of remedial technologies that are tailored to the level of risk posed by site sediments, with more aggressive technologies being applied to areas of greater impact. The selected RA includes a combination of dredging, reactive capping, in situ treatment, EMNR, MNR, and institutional controls, as well as long-term maintenance and monitoring of the remedy. In some areas, partial dredging will be performed to maintain the berthing depth for visiting U.S. Navy ships.

The preliminary remedial design for the PGM site includes the following elements (Figure 3b):

- **Permitting.** Prior to dredging, the U.S. Army Corps of Engineers (USACE), Oregon Department of State Lands (DSL), National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency (USEPA), DEQ, and City of Portland will be consulted to identify required permits for the remediation project. Anticipated permit requirements are discussed in Section 4.3.

- **Debris Removal.** The preponderance of large demolition debris in parts of the RA area, often several feet in dimension, will need to be removed and processed as part of any dredging action. Debris removal will also be needed in some offshore areas to prepare the substrate for cap placement.

- **Hot Spot Removal.** The surficial deposits of tar-like or highly concentrated material in Areas E and G are considered hot spots under Oregon Hazardous Substance Remedial Action Rules (OAR 340-122). The surficial product layers and adjacent contact sediments will be mechanically dredged from these areas, dewatered, and, as appropriate, stabilized or otherwise treated prior to transportation for disposal at a Subtitle D or Subtitle C landfill. The extent of the hot spot removal areas was adjusted based on PDI investigation results, including coring and diver observations, and the practicability of additional removal was evaluated before establishing the final hot spot removal depths. Characterization of potential remediation waste was another objective of the PDI.

- **Pre-Dredging for Berth Maintenance.** Partial dredging actions will occur in Area C1 prior to the placement of a granular activated carbon (GAC)-amended treatment cap to allow the final surface of the cap to be finished below the 1989 dredging elevation, allowing for future maintenance dredging. The final elevation of the armored cap will be placed 24 inches below the 1989 dredging elevation. Removal will occur to -31.7 feet COP in Area C1, with allowance for overdredging and cap overplacement and a sufficient buffer for future maintenance dredging. The nearshore boundary of Area C1 will be dredged to a 3:1 side slope to prevent
sloughing along the seawall. Other side slopes will be cut to a 2:1 slope. Contaminated sediments will be disposed off site at a Subtitle D landfill.

- **Treatment Cap Placement.** In situ treatment caps will be applied in Areas C1 and E in the form of an amended 12-inch-thick isolation layer, plus a 6-inch overplacement allowance. It is anticipated that the isolation layers will be amended with 3% to 5% GAC by weight, depending on final design. The treatment cap will be finished with a 12-inch armor layer, plus a 6-inch overplacement allowance consisting of 3-inch to 4-inch rock to protect against river currents and propwash erosion. Pre-dredging will occur prior to cap placement in Area C1. Following hot spot dredging to remove surface product in Area E, most of this area will be sufficiently deep that the cap can be placed below the berthing depth with sufficient buffer and without the need for additional dredging for berth maintenance.

- **Treatment Cover Placement.** In situ treatment covers will be applied in Areas A and D in the form of an amended 12-inch-thick cover layer, plus a 6-inch overplacement allowance. It is anticipated that the cover layers will be amended with 3% to 5% GAC by weight, depending on final design. The treatment covers are in depositional areas exhibiting substantial recovery over time and will not be armored. Area A is in an area where breasting barges are used to offset U.S. Navy ships from the seawall and will therefore not require pre-dredging. Area D is in sufficiently deep water that pre-dredging will not be required.

- **MNR and EMNR.** Areas with sufficiently high sedimentation rates and weaker groundwater advection will be addressed using MNR (Areas B1 and F2) and EMNR (Areas B2, C3, and F1). EMNR covers are applied rather broadly to help address dredging residuals that may be associated with hot spot removal and pre-dredging actions.

- **Institutional Controls.** Institutional controls will be developed to protect the integrity of the remedy, including limits on the extent and depth of any future maintenance dredging actions, particularly limits on dredging adjacent to the seawall and below the 1989 dredge depth, designation of “no anchor” zones, and a prohibition on upland groundwater use.

- **Construction and Long-Term Monitoring.** Construction and long-term monitoring will be implemented to confirm that acceptable risk reduction has been achieved by the RA and conditions are continuing to improve over time through natural recovery. Capped areas will be monitored to ensure that the caps are functioning as intended, and contingency response procedures will be implemented if it is determined that a cap has been damaged or breached.

### 2.5 Design Adjustments Based on Pre-Design Investigation Results

The design adjustments made in response to PDI results are depicted in the differences between Figure 3a (2017 selected alternative) and Figure 3b (PDI-adjusted design). The design adjustments
resulted in some consolidation of SDUs and refinement of SDU boundaries and technology applications. The SDU adjustments are cross-referenced as follows:

<table>
<thead>
<tr>
<th>Selected Alternative</th>
<th>PDI-Adjusted Design</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>--</td>
<td>No Action</td>
<td>F2</td>
</tr>
<tr>
<td>A1</td>
<td>EMNR</td>
<td>F2</td>
</tr>
<tr>
<td>A2</td>
<td>GAC Cover</td>
<td>A</td>
</tr>
<tr>
<td>C1</td>
<td>Partial Dredge/</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td>GAC Cover</td>
<td></td>
</tr>
<tr>
<td>C2/D1</td>
<td>Partial Dredge/</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td>GAC Cap/Armor</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>GAC Cap/Armor</td>
<td>--/E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>GAC Cap/Armor</td>
<td>D/--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Hot Spot Dredge/</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>GAC Cap/Armor</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>EMNR</td>
<td>F1</td>
</tr>
<tr>
<td>--</td>
<td>No Action</td>
<td>G</td>
</tr>
</tbody>
</table>

Note:
--: not applicable

The primary design adjustments include the following:

- **Refinement and Expansion of Hot Spot Removal Areas.** The boundaries of Area E were refined based on PDI data, including sediment cores and diver surveys, a portion of former Area D2 was included, and a new hot spot removal area—Area G—was added based on sediment core PGM-41. The practicability and effectiveness of removing deeper potential hot spot material was evaluated before the final removal depths were established.

- **Expansion of Cap Armor Area.** Former Area C1, which consisted of in situ treatment with a GAC-amended cover, was converted to an armored GAC-amended cap, including attendant deeper dredging, to provide more robust erosion protection. Former Areas C1, C2, and D1 were then consolidated based on their common remedial technology of pre-dredging for berth maintenance followed by placement of an armored GAC-amended treatment cap.

- **Refinement of Offshore GAC Treatment Area.** The extent of former Areas D2 and D3 was reduced to the footprint of Area D because of the substantial amount of new PDI data below
levels of concern in this area. Specifically, PDI sediment cores PGM-30, PGM-31, PGM-32, PGM-33, PGM-36, and PGM-38 were all below site cleanup levels. The armored GAC-amended treatment cap was converted to a GAC-amended cover because of the substantially reduced footprint and evidence of ongoing deposition and natural recovery at this location.

- **Expansion of MNR Area.** Area F2 was added to formalize long-term monitoring over a broader area. Although all surface sediment samples from this area (including two cores and four surface grab samples) are below cleanup levels, some potential for sediment redistribution is evident, and precautionary monitoring is advised to ensure there is no degradation of sediment quality.

It should be noted that further design adjustments, including the extent, thickness, and composition of dredging, capping, and armoring elements, may occur during the remedial design process.
3 Project Roles, Responsibilities, and Qualifications

3.1 Project Team Organization
The key parties involved with the RA include the following:

- **Regulatory Oversight.** DEQ is the agency that will be overseeing the design and implementation of the RA.
- **Project Owner.** NW Natural is the respondent and project proponent for implementing the cleanup action.
- **Project Consultant.** Anchor QEA, LLC, is the engineering consultant responsible for preparing the design documents and supporting environmental plans.
- **Remediation Contractor.** Sevenson Environmental Services (SES) is the contractor that will be constructing the RA and assisting in the design.

A project organizational chart is shown in Figure 4.

3.2 Roles and Responsibilities of Key Personnel
The roles and responsibilities of key project personnel are as follows:

- **DEQ Project Manager.** DEQ is the regulatory authority and responsible agency for overseeing and authorizing the RA. In this capacity, DEQ reviews design documents, plans, and specifications to ensure that the project is implemented in a manner consistent with the ROD and the RAOs. The DEQ project manager is Dan Hafley, who will manage DEQ's review and approval of the design documents with the assistance of Heidi Nelson, the DEQ engineer.

- **Other Stakeholders.** Coordination with various permitting agencies will be required to authorize the proposed RA. A Rivers and Harbors Act (RHA) Section 10/Clean Water Act (CWA) Section 404 permit will be obtained from USACE, and the National Oceanic and Atmospheric Administration and U.S. Fish and Wildlife Service (USFWS) will be consulted to review the potential effects of the project on endangered species, critical habitat, and essential fish habitat. A CWA Section 401 Water Quality Certification will be obtained from DEQ. If more than 1 acre of uplands is disturbed, a construction stormwater permit 1200-C, or the substantive equivalent, will be obtained from DEQ. A Removal-Fill Permit, or the substantive equivalent, will be obtained from DSL, which will also issue a site-specific aquatic lease or easement for the remediation area. The Oregon Department of Fish and Wildlife will be consulted if a Scientific Taking Permit is needed for possible fish relocation. Finally, to document compliance with the City of Portland code and to obtain authorizations from DEQ and DSL, a Land Use Compatibility Statement will be obtained from the City of Portland. See Section 4.3 for additional discussion of anticipated project permitting requirements and agencies.
• **Bob Wyatt, RG, NW Natural – Respondent Project Manager.** Bob Wyatt is a registered geologist and director of the Legacy Environmental Program at NW Natural. Mr. Wyatt has more than 30 years of experience managing environmental cleanup sites, including the Gasco Early Action within the Portland Harbor Superfund Site. He has been with NW Natural for 17 years. He was also the designated program coordinator on the Administrative Settlement Agreement and Order on Consent for the Portland Harbor Superfund Site, and he chaired the Lower Willamette Group, which conducted an RI/FS for that project. Mr. Wyatt’s responsibilities will include the following:
  – Provide direction to the engineering design team and the remediation contractor.
  – Oversee the project budget, schedule, and project execution.
  – Coordinate NW Natural review of RD documents.
  – Administer the PGM Order.

• **Todd Thornburg, PhD, RG, Anchor QEA – Consultant Project Manager.** Todd Thornburg has been managing sediment cleanup projects for 27 years. He has been managing the PGM site for NW Natural since 2012, and it was under his management that the SI/SCE and FS Reports were prepared and approved and the ROD was issued. Dr. Thornburg’s responsibilities will include the following:
  – Serve as the primary point of contact with the DEQ project manager.
  – Manage the project budget and schedule and the timely delivery of required submittals.
  – Coordinate the design team, DEQ, NW Natural, and SES to implement the RD.
  – Prepare environmental plans to support RD/RA activities, including construction and long-term monitoring plans.
  – Coordinate project permits and regulatory approvals.

• **John Verduin, PE, Anchor QEA – Engineer of Record.** John Verduin is a nationally recognized dredging and capping engineer with almost 30 years of experience in the design of contaminated sediment removal and capping projects throughout the country. Mr. Verduin played a key role in the preparation of the Lower Willamette Group’s FS for the Portland Harbor Superfund Site. Mr. Verduin’s responsibilities will include the following:
  – Act as the engineer of record for remediation plans and specifications.
  – Develop a remediation approach in consultation with NW Natural and SES.
  – Oversee the preparation of RD documents.

• **Kendra Skellenger, PE, Anchor QEA – Project Engineer.** Kendra Skellenger has 13 years of experience designing a diverse range of environmental engineering projects. Ms. Skellenger’s recent projects include the McBride Slough RD, PGM and Gasco FSs, and Millennium Bulk Terminal redevelopment. Ms. Skellenger’s responsibilities will include the following:
  – Prepare project plans and specifications.
  – Prepare the engineer’s cost estimate.
  – Prepare a construction quality assurance plan.
- Review and incorporate constructability input from SES.

- **Mike Crystal, Sevenson Environmental Services – Vice President, Program Manager.**
  Mike Crystal is vice president of operations at SES and the program manager for the PGM cleanup project. Mike is a nationally recognized remediation contractor with 33 years of experience performing successful sediment remediation projects throughout the country, including the Gasco Early Action in Portland Harbor. Mr. Crystal will be supported at SES by **Paul Thomson, Senior Construction Manager; Michael J. Crystal, PE, Supporting Engineer;** and **Tim Donegan, PE, Senior Design Engineer.** The SES team’s responsibilities will include the following:
  - Provide constructability review of design documents.
  - Assist with scheduling and cost estimation of the construction work.
  - Perform laboratory treatability testing and develop sediment stabilization and elutriate water treatment methods and specifications.
  - Prepare the Contractor Health and Safety Plan (HASP).
4 Remedy Implementation

4.1 Design Criteria, Cleanup Levels, and Performance Criteria

4.1.1 Design Criteria

RD criteria will be developed to address the following design objectives:

- Establish the elevations, grades, and extents of dredging in the hot spot removal areas (Areas E and G) and in the areas requiring pre-dredging to maintain berth clearance (Area C1).
- Characterize remediation waste and determine appropriate disposal options.
- Determine sediment handling, transport, and disposal procedures.
- Establish the extent of activated carbon placement and the type of carbon, amendment concentration, thickness, and method of blending and application.
- Establish the physical specifications of the armor stone needed to protect the caps from erosion.
- Establish the extent of sand cover placement in EMNR areas.
- Establish the chemical and physical specifications of the sand cover import material to verify that the sand is below PGM cleanup levels and can be effectively managed during placement.
- Specify construction best management practices (BMPs) to protect human health and the environment during remedial construction and comply with the CWA Section 401 Water Quality Certification.
- Specify construction quality control procedures to verify that the remedy is constructed as designed.
- Develop long-term maintenance and monitoring plans to ensure that the remedy is functioning as intended, including consideration of future maintenance dredging needs, and that site risk is diminished, or diminishing, to acceptable levels.

Specific RD criteria will be presented at the preliminary design (50% design) meeting.

4.1.2 PGM Performance Criteria

Sediment, TZW, and surface water cleanup levels are listed in Table 1. These cleanup levels will serve as long-term performance criteria for remedy effectiveness.

Sediment Cleanup Levels. Sediment cleanup levels in the ROD are based on the following:

- Probable Effects Concentrations (PEC; MacDonald et al. 2000)
- DEQ Bioaccumulative Screening Level Values (BSLV; DEQ 2007)
- Ambient urban background concentrations in the PGM site vicinity
- State of Washington Sediment Quality Values (Avocet 2011)
Cleanup levels for benthic organisms (PEC and Sediment Quality Value) will be evaluated on a point-by-point basis, whereas cleanup levels for bioaccumulation-based criteria (BSLV) will be evaluated on a site-wide basis using surface-weighted average concentrations, which is consistent with the spatially averaged nature of bioaccumulation-based exposures. Surface sediment monitoring locations and procedures for calculating surface-weighted average concentrations for bioaccumulation-based criteria will be provided in the forthcoming Monitoring, Performance Evaluation, and Contingency Plan (MPECP).

**TZW and Surface Water Cleanup Levels.** TZW and surface water cleanup levels in the ROD are listed in Table 1 and are based on the following:

- Oregon DEQ Water Quality Criteria
- USEPA National Recommended Water Quality Criteria
- USEPA Final Chronic Values and Final Acute Values for PAHs (USEPA 2003)
- DEQ Level 2 Screening Level Values (SLVs; DEQ 2001)
- Oak Ridge National Laboratory Tier-2 Chronic Values (ORNL 1996)

Cleanup levels for aquatic life will be evaluated on a point-by-point basis in TZW and surface water. Cleanup levels for bioaccumulation-based criteria (the most conservative being human health/fish consumption criteria) will be evaluated on a site-wide basis using surface-weighted average concentrations in surface water, which is consistent with the spatially averaged nature of bioaccumulation-based exposures. TZW and surface water monitoring locations and procedures for calculating surface-weighted average concentrations for bioaccumulation-based criteria will be provided in the forthcoming MPECP.

**Hot Spot Criteria.** PGM hot spot criteria in the ROD are listed in Table 2 and described further in Section 4.3.2.2.

### 4.1.3 Comparison with Portland Harbor Cleanup Criteria

A comparison of Portland Harbor remedial action levels (RALs), cleanup levels, and principal threat waste (PTW) criteria is provided in Attachment E to the PGM ROD (DEQ 2017) and summarized as follows:

- **Remedial Action Levels.** The Portland Harbor RAL that is relevant for PGM is the RAL for total PAHs (13,000 micrograms per kilogram [µg/kg] in nearshore areas; 170,000 µg/kg in navigation channel). Although the nearshore RAL is lower than the PGM cleanup level of 22,800 µg/kg for total PAHs, the application of the Portland Harbor RAL would not change (i.e., expand) the PGM remediation footprint, mainly because PGM includes cleanup levels for both individual and total PAHs. The identification of in-water remedial action areas at PGM is always driven by individual PAHs because the cleanup levels for individual PAHs are
3 to 10 times more stringent than the cleanup level for total PAHs. Further, the PGM action area does not include shallow nearshore areas like those for which the Portland Harbor nearshore RAL is intended, and the direct human contact exposures that form the basis for that RAL are not present at the PGM site.

- **Cleanup Levels.** Sediment cleanup levels provided in the Portland Harbor ROD are in the same general range as the PGM ROD when adjusted for natural background concentrations or are otherwise captured within the PGM remediation footprint. Surface water cleanup levels are comparable or modestly lower for the Portland Harbor, the main difference being that many of the PGM cleanup levels are based on human fish consumption because drinking water is not a current or reasonably likely future beneficial use at the site. Groundwater cleanup levels in the Portland Harbor ROD are generally lower than TZW criteria at PGM because PGM TZW criteria are based on chronic aquatic life exposures rather than human health criteria, which are applied in near-bottom surface water where these exposures potentially occur at the site. A key difference between the sites is that cleanup levels will be met over a majority of the PGM site at the completion of the remedial action, and all remaining areas are expected to achieve cleanup levels within 7 years, whereas the cleanup levels in Portland Harbor are not expected to be met for at least 30 years.

- **Principal Threat Waste.** Portland Harbor PTW criteria for naphthalene and carcinogenic PAHs are the criteria that would be relevant for the PGM site. The ROD evaluation showed that all locations that would be classified as PTW under Portland Harbor criteria would also be classified as hot spots at PGM under state rule. Further, there are a number of locations where hot spots were identified, but PTW criteria were not exceeded. Thus, the use of hot spot criteria at PGM is consistent with and fully inclusive of PTW designation in Portland Harbor.

Based on this evaluation and in consideration of site-specific conditions, DEQ concluded that the PGM cleanup levels are consistent with and equally if not more protective as the Portland Harbor RALS, cleanup levels, and PTW criteria, and PGM will achieve site cleanup levels in a much more expedited timeframe (DEQ 2017).

### 4.2 Remedial Design/Remedial Action Tasks

The anticipated methods for constructing the selected cleanup action are described in this section. These methods are conceptual in nature, and process details may be revised or refined during the design process.

#### 4.2.1 Dredging

Mechanical dredging methods will be used to remove the hot spots in Areas E and G and to pre-dredge prior to placing caps in Area C1. It is currently anticipated that dredging will be performed using a long stick excavator staged on a spud barge and outfitted with a CableArm
environmental level-cut bucket. This bucket has the ability to rotate 360 degrees for optimal positioning. If debris in the river prevents the environmental bucket from closing or otherwise significantly interferes with its operations, a conventional digging bucket may be used.

SES is experienced in precision dredging methods to minimize the amount of overdredging and optimize the accuracy of the removal action. Precision dredging is accomplished using the positioning system developed by Hypack (Dredgepack), which uses a combination of inclinometers, software, and dual real-time kinetic GPS antennas for the dredge bucket location. This system allows the dredge operator to see the location of the bucket in real time relative to the mudline bathymetry, the target dredge prism, and previous cuts and to develop a digital terrain model of the removal area. The dredge plant will be supported by three or four 500-cubic-yard scows, two push boats, one tender tug, and one tug for maneuvering the loaded scows.

Water quality controls during dredging will likely include the use of an adjustable “moon pool” curtain surrounding the construction area. The length of the curtain can be adjusted to respond to changing tides or river conditions. Rigid containment is infeasible at the PGM site due to the excessive water depth and abundance of large debris on the river bed. Details of proposed water quality controls will be developed in the Pre-Final and Final RD Reports and included in the engineering drawings and specifications.

4.2.2 Debris Removal

Large debris in the remediation area may pose an impediment to dredging and capping operations. During seawall construction, a large pile of building debris was placed approximately 150 to 250 feet offshore, rising 5 to 10 feet above the surrounding riverbed (Section 2.1.1.2). The debris pile contains large sections of brick wall, concrete, lumber, and corrugated sheet metal that are several feet in dimension. Large debris is intermixed with tar-like material in the hot spot removal area (Area E), and larger objects may need to be removed to prepare the substrate for capping, particularly in Area C1.

Precision debris removal is currently expected to be accomplished using the same equipment used for dredging (long stick excavator staged on a spud barge) and positioning software (Dredgepack). The excavator will be fitted with a variety of attachments, including but not limited to an Anvil five-tine grapple, Bodine rake, and a conventional dredge bucket, as appropriate.

The debris targets will be programmed into the positioning system, and the spud barge will be shuttled into each position using a tug or push boat to remove the target objects. The removed debris will be placed on a deck barge with watertight coaming, then transferred to an off-site shoreline processing pad for sorting (location to be determined), given the lack of adjacent upland staging area (i.e., Waterfront Park). The sorting process will involve sizing and cutting/breaking
debris, staging for disposal, cleaning debris with sediment adhered to it, and separating out any ferric metals that can be recycled.

### 4.2.3 Sediment Dewatering, Transport, and Disposal

There are no upland staging or stockpiling areas at the PGM site due to its location adjacent to Waterfront Park. The tug will transport the loaded sediment scows to an off-site transfer facility at a location to be determined. If significant decant water is generated by the dredged material, it will either be pumped through a project-specific water treatment system and returned to the river or pumped to frac tanks for staging for off-site disposal.

Following decanting (if needed), reagent will be added to the wet sediment to reduce the moisture content and prepare the sediment for landfill disposal (i.e., to pass the paint filter test). The barge tonnage will be calculated based on the draft of the scow and used to determine the amount of reagent needed. Portland cement is anticipated to be used as the reagent, although bench-scale tests are being conducted during pre-design to determine the optimal reagent and mixing ratio for site sediments. The amendment process will occur either directly on the barge or in a mixing bin at the transfer facility. Blended sediment will be allowed to cure and then loaded into lined trucks or rail cars for final disposal.

Disposal fee negotiations will be conducted during RD, at which time a specific transfer facility and landfill will be identified for this project. Standard BMPs for sediment management, stockpiling, and transport will be implemented, including appropriate containment and dust suppression BMPs.

### 4.2.4 Placement of Caps, Covers, and Armor Stone

Equipment that comes into contact with contaminated sediment will be decontaminated before switching over to capping operations. Prior to shipping capping materials to the PGM site, representative samples of the material will be tested to verify the physical and chemical suitability of the material for use at the PGM site. Stockpiles of clean imported sand and armor stone will be maintained at an off-site upland staging area (location to be determined). GAC products will be stored in a dry location and covered. GAC and sand will be blended to the specified dry weight mix ratios using two mixing hoppers and a conveyor. Once blended, the material will be loaded onto a deck barge utilizing the same excavators that were used to stabilize sediment and/or offload debris.

Sand, GAC-amended sand, and armor stone will be placed using the same equipment package that is used for the dredging operations. The deck barge and tug will transfer the capping material to the PGM site and position the barge alongside the excavator. The operator will load the bucket with the appropriate material and make a short sweep with the bucket while it is partially open, approximately 1 foot above the water surface, to distribute the materials evenly on the river bed. The operator will
use the Dredgepack software to mark where each bucket of material is released and to track the progress of the capping operations.

### 4.2.5 Remedial Action Verification

Procedures for verification of RA activities will be specified in the Construction Quality Assurance and Control Plan (CQACP; Section 5.4). Verification components specified in the CQACP will include the following:

- Verification of sediment removal to the specified grades and elevations through bathymetric progress surveys
- Verification that import materials conform to the required physical and chemical specifications
- Confirmation of GAC amendment concentrations in blended material prior to applying this material on site
- Confirmation of the minimum placement thickness of sand, GAC-amended sand, and armor stone through bathymetric progress surveys or other suitable means; excessive placement thicknesses will also be monitored to prevent encroachment of the caps into the berthing area
- Confirmation of dredging elutriate quality to determine whether this water may be returned to the river following treatment or alternatively disposed off site
- Stockpile sampling of stabilized sediment for waste characterization, if needed (alternatively, testing data currently being collected as part of the PDI may be sufficient to determine its suitability for landfill disposal)

### 4.2.6 Long-Term Monitoring Program

A long-term monitoring program will be implemented to verify the effectiveness of the remedy and to demonstrate that RAOs are being attained. The details of this program will be specified in the MPECP (Section 5.5). In capping areas, the initial concentration at Year 0 (completion of construction) will be established based on analytical testing of the imported sand and gravel material prior to placement on site, as the cap material is expected to isolate the underlying sediments and fully replace the biological mixing zone. In MNR and EMNR areas, Year 0 concentrations will be sampled directly at the completion of remediation. Post-construction monitoring schedules, sampling locations, sampling and analytical methods, data interpretation methods, performance criteria, and contingency response options will be described in the MPECP.

### 4.3 Permitting and Regulatory Requirements

The anticipated permits and approvals that will be needed to implement the RA are discussed in this section and listed in Table 3.
4.3.1 Federal Approvals

This section summarizes the federal permits and approvals that must be obtained for the PGM RA.

4.3.1.1 U.S. Army Corps of Engineers Rivers and Harbors Act Section 10/Clean Water Act Section 404

USACE may issue a joint permit providing federal authorization for dredging and capping actions in a navigable waterway under its authority for both the RHA Section 10 and CWA Section 404. During the Section 10/404 review, a number of other federal permits and approvals may also be coordinated through this process and are included in this discussion.

Under Section 10 of the RHA, USACE regulates any potential obstruction of navigable waters of the United States related to construction of structures, facilities, and bridges or removal and placement of objects that would obstruct navigation. A review of the extent to which the PGM RA would affect navigability of the Willamette River in the vicinity of the PGM site would be subject to concurrence by USACE through issuance of a RHA Section 10 permit.

CWA Section 404 requires a permit for discharge of fill to waters of the United States. This requirement applies to the discharge of dredged or fill material (i.e., capping) into navigable waters at the PGM site, with the exception of incidental fallback associated with dredging (USEPA 2009). In Oregon, USACE is the designated lead on CWA Section 404 evaluations.

Under the CWA Section 404(b)(1) guidelines, efforts should be made to avoid, minimize, and mitigate adverse effects on the waters of the United States and, where possible, select a practicable and feasible alternative with the least adverse effects that achieve the project purpose and need. As part of Appendix D of the PGM FS (Anchor QEA 2016), a preliminary compensatory mitigation analysis was performed to support CWA Section 404(b)(1) and the DSL Removal Fill Alternatives Evaluation for Determination of Compensatory Mitigation Requirements (Section 4.3.2.3). This preliminary analysis was based on the mitigation evaluation framework developed in coordination with the natural resource agencies for the Portland Harbor. Based on the preliminary analysis, no compensatory mitigation should be required to implement the selected remedy. The habitat provided within the RA project area consists of deep-water habitat that is significantly impaired by the steep seawall structure and a lack of adjoining shallow water habitat and riparian buffer. The selected remedy will have no measurable long-term negative effect on the habitat functions at the PGM site and will result in a net positive effect due to improved substrate conditions provided by debris removal and contaminant remediation. Short-term impacts of the RA will be addressed through use of BMPs and conservation measures intended to protect water quality during construction.
4.3.1.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires that federal agencies consult with the National Marine Fisheries Service and USFWS to ensure that any action “authorized, funded, or carried out by such agency ... is not likely to jeopardize the continued existence of any threatened or endangered species” or result in adverse modification of species’ critical habitat (16 United States Code § 1536(a)(2)). Five species of listed salmonids are known to use the Lower Willamette River as a rearing and migration corridor. An additional eight listed salmon species are known to occur in the Lower Columbia River near the confluence with the Willamette River, and three other species of listed fish may occur. The final determination of species to be included for consideration in the Biological Assessment will be based upon the extent of the proposed action area for the project. The proposed action area is based on the farthest-reaching effects of the activity and may include the transit corridor for material proposed to be dredged from the project area and transported to an off-site disposal facility (such as a Subtitle D landfill facility).

Due to the presence of these listed species at and near the PGM site, ESA consultation is required as precursor to the RHA Section 10 permit authorization process. NW Natural will prepare a draft Biological Assessment compliant with Section 7 of the ESA as part of the RHA Section 10 permit package for the proposed remedial alternative.

In addition, the RA must be compliant with the Fish and Wildlife Coordination Act, the Bald and Golden Eagle Protection Act, and the Migratory Bird Treaty Act. The PGM site is located adjacent to an active downtown park near an intensively developed urban area, but bald eagles and other migratory birds are known to use the Lower Willamette River. Care must be taken to avoid actions that would result in “take” of protected species, which includes harassment and disturbance of these species.

4.3.1.3 Federal Emergency Management Act

Under the Federal Emergency Management Act (FEMA) federal flood insurance program, floodplain development requires that any action that encroaches on the floodways of United States waters (such as the proposed sediment RA) cannot cause an increase in the water surface elevation of the river during a 100-year flood event. FEMA authority is delegated to the local municipality—in this case, the City of Portland Bureau of Development Services. If the cut and fill volumes associated with the RA are balanced (e.g., dredging versus cap and cover placement), the City of Portland will likely conclude that there is no encroachment of the floodway. If there is an excess of fill material placed on the riverbed relative to the removal volume, the City of Portland may require a hydraulic analysis of the selected remedy during RD to determine compliance with this rule or a refinement of the remedy to cause no encroachment of the floodway.
4.3.1.4 National Historic Preservation Act Section 106

Section 106 of the National Historic Preservation Act requires federal agencies to consider effects of their undertakings on historic properties. Per USACE regulations at 33 Code of Federal Regulations (CFR) 325, Appendix C, USACE must conduct a Section 106 review as part of the RHA Section 10 and CWA Section 404 permit approval process. Historic properties may include any district, site, building, structure, or object included in or eligible for the National Register of Historic Places, including artifacts, records, and material remains related to such a property.

Because of the extensive disturbance to the river bottom at the PGM site, it is not likely that National Register of Historic Places-eligible historic properties will be affected by site remediation activities. However, USACE may require an assessment that establishes the project’s Area of Potential Effects. If so, information will be gathered to determine whether historic properties may lie within that area, and USACE would use the information to fulfill the Section 106 requirement to consult with the State Historic Preservation Officer and interested and affected Native American tribes.

4.3.2 State and Local Approvals

4.3.2.1 Clean Water Act Section 401 Water Quality Certification

DEQ is the delegated state authority for this certification process to ensure dredging, capping, and related construction activities do not adversely affect water quality. For projects that involve a discharge into navigable waters of the United States, CWA Section 401 requires that the applicant for federal permits obtain certification from the state (in this case, DEQ) that the action will comply with state water quality standards or federal standards promulgated in CWA Sections 301, 302, 303, 306, and 307. Although state permits are not required under DEQ’s cleanup rules, federal permits are required. Regardless, the selected remedy will comply with state water quality criteria and will include BMPs and conservation measures to ensure substantive compliance with water quality requirements under Section 401.

4.3.2.2 Oregon Hot Spot Rule

Under the State of Oregon’s Environmental Cleanup Law, Oregon “hot spots” are defined as hazardous substances that are present in high concentrations, are highly mobile or cannot be reliably contained and that would present a risk to human health or the environment in excess of acceptable hot spot risk levels if exposure to these materials were to occur [Oregon Revised Statute 465.315(2)(b) and OAR 340-122-115(32)]. Hot spots at the PGM site were defined in the FS (Anchor QEA 2016) and were more specifically delineated based on the pre-design sampling results (Anchor QEA 2018), considering the presence of surficial tar-like material and high concentrations of contaminants in surface sediments or TZW. PGM hot spot criteria are listed in Table 2.
4.3.2.3 Removal-Fill Permit
The State of Oregon owns the submerged lands of navigable waterways within the state. DSL is the responsible agency for managing waterways of the state (including wetlands) and issuing permits and authorizations regarding use and access to these waterways and submerged aquatic lands.

In accordance with the Oregon Removal-Fill Law, a Removal-Fill Permit is required to perform work in waters of the state, including the Willamette River. Because the Willamette River is designated as Essential Salmonid Habitat (DSL 2010), a permit is required for any amount of removal or fill, with no small-volume exemption. The substantive requirements of this state permit must be fulfilled to authorize dredging (removal) and capping (fill) actions in the Willamette River. The substantive requirements of this state permit may be considered achieved through the process of obtaining the USACE Section 10/CWA Section 404 permit along with the associated authorizations from USFWS, the National Marine Fisheries Service, and/or the Oregon Department of Fish and Wildlife; National Historic Preservation Act Section 106; and local agency consistency determinations.

DSL also manages the use of and access to state-owned aquatic lands, as described in Section 4.4.

4.3.2.4 City of Portland Zoning Requirements
For USACE permits, the applicant must provide documentation from local land use authorities that the proposed action is consistent with local land use codes. For this project, land use compliance will be evaluated against the City of Portland’s Greenway development standards. Changes to the land and structures in the water, including excavations and fills located within the City of Portland’s Greenway overlay zone, are subject to Greenway review. Substantive compliance with Greenway standards must be met for this state cleanup project. Greenway review is not required for dredging activities but may be required for capping or monitoring activities that impact the public use of the Willamette River, including recreational access, navigability, and fishing opportunities.

4.3.3 Other Regulatory Considerations
Off-site waste disposal will be conducted in accordance with federal and state solid waste management rules and regulations (40 CFR Parts 460 and 461; OAR 340-093 through OAR 340-097). Dredged material containing MGP residuals is not a characteristic hazardous waste because of toxicity (40 CFR 261.24(a); OAR 340-100-0002(1)). However, dredged material exhibiting the toxicity characteristic at the time of disposal will be disposed of as non-hazardous waste at a Subtitle C facility.

Given the relatively short duration of the construction activities (approximately 1 to 2 months) and the fact that the work will largely be performed in-water, where sediment will be wet and contaminants are not readily volatilized or dispersed, an Air Contaminant Discharge Permit is not expected to be required for this project.
4.3.4 Work Window Requirements

This project will be constructed during the in-water work window to minimize impacts to salmonids and other aquatic resources. The in-water work window for the Lower Willamette River extends from July 1 through October 31.

4.4 Site Access and Easements

The PGM site is located in waters owned by the State of Oregon. The Waterway Remediation and Restoration Rules, administered by DSL, allow for easements, leases, and access authorizations for various remediation and restoration-related uses of state-owned aquatic lands. Based on updated rules effective February 2014 (OAR 141-145-0000 et seq.), NW Natural and DSL will negotiate an agreement that will govern the use of state-owned submerged aquatic lands for the entire PGM remediation project. This agreement will likely take the form, at least in part, of an easement and will be required for MNR, EMNR, capping, dredging, and long-term maintenance and monitoring activities required by DEQ.

4.5 Supplemental Design Investigations

The supplemental design investigations are described in the draft *Pre-Design Investigation Data Report* (Anchor QEA 2018 [currently in revision]) and included the following:

- **Geotechnical Evaluation.** Five geotechnical borings were advanced in remedial dredging areas to evaluate the dredgeability of site sediments and the stability of dredging side slopes, especially along the inner dredge cut, closest to the seawall. The slope of the cap itself will be low or flat, ranging from 3-to-1 to virtually zero; therefore, a seismic analysis of the cap will not be necessary. The borings were characterized using standard penetration tests and analyzed for water content, grain size, specific gravity, and triaxial shear tests. In situ density will be calculated from these measurements, and the bulking of mechanically dredged sediments will be estimated using professional judgment. Sediment compressibility is not a major concern because sand and gravel will be placed over existing sand and gravel deposits at most locations, and cap elevations will be monitored during placement to verify thickness.

- **Elutriate Testing and Treatment Evaluation.** Elutriate tests were conducted on sediment from the hot spot removal area and analyzed for PGM COCs to estimate the quality of the decant water from the dredge barge. These results will be used to determine the type and level of treatment needed to return the elutriate water to the river, or alternatively, whether it is more cost-effective to dispose the water off site.

- **Sediment Stabilization Testing.** The stabilization of dredged sediments was evaluated using reagents at various dosages to determine the most effective recipe that will allow dredged sediment from the PGM site to pass the paint filter test and meet landfill disposal criteria for
strength and workability. The optimal combination of reagent, mix ratio, and cure time was evaluated.

- **Leachate Testing.** To assist in the profiling of dredged material for off-site disposal, toxicity characteristic leaching procedure (TCLP) tests were performed on sediment samples that have been amended and stabilized, as described in the previous design investigation task.

Please refer to the draft *Pre-Design Investigation Data Report* (Anchor QEA 2018 [currently in revision]) for more details on the objectives and results of these investigations.
5 Deliverables

5.1 Remedial Design Reports
The RD will include information necessary to implement the PGM RA as described in Section 2.4 and in the ROD. The RD will consist of a preliminary design meeting (at approximately 50% design), followed by pre-final design (90% design) and final design (100% design) documents. The deliverables for these design phases are described in Sections 5.1.1 through 5.1.3.

5.1.1 Preliminary Design Meeting
During the preliminary design phase (approximately 50% design), the basis of design for the major design elements will be developed and summarized in an oral presentation to DEQ. The objective of this presentation is to solicit input from DEQ on conceptual design elements, which will be incorporated into the later phases of design. The basis of design will include the following:

- Design objectives, criteria, and standards
- Description of design elements
  - Sediment removal: dredge prism surface, approximate dredge volumes, material handling requirements, transportation and disposal
  - Cap and cover placement: cap and cover thickness, GAC concentration, product type, armor stone specifications, material volumes, placement and delivery technology
  - Construction and long-term monitoring concepts: preliminary conceptual approach for construction and long-term monitoring
  - Anticipated water quality controls to be deployed during remedy implementation and other engineering controls as needed
- Preliminary drawings and schematics
- Preliminary construction schedule

5.1.2 Pre-Final Design Report
After incorporating input from DEQ following the preliminary design meeting, the Pre-Final Design Report will be prepared. This report will contain a compilation of major design items reflecting approximately 90% completion of the final design. The Pre-Final Design Report will include the following:

- Design objectives, criteria, and standards
- Design calculations and analyses
- Drawings and drawing index
- Specifications
- Construction schedule
- Detailed description of the RA activities
• Estimates of dredge and fill areas and volumes
• Permitting requirements
• Construction quality assurance/quality control program
• Proposed construction BMPs to minimize releases to the environment
• Land disposal and transportation requirements
• Site security measures

5.1.3 Final Remedial Design Report
The Final RD Report will incorporate DEQ’s review comments on the Pre-Final Design Report. The Final RD Report will include the elements described in Section 5.1.2 plus engineering drawings and specifications prepared at the 100% level of completion, a final schedule for permitting and construction, and copies of approved permits or completed permit applications, as applicable.

5.2 Sampling and Analysis Plan
The PGM Pre-Design Investigation Work Plan, approved by DEQ and dated August 31, 2017 (Anchor QEA 2017), serves as the Sampling and Analysis Plan for this project. Pre-design field data collection and laboratory analytical work were conducted in September and October of 2017, and results are presented in the draft Pre-Design Investigation Data Report (Anchor QEA 2018 [currently in revision]). Additional sampling needs to support RD work are not currently expected; therefore, an amendment to the Sampling and Analysis Plan is not anticipated at this time. The need for additional design-level sampling will be discussed with DEQ during the preliminary (50%) design meeting.

Sampling and analysis for waste characterization, including paint filter tests and TCLP tests, are being performed as part of the PDI and will be presented during the preliminary (50%) design meeting. Sampling and analysis requirements associated with remedy implementation, including verification of the quality of capping and armoring material sources, will be specified in the CQACP (Section 5.4).

5.3 Health and Safety Plan
A HASP will be prepared to address field activities associated with remedial construction work. The contractor will prepare a HASP to cover the construction work, and Anchor QEA will prepare a HASP to cover construction observation, sampling, and monitoring work. A draft HASP will be submitted to DEQ as an appendix to the pre-final (90%) design. After incorporating DEQ comments, a final HASP will be submitted as part of the final (100%) design.
5.4 Construction Quality Assurance and Control Plan

The CQACP will address site-specific components of the construction quality assurance program to ensure that the project will meet or exceed design criteria and conform to the requirements of the plans and specifications. The CQACP will address the following:

- Construction quality assurance objectives, quality control requirements, and performance standards
- Identification of responsibilities and authorities of organizations and key personnel involved in remedial construction
- Description of the construction quality assurance personnel’s qualifications
- Description of inspection activities, observations and tests to be conducted, schedule, and scope
- Procedures for scheduling and managing construction submittals
- Sample types, locations, testing frequency, acceptance criteria, and corrective measures if criteria are not met
- Documentation of inspections and sampling results
- Proposed schedule for submittal of inspection and sampling reports to DEQ

A draft CQACP will be submitted to DEQ as an appendix to the pre-final (90%) design. After incorporating DEQ comments, a final CQACP will be submitted as part of the final (100%) design.

5.5 Monitoring, Performance Evaluation, and Contingency Plan

The MPECP will describe long-term, post-construction monitoring of sediment, TZW, and surface water quality to evaluate the effectiveness of the RA in attaining the RAOs and the cleanup levels for sediment, TZW, and surface water (Table 1). It is anticipated that MPECP activities will begin with the collection of post-construction baseline sampling data and import material testing results to establish the initial conditions at the completion of the RA (Year 0). The plan will also propose a decision framework and response actions that will be triggered if the RA is not performing as expected. The MPECP will address the following:

- A description of all institutional controls associated with the in-water remedy, including restrictions on dredging, anchoring, or spudding
- Proposed frequency of monitoring (e.g., 5-year events)
- Proposed monitoring locations and parameters
- A description of sample collection techniques, sampling equipment, and sample handling procedures
- Descriptions of proposed analytical or test methods
• Quality assurance/quality control procedures for both field and laboratory activities, including specification of appropriate analytical reporting limits to inform long-term site management decisions
• Documentation and data reporting requirements, including a proposed schedule for data report submittals
• Data analysis methods for evaluating changes and trends in sediment or porewater quality over time and progress towards attainment of RAOs and site cleanup goals (Table 1)
• Proposed assessment criteria that would trigger an evaluation of contingency measures
• A contingency plan for evaluating and implementing potential response actions
• Assessment criteria for modifying the long-term monitoring program (e.g., increasing or decreasing monitoring frequency)
• Criteria for terminating the monitoring program
• Management of investigation-derived waste

A draft MPECP will be submitted to DEQ as an appendix to the pre-final (90%) design. After incorporating DEQ comments, a final MPECP will be submitted as part of the final (100%) design.

5.6 Project Completion Report
At the completion of remedial construction, a final inspection will be conducted, and a draft Project Completion Report (PCR) will be prepared. The PCR will address the following:

• Brief description of any issues discovered during the final inspection, if any, and how those issues were resolved
• Description of all work conducted and certification by an Oregon-registered professional engineer that the work was performed in accordance with the approved plans and specifications
• Explanation of any modifications to the approved plans and specifications and why such modifications were necessary
• Final as-built drawings, if different from final design drawings
• Copies of final permits, as applicable
• Results of verification sampling, including data validation

A draft PCR will be prepared and submitted to DEQ following remedy completion, as shown in Figure 5. A final PCR will then be submitted for approval after incorporating DEQ's comments on the draft report.
6  Project Schedule

Figure 5 outlines the proposed schedule for RD/RA activities and deliverables.
7 References


Tables
# Table 1
## Cleanup Levels

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Cleanup Level</th>
<th>Units</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benthic Criteria</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>128</td>
<td>mg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Mercury</td>
<td>1.06</td>
<td>mg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Zinc</td>
<td>459</td>
<td>mg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Total PAH[^3]</td>
<td>22,800</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Anthracene</td>
<td>845</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Fluorene</td>
<td>536</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>561</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>1,170</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>1,050</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>1,450</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Chrysene</td>
<td>1,290</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>2,230</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>Pyrene</td>
<td>1,520</td>
<td>µg/kg</td>
<td>PEC, MacDonald et al. 2000</td>
</tr>
<tr>
<td>TPH-diesel</td>
<td>340</td>
<td>mg/kg</td>
<td>WAC 173-204, Table VI</td>
</tr>
<tr>
<td>TPH-residual</td>
<td>3,600</td>
<td>mg/kg</td>
<td>WAC 173-204, Table VI</td>
</tr>
<tr>
<td><strong>Transition Zone Water[^5]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Cyanide</td>
<td>0.0052</td>
<td>mg/L</td>
<td>OAR 340-041, Table 30</td>
</tr>
<tr>
<td>Lead[^5]</td>
<td>0.54</td>
<td>µg/L</td>
<td>OAR 340-041, Table 30</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.012</td>
<td>µg/L</td>
<td>OAR 340-041, Table 30</td>
</tr>
<tr>
<td>Zinc[^5]</td>
<td>36</td>
<td>µg/L</td>
<td>OAR 340-041, Table 30</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>194</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>72</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>307</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>56</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Fluorene</td>
<td>39</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Anthracene</td>
<td>21</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>19</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Pyrene</td>
<td>10</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>7.1</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>2.2</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Chrysene</td>
<td>2.0</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.96</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>0.68</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>0.64</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(g,h,i)perylene</td>
<td>0.44</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>0.28</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>0.28</td>
<td>µg/L</td>
<td>USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzenes</td>
<td>130</td>
<td>µg/L</td>
<td>ORNL 1996 Tier II Value</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>7.3</td>
<td>µg/L</td>
<td>ORNL 1996 Tier II Value</td>
</tr>
<tr>
<td>Toluene</td>
<td>9.8</td>
<td>µg/L</td>
<td>ORNL 1996 Tier II Value</td>
</tr>
<tr>
<td>Xylenes</td>
<td>13</td>
<td>µg/L</td>
<td>ORNL 1996 Tier II Value</td>
</tr>
</tbody>
</table>

[^3]: TPH = Total Polynuclear Hydrocarbons

[^5]: WAC = Washington Administrative Code

[^6]: USEPA = United States Environmental Protection Agency

[^7]: ORNL = Oak Ridge National Laboratory
## Table 1
**Cleanup Levels**

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Cleanup Level¹</th>
<th>Units</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bioaccumulation Criteria (Site-Wide Mean and 90% UCL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sediment²,⁶</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>37,000</td>
<td>µg/kg</td>
<td>DEQ 2007</td>
</tr>
<tr>
<td>Pyrene</td>
<td>1,900</td>
<td>µg/kg</td>
<td>DEQ 2007</td>
</tr>
<tr>
<td><strong>Near-Bottom Surface Water⁷</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>1.4</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>210</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Toluene</td>
<td>1,500</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Chrysene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>0.0018</td>
<td>µg/L</td>
<td>OAR 340-041, Table 40</td>
</tr>
</tbody>
</table>

Notes:
1. Certain cleanup levels may need to be adjusted for regional or local background conditions.
2. Applicability of cleanup levels in the top foot of sediment is based on a determination that the substrate is stable and not subject to significant erosion from currents or propwash.
3. Cleanup levels include both total PAH and individual PAH criteria.
4. Cleanup levels for transition zone water are based on chronic ambient water quality criteria.
5. Lead and zinc water quality criteria are based on mean Willamette River hardness of 25 mg/L.
6. Surface sediment bioaccumulation criteria for PAHs are based on protection of fish, the most sensitive receptor group.
7. Surface water bioaccumulation criteria are based on protection of humans, the most sensitive receptor group, via fish consumption; the cleanup level is based on a fish ingestion rate of 175 g/day. Bioaccumulation criteria are only listed for those analytes that are more stringent than the corresponding benthic criteria.

µg/kg: microgram per kilogram  
µg/L: microgram per liter  
DEQ: Oregon Department of Environmental Quality  
g/day: gallon per day  
mg/kg: milligram per kilogram  
mg/L: milligram per liter  
OAR: Oregon Administrative Rules  
ORNL: Oak Ridge National Laboratory  
PAH: polycyclic aromatic hydrocarbon  
PFC: probable effects concentration  
TPH: total petroleum hydrocarbon  
UCL: upper confidence limit  
USEPA: U.S. Environmental Protection Agency  
WAC: Washington Administrative Code
## Table 2
### Hot Spot Criteria

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Hot Spot Criteria</th>
<th>Units</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Product Layer</td>
<td>N/A</td>
<td>N/A</td>
<td>DEQ 1998, Section 3.5</td>
</tr>
<tr>
<td>Total PAH[^2]</td>
<td>228,000</td>
<td>µg/kg</td>
<td>10x Probable Effects Concentration (see Benthic Criteria)</td>
</tr>
<tr>
<td><strong>Transition Zone Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td>1,940</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>720</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Acenaphthylene</td>
<td>3,070</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>560</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Fluorene</td>
<td>390</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Anthracene</td>
<td>210</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>190</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Pyrene</td>
<td>100</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>71</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>22</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Chrysene</td>
<td>20</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>9.6</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>6.8</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>6.4</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Benzo(g,h,i)perylene</td>
<td>4.4</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>2.8</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>2.8</td>
<td>µg/L</td>
<td>10x USEPA 2003 Final Chronic Value</td>
</tr>
</tbody>
</table>

Notes:
1. Surface sediments exceeding hot spot criteria are confirmed hot spots of contamination. Subsurface sediments exceeding hot spot criteria are potential hot spots that were further evaluated in the Portland Gas Manufacturing Feasibility Study (Anchor QEA 2016) to determine if they are “highly mobile” or “not reliably containable.”
2. Hot spots and potential hot spots of contamination are identified on the basis of individual hazardous substances under Oregon Administrative Rule [OAR 340-122-0115(32)(b)(A)(iii)]. DEQ and NW Natural have agreed to use total PAH concentrations to identify hot spots of contamination at the Portland Gas Manufacturing site.

[^2]: µg/kg: microgram per kilogram
µg/L: microgram per liter
DEQ: Oregon Department of Environmental Quality
N/A: not applicable
PAH: polycyclic aromatic hydrocarbon
USEPA: U.S. Environmental Protection Agency
### Table 3
Anticipated Construction Permitting Requirements

<table>
<thead>
<tr>
<th>Rule/Regulation</th>
<th>Agency</th>
<th>Permit/Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Water Act Section 404 Rivers and Harbors Act Section 10</td>
<td>USACE</td>
<td>Section 10/404 Permit for work in waters of the United States</td>
</tr>
<tr>
<td>Clean Water Act Section 401</td>
<td>DEQ¹</td>
<td>Water Quality Certification</td>
</tr>
<tr>
<td>OAR 141-085-0500 (Removal-Fill Rule)</td>
<td>DSL¹</td>
<td>Removal-Fill Permit</td>
</tr>
<tr>
<td>Endangered Species Act</td>
<td>NOAA</td>
<td>Biological Opinion</td>
</tr>
<tr>
<td>Magnuson-Stevens Act (Essential Fish Habitat)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Water Act Section 402</td>
<td>DEQ¹</td>
<td>NPDES Construction Stormwater Permit, if needed</td>
</tr>
<tr>
<td>Land Use Compatibility Statement</td>
<td>City of Portland¹</td>
<td>Consistency with City of Portland zoning and floodway management</td>
</tr>
<tr>
<td>OAR 635-007-0900</td>
<td>ODFW¹</td>
<td>Scientific Taking Permit, if needed</td>
</tr>
</tbody>
</table>

Notes:
1. State and local permits are not required for DEQ cleanup actions, but the substantive requirements of the applicable permits must be met.

DEQ: Oregon Department of Environmental Quality
DSL: Oregon Department of State Lands
NOAA: National Oceanic and Atmospheric Administration
NPDES: National Pollutant Discharge Elimination System
OAR: Oregon Administrative Rule
ODFW: Oregon Department of Fish and Wildlife
USACE: U.S. Army Corps of Engineers
Figures
NOTE: Bulk material treatability borings will be positioned based on observations made during the completion of the sediment chemistry and geotechnical borings.


VERTICAL DATUM: City of Portland Datum

NOTE: The existing and pre-design sample locations are indicated on the map. These locations include sediment core sampling, tar-like material sampling, city of Portland sanitary sewer utility locations, and sediment decision unit areas. The remedial design/remedial action work plan is referenced for the Former Portland Gas Manufacturing Site.
**NOTE:**

GAC = Granular Activated Carbon

**HORIZONTAL DATUM:** Oregon State Plane North, NAD83, Int. Feet.

**VERTICAL DATUM:** City of Portland Datum

**NOTE:** GAC = Granular Activated Carbon

**LEGEND:**

- PGM Sediment Core Location
- Historical Sediment Sampling Location
- Surface Tar-Like Material
- City of Portland Sanitary Sewer Utility
- Location of Facility (LOF)
- Sediment Decision Unit Areas

**REMEDIAL TECHNOLOGIES:**

- Monitored Natural Recovery (MNR)
- Enhanced MNR (EMNR)
- GAC-Amended Treatment Cover
- Partial Dredge and GAC-amended Treatment Cover
- Armored Treatment Cap
- Partial Dredge and Armored Treatment Cap
- Surface Product Removal with Armored Treatment Cap

**Figure 3a**

Selected Remedial Alternative

Remedial Design/Remedial Action Work Plan

Former Portland Gas Manufacturing Site
Updated Remedial Design Based on Pre-Design Investigation Results

Remedial Design/Remedial Action Work Plan
Former Portland Gas Manufacturing Site

NOTE: GAC = Granular Activated Carbon

VERTICAL DATUM: City of Portland Datum
NOTE: GAC = Granular Activated Carbon

LEGEND:
- PGM Sediment Core Location
- Historical Sediment Sampling Location
- Surface Tar-Like Material
- City of Portland Sanitary Sewer Utility
- Location of Facility (LOF)
- Sediment Decision Unit Areas

REMEDIAL TECHNOLOGIES:
- Monitored Natural Recovery (MNR)
- Enhanced MNR (EMNR)
- GAC-Amended Treatment Cover
- Partial Dredge and Armored Treatment Cap
- Surface Product Removal with Armored Treatment Cap
- Full Dredge

Figure 3b
Figure 4
Project Team Organizational Chart
Remedial Design/Remedial Action Work Plan
Former Portland Gas Manufacturing Site

Notes:
COP: City of Portland
DEQ: Department of Environmental Quality
NOAA: National Oceanic and Atmospheric Administration
ODFW: Oregon Department of Fish and Wildlife
ODSL: Oregon Department of State Lands
USACE: U.S. Army Corps of Engineers
USEPA: U.S. Environmental Protection Agency
### Project Schedule

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DEQ Staff Report and ROD</td>
<td>540 days</td>
<td>Fri 3/31/17</td>
<td>Fri 9/21/18</td>
</tr>
<tr>
<td>2</td>
<td>ROD Issuance</td>
<td>1 day</td>
<td>Fri 6/30/17</td>
<td>Fri 6/30/17</td>
</tr>
<tr>
<td>3</td>
<td>Amend Consent Order for Pre-Design Work</td>
<td>92 days</td>
<td>Fri 3/31/17</td>
<td>Fri 6/30/17</td>
</tr>
<tr>
<td>4</td>
<td>Consent Judgment (CJ) Negotiation for RD/RA Work</td>
<td>61 days</td>
<td>Thu 5/24/18</td>
<td>Mon 7/23/18</td>
</tr>
<tr>
<td>5</td>
<td>CJ Public Comment and Lodging</td>
<td>60 days</td>
<td>Tue 7/24/18</td>
<td>Fri 9/21/18</td>
</tr>
<tr>
<td>6</td>
<td>Design</td>
<td>358 days</td>
<td>Mon 1/1/18</td>
<td>Mon 1/21/19</td>
</tr>
<tr>
<td>7</td>
<td>Preliminary (50%) Design</td>
<td>135 days</td>
<td>Mon 1/29/18</td>
<td>Wed 6/12/18</td>
</tr>
<tr>
<td>8</td>
<td>Preliminary Design Meeting</td>
<td>0 days</td>
<td>Tue 6/12/18</td>
<td>Tue 6/12/18</td>
</tr>
<tr>
<td>9</td>
<td>DEQ Reviews and Comments Design</td>
<td>14 days</td>
<td>Wed 6/13/18</td>
<td>Wed 6/28/18</td>
</tr>
<tr>
<td>10</td>
<td>Pre-Final (90%) Preliminary Design Report*</td>
<td>101 days</td>
<td>Wed 6/27/18</td>
<td>Fri 10/5/18</td>
</tr>
<tr>
<td>11</td>
<td>DEQ Reviews and Comments on Pre-Final Design Report</td>
<td>45 days</td>
<td>Mon 10/8/18</td>
<td>Wed 11/21/18</td>
</tr>
<tr>
<td>12</td>
<td>Final Design</td>
<td>47 days</td>
<td>Thu 11/22/18</td>
<td>Mon 1/7/19</td>
</tr>
<tr>
<td>13</td>
<td>DEQ Approves Final Design Report</td>
<td>14 days</td>
<td>Tue 1/8/19</td>
<td>Mon 1/21/19</td>
</tr>
<tr>
<td>14</td>
<td>Permitting</td>
<td>458 days</td>
<td>Mon 1/1/18</td>
<td>Wed 4/3/19</td>
</tr>
<tr>
<td>15</td>
<td>DSL Access Negotiations</td>
<td>365 days</td>
<td>Mon 1/1/18</td>
<td>Mon 12/31/18</td>
</tr>
<tr>
<td>16</td>
<td>Early Outreach to Regulatory Agencies</td>
<td>19 days</td>
<td>Mon 5/14/18</td>
<td>Fri 6/1/18</td>
</tr>
<tr>
<td>17</td>
<td>Prepare JPA/BA</td>
<td>89 days</td>
<td>Mon 6/4/18</td>
<td>Fri 8/31/18</td>
</tr>
<tr>
<td>18</td>
<td>Agency Review</td>
<td>180 days</td>
<td>Mon 9/3/18</td>
<td>Fri 3/1/19</td>
</tr>
<tr>
<td>19</td>
<td>NMFS Issues BOP</td>
<td>1 day</td>
<td>Mon 3/4/19</td>
<td>Mon 3/4/19</td>
</tr>
<tr>
<td>20</td>
<td>USACE Finalizes Section 10/404 Permit</td>
<td>30 days</td>
<td>Tue 3/5/19</td>
<td>Wed 4/3/19</td>
</tr>
<tr>
<td>21</td>
<td>Section 10/404 Permit Issued</td>
<td>0 days</td>
<td>Wed 4/3/19</td>
<td>Wed 4/3/19</td>
</tr>
<tr>
<td>22</td>
<td>Construction and Monitoring</td>
<td>104 days</td>
<td>Mon 6/3/19</td>
<td>Sat 9/14/19</td>
</tr>
<tr>
<td>23</td>
<td>Mobilization</td>
<td>27 days</td>
<td>Mon 6/3/19</td>
<td>Sat 6/29/19</td>
</tr>
<tr>
<td>24</td>
<td>Remedial Action</td>
<td>62 days</td>
<td>Mon 7/1/19</td>
<td>Sat 8/11/19</td>
</tr>
<tr>
<td>25</td>
<td>Demobilization</td>
<td>13 days</td>
<td>Mon 9/2/19</td>
<td>Sat 9/14/19</td>
</tr>
<tr>
<td>26</td>
<td>Project Completion Report</td>
<td>151 days</td>
<td>Mon 9/2/19</td>
<td>Thu 1/30/20</td>
</tr>
<tr>
<td>27</td>
<td>Draft Project Completion Report</td>
<td>90 days</td>
<td>Mon 9/2/19</td>
<td>Sat 11/30/19</td>
</tr>
<tr>
<td>28</td>
<td>DEQ Review Draft Project Completion Report</td>
<td>30 days</td>
<td>Mon 12/2/19</td>
<td>Tue 12/31/19</td>
</tr>
<tr>
<td>29</td>
<td>Final Project Completion Report</td>
<td>30 days</td>
<td>Wed 1/1/20</td>
<td>Thu 1/30/20</td>
</tr>
</tbody>
</table>

Note: Pre-Final Design Report will include Health and Safety Plan; Construction Quality Assurance and Control Plan; and Monitoring, Performance Evaluation, and Contingency Plan.

Figure 5

Remedial Design/Remedial Action Work Plan
Former Portland Gas Manufacturing Site