Lower Duwamish Waterway Group

City of Seattle / King County / The Boeing Company

100% Remedial Design Volume II, Part VI

Long-Term Maintenance and Monitoring Plan for the Lower Duwamish Waterway Upper Reach – Annotated Outline

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

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APPENDICES (TO BE PREPARED)

ABBREVIATIONS

AC	activated carbon
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CUL	cleanup level
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
IC	institutional control
LDW	Lower Duwamish Waterway
LTMMP	Long-Term Maintenance and Monitoring Plan
MNR	monitored natural recovery
PCB	polychlorinated biphenyl
RAO	remedial action objective
RD	remedial design
ROD	Record of Decision
SCO	sediment cleanup objective
SMA	sediment management area

1 Introduction

This document provides an annotated outline of the Long-Term Maintenance and Monitoring Plan (LTMMP) for the Lower Duwamish Waterway (LDW) Superfund site. This outline has been developed as part of upper reach remedial design (RD); however, the LTMMP will address the entire in-water portion of the LDW site. This document will remain an annotated outline in the Final (100%) RD for the upper reach. A site-wide LTMMP will be prepared by the Implementing Entity at a future date per the LDW Consent Decree. Additional details regarding monitoring and maintenance for the LDW following remedial actions will be provided in the draft site-wide LTMMP, for which this annotated outline provides a starting point.

The purposes of the LTMMP are to specify the actions that will be taken to monitor long-term remedy performance, and to present potential maintenance or adaptive management activities that will be conducted in the event that performance objectives are not being met or conditions have changed. Monitoring includes analyzing contaminant concentrations in sediments at compliance depths for comparison with the LDW Record of Decision (ROD) remedial action objective (RAO)-specified cleanup levels (EPA 2014), as well as monitoring contaminant concentrations in surface water and biota. If monitoring activities demonstrate an unexpected issue, a phase of diagnostic investigation or more intense monitoring will be initiated to examine the issue and assess the necessity of any corrective actions. Methods that could be used to investigate sediment re-contamination or sediment natural recovery issues that might occur could include evaluating source control data, performing targeted surface sediment sampling, collecting finely sectioned sediment cores, or gathering updated bathymetry data. Specific investigation designs and contingency actions would be developed to address specific issues. For example:

- If a monitored natural recovery (MNR) to benthic sediment cleanup objective (SCO) area is not recovering to the extent predicted (i.e., concentrations exceed benthic SCO 10 years after construction), additional data (e.g., source control data, site-specific deposition rate information) could be collected in the area to determine why recovery has been less than predicted. Based on this information, a contingency action may be necessary (e.g., source control work or enhanced natural recovery [ENR] placement).
- If a sediment composite sample has a substantially higher contaminant concentration than expected, archived grab samples and/or additional sediment samples could be analyzed to identify the cause.
- If a cap is damaged, it will be repaired and the cause of the damage (e.g., vessel grounding) will be determined so additional safeguards (e.g., revised armoring) can be put in place, as needed.

The LTMMP will be developed in accordance with *Guidance for Management of Superfund Remedies in Post Construction* (EPA 2017) and will include elements from the baseline study designs and recommendations described in the *Lower Duwamish Waterway Pre-Design Studies Data Evaluation Report* (Windward 2020). The LTMMP will include both LDW-wide monitoring elements and elements specific to the remedy applied in each reach, such as specific monitoring requirements for caps, ENR areas, and MNR to benthic SCO areas. The LTMMP quality assurance project plan (a forthcoming appendix to the LTMMP) will provide details of long-term monitoring activities, including data quality objectives, sample types and intervals, analytes, location density, and sampling frequency. Monitoring during construction is addressed in the Construction Quality Assurance Plan.

1.1 Purpose

The purposes of the LTMMP are to:

- Specify the actions that will be taken to monitor long-term remedy performance in terms of ROD criteria (EPA 2014)
- Assess the integrity of the remedial actions
- Present potential maintenance or adaptive management activities that could be conducted in the event that performance objectives are not being met.

1.2 Project Organization

Project organization will be summarized using a staff organization chart and descriptions of required roles and responsibilities to complete and implement the LTMMP. The LTMMP will be reviewed and approved by the U.S. Environmental Protection Agency (EPA) per the schedule in the LDW Consent Decree.

1.3 Project Description

1.3.1 Remedial Action Objectives

Section 8.1 of EPA ROD (EPA 2014) outlines the following four RAOs for the LDW.

- RAO 1: Reduce risks associated with the consumption of contaminated resident LDW fish and shellfish by adults and children with the highest potential exposure to protect human health.
- RAO 2: Reduce risks from direct contact (skin contact and incidental ingestion) to contaminated sediments during netfishing, clamming, and beach play to protect human health.
- RAO 3: Reduce to protective levels risks to benthic invertebrates from exposure to contaminated sediments.

- RAO 4: Reduce to protective levels risks to crabs, fish, birds, and mammals from exposure to contaminated sediment, surface water, and prey.

1.3.2 Remedial Actions

1.3.2.1 Upper Reach

The remedial actions for the upper reach are described in the *Basis of Design Report* (BODR). In summary, there are 18 sediment management areas (SMAs) to be addressed in the upper reach, where dredging, partial dredge and engineered capping, engineered capping, and ENR will occur. Areas for monitored MNR to benthic SCO have also been identified, The information in this section will help guide the location and timing of monitoring related to these remedial actions.

1.3.2.2 Middle Reach

The remedial areas and technologies to be applied for sediments in this reach will be determined in RD.

1.3.2.3 Lower Reach

The remedial areas and technologies to be applied for sediments in this reach will be determined in RD.

1.3.3 Role of Source Control

In order to minimize the potential for recontamination, the Washington State Department of Ecology (Ecology) has performed source control sufficiency evaluations to determine whether source control in the vicinity of an SMA is adequate to begin remedial action construction. The results of these evaluations provide information to consider when determining SMA-specific monitoring.

1.3.4 Role of Institutional Controls

Institutional Controls (ICs) will be put in place to support the remedy. For example, capped areas will have ICs to safeguard the stability of the cap. These ICs will be described in the Sediment Remedy Institutional Controls Implementation and Assurance Plan. In addition, seafood consumption-related ICs have been developed by EPA (Lee et al. 2019). The seafood consumption IC program at the site started in 2017 (King County 2017).

1.3.5 EPA Five-Year Reviews

EPA conducts five-year reviews when hazardous substances remain on site above levels that permit unlimited use and unrestricted exposure (EPA 2001). Five-year reviews evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. The reviews take place five years following the start of a CERCLA response action, and

are repeated every succeeding five years so long as future uses remain restricted. EPA is expected to conduct the first five-year review in 2029, assuming the upper reach remedial action begins in 2024. The information obtained through long-term monitoring will inform these reviews.

1.4 Data Quality Objectives

1.4.1 Measuring Progress Toward Compliance with Sediment Cleanup Levels

Section 8.2 of the ROD (EPA 2014) outlines the sediment cleanup levels (CULs) for the site. Two of the key data quality objectives of the LTMMP are to determine when CULs have been met, and to assess progress toward meeting CULs and applicable or relevant and appropriate requirements, as described in Section 13.4 of the ROD.

1.4.2 Measuring Trends in Tissue

Fish, crab, and clam tissues will be monitored for contaminants of concern (COCs) associated with human health seafood consumption risks (RAO 1). The resulting data will be used to inform seafood ICs intended to minimize risk to the LDW fishing community, provide risk communication information, and assess post-remedy tissue concentrations and trends.

1.4.3 Measuring Trends in Water Quality

As sediment remediation and source control continue, surface water will be monitored using passive samplers to assess trends in post-remedy polychlorinated biphenyl (PCB) concentrations. Surface water will also be monitored using grab samples to assess water quality in comparison to applicable or relevant and appropriate requirements.

1.4.4 Technology-Specific Remedy Performance

The upper reach RD specifies where active (e.g., dredging, capping, ENR) and passive (e.g., MNR to benthic SCO, MNR) response actions will be conducted. The LTMMP will outline the monitoring to evaluate the performance of these remedies over time, and it will outline the process to be followed if future investigations or contingency measures are necessary.

1.5 Relationship to Other Monitoring Activities

1.5.1 Baseline Monitoring

Baseline monitoring was conducted as part of the Pre-Design Studies in 2018 and 2019. The results of the baseline monitoring were presented in a data evaluation report in 2020 (Windward 2020). Baseline monitoring included collection of sediment within specific spatial areas and depth intervals

related to RAOs to enable a comparison between pre- and post-remedy conditions, and to assess site conditions following completion of early action areas. Most of the baseline monitoring study designs and concepts will be utilized in the monitoring program described in the LTMMP to support trends analysis and assess RAO compliance.

1.5.2 Periodic Monitoring During Design and Construction

Periodic monitoring of fish, crab, and clam tissue and deployment of surface water passive samplers was conducted in 2023. The resulting periodic monitoring data will support the LTMMP, aspects of which are expected to begin in 2028 after completion of upper reach remedial actions (Section 2).

2 Long-Term Monitoring Components

2.1 LDW-Wide and Area-Specific Monitoring

2.1.1 Sediment

The LDW ROD established CULs applied at different spatial scales, including LDW-wide CULs for RAOs 1, 2 and 4, area-wide beach play and clamming area CULs for RAO 2, and location-specific CULs for RAO 3.

2.1.1.1 LDW Wide

LDW-wide sediment monitoring will be conducted using composite samples to represent the 0–10-cm interval to address RAOs 1, 2 (net fishing), and 4. The study design was established in baseline monitoring: 27 composite samples with 7 grab samples each. The grab sampling locations will be randomly distributed within each composite area each time these samples are collected. Early action areas and the ENR/activated carbon (AC) pilot areas will be included within the areas sampled (Windward 2020, Map 2-1). Samples will be analyzed for PCBs, arsenic, dioxins/furans, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

2.1.1.2 Beach Play Areas

To address the beach play area component of RAO 2, sediment monitoring will be conducted within each beach play area to create three composite samples per area with sediment from the 0–45-cm interval. Samples will be analyzed for PCBs, arsenic, dioxins/furans, and cPAHs. The study design concepts will be the same as those used for the baseline monitoring in beach play areas.

2.1.1.3 Clamming Areas

To address the potential clamming component of RAO 2, sediment monitoring will be conducted within clamming area segments to create composite samples of sediment from the 0–45-cm interval. Samples will be analyzed for PCBs, arsenic, dioxins/furans, and cPAHs. The study design will be similar in many respects to that used for the baseline monitoring, but it will differ in that composite samples will represent segments of the LDW-wide clamming area.[1]

2.1.1.4 Location-Specific Monitoring

To address RAO 3, targeted monitoring (e.g., 0–10 cm, or intervals of recently deposited material) will be conducted at point locations with localized recontamination potential. These areas, which could include locations in early action areas, and the analytes included as part of this monitoring will be

[1] The approach will not involve incremental sampling methodology to the extent utilized in baseline monitoring, because variability is expected to be less after the remedy has been implemented.

determined in consultation with EPA. In addition, RAO 3 is being addressed by monitoring associated with MNR to benthic SCO, as discussed in Section 3.

2.1.2 Tissue

Fish, crab, and clam tissue will be monitored in the same species, using the same collection and compositing approach employed in the baseline sampling (Windward 2017a). Composite samples will be analyzed for the analytes with species-specific target tissue levels. The list of other human health COCs to be monitored may be reduced based on the 2023 periodic monitoring results, as discussed in the data evaluation report (Windward 2020).

2.1.3 Surface water

Surface water will be monitored following the approaches employed in baseline monitoring (i.e., passive samplers and grab samples) (Windward 2017b), in accordance with the recommendations outlined in the data evaluation report (Windward 2020). Specifically, PCB congeners will be analyzed at two locations in 2023 using passive samplers that will allow the calculation of freely dissolved PCBs in the water column. The number of sampling locations may be reduced to one in subsequent events, if PCB concentration variability remains low between the two locations. The whole-water grab samples will be collected at two LDW locations at two depths (i.e., near-surface and near-bottom) under three different weather conditions: dry baseflow, wet baseflow, and following > 0.5 inches of rain within a 24-hour period. A Green River location upstream of the site will be monitored as well. Grab samples will be analyzed for PCBs, arsenic, polycyclic aromatic hydrocarbons, bis(2-ethylhexyl) phthalate, and conventional parameters. Reductions in the numbers of LDW locations, analytes, and weather conditions to be sampled will be considered in coordination with EPA based on the results of each event.

2.2 Schedule of Site-Wide Monitoring Components

The proposed LTMMP monitoring schedule is presented in Figure 2-1. Aspects of the LTMMP are expected to begin in 2028, including sediment sampling in upper reach beach play areas and clamming segments,[2] and tissue and passive water sampling. The other RAO-related sediment monitoring will be conducted after the LDW-wide remedy construction is complete but before the second five-year review. Sediment monitoring will be repeated every five years to support five-year reviews until CULs are met for each COC and RAO, and then once more to confirm these results. If CULs are not met for each COC and RAO, the data will be discussed and next steps will be assessed

[2] Intertidal sediment samples (0–45 cm) will be monitored 1.5 years after upper reach construction is completed at the two beach play areas and the clamming segments located entirely within the upper reach.

as part of future five-year reviews. Next steps could include a revised monitoring design, reduced sampling frequency, or technical impracticability waiver discussion.

Tissue monitoring will be conducted in 2023 (as part of periodic monitoring) and will be repeated every five years as part of the LTMMP to support five-year reviews, with an additional event two years after LDW-wide construction completion (for risk communication). Note that the first LTMMP tissue monitoring (in 2028) will occur during the 10-year remedy construction period, when COC concentrations are likely to be elevated as a result of dredging.[3] Next steps will be assessed for tissue monitoring as part of future five-year reviews. Next steps could include a revised monitoring design or reduced monitoring frequency.

Surface water monitoring with passive samplers will be conducted in 2023 (as part of periodic monitoring) and will be repeated every five years as part of the LTMMP to support five-year reviews. Grab sampling will be conducted every five years following completion of the LDW-wide remedy. Next steps, such as a revised monitoring design or reduced monitoring frequency, will be assessed for surface water monitoring as part of future five-year reviews.

Figure 2-1 also presents the schedule for technology-specific monitoring. Monitoring in MNR to benthic SCO areas and ENR areas will be conducted 1, 3, 5, and 10 years following completion of the LDW-wide remedy. Visual inspection of areas with engineered caps will occur 1 year after initial construction and then after defined events. The frequency of chemical monitoring on caps will be established in the draft site-wide LTMMP.

[3] This prediction of elevated tissue concentrations is based on sampling conducted following dredging during the remedial investigation (Windward 2010).

3 Technology-Specific Monitoring and Maintenance Requirements

3.1 MNR to Benthic SCO Areas

3.1.1 Monitoring

The upper reach RD outlines the locations within Recovery Category 2 or 3 areas where sediment concentrations are greater than benthic SCOs but less than remedial action levels. These areas will be monitored for compliance with benthic SCOs by year 10, following completion of the site-wide remedy. The LTMMP may propose an approach to distinguish between random, ephemeral, low-level exceedances of benthic SCOs and repeated issues with or high-level exceedances of benthic SCOs, the latter of which may signal a need for additional investigation or action.

3.1.2 Contingency Measures

In the event that compliance with benthic SCOs is not achieved, the LTMMP will identify the expected restoration timeframe and recovery rate and provide examples of factors that may affect the recovery rate. In addition, the Implementing Entity will conduct an area-specific assessment or supplemental remedial measures to achieve compliance.

3.2 ENR Areas

3.2.1 Monitoring

Surface (0–10-cm) sediment monitoring will be conducted within each ENR area. It will be coordinated with the surface sediment sampling discussed in Section 2.1.1, in order to optimize the use of grab samples being collected; supplemental surface sediment samples will be collected as needed for coverage. Samples will be analyzed until the benthic SCO is met and confirmed in the next sampling event.

3.2.2 Contingency Measures

In the event of a benthic SCO exceedance in one or more areas, the Implementing Entity will conduct an area-specific assessment (to assess which factors are affecting recovery) or supplemental remedial actions to achieve compliance.

3.3 Engineered Cap Areas

3.3.1 Stability Monitoring

Physical monitoring (e.g., bathymetric surveys) will be performed approximately 12 months after the initial construction of each engineered cap area. Thereafter, physical monitoring will be performed after the following defined events to assess if the physical integrity of the cap has been compromised.

- Vessel grounding
- Seismic event – based on technical evaluations conducted as part of the upper reach 100% RD, a magnitude 6.6 or greater earthquake within a radius of 60 km or closer to the project site would trigger a post-earthquake inspection and, if necessary, repairs. This magnitude is the average of seismic events used to define risk associated with an earthquake with a 50% probability of occurrence in a 50-year timeframe (a 72-year recurrence interval).
- High-flow event

Focused bathymetric surveys, supplemented by probing or other measures, will be used to monitor whether the cap thickness has changed.

3.3.2 Chemical Monitoring

Chemical monitoring will be conducted on caps on a periodic basis. Details will be determined in the draft site-wide LTMMP.

3.3.3 Maintenance and Contingency Measures

If monitoring reveals that the physical integrity of the cap has been compromised, a location-specific study will be performed, if necessary, to identify the cause of the instability. A plan to repair the cap, which could include measures such as placement of additional cap materials, will be prepared and implemented.

3.4 Area-specific Technologies

Upper reach RD currently includes two area-specific technology applications: 1) the use of ENR amended with AC adjacent to structures, and 2) the ENR/AC pilot intertidal plot. Monitoring and contingency measures for locations where these area-specific technologies are used will be developed consistently with the approach for ENR (Section 3.1). In an ENR area with AC, if a sediment concentration is greater than a benthic CUL, additional investigation will be necessary to assess performance (e.g., porewater). This section will be updated as area-specific technologies are identified in other reaches.

4 Support for 5-year reviews

Additional periodic monitoring may be needed to support five-year review. The Implementing Entity will coordinate with EPA as monitoring progresses, and a meeting will be held two to three years prior to each review to identify any additional data needs. If additional work is identified, the LTMMP will be updated.

5 Monitoring and Maintenance Documentation and Reporting

5.1 Data Management

Data will be managed in accordance with the rules outlined for the Pre-Design Studies data evaluation report (Windward 2020).

5.2 Quality Control and Quality Assurance Procedures

Quality assurance/quality control procedures will be outlined for the various matrices in LTMMP Appendices A and D. Procedures will be consistent with those presented in the Pre-Design Studies quality assurance project plans, with updates as needed. Health and safety and inadvertent discovery monitoring will be conducted as outlined in Appendices B and C.

5.3 Communication Protocols

Communication protocols established for the Pre-Design Studies will be revised, as appropriate, and followed for all planned monitoring activities. Protocols will also be established for reporting activities associated with unexpected events (e.g., monitoring after a vessel grounding).

5.4 Reporting

Reporting deliverables will be outlined in the Consent Decree.

6 References

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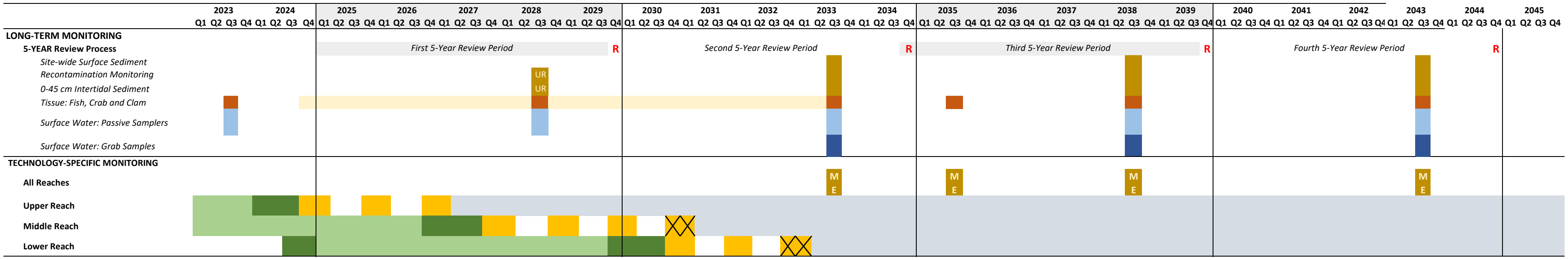
Figures



R = 5 year periodic review report

Tech-Specific Legend:

PDI/Remedial Design
Procurement
Construction and associated monitoring under the CQAP
Construction (Contingency)
Engineered Cap: Visual inspection 12 months after initial construction and then after defined events; Chemical monitoring schedule to be determined

M = Surface sediment sampling in MNR to benthic SCO areas
E = Surface sediment sampling in ENR areas

UR = upper reach intertidal beach play areas and potential clamming segments
Notes:
Elevated tissue concentrations expected (for resident seafood)

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Appendix A
LTMMP Quality Assurance Project Plan(s)

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Appendix B
Health and Safety Plan

100% Remedial Design, Volume II, Part VI

Appendix C
Monitoring and Inadvertent Discovery Plan

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Appendix D
Dive Plan