Source Control Evaluation in Support of No Further Action Source Control Decision, Revised

Northwest Pipe Company
12005 North Burgard Road
Portland, Oregon 97203
ECSI No. 138

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Prepared by

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Executive Summary

This Source Control Evaluation (SCE) was prepared by Jacobs Engineering Group Inc. on behalf of Northwest Pipe Company for the facility located at 12005 North Burgard Road in Portland, Oregon (the Site). Northwest Pipe Company has conducted investigations, stormwater management measures, best management practices (BMPs), and source control measures at the Site since it began operations at the Portland facility in the early 1980s. The purpose of this SCE is to analyze and present existing site information sufficiently to support decision making with respect to the Oregon Department of Environmental Quality's (DEQ's) Hazardous Substance Remedial Action rules. This SCE was performed consistent with DEQ's *Guidance for Evaluating the Stormwater Pathway at Upland Sites* (DEQ, 2010a), specifically the Appendix C Template for a~~–~~ Stormwater Source Control Evaluation Report. Because groundwater is also included in this report, some modifications necessarily have been made to the Appendix C ~~T~~template sections.

This SCE is presented in conjunction with a companion report, *Remedial Investigation in Support of Site-wide No Further Action Determination* (RI). Surface soil, subsurface soil, and groundwater are characterized in both reports. Stormwater and offsite sediment are characterized in this report. The applicable pathways for the Site have been identified as stormwater discharge to surface water and groundwater discharge to surface water. The objective of this SCE is to demonstrate that existing and potential sources of contamination in stormwater and groundwater have been controlled, and that no additional characterization or source control measures are needed. In the case of groundwater, the U.S. Environmental Protection Agency ~~(EPA)~~ and DEQ have directed Northwest Pipe Company to develop a work plan for implementing a Monitored Natural Attenuation (MNA) remedy for shallow groundwater containing volatile organic compounds ~~(VOCs)~~ in the Southeast Area of the Site. The purpose of MNA is to confirm that groundwater conditions are, and remain, protective of human health and the environment. The MNA Work Plan will submitted to DEQ following submittal of the~~is~~ RI and this~~/~~ SCE.

This report presents the fourth version of the SCE, first submitted in 2005, conducted under the 2004 *Voluntary Agreement for Remedial Investigation and Source Control Evaluation* (RI/SCE Agreement) (DEQ agreement LQDVC-NWR-04-01). The Voluntary RI/SCE Agreement was a follow-on to an Expanded Preliminary Assessment ~~(XPA)~~ (DEQ, 2000), which, in turn, was based on ~~remedial investigations~~RIs conducted by Northwest Pipe Company under DEQ oversight since 1988 (DEQ, 1988). Protracted regulatory review periods, changes in regulatory team members, changes in the regulator's findings regarding the Site, ~~and~~ updates to guidance documents, and increasingly stringent data screening values ~~have~~ led to ~~the last three~~ versions of the SCE submitted in 2014, 2015, and~~,~~ now, this version.

Despite the updates to the document and the additional investigations triggered by these factors, the conclusions of the SCE remain the same. Based on the findings of the RI/SCE program, the Northwest Pipe Company Site does not pose an unacceptable risk to human or ecological receptors as defined by Oregon Administrative Rules 340-122-0115. Moreover, on the basis of source control actions, ~~best management practice (~~BMP~~)~~ implementation, and operation of stormwater treatment systems, the Site does not pose a recontamination risk to the Willamette River. Northwest Pipe Company requests that DEQ issue a Source Control Determination of No Further Action for stormwater and groundwater, consistent with the requirements contained in the Oregon Hazardous Substance Remedial Action Rules and associated statutes.

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Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
µmol/L	micromole(s) per liter
AOPC	Area of Potential Concern
AST	above-ground storage tank
BES	Bureau of Environmental Services
bgs	below ground surface
BMP	best management practice
CB	catch basin
CEM	conceptual site exposure model
CH2M	CH2M HILL Engineers, Inc.
cis-1,2-DCE	cis-1,2-dichloroethene
CMMP	Contaminated Media Management Plan
COI	contaminant of interest
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CUL	Clean Up Level
DCE	dichloroethene
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
DPT	direct-push technology
DS	downspout
EPA	U.S. Environmental Protection Agency
Fe2+	ferric iron
Fe3+	ferrous iron
ft/ft	foot per foot
GP	Geoprobe
gpm	gallons per minute
GW	groundwater
HSCS	hot spot confirmation sample
IDZ	isolated drainage zone
IRM	Iinterim Rremedial Mmeasure
IT	International Terminals
Jacobs	Jacobs Engineering Group Inc.
JSCS	Joint Source Control Strategy

K_{ow}	octanol-water partition coefficient
LWG	Lower Willamette Group
mg/kg	milligrams(s) per kilogram
mg/L	milligram(s) per liter
MNA	monitored natural attenuation
mV	millivolt(s)
MW	monitoring well
NPDES	National Pollutant Discharge Elimination System
ORP	oxidation-reduction potential
OSC	Oregon Shipbuilding Corporation
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAO	remedial action objective
RBC	risk-based concentration
RI	Remedial Investigation
ROD	Record of Decision
SCE	Source Control Evaluation
SCM	source control measure
Site	Northwest Pipe Company Site, 12005 North Burgard Road, Portland, Oregon
SLV	Sscreening Llevel Vvalue
SP	sample port
SS	soil surface
StormwateRx	StormwateRx LLC
SW	surface water
SWPCP	Stormwater Pollution Control Plan
TCE	trichloroethene
TOC	total organic carbon
TP	test pit
TPH	total petroleum hydrocarbons
TSS	total suspended solids
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
XPA	Expanded Preliminary Assessment

1. Introduction

1.1 Purpose

This report presents the results of a Source Control Evaluation (SCE) for the Northwest Pipe Company Site, located at 12005 North Burgard Road, Portland, Oregon (Site). In response to a request[1] by the Oregon Department of Environmental Quality (DEQ), this SCE was performed consistent with DEQ's *Guidance for Evaluating the Stormwater Pathway at Upland Sites* (DEQ, 2010a) to identify, evaluate, and control sources of contamination that may reach the Willamette River.

1.2 Source Control Objective

The source control objective is to identify, evaluate, and, if necessary, recommend control strategies for sources of contamination that may reach the Willamette River in concentrations that exceed Portland Harbor cleanup values. Because the applicable pathways for the Site have been identified in Section 5 ~~of this report~~ as stormwater discharge to surface water and groundwater discharge to surface water, the objective of this SCE is to demonstrate that existing and potential sources of contamination in stormwater and groundwater have been controlled, and that no additional characterization or source control measures (SCMs) are needed. In the case of groundwater, the additional objective is to demonstrate that no further action is required by continuing to evaluate the control with a monitored natural attenuation (MNA) remedy for volatile organic compounds (VOCs) in shallow groundwater located in the Southeast Area of the Site.

1.3 Regulatory Framework

This SCE was completed pursuant to a *Voluntary Agreement for Remedial Investigation and Source Control Evaluation* (DEQ agreement LQDVC-NWR-04-01) (RI/SCE Agreement) consistent with relevant regulations, as well as DEQ's *Guidance for Evaluating the Stormwater Pathway at Upland Sites* (DEQ, 2010a). The RI/SCE Agreement was a follow-on to an Expanded Preliminary Assessment (XPA) (~~DEQ~~CH2M~~,~~ 2000), which in turn, was based on remedial investigations (RIs) conducted by Northwest Pipe Company under DEQ oversight since 1988 (DEQ, 1988).

In response to the pending listing of the Portland Harbor as a Superfund site in December 2000, DEQ requested that Northwest Pipe Company, among a number of other companies, prepare an XPA as part of the Department's efforts to identify potential sources of contamination to the Willamette River. Northwest Pipe Company complied with DEQ's request for an XPA pursuant to a Letter Agreement dated July 14, 2000. After the Portland Harbor Superfund Site was listed on the National Priorities List, DEQ began developing a standardized approach to source control site assessments in the Harbor. In 2004, Northwest Pipe Company and DEQ executed the RI/SCE Agreement.

This report presents the results of the SCE conducted under the 2004 agreement, ~~as well as~~and describes an Interim Remedial Measure (IRM) that was completed, with DEQ approval, in 2012. The results of the RI also are being provided as a companion report.

The Site's stormwater discharge is authorized by DEQ under a National Pollutant Discharge Elimination System (NPDES) permit, and the Site has operated under an NPDES permit since Northwest Pipe Company began operations. The current permit is managed under the City of Portland's Bureau of Environmental Services (BES) Industrial Stormwater Program. The Site maintains compliance with its stormwater permit using a state-of-the-art stormwater treatment technology, which constitutes an important part of the overall source control for stormwater at the Site.

[1] These DEQ "requests" gave companies an opportunity to conduct their own assessments rather than paying for assessments that DEQ would conduct without the companies' consent, including potential penalties.

1.4 Report Organization

This document reflects the SCE for both the stormwater and groundwater pathways. This report follows DEQ's *Appendix C: Template for a Stormwater Source Control Evaluation Report* found in DEQ's *Guidance for Evaluating the Stormwater Pathway at Upland Sites* (DEQ, 2010a) and incorporates groundwater SCE elements. RI and SCE data collected at the Site are included in this report at the request of DEQ. Surface and subsurface soil data are included in Section 3.1 and general groundwater data for the Site are included in Section 3.1.3 to help identify potential contaminants of interest at the Site. Data specific to the Southeast Area are included in the groundwater pathway discussion in Section 5.2 and the human and ecological risk screening evaluation in Section 7.2. Stormwater, roof runoff, and catch basin solids data are presented in support of the stormwater pathway discussion in Sections 5.1 and 7.1.

Northwest Pipe has been investigating environmental conditions under DEQ oversight beginning in 1988. Since Northwest Pipe began working on the Portland Harbor source control effort, screening level values (SLVs) have been updated several times, DEQ Project Managers assigned to the Site have changed, and additional sampling data have become available (such as Lower Willamette Group [LWG] samples, Port of Portland samples, pre-remedial design samples, and others).

The 2005, 2014, and 2015 RI and /SCE reports (CH2M HILL, 2005b, 2014, and 2015) combined the RI reporting elements with the SCE reporting elements. This report contains the SCE elements, and the RI elements are presented separately in a companion document. Organization of the SCE report is as follows:

- **Section 1, Introduction:** The introduction presents the purpose, objectives, and an overview of the regulatory framework.
- **Section 2, Site Background:** The background section details the Site location, the history of ownership, activities at the property, and facility operations. The stormwater system, regulatory permits, determinations, and previous investigations are described in this section.
- **Section 3, Potential Sources and Contaminants of Interest:** This section identifies potential current and historical contaminant sources, reviews Site soil and groundwater data, summarizes readily available information on sediment data near the communal stormwater discharge point Outfall 18 (shared with other industrial parties in the area) discharging to the International Terminals (IT) Slip, and presents the contaminants of interest (COIs) associated with the Site.
- **Section 4, Past and Ongoing Stormwater Management Measures:** Given the long history of stormwater management measures conducted for the Site, this section provides a description of the improvements and best management practices (BMPs) implemented through 2008.
- **Section 5, Data Collection and Interpretation:** This section presents data for the stormwater pathway and the groundwater discharge to surface water pathway. Stormwater data, roof runoff data, catch basin solids data, and groundwater data are assessed.
- **Section 6, Stormwater Source Control Measures:** Improvements to the stormwater system, BMPs associated with Site operations, and Site remediation actions completed from 2009 through 2012 are described in this section.
- **Section 7, Source Control Evaluation:** This section presents a summary of stormwater data indicating the stormwater pathway is controlled, a human health and ecological risk screening evaluation for surface water indicating the groundwater to surface water pathway is controlled, and other lines of evidence supporting the Source Control Decision.
- **Section 8, Findings and Conclusions and Recommendations:** This section summarizes presents the findings and the conclusions of the SCE and the recommendation for a No Further Action Source Control Decision for stormwater and groundwater, relying on an upcoming MNA remedial action Work Plan for VOCs in shallow groundwater in the Southeast Area.
- **Section 9, References**: This section presents a list of documents used in preparing this SCE Report.

Tables and figures are located at the end of this document, following Section 9. Appendixes follow the tables and figures and are provided electronically.

2. Site Background

This section includes a description of the physical features of the site, the stormwater conveyance system, site ownership and operating history, regulatory history, and previous investigations.

2.1 Site Description

The Site is located in the area generally referred to as the Burgard Industrial Park, in the northern part of Portland, Oregon (Figure 2-1). The term “Burgard Industrial Park” refers to a collection of industrial parcels located east and south the Schnitzer IT Slip and includes the Northwest Pipe Site. The Burgard Industrial Park ~~is comprised~~consists of seven parcels that share the 12005 North Burgard Road street address. The Northwest Pipe site measures approximately 1,013 feet long and 777 feet wide and is located approximately 1,500 feet from the eastern bank of the Willamette River. The Site borders no surface water body and is situated between and east of two manmade slips: the Port of Portland Terminal 4 ~~(T4)~~ Slip 1 and the IT Slip, which is privately owned by Schnitzer Investment Corp (now known as MMGL Corp.) and Schnitzer Steel Industries.

Encompassing 29.15 acres of flat terrain, the Site includes property owned by Northwest Pipe (25.96 acres split into a 25.29-acre manufacturing area and a 0.67-acre office area), as well as a small (3.19-acre) parcel owned by, and leased from, Felton Properties, Inc. of Portland, Oregon, located at the southern border of the Northwest Pipe Company property. The remainder of Burgard Industrial Park surrounds the Site. Land use surrounding the Site is zoned by the City of Portland Bureau of Planning as “IHi,” an abbreviation for heavy industrial/river industrial (City of Portland~~,~~ 2014) and includes such processes as ship breaking, metal sorting, vehicle shredding, shipping, sand blasting, metal fabrication, and manufacturing.

The Site includes an administrative office, the Main Production Buildings (Bays 1 through 6 in the large building and Bay 9 in a smaller building), the pipe coating and lining operations, a general storage area for supplies, a cement mortar coating operation, and the flammable materials storage building. The ground surface of the Site is covered either by buildings or asphalt pavement. The interior floors of buildings are predominantly concrete, with some areas of asphalt. A facility map is shown on Figure 2-2.

As shown on an 1897 U.S. Geological Survey (USGS) map of the area (USGS~~,~~ 1897), the Site was a former marsh and alluvial floodplain of the Willamette River before its development in 1941 (Figure 2-3). Gatton Creek was located to the east of the Site and flowed south to the area now occupied by Terminal 4 Slip 1. As part of the Oregon Shipbuilding Corporation’s (OSC’s) shipyard development, the marsh was filled with dredge material to raise the elevation of the area to facilitate industrial development. The Linnton, Oregon USGS 7.5-minute topographic map indicates the topography of the Site is relatively flat (USGS~~,~~ 1961). Surface elevations range from 30 to 35 feet above mean sea level with elevations in the northern part of the Site slightly lower than in the southern part. The Site is paved and is developed for industrial purposes.

Based on inference from boring logs across the Site, the Site is underlain by a shallow silty sand dredged material fill interval placed during original site development in the early 1940s. This fill is underlain by native silt historically deposited in side channels of the Willamette River, likely the former surface of the floodplain that existed prior to filling and site development. The thickness of the native silt may exceed 100 feet based on Oregon Water Resources Department logs of water wells (CH2M~~ HILL,~~ 2005b). The depth to groundwater in the shallow aquifer is shallower in the central part of the site. A groundwater divide in the shallow aquifer occurs between the two slips located north and south of the Site, with groundwater occurring deeper on the north and south borders of the Site.

Underground utilities on or near the Site include stormwater, sewer, and water lines. Utilities were installed to support shipyard activities and have been modified and updated since then. A comparison between Site stormwater drain lines and groundwater levels determined that drain lines are relatively shallow in the southern portion of the Site (approximately 1 to 2 feet below ground surface [bgs]) and are deeper as they proceed to the north (approximately 4 to 5 feet bgs at the northern end of the Site)

(CH2M HILL, 2015). As discussed in Section 5, shallow groundwater, including seasonally high levels, occurs at greater depths than the Site drain lines. Therefore, the drain lines do not provide a preferential pathway for groundwater to reach the Willamette River. Consistent with this finding, dry weather flow in stormwater drains has not been observed at the Site.

A municipal gravity sanitary sewer line crosses the northern portion of the Site and is situated approximately 20 feet bgs, again below the shallow groundwater. This line is sloped to drain eastward, away from the Willamette River and toward a lift station that pumps sewage to the Columbia Boulevard Wastewater Treatment Plant. The underground utility lines that have been exposed to date are situated in the fine sand and silty sand fill material that occurs from below site pavement to a depth of 28 feet bgs. No crushed gravel or other pipe bedding material has been encountered around the underground utilities. Consequently, coarse bedding material that could provide a preferential pathway for flow is absent at the Site.

2.2 Stormwater Conveyance System

The current configuration of the stormwater conveyance system has been evaluated through observations in the field, drain line video logging results, facility personnel site knowledge, and historical maps, figures, and City of Portland plumbing records. This section describes the current understanding of the Site's operating stormwater conveyance system.

Northwest Pipe Company's stormwater system consists of roof downspouts and catch basins that drain into a network of stormwater conveyance lines, which in turn flow to the north/northeast before leaving the Site via two discharge lines along the northern Site boundary (Figure 2-4). These two lines discharge into a single communal stormwater line that subsequently discharges into the IT Slip through a single outfall commonly referred to as Outfall 18 (also known by LWG Outfall designation WR-123) located over one-third mile (approximately 1,960 feet) from the mouth of the slip. The majority of the subsurface portion of the Site's stormwater system was constructed during initial site development as part of a shipyard in the early 1940s, with modifications as needed to support changes in Site use since that time.

The IT Slip is on the eastern bank of the Willamette River approximately 4 miles upstream of the confluence of the Willamette and Columbia rivers. This slip was constructed by the OSC in 1941 and used during World War II in the construction of Liberty Ships, Victory Ships, and troop transports that were manufactured in the adjacent (off the present-day Site) shipways. The activities carried out in the IT Slip during World War II included machinery work, system testing, welding, electrical work, finish coats of paint, and other final touches before commissioning the ships for duty. Based on historical aerial photographs taken after the war, the IT Slip was used for various purposes including to store log rafts awaiting transport to local sawmills. Sometime between 1966 and 1968, old ships were docked in the slip as well as the log rafts. Sometime in the early 1970s, log rafts were no longer stored in the slip. The old ships that were in the slip were cut up in the slip for recycling as scrap metal. A 1998 aerial photograph shows a barge partially dragged out of the water by bulldozers at the head of the slip being dismantled in the general vicinity of Outfall 18. The practice of dismantling ships was observed in the IT Slip as recently as July 2008.

Figure 2-4 depicts the Site drainage and includes directional stormwater runoff patterns of the Site, identifies three isolated drainage zones (IDZ), and shows the approximate locations of local drainage divides. These three IDZs are described as follows:

- Stormwater in IDZ 1 drains through a water recycling system designed to capture and recycle stormwater falling within the cement mortar plant area and wash water used in the mortar lining process. This system consists of a series of settling basins that is used to settle out solids and reduce the turbidity of water captured in this area for re-use. These basins discharge into a series of tanks that hold the captured water until it is needed for production. This system was put in place to reduce the potential for discharge of stormwater that has come into contact with cement mortar operations.

- IDZ 2 is a covered storage area with containment berms for cement mortar rebound staged for offsite removal. Rebound is the portion of the material that bounces from the pipe when applying cement mortar to spinning pipe. Any stormwater that inadvertently blows in during a rain event evaporates.

- Stormwater that falls in the refueling area, referred to as IDZ 3, is captured and flows through an oil/water separator before being discharged to the sanitary sewer.

The Site's catch basins consist of a combination of flow-through basins and Lynch-style basins. The flow-through basins have an inlet pipe that conveys water into the basin and an outlet pipe with an invert slightly above the bottom of the catch basin to allow suspended solids to settle out of the stormwater. The Lynch-style basins have a settling sump in which stormwater collects until it reaches the invert elevation of the outlet pipe, which allows the stormwater to exit the catch basin and flow into one of the main stormwater conveyance lines. The Lynch-style catch basins are located generally in the northeastern portion of the Site where the stormwater conveyance line is more than 3 or 4 feet bgs. All catch basins have a replaceable fabric filter and oil absorbent sock installed to further reduce sediment loading of the stormwater. Facility personnel regularly inspect and maintain the filters and filter socks to confirm they remain functional and effective for their intended purpose. The underground storm drain pipe lines throughout the Site are predominately corrugated galvanized steel, and connect to some shorter lengths of larger concrete pipes just before merging with the communal system offsite. Northwest Pipe Company has installed some shorter lengths of polyvinyl chloride drain lines during maintenance and upgrading activities. In January 2012, Northwest Pipe Company installed a stormwater treatment system on the two lines conveying stormwater offsite. Further details regarding this system are provided in Section 6 Stormwater Source Control Measures.

Surface runoff from offsite areas along the southern and southeastern fence line has been observed to flow into Northwest Pipe Company's stormwater system and deposit eroded offsite material on the Northwest Pipe Company property (Figure 2-5). Most of this surface flow originates from the access road to the neighboring metal recycling facility. Scrap metal haulers delivering material to this neighboring facility use this roadway. Uncovered dumpsters and trailers containing a variety of scrap metals are routinely staged or parked along the sides of this roadway. Other onsite surface flow originates from a historical railroad line that is elevated relative to the rest of the Site. This railroad line runs along the southern and western boundary of the Site but is only above the facility's ground level on the southern side.

Northwest Pipe Company experienced unusual flooding along the railroad spur just east of the Site between 2009 and 2011 (Figure 2-5). This flooding occurred throughout the winter and spring of these years and ended in 2011. After observing conditions in the area, Northwest Pipe Company staff determined that the flooding occurred because of changes to drainage patterns at the Northwest Container Corporation property, and due to construction activity on North Burgard Road by the City of Portland's Department of Transportation and the BES to the east and upgradient of the Site. The area of flooding previously drained onto the Site by sheet flow and would discharge into the Site's stormwater catch basins. The City of Portland has since completed construction activities, which eliminated most of the flooding conditions. The Site's border with this area has also been re-graded and paved to prevent most of this run-on under typical rainfall conditions except for some run-on that still occurs on occasion through the main gate area of the Site. Northwest Pipe Company may elect to further raise the grade at the main gate area to more effectively eliminate run-on in this area.

2.3 Site Ownership and Operating History

The Site comprises two owned parcels and one leased parcel where operations occur, making up 29.15 acres. For purposes of discussing ownership and operations, the 25.29-acre manufacturing area is identified as Parcel A, the 3.19-acre parcel leased by Northwest Pipe Company is identified as Parcel B, and the 0.67-acre office area is identified as Parcel C. Table 2-1 presents a summary of ownership and operations organized by Parcels A, B, and C shown on an inset map in Table 2-1. Aerial photography shows the Site was undeveloped before World War II. Based on a review of the title chain for the two parcels now owned by Northwest Pipe Company (Parcels A and C, Table 2-1), the property owners during the pre-World War II era included the City of Portland and the William Gatton Estate Company, a corporation that managed the former William Gatton donation land claim (circa 1926 to 1941). As part of the leadup to World War II, OSC (one of three Kaiser shipyards in the Portland-Vancouver area) leased, and then purchased, several parcels in the area now known as the Burgard Industrial Park, from 1941 through 1949. Other property owners in the area included the United States government and the City of Portland (Table 2-1).

Beall Pipe and Tank Company (which operated as a division or subsidiary of L.B. Foster Company), purchased the two properties (Parcels A and C, Table 2-1) in 1950. Multnomah Land and Equipment acquired the properties in 1982, which is when Northwest Pipe and Casing Company (now Northwest Pipe Company) leased the properties and began operations. Northwest Pipe Company purchased the two parcels in 1997.

The historical ownership of the third parcel (Parcel B, Table 2-1) is less certain. Review of the available ownership records shows it was owned by the City of Portland and the William Gatton Estate Company in the pre-World War II era (1926 through 1941), and that OSCS leased and then purchased this property during the World War II era. From 1972 through 2006, Schnitzer owned the property, and from 2006 until present the parcel is owned by 12005 Burgard Equities LLC.

2.3.1 Historical Operations

Property currently owned and leased by Northwest Pipe Company has been used for industrial activities since its development by the OSC (one of the Kaiser shipyards) in 1941. Under contract to the federal government and at its direction, OSC constructed and operated a shipyard on the Site that produced more than 450 Liberty ships, Victory ships, and troop transports as part of the war effort. Sections of the ships were constructed in a large building composed of 11 manufacturing bays, some of which were subsequently damaged by fire and removed. Remaining portions of the footprint of this once-larger building are occupied by the present-day Bays 1 through 6 and Bay 9. The fabricated ship components then were moved to the shipways located to the west along the Willamette River and assembled to create ships. The known activities that occurred on the property now owned by Northwest Pipe Company consisted of cutting/drilling sheet steel, forming sheet steel, welding, and riveting (OSC, 1945). Following the war, a portion of the Site was used as a grain warehouse. Activities on other parts of the Site during this time are not known. The warehouse was substantially destroyed by fire in 1961 and rebuilt prior to Northwest Pipe Company's ownership. From 1950 through 1982, Beall Pipe and Tank Company used the Site to manufacture steel pipe and tanker trucks as well as to clean and repair used tanker trucks.

2.3.2 Current Site Operations

Northwest Pipe Company began operations at the Site in 1982 under a lease and acquired the Site in 1997. Northwest Pipe Company manufactures steel pipe at the Site that is used for a variety of municipal, industrial, and utility applications, primarily potable water transmission. Steel pipe is manufactured using the submerged arc welding process. The Site is a "job shop" in which operations are run based on the orders placed by customers. The Site conducts operations as needed to fill specific orders. Not all equipment or operations discussed in this section run continuously.

Northwest Pipe Company operates three spiral weld mills to produce welded steel pipe ranging in size from 17-inch outside diameter through 144-inch outside diameter. The submerged arc welding process produces little to no welding fumes, and welding is predominantly conducted indoors. If requested by the customer, the Site can produce pipe with coatings and linings (specifically, cement mortar, polyethylene tape, polyurethane, and specialty paints).

Figure 2-6 presents the specific locations of industrial activities throughout the Site. Pipe is welded and cut in Bays 1 through 5. The X-ray area, quality control laboratory, and shipping and receiving area are adjacent to Bay 1. Pipe fittings such as elbows, tees, manifolds, reducers, and manholes are fabricated in Bay 3. Abrasive blasting prior to taping or coating occurs in the Lining and Coating Building, western end of Bay 6, and within the Sand Blast Room in Bay 9. The Maintenance Shop is located adjacent to Bay 6. Pipe fittings that require a cement lining are treated in the mortar spraying area just northwest of Bay 9. A hydro-test facility is located in western end of Bay 9. Dumpsters that contain scrap materials and refuse are stored under cover in the Bay 9 Annex.

Cement mortar lining and coating occurs at the Cement Plant near the northwestern corner of the Site. The Cement Curing Bays are located north of the Cement Plant at the northern edge of the property. Paint and other coatings are applied in the Lining and Coating Building, Bay 6, and Bay 9. Paint is stored in a contained area under cover in the flammable materials storage building near the eastern property line. Gasoline and diesel fuel are stored in two aboveground storage tanks (ASTs) with secondary containment. An office building containing offices, restrooms, and a meeting room is east of Bay 3. The remainder of the Site is used for storing finished pipe and for shipping access by rail and truck. Northwest Pipe Company decommissioned the underground storage tanks (USTs) found onsite in the early 1990s with DEQ oversight, has conducted extensive site investigations and cleanup, and has made improvements to the existing facilities at the property throughout its tenure at the Site.

The 0.67-acre office area parcel has no history of industrial use and is therefore not included in the investigation portion of this report.

2.4 Regulatory History

This section summarizes permits held by Northwest Pipe Company and regulatory determinations.

2.4.1 Permits

Northwest Pipe Company has operated under and maintained general compliance with required permits since February 1982 when operations on the Site began. Northwest Pipe Company currently operates under stormwater, air, and hazardous waste generator permits. Because of the nature of the Site's operations (for example, hazardous waste is stored for less than 90 days inside and under roof), only the stormwater permit is relevant to the source control evaluationSCE. From 1993 through 1996, before the issuance of the 1200-Z permits, the Site discharged stormwater through a 1200-H permit (Permit 10043). From the beginning of Site operations through 2001, the facility also discharged non-contact cooling water through a GEN01 100-J NPDES permit issued by DEQ (Permit 10044). Production changes occurred that eliminated the cooling water discharge in 2001. The Site also operated under a 1200-C permit (Permit 27413) during construction activities for the IRM (capping with pavement the remaining non-paved areas of the Site, pavement maintenance activities, and hot spot removal) from July 2011 through June 2012.

Currently, the Site's stormwater discharge is authorized by DEQ under a general NPDES, 1200-Z permit (File 6739), re-issued on October 22, 2018. The Site has operated under a 1200-Z permit since 1997. The permit is managed under the City of Portland's BES Industrial Stormwater Program. This permit requires monitoring for copper, lead, zinc, pH, total suspended solids (TSS), oil and grease, iron, aluminum, cadmium, nickel, mercury, aldrin, chlordane, cyanide, dieldrin, hexachlorobenzene, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), pentachlorophenol, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (acenaphthene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene and pyrene).

Currently, the Site's stormwater discharge system operates under NPDES monitoring waivers, which remove the requirement to conduct compliance sampling. The Site has received waivers for sampling locations and parameters as stormwater quality discharged from the Site has continually improved (Appendix A). Northwest Pipe Company received monitoring waivers from the City of Portland in 2014, 2018, and 2019 for the 1200-Z general stormwater discharge permit. In September 2014, a monitoring waiver was granted for all parameters at both monitoring points for the remainder of the permit term. In September 2018, a monitoring waiver was approved for both sample points for pH, TSS, oil and grease, copper, lead, zinc, iron, and aluminum for the remainder of the permit term. In July 2019, a monitoring waiver was approved for the remaining constituents at two sample points for the remaining permit term. Northwest Pipe Company voluntarily conducts performance sampling for benchmark metals (copper, lead, zinc, iron, and aluminum) at the outlet of the stormwater treatment system filters twice each year to confirm that the filters function properly.

2.5 Previous Investigations

In 1989, a Phase I and Phase II Environmental Site Assessment was conducted for Northwest Pipe Company (Dames & Moore, 1989). This work was conducted to identify environmental concerns associated with the property prior to the planned property acquisition, which occurred in 1997, and was under a voluntary agreement with DEQ. Northwest Pipe Company completed an XPA (CH2M HILL, 2000) under a second voluntary cleanup letter agreement with DEQ dated July 14, 2000 (DEQ, 2000).

In response to the pending listing of the Portland Harbor as a Superfund site in December 2000, DEQ requested that Northwest Pipe Company prepare an XPA as part of the Department's efforts to identify potential sources of contamination to the Willamette River. As site investigation work progressed, and subsequent to submitting the XPA report and its addendum (CH2M HILL, 2000 and 2001a), a Voluntary Agreement for Remedial Investigation and Source Control was signed between Northwest Pipe and DEQ, effective December 30, 2004 (DEQ, 2004). The Site characterization and remediation/source control work conducted by Northwest Pipe Company between 2001 and late 2006 focused, with DEQ's concurrence, primarily on 8 of 14 areas of potential interest originally identified in Dames & Moore (1989).

A Draft RI/SCE Report was submitted in December 2005 to DEQ (CH2M HILL, 2005a). Following submittal of the 2005 RI/SCE report, the Joint Source Control Strategy (JSCS) guidance, including updated SLVs, was finalized in December 2005 (DEQ and EPA, 2005). Northwest Pipe Company collected surface soil and catch basin solids samples in 2006 as part of the Site's source control evaluation SCE and a more extensive soil and groundwater investigation was performed in 2007. JSCS SLVs were again updated in July 2007.

In a letter dated June 20, 2008, DEQ presented its comments on the 2005 RI/SCE report (CH2M 2005b). Later in 2008, DEQ requested a work plan to address its comments. A Supplemental RI Work Plan was prepared (CH2M HILL, 2009a) that described enhanced investigations for surface soil, groundwater, and stormwater. Through discussions with DEQ, the work plan became a series of five plans focused on surface soil, roof runoff, an expanded risk assessment, stormwater infrastructure, and a final stormwater source control evaluationSCE.

Based on the results of surface soil sampling in 2010, two soil hot spots were identified in surface soil with constituents, primarily benzo(a)pyrene, exceeding DEQ risk-based concentrations (RBCs). The two hot spots were identified at the following locations: (1) in a narrow strip of soil north of the Lining and Coating Building, and (2) in soil that had sloughed onto the pavement on the leased portion of the Site from offsite. The offsite source is raised ground along a railroad spur and the access road to Schnitzer Steel, which form the southern boundary of the leased portion of the Site. At the time of the hot spot remediation work, the then-current hot spot values did not indicate any other areas of the Site where hot spot level concentrations were present. The hot spot values were updated to be more stringent in 2018, and applied retroactively at the time of this report, would indicate six other 2010 sample locations that would exceed RBCs for benzo(a)pyrene and five locations that would exceed total PCB hot spot concentrations. The areas of these exceedances have since been fully capped with pavement as part of a DEQ-approved IRM, eliminating the potential exposure pathway.

DEQ approved the *Surface Soil Risk Screening and Focused Feasibility Study for Interim Action* (CH2M HILL, 2010b) and issued notice to proceed with the IRM of soil capping and removal (DEQ, 2010b). During hot spot removal in the area north of the Lining and Coating Building, workers discovered an area of stained soil in the shallow subsurface at a depth of approximately 1 foot below grade. Excavation continued at this location until groundwater was encountered at a depth of about 8 feet. Samples collected from the sidewalls of the deeper excavation at approximately 5.5 feet bgs confirmed detectable concentrations of PAHs and the PCB Aroclor-1254. Additional soil and groundwater sampling were conducted in the area under DEQ oversight. A natural attenuation evaluation for PAHs in groundwater showed a predicted migration distance of 100 feet until PAHs degrade below 0.001 milligram per liter (mg/L) under conservative assumptions; this distance is more than 1,900 feet from the Willamette

River (CH2M HILL, 2013). Based on this evaluation, the reported concentrations of PAHs in soil and groundwater do not pose an excess risk to potential receptors, including to the Willamette River. Based on these results and evaluation findings, no further groundwater sampling or analysis associated with the stained soil remediation area was requested by DEQ.

The final SCE stormwater sampling was completed in 2012 through 2013, consistent with the DEQ-approved work plan. The sampling included two samples collected from each of the stormwater treatment system sample points (Sample Points 3 and 4[2]) for four storm events. Following the completion of these activities, the RI/SCE report was updated in January 2014 (CH2M HILL 2014), comments were received from DEQ and addressed in the reissued version of the report in March 2015 (CH2M HILL 2015). Following the receipt of the March 2015 RI/SCE, DEQ and the U.S. Environmental Protection Agency (EPA) required additional investigation into VOCs in groundwater in the Southeast Area at the Site.

Data indicate an area of elevated VOC concentrations in the shallow groundwater at the Southeast Area. Sampling work for groundwater in the Southeast Area began in 2001 and continues through the present (CH2M HILL, 2001b, 2002, 2003a, 2004a, 2004b, 2017, and 2019;, and Jacobs, 2019). VOCs are the constituents of interest COIs in this area, primarily the VOC tetrachloroethene (PCE) and its breakdown products trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride. VOCs are confined to the shallow aquifer and groundwater flow in this area is toward Terminal 4 Slip 1 on the Port of Portland property south of the Site; therefore, current monitoring includes several wells on the Port of Portland property. DEQ, EPA, and Northwest Pipe Company have discussed implementing an MNA remedy for groundwater in the Southeast Area, and, at the request of the agencies, At the direction of DEQ and EPA, Northwest Pipe Company is developing an MNA wWork pPlan for the shallow groundwater remedy in this area.

In response to DEQ comments, this report contains the SCE elements of the RI/SCE, and the RI elements are presented separately in a companion document. Furthermore, as requested by DEQ, all RI and SCE data collected at the Site are included in this report and screened against the most applicable Portland Harbor Record of Decision (ROD) Clean Uup Level (CUL) concentrations. Where ROD CULs were not available, the most applicable JSCS SLVs were used for screening Site data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a).

[2] The NPDES sample locations were renamed from Sample Point 3 (SP-003) and Sample Point 4 (SP-004) to SP-001 and SP-002, respectively, in November 2017 at BESBureau of Environmental Services request.

3. Potential Sources and, Contaminants of Interest

This section identifies the COIs based on current and historical contaminant sources, site history, previous environmental investigations, and outfall sediment data.

3.1 Potential Contaminant Sources

The Site has a nearly 80-year history of heavy industrial use beginning as part of a World War II shipyard and transitioning into a steel water transmission pipe manufacturing facility. The potential contaminant sources at the Site include the following:

- High intensity ship manufacturing during WWII, prior to the modern era of waste management regulation or use of best practices for waste materials management and stormwater quality protection
- Historical use of the Site for grain storage
- Environmental effects (such as formation of combustion byproducts, including PAHs) from the 1961 fire at the Site
- Historical use of the Site for new tanker truck manufacturing and used tanker truck cleaning prior to the modern era of waste management regulation or environmental permitting that emerged in the 1980s
- Historical use of the Site for materials and used oil storage, a practice that has evolved over time from being virtually unregulated, except for fire protection purposes, to being highly regulated under, for example, the Resource Conservation and Recovery Act and municipal stormwater regulations
- Historical heavy manufacturing operations, which, as noted above, have become more highly regulated over time in response to modern waste management regulations and permitting requirements, thereby reducing over time the potential for causing environmental contamination
- Shipbreaking and metal scrapping activities on adjacent properties, which could lead to contaminant loading onto the Site from deposition of fugitive dust emissions and off the site both from stormwater discharge to the IT Slip as well as over-water industrial activities in the slip

While the Site currently is used for heavy industry and stores certain materials under roof (such as used oil and flammable materials), current regulations, materials handling and storage, and industrial processes reduce and minimize the potential for environmental contamination. The greatest potential contributors to Site contamination are legacy Site uses such as the shipyard activities in the 1940s. Other potential contaminant sources at the Site, many of which have been controlled by site improvements or removal, include exposed soil, galvanized roofing material, downspout piping, settled solids in the stormwater conveyance system, and groundwater containing VOCs, although monitoring data indicate that VOCs in groundwater degrade below ROD cleanup values before reaching surface water (see Section 7.2.1.5).

Areas of soil and groundwater investigations have been focused on eight of the 14 investigation areas, or areas of concern, identified in the 1989 Dames & Moore Phase I and Phase II Property Transfer Assessment (also known as an Environmental Site Assessment) (Figure 3-1) (Dames & Moore 1989). Following further investigations and removal actions described in Table 3-1, DEQ issued a letter of no further action for the removal of the 2,000-gallon AST, 1,000-gallon UST, and associated removal and disposal of 300 cubic yards of contaminated soil (DEQ, 1990). Data and location maps for soil and groundwater samples collected between 1988 and 1990 during initial site investigations are presented in Appendix B.

In 2001 through 2019, additional general site and focused investigations were conducted. Sections 3.1.1 and through 3.1.23 present soil and groundwater data compared to the Portland Harbor ROD Clean Up Levels (CULs) presented in Table 17 of the ROD (EPA, 2017). This information is intended to summarize contamination detected in soil and groundwater at the Site and provide a basis for identification of the COIs associated with the Site.

3.1.1 Characterization of Surface Soil

Surface soil sampling was conducted in 2001, 2005, 2006, 2007, and 2009 to characterize unpaved areas at the site (Figure 3-2). Soil was characterized in the following investigations:

- In 2001, surface soil samples were collected from three locations (soil surface [SS] SS-1, SS-2, and Geoprobe [GP] GP-5).
- In 2005, surface soil samples were collected from the transformer area (Area 11 shown in Figure 3-1) to investigate whether PCBs were present in surface soil above generic PCB industrial RBCs. Four randomly located surface soil samples (SS-101 through SS-104) were collected from 0 to 0.5 foot below the bottom of compacted gravel and analyzed for PCBs.
- In 2006, 19 surface soil samples (SS-1 through SS-19) were collected from areas of exposed soil across the Site. All samples were analyzed for zinc and a subset of samples was analyzed for PAHs, PCBs, and diesel-range total petroleum hydrocarbons (TPH).
- In 2007, 21 surface soil samples (SS-301 through SS-321)(SS301 through SS321) were collected from 0 to 6 inches in depth from areas of exposed soil across the Site. All soil samples were analyzed for diesel-range TPH, and a subset of 14 samples was analyzed for PAHs and PCBs.
- The most recent collection event for surface soil occurred in 2009 and included 11 samples (SS-401 through SS-411) collected at a depth of 0 to 6 inches from various points located across the Site. Samples were analyzed for inorganic constituents (arsenic, selenium, and specific metals) and organic constituents (phthalates, PCBs, pesticides, and total organic carbon [TOC]). A subset of samples was analyzed for PAHs.

Data from this work are screened and presented in Table 3-2. Although the Site does not border the Willamette River, data associated with these sampling events were screened conservatively against river bank soil and river sediment ROD CULs for remedial action objectives (RAOs) 1 and 5 (Table 17 from EPA, 2017) at DEQ's request. Where ROD CULs were not available, JSCS SLVs for Upland Soil and Stormwater Sediment were used for screening Site soil data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). If the constituent concentrations were found to exceed any of the selected ROD CULs or JSCS SLVs, an exceedance factor was calculated and is reported beside the constituent concentrations in Tables 3-2 in italics. DEQ guidance (2010a) requests the analysis include a description of the magnitude of exceedance of the ROD CULs or JSCS SLVs; furthermore, Jim Orr of DEQ requested the magnitude of exceedance be grouped in the following categories: less than 10, 10, 100, or 1,000 times the screening value (DEQ, 2017). Based on this direction, exceedance factors less than 10 are shown as "<10" in the tables and discussed in the corresponding text in this report. Sample locations are shown on Figure 3-2, analytical laboratory reports are included in Appendix C, and data validation reports are included in Appendix D.

Inorganic constituent results are available for samples collected in 2006 (zinc only, 19 samples) and 2009 (11 samples). Two out of 19 samples (SS-10 and SS-13) from 2006 exceed the ROD CUL for zinc at less than 10 times the screening value. Exceedances of CULs or SLVs for the 2009 data included arsenic, cadmium, chromium, mercury, nickel, selenium, and zinc. Most inorganic constituent exceedances are less than 10 times the screening values. Of the samples, 2 of 11 measured concentrations of arsenic exceeded the regional background for soil in the Portland Basin of 8.8 milligrams per kilogram (mg/kg) (DEQ, 2013b). Areas of exceedances were ultimately capped during the IRM.

PAHs were analyzed in 29 of the 58 total samples. ROD CULs are only available for total PAHs, not individual PAHs, which were calculated for each sample by summing the detected individual PAHs. Total PAHs at 10 locations exceeded the ROD CUL for total PAHs. The locations with the greatest exceedance factors were subject to removal efforts during an IRM conducted in 2011 and 2012. Remaining soil at the site has exceedance factors of less than 10 times the ROD CUL and ultimately was capped during the IRM.

PCBs were measured for 32 of the 58 total samples. Only PCB Aroclors 1254 and 1260 have been detected at the Site, with Aroclor 1254 detected in 31 surface soil samples and Aroclor--1260 detected 10 surface soil samples. Of the 31 surface soil sample locations with Aroclor--1254 detections, 22 locations have concentrations of Aroclor--1254 exceeding the JSCS SLV of 300 micrograms per kilogram (µg/kg). All but five of the locations with exceedances are less than 10 times the JSCS SLV (SS-2, SS-13, SS-306, SS-307, and SS-409). Six locations for Aroclor--1260 exceeded the JSCS SLV of 200 µg/kg. ROD CULs are only available for total PCBs, which were calculated for each sample by summing the detected PCBs. All but one sample location exceeded the ROD CUL of 9 µg/kg for total PCBs.

Heavier Aroclors (1254 and above) constitute the majority of PCB Aroclors associated with naval ship materials, primarily in paint, electrical cable, insulation materials, and rubber (Larcom et al., 1996). Fiedler (2009) notes that, in the United States, PCB Aroclors 1260 and 1254 were used more commonly than other Aroclors prior to 1950. Aroclor 1242 was the dominant mixture of PCB congeners used in the 1950s and 1960s, until it was phased out in 1971 and replaced with Aroclor 1016. The detection of only PCB Aroclors 1254 and 1260 at the Site and the absence of other Aroclors, would be consistent with a conclusion that the PCBs detected at the site originated from releases that occurred prior to 1950. Most likely, given known site history, PCBs would have come to be present at the Site during the OSC's period of intense wartime manufacturing activity as the Site was predominantly an idle, surplus United States property during the period immediately following WWII (Table 2-1). All areas of PCB exceedances ultimately were capped during the IRM.

Organochlorine pesticides were analyzed in 11 surface soil samples in 2009. One constituent, alpha-BHC, was identified in one sample (SS-409) exceeding the method detection limit but less than the laboratory reporting limit at one sample location. The laboratory estimated its concentration as very low at 6.78 µg/kg. Concentrations at this low level may be attributable to air deposition of fugitive dust, such as dust from traffic on the access road to Schnitzer Steel lying south of the Northwest Pipe Company property, or from the 2008 demolition of several large grain silos formerly located across the access road from this location on Port of Portland property. The location with the detected constituent (SS-409) was ultimately capped during the IRM.

Phthalate esters were analyzed in 11 surface soil samples in 2009. Only bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, and di-n-butyl phthalate were detected. Bis(2-ethylhexyl) phthalate and di-n-butyl phthalate exceeded ROD CULs. Even though the method blanks associated with these samples did not contain phthalate esters exceeding laboratory reporting limits, EPA recognizes phthalate ester plasticizers and bis(2-ethylhexyl) phthalate specifically (the most widely reported phthalate in these samples) as common laboratory contaminants due to their presence in flexible plastic tubing used in some laboratory analytical equipment (EPA, 2008). Because the Site has a long history of steel fabrication processes and does not use phthalate plasticizers in that process, the detection of low concentrations of certain phthalate esters is likely associated with laboratory contamination. All areas of exceedances were ultimately capped.

Gasoline-range and motor-oil range TPH was measured in 3 samples while diesel-range TPH was measured in 31 samples. Eleven of the 31 samples analyzed for diesel-range TPH exceeded the ROD CUL of 91 mg/kg. All exceedances are less than 10 times the ROD CUL. All areas of exceedances were ultimately capped.

VOCs were analyzed in one surface soil sample (GP-5). No constituents were detected.

3.1.2 Characterization of Subsurface Soil

Sitewide subsurface soil sampling was conducted in 2001, 2002, 2007, and 2008, totaling 44 samples. An IRM was conducted in 2011 and 2012, which included the excavation and removal of two discrete isolated areas of contaminated soil. Confirmation sampling was conducted in 2011 and additional sampling was conducted in 2012 because of the discovery of stained soil during the IRM actions, which led DEQ to require a follow-up investigation.

- In 2001, a total of four subsurface soil samples were collected from three locations (GP-1, GP-2, and GP-5) ranging from 3 to 18 feet bgs.

- In 2002, subsurface soil samples were collected to further investigate VOC presence in the Southeast Area. Three samples were collected from two locations (groundwater [GW] ~~GW-~~03 and GW-05) ranging from 2.5 to 13.5 feet bgs.
- In 2007, 14 subsurface soil samples (GP-201 through GP-214) were collected from 8 to 10 feet bgs across the Site to better characterize general subsurface soil conditions. Each sample was collected just above the water table. All 2007 soil samples were analyzed for TPH, and a subset of samples was analyzed for PAHs, VOCs, PCBs, and zinc.
- In January 2008, soil samples were collected from three test pits (test pit [TP]-101, TP-102, and TP-103) from depths between 1 foot and 3 feet bgs. Samples were analyzed for total zinc, PAHs, and PCBs.
- In 2011, confirmation soil samples were collected from the soil excavation area as part of the IRM (hot spot confirmation sample [HSCS]-1 through HSCS-10). Ten samples were collected from 1.5 to 5.5 feet bgs. Samples were analyzed for PAHs and PCBs.
- In 2012, seven subsurface soil samples (GP-301 through GP-307) were collected during the follow-up stained soil investigation. Sample~~s~~ depths ranged from 7 to 14 feet bgs and were analyzed for TOC, metals, PAHs, PCBs, TPH, and volatile and extractable petroleum hydrocarbons.

Data are screened and presented in Table 3-3. Although the Northwest Pipe site does not border the Willamette River, data associated with these sampling events were conservatively screened against ROD CULs for river bank soil and sediment for RAOs 1 and 5 (Table 17 from EPA~~,~~ 2017) as requested by DEQ~~,~~ and are presented in Table 3-3. Where ROD CULs were not available, JSCS SLVs for Upland Soil and Stormwater Sediment were used for screening site soil data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). DEQ guidance (2010a) requests the analysis include a description of the magnitude of exceedance of the ROD CULs or JSCS SLVs, and, furthermore, Jim Orr of DEQ requested the magnitude of exceedance be grouped in the following categories less than 10, 10, 100, or 1,000 times the screening value (DEQ~~,~~ 2017). Boring and test pit locations are shown on Figure 3-3 and IRM confirmation soil sampling and stained soil investigation sampling locations are shown on Figures 3-4 and 3-5, respectively. Laboratory reports are included in Appendix C, data validation reports are included in Appendix D, and boring logs are included in Appendix E.

Of the 44 subsurface samples, 1 sample (GP-302) was analyzed for metals while 14 samples were analyzed for zinc only. None of the measured metals concentrations exceeded screening values.

PAHs were measured in 32 of the 44 subsurface soil samples. ROD CULs are only available for total PAHs, which were calculated for each sample by summing the detected PAHs. Five of the 32 samples had exceedances of the ROD CUL for total PAHs. All exceedances of total PAHs occurred in the IRM location where stained soil was observed, further investigated, and ultimately removed (Figure 3-5). Individual PAHs exceeded JSCS SLVs in the same five locations (HSCS-1 through HSCS-4 and GP-302) and in the test pit (TP-101) at a depth of 1 foot bgs, also collocated within the IRM location. PCBs were measured in 21 of the 44 subsurface soil samples. Only PCB Aroclors 1254 and 1260 have been detected at the Site, with Aroclor 1254 detected in 8 of the 21 samples and Aroclor 1260 detected in 2 of the 21 samples. Of the eight soil sample locations with detections, six locations have concentrations of Aroclor 1254 exceeding the JSCS SLV. Concentrations at one location within the stained soil investigation area (HSCS-2) exceeded 10 times the JSCS SLV. ROD CULs are only available for total PCBs, which were calculated for each sample by summing the detected PCBs. All but one sample location had concentrations exceeding the ROD CUL for total PCBs. All areas of exceedance were ultimately removed or capped with pavement.

Diesel-range TPH was measured in 23 subsurface soil samples, gasoline-range TPH was measured in 18 soil samples, and oil-range TPH was measured in 9 soil samples. Diesel-range TPH exceeded the ROD CUL of 91 mg/kg at two locations (GP-212 and GP-302). Both exceedances were greater than 10 times the ROD CUL. The highest concentration was measured at GP-302 in the stained soil investigation area, which is capped with pavement.

VOCs were analyzed in subsurface soil at 14 locations. Detected VOCs include chlorobenzene, cis-1,2-DCE, methylene chloride, PCE, and TCE. Samples with detectable concentrations of VOCs were associated with additional investigation into the Dames & Moore (1989) areas of concern (GP-1, GP-2, GP-5, GW-03, and GW-05) as well as locations GP-203, GP-207, and GP-212. Only one VOC in one subsurface sample exceeded the JSCS SLV (PCE in the sample from location GP-2). This area is capped with pavement.

3.1.3 Characterization of Groundwater

Groundwater sampling at the Site was completed to characterize selected areas of concern identified in Dames & Moore (1989), investigate the Stained Soil Area, and characterize groundwater contamination in the Southeast Area. Initial investigation into the Dames & Moore (1989) areas of concern was done in 2001 following the previous work by Dames & Moore, Crosby & Overton, and OMNI Environmental presented in the XPA report (CH2M HILL, 2000). DEQ requested additional investigation into 8 of the 14 areas of concern. With DEQ concurrence, groundwater characterization was included in the investigation of Areas 1, 2, 3, 7, 9, and 12.

In September 2007, a soil and groundwater sampling effort was conducted to supplement the existing data and to further document groundwater conditions at the Northwest Pipe Company Site. Fourteen shallow groundwater samples (13 to 14 feet bgs) were collected from approximately 5 feet below the water table using temporary stainless-steel well points placed using direct-push technology (DPT).

During hot spot removal in the area north of the Lining and Coating Building as part of the IRM, a previously-unknown area of stained soil was observed in the shallow subsurface at a depth of approximately 1 foot below grade. An investigation was completed in 2012 to assess the nature and extent of the stained soil. Three monitoring wells were installed in the area and data evaluation included natural attenuation modeling for selected PAHs in groundwater.

The Southeast Area has been the focus of continued investigation for VOCs in shallow groundwater. The VOCs of concern in this area are PCE, TCE, cis-1,2-DCE, and vinyl chloride. Natural attenuation by reductive dechlorination is ongoing and reducing the presence and concentration of VOCs in groundwater. PCE is a parent compound, while TCE may be a parent compound or the product of PCE degradation. The reductive dechlorination sequence progresses by reducing PCE to TCE, TCE to DCE, DCE to vinyl chloride, and vinyl chloride to ethene. Reductive dechlorination is an important biologically-mediated fate process for natural attenuation of VOCs, where chlorine atoms are removed sequentially from the VOC molecule by subsurface bacteria and replaced with hydrogen ions. The removal of the chlorine atoms occurs as anaerobic microorganisms obtain energy by transferring electrons from electron donors (such as naturally occurring organic matter) to electron acceptors, such as dissolved oxygen (DO), nitrate, ferric iron (Fe^{3+}), sulfate, carbon dioxide, and chlorinated aliphatic hydrocarbons such as PCE, TCE, DCE, and vinyl chloride. Samples in the Southeast Area were collected in investigations conducted in 2001 through 2005, 2007, and 2016 through 2019. Six wells have been installed in the area and Geoprobe sampling has been completed on several occasions. Routine groundwater monitoring is continuing in the Southeast Area on a semiannual basis as the Source Control Decision is expected to include MNA. An MNA Work Planplan currently is being developed by Northwest Pipe Company as directed by DEQ and EPA.

Data associated with these sampling events, screened against groundwater ROD CULs for RAOs 4 and 8 (Table 17 from EPA, 2017), are presented in Table 3-4. Where ROD CULs were not available, JSCS SLVs for Groundwater/Surface Water/Stormwater were used for screening site groundwater data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). Sample locations are shown on Figure 3-6, analytical laboratory reports are included in Appendix C, data validation reports are included in Appendix D, and well logs are included in Appendix E.

An in-depth analysis of groundwater results is presented in Section 5.12.

3.2 Outfall Sediment Data

The only stormwater discharge from the Site to the Willamette River is via a single communal outfall that discharges near the east end of the IT Slip, Outfall 18/WR-123. The outfall is located approximately 1,960 feet from the mouth of the slip, where it connects with the Willamette River. The Site did constitutes approximately 27 percent of the drainage area of the Outfall 18/WR-123, based on topography, stormwater system mapping, and interpretation of drainage basins for stormwater system elements (CH2M HILL, 2010ca). Since 2010, modifications to the drainage have resulted in a smaller Outfall 18/WR-123 acreage. The Site currently constitutes approximately 30 percent of the basin (*Analysis of Outfall 18 Drainage Area Relative to Northwest Pipe Memorandum*, [Jacobs 2021a]).

The IT Slip is a closed end harbor basin about 2,200 feet long and 300 feet wide. It contains quiescent water and has limited water exchange with the Willamette River because of its shape, length, and orientation relative to river flow. LWG completed hydrodynamic sediment transport modeling for Portland Harbor, which confirmed that the sediment in the IT Slip experiences the lowest modeled bed shear (potential sediment erosional forces) found anywhere in the harbor under both normal flow conditions and flood flow conditions (LWG, 2009). The east end of the IT slip near Outfall 18/WR-123 is a stable to depositional environment rather than an erosional environment. Evaluation of changes in sediment surface bathymetry over time in the IT Slip show specific areas within the central and western part of the slip closer to the Willamette River, mostly in the time interval from 2002 to 2009, where the sediment surface elevation decreased (CH2M HILL, 2009b; AECOM and Geosyntec, 2019). These locations correspond to a 2004 maintenance dredging project completed in the slip under Oregon Division of State Lands Permit Number 30897-RP. The length, configuration, orientation, and hydrodynamic features of the IT Slip effectively isolate sediment in the eastern portion of the slip from the main stem of the Willamette River, a conclusion further substantiated by the constituent fingerprinting (CH2M HILL, 2009b).

Sediment analysis conducted in the IT Slip and around Outfall 18/WR-123 (LWG, 2009; CH2M HILL, 2009b[3]) indicated the presence of arsenic, cadmium, copper, mercury, silver, tributyltin, zinc, PAHs, phenol, PCBs, and selected pesticides in certain samples from the IT Slip vicinity (LWG, 2012). The results indicate that PAHs and PCBs are detected at most sample locations throughout the slip and in the Willamette River. However, PAHs and PCBs that are compositionally consistent with the Site soil and catch basin solids with respect to PAHs, and PCBs are limited to a small area of approximately 1.2 acres in the immediate vicinity of Outfall 18/WR-123. By comparison, sediment farther west within the slip and in the Willamette River outside the slip shows distinctly different signatures of PAHs and PCBs. The contamination in that area is consistent with the IT Slip serving as a sediment deposition area with negligible water exchange, and in the eastern part of the slip, no demonstrated sediment exchange with the Willamette River. In conclusion, based on these data, the affected sediment in the immediate vicinity of Outfall 18/WR-123 has the following characteristics:

Commented [A1]: Footnote reference was added in response to DEQ comment 2.

- The affected sediment in the immediate vicinity of Outfall 18/WR-123 is located in a stable, non-erosional area of the IT Slip.
- The area of the affected sediment is small (occupying only about 1.2 acres of the 13.9 acres of the entire IT Slip).
- The radius of the affected sediment located within the slip extends toward the Willamette River only about 175 feet to the west from Outfall 18/WR-123. This means the affected sediment is still over 1,785 feet (over one-third mile) away from the main stem of the Willamette River.
- The affected sediment is within an area owned, operated, and controlled by Schnitzer Steel Industries, where prop wash regularly occurs and maintenance dredging occurs as needed to maintain appropriate navigation channels to facilitate ship and barge movement.

[3] Note, the sediment samples summarized in this report were collected independent of DEQ oversight.

3.3 Contaminants of Interest

COIs for this source control evaluationSCE were based on the following information:

- Review of site history including legacy and current operations (see Section 2.3)
- Results of extensive historical site characterization sampling (see Section 3.1)
- Review of the JSCS guidance document (DEQ and EPA, 2005)
- Review of LWG's stormwater and sediment data collected from the outfall Schnitzer Investment Corp. refers to as Outfall 18 (LWG sample point WR-123) (LWG, 2008) (see Section 3.2)

Based on this evaluation and discussions with DEQ, the COIs for this evaluation include inorganic constituents (aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), PAHs, PCB Aroclors, TSS, TOC, and VOCs.

Tributyltin and phenol, while detected in some IT Slip sediment samples, are not COIs for the Site as neither tributyltin nor phenol were used or affiliated with NWP operations (CH2M 2009a). Tributyltin was used as an anti-fouling agent in ship hull paints starting in the 1960's and ship building operations ceased at this property in 1945 (OSC 1945). Furthermore, steel coating activities were not associated with shipbuilding operations on the property now owned by Northwest Pipe. Rather, portions of the large manufacturing bays currently on the Northwest Pipe facility were used during World War II to weld uncoated steel plate and coiled steel into ship components. These components were then transported to the river bank shipways (situated on current Schnitzer property) where they were attached to the ship hulls and used to construct vessels needed for wartime operations. In summary, both the time period tributyltin was used and the area where ships were painted in the historic shipyard operations in the area demonstrate that tributyltin is not a COI for the Site. This conclusion is consistent with the DEQ-approved Supplemental RI Work Plan (CH2M 2009a), which did not include tributyltin as a COI.

Commented [A2]: Text in this section was added in response to DEQ comment 3.

Tributyltin and phenol, while detected in some IT Slip sediment samples, are not COIs for the Site (CH2M HILL 2009a). Although not associated with past or ongoing industrial activities at the Site, DEQ requested that phthalates and organochlorine pesticides also be analyzed in source control samples.

3.4 Site Specific Pathways

The following potential upland contaminant migration pathways that may affect the Willamette River were identified for the Portland Harbor Superfund Site in the Joint Source Control StrategyJSCS guidance (DEQ and EPA, 2005):

- Direct discharge – including permitted discharges from stormwater runoff
- Groundwater – discharge through sediment, bank seeps, or infiltration into storm drains or pipes
- Erosion/leaching – includes soil erosion to stormwater or leaching to groundwater
- Overwater activities
- Air pollution

Consistent with previous determinations, in the most recent Milestone Report for Upland Source Control (DEQ, 2013a), DEQ determined the following pathways are "not applicable" for the Northwest Pipe Company Site:

- Overland transport/sheet flow
- Bank erosion
- Overwater activities
- Other, which includes factors such as permitted wastewater discharges and air pollution

With respect to Pathway Priority Level, DEQ determined the priority of these pathways for the Site as "none" (DEQ, 2013a).

The potentially applicable pathways for the Site include soil erosion to stormwater (historical), permitted direct discharge of stormwater, and groundwater to surface water.

4. Past and Ongoing Stormwater Management Measures

Throughout its operations, Northwest Pipe Company has implemented a number of stormwater improvements and source control measures (SCMs), and the Site has continued to evaluate effectiveness of these measures and improvements through sampling conducted under its NPDES permit. Stormwater source control sampling data has been collected for the Site following incremental improvements in 2003, 2005, 2006, 2007, 2012, and 2013. This section summarizes improvements and best management practices (BMPs) implemented through 2008, while Section 6 summarizes SCMs implemented between 2009 and 2012. This division allows the improvement in stormwater quality as a result of ongoing SCMs to be evaluated more clearly in Section 7. This section also includes ongoing stormwater management measures to align with DEQ's *Appendix C: Template for a Stormwater Source Control Evaluation Report* (DEQ, 2010a).

As part of the stormwater source control evaluationSCE, and in response to comments on the 2005 draft RI/SCE, the stormwater system, current stormwater cleanout procedures, and BMPs used by Northwest Pipe Company to maintain stormwater permit compliance at the Site were investigated (CH2M HILL, 2009a). Section 4.1 provides a summary of the historical stormwater system and modifications made to the system through the 2012 SCM. Section 4.2 includes key actions and improvements to the stormwater system, BMPs associated with site operations, and Site remediation actions. This division was selected because of the significant actions taken in 2009 (roof painting) and 2011 through 2012 (stormwater treatment system installation and facility paving).

While not directly related to stormwater management, several Site remediation actions were also conducted through the 2012 SCM and would have therefore improved stormwater quality. As described in Section 3.1, a 2,000-gallon AST and a 1,000-gallon UST removal and associated removal and disposal of 300 cubic yards of contaminated soil were completed in response to these early investigations (Dames & Moore, 1989). DEQ issued a letter of no further action for these removal actions in 1990 (DEQ, 1990). Following these early actions, site characterization and investigation continued from 2001 through 2011, culminating in an IRM conducted in 2011 and 2012 and further described in Section 6.

4.1 Stormwater System Modifications (Prior to 2009, Pre-SCMs)

Historical World War II-era maps depict the original stormwater system for the area now known as Burgard Industrial Park (Figure 4-1). As noted in Section 2.3.2, Northwest Pipe Company operations occur in a small portion of what was originally a large shipyard. This original stormwater system, with subsequent modifications, is used by the multiple businesses and industries currently occupying Burgard Industrial Park. As a result, many businesses in the industrial park discharge stormwater to communal stormwater drain lines. Known modifications to this historical system on Northwest Pipe Company property are summarized below and shown on Figure 4-2.

Prior to the start of Northwest Pipe Company operations on the Site in 1982, old shipyard stormwater lines near the northern site boundary were abandoned (Figure 4-2). Also prior to Northwest Pipe Company operations, the stormwater system just east of the former Mortar Lining Facility, now Cement Plant, (in the northwestern portion of the Site) was modified to incorporate a series of settling basins to reduce the suspended solids in stormwater leaving the Site (Figure 4-2). In 1987, the westernmost stormwater drain line was rerouted around the western side of the Cement Plant (Number 1 on Figure 4-2). In 2002, the easternmost setting basin near the Cement Plant was installed and the overflow water was routed toward five newly installed small underground settling vaults located to the north to settle out solids (Number 6 on Figure 4-2). These basins are cleaned out as needed. In 2009, three aboveground vertical tanks, located north of the settling vaults, were installed to increase capacity of the Cement Plant closed loop recycle water system (Number 20 on Figure 4-2). The area was also regraded to create an isolated drainage zoneIDZ, preventing stormwater that has been in contact with activities in this area from discharging to the Site's stormwater. Also in 2009, the southern portion of the line east of the Cement Plant installed prior to Northwest Pipe Company operations was sealed off, and the southernmost settling basin was abandoned (Number 22 on Figure 4-2).

Historical maps depict a connection between the southwestern corner of the present-day Northwest Pipe Company Site and an old Willamette River outfall, referred to as Schnitzer Steel Outfall 1 or Lower Willamette Group Outfall WR-108. However, this line was nonfunctioning at the time Northwest Pipe Company operations commenced in 1982. Northwest Pipe Company constructed system modifications in 2001 that permanently removed the connection to the inactive, non-functioning stormwater line leading to Schnitzer Steel Outfall 1/WR-108 (Number 5 on Figure 4-2). As part of these modifications, a stormwater settling basin and lift station were installed to move stormwater from the southwestern part of the Site to the north, where it eventually would discharge from the Site via an existing Northwest Pipe Company stormwater line, to the large communal stormwater line that discharges to the IT Slip via Outfall 18/WR-123 (Number 5 on Figure 4-2). This project was undertaken to alleviate frequent ponding of water in the southwest part of the site, which apparently occurred because of the nonfunctioning storm line to which catch basins in the southwest part of the Site had been connected (Figure 2-5).

In 2002, the stormwater line was investigated by Schnitzer Steel Industries, Inc. as requested by DEQ (Bridgewater Group, Inc. 2000). The investigation revealed that the line was subject to differential settlement and separation after its installation in the early 1940s. Hydraulic fill typically would have been placed without constructing lifts and compacting them sequentially. While normally the fill would have compacted over time due to the action of gravity and the effect of loads placed on it by surface activities. In this case, the shipyard's subsurface infrastructure would have been built soon after the fill was placed and before much time had passed, increasing the likelihood of differential settlement. Thus, the separation may have occurred soon after the line was constructed given the nature of the fill material and operations at the Site, including the movement of large, heavy pieces of fabricated ship hulls that were moved across the Site to the shipways. Stormwater flowing into the line would have percolated into soil, rather than reaching the river.

During the WWII shipyard era, the main facility currently used by Northwest Pipe had 11 bays and the area under roof was narrower east-to-west, with crane ways that extended to the west out of each bay (Figure 4-3). Over the years, the bay roof lines were extended west to cover these crane ways. In 2002, Northwest Pipe Company started sealing off catch basins that had been brought under the roof inside the Main Production Building by this extension (Number 8 on Figure 4-2). Not all of these catch basins or their associated drain lines were physically accessible. Consequently, some catch basins were not sealed off until 2008 when they were made accessible by the movement of plant machinery in response to production modifications and evolving business needs, and sufficient funds were available to complete the work.

Test ports at the discharge points from the Site were also installed in 2002 to facilitate stormwater monitoring. While repairing a broken water line, Northwest Pipe Company maintenance workers uncovered an old shipyard-era drain line between the Main Production Building and Bay 9. This line was abandoned in 2004 (Number 14 on Figure 4-2).

4.2 Ongoing Stormwater Management Measures (Pre and Post-SCMs)

In addition to the stormwater system improvements described in Section 4.1, numerous BMPs have been enacted at the Site to reduce the potential for contamination to Site stormwater. These actions are listed in Table 4-1. Among other actions, catch basins at the Site were outfitted with replaceable fabric filters to retain soil that may be suspended in stormwater entering the stormwater system. Additionally, all catch basins have an oil-absorbent filter sock installed with the sediment filter fabric. The catch basin filters and filter socks are replaced as needed as described in the Site's Stormwater Pollution Control Plan (SWPCP). In some instances, these may be changed more frequently if the monthly inspection indicates a need for replacement.

Additional BMPs implemented at the site include weekly road sweeping and jet-cleaning of stormwater lines. Northwest Pipe Company has retained a commercial sweeping service to sweep the road surfaces throughout the Site on a weekly basis. This practice was implemented beginning in 2007 to reduce the dust and debris that could be captured in stormwater flowing across road surfaces. Periodic jet-cleaning of stormwater lines was implemented in 2002 to remove any settled solids that might have collected in the lines. The stormwater system is cleaned as needed. The timing of these clean-out events varies based on the level of production at the plant, accessibility to the storm lines, and availability of maintenance staff. A subcontractor cleans the system to remove debris or solid deposits that may accumulate in the stormwater conveyance system and capture them in a vacuum truck. Once captured, the solids are allowed to settle out of the water. The water is discharged onsite to the sanitary sewer through a batch discharge permit obtained by Northwest Pipe Company. The solids are processed offsite and disposed of at a permitted landfill.

Several BMPs were also implemented as part of the Site’s SWPCP. Spill response kits are stationed throughout the plant. Plant personnel are trained annually on environmental awareness to improve compliance with the Plan and protect stormwater quality. Monthly inspections of storm drain catch basin filters, fuel tanks, forklifts, covered waste dumpsters, and general plant cleanliness are also conducted under the Site’s SWPCP.

5. Data Collection and Interpretation

This section describes the stormwater and groundwater pathways and summarizes past water quality evaluated from Site data.

5.1 Stormwater Pathway

While the stormwater pathway is complete, potential sources (that is, unpaved soil, stored materials, and settled solids) in the stormwater conveyance system were either removed or controlled by a range of actions taken over the past 30 years. Sections 4.1 and 4.2 and Table 4-1 summarize actions undertaken to control potential sources to stormwater. Improvements to the stormwater system, enhanced BMPs, changes to site operations, and remedial actions conducted, as well as stormwater data have been collected regularly throughout this period. Actions and data have been grouped for the purposes of reporting. Stormwater data, roof runoff data, and catch basin solids data collected between 2003 and 2008 are presented in Sections 5.1.1 through 5.1.4 to characterize pre-SCMs conditions. in Sections 5.1.1, 5.1.3, and 5.1.5, respectively. Stormwater improvements that occurred prior to and during this time period are described in Section 4. Primary Site SCMs were implemented between 2009 and 2012 and are described in Section 6. Stormwater and roof runoff data collected between 2009 and 2013 to characterize post-SCMs conditions are described in Sections 5.1.32 and 5.1.4. This division was selected because of the significant actions taken in 2009 (roof painting) and 2011 through 2012 (stormwater treatment system installation and facility paving).

Data collection and interpretation are grouped by environmental media as recommended in the DEQ Appendix C (Template for a Stormwater Source Control Evaluation Report [DEQ 2010a]) Appendix C guidance outline:

- Catch basin solids data are presented in Section 5.1.4.
- Stormwater data are presented in Section 5.1.1.
- Other media are presented in Sections 5.1.2 and 5.1.3 (roof runoff), Section 5.2 (groundwater), and Sections 3.1.1 and 3.1.2 (soil).

5.1.1 Source Control Stormwater Data (2003 through 2007, Pre-SCMs)

Stormwater samples collected in various catch basins (CB) and sample ports (SP) around the Site for the purposes of evaluating source control were collected in 2003, 2005, 2006, and 2007 (CH2M HILL, 2003b, 2005a, 2005b, and 2008). Sample locations are shown on Figure 5-1. Note the NPDES sample locations were renamed from sample port [SP]-003 and SP-004 to SP-001 and SP-002, respectively, in November 2017 at BES's' direction. The sampling events are summarized as follows:

- On September 9, 2003, Northwest Pipe Company collected stormwater samples from five points on and around the Site (catch basin [CB]-105, CB-201, CB-202, SP-003, and SP-004). Data were screened for TSS, dissolved and total metals, PAHs, PCBs, and TPH.
- On July 8, 2005, stormwater sampling was conducted at three locations (CB-202, SP-003, and SP-004) to further characterize stormwater discharge from the Site. The stormwater samples were analyzed for constituents potentially related to legacy or current Site activities, specifically PAHs, PCBs, and both dissolved and total metals (lead, copper, zinc, manganese, chromium, nickel, molybdenum, and aluminum), pH, oil and grease, and TSS.
- On November 7, 2006, stormwater samples were collected at six locations (CB-101, CB-106, CB-107, SP-002, SP-003, and SP-004). All samples were analyzed for total zinc and copper, PAHs, and PCBs. Some samples were analyzed for total lead, oil and grease, and TSS to characterize potential sources of COIs. Sampling locations were selected to characterize facility-wide stormwater.
- On December 3, 2007, stormwater samples were collected from 11 locations (CB-101, CB-103, CB-106, CB-107, CB-202, SP-002, SP-003, SP-004, SP-005, surface water [SW] SW-110, and SW-119). Samples were analyzed for total zinc and PAHs. Some samples were analyzed for diesel-

range and oil-range TPH to characterize potential sources of COIs. Sampling locations were selected to characterize facility-wide stormwater.

Data associated with these sampling events screened against ROD CULs for surface water for RAOs 3 and 7 (Table 17 from EPA~~,~~ 2017) are presented in Table 5-1. Where ROD CULs were not available, JSCS SLVs for Groundwater/Surface Water/Stormwater were used for screening site stormwater data. Sample locations are presented on Figure 5-1, laboratory analytical reports are provided in Appendix C, and data validation reports are included in Appendix D. Figures 5-2a through 5-2d show the start time of sample collection for each event compared to the rainfall events noted for the City of Portland's HYDRA Terminal 4 NE rain gage~~Rain Gage~~ located at 11040 N Lombard St., approximately 1,700 feet south of the southern boundary of the Site.

Historical stormwater data presented in Table 5-1 show exceedances of surface water/drinking water ROD CULs or JSCS SLVs for selected total metals (aluminum, copper, lead, manganese, and zinc), dissolved metals (aluminum, copper, manganese, and zinc), most PAHs, and selected PCBs (Aroclor-1254, Aroclor-1260, and total PCBs). Exceedances are present at multiple locations and over several years of sampling.

5.1.2 Roof Runoff Data (2006 through 2008, Pre-SCMs)

To investigate the potential sources of zinc as part of its ~~source control evaluation~~SCE, Northwest Pipe Company conducted several stormwater roof runoff sampling events focusing on zinc concentrations, including sampling events in November 2006, December 2007, June 2008, November 2008, and December 2008. Sample locations were selected from representative locations around the Facility are presented on Figure 5-3, analytical data are presented in Table 5-2, laboratory analytical reports are provided in Appendix C, and data validation reports are included in Appendix D. Sampling events conducted in 2006 and 2007 evaluated the roofs of various facility buildings as sources of zinc loading to site stormwater. When compared to the ROD CUL for zinc in surface water for RAOs 3 and 7 (EPA~~,~~ 2017), a value of 0.0365 mg/L, results verified the 6.7-acre galvanized roof of the Main Production Building contributed to elevated zinc with concentrations exceeding over 80 times the CUL in 2006 and approximately 50 to 70 times the surface water/drinking water ROD CUL in 2007.

Once the 6.7-acre galvanized roof was identified as the main source of zinc loading to site stormwater, the efficacy of a potential source control action was evaluated. In 2008, a test panel of roof was coated to reduce zinc concentrations in runoff. Samples collected in June, November, and December 2008 showed a significant reduction in zinc loading to stormwater, ranging from 27 times to less than 10 times the surface water/drinking water ROD CUL. Once proven effective, the roof coating was applied to the remainder of the Main Production Building, becoming one of the major SCMs completed in 2009 resulting in a zinc reduction of 98 percent in roof runoff (see Section 5.1.3). During summer 2009, Northwest Pipe Company cleaned and coated the roof of the Main Production Building, covering approximately 292,320 square feet (6.7 acres) of galvanized roofing, as part of its source control efforts.

5.1.3 Roof Runoff Data (2009, Post-SCM)

Stormwater roof run-off samples were collected on November 7, 2009, in accordance with the DEQ-approved Work Plan (CH2M~~ HILL,~~ 2009a). According to the City of Portland's ~~Hydra~~ HYDRA rain gauge at the Port of Portland Terminal 4, 1.19 inches of precipitation fell on November 7, 2009, the majority of which occurred in the afternoon coinciding with sampling activities (USGS~~,~~ 2010). Samples were collected from the Main Production Building, Bay 9, the Lining and Coating Building, Steam Bay, and Maintenance Building. Sample locations are shown on Figure 5-3. Historical stormwater roof runoff samples focused solely on total zinc concentrations because it was associated with past work to identify and control potential zinc in Site stormwater (Section 5.1.3). For this post-SCMs sampling, at least one sample from each of the buildings was analyzed for total concentrations of other inorganic constituents (aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), for organic constituents (phthalates, PCBs, PAHs, and VOCs), and for TSS, as required by DEQ.

Associated analytical data screened against surface water/drinking water ROD CULs for RAOs 3 and 7 (Table 17 from EPA~~,~~ 2017) are presented in Table 5-3. Where ROD CULs were not available, JSCS SLVs for Groundwater/Surface Water/Stormwater were used for screening site stormwater data. Laboratory analytical reports are provided in Appendix C and data validation reports are included in Appendix D.

Six of the 11 roof runoff samples were analyzed for the following inorganic constituents in the November 2009 sampling effort: aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. The only inorganic constituents that exceeded the ROD CULs or JSCS SLVs were arsenic and zinc. Arsenic was detected at concentrations less than the laboratory reporting limit in three of the six samples analyzed for the full suite of inorganic constituents. The other three samples analyzed for arsenic did not have arsenic concentrations exceeding the method detection limit. Of the three samples that contained arsenic exceeding the method detection limit, one sample was a field duplicate sample for a parent sample that contained no detectable arsenic. Arsenic is a naturally occurring element in area soil. DEQ has calculated that the Portland Basin has a background concentration of 8.8 mg/kg (DEQ, 2013b), so these low concentrations of arsenic may be attributable to soil dust captured in the sample rather than originating from the roofs themselves.

The roof cleaning and coating SCM reduced zinc concentrations in roof runoff from the Main Production Building by 98 percent, with pre-coating concentrations averaging 2.56 mg/L and the concentrations observed in 2009 samples averaging 0.063 mg/L (Tables 5-2 and 5-3). Zinc values observed in the roof runoff from the 2009 sampling event for the Main Production Building are consistently less than the current NPDES permit benchmark (0.12 mg/L) but slightly exceed the conservative surface water/drinking water ROD CUL (0.0365 mg/L). Zinc concentrations found in the roof runoff on other buildings range between 0.0171 and 0.98 mg/L. The observed variance of zinc concentrations in roof runoff may be attributed to the downspout piping, roofing material, and the age of these materials. Older galvanized coatings are more pitted from weathering and age, creating a greater surface area that exposes more zinc to precipitation and roof runoff. Figure 5-4, which shows zinc concentrations in Site stormwater from April 2005 to June 2019, shows that coating the 6.7 acres of galvanized of roof of the Main Production Building has helped the Site maintain compliance with its stormwater permit benchmark for zinc and is effectively controlled the most significant zinc source of the property.

Two of the five roof runoff samples analyzed for PAHs (downspout [DS] DS-005 and DS-012) were less than detection limits for all PAHs. Two other samples (DS-223 and DS-221) were found to have low concentrations of phenanthrene. The reported concentrations of phenanthrene in these samples were less than both the conservative JSCS SLV and the laboratory reporting level. The remaining sample point, DS-120, was the only sample with PAH concentrations exceeding the laboratory reporting level for fluorene and phenanthrene. Pyrene also was detected but at concentrations less than the laboratory reporting level. All detected concentrations in each of the roof run-off samples were less than the ROD CULs or JSCS SLVs for PAHs. These low concentrations may be attributable to deposition of fugitive dust from area sites containing low levels of PAHs.

Of the remaining constituents (PCBs, phthalates, and VOCs), only two VOCs were detected: 2-butanone (also known as methyl ethyl ketone) and acetone, which are common laboratory contaminants (EPA, 2008). Both of these constituents were detected in all samples analyzed for VOCs. All detected VOC concentrations were less than the JSCS SLVs.

Since roof runoff undergoes treatment in the Site's stormwater treatment systems prior to discharge, an exceedance of a ROD CUL or JSCS SLV in roof runoff does not indicate stormwater discharge from the Site would exceed ROD CULs or JSCS SLVs.

5.1.4 Catch Basin Solids (2006, Pre-SCMs)

Settled solids that had accumulated in selected catch basins at the Site were sampled for SCE purposes in October 2006. Sampling focused on principal drain lines running near manufacturing process areas on the east and west sides of the Site, on either side of the manufacturing bays. Samples were collected from relatively "upstream" and "downstream" locations along the stormwater lines to assess potential changes in the composition of settled solids along those lines. Data associated with this sampling event screened against river bank soil and sediment ROD CULs for RAOs 1 and 5 (Table 17 from EPA, 2017) are presented in Table 5-4. Where ROD CULs were not available, JSCS SLVs for Upland Soil and

Stormwater Sediment were used for screening site soil data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). Sample locations are presented on Figure 5-5, laboratory analytical reports are provided in Appendix C, and data validation reports are included in Appendix D.

The Site's catch basin solids were analyzed for zinc, PAHs, PCBs, and diesel-range TPH. Of the five catch basins sampled, four exceeded the ROD CUL for zinc of 459 mg/kg (the Portland Basin background concentration for zinc in soil has been calculated to be 180 mg/kg [DEQ, 2013b]). Each of the five sampled catch basins was found to contain solids with detectable levels of PAHs. Benzo(b)fluoranthene and benzo(k)fluoranthene were detected at concentrations less that their JSCS SLVs. The remaining PAHs exceeded JSCS SLVs in a least one of the sampled solids. Total PAHs, calculated by summing the concentrations of individual detected PAHs, were found to exceed the ROD CUL in all samples by less than 10 times the CUL.

The catch basin solids samples were found to contain detectable levels of two PCB Aroclors (Aroclor-1254 and Aroclor-1260). Each of the five catch basin solids samples exceeded the JSCS SLV for Aroclor-1254 and one sample exceeded the JSCS SLV for Aroclor-1260. All five samples exceeded the ROD CUL for total PCBs. Diesel concentrations in all samples were found to be less than 10 times the ROD CUL.

While catch basin data may be used for determining the potential release of COIs, by their nature, catch basin solids are materials captured in the stormwater system and do not necessarily represent the composition of suspended solids that may have been discharged via the stormwater system. Furthermore, ROD CULs were not developed for catch basin solids, thus comparison of catch basin solids to screening values developed for riverbank soil and sediment may be overly conservative. Post-SCM sampling has not been conducted for catch basin solids as the stormwater system uses catch basin filters to exclude solids from the system and the system is regularly cleaned out; therefore, sufficient solids for sampling would not be expected to be present. In fact, the regular cleaning of the catch basins was changed from an annual to an as-needed schedule since solids accumulation was so minimal.

5.2 Groundwater Pathway

The groundwater pathway has been investigated to document the nature and both the horizontal and vertical extent of constituents, modeling of fate and transport, and a human health and ecological risk assessment (CH2M HILL, 2005a, 2012a, 2012b, and 2017). Groundwater investigations focused on two areas: the Stained Soil Investigation Area identified during IRM implementation and the Southeast Area. The investigation included hydrogeologic characterizations and natural attenuation evaluations to determine whether contaminants would be likely to migrate to a discharge point and pose excess risk to potential receptors.

5.2.1 Stained Soil Investigation Area

At the request of DEQ, a stained soil investigation work plan was prepared for Northwest Pipe Company. DEQ approved the work, which involved subsurface soil sampling; installing, developing, and sampling three monitoring wells; and data evaluation, including natural attenuation modeling/sensitivity analysis for conservatively selected PAHs in groundwater. Three monitoring wells were installed in the Stained Soil Area just north of the Lining and Coating Building in June 2012 (monitoring well [MW]-7, MW-8, and MW-9, shown on Figure 35-6). Well construction details are included in Table 5-5 and boring logs are included in Appendix E. The first well (MW-7) was installed in the footprint of the stained soil excavation after it was backfilled. The second and third wells (MW-8 and MW-9, respectively) were installed approximately 10 feet beyond the location of the most distant stained soil investigation subsurface soil sample location. The wells were installed such that the screened interval straddled the water table observed at the time of well installation; however, subsequent water level measurements recorded during sampling events indicated that the static water level in the wells generally is above the top of the screened interval in each well. Groundwater flow directions for the Stained Soil Area are shown on Figure 5-6.

Two rounds of groundwater samples were collected from these wells: the initial samples in June 2012 and the second set of samples in May 2013. Sample collection followed the procedures identified in the DEQ-approved Work Plan (CH2M HILL, 2012a) and follow-up email communications between DEQ and the project team. The key difference between the two sampling events is that the second set of samples was collected with a sampling pump (peristaltic pump) while the water level in the well was artificially drawn down to below the top of the well screen by pumping from a lower, stainless steel submersible pump as required by DEQ. The intent of this method was to identify any light, phase-separated hydrocarbons present near the well, if any, by artificially lowering the water table by pumping prior to collecting a groundwater sample. No such hydrocarbons were observed during sampling, and the sample results, which were comparable to the first sample set from these wells in June 2012, are consistent with the absence of phase-separated hydrocarbons.

Groundwater elevations were measured in site monitoring wells screened in the shallow fill aquifer in June 2012 and May 2013 (Table 5-6). Figure 5-7 depicts the resulting potentiometric surface of the shallow aquifer for both events. Water levels in May 2013 were approximately 0.9 foot lower than observed in June 2012. The hydraulic gradient for the two sample events was similar, directed west-northwest, with a consistent magnitude of approximately 0.0013 foot per foot (ft/ft). Based on the June 2012 hydraulic gradient, the discharge point for groundwater to surface water would have been approximately 2,000 feet from the investigation area to the main stem of the Willamette River.

Samples were collected using low-flow sampling techniques and submitted to the laboratory for analysis for current and legacy COIs (total and dissolved metals, PAHs, TPH diesel and oil range hydrocarbons, PCBs, and TSS). DEQ did not request PCB analysis in the second set of groundwater samples from the Stained Soil Area since no PCBs were detected in the first set of samples. Table 3-4 summarizes the analytical results and includes a comparison of the constituents to groundwater ROD CULs for RAOs 4 and 8 (Table 17 from EPA, 2017). Where ROD CULs were not available, the JSCS SLVs recommended values for Groundwater/Surface Water/Stormwater were used for screening site groundwater data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). Analytical laboratory reports are included in Appendix C and data validation reports are included in Appendix D.

MW-7, which was installed in the footprint of the Stained Soil Area, had the highest concentration of PAHs and petroleum hydrocarbons, with MW-8 and MW-9 reflecting low concentrations at the upper end to values less than the laboratory reporting limit at the lower end (Table 3-4). PCBs were not detected in the initial groundwater samples in June 2012, and no further sample analysis for PCBs was requested by DEQ. Inorganic constituent concentrations were generally low or less than laboratory reporting limits, except for manganese and arsenic. Elevated manganese and arsenic concentrations may be the result of geochemically reducing conditions, which can cause naturally occurring concentrations in the basalt-derived soil and sediments known of this area to enter solution. Constituents with exceedances of ROD CULs or JSCS SLVs included arsenic, copper, lead, manganese, selected individual PAHs, and total carcinogenic PAHs (cPAHs[4]).

Field parameters indicate near-neutral groundwater pH, low specific conductance typical for shallow groundwater in the area, and geochemically reducing conditions. The uniformly negative oxidation-reduction potential (ORP) values and the low DO content indicate the presence of geochemically reducing conditions. Reducing conditions have been documented in both the Stained Soil Investigation Area and the Southeast Area of the Site. The reducing conditions may be attributed to decomposing natural organic matter incorporated into the dredged material used as fill material at the Site.

A natural attenuation evaluation was completed using the EPA's screening tool BIOSCREEN (EPA, 1997). The potential for PAHs, reported in groundwater near the Stained Soil Area to migrate a substantial distance in the subsurface (CH2M HILL, 2013) was investigated. The evaluation was conducted because PAHs have the following characteristics: (1) exhibit notably low solubility, (2) tend to adsorb to organic carbon in the subsurface, (3) are known to attenuate under both aerobic and anaerobic conditions, and (4) do not tend to form extensive plumes in groundwater except in unusual circumstances (such as manufactured gas plants or creosote wood treating operations) where large quantities of nonaqueous phase liquids are present in the subsurface. The results of the BIOSCREEN evaluation showed a predicted migration distance of 100 feet until PAHs degrade to concentrations less than 0.001 mg/L under conservative assumptions; this distance is more than 1,900 feet from the bank of the Willamette River (CH2M HILL, 2013). Based on this evaluation, the reported concentrations of PAHs in soil and groundwater do not pose an excess risk to potential receptors, including to the Willamette River,

[4] cPAHs were calculated by summing concentrations of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

and no further groundwater sampling or analysis associated with the stained soil remediation area is indicated. The sampling results and analysis confirm that the pocket of contamination identified in the stained soil area is contained.

5.2.2 Southeast Area Groundwater

Samples in the Southeast Area were collected in 2001 through 2005 to support the 2000 XPA (CH2M ~~HILL,~~ 2000) and the Draft 2005 RI/SCE (CH2M ~~HILL,~~ 2005b~~a~~). Northwest Pipe Company collected groundwater samples in 2007 to supplement the site characterization. These results were integrated into the updated and reissued RI/SCE report in January 2014 (CH2M ~~HILL,~~ 2014), and the subsequent RI/SCE report March 2015 (CH2M ~~HILL,~~ 2015). Following the receipt of the March 2015 RI/SCE report, EPA required additional investigation into the VOCs in the Southeast Area. Groundwater sampling restarted in 2016 and continues through the present. VOCs are the ~~chemicals of interest~~COIs in this area, primarily the chlorinated solvent PCE and its breakdown products TCE, cis-1,2-DCE, and vinyl chloride. While TCE is a breakdown product of PCE, historically it was also used as a commercially available solvent and its presence may be attributable, in part, to the historical use of products containing TCE. Elevated VOC concentrations were determined in 2004 to be limited to the shallow unconfined aquifer. The groundwater flow direction in the Southeast Area generally is south-southwest, toward Terminal 4 Slip 1 on the Port of Portland property.

In 2001, 2002, and 2004, groundwater in the Southeast Area was characterized using ~~DPT~~ direct-push technology sampling. In 2003 and 2004, six monitoring wells were installed in the shallow aquifer and comprise the groundwater monitoring network in the Southeast Area, with sampling from 2003 to the present (Figure 3-6). A compilation of VOC concentrations from the Southeast Area, including Geoprobe and initial monitoring well results for 2001 through 2005, is presented on Figure 5-7. Table 3-4 summarizes all groundwater analytical results and includes a comparison of the constituents to groundwater ROD CULs for RAOs 4 and 8 (Table 17 from EPA, 2017). Where ROD CULs were not available, the JSCS SLVs recommended values for Groundwater/Surface Water/Stormwater were used for screening site groundwater data (Table 3.1 - Revision 7/16/07 from DEQ, 2007a). The early sampling investigations in the Southeast Area are described as follows:

- In 2001, two probes were advanced in the vicinity of a former AST in the Southeast Area. PCE was detected at a maximum concentration of 9,800 micrograms per liter (µg/L) in sampling location GP-1. Sample GP-2, which was located approximately 40 feet west of GP-1, had a PCE concentration of 4,300 µg/L. Based on these investigation results, additional groundwater investigations were conducted in the Southeast Area.
- In 2002, 12 Geoprobe locations (GW-01 through GW-12) were advanced in the Southeast Area. The highest concentrations of VOCs were found near the eastern property boundary of the Southeast Area. These results suggest that at least some of the observed VOCs in the Southeast Area may have migrated onto the Site from the east/northeast offsite area. Maximum concentrations of PCE observed in 2002 were less than those observed in 2001 at GP-1 and GP-2, reflecting spatial and/or temporal variation in concentrations. As listed in Table 3-4, degradation products of PCE also were detected in groundwater in this area. Specifically, TCE and cis-1,2-DCE were found at the highest concentrations and in the greatest numbers of sample locations.
- In 2004, 11 Geoprobe (GP-101 through GP-111) samplers were advanced and 12 groundwater samples collected to further investigate both the lateral and vertical extent of VOCs in the Southeast Area. Nine of these Geoprobe sample locations were situated along the east-northeast and south borders of the Southeast Area to investigate the concentrations of VOCs on the upgradient (east) and downgradient (south) portions of the Southeast Area (Figure 3-6). VOCs were detected along the northeast border of the Southeast Area. Concentrations in this area exceeded laboratory reporting limits for PCE and its breakdown products TCE, cis-1,2-DCE, and vinyl chloride. Geoprobe sampling locations GP-102, GP-103, and GP-104 were located downgradient of older Geoprobe samples GP-1 and GP-2 along the south edge of the Southeast Area. Analytical results in GP-102, GP-103, and GP-104 indicated PCE concentrations more than 1 to 2 orders of magnitude lower (ranging from 59 µg/L at GP-102 to 260 µg/L at GP-104) than those observed at GP-1. These results indicate that concentrations of VOCs decrease rapidly as groundwater migrates southward toward the Site boundary.

- Also in 2004, a deep Geoprobe (GP-112 on Figure 3-6) was advanced to a depth of 120 feet bgs near the location of previous sample GP-1. The location coincides with the highest observed concentration of VOCs. GP-112 was advanced to investigate the vertical extent of VOCs in the subsurface. The subsurface profile encountered during probing was predominantly silt below a depth of 28 feet bgs. Two thin, slightly sandier, water-bearing intervals were encountered at depths of 65 and 98 feet, from which groundwater samples were collected and subsequently analyzed for VOCs (Figure 5-8). VOCs were not detected in either of these two deep samples (Table 3-4). The upward gradient characteristic of the groundwater regime, the presence of the thick, low-permeability silt zone below 28 feet, as well as the absence of VOCs in the two samples collected at 62 and 96 feet, confirm that the VOCs are limited to the shallow water-bearing in the Southeast Area.
- In 2003, six groundwater monitoring wells (MW-01 through MW-06) were installed in the Southeast Area to further evaluate the presence of VOCs and to assess the subsurface profile, local hydrology, and the hydraulic gradient beneath the Site. The locations of the monitoring wells are shown on Figure 3-6. Monitoring well construction information for the Southeast Area wells is summarized in Table 5-6 and well logs are included in Appendix E. Constituents detected exceeding the laboratory reporting limits in monitoring well samples are PCE and its breakdown products: TCE, cis-1,2-DCE, trans-1,2-dichloroetheneDCE, 1,1-dichloroetheneDCE, and vinyl chloride (Table 3-4). Other VOCs (1,1-dichloroethane, toluene, benzene, and chloromethane) were detected at concentrations less than the laboratory reporting limits at estimated concentrations during the 2004 monitoring event, but none of these constituents was detected during any of the 2005 monitoring events. Chloroform and acetone, which are common laboratory contaminants, were detected in samples collected from MW-06 during the January 2005 monitoring event.

The spatial distribution of VOCs in groundwater in the Southeast Area in 2001 through 2005 (Figure 5-7) indicate the highest concentrations of PCE occurred near MW-06 and MW-01 during this period, with lower concentrations detected both upgradient (MW-05) and downgradient (MW-03 and MW-04) of these wells. MW-02, located west of GP-1 and GP-2, defines the approximate westward extent of VOCs in groundwater. In September 2005, the PCE concentrations observed in the upgradient well MW-05 (Figure 5-7) were higher than previously observed but were still well below concentrations observed farther downgradient (sample locations MW-06 and GP-1).

The Southeast Area groundwater wells were resampled as part of the general site groundwater characterization in 2007. The wells were also sampled during the supplemental groundwater investigation that occurred in 2016 through 2017 (CH2M, 2016, 2017). Sampling is currently ongoing on a semiannual basis in the Southeast Area, as an MNA wWork pPlan is being prepared at the request of DEQ and EPA.

Since 2016, the groundwater investigation has included sampling of selected Port of Portland wells to characterize downgradient fate of the VOC plume (T4S1MW-03S, T4S1MW-09, T4S1MW-23, and T4S1MW-24) as provided by the approved work plan (CH2M, 2016) and under an agreement with the Port of Portland, owner of the wells. Two of these wells were chosen for their proximity to the slip at the downgradient end of the flow path (T4S1MW-03S and T4S1MW-09), while the other two wells were chosen for their location closest to the upgradient flow path (T4S1MW-23 and T4S1MW-24).

To aid in analysis, Port data prior to 2016 were obtained from Ash Creek Associates, Inc. (2007). Groundwater in this offsite area contains VOCs from past practices, possibly as fumigants in the large grain storage operation that formerly existed on the Port's property (OSHA, 2015). Port groundwater data from 2004 through 2019 are presented in Table 5-78. Locations of Port of Portland monitoring wells and groundwater elevation contour maps corresponding to the sampling data are provided in Appendix F. Monitoring well data for both the Northwest Pipe Company site and Port site from 2003 through 2019 are shown on Figures 5-9a and 5-9b, respectively.

The wells with the highest VOC concentrations observed during this more recent sampling period have consistently been wells MW-05 and MW-06. By comparison, MW-01, MW-03, and MW-04 have shown consistently moderate concentrations during this period, and MW-02 and the Port property wells have concentrations near or less than the laboratory reporting limits for VOCs. Although the recent data (collected from 2016 through 2019) shown on Figures 5-9a and 5-9b exhibit temporal variability in concentration, the maximum value of the most highly concentrated VOC identified in data (PCE in MW-

05) is less than half the maximum concentration previously detected in groundwater at the site (PCE in GP-1). Based on the stability in the relative distribution of VOCs within the plume, and the consistently low to nondetectable results for VOCs detected in Port wells, with concentrations lower than reported previously, the plume extent is stable and possibly shrinking, with some variation in concentration, increasing or decreasing, within the interior of the plume. These characteristics are consistent with a stable or decreasing plume that is effectively controlled by natural attenuation processes.

Commented [A3]: Text deleted in response to EPA comment 1.

Elevated VOC concentrations identified in the Southeast Area are limited to the shallow unconfined aquifer, based on previous Geoprobe sampling in the area. The shallow aquifer is located within hydraulic fill (dredged river sediment) placed in the late 1930s and early 1940s over the mudflats that formerly existed in the site vicinity (see Figure 2-3). The hydraulic fill is characterized by fine sand and silty sand extending from the ground surface to approximately 28 feet bgs, saturated in its lower half under unconfined conditions and underlain by a thick, low-permeability confining layer. The confining layer consists of low-permeability silt with sparsely interbedded sand from approximately 28 to 161 feet bgs (Figure 5-8). The top of this confining layer represents the historical ground surface prior to site filling and development.

A hydrologic characterization of the shallow aquifer in the Southeast Area was conducted in 2016 through 2017 and is described in greater detail in the Supplemental Groundwater Data Report (CH2M, 2017). Data collection has continued through 2019 resulting in seven measurement events of both water levels and groundwater concentrations from 2016 through 2019. Key attributes of the hydrologic characterization (evaluated using data from the seven events) are summarized as follows:

- Groundwater flow directions in the Southeast Area are south-southwest toward Terminal 4 Slip 1 on the Port of Portland property, located south of the Site. For this reason, monitoring includes several wells on the southwest, downgradient Port of Portland property. These wells are included in the hydrologic characterization.
- The historical offsite location of Gatton Creek (Figure 2-3) prevents it from acting as a preferential flow path for the Southeast Area plume as it is located cross-gradient of the flow path.
- Consistent with historical measurements, the measured depth to groundwater ranged from 6.66 to 13.89 feet bgs on the Northwest Pipe Company site. Depth to groundwater was from 5.65 to 19.99 feet bgs on the Port property (Table 5-8).
- Groundwater elevation contour maps were prepared for seven measurement events. The most recent map from October 2019 is presented on Figure 5-10, while all other available contour maps are included in Appendix F[5]. Groundwater flow direction is consistently south to southwest toward Slip 1 on the Port site, downgradient from the Southeast Area. On the Northwest Pipe Company Site, the hydraulic gradient is smaller in magnitude and more variable than it is further south, but flow is predominantly southerly. The observed variability in hydraulic gradient based on quarterly water level measurements appears to be caused by aquifer response to changes in river stage and precipitation events.
- As is typical for local and regional groundwater discharge areas, the hydraulic gradient increases approaching Terminal 4 Slip 1, increasing from an average of 0.005 ft/ft at the southern boundary of the Northwest Pipe site through the middle of the Port property, then transitioning to an average of 0.01 ft/ft near the slip. Although brief apparent gradient reversals appear to occur on the Northwest Pipe Company Site, actual groundwater movement against the predominant flow direction is negligible given the combination of low hydraulic gradient, low hydraulic conductivity, short duration, and the overall flow regime of flow toward the Willamette River, the regional groundwater discharge point. The strongest gradient across the Southeast Area (0.0013 ft/ft) was measured during a period of south to southwest flow from MW-05 to MW-06 to MW-03 in July 2017.
- Hydraulic conductivity in wells in and downgradient of the Southeast Area was investigated in 2016 (Table 5-79). The typical hydraulic conductivity for the shallow aquifer along the flow path ranges from approximately 2 to 25 feet per day. The hydraulic conductivity of MW-05 was calculated to be higher than the typical range (134 feet per day) indicating that this well is screened in an isolated zone of

[5] Selected maps (April 2017 and July 2017) from the 2016 to 2017 *Supplemental Groundwater Sampling and Data Evaluation* have been revised because of a conversion error from measured depth to groundwater to groundwater elevation.

higher hydraulic conductivity and not representative of the majority of the flow path. This zone of higher hydraulic conductivity is unlikely to have a substantial impact on groundwater flow rate since downgradient flow is limited by the bounding aquifer zones of lower hydraulic conductivity, including in the downgradient direction (CH2M, 2017).

The VOCs concentration trends in the plume interior of the Southeast Area are more complex than the consistently decreasing concentrations at the plume margins on the Port property (Figures 5-11a and 5-11b). As DEQ requested, the concentration trend plots are presented at differing concentration scales to magnify the trends observed. The variability of concentration within the plume interior represents higher- and lower-concentration zones within the plume flowing past individual monitoring wells.

Monitoring wells MW-01, MW-02, and MW-04 have reported the lowest VOCs concentrations of the wells along the perimeter of the plume in the Southeast Area. Concentrations of VOCs in MW-02 are low and remain the lowest in the Southeast Area. Concentrations in MW-01 have decreased since the last measurement events in 2003 to 2007. Concentrations in MW-04 are generally stable to decreasing, with the exception of cis-1,2-DCE, which is higher than measured in 2007, but about half of the peak concentration measured in 2004. Concentrations in MW-05, along the upgradient edge of the Northwest Pipe Company Site, show increasing trends.

To provide the line of evidence that degradation is occurring, and to allow a clear interpretation of VOC trends, VOC concentrations were converted from µg/L micrograms per liter to micromoles per liter (µmol/L, based on molarity) by dividing concentration data for different VOCs by molecular weight using data from the three wells along the assumed centerline, or highest concentration zone, of the plume (MW-05, MW-06, and MW-03) (Figure 5-12). This removes the effect of different molecular weights for different constituents. The resulting plots allow for the direct comparison of the magnitude of different VOCs in each subsequent well. The three plots have different axes to allow for the detail of the concentration trends to be observed. PCE is a definitive parent compound, while TCE may be a parent compound or a breakdown or daughter product of PCE.

Additional evidence of degradation beyond the Southeast Area is observed when average molar concentrations are compared between wells in the Southeast Area and wells on Port property for principal VOCs. Average molar concentrations are presented for the three highest-concentration wells in the Southeast Area (MW-05, MW-06, and MW-03), along with Port wells T4S1MW-22 (cross-gradient, from the plume, but higher concentrations than T4S1MW-23), T4S1MW-03Ss, and T4S1MW-09 closest to Slip 1 (Figure 5-13). Molar concentrations of PCE are reduced from an average of 18.5 µmol/L at MW-05 to 3.5 µmol/L at MW-03. Degradation product cis-1,2-DCE peaks in concentration at MW-06 and is further degraded by the time groundwater reaches MW-03. Downgradient on the Port- property, all average VOC molar concentrations are less than 0.05 µmol/L, confirming VOC concentrations are substantially reduced on the Northwest Pipe Site, and further reduced to very low levels before reaching the Port wells T41MW-03S and T4S1MW-09.

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The presence of PCE and TCE daughter products, in particular the more common biological breakdown product of cis-1,2-DCE (compared to 1,1-DCE and trans-1,2-DCE), and vinyl chloride in the shallow groundwater indicates that natural attenuation from reductive dechlorination is occurring (EPA, 1998). In addition, the elevated chloride concentrations in the source area (in well MW-06) and the geochemically reducing conditions (Table 3-4) are consistent with conditions indicating active reductive dechlorination processes.

To supplement the evidence of reductive dechlorination, natural attenuation parameters were also analyzed for Southeast Area groundwater and the potential for natural attenuation was evaluated. Reductive dechlorination is most effective in the range corresponding to sulfate reduction and methanogenesis (which occurs through the reduction of carbon dioxide). Groundwater chemistry that indicates sulfate-reducing or methanogenic conditions includes the following:

- Low DO concentrations, typically less than 0.5 mg/L
- Low ORP, typically less than 50 millivolts (mV) and preferablye less than -100 millivoltsV
- Low concentrations of nitrate, typically less than 1 mg/L

- The presence of ferric iron ($Fe2+$), which results from the reduction of $Fe3+$, at concentrations greater than 1 mg/L

Natural attenuation parameters were measured in 2005 and from 2016 through 2019 to evaluate the potential for reductive dechlorination based on geochemical conditions at the Site (Table 3-4). DO and ORP levels measured at site monitoring wells typically meet the criteria for sulfate-reducing or methanogenic conditions listed above. Additionally, pH measurements are within the range amenable to microorganism survival, and the alkalinity (measured in 2005) is sufficient for buffering the pH against acids produced during biodegradation.

Evaluation of the Site's natural attenuation data using EPA's screening worksheet shows the Site has a strong evidence for reductive dechlorination based on geochemical conditions (EPA, 1998). The evaluation used data from MW-02 for background conditions for both datasets. For data representing the most elevated zone of VOCs, wells MW-01, MW-04, and MW-06 were selected for 2005 and MW-05 and MW-06 were selected for 2016 through 2019. The potential for reductive dechlorination on the Port property was also evaluated for 2016 through 2019 using wells T4S1MW-03S, T4S1MW-09, T4S1MW-23, and T4S1MW-24, though the evaluation is intended for use with data from the most elevated zone (EPA, 1998). Table 5-10 contains the worksheet, along with scores assigned to the Northwest Pipe Company facility for 2005 and 2016 through 2019, and to the Port of Portland property wells for 2016 through 2019 based on available monitoring well data. The total scores of 23 for 2005 data and 23[6] for 2016 through 2019 for Northwest Pipe Company Site data both fall within the "strong evidence" category identified by EPA for VOC degradation via reductive dechlorination (EPA, 1998), indicating that geochemical conditions at the Site are conducive to reductive dechlorination and consistent with the observed limited migration of VOCs. The score for the Port of Portland wells is 8 for data collected from 2016 through 2019 falling within the "limited evidence" category identified by EPA for VOC degradation via reductive dechlorination (EPA, 1998). However, these wells are located significantly downgradient of the Southeast Area where VOC concentrations have already undergone significant reductive dechlorination. These results are meaningful in that they indicate the interval of the aquifer between MW-06 and MW-03 is very important to removing a substantial fraction of the VOCs from groundwater. Furthermore, the much slower rate of biodegradation that evidently is happening downgradient of MW-03 is still very important in further reducing concentrations to acceptable levels, owing to the great distance over which this slower degradation rate has the opportunity to operate.

Consistent with the data collected from groundwater monitoring over nearly 20 years at the Site, an MNA Work pPlan is being developed and will follow the submission of this document. Considering the observed groundwater concentrations both on the Northwest Pipe Company Site and on the Port of Portland property near Terminal 4 Slip 1, the VOCs that have been documented in Southeast Area groundwater are contained by ongoing MNA processes.

[6] Ferrous iron concentrations for the data period of 2016 through 2019 were used from sampling events conducted in December 2018, May 2019, and October 2019.

6. Stormwater Source Control Measures

This section presents the key SCMs implemented by Northwest Pipe Company from 2009 through 2012. Stormwater management measures taken prior to 2009, or pre-SCMs, are summarized in Section 4.1. Current and ongoing stormwater improvement activities, pre- and post-SCMs, are summarized in Section 4.2. Key actions from all periods are summarized in Table 4-1.

6.1 Main Production Building Roof Cleaning and Coating

During summer 2009, Northwest Pipe Company cleaned and coated the roof of the Main Production Building, covering approximately 292,320 square feet (6.7 acres) of galvanized roofing, as part of its source control efforts. After the cleaning and coating project was complete, an investigation provided data to show the roof improvements were effective in reducing zinc discharging from the Site by 98 percent (see Section 5.1.34).

6.2 Stormwater Catch Basins and Conveyance System Improvements

A video inspection was conducted of lengths of the stormwater system to document existing conditions (CH2M HILL, 2011) (Figure 6-1). The video inspection encountered four previously unknown features: two catch basins that were either covered by pavement or not functioning, as well as two tributary lengths of pipe that were not functioning. These features were all located in the eastern corner of the leased portion of the Site (Figure 6-1). Based on the results of the investigation, Northwest Pipe Company determined that the area around these features should be excavated and the features closed off and properly abandoned. Northwest Pipe Company contacted the property owner, 12005 Burgard Equities, at the time of the recommendations, but the property owner declined to allow Northwest Pipe Company to construct infrastructure upgrades. Since the previously unknown catch basins and tributary lines were confirmed as not functioning during the video inspection, no migration of stormwater offsite can occur through them. Instead, stormwater runoff in this portion of the Site is directed to a trench drain and ultimately enters the onsite stormwater treatment system. Consequently, potential stormwater sources are effectively collected and treated prior to discharge, and therefore controlled.

Following the video inspection, Northwest Pipe implemented improvements to the stormwater system including the following actions (listed in Table 4-1 and shown on Figure 4-2, actions numbered 23 through 29):

- Installed six new clean-out manholes in the east side stormwater piping, to access stormwater pipes for cleaning.
- Installed one new catch basin on the west side of the railroad tracks to improve accessibility.
- Installed three new catch basins on the eastern-most stormwater line near the Paint Shed to improve drainage.
- Installed four new stormwater drainage basins to improve drainage in the north end of the property.
- Uncovered a catch basin located near east end of the historic Bay 11 and put into use, thereby improving drainage.
- Installed a diversion drain to prevent water from entering Bay 9.
- Redirected Sample Point 5 to Sample Point 3 by installing a cross-over pipe, reducing three stormwater discharge points to the communal Outfall 18 to two discharge points.

Other ongoing stormwater management measures include the installation of stormwater diversion structures in 2011 to reduce run-on from neighboring properties (concrete eco-blocks, as described in Section 6.3), installation of diversion drains in 2011 to prevent runoff from entering buildings and improve drainage (Numbers 26 and 28 on Figure 4-2), replacement of catch basins in 2015 from flow through to

Lynch style to promote more effective settling of solids, and installation of an additional drain at the northern rail crossing to improve drainage (Number 36 on Figure 4-2).

6.3 Site Grading and Capping

As discussed in Section 3.1.21, Northwest Pipe Company completed an IRM in 2012 to address potential risk to Site workers posed by PAHs and PCBs in surface soil from past practices as a shipyard, and to reduce the potential for soil erosion and transport via stormwater. The IRM occurred between July 2011 and June 2012, and consisted of hot spot removal, grading, storm drain line improvements, and paving of approximately 4 acres of previously-unpaved soil. In addition, concrete eco-blocks (2 feet square in cross section and 6 feet long) were placed in the area of soil sloughing to minimize future sloughing onto the Site.

During capping activities, the Site was regraded to improve stormwater drainage, a drywell was removed, and several other stormwater flow modifications were completed (see Section 6.2 for additional details). The cement-mortar lining area was converted to an isolated drainage zoneIDZ in October 2009 to segregate and collect precipitation from the area surrounding the mortar lining and coating plant. Stormwater captured in this area is used in production activities and kept separate from the stormwater leaving the Site via permitted stormwater discharge points. Berms were added to the outdoor transformer and transformer storage areas. Regrading also targeted reducing or preventing offsite run-on where possible.

As part of this effort, CH2M HILL Engineers, Inc. completed a hydraulic analysis of the facility's stormwater conveyance system to confirm that increased runoff caused by paving the remaining unpaved portions of the Site would not cause temporary flooding during the design storm events (24-hour, and 2-, 10-, and 25-year storms[7]). Results of the modeling, completed with XP-SWMM stormwater modeling code, were used to develop and evaluate a grading plan to promote effective runoff management. A copy of the analysis and grading plan are provided in Appendix G. The modeling included in Appendix G represents a predictive model assessing the carrying capacity of the stormwater conveyance system and the potential impacts from increased runoff due to the 2009 through 2012 SCM regrading, additional site paving, and stormwater discharge point modifications, which are described in Section 6.2. Since the work was completed in 2012, the stormwater conveyance system has been and remains adequate for managing stormwater without interfering with facility production or site management. The stormwater flow capacity on the Site is consistent with or exceeds model predictions.

The IRM also included the development of a site-wide Contaminated Media Management Plan (CMMP). An updated copy of the CMMP is attached as Appendix H. The CMMP provides guidance to plant staff describing how to manage potentially affected media to which receptors may be briefly exposed during short-term subsurface construction activities in the future (CH2M HILL, 2011).

The Site's pavement cap is routinely inspected and maintained. An example map from a paving inspection completed November 30, 2017, with notation of areas repaved or repaired since the IRM was implemented from 2011 through 2012, is presented on Figure 6-2.

6.4 Installation of Industrial Stormwater Treatment Systems

In 2011, Northwest Pipe Company installed two state-of-the-art industrial stormwater treatment systems, one on each stormwater line carrying water to the Outfall 18/WR-123 communal outfall (Number 30 on Figure 4-2). The two systems, marketed as the Aquip system by StormwateRx, LLC (StormwateRx) of Portland, Oregon, include a diversion structure that captures stormwater in the first portion of a settling

[7] The precipitation scenarios used for evaluation of the stormwater conveyance system differ from that used for the sizing of the stormwater treatment system (0.83 inch of rainfall over a 24-hour period). The stormwater conveyance system capacity was evaluated using anticipated flows from various storm events, while the design criteria for the sizing the two aboveground stormwater treatment systems (discussed subsequently) were required by Appendix E of the City of Portland's Stormwater Management Manual (2016). The differing purposes of the evaluations account for the difference in evaluation criteria.

basin. Water in this basin is pumped into holding tanks; from the holding tanks, the water is pumped into the filtration system where it percolates through a sand medium to remove particulate matter. The water is gravity fed through the filter medium and into the second portion of the diversion structure for each system, where it discharges into the existing stormwater line. The system is constructed with two pumps in the diversion structure. The secondary pump provides redundancy; if one pump fails, the system will still operate at capacity. During a heavy rain event, both pumps turn on to pump water to the retention tank. As the rain event subsides, water in the tank continues to be processed through the filter. A copy of the operations manual is included in Appendix I.

This system was designed specifically for the Northwest Pipe Company Site. A single-storm hydrograph-based analysis (the Santa Barbara Urban Hydrograph) was used to calculate the flow rate for 0.83 inches of rainfall over a 24-hour storm event (which accounts for 90 percent of the average annual runoff) and Natural Resources Conservation Service Type IA rainfall distribution. Consistent with the City of Portland's Stormwater Management Manual (2016), the 10-year peak flow rate was calculated using the rational method for conveyance pipe sizing of the storm drain line to connect existing stormwater discharge points, resulting in a required system capacity of 55,034 gallons. The system capacity was based on the ability of the system to treat 100 percent of the resulting volume from the statistical storm event within a 24-hour period, which is beyond the 90 percent value contained in the Stormwater Management Manual. The northwest treatment system has a total storage capacity of 35,383 gallons, 868 gallons greater than required (StormwateRx, 2011). ~~and t~~The northeast treatment system has a total storage capacity of 27,977 gallons, 7,458 gallons greater than required (StormwateRx, 2011). Together, the systems ~~which together~~ provide a 63,360-gallon capacity. Sufficient capacity has been demonstrated under a wide range of precipitation conditions during the ten years of successful operation since the system was installed, including 2012, when precipitation was 163 percent of normal (WorldClimate 2021; Lawrimore 2016). If the capacity of the stormwater treatment system were to be exceeded, an overflow valve would allow discharge to the ground within the Site boundary. This stormwater overflow would recirculate through the Site's stormwater system until precipitation diminishes and stormwater loading to the treatment system decreases sufficiently to allow the system to catch up with the total treatment demand.

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In response to a September 12, 2019, follow-up question from EPA and DEQ regarding the impact of particulate loading to filter media and resulting diminished pore space, StormwateRx reports that the filters installed in the Northwest Pipe Company treatment systems (Aquip filters) are designed and intended to operate significantly below the maximum hydraulic capacity to allow accumulation of solids in the filter media pore spaces, which is a necessary consequence of suspended particulate removal. The design treatment flow rates for each Aquip filter correspond to a surface loading rate of 1 gallon per minute ~~(gpm)~~ per square foot of media bed surface (Appendix I). However, Aquip filters with equivalent media and hydraulic designs have demonstrated flow capacity at surface loading rates up to 3.5 ~~gpm~~ gallons per minute per square foot. This capability allows the filter to remain in operation at its design treatment flow rate for extended periods of time between maintenance intervals.

In response to a September 12, 2019, follow-up question from EPA and DEQ regarding the impact to the system from stormwater run-on from off-site, Northwest Pipe Company has reduced the run-on by Site regrading during and after the IRM. More significantly, the City of Portland Burgard Overpass project, which increased run-on to the Site, has been completed as has the neighboring Portland Container (former Union Carbide site) stormwater rerouting project, which was also overseen by BES. The original design of the treatment storage volumes resulted in additional capacity as described above. Current run-on from offsite was re-evaluated in January 2020 to assess the effect (flow rate and volume) on the existing treatment system design. StormwateRx estimates that the existing treatment system has sufficient surplus pump capacity and detention storage capacity to accommodate the observed occasional run-on from off-site. As part of its ongoing implementation of BMPs, Northwest Pipe Company regularly evaluates areas of potential run-on and whether grading or other measures to reduce or eliminate run-on are warranted.

6.5 Other SCMs and Stormwater System Improvements

Northwest Pipe Company completed various additional stormwater improvements and SCMs from 2009 through 2012 (Table 4-1). In 2009, curbing was added around the around transformer area (north of Bay 9) and transformer storage area (north of Bay 6). In 2010, Northwest Pipe Company relocated its outdoor cement-mortar rebound storage under cover. In 2011, covered exterior waste bins were installed and scrap metal staging bins were moved under covered storage. In 2012, Northwest Pipe Company installed a segregated stormwater drainage system, which discharges to the City of Portland sanitary sewer, at its fuel transfer area. The system includes an oil-water separator and a shut-off valve.

6.6 2009-2012 SCMs Conclusion

Northwest Pipe Company has implemented a variety of SCMs and BMPs to reduce or eliminate legacy pollutants and prevent industrial activities from impacting stormwater. Table 4-1 provides a summary of these measures, which include the primary Site SCMs of installation of two state-of-the-art stormwater treatment systems, cleaning and coating of the Main Production Building roof, modification of the stormwater system to create isolated drainage areas in conjunction with construction of covered areas over sensitive operations and such as the cement mortar rebound storage area and the fueling area, material usage changes to limit potential contaminants at the Site, as well as enhanced facility sweeping and cleaning procedures. Northwest Pipe Company is committed to continue to implement improved stormwater management practices and SCMs, and will continue to monitor the effectiveness of these activities. In addition to the two stormwater treatment systems, Northwest Pipe Company facility management uses a Preventive Maintenance program, a CMMP, performance monitoring, implementation of NPDES BMPs, and corporate environmental oversight, as its normal course of business. As such, stormwater at the Site poses no threat to the Willamette River since any potential sources of contamination to stormwater at the site are contained and Site stormwater is treated prior to discharge. Adequate measures are in place to ensure source control and good stormwater management measures continue into the future. Section 7 presents how these SCMs have been effective at improving stormwater for the Site.

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7. Source Control Evaluation

This section presents the source control evaluationSCE for the stormwater pathway (Section 7.1) and the groundwater pathway (Section 7.2). The stormwater pathway evaluation presents evidence in support of the determination that stormwater source control is complete, and no additional stormwater characterization or SCMs are needed at the Site. The groundwater pathway evaluation provides the results of a human health and ecological risk screening concerning the groundwater discharge to surface water pathway evaluation. As presented in Section 5, groundwater in the Southeast Area is likely to be subject to ongoing monitoring. An MNA groundwater sampling Wwork pPlan currently is being developed in response to agency requests.

7.1 Stormwater Pathway

The implementation of stormwater SCMs described in Section 6 has resulted in significant improvement in the quality of stormwater discharging from the Site. Section 7.1.1 presents the final source control sampling events of 2012 and 2013. Section 7.1.2 presents additional lines of evidence regarding the effectiveness of stormwater source control, including more recent stormwater sampling conducted to support the Site's 1200Z permit. Constituent concentrations from those more recent samples were averaged with those from the 2012 and 2013 sampling events to yield post-SCM concentrations which were then compared to averaged pre-SCM stormwater constituent concentrations presented in Section 5.1.1. This comparison supports a Source Control Decision of No Further Action for stormwater by illustrating that the primary Site SCMs, as well as numerous other past and ongoing stormwater management measures and Site BMPs, have successfully reduced all remaining detected Site COIs between 62 to 99 percent (Section 7.1.2.2).

7.1.1 Final Source Control Stormwater (2012 and 2013, Post-SCMs)

Source control stormwater sampling in 2012 and 2013 was conducted in accordance with the DEQ-approved Final Supplemental RI/SCE Work Plan (CH2M HILL, 2009a) and the updated Work Plan 5: Final Stormwater Source Control Evaluation (CH2M HILL, 2012b). Samples were collected December 11, 2012, and May 22, November 18, and December 20, 2013, at sample points SP-003 and SP-004. Samples were evaluated for TOC, TSS, pH, inorganics, PCBs, VOCs, chlorinated pesticides, phthalates, and PAHs. Data associated with these sampling events, screened against surface water ROD CULs for RAOs 3 and 7 (Table 17 from EPA, 2017), are presented in Table 7-1. Where ROD CULs were not available, JSCS SLVs for Groundwater/Surface Water/Stormwater were used for screening site stormwater data. Sample locations are shown on Figure 5-1, laboratory analytical reports are provided in Appendix C, and data validation reports are included in Appendix D. Figures 7-1a through 7-1d show the time of sample collection for each event compared to the rainfall events noted for the City of Portland's HYDRA Shipyard Rain Gage[8] located at 8900 North Sever Road, approximately 225 feet east of the eastern boundary of the Site.

Of the total 13 inorganic constituents sampled, eight had concentrations less than ROD CULs or JSCS SLVs. Some aluminum, arsenic, copper, and zinc concentrations exceeded ROD CULs for surface water/drinking water and some lead concentrations exceeded the JSCS SLV, all at exceedance factors of less than 10.

Low concentrations of PAHs were detected in the stormwater samples, generally less than laboratory reporting limits, with the exception of the seven individual PAHs (benzo(a) anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) that exceeded surface water/drinking water ROD CULs. Sampling events with exceedances occurred in December 2012 and May 2013.

[8] The City of Portland's HYDRA Terminal 4 NE Rain Gage was retired August 25, 2011 and the Shipyard Rain Gage began operation on August 11, 2011.

Of the remaining constituents (PCBs, pesticides, phthalates, and TPH), no PCB Aroclors or oil and grease were detected in stormwater source control samples. Three pesticides were detected at concentrations less than laboratory reporting limits. Two of those constituents (aldrin and DDT) exceeded their surface water/drinking water ROD CULs, both at greater than 10 times the ROD CULs. Pesticides are not manufactured, stored, or used on the Site. The sporadic nature of the detections, as well as the low concentrations detected, indicate that the Site is not a source of pesticides and does not pose a risk to potential receptors in the Willamette River attributable to pesticides.

Phthalate esters were generally less than laboratory reporting limits, except for bis(2-ethylehexyethylhexyl) phthalate and di-n-octyl phthalate. Both detected phthalates exceeded their respective ROD CULs or JSCS SLVs, but both had exceedance factors of less than 10. Because phthalates are not used nor are they a byproduct of activities at the Site, phthalates were not included in the suite of analysis for the catch basin solids samples. At DEQ's request, Northwest Pipe Company included phthalates as an analytical constituent for SCE stormwater samples. The Site's stormwater data indicate there was a low detection of only one phthalate during the sampling events at concentrations slightly exceeding ROD CULs or JSCS SLVs. Based on these results (few detections, barely exceeding ROD CULs or JSCS SLVs), it can be concluded that the Site is not contributing to releases of phthalates to the Willamette River via stormwater at concentrations exceeding DEQ target risk levels.

The implementation of stormwater SCMs described in Section 6 has resulted in significant improvement in the quality of stormwater discharging from the Site. Some constituents such as PCBs and oil and grease now have concentrations less than laboratory reporting limits, while all remaining detected constituent concentrations are significantly reduced. Section 7.1.2 presents more recent stormwater sampling conducted to support the Site's 1200Z permit. Constituent concentrations from those more recent samples were averaged with those from the final source control sampling events of 2012 and 2013 to yield post-SCM concentrations which were then compared to averaged pre-SCM stormwater constituent concentrations presented in Section 5.1.1. The results of this comparison are presented in Table 7-2. This comparison supports a Source Control determination of No Further Action for stormwater by illustrating that the primary Site SCMs, as well as numerous other past and ongoing stormwater management measures and Site BMPs, have successfully reduced all remaining detected Site COIs between 62 to 99 percent (Table 7-2).

7.1.2 Other Lines of Evidence – Stormwater

This section presents other lines of evidence indicating the stormwater pathway is controlled for the Site.

7.1.2.1 1200Z Stormwater Sampling

In addition to the 2012 to 2013 source control stormwater sampling event, more recent stormwater data for the Site are available through the Site's 1200Z permit required sampling. NPDES sampling events since 2013 included the following: March 26 and May 29, 2014 (SP-003 and SP-004); November 15 and December 27, 2017 (SP-001 and SP-002 – note locations were renamed from SP-003 and SP-004, respectively); January 22, March 13, November 30, and December 20, 2018 (SP-001 and SP-002); and February 12 and June 7, 2019 (SP-001 and SP-002). These events were all conducted at the Site's two NPDES sampling ports located downstream of the Site's stormwater treatment units. Because of the storage and treatment elements of the Site's stormwater treatment system, the concept of capturing samples that meet DEQ's definition of a "first flush" were not relevant for these sampling events. Samples were collected within 10 minutes of manually initiating discharge by opening a valve in the treatment system.

The Site's NPDES permit requires monitoring for copper, lead, zinc, pH, TSS, oil and grease, iron, aluminum, cadmium, nickel, mercury, aldrin, chlordane, cyanide, dieldrin, hexachlorobenzene, DDT, DDE, pentachlorophenol, PCBs, and PAHs (acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene and pyrene). The Site received stormwater sampling waivers for sampling locations and parameters (Appendix A). Northwest Pipe Company received monitoring waivers from the City of Portland in 2014, 2018, and 2019 for the 1200-Z general stormwater discharge permit. In

September 2014, a monitoring waiver was granted for all parameters at both monitoring points for the remainder of the permit term. In September 2018, a monitoring waiver was approved for both sample points for pH, TSS, oil and grease, copper, lead, zinc, iron, and aluminum for the remainder of the permit term. In July 2019, a monitoring waiver was approved for the remaining constituents at the two sample points for the remaining 3 years of the permit term.

Data collected between 2014 and 2019 are presented in Table 7-3 and screened against NPDES benchmarks as well as ROD CULs for surface water for RAOs 3 and 7 (Table 17 from EPA, 2017). Where ROD CULs were not available, JSCS SLVs for Groundwater/Surface Water/Stormwater were used for screening site stormwater data. Sample locations are presented on Figure 5-1 and laboratory analytical reports are provided in Appendix C. As discussed in Section 7.1, a significant reduction in the concentrations of constituents was measured in stormwater in 2012 through 2019 (Tables 7-1 and 7-3) compared to stormwater collected in the pre-SCMs period of 2003 through 2007 (Table 5-1). The implementation of stormwater SCMs described in Section 6 resulted in reducing concentrations of some constituents to less than the laboratory reporting limits (including PCBs and oil and grease), while all remaining detected constituent concentrations were reduced between 62 to 99 percent (Table 7-2). This reduction emphasizes the cumulative improvement in stormwater quality resulting from the primary Site SCMs, past and ongoing stormwater management measures, and Site BMPs.

7.1.2.2 Northwest Pipe Stormwater Sample Results Compared to Other Harbor Sites

Figures 7-2a through 7-2k present plots developed by DEQ in 2009 of the concentrations of “typical” and “elevated” industrial stormwater concentrations for certain constituents identified by DEQ (DEQ, 2010a; data updated October 2015). Northwest Pipe Company stormwater data collected post-SCMs were evaluated for minimum, maximum, and average values and compared to the DEQ Portland Harbor data shown in the graphs. Inorganic constituents are well within the typical range noted by DEQ. The concentrations in stormwater leaving the Site of organic COIs, for which DEQ provides a comparison chart (DEQ, 2010a), were found to be substantially less than the “toe of the slope” indicating where typical concentrations transition to elevated concentrations. In summary, stormwater discharging from the Site is at lower concentrations than DEQ has documented as discharging from the majority of other facilities in the Portland Harbor study area.

7.1.2.3 Effectiveness of Stormwater Source Control Measures

Northwest Pipe Company has been in material compliance with its NPDES stormwater permit since beginning Site operations. Numerous source control actions have been completed at the Site over the past 30 years to improve the quality of stormwater discharging from the Site (Table 4-1). Table 7-2 compares the average concentration in stormwater samples collected from the pre-SCMs period of 2003 to 2007 with the average results from the post-SCMs period of 2012 to 2019. As noted in Table 7-2, PAH concentrations have decreased by an average of 91 percent, with decreases ranging from 62 to 99 percent for individual compounds. No PCB Aroclors were detected in the samples from 2012 through 2019, with laboratory reporting limits less than previously detected. Lastly, zinc concentrations from 2012 through 2019 were 89 percent lower, on average, than in 2001 to 2007, attributable at least in part to a 98 percent zinc concentration reduction in roof runoff accomplished by coating the roof of the Main Production Building. These results indicate the source control actions taken by Northwest Pipe Company have had a significant and beneficial effect on improving stormwater quality at the Site.

7.1.2.4 Lower Willamette River Sediment Data in IT Slip

Outfall 18/ WR-123 discharges into the IT Slip, which is connected to the Willamette River. Sediment analysis has indicated the presence of arsenic, cadmium, copper, mercury, silver, tributyltin, zinc, PAHs, phenol, PCBs, and selected pesticides in certain samples from the IT Slip vicinity (LWG, 2012). Only a few of these constituents were found at elevated levels in sediment around Outfall 18; specifically, arsenic, copper, zinc, PAH, PCBs, and pesticides. In addition, tributyltin and phenol, along with other constituents, are not COIs for the Northwest Pipe Company Site (CH2M HILL, 2009a). Comparing the list of COIs for the Site with constituents found at elevated concentrations in sediment near the Site’s only connection to the IT Slip at communal Outfall 18/WR-123, the potential focus of concern for potential recontamination of the IT Slip in the future might be for arsenic, copper, zinc, PAHs, PCBs, and chlorinated pesticides.

As described in Section 7.1, the stormwater source control sample data for arsenic, copper, and zinc indicate low concentrations generally near or less than ROD CULs. The very low ROD CULs for these constituents are for the drinking water exposure pathway for surface water, an improbable pathway for the IT Slip and consequently the Site. The arsenic concentrations reported in stormwater samples were well below levels protective of aquatic biota. As described in Section 7.1, concentrations of PCBs, PAHs, and chlorinated pesticides in Northwest Pipe Company stormwater discharge are very low to non-detectable.

The Site currently constitutes approximately 27 30 percent of the drainage area of the outfall (Jacobs 2021a). Stormwater leaving Outfall 18/WR-123 would naturally mix with the water in the communal stormwater lines in the drainage basin. This communal discharge also further mixes upon entering the IT Slip, immediately lowering concentrations to less than even the low values detected in source control samples. This mechanism is particularly important to note for the three metals (copper, lead, and zinc) that were detected at low concentrations in Site stormwater, but exceeding ROD CULs or JSCS SLVs. The only screening scenario that was exceeded was that for chronic (that is, long-term) exposure by aquatic organisms, an exposure scenario that could occur only after the stormwater had discharged and any constituent concentrations lowered by mixing with the large quantity of water in the IT Slip.

In summary, with implementation of the SCMs identified in Sections 4 and 6 and the low to non-detectable levels of suspended solids in stormwater discharging from the Site, potential sources of contaminants to the river have been controlled and consequently should not affect stormwater quality leaving the Site at levels that would result in risk to potential receptors in the Willamette River or a risk of sediment recontamination in the future.

7.1.2.5 Sediment Analysis near Outfall 18/WR-123 in the IT Slip

Sediment characterization in the IT Slip near the outfall serving the Site shows that the east end of the IT Slip near Outfall 18/WR-123 is a stable to depositional environment rather than an erosional environment. Evaluation of changes in sediment surface bathymetry over time in the slip show specific areas within the central and western part of the slip closer to the Willamette River, mostly in the time interval from 2002 to 2009, where the sediment surface elevation decreased (CH2M HILL, 2009b; AECOM and Geosyntec, 2019). These locations likely correspond to a 2004 maintenance dredging project completed in the IT Slip under Oregon Division of State Lands Permit Number 30897-RP.

Constituent fingerprinting (CH2M HILL, 2010c) demonstrates that sediment quality in the immediate vicinity of Outfall 18/WR-123 can be distinguished from sediment quality in other parts of the IT Slip as well as from the main stem of the Willamette River. This finding is consistent with an isolated area of limited dimensions that is effectively separated from the rest of the slip and the Willamette River by over a thousand feet of quiescent water and a generally depositional environment for sediment.

These findings show that stormwater from the Northwest Pipe Company Site has very little, if any, effect on the Willamette River. The IT Slip is a stable to depositional environment, indicating low flow rates of the receiving waterbody to the Site's stormwater. Suspended sediments carried by the stormwater discharging into a quiescent waterbody would settle more rapidly and be more likely to settle in a localized area rather than being more broadly dispersed downstream. Therefore, stormwater from the Site impacts a discrete area at the head of the IT Slip, but it does not reach the main stem of Willamette River. Any effects from Site stormwater to slip sediment are contained and localized. Effects from Site stormwater are demonstrably small, with the Site comprising only approximately 27 30 percent of the total drainage area to the IT Slip (Jacobs 2021a) and contributing very low concentrations of COIs. Lastly, the affected area is located in an area corresponding to regular maintenance dredging.

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7.1.2.6 Weight of Evidence Evaluation

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This section presents a summary of the weight-of-evidence indicating stormwater is unlikely to have an adverse effect on water or sediment quality in Portland Harbor. This evaluation includes the site-specific factors listed in Section 5.3 of the JSCS guidance document (DEQ and EPA, 2005). Many of these factors are addressed elsewhere in this SCE and these discussions have been cross-referenced.

- **Identification and characterization of potential source of contaminants:** The Site has a nearly 80-year history of heavy industrial use beginning as part of a World War II shipyard and transitioning into a steel water transmission pipe manufacturing facility. Historical potential contaminant sources and soil and groundwater concentrations of COIs are reviewed in Section 3.1. As described in Section 3.3, the COIs for the site are inorganic constituents (aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), PAHs, PCB Aroclors, TSS, TOC, and VOCs. Potential contaminant sources to stormwater (that is, unpaved soil, stored materials, and settled solids) were either removed or controlled by a wide range of actions taken over the past 30 years.

- **Magnitude of storm-water and storm-water sediment exceedance at each sampling point and proximity of sampling point to the river:** Stormwater data, roof runoff data, and catch basin solids data collected between 2003 and 2008 are presented in Sections 5.1.1, 5.1.2, and 5.1.4, respectively, to characterize pre-SCM conditions. The implementation of stormwater SCMs described in Section 6 resulted in substantial improvement in the quality of stormwater discharging from the Site. Section 7.1.1 presents the final source control sampling events of 2012 and 2013, and Section 7.1.2 presents more recent stormwater sampling conducted to support the Site's 1200Z permit.

- **Regional background soil concentrations of naturally occurring chemicals for evaluating storm-water sediment:** Regional background soil concentrations for arsenic and zinc are addressed in Sections 3.1.1 and 5.1.3 (arsenic in surface soil and roof runoff, respectively) and Section 5.1.4 (zinc in catch basin solids).

- **Presence of bioaccumulative chemicals:** As discussed in the Ecological Risk Assessment in Section 7.2.1.3 for groundwater, the Site COIs are not bioaccumulative.

- **Site hydrology including Site conditions, size of drainage, and location and estimated size of discharge:** Sections 2.1 and 2.2 provide a detailed discussion of the Site conditions and the current Site stormwater conveyance system. The Site was paved as part of the IRM that was conducted under DEQ review and approval. The Site currently constitutes approximately 30 percent of the drainage area of the outfall (Jacobs 2021a). Stormwater leaving Outfall 18/WR 123 would mix with the water in the communal stormwater lines in the drainage basin.

- **Storm-water system design and management:** Section 2.2 describes the current understanding of the Site's operating stormwater conveyance system. Section 4 provides a summary of the historical stormwater system (Section 4.1) and modifications made to the system through the 2012 SCMs (Section 4.2). Sections 6.4 and 6.5 include key actions and improvements to the stormwater system, including installation of two state-of-the-art industrial stormwater treatment systems, one on each stormwater line carrying water to the Outfall 18/WR-123 communal outfall. BMPs associated with site operations are also addressed.

- **Maintenance and condition of conveyance system:** Section 4.2 describes the routine maintenance of the conveyance system. Northwest Pipe Company has implemented a variety of SCMs and BMPs to reduce or eliminate legacy pollutants and prevent industrial activities from impactingimpairing stormwater quality. Table 4-1 provides a summary of these measures. Northwest Pipe Company facility management uses a Preventive Maintenance program, a CMMP, performance monitoring, implementation of NPDES BMPs, and corporate environmental oversight, as its normal course of business.

Contaminant fate and transport, and physical properties: Potential contaminant sources to stormwater include unpaved soil, stored materials, deposition of fugitive dust emissions, and settled solids. As discussed in Section 2.1, groundwater is not expected to be preferably transported through the stormwater system as shallow groundwater, including seasonally high levels, occurs at greater depths than the Site drain lines. Consistent with this finding, dry weather flow in stormwater drains has not been observed at the Site. The potential contaminants associated with the stormwater pathway, are inorganics, PAHs, and PCBs as discussed in Section 5.1.;

Inorganic constituents, such as metals, are often associated with stormwater. Metals generally have low solubility in water and predominately are found in stormwater in association with suspended solids.

PAHs also have low solubility in water, which limits their mobility since they tend to adsorb to organic carbon in soil and are also associated with suspended solids. Solubility of the various PAHs decreases as the mass of the molecule increases (Johnsen, et. al., 2005). The log Kow for these compounds ranges from 3.3 (naphthalene) to 6.3 (indeno(1,2,3-cd)pyrene) (Sahu and Pandit, 2003). The persistence of PAHs in the environment generally varies in direct proportion to molecular weight, with the lighter PAHs, such as naphthalene, being relatively easily biodegradable while the heavier PAHs, such as benzo(a)pyrene, being relatively persistent in the environment.

PCBs are a class of chlorinated compounds in which chlorine atoms are attached to the biphenyl molecule. There are 209 possible PCB congeners. PCB Aroclors are made up of the most common commercial mixtures of specific congeners. PCBs are hydrophobic and tend to persist in the environment. The octanol/water partition coefficient (K_{ow}) values for PCBs vary by congener with literature having a wide range of values in some cases (EPA 1996).

Potential contaminant sources to stormwater (that is, unpaved soil, stored materials, deposition of fugitive dust, and settled solids) were either removed or controlled by a wide range of actions taken over the past 30 years (Table 4-1). The potential contaminants associated with the stormwater pathway, such as inorganics, PAHs, and PCBs, are discussed in several sections of this report including Section 5.1. Section 6 discusses SCMs in place to mitigate contamination sources and migration, which include cleaning and coating the Main Production Building roof; site grading and capping; and the stormwater treatment system, which is particularly effective at removing any hydrophobic or low-solubility contaminants that may enter the stormwater system.

The weight of evidence evaluation for COIs related to stormwater indicates that potential site contaminants for stormwater generally have low solubility, low mobility in the environment, and have been isolated from potential contact with stormwater by a range of SCMs reinforced with ongoing stormwater treatment and consistent implementation of BMPs aimed at controlling potential sources.

- ;**Estimate of potential contaminant loading to the river:** The implementation of stormwater SCMs described in Section 6 has resulted in significant improvement in the quality of stormwater discharging from the Site. As described in Section 7.1.2.2 and Section 7.1.2.3, the comparison of pre- and post-SCM data supports a Source Control determination of No Further Action for stormwater by illustrating that the primary Site SCMs, as well as numerous other past and ongoing stormwater management measures and Site BMPs, have successfully reduced all remaining detected Site COIs to between 62 to 99 percent (Table 7-2).

Based on these Site-specific factors, the weight-of-evidence evaluation indicates that stormwater is unlikely to have an adverse effect on water or sediment quality. This supports the analysis presented elsewhere in Section 7.1.

7.2 Groundwater Pathway

7.2.1 Groundwater Pathway and Risk Assessment

To support the assessment of the groundwater pathway source control evaluationSCE, a human health and ecological risk screening for the groundwater discharge to surface water pathway was conducted. While groundwater in the Southeast Area is likely to be subject to ongoing monitoring, this evaluation shows that groundwater samples collected since the Portland Harbor ROD was published indicate that areas of groundwater containing detectable COIs on the Northwest Pipe Company Site pose no threat to the Willamette River and, therefore, are contained.

7.2.17.2.2 Human Health and Ecological Risk Assessment Screening Evaluation

A conceptual site exposure model (CEM) was developed as part of the RI using regulatory guidance supplemented by information on constituent sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the Site to identify potentially complete human and ecological exposure pathways for groundwater COIs. Figure 7-3 is a comprehensive human health and ecological CEM conceptual site exposure model schematic for the Site, including information relevant to soil and groundwater. Upland exposures (pathways highlighted in orange on Figure 7-3) are evaluated in the RI, while offsite surface water exposures (pathways highlighted in blue on Figure 7-3) are evaluated as part of the SCE. Potential pathways of site-related COIs to the Willamette River could include groundwater discharge and stormwater runoff, which is collected and treated before offsite discharge.

The Willamette River is approximately 1,500 feet west of the Site, and the Site neither abuts nor discharges surface water directly to the main channel of the Willamette River. A groundwater divide occurs in the central part of the Site causing shallow groundwater to migrate offsite to the northwest and southwest. After migrating offsite to the northwest and southwest, groundwater continues to flow toward either the Willamette River or associated slips located north (IT Slip) and south (Terminal 4 Slip 1) of the Site, ultimately discharging either as subaqueous seepage or as seepage on the river bank above the river level, where it would be partially or (depending on season) completely lost to evaporation and/or plant transpiration processes prior to reaching the river. The Site discharges stormwater through a communal discharge pipe to the IT Slip. Both slips are active industrial slips, parts of which are regularly disturbed by vessel traffic and periodically dredged. The IT Slip is used for salvaging raw materials from ships and barges as well as loading ships and barges with scrap metal for reprocessing. Accordingly, ecological habitat is neither fostered nor encouraged; however, some hardier opportunistic plant and animal species that have adapted to the disruptive disrupted nature of industrial areas may be sparsely present. Some semi-resident piscivorous fish, such as smallmouth bass, are affiliated with certain in-water structures and, therefore, may be found in these slips. Also, anadromous fish may use the slips as temporary refuge and resting areas away from the main channel of the river.

Human exposure to Site-related COIs may be possible during recreational activities (such as fishing and swimming), and hypothetically in a future drinking water scenario. Therefore, as required by DEQ and EPA, groundwater concentrations are compared to ROD CULs and JSCS SLVs. Additionally, aquatic habitat in Terminal 4 Slip 1 and the IT Slip is disturbed by industrial activities, such as vessel movement and periodic dredging, and is degraded because of physical aspects of the slips, but may be capable of supporting some opportunistic aquatic species. Therefore, assuming that COIs at the Site could potentially reach either slip, a screening evaluation was undertaken to evaluate whether concentrations of COIs detected in shallow groundwater pose a potential for risk (exceeding DEQ targets) to aquatic resources and riparian wildlife (that is, birds and mammals) using the Terminal 4 Slip 1 and the IT Slip. The primary COIs identified at the Site related to groundwater are VOCs, with relatively low concentrations of petroleum hydrocarbons, PAHs, and arsenic.

The risk screening evaluation considers an offsite recreational user (dermal contact and incidental ingestion from exposure during swimming and fish consumption), a hypothetical future drinking water scenario, and exposure of aquatic organisms, birds and mammals to surface water. The assumptions included in these scenarios are discussed in the following sectionsSections 7.2.2.1 through 7.2.2.4.

~~7.2.1.1~~7.2.2.1 Offsite Recreational User Exposure Scenario

The potential route of exposure to groundwater for the offsite recreational user scenario is ingestion of fish that may have accumulated COIs. Dermal absorption and incidental ingestion of water during recreational activities are also considered complete, but less significant, exposure pathways. This exposure scenario assumes the following:

- These constituents migrate from groundwater to surface water without attenuating below concentrations of concern or levels of detection, which is contrary to the data presented in Section 5.2.2~~ of this report~~, and also a conservative assumption considering likely in-bank mixing.
- The constituents then bioaccumulate into fish despite low ~~octanol-water partition coefficients (~~K_{ow}~~)~~ particularly of VOCs (TCE log K_{ow}= 2.71, PCE log K_{ow}=2.67, and vinyl chloride log K_{ow}=1.50 [EPA, 1996]), which is recognized to be associated with low bioaccumulation rates.
- The fish are then consumed by humans in large quantities (17.5 grams per~~/~~day) over the course of a year, for 70 consecutive years.
- The IT Slip is privately owned and tightly controlled consistent with Department of Homeland Security requirements. Public access to the slip from the shore is intentionally prevented by chain link fencing, a locked and chained gate, and signage warning against trespassing. Fishers are, however, known to trespass at the slip. The Port of Portland's Terminal 4 is similarly protected against public access. Access to the slips by recreational boaters is known to occur on occasion, but the physical dangers presented by industrial activities, especially in the IT Slip (such as loading scrap steel over water using cranes and movement of large vessels in and out of the slip) serve to discourage frequent access.

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~~7.2.1.2~~7.2.2.2 Offsite Drinking Water Scenario

The potential route of exposure to groundwater/surface water for the Offsite Drinking Water Scenario is direct ingestion of the Willamette River or direct ingestion of groundwater from a shallow aquifer well near the Northwest Pipe Company Site in the path of a migrating plume. Receptor exposure in a future drinking water scenario would require several highly unlikely occurrences. This exposure assumes the following:

- River water used as drinking water also is unlikely for the same reasons. For the comparison of groundwater concentration data against ROD CULs presented in this document to be valid, a surface water intake would need to be constructed a short distance downstream from the City of Portland's combined sewer outfalls. These outfalls are explicitly permitted to discharge raw, untreated sewage into the river up to four times per year, triggering warnings to not have contact with river water (City of Portland~~,~~ 2013). Treatment technologies used to address sewage present in drinking water, such as aeration, ultraviolet oxidation, or ozonation, also would address the low concentrations of VOCs that may be potentially attributable to groundwater discharge to the river. Mixing between groundwater and surface water also would occur as groundwater seepage discharges and migrates vertically and laterally through the river to a potential surface water intake. Volatilization, photolysis, hydrolysis, or biodegradation of VOCs also occur in surface water, and these processes would further act to reduce VOC concentrations in water.

- For use of groundwater as drinking water, a shallow-aquifer drinking water well would have to be installed within the Port of Portland's Terminal 4 area. This area is zoned and actively used for heavy industry and is served by the City of Portland's municipal water system. Use of the shallow aquifer for drinking water is unlikely because of documented poor natural water quality in the shallow aquifer, specifically elevated concentrations of naturally-occurring iron, manganese, and arsenic due to reducing geochemical conditions. In addition, the shallow aquifer is documented as having poor well yield. Lastly, the shallow aquifer has never been used for water supply. The City of Portland public water system, which originates at Bull Run Reservoir and is supplemented by the Columbia South Shore well field in northeastern Portland, delivers readily available, high-quality municipal water. Thus, it is highly unlikely that the shallow aquifer would ever be used for a drinking water supply in the future.

A simplistic comparison of ROD CULs with groundwater concentration data from upland monitoring wells ignores all of the known existing attenuation factors.

~~7.2.1.3~~7.2.2.3 Ecological Exposure Scenario

Commented [A10]: Text in this section, as well as in section 7.2.2.4 and 7.2.2.5, was edited in response to DEQ comment 7.

Based on the Level I Scoping Assessment (CH2M ~~HILL,~~ 2005a) and evaluation of potential habitats and exposure pathways, the following ecological exposure pathways were reviewed to identify potentially complete exposure pathways ~~could be complete for~~ for receptors using the Willamette River ~~and are further evaluated~~:

- Potential future exposure of offsite aquatic resources to Site-related VOCs detected in shallow groundwater was considered a potentially complete~~,~~ exposure pathway if these chemicals migrate offsite and discharge to surface water
- Potential future exposure of birds or mammals that may ingest Site-related VOCs detected in shallow groundwater was considered a potentially complete exposure pathway~~,~~ if these chemicals migrate offsite and discharge to surface water
- Potential future exposure of upper trophic level birds or mammals through bioaccumulation of Site-related VOCs in shallow groundwater through the aquatic food chain was considered a minor exposure pathway and was not retained for further evaluation. The VOCs detected in shallow groundwater are not considered significant or persistent bioaccumulative chemicals as defined by DEQ and EPA guidance (DEQ 2007a; EPA 2000, 2005).

~~Jacobs has concluded that potential bioaccumulation of Site-related VOCs in groundwater through the aquatic food chain to upper trophic level birds or mammals is insignificant because none of the detected VOCs in groundwater from wells downgradient of the Site would be considered under DEQ and EPA guidance to be significantly or persistently bioaccumulative (EPA, 2000, 2005; DEQ, 2007b).~~

~~7.2.1.4~~7.2.2.4 Surface Water and Groundwater Risk Assessment Screening Methodology

Well-specific data from perimeter wells downgradient of the Site were evaluated in two groups; (1) 2001 through 2015 and (2) 2016 through 2019. The following screening benchmarks were used to determine the potential for unacceptable risk:

- DEQ Level II (DEQ, 2001) risk screening benchmarks for protection of aquatic organisms and wildlife (birds and mammals)
- Surface water and groundwater ROD CULs (EPA~~,~~ 2017~~2018~~) for protection of aquatic organisms, recreational users (such as ~~fisherman~~fishermen) and for use of the Willamette River as a drinking water supply
- For COIs without ROD CULs, the lowest of the groundwater and surface water SLVs from the JSCS guidance (DEQ, 2007a)

Data[9] from groundwater downgradient of potential source areas are directly compared with screening benchmarks described above and results are discussed in Section 7.2.2.5. This screening evaluation does not account for attenuation that would occur between the points of measurement and the potential points of exposure. That is, it is assumed that groundwater concentrations from the sample locations do not attenuate during transport through the aquifer prior to reaching surface water and, after discharging to the slip, that water concentrations in the slip would be the same as groundwater concentrations from the well sample locations. These are very conservative assumptions that would never be met in nature because: (1) they are contrary to the natural attenuation data described in Section 5.2.2 ~~of this report~~ and (2) VOCs, if they were to discharge to surface water, would unavoidably and rapidly dissipate through photodegradation, volatilization, diffusion, and groundwater/surface water mixing.

[9] Carbon disulfide, which has been detected in 11 samples downgradient of the Site has not been used at the Site, it has not been detected in the groundwater samples from the Site, nor is it a daughter product of the COIs identified for the property. Carbon disulfide is attributable to the downgradient sites. For these reasons, carbon disulfide is not considered a COI for the Site.

7.2.1.57.2.2.5 Groundwater Risk Assessment Screening Results

Data from individual shallow groundwater samples collected from downgradient monitoring wells (T4S1MW-01, T4S1MW-07, T4S1MW-03S, T4S1MW-08, T4S1MW-09, and T4S1MW-10, representing groundwater quality nearest the point of discharge to the Terminal 4 Slip 1) and Geoprobes (GP-201, GP-202, and GP-203, representing groundwater quality nearest the point of discharge to the IT Slip) at locations downgradient of the Site and nearest to potential exposure points were used for this evaluation. The nearest exposure points, potentially, are Terminal 4 Slip 1 and the IT Slip off the Willamette River.

The results of this comparison are provided in Table 7-4 and the findings are as follows:

- No COI concentrations in groundwater samples exceed DEQ Level II SLVs for potential aquatic, bird, or mammalian receptors.
- No COI concentrations in groundwater samples exceed the surface water ROD CULs.
- COI concentrations for benzene, PCE, TCE, cis-1,2-DCE, and vinyl chloride exceed the groundwater ROD CULs in samples collected prior to 2016. Benzene's maximum factor of exceedance of 1.3 comes from GP-203. T4S1MW-03S (monitoring well location closest to Terminal 4 Slip 1) had the highest historical concentrations with maximum factors of exceedances of 1.3, 58, 5.8, 9, and 249 58 (PCE), 5.8 (TCE), 1.3 (cis-1,2-DCE), and 245 (vinyl chloride)6 for the respective COIs listed above, but more recent sampling and analysis since 2016 demonstrate that these concentrations values are not present in recent samples.
- No COI concentrations in groundwater samples collected from these downgradient monitoring wells during the period in 2016 through 2019 exceed groundwater ROD CULs.
- COI concentrations in groundwater for chloroform and trans-1,2-DCE exceed the lowest surface water or groundwater JSCS SLVs for samples collected prior to 2016. Both exceedances are for Groundwater/Surface Water/Stormwater JSCS SLVs by only a factor of 3 and 2, for chloroform and trans-1,2-DCE, respectively. These constituents were not measured in samples collected in 2016 through 2019.

Data from the most recent sampling events (2016 through 2019) indicate that areas of groundwater containing detectable COIs on the Northwest Pipe Company Site pose no threat to the Willamette River and, therefore, are contained.

Commented [A11]: Text edited in response to DEQ comment 7, and for accuracy.

8. Findings and Conclusions

The findings statements presented in Section 8.1 are presented verbatim from DEQ's *Appendix C: Template for a Stormwater Source Control Evaluation Report* (DEQ, 2010a). Each statement is followed by bullets illustrating how the condition has been met for both the stormwater and groundwater pathways. Section 8.2 presents the conclusion that DEQ should issue a Source Control determination of No Further Action for stormwater and groundwater for the Northwest Pipe Company Site.

8.1 Findings

As outlined in DEQ's *Appendix C: Template for a Stormwater Source Control Evaluation Report*, the following provides the basis ~~that~~ upon which each condition has been met.

1. Existing and potential facility-related contaminant sources have been identified and characterized.

- **Stormwater.** Stormwater was determined to have a complete pathway to the Willamette River, as Site stormwater discharges via a single communal outfall to a privately-owned slip (the IT Slip). The outfall, referred to as Outfall 18/WR-123, discharges stormwater to the eastern end of the slip approximately one-third mile from the Willamette River main stem. In addition to stormwater originating on the Site, Outfall 18/WR-123 carries stormwater from approximately 120 additional acres of industrial land. Given the proportion of surface area within the Outfall 18/WR-123 drainage basin, the Northwest Pipe Company Site contributes approximately ~~24~~ 30 percent of the discharge flowing through communal Outfall 18/WR-123 (Jacobs 2021a). Stormwater discharges from the Site are permitted under a general 1200-Z industrial stormwater permit and, as a result of BMPs and site improvements including installation of state-of-the-art stormwater treatment systems on Site stormwater discharge lines, the Site maintains compliance with its stormwater discharge benchmarks. Existing and potential facility-related stormwater contaminant sources have been identified and characterized.

- **Groundwater.** Groundwater at the Site has been ~~characterized~~ evaluated and ~~sufficiently to support decision-making and determined to have~~ shows that ~~l~~localizedw concentrations of hydrocarbons and VOCs have been identified at scattered locations at the Site, consistent with long-term industrial use. Detected concentrations generally are low and less than levels of potential concern. Two areas of the Site were a particular focus of investigation: the Southeast Area, where VOCs have been detected in shallow groundwater, and the Stained Soil Area, where PAHs were detected in shallow groundwater at an area where subsurface stained soil had been identified. ~~Existing and potential facility-related groundwater contaminant sources have been identified and characterized.~~. Supplemental data will be collected as needed to inform additional well locations as part of the proposed MNA remedy.

Commented [A12]: Text in this section was edited in response to DEQ comment 8.

2. Contaminant sources are being controlled to the extent feasible.

- **Stormwater.** Northwest Pipe Company has implemented a variety of SCMs and BMPs to reduce or eliminate legacy pollutants and prevent industrial activities from impacting stormwater. Table 4-1 provides a summary of these measures, which include the primary SCMs of installation of two state-of-the-art stormwater treatment systems, cleaning and coating of the Main Production Building roof, hot spot removal and site paving, modification of the stormwater system to create isolated drainage areas in conjunction with construction of covered areas over sensitive operations such as the cement mortar rebound storage area and the fueling area, material usage changes to limit potential contaminants at the Site, as well as enhanced facility sweeping and cleaning procedures. Considering the extent and the number of improvements made at the Site during Northwest Pipe Company's tenure and the improvement in stormwater quality documented due to source control actions (such as zinc, PAHs, and PCB reductions), the Site has effectively controlled potential sources to stormwater and does not pose a risk of re-contaminating sediment in the IT Slip or contaminating the main stem of the Willamette River itself. Stormwater contaminant sources have been effectively controlled.

- **Groundwater.** Remedial actions at the Site have resulted in the identification and removal of potential groundwater sources, including removal of a 2,000-gallon AST and a 1,000-gallon UST and associated removal and disposal of 300 cubic yards of contaminated soil in 1989, as well as the Site IRM implemented in 2012, which included hot spot removal to address potential risk to Site workers posed by PAHs and PCBs in surface soil. While underground utilities do not provide a preferential pathway to the river, groundwater discharge to surface water is a potentially complete pathway for the Site. A groundwater risk assessment and contaminant fate modeling for the Stained Soil Area and the Southeast Area determined that Site groundwater does not pose an excess risk to receptors in the Willamette River because VOC and PAH concentrations, where present, are attenuating to concentrations less than levels of potential concern before reaching surface water. Moreover, Site groundwater was determined to not pose a risk to potential human or ecological receptors given current and reasonably likely future beneficial use of groundwater. DEQ, EPA, and Northwest Pipe Company have discussed implementing an MNA remedy for shallow groundwater in the Southeast Area, and, at the direction of the agencies, Northwest Pipe Company is developing an MNA wWork pPlan for groundwater in this area. Groundwater containing detectable COIs on the Site poses no threat to the Willamette River and, therefore, is contained. Groundwater contaminant sources have been removed, and natural attenuation processes are predicted to continue to be effective at controlling groundwater COIs.

3. ***Pre- and post-SCM data were collected and post-SCM data supports the conclusion that the SCMs are effective.***

- **Stormwater.** A significant reduction in the concentrations of constituents was measured in stormwater in 2012 through 2019 compared to stormwater collected in 2002 through 2007. The implementation of stormwater SCMs has resulted in reducing concentrations of some constituents to less than the laboratory reporting limits (including PCBs and oil and grease), while all remaining detected constituent concentrations were reduced between 62 to 99 percent (Table 7-2). Stormwater SCMs are effective.

- **Groundwater.** DEQ, EPA, and Northwest Pipe Company have discussed implementing an MNA remedy for groundwater in the Southeast Area, and, aAt the direction of DEQ and EPAthe agencies, Northwest Pipe Company is developing an MNA Wwork pPlan for shallow groundwater in the Southeast Areathis area. Current groundwater data indicate that COIs are not present near the IT Slip. However, there is some uncertainty regarding the location of the downgradient edge of the groundwater plume, due to the lackcurrent spacing of monitoring wells in the area between MW-03 (detectable concentrations) and T4S1MW-03S (non-detectable concentrations). A soil gas investigation was conducted in April 2021 to support the upcoming MNA Work Plan and assist in determining locations for additional monitoring wells. Results are presented in the *Passive Soil Gas Investigation Results and Proposed Well Locations Memorandum*, Jacobs 2021ba. The MNA Work Plan includes the installation of additional wells at locations requested by DEQ and EPAGroundwater containing detectable COIs on the Site poses no threat to the Willamette River and, therefore, is contained, and an MNA program is being developed to demonstrate ongoing effectiveness.

Commented [A13]: Text in this section was edited in response to EPA comment 5 and comment 6.

4. ***Adequate measures are in place to ensure source control and good stormwater management measures occur in the future.***

- **Stormwater.** Northwest Pipe Company is committed to continue to implement improved stormwater management practices and SCMs and monitor the effectiveness of these activities. In addition to the two stormwater treatment systems, Northwest Pipe Company facility management uses a Preventive Maintenance program, a CMMP, implementation of NPDES BMPs, and corporate environmental oversight as its normal course of business. As such, sStormwater at the Site poses no threat to the Willamette River and,since therefore, any potential sources of contamination to stormwater at the Site are contained and Site stormwater is treated prior to

Commented [A14]: Text in this section was edited in response to EPA to be considered comment 4.

discharge. Adequate measures are in place to ensure source control and good stormwater management measures continue in the future.

- **Groundwater.** DEQ, EPA, and Northwest Pipe Company have discussed implementing an MNA remedy for groundwater in the Southeast Area, and, aAt the direction of DEQ and EPA, request of the agencies, Northwest Pipe is developing an MNA wWork pPlan for groundwater in this area. The monitoring data generated under the approved MNA wWork pPlan will provide ongoing documentation of source control for groundwater. Groundwater containing detectable COIs on the Northwest Pipe Site poses no threat to the Willamette River and, therefore, is contained. An MNA program is the adequate measure to assure source control continues in the future.

5. ***Contaminants in Site stormwater or groundwater that continue to exceed SLVs in spite of SCMs and stormwater management measures are not likely to result in sediment contamination in the receiving waterbody or contribute to unacceptable risk.***

- **Stormwater.** The Site constitutes approximately 27 30 percent of the drainage area of the receiving Outfall 18/WR-123 and only 24 percent of the stormwater discharge (Jacobs 2021a). The affected sediment in the immediate vicinity of Outfall 18/WR-123 is a stable, non-erosional area of the IT Slip. The affected area occupies only about 1.2 acres of the 13.9 acres of the entire IT Slip and extends toward the river only about 175 feet to the west from Outfall 18/WR-123. In addition, a comparison of pre- and post-SCM data supports a Source Control determination of No Further Action for stormwater by illustrating that the primary Site SCMs, as well as numerous other past and ongoing stormwater management measures and Site BMPs, have successfully reduced all remaining detected Site COIs between 62 to 99 percent (Table 7-2). Because of these factors, the minimal exceedances of the SLVs are not likely to result in sediment contamination in the receiving waterbody or contribute to unacceptable risk.

- **Groundwater.** DEQ, EPA, and Northwest Pipe Company have discussed implementing an MNA remedy for groundwater in the Southeast Area, and, aAt the direction of DEQ and EPA, the agencies, Northwest Pipe currently is developing an MNA wWork pPlan for shallow groundwater in the Southeast Areathis area. Groundwater containing detectable COIs on the Northwest Pipe Company Site poses no threat to the Willamette River and, therefore, is contained and is not likely to result in sediment contamination in the receiving waterbody or contribute to unacceptable risk.

Commented [A15]: Text in this section was edited in response to EPA to be considered comment 5.

8.2 Conclusion

Over the past 30 years, Northwest Pipe Company has completed a combination of independent and voluntary site investigations, remediation, and source control activities at the 29.15 acres it owns and leases for industrial activities in Portland, Oregon. This report documents the effectiveness of the targeted remedial actions and SCMs taken by Northwest Pipe Company.

The Site, which has a nearly 80-year history of heavy industrial use beginning as part of a World War II shipyard and transitioning into a steel water transmission pipe manufacturing facility, is located about one-third mile from the main stem of the Willamette River. Site investigation, remediation, upgrades, and source control work have been conducted at the Site since 1988. This work has been done under DEQ review and approval, supplemented with focused independent investigation steps completed during periods when DEQ was absent from the Site, with resulting data subsequently reported to DEQ.

Based on the findings of the RI/SCE program and the results of capping and soil removal under the IRM, the Northwest Pipe Company Site does not pose an unacceptable risk to human or ecological receptors as defined by Oregon Administrative Rules 340-122-0115. Moreover, on the basis of source control actions, BMP implementation, and operation of stormwater treatment systems, the Site does not pose a recontamination risk to the Willamette River. As part of the IRM implementation, Northwest Pipe Company already prepared a DEQ-approved CMMP to confirm that future management of contaminated media from the Site, if any, will be conducted in accordance with local, state, and federal regulations.

Consequently, Northwest Pipe Company requests that DEQ issue a Source Control determination of No Further Action for stormwater and groundwater, relying on an MNA remedial action for VOCs in shallow groundwater in the Southeast Area. Such a determination would recognize the Site's status as properly managed consistent with the requirements contained in the Oregon Hazardous Substance Remedial Action Rules and associated statutes.

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Tables

Figures

Appendixes

Provided electronically