Appendix B – Development of Sediment Cleanup Objectives and Cleanup Screening Levels for Human Health and Ecological Receptors

Chapter 1. Introduction

The Sediment Management Standards (SMS; Washington Administrative Code [WAC] 173-204) includes requirements for the protection of human health and the environment. The SMS rule includes a two-tier framework for developing human health risk-based sediment cleanup objectives (SCOs) and cleanup screening levels (CSLs) to address the bioaccumulative (via seafood consumption) and direct contact exposure pathways (WAC 173-204-561). Under the SMS rule, human health sediment RBCs are a component of sediment cleanup level development, as described in Chapter 8 of the Remedial Investigation (RI) report.

This appendix includes the selection of bioaccumulative chemicals of concern (COCs; Chapter 2), exposure pathways and reasonable maximum scenarios (Chapter 3), and the development of SCOs and CSLs for the Albert Jensen and Sons Inc. Boatyard and Marina (Jensen Marina) that are protective of human and ecological health (Chapter 4). The SCOs and CSLs are summarized in Chapter 5.

Chapter 2. Site Bioaccumulative Chemicals of Concern

The Dredged Material Management Program (DMMP) agencies have developed a list of bioaccumulative chemicals based on a comprehensive analysis of chemicals found in sediment and fish tissue in Washington State that are known to have effects on human health and wildlife (Ecology 2021):

- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs)
- Polychlorinated biphenyls (PCBs)
- Dioxin/furan congeners
- Dichlorodiphenyltrichloroethanes (DDTs)
- Other pesticides such as dieldrin, lindane, endosulfans, and methoxychlor
- Chlorinated organics such as hexachlorobenzene and pentachlorophenol
- Metals that have organic forms such as arsenic, mercury, cadmium, and butyltins

All these chemicals have been analyzed in sediments collected from Jensen Marina site. However, only some of these chemicals have been detected in site sediments above the method reporting limit (MRL). Using detection above the MRL as the primary criterion, the bioaccumulative COCs at the site are:

- cPAHs, expressed as toxic equivalents (TEQ)
- PCBs
- Dioxin/furan congeners, expressed as TEQ
- Pentachlorophenol
- Arsenic
- Cadmium
- Mercury
- Butyltins

SCOs and CSLs have been developed for these bioaccumulative chemicals.

Chapter 3. Exposure Pathways and Reasonable Maximum Exposure

The RI Work Plan identified multiple scenarios related to potential human exposure to sediment, surface water, and soil at the site, including water recreation; shore and upland recreation; occupational; fish, crab, and clam collection; and fish, crab, and clam consumption (Leon Environmental & Crete Consulting 2022). Although each of the exposure pathways included in these scenarios is theoretically complete, the activities associated with some of these pathways are unlikely to occur frequently under both current and future use of the site. For example, direct contact with surface water may occur incidentally during fishing or boating, but swimming in the vicinity of the marina is unlikely given the vessel traffic at the marina. Similarly, occupational exposure would likely occur only sporadically. The exposure pathways that are most likely to occur at the site are incidental ingestion and dermal contact with site sediments and fish/shellfish consumption.

At sites where scenarios that include sediment contact and fish/shellfish consumption apply in the same areas for the same chemicals, the fish/shellfish consumption exposure pathway often represents the highest risk. At such sites, calculation of risk-based sediment concentrations for both pathways calculations is typically not necessary. However, at the Jensen Marina site, the intertidal area can be considered a separate exposure area from the rest of the site and could ultimately be treated as a separate sediment management area. Consequently, it is appropriate to evaluate a direct sediment contact scenario for intertidal areas at the site (Section 3.1) in addition to the fish/shellfish consumption scenario (Section 3.2).

3.1 Direct Contact with Sediment

Activities with the potential for sediment exposure include beach play, clamming, launching small vessels, and shoreline fishing. Exposure to sediments is currently infrequent in intertidal areas along the western half of the property in front of the active boatyard. Intertidal areas in the eastern half of the site are currently more accessible to the public, but the Port of Friday Harbor is planning to develop this area such that public access would be unlikely in the future. Nonetheless, a direct sediment contact scenario was developed to address potential current use.

Ecology (2021) has included three default scenarios for evaluating human health risk from direct sediment contact at sediment cleanup sites: child beach play, subsistence clam digging by adults, and tribal net fishing by adults. Child beach play and clam digging are applicable to intertidal areas and tribal net fishing is applicable to subtidal areas. While clam digging is currently possible at the site, there is no evidence that clamming occurs at the default frequency (120 days/year) included for this scenario in Ecology's (2021) risk calculation spreadsheet. Given the physical constraints to net fishing that are associated with an active marina, the tribal net fishing scenario is also not appropriate for the Jensen Marina site. There is no evidence that tribal net fishing occurs in the vicinity of the marina.

A beach play scenario was developed to assess risks to young children (i.e., up to 6 years of age) from playing in intertidal sediments at the site. Default exposure parameters were used in the absence of site-specific data, including an exposure frequency of 41 days/year and a sediment ingestion rate of 200 mg/day (Ecology 2021). The exposure frequency assumption for this scenario is almost certainly an overestimate of current conditions, based on observations made at the site, but it provides a significant degree of protectiveness.

3.2 Consumption of Fish, Crabs, and Clams

The extent and frequency of the consumption of fish, crabs, and clams collected from the Jensen Marina area (or within the nearby shallow embayment) are unknown, but existing evidence suggests that harvesting does not occur. However, fish and crabs could be exposed to site sediments and later be harvested elsewhere, outside the site. For this reason, this exposure pathway was considered in the development of SCOs and CSLs.

No fish, crab, or clam chemistry data have been collected at the site. Without such data, the calculation of site-specific risk-based sediment concentrations for the protection of seafood consumers is highly uncertain (Ecology 2021). This is because tissue chemistry data are needed to calculate site-specific biota-sediment accumulation factors (BSAFs), which are used to calculate sediment concentrations from protective seafood tissue concentrations. At sites without tissue chemistry, Ecology (2021) guidance provides a simplified approach where the SCO and CSL are established at background (natural or regional, respectively) or the practical quantitation limit (PQL), whichever value is higher. Ecology (2021) has concluded that this approach is protective because risk-based sediment concentrations for most bioaccumulative chemicals are frequently below natural background.

For the Jensen Marina site, the simplified approach (i.e., natural background or PQL) was followed. To provide additional risk communication context for a range of seafood consumption scenarios, sediment concentrations protective of seafood consumption were also calculated using BSAFs from technical literature or other Puget Sound sediment sites.

Ecology's risk calculation spreadsheet provides three default Reasonable Maximum Exposure (RME) scenarios, corresponding to Suquamish Tribal Adults, Tulalip Tribal Adults, and Columbia River Tribal Adults (Ecology 2021). The Suquamish and Tulalip scenarios are applicable to Puget Sound sites. Although the consumption rates associated with these tribal scenarios are not sustainable at a site as small as Jensen Marina, for the purposes of risk communication, risk-based sediment concentrations were calculated for risk-based tissue concentrations based on the Tulalip Tribal Adult RME scenario. This RME scenario includes a seafood consumption rate of 193 g/day, which includes seafood obtained from all sources (e.g., stores, restaurants), not just self-caught seafood from Puget Sound. This consumption rate also includes salmon, whose exposure to contaminants occurs primarily outside Puget Sound.

Risk-based sediment concentrations were also calculated for a second scenario that is more reflective of recreational fishing. This scenario assumed one meal of seafood per month, which is equivalent to 7.5 g/day.

3.3 Ecological Receptors

Higher trophic level species such as birds and mammals are similar to humans in that the greatest risks are associated with consumption of fish and shellfish (Ecology 2021). Risk-based sediment concentrations derived according to Section 3.2 are also expected to be protective of higher-trophic level aquatic-dependent wildlife (e.g., otters) that may be exposed to bioaccumulative chemicals (through foraging) at the site, so no SCOs or CSLs specific to higher trophic level ecological receptors were calculated.

Chapter 4. SCO and CSL Development

For a given COC, the SCO and CSL for human health are determined based on the highest of the following:

- The lowest appropriate risk-based concentration (RBC) for the protection of human health for the 1×10^{-6} (for the SCO) or 1×10^{-5} (for the CSL) excess lifetime cancer risk threshold and/or a hazard quotient (HQ) of 1
- Natural background (for the SCO) or regional background (for the CSL)
- PQL

4.1 Risk-based Sediment Concentrations

4.1.1 Sediment Ingestion/Dermal Contact – Beach Play Scenario

Equations for risk-based sediment cleanup levels (SCLs) for sediment ingestion/dermal contact are provided in Ecology (2021) and also below. Carcinogenic PAHs are evaluated differently from other chemicals with carcinogenic effects (Equation 4-2).

Equation 4-1 – Sediment cleanup level for carcinogens for sediment ingestion/dermal contact exposure pathway

$$SCL_{Cancer} \quad \frac{ACR \times BW \times AT_{cr} \times UCF}{EF \times ED \times [(IR \times AB \times CPF_o) + (SA \times AF \times ABS \times CPF_d)]}$$

Equation 4-2 – Sediment cleanup levels for cPAHs for the sediment ingestion/dermal contact exposure pathway

$$IRF_{child\text{-}adj}\ (mg/kg) = \frac{IRF_{0\text{-}2} \times ED_{0\text{-}2} \times EF_{0\text{-}2} \times ADAF_{0\text{-}2}}{BW_{0\text{-}2}} + (2\text{-}6yr,\ 6\text{-}16yr,\ 16\text{-}70yr)$$

$$DF_{child\text{-}adj}\ (mg/kg) = \frac{SA_{0\text{-}2} \times ED_{0\text{-}2} \times EF_{0\text{-}2} \times AF_{0\text{-}2} \times ADAF_{0\text{-}2}}{BW_{0\text{-}2}} + (2\text{-}6yr,\ 6\text{-}16yr,\ 16\text{-}70yr)$$

$$SCL_{mutagen}\ (mg/kg) = \frac{ACR \times AT_{cr} \times UCF}{[(IRF_{child\text{-}adj} \times AB \times CPF_o) + (DF_{child\text{-}adj} \times ABS \times CPF_d)]}$$

Where:

AB = gastrointestinal absorption factor (unitless)
ABS = dermal absorption factor (unitless)
ACR = acceptable cancer risk (unitless; e.g., 1 in 1,000,000)
ADAF = age-dependent adjustment factor (unitless)
AF = sediment-to-skin adherence factor (mg/cm^2-day)
AT = averaging time (70 × 365 days/year)
BW = body weight (kg)
CPF_o = oral cancer potency factor $(mg/kg\text{-}day)^{-1}$
CPF_d = cancer potency factor adjusted for dermal exposure $(mg/kg\text{-}day)^{-1}$
$DF_{Child\text{-}adj}$ = child mutagenic dermal factor – age adjusted (mg/kg)
EF = exposure frequency (day/year)
ED = exposure duration (year)

$IRF_{Child\text{-}adj}$ = age-adjusted child ingestion factor (mg/kg)
IR = ingestion rate (mg/day)
SA = dermal surface area (cm^2)
SCL = risk-based sediment cleanup level concentration (mg/kg dry weight)
UCF = unit conversion factor (1,000,000 mg/kg)

Equation 4-3. Sediment cleanup levels for chemicals with non-carcinogen effects for sediment ingestion/dermal contact

$$SCL_{NonCancer} = \frac{HQ \times BW \times AT_{nc} \times UCF}{EF \times ED \times [((1/RfD_o) \times (IR \times AB)) + ((1/RfD_d) \times (SA \times AF \times ABS))]}$$

Where:
SCL = risk-based sediment cleanup level concentration (mg/kg dry weight)
HQ = hazard quotient (unitless)
RfD_o = oral reference dose (mg/kg-day)
RfD_d = reference dose adjusted for dermal exposure (mg/kg-day)
All other terms are the same as in Equation 4-1

In Equations 4-1 through 4-3, the CPF_d and RfD_d are derived from the CPF_o and RfD_o, as follows:

Equation 4-4. Conversion of RfD_o to RfD_d

$$RfD_d = RfD_o \times GI$$

Equation 4-5. Conversion of CPF_o to CPF_d

$$CPF_d = CPF_o / GI$$

Values for the beach play scenario for the parameters included in Equations 4-1 to 4-5 are presented in Table 4-1. Toxicity values are presented in Table 4-2.

Table 4-1. Sediment Direct Contact RBC Equation Parameters

Parameter Abbreviation	Parameter Name	Parameter Value	Units	Source
AB	gastrointestinal absorption factor	1 0.6 (dioxins/furans)	unitless	Ecology (2021)
ABS	dermal absorption factor	0.01 (inorganic) 0.1 (organic)	unitless	Ecology (2021)
ACR	acceptable excess lifetime excess cancer risk	1×10^{-6} (SCO) 1×10^{-5} (CSL)	unitless	Ecology (2021)
ADAF	age-dependent adjustment factor	10 (ages 0-2) 3 (ages 2-6)	unitless	Ecology (2021)
AF	sediment-to-skin adherence factor	2.6	$mg/cm^2 \cdot day$	Ecology (2021)
AT	averaging time	2,190 (non-cancer)	days	Ecology (2021)

Parameter Abbreviation	Parameter Name	Parameter Value	Units	Source
		25,550 (cancer)		
BW	body weight	15 (ages 0-6) 10 (ages 0-2) 17 (ages 2-6)	kg	Ecology (2021)
CPF_o	cancer potency factor – oral	Table 4-2	$mg/kg·day^{-1}$	Ecology (2021)
CPF_d	cancer potency factor – dermal	Table 4-2	$mg/kg·day^{-1}$	Ecology (2021)
$DF_{Child-adj}$	age-adjusted child mutagenic dermal factor	Equation 4-2	mg/kg	Ecology (2021)
EF	exposure frequency	41	days/year	Ecology (2021)
ED	exposure duration	6	years	Ecology (2021)
GI	gastrointestinal conversion factor	0.2 (inorganic) 0.8 (dioxin/furan) 0.5 (other organic)	unitless	Ecology (2021)
HQ	hazard quotient	1	unitless	Ecology (2021)
$IRF_{Child-adj}$	age-adjusted child ingestion factor	Equation 4-2	mg/kg	Ecology (2021)
IR	ingestion rate	200	mg/day	Ecology (2021)
RfD_o	reference dose – oral	Table RISK-2	mg/kg·day	Ecology (2021)
RfD_d	reference dose - dermal	Table RISK-2	mg/kg·day	Ecology (2021)
SA	dermal surface area	3,835 (ages 0-6) 2,989 (ages 0-2) 4,258 (ages 2-6)	cm^2	Ecology (2021)
UCF	unit conversion factor	1,000,000	mg/kg	Ecology (2021)

Table 4-2. Toxicity Values

Chemical	CPF_o $(mg/kg·day)^{-1}$	RfD_o (mg/kg·day)	CPF_d $(mg/kg·day)^{-1}$	RfD_d (mg/kg·day)
cPAH TEQ	1	0.0003	1	0.0003
PCBs	2	0.00002	2	0.00002
Dioxin/furan TEQ	130,000	0.0000000007	130,000	0.0000000007
Pentachlorophenol	0.4	0.005	0.4	0.005
Arsenic	1.5	0.0003	1.5	0.0003
Cadmium	none	0.001	none	0.000025
Mercury	none	0.0001	none	0.0001
Tributyltin oxide	none	0.0003	none	0.0003

4.1.2 Seafood Consumption

Calculating risk-based sediment concentrations from risk-based tissue concentrations based on the fish/shellfish consumption exposure pathway consists of two steps, in the absence of site-specific tissue chemistry data:

<u>Step 1</u>: Determine the risk-based concentration in tissue for each COC for each seafood consumption scenario, using Equations 4-6, 4-7, and 4-8.
<u>Step 2</u>: Using literature-based BSAFs or BSAFs from other Puget Sound sediment sites, calculate risk-based sediment concentrations for the lowest risk-based tissue concentrations for each COC and seafood consumption scenario, using Equation 4-9 for metals and Equation 4-10 for organics and organometals.

Equation 4-6. Risk-based tissue concentrations for carcinogens for the seafood consumption exposure pathway

$$RBC_{cancer} = (ACR \times BW \times AT_{cr} \times UCF) / (CPF_o \times FCR \times FDF \times EF \times ED)$$

Equation 4-7. Risk-based tissue concentrations for carcinogens that have a mutagenic mode of action (e.g., cPAHs) for the seafood consumption exposure pathway

$$FCR_{child\text{-}adj}\ (mg/kg) = \frac{FCR_{0\text{-}2} \times ED_{0\text{-}2} \times EF_{0\text{-}2} \times ADAF_{0\text{-}2}}{BW_{0\text{-}2}} + (2\text{-}6yr,\ 6\text{-}16yr,\ 16\text{-}70yr)$$

$$RBC_{mutagen}\ (mg/kg) = (ACR \times AT_{cr} \times UCF) / (CPF_o \times FCR_{child\text{-}adj} \times FDF)$$

Equation 4-8. Risk-based tissue concentrations for chemicals with non-carcinogenic effects for the seafood consumption exposure pathway

$$RBC_{Noncancer} = (HQ \times BW \times AT_{nc} \times UCF \times RFD_o) / (FCR \times FDF \times EF \times ED)$$

Where:

- RBC_{cancer} = risk-based tissue concentration based on cancer endpoint (mg/kg)
- $RBC_{noncancer}$ = risk-based tissue concentration based on non-carcinogenic effects (mg/kg)
- FCR = fish/shellfish consumption rate (g/day)
- FDF = fish diet fraction
- All other terms are defined above for Equations 4-1, 4-2, or 4-3

Values for the seafood consumption scenarios for the parameters included in Equations 4-6 to 4-8 are presented in Table 4-3.

Table 4-3. Tissue RBC Equation Parameters

Parameter Abbreviation	Parameter Name	Parameter Value	Units	Source
ACR	acceptable excess lifetime excess cancer risk	1×10^{-6} (SCO) 1×10^{-5} (CSL)	unitless	Ecology (2021)
ADAF	age-dependent adjustment factor	10 (ages 0-2) 3 (ages 2-16)	unitless	Ecology (2021)
AT	averaging time	25,550	days	Ecology (2021)
BW	body weight	10 (ages 0-2) 17 (ages 2-6) 44 (ages 6-16) 80 (adult)	kg	Ecology (2021)
CPF_o	cancer potency factor – oral	Table 4-2	$mg/kg \cdot day^{-1}$	Ecology (2021)

Parameter Abbreviation	Parameter Name	Parameter Value	Units	Source
EF	exposure frequency	365	days/year	Ecology (2021)
ED	exposure duration	70	years	Ecology (2021)
FCR	fish/shellfish consumption rate	193 (Tulalip) 7.5 (Recreational)	g/day	Ecology (2021)
FDF	fish diet fraction	1	unitless	Ecology (2021)
HQ	hazard quotient	1	unitless	Ecology (2021)
RfD_o	reference dose – oral	Table 4-2	mg/kg·day	Ecology (2021)
UCF	unit conversion factor	1,000,000	mg/kg	Ecology (2021)

Once tissue RBCs are calculated, they are converted to sediment RBCs using Equation 4-9 for metals and Equation 4-10 for organics and organometals.

Equation 4-9. Risk-based Sediment Concentration Based on Seafood Consumption Pathway (metals)

$$RBC = \frac{TSL}{BSAF \times SUF}$$

Equation 4-10. Risk-based Sediment Concentration Based on Seafood Consumption Pathway (organics and organometals)

$$RBC = \frac{TSL \times (\%TOC/100)}{BSAF \times SUF \times (\%lipid/100)}$$

Where:

RBC = risk-based sediment concentration based on seafood consumption (mg/kg)
TSL = tissue screening level calculated according to Equations 4-6, 4-7, and 4-8 (referred to as RBCs in those equations) (mg/kg)
BSAF = biota sediment accumulation factor (tissue concentration/sediment concentration) (unitless)
SUF = site use factor (equivalent to fish diet fraction) (unitless)

The BSAFs used for Equations 4-9 and 4-10 were obtained from other Puget Sound studies, as indicated in Table 4-4. The BSAFs were for clam species found in Puget Sound. BSAFs for relatively sedentary organisms like clams are subject to less spatial variability compared to BSAFs for more mobile organisms and are the most appropriate for evaluating the seafood consumption pathway at this site. The BSAFs for cPAHs, PCBs, and dioxin/furans were calculated using clam tissue (*Mya arenaria*) and sediment data collected for the Jeld-Wen Remedial Investigation in Everett, Washington (SLR International Corporation & Anchor QEA 2021). The BSAFs for arsenic, cadmium, and mercury were calculated using data obtained Ecology's EIM database for the 2016 study called Keyport Area 8 Tissue/Sediment Evaluation (StudyID USNKPLTM16 in EIM). This study included the collection of composite samples of littleneck clams (*Protothaca staminea*) and sediment from nearby locations (Figures 4-1 and 4-2). The BSAF for TBT was obtained from a TBT study conducted for Squalicum Harbor in Bellingham, Washington. This study involved replicate analyses of clam samples (*Macoma nasuta*) exposed to field-collected sediment in a laboratory bioaccumulation study. Two of the sediment samples tested in that study had TBT concentrations similar to the average sediment TBT concentration in sediments from the Jensen Marina site. The BSAFs calculated for these two sediment samples were 0.78 and 1.6 (average of 1.2).

Table 4-4. BSAFs

Chemical	Units	BSAF	Source
cPAH TEQ	µg/kg	0.67	SLR International Corporation & Anchor QEA (2021)
PCBs	µg/kg	0.032	SLR International Corporation & Anchor QEA (2021)
Dioxin/furan TEQ	ng/kg	0.06	SLR International Corporation & Anchor QEA (2021)
Pentachlorophenol	µg/kg	0.384	Ecology and Environment (2009) (shellfish)
Arsenic	mg/kg	0.78	Keyport Area 8 Tissue/Sediment Evaluation (2016)
Cadmium	mg/kg	0.22	Keyport Area 8 Tissue/Sediment Evaluation (2016)
Mercury	mg/kg	0.15	Keyport Area 8 Tissue/Sediment Evaluation (2016)
Tributyltin	µg/kg	1.2	Squalicum Harbor TBT Investigation (Ecology 2007)

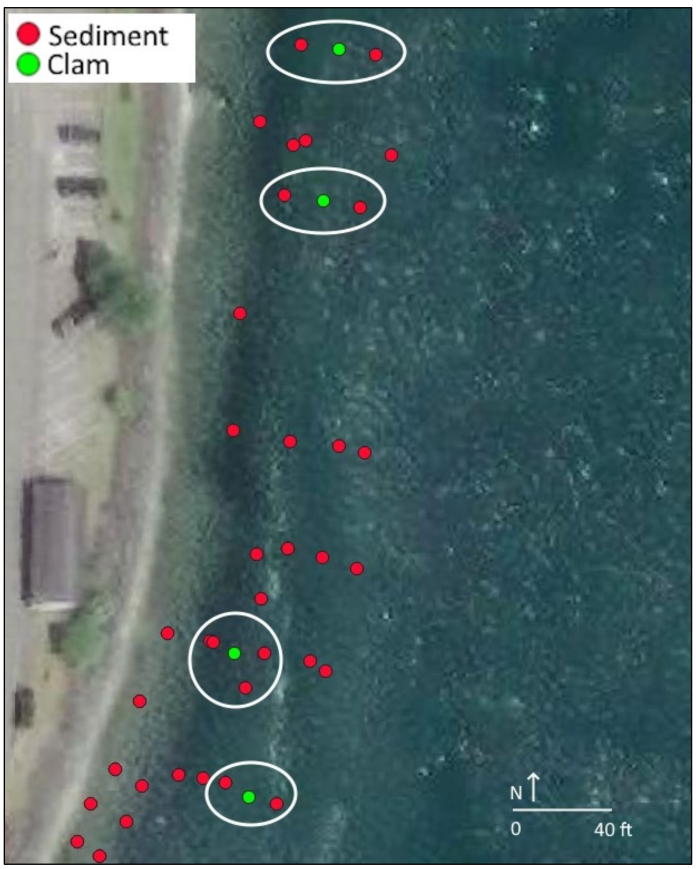

Figure 4-1. Sampling Locations for Keyport Area 8 Tissue/Sediment Evaluation

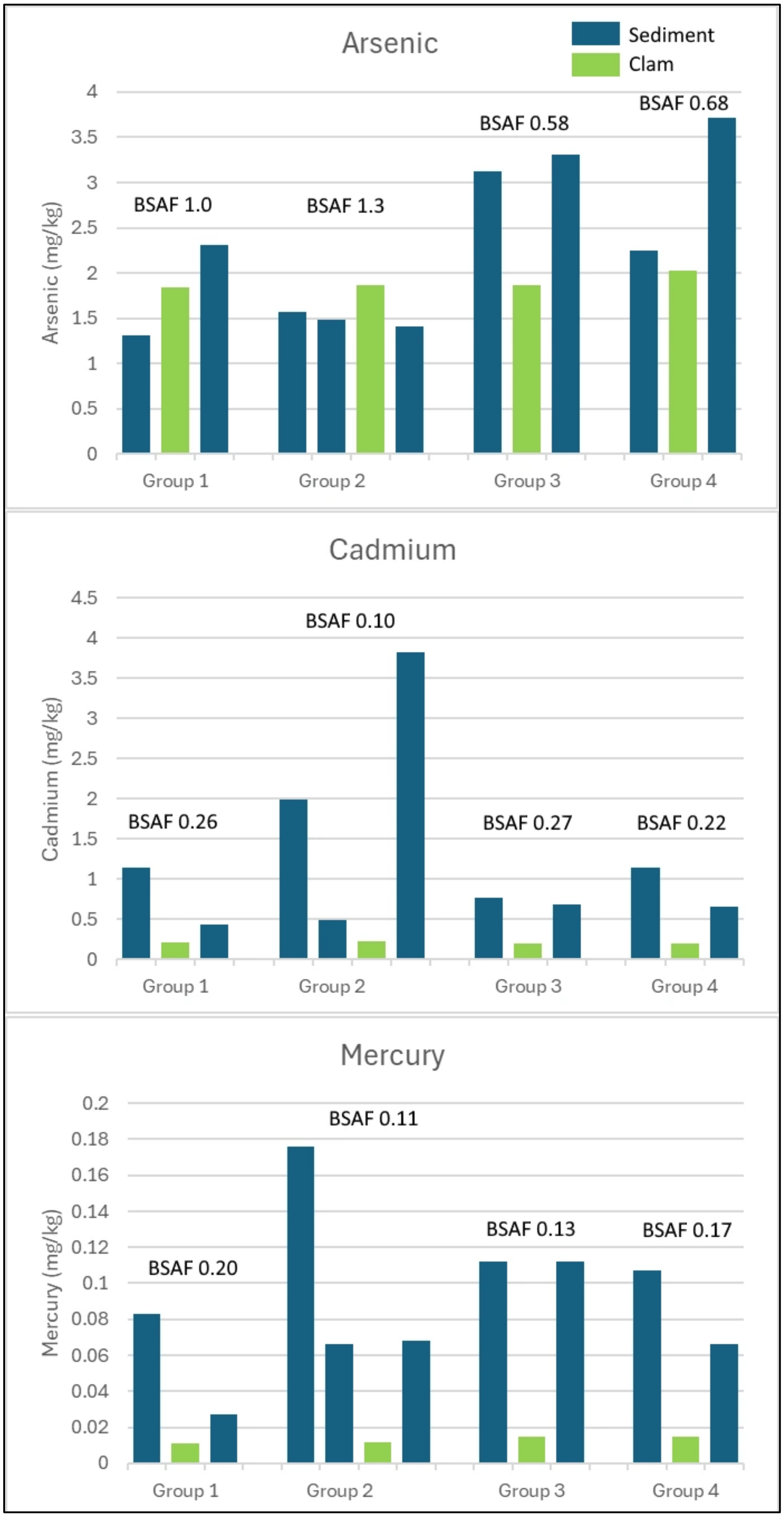

Figure 4-2. BSAFs for Keyport Area 8 Tissue/Sediment Evaluation

4.2 Natural Background

Natural background values were adopted from SCUM Table 10-1 (Ecology 2021) for six of the eight bioaccumulative COCs (all except pentachlorophenol and TBT) (Table 4-5). These natural background concentrations were derived as the 90/90 upper tolerance limit (UTL) of the Ocean Survey Vessel Bold Survey data (DMMP 2009) and additional datasets selected by Ecology (collectively referred to as the "BOLD Plus" dataset; Ecology 2021).

Table 4-5. Natural Background Concentrations

Chemical	Units	Concentration	Source
cPAH TEQ	µg/kg	21	Ecology (2021)
PCBs	µg/kg	3.5	Ecology (2021)
Dioxin/furan TEQ	ng/kg	4	Ecology (2021)
Pentachlorophenol	µg/kg	Not detected	Ecology (2021)
Arsenic	mg/kg	11	Ecology (2021)
Cadmium	mg/kg	0.8	Ecology (2021)
Mercury	mg/kg	0.2	Ecology (2021)
Tributyltin	µg/kg	3.5	Puget Sound Ambient Monitoring Program[a]

[a] Puget Sound Ambient Monitoring Program data collected in 2002-2003 from Ecology's EIM database (Study ID PSAMP_PS). TBT was detected in 19 of 65 surface sediment samples (maximum detected concentration was 8.1 µg/kg). Value reported in this table is the 90/90 UTL calculated using ProUCL (v. 5.1) software.

4.3 Practical Quantitation Limit

SMS allows consideration of the PQL in establishing the cleanup levels when a COC concentration determined to be protective cannot be reliably detected using state-of-the-art, currently available analytical instruments and methods [WAC 173-204-505(15)]. If a natural background or the risk-based SCO is below the concentration at which a contaminant can be reliably quantified, then the SCO for that contaminant may default to the analytical PQL. Table 6-6 includes PQLs for the eight bioaccumulative COCs evaluated at this site. The PQLs for five of the COCs are based on the programmatic PQLs presented in SCUM Table 11-1 (Ecology 2021). The other three PQLs are from the analytical laboratories used for the sediment investigations at this site.

Table 6-6. Practical Quantitation Limits for Sediment

Chemical	Units	PQL	Source
cPAH TEQ	µg/kg	9	Ecology (2021)
PCBs	µg/kg	4	Friedman & Bruya, Inc.[a]
Dioxin/furan TEQ	ng/kg	5	Ecology (2021)
Pentachlorophenol	µg/kg	50	Friedman & Bruya, Inc.[a]
Arsenic	mg/kg	0.3	Ecology (2021)
Cadmium	mg/kg	0.07	Ecology (2021)
Mercury	mg/kg	0.02	Ecology (2021)
Tributyltin	µg/kg	4	Analytical Resources LLC[a]

[a] Based on data collected for this Remedial Investigation

Chapter 5. Summary

The human health SCOs and CSLs calculated according to the scenarios and equations presented in Chapters 3 and 4 are presented in Table 5-1. These values are referenced and discussed in greater detail in Chapter 8 of the RI report. The SCO and CSL values for five of the eight bioaccumulative COCs (cPAHs, PCBs, dioxin/furan TEQ, pentachorophenol, and arsenic) are the natural background concentration or the PQL. The SCOs and CSLs for the other COCs (cadmium, mercury, TBT) are based on the tribal seafood consumption scenario.

Table 5-1. Human Health Risk-Based Sediment SCOs and CSLs

Chemical	Units	Protection of Human Health									Natural Background	PQL	SCO	CSL
		Seafood Consumption – Tribal			Seafood Consumption - Recreational			Beach Play						
		Carcinogenic		Non-Carcinogenic	Carcinogenic		Non-Carcinogenic	Carcinogenic		Non-Carcinogenic				
		10^{-6} (SCO)	10^{-5} (CSL)	HQ=1 (SCO and CSL)	10^{-6} (SCO)	10^{-5} (CSL)	HQ=1 (SCO and CSL)	10^{-6} (SCO)	10^{-5} (CSL)	HQ=1 (SCO and CSL)				
cPAH TEQ	µg/kg	0.22	2.2	65	1.2	12	1,680	170	1,700	27,000	21	9	**21**	**21**
PCBs	µg/kg	2.3	23	91	59	590	2,340	490	4,900	1,700	3.5	4	**4**	**4**
Dioxin/furan TEQ	ng/kg	0.019	0.19	1.7	0.48	4.8	44	29	290	220	4	5	**5**	**5**
Pentachlorophenol	µg/kg	0.95	9.5	1,900	24	240	49,000	1,500	15,000	250,000	n/d	50	**50**	**50**
Arsenic	mg/kg	0.00035	0.0035	0.16	0.009	0.09	4.1	2.1	21	80	11	0.3	**11**	**11**
Cadmium	mg/kg	n/a	n/a	1.9	n/a	n/a	49	n/a	n/a	220	0.8	0.07	**1.9**	**1.9**
Mercury	mg/kg	n/a	n/a	0.28	n/a	n/a	7.1	n/a	n/a	67	0.2	0.02	**0.28**	**0.28**
Tributyltin	µg/kg	n/a	n/a	26	n/a	n/a	680	n/a	n/a	34,000	3.5	4	**26**	**26**

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