Lower Duwamish Waterway Group

Port of Seattle | City of Seattle | King County | The Boeing Company

Lower Duwamish Waterway Remedial Investigation

TASK 7: IDENTIFICATION OF DATA NEEDS FINAL

For Submittal to:

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

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Acronyms

Acronym	definition
AOC	administrative order on consent
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level of SMS
DMMP	Dredged Material Management Program
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESA	Endangered Species Act
FS	feasibility study
HHRA	human health risk assessment
HQ	hazard quotient
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
ML	maximum level in DMMP
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROC	receptor of concern
SL	screening level in DMMP
SMS	Washington State Sediment Management Standards
SQS	sediment quality standards of SMS
SVOC	semivolatile organic compound
TBT	tributyltin
TOC	total organic carbon
TRV	toxicity reference value
VOC	volatile organic compound

Executive Summary

The Lower Duwamish Waterway (LDW) was added to the US Environmental Protection Agency's (EPA's) National Priorities List (NPL, also known as Superfund) on September 13, 2001. Under Superfund regulations, EPA requires that a remedial investigation and feasibility study (RI/FS) be conducted for all listed sites. The key parties involved in the LDW RI/FS are the City of Seattle, King County, the Port of Seattle, and The Boeing Company, working together for this project as the Lower Duwamish Waterway Group (LDWG), in addition to EPA and the Washington Department of Ecology. These parties agreed (in an Administrative Order on Consent or AOC) to conduct the RI for the LDW in two phases. The Phase 1 RI (Windward 2003) is an analysis of what is already known from previous studies of the LDW, aimed at answering three questions:

1. Based on existing data, what are the risks to human health and the environment from sediment-associated chemicals in the LDW?
2. Are there areas within the LDW that might be candidates for early action because of their relatively higher levels of risks?
3. What additional information is needed to understand the nature and extent of sediment-associated chemical distributions in the LDW and to characterize risks to human health and the environment sufficiently to make final remedial decisions in the LDW?

The Phase 2 RI, which will be initiated in 2003, will include the collection of additional data to fill critical data gaps identified in Phase 1. These data will be used in the Phase 2 RI to estimate the nature and extent of sediment-associated chemicals and in the Phase 2 ecological and human health risk assessments (ERA and HHRA) to estimate risks to the environment and human health both with and without early actions.

This memorandum addresses the third question described above. It summarizes the data gaps identified in the Phase 1 RI and risk assessments, and provides recommendations regarding which data gaps should be further investigated as part of the Phase 2 RI. The data needs described in this memorandum can be grouped into three general types: chemical, physical, and biological. Additional collection and analysis of sediment and tissue samples is needed to reduce uncertainties in the exposure assessment of the Phase 1 ERA and HHRA. The primary physical data need is a complete bathymetric survey of the LDW, although some additional data on physical sediment properties will also be collected. Such a survey will provide valuable data to better characterize the existing and potential habitat distribution within the site and will be useful in designing future sampling efforts and potential

remedial efforts. Coupled with other information to be collected for characterizing sediment fate and transport, the bathymetry survey will provide information to help interpret the location of erosional and depositional areas. Better site usage data are needed for some of the receptors of concern characterized in the Phase 1 risk assessments, including crab, clams, rockfish,[1] sandpiper, and recreational users of the intertidal zone (e.g., beach play areas). These data will reduce uncertainties in the exposure assessments and provide additional information to assess links between concentrations of chemicals of potential concern (COPCs) in fish and shellfish tissue, and chemical concentrations in sediment using a food web model. Additional sediment toxicity tests will also be conducted in Phase 2. The scope of work for the data needs summarized in this memorandum will be presented in the Phase 2 work plan, while the details will be provided in field and laboratory study plans. Both the Phase 2 work plan and the field and laboratory study plans will be developed in coordination with the agencies and other interested parties as part of the scoping process for the Phase 2 RI.

[1] Rockfish were not assessed as a receptor of concern (ROC) in the Phase 1 ERA, but are being considered as a potential ROC in the Phase 2 ERA.

1.0 Introduction

The Lower Duwamish Waterway (LDW) was added to the US Environmental Protection Agency's (EPA's) National Priorities List (NPL) on September 13, 2001. Under Superfund regulations, EPA requires that a remedial investigation and feasibility study (RI/FS) be conducted for all listed sites. An RI identifies areas that should be remediated because they pose an unacceptable risk to human health or the environment. An FS proposes a number of alternative approaches to remediating the areas with unacceptable risk, and analyzes and compares these alternatives.

The key parties involved in the LDW RI/FS are the City of Seattle, King County, the Port of Seattle, and The Boeing Company, working together for this project as the Lower Duwamish Waterway Group (LDWG), in addition to EPA and the Washington Department of Ecology. These parties agreed (in an Administrative Order on Consent or AOC) to conduct the RI for the LDW in two phases. The Phase 1 RI (Windward 2003) is an analysis of what is already known from previous studies of the LDW, aimed at answering three questions:

1. Based on existing data, what are the risks to human health and the environment from sediment-associated chemicals in the LDW?

2. Are there areas within the LDW that might be candidates for early action because of their relatively higher levels of risks?

3. What additional information is needed to understand the nature and extent of sediment-associated chemical distributions in the LDW and to characterize risks to human health and the environment sufficiently to make final remedial decisions in the LDW?

This memorandum addresses the third question of the Phase 1 RI for the LDW, which is to identify and discuss additional data that may be needed to complete the RI. Data needs are identified based on an analysis of the uncertainties associated with the nature and extent of contamination, as presented in the Phase 1 RI, and on uncertainties identified in the Phase 1 ecological and human health risk assessments (ERA and HHRA), which are appendices to the Phase 1 RI report (Windward 2003). This memorandum provides an overview of these uncertainties and discusses which data collection activities should be conducted to fill these data gaps.

The intent of additional sampling in the LDW is to reduce key uncertainties in the nature and extent of contamination and the preliminary risk estimates developed in Phase 1, and to provide additional information needed to complete Phase 2 of the RI, including the baseline risk assessments. As stated in the Statement of Work for the LDW (EPA and Ecology 2000), Phase 2 risk assessments will be conducted as part of

Task 11 for two exposure regimes: 1) baseline sediment conditions as they exist prior to early actions, and 2) residual sediment conditions that can be expected in the LDW at the conclusion of early actions. The latter assessment will provide an estimate of residual risks following early actions, and will be used to determine whether additional remedial actions, beyond the early actions, are warranted.[2] Data needs discussed in this memorandum must be inclusive of data needs for both assessments described above. A general schedule for the Phase 2 sampling will be provided with the Phase 2 Work Plan. The schedule will be refined as specific Phase 2 quality assurance project plans (QAPPs) are approved.

This memorandum does not provide specific details for proposed studies; detailed study designs will be developed in coordination with the agencies and other interested parties. This memorandum also does not discuss potential data gaps that may be associated with the feasibility study (FS) that will be conducted as part of Phase 2. Feasibility study data gaps will be presented in the FS work plan to be developed in coordination with the agencies and other interested parties.

The remainder of this memorandum is organized into four sections. Section 2 provides an overview of the uncertainties identified in the Phase 1 RI, ERA, and HHRA, including a rationale for whether data gaps associated with these uncertainties should be further investigated, and if they should, what type of investigations should be conducted. Section 3 organizes the data needs identified in Section 2 by specific media to aid in designing field studies. The primary environmental media for chemical analysis are sediment and tissue, but other data types such as sediment toxicity tests or site usage studies will also be included in Phase 2. Section 4 presents a summary, and references are provided in Section 5.

2.0 Uncertainties Identified in Phase 1 and Selection of Data Needs

This section summarizes uncertainties associated with the Phase 1 RI (Section 2.1), ERA (Section 2.2), and HHRA (Section 2.3). Recommendations are made on data gaps that should be filled to reduce key uncertainties for the Phase 2 RI.

In the ERA and HHRA, summary tables were presented in which key uncertainties were qualitatively ranked as low, medium, or high with respect to the following:

- level of uncertainty (i.e., degree to which a particular variable is known)

[2] Because some of the early actions may not be completed when the residual risk assessment is conducted, some uncertainty will remain regarding associated ecological and human health risk reduction. An interim deliverable will be submitted to the agencies to outline an approach for predicting exposures in the post-early action exposure regime.

- potential for additional data to change preliminary risk conclusions (i.e., whether additional data may result in a hazard quotient [HQ][3] changing from less than to greater than 1)
- feasibility of collecting data or further investigating an issue (i.e., potential costs and ability of additional studies to reduce uncertainty)

These summary tables[4] form the basis for the identification of risk assessment data needs in this memorandum. Based on these tables, uncertainties were assessed on a qualitative cost-benefit basis with respect to their potential impact on remedial decision-making at the site, and LDWG's recommendations are then made regarding proposed activities in Phase 2 to reduce uncertainty.

2.1 REMEDIAL INVESTIGATION

Table 2-1 presents an overview of potential data needs identified in the course of preparing the Phase 1 RI. In this table, and similar tables in Sections 2.2 and 2.3, data uncertainties are listed followed by a yes/no recommendation and the rationale regarding whether additional field or laboratory work should be conducted to reduce the uncertainty. If additional actions are recommended, these actions are also briefly described in the table, although as stated in Section 1, specific details for these actions are not presented here. Study designs will be further defined in the Phase 2 work plan and specific sampling and analysis plans developed in coordination with the agencies and interested parties. In addition to the data gathering activities described herein, other sampling activities are being planned in the LDW (e.g., early action cleanup studies, Waterway Resource Inventory Area (WRIA) studies, habitat monitoring). Any additional laboratory or field data available from other parties will also be considered in the Phase 2 RI.

Additional sediment (surface[5] and subsurface) and tissue chemistry data are needed in Phase 2 to define the nature and extent of sediment-associated chemicals of potential concern (COPCs) (Table 2-1). These data needs are discussed further in Sections 2.2 and 2.3. No additional surface water chemistry data are needed to delineate the nature and extent of sediment-associated COPCs because sufficient surface water chemistry data already exist to assess risk in Phase 2[6] (i.e., King County [1999]). Porewater chemistry data may be of some interest in areas where contaminated groundwater discharges to the LDW. Porewater chemistry data are not needed, however, for

[3] HQ = exposure concentration (or dose)/concentration (or dose) associated with adverse effect.
[4] Tables A-7-15, A-7-27, A-7-38, A-7-46 in the ERA and Table B-33 in the HHRA.
[5] Including relevant intertidal areas below mean higher high water (MHHW).
[6] As agreed by the agencies at the surface water meeting held February 4, 2003. Note that critical data needs for the food web model are currently being evaluated and will be discussed at an upcoming meeting with the agencies. If additional surface water data are determined to be critical to the modeling effort, the potential collection of these data in Phase 2 will be discussed with the agencies.

chemicals that are associated with bulk sediment and that are stable in porewater of bulk sediment samples (e.g., hydrophobic organic chemicals and metals), because existing or proposed sediment or tissue chemistry data will be sufficient to document the nature and extent of sediment-associated COPCs and to estimate baseline risks.[7] The need for porewater data on groundwater chemicals that may not be stable in bulk sediment porewater, such as volatile organic compounds (VOCs), will be determined using an approach to be developed in coordination with the agencies (see Table 2-1). Additional chemical source data (e.g., groundwater, permitted discharges) are not proposed for collection at this time, although a visual reconnaissance of intertidal areas will be conducted to note the potential presence of fill material, seeps, and discoloration. A conceptual model of seep flow will be prepared to determine the objective and need for potential seep sampling. Some sediment fate and transport data will be collected during the Phase 2 RI; additional data collection will also be considered in the work plan for the Feasibility Study. The bathymetric survey planned for habitat characterization will be used in conjunction with other sediment fate and transport data and earlier bathymetric studies to help determine the location of erosional or depositional areas of the LDW.

Table 2-1. Potential data needs for the Phase 2 RI[a]

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Surface sediment chemistry data	yes	Additional surface sediment chemistry data are needed to further characterize the nature and extent of COPC distributions.	Criteria to determine sampling locations for surface sediment samples will be outlined in the Phase 2 work plan. Key considerations for placement of surface samples are: 1) areas with low spatial coverage, particularly at sites where single SQS or CSL exceedances were observed with few nearby stations, near special use areas (e.g., beaches), or near probable chemical sources; 2) co-located with SMS-approved toxicity tests and certain tissue collection locations; and 3) analyte considerations including chemicals with relatively low numbers of samples or locations with sufficiently low detection limits.
Subsurface sediment chemistry data	yes	Additional subsurface sediment chemistry data are needed to further characterize the nature and extent of COPC distributions.	Key considerations for placement of subsurface sediment samples are: 1) erosion potential, 2) proximity to probable chemical sources, and 3) existing surface and subsurface sediment chemistry data.

[7] LDWG and the agencies are discussing the potential need for TBT measurement in porewater; the outcome of these discussions will be documented in the Phase 2 work plan.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Water chemistry data	no[b]	Sufficient data are available in the King County Water Quality Assessment (King County 1999).	No fieldwork is proposed.
Groundwater chemistry data	no	These data will be collected as part of site-specific investigations by responsible parties, and are not a RI responsibility.	No fieldwork is proposed.
Porewater chemistry data[c]	yes	Sediment and tissue data are sufficient to estimate risks and to delineate COPC distributions for groundwater chemicals that are associated with sediment and that are stable in porewater. For groundwater chemicals less stable in porewater (i.e., VOCs), focused sampling will be conducted where there is a significant potential for groundwater plumes to intersect the LDW.	LDWG will prepare a decision tree and coordinate with the agencies to determine where porewater sampling may be appropriate. Porewater sampling would first focus on worst-case areas where there is a potential for contamination originating from groundwater. Additional porewater sampling in other areas would only be conducted if the worst-case areas indicated a strong likelihood of unacceptable risk.
Tissue chemistry data	yes	Additional data are needed for the Phase 2 risk assessments.	Data collected to address ERA and HHRA data gaps will fill this data gap (see Sections 2.2 and 2.3).
Seep chemistry data	determined through a decision tree	A visual reconnaissance of intertidal areas below mean higher high water will be conducted to note the potential presence of fill material, seeps, and discoloration. Seep samples may be collected in areas where there is a strong reason to believe that chemicals may be entering the LDW via these seeps.	LDWG, in coordination with the agencies, will develop a conceptual model of seep flow and prepare a decision tree to determine if seeps should be sampled, and if yes, where focused sampling should occur.
COPC sources	no	Site-specific data needs will be determined at sites proposed for remedial action; thus, these data needs cannot be determined at this time.	Source sampling will be conducted as part of site-specific remedial actions by the parties responsible for those actions.
Habitat characterization	yes	Water depth and location of intertidal areas are needed to identify habitat types throughout the LDW.	A single bathymetric survey is proposed.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Fate and transport of sediments	yes	Existing data focused on specific LDW areas; additional data needed for further characterization.	In addition to the bathymetric survey (described above), additional information on near-bottom current velocities will be compiled, either from existing LDW models or through deployment of current meters. Data on physical properties of sediments will be collected in areas representing the range of LDW sediment characteristics. These data sets will help identify erosional or depositional areas. In addition, LDWG will coordinate with the agencies and the FS contractor to identify specific data needs not filled during the Phase 2 RI.

[a] Data needs associated with the Phase 1 ERA and HHRA are presented in Tables 2-2 through 2-6.

[b] Pending final resolution of food web model data needs.

[c] LDWG and the agencies are discussing the potential need for TBT measurement in porewater; the outcome of these discussions will be documented in the Phase 2 work plan.

2.2 Ecological Risk Assessment

This section presents an overview of uncertainties identified in the ERA, and presents the rationale for selection of specific uncertainties for further investigation based on the likelihood for additional field data to substantially reduce these uncertainties. Uncertainties are grouped according to the ecological receptor groups evaluated in the ERA. The specific receptors of concern (ROCs) for each group are described briefly, along with a brief description of how the risks to these ROCs were evaluated. Additional details are provided in the Phase 1 ERA, which is an appendix to the Phase 1 RI report (Windward 2003).

2.2.1 Benthic invertebrates

A wide variety of benthic invertebrate species inhabit the LDW. In the ERA, risks to most benthic invertebrates were evaluated based on a comparison between concentrations of COPCs measured in sediment and the numerical chemical standards (sediment quality standards [SQS] and cleanup screening levels [CSL]) of the Washington State Sediment Management Standards (SMS).[8] These standards were developed to be protective of the benthic invertebrate community, including both epibenthic and infaunal species. Tributyltin (TBT) was evaluated using a tissue residue approach rather than the SMS approach described above because sediment or

[8] Dredged Material Management Program (DMMP) guidelines (screening level [SL] and maximum level [ML]) were used for chemicals without numerical chemical standards in the SMS.

porewater TBT concentrations may not be predictive of potential adverse effects to benthic invertebrates (EPA 1999).

Because the numerical chemical standards of the SMS were not specifically designed to be protective of higher-trophic level invertebrate species exposed through the food web, crabs were selected as an additional benthic invertebrate ROC. Crabs are higher on the food web and more mobile than other benthic invertebrate species addressed by the numerical SMS. Risks to crabs were evaluated using a tissue residue approach, because most available data on adverse effects are based on chemical concentrations in crab tissue rather than dietary concentrations.

Potential data needs associated with the benthic invertebrate assessment are summarized in Table 2-2. Collection of additional surface sediment and tissue samples is proposed for chemical analysis to supplement existing data. Crab, clam, and shrimp site usage will also be further investigated, and crab, and possibly clam, tissue samples will be collected for chemical analysis to further supplement the existing dataset. The need for clam chemistry data will be discussed with the agencies following completion of the clam site usage study. Data on the presence of burrowing organisms (e.g., clams) below 15 cm will be collected during the clam survey to evaluate the potential exposure of these organisms to subsurface contamination. Finally, additional toxicity tests are proposed for Phase 2 to supplement the limited existing dataset. A specific approach, which will be outlined in the Phase 2 work plan, will be developed in coordination with the agencies and interested parties to determine sediment collection locations for toxicity tests and the types of SMS-approved toxicity tests to be performed.

Table 2-2. Potential data needs for benthic invertebrate risk assessment

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Spatial coverage of surface sediment chemistry data for COPCs[a]	yes	Additional surface sediment chemistry data are needed for some COPCs that have been analyzed less frequently than most other COPCs.	In consultation with the agencies and interested parties, specific locations for surface sediment sampling will be identified and samples will then be collected and analyzed for the appropriate COPCs. For example, TBT should be sampled in marinas and other areas frequented by ships, barges, and boats (such as Slips 1 and 3).
Some detection limits higher than numeric chemical standards and guidelines	yes	In the existing dataset, many infrequently detected chemicals, particularly some semi-volatile organic compounds (SVOCs), have detection limits higher than numerical standards and guidelines.	Criteria to determine sampling locations for surface and subsurface sediment samples will be outlined in the Phase 2 work plan. One of the criteria will be consideration of areas where certain COPCs were analyzed previously with high detection limits.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Use of numerical sediment standards and guidelines to assess risks to benthic invertebrates	yes	Few site-specific toxicity tests are available to confirm risks based solely on SQS/CSL exceedances.	A specific approach to determine locations for additional toxicity tests will be developed in coordination with the agencies and interested parties. Some additional benthic community analyses are proposed to characterize the resident communities, but will not be used to assess chemical impacts due to lack of a suitable reference area.
Exposure of burrowing animals (e.g., clams below 15 cm) to sediment-associated chemicals	yes	Burrowing organisms may be exposed to contamination at greater depths than assessed using the standard SMS approach (i.e., top 15 cm).	The depth of occurrence of clams will be noted during abundance and distribution surveys conducted for the human health risk assessment (see Table 2-6).
TBT concentrations in benthic invertebrate tissues	yes	No tissue chemistry data have been collected from areas with the highest sediment TBT concentrations; predicted tissue concentrations in these areas are highly uncertain.	Collect neo- and mesogastropods[b] from areas that have a broad range of sediment TBT concentrations, including those with the highest sediment TBT concentrations in the LDW based on existing sediment data and additional data collected as part of Phase 2.
Crab tissue chemistry data	yes	Additional crab tissue chemistry data are needed to supplement the limited existing dataset.	Collect crabs in various areas based on potential crab habitat (see below) and sediment contamination. The analyte list will be determined in coordination with the agencies and other interested parties.
Site utilization by crabs	yes	Relative abundance and habitat usage data needed to determine relevance of existing tissue data, and to determine locations for additional tissue collections.	Conduct a survey to evaluate crab site usage in the LDW during different seasons.
Limited toxicity data available for crab	no	Derivation of additional toxicity data for crab is not justified because risks to crabs appear to be relatively low based on the limited available data.	No field or laboratory work proposed. An additional literature search will be conducted.
Crab as representative species for other upper trophic level benthic invertebrates	no	Crabs are considered to be a suitable representative.	No field or laboratory work proposed.

[a] COPCs for benthic invertebrates in the Phase 1 ERA included all SMS chemicals (see WAC 173-204) plus the following chemicals with DMMP guidelines: 1,3-dichlorobenzene, aldrin, alpha-chlordane, dieldrin, ethylbenzene, gamma-BHC, heptachlor, hexachloroethane, tetrachloroethene, tributyltin, trichloroethene, and total DDTs.

[b] Neo and mesogastropods (two orders of snails) are highly sensitive to TBT based on an imposex endpoint. If insufficient gastropod tissue is available for collection across a range of TBT concentrations in sediment (or porewater, pending final resolution of this issue in the Phase 2 work plan), then a surrogate benthic invertebrate group (phyla) will be targeted for collection and TBT analysis.

2.2.2 Fish

Three fish species were selected in the Phase 1 ERA as ROCs to represent risk from sediment-associated chemicals to the LDW fish community:

- Juvenile chinook salmon were selected to represent outmigrating juvenile salmonids
- Bull trout were selected to represent piscivorous fish
- English sole were selected to represent all fish not explicitly represented by the above two species.

Juvenile chinook salmon were selected because they are thought to be the most exposed juvenile salmonid and because they are listed as a threatened species under the federal Endangered Species Act (ESA). The other two fish species were selected primarily to represent high-exposure regimes. Bull trout were also selected because of their piscivorous diet and listed status under ESA. English sole were also selected because of their high direct sediment contact and benthivorous diet. In addition, site-specific exposure and effects data were available for English sole.

The Phase 1 fish risk assessment focused on estimating the potential for effects on survival,[9] growth, and reproduction of fish ROCs using comparisons of estimated or measured COPC[10] concentrations in sediment and tissue to relevant toxicological data. Depending on the bioaccumulative properties of the COPC, either a critical tissue residue approach or a dietary approach was used to estimate risk. Potential data needs associated with the fish assessment are summarized in Table 2-3.

As discussed above, bull trout was selected as the fish ROC representing piscivorous fish in the Phase 1 ERA because of its piscivorous diet and listed status under ESA. Because no tissue data were available for any piscivorous fish and all effects data were used, the species selected did not influence the Phase 1 risk conclusions for this group of fish. However, in Phase 2, an alternative piscivorous fish species will be assessed because bull trout are not believed to be the best species to propose for tissue collection because they are rare in the LDW (Taylor et al. 1999) and it is difficult to obtain collection permits for a listed species. Therefore, a meeting in May 2002 was held with the agencies and other interested parties to recommend an alternative fish ROC. At this meeting, interest in the Pacific staghorn sculpin was expressed because of

[9] Immunosuppression was also assessed as an endpoint for juvenile chinook salmon, but reproduction was not.

[10] COPCs for Phase 2 will be identified in the Phase 2 ERA problem formulation.

their high abundance in past surveys, piscivorous diet, close association with sediment, and high site usage. Rockfish were also discussed as a potential fish ROC, but their site usage is uncertain. Thus, these data needs are also discussed in Table 2-3. Sculpin will likely be used as the piscivorous fish ROC in place of bull trout in the Phase 2 ERA.

As shown in Table 2-3, collection of additional tissue data is proposed for Pacific staghorn sculpin, English sole, juvenile chinook salmon, and prey species of all three fish ROCs. Analytes in each fish species will be determined in coordination with the agencies and other interested parties, and presented in the Phase 2 work plan. An investigation of site usage by rockfish is also proposed, with possible collection of tissue data, depending on site usage information. Details for these additional field efforts will be determined in coordination with the agencies and other interested parties and will be documented in the Phase 2 work plan and sampling and analysis plans.

Table 2-3. Potential data needs for fish risk assessment

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Piscivorous fish tissue data	yes	No tissue data are currently available for piscivorous fish; these data are needed to estimate risks to upper trophic level fish.	Collect Pacific staghorn sculpin [a] and synoptic sediment data from several locations in the LDW.
Juvenile chinook salmon tissue data	yes	Data are needed to supplement existing data collected by NMFS.	Collect juvenile chinook salmon from several locations within the LDW.
English sole tissue data	yes	Existing whole body data are few (3 composites of 20 fish each) and compromised (portions of those fish were removed for other analyses).	Collect English sole tissue data from several locations within the LDW.
Piscivore/English sole/juvenile chinook salmon prey tissue data	yes	Limited tissue data are available to assess dietary exposure to COPCs.	Collect prey items in several areas of the LDW based on site usage of these fish species as well as sediment COPC contamination patterns. Benthic invertebrate prey will likely be assessed using a "market basket" approach, pending a review of food web model data needs.
Dietary and chemical composition of stomach contents of fish ROCs	yes	The preferred prey for sculpin in the LDW is uncertain; it is expected to be highly variable because these species are largely opportunistic feeders. Available stomach content chemical data for juvenile chinook salmon have low QA/QC documentation.	Composite samples of stomach contents of juvenile chinook salmon will be archived for potential chemical analysis; LDWG will review stomach content prey identification data from sculpin collected by EPA.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
English sole site usage	no	Site usage study is of uncertain utility pending refinement of the risk calculations, and of uncertain feasibility and interpretation.	No field or laboratory work proposed. Tissue data from several locations may be useful in assessing home range.[b]
Juvenile chinook salmon site usage	no	Useful information may be gained from ongoing studies sponsored by the Port of Seattle and King County.	No field or laboratory work is proposed.
Sculpin site usage	no	Site usage study is of uncertain utility pending refinement of the risk calculations, and of uncertain feasibility and interpretation.	No field or laboratory work is proposed. Tissue data from several locations may be useful in assessing home range.
Rockfish site usage	Yes	Stakeholder interest has been expressed in the potential site usage of rockfish in the LDW because these fish have been shown to accumulate high tissue residues elsewhere in Puget Sound.	Rockfish site usage (largely a presence/absence approach) in the LDW will be assessed through an approach outlined in the Phase 2 work plan. Rockfish tissue may also be collected, depending on extent of site usage.
Uncertainties in application of available toxicity reference values (TRVs)	No	Conducting toxicity tests for fish is not justified because sufficient data are available for COPCs that are likely to be risk drivers at the site, and development of additional chemical-specific toxicity data would be resource intensive.	No field or laboratory work is proposed. However, an additional literature search will be conducted for PAH-related TRVs for fish.

[a] Pacific staghorn sculpin are recommended as a piscivorous ROC instead of bull trout for Phase 2.

[b] Tissue and sediment data will be evaluated together to determine whether inferences can be made regarding the home range.

2.2.3 Wildlife

In the Phase 1 ERA, wildlife ROCs were grouped into the following three broad categories at the site:

- Piscivorous/carnivorous birds (e.g., great blue heron, western grebe, cormorant, osprey, and bald eagle)
- Benthivorous birds (e.g., spotted sandpiper, killdeer, and dabbling ducks)
- Piscivorous mammals (e.g., river otter and harbor seal).

Other broad categories of wildlife receptors, such as herbivorous birds, passerine birds, or omnivorous mammals were assumed to be less exposed to sediment-associated COPCs from the LDW through their diet and sediment ingestion than the three categories listed above. The following wildlife species were selected as ROCs in the LDW:

- Great blue heron—piscivorous birds
- Bald eagle—piscivorous and carnivorous birds
- Spotted sandpiper—benthivorous birds
- River otter—piscivorous mammals
- Harbor seal—piscivorous mammals

The Phase 1 ERA focused on estimating the potential for effects on survival, growth, and reproduction of these wildlife species using comparisons of estimated COPC[11] doses to relevant toxicological data. In addition, PCB concentrations in great blue heron eggs were compared to relevant toxicological data.

Potential data needs associated with the wildlife assessment are summarized in Table 2-4. Additional collection of wildlife prey species for tissue analysis is proposed to reduce uncertainties in the wildlife exposure assessment. Detailed study designs for this effort will be developed in coordination with the agencies and other interested parties, including details regarding analyte lists, sampling locations, and prey types. In addition, a limited survey is proposed to assess the quality of sandpiper habitat in areas of the LDW with higher concentrations of COPCs.

Table 2-4. Potential data needs for wildlife risk assessment

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of additional action, if Proposed
Prey tissue data (fish and benthic invertebrates) for all wildlife receptors	yes	Existing dataset is limited with respect to tissue types, sampling locations, and analytes.	Collect prey fish of preferred size and benthic invertebrates from selected areas in the LDW. Benthic invertebrate prey will likely be assessed using a "market basket" approach, pending a final review of food web model data needs.
Bird tissue chemistry data for ingestion by eagle	no	Collection of piscivorous bird tissues (i.e., grebes) would be difficult due to permitting constraints. In addition, tissue residues associated with LDW exposures would be uncertain.	No field or laboratory work is proposed. The scientific literature will be searched for biomagnification factors to relate concentrations in fish to concentrations in birds, such as grebes, gulls, and waterfowl species, that eagle may prey upon
Proportion of prey types, including fish species, in wildlife diets	no	Sufficient data exist in the literature regarding prey preferences, thus additional studies are likely to have a relatively low influence on risk conclusions.	No field or laboratory work is proposed. Relevant literature will be consulted.

[11] COPCs for Phase 2 will be identified in the Phase 2 ERA problem formulation

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of additional action, if Proposed
Site use data for eagle	no	Additional data are unlikely to change risk conclusions for eagle COPCs.	No field or laboratory work is proposed.
Site use data for sandpiper	yes	Limited data exist regarding sandpiper site use; additional data could impact risk conclusions.	Conduct a visual site survey to assess the suitability of habitat for use by sandpipers near sites with highest concentrations of sandpiper COPCs.
Daily food consumption rate for otter	no	Study would be unlikely to substantially alter risk conclusions from the Phase 1 ERA.	No field or laboratory work is proposed.
Uncertainties in application of available TRVs	no	Conducting toxicity tests for wildlife is not justified because sufficient data are available for COPCs that are likely to be risk drivers at the site, and development of additional chemical-specific toxicity data would be resource intensive.	No field or laboratory work is proposed.

2.2.4 Plants

Emergent aquatic plants were selected as an ROC for the ERA. These plants are a potential food source for a few terrestrial and aquatic animals in the LDW, and provide cover habitat for many fish and invertebrates. Emergent plants are rooted in sediment; thus, they are exposed to sediment-associated chemicals through root uptake and direct contact. Some studies on the effects of chemicals on emergent aquatic plants have been published; however, no toxicological data are available relating sediment chemical concentrations to plant toxicity. Thus, soil toxicity data were used as a surrogate in the ERA. Potential data needs associated with the plant assessment are summarized in Table 2-4. No additional fieldwork is proposed to reduce the uncertainty in the plant assessment because the key uncertainty in the plant assessment is the relevance of available toxicity data.

Table 2-5. Potential data needs for plants risk assessment

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Use of sediment chemistry data to estimate exposure, rather than water chemistry data	no	Water chemistry data are not very relevant because rooted aquatic plants in LDW are rarely under water.	No field or laboratory work is proposed.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Limited marsh sediment data	no	Key uncertainty for plants is effects data, so additional marsh data are unlikely to reduce uncertainty in plant assessment.	No field or laboratory work is proposed. Additional sediment data will be collected in Phase 2 for various other considerations, and those data may be appropriate for use in assessing risks to plants in the baseline ERA.
Relevance of existing soil toxicity data	no	These data are unlikely to change risk conclusions for plants due to the low exposure of rooted aquatic plants in the LDW. Also, development of additional chemical-specific toxicity data would be resource intensive.	No field or laboratory work is proposed.

2.3 Human Health Risk Assessment

The Phase 1 HHRA quantified risks for three exposure scenarios: consumption of fish and shellfish, commercial netfishing, and recreational users of intertidal areas (e.g., beach play). Direct water contact pathways, such as swimming, were not quantitatively evaluated in the Phase 1 HHRA because a previously conducted risk assessment suggested risks from these activities were low in the LDW (King County 1999). Risks were estimated using standard EPA guidance and site-specific data. Additional details are provided in the Phase 1 HHRA, which is an appendix to the Phase 1 RI report (Windward 2003).

Table 2-6 presents an overview of potential data needs identified in the Phase 1 HHRA. Collection of sediment and tissue samples from outside the LDW and analysis of those samples for arsenic[12] is proposed to evaluate risks relative to background. Collection of additional tissue chemistry data is recommended to reduce uncertainty in the exposure assessment and to supplement the market basket approach.[13] Target species and tissues, analyte lists, and collection locations will be developed in coordination with the agencies and other interested parties, and a complete list of analytes will be presented in the Phase 2 work plan. In addition, the current and future ability of the LDW to support the shellfish consumption rates documented in the Suquamish Tribe seafood consumption survey will be investigated through literature reviews and abundance surveys of these organisms. Human site usage of the intertidal

[12] A few additional chemicals may also be analyzed from background locations. The background sampling approach will be discussed with the agencies and described in more detail in the Phase 2 work plan.

[13] This approach utilizes separate human consumption rates for each species, such as English sole, perch, and crab. The chemical intakes associated with each species are then summed to yield an overall chemical intake for risk calculations.

areas will also be further assessed through a qualitative reconnaissance effort to determine whether additional intertidal sediment data are needed to further characterize this exposure pathway. Additional sediment chemistry data may be collected for certain chemicals with detection limits above risk-based screening concentrations if available data suggest that these chemicals are likely to be present in the LDW.

Table 2-6. Potential data needs for human health risk assessment

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Background arsenic [a] concentrations in tissue and sediment	yes	Existing sediment and tissue chemistry data may be useful for evaluating arsenic risk relative to background concentrations, but additional data will be required.	Arsenic will be analyzed in sediment samples collected upstream of the LDW. Arsenic will also be analyzed in tissue samples collected from outside the Green/Duwamish watershed. A subset of the background tissue samples will be analyzed for arsenic species (i.e., inorganic vs. organic forms). Details of the proposed sampling design will be included in the Phase 2 work plan.
Fish and shellfish tissue chemistry data	yes	Existing tissue chemistry data to estimate exposure are limited. Collection of more complete chemical data would enable identification of COPCs for each market basket component.	Collect target species for potential tissue analysis if sufficient numbers are present to support harvest; additional species may contribute to a more robust market basket approach. Arsenic speciation analysis will be conducted on tissues of several species proposed for collection. Target species will represent each market basket component: benthic fish, pelagic fish, and shellfish. Tissue types analyzed will reflect consumption preferences of potentially exposed populations.
Fish/shellfish abundances	yes	Verify the capacity of the LDW, currently and in future-use scenarios, to support consumption rates derived from a broad region of Puget Sound.	Conduct relative abundance and distribution surveys to estimate harvest sustainability in the LDW and the appropriate consumption rates to use for the Phase 2 HHRA.
Representativeness of existing tissue chemistry data for all potentially exposed populations	yes	Few data are available for specific fish and shellfish tissues consumed by a subset of the population (e.g., crab hepatopancreas).	Conduct a subset of the proposed additional tissue chemistry sampling on sample types that reflect fish consumption practices of groups such as Asian ethnic groups and Pacific Islanders.
Exposure area used for beach play scenario	yes	Intertidal site usage information (e.g., beach play) is limited.	Conduct additional qualitative reconnaissance of potential intertidal human use areas. Additional intertidal sediment chemistry data may be needed where historical sampling densities are low in identified human use areas.

Uncertainties in Data	Additional Field or Laboratory Work Proposed?	Rationale for Recommendation	Details of Additional Action, if Proposed
Elevated detection limits for some COPCs in sediment	yes, if screening warrants	Detection limits of some chemicals exceeded risk-based screening concentrations.	In the Phase 1 HHRA, certain chemicals were never detected but resulted in cancer risk estimates (based on half-detection limits) greater than 1 in 1,000,000 or hazard quotients greater than 1. If, based on a review of current and historical industrial practices in the LDW, there is reason to believe that these chemicals could be present, conduct focused sampling for these chemicals using lower detection limits, if achievable.
Uncertainty in toxicity benchmarks and available data	no	Toxicity benchmarks established by EPA have been extensively peer-reviewed and accepted.	No field or laboratory work is proposed.

[a] A few additional chemicals may also be analyzed from background locations. The background sampling approach will be discussed with the agencies and described in more detail in the Phase 2 work plan.

3.0 Data Needs Grouped by Medium and Type

This section provides an overview, by data type, of the additional actions proposed in Section 2. Grouping the data needs by data type allows for efficient recommendations for the project as a whole because individual data collection activities may fill more than one data need. Note that critical data needs for the food web model are currently being evaluated and are scheduled to be discussed with the agencies. If any additional critical data needs are identified specific to the food web model, they will be outlined in the Phase 2 work plan.

3.1 CHEMICAL

Additional chemistry data are suggested for sediment and tissue. Each data type is discussed in separate sections below.

3.1.1 Sediment chemistry

Given the large number of sediment samples that have been collected and analyzed within the last 10 years, reconnaissance-level sediment sampling over the entire LDW is not necessary. However, collection of additional sediment samples is recommended in specific areas to better understand the areal and vertical extent of COPCs (Table 3-1). A complete analyte list for sediment will be presented in the Phase 2 work plan. In addition, focused sediment sampling and a limited amount of reconnaissance-level sampling will be conducted to better characterize the spatial distribution of some chemicals (e.g., TBT, DDT) that have been analyzed less frequently compared to other

chemicals or that had elevated detection limits. Intertidal sediment areas with high recreational usage will also be further sampled.

Table 3-1. Sediment chemistry data needs and proposed actions

DATA TYPE	ASSESSMENT WITH DATA NEED	PURPOSE	LOCATIONS
Surface sediment	benthic invertebrate risk	to better characterize benthic invertebrate exposure, including exposure to COPCs that were previously analyzed in relatively few samples	Sample locations will be co-located with toxicity test locations, and benthic invertebrate tissue collection locations.
	human health and benthic invertebrate risk	to analyze additional sediment samples with attention to achieving lower detection limits because detection limits for existing data exceeded risk-based screening concentrations and/or SQS/CSL	Collect samples in select areas in LDW.
	human health risk	to better characterize exposure during beach play	Collect samples in intertidal areas where human exposure is likely to occur.
	human health risk	to evaluate arsenic[a] risk relative to background	Collect samples upstream of the LDW.
	remedial investigation	to collect data for additional nature and extent characterization	Sample locations will be targeted based on the following key considerations: 1) areas with low spatial coverage, particularly at sites where single SQS or CSL exceedances were observed with few nearby stations, near special use areas (e.g., beaches), or near probable chemical sources; 2) co-located with SMS-approved toxicity tests and certain tissue collection locations; and 3) analyte considerations including chemicals with relatively low numbers of historical samples or historical locations that did not have sufficiently low detection limits for certain chemicals. Criteria will be outlined in the Phase 2 work plan.
Subsurface sediment	remedial Investigation	to collect data for additional nature and extent characterization, particularly in areas potentially subject to erosion	Sample locations will be targeted based on the following key considerations: 1) erosion potential, 2) proximity to probable chemical sources, and 3) existing surface and subsurface chemistry data. Criteria will be outlined in the Phase 2 work plan.

[a] A few additional chemicals may also be analyzed from background locations. The background sampling approach will be discussed with the agencies and described in more detail in the Phase 2 work plan.

3.1.2 Tissue chemistry

Existing tissue chemistry data were sufficient to allow calculation of preliminary risk estimates for the Phase 1 ERA and HHRA, but considerable uncertainty remains in many areas because of the small number of samples collected for some species. The data needs summarized in Table 3-2 are focused on increasing the number, type of organism, and chemicals analyzed in tissue samples to support baseline exposure assessments in the Phase 2 ERA and HHRAs. Analytes for each tissue type will be developed in coordination with the agencies and presented in the Phase 2 work plan. Tissue collection locations will be determined based on habitat preferences for species collected, contamination patterns, and other considerations relevant to assessing Phase 2 risks with or without early actions. In addition, for human health, locations will be based on public accessibility of sites, the presence of harvestable populations (e.g., for clam and crab collection), and preferred fishing locations.

Table 3-2. Tissue chemistry data needs and actions

TARGET TISSUE	ROC	TYPE OF DATA	PURPOSE
Benthic invertebrates	benthic invertebrates	neo- and mesogastropods[a]	These data will make it possible to evaluate the imposex endpoint for these two orders of snails.
	juvenile chinook salmon and English sole	epibenthic and infaunal invertebrates, as prey items (combined, using a market basket approach)	Existing tissue data are few, potentially not representative of all prey, and potentially not spatially representative of LDW.
	spotted sandpiper	epibenthic and infaunal benthic invertebrates, as prey items (combined, using a market basket approach)	Existing tissue data are limited and were not collected from areas with highest concentrations that may be sandpiper habitat.
Crab[b]	crab	adult whole body and hepatopancreas	Existing tissue data are limited from both an analyte and spatial perspective.
	human shellfish consumers	adult edible crab meat, hepatopancreas (separate samples)	These data will make it possible to increase confidence in existing exposure point concentrations, and to evaluate arsenic speciation in a subset of samples.
Pacific staghorn sculpin	piscivorous fish[d]	whole body (>15 cm[c])	There are no existing data to estimate exposure to piscivorous fish.
	heron, eagle, otter, seal	whole body (typically <30 cm for heron, eagle, and seal, up to 40 cm for otter)	There are no existing data for piscivorous fish as prey items for wildlife.

TARGET TISSUE	ROC	TYPE OF DATA	PURPOSE
English sole	English sole	whole body adult	Existing data are too few (3 composites of 20 fish each) and compromised (portions of those fish removed for other analyses).
	otter, seal	whole body (typically <30 cm for seal, up to 40 cm for otter)	Existing data are few (3 composites of 20 fish each) and compromised (portions of those fish removed for other analyses).
	human fish consumers	fillets, potentially whole body minus guts	Existing data are too few to characterize exposure by subpopulations with alternative consumption patterns.
Juvenile chinook salmon	juvenile chinook salmon	whole body	Existing data may be qualified due to insufficient QA/QC documentation.
	piscivorous wildlife and fish	whole body	Existing data may be qualified due to insufficient QA/QC documentation; perch data may also be used as a surrogate for certain analytes.
Shiner surfperch	sculpin, heron, eagle, otter, seal, human consumers (potentially)	whole body fish as prey items; fillet and some whole body samples for human health	Existing data are limited
Clams	human consumers	edible meat	Clams may be collected for chemical analysis if abundance survey indicates harvestable populations are present.
Other fish species	human consumers	mostly fillet, some whole-body	The number of fish species for the benthic and pelagic components of the market basket may include more than one species for each component if these species can be harvested using conventional fishing techniques likely to be used by the potentially exposed population.

[a] If sufficient neo- and mesogastropod tissue is not available, a surrogate benthic invertebrate group (phyla) will be collected for TBT analysis.

[b] Crab data could also be used for river otter exposure, although limited crab data were not identified as a primary uncertainty for otter risk estimates.

[c] Defined by Weitkamp and Campbell (1980) as size of fish with piscivorous diet.

[d] Rockfish may also be collected for analysis if warranted based on site usage data.

3.2 PHYSICAL

The physical characteristics of sediment, including grain size and organic carbon content, are reasonably well known given the large number of sediment samples that have been analyzed. Grain size and organic carbon content are two important

characteristics for describing habitat value for animals associated with the sediment. These parameters will be analyzed in any additional sediment samples collected during Phase 2. In addition, other physical properties such as bulk density and mineralogic characteristics will be quantified for some of the surface and subsurface sediment samples collected during Phase 2. A third important characteristic for describing habitat value is depth. A single bathymetric survey will be conducted in Phase 2 to provide a more complete habitat characterization. The results of this bathymetric survey may also help identify erosional and depositional areas when used with previously collected bathymetry data and other sediment fate and transport data.

Much of the existing data on sediment fate and transport is focused on specific areas within the LDW; additional data are needed for other areas of the LDW. Additional near-bottom current velocity data are needed to allow more complete characterization of the erosion potential within the LDW. These data may be obtained from models previously used for the LDW or additional field data may be collected through the deployment of current meters.

3.3 BIOLOGICAL

This section describes biological studies, including sediment toxicity tests and site usage studies, recommended for Phase 2 to better understand site characteristics and the site-specific behavior of animals and people.

3.3.1 Sediment toxicity tests

One of the data gaps from the benthic invertebrate component of the ERA is the limited number of site-specific sediment toxicity tests conducted within the LDW. A specific strategy for identifying sampling locations and integrating additional toxicity test and synoptic sediment chemistry analyses into the RI process will be developed in coordination with the agencies and other interested parties during the development of the Phase 2 work plan and sampling and analysis plans.

3.3.2 Site usage studies

Available data are generally sufficient to indicate presence/absence and the approximate abundance and distribution for many of the ROCs evaluated in the ERA and HHRA, but detailed site usage has not been well characterized for some key species. Additional data on this topic are important for reducing uncertainty in the exposure assessments conducted for both the ERA and HHRA (Table 3-3). For example, the human fish and shellfish consumption scenario evaluated in the HHRA assumed that 100% of the fish/shellfish that people consumed were collected in the LDW. It is uncertain whether current or future shellfish populations in the LDW are large enough to support consumption at the rates assumed in the Phase 1 HHRA exposure assessment.

Another important data need is site usage information for fish species within, and potentially outside, the LDW. Based on the Phase 1 risk assessments, resident fish and shellfish in the LDW contain chemical concentrations that result in preliminary risk estimates that are unacceptably high. These estimates will be further refined in Phase 2. If they remain unacceptably high, then a linkage between chemical concentrations in those organisms and sediment concentrations may be needed as part of Phase 2 RI or FS activities to support any sediment remediation that may occur in addition to early actions. Identification of any data needs associated with establishing this link, in addition to the site usage information discussed below, will be determined in coordination with the agencies and other interested parties.

Table 3-3. Site usage data needs and actions

ROC	PURPOSE	DETAILS
Crab	to assess relative abundance and habitat usage needed to determine relevance of existing data and to determine locations for additional tissue collection	Conduct a survey in LDW assessing crab site usage during different seasons.
Benthic community (i.e., burrowing organisms)	to evaluate presence of clams for exposures in subsurface sediments (below 15 cm)	Evaluate depth of clam occurrence during the clam abundance survey for the human health assessment.
Benthic community	to generally characterize types of benthic invertebrates found in LDW sediments	Conduct limited benthic community surveys
Rockfish	to assess presence/absence of rockfish in the LDW to evaluate potential inclusion as a fish ROC	Conduct a limited survey to assess site usage, based on habitat identified in the bathymetric survey.
Sandpiper	to reduce uncertainty in the sandpiper exposure assessment	Conduct a limited visual survey of the suitability of intertidal habitats for use by sandpipers near sites with high COPC concentrations.
Human fish and shellfish consumers	to determine harvest sustainability in the LDW	Conduct clam and crab surveys, and a limited shrimp survey, to determine relative abundance and distribution. In addition, the presence of marine shellfish species in the LDW will be determined based on literature reviews and interviews with biologists that have conducted LDW field work.
Human users of the intertidal zone	to reduce uncertainty in the potential use of intertidal areas for recreational purposes (e.g., beach play)	Conduct additional qualitative reconnaissance of potential intertidal human use areas.

4.0 Summary

The data needs described in Section 3 can be grouped into three types: chemical, physical, and biological. Additional chemical data are needed for both sediment and tissue to reduce uncertainties identified for the exposure assessment in the Phase 1ERA and HHRA. The primary physical data need is a complete bathymetric survey of the LDW, although some additional data on physical sediment properties will also be collected. Better site usage data are needed for some of the ROCs characterized in the Phase 1 risk assessments, including crab, clams, shrimp, sandpiper, rockfish,[14] and human recreational users of the intertidal zone (e.g., beach play). These data will reduce uncertainties in the exposure assessments and provide additional information to assess links between COPC concentrations in fish and shellfish tissue and chemical concentrations in sediment through a food web model. Additional sediment toxicity tests will also be conducted in Phase 2. The scope of work for the data needs summarized in this memorandum will be presented in the Phase 2 work plan, while the details will be provided in field and laboratory study plans. Both the Phase 2 work plan and field and laboratory study plans will be developed in coordination with the agencies and other interested parties as part of the scoping process for the Phase 2 RI.

5.0 References

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EPA and Ecology. 2000. Lower Duwamish Waterway remedial investigation/feasibility study statement of work. US Environmental Protection Agency, Region 10, Seattle, WA and the Washington Department of Ecology, Northwest Regional Office, Bellevue, WA.

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[14] Rockfish were not assessed as a ROC in the Phase 1 ERA, but are being considered as a potential ROC in the Phase 2 ERA.

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