EXECUTIVE SUMMARY

This Comprehensive Round 2 Site Characterization Summary Report evaluates the physical, chemical, and biological information collected through the Round 2 sampling effort in order to focus the Round 3 data collection effort and, to the extent practicable, determine the final data needs for the RI/FS. In order to meet this objective, the following topics are covered in the Round 2 Report:

- Review of the investigative activities, including major sample collection phases and goals (Section 2)
- Description of the upland and in-water physical characteristics of the Site (Section 4)
- Identification of potential historical and current contaminant sources and transport pathways to the Study Area (Section 5)
- Identification and mapping of the nature and distribution of chemical concentrations in sediments, transition zone water, surface water, and tissue (Section 6)
- Initial evaluation of chemical loading, fate, and transport processes (Section 7)
- Documentation of the results of the Round 2 human health and ecological risk assessments (Sections 8 and 9)
- Identification of initial Preliminary Remediation Goals (iPRGs) and initial areas of potential concern (iAOPCs) based on the Round 2 human and ecological risk assessment results (Section 10)
- Presentation of a revised conceptual site model at the scale of the entire Study Area and for individual iAOPCs, portraying the relationships among sources, chemicals, transport mechanisms, and receptors, including evaluation of the relative contribution of known sources to the iAOPCs (Sections 3 and 11)
- Identification of data needed to complete the RI/FS and next steps (Section 13).

Based on the results of the data analysis, the majority of potential human health risk at this site is from consumption of resident fish contaminated with PCBs, and higher levels of PCBs in sediment are confined to discrete near-shore locations along both banks of the Study Area. PCBs are also the chemicals with the greatest potential to pose ecological risk.

The data needed to complete the in-water RI/FS have also been identified and include:

- Additional data for sediment, surface water, and stormwater at specific locations in order to fill spatial gaps and reduce uncertainties, and
- Additional benthic community, lamprey, and sturgeon data to evaluate species-specific considerations.

Sampling plans have already been initiated for several of these media through the Round 3A collection effort. The remaining data needs will be collected in Round 3B later in 2007.

Although these additional data will be useful in addressing specific questions and reducing some uncertainties, and recognizing that the final remedial investigation and baseline risk assessments may include analyses not presented in this report, the Lower Willamette Group (LWG) does not anticipate that these efforts will have an appreciable effect on the general results and conclusions presented in this report (e.g., PCBs will still be the most significant contributors to potential risks at this site).

Sources of Data

According to the EPA-approved Programmatic Work Plan for the Portland Harbor Superfund Site, the field work for the physical, biological, and chemical systems is divided into four stages: pre-AOC (including characterization of the physical system), Round 1 (including tissue collection and compilation of historical data), Round 2 (including characterization of nature and extent, additional biological testing, and collection of feasibility study data), and Round 3. Rounds 1 and 2 were intended to collect the majority of data needed to complete the remedial investigation and feasibility study, and Round 3 is to fill any remaining data gaps or data needs.

The Round 2 Report presents an analysis of all data collected by the LWG since 2001, as well as historical data that meet quality assurance criteria. The data sources are summarized in Section 2 and include:

- 2000 individual fish and invertebrate samples
- 1,800 subsurface sediment chemistry samples (from about 660 coring locations)
- 1,650 surface sediment chemistry samples
- 800 sediment trend analysis sample points
- 500 Sediment Profile Images
- 225 transition zone water samples from 108 stations at 9 sites
- 130 surface water samples from 25 point and transect stations
- 4 major annual bathymetry surveys of 16 miles of the lower Willamette River (LWR)
- 3 wildlife habitat surveys.

Physical Setting

Over the past 150 years the Portland Harbor area of the LWR has been redirected, straightened, filled, and deepened by dredging. Most of the riverbank has been filled, stabilized, and/or engineered for industrial or port operations with riprap, bulkheads, and overwater piers and docks. Portland Harbor remains today the industrial sanctuary for the Portland metropolitan area, yet includes some residential enclaves and recreational facilities.

River flow varies dramatically with the seasons, with low late-summer dry-season levels and high rainy season and spring snow melt levels; periodic flow reversals within the LWR also occur due to tidal effects.

The Willamette River flows into both the Columbia River and Multnomah Channel. Under certain conditions, more than half of the LWR flow is directed into Multnomah Channel. The width and depth of the river affect the flow velocities and determine in part where sediment is eroded and deposited. A federally maintained navigation channel throughout the Study Area has been dredged historically to a level of -40 feet. Section 4 provides additional detail on the physical setting of the LWR.

Conceptual Site Model

In order to focus sampling and other investigations, a conceptual site model (CSM) for the Portland Harbor RI/FS Study Area was developed and is periodically updated. The CSM describes the current understanding of potential chemical sources, pathways, and receptors in the Study Area and evaluates the relative importance of different pathways for both historical and current potential sources. The primary function of the CSM at this stage in the RI/FS is threefold: 1) to structure an initial evaluation of sources of iCOCs to the Study Area and individual iAOPCs, 2) to assess the relative contribution of those sources and pathways, and 3) to identify data gaps for completion of the RI/FS. This information will also be used to help inform the DEQ source control program. The CSM is described generally in Section 3 and in detail in Section 11.

Other sections of the report also support the CSM. Section 7 presents the Round 2 assessment of contaminant loading, fate, and transport processes in the Study Area. Sections 8 and 9 identify the exposure media, exposure scenarios, iCOCs, and potential iCOCs for the human health and ecological risk assessments, respectively. Development of iPRGs and iAOPCs is described in Section 10.

Potential Sources/Pathways

The evaluation of potential sources included reviewing available upland source information and assessing the likelihood that chemicals associated with facility operations or other potential sources, such as stormwater, may have migrated or been released to the river. Additionally, potential sources outside the Study Area from other reaches of the LWR were identified. Potential source and pathway information is summarized in Section 5 and will be updated in the final RI report.

This evaluation of potential sources concludes:

- There probably were numerous historical sources that contributed contamination to the river via all pathways (surface water, sediment transport, groundwater, stormwater and process wastewater discharge, overland flow, bank erosion, overwater activities and spills, and atmospheric deposition).
- Most historical sources are no longer active or have been significantly diminished.
- Upstream surface water, sediment transport, and stormwater from within and upstream of the Study Area remain the most likely significant pathways.

Distribution of Chemicals

The LWG analyzed samples for more than 540 chemicals of interest. The distribution of key indicator chemicals is discussed in Section 6. Taken as a whole, these data show that sediment concentrations tend to be fairly uniform across the Study Area except in nearshore or off-channel areas that are generally associated with known or suspected historical or current sources, where concentrations tend to be higher. In general, except for arsenic and mercury, sediment data from areas outside the Study Area show lower concentrations of indicator chemicals than the Study Area.

Round 2 Human Health Risk Assessment

The Round 2 Human Health Risk Assessment (HHRA) evaluated potential risks to human health resulting from exposure to chemicals of potential concern through direct exposure to beach sediment, in-water sediment, surface water and groundwater seeps, and through fish and shellfish consumption. For the Round 2 Report, conservative exposure assumptions were used to assess potential risks. The Round 2 HHRA is not the baseline HHRA (which will be presented in the RI report). The Round 2 analysis was intended to identify potential data gaps remaining for the RI/FS and was not intended to develop final cleanup levels or identify areas in need of remediation. The Round 2 HHRA is summarized in Section 8, and detailed information is provided in Appendix F.

The Round 2 HHRA evaluated the following exposure scenarios, as provided in the approved Programmatic Work Plan:

- Dockside worker — direct exposure to beach sediment
- In-water worker — direct exposure to in-water sediment
- Adult and child recreational beach user — direct exposure to beach sediment and surface water (for swimming scenarios)
- Transient — direct exposure to beach sediment, surface water (for bathing and drinking water scenarios), and groundwater seeps
- Native American fisher — direct exposure to beach sediment or in-water sediment and fish consumption
- Non-tribal fisher — direct exposure to beach sediment or in-water sediment, fish consumption, and shellfish consumption.

The key conclusions of the Round 2 HHRA are:

- Potential risks from consumption of fish or shellfish are generally orders of magnitude higher than any of the other exposure scenarios.
- Potential risks from consumption of fish or shellfish are within or above the EPA target cancer risk range of 10^{-4} to 10^{-6} and exceed the target noncancer hazard index of 1.

- Potential risks from consumption of upstream (Willamette Falls) fish also are within or above the EPA target cancer risk range of 10^{-4} to 10^{-6} and exceed the target noncancer hazard index of one.
- PCBs result in the highest potential cancer and noncancer risks from fish consumption.
- With the exception of a single in-water sediment exposure scenario at two 0.5-mile river segments, potential risks from direct exposure to beach sediment, in-water sediment, surface water, and groundwater seeps are within or below EPA's target 1one.
- No additional data collection is needed to complete the baseline HHRA; however, existing data, particularly tissue data, and the exposure assumptions used to evaluate fish consumption risks will be evaluated further.

Round 2 Ecological Risk Assessment

The Round 2 Ecological Risk Assessment (ERA) presents an evaluation of potential risks to ecological receptors within the Study Area. The baseline ERA will be developed for the RI report. Again, the Round 2 analysis was intended to identify potential data gaps remaining for the RI/FS and was not intended to develop final cleanup levels or identify areas in need of remediation. The Round 2 ERA is summarized in Section 9, and detailed information is provided in Appendix G.

The Round 2 ERA evaluated potential risks to the following groups of ecological receptors, as provided in the approved Programmatic Work Plan:

- Benthic community
- Fish
- Wildlife
- Amphibians and reptiles
- Aquatic plants.

The conservative screening-level ecological risk assessment identified numerous chemicals of potential concern (Round 2 COPCs). These Round 2 COPCs will be considered in refining the list of chemicals of concern for the baseline ERA. The key conclusions of the Round 2 ERA are:

<u>Benthic Community</u>

- Areas of potential risk to the benthic community were identified using benthic toxicity testing, predictive models of benthic toxicity, and other lines of evidence (LOE). These areas are located primarily nearshore adjacent to known or suspected chemical sources.
- A high percentage (79 percent) of the sampled sites was classified as nontoxic to benthic invertebrates. Only 13 percent were classified as toxic, with the remaining

stations (8 percent) either not evaluated due to limited chemistry data and no sediment toxicity data, or identified as indeterminate.

- Initial chemicals of concern (iCOCs) for benthic invertebrates based on multiple lines of evidence include 3 metals, PCBs, 3 individual PAHs, total PAHs, and DDTs.
- Other potential iCOCs for benthic invertebrates were identified as those chemicals associated with high uncertainty or identified solely based on transition zone water exceedances of surface water screening levels, but not supported by other LOEs, as posing risks to benthic invertebrates. These potential iCOCs are not expected to pose significant risks to benthic invertebrates because there is limited potential for exposure.

Fish

- Potential risks to fish were identified through the Round 2 ERA. The chemicals that have the greatest potential for posing risk to fish are PCBs.
- Other iCOCs for fish include DDTs, phthalates, mercury, and tributyl tin.

Wildlife

- Potential risks to wildlife were identified through the Round 2 ERA. The iCOCs are PCBs, dioxins, mercury, DDTs, and aldrin.
- Potential risks to most wildlife receptors were identified based on dietary exposure to PCBs, dioxins and furans, and DDE. DDE also represented a potential risk to osprey and bald eagle based on the bird egg tissue LOE.
- Potential localized risks to shorebirds (represented by spotted sandpiper) were associated with six specific foraging beach areas and based on dietary exposure to PCBs, dioxins and furans, DDD, and aldrin.

Amphibians, Reptiles, and Aquatic plants

- No iCOCs were identified for amphibians, reptiles, and aquatic plants.

Most of the data needed to complete a baseline ERA have already been collected. The remaining data needs have been identified, and the sampling efforts are either underway or achievable through the Round 3 sampling program.

Initial Areas of Potential Concern

Initial areas of potential concern (iAOPCs) within the Study Area were identified to help identify data needs to complete the RI/FS. iAOPC development is described in Section 10. Chemical-specific iPRGs were developed for iCOCs identified through the Round 2 HHRA and ERA. iPRGs and other risk information were then applied to generate maps of areas where chemical concentrations are high enough to be of potential concern, based on the conservative assumptions used for the Round 2 HHRA and ERA. Finally, these maps were combined to

identify areas of overlapping or contiguous potential risks. iAOPCs for the Round 2 report were based solely on surface sediment data and will be refined to develop AOPCs for the RI report. Based upon the Round 2 evaluations:

- 29 iAOPCs were identified (28 specific sites and one "site-wide" area for the risks associated with PCBs).
- Specific iAOPC sites range from under 0.2 acres to just over 40 acres:
  - 5 are less than one acre
  - 10 are between 1 and 10 acres
  - 13 are between 10 and 40 acres
- Typically, the more receptors and scenarios at potential risk the higher the iCOC concentrations at that area.
- PCBs are the most widespread chemical causing the identification of iAOPCs, and PCB risks are present in almost every iAOPC.

RI/FS Data Gaps

As a result of data collection and analysis through Round 2, the following data are needed to complete the RI/FS:

- Sediment trap data
- Surface sediment data
- Subsurface sediment data
- Surface water data
- Stormwater data
- Lamprey and sturgeon tissue data
- Lamprey and benthic toxicity data.

Other specific data needs were identified for specific iAOPCs (e.g., side scan sonar). Data types and proposed general locations are discussed in Section 12. Most of the identified data gaps will address the spatial distribution of sample locations and reduce uncertainties, while other data gaps will address species-specific toxicity questions.

Of these remaining data needs, sediment trap, surface sediment, subsurface sediment, surface water, stormwater, lamprey and sturgeon tissue, and lamprey toxicity data are already being addressed through Round 3A data collection activities.

Additional surface sediment and subsurface sediment data, along with benthic toxicity data, have been identified as Round 3B data needs. The LWG will work collaboratively with EPA

and its partners to generate the field sampling plans for Round 3B. Once these data are collected and analyzed, the LWG will complete the final Remedial Investigation (including baseline risk assessments) and Feasibility Study for the Study Area.

EXECUTIVE SUMMARY

SECTION 4 – PHYSICAL SETTING

Abstract

The physical setting of the Portland Harbor Study Area is detailed in Section 4. Physical studies conducted by the LWG have focused on the detailed conditions of the riverbed, the flow characteristics of the river, and the locations of groundwater plume discharge areas on the river bottom. It is important to understand these physical processes and conditions in order to further understand the CSM, and support the fate and transport modeling and the Feasibility Study.

Over the past 150 years, the Portland Harbor area of the LWR has been redirected, straightened, filled, and deepened by dredging. Most of the riverbank has been filled, stabilized, and/or engineered for industrial or port operations with riprap, bulkheads, and overwater piers and docks. The river flow varies dramatically with the seasons, with low late-summer dry-season levels and high rainy season and spring snow melt levels; periodic flow reversals within Portland Harbor also occur due to tidal effects. The Willamette River flows into both the Columbia River and Multnomah Channel and under certain conditions more than half the river flow is directed into Multnomah Channel. The width and depth of the river affect the flow velocities and determine in part where sediment is eroded and deposited.

The data set utilized to assess the physical conditions and processes of the Study Area will meet the goals of the RI/FS, with the following additions: limited bathymetric data within Multnomah Channel, further physical and chemical sediment characterization within the Study Area and upstream areas to address completion of the physical CSM, characterization of background, upstream contaminant loading estimates, and Feasibility Study data needs.

Work Plan and Field Sampling Plan Directives

The Programmatic Work Plan (April 2004) established the overall framework and objectives for the characterization of the physical system for the RI/FS that built upon the extensive amount of existing data collected by members of the LWG and others within the harbor. Numerous media-specific field sampling and quality assurance project plans that detailed sampling design and rationale, data use objectives, field and laboratory sampling and analysis methods, and data management and reporting requirements were developed with and approved by EPA and its partners.

Data Collection Activities

Collection of data to support characterization of the physical system for the Study Area began before the AOC was signed and has continued through Round 2. Physical system investigations conducted by the LWG included collection of the following types of data:

- Multibeam acoustic bathymetry surveys from RM 0 to Ross Island conducted in January and July-September 2002, May 2003, and February 2004

- Integration of a sediment trend analysis and an evaluation of historical bathymetry
- Sediment-profile imaging field study
- Time-series sediment stake measurements to document nearshore bank elevation changes
- Three acoustic Doppler current profiler (ADCP) surveys to provide river flow measurements during specific hydrological conditions
- Physical system data to calibrate the hydrodynamic sedimentation model: total suspended solids (TSS) concentration sampling, cohesive suspended sediment settling velocities measurements, and measurement of erosion rates and critical erosion velocities in a laboratory sediment flume
- Preliminary natural attenuation sampling (e.g., radioisotope cores) targeted for areas that may have potential natural processes to support this alternative.

Preliminary Assessment of Findings

Historically, the Portland Harbor area was a relatively shallow, meandering portion of the LWR surrounded by forested wetlands and floodplains; decades of urban development and industrialization resulted in a river that has been redirected, straightened, filled, and deepened. A -40 ft federally maintained (i.e., dredged) navigation channel, twice as deep as the original river, runs the length of the Study Area. Much of the riverbank has been progressively filled, stabilized, and/or engineered for industrial or port operations with riprap, bulkheads, and overwater piers and docks.

The river flow typically varies seasonally from 10,000 cubic foot per second or cfs (late summer) to about 100,000 cfs (rainy season), with an annual average of about 40,000 cfs. The LWR upstream of the Study Area (RM 11 to Willamette Falls at RM 26) is markedly narrower, more confined by bedrock outcrops, and faster flowing than in Portland Harbor. The reach immediately downstream of the Study Area (RM 2 to the Columbia River) is also narrower as the river turns northward and converges with the Columbia. The much larger Columbia River sometimes acts as a dam, backing up the Willamette, especially during spring snowmelt when the Columbia is high. At RM 3, the Multnomah Channel diverges west from the Willamette, seasonally carrying more than half of the Willamette River discharge. During low-flow periods on the LWR, Columbia River tidal fluctuations extend into the Study Area, producing periodic upstream flows.

Portions of the Study Area vary in hydrodynamic and sediment transport characteristics as a function of the cross-sectional area, navigation channel width, and off-channel features. The river transitions from its more dynamic upriver character to a predominantly depositional setting from RM 10 to RM 7 and is dominated by fine-grained sediments. Extensive shoaling occurs in this reach, requiring regular maintenance dredging in the navigation channel between RM 8 and 10. The Study Area becomes predominantly sandy between RM 5 and RM 7, where the river narrows. Sediments that arrive in the channel in this reach likely move downstream. As the river widens from RM 5 downstream to RM 2, it again becomes predominantly

depositional or stable in character. Division of the river flows by the Multnomah Channel at RM 3 results in a second area of extensive shoaling in the channel from RM 3 to RM 2. Finally, throughout the Study Area, sheltered off-channel areas, such as Swan Island Lagoon and Willamette Cove, are largely protected from natural disturbances but localized anthropogenic disturbances (e.g., propwash) can be widespread.

Time-series bathymetry data and sediment-profile images throughout the Study Area reveal a relatively active mixed surface sediment layer that would be expected from the hydrodynamics and sediment transport characteristics observed in the river. Small-scale (i.e., less than 30 cm) scour and deposition is widespread, and rapid changes in sediment texture are evident both laterally and sometimes vertically in the sediment column along the river edges as a function of localized shoreline morphology and riverbank modifications, including in-water structures such as piers or docks. Offshore channel environments are more texturally similar over large areas, reflecting the large-scale hydrodynamics of the river.

Some large contiguous areas of deposition or active transport are apparent within the Study Area. The forces that produce this dynamic surface sediment layer include both natural (e.g., river flows) and anthropogenic (e.g., propwash) disturbance factors. Sediment quality in the surface sediment layer (30 cm) is both temporally and spatially persistent, reflecting the effects of small-scale mixing. Below 30 cm, the sediment column is stable, particularly in nearshore and off-channel areas, under typical hydrodynamic and anthropogenic forces.

Additional Data/Next Steps

<u>Sediments</u>

Some additional sediment radioisotope and chemistry data will be collected as part of Round 3 for the following data needs:

- Upstream subsurface sediment core samples will be collected in Round 3A to inform the definition of background, and support evaluation of contaminant loading to the Study Area from upstream
- Representative engineering properties of sediments in iAOPCs will be determined to support the FS.

<u>Bathymetric Surveys</u>

An additional bathymetric survey of the upper portion of Multnomah Channel will be conducted in Round 3A to support an assessment of the downstream transport of contaminants from the Study Area into Multnomah Channel.

All additional physical characterization data collected in Round 3 or compiled from non-LWG sources will be evaluated as part of the final physical setting discussion presented in the RI/FS report.

EXECUTIVE SUMMARY

SECTION 5 – POTENTIAL SOURCES

Abstract

Section 5 presents, to the extent practicable, the potential current and historical sources and pathways of contamination to in-water media in the Study Area. This section evaluates available upland source information and the likelihood that chemicals associated with facility operations may have migrated or been released to the river via one or more pathways. Additionally, potential sources outside the Study Area from other reaches of the LWR are identified.

This evaluation of potential sources concludes:

- There were likely numerous historical sources that contributed contamination to the river via all pathways (surface water, sediment transport, groundwater, stormwater and process wastewater discharge, overland flow, bank erosion, overwater activities/spills, and atmospheric deposition)
- Most historical sources are no longer active or have been significantly diminished
- Upstream surface water, sediment transport, and stormwater from within and upstream of the Study Area remain the most likely current significant pathways.

This information was used to refine the CSM for the Portland Harbor (see Sections 3 and 11), and to guide planning for Round 3 sampling efforts to fill data gaps necessary to complete the RI/FS. A final assessment of potential sources and pathways of contaminants to the in-water system will be further updated, evaluated, and presented in the RI. Some of these sources may require additional evaluation or investigation as part of Oregon Department of Environmental Quality's (DEQ) source control program.

Although potential source and pathway information will be updated in the final RI, the quantity and quality of information presented in this section, along with the CSMs developed and presented in Sections 3 and 11, is adequate to support the Round 3 data gap and data needs analysis.

Work Plan and Field Sampling Plan Directives

The Round 2 Report updates the CSM initially developed in the Programmatic Work Plan (2004) and refined in a later document by integrating information on sources and pathways available through completion of Round 2.

A summary of the current harbor-wide CSM is presented in Section 3, including a general discussion of the types of potential sources of contaminants and pathways that could adversely impact the river. Section 5 provides more details about specific potential sources and pathways within and upstream of the Study Area. This information is then utilized in Section 11 to

develop CSMs for each iAOPC, drawing relationships between specific potential sources and pathways and their potential impact on in-water media, where possible.

Data Collection Activities

The primary evidence regarding potential upland sources and releases to the river are the site summaries assembled from currently available information provided by DEQ and the LWG for facilities proximal to the river. Most site summaries were submitted to EPA in 2005 and 2006. The remaining site summaries, as well as updates for some previously submitted, were submitted in a separate deliverable in February 2007. A list of all site summaries is contained in Appendix J.

Originally, the site summaries were prepared based on reviews of the DEQ Environmental Cleanup Site Inventory (ECSI) database and Strategy Recommendations prepared by DEQ that provided information on facility operations, possible chemicals of concern associated with the industrial processes at a facility, and pathways to the river. (Note that the amount of available information varies by facility, and not all facilities adjacent to Portland Harbor are included in DEQ's ECSI database.) Site summaries have been periodically updated based on new information added to the ECSI database and other site information as it is made available to the LWG, including reports documenting the results of site investigations, source control activities or status, monitoring data, permit applications, or spill records.

Preliminary Assessment of Findings

Groundwater seepage, direct discharges (spills, waste disposal practices, stormwater and wastewater discharges), riverbank erosion, atmospheric deposition, and overwater activities were assessed as potential pathways for transporting contaminants to the river from potential sources at 79 upland sites bordering the Study Area. Pathways were characterized as either historical or current and whether they were complete, likely complete, incomplete, or indeterminate. Sources to the harbor from outside the Study Area are also briefly characterized.

<u>Groundwater</u>

The Round 2 assessment of the groundwater pathway updates an earlier assessment made by DEQ (2006), and includes an evaluation of transition zone water sampled by the LWG at nine facilities within the Study Area. Overall, there is evidence that groundwater from 14 facilities or properties may currently transport upland site-related contaminants to the river. Groundwater at the remainder of the upland parcels is either not a current pathway to the river or deemed to pose an insignificant risk to the in-water system. Groundwater was likely a more significant pathway to the river historically, when upland sources and onsite disposal practices were uncontrolled.

<u>Direct Discharge</u>

Most stormwater and wastewater discharges entering the river require a permit under the National Pollutant Discharge Elimination System (NPDES). Nearly all the industrial permittees

within the Study Area have general permits (96 for the discharge of stormwater, 16 for other types of discharges, including cooling water, blowdown, and treated groundwater), which are used for minor discharges from similar operations and wastes. Based on available information, there are only eight individual wastewater permits issued for facilities with unique industrial processes that merit customized monitoring programs and three individual permits for municipal-separated stormwater discharges. There are no municipal sewage treatment plant discharges in the Study Area; combined sewage overflows, although significantly reduced in volume and frequency today, occurred for decades.

Extensive efforts were made to characterize current stormwater drainage basins adjacent to the river. About 60 percent of the total area represented by these basins contributes stormwater to the Study Area; about 22 percent of the watershed draining to the river is largely uncharacterized.

The potential for either stormwater or wastewater to act as potential pathways to the river was evaluated at 311 outfalls within the Study Area (the exact number of outfalls within the Study Area is continuing to be evaluated). Sediment chemistry in the vicinity of a subset of the outfalls associated with sites actively under investigation by DEQ was compared to adjacent upland site information to assess whether an outfall may have transported upland contaminants to the river. Sediment in the vicinity of 145 of these outfalls had contaminants similar to those in media from adjacent upland facilities; however, almost all of these locations had facilities upstream with similar contaminants detected in upland site media as well, suggesting that sediment transport might also have affected sediment quality in the vicinity of those outfalls. About half of those outfalls potentially linked to in-river contamination are classified as active; the status of the remainder has not been evaluated. The presence and significance of ongoing stormwater and wastewater discharges may require additional evaluation or investigation as part of DEQ's source control program; however, current wastewater discharges are probably a negligible pathway to the river due to regulatory controls. Historically, stormwater and process wastewater discharges were likely significant pathways to the river. Stormwater likely continues to be a source but at rates significantly less than historical contributions.

Bank Erosion

Various engineered structures or materials, including seawalls, riprap, and engineered soil, cover about half of the Study Area riverbanks. Unarmored shorelines may be eroded from in-river processes and localized human activities. Although relatively little riverbank soil data are available, contaminants potentially associated with upland site activities have been detected at approximately 19 sites. Riverbank erosion is not anticipated to be a major ongoing release mechanism harbor-wide, although it may be significant on a site- or iAOPC-specific basis. Bank erosion may have been more significant historically, as upland and in-water facilities were constructed and the shoreline was developed.

Atmospheric Deposition

Atmospheric deposition is known to be a source of contamination globally. A literature-based evaluation of atmospheric deposition to surface water in the Study Area is presented in

Section 7. Atmospheric deposition in the entire drainage basin, which could then enter the Study Area through stormwater, could be more significant. This will be accounted for in the Round 3A stormwater evaluations.

Overwater Activities

The overwater activities most commonly associated with release of materials to the river are product handling, refueling, overwater construction, repair or maintenance (e.g., ships, piers, pipes, etc.), and leaks or direct discharges from vessels (diesel fuel, gasoline, hydraulic oil, lubricating oil, waste oil, bilge and ballast water). Historical records of these unpermitted discharges are limited to the last several decades, and information tends to be general, especially for the earliest records. Few spill reports are available, and those reported ranged in volume from less than a gallon to over a thousand gallons. Historical overwater activities were likely significant sources to the river; current activities are subject to improved technologies and best management practices that limit the occurrence or extent of spills.

External Sources to the Study Area

Sources in the LWR, both downstream and upstream of the Study Area, may contribute to chemical deposition in the Study Area. Potential sources immediately upstream of the Study Area include aluminum storage facilities, rail yard maintenance operations, cement manufacturing, marinas, and numerous (hundreds) private and public outfalls. Johnson Creek, a tributary that enters at RM 18, is a known source of contaminants such as PCBs, PAHs, DDT, and dieldrin.

Under certain river stage, flow, and tidal conditions, the tidal influence of the Columbia River estuary causes seasonal flow reversals that could transport sediment-bound chemicals from downstream reaches of the Columbia River into the Study Area.

More than 750 permitted discharges enter the Willamette River upstream of Willamette Falls, including municipal sewage treatment and stormwater discharges. Unregulated runoff from residential, industrial, and commercial areas in the upper river is a potential source of pesticides, PAHs, and metals. Most of the agricultural and forested lands in the Willamette River basin are considered non-point sources of sediments, nutrients, fertilizers, pesticides, and herbicides. Runoff from natural volcanic sources, past mining activities, and atmospheric deposition in the upstream reaches of the Willamette River basin has contributed to high levels of mercury in fish throughout the entire main stem of the Willamette River, resulting in fish consumption advisory.

Next Steps

Information regarding upland sources and potential ongoing releases to the river will be presented in the RI Report as part of finalizing the CSM. Recommendations regarding the potential need for investigation or source control will be prepared for agency use as potential ongoing sources are identified.

EXECUTIVE SUMMARY

SECTION 6 – IN-RIVER CHEMICAL DISTRIBUTION

Abstract

The distribution of chemicals in sediment, water, and biota is detailed in Section 6. The nature and extent data set includes all LWG data collected through Round 2 of the RI/FS and any other existing data collected from the Study Area between May 1997 and December 2005 and determined by EPA to be of suitable quality. The nature and extent of COPCs identified from the ecological and human health risk screening steps (see Appendices F and G of this report) is examined. Key COPCs include arsenic, mercury, PCBs, DDx, PAHs, petroleum, some phthalates, and dioxins and furans. Detailed information on the distribution of these compounds in sediment is presented graphically and on maps for the Study Area (RM 2 to RM 11). Taken as a whole, these data show that sediment concentrations tend to be fairly uniform across the Study Area except in nearshore or off-channel areas that are generally associated with known or suspected historical or current sources, where concentrations tend to be higher.

Sediment data are also available from areas outside the Study Area; these areas include upriver (RM 15.3 to RM 26), the downtown corridor (RM 11 to RM 15.3), downstream (RM 0- RM 2), the upper Multnomah Channel, and the riparian zone bordering the in-water Study Area. In general, except for arsenic and mercury, these areas show lower concentrations of COPCs than the Study Area.

Based on the quantity and quality of the chemical data sets, along with the spatial distribution and density of sampling locations:

- The information is adequate to establish the nature and extent of contamination in the harbor, conduct fate and transport modeling, support the human and ecological risk evaluations, and identify data gaps.

- Limited additional sediment and surface water chemical data collection is proposed for Round 3 in the Study Area and upstream and downstream primarily to address site boundary, background, upstream contaminant loading, and FS data needs.

- Any data collected during Round 3 will also be used to augment the nature and extent data set.

Work Plan and Field Sampling Plan Directives

The Programmatic Work Plan (April 2004) established the overall framework and objectives for the characterization of the nature and extent of contaminants in abiotic and biotic media for the RI/FS that built upon the extensive amount of existing data collected by members of the LWG and others within the Study Area. Numerous media-specific Field Sampling and Quality Assurance Project Plans that detailed sampling design and rationale, data use objectives, field

and laboratory sampling and analysis methods, and data management and reporting requirements, were developed with and approved by EPA and its partners.

Data Collection Activities

Nature and extent samples collected by the LWG through Round 2 of the RI include beach sediment, surface and subsurface riverbed sediment, TZW, surface water, groundwater seep, shellfish and other invertebrate tissue, and fish tissue. Also evaluated in this report were additional beach and riverbed sediment data, limited TZW data, conventional water quality data, and upriver fish tissue data collected by other parties. The extensive data set used in the Round 2 nature and extent evaluation includes approximately:

- 1,650 surface sediment chemistry samples (270 of these samples were subjected to amphipod and midge bioassay/clam and worm bioaccumulation testing) from the Study Area and upstream and downstream reaches
- 1,800 subsurface sediment chemistry samples (from about 660 coring locations) in the Study Area
- 225 TZW samples from 108 stations at nine sites in the Study Area
- 130 water samples from 25 point and transect stations from the Study Area
- 150 fish and invertebrate (clams, crayfish, and epibenthic invertebrates) composite samples from throughout the Study Area and upriver (generated from over 2000 individual fish and invertebrate specimens).

All media were analyzed for more than 540 target chemicals, including conventional parameters (e.g., pH, conductivity, and suspended solids), metals, PAHs, PCBs, pesticides, herbicides, petroleum, phenols, phthalates, other SVOCs, and dioxins and furans. The sediment and tissue samples span the entire Study Area but were generally focused on areas of known historical contamination along the shore. Beach sediment samples were collected in potential human and ecological exposure areas. TZW samples were collected in nine areas with upland groundwater plumes with the potential to discharge to the river. Surface water was collected along transects at the boundaries and middle of the Study Area to provide general water quality characteristics as well as at discrete locations that targeted potential sources and ecological or human health exposure pathways.

Preliminary Assessment of Findings

<u>Sediments</u>

The concentrations of COPCs in Study Area sediments are generally higher in localized nearshore and off-channel areas relative to sediments from the navigation channel, upriver and downstream areas, particularly for organic compounds. Metals concentrations tended to be similar among all areas sampled. PCBs, PAHs, DDx, dioxin and furans are found across the Study Area, but concentrations vary by orders of magnitude. In most areas, concentrations are more elevated at the surface, while a few areas show elevated levels in subsurface sediments

underlying relatively uncontaminated surface sediment. Metals generally show a much narrower concentration range and fewer and less steep horizontal and vertical gradients within the sediment column.

Transition Zone Water

TZW was sampled in nine areas along the river bed with known or likely discharge of contaminated groundwater. Multiple lines of evidence, including upland groundwater chemistry and potentiometric observations, upland and in-river stratigraphy, sediment texture mapping, and in-river discharge mapping were used to interpret whether and where upland groundwater plumes were discharging to the river at the nine study sites. TZW analyses reflected site-specific groundwater information from adjacent upland facilities and included conventional analytes, cyanide, perchlorate, metals, pesticides, herbicides, PAHs, TPH, SVOCs, and VOCs. Concentrations varied between study sites, reflecting variability in upland groundwater source concentrations, in-river sediment concentrations, and completeness of the groundwater pathway at each site. Areas where there are likely links between the upland groundwater and river sediment were observed on the west bank of the river at RM 6 and RM 8.5.

Surface Water

Round 2 surface water samples were collected in November 2004, March 2005, and July 2005. Although designed to reflect water quality during different seasonal flow conditions, comparable, low-flow levels occurred during all three events. Consistent temporal trends in contaminant concentrations were not apparent in this Round 2 surface water data set. Spatial trends were also difficult to discern. Chemical concentrations in surface water samples were generally much lower than those measured in sediments; however, certain parameters (e.g., PAHs, PCBs, dioxins, furans, and DDx) were elevated in some near-bottom water samples relative to others, suggesting input from localized sources. PCB composition patterns in suspended solids generally reflected patterns found in nearby surface sediment, suggesting that bottom sediment may become entrained in the water column at these locations. Also, concentrations of many organic COPCs were somewhat higher in river transect sample locations within the Study Area than in the transect from the upstream boundary at RM 11. Together, these data suggest that these contaminants are entering the Study Area both from upstream and within Study Area sources.

Tissue Samples

Data for a variety of tissue samples were collected to support the human health and ecological risk evaluations. Nine finfish species, representing different feeding guilds and home ranges, plus crayfish and epibenthic invertebrates, were collected from throughout the Study Area. Tissues from both field-collected and laboratory exposed clams and laboratory-exposed worm samples were also analyzed from numerous locations in the Study Area. PCBs, DDx and dioxins and furans were detected in nearly all tissues analyzed. Maximum concentrations for individual COPCs varied among species and sampling locations. The highest tissue concentrations were typically measured in laboratory exposed worms, carp, sculpin and

smallmouth bass. Fish with smaller home ranges and invertebrate samples with the highest tissue concentrations of PCBs or DDx tended to be co-located with sediment and/or water samples that also had elevated concentrations (relative to general conditions within the Study Area). Other chemical groups such as phthalates, phenolic compounds, and other semivolatile organic compounds were seldom detected in fish or invertebrates.

Additional Data/Next Steps

Sediments

The nature and extent sediment data set for the RI/FS is largely complete. Some additional sediment chemistry data will be collected as part of Round 3 for the following data needs:

- Upstream and downstream surface, subsurface, and suspended (sediment trap) sediment samples will be collected in Round 3 to help define final site boundaries, characterize background conditions, and support evaluation of contaminant loading to the Study Area from upstream.
- Study Area surface and subsurface sediment samples will be collected as part of Round 3 to address iAOPC-specific FS data needs.

Transition Zone Water

The Round 2 TZW investigation study has delineated the majority of TZW contamination in the Study Area originating from upland groundwater plumes, and no further TZW data collection is anticipated.

Surface Water

Additional far-field surface water data will be collected in Round 3 to complete the surface water nature and extent characterization. Round 3 water sampling will include an additional low flow period (summer/fall), a winter high flow period, an extreme high water event, and an early rainy season period to capture potential stormwater inputs.

Tissue Data

The tissue data collected through Round 2 will continue to be evaluated in the baseline risk assessments. Round 3 sampling will include the collection of lamprey ammocoetes and pre-breeding sturgeon to support the baseline risk assessments.

All additional nature and extent data collected in Round 3 or compiled from non-LWG sources will be evaluated as part of the final in-river chemical nature and extent discussion presented in the RI/FS report.

EXECUTIVE SUMMARY

SECTION 7 – ASSESSMENT OF LOADING, FATE, AND TRANSPORT PROCESSES

Abstract

Section 7 provides an overview of contaminant inputs and relevant fate and transport mechanisms for key containments in the Study Area as identified through the Round 2 risk assessment process (iCOCs and potential iCOCs). Primary contaminant inputs (or loading terms) to the Study Area from external sources are identified and estimated, where feasible. The physical, chemical, and biological processes affecting the transport and fate of contaminants once they enter the river are described. Available data types and sources, the approach used in these interim Round 2 calculations and evaluations, and the anticipated path forward for completing these assessments in the RI/FS are presented. This section also describes the purpose and objectives of and approach to the planned hybrid fate and transport modeling, which will be used to assess and predict the important aspects of loading, fate, and transport for the Study Area.

Section 7 identifies the following additional data needs and next steps:

- Refined estimates of loading from upstream surface water and sediments based on planned Round 3 sampling (surface water and sediment) and modeling
- Refined estimates of current stormwater loading rates, based on additional analysis of drainage basin information as well planned Round 3 stormwater and surface water sampling
- Compilation of permitted wastewater discharge information and monitoring data to estimate loading associated with permitted discharges
- Additional review of information related to historical loading terms, as needed for the RI/FS.

The hybrid fate and transport modeling effort is ongoing and will continue though mid-2007. No hybrid model-specific data needs beyond the planned Round 3 data collection activities are anticipated.

Work Plan and Field Sampling Plan Directives

The Programmatic Work Plan (April 2004) identified the need to understand chemical fate and transport in Portland Harbor to support the CSM (see Section 11) and resolve specific FS questions, such as the potential for recontamination and natural attenuation. The need for physical studies and modeling was also identified in the Work Plan to understand short- and long-term sediment movement in the Study Area, an important element of contaminant fate and transport, particularly for sediment-bound iCOCs, such as PCBs and dioxins. The general approach for integrating and assessing information on upland and upstream contaminant

sources and determining the relative inputs from different potential sources of contaminants to the Study Area (e.g., upstream loading, stormwater, etc.) is derived from scoping documents and correspondence with EPA and its partners.

Data Collection Activities

The chemical loading and fate and transport assessments were based on available upland site data, physical system data (e.g., hydrology, see Section 4) and chemical nature and extent data (sediment, surface and transition zone water chemistry, see Section 6) either compiled or collected by the LWG through Round 2. In addition, generalized information and data from the literature were used, where site-specific data were not available.

Preliminary Assessment Methods

The approaches used to develop qualitative to semi-quantitative current loading rate estimates for upstream surface water, stormwater, upland groundwater, and atmospheric deposition loading terms are presented. Additionally, transport of sediment contamination to the water column by groundwater discharge (groundwater advection transport term) was estimated semi-quantitatively. Potential current loading rates from upstream sediment, bank erosion, permitted wastewater discharges, and overwater releases (e.g., spills, etc.) are not estimated. Similarly, historical loading rates for each term are not estimated. Data sources and assumptions for loading estimates included:

- Surface water loading rates derived from historical flow data for the Willamette River and high volume/high resolution chemistry data collected from the upstream transect at RM 11 between November 2004 and July 2005
- Land use information for the Willamette River basin and stormwater chemical characteristics from published studies used for stormwater loading rate estimates
- Upland groundwater plume contribution estimates based on Study Area-specific transition zone water (TZW) and seepage meter data
- Generalized groundwater loading rate estimates based on area-weighted sediment chemistry, estimates of average groundwater seepage through the river bottom, and literature-derived partitioning constants between the sediment solids and the porewater
- Atmospheric deposition to the river surface derived primarily from literature-reported regional air quality data and deposition rates (either measured or modeled).

For all estimated terms, ranges of loading rates were generated to reflect the uncertainty in the assumptions. The detailed loading calculations are provided in Appendix D of the Round 2 report and the relative contributions of the various loading terms (based on this Round 2 data set and evaluation) are presented and discussed within the context of the CSM in Section 11.

Some important fate and transport characteristics of the Study Area are discussed below.

Many iCOCs in the Study Area are chlorinated organics (e.g., PCBs, dioxins, and DDx pesticides). These compounds are persistent in the environment and exhibit a strong tendency to be associated with sediment particles, especially those with high organic content. Consequently, the fate and transport of these chemicals is strongly associated with bedded and suspended sediment and the physical processes that move sediment. Bioaccumulation of these chlorinated compounds would also be expected and is shown by both the empirical and modeled data for the Study Area. Other contaminants exhibit a wide range of chemical properties that affect where they are found and how long they persist in the environment. Many metals sorb strongly to fine-grained sediments and are therefore also controlled by sediment transport processes. Some chemicals, such as volatile organic compounds, are not expected to bioaccumulate. Several COPCs, such as PAHs and phthalates, can be metabolized or transformed by biological processes, which results in changes in chemical concentrations and bioavailability.

The movement, erosion, deposition, and resuspension of sediments through and within the Study Area are a function of the complex interactions of temporally and spatially varying flow regimes, total suspended solids concentrations, and physical and biological disturbance. A numerical hydrodynamic/sediment transport model (Environmental Fluid Dynamics Code, EFDC) is being used with Study Area-specific data (e.g., settling and erosion rates) to predict water and sediment movement in the LWR over a range of hydrological conditions. The bioaccumulation of chemicals is predicted by food web models (FWMs), which mechanistically describe these processes. The Arnot and Gobas (2004) FWM is being used, with the extensive sediment, water, and tissue chemistry data set for the Portland Harbor Study Area, to develop initial preliminary remediation goals for PCBs, DDx, and dioxin-like chemicals.

Through discussions with EPA, a modeling approach that integrates biological, chemical, and physical fate and transport processes has been identified for use in the RI/FS. Termed the "Hybrid Model", it consists of three primary components: the EFDC-based hydrodynamic and sediment transport model to describe the movement of water and sediments throughout the Study Area, an abiotic chemical fate and transport box model developed by EPA to describe chemical movement and distribution within abiotic environmental media in smaller areas, and a food web model to describe the movement of chemicals through the aquatic food chain within the river. By 2007, these pieces will be combined into a Hybrid Model that should be capable of describing the movement of chemical masses in particulates (sediments), water, and through the food web for the Study Area.

Additional Data/Next Steps

The RI/FS will expand upon and complete the preliminary analysis of current chemical loading rates and fate and transport processes relevant to completion of the RI/FS. Round 3 data needed to complete the assessment of upstream inputs of contaminants in surface water and sediments have been identified and are being collected in 2006/2007. These include upstream surface water and sediment trap data as well as bedded sediment chemistry and radioisotope data from upper Study Area cores. These data will be used to calculate or update contaminant

loads entering the Study Area on sediments and in surface water. The preliminary stormwater load estimates calculated here will be updated based on additional analysis of drainage basin information as well as the Study Area-specific stormwater data that will be collected by the LWG and EPA/DEQ. No additional refinements of the groundwater and atmospheric loading estimates are needed for the RI. Permitted wastewater discharge loads will be estimated for the RI based on a compilation of information and monitoring data on permitted discharges. Current bank erosion is a highly uncertain loading term; however, estimation of this term is not considered necessary for the purposes of the RI/FS and will instead be evaluated on an area-specific basis, as needed, as a part of the remedial design process for each SMA As needed, additional review of information related to historical loading terms may be performed to support the RI/FS.

The hybrid fate and transport modeling effort is ongoing and will continue though mid-2007. No hybrid model-specific data needs beyond the planned Round 3 data collection activities are anticipated.

EXECUTIVE SUMMARY

SECTION 8 – ROUND 2 HUMAN HEALTH RISK ASSESSMENT

Abstract

This Round 2 human health risk assessment (HHRA) presents an initial evaluation of potential risks to human health for the Study Area using the data available at the conclusion of Round 2 of the RI/FS. The Round 2 HHRA was conducted to identify those chemicals and exposure pathways that are predicted to have the highest contribution to the risks at the Study Area, to focus subsequent RI/FS tasks, and to identify the remaining data needs for the baseline HHRA. Because the Round 2 HHRA is not the baseline HHRA, the results are not intended for developing final cleanup levels or identifying areas in need of remediation. The Round 2 HHRA evaluated preliminary risks to human health resulting from exposure to COPCs through direct exposure to beach sediment, in-water sediment, surface water, and groundwater seeps and through fish and shellfish consumption.

Fish and shellfish consumption exposure scenarios result in estimated risks that exceed EPA target risk levels (cancer risk range of 10^{-4} to 10^{-6} or noncancer hazard index of one) and are generally orders of magnitude higher than the other exposure scenarios evaluated based on the conservative assumptions used in the preliminary risk evaluation. Because it is not known to what extent, if at all, shellfish consumption actually occurs at the Study Area and risks from fish consumption are higher than those from shellfish consumption, risks from fish consumption are considered the main risk driver for human health. For the fish consumption scenarios, approximately 85 percent of the estimated cancer risk is due to PCBs. Additionally, the PCB noncancer hazard for some fish consumption scenarios is 80 times higher than for any other chemical. While tissue concentrations within the Study Area are higher than upstream tissue concentrations, the Round 2 HHRA found that risks from consumption of fish collected upstream of the Study Area also exceed EPA target risk levels.

Uncertainties associated with the risk estimates were analyzed. Uncertainties that could impact the conclusions of the Round 2 HHRA and thus have significance to risk management decisions were identified. Those uncertainties were the focus of the data needs evaluation.

While existing data, particularly tissue data, and the exposure assumptions used to evaluate fish consumption risks will be evaluated further, the quantity and quality of the existing data set is adequate to complete the baseline HHRA. Therefore, no additional data collection is needed to complete the baseline HHRA.

Work Plan and Field Sampling Plan Directives

The Programmatic Work Plan established the overall approach for the Round 2 HHRA, and subsequent interim deliverables that were approved by EPA provided the detailed methods and values used in the risk calculations. The Round 2 HHRA was developed consistent with the Programmatic Work Plan and the interim deliverables, as well as numerous discussions among EPA, DEQ, ODHS, and Native American tribes on appropriate risk assessment techniques for

the Study Area. In addition, the Round 2 HHRA incorporated further requirements from EPA by including risks from consumption of clams and a screening evaluation of surface water and transition zone water against specified criteria. The screening evaluation was done to identify potential data gaps and does not indicate unacceptable risks or areas requiring remediation, nor should it be used to establish cleanup levels.

Data Collection Activities

Preliminary risks were estimated using beach sediment, in-water sediment, surface water, groundwater seep, shellfish tissue, and fish tissue data that resulted from the extensive data collection and compilation activities implemented through Round 2 of the RI. These data points can be broken down as approximately 1,200 sediment samples, 130 water samples, and 150 fish and shellfish samples. For fish, both whole body tissue samples and fillet tissue samples were included in the Round 2 HHRA. Samples were analyzed for nearly 300 chemicals, which included dioxins and furans, herbicides, metals, PAHs, PCBs, pesticides, petroleum, phenols, phthalates, and SVOCs.

Preliminary Assessment of Findings

The following findings are based on the conservative Round 2 HHRA preliminary evaluation:

- Risks from consumption of fish or shellfish are generally orders of magnitude higher than any of the other exposure scenarios.
- Risks from consumption of fish or shellfish are within or above the EPA target cancer risk range of 10^{-4} to 10^{-6} and exceed the target noncancer hazard index of one.
- Risks from consumption of upstream (Willamette Falls) fish also are within or above the EPA target cancer risk range of 10^{-4} to 10^{-6} and exceed the target noncancer hazard index of one.
- PCBs result in the highest cancer and noncancer risks from fish consumption.
- With the exception of a single in-water sediment exposure scenario at two ½-mile river segments, risks from direct exposure to beach sediment, in-water sediment, surface water, and groundwater seeps are within or below EPA's target cancer risk range of 10^{-4} to 10^{-6} and below the target noncancer hazard index of one.

Data Interpretation Methods

The Round 2 HHRA followed EPA and DEQ risk assessment guidance and incorporated the four steps of the baseline risk assessment process: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization, which included an uncertainty assessment.

The preliminary exposure assessment identified the potentially exposed populations, identified and characterized the exposure pathways, and estimated the amount and extent of exposure. A conceptual site model was developed for the Round 2 HHRA based on the current

understanding of the Study Area to depict the pathways through which human populations may be exposed to COPCs. Only those pathways that were found to be potentially complete and significant were evaluated quantitatively in the Round 2 HHRA.

The following populations and associated exposure scenarios were quantitatively evaluated in the Round 2 HHRA:

- Dockside worker - direct exposure to beach sediment;
- In-water worker - direct exposure to in-water sediment;
- Adult and child recreational beach user - direct exposure to beach sediment and surface water (for swimming scenarios);
- Transient - direct exposure to beach sediment, surface water (for bathing and drinking water scenarios), and groundwater seeps;
- Native American fisher - direct exposure to beach sediment or in-water sediment and fish consumption; and
- Non-tribal fisher - direct exposure to beach sediment or in-water sediment, fish consumption, and shellfish consumption.

As approved by EPA, a range of conservative values was used to estimate exposures and risks in order to incorporate reasonable maximum exposures, which are intended to be protective of highly exposed populations. Preliminary exposures and risks were estimated on a Study Area-wide basis as well as more localized spatial scales as appropriate for each exposure scenario, in accordance with EPA-approved methodologies. Toxicity values used in the Round 2 HHRA were obtained from EPA's recommended hierarchy of sources for Superfund sites. Toxicity values were evaluated for both cancer and noncancer endpoints of COPCs.

Preliminary noncancer risks were estimated using hazard indices and were compared to EPA's target hazard index of one, below which remedial action at a Superfund site is generally not warranted. Preliminary cancer risks were estimated by summing risks for each exposure area across all chemicals and were compared to EPA's target cancer risk range of 10^{-4} to 10^{-6}, which is the target range within which EPA strives to manage risk as part of the Superfund program. Preliminary risks were calculated for all of the above exposure scenarios. Chemicals that resulted in a cancer risk greater than $1x10^{-6}$ or a hazard quotient greater than one under any of the preliminary scenarios were identified as iCOCs. Uncertainties in the risk estimates included the exposure values used for the fish and shellfish consumption scenarios, the exposure point concentrations used in the maximum exposure scenarios, and consideration of background in the risk estimates. In most cases the noted uncertainties are counter-balanced by the conservative assumptions and factors utilized in the Round 2 HHRA.

In addition to the preliminary risk evaluation, the Round 2 HHRA also included a screening evaluation of surface water and transition zone water using criteria specified by EPA for exposure pathways not considered in the Round 2 HHRA. The screening evaluation was done to identify potential data gaps and does not indicate unacceptable risks nor should it be used to

establish cleanup levels. Even with the use of maximum detected concentrations at the locations anticipated to have the greatest impacts, only a few chemicals exceeded their respective screening levels and were retained as potential iCOCs following the screening evaluation. These chemicals had already been identified as iCOCs through the Round 2 HHRA for other exposure scenarios or are dependent on further policy decisions regarding the use of the Study Area as a drinking water source. Therefore, no additional data needs have been identified for surface water or transition zone water.

Next Steps

While additional data are not needed to complete the baseline HHRA, data collected during Round 3 that are appropriate for inclusion in the baseline HHRA will be used in the final risk estimates. In developing the baseline HHRA, efforts will focus on further evaluation of existing data, particularly tissue data, and refining the exposure factors used in the fish and shellfish consumption scenarios through further discussions with EPA and its partners.

EXECUTIVE SUMMARY

SECTION 9 – ROUND 2 ECOLOGICAL RISK ASSESSMENT

Abstract

This Round 2 ecological risk assessment (ERA) presents an evaluation of potential risks to ecological receptors for the Study Area using the data available at the conclusion of Round 2 of the RI/FS. The term potential risk indicates exceedance of screening levels that identify chemicals warranting further evaluation in a baseline ecological risk assessment. The purpose of this Round 2 ERA is to help focus subsequent RI/FS tasks and identify remaining data needs for the baseline ERA.

Receptors addressed in this Round 2 ERA include benthic invertebrates, fish, wildlife, amphibians and reptiles, and aquatic plants. Multiple lines of evidence (LOEs) were used to assess risks to each receptor. This represents a screening-level ecological risk assessment (SLERA) per U.S. Environmental Protection Agency (EPA) 1997 guidelines (EPA 1997) and is consistent with EPA 1998 guidance (EPA 1998). The additional effort to identify initial chemicals of concern (iCOCs) was necessary to establish iPRGs and iAOPCs. This screening-level assessment was done to identify data gaps and to prepare for developing the Baseline ERA Problem Formulation; it is not intended to indicate unacceptable risks or areas requiring remediation, nor should it be used to establish cleanup levels.

The findings of this Round 2 ERA indicate:

- Much of the Study Area does not pose a significant risk to ecological receptors.
- A high percentage of sediment sampling stations were classified as nontoxic to benthic invertebrates despite extensive sampling near known or suspected potential sources of COPCs and in sediments with contamination levels characteristic of an urban harbor. Benthic invertebrate iCOCs included selected metals, PCBs, PAHs, and DDTs.
- It is not expected that the baseline ERA will conclude population-level effects on fish and wildlife, despite preliminary identification of iCOCs for fish and wildlife.
- No iCOCs were identified for amphibians, reptiles, and aquatic plants.

Uncertainties in the risk estimates and related conclusions of the Round 2 ERA that could have significance for risk management decisions were identified. Those uncertainties were the focus of the data needs evaluation. Data that are or will be collected as part of Round 3 sampling programs will supplement the existing data set and fulfill all data needs for the baseline ERA.

Work Plan and Field Sampling Plan Directives

Following development of the Work Plan (Appendix B: Ecological Risk Assessment Approach of the *Portland Harbor RI/FS Programmatic Work Plan*; Integral et al. 2004 and related documents listed in Appendix G) and preparation of the ecological preliminary risk evaluation

(PRE) (Windward 2005), the LWG developed the *Portland Harbor Superfund Site Proposed Ecological Risk Assessment Decision Framework* (Windward 2006). This document describes the approach to spatial analysis and risk characterization in more detail than the Work Plan and outlines a weight of evidence approach to risk characterization. Subsequently, LWG worked with the U.S. Environmental Protection Agency (EPA) to develop the initial LOEs for the ERA. EPA directed LWG to use all of the proposed LOEs for the Round 2 ERA. LWG has coordinated with EPA to develop data analysis methods, exposure assumptions, and effects-based thresholds (e.g., toxicity reference values [TRVs], ecological screening levels [Eco SLs] in water) for the Round 2 ERA. While the Round 2 ERA is less conservative than the PRE (Windward 2005), it is still a screening-level assessment and the results are most useful for the intended purpose of defining data gaps, not for identifying areas definitely in need of remediation or for developing final cleanup levels.

Data Collection Activities

The project data set for surface sediment chemistry and toxicity, surface water chemistry, TZW chemistry, and fish and aquatic invertebrate tissue chemistry was used to assess ecological risks at the Study Area. See Section 2 of this Report for a summary of the sources of data and Section 6 for an overview of the distribution of Round 2 COPCs at the Study Area.

Data Interpretation Methods

Benthic community responses were used to evaluate Study Area-specific risks from exposure to sediment and its associated TZW. Ingestion of sediment or prey and direct contact with sediment, near-bottom surface water, and TZW were considered the primary routes of exposure for benthic invertebrates. Multiple LOEs were used to assess risks to benthic communities. Results of laboratory toxicity tests of surface sediment collected from 227 stations in the Study Area comprised the primary LOE. Predictive models derived from the toxicity responses in relation to sediment chemistry were applied to assess the potential toxicity of sediments at locations where sediment chemistry data were available but toxicity data were not. Risks to benthic invertebrates were also assessed by comparing empirical or predicted tissue chemical concentrations to aquatic tissue-based TRVs, and by comparing chemical concentrations in near-bottom surface water or TZW to Eco SLs for water developed based on ambient water quality criteria (AWQC) or other water screening benchmarks. A TZW framework was developed to further evaluate TZW risks to benthic invertebrates.

Risks to fish and wildlife receptors were assessed primarily by comparing tissue residue data or modeled estimates of ingested dietary dose of chemical to TRVs, either residue-based or dose-based toxicity benchmarks respectively. Risks to fish were also assessed by comparing surface water and TZW chemical concentrations to the Eco SLs. Risks to piscivorous birds were also assessed by comparing estimated concentrations of COPCs in bird egg tissue to bird egg-based TRVs.

Risks to amphibians and aquatic plants were assessed by comparing surface water and/or TZW chemical concentrations to Eco SLs in water developed based on AWQC or other water screening benchmarks.

Preliminary Assessment of Findings

Benthic invertebrates

- Areas of potential risk to the benthic community were identified using benthic toxicity testing, predictive models of benthic toxicity and other lines of evidence. These areas are located primarily nearshore adjacent to known chemical sources.
- A high percentage (79 percent) of the sampled sites was classified as nontoxic to benthic invertebrates. Only 13 percent were classified as toxic, with the remaining stations (8 percent) either not evaluated due to limited chemistry data and no sediment toxicity data or identified as indeterminate.
- iCOCs for benthic invertebrates based on multiple LOEs include 3 metals, PCBs, 3 individual PAHs, total PAHs, and DDTs.
- Other, potential iCOCs for benthic invertebrates also were identified as those chemicals associated with high uncertainty or identified solely based on transition zone water exceedances of surface water screening levels, not supported by other LOEs, as posing risks to benthic invertebrates. These potential iCOCs are not expected to pose significant risks to benthic invertebrates because there is limited potential for exposure.

Fish

- Potential risks to fish were identified through the Round 2 ERA. The chemicals that have the greatest potential for posing risk to fish are PCBs.
- Other iCOCs for fish include DDTs, phthalates, mercury and tributyl tin.

Wildlife

- Potential risks to wildlife were identified through the Round 2 ERA. The iCOCs are PCBs, dioxins, mercury, DDTs and aldrin.
- Potential risks to most wildlife receptors were identified based on dietary exposure to PCBs, dioxins and furans, and DDE. DDE also represented a potential risk to osprey and bald eagle based on the bird egg tissue LOE.
- Potential localized risks to shorebirds (represented by spotted sandpiper) were associated with six specific foraging beach areas and based on dietary exposure to PCBs, dioxins and furans, sum DDD, and aldrin.

Amphibians, reptiles, and aquatic plants

- No iCOCs were identified for amphibians, reptiles, and aquatic plants; therefore, no data gaps were identified.

Next Steps

Most of the data needed to complete a baseline ERA have already been collected. The extensive site-specific data set already available for sediments, surface water, TZW, and biological tissues will provide most of the data needed to complete the baseline ERA. The remaining data needs have been identified and the sampling efforts are either underway or achievable through the Round 3 sampling program. Data collected during Round 3 – including sediment, surface water and stormwater chemistry data, lamprey and sturgeon tissue concentration data, lamprey toxicity data and potentially additional benthic toxicity data – will provide additional targeted data to augment the existing data set for assessing ecological risks in the baseline ERA. Further evaluation of data and discussions with EPA and its partners will be helpful in producing the baseline problem formulation, study design and determining final data needs.

EXECUTIVE SUMMARY

SECTION 10 – INITIAL AREAS OF POTENTIAL CONCERN

Abstract

Initial areas of potential concern (iAOPCs) were developed by integrating the results of the preliminary risk evaluations. These iAOPCs will be modified based upon the results of Round 3 sampling and, based on determinations made pursuant to the National Contingency Plan (NCP) evaluation criteria, SMAs in the FS. The human health and ecological preliminary risk evaluation results (a total of ten receptors/pathways combined) were translated into initial preliminary remediation goals (iPRGs). Areas within the Study Area with iPRG exceedances, areas that contributed to exceedance of site-wide iPRGs, or areas with other indicators of risk were identified and compiled, resulting in a total of 28 iAOPCs. These iAOPCs range from approximately 0.2 to 40 acres in size. Some iAOPCs exhibited overlapping risks for more than one pathway or receptor, typically in areas of higher iCOC concentrations.

Based on the results of the iAOPC analysis, the following conclusions were made and data gaps identified:

- Additional assessment of the surface water concentrations and inputs must be made in order to conclusively determine whether or not the surface water component will affect what is currently a sediment-based delineation of iAOPCs.
- Further evaluation of the potential iCOCs identified based on TZW is needed in the baseline risk assessment. Depending on the outcome of this evaluation, TZW information may be incorporated into the delineation of final AOPCs/SMAs.
- The issue of the most appropriate approach for addressing background concentration concerns associated with arsenic and PCBs should be addressed in risk management determinations made pursuant to NCP evaluation criteria in the FS and ROD phases of the project.

Additional surface water and sediment trap data are needed to address the first bullet (currently being collected as part of Round 3A). In addition, focused stormwater samples and sediment trap data from specific outfalls within the Study Area will also help with this analysis (this work is currently being scoped by LWG and EPA). Also, some additional data on the spatial and volume extent of contaminated sediments and benthic toxicity in and around some iAOPCs to assist in FS evaluations will be collected in Round 3B. Otherwise, the existing quantity and quality of data is adequate to complete the iAOPC evaluation.

Work Plan and Field Sampling Plan Directives

Numerous risk assessment related work plans and field sampling plan activities were followed in developing the risk assessment results that led to the development of the iAOPCs. These are described in the summaries of Sections 8 and 9. The Work Plan describes a general process of

developing Areas of Potential Concern that become SMAs. A Technical Memorandum on the development of PRGs was submitted to and commented on by EPA in 2005. This section was developed consistent with the Work Plan and the LWG responses to EPA's comments on the PRG Technical Memorandum.

Data Collection Activities

Although no data collection activities were conducted specifically for the purpose of iAOPC development, the identification of the iAOPCs is the culmination of extensive data collection activities implemented through Round 2 sampling for the RI.

Data Interpretation Methods

Two primary steps were involved in developing the iAOPCs. The first step is to develop chemical-specific iPRGs that are protective of both human health and ecological receptors . The first step in the process involves calculating a sediment-based iPRG. This step incorporates the food web model results and biota-sediment accumulation factors (BSAFs) to transition from tissue-based risks to sediment-based risks. Other risks, such as direct sediment contact/exposure, were more straightforward in terms of getting to a sediment-based iPRG and did not involve a food web model or use of BSAFs, and some risk evaluation information was used directly in the determination of iAOPCs.

Once iPRGs were developed, they were compared to the calculated side wide sediment concentrations to identify iAOPCs. Identification of iAOPCs integrates multiple constituents, multiple risk pathways, and multiple risk receptors identified in both the ecological and human health risks. In delineating the size of an iAOPC associated with risks to different receptors within the Willamette River, spatial scales are an important factor. Three basic scales were considered, a *site-wide scale* that was relevant for wide-ranging ecological receptors, an *area-specific scale* for receptors that did not encompass the entire Study Area, but were more wide-ranging than individual sediment stations, and *location-specific* scale for point specific exposures that were represented by an individual sediment station.

As a result of application of individual sediment-based iPRGs and other risk information, individual iAOPCs were developed for ten different pathway/receptor individual iAOPC maps (five human health and five ecological). The individual human health iAOPC delineations include beach sediment ingestion, in-water sediment ingestion, shellfish consumption, site-wide fish consumption, and area-specific fish consumption. The individual ecological iAOPC delineations included benthic community, sculpin, bass, otter, and shorebirds.

Using a process referred to as "hilltopping" and a GIS overlay process for site-wide and area-specific scales of risk as well as location-specific information, iAOPC areas were delineated that consisted of areas of overlapping and contiguous risk or areas that substantially contribute to site-wide scale or area-specific risks for all ten of these receptor/pathway groups and represented reasonably discrete iAOPCs. These iAOPCs represent areas that if a sediment remedial action were to occur, the overall risk for relevant receptors/pathways would be reduced to an acceptable level for area-specific risks and would potentially reduce site-area

wide risks that the area is contributing to. In doing the hilltopping procedure, it was assumed that areas targeted for hilltopping would be replaced with sediment concentrations that are consistent with preliminary current background levels measured upstream of the Study Area. This approach was acceptable for all constituents except arsenic (beach and in-water sediments) and PCBs (human health fish consumption). For these two constituents, preliminary background concentrations were so close to the iPRGs that replacing remediated areas with background results in only a negligible improvement in risk reduction (not to acceptable levels). A better understanding of background conditions for these chemicals will provide for appropriate risk management decisions pursuant to NCP evaluation criteria in the FS and ROD process.

iPRGs were not developed for surface water or transition zone water (TZW). Therefore, the iAOPCs that are delineated do not take into account these media/pathways. For the RI, surface water iPRGs will be developed using Round 3 information, but these iPRGs are not expected to provide substantial information for refining the spational delineation of the sediment AOPCs because of the transient and dynamic nature of surface water in river systems. For TZW, a spatial evaluation comparing the distribution of potential iCOCs based on TZW to the iAOPC locations was conducted.

Preliminary Assessment of Findings

It is important to note that there might be alternative methods to achieve site-wide iPRGs than actually remediating the hilltop areas identified by the process described above. Determining suitable remediation areas is part of the FS process the configuration/location of the iAOPCs that have been initially developed using the hilltopping procedure as the principle basis for some risks for delineating the areas to attain iPRGs will be refined and addressed in the FS using the NCP evaluation criteria. The following summary highlights the key findings of iAOPC delineation process.

- A total of 29 [including T4 and site-wide] iAOPCs were identified within the nine-mile Study Area
- The iAOPCs ranged in size from under 0.2 acres, to just over 40 acres
- Five of the iAOPCs were less than 1 acre; ten of the iAOPCs were between 1 and 10 acres; and thirteen of the iAOPCs were between 10 and 40 acres
- Generally, individual iAOPCs had two or more human health and/or ecological receptors/scenarios driving the risk within that iAOPC
- Typically, the more receptors/scenarios that drove the risk within the iAOPC, the higher the concentrations of iCOCs at that area
- While the use of background concentrations in the hilltopping procedures was effective for most chemicals, it was not effective for arsenic or PCBs because preliminary background concentrations are too high to effectively reduce risk via the “substitution method”

- Where two or more risk areas overlapped, the area was defined as iAOPC regardless of any other mitigating circumstances
- Stations exhibiting benthic toxicity that fell within statistical clusters were also defined as iAOPCs, even in those cases where it was the only line of evidence
- PCBs are the most wide-spread chemical causing the identification of iAOPCs, and PCBs risks are present in almost every iAOPC. In comparison, other chemicals sporadically contribute to iAOPC development in one or several areas
- The iAOPCs encompass all of the locations where TZW concentrations led to the identification of potential iCOCs based on TZW for human health; and all but three of the locations where TZW concentrations led to the identification of potential iCOCs based on TZW for benthic invertebrates.

Additional Data Needs

Round 3 data are needed to assess surface water contributions to potential human health and ecological risks, particularly from exposure to PCBs. Understanding surface water contributions will be helpful in defining preliminary remediation goals (PRGs) in the Remedial Investigation and in assessing the risks and benefits of remedial alternatives in the Feasibility Study. Further evaluation of the potential iCOCs identified based on TZW is needed in the baseline risk assessment. Depending on the outcome of this evaluation, TZW information may be incorporated into the delineation of final AOPCs/SMAs. Also, some additional data on the spatial and volume extent of contaminated sediments and benthic toxicity in and around some iAOPCs to assist in FS evaluations will be collected in Round 3B. The issue of the most appropriate approach for addressing background concentration concerns associated with arsenic and PCBs should be addressed in risk management determinations made in the FS and ROD phases of the project.

EXECUTIVE SUMMARY

SECTION 11 – CONCEPTUAL SITE MODEL

Abstract

The CSM describes the current understanding of chemical sources, pathways and receptors in the Lower Willamette River. The analysis consists of two parts, a preliminary evaluation of the relative importance of both historical and current potential loading terms on a site-wide scale and a comparison of the spatial distribution of iCOCs in sediment to known or potential sources on an iAOPC-specific scale. This analysis serves to identify additional data needed to complete the in-water RI/FS and to help inform the DEQ source control program.

Estimates of contaminant mass loading to the Study Area were developed to refine the CSM on a site-wide basis, provide a preliminary assessment of the relative importance of historical and current potential sources to the Study Area, and identify areas of uncertainty.

The iAOPC-specific analysis of relative contributions is primarily a comparison of the spatial distribution of iCOCs in sediment to known or potential sources. The results of the iAOPC - specific CSMs indicate:

- In-water sampling has been conducted at areas of known or likely discharges from upland pathways
- At many iAOPCs, patterns of contamination in in-water media provide preliminary evidence of current and historical upland sources and transport pathways
- The LWG will work closely with DEQ to identify potential on-going sources of iCOCs at the iAOPCs, which may result in the need for additional source control investigation at some upland sites under the DEQ source control program
- iAOPCs that eventually become Sediment Management Areas (SMAs) may require additional in-water sampling during the post-ROD, RD/RA phase to define final remediation areas and volumes and/or evaluate recontamination potential.

Work Plan and Field Sampling Plan Directives

Development and refinement of a CSM is a critical part of the RI/FS process, according to EPA guidance (Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites [Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-08 (EPA 2002b)]. A CSM portrays the relationship among sources, chemicals, transport mechanisms), receptors, and other parameters that are determined to be relevant for the site. Per the Programmatic Work Plan, the purpose of the Round 2 CSM is to:

- Focus sampling and other investigations;
- Gain an understanding of potential contaminant loadings from upland sources (including direct discharge, overland transport, groundwater, and bank erosion) and the

scale and relative importance of the various pathways by which contaminants are transported to the river

- Identify where there may be continuing sources of contamination and pathways to the river (including persistent bioaccumulative toxins) based on historical site use, current site information, and analytical data
- Identify and determine the relative importance of historical sources of contamination and pathways to the river
- Identify areas of the river where recontamination of sediments is likely
- Gain insight regarding upland source control strategies and help DEQ identify where additional work must be done by responsible parties and DEQ on upland sites.

The primary function of this CSM is threefold: to structure an initial evaluation of sources of iCOCs to the Study Area and individual iAOPCs, to assess the relative contribution of those sources and pathways, and to identify data gaps for completion of the RI/FS. This information will also be used to help inform the DEQ source control program. The CSM builds on information presented in the previous sections of this report, the Programmatic Work Plan (Integral et al. 2004) and earlier CSM updates (Integral 2004). The CSM will be refined further in the RI/FS, as additional data and other information become available.

Data Collection Activities

Information used to refine the CSM included sediment, water, and biota data collected during Rounds 1 and 2, the Round 2 human health and ecological risk assessments, models and calculations developed for the site, data from the literature, upland site summaries prepared by the LWG and its members (Integral 2004, 2006), and professional judgment.

Preliminary, qualitative to semi-quantitative chemical loading rates for iCOCs entering the Study Area were estimated for upstream surface water, stormwater runoff, upland groundwater plumes, and atmospheric deposition. Rate estimates for the transfer of sediment contamination to the water column by groundwater flow were also generated. No estimates of loading from upstream sediment, bank erosion, permitted wastewater discharges, or historical releases by any loading mechanism (e.g., spills, industrial discharge, stormwater runoff, etc.) were made. A preliminary assessment of the potential relevance of each loading term, including historical contributions, was generated, based on available loading estimates and an understanding of chemical properties for each iCOC.

Surface water loading rates were estimated from high volume/high resolution chemistry data collected from the upstream transect at RM 11 during three sampling events between November 2004 and July 2005. Land use information for the Willamette River basin and stormwater chemical characteristics from published studies provided the basis of stormwater loading estimates. Upland groundwater plume contribution estimates relied on site-specific TZW chemistry and seepage meter data. Groundwater advective transport estimates were based on area-weighted sediment chemistry, estimates of average groundwater flux through the river bottom, and assumed partitioning between the sediment solids and the porewater, based

on literature partitioning constants. Atmospheric deposition to the river surface was derived primarily from literature-reported, regional air quality data and deposition rates (either measured or modeled). A range of estimates was produced for each loading term, reflecting uncertainty in input parameters.

No loading estimates were made for site-specific iAOPCs. Rather, current and historical information about adjacent facility activities, chemical processes or use, waste disposal practices, stormwater management, and chemistry of upland media were used to assess the potential links between the adjacent upland facilities and in the in-river environment for individual iAOPCs.

Preliminary Assessment of Findings

CSM Overview for the Study Area

Receptors, exposure scenarios, and associated iCOCs and potential iCOCs were identified in the Round 2 preliminary risk evaluations and are integrated into the revised CSM for the Study Area. The loading, fate, and transport assessment for the Study Area found that the relative importance of the various external loading terms and fate and transport processes varied by iCOC. In general, however, historical loading from direct discharges of industrial process wastes and wastewater, overwater releases, upstream surface water, upstream sediment, and stormwater runoff are expected to be the most significant loading terms for many of the iCOCs. Current loads from these sources are anticipated to be substantially lower than historical levels.

Among the current loads, upstream surface water loading is expected to be significant. Upstream sediment loading is uncertain and will be assessed following completion of planned Round 3 work, including surface water sampling, sediment grab collection, sediment trap sampling, and additional modeling. Stormwater loading is also a highly uncertain term that will be addressed by planned Round 3 sampling (stormwater sampling at 31 basins around the Study Area). In contrast, current permitted wastewater discharges are expected to be an insignificant current contributor. Upland groundwater plume loading is expected to be locally important for a subset of iCOCs (e.g., LPAHs and DDx pesticides) and potential iCOCs (i.e., cyanide, chloroform, perchlorate, TCE). Current bank erosion is a highly uncertain loading term; however, estimation of this term is not considered necessary for the purposes of the RI/FS and will instead be evaluated on an area-specific basis, as needed, as a part of the remedial design process for each SMA. Finally, atmospheric deposition is expected to be a minor contributor for most iCOCs.

Site-Wide iAOPC CSM

Risks to people eating fish contaminated with PCBs resulted in identification of an iAOPC that encompasses the entire Study Area. PCBs were detected in all media sampled: sediment, tissue, and surface water. (Note: TZW was not sampled for PCBs because PCBs were not identified as upland groundwater chemical of interest). Based on the spatial distribution of PCBs in sediment and the current understanding of current and historical sources, the majority of PCBs in sediment are likely a result of historical overwater releases, upstream releases,

waste and wastewater discharges, and overland transport via stormwater runoff. Ongoing releases of PCBs from stormwater discharge will be evaluated in Round 3 to determine the significance of this pathway. Additional ongoing sources to the Study Area include sediment transport and riverbank erosion at certain sites. Sediment transport will be evaluated in the final RI Report. Atmospheric deposition to the water surface is considered a minor source to the river and will not be evaluated further.

Individual iAOPC CSMs

Twenty-seven individual iAOPCs have been identified throughout the Study Area based on initial human health and ecological risk estimates. Two others are Terminal 4 and the side-wide iAOPC for PCBs. Other iCOCs associated with iAOPC-specific risks varied by location and may have included metals (e.g., arsenic, cadmium, mercury, and zinc), pesticides (e.g., DDD, DDT, and delta-BHC), dioxins, PAHs (e.g., benzo(a)pyrene), and phthalates (bis(2 -ethylhexyl)phthalate). Potential iCOCs were also identified at some iAOPCs based on less certain and/or less rigorous evaluations including the floating percentile model (FPM) or other highly uncertain lines of evidence.

As with the site-wide iAOPC, iCOCs in the sediment appear to be primarily related to releases from historical nearshore and upland sources. Overwater activities (including spills), stormwater runoff (including CSOs), waste disposal practices (including in-river disposal or process waste discharge) were potentially the most significant pathways linking upland activities and sources with in-river receptors (sediment and biota). Groundwater discharges from adjacent upland facilities may also have been historically significant for some iAOPCs; however, in most cases the contribution is low compared to releases from associated or concurrent operations. Stormwater discharges are likely the most significant current pathway, but are expected to be significantly less than historical contributions. Sediment transport of contaminants has and continues to redistribute contaminants within the river. The relative contribution of these potential current sources and pathways within the individual iAOPCs will be further quantified in the RI Report.

Next Steps

Refined estimates of physical/chemical fate and transport processes will be developed based on the results of planned Round 3 surface water, sediment, and stormwater sampling and completion of the fate and transport model. Details of these next steps are presented in Sections 7 and 12 of this report.

The understanding of biotic fate and transport will be further developed based on refinements to the food web model that was used to develop iPRGs that defined the iAOPCs. The FWM will be linked to the physical/chemical fate and transport model to assess the relative risk reductions associated with various alternative evaluated in the FS.

EXECUTIVE SUMMARY

SECTION 12 – DATA GAPS

As a result of data collection and analysis through Round 2, data needs to complete the RI/FS are identified in Section 12. These data focus on:

- Sediment traps
- Surface sediments
- Subsurface sediments
- Surface water
- Stormwater
- Lamprey and sturgeon tissue
- Lamprey and benthic toxicity.

Of these data needs, sediment trap, surface sediment, subsurface sediment, surface water, stormwater, lamprey and sturgeon tissue, and lamprey toxicity data are already being addressed through Round 3A data collection activities. Additional surface sediment and subsurface sediment data along with benthic toxicity data have been identified as Round 3B data needs. The data needs are evaluated on both a area-wide and site-specific basis.