T-91 Submerged Lands Area Preliminary Investigation

Phase 2: Surface and Subsurface Sediment Characterization Results

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Acronyms

2LAET	second lowest apparent effects threshold
ARI	Analytical Resources, Inc.
COC	chain of custody
CSL	cleanup screening level
DL	detection limit
dw	dry weight
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
ID	identification
HASL	Health and Safety Laboratory
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
LAET	lowest apparent effects threshold
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
MLLW	mean lower low water
MTC	Materials Testing and Consulting, Inc.
NAD83	North American Datum of 1983
OC	organic carbon
Order	Agreed Order No. DE8938
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi	picocurie
Port	Port of Seattle
PSEP	Puget Sound Estuary Program
SAP	sampling and analysis plan
SCO	sediment cleanup objective
SIM	selected ion monitoring
SM	standard method
SMS	Washington State Sediment Management Standards
SQS	sediment quality standards

SVOC	semivolatile organic compound
T-91	Terminal 91
TBT	tributyltin
TOC	total organic carbon

1 Introduction

This sediment data report for the Port of Seattle's (Port's) Terminal 91 (T-91) is required under Section VII(B) Task 2 of Amendment 1 to Washington State Department of Ecology (Ecology)/Port Agreed Order No. DE8938 (Order). The data presented herein were collected following the T-91 sediment sampling and analysis plan (SAP) (Windward 2017). The surface sediment and sediment core results presented in this report are from the second phase of the preliminary investigation sampling, as described in the SAP.

As stated in the Order, the Port "must evaluate whether releases of hazardous substances have occurred within the Submerged Lands Area that present an unacceptable risk to human health or the environment." This data report, in combination with the Phase 1 data report (Windward 2018), "will furnish a basis to identify whether further remedial actions shall be required, as well as preliminary indications of historic and current sources of contamination and identification of potentially responsible parties."

Data management procedures are described in Appendix A. Data tables are provided in Appendix B. Field notes, sample photographs, sample collection forms, and chain of custody (COC) forms are provided in Appendix C. Laboratory reports and the data validation report are provided in Appendix D.

2 Methods

2.1 FIELD METHODS

Surface sediment grabs were collected from four locations using a pneumatic power grab sampler from a sampling vessel, in accordance with the SAP (Windward 2017).

Sediment samples were evaluated using the following sediment acceptance criteria:

- Sediment did not extrude from the upper face of the sampler.
- Overlying water was present (indicating minimal leakage).
- The sediment surface was relatively flat (indicating minimal disturbance or winnowing).
- A penetration depth of at least 11 cm was achieved.

Sediment cores were collected using a vibracorer deployed from the research vessel, as described in the SAP (Windward 2017). The vibracorer was driven into the sediment to refusal. Cores were collected from two locations and were evaluated using the following acceptance criteria:

- Material was collected to an acceptable depth (e.g., 10 ft or to refusal).
- Recovery (determined by measuring the headspace and subtracting that measurement from the length of the core tube upon retrieval) was greater than 75%.
- The core tube appeared to be intact without obstructions or blocking.

One geochronology core was collected to refusal using a diver-operated hammer corer with a 4-in. (outer diameter) steel core tube and a butyl acetate (or polycarbonate) core tube liner, in accordance with the SAP (Windward 2017).

Sediment and geochronology cores were logged and processed on the research vessel.

2.2 FIELD DEVIATIONS

Two deviations from the SAP (Windward 2017) occurred during sampling activities:

- A sediment core was not collected from within 10 ft of the target coordinates for location T91-2018-SC01, because the location was blocked by a moorage dolphin and further obstructed by a low-hanging power cable. Location T91-2018-SC01 was relocated as near to the target coordinates as possible to avoid the power cable.
- A sediment core was not collected from within 10 ft of the target coordinates for location T91-2018-SC02, because the area was blocked by a tug boat. Location T91-2018-SC02 was relocated as near to the target coordinates as possible while remaining within the former dry dock area.

- A geochronology core was not collected from within 10 ft of the target coordinates for location T91-2018-SCGC01, because the area was on a rocky mound. The geochronology core was collected as close to the target coordinates as possible where there was sediment that could be sampled.

2.3 Analytical Methods

The sediment samples were analyzed for Washington State Sediment Management Standards (SMS) chemicals, total organic carbon (TOC), total solids, and grain size, as shown in Table 1.

Table 1. Analytical methods

Parameter Group	Method	Laboratory
Total metals	EPA 6020A/7471B	ARI
SVOCs	EPA 8270D/8270D-SIM/8081B	ARI
PCB Aroclors	EPA 8082A	ARI
TBT	EPA 8270D-SIM	ARI
TOC	Plumb (1981)	ARI
Total solids	SM 2540-G	ARI
Grain size	PSEP (1986)	MTC
Geochronology	HASL-300 by gamma spectroscopy	Test America, Inc.

ARI – Analytical Resources, Inc.
EPA – US Environmental Protection Agency
HASL – Health and Safety Laboratory
MTC – Materials Testing and Consulting, Inc.
PCB – polychlorinated biphenyl
PSEP – Puget Sound Estuary Program
SIM – selected ion monitoring
SM – standard method
SVOC – semi-volatile organic compound
TBT – tributyltin
TOC – total organic carbon

3 Results

3.1 Locations

Sediment grabs, sediment cores, and a geochronology core were collected on April 26 and 27, 2018.

All accepted sediment grab samples were collected after one grab attempt at each of the four targeted sampling locations. One field duplicate was also collected from location T91-2019-SS31. To collect acceptable sediment core samples, four attempts were made at location T91-2018-SC01, and three attempts were made at location T91-2018-SC02. Two attempts were made at location T91-2018-SCGC01 to collect an acceptable geochronology core sample.

The sampling locations—provided in Table 2 and on Map 1—were consistent with the target coordinates specified in the SAP (Windward 2017) for all locations, with the exceptions of the two sediment core and one geochronology core locations. These locations were relocated for the following reasons:

- Location T91-2018-SC01: blocked by a moorage dolphin and a low-hanging power cable
- Location T91-2018-SC02: not accessible due to tug boat in the vicinity
- Location T91-2018-SCGC01: location moved to avoid rock mound

Table 2. Sampling coordinates

Sample ID	Easting (ft)[a]	Northing (ft)[a]	Latitude (°N)[b]	Longitude (°W)[b]	Distance to Target (ft)	Depth (ft)
T91-2018-SC01	1259263	234663	-122.379323	47.632823	17.5	-1
T91-2018-SC02	1259219	234150	-122.379459	47.631414	194.3	na
T91-2018-SCGC01	1259229	234648	-122.379459	47.632780	47	-3
T91-2018-SS30	1259263	233724	-122.379246	47.630249	0.6	-36
T91-2018-SS31	1259219	232806	-122.379350	47.627730	1.5	-31
T91-2018-SS32	1259215	232381	-122.379331	47.626565	3.3	-38
T91-2018-SS33	1258128	233388	-122.383821	47.629265	0.3*	-36

[a] NAD83 Washington State Plane North coordinates – US survey feet.
[b] NAD83 Geographic coordinates – decimal degrees.
ID – identification
na – not available because the bathymetry layer does not extend to this location.
NAD83 – North American Datum of 1983

3.2 CHEMISTRY RESULTS

Metals and organic chemicals (i.e., polycyclic aromatic hydrocarbons [PAHs], semivolatile organic compounds [SVOCs], and polychlorinated biphenyls [PCBs]) data are summarized in Sections 3.2.1 and 3.2.2 and on Maps 2 through 4. Conventionals data (i.e., total solids, TOC, and grain size) are Section 3.2.4. Appendix B includes metals, organics, and conventionals results for all samples (Table B1), as well as tables comparing each sample to appropriate SMS criteria (Tables B2 through B4).

3.2.1 Metals

Metals data for the surface sediment samples are provided in Table 3. Metals results for each sample were compared to SMS criteria (i.e., sediment cleanup objectives [SCOs] and cleanup screening levels [CSLs]) on a dry weight basis. There were no SMS exceedances for metals.

Table 3. Surface sediment samples metals data

Chemical	Unit	SCO	CSL	Sample T91-2018-				
				SS30	SS31	SS34[a]	SS32	SS33
Metals								
Arsenic	mg/kg dw	57	93	6.87	6.67	7.30	4.25	7.04
Cadmium	mg/kg dw	5.1	6.7	0.33	0.35	0.44	0.22	0.40
Chromium	mg/kg dw	260	270	25.8	23.5	24.2	18.1	26.0
Copper	mg/kg dw	390	390	38.5 J	43.1 J	43.4 J	28.5 J	52.0 J
Lead	mg/kg dw	450	530	29.9 J	41.8 J	43.9 J	24.5 J	34.3 J
Mercury	mg/kg dw	0.41	0.59	0.175 J	0.244 J	0.272 J	0.137 J	0.295 J
Silver	mg/kg dw	6.1	6.1	0.350 J	0.660 J	0.680 J	0.250 J	0.330 J
Zinc	mg/kg dw	410	960	66.7 J	74.4 J	82.8 J	63.5 J	101 J

CSL – cleanup screening level
dw – dry weight
J – estimated concentration
SCO – sediment cleanup objective

The metals data for the sediment cores is provided in Table 4. Mercury concentrations in the 2-4ft interval of SC01 and the 1-2ft and 2-4ft intervals of SC-02 exceeded the CSL.

Table 4. April 2018 core samples data

Chemical	Unit	SCO	CSL	SC01-			SC02-		
				0-1 ft	1-2 ft	2-4 ft	0-1 ft	1-2 ft	2-4 ft
Metals									
Arsenic	mg/kg dw	57	93	5.88	6.38	4.72	9.75	14.9	7.64
Cadmium	mg/kg dw	5.1	6.7	0.77	1.07	0.91	0.88	2.85	0.84
Chromium	mg/kg dw	260	270	33.4	36.6	31.1	43.2	63.2	36.0
Copper	mg/kg dw	390	390	67.3 J	74.0 J	54.2 J	56.4 J	136 J	64.7 J
Lead	mg/kg dw	450	530	58.3 J	97.9 J	157 J	69.7 J	221 J	54.2 J
Mercury	mg/kg dw	0.41	0.59	0.0733 J	0.144 J	<u>**1.75 J**</u>	0.228 J	<u>**1.31 J**</u>	<u>**1.69 J**</u>
Silver	mg/kg dw	6.1	6.1	0.290 J	0.420 J	0.770 J	0.750 J	3.86 J	0.560 J
Zinc	mg/kg dw	410	960	203 J	279 J	185 J	166 J	236 J	121 J
TBT as ion[a]	mg/kg dw	nc	nc	na	na	na	71.0	46.1	5.82 U

Bold result indicates exceedance of SCO.
<u>**Bold underlined**</u> result indicates exceedance of CSL.

CSL – cleanup screening level
dw – dry weight
J – estimated concentration
na – not analyzed
nc – no criteria
SCO – sediment cleanup objective
SQS – sediment quality standards
TBT – tributyltin
U – not detected at given concentration

3.2.2 Organic chemicals (PAHs, phthalates, other SVOCs, and PCBs)

Surface sediment concentrations of the organic chemicals (PAHs, phthalates, other SVOCs, and PCBs) are provided in Table 5. The SMS criteria for many of these chemicals are organic carbon (OC) normalized when the sediment TOC values are between 0.5 and 3.5%. All of the surface sediment samples were within this TOC range and the results are compared to the OC-normalized criteria in Table 5.

Table 5. Surface sediment SMS comparison

Chemical	Unit	SCO	CSL	T91-2018-				
				SS30	SS31	SS34[a]	SS32	SS33
PAHs								
2-Methylnaphthalene	mg/kg OC	38	64	3.70	4.90	3.66	2.70 J	5.42
Acenaphthene	mg/kg OC	16	57	6.50	9.10	4.06	5.70	6.74
Acenaphthylene	mg/kg OC	66	66	17.0	26.0	3.32 U	20.0	14.3
Anthracene	mg/kg OC	220	1,200	48.0	56.0	27.9	42.0	47.4
Benzo(a)anthracene	mg/kg OC	110	270	62.0	60.0	37.2	70.0	77.8
Benzo(a)pyrene	mg/kg OC	99	210	89.0 J	**130 J**	75.8 J	95.0 J	**158 J**
Benzo(g,h,i)perylene	mg/kg OC	31	78	27.0	**32.0**	**33.6**	28.0	**50.3**
Total benzofluoranthenes	mg/kg OC	230	450	220	**350**	201	**250**	**366**
Chrysene	mg/kg OC	110	460	**140**	100	64.4	**170**	**217**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	**14.0**	**18.0**	**15.7**	**15.0**	**21.6**
Dibenzofuran	mg/kg OC	15	58	5.70	7.40	5.27	3.90	6.39
Fluoranthene	mg/kg OC	160	1,200	100	83.0	51.7	**270**	**192**
Fluorene	mg/kg OC	23	79	13.0	10.0	5.27	9.40	7.95
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	88	32.0	39.0	**35.8**	34.0	**52.8**
Naphthalene	mg/kg OC	99	170	8.80	15.0	11.3	7.30	17.5
Phenanthrene	mg/kg OC	100	480	77.0	45.0	26.1	87.0	36.7
Pyrene	mg/kg OC	1,000	1,400	130	190	103	290	239
Total HPAHs	mg/kg OC	960	5,300	810 J	**1000 J**	618 J	**1200 J**	**1370 J**
Total LPAHs	mg/kg OC	370	780	170	160	74.7	170	131
Phthalates								
Bis(2-ethylhexyl)phthalate	mg/kg OC	47	78	22.0	32.0	21.5	12.0	24.0
Butyl benzyl phthalate	mg/kg OC	4.9	64	2.30 U	4.40	3.32 U	3.10 U	2.40
Diethyl phthalate	mg/kg OC	61	110	2.30 U	2.60 U	3.32 U	3.10 U	1.81 U
Dimethyl phthalate	mg/kg OC	53	53	2.30 U	2.60 U	3.32 U	3.10 U	1.81 U
Di-n-butyl phthalate	mg/kg OC	220	1,700	2.30 U	2.60 U	3.32 U	3.10 U	1.81 U
Di-n-octyl phthalate	mg/kg OC	58	4,500	1.60 J	2.20 J	3.32 U	3.10 U	14.2

Chemical	Unit	SCO	CSL	T91-2018-				
				SS30	SS31	SS34[a]	SS32	SS33
Other SVOCs								
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	0.58 U	0.66 U	**0.83 U**	0.78 U	0.45 U
1,2-Dichlorobenzene	mg/kg OC	2.3	2.3	2.30 U	**2.60 U**	**3.32 U**	**3.10 U**	1.81 U
1,4-Dichlorobenzene	mg/kg OC	3.1	9	1.40 J	**23.0**	1.29 J	3.10 U	1.96
2,4-Dimethylphenol	µg/kg dw	29	29	4.5 J	7.2 J	9.3 J	4.2 J	7.8 J
2-Methylphenol	µg/kg dw	63	63	19.4 U	19.2 U	39.8 U	19.7 U	19.7 U
4-Methylphenol	µg/kg dw	670	670	19.4 U	16.3 J	39.8 U	19.7 U	22.2
Benzoic acid	µg/kg dw	650	650	194 U	192 U	398 U	197 U	197 U
Benzyl alcohol	µg/kg dw	57	73	19.4 U	19.2 U	39.8 U	19.7 U	**58.8**
Hexachlorobenzene	mg/kg OC	0.38	2.3	0.057 U	0.068 U	0.041 U	0.076 U	0.045 U
Hexachlorobutadiene	mg/kg OC	3.9	6.2	2.30 U	2.60 U	3.32 U	3.10 U	1.81 U
n-Nitrosodiphenylamine	mg/kg OC	11	11	2.30 U	2.60 U	3.32 U	3.10 U	1.81 U
Pentachlorophenol	µg/kg dw	360	690	97.0 U	95.8 U	199 U	98.5 U	98.5 U
Phenol	µg/kg dw	420	1,200	13.2 J	16.9 J	39.8 U	17.7 J	36.2
PCBs								
Total PCB Aroclors	mg/kg OC	12	65	10.0	**17.0**	9.93	9.10	9.52
Conventionals								
TOC	%	nc	nc	0.84 J	0.73 J	1.20 J	0.63 J	1.09 J

[a] Field duplicate of sample T91-2018-SS31.
Bold result indicates exceedance of SQS.
Bold underlined result indicates exceedance of CSL.

CSL – cleanup screening level
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
nc – no criteria
OC – organic carbon
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SCO – sediment cleanup objective
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards
SVOC – semivolatile organic compound
TOC – total organic carbon
U – not detected at given concentration

PAH concentrations exceeded the PAH SCO values in all of the surface sediment samples (Map 3). Two individual PAH compounds exceeded the SCOs at location SS30. Individual PAH compounds and HPAH sums exceeded SCOs at locations SS31, SS32 and SS33. None of the samples exceeded the CSL. The PCB concentration at SS31 exceeded the SCO but not the CSL and the 1,4-dichlorobenzene concentration exceeded the CSL. Finally, the benzyl alcohol concentration at location SS33 exceeded the SCO but not the CSL.

The subsurface sediment concentrations of the organic chemicals (PAHs, phthalates, other SVOCs, and PCBs) are provided in Tables 6 and 7. The SMS criteria for many of these chemicals are organic carbon (OC) normalized when the sediment TOC values are between 0.5 and 3.5%. The results for samples that are within this TOC range are shown in Table 6. Two of the samples from core SC01 (SC01 0-1 ft and 2-4 ft) had TOC values greater than 3.5% and therefore the results for these samples were compared to dry weight criteria in Table 7.

There were no exceedances for PAHs in the subsurface samples that were OC normalized PAH concentrations exceed the SMS criteria on a dry weight basis in two intervals of core SC01 (0-1ft and 2-4ft) (Map 3). Phthalate concentrations exceeded SMS criteria in both cores for both OC normalized and dry weight samples. The sample from SCO01 2-4ft had a 1,4-dichlorobenzene concentration above the CSL. Finally, PCB concentrations exceeded the SCO criteria in both cores for both OC normalized and dry weight samples (Tables 6 and 7, Map 4).

Table 6. Subsurface sediment results for organic chemicals (TOC between 0.5% and 3.5%)

Chemical	Unit	SCO	CSL	T91-2018-			
				SC01-1-2ft	SC02-0-1ft	SC02-1-2ft	SC02-2-4ft
PAHs							
2-Methylnaphthalene	mg/kg OC	38	64	0.622 U	2.33	2.31	6.70
Acenaphthene	mg/kg OC	16	57	1.47	3.21	1.69	7.40
Acenaphthylene	mg/kg OC	66	66	1.75	13.1	4.41	9.20
Anthracene	mg/kg OC	220	1,200	10.9	26.6	11.9	33.0
Benzo(a)anthracene	mg/kg OC	110	270	23.8	40.4	14.9	31.0
Benzo(a)pyrene	mg/kg OC	99	210	22.5 J	79.2 J	31.5 J	75.0 J
Benzo(g,h,i)perylene	mg/kg OC	31	78	10.2	26.9	7.96 J	20.0
Total benzofluoranthenes	mg/kg OC	230	450	61.5	208	89.3	200
Chrysene	mg/kg OC	110	460	40.7	77.8	18.5 J	46.0
Dibenzo(a,h)anthracene	mg/kg OC	12	33	4.81	11.3	3.65	8.90
Dibenzofuran	mg/kg OC	15	58	1.27	3.03	2.14	9.50
Fluoranthene	mg/kg OC	160	1,200	93.9	102	19.3 J	37.0
Fluorene	mg/kg OC	23	79	2.46	4.72	2.19	9.00
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	88	10.4	30.8	9.04	22.0
Naphthalene	mg/kg OC	99	170	2.04	5.93	6.09	21.0
Phenanthrene	mg/kg OC	100	480	21.7	35.5	13.0	36.0
Pyrene	mg/kg OC	1,000	1,400	81.7	188	116 J	340
Total HPAHs	mg/kg OC	960	5,300	350 J	765 J	310 J	770 J
Total LPAHs	mg/kg OC	370	780	40.3	89.0	39.3	110

Chemical	Unit	SCO	CSL	T91-2018-			
				SC01-1-2ft	SC02-0-1ft	SC02-1-2ft	SC02-2-4ft
Phthalates							
Bis(2-ethylhexyl)phthalate	mg/kg OC	47	78	**<u>151</u>**	**49.9**	**52.3**	13.0
Butyl benzyl phthalate	mg/kg OC	4.9	64	4.49	2.42	0.725 U	**2.70 U**
Diethyl phthalate	mg/kg OC	61	110	0.862	1.32 U	0.725 U	2.70 U
Dimethyl phthalate	mg/kg OC	53	53	2.43	1.32 U	0.725 U	2.70 U
Di-n-butyl phthalate	mg/kg OC	220	1,700	0.590 J	1.32 U	0.725 U	2.70 U
Di-n-octyl phthalate	mg/kg OC	58	4,500	0.622 U	1.32 U	0.725 U	2.70 U
Other SVOCs							
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	0.15 U	0.33 U	0.18 U	0.67 U
1,2-Dichlorobenzene	mg/kg OC	2.3	2.3	0.622 U	1.32 U	0.725 U	**<u>2.70 U</u>**
1,4-Dichlorobenzene	mg/kg OC	3.1	9	0.603 J	1.79	2.94	1.60 J
2,4-Dimethylphenol	µg/kg dw	29	29	6.2 J	7.3 J	11.7 J	9.3 J
2-Methylphenol	µg/kg dw	63	63	19.4 U	19.0 U	19.4 U	19.0 U
4-Methylphenol	µg/kg dw	670	670	47.9	31.4	48.8	24.1
Benzoic acid	µg/kg dw	650	650	90.0 J	190 U	194 J	190 U
Benzyl alcohol	µg/kg dw	57	73	19.4 U	19.0 U	19.4 U	19.0 U
Hexachlorobenzene	mg/kg OC	0.38	2.3	0.016 U	0.033 U	0.019 U	0.071 U
Hexachlorobutadiene	mg/kg OC	3.9	6.2	0.622 U	1.32 U	0.725 U	2.70 U
n-Nitrosodiphenylamine	mg/kg OC	11	11	0.622 U	1.32 U	0.725 U	2.70 U
Pentachlorophenol	µg/kg dw	360	690	96.9 U	95.1 U	97.1 U	94.9 U
Phenol	µg/kg dw	420	1,200	41.5	49.0	31.7	32.0
PCBs							
Total PCB Aroclors - zero DL	mg/kg OC	12	65	6.57 J	**15.6**	**48.8**	**18.0 J**
Conventionals							
TOC	%	nc	nc	3.12 J	1.44 J	2.68 J	0.70 J

Bold result indicates exceedance of SQS.
<u>Bold underlined</u> result indicates exceedance of CSL.

CSL – cleanup screening level
DL – detection limit
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
nc – no criteria
OC – organic carbon
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SCO – sediment cleanup objective
SQS – sediment quality standards
SVOC – semivolatile organic compound
TOC – total organic carbon
U – not detected at given concentration

Table 7. SMS comparison of cores with > 3.5% TOC

Chemical	Unit	SCO/LAET	CSL/2LAET	T91-2018-SC01-0-1	T91-2018-SC01-2-4
PAHs					
2-Methylnaphthalene	µg/kg dw	670	670	28.2	57.5
Acenaphthene	µg/kg dw	500	500	58.3	57.8
Acenaphthylene	µg/kg dw	1,300	1,300	75.7	63.4
Anthracene	µg/kg dw	960	960	304	328
Benzo(a)anthracene	µg/kg dw	1,300	1,600	666	990
Benzo(a)pyrene	µg/kg dw	1,600	1,600	525 J	908 J
Benzo(g,h,i)perylene	µg/kg dw	670	720	259	320
Total benzofluoranthenes	µg/kg dw	3,200	3,600	1,860	2,390
Chrysene	µg/kg dw	1,400	2,800	**1,830**	**1,840**
Dibenzo(a,h)anthracene	µg/kg dw	230	230	78.2	124
Dibenzofuran	µg/kg dw	540	540	65.1	43.5
Fluoranthene	µg/kg dw	1,700	2,500	<u>**3,360**</u>	<u>**3,670**</u>
Fluorene	µg/kg dw	540	540	138	76.8
Indeno(1,2,3-cd)pyrene	µg/kg dw	600	690	256	371
Naphthalene	µg/kg dw	2,100	2,100	82.5	142
Phenanthrene	µg/kg dw	1,500	1,500	<u>**1,640**</u>	776
Pyrene	µg/kg dw	2,600	3,300	2,270	**3,100**
Total HPAHs	µg/kg dw	12,000	17,000	11,100 J	**13,710 J**
Total LPAHs	µg/kg dw	5,200	5,200	2,300	1,444
Phthalates				-	-
Bis(2-ethylhexyl)phthalate	µg/kg dw	1,300	1,900	<u>**2,020**</u>	<u>**8,690**</u>
Butyl benzyl phthalate	µg/kg dw	63	900	**93.9**	**121**
Diethyl phthalate	µg/kg dw	200	1,200	19.3 U	19.0 U
Dimethyl phthalate	µg/kg dw	71	160	19.3 U	19.0 U
Di-n-butyl phthalate	µg/kg dw	1,400	1,400	14.8 J	19.0 U
Di-n-octyl phthalate	µg/kg dw	6,200	6,200	91.7	756
Other SVOCs					
1,2,4-Trichlorobenzene	µg/kg dw	31	51	4.8 U	4.8 U
1,2-Dichlorobenzene	µg/kg dw	35	50	19.3 U	19.0 U
1,4-Dichlorobenzene	µg/kg dw	110	110	7.5 J	<u>**254**</u>
2,4-Dimethylphenol	µg/kg dw	29	29	5.4 J	23.8 UJ
2-Methylphenol	µg/kg dw	63	63	19.3 U	19.0 U
4-Methylphenol	µg/kg dw	670	670	67.1	167
Benzoic acid	µg/kg dw	650	650	278	59.1 J
Benzyl alcohol	µg/kg dw	57	73	19.3 U	19.0 U

Chemical	Unit	SCO/LAET	CSL/2LAET	T91-2018-SC01-0-1	T91-2018-SC01-2-4
Hexachlorobenzene	µg/kg dw	22	70	0.50 U	0.50 U
Hexachlorobutadiene	µg/kg dw	11	120	**19.3 U**	**19.0 U**
n-Nitrosodiphenylamine	µg/kg dw	28	40	19.3 U	19.0 U
Pentachlorophenol	µg/kg dw	360	690	96.7 U	95.1 U
Phenol	µg/kg dw	420	1,200	47.5	34.3
PCBs					
Total PCB Aroclors	µg/kg dw	130	1,000	93.4 J	**211.1**
Conventionals					
TOC	%	nc	nc	7.08 J	3.51 J

Bold result indicates exceedance of SQS.
Bold underlined result indicates exceedance of CSL.

2LAET – second lowest apparent effects threshold
CSL – cleanup screening level
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
LAET – lowest apparent effects threshold
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SCO – sediment cleanup objective
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards
SVOC – semivolatile organic compound
TOC – total organic carbon
U – not detected at given concentration

3.2.3 Geochronological core results

The results for cesium-137 (Cs-137) and lead-210 (Pb-210) in the geochronologic core are provided in Table 8. The sediment profiles for both Cs-137 and Pb-210 were evaluated. There is some uncertainty in these profiles due to the fact that both radioisotopes were not detected in intervals of both cores. A net sedimentation rate could not be estimated for Pb-210 due to low correlation ($R^2 < 0.50$). The peak Cesium-137 activity was measured at 74 cm and a net sedimentation rate of 1.3 cm/year was calculated for this location (Figure 1).

Table 8. Radio chemical results

Sample ID	Sediment Interval (cm)	Cs-137 (pCi/g dw)	Pb--210 (pCi/g dw)
T91-2018-SCGC01-0-2	0–2 cm	0.104 U	0.774 U
T91-2018-SCGC01-6-8	6–8 cm	0.0772 U	0.619 U
T91-2018-SCGC01-12-14	12–14 cm	0.0707 U	0.811 U
T91-2018-SCGC01-18-20	18–20 cm	0.0732 U	0.605 U
T91-2018-SCGC01-24-26	24–26 cm	0.0683	1.36
T91-2018-SCGC01-30-32	30–32 cm	0.0771 U	0.610 U
T91-2018-SCGC01-36-38	36–38 cm	0.0756 U	1.37 U

Sample ID	Sediment Interval (cm)	Cs-137 (pCi/g dw)	Pb--210 (pCi/g dw)
T91-2018-SCGC01-42-44	42–44 cm	0.211	2.36
T91-2018-SCGC01-48-50	48–50 cm	0.0995	2.56
T91-2018-SCGC01-54-56	54–56 cm	0.0743	0.914 U
T91-2018-SCGC01-60-62	60–62 cm	0.159	1.24
T91-2018-SCGC01-66-68	66–68 cm	0.157 U	1.38 U
T91-2018-SCGC01-72-74	72–74 cm	0.220	1.56
T91-2018-SCGC01-78-80	78–80 cm	0.115	1.00 U

dw – dry weight
pCi – picocurie
U – not detected at given concentration

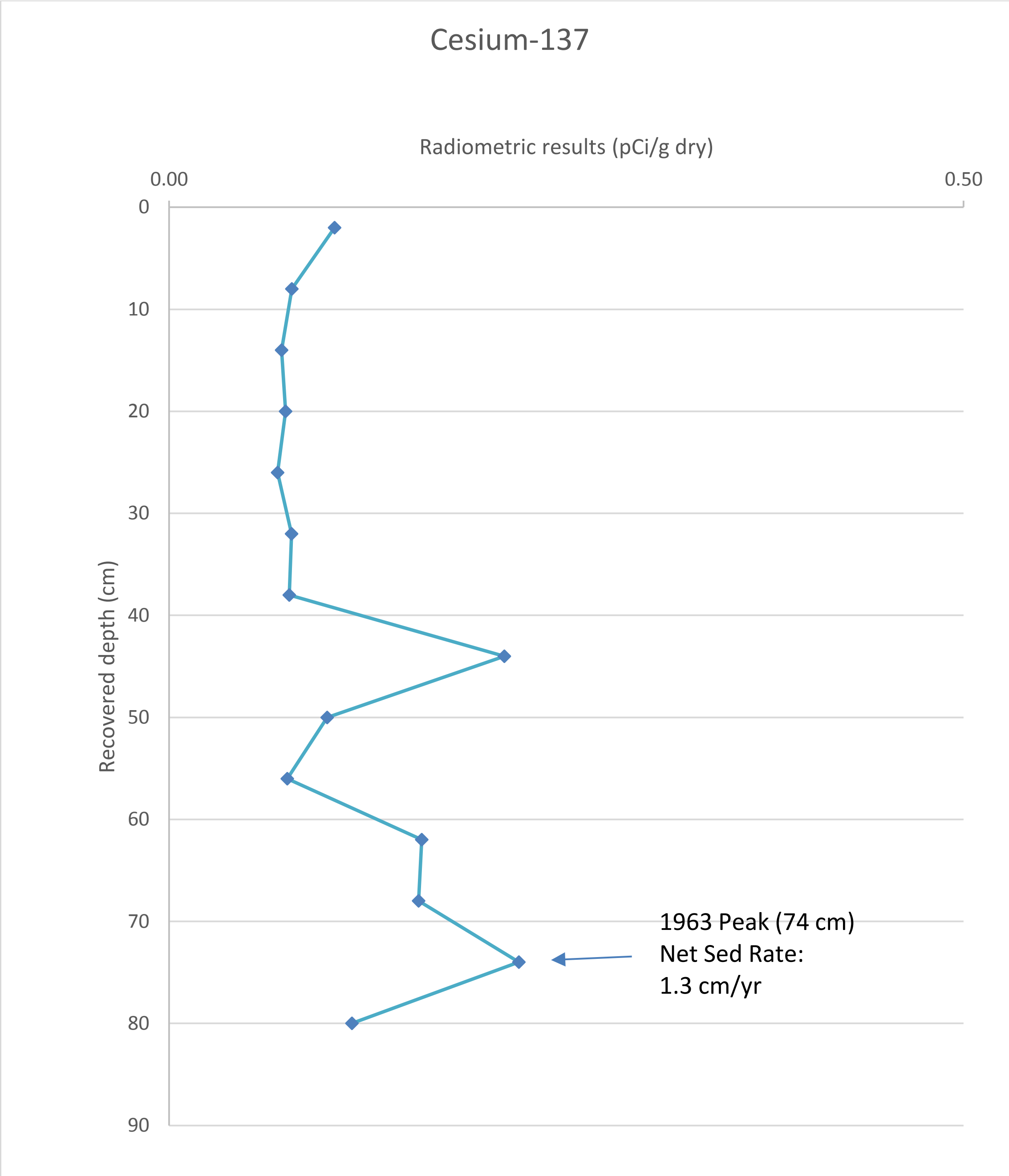

Figure 1. Cesium-137 profile for SCGC-01

3.2.4 Conventionals

Total grain size fractions, TOC, and total solids results are presented in Table 9. In general, samples with lower TOC were predominantly composed of sand and contained lower percentages of total fines (i.e., silt and clay), while samples with higher TOC contained more fines and less sand.

Table 9. Grain size, TOC and total solids data

Sample ID	Grain Size (% dw)					TOC (% dw)	Total Solids (% ww)
	Total Gravel	Total Sand	Total Silt	Total Clay	Total Fines[a]		
Surface sediment							
T91-2018-SS30	0.1	69.8	19.9	10.3	30.2	0.84 J	65.89
T91-2018-SS31	0.6	67.5	20.7	11.2	31.9	0.73 J	68.69
T91-2018-SS34[b]	0.4	73.7	20.6	5.3	25.9	1.20 J	68.44
T91-2018-SS32	12.9	69.3	11.4	6.4	17.8	0.63 J	67.38
T91-2018-SS33	16.3	48.7	30.8	4.2	35	1.09 J	66.69
Sediment cores							
T91-2018-SC01-0-1	2.9	70.6	21.2	5.4	26.6	7.08 J	46.06
T91-2018-SC01-1-2	3.3	54.3	32.7	9.7	42.4	3.12 J	57.46
T91-2018-SC01-2-4	4.1	69.4	22.1	4.3	26.4	3.51 J	66.84
T91-2018-SC02-0-1	1.2	57.5	29.5	11.9	41.4	1.44 J	61.77
T91-2018-SC02-1-2	1.7	36.6	38.0	23.8	61.8	2.68 J	56.11
T91-2018-SC02-2-4	3.3	42.2	37.5	17.17	54.6	0.70 J	66.37
T91-2018-SCGC01-0-20	1.3	95.8	2.9 U	2.9 U	2.9 U	0.68 J	76.97
T91-2018-SCGC01-20-40	36.2	57.1	4.8	1.9	6.7	2.12 J	72.30
T91-2018-SCGC01-40-60	0.6	51.1	36.8	11.4	48.2	2.99 J	60.14
T91-2018-SCGC01-60-82	4.0	51.7	31.6	12.7	44.3	3.09 J	57.52

[a] Total fines is the sum of the total silt and total clay fractions.

[b] Field duplicate of sample T91-2018-SS31.

dw – dry weight
ID – identification
J – estimated concentration
TOC – total organic carbon
U – not detected at given concentration
ww – wet weight

4 Data Quality Review

Independent data validation was performed on all results by Ecochem. A summary-level validation review was conducted. Gamma Radioassay Lead-210 minimum detectable concentrations in 6 core samples were greater than the requested reporting limit due to insufficient sample mass. All data were determined to be acceptable for use as qualified. No data were rejected.

The data validation report, with detailed information regarding every qualified sample, is presented in Appendix D.

5 References

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