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Technical Memorandum

To: David South, Washington State Department of Ecology

Copies: Don Robbins, Port of Seattle

From: Amanda McKay and Megan McCullough

Date: December 29, 2014

Project No: POS-LLA

Re: **Proposed Sediment Cleanup Levels for the Lora Lake Parcel Protective of Human Health Risk**

1.0 OVERVIEW

1.1 Regulatory Background

The Sediment Management Standards (SMS) Rule (Washington Administrative Code [WAC] 173-204) includes requirements for the protection of both human health and the environment. Prior to SMS Rule revisions released in February 2013 (WSDOE 2013a), the SMS Rule included narrative requirements for the protection of human health, but did not require specific procedures to develop cleanup levels (CULs) addressing human health risk posed by the bioaccumulative exposure pathway. The revised SMS Rule, however, provides specific requirements for the establishment of sediment CULs to address this exposure pathway (WAC 173-204-560). For the Lora Lake Apartments Site (LL Apartments Site, or Site), numerical sediment CULs protective of human health were not previously developed because the original Draft Remedial Investigation/Feasibility Study (RI/FS) was submitted prior to the SMS Rule revisions, in January 2012. To address this discrepancy, this technical memorandum proposes numerical sediment CULs for all of the sediment contaminants of concern (COCs) at the Site using the revised SMS Rule procedures.

The updated SMS process to determine sediment CULs uses a modified version of the two-tiered CUL determination framework that exists for the protection of benthic species. Under the revised framework, the development of human health risk-based levels is a component of the overall sediment CUL development. The risk-based levels are used in conjunction with background concentrations and practical quantitation limits (PQLs) to derive Sediment Cleanup Objectives (SCOs) and Cleanup Screening Levels (CSLs). The SCO defines the lower bound of a sediment CUL and the CSL defines the upper bound, with the final site-specific CUL defined on a site-by-site basis.

1.2 Site Background

As discussed in the Draft RI/FS (Floyd|Snider 2012), a potential human health exposure pathway exists at Miller Creek via downstream recreational consumption of aquatic organisms (i.e., fish) that spend some period of time in Lora Lake and may bioaccumulate site COCs via surface water and sediment exposure before returning to Miller Creek. Public access to fishing in Miller Creek exists approximately 1.3 miles downstream from Lora Lake, at the point that Miller Creek exits the secured Seattle-Tacoma International Airport security fence. The drainage culvert that connects Lora Lake to Miller Creek may potentially allow for passage of fish from the creek into the lake and vice versa. There is not, however, a current human health exposure pathway for sediment via direct contact in Lora Lake because access to Lora Lake is restricted, and the risk posed by direct contact to sediments by humans is not evaluated further in this memorandum.

This memorandum presents the approach used to determine site-specific SCOs and CSLs protective of human health via the fish consumption exposure pathway by considering calculated risk-based levels, PQLs, and natural or regional background consistent with the revised SMS Rule requirements. Sediment COCs determined in the Draft RI/FS and evaluated here include arsenic, lead, pentachlorophenol, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and dioxins/furans. The approach used to derive sediment CULs is described in detail below.

2.0 DETERMINATION OF SEDIMENT CLEANUP OBJECTIVES

As described briefly above, the SCO is established generally in accordance with WAC 173-204-560(3) as the highest of the following levels:

- The concentration of the COC based on protection of human health (at carcinogenic risk of less than or equal to 1 in 1,000,000 or a non-carcinogenic risk of less than or equal to a hazard quotient of 1, [evaluated separately for lead]) as specified in WAC 173-204-561(3). The value is calculated using equations presented below.
- PQL
- Natural background

2.1 Calculation of Risk-Based Levels Protective of Human Health

Bioaccumulative risk-based levels protective of fish consumption by humans are calculated using the equations and input parameters provided by Washington State Department of Ecology (WSDOE) in the draft *Sediment Cleanup Users Manual* II (SCUM II, WSDOE 2013b). These risk-based levels are the concentrations in sediment at and below which chemicals would not be expected to accumulate in tissues of fish at levels greater than those acceptable for human consumption. The risk-based levels are based on both carcinogenic and non-carcinogenic health effects, which are evaluated separately because of the differences in their toxicological mechanisms of action. Risk-based levels for lead are derived separately using the Adult Lead Model (ALM; USEPA 2003). Details of the CULs derived for lead is discussed in Section 2.1.4.

2.1.1 Risk Levels Based on Carcinogenic Effects

The two equations presented below are used to derive risk-based levels for those COCs with carcinogenic effects, which include arsenic, pentachlorophenol, cPAHs, and dioxins/furans. Equation 1 is valid for non-polar organic hazardous substances, and is, therefore, used to calculate risk-based levels for pentachlorophenol, cPAHs, and dioxins/furans. Equation 2 is valid for hazardous substances for which Equation 1 does not apply, and is, therefore, used to calculate a risk-based level for arsenic.

Equation 1:

$$\mathrm{CUL_{Cancer}} = \left\{\left(\frac{(\mathrm{CR} \times \mathrm{BW} \times \mathrm{AT} \times \mathrm{UCF})}{(\mathrm{SFo} \times \mathrm{FCR} \times \mathrm{FDF} \times \mathrm{EF} \times \mathrm{ED})}\right) \times \left(\frac{\mathrm{S_{foc}}}{\mathrm{SUF} \times \mathrm{SL} \times \mathrm{BSAF}}\right)\right\}$$

Equation 2:

$$\mathrm{CUL_{Cancer}} = \left\{\left(\frac{(\mathrm{CR} \times \mathrm{BW} \times \mathrm{AT} \times \mathrm{UCF})}{(\mathrm{SFo} \times \mathrm{FCR} \times \mathrm{FDF} \times \mathrm{EF} \times \mathrm{ED})}\right) \times \left(\frac{1}{\mathrm{SUF} \times \mathrm{BAF}}\right)\right\}$$

Where:

CR = Cancer risk level (unitless)
BW = Body weight (kilograms)
AT = Averaging time (days)
UCF = Unit conversion factor (grams/kilogram)
SFo = Oral cancer slope factor (kilograms per day/milligram)
FCR = Fish consumption rate (grams/day)
FDF = Fish diet fraction (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
SUF = Site use factor (unitless)
SL = Fish lipid fraction (gram/gram)
S_{foc} = Fraction of organic carbon in sediment (gram/gram)
BSAF = Biota-Sediment Accumulation Factor (gram tissue-lipid normalized [wet weight]/gram sediment–organic carbon normalized [dry weight])
BAF = Bioaccumulation Factor (gram tissue [wet weight]/gram sediment [dry weight])

The parameters employed for each potential exposure scenario are used to describe the frequency, duration, and magnitude of the potential exposures and characteristics of the receptor populations. Values for each of the listed parameters are presented in Tables 1 and 2. Generally, WSDOE default parameters are used; they are not described here in detail. Site-specific and chemical-specific parameters are discussed further in Section 2.1.3. Calculated risk-based levels are presented in Table 3.

2.1.2 Risk Levels Based on Non-Carcinogenic Effects

The two equations presented below are used to derive risk-based levels for those COCs with non-carcinogenic effects, which include arsenic, pentachlorophenol, and dioxins/furans. Equation 1 is valid for non-polar organic hazardous substances, and is, therefore, used to calculate risk-based levels for pentachlorophenol and dioxins/furans. Equation 2 is valid for hazardous substances for which Equation 1 does not apply, and is, therefore, used to calculate a risk-based level for arsenic.

Equation 1:

$$\mathrm{CUL_{Noncancer}} = \left\{\left(\frac{(\mathrm{HQ} \times \mathrm{BW} \times \mathrm{AT} \times \mathrm{UCF} \times \mathrm{RfDo})}{(\mathrm{FCR} \times \mathrm{FDF} \times \mathrm{EF} \times \mathrm{ED})}\right) \times \left(\frac{\mathrm{S_{foc}}}{\mathrm{SUF} \times \mathrm{SL} \times \mathrm{BSAF}}\right)\right\}$$

Equation 2:

$$\mathrm{CUL_{noncancer}} = \left\{\left(\frac{(\mathrm{HQ} \times \mathrm{BW} \times \mathrm{AT} \times \mathrm{UCF} \times \mathrm{RfDo})}{(\mathrm{FCR} \times \mathrm{FDF} \times \mathrm{EF} \times \mathrm{ED})}\right) \times \left(\frac{1}{\mathrm{SUF} \times \mathrm{BAF}}\right)\right\}$$

Where:

HQ = Hazard quotient (unitless)
BW = Body weight (kilograms)
AT = Averaging time (days)
UCF = Unit conversion factor (grams/kilogram)
RfDo = Oral reference dose (milligrams/kilogram per day)
FCR = Fish consumption rate (grams/day)
FDF = Fish diet fraction (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
SUF = Site use factor (unitless)
SL = Fish lipid fraction (gram/gram)
Sf_{oc} = Fraction of organic carbon in sediment (gram/gram)
BSAF = Biota-Sediment Accumulation Factor (gram tissue-lipid normalized [wet weight]/gram sediment–organic carbon normalized [dry weight])
BAF = Bioaccumulation Factor (gram tissue [wet weight]/gram sediment [dry weight])

Values for each of the listed parameters are presented in Tables 1 and 2. Site-specific parameters and chemical-specific parameters are discussed further in Section 2.1.3. Calculated risk-based levels are presented in Table 3.

2.1.3 Site-Specific and Chemical-Specific Parameters

2.1.3.1 Fish Consumption Rate

The SCUM II does not provide a fish consumption rate for the recreational fishers considered in this evaluation. However, the Model Toxics Control Act (MTCA) Cleanup Regulation includes a default fish consumption rate of 54 grams (1.9 ounces) per day. This value is considered a conservative assumption of the recreational use of Miller Creek, and, therefore, has been applied here.

2.1.3.2 Fraction of Organic Carbon in Sediment

This parameter is based on the average organic carbon fraction in the four surface sediment samples collected in Lora Lake, resulting in a value of 0.086 grams organic carbon per grams of sediment.

2.1.3.3 Cancer Slope Factors and Reference Doses

Toxicity values including oral and dermal cancer slope factors and reference doses are presented in Table 2. These toxicity values are obtained from the U.S. Environmental Protection Agency's (USEPA's) Integrated Risk Information System (IRIS) Database as required by WAC 173-204-561. Slope factors are an upper-bound estimate of a chemical's probability of causing cancer over a lifetime (75 years per MTCA). The reference dose is an estimate of a chronic oral daily exposure to the human population, including sensitive subgroups such as children, which is not likely to cause harmful effects during the exposure.

2.1.3.4 Biota-Sediment Accumulation Factors/Bioaccumulation Factors

The extent of chemical bioaccumulation from sediment is typically expressed using a biota-sediment accumulation factor (BSAF) or bioaccumulation factor (BAF). A BSAF is the ratio of the concentration of a bioaccumulating nonpolar organic chemical in the total extractable lipids of an organism normalized on the lipid fraction to the concentration of the chemical in sediment normalized on the organic carbon content of sediment. A BAF is derived for metals or other compounds where organic carbon normalization is not appropriate, and is the ratio of the chemical concentration in fish to the chemical concentration in sediment. Existing BSAFs (published from other studies) can be used at sites where site-specific data are not available, though there is no one source that includes BSAFs/BAFs for all of the Site sediment COCs. BSAFs/BAFs are presented in Table 2 and are derived from the following sources:

- **Arsenic.** The *Preliminary Sediment Cleanup Objectives for Port Angeles Harbor* document prepared for WSDOE (NewFields 2012) includes a comprehensive summary of available BAFs for arsenic. These BAFs were derived from studies in marine environments and, therefore, do not directly apply to Lora Lake, but are used due to

limited available information for freshwater sites. The arsenic BAF is based on the average of the BAFs presented for finfish species.

- **Pentachlorophenol.** The BSAF for pentachlorophenol is sourced from the *Control of Toxic Chemicals in Puget Sound. Phase 2: Sediment Flux/Puget Sound Sediments Bioaccumulation Model—Derived Concentrations for Toxics* document prepared for WSDOE (E&E 2009). The BSAF is based on the average BSAFs predicted by the bioaccumulation model for finfish species.
- **cPAHs and dioxins/furans.** The Mid-Continent Division of the USEPA maintains a database, which includes BSAF values generated for USEPA-related sites (USEPA 2009). BSAFs from freshwater sites and all species (sufficient finfish data are not available) were obtained from the database and averaged to determine the values. Because BSAFs only exist for individual compounds and not for toxic equivalency quotients (TEQs), BSAFs for benzo(a)pyrene and 2,3,7,8-TCDD are used as surrogates for cPAH TEQ and dioxins/furans TEQ, respectively.

2.1.4 Risk-Based Levels Protective of Lead Exposure in Fish Tissue

USEPA has no consensus toxicity factors for inorganic lead, so it is not possible to calculate risk-based levels as described above. USEPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop a reference dose (i.e., the intake level at which toxicity is expected to occur). Therefore, USEPA evaluates lead by using blood-lead modeling (USEPA 2003). The ALM is used here to derive a risk-based level protective of lead exposure at the Site. The ALM methodology focuses on estimating fetal blood lead concentration in women exposed to lead-contaminated soils, the most sensitive subpopulation affected by adult lead exposure. Although the model was developed to assess soil exposures, it is applied here to evaluate exposure to lead via consumption of fish only (sediment exposure is assumed to be 0 milligrams per day). Adjustments are made to account for fish intake per USEPA guidance (USEPA 2007). A maximum allowable blood level of 10 micrograms per deciliter (µg/dL) is assumed in the developing fetus, and the risk-based level protective of this blood level (i.e., ensuring a blood level of less than 10 µg/dL) is calculated.

The equation used to determine the risk-based CUL is presented below.

$$Risk\text{-}Based\ Level = \frac{\left(\frac{Pbf}{\left(R\ x\ (GSD^{1.645})\right)} - Pbo\right) x\ AT}{(\mathrm{BKSF}\ x\ \mathrm{IRs}\ x\ \mathrm{AFs}\ x\ \mathrm{EFs}) + (\mathrm{BKSF}\ x\ \mathrm{IRf}\ x\ \mathrm{AFf}\ x\ \mathrm{EFf})}$$

Where:

Pb_f = 95th percentile lead among fetuses (µg/dL)
Pb_0 = Adult baseline (geometric mean) blood lead level (µg/dL)
R = Fetal/maternal lead ratio (unitless)

GSD = Estimated value of the individual geometric standard deviation (unitless); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures
AT = Averaging time (days)
BKSF = Biokinetic slope factor (µg/dL per micrograms/day)
IR_s = Sediment ingestion rate (grams/day; assumed to be 0 grams/day)
AF_s = Gastrointestinal absorption fraction for lead in sediment (unitless)
EF_s = Exposure frequency for recreational fishers (days/year)
IR_f = Fish ingestion rate (grams/day)
AF_f = Gastrointestinal absorption fraction for lead in tissue (unitless)
EF_f = Exposure frequency for fish ingestion (days/year)

The USEPA provides two different analyses (NHANES 1999–2004 and NHANES III, refer to Table 4) to determine the risk-based CULs, with the only difference between the two being the baseline adult lead concentration and geometric standard deviation (GSD) parameters. For conservatism, the lower of the risk-based CULs between the two analyses is selected. All other exposure parameters are default USEPA parameters and are presented in Table 4.

2.2 Practical Quantitation Limits

A PQL is defined by SMS as the "lowest concentration that can be reliably measured within specified limits of precision, accuracy, representativeness, completeness, and comparability during routine laboratory operating conditions, using department approved methods" (WAC 173-204-505(15)). SMS allows consideration of the PQL in establishing the SCO to address circumstances in which a concentration determined to be protective cannot be reliably detected using state-of-the-art analytical instruments and methods.

Therefore, PQLs have been selected from Appendix F of the SCUM II (WSDOE 2013b). While the document is still in draft form, the PQLs listed in the document are approved by WSDOE and are considered final. These PQLs are applicable to the Site, and have, therefore, been considered in the SCO selection process. The PQLs are presented in Table 3.

2.3 Natural Background

The most extensive dataset available for sediment background contaminant concentrations within Western Washington is from the USEPA Ocean Survey Vessel Bold Survey for Puget Sound (OSV Bold Survey; USEPA 2009). This survey collected and analyzed Puget Sound surface sediments from locations away from known sources of contamination and cleanup sites. Sediment was collected from locations within four existing sediment reference areas: Dabob Bay, Carr Inlet, Holmes Harbor, and Samish Bay. The Bold Survey background data are for marine

sediments. There are no datasets available for natural background sediment freshwater concentrations.

Table 11-1 of the SCUM II provides recommended natural background values for marine sediments calculated from the 90/90 upper tolerance limit (i.e., the 90 percent upper confidence limit on the 90th percentile) of the OSV Bold Survey data plus data from approved reference sites (presented in Appendix L of SCUM II), which are presented in Table 3.

The area-wide soil arsenic concentrations surrounding Lora Lake and Miller Creek identified in the WSDOE Tacoma Smelter Plume map range from 20 to 40 milligrams per kilogram (mg/kg), as indicated on the Washington State Everett and Tacoma Smelter Search Website (WSDOE 2013c). These concentrations are consistent with the arsenic sediment natural background value as reported in the OSV Bold Survey. Lead data surrounding Lora Lake and Miller Creek are not readily available on the Smelter Search website. However, lead is one of the contaminants of concern within the smelter plume, and the lead to arsenic concentration ratio in King County has been found to be approximately 3:1 (Pacific Groundwater Group and TerraStat Inc. 2005). Therefore, sediment natural background from the OSV Bold Survey for arsenic and lead are much less than those arsenic and lead concentrations expected in the vicinity of Lora Lake and Miller Creek, due to the Tacoma Smelter Plume.

2.4 Proposed Sediment Cleanup Objectives

The proposed SCO for each Site COC is presented below, along with its basis. All of the potential SCOs are presented in Table 3. As described above, the selection of SCO is based on the highest value of human health risk-based levels, natural background, and the PQL.

Contaminant of Concern	Proposed Sediment Cleanup Objective	Basis
Arsenic	11 mg/kg	Natural background
Lead	21 mg/kg	Natural background
Pentachlorophenol	160 µg/kg	Risk-based level
cPAH TEQ	440 µg/kg	Risk-based level
Dioxins/furans TEQ	5 ng/kg	PQL

Abbreviations:

cPAH	Carcinogenic polycyclic aromatic hydrocarbon
µg/kg	Micrograms per kilogram (parts per billion)
mg/kg	Milligrams per kilogram (parts per million)
ng/kg	Nanograms per kilogram (parts per trillion)
PQL	Practical quantitation limit
TEQ	Toxicity equivalency quotient

3.0 DETERMINATION OF SEDIMENT CLEANUP SCREENING LEVELS

The CSL is established in accordance with WAC 173-204-560(4) as the highest of the following levels:

- The concentration of the COC based on protection of human health (at carcinogenic risk of less than or equal to 1 in 100,000 or a non-carcinogenic risk of less than or equal to a hazard quotient of 1 [evaluated separately for lead])
- PQL
- Regional background

At the Site, the only COCs resulting in a greater CSL than SCO are those based on carcinogenic risk, which is allowed to be adjusted upward from the risk used to calculate the SCO. These COCs include cPAH TEQ and pentachlorophenol. Regional background is not available and, therefore, natural background will be used in its place for conservatism. Therefore, the CSLs for the Site are as follows:

Contaminant of Concern	Proposed Cleanup Screening Levels	Basis
Arsenic	11 mg/kg	Natural background
Lead	21 mg/kg	Natural background
Pentachlorophenol	1,600 µg/kg	Risk-based level
cPAH TEQ	4,400 µg/kg	Risk-based level
Dioxins/furans TEQ	5 ng/kg	PQL

Abbreviations:

cPAH	Carcinogenic polycyclic aromatic hydrocarbon
□g/kg	Micrograms per kilogram (parts per billion)
mg/kg	Milligrams per kilogram (parts per million)
ng/kg	Nanograms per kilogram (parts per trillion)
PQL	Practical quantitation limit
TEQ	Toxicity equivalency quotient

4.0 CONCLUSIONS

The SCOs and CSLs derived in this memorandum for all of the Site sediment COCs are evaluated further as CULs in the Final RI/FS. Table 6.4 in the RI/FS presents, separately, sediment CULs protective of benthic species and sediment CULs protective of human health. Though the CULs protective of human health are more stringent than those protective of benthic species, this does not change the preferred remedy to address toxicity posed by Lora Lake sediments. As described in the RI/FS, proposed remedial actions (with the exception of Alternative 1), including the recommended alternative, address all sediments within the lake, thereby removing both benthic and human health exposure pathways. The information in this memorandum complies with the

SMS regulation for sediment cleanup standards development. Results of this evaluation does not impact the degree or extent of cleanup proposed in the Final RI/FS, or the Cleanup Action Plan.

5.0 REFERENCES

Ecology and Environment, Inc. (E&E). 2009. *Control of Toxic Chemicals in Puget Sound. Phase 2: Sediment Flux/Puget Sound Sediments Bioaccumulation Model—Derived Concentrations for Toxics*. Prepared for Washington State Department of Ecology. May.

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LIST OF ATTACHMENTS

Table 1 Screening Level Equations Exposure Parameters

Table 2 Chemical-Specific Exposure Parameters

Table 3 Proposed Sediment Cleanup Objectives and Cleanup Screening Levels

Table 4 Adult Lead Model Parameters and Calculated Screening Levels

Tables

Table 1

Screening Level Equations Exposure Parameters

Parameter Name	Unit	Value
Cancer Risk	unitless	1×10^{-6}
Hazard Quotient	unitless	1
Body Weight	kg	70
Averaging Time	days	27,375
Exposure Frequency	days/year	365
Exposure Duration	years	70
Oral Slope Factor	kg-day/mg	Chemical-specific, refer to Table 2
Fish Consumption Rate	grams/day	54
Fish Diet Fraction	proportion	1
Biota-Sediment Accumulation Factor	gram tissue-lipid normalized (wet weight)/gram sediment-organic carbon normalized (dry weight)	Chemical-specific, refer to Table 2
Bioaccumulation Factor	g tissue (wet weight)/ g sediment (dry weight)	Chemical-specific, refer to Table 2
Site Use Factor	unitless	1
Fish Lipid Fraction	gram/gram	0.03
Fraction of Organic Carbon in Sediment	gram/gram	0.086

Abbreviations:

g	Grams
kg	Kilograms
mg	Milligrams
WAC	Washington Administrative Code

Table 2
Chemical-Specific Exposure Parameters

Analyte	Oral Cancer Slope Factor (kg-day/mg)	Oral Reference Dose (mg/kg-day)	BSAF [g tissue-lipid normalized (ww)/ g sediment – OC normalized (dw)]	BAF [g tissue (ww)/g sediment (dw)]
Arsenic	1.5	0.0003	--	0.24
Lead	Refer to Table 3			
Pentachlorophenol	4.00E-01	0.0050	0.06	--
cPAH TEQ	7.3	--	0.00125	--
Dioxins/Furans TEQ	130,000	0.0000000007	0.48	--

Note:

-- Means not applicable.

Abbreviations:

BAF Biota Accumulation Factor
BSAF Biota Sediment Accumulation Factor
cPAH Carcinogenic polycyclic aromatic hydrocarbon
dw Dry weight
g Grams
kg Kilogram
mg Milligram
OC Organic carbon
TEQ Toxic equivalency quotient
ww Wet weight

Table 3
Proposed Sediment Cleanup Objectives and Cleanup Screening Levels

Chemical of Concern	Units	Risk-Based Levels		Lowest of the Human Health Risk-Based Levels	PQL[1]	Natural Background	Proposed SCO[2]	Proposed CSL[3]
		Carcinogenic	Non-Carcinogenic					
		Fish Consumption Screening Level	Fish Consumption Screening Level					
Arsenic	mg/kg	0.0039	1.8	0.0039	0.5	11	11	11
Lead	mg/kg	--	0.69	0.69	0.3	21	21	21
Pentachlorophenol	µg/kg	160	330	160	100	--	160	1,600
cPAH TEQ	µg/kg	440	--	440	9.0	16	440	4,400
Dioxins/Furans TEQ	ng/kg	0.006	5.8	0.006	5.0	4.0	5.0	5.0

Notes:

-- Not available.

1 PQL derived from the Appendix F of the Draft Sediment Cleanup Users Manuals II (SCUM II; WSDOE 2012). PQLs for arsenic, lead, pentachlorophenol, and cPAHs were selected based on the analytical methods used in the LL Apartments Site Remedial Investigation/Feasibility Study. The PQL for cPAH TEQ was calculated using the procedure recommended by WSDOE in the SCUM II. The dioxins/furans TEQ PQL is the PQL recommended by WSDOE.

2 Proposed SCO is the highest of: (1) lowest of the human health risk-based levels based on cancer risk of 1 in 1,000,000; (2) natural background; and (3) PQL.

3 Proposed CSL is the highest of: (1) lowest of the human health risk-based levels based on cancer risk of 1 in 100,000; (2) natural background (because regional background values are not available); and (3) PQL.

Abbreviations:

COC Chemical of concern
cPAH Carcinogenic polycyclic aromatic hydrocarbon
CSL Cleanup screening level
µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
ng/kg Nanograms per kilogram
PQL Practical Quantitation Limit
SCO Sediment Cleanup Objective
TEQ Toxicity equivalency quotient
WSDOE Washington State Department of Ecology

Table 4

Adult Lead Model Parameters and Calculated Screening Levels

Variable	Description of Variable	Units	GSD_i and Pb_o from Analysis of NHANES 1999–2004	GSD_i and Pb_o from Analysis of NHANES III (Phases 1&2)
$Pb_{fetal,\ 0.95}$	95^{th} percentile Pb among fetuses	µg/dL	10	10
$R_{fetal/maternal}$	Fetal/maternal Pb ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4
GSD_i	Estimated value of the individual geometric standard deviation; the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures.	--	1.8	2.1
Pb_0	Adult baseline (geometric mean) blood lead level	µg/dL	1.0	1.5
IR_S	Sediment ingestion rate	g/day	NA	NA
AF_S	Sediment gastrointestinal absorption fraction (USEPA default in soil)	--	NA	NA
EF_s	Sediment exposure frequency	days/yr	NA	NA
AT	Averaging time	days/yr	365	365
IR_f	Fish consumption rate	g/day	54	54
AF_f	Fish gastrointestinal absorption fraction (USEPA 2007)	--	0.12	0.12
EF_f	Fish exposure frequency	days/yr	365	365
Calculated Screening Levels		**mg/kg**	**1.24**	**0.69**

Abbreviations:

g	Grams
µg/dL	Micrograms per deciliter
mg/kg	Milligrams per kilogram
NA	Not applicable
NHANES	National Health and Nutrition Examination Survey
Pb	Lead
USEPA	U.S. Environmental Protection Agency
yr	Year