Terminal 91 Submerged Lands Remedial Investigation

REMEDIAL INVESTIGATION WORK PLAN

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January 4, 2021

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Acronyms

AO	Agreed Order
AOC	Area of Concern
BBP	butyl benzyl phthalate
BEHP	bis(2-ethylhexyl) phthalate
BEI	Burlington Environmental, Inc.
bgs	below ground surface
BHC	benzene hexachloride
BNSF	Burlington Northern Santa Fe
BSAF	biota sediment accumulation factor
CAP	cleanup action plan
City	City of Seattle
COC	contaminant of concern
COPC	contaminant of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level
CSM	conceptual site model
CSO	combined sewer overflow
CUL	cleanup level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DL	detection limit
DMM	discarded military munition
DNR	Department of Natural Resources
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency

FS	feasibility study
FUDS	Formerly Used Defense Site
HCH	hexachlorocyclohexane
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HQ	hazard quotient
LNAPL	light non-aqueous phase liquid
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
MLLW	mean lower low water
MRA	munitions response area
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
OC	organic carbon
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
SCO	sediment cleanup objective
PNO	Pacific Northern Oil Corporation
Port	Port of Seattle
PQL	practical quantitation limit
PSAMP	Puget Sound Assessment and Monitoring Program
PSC	Philip Services Corporation
RCRA	Resource Conservation and Recovery Act
RBC	risk-based concentration
RI	remedial investigation
RL	reporting limit
RME	reasonable maximum exposure
SAP	sampling and analysis plan
SCL	Seattle City Light

SCO	sediment cleanup level
SLA	Submerged Lands Area
SMS	Washington State Sediment Management Standards
SPU	Seattle Public Utilities
SUF	site use factor
SVOC	semivolatile organic compound
SWAC	spatially weighted average concentration
SWMU	Solid Waste Management Unit
T-91	Terminal 91
TBT	tributyltin
TEQ	toxic equivalent
TFAA	Tank Farm Affected Area
TFLP	Tank Farm Lease Parcel
TOC	total organic carbon
TPH	total petroleum hydrocarbons
USACE	US Army Corps of Engineers
VOC	volatile organic compound
WDFW	Washington Department of Fish and Wildlife

1 Introduction

This work plan presents the approach for the remedial investigation (RI) for the Submerged Lands Area (SLA) of Terminal 91 (T-91). T-91 is an approximately 210-acre property, owned by the Port of Seattle (Port), that is located at 2001 West Garfield Street in the Interbay neighborhood of Seattle, Washington. The property consists of an upland area, two piers (Piers 90 and 91), and about 85 ac of submerged lands around the piers (Map 1-1). The property has had a variety of land uses and has played an important role in the City of Seattle's (City's) development since around the turn of the 20th century.

T-91 is regulated under both a Dangerous Waste Management Permit and a Model Toxics Control Act (MTCA) Agreed Order (AO). The Dangerous Waste Management Permit is issued by the Washington State Department Ecology (Ecology) and establishes corrective action requirements pursuant to the federal Resource Conservation and Recovery Act (RCRA). RCRA requires corrective action to address releases at permitted hazardous waste treatment, storage, and disposal facilities. Corrective action requirements for T-91 are due solely to the former presence of a tenant-operated dangerous waste treatment and storage facility (Tank Farm Lease Parcel [TFLP]) on a 4-ac parcel within T-91. That former facility's regulatory status subjects all contiguous Port-owned property, including T-91, to corrective action requirements.

Ecology employs MTCA authority and procedures to implement RCRA corrective action requirements. Under a series of AOs, Ecology and the Port have conducted site investigations and cleanups since Ecology took over RCRA corrective action oversight responsibilities for T-91 from the US Environmental Protection Agency (EPA) in 1998. These AOs and their requirements are summarized below.

- **1998 AO (Tank Farm Affected Area) and Voluntary Cleanup Program Work (Discrete Units).** The first AO for T-91 was signed in 1998 (Ecology 1998). It required the Port and other parties[1] to conduct an RI and feasibility study (FS) for the former Burlington Environmental, Inc. (BEI) dangerous waste treatment and storage facility, commonly referred to as the Tank Farm. The study area extended beyond the 4-acre Tank Farm boundaries to include any area determined to have been affected by releases from the facility. Investigations conducted since 1998 have determined the extent of the Tank Farm Affected Area (TFAA). Generally, it extends southward from the Tank Farm onto Piers 90 and 91, but it does not include the adjacent Port-owned marine sediment in the SLA (Map 1-1).

[1] In addition to the Port and Ecology, parties to the 1998 AO included BEI (dba Philip Services Corporation [PSC]) and the Pacific Northern Oil Corporation (PNO).

Under Ecology's voluntary cleanup program, the Port undertook investigations and cleanups, as appropriate, at 38 other known or suspected release areas on T-91 that were not within the TFAA. These areas are referred to as Discrete Units. Most of the Discrete Units had been identified by EPA as a result of a RCRA facility assessment study in 1994, the purpose of which had been to identify all areas at T-91 affected by hazardous substances releases (EPA 1994). Based on Port records regarding management of T-91, the Port identified additional Discrete Units in 1997 (Kennedy/Jenks 1997). All of the Discrete Units were located within the upland area and not within the SLA. .

- **2010 AO.** Ecology and the Port[2] entered a replacement AO in 2010 (Ecology 2010). The 2010 AO required the Port to complete the work that had been requisite under the 1998 AO (Ecology 1998), including the development of a draft cleanup action plan (CAP) for the TFAA. The 2010 AO (Ecology 2010) also extended the site to include the rest of the contiguously owned Port property (i.e., all 216 ac[3] of T-91) in order to align with the RCRA requirement calling for corrective action with respect to the entire facility.[4] The 2010 AO also listed all previously identified Discrete Units for T-91 and set requirements for the Port to address them. Although the 2010 AO included the SLA, no Discrete Units were located there; accordingly, the 2010 AO deferred the need to consider investigation or remediation of the SLA. Meanwhile, upland investigations of subsurface contamination revealed no evidence that contamination from the Tank Farm or Discrete Units had migrated to or otherwise affected the SLA.
- **2012 AO.** In 2012, the Port and Ecology signed a new AO, which required the Port to carry out the CAP with respect to the TFAA and an adjacent Discrete Unit (Solid Waste Management Unit [SWMU 30]), and to continue work on the remaining Discrete Units (Ecology 2012a). By 2015, the Port had completed active work (i.e., construction of the remedial features) at the TFAA and SWMU 30; by mid-2016, Ecology had approved all but one Discrete Unit as having been adequately addressed.
- **Minor change to 2012 AO.** The Port and Ecology signed a minor change to the 2012 AO to remove the West Yard from the AO to facilitate purchase of the West Yard. This amendment removed the West Yard from the facility and it is no longer subject to the Order.

[2] The other parties to the 1998 AO, BEI and PNO, were not parties to the 2010 AO. BEI had declared bankruptcy in 2003, and PNO had ceased operations in 1995.

[3] T-91 comprised 216 acres from the time of the 1998 AO until 2013, when approximately 6 acres were removed by conveyance to King County for use in constructing wastewater management facilities.

[4] Per RCRA, "facility" was defined as the former Tank Farm dangerous waste facility and all contiguously owned property.

- **<u>2016 AO Amendment</u>.** In January 2016, Ecology and the Port entered an amendment to the 2012 AO (First Amendment) under which the Port agreed to conduct two new, separate actions (Ecology 2016b):
  - Action 1 Regrade Project – Regrade the accumulated shoal material along the southeast portion of Pier 91 in the SLA. This task, known as the Regrade Project, was completed in April 2016.
  - Action 2 Submerged Lands Preliminary Investigation – Conduct a preliminary site investigation in the SLA.
- **<u>2020 AO.</u>** In 2020, Ecology and the Port entered a new AO under which the Port agreed to conduct an RI for the SLA area of T-91 (Ecology 2020a). The AO requires the Port to complete three tasks:
  - Task 1: RI Work Plan
  - Task 2: RI
  - Task 3: interim action (if required)

This RI Work Plan is the first deliverable required under Task 1 of the 2020 AO (Ecology 2020a).

1.1 Study Objectives and Context

The primary objectives of this RI Work Plan are to summarize the existing information regarding the T-91 SLA, present a conceptual site model (CSM), and identify RI data gaps. The RI Work Plan includes the following:

- General facility information including site history and conditions
- Descriptions of previous SLA investigations and summaries of existing data
- A preliminary CSM that describes the origin and distribution of contaminants and identifies important fate and transport pathways
- A summary of natural resources and ecological receptors
- A summary of data gaps for the RI

The RI Work Plan was developed in compliance with the *Sediment Cleanup User's Manual (SCUM) – Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards WAC 173-204* (Ecology 2019).

This RI Work Plan also provides a summary of previous investigations of discarded military munitions (DMMs), although DMMs will not be considered in the preliminary CSM or addressed in the RI. Instead, a separate RI was conducted by the US Army Corps of Engineers (USACE) to address the presence of DMMs.

1.2 WORK PLAN ORGANIZATION

The RI Work Plan is organized as follows:

- Section 2 provides the site description and background of the T-91 SLA, including a summary of current and historical operations and a summary of the previous site investigations.
- Section 3 presents a preliminary CSM, including an evaluation of source control and sediment fate and transport, as well as human and ecological receptors and relevant pathways of exposure.
- Section 4 discusses potential data gaps.
- Section 5 describes RI tasks.

The following appendices are attached:

- Appendix A – Data Management Plan
- Appendix B– Data Tables
- Appendix C – SAP/QAPP and HSP

2 Site Description and Background

This section provides a description of the T-91 SLA, a summary of its current and historical uses, and a summary of previous sediment and tissue investigations. Additional information is available in the T-91 historical review report (Windward 2017).

2.1 Current Site Features and Conditions

The T-91 SLA is comprised of three berth areas: the western berth area to the west of Pier 91, the central berth area between Piers 90 and 91, and the eastern berth area to the east of Pier 90. The submerged lands are owned by the Port and Washington State Department of Natural Resources (DNR) (Map 2-1).

A high-resolution bathymetry survey of the SLA was conducted in 2018 (Map 2-2). The T-91 SLA is 85 acres, 82% (70 acres) of which is subtidal sediment. The deepest portions of the berth areas average between -30 and -50 ft mean lower low water (MLLW). There are 16 acres of intertidal area in the western portion of the western berth area and the eastern portion of the eastern berth area. South of the T-91 SLA boundary, the depths increase towards Elliott Bay (Map 2-2).

Piers 90 and 91 are earthen berms constructed in 1913 and 1919, respectively. A schematic cross section of the T-91 SLA is provided in Figure 2-1. The earthen berms were constructed with 2:1 slopes with riprap. The earthen berms function as a solid barrier between the berth areas and prevent the transport of water and sediment laterally between adjacent berth areas.

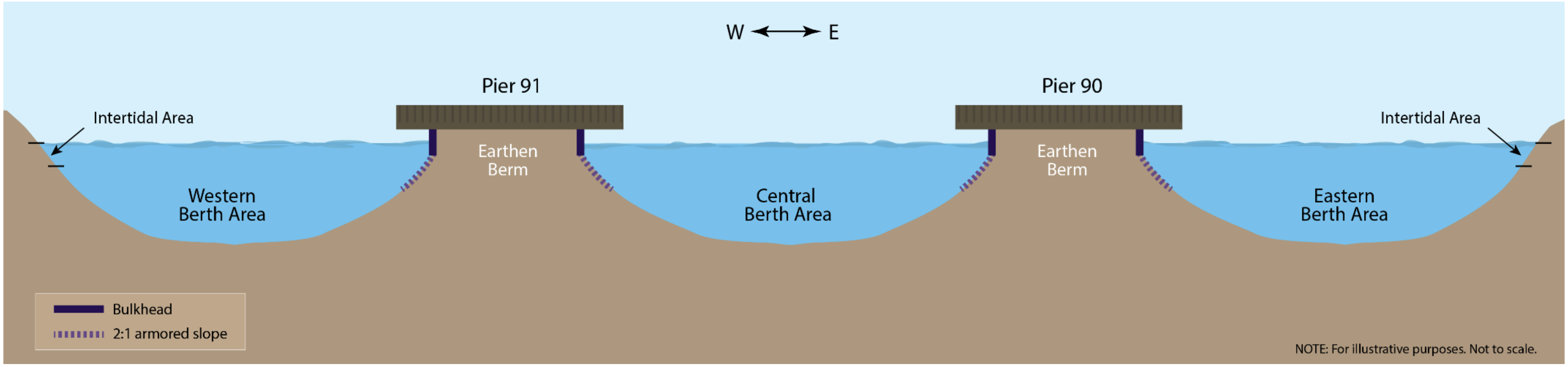
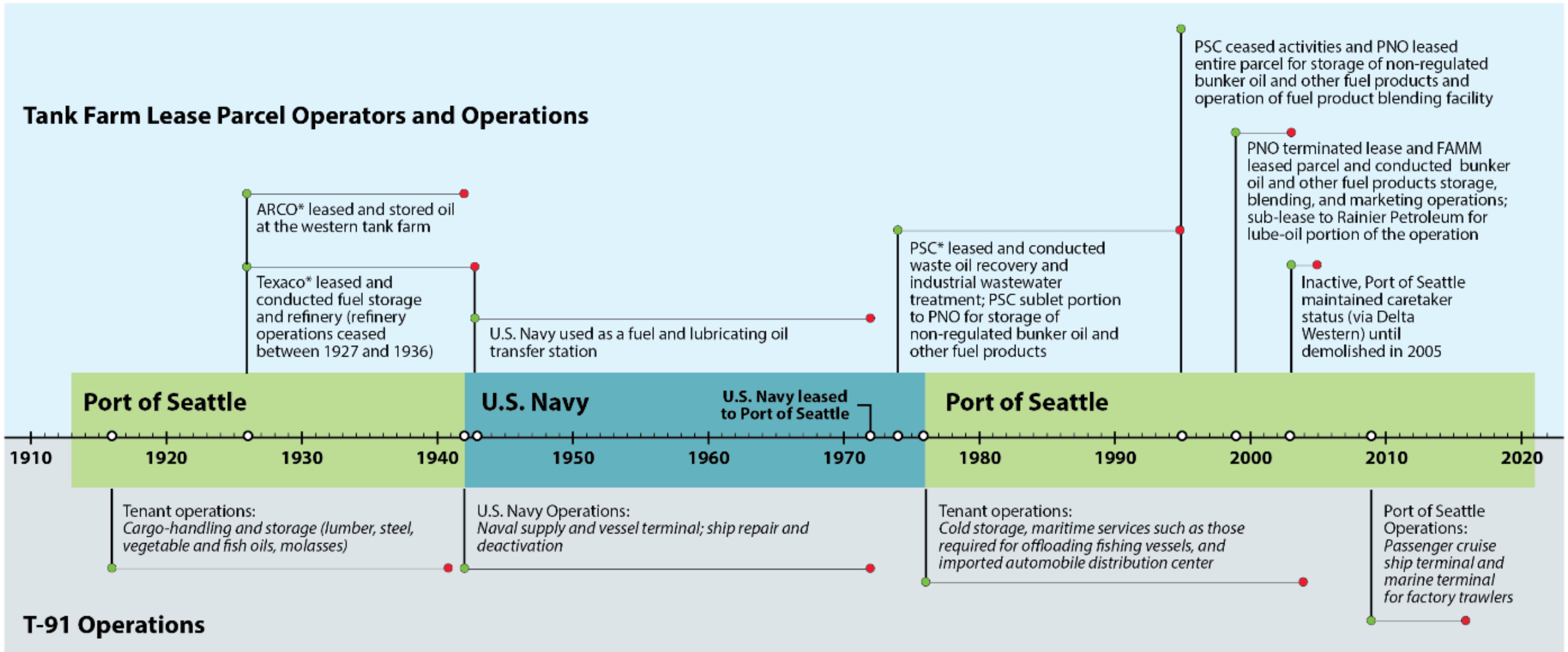


Figure 2-1. T-91 SLA schematic cross section

2.2 SITE HISTORY

The T-91 property has had a variety of land uses and has played an important role in the City's development since around the turn of the 20^{th} century. The ownership of T-91 can be divided into three periods, as shown in Figure 2-2 and discussed in the following sections. The original Port ownership included only portions of the present-day T-91 property. The US Navy expanded and consolidated the T-91 property during its ownership.



Note: Texaco includes the Texas Company and the Olympic Calpet Refining Company. PSC includes Chemical Processors Inc. and its successor, BEI. ARCO includes Richfield Oil Company.

Figure 2-2. Timeline of T-91 ownership and operations

2.2.1 Port of Seattle ownership (1913 to 1942)

The Port owned T-91 from 1913 to 1942, although the extent of the Port-owned property during this period was only a portion of the present-day T-91. Pier 90 was constructed in 1913 and Pier 91 was constructed in 1919, and they were designated as Pier 40 and Pier 41, respectively. They were the largest earth-filled commercial piers in the world at that time. Piers 90 and 91 were originally used for loading and unloading materials such as lumber, steel, and coal and for storing vegetable oil (Pinnacle 2006). The area now known as the TFLP was developed in the 1920s. This area, comprising approximately 4 ac on the northern side of West Garfield Street, was used by a variety of tenants for different purposes, including storing vegetable and fish oils and refining and storing petroleum (Windward 2017).

2.2.2 US Navy ownership (1942 to 1976)

The US Navy took over ownership of the T-91 SLA from 1942 to 1976, during which time it enlarged T-91 to encompass all of the property it includes today. During World War II and into the early 1950s, the US Navy conducted extensive operations at the T-91 SLA, which was used as an active naval station (USACE 2013). Within the T-91 SLA, the US Navy conducted extensive naval craft mooring, repair, and deactivation activities, including hull maintenance; sandblasting and painting; and electrical, plumbing, and mechanical repairs (Bureau of Ships 1947, 1950b, a; Clay 1971). The US Navy used the upland TFLP primarily as a fuel and lubricating oil transfer station and built up the surrounding facility to support active wartime naval operations.

2.2.3 Port of Seattle ownership (1976 to present)

The US Navy transferred ownership of the T-91 SLA back to the Port in approximately 1976. The Tank Farm remained active until 2003 under various leases for a variety of activities, including waste treatment and dangerous wastes and fuel products storage.

The Tank Farm aboveground structures (excluding the tank bases) were demolished in 2005 (Roth Consulting 2007). Structures on the piers have been demolished and constructed throughout the Port's ownership.

Operations conducted by recent Port tenants at T-91 have included cold storage; maritime services, such as those required for offloading fishing vessels; procedures at an imported automobile distribution center (Pinnacle 2006); and cruise provisioning and passenger movement. In 2009, the Port began using Pier 91 as a passenger cruise ship terminal for cruises to Alaska, making it an important economic feature of Seattle and adding more than $400 million to the local economy (USACE 2013).

2.3 History of Dredging Operations

There have been relatively few dredging operations documented within the T-91 SLA. No documented maintenance dredging events have been conducted, which is consistent with the relatively low sedimentation rates in this area.

Focused dredging has been conducted in the areas where an increased depth was required for navigation purposes. Dredged areas within the T-91 SLA are identified in Map 2-3. There have been two dredging events: one conducted in 1992 in the western berth area, with a dredge volume of 10,000 cubic yards; and one conducted in 2007 in the cruise ship berthing areas,[5] with a dredge volume of 11,500 cubic yards.

In 2016, material along the eastern face of Pier 91 was affecting cruise ship access to the berthing area at low tides. Dredging was not possible because the potential presence of DMMs in this area prevented the transport of the dredged material to a landfill. Therefore, sediment regrading, which is the transfer of sediment from one location to another underwater, was conducted in the central berth area. Sediment was removed from higher elevations along the pier face and placed in adjacent subtidal areas (Map 2-3). The changes in sediment elevations that resulted from the sediment regrading are shown in Map 2-4.

2.4 Summary of Previous Investigations

Ecology and the Port have conducted site investigations and cleanups under a series of AOs since Ecology took over RCRA corrective action oversight responsibilities for T-91 from EPA in 1998.

2.4.1 Sediment investigations

Between 2005 and 2008, 12 sediment investigations were conducted within the T-91 SLA for dredged material characterization, post-dredge characterization, and Elliott Bay monitoring programs. Sediment data associated with locations that have been dredged or affected by regrading have been excluded from the RI dataset, because they do not represent current site conditions. Table 2-1 presents a summary of investigations that included the collection of surface sediment samples. The 55 sampling locations are well distributed throughout the T-91 SLA (Map 2-5). There is a high density of surface sediment sampling locations adjacent to the southern portion of Pier 91 in the central berth; these locations were sampled in 2016 to characterize surface sediment after the completion of regrading that same year (Map 2-4).

[5] Dredging was conducted in the cruise ship berthing areas to provide sufficient navigation depth (-35 ft MLLW).

Table 2-1. Summary of T-91 surface sediment investigations

Sampling Event	Count Samples	Purpose	Chemical Group(s)	Source
LDW dioxin sampling	2 (composites)	characterize regional dioxin/furan concentrations	dioxins/furans	Windward (2005)
2007 Ecology Urban Bays Monitoring Program	2	subset of samples (1 location each in berths east and southeast of Pier 90) collected to evaluate sediment condition over time using chemistry, toxicity, and benthic community indices	dioxins/furans[a]	Ecology (2016c)
2007 King County DNR monitoring	1	post-remediation monitoring for the Denny Way/Lake Union CSO control project	metals, PCBs, semivolatile organics, pesticides, total solids, TOC, total sulfides, and grain size	DNR (2009)
2008 post-dredge characterization	3	post-dredge surface characterization in the berth west of Pier 91	metals, PCBs, semivolatile and volatile organics, pesticides, total solids, total volatile solids, TOC, total sulfides, grain size, and TBT (porewater)	Anchor (2008)
2009 PSAMP spatial/temporal monitoring project	1	samples collected as part of Puget Sound monitoring study t	metals, PCBs, semivolatile organics, pesticides, total solids, TOC, and grain size	Ecology and PSAMP (2009)
2013 Ecology Urban Bays Monitoring Program	3	samples (1 location in berth east of Pier 90 and 2 locations southeast of Pier 90) collected as part of for the Ecology Urban Bays Monitoring Program	metals, semivolatile organics, pesticides, total solids, TOC, grain size, and pharmaceuticals	Ecology (2016c)
2015 pre-sediment regrading characterization	1	pre-sediment regrading characterization in the berth east of Pier 91	metals, PCBs, semivolatile organics, pesticides, total solids, TOC, TBT, and dioxins/furans	Windward (2015)
2016 post-sediment regrading characterization	10	post-sediment regrading characterization in the berth east of Pier 91	metals, PCBs, semivolatile organics, pesticides, total solids, total volatile solids, TOC, total sulfides, grain size, TBT, and dioxins/furans	Windward (2016)
2017 SLA preliminary investigation	28	first phase of preliminary investigation sampling to assess need for remedial actions within the SLA	metals, semivolatile organics, PCBs, total solids, TOC, and grain size	Windward (2018b)
2018 SLA preliminary investigation	4	second phase of preliminary investigation sampling to assess need for remedial actions within the SLA	metals, semivolatile organics, PCBs, total solids, TOC, and grain size	Windward (2018a)

[a] Dioxin/furan data were retained from the 2007 sampling event to represent existing sediment conditions, because the 2013 samples collected at the same locations were not analyzed for dioxins/furans. Data for other parameters (i.e., metals, PCBs, semivolatile organics, pesticides, total solids, TOC, grain size, and TBT) were outweighed by the 2013 results.

CSO – combined sewer overflow
DNR – Department of Natural Resources
PSAMP – Puget Sound Assessment and Monitoring Program
SLA – Submerged Lands Area

Ecology – Washington State Department of Ecology
LDW – Lower Duwamish Waterway
PCB – polychlorinated biphenyl
T-91 – Terminal 91
TBT – tributyltin
TOC – total organic carbon

Sediment investigations that included the collection of sediment cores are summarized in Table 2-2. Sediment cores were collected at a total of seven locations for chemical analyses (Map 2-6). One core location in the central berth area was collected as part of a dredge characterization in 2013. The sample from this core had elevated polychlorinated biphenyl (PCB) concentrations. To further characterize the area, an additional four cores were collected in 2014. In 2018, two cores were collected from the northern portion of eastern berth area as part of the preliminary sediment investigation.

Table 2-2. Summary of T-91 subsurface sediment investigations

Sampling Event	Sediment Cores (n)	Purpose	Chemical Group	Source
2013 pre-dredge characterization	1	pre-dredge sediment characterization for dredged materials disposal and Z-layer assessment in the berth east of Pier 91	metals, PCBs, semivolatile organics, pesticides, total solids, total volatile solids, TOC, total sulfides, grain size, TBT, and dioxins/furans	Windward (2014b)
2014 sediment characterization	4	characterization to determine the lateral distribution of total PCBs in the vicinity of the sample with the highest PCB concentration in the Z-layer sediment in the east berth of Pier 91	PCBs	Windward (2014a)
2018 SLA preliminary investigation	3 (2 chemistry cores and 1 geochronology core)	second phase of preliminary investigation sampling to assess need for remedial actions within the SLA	metals, semivolatile organics, TBT, PCBs, total solids, TOC, and grain size, and geochronology	Windward (2018a)

PCB – polychlorinated biphenyl
SLA – Submerged Lands Area
T-91 – Terminal 91
TBT – tributyltin
TOC – total organic carbon

2.4.2 Formerly Used Defense Site RI

As discussed in Section 2.2.2, the US Navy took over ownership of the T-91 SLA from 1942 to 1976 and used it for various purposes. Although T-91 was not used as an ammunition resupply facility, the Port Police Department Dive Team encountered DMMs in sediments around Piers 90 and 91 during a routine underwater inspection in April 2010 (USACE 2013). That year, US Navy Explosive Ordnance Disposal personnel responded to seven subsequent incidents of DMM discovery in the sediment. As a result, in December 2010, USACE initiated an RI for Piers 90 and 91 to characterize the nature and extent of DMM occurrence in the munitions response area (MRA) shown on Map 2-7.

USACE conducted a Formerly Used Defense Site (FUDS) RI for the former Seattle naval supply depot at T-91 from 2010 to 2012. The objective of the RI was to define the nature and extent of DMMs around and under Piers 90 and 91, and to evaluate the potential explosive hazard and chemical risk of DMMs. Acoustic surveys, remotely operated vehicles, and unexploded ordinance divers were employed to locate DMMs during two field seasons. Thirty DMMs were found on the sediment surface, and 2 DMMs were buried in sediment. All DMMs were located in the southern portion of the central berth area (Map 2-7). Twelve samples of sediment directly beneath discovered DMMs[6] were collected and analyzed for munitions constituents (i.e., explosives, propellant stabilizers, and propellant plasticizers). The results were used to evaluate potential risks to human health and ecological receptors. Concentrations were below human health risk thresholds based on realistic exposure assumptions, and concentrations of detected chemicals were below sediment quality benchmarks for benthic invertebrates (USACE 2013).

The sediment analyzed for munitions constituents represented a worst-case exposure scenario, since the samples would be expected to have the highest potential concentrations (i.e., in close proximity to the munitions discovered). Thus, these constituents will not be further evaluated in the T-91 SLA RI.

2.4.3 Current sediment quality

The dataset used to characterize current sediment quality includes data collected from 2005 to 2018. The data management rules that were used to process the data and calculate sums are provided in Appendix A. Surface sediment (0 to 10-cm) data are summarized in Table 2-3. The complete surface sediment dataset is provided in Appendix B. In addition to the 0 to 10-cm surface sediment data presented in Table 2-3, the RI dataset includes data for other surface sediment intervals (e.g., 0 to 2- and 0 to 3-cm) that were not used for screening purposes.

[6] The depth of sediment collected varied depending on the size and depth of the DMM. Most samples were collected from the top 6 in. of sediment.

Table 2-3. Summary of T-91 surface sediment (0–10-cm) data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
Metals (mg/kg dw)							
Antimony	6/15	40	0.4	20.1	4	0.052	7
Arsenic	46/49	94	1.64	111	9.5	6	7
Cadmium	47/49	96	0.03	1.8	0.5	0.2	0.2
Chromium	49/49	100	6.2	102	29	na	na
Copper	49/49	100	5.45	820	65	na	na
Lead	47/49	96	3.2	816	80	2	3
Mercury	43/49	88	0.0214	2.89	0.4	0.0261	0.06
Nickel	3/3	100	23	35	30	na	na
Selenium	9/15	60	0.17	1.2	0.9	0.2	0.7
Silver	44/49	90	0.04	2.5	0.52	0.3	0.4
Zinc	49/49	100	19	1,060	140	na	na
Organometals (ug/kg dw)							
TBT as ion	12/12	100	3.5	200	46	na	na
PAHs (ug/kg dw)							
2-Methylnaphthalene	34/49	69	15	400	87	18.8	56.9
Acenaphthene	34/49	69	9	1,100	170	18.8	60
Acenaphthylene	39/49	80	5.9	1,100	180	7.5	39.8
Anthracene	44/49	90	6.7	14,600	1,100	18.8	20
Benzo(a)anthracene	46/49	94	6.1	23,000	1,700	19.1	20
Benzo(a)pyrene	46/49	94	12	20,000	2,100	18.8	20
Benzo(b)fluoranthene	2/3	67	22	80	51	20	20
Benzo(g,h,i)perylene	45/49	92	12.7	8,600	840	18.8	20
Benzo(k)fluoranthene	2/3	67	14	64	39	20	20
Total benzofluoranthenes	48/49	98	14.3	37,000	4,200	20	20
Chrysene	47/49	96	9.2	41,000	3,000	19.8	20
Dibenzo(a,h)anthracene	42/49	86	10.4	2,900	370	18.8	20
Dibenzofuran	38/49	78	5.8	750	120	18.8	60
Fluoranthene	48/49	98	8.4	51,000	3,700	20	20
Fluorene	39/49	80	9.3	980	200	18.8	60
Indeno(1,2,3-cd)pyrene	44/49	90	12	8,000	820	18.8	20
Naphthalene	41/49	84	10	1,800	250	18.8	20
Phenanthrene	45/49	92	8.1	9,100	920	18.8	20
Pyrene	48/49	98	7	59,000	5,300	20	20
Total HPAHs	48/49	98	38.9	199,000	22,000	20	20
Total LPAHs	45/49	92	14.8	18,400	2,600	18.8	20

Table 2-3. Summary of T-91 surface sediment (0–10-cm) data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
Total PAHs	48/49	98	38.9	215,000	24,000	20	20
cPAH TEQ	48/49	98	16.6	28,000	2,800	18	18
Phthalates (ug/kg dw)							
BEHP	36/49	73	16	3,610	410	20	144
BBP	9/49	18	10.8	82.8	32	18.8	60
Diethyl phthalate	9/49	18	17.9	54	29	18.8	99.5
Dimethyl phthalate	1/49	2	44.5	44.5	na	18.8	99.5
Di-n-butyl phthalate	6/49	12	6.2	77.2	21	18.8	60
Di-n-octyl phthalate	6/49	12	13.6	249	80.7	18.8	60
Other SVOCs (ug/kg dw)							
1,2,4-Trichlorobenzene	1/49	2	3.4	3.4	na	4.3	24.9
1,2-Dichlorobenzene	1/49	2	3.2	3.2	na	0.9	99.5
1,3-Dichlorobenzene	0/3	0	na	na	na	0.9	1.1
1,4-Dichlorobenzene	26/49	53	8.1	2,400	170	0.9	99.5
2,4-Dimethylphenol	21/49	43	4.2	83	18	20	124
2-Methylphenol	8/49	16	7.9	60.9	27	18.8	99.5
4-Methylphenol	20/49	41	16	190	50	18.8	99.5
Benzoic acid	3/49	6.1	189	191	190	188	995
Benzyl alcohol	1/47	2.1	58.8	58.8	na	18.8	99.5
Hexachlorobenzene	1/49	2	5.74	5.74	na	0.47	5
Hexachlorobutadiene	0/49	0	na	na	na	0.95	99.5
Hexachloroethane	0/3	0	na	na	na	20	20
n-Nitrosodiphenylamine	0/49	0	na	na	na	18.8	99.5
PCP	2/49	4.1	94.7	95.4	95.1	93.9	498
Phenol	30/49	61	8.9	163	41	17	60
PCBs (ug/kg dw)							
Total PCB Aroclors	48/51	94	1.6	1,270	220	9.8	9.9
Pesticides (ug/kg dw)							
Total DDTs	2/15	13	25	55	40	1.8	48
Aldrin	0/15	0	na	na	na	0.49	100
Dieldrin	0/15	0	na	na	na	0.95	5
gamma-BHC	0/15	0	na	na	na	0.47	2.5
alpha-Chlordane	0/15	0	na	na	na	0.47	2.5
beta-Chlordane	0/15	0	na	na	na	0.47	6.9
Total chlordane	0/3	0	na	na	na	1.9	4

Table 2-3. Summary of T-91 surface sediment (0–10-cm) data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
Heptachlor	0/15	0	na	na	na	0.47	2.5
cis-Nonachlor	0/3	0	na	na	na	1.9	4
trans-Nonachlor	0/3	0	na	na	na	1.9	4
Oxychlordane	0/3	0	na	na	na	1.9	4
Dioxin/furan (ng/kg dw)							
Dioxin/furan TEQ	15/15	100	2.68	50	19	na	na
Conventionals							
TOC (%)	51/51	100	0.06	6.8	1	na	na
Total solids (%)	51/51	100	33.76	85.2	70	na	na

a Includes field duplicates

b Range for non-detect samples.

BBP – butyl benzyl phthalate
BEHP – bis(2-ethylhexyl) phthalate
BHC – benzene hexachloride
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DDT – dichlorodiphenyltrichloroethane
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
RL – reporting limit
SVOC – semivolatile organic compound
T-91 – Terminal 91
TBT – tributyltin
TEQ – toxic equivalent
TOC – total organic carbon

Subsurface sediment data are summarized in Table 2-4. One core in the central berth area that was collected as part of dredge characterization (T91-13-Z6) was characterized for the Washington State Sediment Management Standards (SMS) chemicals, dioxins/furans, tributyltin (TBT), and pesticides. Sediment from this sample's subsurface interval (1.6 to 3.6 ft) was analyzed as a Z-sample to characterize the post-dredge surface. This sample had a total PCB concentration of 47,000 µg/kg. To further characterize the area, an additional six cores were collected in 2014, from which 15 subsurface sediment samples were analyzed for PCBs. In 2018, two cores were collected from the northern portion of the eastern berth area as part of the preliminary sediment investigation. Three sediment intervals (0 to 1, 1 to 2, and 2 to 4 ft) in both cores were analyzed for SMS chemicals. The complete subsurface sediment dataset is provided in Appendix B.

Table 2-4. Summary of T-91 subsurface sediment data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
Metals (mg/kg dw)							
Antimony	1 / 1	100	14.8	14.8	na	na	na
Arsenic	7 / 7	100	4.72	30.7	11.4	na	na
Cadmium	7 / 7	100	0.77	2.85	1.4	na	na
Chromium	7 / 7	100	31.1	102	49.4	na	na
Copper	7 / 7	100	54.2	256	101	na	na
Lead	7 / 7	100	54.2	604	180	na	na
Mercury	7 / 7	100	0.0733	1.75	0.925	na	na
Selenium	0 / 1	0	na	na	na	1	1
Silver	7 / 7	100	0.29	3.86	1.5	na	na
Zinc	7 / 7	100	121	700	270	na	na
Organometals (ug/kg dw)							
TBT as ion	3 / 4	75	46.1	100	72	5.82	5.82
PAHs (ug/kg dw)							
2-Methylnaphthalene	6 / 7	86	28.2	140	61	19.4	19.4
Acenaphthene	7 / 7	100	45.2	74	54	na	na
Acenaphthylene	7 / 7	100	54.6	260	120	na	na
Anthracene	7 / 7	100	229	810	390	na	na
Benzo(a)anthracene	7 / 7	100	218	990	640	na	na
Benzo(a)pyrene	7 / 7	100	523	5,200	1,400	na	na
Benzo(g,h,i)perylene	7 / 7	100	140	1,000	380	na	na
Total benzofluoranthenes	7 / 7	100	1,390	10,000	3,300	na	na
Chrysene	7 / 7	100	321	1,900	1,300	na	na
Dibenzo(a,h)anthracene	7 / 7	100	62.6	390	150	na	na
Dibenzofuran	7 / 7	100	39.5	120	62	na	na
Fluoranthene	7 / 7	100	261	3,670	1,800	na	na
Fluorene	7 / 7	100	58.5	140	89	na	na
Indeno(1,2,3-cd)pyrene	7 / 7	100	156	1,000	400	na	na
Naphthalene	7 / 7	100	63.5	350	150	na	na
Phenanthrene	7 / 7	100	250	1,640	690	na	na
Pyrene	7 / 7	100	2,270	12,000	4,000	na	na
Total HPAHs	7 / 7	100	5,420	33,000	13,000	na	na
Total LPAHs	7 / 7	100	804	2,300	1,490	na	na
Total PAHs	7 / 7	100	6,230	35,000	15,000	na	na
cPAHs - mammal (one-half DL)	7 / 7	100	728	6,600	1,920	na	na

Table 2-4. Summary of T-91 subsurface sediment data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
Phthalates (ug/kg dw)							
BEHP	7 / 7	100	89.3	8,690	2,800	na	na
BBP	4 / 7	57	34.9	140	97.5	19	33
Diethyl phthalate	1 / 7	14	26.9	26.9	na	19	33
Dimethyl phthalate	1 / 7	14	75.9	75.9	na	19	33
Di-n-butyl phthalate	2 / 7	29	14.8	18.4	16.6	19	33
Di-n-octyl phthalate	2 / 7	29	91.7	756	424	19	33
Other SVOCs (ug/kg dw)							
1,2,4-Trichlorobenzene	0 / 7	0	na	na	na	4.7	33
1,2-Dichlorobenzene	0 / 7	0	na	na	na	19	33
1,4-Dichlorobenzene	7 / 7	100	7.5	1,900	330	na	na
2,4-Dimethylphenol	5 / 7	71	5.4	11.7	8	23.8	160
2-Methylphenol	0 / 7	0	na	na	na	19	33
4-Methylphenol	7 / 7	100	24.1	167	64	na	na
Benzoic acid	4 / 7	57	59.1	278	155	190	330
Benzyl alcohol	0 / 7	0	na	na	na	19	33
Hexachlorobenzene	0 / 7	0	na	na	na	0.48	4.8
Hexachlorobutadiene	0 / 7	0	na	na	na	4.8	19.4
n-Nitrosodiphenylamine	0 / 7	0	na	na	na	19	33
PCP	0 / 7	0	na	na	na	94.9	160
Phenol	7 / 7	100	31.7	82	45	na	na
PCBs (ug/kg dw)							
Total PCB Aroclors	17 / 18	94	19	47,000	4,900	88	88
Pesticides (ug/kg dw)							
4,4'-DDD	0 / 1	0	na	na	na	4.8	4.8
4,4'-DDE	0 / 1	0	na	na	na	830	830
4,4'-DDT	0 / 1	0	na	na	na	790	790
Total DDTs	0 / 1	0	na	na	na	830	830
Aldrin	0 / 1	0	na	na	na	2.4	2.4
Dieldrin	0 / 1	0	na	na	na	630	630
alpha-Chlordane	0 / 1	0	na	na	na	57	57
beta-Chlordane	0 / 1	0	na	na	na	270	270
Total chlordane	0 / 1	0	na	na	na	270	270
Heptachlor	0 / 1	0	na	na	na	15	15
cis-Nonachlor	0 / 1	0	na	na	na	4.8	4.8

Table 2-4. Summary of T-91 subsurface sediment data

Chemical	Detection Frequency[a]		Detected Results			RL[b]	
	Ratio	%	Min.	Max.	Mean	Min.	Max.
trans-Nonachlor	0 / 1	0	na	na	na	250	250
Oxychlordane	0 / 1	0	na	na	na	4.8	4.8
Dioxin/furan (ng/kg dw)							
Dioxin/furan TEQ - mammal (one-half DL)	1 / 1	100	78.4	78.4	na	na	na
Conventionals							
TOC (%)	11 / 11	100	0.68	7.08	2.8	na	na
Total solids (%)	22 / 22	100	45.2	94.2	62.5	na	na

[a] Including field duplicates.

[b] Range for non-detect samples.

BBP – butyl benzyl phthalate
BEHP – bis(2-ethylhexyl) phthalate
cPAH – carcinogenic polycyclic aromatic hydrocarbon
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DL – detection limit
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
RL – reporting limit
SVOC – semi-volatile organic compound
T-91 – Terminal 91
TBT – tributyltin
TEQ – toxic equivalent
TOC – total organic carbon

2.4.4 Tissue data

The only tissue data for the T-91 SLA are from two Washington Department of Fish and Wildlife (WDFW) mussel studies conducted from 2015 to 2016 and from 2017 to 2018. Native mussels were transplanted at various locations throughout Puget Sound, including Smith Cove at T-91 (northern end of the eastern berth) (Lanksbury et al. 2017; Langness and West 2020). After approximately 90 days of exposure, mussel tissue from each location was composited into a single sample and analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), PCBs, polybrominated diphenyl ethers (PBDEs), and dichlorodiphenyltrichloroethanes (DDTs). The results for the T-91 SLA are presented in Table 2-5.

Table 2-5. WDFW transplanted mussel study results for T-91

Chemical	2015–2016 Result	2017–2018 Result
Metals (mg/kg dw)		
Aluminum	not reported	179
Arsenic	6.33	8.10
Cadmium	1.60	2.22
Copper	9.66	10.1
Lead	0.70	0.752
Mercury	0.0493	0.0729
Zinc	99.3	125
Organics (ng/g dw)		
∑ PAHs[a]	7,349	7,020
Total PCBs	236.0	214
∑ $_{11}$PBDEs	21.9	16.0
∑ DDTs	50.4	21.7
∑ Chlordanes	5.1	8.79
∑ HCHs	2.8	< 0.713
Dieldrin	3.0	2.14
Hexachlorobenzene	nd	nd
Mirex	nd	nd
Aldrin	nd	nd
Endosulfan	nd	nd

Source: Lanksbury et al. (2017) and Langness and West (2020).

[a] The 2015–2016 result is the sum of 38 PAHs. The 2017–2018 result is the sum of 42 PAHs.

DDT – dichlorodiphenyltrichloroethane
dw – dry weight
nd – not detected
HCH – hexachlorocyclohexane
PAH – polyaromatic hydrocarbon
PBDE – polybrominated diphenyl ether
PCB – polychlorinated biphenyl
T-91 – Terminal 91
WDFW – Washington Department of Fish and Wildlife

3 Preliminary Conceptual Site Model

This section presents the preliminary CSM for the T-91 SLA based on existing data. The CSM will be updated throughout the RI as additional data are collected.

3.1 Physical Site Features and Characteristics

The T-91 SLA includes 85 acres of submerged lands. The two pier structures separate the three berth areas within the T-91 SLA. The sediment surrounding the two pier structures is subtidal, with intertidal areas on the western edge of the western berth area and the eastern edge of the eastern berth area (Map 2-2).

The central berth area is predominately subtidal, with only 1.2% of the total submerged lands being classified as intertidal (Table 3-1). The central berth area is bounded by pier structures, with 30% of the area being rip-rap on slopes beneath the pier structures (under-pier area). The intertidal areas within the western and eastern berth areas each represent approximately 25% of their respective berth areas. In addition, the under-pier areas are only 15% of the total areas of their respective berth areas, because they are bounded on only one side by a pier structure (Table 3-1).

Table 3-1. Berth area acreages

Berth Area	Total Area (acres)	Intertidal Area (acres)	Under-pier Area (acres)
Central	24.6	0.3	7.4
Western	33.8	8.0	5.1
Eastern	27.1	7.3	4.0

3.1.1 Sediment characteristics

The sediment on the western and eastern edges of the T-91 SLA is predominantly sandy, with less than 10% being fine-grained sediment (Map 3-1). The sediment with the greatest amount of fines is in the central berth area and along the western side of Pier 91 in the western berth area. In the eastern berth area, greater percentages of fines are present in the vicinity of Outfall 68 and along the eastern side of Pier 90 (Map 3-1).

With respect to total organic carbon (TOC) (Map 3-2), the areas with higher TOC values have lower percentages of fine-grained sediment; sediment in the eastern and western portions of the T-91 SLA that are predominantly sandy have less than 0.5% TOC. Sediment TOC is generally higher in the central berth, where two areas along the eastern side of Pier 91 have greater than 3.5% TOC. In the eastern berth, the area near Outfall 68 that had more than 40% fines also had TOC levels greater than 3.5%. As discussed in SCUM (Ecology 2019), only samples with TOC values of 0.5 to 3.5% are carbon normalized for comparison to SMS for certain chemicals (see Section 3.6.4).

3.1.2 Constructed habitat areas

The Port has conducted restoration in three intertidal areas and constructed an intertidal habitat mound (PES et al. 2009) (Map 3-3). These intertidal habitat sites are maintained as compensatory restoration areas associated with previous development actions at T-91 (USACE 2016). In addition, as part of a pilot study, the Port has transplanted eel grass to a subtidal area west of Pier 91. More detailed descriptions of these sites are as follows:

- Approximately 0.73 acres at the northwest margin of the western berth area were restored as intertidal habitat by removing previously placed fill material.
- Approximately 0.12 acres of deep subtidal habitat were elevated to shallow subtidal elevations in the southwest portion of the western berth area by placement of beneficial fill material.
- The water-ward portion of the short fill area in the central berth area, between Piers 90 and 91, includes approximately 0.6 acres of intertidal berm surface improved as habitat substrate.
- The eastern berth area includes two intertidal restoration areas:
    - A constructed intertidal mound, approximately 0.47 acres in size, consisting of habitat substrate placed in the subtidal aquatic area at the north end of the eastern berth area to create a habitat area subject to daily tidal exposure
    - Approximately 0.7 acres of intertidal mud-sand substrate at the northeast margin of the eastern berth area, restored by removing previously placed fill material, thereby re-exposing low-slope aquatic habitat conditions

In addition, further habitat improvements have been implemented in the western berth area as part of the Smith Cove Blue Carbon Pilot Project that began in 2018. As part of this project, native shellfish, eel grass, and kelp have been transplanted in approximately 2.5 acres of aquatic area.

3.2 Potential Sources

Understanding historical sources of contamination and identifying and controlling potential ongoing sources are important components of the overall cleanup effort. This section reviews available information for historical and potentially ongoing sources of contamination, including lateral inputs, spills and leaks, upland soils and groundwater cleanup sites, bank erosion, and treated-wood structures.

3.2.1 Lateral inputs

Throughout the history of operations at T-91, stormwater discharges, combined sewer overflow (CSO) discharges, and other outfalls have been potential pathways for contaminants to enter the T-91 SLA. Spills and leaks also have had the potential to enter the T-91 SLA via lateral inputs, as discussed in Section 3.2.2.

Two main outfalls to the T-91 SLA are the primary sources of ongoing stormwater discharge: a 42-in.-diameter outfall (referred to herein as Outfall A) located at the head of the western berth area that drains the T-91 upland area and areas north of T-91; and a 96-in.-diameter outfall (referred to herein as Outfall 68) located at the head of the eastern berth area that drains an upland area north and east of T-91 (Map 3-4).

3.2.1.1 Outfall A

Stormwater from approximately 100 acres of the T-91 upland area discharges into Outfall A. Other inputs to the conveyance system that discharges to this outfall include those from the Seattle Public Utilities (SPU) Halladay Decant Facility, the mixed-use property north of T-91 (acreage unknown), surrounding residential/commercial use areas, and potentially some portion of the Burlington Northern Santa Fe (BNSF) Balmer Yard (acreage unknown). In 1956, during US Navy ownership, approximately 38 acres that included BNSF railroad yard buildings discharged at a location corresponding to Outfall A (Pinnacle 2013). Facilities currently draining to Outfall A maintain National Pollutant Discharge Elimination System (NPDES) permits that require regular monitoring and best management practices.

3.2.1.2 Outfall 68/combined sewer overflow

Outfall 68 is a City-owned outfall that discharges to Elliott Bay, east of Pier 90 (Ecology 2016a). The existing Outfall 68 was likely installed sometime after 1971; prior to 1971, the location was an active combined storm and sewer discharge point (Clay 1971). The stormwater drainage basins that currently discharge at Outfall 68 do not include the T-91 upland area, but they do include the following areas to the north and east of T-91: 60 acres of the BNSF Balmer Yard; a portion of the BNSF Interbay Yard (acreage unknown); and 343 acres of mixed use land, including the 55-acre Interbay sanitary landfill, which drains to the connected City conveyance system.

The City's Interbay landfill, which was in use from 1911 until 1968, historically drained to a pond that discharged to the stormwater conveyance system leading to Outfall 68. The landfill was a disposal site for a wide range of material, including military waste (Seattle-King County Department of Public Health 1984).

Outfall 68 is also a controlled City CSO for two sub-basins (68A and 68B) that account for a total of 290 acres of mostly residential land. Each sub-basin has a single overflow structure that discharges into a pipe that normally conveys stormwater only to Outfall 68. During large precipitation events, when the capacity of the combined sewer system is exceeded, excess flows discharge through these CSO overflow structures into the storm drain and through Outfall 68.

The previous permit did not require monitoring of the concentrations of pollutants in the CSO discharges for the NPDES application or the monthly discharge monitoring reports (Ecology 2016a). The duration and volume of discharges were recorded from 2016 to 2020 (Ecology 2020e). In 2019, two discharge events occurred at Outfall 68, the average duration of which was 13.5 hours; an average of 491,509 gal. of overflow was discharged to Elliott Bay during each event. The average number of discharges from the CSO from 1997 to 2016 was fewer than one per year (Ecology 2017).

3.2.1.3 Other outfalls and discharge points

At T-91, numerous deck drains and active outfalls or discharge points drain Piers 90 and 91. The majority of the outfalls are located on the northern portions of the piers and adjacent to the Short Fill area, and they discharge to the west and east of the piers (Map 3-4). Three outfalls (two Port and one City) are located at the head of the eastern berth area. In addition, four 12-in.-diameter City outfalls discharge to the eastern shoreline of the eastern berth area (City of Seattle 2001a, b).

Under Port ownership, stormwater discharges at T-91 have been regulated primarily under the Port's Phase I NPDES municipal stormwater general permit (WAR044701) since 2007, as well as under industrial stormwater permits held by various tenants (Aspect 2014; Port of Seattle 2016). Between 1995 and 2007, earlier versions of the municipal stormwater general permit were in place. Prior to 1995, stormwater and industrial discharges were not regulated.

Additionally, the US Navy's wartime operations included extensive naval maintenance and deactivation activities. Vessels were repaired while on dry docks or moored at the piers, and wastewater and materials from these efforts were dumped directly into the water or processed at upland facilities.

3.2.2 Spills and leaks

Spills and leaks include fuel spills, pipeline releases, and releases from historical overwater activities.

3.2.2.1 Fuel spills

Fuel spills into marine waters as a result of fuel transfers on Piers 90 and 91 may have released fuel products to the T-91 SLA via direct discharge or surface water runoff. Spills in areas upland of the T-91 SLA may be contaminant sources via surface water runoff or discharge from stormwater outfalls.

Ecology's Spill Response Division maintains public records detailing reported fuel and oil product spills for the last five years. From 2015 to 2020, 15 spills to marine waters or drainages in the immediate upland vicinity of the T-91 SLA were reported (Ecology 2020e). Nine of these spills were of 5 gal. or less of oil or fuel product; details on the remaining six spills are as follows:

- In 2016, a Norwegian Cruise Lines vessel spilled 105 gal. of lube/motor oil into marine waters while docked at Pier 90.
- In 2016, fishing vessel *Katie Ann* spilled 10 gal. of hydraulic oil into marine waters while docked at Pier 91.
- In 2017, fishing vessel *Pacific Glacier* spilled 50 gal. of oil fuel into marine waters at Pier 91.
- In 2018, fishing vessel *Excellence* spilled 148 gal. of diesel into Elliott Bay during a fuel transfer at Pier 90 (Ecology 2020e). In compliance with state regulations, the vessel had been pre-boomed, which prevented the spill from spreading. Vessel crew immediately responded to the spill and, along with response contractors, recovered approximately 134 gal. of diesel.
- In 2019, fishing vessel *Katie Ann* spilled 55 gallons of hydraulic oil into marine waters while docked at Pier 91; 5 gal. were recovered.
- In 2019, a damaged underground heating oil tank at a construction site upland of the T-91 SLA spilled 10 gal. of heating oil into a storm drain that discharged near Pier 91.

Prior to 2015, several other significant spills were recorded:

- In 2007, approximately 93 gal. of intermediate fuel were released from a ship anchored about a 0.5 miles south of Smith Cove (outside of the T-91 SLA) (Ecology 2008). A cleanup effort was conducted; however, prior to the cleanup, a sheen was evident on the pilings under Pier 91.
- In 2011, 177 gal. of diesel fuel were spilled into Elliott Bay while a fishing vessel was taking on fuel at Pier 90 (Ecology 2013). A cleanup response was conducted and an oil spill boom had been placed around the vessel prior to fueling, which prevented the fuel from spreading beyond the immediate vicinity.
- In 2013, fishing vessel *Bristol Leader* spilled 181 gal. of diesel fuel into Elliott Bay while taking on fuel from a tank truck at T-91 (Ecology 2015).
- Other spills have been documented at the BNSF Balmer and Interbay Yards clean-up sites; these spills potentially drained to the adjacent T-91 property. The stormwater conveyance systems at the Balmer Yard ultimately discharge to Outfall 68, located in the eastern berth area of the T-91 SLA. More detailed discussion of spills at the BNSF properties occurs in Section 3.2.3.3.

3.2.2.2 Pipeline releases

From approximately 1974 through 1995, a portion of the TFLP was sublet to PNO for storing non-regulated bunker oil and blending and storing marine boiler fuel, diesel, and other petroleum products (Roth Consulting 2007). PNO used aboveground and underground piping systems to transfer bunker oil and fuels in the TFLP and other areas of T-91. In 1999, PNO terminated its lease with the Port and discontinued operations at T-91. In the spring of 2005, the Port removed the remaining aboveground equipment to reduce the risk of hazardous substance releases, as part of an independent interim remedial action. Map 3-4 shows the locations of pipeline releases described in this section.

In 1990, a break occurred in the PNO-operated Bunker C fuel line south of building T-38 on Pier 91 (Kennedy/Jenks 1997). In 1991, a break occurred in the same pipeline at the south end of Pier 91. In both cases, contaminated soil was remediated, and contaminants in soil samples from the bottoms and sidewalls of the excavations generally did not exceed MTCA Method A cleanup levels. Another small break occurred in the PNO-operated pipeline in 1996, and impacted soil was removed.

In 1999, a pipeline operated by PNO was identified as the source of a subsurface release of bunker oil to the north of Pier 90 (Kennedy/Jenks 2011). An emergency spill response and subsequent remedial action were performed. The remedial action included excavation of affected soil; however, the presence of underground structures (e.g., vaults, pipeline anchors, duct banks, and utilities) prohibited the removal of some soil beneath these structures. In February 2011, soil and groundwater samples collected in this area showed no indication of petroleum hydrocarbon impacts.

In all cases, these documented pipeline releases were remediated, and no evidence of contamination in the T-91 SLA was documented.

3.2.2.3 Former US Navy overwater activities

From 1942 to 1976, the US Navy conducted extensive naval craft mooring, repair, and deactivation activities at T-91, including hull maintenance; sandblasting and painting; and electrical, plumbing, and mechanical repairs (Bureau of Ships 1950a, b, 1947; Clay 1971). Many of these activities were conducted while vessels were on the dry dock or moored at the piers, and some of the associated wastes (e.g., paint and sandblast waste) likely entered Elliott Bay. Furthermore, bilge water that was not processed at the Tank Farm was dumped into the bay (Port of Seattle 1974).

3.2.3 Upland soils and groundwater sites

Through a series of AOs with Ecology, the Port has carried out investigations and cleanup actions at all known release sites located within the T-91 upland area. These investigations and cleanups were found not to have affected the SLA but are summarized herein for context.

3.2.3.1 Tank Farm Affected Area

The TFAA (approximately 17 acres) includes the TFLP and areas where hazardous substances originating from TFLP operations are located. Map 3-4 shows the location of the TFAA.

Sources of Contamination

Historically, contaminants of concern (COCs) at the TFAA have included petroleum products, volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) (including PAHs), metals, and PCBs (Roth Consulting 2007; Ecology 2010). Likely sources of these chemicals have included leaks of fuel and wastes from tanks and other equipment, and leaks during fuel and waste handling and transfer operations (Roth Consulting 2007).

A number of documented releases have occurred at the Tank Farm, including two large releases of petroleum hydrocarbons in 1978 (420,000 gal. of Bunker C) and 1980 (up to 113,000 gal. of oil) (Port of Seattle 2010). In both cases, the release was contained by concrete dikes, and the oil and impacted soil were removed to the extent practicable. A number of smaller releases of petroleum products and/or oily water have been documented, ranging in size from several hundred to 20,000 gal., but in all cases, cleanup was documented. No releases were documented prior to 1971, although unreported historical releases from the Tank Farm and the former western tank farm in Area of Concern (AOC) 11 are suspected.

In addition to the releases at the TFLP, approximately 340 to 1,370 gal. of fuel were released at SWMU 30 in 1989. After a series of investigations in 1989 and 1990, it was confirmed that the release was the result of a pipeline failure. The pipeline was repaired, and a product recovery system was installed and operated between 1991 and 1994. Passive product recovery (i.e., bailing) was conducted beginning in 1994, recovering a limited volume of product. The final cleanup action for SWMU 30 was implemented in late 2013 and early 2014. The two areas where light non-aqueous phase liquid (LNAPL) had been observed in SWMU 30 were excavated, backfilled with concrete fill, and covered with asphalt.

The *Final Remedial Investigation Summary Report* (Roth Consulting 2007) found that a LNAPL plume was present beneath and in the immediate vicinity of the TFLP, but the plume did not appear to be expanding. A groundwater seepage evaluation was performed downgradient of the TFLP, including areas along Piers 90 and 91. As part of this effort, compliance wells were installed upgradient of the areas of significant seepage along Piers 90 and 91. Very low concentrations of only a few chemicals have been detected in these wells (Roth Consulting 2007; PGG 2019b).

Cleanup Activities

Cleanup activities at T-91 have been conducted under EPA and Ecology oversight due to the PSC dangerous waste treatment and storage facility at the Tank Farm. RIs at the Tank Farm commenced under EPA oversight, with PSC performing various investigations focused on the Tank Farm. The Port became involved after Ecology assumed primary regulatory oversight responsibility under the 1998 AO. Under that and subsequent AOs, the Port investigated soil and groundwater contamination that had originated at the TFLP and determined the extent of migration (Roth Consulting 2007). That extent is reflected by the defined TFAA, which does not include the T-91 SLA.

The 2012 AO (Ecology 2012a) required the Port to carry out the CAP with respect to the TFAA and an adjacent Discrete Unit (SWMU 30), and to continue work on the remaining Discrete Units. Remedial actions at the TFLP associated with the final CAP began in 2014 and were completed in 2015 (PES Environmental 2015). The cleanup actions at the TFLP included:

- Removal of pipelines and any remaining aboveground structures within the TFLP and cleaning and grouting of existing fuel lines outside the TFLP
- Installation of the subsurface cutoff wall around the perimeter of the former Tank Farm
- Installation of the enhanced LNAPL recovery system
- Installation of the asphalt cover
- Installation of a stormwater management system

In August 2015, after completion of the remedial actions, compliance monitoring and operation and maintenance activities were initiated (PES Environmental 2015). These activities included asphalt paving inspections and maintenance, LNAPL monitoring, passive recovery from the LNAPL recovery trenches and monitoring wells, and compliance and natural attenuation groundwater monitoring.

The final cleanup action for SWMU 30 was implemented in late 2013 and early 2014. The two areas where LNAPL had been observed in SWMU 30 were excavated, backfilled with concrete, and covered with asphalt.

Shoreline Groundwater Monitoring near the SLA

Shallow groundwater enters the earthen berms under Piers 90 and 91 and then discharges to Elliott Bay, apparently from the more seaward portions of the piers, where the pier bulkheads appear to exert less control on groundwater flow (Port of Seattle 2010).

Groundwater monitoring shifted from quarterly to annual in September 2019, following Ecology's approval of a statistical review of groundwater monitoring data (PGG 2019b). LNAPL gauging remains on a quarterly schedule (PGG 2019a). The fourth Annual Compliance Monitoring Report describes the results of this groundwater compliance monitoring and LNAPL gauging at the TFAA.

Groundwater samples were tested for gasoline-range, diesel-range, and oil-range hydrocarbons. All contaminant concentrations at compliance wells located at the downgradient end of the three groundwater flow paths to surface water remained below cleanup levels for all analytes. Data trends showed generally decreasing concentrations or a lack of detections at these downgradient wells. Benzene, toluene, and xylenes were not detected above reporting limits (RLs) in most samples and did not exceed any cleanup levels (PGG 2019a). The groundwater data from the most recent sampling events in November 2018 and May 2019 confirmed that compliance monitoring goals were met.

3.2.3.2 Areas outside TFAA

Ecology compiled a list of all T-91 Discrete Units (i.e., all known hazardous substance release sites outside of the TFAA) in the 2010 AO (Ecology 2010). The Port's responsibility was to investigate the releases (e.g., soil or groundwater monitoring), determine whether further action was necessary to protect human health and the environment, implement such action where warranted (e.g., excavation of contaminated soil, removal of inactive fuel lines or tanks), and obtain Ecology's concurrence that no further action was required. Subsequent investigation and corrective actions have addressed all AOCs and SWMUs (PGG 2019c). Investigations of Discrete Units have not indicated that contamination migrated from any of the Discrete Units to the T-91 SLA.

3.2.3.3 Adjacent properties

Adjacent properties located to the north and east of the T-91 SLA have fairly complex histories of ownership and operations. These operations are summarized and included herein because of:

- The types of substances used, stored, treated, or transferred on these properties
- The properties' proximities to the T-91 SLA
- The direction of surface and groundwater flow (i.e., toward Elliott Bay)
- The stormwater conveyance system connections between these properties and the T-91 SLA

Apart from T-91, the primary facilities of interest in relation to the T-91 SLA are the two BNSF railway yards (Balmer and Interbay Yards), the SPU Halliday Decant Facility, the Mehrer Drywall Facility, and the abandoned Interbay landfill. These properties and their operations are described in the following subsections.

BNSF Balmer and Interbay Yards

BNSF has operated 80 acres of railyard adjacent to T-91 since the 1970s (Pinnacle 2013). The railyards each include rail tracks, various repair and maintenance shops, an equipment storage yard, a fueling facility, fuel storage facilities, and office buildings. BNSF repairs and fuels locomotives (and other vehicles and equipment) and conducts switching operations in these railyards.

The Balmer Yard, which is the larger of the two railyards, is located north and east of T-91 (Map 3-4). Historical fueling and maintenance operations at the Balmer Yard resulted in total petroleum hydrocarbons (TPH) soil and groundwater contamination; as a result, the Balmer Yard became a Voluntary Cleanup Program site in 2005 (Pinnacle 2013). The private stormwater conveyance system at the Balmer Yard ultimately discharges to Outfall 68, located in the eastern berth area of the T-91 SLA.

The Interbay Yard has been active since the late 1800s and is located northeast of the Balmer Yard. Halogenated organics and petroleum product contamination in soil, groundwater, and surface water was confirmed at the Interbay Yard. Ecology listed the Interbay Yard as a hazardous site in 1991. Stormwater at the Interbay Yard has been collected for on-site treatment since approximately the mid-1970s.

In 2011, BNSF was found liable for Clean Water Act violations, which were initially filed by the Puget Soundkeeper Alliance in 2009. BNSF had been discharging industrial stormwater without an NPDES industrial stormwater general permit and had failed to implement pollution control measures at the Balmer Yard. Documented releases occurred in 1993, 2001, 2012, and 2018. In 1993, 250 to 500 gal. of diesel fuel were released by a locomotive fuel tank rupture during derailment (Pinnacle 2013). In 2001, 2,000 gal. of diesel fuel were released. In 2012, a locomotive derailed and 3,000 gal. of diesel oil spilled onto the ground and entered a drainage ditch (Ecology 2012b). Some of the oil entered the public sewer system, so oil containment materials were placed outside of Outfall 68 as a precaution. In 2018, 100 gal. of unknown oil product were released to water at the BNSF property; 75 gal. of product were recovered (Ecology 2020e).

SPU Halladay Decant Facility

The Halladay Decant Facility, which is located just north of T-91 (Map 3-4), is owned by the City and operated by SPU (Pinnacle 2013). It was established in the late 1970s or early 1980s for the temporary storage and dewatering of vactor truck wastes. Formerly, the City had used a small portion of T-91 (without a lease) as part of the facility. Vactor wastes handled at the facility were primarily stormwater solids from City catch basins. Seattle City Light (SCL) also disposed of vactor wastes from transformer vaults at the facility until the early to late 2000s. It is unknown when this practice began.

Historically, vactor wastes were held in an Ecology block storage cell so that water could be decanted from settled wastes (Pinnacle 2013). Until the late 1980s or early 1990s, the SPU Halladay Decant Facility discharged decanted wastewater and stormwater runoff to a wetland pond. The pond drained to the stormwater conveyance system at T-91 that ultimately discharges to Outfall A, located in the western berth area. Currently, vactor wastes are contained in a decant pit that connects to an oil/water separator and the City sanitary sewer system. Vactor solids are dried on-site prior to disposal.

Between 2008 and 2011, source control violations at the Halladay Decant Facility (Map 3-4) have included uncovered, unbermed vactor solids that were exposed to stormwater runoff, and vactor solids that were leaching through containment walls into catch basins (Pinnacle 2013). The facility was closed in 2013/2014 in order to implement modifications to address these source control issues.

Data for wastewater and solids samples collected in recent years (between the early 1990s and 2015) showed elevated concentrations of metals (e.g., copper, lead, mercury, and zinc) and petroleum hydrocarbons (Pinnacle 2013).

Vactor wastes from SCL transformer vaults were formerly handled at the Halladay Decant Facility, a practice that was discontinued between 2003 and 2008 (Pinnacle 2013). There was concern from the King County Industrial Waste Program about the use of the facility for transformer vault waste because PCBs were potentially present in transformer oil. In addition to vactor wastes, soil contamination at the SPU Halladay Decant Facility includes petroleum hydrocarbons and lead. Ecology listed the Halladay Decant Facility as a known contaminated site under MTCA in 2012. Site remediation as part of an independent action has been initiated (Ecology 2020b).

Mehrer Drywall Facility

The Mehrer Drywall Facility, a drywall and woodworking machinery facility that has been in operation since at least 1995, is located north of T-91 on two properties; the southern of the two properties is located adjacent to the SPU Halladay Decant Facility (Map 3-4). Stormwater runoff from the southern Mehrer Drywall Facility property discharges to the wetland pond west of the Halladay Decant Facility property. This pond then discharges to the T- 91 conveyance system and eventually to Elliott Bay at the outfall located at the head of the western berth area (Outfall A). The northern Mehrer Drywall Facility property (office area) is contaminated with gasoline, benzene, and xylenes (soil and groundwater) due to a 1998 release from the on-site underground storage tank (Pinnacle 2013). As a result of the leaking underground storage tank, the Mehrer Drywall site is regulated under MTCA with a moderate ranking (Ecology 2020d). Cleanup has started under an independent action (Ecology 2020b).

Abandoned Interbay Sanitary Landfill

The Interbay Golf Course, located northeast of T-91, was originally the location of the 55-acre Interbay Sanitary Landfill (Map 3-4). The landfill operated from approximately 1911 to 1968 and included residential, industrial, and military wastes (Seattle-King County Department of Public Health 1984). Historically, the landfill drained to a pond that then discharged to the stormwater conveyance system leading to Outfall 68, which discharges to the head of the eastern berth area.

Halogenated organics, priority pollutant metals, pesticides, and PAHs are suspected contaminants in groundwater and soil at the landfill. Studies conducted in 1977 showed evidence of high groundwater levels (within 7 to 10 ft of ground surface) in places at the site, creating the potential for leachate formation (Seattle-King County Department of Public Health 1984). In 1984, groundwater seepage was observed ponding at the base of the steep embankments at the north, west, and south perimeters of the landfill (SoundEarth 2014). The odor, color, and algal buildup in the sampling sites indicated the presence of leachate; water sample data reflected relatively low dissolved oxygen concentrations and elevated electrical conductivity, values indicating that leachate is seeping through the clay sidecaps and draining off-site. The site is regulated under MTCA and is currently awaiting cleanup (Ecology 2020c).

3.2.4 Bank erosion

Unarmored bank soils can be susceptible to erosion through surface water runoff, wind waves, and the action of vessel wakes and propeller wash. The presence of shoreline armoring and vegetation reduces the potential for bank erosion. Bank slope and soil properties are also factors in the susceptibility of bank areas to erosion; steeper banks are more susceptible to erosion for any given grain size. If shoreline soils are contaminated, bank erosion can represent a pathway of contaminants to the SLA.

Both the upland tank farm areas and piers at the T-91 SLA overlie a portion of the Smith Cove inlet that was initially filled in the early 1900s (PES et al. 2009) and given additional fill until 1920 (Port of Seattle 2010); the northern portion subsequently was filled by the US Navy during its ownership. Upland fill material consisted primarily of moderately to poorly sorted, fine- to medium-grained unconsolidated sand, with laminations of silty sand and gravel lenses occurring locally (PGG 2019a). Fill material extends vertically from just below the paved ground surface to between 15 and 20 ft below ground surface (bgs).

Riprap covers the majority of the shoreline surrounding T-91. Armoring of shoreline around Smith Cove is extensive and includes riprap, seawalls, bulkheads, barriers, and pilings (USACE 2016). Riprap armoring present around Piers 90 and 91 limits erosion in intertidal areas. Dive survey monitoring data from around Pier 91 indicate that riprap armoring along the western face of Pier 91 extends from the bulkhead down to between -2 and -17 ft MLLW (Anchor 2014). Deeper elevations are composed of fish rock and silt. Along the shoreward eastern berth of Pier 91, fish rock is the primary cover, and riprap armors the top few feet below the bulkhead.

3.2.5 Treated-wood structures

Treated-wood structures are a potential source of contaminants, which can be released to sediments by abrasion or through leaching. Historically, pilings and wooden structures treated with creosote or other wood preservatives were commonly used as part of navigation/berthing improvements (e.g., pier and wharf structures, fender systems, and dolphins) and marine structures (e.g., wooden bulkheads). Treated-wood structures are largely historical because the installation of new treated-wood structures is restricted by state and federal permitting requirements, and most treated-wood structures are removed from waterways during waterfront facility upgrades.

The west, south, and east perimeters of each pier include treated wood pilings, fitted with a combined timber/steel pier fender piling system (USACE 2013). In addition to active structures, some derelict, broken timber piles are present beneath the bull rails in the Pier 91 under-pier area (Anchor 2017). These piles may have been foundation elements for the former timber pier structure that were left in place, cut off at the mudline, during construction of the existing concrete pier. Underwater baseline monitoring and yearly monitoring following the commencement of cruise ship operations (2009 to 2014) at Pier 91 noted pile stubs adjacent to the pierhead line at 9 of the 10 transects spanning the length of the pier (Anchor 2014). Clusters of discarded wooden piles were also present in many areas of the MRA environment during the 2016 DMM investigation (USACE 2016). Treated-wood structures could be a source of contamination to the T-91 SLA, although treated wood still present is likely decades old and thus less likely to leach.

3.2.6 Sediment transport

Bed sediments within the T-91 SLA have the potential to be mobilized by wind waves, boat wakes, and propeller wash. Since the water within the berths is deep compared to the expected heights of both wind waves and boat wakes at the site, waves and wakes are not expected to significantly mobilize bed sediment in the berths.

Propeller wash is the primary mechanism of sediment erosion and mixing at T-91 berths. Vessels that call on T-91 are primarily cruise ships, which have deep drafts, large propellers with minimal freeboard above the bed, and powerful bow and stern thrusters. Other vessels include tugs that may assist the cruise ships into and out of the berths and larger fishing vessels. While these vessels have shallower drafts and smaller propellers than the cruise ships, they can have powerful engines and may produce significant propeller wash velocities on the bed under some operational scenarios, even in deep water.

Vessel operations in the T-91 berths can cause the suspension of bed sediments and sediments on channel side slopes and under-pier areas. In the case of the cruise ships, vessel operations can produce localized deep scour holes in the bed in deep water within the berthing areas. It is also possible that the larger fishing vessels or tugs could produce smaller scour holes in the bed in shallower areas of the berths.

In order to develop a preliminary understanding of potential scour depths in the berthing areas due to propeller wash from cruise ships (or other vessels), the 2018 high-resolution bathymetry data were reviewed. Scour holes along the bed on both the west and east sides of Pier 91 were identified. The locations and cross sections of the identified scour locations and estimated depths of the scour holes compared to the adjacent bed elevations are shown in Map 3-5. The measured scour hole depths vary from approximately 1.2 to 7.5 ft. The observed scour holes are the result of high near-bed velocities and shear stresses induced by the propeller wash effects during vessel arrivals and departures. The largest scour holes are in the deeper portions of the western and central berth areas along the southern end of Pier 91 and are attributed to cruise ship operations. Smaller scour holes have been identified in the northern portion of the western berth area along Pier 91, on the eastern and western sides of Pier 90, and in the center of the eastern berth area (Map 3-5). The smaller scour holes may be caused by operations of other vessels in the berths.

Areas with the potential for propeller scour to depths greater than 5 ft have been identified based on this preliminary analysis of propeller scour using the 2018 bathymetry (Map 3-6). Subsurface sediment sampling depths in these areas in the RI will account for the potential for sediment resuspension and mixing associated with large vessel operation.

3.3 Fate and Transport Pathways of Contaminants

The fate and transport of contaminants in the T-91 SLA is affected by a variety of anthropogenic and natural processes. A preliminary CSM illustrating the important fate and transport pathways of contaminants within the T-91 SLA is provided in Figure 3-1. Anthropogenic processes include discharge from lateral sources, such as storm drains and the CSO, as well as propeller wash associated with large vessel operation within the berth areas, as discussed in Section 3.2.6. Natural processes include tidal exchange with Elliott Bay and bioturbation of surface sediment within the berth areas.

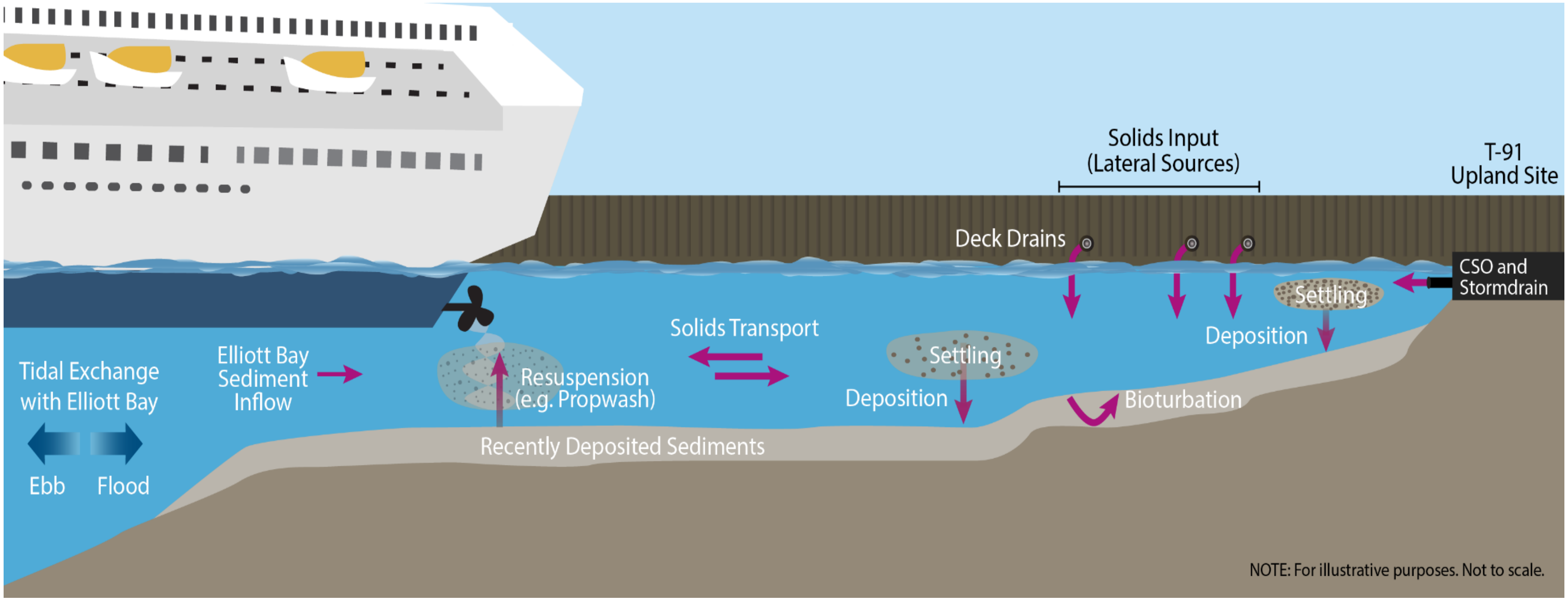


Figure 3-1.T-91 fate and transport pathways

3.4 POTENTIAL RECEPTORS AND EXPOSURE SCENARIOS

Based on SCUM (Ecology 2019), sites can be characterized as simple or complex: "A site may be considered simple where (as a whole or in combination):

- There are a limited number of risk driver chemicals of concern and sources of contamination.
- Chemical distribution and exposure pathways are not complex.
- The physical and hydraulic features of the site are straightforward.
- The site is small or isolated.
- A permanent cleanup action alternative is implementable and the PLP is willing to perform the cleanup."

Based on these criteria, the T-91 SLA can be considered a simple site. Therefore, in-depth ecological and human health risk assessments are not proposed. Instead, a simpler approach using only sediment data will be used, following the Option 1 method outlined in Ecology's SCUM guidance (Ecology 2019). This approach recognizes that among the key bioaccumulative chemicals likely to drive cleanup at the T-91 SLA, risk-based concentrations (RBCs) are expected to be less than Ecology's background concentrations and/or practical quantification limits (PQLs). Thus, while RBCs based on the protection of humans and ecological receptors will be developed for comparison to T-91 SLA sediment data, cleanup levels will likely ultimately be based on background concentrations and/or PQLs.

Consistent with SCUM guidance (Ecology 2019), typical receptors to be evaluated for the T-91 SLA include the following (See Figure 3-2):

- **Humans** – People may be exposed to contaminated sediment at the T-91 SLA in several ways:
  - Indirectly via the consumption of contaminated fish and/or shellfish
  - Directly via exposure to contaminated sediment during activities such as beach play, clamming, or netfishing
- **Benthic invertebrates** – Invertebrates (including shellfish) may be exposed directly to contaminated sediment or indirectly via the consumption of contaminated prey.
- **Higher trophic level species** – These species (which include benthic fish, pelagic fish, aquatic birds, and aquatic mammals) may be exposed to contaminated sediment, indirectly via the consumption of contaminated prey. Direct exposure to contaminated sediment may also occur for some higher trophic level species (e.g., benthic fish).

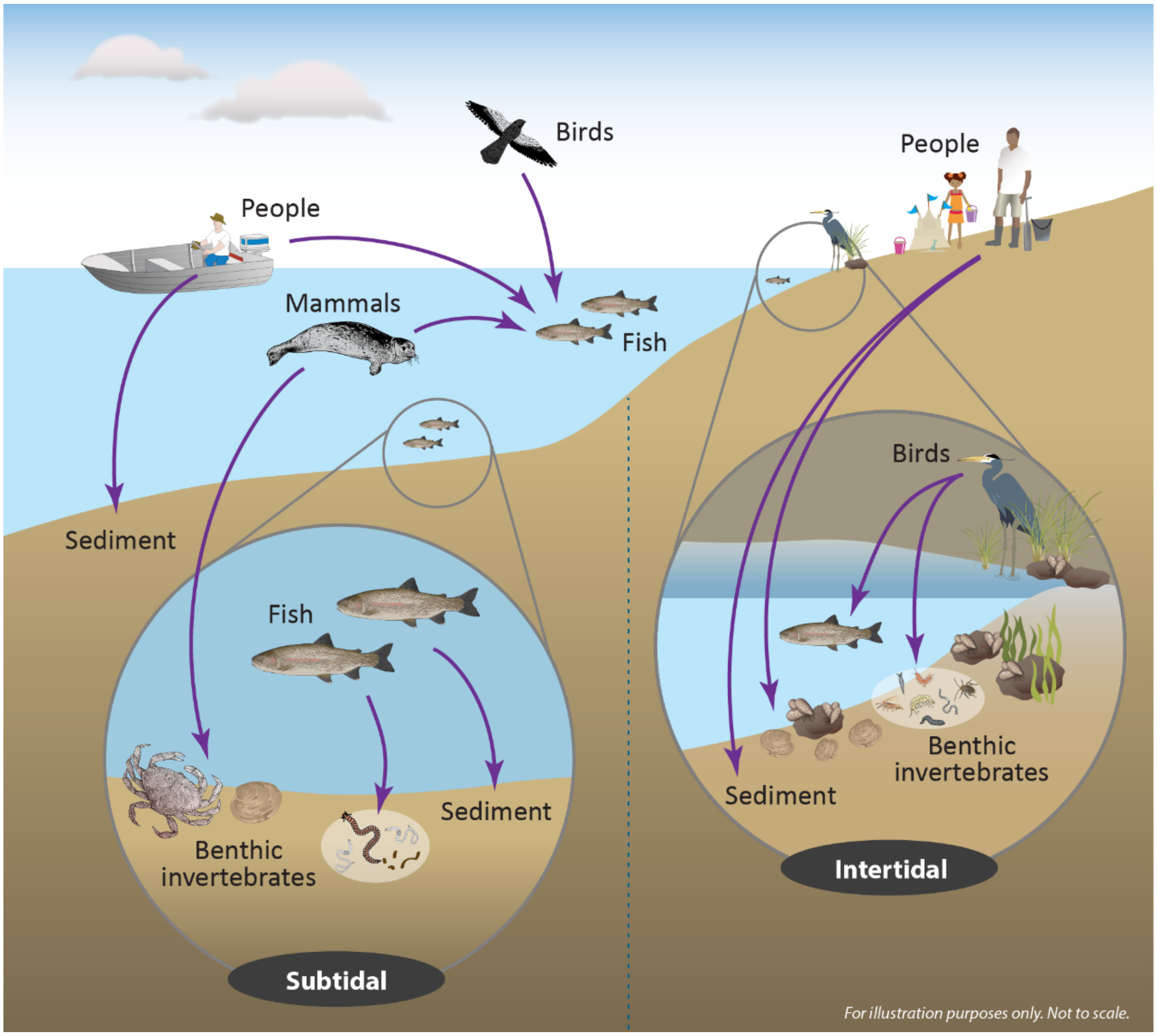


Figure 3-2.Human health and ecological exposure pathways

For pathways involving the consumption of seafood (human health and ecological receptors), sediment RBCs will be estimated, as needed, from tissue RBCs using biota sediment accumulation factors (BSAFs) derived from the scientific literature and/or based on regional datasets (see Section 3.4.3). Consistent with Ecology's SCUM guidance for a simple sediment cleanup site (Ecology 2019), no tissue data collection is proposed. The small size of the T-91 SLA relative to the expected home range of species that could be collected further supports this approach.

Details regarding the receptors and exposure pathways to be evaluated are presented in Table 3-2.

Table 3-2. Overview of risk evaluation methods

Receptor Group	Pathway(s) for Exposure to Sediment	Scenario / Receptor	Relevant Sediment Area	Method for Risk Evaluation
Humans	indirect exposure (seafood consumption)	seafood consumption	intertidal and subtidal sediment	Compare sediment with back-calculated sediment RBCs using literature-derived BSAFs.
	direct exposure (incidental ingestion and dermal absorption)	netfishing	intertidal and subtidal sediment	Compare sediment with back-calculated RBCs.
		clamming and beach play	intertidal sediment only	
Benthic invertebrates	direct exposure and indirect exposure (consumption of contaminated prey)	diverse invertebrate community	intertidal and subtidal sediment	Compare sediment with marine SMS criteria.
Higher trophic level species (fish, birds, mammals)	indirect exposure (consumption of contaminated prey) and/or direct exposure	Species that use the area will be discussed as part of the RI.	intertidal and subtidal sediment	Per SCUM (Ecology 2019), compare sediment with risk-based criteria for human health assumed to be protective of higher-trophic-level ecological receptors.

BSAF – biota-sediment accumulation factor
RBC – risk-based concentration
RI – remedial investigation
SCUM – Sediment Cleanup User's Manual
SMS – Washington State Sediment Management Standards

The subsections that follow present details regarding the approach for evaluating risks to human health and ecological receptors and reviewing the literature for BSAFs.

3.4.1 Evaluation of human health risks

Risks to human health will be evaluated for both indirect exposure (via seafood consumption) and direct exposure (via activities such as beach play, clamming, and netfishing) to sediment. To assess risks, T-91 SLA spatially weighted average concentrations (SWACs) will be compared with back-calculated RBCs. RBCs protective of the applicable human health exposure pathways will be back-calculated from target risk levels (i.e., from an excess cancer risk of 1×10^{-6} and/or from a hazard quotient [HQ] of 1). For the seafood consumption pathway, sediment will be estimated from target RBCs using BSAFs. T-91 SLA sediment concentrations greater than RBCs will indicate that excess cancer risks or HQs are above the acceptable risk thresholds.

Default reasonable maximum exposure (RME) parameter values will be used as a starting point for evaluating risk (Table 3-3). These exposure parameters will be evaluated as part of the RI to determine if site-specific factors warrant any modification of these parameter values. Any adjustments to these parameter values will be made in consultation with Ecology and the Tribes.

Table 3-3. Default human health exposure parameters

Parameter	Abrv.	Unit	Default RME Parameters Values by Scenario			
			Seafood Consumption[a]	Beach Play (Child)	Clam Digging (Adult)	Netfishing (Adult)
Exposure frequency	EF	days/yr	365	41	120	119
Exposure duration	ED	years	70	6	70	70
Body weight (kg)	BW	kg	85	15	75	75
Averaging time, cancer	AT	days	25,550	25,550	25,550	25,550
Averaging time, non-cancer	AT	days	25,550	2,190	25,550	25,550
Parameters specific to seafood consumption scenarios						
Fish consumption rate	FCR	g/day	TBD[b]	-	-	-
FDF[c]	FDF	unitless	1[b]	-	-	-
Parameters specific to direct contact scenarios						
Ingestion rate	IR	mg/day	-	200	100	50
Dermal surface area	SA	cm^2	-	2,378	3,212	3,212
Skin-to-sediment adherence factor	AF	mg/cm^2-day	-	0.2	0.6	0.02

Source: SCUM, Appendix E (Ecology 2019).

[a] Default parameters are only presented for adult seafood consumers; consumption of seafood by children will also be considered.

[b] As described in SCUM guidance (Ecology 2019), fish consumption rates and fish diet fraction may be established on a site-specific basis in consultation with the affected Tribes.

[c] The FDF is the proportion of fish or shellfish in the diet that is from the site (or from the vicinity of the site).

FDF – fish diet fraction

RME – reasonable maximum exposure

TBD – to be determined

3.4.2 Evaluation of ecological risks

As described, risks to ecological receptors will be considered for both benthic invertebrates and higher-trophic-level species (i.e., fish, birds, and mammals). For the evaluation of benthic invertebrates, T-91 SLA surface sediment data will be compared to marine SMS criteria on a point-by-point basis.

For higher-trophic-level species, as described in SCUM (Ecology 2019), it is generally expected that RBCs protective of human health will also be protective of ecological receptors. However, chemicals that may pose greater risks to higher-trophic-level receptors than to humans should be considered. SCUM lists lead, mercury, selenium, TBT, pentachlorophenol (PCP), pyrene, and fluoranthene as potentially meeting these criteria. For the T-91 SLA, these chemicals are infrequently detected, have SWACs that are lower than natural background concentrations, and/or are co-located with PCBs. Thus, the evaluation of risks to higher-trophic-level ecological receptors in the RI will discuss species that use the area and will focus on confirming the assumption that higher-trophic-level ecological receptors will be protected based on cleanup levels (CULs) protective of human health.

3.4.3 Development of literature-derived BSAFs

For pathways that involve seafood consumption, BSAFs will be derived from the scientific literature and/or based on regional datasets. Sediment RBCs will be calculated using the tissue RBC and BSAFs as shown in Equation 3-1.

$$RBC_{sediment} = \frac{RBC_{tissue}}{BSAF \times SUF} \qquad \textbf{Equation 3-1}$$

Where:

RBC_{tissue}	=	risk-based concentration in tissue, which will be back-calculated from target risk levels using human health exposure parameters (mg/kg ww)
$RBC_{sediment}$	=	risk-based concentration in sediment (mg/kg dw)
BSAF	=	chemical-specific biota-sediment accumulation factor
SUF	=	site use factor

The following will be considered in the back-calculation of sediment RBCs.

- **Nonpolar organic chemicals (e.g., PCBs, dioxin/furans, and PAHs)** – Consistent with Ecology's SCUM guidance (Ecology 2019), the tissue concentration used to calculate the BSAF will be lipid normalized, and the sediment concentrations will be organic carbon (OC) normalized, because these chemicals are primarily found in fatty tissue and the organic fraction of sediment.
  - Site-specific sediment OC data will be used to convert the OC-normalized risk-based sediment value to dry weight for comparison to background levels.
  - Lipid values will be based on region-specific data (e.g., lipid data collected from relevant species in Elliott Bay, the East Waterway, or the Lower Duwamish Waterway).
- **Metals** – BSAFs for metals will not be normalized; calculated sediment concentrations will be in dry weight, so no conversion will be needed for comparison to background levels.
- **SUF** – A default site use factor (SUF) of 1 (i.e., assuming 100% site use) will be used as a starting point for calculating sediment RBCs; the use of a different SUF may be evaluated as part of the RI for human health scenarios and ecological receptors based on available site-specific information, due to the relatively small size of the T-91 SLA.

BSAF values based on co-located, paired sediment and whole-body tissue will be compiled from the scientific literature. The following possible sources will be considered for inclusion in BSAF development:

- EPA's Superfund BSAF database (EPA 2016) – This database, which was last updated in 2008, includes location-specific BSAFs based on co-located data for organic compounds for both fish and invertebrates from 20 Superfund sites.
- USACE BSAF database (USACE 2017) – This database, which was last updated in 2017, includes location-specific BSAFs based on co-located data from peer-reviewed literature and reports submitted by US government agencies for organic compounds for both fish and invertebrates.
- ORNL (Bechtel Jacobs 1998) – This source reports BSAFs for freshwater benthic invertebrates and inorganic chemicals (i.e., metals) and PCBs from published and unpublished literature.
- PTI Environmental Services (PTI 1995b, a) – This source reports BSAFs for fish and metals and organic compounds compiled for Ecology.

Appropriate BSAF values (or ranges of values) will be determined in the RI for use in the derivation of sediment RBCs. In addition to the literature, regional data may be considered for the development of BSAFs (e.g., paired sediment and whole-body tissue datasets from nearby sites such as Elliott Bay, the East Waterway, or the Lower Duwamish Waterway.

3.5 Site COPC Identification

Because a comprehensive surface sediment dataset already exists for the T-91 SLA, the available data were compared with benthic screening levels and with Ecology's natural background concentrations to derive a list of preliminary contaminants of potential concern (COPCs). Preliminary COPCs were identified based on the following:

- **Benthic criteria** – Surface sediment data were compared on a point-by-point basis with Ecology's SMS criteria protective of benthic invertebrates. Chemicals for which the maximum concentration in surface sediment was greater than the sediment cleanup objective (SCO) were considered COPCs.
- **Bioaccumulative chemicals** – SWACs for T-91 SLA surface sediment were compared with Ecology's Washington State natural background values, because no regional background values for Elliott Bay are currently available (Ecology 2019).[7] SWACs greater than the natural background concentrations

[7] Regional background concentrations for Elliott Bay may be derived in parallel with the RI/FS (see Section 4.0).

were identified as COPCs. When insufficient data were available to calculate a SWAC, the mean value was used for this screening evaluation.

The results of these screening evaluations are presented in Tables 3-4 and 3-5.

Table 3-4. COPC identification based the comparison of surface sediment data with SMS criteria

Chemical	Detection Frequency		Count of Detects Above SMS Criteria		Identified as COPC?
	Ratio	Percent	> SCO	> CSL (and SCO)	
Metals					
Arsenic	46 / 49	94	1	1	**yes**
Cadmium	47 / 49	96	0	0	no
Chromium	49 / 49	100	0	0	no
Copper	49 / 49	100	1	1	**yes**
Lead	47 / 49	96	2	2	**yes**
Mercury	43 / 49	88	12	11	**yes**
Silver	44 / 49	90	0	0	no
Zinc	49 / 49	100	2	1	**yes**
PAHs					
2-Methylnaphthalene	34 / 49	69	0	0	no
Acenaphthene	34 / 49	69	3	1	**yes**
Acenaphthylene	39 / 49	80	0	0	no
Anthracene	44 / 49	90	4	2	**yes**
Benzo(a)anthracene	46 / 49	94	6	4	**yes**
Benzo(a)pyrene	46 / 49	94	23	6	**yes**
Benzo(g,h,i)perylene	45 / 49	92	26	7	**yes**
Total benzofluoranthenes	48 / 49	98	22	5	**yes**
Chrysene	47 / 49	96	21	4	**yes**
Dibenzo(a,h)anthracene	42 / 49	86	29	7	**yes**
Dibenzofuran	38 / 49	78	3	0	**yes**
Fluoranthene	48 / 49	98	14	4	**yes**
Fluorene	39 / 49	80	5	2	**yes**
Indeno(1,2,3-cd)pyrene	44 / 49	90	24	6	**yes**
Naphthalene	41 / 49	84	0	0	no
Phenanthrene	45 / 49	92	6	1	**yes**
Pyrene	48 / 49	98	5	3	**yes**
Total HPAHs	48 / 49	98	20	5	**yes**
Total LPAHs	45 / 49	92	3	3	**yes**
Phthalates					
BEHP	36 / 49	73	4	2	**yes**
BBP	9 / 49	18	1	0	**yes**

Chemical	Detection Frequency		Count of Detects Above SMS Criteria		Identified as COPC?
	Ratio	Percent	> SCO	> CSL (and SCO)	
Diethyl phthalate	9 / 49	18	0	0	no
Dimethyl phthalate	1 / 49	2	0	0	no
Di-n-butyl phthalate	6 / 49	12	0	0	no
Di-n-octyl phthalate	6 / 49	12	0	0	no
Other SVOCs					
1,2,4-Trichlorobenzene	1 / 49	2	0	0	no
1,2-Dichlorobenzene	1 / 49	2	0	0	no
1,4-Dichlorobenzene	26 / 49	53	14	4	**yes**
2,4-Dimethylphenol	21 / 49	43	3	3	**yes**
2-Methylphenol	8 / 49	16	0	0	no
4-Methylphenol	20 / 49	41	0	0	no
Benzoic acid	3 / 49	6.1	0	0	no
Benzyl alcohol	1 / 47	2.1	1	0	**yes**
Hexachlorobenzene	1 / 49	2	0	0	no
Hexachlorobutadiene	0 / 49	0	0	0	no
n-Nitrosodiphenylamine	0 / 49	0	0	0	no
PCP	2 / 49	4.1	0	0	no
Phenol	30 / 49	61	0	0	no
PCBs					
Total PCB Aroclors	46 / 49	94	21	2	**yes**

BBP – butyl benzyl phthalate
BEHP – bis(2-ethylhexyl) phthalate
COPC – contaminant of potential concern
CSL – cleanup screening level
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PCP – pentachlorophenol
SCO – sediment cleanup objective
SMS –Washington State Sediment Management Standards
SVOC – semivolatile organic compound

Table 3-5. COPC identification of bioaccumulative chemicals based on the comparison of surface sediment SWACs to natural background concentrations

Chemical	Unit	T-91 Surface Sediment			Natural Background[a]	Identified as COPC?
		Detection Frequency	Mean Detect	SWAC		
Dioxins/furan TEQ	ng/kg dw	13 / 13	19.4	isd	4	**yes**
PCB TEQ	ng/kg dw	nd	nd	nd	0.2	ne[b]
Total PCBs	µg/kg dw	46 / 49	230	151	3.5	**yes**
cPAH TEQ	µg/kg dw	48 / 49	2,800	1,620	21	**yes**
Arsenic	mg/kg dw	46 / 49	9.5	7.03	11	no

Chemical	Unit	T-91 Surface Sediment			Natural Background[a]	Identified as COPC?
		Detection Frequency	Mean Detect	SWAC		
Cadmium	mg/kg dw	47 / 49	0.5	0.37	0.8	no
Chromium	mg/kg dw	49 / 49	29	25.2	62	no
Copper	mg/kg dw	49 / 49	65	40.9	45	no
Lead	mg/kg dw	47 / 49	80	39.8	21	**yes**
Mercury	mg/kg dw	43 / 49	0.4	0.305	0.2	**yes**
Nickel	mg/kg dw	3 / 3	30	isd	50	no
Silver	mg/kg dw	44 / 49	0.52	0.35	0.24	**yes**
Zinc	mg/kg dw	49 / 49	140	95.5	93	**yes**

a The natural background numbers for marine sediment are those derived by Ecology as the 90/90 upper tolerance limit of the Bold Study, as reported in SCUM (Ecology 2019).

b No PCB congener data are available; PCB TEQ will be evaluated in the RI after additional data have been collected.

COPC – contaminant of potential concern
cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
Ecology – Washington State Department of Ecology
isd – insufficient data
nd – no data
ne – not evaluated
PCB – polychlorinated biphenyl
RI – remedial investigation
SCUM – Sediment Cleanup User's Manual
SWAC – spatially weighted average concentration
TEQ – toxic equivalent

Based on the comparison of T-91 SLA sediment concentrations with SMS criteria protective of benthic invertebrates, and the comparison of SWACs with Ecology's natural background concentrations, the preliminary COPC list for the site includes the following:

- Metals – arsenic, copper, lead, mercury, silver, and zinc
- PAHs – 14 individual PAHs, total high-molecular-weight polycyclic aromatic hydrocarbons (HPAHs), total low-molecular-weight polycyclic aromatic hydrocarbons (LPAHs), and carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalent (TEQ)
- Phthalates – bis(2-ethylhexyl) phthalate (BEHP) and butyl benzyl phthalate (BBP)
- Other SVOCs – 1,4-dichlorobenzene, 2,4-dimethylphenol, and benzyl alcohol
- Total PCBs
- Dioxin/furan TEQ

The list of site COPCs will be refined as part of the RI after additional data have been collected and risk-based concentrations have been calculated for relevant exposure pathways (Section 3.4).

Ultimately, the identification of COCs among bioaccumulative chemicals will be based on a comparison of sediment concentrations with background concentration, risk-based concentration, or PQL, whichever is greatest. In addition, the COC list will consider the identification of indicator chemicals to help focus the RI/FS. Indicator chemicals will be determined using the criteria described in SCUM (Ecology 2019), and they will include chemicals that 1) are expected to have the greatest contributions to ecological and human health risk, 2) have the largest contamination footprint, and 3) represent each major analytical group. In addition, contribution to the total TEQ will be considered for PCB TEQ and dioxin/furan TEQ.

3.6 COPC Distributions

The existing dataset can be used to evaluate the distribution of COPCs in surface sediment. The subsurface sediment dataset is limited, and therefore, the subsurface COPC distributions cannot be evaluated until additional subsurface sediment data are collected as part of the RI.

3.6.1 Surface and subsurface sediment PCB concentrations

Surface and subsurface sediment PCB concentrations are shown on Map 3-7. The central berth area has the highest surface and subsurface sediment concentrations. Two surface sediment samples with PCB concentrations greater than 1,000 µg/kg were collected along the eastern edge of Pier 91, and four of the five cores collected in this area had sediment intervals with PCB concentrations greater than 1,000 µg/kg; the maximum concentration of 47,000 µg/kg was from the 1.6- to 3.6-ft interval of T91-13-06 (Map 3-7). The cores in the central berth area were collected to characterize the subsurface sediment in the vicinity. In the eastern berth area, the highest PCB concentrations (up to 1,270 µg/kg) were in the vicinity of Outfall 68 in the northern portion of the berth area. PCB concentrations were generally low (less than 13 µg/kg dw) in the intertidal areas along the western and eastern shorelines of the T-91 SLA.

3.6.2 Surface sediment cPAH TEQs

The distribution of surface sediment cPAH TEQs is shown in Map 3-8. The cPAH TEQs in the intertidal areas are less than 1,000 µg/kg, except in the areas adjacent to the outfalls at the northern end of the berth areas. The highest TEQs are in the regrade area east of Pier 91 and east of the end of Pier 90.

Few data are available to assess cPAH TEQs in subtidal sediment. cPAH TEQ values were greater than 5,000 µg/kg at the southern end of each pier.

3.6.3 Surface sediment dioxin/furan TEQs

The sediment dioxin/furan data are limited and are not sufficient for interpolation. The dioxin/furan TEQ results for 15 surface sediment locations are shown in Map 3-9. Most of the data are from the regrade area in the south end of the central berth area, where dioxin/furan TEQs ranged from 2.68 to 50.0 ng/kg. Two surface sediment composite samples were collected in the vicinity of Outfall 68, with dioxin/furan

TEQs of 13.7 and 18.9 ng/kg. One central berth area core (T91-13-06) was collected and analyzed for dioxins/furans; the subsurface sediment dioxin/furan TEQ in the 1.6- to 3.6-ft interval of T91-13-06 was 78.4 ng/kg.

3.6.4 Surface sediment SMS comparison

Concentrations of SMS chemicals in surface sediment were compared to SMS criteria on a point-by-point basis; the results are shown in Map 3-10. Most of the SMS exceedances were for PCBs and PAHs. Nineteen locations had PCB concentrations greater than the SCO, and two locations had PCB concentrations greater than the cleanup screening level (CSL). Twenty-nine locations had PAH concentrations greater than the SCO, and seven locations had PAH concentrations greater than the CSL.

In the central berth areas, only 1 of the 18 samples collected did not have any SMS exceedances. The SMS chemicals with the greatest numbers of exceedances were PCBs, PAHs, and mercury.

In the southern portion of the central berth area, where the sediment regrading had been conducted, SMS exceedances were reported for 1,4-dichlorobenzene (eight locations), 2,4-dimethyl phenol (two locations), phthalates (two locations), arsenic (one location), and lead (one location). SMS exceedances were associated with locations along the pier where sediment had been removed, as well as locations where the sediment had been placed.

In the western berth area, there were no SMS exceedances along the western boundary of the T-91 SLA. Four locations along the western side of Pier 91 had concentrations of PAHs exceeding the SCO. Only one sample had a PCB concentration exceeding the SCO.

In the eastern berth area, 17 surface sediment samples were collected (Map 3-10). PAHs and PCBs were the SMS chemicals with the greatest numbers of exceedances. The eastern berth area was the only area with BEHP concentrations exceeding the SMS. The samples collected in the eastern portion of the berth area had no SMS exceedances.

4 Remedial Investigation Data Gaps

In order to identify data gaps, data quality objectives (DQOs) were established according to the process outlined by EPA (2006). For sediment, five DQOs were identified. The sediment DQOs, study questions, existing data, and RI data gaps are summarized in Table 4-1. A sampling and analysis plan (SAP) to fulfill these data gaps is presented in Appendix C. Additional DQO discussion and rationale for the study design is presented therein.

Table 4-1. Sediment DQOs and data gaps

DQO	Study Questions	Existing Data	RI Data Gaps
1 - Nature and extent	What is the horizontal and vertical extent of contamination?	- 49 surface sediment samples (2018) analyzed for full SMS suite - 1 core in the central berth analyzed for full SMS and dioxins/furans - 5 cores in the central berth area analyzed for PCBs only - 2 cores in eastern berth area analyzed for full SMS suite	- Collect surface sediment for COPCs without sufficient coverage (e.g., dioxins/furans and PCB congeners). - Collect cores in areas with potential sources around piers and in berth areas to characterize vertical extent. - Collect deeper cores (up to 10 ft) in cruise ship berth areas with potential for propeller scour.
2 - Site cleanup boundary	What is the extent of the site-related contamination?	only a few sampling locations near the southern end of the T-91 SLA	Collect sediment samples on either side of the AO boundary.
3 - Source identification and re-contamination potential	What do the sediment data tell us about potential sources?	- surface sediment data near Outfall A, Outfall 68/CSO, and primary storm drains, including dioxins/furan composite samples by Outfall 68 - subsurface data limited to two cores collected near Outfall 68/CSO	- Collect surface sediment and core samples to provide coverage near outfalls and any other potential source. - Use sediment traps at some outfalls to assess the potential for re-contamination.
4 - CUL derivation and comparison	What sampling design is needed to calculate SWACs for comparison to CULs? Are regional background data needed to establish CULs?	49 surface sediment samples analyzed within the T-91 SLA for most COPCs, allowing for SWACs	- Collect composite samples in the intertidal; depth to be determined based on clam species in the area. - Collect PCB congener data in a subset of samples. - Collect additional data for any COPC without sufficient data to calculate a SWAC. - Develop regional background concentrations in Elliott Bay
5 - FS data needs	What sediment data can be collected to facilitate FS evaluation of remedial alternatives?	-none	Collect Atterberg limits and specific densities for cores in areas likely to require remediation.

AO – Agreed Order
COPC – contaminant of potential concern
CUL – cleanup level
PCB – polychlorinated biphenyl
Port – Port of Seattle
RI – remedial investigation

DQO – data quality objective	SMS – Washington State Sediment Management Standards
FS – feasibility study	SWAC – spatially weighted average concentration
ID – identification	T-91 – Terminal 91

In addition to collecting data to fulfill sediment DQOs, the following information or studies are needed as part of the RI/FS to fill existing data gaps for propeller wash:

- Update the propeller wash evaluation to reflect current (2020) use of T-91, as well as potential future vessel use at the terminal.
- Develop a list of operation scenarios for each design vessel based on interviews with vessel pilots.
- Complete a holistic propeller wash evaluation for all vessels and operational scenarios that may cause significant sediment resuspension and local scour within the berths at T-91.
- Identify the most significant propeller wash scenarios for the T-91 berths. It may be necessary to parse the T-91 berths into sub-areas based on propeller wash and/or scour estimates.
- Calculate scour depths and stable sediment sizes within the T-91 berths (and sub-areas, if needed).

In addition, regional background values for Elliott Bay should be developed in order to establish the T-91 SLA boundary and set the CULs. In the RI, the boundary can be set using SCUM guidance for sediment cleanup units, but ultimately regional background should be established. Because this process generally takes longer than one year, discussions with Ecology and other interested parties will occur in parallel with the RI.

5 Remedial Investigation

The AO (Ecology 2020a) lists three major tasks. The first is addressed through the preparation of this RI Work Plan. The second involves conducting an RI for the T-91 SLA, and the third is related to interim action(s), if required. This section addresses the investigations needed to complete the second task (i.e., conducting an RI).

5.1 Remedial Investigation Investigations

In order to prepare an RI, the following RI investigations will be conducted to address the data gaps identified in Section 4. Three sediment investigations will be conducted following approval of the RI Work Plan. The SAP for the sediment investigations is provided in Appendix C. The SAP includes detailed descriptions and schedules for each of the sediment investigations summarized below.

5.1.1 Surface sediment investigation

Surface sediment will be collected throughout the T-91 SLA to establish the nature and extent of COPCs for which there is insufficient coverage, such as dioxins/furans and PCB congeners. In addition, surface sediment data will be collected to conduct toxicity tests (for locations without human health drivers), define the southern site boundary, and characterize potential source areas.

The surface sediment investigation will be the first investigation conducted after the finalization of the RI Work Plan in the spring of 2021.

5.1.2 Intertidal sediment investigation

The intertidal areas in the eastern and western berth areas will be characterized to support the development of CULs for direct contact human health risks associated with clamming and beach play.

The intertidal sediment investigation will be conducted in late June/July of 2021 to take advantage of the low daytime tides during that period.

5.1.3 Subsurface sediment investigation

The subsurface sediment investigation will be conducted to establish the nature and extent of deeper contamination, establish the southern site boundary, and characterize potential source areas.

The subsurface sediment investigation will be conducted after a review of the preliminary results from the surface sediment investigation to finalize the locations for sediment cores. For example, if the surface sediment results identify new areas of concern or new potential sources of contamination, then cores may be relocated or added to characterize these areas.

5.1.4 Other investigations

In addition to the sediment investigations covered in the SAP, three other investigations will be conducted: a source control investigation, an investigation of the extent of areas of intensive propeller wash, and an investigation for the development of regional background concentrations. These investigations are not covered by the SAP in Appendix C, because either they will be addressed through a SAP addendum, they do not require sample collection and analysis, or they will be addressed through a separate process.

The source control investigation will include a review of upcoming Port and City source control sampling programs to determine if storm drain and CSO solids samples will be collected under existing programs. If not, storm drain and CSO solids samples will be collected as an RI investigation from outfalls of potential concern based on sediment data. A SAP addendum will be prepared to cover the sampling.

In order to address the data gaps identified for the propeller wash investigation, additional information will be obtained from vessel operators, including specific information regarding the sizes and types of vessels currently using and anticipated to use T-91 in the future. Vessel pilots may be interviewed to identify relevant berthing maneuvers for evaluation.

Elliott Bay regional background concentrations have not been developed. The development of regional background requires more than one year; therefore, it is not likely that regional background could be developed before the RI is finalized. These values would be very useful for developing CULs and setting the final site boundary in the FS. Therefore, the Port will coordinate with Ecology and other interested parties to determine if data can be collected during the RI to facilitate the development of Elliot Bay regional background concentrations by Ecology.

5.2 SCHEDULE

The schedule for the RI was established in the AO (Ecology 2020a). The AO schedule, which is contingent on the completion of earlier milestones, is provided in Table 5-1. The projected dates for the finalization of the RI Work Plan and the commencement of fieldwork are based on an assumed Ecology review schedule.

Table 5-1. T-91 RI schedule

Task or Deliverable	Schedule in AO	Date
Service directive approval	not applicable	October 5, 2020
RI planning Meeting	prior to commencing work on the draft RI work plan	November 20, 2020
Agency review draft RI Work Plan	90 days after approval of service directive	January 4, 2021
Final RI Work Plan	45 days after the receipt of Ecology comments	*March 24, 2021*[a]
RI fieldwork begins	30 days after RI Work Plan approval	*April 23, 2021*
RI fieldwork complete	180 days after RI Work Plan approval[b]	*September 20, 2021*
Agency review draft RI	90 days after completion of fieldwork	*December 19, 2021*
Public review draft RI	30 days after receipt of Ecology comments	*February 17, 2022*[a]

Note: *Text in italics* indicates tentative dates.

[a] Based on assumption of 30 days for Ecology review.

[b] RI fieldwork will be considered complete when the RI dataset is finalized.

AO – Agreed Order
Ecology – Washington State Department of ecology
RI – remedial investigation
T-91 – Terminal 91

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