

Appendix C

DEQ Characterization of Potential Upland Contaminant Sources

This document provides information and technical assistance to the public and employees of the Department of Environmental Quality regarding the Department's cleanup program. The information should be interpreted and used in a manner that is fully consistent with the state's environmental cleanup laws and implementing rules. This document does not constitute rulemaking by the Environmental Quality Commission, and may not be relied upon to create a right or benefit, substantive or procedural, enforceable in law or equity, by any person, including the Department. The Department may take action at variance with this document.

This page left intentionally blank

Appendix C DEQ Characterization of Potential Upland Contaminant Sources

This Appendix describes DEQ's general process for characterizing potential upland contaminant sources within the area of the Portland Harbor Superfund site and provides general considerations for developing upland conceptual site models. This approach should be viewed as a dynamic, flexible process that can and should be tailored to the specific circumstances of individual sites. The goal is to conduct efficient and effective investigations that achieve high quality results in a timely and cost-effective manner.

Site characterization will be required for sites identified as a high priority by DEQ. In general, site characterization activities will be conducted in accordance with EPA's "*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*"¹ and the objective of the RI/FS process is not the unobtainable goal of removing all uncertainty, but to gather information sufficient to support an informed risk management decision. This Appendix focuses on the evaluation of the groundwater and stormwater contaminant migration pathways.

C.1 DEQ Portland Harbor Remedial Investigations

Upland characterization activities typically begin during the expanded preliminary assessment (XPA) or in the initial phases of the remedial investigation (RI). A RI is a detailed study that may include groundwater, soil, sediment, stormwater, and surface water sampling to determine the nature and extent of contamination at a site. The RI emphasizes data collection and site characterization including sampling and monitoring as necessary to gather sufficient information to support the risk assessment which estimates risks to human health and the environment as a result of the contamination and to determine the necessity for remedial action.

During the RI, the full nature and extent of upland contamination should be defined. In order to complete an acceptable XPA or RI, site characterization activities should be conducted in accordance the DEQ agreement², applicable DEQ and EPA guidance, and a DEQ-approved work plan(s). In addition, reports documenting investigation rationale, procedures, and results should be required for the administrative record to support remedial action and source control decisions.

In general, a site characterization should result in a complete description of the following:

- Evaluation of current and historical uses of the property (Note: the history of Portland Harbor sites should typically be documented back to the early 1900's if possible);
- Current and historic potential sources of contamination (including overwater facilities);
- Regulatory compliance history (*e.g.*, NPDES, RCRA, Air Quality);
- Environmental setting (*e.g.*, site hydrogeological conceptual model);

¹ Interim Final. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. OSWER Directive 9355.3-01. October 1988. EPA/540/G-89/004.

² The boilerplate for an RI investigation agreement is available at [http://www.deq.state.or.us/wmc/documents/RI-FS-SOW\(long\).pdf](http://www.deq.state.or.us/wmc/documents/RI-FS-SOW(long).pdf).

- Contaminants of interest;
- Extent of impacted media (soil, storm water, surface water, groundwater, air);
- Potential contaminant migration pathways and receptors; and
- Contaminant fate and transport.

The Portland Harbor RI agreement distinguishes between the upland and in-water portions of the cleanup site and states that the portion of the site below the mean high-water mark of the Willamette River may not be included in this work. The in-water portion of the investigation will generally take place under EPA oversight in accordance with EPA's Agreement on Consent (AOC) with the Lower Willamette Group (LWG) for Portland Harbor Sediment RI/FS.

DEQ's Portland Harbor upland RI scope of work (SOW) requirements differs from DEQ's standard RI/FS SOW in a number of ways. Some key differences are:

- Site Characterization: The full characterization of all hazardous substance source areas at the facility is required. In addition, PRPs are required to evaluate all contaminant migration pathways with a focus on those pathways that may result in hazardous substance releases to the Willamette River. Because work below the mean high-water mark of the river is excluded, DEQ will not generally require in-water characterization activities unless necessary to properly evaluate contaminant migration pathways, establish contaminant concentrations at the in-water point of exposure, or evaluate, design and implement source control measures.
- RI Off-ramp. During the RI process if it can be demonstrated that a facility is not an ongoing (i.e., current) source of contamination to the river, DEQ may reprioritize the site and issue a determination stating that source control measures are not required at this time. The site will then be referred to the DEQ cleanup program to address upland issues unrelated to Portland Harbor and to EPA for evaluation of potential historic sources of in-water contamination.
- Land and Beneficial Water Use: The identification of land and beneficial water uses associated with the Willamette River are specifically excluded.
- Risk Assessment: The risk assessment is limited to upland human health and ecological risk assessments.
- Evaluation and Implementation of Source Control Measures: The site characterization must be adequate to evaluate, design, and implement necessary source control measures. Source control measures must address contaminant migration to the river that warrants removal action under OAR 340-122-0070 (See Section 4.0 of the JSCS).
- Feasibility Study: A feasibility study is not included. The upland SOW contemplates the implementation of source control measures as a *removal* action. If necessary, feasibility studies would be completed under a separate agreement with DEQ.

Although many elements of the RI are focused solely on the upland portion of the site, the SOW requires the evaluation of all contaminant migration pathways at the site, particularly those related to the Willamette River. This may include the collection of sediment and/or pore water data from below the high-water mark³ to characterize and evaluate groundwater or storm water discharges to the river.

The RI should include two distinct elements: (1) the investigation and assessment of upland contamination unrelated to Portland Harbor, and (2) the identification and characterization of sources and pathways of contamination potentially impacting the river. These elements are described in the following sections.

C.2 Conceptual Site Model Development

Prior to initiating the RI, it is very important for the PRP and DEQ to develop a working hypotheses of the chemical and physical processes controlling contaminant fate and transport and how potential receptors might be exposed to site contaminants. The conceptual site model (CSM) describes upland sources, contaminants of interest (COI), site geology, hydrology, hydrogeology, contaminant migration pathways, and contaminant fate and transport. The risk assessment exposure conceptual site model (ECSM) describes potential routes of exposure to potential site receptors. These conceptual site models are briefly described below.

C.2.1 Conceptual Site Model

The CSM incorporates physical and chemical information to understand contaminant fate and transport and potential impacts to the river. Development of the CSM is an iterative process beginning with a conceptual understanding of the hydrogeological and hydrological system at the site and ending with a detailed understanding of site-specific conditions governing contaminant fate and transport through pathways which may impact the river. The CSM should include information on the following:

- Current, historical, and potential future sources of contamination;
- COIs;
- Physical (*e.g.*, density and viscosity) and chemical characteristics (*e.g.*, solubility, K_{oc} , K_{ow}) of the COIs;
- NAPL properties and anticipated behavior (*i.e.*, mobility), if relevant to the site;
- Site geology and hydrogeology including physical characteristics (*e.g.*, grain size, K_d , f_{oc}) of the site;
- Site surface water hydrology (*e.g.*, description of site storm water flow and management);
- Assumed distribution of COIs based on site conditions (geology, hydrogeology, hydrology, land use, type of release, area of release, size of release, age of release, *etc.*);

³ For Portland Harbor upland projects, DEQ has chosen to provide an initial definition of an upland harbor site boundary using one elevation for consistency and to minimize gaps in river bank evaluations. DEQ's initial definition is 8 feet Columbia River Datum (9.85 feet National Geodetic Vertical Datum) as measured on the USGS Morrison Bridge river gauge. This starting point elevation definition should be combined with site-specific discretionary modifications.

- Factors that influence groundwater discharge to surface water (e.g., tidal effects, sediment type in discharge zone, geochemistry);
- Potential points of exposure;⁴
- Representative geologic cross sections⁵ parallel and perpendicular to the groundwater flow direction. These figures should illustrate:
 - Site topography and river bathymetry;
 - Extent of primary geologic units;
 - Location of contaminant sources;
 - Monitoring well depths, screened intervals, and representative concentrations;
 - Utilities or other potential preferential pathways;
 - Vertical and horizontal delineation of groundwater plume(s) either as contours or the expected extent of contamination; and
 - Groundwater flow direction (vertical and horizontal).
- Site maps that illustrate the following:
 - Site layout (location of contaminant sources, well locations, proximity to the river, storm water drainage systems, outfalls, etc.);
 - Representative concentrations in each medium;
 - Delineation of extent of contamination in each medium (surface soil, subsurface soil, groundwater (each zone of concern), sediment, either as contours or the expected extent of contamination; and
 - Subsurface utility corridor maps.

Periodically the data collected during the RI/FS process should be checked against the CSM and the CSM refined as needed to more accurately describe contaminant distribution and transport. The CSM should be used to help focus data collection on the key information needed to complete delineation of the nature and extent of contamination and to gather information sufficient to support an informed source control or risk management decision.

C.2.2 Exposure Conceptual Site Model

Another critical step in the site characterization and risk assessment process is the development of a site exposure conceptual site model (ECSM). This model should show the link between potential sources, contaminant migration pathways and potential exposure pathways to human and ecological receptors. An iterative process should be used to develop the ECSM, starting with an understanding of the hydrogeological and hydrological system at the site (see Section C.2) and then incorporate a thorough understanding of potential exposure pathways and receptors. The ECSM should be revised throughout the investigation as data are developed and finalized for the baseline risk assessment. For further discussion on ECSM development, refer to

⁴ The CSM development should be conducted concurrently with the Risk Assessment exposure conceptual site model.

⁵ Geologic interpretation must be performed by an Oregon Registered Geologist or an Oregon Licensed Professional Engineer (PE). Documents, reports, containing this information must be signed and stamped in accordance with Oregon regulations (ORS 672.525).

DEQ's *Guidance for Ecological Risk Assessment*⁶ and the *Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites*.⁷

C.3 Groundwater to Surface Water Pathway Considerations

Contaminated groundwater discharging to Willamette River sediments and surface water poses a potential threat to human health and the environment. Therefore, during Portland Harbor upland investigations the following questions should be considered periodically throughout the project to assure adequate characterization of the nature and extent of contamination and to aid in source control decisions:

C.3.1 Upland Considerations

Upland Groundwater Extent of Contamination

- Can the upland groundwater plume be delineated to appropriate screening levels (e.g., chronic AWQC or MCLs)?
- What additional work is needed to complete the upland delineation of groundwater investigation?
- Are additional upland wells needed to define the vertical or horizontal extent or evaluate additional source areas? If so, are these wells currently planned?
- Are additional rounds of groundwater elevation or quality monitoring needed to evaluate temporal trends (*i.e.*, verify steady-state conditions)?
- Do we sufficiently understand groundwater flow (including seasonal or tidal changes)?
- Has the contamination been delineated to sufficiently predict where the plume may discharge into the river?
- Have potential geologic controls on groundwater contaminant migration (water bearing zones, aquitards, perched groundwater, basalt) been adequately identified and evaluated?
- Have potential preferential groundwater flow paths (natural or man-made) been identified and evaluated?
- What COIs are may be impacting the river?
- If groundwater concentrations exceed source control SLVs are source control alternatives being evaluated? If so, what types of actions are being considered and what data is needed for design?
- Is there sufficient data to evaluate plume stability or to assess future conditions? How will plume stability be evaluated? Do we have sufficient data to determine if the plume is stable or if it may reach the river at some point in the future (does it present a potential threat to the river)?

Nonaqueous Phase Liquid (NAPL)

- Is LNAPL or DNAPL present? Where?

⁶ Available on-line at <http://www.deq.state.or.us/wmc/cleanup/ecocover.htm>

⁷ Available on-line at <http://www.deq.state.or.us/wmc/tank/rbdlm.htm>

- Have the physical and chemical properties of the NAPL been characterized?
- Is the extent of NAPL defined?
- Is the NAPL potentially mobile?
- Is the NAPL recoverable?

Groundwater Seeps

- Have groundwater seeps been identified?
- Have groundwater seeps been characterized (e.g., contaminant concentrations, discharge rates, loading to river)?

C.3.2 Transition Zone Considerations

- What data is needed to determine if groundwater is discharging to the river and where (i.e., GW discharge mapping)?
- Is sufficient groundwater data available such that the DEQ project team can provide recommendations to EPA for in-water groundwater sampling (e.g., core locations, porewater sampling locations)?
 - If no, when will the project be at that point - what data is needed to get there?
 - If yes, what data are necessary to define the nature and extent of contamination, confirm the site hydrogeologic CSM, determine if source control is needed, and to perform a "localized" ecological risk assessment?
 - Updated HCSM- Evaluate existing upland data and offshore sediment data and core logs to project stratigraphic or water bearing zones into the river (i.e., revise HCSM and prepare cross sections extending into the river showing bathymetry and stratigraphy).
 - Off-shore borings to define stratigraphy in the river. What is the expected depth of these cores?
 - Off-shore borings to collect groundwater grab samples to track groundwater contamination to into the river to define extent of contamination, groundwater flow paths, and help identify potential groundwater discharge areas.
 - Groundwater discharge mapping (towed probes, Trident Probe grid sampling) in area of expected groundwater discharge or preferential flow pathways to:
 - 1) Identify potential transition zone water (i.e., porewater) quality sampling locations.
 - 2) Identify potential areas to measure groundwater discharge rates (flux).
 - 3) Provide understanding of groundwater discharge to evaluate the results of the in-water surface and sediment sampling locations (i.e., are existing sediment sample locations in the right locations to utilize "bulk" sediment results to evaluate the groundwater pathway).
- Does sufficient transition zone data (i.e., porewater) exist in groundwater discharge areas to:
 - Define the nature and extent of groundwater contamination.
 - Determine exposure point concentrations for ecological risk assessment.
 - Identify potential locations for additional site specific surface water sampling.
- Has groundwater flux been quantified to:
 - Characterize groundwater discharge zone.

- Estimate potential contaminant loading to river.
- Identify areas that may require early action or source control measures.

C.3.3 Groundwater to Surface Water Characterization Techniques

Within Portland Harbor, groundwater flow is generally towards the Willamette River. Although flow reversals from surface water to groundwater may occur in response to a rapid rise in surface water elevation, these effects are generally of short duration. Flow within the Willamette River, water occurs not only in the open stream channel but although through the underlying sediment. This region, where surface water and groundwater mix, is known as the *hyporheic zone*. The hyporheic zone is a region of biological productivity that serves as habitat for benthic organisms and a source of food for bottom feeding fish. As a result, characterizing groundwater discharges to the Willamette River is a critical part of developing an understanding of potential affects of groundwater contamination on in-water receptors. This information is also needed to design and implement source control measures. Methods for the additional characterization of the groundwater/surface water interactions can include, but is not limited to the installation of:

- Push-probe sampling devices to collect groundwater data from beneath the river;
- Seepage meters to estimate groundwater flux to or from the river;
- Seepage meters to evaluate quality of water discharging to surface water; and
- Diffusion-based sampling devices to identify contaminated groundwater discharge points or identify preferential groundwater migration pathways.

A summary of some techniques is provided below:

Groundwater Direction

Initial upland characterization should focus on obtaining groundwater level measurements to map the hydraulic gradient across the site. Groundwater levels should be measured relative to Willamette River levels. Due to the potential for rapid changes in Willamette River levels as a result of storm events and tidal fluctuations, continuous water level monitoring may be required to understand how groundwater levels respond to these changes. Off-shore characterization of the potentiometric head associated with groundwater beneath the river may also be needed to understand the rate and direction of groundwater flow to the river. Mini-piezometers, and in some cases, nested clusters of mini-piezometers, can be used to collect this information.

Groundwater Flux

Although chemical concentrations are typically used in risk assessments or for comparison to benchmarks, contaminant flux is also useful for evaluating source control measures. Qualitative assessments of groundwater flux can be identified by monitoring for and observing changes in groundwater and surface water temperatures and conductivity. The relative changes of these parameters can be used to map out where groundwater flows into the surface water and where the flow is reversed.

Groundwater flux to surface water can be estimated from water level measurements or measured with seepage meters, which are specifically designed to measure the volume of water flowing through the sediment/surface water interface. Simple seepage meters can be constructed from a 55-gallon drum cut in half. A Teflon® or Tedlar® bag is attached to the closed end of the drum through a water-tight fitting that penetrates the drum. The open end of the drum is inserted into

the sediment. Groundwater flux is measured from the volume of water that flows into the bag after a known period of time.

Transition Zone Water Quality

Measurement devices for assessing Transition zone (i.e., porewater) water quality may be divided into two categories, passive and active sampling techniques. In addition to analyzing samples for contaminants of interest, other field parameters such as pH, temperature, specific conductance, dissolved oxygen, and common anions and cations as tracers should also be performed.

Passive Sampling Devices

Passive sampling techniques involve the placement of a sampling device in sediment or in the water column and allowing that device to equilibrate over time. The time required for equilibrium is dependent on the contaminants of interest. Passive devices result in quantitative or semi-quantitative results. The characteristics of the receiving body, site lithology and the nature of the contaminant plume are used to select appropriate placement location and depth. Passive devices include semi-permeable membrane devices, diffusion samplers, and peepers.

Semi-permeable membrane devices (SPMDs) are designed to gather time-integrated data on aquatic contaminants over a period of days to weeks. SPMDs are typically constructed of low density polyethylene and are designed to mimic the bioconcentration of organic contaminants in the fatty tissues of organisms. SPMDs are generally installed in the water column. If diffusion constants are available for the COIs, SPMD data can be used to calculate water column concentrations.

Diffusion samplers include water-to-vapor diffusion and water-to-water diffusion devices. These devices are typically used for VOCs as an indirect measurement of aqueous concentrations. However, these devices only provide semi-quantitative information and are typically used for the identification of groundwater plumes discharging to surface water. The devices are installed by burying them at the desired depth and location and allowing them to equilibrate over time.

Peepers are subsurface chambers for sampling a variety of dissolved contaminants. Peepers are most often used for metals, although they have been used successfully to characterize volatile organic compounds. A mesh or semi-permeable membrane is placed across an opening in a chamber, which is buried, much like the diffusion-based devices, until equilibrium is reached. Peepers can also be used to assess biological exposures to pore water. The primary disadvantage associated with the use of peepers is membrane clogging.

Active Sampling Devices

Active sampling devices are designed to collect a representative sample of pore water or groundwater. The devices are similar to monitoring wells in that a water sample is obtained from below the sediment-water interface. Active sampling devices include mini-piezometers, direct-push devices, and multi-level sampler devices.

Direct-push techniques such as the Geoprobe® may easily be adapted to obtain groundwater samples off-shore of upland facilities. Geoprobe® rigs are typically mounted on work barges and floated into place. A drive point sampler is driven to the desired depth and an interstitial water sample is withdrawn and sent for analysis. Another approach is the use of a mini-piezometer such as the MHE Push Point Sampling Device. The device is a rigid 1/8-inch diameter stainless steel probe that can be used to collect shallow water samples. Although it can

be deployed easily in shallow water, divers must be present to use the device in deeper waters such as those that exist in Portland Harbor.

In some cases, drivable multilevel samplers may also be deployed. These devices are similar to direct-push or mini-piezometers except that they allow for the collection of samples at multiple depths.

C.4 Storm Water to Surface Water Pathway Considerations

Permitted and unpermitted storm water discharges may represent a significant pathway of contamination to river sediments at sites where runoff comes into contact with contaminated media. These discharges should be evaluated and controlled to the extent feasible in order to prevent significant sediment recontamination and to protect water column organisms from adverse effects.

C.4.1 Upland Considerations

During Portland Harbor RI upland investigations the following questions should be considered periodically throughout the project to assure adequate characterization of the nature and extent of contamination and to aid in source control decisions:

- Is storm water system adequately understood (*e.g.*, basin delineation, conveyance lines, potential source areas, COIs)?
- Have the types, concentrations, and variability of hazardous substances (including Persistent, Bioaccumulative and Toxic pollutants (PBTs) such as PCBs and phthalates) in storm water discharges (both liquid and solid) been adequately characterized?
- Can storm water discharges be defined to appropriate screening levels (*e.g.*, chronic AWQC or MCLs)?
- What additional work is needed to complete the storm water investigation?
- Are sampling events needed or different sample types (whole water, sediment traps, conveyance line sediments) to define the extent of contamination or to refine the understanding of source areas? If so, is this sampling currently planned?
- Are contaminants being discharged to the river as dissolved phase? Particulates? Both? Is additional information, needed for source control decisions? Recontamination decisions?
- Are discharge measurements needed to estimate or quantify potential contaminants loading to the river?
- Is the variability in storm water quality and quantity sufficiently understood to determine if source control is needed or if best management practices (BMPs) are effective?
- Do the storm water conveyance lines contain accumulated sediments that may be acting as an ongoing source of contaminants to the river?
- Should the storm water conveyance system (*e.g.*, catch basins and lines) be inspected and/or cleaned to eliminate potential source material?
- Does the storm water system potentially serve as a preferential groundwater flow pathway? If so, has this potential been evaluated?

- If storm water concentrations exceed source control SLVs are source control alternatives being evaluated? If so, what types of actions are being considered and what data is needed for design?
- Have the effectiveness of Best Management Practices (BMPs) been determined and the need for additional source control evaluated?

C.4.2 Storm Water Characterization Techniques

Storm water discharges are highly variable both in terms of flow and pollutant concentrations. Based on the intermittent discharge periods and unknown pollutant and sediment loads associated with storm water, a conservative approach is used in the JSCS for screening. The purpose of this approach is to identify potentially significant contaminant sources of hazardous substances (*i.e.*, dissolved or sediment loads) to the river.

Piped storm water or sheet flow discharges have the potential to suspend and transport soil (including catch-basin or conveyance line sediment) into the river, especially during storm events. Particulates settling out of storm water discharges may represent a source of contaminant loading to river sediment, therefore cumulative sampling approaches may be required (*e.g.*, sediment traps).

It is assumed that upland sites will perform both storm water (liquid phase) and storm water sediment (solid phase) sampling and analyses during upland investigations. DEQ's "*Framework for Portland Harbor Storm Water Screening Evaluations*" (December 2005; see Appendix D of the JSCS) provides guidance for sampling storm water and catch basin samples. The specific objectives of this framework are to:

- 1) Provide acceptable sampling procedures and sampling frequencies, consistent with the JSCS, for characterizing storm water discharges (*i.e.*, liquid and particulate transport) to the Willamette River through individual or shared storm water conveyance systems; and
- 2) Provide consistency in storm water collection and evaluation between individual Portland Harbor facilities through implementation of this framework.

In addition to the evaluation described in the framework, additional sampling may be required to assess the variability in storm water quality (whole water) or to evaluate stormwater sediments to either estimate contaminant loading to the river or to evaluate the potential for stormwater to recontaminate sediments in the Willamette River after implementation of in-water cleanup activities. Possible methods for evaluating stormwater sediments include:

- Catch basin (manholes, sumps, etc.) sediment sampling;
- Conveyance line sediment sampling;
- Sediment traps; and/or
- Filtered effluent from the whole water phase.

Analytical testing requirements should be based on:

- Site-specific contaminants of interest (COI);
- Portland Harbor Willamette River data (*e.g.*, surface water or sediment) supporting a specific suite of COIs;
- Facility NPDES permit parameters; and
- Other applicable regulatory requirements (*e.g.* whether the facility discharges to an impaired (303(d) listed) water body, available or proposed Total Maximum Daily Loads (TMDLs)).

In addition, additional analysis may be needed for quantify organic carbon, total suspended solids, sediment grain size, etc.

This page left intentionally blank