Lower Duwamish Waterway Group

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

Appendix F
Evaluation of Natural Recovery, Empirical Trends, and Model Predictions

Final Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

FOR SUBMITTAL TO:

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

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

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F.1 Introduction

This appendix evaluates the potential for natural recovery in the Lower Duwamish Waterway (LDW). It employs a weight-of-evidence approach to investigate the viability of natural recovery at broad spatial scales, and in specific locations, within the LDW based on available technical information, empirical data, and predictive models (see Section 5). The results of this analysis were used in two ways: 1) to evaluate whether monitored natural recovery (MNR) is a viable remedial technology applicable to the LDW, and 2) to inform the assignment of remedial technologies in developing remedial alternatives discussed in Section 8 of this feasibility study (FS).

In this appendix, the conceptual site model (CSM) of recovery potential in the LDW is presented first. Next, chemical and biological trend information is presented and compared to modeled recovery predictions. Following the discussion of trends, this appendix presents the data limitations and associated uncertainties. Last, this natural recovery evaluation is summarized according to the weight-of-evidence approach discussed in Section F.1.2 (Davis et al. 2004; NRC 2001; EPA 2005). Collectively, these assessments show that natural recovery is occurring at broad scales and in many localized areas in the LDW. Areas that are not recovering have been prioritized for remedial actions in this FS.

F.1.1 Natural Recovery and Monitored Natural Recovery

Natural recovery is used to some extent for remediating almost all contaminated sediment sites because natural attenuation processes are occurring whether an active cleanup is ongoing or not. Attenuation processes that are potentially applicable to the natural recovery of contaminants in sediment include:

- Deposition of cleaner sediment on top of existing sediment, burying contaminated sediment
- Mixing of cleaner deposited sediment with existing sediment
- Dispersion, dilution, sorption and desorption, volatilization, and diffusion
- Biodegradation and abiotic degradation/transformation.

The cumulative effect of all or some of these processes can be a reduction in contaminant concentrations in the biologically active zone, thus potentially reducing exposure and ultimately risks in all pathways that include surface sediments or benthic organisms.

MNR, as a component of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Model Toxics Control Act (MTCA) remedial actions, is different from natural recovery (discussed in this appendix) in that it includes the establishment of cleanup levels and long-term goals, the assignment of a particular time frame for achieving those goals, the use of a monitoring program to track success, and a decision framework for implementing contingency actions if needed (adaptive management; EPA 2005).

MNR as a remedial technology is discussed in Section 7 of this FS. MNR is often combined with other remedial technologies when addressing complex sediment sites. Its benefits and limitations must be balanced against those of active remedial technologies. Section 8 of this FS identifies a range of alternatives that employ MNR to varying degrees, in combination with active technologies.

This is an FS-level assessment, and further information may be required during remedial design to verify the FS conclusions regarding natural recovery potential in individual areas. It should be noted that in most of the FS, the term "recovery" refers to sediment concentrations, either on a point-basis or on an area-weighted average basis, decreasing to below particular thresholds. In this appendix, "recovery," when used in the term "natural recovery," refers to decreases in surface sediment concentrations over time and is not tied to a threshold.

F.1.2 Weight-of-Evidence Approach

A weight-of-evidence approach for evaluating natural recovery was formalized by the Remediation Technologies Development Forum (RTDF) (Davis et al. 2004). The RTDF identified five general considerations for demonstrating a site's ability to recover naturally and for MNR to be considered an effective remedial action:

- Assessment of ongoing sources, although important, is only briefly discussed in this appendix. Source control efforts are described in Section 2, and ongoing sources related to recontamination potential are discussed in Appendix J. Historical source control efforts are discussed in Section F.2.
- An understanding of the fate and transport mechanisms at the site is discussed in Section F.3 in the context of the physical CSM.
- A review of the historical record of contamination in terms of empirical chemical trends is discussed in Section F.4.
- A consideration of biological trends is discussed in Section F.5.
- The use of predictive tools (e.g., models) is discussed in Section F.6.

Each of these weight-of–evidence considerations identified by the RTDF is discussed in this appendix as it applies to the LDW, followed by an uncertainty section (F.7) and summary (F.8). Reviewing site data and using models are components of the guiding principles described in the U.S. Environmental Protection Agency (EPA) sediment guidance (EPA 2005).

F.1.3 Common Tools for Assessing Recovery

MNR has been evaluated and implemented at large and small sites over the past 10 years, with various hydrologic conditions, contaminants of concern (COCs), ongoing and historical sources, risk drivers, natural recovery processes, and remedial strategies (NRC 2001 and 2007). EPA has selected MNR as a part of the remedy for at least 15 CERCLA sediment sites nationally (EPA 2010a and 2010b, Magar et al. 2009; see Table F-1). MNR has also been selected by the Washington State Department of Ecology (Ecology) as part of the remedy for the Whatcom Waterway, Bellingham Bay, WA (Anchor QEA 2010).

Common tools used to guide the selection of MNR as a remedial technology include qualitative assessments of natural recovery processes, assessment of empirical data trends, and predictive modeling. Qualitative assessments may include identifying areas of deposition and scour and routes of sediment transport. Empirical investigations of site conditions often include collecting chemical data to estimate rates of concentration reduction in sediment and in the tissues of ecological receptors, and measuring or estimating sedimentation rates at the site, particularly where physical isolation (burial) is a key recovery process. Bathymetric soundings, radioisotope analysis, and sediment traps are tools often employed to estimate current or historical sediment deposition rates.

At most sites where MNR is evaluated, empirical data collection is often followed by modeling to interpret the data and predict future conditions. Measured sediment deposition rates are used during calibration and verification of various mechanistic sediment deposition models that are then used to predict future surface sediment concentrations. Typically, model predictions were supported by empirical time trends depicting either decreasing surface sediment concentrations over time or sediment coring data with lower concentrations in surface sediments than in subsurface sediments.

These tools have been used to develop a CSM for potential recovery trends in the LDW and to predict future contaminant concentrations. The two types of sediment chemistry data used for assessing recovery potential in the LDW are:

- Contaminant concentrations in surface sediment representative of approximately the same area sampled at different times (typically separated by several years)
- Contaminant concentration trends with depth (and therefore time) in sediment cores.

The fact that the LDW has been studied over many years offers the opportunity to assess surface sediment concentration changes over time. The use of sediment cores to evaluate chemical profiles and calculate net sedimentation rates in the LDW was documented in Appendix F of the *Sediment Transport Analysis Report* (STAR; Windward and QEA 2008). The use of core profiles to assess natural recovery is well documented at other sediment sites (e.g., Fox River, Hudson River, Passaic River, and Bellingham Bay).

Empirical sediment chemistry data for total polychlorinated biphenyls (PCBs), arsenic, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), bis(2-ethylhexyl)phthalate (BEHP), and other Washington State Sediment Management Standards (SMS) contaminants (the risk drivers) are used in the discussion of natural recovery in this appendix. Far fewer dioxin/furan data are available in the LDW, and thus this risk driver is only briefly discussed. Much of the discussion of empirical data in this appendix focuses on total PCB trends because PCBs are man-made, have a clear history of industrial use and release via a range of pathways to the LDW, were phased out of manufacture and use in the U.S. during the late 1970s, and are consistently present in the LDW. These special circumstances allow relative dating of sediments and identification of associated trends in sediment chemistry. Further, PCB trends mirror the decreasing contributions from industrial sources (and improvements in source control) within the LDW drainage basin.

Arsenic, dioxins/furans, phthalates, and cPAHs are prevalent in urban watersheds, with the latter three still being produced and released to the environment by various mechanisms. Temporal trend information associated with these contaminants is pertinent in the context of recontamination potential (evaluated in Appendix J), as well as natural recovery. The evaluation of BEHP trends, in particular, can help identify areas where ongoing sources on a broader scale have an effect on LDW sediment chemistry. These areas would need more extensive source control before goals can be achieved. Trends for these contaminants, where available, are discussed in this appendix. However, the discussion focuses on PCBs because they are expected to have identifiable trends and can be associated with particular time markers in sediment. A summary of the empirical lines of evidence discussed in this appendix is provided in Table F-2.

The final tool used to evaluate natural recovery in the LDW is a predictive contaminant model, the bed composition model (BCM; see Section F.6). The BCM predicts contaminant recovery over time in surface sediments using output from the sediment transport model (STM; see Section 5).

F.1.4 Relevant Guidance

The use of MNR as a remedial technology is described by federal and state guidance, as presented below.

F.1.4.1 Federal Guidance

EPA has issued guidance on the evaluation and use of MNR as a remedial technology at sediment sites (EPA 2005). When EPA published *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA 2005), MNR had been selected as a component of the remedial action at approximately one dozen CERCLA sediment sites (see Table F-1).

The EPA guidance states that there should not necessarily be a presumption that removal of contaminated sediments from a water body will be more effective or permanent than MNR and recommends that an evaluation of MNR as a potential remedy or remedy component should, at a minimum, generally focus on the following questions:

- Is there evidence that the system is recovering?
- Why is the system recovering or not recovering?
- What is the pattern of recovery or non-recovery expected in the future?

The EPA guidance recommends that MNR evaluations be supported by various site-specific characterization data, often with modeling, and suggests that a weight-of-evidence approach can provide a general framework for evaluating recovery potential (Section F.1.2).

EPA's Office of Research and Development has developed two technical documents related to MNR in sediments. Specifically, these documents address the determination of rates and extent of dechlorination in PCB-contaminated sediments during natural recovery (EPA 2008a) and the use of sediment core profiling in assessing the effectiveness of MNR (EPA 2008b). EPA's Office of Superfund Remediation and Technology cites eleven guiding principles when evaluating sediment sites for remedial technologies, and includes MNR as a part of combined remedies. These principles include using CSMs, managing uncertainty (e.g., with model predictions), focusing data collection, setting realistic cleanup goals, and considering interim remedies (Ells 2010).

The U.S. Department of Defense, Environmental Security Technology Certification Program (ESTCP) has also published guidance for MNR, with the issuance of *Technical Guide – Monitored Natural Recovery at Contaminated Sites* (Magar et al. 2009). This guide provides the state of the science on MNR, and describes several case studies on the use of MNR (see Table F-1).

In addition, members of the joint industry-EPA Sediments Remediation Action Team of the RTDF have developed a series of working papers on MNR (Davis et al. 2004, Dekker et al. 2004, Erickson et al. 2004, Magar et al. 2004, Patmont et al. 2003). These papers provide a recommended framework for evaluating MNR, which is used in this appendix.

Finally, the EPA National Risk Management Research Laboratory is documenting the use of effective, inexpensive remediation strategies, including MNR, for managing contaminated sediment sites. The laboratory has documented its review of the success of MNR for PCBs and for polycyclic aromatic hydrocarbons (PAHs) in two recent case studies: Wyckoff/Eagle Harbor East Superfund Site near Bainbridge Island in Puget Sound, WA, and the Sangamo-Weston/Twelvemile Creek/Lake Hartwell Superfund Site in Pickens County, SC (EPA 2008b).

F.1.4.2 State Guidance

Ecology has issued the *Sediment Cleanup Standards User Manual* (Ecology 1991). This manual indicates that one of the major elements of a sediment cleanup action is natural recovery through chemical degradation and deposition of clean sediment for areas of a site that have relatively low surface sediment contaminant concentrations. The manual also states that estimated sedimentation rates are one indicator of the potential for contaminated sediments within an area to recover naturally. Thus, in this appendix, sedimentation rates, estimated using empirical evidence and predicted with the STM, are discussed.

Ecology's manual notes that the rate of natural recovery will also be affected by the rate that ongoing sources, such as storm drains, introduce contaminants into the environment. The manual also discusses using models to predict chemical decay and burial. Burial is incorporated into the FS predictive model, described in this appendix as one of the five weight-of-evidence considerations. Appendix J discusses ongoing sources and recontamination potential.

Finally, the SMS require that natural recovery processes be considered when evaluating the restoration time frame for completing the cleanup action (Washington Administrative Code [WAC] 173-204-580(3)(vii).

F.1.5 Examples of Sites That Have Used MNR

Precedent for applying MNR as a remedial technology is supported by its use at other sites. MNR has been selected as a remedy or a remedy component for at least 15 CERCLA sediment sites nationwide (Table F-1; EPA 2010a and 2010b, Magar et al. 2009, Brenner et al. 2004, NYSDEC and EPA 2005, USACE 2007).

As noted above, the ESTCP published guidance in May 2009, which includes case studies of MNR at several contaminated sediment sites. Since issuance of this document, MNR has been selected or proposed as part of the remedy at two additional sites: the Palos Verdes Shelf and the Nyanza Chemical Waste Dump (EPA 2010b). A Record of Decision (ROD) was recently released for the Palos Verdes Shelf Superfund Site in Los Angeles County, CA (EPA 2010a).

The sites listed in Table F-1 are in various stages of monitoring, and the data show varying degrees of success. The majority of sites, where enough data have been collected to examine trends, demonstrate that they have achieved or are on trajectory to achieve cleanup goals. Although some sites exhibit fish tissue contaminant concentrations above targets, this is not different from most sediment cleanup sites that have relied on active remedies (e.g., dredging, capping). In addition, a number of other site- and remedy-related factors (such as dredging residuals and ongoing sources) can cause fish tissue contaminant concentrations to be above targets following remediation.

F.2 Source Control

Like other remedial technologies (e.g., dredging, capping, enhanced natural recovery [ENR]), the viability of natural recovery is dependent in part on the nature and magnitude of ongoing sources that may exist upon implementation of the remedy. Source control is a complex assessment, however, and should be considered in both a location-specific and site-wide context, as described in this appendix and in Appendix J.

The types of potential contaminant sources (loading) are cataloged in the remedial investigation (RI; Windward 2010) and summarized in Section 2 of the FS. This FS assumes that source control efforts, best management practices (BMPs), or the remediation itself will sufficiently address many of the potential sources of recontamination to the LDW sediment to the extent practicable. Recontamination potential based on model estimates and empirical trends within the LDW is discussed in Appendix J.

A generalized schematic of historical LDW-wide events, historical chemical uses, and source control activities, as evidenced through chemical trends and stratigraphic units in cores, is shown in Figure F-1. General conditions of the LDW related to historical pollutant sources and control efforts and ongoing source control efforts are discussed below. The section below discusses contamination from various sources that may have contributed to environmental degradation in the LDW. It also discusses how these sources have been addressed over the past 30 years. The effects of these efforts are preserved in the sediment record and provide context for the shift in common practices, BMPs, system upgrades, and other control efforts that influence the recovery of the LDW.

F.2.1 Historical Source Control Efforts in the LDW

Several reports from the 1950s through the 1970s have documented the poor condition of surface water and fish health in the LDW during this period. Historical source control efforts in the LDW have included the development of a sewer system and subsequent upgrades to this system, along with efforts to reduce contaminant inputs to the receiving water body. Although these historical source control efforts are not necessarily specifically related to LDW risk drivers or COCs, they provide context for the changes in common business and waste management practices over time. They are indicators of improvements in practices and associated reductions in contaminant releases. These actions are discussed in this section.

Prior to 1965, raw and partially treated sewage, as well as wastes from manufacturing and food processing plants, were discharged directly to the LDW (Santos and Stoner 1972). In 1935, the East Marginal trunk was constructed, diverting several raw sewage outfalls along the east shoreline of the LDW to the Diagonal Way Sewage Treatment Plant (STP), which discharged primary treated effluent to the LDW at river mile (RM) 0.55E. The STP captured combined sewer flows from most of the eastern half of the LDW drainage basin, although significant overflows occurred regularly at the old raw sewer outfall locations as the system was over capacity by World War II. In the late 1950s, the Washington State Pollution Control Commission (a predecessor of Ecology) attempted to route all untreated direct discharges from the eastern side of the LDW to the East Marginal Way sewer line, which flowed to the Diagonal Way STP. In 1958, the biological oxygen demand in the LDW and Green/Duwamish River was estimated to be 26,000 pounds (lbs) per day. Three thousand pounds of this load were discharged between Auburn and Tukwila, with the remainder being discharged within the LDW (Brown and Caldwell 1958).

Beginning in 1965, portions of the effluent to the Green/Duwamish River and LDW (not already being diverted to the Diagonal Way STP) were diverted to the Renton wastewater treatment plant (WWTP), which discharged secondary treated effluent and was located approximately 13.5 miles upstream of the LDW (Santos and Stoner 1972). In 1966, the Renton WWTP operated at 9% of its capacity, but continued to increase over time as more sewer lines were diverted to it. A 1978 report from Ecology cited a 33 million gallon per day discharge from the Renton WWTP. In 1987, an upgrade to the Renton WWTP diverted the discharge of secondary treated effluent from the Green River to a deep outfall in Puget Sound.

In 1969 and early 1970, an interceptor sewer was constructed to collect combined sewer flow that had previously gone to the Diagonal Way STP (RM 0.55 E). The interceptor sent the flow to the West Point WWTP (northwest of Elliott Bay), diverting it from the LDW (Ecology 1978). Transfer of this flow to the higher capacity system also dramatically decreased the frequency and volume of combined sewer overflow (CSO) discharges into the LDW along the eastern shoreline and eliminated several raw sewer outfalls on the western shoreline (replaced by CSOs).

These two regional "upgrades" are important source control efforts that were initiated in the 1970s and 1980s. Prior to 1987, concentrations of coliform bacteria, indicators of raw sewage, typically measured more than 1,000 colony forming units (CFUs) per 100 milliliters (mL) at the King County long-term surface water monitoring station at RM 3.4 (Mickelson 2009). Since 1987, coliform bacteria counts have declined (although data are not directly comparable), with newer data ranging from 1 to 830 CFUs/100 mL (with one outlier at 4,000 CFUs/100 mL).[1] Phytoplankton blooms were frequently reported in the LDW in the 1960s (Welch 1969); currently (in the 2000s), blooms are absent, indicating an improvement in water quality, an increase in dissolved oxygen concentrations, a reduction in nutrient loading, and better source controls. Although coliform bacteria are not considered COCs, reductions in their levels indicate successful source controls that likely also reduce levels of other constituents (i.e., they are indicators of improving conditions).

The development of the Municipality of Metropolitan Seattle (Metro) regional sewer system has reduced the flow of untreated or poorly treated wastewater flowing to the Duwamish River and the LDW by 23,000 million gallons per year since its founding in 1958. The remaining CSO flows have been reduced by 77% since 1990 to an average of 180 million gallons per year.

In addition to the sewer system development and upgrades, many significant source control efforts have been undertaken in the LDW and in the broader Puget Sound region to reduce inputs of contaminants to receiving water bodies. The effectiveness of those efforts has been demonstrated by decreasing sediment concentrations. Some of the more concerted efforts over the last 50 years include the following:

- In the late 1950s, the Pollution Control Commission conducted an investigation of pollution in the Green/Duwamish River (PCC 1955) and subsequently required all direct discharges into the LDW from the eastern shore upstream of RM 0.5 to hook up to the local East Marginal Way sewer that flowed to the Diagonal Way STP. This included much of the heavy industry along the LDW at the time.
- Metro conducted a series of efforts to identify and control sources in the LDW from the late 1970s to the mid 1980s. Documents covering this work include: *Toxicants of Urban Runoff* (Galvin and Moore 1982), *Water Quality Assessment of Duwamish Estuary* (Harper-Owes 1982), and the *Toxicant Pretreatment Planning Study* (TPPS; Metro 1983a). These studies led to the *Duwamish Clean Water Plan* (Metro 1983b) and the *Duwamish Industrial Non-point Source Investigation* (Metro 1985).
- The Puget Sound Estuary Program conducted the Urban Bays Studies, which produced the Elliott Bay Toxics Action Program, including an *Evaluation of Potential Contaminant Sources* (PTI Environmental Services and Tetra Tech 1988) and the *Elliott Bay Action Plan* (PTI Environmental Services 1988).

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[1] Per the Washington State Department of Health, Office of Shellfish and Water Protection, the water quality standard for shellfish growing is less than 14 organisms per 100 mL (geometric mean). The 90th percentile is less than 43 organisms per 100 mL (WDOH 2009).

- Quemetco Inc.'s former lead smelter on Harbor Island adjacent to the LDW began secondary lead smelting operations in 1937. The smelter, which reclaimed lead from automobile and industrial batteries, ceased operations in April 1984. During its time in operation, Quemetco was a source of fugitive dust emissions and groundwater contamination. The state established air quality standards for lead in 1978. Source control upgrades were implemented in 1980. Soil sampling conducted in parking areas near Quemetco in 1979 and again in 1982 by the Puget Sound Air Pollution Control Agency (PSAPCA) found a 60% decrease in soil lead content between the two sampling events (PSAPCA and Ecology 1983).

- Ecology developed stormwater regulations in the early 1990s that gave authority to local jurisdictions to make the introduction of pollutants to surface waters illegal and required stormwater BMPs to be implemented for all pollutant-generating activities. The regulations also required new developments to include stormwater treatment. Ecology continues to update the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit requirements, which have increasingly led to advances in monitoring, BMPs, operation and maintenance, and treatment studies. Stormwater pollution prevention plans are developed by permittees to implement these requirements.

- The Port of Seattle and the Puget Sound Clean Air Agency developed the "Scrappage and Retrofits for Air in Puget Sound" program in November 2009. Through the end of 2010, 276 trucks were retired through the program. Through the buy-back efforts and by also retrofitting exhaust systems of newer trucks, tailpipe emissions (including diesel particulate matter) from trucks visiting Seattle ports have been greatly reduced (Port of Seattle 2010a; Takasaki, personal communication, 2011).

- In 2004, the Port of Seattle, Ecology, and the Northwest Cruise Ship Association signed a Memorandum of Understanding (MOU) setting strong standards for the treatment of waste discharges from cruise ships operating in Washington waters. This voluntary agreement exceeds the federal requirements that ordinarily apply to cruise ships. The MOU prohibits discharges of untreated wastewater within Washington waters. The MOU also prohibits discharges of treated black water and treated gray water unless it is from an Advanced Wastewater Treatment System (Port of Seattle 2010b).

- In 2005, the Port of Seattle berth for cruise ships at Terminal 30, just north of the LDW, was retrofitted with shore power. In 2009, when use of Terminal 30 as a cruise terminal was ceased, shore power was moved to Terminal

90/91. Shore power allows ships to turn off their internal power systems while berthed, reducing emissions by an estimated 30%. Those emissions could affect the LDW and Elliott Bay through atmospheric deposition onto the drainage basins (Port of Seattle 2005; Takasaki, personal communication, 2011).

- Ships at the Port of Seattle have reduced emissions of sulfur dioxide by at least 80% and diesel particulate matter by 60% through an innovative program called At-Berth Clean Fuels. Vessels participating in the program agree to use low sulfur fuel (0.5% or less) in their auxiliary engines while docked in Seattle. In exchange, the Puget Sound Clean Air Agency helps defray the cost of the more expensive low sulfur fuel by providing participating vessels with $1,500 for each port call (Port of Seattle 2009).

F.2.2 Ongoing Source Control Efforts in the LDW

Potential ongoing sources to the LDW are discussed in Section 2 and are evaluated as recontamination potential in Appendix J. A representation of lateral sources (watershed runoff, outfall discharges, and atmospheric deposition on drainage area land) is included in modeling estimates of lateral loads used in the BCM. The chemical input parameters used in the BCM for lateral sources were derived from samples collected over the past ten years by the City of Seattle, King County, and The Boeing Company. These data include whole-water samples collected from outfalls and sediment samples collected from storm drains (in-line sediment traps and grab samples) and catch basins. These values, as used in the BCM modeling process, are discussed in Section 5 and Appendix C.

Ecology is the lead entity for implementing source controls in the LDW and works in cooperation with local jurisdictions and EPA to create and implement source control strategy and action plans and to prioritize upland cleanup efforts in the LDW. The LDW source control strategy (Ecology 2004) describes how recontamination of LDW sediments will be controlled to the maximum extent practicable. The goal is to limit sediment recontamination that exceeds site-specific standards, where feasible. The LDW source control efforts are designed to identify and manage sources of contaminants to waterway sediments in coordination with sediment cleanups. Section 2.4 describes the scope, goals, and schedule for the source control work in the LDW and other regional source control efforts.

F.2.3 Historical Trends in Puget Sound

Contaminant trends in surface sediments (over time) and in sediment cores (by depth) at sites outside of the LDW provide evidence of regional or global trends in contaminant use, transport, and natural recovery. Additionally, the methods used at other locations establish precedence for the methods employed in the LDW.

Natural recovery is evident in Puget Sound sediments that are not being affected by new inputs from localized sources. Production of PCBs was banned in 1979 in the United States, and subsurface sediment contaminant trends by depth in Puget Sound mirror the PCB use pattern. Other contaminants related to industrial processes exhibit similar trends that are related to regulations requiring source control measures that have been put in place since the 1980s, such as good housekeeping practices, waste disposal, and wastewater treatment (Figure F-1).

Researchers from Battelle (Brandenberger et al. 2008) have collected sediment cores in Puget Sound during three events (1982, 1991, and 2005) and compared the depths of stratigraphic markers within these cores. A regression of the depth of this stratigraphic marker versus elapsed time (between sample events) indicated that cleaner sediments are burying historically more contaminated sediment at a rate of approximately 1.3 ± 0.1 centimeters per year (cm/yr) in a set of cores collected in Puget Sound near Tacoma (PS-1 core set). These rates were comparable to rates derived from the radioisotope (lead-210) profile in the 2005 core alone and confirmed the validity of this widely used radioisotope technique (Brandenberger et al. 2008). Radioisotope cores were thus used as one line of evidence to estimate net sedimentation rates in the LDW (Appendix F of the STAR; Windward and QEA 2008).

The data from the Battelle coring studies were also used to predict simplistic natural recovery rates for the 20th and 21st centuries using a regression that estimated surface sediment chemistry over time (based on trends from core data). This regression method has revealed that 21st century recovery rates are non-linear and have slowed from the 20th century rates. This provides a basis for calculating separate 21st century recovery rates, which predict lead recovery to pre-industrial levels near Seattle (PS-4) by 2050 ±20 years and copper by 2020 ±10 years. The identification of two different recovery rates supports the use of two different trend analyses in cores in this appendix: historical trends evaluated throughout the entire depth of the core, and 21st century rates found through trends in the top two intervals.

An exception to this is arsenic. Arsenic has already shown recovery in the Elliott Bay core set (PS-4) as a result of removing a known point source in Ruston, the ASARCO smelter, whose aerial plume is known to have contaminated a broad downwind area. Arsenic concentrations in sediment cores increased above background beginning around 1900, peaked around 1960, and decreased significantly following the smelter closure in 1986 (Brandenberger et al. 2008).

The Battelle coring studies tracked recovery rates of metals above the natural background versus estimating an absolute natural recovery rate (which cannot be estimated because arsenic, for example, occurs naturally in sediment). The study indicated that the natural background concentration of arsenic in Puget Sound sediments is 8.57 ±1.5 milligrams per kilogram dry weight (mg/kg dw). The arsenic recovery rates in the Battelle study are consistent with the arsenic recovery rates in the

LDW. These recovery rates are not as pronounced as PCB recovery rates, because arsenic concentrations cannot fall below natural background.

F.3 Physical Conceptual Site Model of Natural Recovery Mechanisms in the LDW

This section describes the CSM-based physical site conditions and how they relate to natural recovery potential in the LDW. The CSM for natural recovery in the LDW assumes that burial of contaminated sediment by cleaner sediment (transported from the Green/Duwamish River), combined with active vertical mixing in the biologically active zone (upper 10 cm) are the primary recovery mechanisms.[2] Deposition of cleaner material over existing contaminated surface and subsurface sediment limits the contaminated material from coming into contact with the water column (by burial, which decreases diffusion and advection of contaminants to the water column) and thereby eventually reduces exposure of human and ecological receptors to contaminants. In general, burial is more rapid in areas with moderate to high net sedimentation rates and slower in areas with either low net sedimentation rates or with the potential for significant scour.

For the CSM, the LDW is divided into three reaches (QEA 2008), each of which has distinct physical properties and recovery potentials (Figures 2-8a through 2-8c show the features of these reaches).

- **Reach 1** is downstream (north) of RM 2.2. A saltwater wedge (which can protect the sediment bed from significant erosion) is located in this reach during all flow and tidal conditions. Overall, this reach is net depositional. Both model and empirical data show that net sedimentation rates in this reach range from relatively low, on the order of 0.5 cm/yr in intertidal areas, to moderate on the order of 1 to 2 cm/yr in subtidal areas. This reach would not likely be subject to scour during the most aggressive high-flow event (the 100-year, spring-tide, high-flow) except perhaps in a few localized areas. While vessel traffic is common in this reach, maintenance dredging rarely occurs in the authorized navigation channel or berthing areas because depths are sufficient for navigation.
- **Reach 2** extends from RM 2.2 to RM 4.0 and includes the toe of the saltwater wedge during high-flow events; the saltwater wedge extends even farther upstream during average-flow conditions. The toe of the saltwater wedge is pushed downstream of this reach (to roughly around RM 1.8) only during extreme flow events (100-year high-flow event and greater). Reach 2 is

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[2] The STM can be used to predict these mixing and burial processes. The BCM (see Section 5 of the FS) estimates changes in the contaminant composition of surface sediment (upper 10 cm) over time. Mechanics of the BCM are described in Appendix A.

narrower than Reach 1, and portions are subject to some scour during high-flow events, but this reach is net depositional on an annual basis. The deepest estimated scour depth (22 cm) during the 100-year high-flow event is at RM 3.1. Berthing areas are periodically dredged in this reach.

- **Reach 3** is upstream of RM 4.0. Flow in portions of this reach is characteristic of a freshwater tidal river during high-flow events. This reach is occupied by the saltwater wedge only during low- and average-flow conditions. This reach is also net depositional on an annual basis. Both model and empirical data indicate that the navigation channel and Upper Turning Basin located in Reach 3 have higher net sedimentation rates than other areas of the LDW. This is also supported by the need for frequent dredging events (every two to four years) conducted in this reach by the United States Army Corps of Engineers (USACE) to maintain authorized navigation depths. This dredging creates a disequilibrium that results in a net depositional environment.

The CSM also includes the assumption that the human health risk drivers (total PCBs, arsenic, cPAHs, and dioxins/furans) are not subject to significant degradation by natural biotic or abiotic chemical reaction processes and do not readily desorb into the water column or volatilize. Therefore, in the absence of active remediation, burial of surface sediments containing these contaminants is the primary mechanism for risk reduction. Arsenic is a metal and is therefore not subject to degradation. cPAHs may degrade slowly, but can continue to enter the LDW from nonpoint sources. Organochlorine compounds, such as PCBs and dioxins/furans, degrade only very slowly in the sediment environment (see Section 5). The desorption of PCBs from sediment particles is limited by their low solubility and high hydrophobicity and by the organic carbon content and type of sediment.

Because burial by clean sediments is the primary mechanism for risk reduction, the CSM acknowledges that both the rate and extent of natural recovery in the LDW are influenced by existing and future sources of contaminants and the extent to which sources are controlled. Source control is important to the success of natural recovery and to the success of all remedial technologies contemplated for the LDW.[3]

Finally, bed stability is of central importance to natural recovery in the LDW and is an important element of the CSM. In the absence of navigational uses of the LDW and assuming effective source control, rates of natural recovery in the LDW would be tied predominately to sedimentation rates and to erosion potential during high-flow events. Under current and foreseeable future use conditions, both natural erosional events and scour from ship propellers are expected to have some localized effects on recovery. This stems from the simple notion that sources of scour, if sufficiently energetic, can make

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[3] It is one of the five key lines of evidence discussed in this appendix (see Table F-2).

subsurface sediment available to receptors on at least a localized and temporally limited basis. The location and magnitude of predicted scour are important considerations in determining where risks of recontamination may be unacceptably high, and are therefore factored into the remedial alternatives developed and presented in Section 8.

F.3.1 Sedimentation

Net sedimentation is the net effect of sediment deposition and erosion, expressed as a rate of cm/yr. Estimates of net sedimentation are important for understanding and gauging natural recovery potential.

F.3.1.1 Net Sedimentation Rates Estimated from Sediment Cores

Empirical evidence of net sedimentation over time is contained in the signatures of chemical and physical markers found in sediment cores collected throughout the LDW. Trends in the chemical and physical properties in sediment cores were evaluated as a function of time, where the sampled depth intervals could be assigned a time frame during which the particular sediment was deposited. The amount of sediment that accumulated above the base time-calibrated depth of each viable core was used to estimate a net sedimentation rate (Windward and QEA 2008).

The empirically derived net sedimentation rates are based on numerous lines of evidence observed in cores, including:

- Stratigraphic units
- Radioisotope analyses (cesium-137, lead-210)
- Chemical profiling.

Of the 62 cores evaluated in the STAR and used to calibrate the model (Windward and QEA 2008[4]), net sedimentation rates could be estimated for 55 cores, and those rates ranged from 0.7 cm/yr to >3 cm/yr (see Table F-3 and Figure F-2). The other 7 cores did not have discernible markers from which rates could be calculated. This lack of markers indicates possible mixing of sediment or contributions from ongoing sources. Overall, the 55 cores with markers demonstrate that sedimentation is occurring in the LDW. These trends alone do not indicate natural recovery is necessarily occurring because the sediments responsible for burial may have high contaminant concentrations. Further, empirical chemical data and BCM predictions (discussed in Sections F.4 and F.6, respectively) must also be evaluated to estimate natural recovery potential, because mixing mechanisms (e.g., bioturbation) can also play a role in natural recovery by causing recently deposited material to commingle with older underlying contaminated material.

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[4] Approval of the STAR by the EPA was documented in a January 25, 2008 letter.

An additional set of 19 cores (beyond the 62 mentioned above), collected as part of the early action area (EAA) investigations, was also evaluated for net sedimentation rates (Table F-3 and Figure F-2). The estimated net sedimentation rates from these core data were generally >1 cm/yr, which demonstrates that sedimentation occurs in the EAAs. However, in these particular areas, active remediation may be necessary to remove or isolate sediments with high contaminant concentrations, because the net sedimentation rate may not be sufficient for natural recovery to occur within a desired time frame.

Other observations of the evaluated cores lend additional qualitative support to the marker-based sedimentation rate calculations. Man-made debris, fill material, and sheen were often observed approximately 1 ft or more below the mudline. This is indicative of burial by soft, recent sediments over older debris-impacted sediments. Twelve of the 56 cores collected in 2006 by LDWG for the RI contained multiple (or scattered) pieces of debris (see Section 2). The shallowest debris in 9 of these 12 cores was at least 1 ft deep. Some debris was found as deep as 13 ft. These observations indicate that burial has occurred in the past and is likely still occurring.

Further, accumulations of soft sediment were frequently observed, an indication of quiescent and/or relatively stable environments where lower energy flow regimes allow deposition of finer-grained sediment. Thicknesses of "recent" soft sediment varied from 0.1 ft (SC-2 at RM 0.2) to 13 ft (SC-17 at the head of Slip 1).

F.3.1.2 Net Sedimentation Rates Estimated by the STM Compared to Rates Estimated by Cores

The STM estimates net sedimentation rates in the LDW based on grain sizes, sediment loading from lateral and upstream sources, and the historical flow regime of the Green/Duwamish River (QEA 2008). The net sedimentation rates estimated by the STM are shown in Figure F-2.

The net sedimentation rates estimated by the STM were compared to those derived from the empirical data. In general, the empirically derived net sedimentation rates shown in Table F-3 were consistent with those of the STM. Net sedimentation rates were evaluated for 62 cores (56 RI cores and 6 historical cores), with 55 of these cores having identifiable markers. The net sedimentation rates estimated for 45 of these 55 cores match or exceed the net sedimentation rates estimated by the STM. The middle value in the range of net sedimentation rates calculated for each core was compared to the STM-estimated net sedimentation rate in a one-to-one comparison. Figure F-2 shows the locations of all cores for which net sedimentation rates were calculated, along with the STM-estimated net sedimentation rates. Figure F-2 also provides information on the nine[5] cores with rates lower than those estimated by the STM and the one core outside of the model domain. These inconsistencies are typically associated with physical

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[5] Figure F-2 contains text boxes for 10 cores. Nine cores have estimated net sedimentation rates lower than those estimated by the STM. One core, LDW-SC11, is outside of the model domain.

features and/or events not accounted for in the model (e.g., dredging events, bridge structures, pilings or other overwater structures, and localized scour events from vessel traffic). Overall, the good match between cores and STM estimates adds confidence to the understanding of the physical mechanisms of the LDW and the utility of the STM to track the fate and transport of sediment particles throughout the LDW.

Net sedimentation rates estimated from the radioisotope cores shown in Figure F-2 also have generally good agreement with the rates estimated from the STM (QEA 2008). The methods of collecting and evaluating these cores are described in the STAR (Windward and QEA 2008).

In summary, because net sedimentation rates from the STM generally agree with empirical data, STM-derived sedimentation rates are used in conjunction with the BCM to predict future concentrations. Areas where discrepancies are noted (as shown in Figure F-2) are tracked and managed in assigning recovery categories (Section 6 and Section F.3.2) and assigning remedial technologies (Section 8).

F.3.2 Recovery Categories

Physical conditions were used as lines of evidence to identify areas where natural recovery is predicted, less certain, or presumed limited. A recovery category represents areas of the LDW that share similar characteristics (i.e., net sedimentation rates, scour potential, berthing areas, plus empirical trends) that could affect the extent to which recovery can occur. The three recovery categories as defined for this FS are:

- **Category 1** includes areas where recovery is presumed to be limited. It includes areas with observed and predicted scour, net scour, and empirical data demonstrating increasing concentrations over time.
- **Category 2** includes areas where recovery is less certain. It includes areas with net sedimentation and mixed empirical contaminant trends.
- **Category 3** includes areas where recovery is predicted. It includes areas with minimal to no scour potential, net sedimentation, and empirical trends of decreasing concentrations.

Section 6 provides a detailed discussion of recovery categories, including the methods and criteria for delineating these categories using the lines of evidence discussed in this section. Section 8 uses these recovery categories when assigning remedial technologies.

F.4 Natural Recovery Potential in the LDW Based on Empirical Contaminant Concentration Trends

Empirical information obtained from the LDW is discussed in this section as it relates to ongoing natural recovery. This information demonstrates that sedimentation is occurring and that, in general, total PCBs and other contaminants in the surface sediment are decreasing on an LDW-wide basis. Empirical lines of evidence are summarized in Table F-2 and discussed below. Total PCB and other SMS contaminant trends in resampled surface sediment locations and in the top two intervals of cores were used on a case-by-case basis to adjust recovery category delineations based on physical criteria (Table 6-3). As noted above, areas with decreasing trends were assigned to Recovery Category 3; areas with mixed results were assigned to Recovery Category 2; and areas with increasing trends were assigned to Recovery Category 1.[6]

F.4.1 Changes in Surface Sediment Contaminant Concentrations

Changes in surface sediment contaminant concentrations over time provide a strong indication of natural recovery potential. These changes can be observed in unremediated/undisturbed locations that have been sampled at different times. Surface sediment data presented in this section include:

- Population and location-by-location chemical trends of resampled surface sediment locations site-wide (see Section F.4.1.1)
- Results from established monitoring locations around the perimeter of the Duwamish/Diagonal EAA that have been sampled from 2003 to 2009 (see Section F.4.1.2)
- General temporal trends in surface sediment data collected in and around the Slip 4 EAA (see Section F.4.1.3).

In this analysis, it is important to consider the analytical accuracy and precision when comparing surface sediment contaminant concentrations between locations. Analytical variability between locations can commonly be as high as 25%, even between two analyses of the same sample. Field replicate variability reported in the RI ranged from 8% (arsenic) to 48% (cPAHs).[7] Thus, location-specific conclusions when comparing sample results from one location that were collected at different times, and potentially with different sampling or analysis methods, must be used cautiously. In contrast, comparing populations of resampled data is a more statistically powerful analysis; however, this analysis (evaluation of the entire LDW-wide population) can only lead to conclusions regarding large spatial areas. Therefore, this appendix evaluates recovery at two scales: site-wide trends and location-by-location trends.

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[6] These criteria were generally used to assign recovery categories, but best professional judgment was used in some of these assignments, for example when ongoing sources may have been contributing to mixed chemical trends. Category 3 can also include empirical trends demonstrating a mixture of decreasing contaminant concentrations and equilibrium. Predictions of future sediment conditions based on the BCM were not used in the assignment of recovery categories.

[7] Field replicate variability for total PCBs was 39% and for BEHP was 18%. These findings are reported in Section 4.2 of the Final RI (Windward 2010).

F.4.1.1 Analysis of Resampled Surface Sediment Locations

Evidence of natural recovery was based on surface sediment locations that have been resampled (newer stations needed to be within 10 ft of the original sampling location). Seventy locations have been resampled at various times for PCBs. Older data at each location were collected in 1991 through 2006, while the newer data were collected in 1998 through 2008, with an average time interval of seven years between samples at any location. Locations resampled for arsenic, cPAHs, and BEHP are also discussed herein; however, fewer locations were compared for these COCs (n = 56, 53, and 53, respectively) because some of the older samples were analyzed only for PCBs.

F.4.1.1.1 Analysis of Population Trends for Resampled Locations

Generally, observations of increasing or decreasing concentrations (i.e., trends) at resampled locations vary by COC and location (see box plot Figures F-3a and F-3b and Table F-4a).

Of the 70 locations where resampled data are available for total PCBs, summary statistics were generated for 67 locations,[8] with the older data being summarized separately from the newer data at each location. Comparison of the total PCB summary statistics of the newer data to the older data (for the 67-location dataset) revealed a 62% decrease in the mean total PCB concentration. As shown in Table F-4a, the 25th and 90th percentiles of these datasets also decreased by more than 30% and 60%, respectively. These data show that, on average, areas with both high and low initial PCB concentrations are experiencing recovery.

Summary statistics were also developed for 53 to 56 locations for arsenic, cPAHs, and BEHP. For arsenic, these data show that concentrations remain relatively unchanged, while concentrations of cPAHs and BEHP exhibit decreases at resampled locations, especially at stations with higher initial concentrations. The means for the cPAH and BEHP datasets decreased by 72% and 63%, respectively (Table F-4a).

These datasets were also evaluated for significant differences between the older and newer populations of data through a Wilcoxon-Mann-Whitney test (Table F-4b). The test found that the older datasets for total PCBs (70 locations) and arsenic were not significantly different from the newer datasets for these two risk drivers. However, when three total PCB samples at RM 3.7E were excluded,[9] and the populations were compared in a hypothesis test that assumes the samples are paired (related), a significant difference was identified for total PCBs. The box plot (Figure F-3a) illustrates lower concentrations in the newer data as compared to the older data for both data

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[8] Three outlier samples at RM 3.7E were removed from the dataset because the statistical software ProUCL identified them as outliers (using the Rosner test). Statistics were run with and without the outlier data points.

[9] Maximum value of newer data when all locations were included was 13,000 µg/kg dw. When the three outliers are excluded, the maximum value of the newer data was 5,100 µg/kg dw.

treatments (i.e., one dataset with all samples included [n = 70] and one dataset with the three outliers removed [n = 67]).

The differences between the older and newer populations of cPAH and BEHP data are significant (Table F-4b). Although, on a population basis, these COCs display significant decreases, they have fewer individual locations that exhibit decreases (≥50%) compared to the total PCB trends (as discussed in the following section). This is likely due to localized effects from ongoing sources.

Resampled surface sediment locations with total PCB data were also evaluated on a reach-by-reach basis (Figure F-3b). Within each reach, the population of data is trending toward lower concentrations, with the greatest decrease in concentrations observed in Reach 3.

F.4.1.1.2 Location-by-Location Comparisons at Resampled Locations

In areas where net sedimentation is occurring, it is expected that historically-elevated concentrations will decrease over time, unless a nearby ongoing source is identified or the surface has been disturbed. Further, in areas where the older concentrations were comparatively low, either little or no change in concentrations is expected. Figure F-4 and Table F-5a show changes in total PCB concentrations at resampled surface sediment locations. Locations were also evaluated for temporal changes in arsenic, cPAH, and BEHP concentrations (Figures F-5 through F-7, respectively, and Tables F-5b through F-5d, respectively). Trends were evaluated at each resampled location for any SMS contaminant (other than total PCBs, arsenic, or BEHP) with a detected sediment quality standard (SQS) exceedance in either the older or newer sample (Tables F-5e and F-5f, respectively).

Defining a Percent Change for Sample-to-Sample Results

If concentration changes for the resampled locations are small, it can be difficult to discern if the change is significant. These locations may be in equilibrium; slight increases or decreases may result from site heterogeneity, analytical variability, or ongoing sources. In Tables F-5a through F-5f, which display concentration changes on a location-by-location basis, concentration changes must be greater than 50% for the location to be considered as exhibiting a decrease or increase. The location is described as being in equilibrium when concentration changes are less than 50%.

Among samples with numerous SMS exceedances, concentrations were categorized as decreasing if all SMS contaminants with detected SQS exceedances had concentration decreases of 50% or more. This degree of change is an indication that natural recovery might be occurring in the sample area. Locations with concentration changes of less than 50% and those with mixed results by SMS contaminant were identified as "equilibrium/mixed." See Section F.7.1 for a discussion of uncertainty in distinguishing trends between paired samples.

Total PCBs

For the total PCB dataset (a total of 70 resampled locations), 60 of the locations include data collected 5 or more years apart (Table F-5a). For locations where total PCB concentrations exceeded 1,300 micrograms (µg)/kg dw in the initial sample (11 locations with 5 or more years between samples), recovery trends for 10 of the locations are pronounced (decreases ranged from 56% to 98%). For locations where the original total PCB concentration was between 240 and 1,300 µg/kg dw (17 locations with 5 or more years between samples), 7 show recovery trends (greater than 50% decrease), 6 show minimal change, and 4 show concentration increases (by at least 90%).[10]

For locations where the original total PCB concentration was below 240 µg/kg dw, most locations are in equilibrium or have concentration increases. When initial concentrations are lower, recovery is less evident because:

- A 50% concentration change relative to a low initial concentration, especially at concentrations below 100 µg/kg dw, may be within the range of analytical variability. Detection at low concentrations may be beyond the precision of some analytical techniques (i.e., some techniques are not able to accurately quantify concentrations this low).
- Concentrations of newly deposited sediment are similar to existing bed sediment. Because recovery is largely based on burial by cleaner sediment, when the difference in concentration between the initial bed sediment and the incoming deposited sediments is low, the decrease in bed sediment concentration from deposition of this incoming sediment will not be substantial. At low concentrations, an area may be considered "in equilibrium" with surrounding sediment concentrations.

When PCB trends are reviewed on a reach-by-reach basis, it is clear that the greatest rate of recovery is observed in Reach 3, and the lowest rate of recovery is observed in Reach 2 (Table F-5a; Figure F-3b). However, all three reaches show increases and decreases in concentrations at individual locations. Reach 3 has the highest percent reduction in total PCB concentrations (90% decrease in average initial concentration compared to newer concentration). Reach 2 has a higher percentage of sample locations with no significant change compared to other reaches (only 29% decrease in the average PCB concentration); this area exhibits the most net erosion and the greatest number of hot-spot areas. These observations align with the CSM, which identifies Reach 3 as having both high net sedimentation rates and as receiving sediment sourced from upstream, and Reach 2 as experiencing both significant high-flow scour and lower sedimentation. However, locations in all recovery categories, even in areas subject to

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[10] Only the surface sediment locations with SQS exceedances in either the older or newer sample were used in the delineation of recovery categories and shown in Figure F-8 and Figures F-22a through F-22c.

scour (Recovery Category 1), are showing decreasing concentrations in samples collected (on a location-by-location basis; Table F-5a).

Other Risk Drivers

Sample locations with higher initial concentrations showed the greatest concentration decreases, especially for historical industrial chemicals (e.g., PCBs). On the other hand, sample locations with mixed results (meaning some increasing concentrations and some decreasing concentrations) are generally observed for urban-related, non-point source contaminants, such as cPAHs and BEHP. At lower concentrations, it appears that a state of equilibrium is reached where concentrations change by less than 50% within sample pairs.

Table F-5b illustrates that arsenic samples are generally in equilibrium, with some decreases noted at higher concentrations, above the cleanup screening level (CSL) of 93 mg/kg dw. Table F-5c illustrates lower concentrations for cPAHs among new samples compared to older samples for concentrations above about 500 µg toxic equivalent (TEQ)/kg dw. Most cPAH samples below a starting concentration of 500 µg TEQ/kg dw are at equilibrium.[11] This equilibrium may change in the future as source control and sediment cleanup efforts continue. Table F-5d illustrates steadily decreasing BEHP concentrations at most locations that were above 460 µg/kg dw. Samples were also grouped by reach and by recovery category with similar results.

As shown in Table F-5e, most concentrations have decreased over time (at least 50% concentration change) in the resampled locations where the older samples had SQS exceedances. For locations having SQS exceedances in the newer sample, concentration changes were either increasing or in equilibrium. Many of the newer samples were analyzed for benthic toxicity and have passing results (Table F-5f). Of the 58 resampled surface sediment locations evaluated for trends in SMS contaminants other than total PCBs, 38 had an SQS exceedance in either the older or newer sample. Of those 38:

- Eighteen have decreasing trends (>50% decrease) for all SMS contaminants evaluated (i.e., all SMS contaminants, except total PCBs, with SQS exceedances).
- Eleven have increasing trends.
- Nine have either mixed results or are in equilibrium (Figure F-8). Of these nine locations, five have mixed results.[12] One location has benzyl alcohol decreasing and 2,4-dimethylphenol increasing.

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[11] Most locations with starting concentrations below 500 µg TEQ/kg dw are coded white in Table F-5c either because the change in concentration is at equilibrium (less than 50% change) or because fewer than 5 years have elapsed between sampling events.

[12] At some locations, PAHs were decreasing while phthalates were in equilibrium; other locations showed the reverse.

Summary

Based on these results, recovery is expected to certain degrees for all of the contaminants evaluated. However, how much concentrations of certain contaminants can decrease is likely limited because some occur naturally in soils and sediment (e.g., arsenic); some are in watershed soils from atmospheric deposition of particulates from emissions (e.g., arsenic, dioxins/furans, and cPAHs); or some are released from nonpoint urban sources (e.g., cPAHs, dioxins/furans, and phthalates). Discussions of recontamination and potential recovery limits are presented in Appendix J.

Sample locations with concentration increases[13] are generally within areas with ongoing sources and/or exhibiting low sedimentation rates. These areas are also generally not predicted to recover based on BCM outputs. These areas are designated as Recovery Category 1 (Section 6) and are prioritized for active remediation in the remedial alternatives presented in this FS. Where increasing empirical trends are outside of Recovery Category 1, these trends are believed to be due to ongoing sources, not due to internal mechanisms, such as scour.

F.4.1.2 Duwamish/Diagonal Trends

Monitoring data collected around the Duwamish/Diagonal EAA cleanup action lend empirical support to natural recovery occurring in the LDW. This project involved a combination of dredging and capping in 2003 to 2004, and thin-layer sand placement (ENR) in 2005. Surface sediment chemistry is being monitored on and adjacent to the actively remediated areas of this EAA. This section presents surface sediment chemistry data collected peripheral to the actively remediated area (Figure F-9 and Table F-6).

These data suggest that contamination from resuspension and dispersal during the dredging operation may have been responsible for total PCB concentrations increasing for a year after dredging and then recovering to predredge concentrations. Overall, total PCB concentrations have declined by 50% or more at five of the eight perimeter locations, presumably as a result of natural recovery processes. Although four of the eight stations remained at or above the SQS (12 mg/kg organic carbon [oc]) for total PCBs in 2009, concentrations are decreasing over time (Table F-6). The average concentration of the perimeter stations graphed in Figure F-9 had already decreased (after 5 years) to below modeled predictions of recovery 10 years following remediation (Stern et al. 2009).

Location DUD_8C is notable because, although it has a 47% concentration reduction from 2003 to 2009, it had a considerable concentration increase in 2009 compared to other years post-ENR (2006 to 2008). This location has been used repeatedly for the collection of both parent and field replicate samples (10 double Van Veen grabs for each

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[13] Figures F-4 through F-7 display resampled locations by the absolute concentration changes. Figure F-8 and Tables F-5a through F-5f display percent change in concentration (minimum of 50%) relative to the starting concentration.

monitoring period). A depression formed in this area may be due to the volume of sediment removed during these monitoring events. Other possible explanations for this depression include disturbances from tug traffic and from tidal action. A comparison of 2004 to 2009 bathymetry in the *Duwamish/Diagonal Sediment Remediation: 2009 ENR Physical Monitoring* Memorandum (Anchor QEA 2009; Appendix A of King County 2010) reveals a small area of deepening bathymetry in this general location. It is believed that data in this area represent contributions from older sediment that was below recently deposited sediments but has been exposed. Unpublished PCB data from 2010 sampling at this location indicate that the total PCB concentration had decreased by approximately 67% from that observed in 2009 (personal communication, D. Williston 2010) indicating the area is continuing to recover after the episode that exposed higher subsurface contamination.

Table F-6 also displays trends in the eight perimeter monitoring locations for arsenic, cPAHs, and BEHP. All samples collected in 2009 have arsenic concentrations that are below the SQS, and arsenic concentrations are decreasing over time at six of these locations (from 2003 to 2009). cPAH concentrations are decreasing over time at all locations. For BEHP, one of the eight perimeter stations exceeded the SQS in 2009. Seven of the eight perimeter stations have post-remediation BEHP concentration decreases (more than 50%) from 2003 to 2009, and five of the 2009 samples were undetected for BEHP. This overall trend is used to assign this area to Recovery Category 3.

F.4.1.3 Slip 4 Population Trends

Additional empirical data supportive of natural recovery occurring in the LDW are available from the Slip 4 surface sediment dataset, as shown in Figure F-10. This figure shows where surface sediment samples were collected and analyzed for total PCBs within Slip 4. These data were divided into two groups, representing conditions observed before 1999 and conditions observed in 2004. The two datasets were analyzed statistically and determined to be significantly different ($p<0.05$; Mann-Whitney two-sample test). The mean total PCB concentration in the 2004 dataset (1,400 µg/kg dw) is less than one-half the mean concentration of the pre-1999 dataset (3,300 µg/kg dw). Although the samples are not co-located, these two groups of samples reveal concentration decreases over time, and this trend is used to assign this area to Recovery Category 3.

F.4.2 Contaminant Concentration Trends with Depth

Profiles of contaminant concentration with depth (and therefore time) are an additional line of evidence for natural recovery. Empirical evidence of temporal trends in contaminant concentrations was evaluated as a separate line of evidence in two ways:

- In the sediment cores collected in 2006 for the RI, the peak concentration of total PCBs was identified, and a percent reduction was calculated for those cores having buried peaks. This evaluation provided evidence of long-term trends and reveals the history of contamination through the depth of the core. The depths corresponding to PCB introduction (1935), peak use (1960s and 1970s), and ban/source control (1980s and later) can be identified. They were used to identify chemical markers for estimating net sedimentation rates, discussed in Section F.3.1.2. This evaluation has limited use for predicting future chemical trends because the reduction from the time of peak use of PCBs (1960s and 1970s) was largely because of the PCB manufacturing ban in 1979 and nationwide regulations on the discharge of pollutants. Therefore, this particular evaluation (looking at deeper intervals) was not used to assign recovery categories, which are based on more recent recovery trends (since the 1980s).

- In all cores with adequate sampling resolution by depth, trends in the top two (shallowest) intervals were evaluated for total PCBs and for any SMS contaminants with detected SQS exceedances. The trends in the shallow sediment are assumed to continue into the future and were used to assign recovery categories. They represent a best estimate of changes in contaminant concentrations following the implementation of nationwide source control regulations and chemical bans (post 1980). These data were one criterion used in assigning recovery categories.

The rate and magnitude of concentration change may differ between the historical peak use time period (1960s through 1970s) and the more recent time period (post 1980s) because major source control efforts were implemented in the 1980s. Therefore, the first analysis was conducted to evaluate overall time trends, focusing on total PCBs, which have a distinct historical high use period prior to the production ban in 1979. The second analysis was conducted to evaluate recent time trends. It can be expected that trends observed in the shallowest two intervals of cores may continue into the future.

F.4.2.1 Percent Reduction of Total PCB Concentrations in Cores

PCB trends by depth in the sediment cores collected in 2006 for the RI were used to calculate percent reduction as evidence of long-term natural recovery trends and were used as chemical time markers for estimating net sedimentation rates (Section F.3.1.1). The maximum concentration within each core was found, regardless of depth. That maximum concentration must be at least twice the concentrations at shallower intervals, otherwise the core was considered to have no strong trend. Selected example profiles are shown in Figures F-11a through F-11c. These figures illustrate that core profiles can be a valuable visual tool to help understand natural recovery potential, and that multiple lines of evidence should be used to evaluate natural recovery potential. In this case, contaminant profiles, radioisotope profiles, and net sedimentation rate estimates are used collectively to inform the CSM. Where PCB peak concentrations occurred at depth in cores, the observed percent change was calculated by first subtracting the total

PCB concentration in the top interval from the peak concentration at depth and then dividing that difference by the peak concentration using Equation F-1:

$$PR_{core} = (C_{peak} - C_{top}) / C_{peak} \times 100 \qquad \textbf{Equation F-1}$$

Where:

PR_{core} = percent change in total PCB concentration (%)

C_{peak} = peak or maximum total PCB concentration in a core (µg/kg dw)

C_{top} = total PCB concentration in the top interval of the core (µg/kg dw)

Data were analyzed at 1- or 2-ft intervals (considered “low resolution” data) in all sediment cores collected in 2006 for the RI, and at 0.5-ft intervals (considered “high resolution” data) in a subset (of seven cores) with 2-ft data. In the sediment cores collected in 2006 for the RI, samples were collected either at 1-ft or 2-ft intervals. In those with 2-ft interval data, samples collected at 0.5-ft intervals were archived. The finer resolution data were generated for seven cores in a second round of analysis after the contaminant trends in the 2-ft sample intervals were evaluated. Cores with finer sampling intervals (0.5-ft) were used to refine the contaminant trends in the top 2 ft; trends were analyzed at the 0.5-ft scale in this appendix.[14] The Table F-7 series describe the cores for which:

- Total PCB recovery trends were discernible (subsurface PCB peaks) (Table F-7a).
- There were no strong trends (concentrations were low throughout the core) (Table F-7b).
- The highest concentrations were in the surface intervals (Table F-7c).

Sediment cores where decreasing total PCB trends by depth could be calculated (Table F-7a; a total of 24 cores) were typically located in areas where the STM predicted high percentages of Green/Duwamish River sediment and low percentages of bed sediment after 10 years (i.e., contaminated sediment was likely buried and/or surficially mixed). The highest total PCB concentrations were typically at depth (ranging from 2 to 8 ft below the mudline), with markedly lower concentrations in the surface interval (and in

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[14] Sometimes, lower resolution data would indicate that the peak concentration was in the surface interval; however, when the high resolution data were considered, the peak was found to be below the surface. For example, 5 of 7 cores having both high and low resolution data had peaks in the subsurface using the 0.5-ft (high) resolution data, but the lower resolution data led to the conclusion that the peak was in the surface interval. The low resolution data (i.e., 1- to 2-foot intervals) were not fine enough to reveal the true depth of the peak.

other shallow intervals). For these cores, most of these empirically derived percent reductions ranged from 50% to approximately 95%.[15]

For those cores with no discernible trend (Table F-7b), most are in Recovery Category 3 and have contaminant concentrations in the top two intervals (total PCBs and other SMS contaminants) that are below the SQS or are in equilibrium. Although these cores do not exhibit decreasing concentrations, the areas represented by these cores are designated as Recovery Category 3 because of the absence of scour or other physical criteria that would preclude recovery (such as berthing areas). Empirical data for detected SMS contaminants exceeding the SQS were used on a case-by-case basis to override physical criteria that could suggest recovery was not occurring (for example moving an area from Recovery Category 1 to 2), but cores exhibiting equilibrium were not used to place areas in more restrictive recovery categories when scour or berthing areas were absent. Those cores without discernible trends that are in Recovery Category 1 are either actively remediated by Alternative 2 or have low enough surface sediment concentrations that they are not included in Area of Potential Concern 1 (AOPC 1) (i.e., not actively remediated until Alternative 6).

For those cores with the highest concentration in the surface interval, additional details are provided in Table F-7c, including whether scour is predicted or whether co-located surface sediment samples have lower concentrations. Often these cores are near EAAs, in potential scour areas, or in areas with low estimated net sedimentation rates. These cores are also often located in areas of the LDW not expected to recover naturally and are designated for active management under most remedial alternatives.

The F-7 table series also identifies the recovery category (Section 6), the remedial alternative when the core is first actively remediated (Section 8), and the trends for total PCBs and other SMS contaminants in the shallowest two intervals (see next section). Core data with subsurface peaks (Table F-7a) show that Recovery Category 1 assignments are fairly conservative (because active remediation is designated for some areas showing evidence of natural recovery) and that some recovery may be occurring over a longer period in some of the areas designated as priority cleanup areas.

In Table F-7c, the inverse is also true. Many of the higher surface concentrations are decreasing rapidly (at higher rates) and therefore have been assigned to Recovery Category 3, but are nevertheless prioritized for active remediation because of high concentrations. Figure F-12 shows decadal changes in total PCB concentrations based on net sedimentation rates estimated for the sediment cores collected in 2006 for the RI. These sediment cores typically span a period of about 90 years (~1916 to 2006), with the more recent trends targeted to represent the last 20 years (post 1980), generally observed in the upper 1 to 2 ft of the core. For this analysis, the subsurface peak total

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[15] However, it is noted that a particular core must show at least a 50% change (i.e., concentration of the peak is twice that in the shallowest sample interval) to be placed in Table F-5a.

PCB concentration was set to 1960 (peak PCB use), and the core-specific net sedimentation rate was used to assign a period (year) to sample intervals above and below the interval with the peak concentration. Figure F-12 shows that, as expected, average total PCB concentrations increased from pre-industrial times to the 1950s to 1970s and then steadily decreased regardless of the recovery category. Although these decreases were observed in Recovery Category 1, there may be concerns with these areas achieving goals, due to other factors (such as scour), and thus MNR is not assigned in these areas when remedial action levels (RALs) are exceeded (Section 8). These results show general site-wide declines in total PCB concentrations since the 1960s and 1970s that correspond with sediment burial and deposition processes (see Section F.3 for physical results and radioisotope profiles).

F.4.2.2 Core Trends in the Top Two Intervals

To assess recent recovery trends, concentration changes were evaluated across the top two intervals within the upper 2 ft in cores (Table F-8). These trends are assumed to be indicative of contaminant conditions following the implementation of nationwide source control actions and chemical bans (targeted to represent 1980s and later) and are assumed to be more indicative of trends expected to occur in the future than trends based on longer time frames.

This analysis uses cores with 1-ft or shallower sampling intervals or with co-located surface sediment locations (167 cores in the FS baseline dataset). If a surface sediment sample was located within 10 ft of a core, that sample was used to represent the shallowest intervals, while the top interval of the core (either a 0- to 1-ft or a 0- to 2-ft interval) was used as the comparison (deeper) interval.[16]

When total PCBs were detected above the SQS in either interval, cores were analyzed for total PCB trends. If any of the other SMS contaminants were detected above the SQS in either interval, core trends were analyzed for those other SMS contaminants (as a group). The analysis was performed for total PCBs separately because PCBs have the potential to show a distinct natural recovery trend over time as the production of PCBs was phased out during the late 1970s, and because PCBs are not a by-product of urban activities (as PAHs are). However, PCBs can be discharged to the LDW through ongoing pathways from historically contaminated media and atmospheric deposition. Increasing PCB concentrations in cores can identify the need for source controls or identify areas subject to scour.

For the SMS contaminant analysis, only cores with detected SQS exceedances (for SMS contaminants other than total PCBs) in either sample interval were used. Those cores without detected SQS exceedances in these intervals are colored green in Figure F-13. The analysis identified the SMS contaminant(s) that exceeded the SQS in either of the

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[16] If the core had 0.5-ft data, those samples were used in this analysis for both the shallow and deeper data; co-located surface sediment data were not used if 0.5-ft data were available.

two sample intervals. The percent change in concentration from the deeper interval to the shallower interval was calculated for each SMS contaminant identified using an equation similar to F-1. The concentrations were described as decreasing if all SMS contaminants with detected SQS exceedances had concentration decreases of 50% or more. This degree of change indicates that natural recovery might be occurring in this area. However, if the top interval had higher concentrations, and the percent increase within the core was 50% or more for each SMS contaminant evaluated, the core was classified as having an increasing trend. Concentration changes of less than 50% were identified as "equilibrium." If the SMS contaminants evaluated in a core did not all exhibit the same trend (e.g., some decreased, and others showed minimal change), the core was classified as having mixed results.

Of the 167 cores with the appropriate sampling density (i.e., 1- or 0.5-ft sample intervals or a co-located surface sample [that could be compared to a 0- to 2-ft sample]), 122 had at least 1 sample with total PCBs detected above the SQS. Of those 122 cores, 43 had a decreasing total PCB trend; 39 had increasing concentrations; and 40 showed no indication of total PCB trend with depth (i.e., the total PCB percent change was between -50% and +50% and the core is classified as being in equilibrium). Table F-8 includes all data evaluated (i.e., total PCBs in the top two intervals and detected SQS exceedances in the top two intervals). Tables F-7a through F-7c, which describe the total PCB profiles in the sediment cores collected in 2006 for the RI, also identify the trends from this analysis.

Trends for the other SMS contaminants were analyzed in the 165 cores; 57 of these cores had SQS exceedances. Sixty-five percent (108 of 165) of these cores did not have detected SQS exceedances in either interval evaluated, indicating that contamination is fairly localized (Table F-8). Of the 57 cores with SQS exceedances, 9 had a decreasing trend; 14 had an increasing trend; and 10 did not show any trend with depth (equilibrium). Twenty-four cores had a mixture of trends for the SMS contaminants evaluated, indicating a potential source control or recontamination issue for particular SMS contaminants. Of the 38 cores with either increasing or mixed trends, 7 are in EAAs. The most common SMS contaminant groups with increasing concentrations are PAHs and phthalates (Table F-9). Figure F-13 displays these core trends with the recovery categories, most of which are consistent with the CSM.

F.5 Biological Trends

Changes in contaminant concentrations in surface sediments provide empirical evidence of recovery; however, the health of the biota reflects the effects of all of the conditions in the environment. These include the mixture of contaminants present, the grain sizes, bioavailability, water quality, and other factors. Biological data provide holistic evidence of recovery, as opposed to trends for one contaminant, which describe only one component of sediment health. To evaluate biological trends for the LDW, historical trends of recovery (1970s) in fish health and fish tissue concentrations in the LDW were reviewed.

F.5.1 Biotic Health

The health conditions of biota reflect the cumulative effects of stressors in an estuary. Fish collected from the LDW in 1974 and 1975 exhibited high incidences of tumors, liver abnormalities, lesions, elevated concentrations of marker chemicals (potassium and cholesterol signaling cellular damage and liver malfunction, respectively), and fin erosion disease. Bacteria swabbed from the skin of fish collected in the LDW during this study were at concentrations (bacteria per square cm of fish surface area) 5- and 10-fold higher than those on fish collected from Alki Point and West Point, respectively (Miller et al. 1976, Miller et al. 1975). Although a comparable, quantitative study has not been conducted in the past 10 years, fish lesions and fin erosion were not visually observed or recorded during the RI tissue collection efforts in 2004 through 2007.

In another study, Harper-Owes (1982) documented decreases in biotic abnormalities, primarily incidences of fin erosion, over time. Observations of fin erosion on starry flounder were at 15.6% (i.e., the percentage of fish caught with observed abnormalities) in the 1966 to 1971 period, 10.3% in the 1974 to 1976 period, and 2.9% in the 1978 to 1980 period. Studies hypothesized that fin erosion disease was sediment-related because higher frequencies of fin erosion were observed on fishes' bottom fins (e.g., pelvic fins), which are in contact with sediment. Fins on the sides and top of the same fish, which are usually in contact with surface water (e.g., dorsal fins), had less observed erosion (Miller et al. 1976, Miller et al. 1975). As evidence of improvements in the LDW over time, fin erosion was not observed or documented during the RI tissue collection efforts. Some of the decline may be due to differences in sampling methods and different histological criteria; however, the data suggest a notable decline in disease, coincident with a reduction in pollutant inputs to the LDW (Harper-Owes 1982).

Tetra Tech (1988) cited cancerous liver tumors in 16% of English sole caught in "contaminated areas" of Elliott Bay and the LDW, whereas these lesions were absent in fish caught in relatively uncontaminated areas.

PAH-related liver disease in English sole has been monitored in Elliott Bay for more than 17 years (1989 to 2005) through the Puget Sound Ambient Monitoring Program. During this time, declining trends were observed in Elliott Bay, with the incidence of liver disease declining sharply from 1999 to 2005 (Puget Sound Action Team 2007). Although these studies do not document the same types of tests, species, or exact spatial areas, they describe the general improvement in the health of Elliott Bay related to control of pollutant sources, resulting in natural recovery of the sediments. This FS assumes that practices that improve the health of Elliott Bay may also be affecting the LDW, or that improvements in Elliott Bay could be indicative of improvements in the discharges from the LDW.

F.5.2 Tissue Concentrations

Harper-Owes (1982) also reported declines in total PCB concentrations for whole-body English sole, Pacific staghorn sculpin, and starry flounder collected from the LDW during the 1972 to 1979 period. Total PCB concentrations in English sole collected in the LDW from 1972 to 1975 averaged 1,700 µg/kg wet weight (ww), whereas total PCBs were undetected in those species collected from other estuaries during that time. Data from this period suggested a half-time (number of years required to reduce the concentration by 50%) in tissue concentrations of approximately 3.4 years (± 1.1 years). The long-term trend in the data suggests a drop in average concentrations in fillets from 1,760 µg/kg ww in the early 1970s to 350 µg/kg ww in 2007 (Figure F-14 and Table F-10). However, year-to-year comparisons of tissue data must be interpreted with caution because some historical data were collected in different portions of the LDW, in different seasons, for different size fish, and using different analytical methods.

It is noted that short-term PCB releases associated with more recent contaminated sediment dredging projects (e.g., Duwamish/Diagonal EAA, East Waterway, Lockheed, and Todd Shipyards) may have resulted in a temporary increase in fish tissue PCB concentrations in 2004. This temporary increase returned fish tissue PCB concentrations to historical concentrations, tissue concentrations then declined over the next several years (Stern 2007). Lipid-normalized monitoring data (Figure F-15) indicate that fish tissue total PCB concentrations declined from 1997 to 2007 and may not show a dredging-related 2004 spike. While this trend in the lipid-normalized data is obscured by the high variability in the 1997 lipid levels, the time series data still suggest that the dredge events may have had a short-term effect on the tissue concentration trends. This observation is consistent with fish tissue contaminant concentrations documented at other sites following dredging (NRC 2007).

F.6 Use of Predictive Tools – the BCM

Over most of the LDW, both empirical data and model estimates either provide evidence of, or are used to predict, natural recovery of legacy contaminants, primarily through deposition, vertical mixing, and burial.

While empirical data are valuable to use in determining past trends, they have limited use in predicting future conditions. Because of this, the BCM was developed as a tool to predict contaminant recovery as a function of location and time within the LDW. In this FS, the BCM predicts changes in surface sediment contaminant concentrations in specific areas and on a site-wide basis for the LDW. The STM is run continuously over a 30-year period to estimate scour potential, net sedimentation rates, and the future composition of surface sediment. Future surface sediment is represented by contributions from three sources: the LDW bed at the time the model period begins, lateral sources (storm drains, CSOs, and streams), and upstream from the Green/Duwamish River.

Using output from the STM at 5-year intervals, the BCM applies contaminant concentrations to these three sediment sources, as described in Section 5 and Appendix C. Model-predicted trends for total PCBs, arsenic, cPAHs, dioxins/furans, BEHP, and SMS contaminants are described below as a line of evidence for recovery potential. These trends are based primarily on sedimentation rates, scour potential, and incoming contaminant concentrations. These model predictions were used to assign remedial technologies for alternatives (Section 8). Predictions are applied at two spatial scales: 1) spatially-weighted average concentrations (SWACs) applied either site-wide or to specific areas, and 2) concentrations at discrete points for SMS contaminants (see Section F.6.1.5).

Similarly, predictive tools are being used to assess natural recovery at several other complex sediment sites including the Passaic River (NJ; EPA 2007), the Lower Fox River (WI; RETEC 2002), the Housatonic River (MA; Weston 2006), and the Portland Harbor Superfund Site (Lower Willamette River, OR; Anchor 2005). Predictive models are used to determine whether past reductions in contaminant concentrations (where sources have been controlled) can be expected to continue or may need to be augmented in the future with further source controls. The modeling efforts can range from extrapolation of historical trends into the future (where conditions are expected to be the same) to the use of computer models of varying complexity. Both empirical and predictive modeling tools are used in this FS, consistent with EPA guidance (EPA 2005) and the state-of-the-science being used at similar sites.

F.6.1 Model Predictions within 10 Years

As discussed in Section 5, the BCM is a spreadsheet-based tool that uses ranges of contaminant concentrations on upstream and lateral sediments to predict future surface sediment concentrations in 10 ft x 10 ft model grid cells at 5-year intervals. (Output is exported from the STM at 5-year intervals and used as input in the BCM. The BCM uses STM predictions of the sediment sources in each grid cell to predict future surface sediment concentrations for each 5-year interval [see Section 5].) These predictions are then converted into SWACs for the four human health risk drivers (total PCBs, arsenic, cPAHs, and dioxins/furans) to assess the ability of each remedial alternative to achieve the preliminary remediation goals (PRGs). The other SMS contaminants are spatially interpolated as Thiessen polygons, with the polygon being mapped, not by concentrations, but by one of three categories based on the maximum exceedance of the SQS for any SMS contaminant: pass, >SQS, and >CSL.

The results of this analysis, using the recommended (mid) input parameters 10 years after completion of Alternative 1 (the EAAs), are discussed below and shown in Figures F-16 through F-20 for total PCBs, arsenic, cPAHs, dioxins/furans, and SMS contaminants, respectively. Note that these results reflect no active remediation in areas outside of the EAAs; they are just a model prediction of what natural recovery could achieve for the LDW. In general, the model predicts recovery for the risk drivers. The

BCM does not account for potential recontamination of sediments adjacent to the EAAs by dredging residuals.

F.6.1.1 Total PCBs

Ten years following completion of Alternative 1, the total PCB SWAC is predicted to decrease by 60% (from 180 to 73 µg/kg dw; Figure F-16).[17] Total PCB percent reductions as high as 97% were predicted in some grid cells. Where little or no reduction was predicted, the starting grid cell (bed sediment) concentration was typically low, such that the total PCB concentrations associated with upstream-sourced sediments was not significantly lower. Alternatively, the BCM predicts concentration increases in some areas because the STM estimates the grid cell will receive a substantial amount of sediment from lateral sources or will retain a large proportion of the original bed sediment (net sedimentation less than 1 cm/yr) over the 10-year model time frame.

F.6.1.2 Arsenic

A similar analysis completed for arsenic predicted about a 30% reduction in the site-wide SWAC within 10 years (from 16 to 11 mg/kg dw) (Figure F-17). Most grid cells show minimal change in concentrations (equilibrium) because arsenic baseline (Year 0, the model starting point) concentrations are not elevated in most areas.

F.6.1.3 cPAHs

The site-wide reduction for cPAH SWAC is about 55% within 10 years (360 to 160 µg TEQ/kg dw) (Figure F-18). Although sedimentation is a strong factor governing natural recovery in the LDW, recovery is realized only when the depositing materials have lower concentrations of PAHs and the bed remains stable. With contaminants entering from diffuse urban watershed sources, recovery relies on practices that limit inputs from nonpoint sources. PAH contributions from urban sources were discussed in Section F.2.

F.6.1.4 Dioxins/Furans

For dioxins/furans, the BCM predicts that the average concentration in the LDW would decrease by almost 70% within 10 years (from 24 to 7.9 nanograms [ng] TEQ/kg dw) (Figure F-19).[18]

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[17] Percent reductions in total PCBs over 10 years were determined by comparing concentrations predicted by the BCM starting at current conditions (Year 0) to conditions at the end of 10 years. These predictions were made assuming some level of source control, and assuming that the EAAs have been completed.

[18] The dioxin/furan concentrations displayed in Thiessen polygons were converted to spatial data simulating a 10′× 10′ raster so that these data could be evaluated in the BCM spreadsheet platform in the same manner as the other risk drivers. This is necessary because the STM grid cells don’t align with the Thiessen polygons. The map of 10-year predictions (Figure F-19) thus looks similar to the inverse distance weighting interpolations shown for the other risk drivers whose BCM outputs have different predicted contaminant concentrations within the same Thiessen polygon in 10 years.

F.6.1.5 Other SMS Contaminants

The BCM can also be used to predict future SQS and CSL exceedances. Of the 224 stations outside of the EAAs with detected SQS exceedances (of any SMS contaminant[19]), the BCM predicts that 67 of the stations with exceedances would continue to exceed the SQS after 10 years (Figure F-20), and 34 of the stations would continue to exceed the SQS after 30 years. The BCM was run only for locations with detected baseline SQS exceedances based on chemistry and toxicity results (when available), i.e., locations that passed toxicity tests were not included. Specifically, a location with an SMS contaminant exceedance but a toxicity pass was not considered to have an SQS exceedance, and was not modeled by the BCM. Conversely, locations with SMS contaminant passes but toxicity exceedances are considered exceedances for this FS; however, predictions for these locations could not be modeled because the BCM predicts future surface sediment contaminant concentrations but cannot predict future toxicity test results.

F.6.2 Empirical Trends Compared to Model Predictions

Empirical trends for total PCBs and other SMS contaminants were compared to the BCM predictions to find areas where natural recovery predictions are uncertain (Figure F-21). In general, both the model predictions and the empirical data suggest that recovery is occurring. Most of the empirical data exhibited contaminant decreases at locations that coincided with model predictions of natural recovery. Locations with increasing contaminant trends were frequently coincident with locations that have STM-predicted high-flow scour deeper than 10 cm, low net sedimentation rates, or inputs from lateral sources. This is consistent with the expectation of limited recovery potential under those conditions.

The following factors may play a role in areas where the empirical trends and the BCM predictions do not match:

- The STM may not have adequate fine-scale resolution to account for small-scale processes, such as near-field effects near outfalls or around in-water structures.
- There is uncertainty in the contaminant concentrations associated with the BCM input parameters, which are not varied spatially (e.g., across outfalls, by deposition patterns, or by grain sizes of transported material) or temporally (e.g., for differing flow conditions, tidal stages, seasons, and over time as inputs could change).

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[19] This evaluation includes total PCBs and arsenic, which are managed on a point basis for remedial action objective (RAO) 3 (for which they are benthic invertebrate risk drivers). These two contaminants are also human health risk drivers, and are managed on a spatially-weighted area-wide basis for the other RAOs.

- The STM can under- or overpredict sedimentation in areas containing overwater structures that the model does not account for or in areas with vessel scour.

Figures F-22a through F-22c illustrate the areas where scour is expected from high-flow events and maneuvering vessels (see Section 5). These figures also illustrate where berthing areas or overwater structures are located. These physical considerations are coupled with empirical recovery data to delineate the recovery categories (right panels in Figures F-22a through F-22c). Although the BCM predictions are not used to delineate recovery categories, most areas where both the empirical data and the BCM predictions match are in Recovery Category 3 and have moderate to high net sedimentation rates with relatively minimal influence from lateral sources.

Figure F-23 compares estimated recovery rates for resampled surface sediment locations to the recovery rates predicted by the BCM for the areas in which the empirical data are located. Estimated recovery rates from high resolution cores are also included. These data show that empirical data support the BCM predictions and that recovery is expected for most locations, based on both the BCM and the empirical data (Figure F-23). In areas where the empirical data and BCM predictions do not match, active remediation is typically called for and source control may be needed.

Natural recovery potential is generally expected to be limited in historically contaminated areas (EAAs, other hot spots) where physical obstructions hinder sedimentation (e.g., around bridge footings) and where high-flow events or vessel scour can cause erosion of the bed sediment. In areas where the BCM predicts recovery but the empirical data do not, vessel scour and physical structures (e.g., dolphins and piers) that are not considered by the model may be causing small-scale effects that impede recovery processes.

F.7 Limitations and Data Uncertainty

Uncertainty is an important consideration in evaluating natural recovery for the LDW, and therefore conclusions must be regarded with caution. A weight-of-evidence approach helps reduce uncertainty because it employs multiple types of information to draw conclusions. These uncertainties and how they are being managed in the FS are discussed in the following sections. Ultimately, long-term monitoring will be required to demonstrate that the LDW is recovering as predicted (EPA 2008b).

F.7.1 Uncertainty in Resampled Surface Sediment Trends

Analysis of resampled sediment locations introduced an element of uncertainty because data may not be truly co-located, but could be up to 10 ft apart.[20] Not all samples were

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[20] Due to potential uncertainty in coordinates of historical data, co-located samples may actually be more than 10 ft apart.

collected by LDWG, and thus LDWG relied on the data reports prepared by others to provide accurate positional information. Errors can occur when different horizontal datums are used (because of conversion errors), during transcription into databases, and when positioning a boat over a static location because tidal flows and passing vessel wakes can move sampling equipment off position. The evaluation of these datasets at a population level helps to reduce these uncertainties, yielding conclusions that are useful on a site-wide basis (average condition across the whole site).

In addition, samples were not always analyzed using the same methods. Only data with sufficiently documented and appropriate quality control measures were used in the FS. However, among methods that are recognized as appropriate, variances of up to 25% in the results are not uncommon. These variances can also occur between two analyses of the same sample using the same method. This analytical uncertainty was taken into consideration by defining an increase or decrease as a change of >50% compared to the original concentration. Analytical variability has greater influence on results at lower concentrations. Therefore, empirical trends were only evaluated and mapped (dataset used for recovery categories) where either the initial or ending sample exceeded the SQS for at least one SMS contaminant.

Finally, the LDW surface sediments have a degree of spatial heterogeneity. The RI has shown that chemical gradients can be steep and that hot spots may be isolated and well contained, such that moving several feet off-station can yield different results, even during the same sampling event. These artifacts can mask actual recovery (or concentration increases) occurring in the LDW. This effect supports the use of population averages instead of evaluations of individual points. Population averages are also more relevant when evaluating reductions in the exposure of mobile biota with home ranges near the scale of the LDW; but population averages may not reflect potential effects to sessile biota or biota with small home ranges.

Therefore, the trend analyses are used to provide general evidence of recovery in the LDW. The trends are coupled with multiple lines of evidence, including STM outputs. Additional baseline and long-term sampling will be performed in any areas where MNR is selected as a remedial alternative.

F.7.2 Uncertainty in Core Profiles

The resolution with which net sedimentation rates (based on physical, chemical, and radioisotope time markers) and chemical trends can be discerned in cores is dependent upon the resolution used for collecting these data. Samples composited over 2 or more ft of depth lack spatial resolution when compared to cores with 0.5-ft or 1-ft depth composites. Only seven cores in the dataset have data at a 0.5-ft resolution, and data at this resolution were used when available. These finer resolution data refine the depths and the magnitudes of peak concentrations discerned from lower resolution data. For those cores initially identified as having total PCB peak concentrations in the uppermost sample interval (with low resolution sampling), sampling in 0.5-ft intervals often reveals that the peak is not really in the surface, but is buried by some depth (0.5 ft or more) of sediment having lower concentrations. However, this distinction could only be drawn on the seven cores with high resolution data.

Uncertainty in using the cores for estimating net sedimentation rates is diminished by the use of physical markers in cores and observations of anthropogenic impacts, such as debris, sheen, and odor. These observations are not limited by sampling resolution, because they are based on field observations independent of the resolution of contaminant sample collection. Therefore, the use of multiple lines of evidence to estimate net sedimentation rates (i.e., combining visual evidence with chemical trends and with co-located radioisotope trends) gives greater confidence to these empirical data and reduces uncertainty. Uncertainty is also introduced in core data (visual or chemical) by sample collection methods that result in poor substrate penetration or low sediment yield within the core. The depths at which sediment intervals are collected from or observed in core tubes are the recovered depths. These depths are adjusted to *in situ* depths, meant to describe the actual location of the sediment in the environment, using readings taken during sample collection. Using only recovered depths can either overestimate or underestimate trends from cores. This uncertainty is diminished for the sediment cores collected in 2006 for the RI, as field measurements were carefully recorded so that *in situ* depths could be accurately calculated with confidence. However, for historical cores collected by other parties, recorded *in situ* depths may be less precise or are completely absent.

Uncertainties in core trends can be diminished when co-located radioisotope cores or co-located surface sediment grab samples are available, or when other lines of evidence corroborate findings. In evaluating trends in the top two intervals of the cores for total PCBs and other SMS contaminants, co-located surface sediment locations were used to represent the shallowest interval, when available (if 0.5-ft interval data were available, the top 0.5 ft were used to represent the surface condition rather than a co-located surface sample). Of the cores evaluated in this appendix, 85 have co-located surface sediment data available. An example of co-located surface sediment data clarifying chemical trends can be seen in Figure F-11c where the cores shown in the profiles (SC-51 and SC-52) did not show total PCB concentration changes by depth. Therefore, these cores were placed in the “highest concentration at surface” category. However, when co-located surface sediment data are available, they can show that the top 10 cm have lower concentrations. These cores were therefore mapped as “decreases” using the trends in the top two intervals (with the surface sediment sample being the top interval). Additional lines of evidence are used whenever available to reduce uncertainties.

F.7.3 Scour Uncertainty

Some level of uncertainty exists in identifying areas potentially subject to scour in the LDW, stemming from both the STM and from the visual identification of vessel scour. The STM uses a myriad of input parameters (related to channel dynamics, sediment properties, solids loading, and river flow conditions) to model the movement of sediment in the LDW and the changes in the bed sediment. Various flow conditions and tidal stages can affect sedimentation and scour of the bed sediment. The STM was run with a combination of input parameters that most closely simulated real data. Adjusting any of these parameters could change the location and depth of scour estimated by the STM. The areas identified in Figures F-22a through F-22c are the best estimation from the model of where scour is expected to be deeper than 10 cm during a 30-year simulation based on high-flow conditions. Uncertainty was reduced by using a low-probability, worst–case scenario of high flows and highest tidal exchanges to estimate maximum scour potential in the STM bounding runs.

The potential vessel scour identified in Figures F-22a through F-22c represents observations made on bathymetric data collected during one survey in 2003. These bathymetric data represent a single time point, not an evaluation of changes in bathymetry over time. Further, the spatial coverage of the bathymetric data includes most, but not all, of the LDW. Obstructions such as moored vessels and overwater structures restricted collection of data in some parts of the LDW. Therefore, the areas where observations of ridges and depressions in the sediment bed were made are subject to some judgment and extrapolation outside the spatial extent of the data. These areas were typically extended to the shore (even in the absence of data) and believed to be centered around berthing areas. Further, these are simply observations of where ridges and depressions in the sediment bed existed based on the 2003 bathymetric data. They do not represent unequivocal evidence of scour.

F.7.4 BCM Uncertainties

The BCM was run using a range of concentrations for three input parameters: upstream inflow, lateral inflow, and post-remedy bed sediment replacement values. These data ranges are used to bracket the uncertainty in the long-term model-predicted concentrations. Recommended input parameters were generated by summary statistics from various datasets, discussed in Appendix C of this FS. Each dataset has some degree of uncertainty relating to aspects, such as the matrix from which the sample was collected, the location from which the sample was collected, the time (season, river flow) of sample collection, and other factors. By using several lines of evidence and a range of input parameters derived from these data, the uncertainty is diminished.

How the concentrations of these input parameters may change over time is also uncertain. For example, inputs from upstream and lateral sources could increase as a result of urbanization, or they could decrease as effective source control efforts continue. The ranges of lateral and upstream BCM input parameters were developed to account for future assumptions regarding increases in source control. Section 9 of the FS describes the effects of using ranges of values for input parameters on predictions of sediment recovery following active remediation.

Subsurface sediment could be exposed in the future as a result of construction, vessel scour, or earthquakes. These processes and their potential cumulative effects on the SWAC were not accounted for in the BCM, but Section 9 of the FS evaluated potential exposure of subsurface contamination by disturbances and the effects on PCB SWACs compared to long-term model-predicted concentrations and the time to achieve cleanup objectives.

Uncertainty also exists in locations where the STM resolution may be too coarse to model the effects of structures, like piers, on sediment deposition. Additionally, the STM did not cover the entire FS study area. The STM covers approximately 398 acres of the 441-acre site and ends at RM 4.75 (coverage is from RM 0.0 to RM 4.75). It also does not extend laterally to cover all inlets nor does it reach the shoreline (top of bank) in all places. The STM outputs were extrapolated in these locations to match the FS study area (up to RM 4.75 in the east to west extent). In these areas (where the STM is too coarse and where the STM output was extrapolated), the BCM may under- or over-predict future contaminant concentrations.

F.7.5 Uncertainty of Remedy Reliability

MNR can be a successful remedial technology at complex sediment sites (either alone or in combination with other technologies [Magar et al. 2009]). This evaluation has suggested that natural recovery is occurring in some parts of the LDW and thus MNR is considered with other technologies in this FS.

As discussed in Section 8, the effectiveness of MNR is a key uncertainty for Alternatives 2 through 4. MNR uncertainty was accounted for in this FS by limiting its assignment based on a set of assumptions (e.g., no MNR in Recovery Categories 1 or 2 when RALs are exceeded), and by assuming that a percent of the area assigned to MNR will actually be dredged as a result of remedial design investigations or as a contingency action if long-term monitoring shows that recovery is not occurring as expected. These adaptive management components are included in the cost estimates in Appendix I.

F.8 Summary of Natural Recovery Potential

Over most of the LDW, the five lines of evidence (Davis et al. 2004) suggest that the LDW has the ability to recover naturally in some areas. Both the empirical data and model outputs provide evidence of, or are used to predict, natural recovery of legacy contaminants, primarily through burial and source control. Overall, this appendix provides evaluations that help determine where active remediation is required (i.e., in those areas not expected to recover). The findings that address each of these five considerations (ongoing sources, fate and transport mechanisms, historical record of contamination, biological endpoints, and predictive tools/models) are summarized below for the LDW.

F.8.1 Assessment of Ongoing Sources

Consistent with historical trends observed in Puget Sound, historical point sources (primary sources) of contamination to the LDW have been largely controlled. Ongoing sources continue to a lesser extent due to general urbanization and nonpoint source pathways associated with historically impacted media (e.g., soils in the drainage basin affected by historical spills [secondary sources]).

Source control is imperative to the success of any remediation method, including natural recovery, and an LDW-wide source control program is underway. Where it is difficult to control sources, the effectiveness of remedial alternatives from MNR to dredging can be significantly impeded. The expectation is that source control efforts will be prioritized to match the sequencing of remedial actions so that, once completed, remediated areas will have minimal potential for recontamination (from lateral sources). The LDW source control strategy includes conducting field inspections, assessing sediment and contaminant loads to the LDW, tracing sources through sampling of drainage systems, cleaning out storm and sewer drains, and enforcing the use of BMPs (Ecology 2004). Ecology is also initiating agreed orders with several contaminated properties adjacent to the LDW to conduct RI/FS activities.

PCB contamination is predominantly from historical uses. PCBs are considered legacy contaminants in Puget Sound and the LDW, with peak PCB use occurring in the 1960s and 1970s. Total PCB concentrations have been decreasing site-wide following the federal ban on their production and significant source control upgrades in the 1970s and 1980s. Because primary sources have been controlled, the main focus of the remedial actions will be to address secondary sources and residual contamination in LDW sediments. Some regional sources of PCBs continue to exist, but additional source control efforts and cleanup of sediment and upland hot spots are expected to continue decreasing the surface sediment concentrations of total PCBs over time. However, global and regional atmospheric transport and deposition will continue, as well as low level non-point sources in urban areas. Therefore, PCBs cannot be completely eliminated from the LDW.

Arsenic concentrations are nearing equilibrium, and other risk drivers are derived from ongoing urban sources. Recovery may be less pronounced for contaminants other than PCBs because either they occur naturally in soils and sediment (arsenic and other metals), are in watershed soils from atmospheric deposition of particulates from emissions (arsenic, dioxins/furans, and PAHs), or are released from nonpoint urban sources (PAHs, dioxins/furans, and phthalates). For arsenic, approximately 99% of the LDW is already below the SQS of 57 mg/kg dw. Minimal changes in the average surface sediment concentrations of arsenic are predicted based on elevated concentrations in surrounding soils from historical smelting activities. For PAHs and phthalates, studies have shown that low level (or urban background) concentrations are expected to increase over time as a result of more urbanization. In localized areas, previously elevated concentrations of these contaminants are showing substantial decreases, but are still subject to continued inputs from lateral sources.

Elevated dioxin/furan concentrations are localized. The available data for dioxins/furans in the LDW show that high dioxin/furan concentrations are localized near discrete hot spots and that many other areas have concentrations within the range of upstream inputs. The five highest dioxin/furan sample concentrations are located at stations within the Duwamish/Diagonal EAA, in the embayment at Glacier Northwest (RM 1.4 – 1.5W), and in the Trotsky Inlet (Figures 2-16 and 2-17). Two of the 29 dioxin/furan cores have five-fold higher concentrations at depth (in the 4- to 8-ft depth interval) than in the surface interval (Figure 2-17). The other dioxin/furan cores have similar concentrations throughout their depths.

F.8.2 Physical CSM and Fate and Transport Mechanisms

The primary mechanism for natural recovery in the LDW is sedimentation, and sedimentation rates derived from the model generally correlate with empirically derived estimates. The physical conditions of the LDW are well understood as a result of a well-calibrated hydrodynamic and sediment transport model (QEA 2008). Scour and sedimentation processes are dominated by geomorphology, water depth, and the presence of a saltwater wedge in the downstream portions of the LDW. Over 83% of the LDW is net depositional, with net sedimentation rates greater than 1 cm/yr; the remaining areas are either in dynamic equilibrium or have net scour. Over 75% of the net sedimentation rates estimated from sediment chemistry and radioisotope cores (when rates could be derived) correlated with model predictions. Based on this validation, the STM is a reliable tool for predicting future conditions in the LDW, once contaminant concentrations have been assigned to the particles depositing in the LDW. Because the primary mechanism for natural recovery is burial by cleaner material, the contaminants in solids coming from upstream will likely dominate the level of sediment contamination with time, although lateral sources to the LDW also contribute to sediment concentrations.

Erosional processes are localized and limited to the upper 25 cm; recovery is presumed to be limited in these areas (Recovery Category 1). The effects of high-flow scour events and vessels navigating the LDW represent the principal forces affecting sediment stability. The STM report (QEA 2008) and this FS (Section 5) have identified localized areas with potential scour greater than the active mixing depth of 10 cm. In these areas, fine-grained sediments can be resuspended, mixed, and transported by high bottom velocities. The erosional forces vary with location, water depth, and particle size, but are generally limited in extent. Slightly more than 1 percent (or 5 acres) of the LDW has potential high-flow scour of more than 10 cm, with some subsurface

SQS exceedances subject to this potential scour. These areas, and areas with evidence of vessel scour, have been assigned to Recovery Category 1 and have been prioritized for consideration in the assembly of remedial alternatives. Even so, empirical data have shown that recovery can occur in potential scour areas[21] if net sedimentation rates are sufficient to bury the material of concern eventually (i.e., enough sedimentation occurs between the relatively infrequent high-flow conditions that more than compensates for the erosion that may occur during those infrequent episodic events). Other processes that may affect sediment stability (e.g., anchor drag, barge spudding, navigational dredging) will be managed via institutional controls. Evidence of erosion by vessels in berthing areas was used to assign these areas to Recovery Category 1. Berthing areas without evidence of vessel scour were assigned to Recovery Category 2.

Areas with limited recovery potential are managed by assignment of recovery categories. The physical, empirical, and model-predicted lines of evidence presented in this appendix were collectively evaluated to delineate three recovery categories. These categories represent a best estimate of where recovery is presumed to be limited, less certain, and predicted. Notable differences observed among the various lines of evidence highlight the need to consider multiple lines of evidence when evaluating natural recovery potential at a site, as was done in this FS. The level of effort and the recovery assignments presented in this appendix and in Section 6 are suitable for FS-level analyses. Site managers will use design-level sampling and analyses to clarify these recovery assignments and to select suitable remedial technologies on a small-scale basis before remedial actions occur in the LDW.

F.8.3 Historical Record of Contamination

Concentrations of most risk drivers in surface sediment are decreasing. Among resampled surface sediment locations, the more recent contaminant concentrations are 35 to 60% lower than the older data, depending on the statistic considered (e.g., mean, median, 90th percentile) and the contaminant. The populations of newer total PCB, cPAH, and BEHP data are significantly different (lower concentrations) than those of the older data, indicating overall site improvements. The same general trend is also observed among the sediment cores. In areas assigned to Recovery Categories 2 and 3, the average percent change in contaminant concentrations among resampled stations was greater than 50% (56 to 78% decrease) for total PCBs and cPAHs.[22] The average percent change in areas assigned to Recovery Category 1 was about 10% less than those in the other recovery categories. In EAAs, the average contaminant concentrations among newer samples slightly increased (1 to 20%). Arsenic concentrations in surface

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[21] Empirical data demonstrating recovery may be used to assign an area with scour to Recovery Category 2 or 3, as described in Section 6.

[22] Recovery Category 1 = recovery presumed to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

sediment, however, are in equilibrium. With the exception of small localized areas, minimal change has occurred in arsenic concentrations over time.

F.8.4 Biological Endpoints

Biological conditions have improved since the 1970s. Historical studies from the 1970s documented significant adverse effects in fish caught in the LDW, including lesions, tumors, and fin erosion. Bacterial concentrations were also high in the surface water from raw sewage being discharged directly into the Green/Duwamish River. Source control efforts from the 1980s through today have greatly improved the water quality and tissue contaminant concentrations in the LDW, although year-to-year comparisons of tissue data must be interpreted with caution because some historical data were collected in different portions of the LDW, in different seasons, for different size fish, and using different analytical methods. Elevated fish tissue contaminant concentrations have been recently documented in the LDW (relative to other years), likely caused by exposure to dredge residuals during removal operations (see Section 9). The state-of-the-art dredging operations have improved in recent years with regard to precision dredging and containment, but a small portion of resuspended, fine-grained material will always escape from the dredging operations (see Appendix M, Part 2). Therefore, although natural recovery is occurring, fish tissue concentrations may not always reflect these improvements during the construction period, because if the remedy also includes dredging, dredging residuals affect fish tissue over that period.

F.8.5 Predictive Tools and Models

Areas of the LDW that are not expected to recover naturally are being prioritized for active remediation. Those areas that are not showing recovery (decreasing concentrations) through model predictions, empirical trends, or physical considerations (such as vessel scour) have been assigned to Recovery Category 1. Areas where natural recovery is not expected are typically found in hot-spot areas with high COC concentrations, where physical obstructions can hinder sedimentation (e.g., around bridge footings), or where high-flow events or vessel scour can cause sediment erosion. This appendix supports using active remediation in the areas not expected to recover, and then allowing for natural recovery to achieve cleanup objectives over time.

Reasonably good agreement exists between the model predictions and empirical recovery estimates. The time trend data from resampled surface locations and shallow core trends show that most empirical data support the BCM predictions and that recovery is expected for many areas. The empirical data are typically more variable (greater percent changes in concentrations either higher or lower) than the base-case recommended model predictions.

F.8.6 Conclusions

Using the weight-of-evidence approach, all five considerations evaluated in this appendix independently demonstrate the potential for recovery to occur in many parts of the LDW, suggesting MNR is a viable remedial technology to be used when developing remedial alternatives. Empirical trends show risk-driver concentrations are decreasing in sediment in many areas of the LDW. In areas predicted to show recovery, concentrations are projected to decline to levels that contribute to achievement of cleanup objectives or are trending toward the long-term model-predicted concentrations within 10 to 20 years (when combined in an area-wide or site-wide SWAC with the reductions in other areas modeled to undergo active remediation). This depends upon initial sediment concentrations and other factors (such as net sedimentation rate). Improvements in natural recovery time frames for some contaminants depend largely on the effectiveness of source control efforts. However, as shown by the modeling and empirical data, not all areas of the LDW are expected to recover naturally.

Empirical recovery trends, the CSM, and modeled concentration changes all show reasonable agreement and support using the BCM to predict natural recovery in the LDW. Any recovery expectations will need to be confirmed during remedial design to account for localized physical and chemical conditions in the area being evaluated. Trends identified at particular locations in the LDW (e.g., on the Duwamish/Diagonal cap) may not be indicative of trends that would occur in other areas of the LDW. Areas that are not recovering, or are not predicted to recover, were prioritized for active remediation during development of remedial alternatives and assignment of recovery categories in the FS.

The combined empirical information and predictive tools are considered sufficient for FS assessments of natural recovery potential. However, considerable uncertainties are inherent in natural recovery predictions, particularly when assessing individual locations.

Area-specific natural recovery potential will need to be confirmed during remedial design when MNR is being considered. Periodic monitoring will be required to ensure that MNR is performing as anticipated, and these data should be used to adaptively manage the area through the recovery period. Should monitoring show that recovery is not occurring or is slower than required, contingency actions will be identified.

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Table F-1 Example Sites that Have Used MNR as a Remedial Technology

Site Name	Portion of Cleanup Using MNR	Comments (Source: Magar et al. 2004, unless otherwise noted)
CERCLA Sites		
Commencement Bay, WA	Partial	Monitoring data show that mercury levels in surface sediments have decreased. Cleanup levels achieved in Sitcum Waterway. Monitoring of Thea Foss and Wheeler-Osgood Waterways ongoing.
Bremerton Naval Shipyard, WA	Partial	Monitoring data through 2010 and a trend analysis suggest that total PCB concentrations have a high probability of achieving the cleanup goal (3 mg/kg oc) by 2014 (Vita et al. 2011).
Elizabeth Mine, VT	Entire	Monitoring ongoing and/or data not yet available.
Hackensack River, NJ	Partial	Monitoring ongoing and/or data not yet available.
James River, MA	Entire	Continued low-level contamination in fish tissue, but concentrations are below action level.
Ketchikan Pulp Company, AK	Partial	Recovery is progressing in the natural recovery areas, such that all four areas have achieved the RAO for sediment toxicity, and three of the four areas have achieved healthy benthic communities with multiple taxonomic groups. The weight-of-evidence for the fourth natural recovery area indicates that, in addition to achieving the RAO for sediment toxicity, substantial and acceptable progress has been made toward achieving a healthy benthic community (Integral 2009).
Koppers Company, FL	Partial	Monitoring data show that sediment PAH concentrations have been decreasing.
Lavaca Bay, TX	Partial	Monitoring data show that mercury concentrations in surface sediment are below cleanup levels, but concentrations fluctuate and remain elevated in biota.
Lower Fox River/Green Bay: OU 2 and 5, WI	Partial	Monitoring ongoing and/or data not yet available.
Mississippi River Pool 15, IA	Entire	Although monitoring data are limited, available data indicate decreasing PCB levels in fish.
Sangamo/Twelve Mile Creek/Lake Hartwell, SC	Entire	Monitoring data show significant reductions in surface sediment total PCB concentrations, but total PCB concentrations in fish continue to exceed 2 mg/kg, thereby requiring other activities (EPA 2008b and 2009).
Wyckoff/Eagle Harbor, West and East Harbor OUs, WA	Partial	West Harbor monitoring data showed that surface sediment and biota levels were achieving remedial goals in capping and natural recovery areas. However, seeps were identified in intertidal areas and eelgrass beds in habitat restoration areas were not growing. East Harbor data indicate that contamination remains on the East Beach. Monitoring will continue to determine whether natural recovery aided by source control will achieve goals (USACE 2007, EPA 2008b).
Palos Verdes Shelf, CA	Partial	No monitoring data yet (EPA 2010a).
Nyanza Chemical Waste Dump, Sudbury River, MA	Partial	No monitoring data yet (EPA 2010b).
Onondaga Lake, NY	Partial	Monitoring ongoing, but data not yet available (NYSDEC and EPA 2005).
Washington MTCA Site		
Whatcom Waterway, Bellingham Bay, WA	Partial	Two natural recovery areas (3A and 5C) have surface sediment concentrations below the SQS and match model predictions (Anchor QEA 2010).

Notes:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; EPA = U.S. Environmental Protection Agency; kg = kilogram; mg = milligram; MNR = monitored natural recovery; MTCA = Model Toxics Control Act; NYSDEC = New York State Department of Environmental Conservation; oc = organic carbon; OU = operable unit; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; RAO = remedial action objective; SQS = sediment quality standards; USACE = U.S. Army Corps of Engineers

Table F-2 Summary of Empirical Lines of Evidence

Line of Evidence Used for Evaluating Natural Recovery	Count	Description	Where Presented	How Is This Line of Evidence Used in this FS?	How Is Recovery Defined?
Net Sedimentation Rates in Cores					
Cores Collected in 2006 for the RI	56	Various time markers were used to calculate net sedimentation rates in cores. Net sedimentation rates were used to assign years to intervals of cores collected in 2006 for the RI (for Figure F-12).	Figure F-2 and Figure F-12	Used to calibrate the STM net sedimentation rates	Net sedimentation of 1 cm/year or more
Historical Cores	25				
Resampled Surface Sediment Locations					
Total PCBs	70	Surface sediment samples located within 10 ft of one another sampled at different times	Tables F-4a, F-4b, and F-5a; Figures F-3a, F-3b, F-4, and F-8	Total PCBs and SMS contaminants (not cPAHs) are used for assigning recovery categories; population trends are used to discuss site-wide recovery.	Concentration decrease of 50% of more from older to newer sample
Arsenic	56		Tables F-4a, F-4b, and F-5b; Figures F-3a, F-5, and F-8		
cPAH	53		Tables F-4a, F-4b, and F-5c; Figures F-3a and F-6		
BEHP	53		Tables F-4a, F-4b, and F-5d; Figures F-3a, F-7, and F-8		
Other SMS Contaminants – old sample >SQS	23		Table F-5e and Figure F-8		
Other SMS Contaminants – new sample >SQS	24		Table F-5f and Figure F-8		
Surface Sediment Temporal Trends In and Around EAAs					
Duwamish/Diagonal Perimeter Monitoring Locations	8	Annual monitoring data from established monitoring stations sampled from 2003 to 2009	Table F-6 and Figure F-9	Data for total PCBs, arsenic, cPAHs, and BEHP used as general area recovery evidence for BPJ	Decreasing concentrations over time
Slip 4 Surface Sediment Data	60	Data collected from various events from 1997 to 2004; not co-located	Figure F-10	Data for total PCBs used as general area recovery evidence for BPJ	Decreasing concentrations over time
Trends at Depth in Cores Collected in 2006 for the RI					
Total PCBs	59	Identify depth of highest concentration either in the subsurface or surface, or no strong trend in core.	Tables F-7a, F-7b, and F-7c	Additional support for core trends in top two intervals, but not directly used in calculations	Cores with a buried peak demonstrate that recovery is occurring; those with the peak at the surface may be in areas subject to recontamination or with low recovery.
Trends in Top Two Intervals in Cores					
Total PCBs	165 total; 119 with detected total PCB SQS exceedances	Concentration changes for contaminants exceeding the SQS were evaluated in the two shallowest intervals in cores (representing the time since ~1980s). 1-ft intervals were used (or shorter) unless a co-located surface sediment sample was available.	Tables F-7a through F-8; Figures F-13 and F-22a through 22c	Used for assigning recovery categories	Concentration decrease of 50% of more from deeper to shallower interval
SMS Contaminants Other than Total PCBs	165 total; 57 with detected SQS exceedances				
Fish Tissue Trends					
Mean Total PCB Concentrations from English Sole Fillets Collected in the LDW by Year	61 samples	16 years of data spanning 1972 to 2007	Table F-10; Figures F-14 and F-15	Provides general information about recovery of the LDW and the impact of dredging residuals	Although historical data must be interpreted with caution, there is some indication of decreasing concentrations over time

Notes:

BEHP = bis(2-ethylhexyl)phthalate; BPJ = best professional judgment (when assigning remedial technologies); cPAHs = carcinogenic polycyclic aromatic hydrocarbons; EAA = early action area; FS = feasibility study; LDW = Lower Duwamish Waterway; PCBs = polychlorinated biphenyls; RI = remedial investigation; SMS = Sediment Management Standards; SQS = sediment quality standard

Table F-3 Net Sedimentation Rates in the LDW Estimated from Physical and Chemical Time Markers

		Net Sedimentation Rates (cm/year) Estimated from Time Markers and Event Horizons[a]								
		Physical[b]			Contaminant (1-ft, 2-ft Intervals)			Contaminant (6-in Intervals) from a Subset of 2006 Cores		
	Approx. River Mile	Interface between Lower Alluvium and Upper Alluvium[c]	Interface between Upper Alluvium and Recent Sediments[d]	Dredge Horizon[e]	Lead/ PCB/ Phthalate Introduction	PCB Peak Usage/ Spill	Control Sources	PCB Introduction	PCB Peak Usage/ Spill	Control Sources
Subsurface Core ID		1916	1961	Variable	1920/1935/ 1950	1960/ 1974	1980	1935	1960/ 1974	1980
RI 2006 Cores										
SC-1	0.0	0.9			1.7			1.1	0.9	0.9
SC-2	0.1									
SC-3	0.1	0.4								
SC-4	0.2	1.1			1.7		1.2			
SC-5	0.2	0.7	0.5		0.5, 0.9					
SC-6	0.3	2.6	3.0		2.3		2.3	2.6	2.3	2.7
SC-7	0.3				0.7					
SC-8	0.4					3.3	1.2			
SC-9	0.5		1.8	1.5						
SC-10	0.5	2.4	2.7	2.4		2.9				
SC-11	0.5		0.5		0.4					
SC-12	0.6	2.3	1.8		2.9	2.0	2.3, 1.2	2.6	2.0	2.1
SC-13	0.9				1.1			1.1 to 2.1		
SC-14	0.9	2.9			4.0					
SC-15	0.9	2.5	1.4		3.0	4.8				
SC-16	0.9	2.4			3.8	2.9	2.3, 1.2			
SC-17	1.0					2.9				
SC-18	1.0	1.9		1.5, 1.9	0.7, 0.9, 1.1					
SC-19	1.0	3.0	4.7		3.4	4.3				
SC-20	1.0									
SC-21	1.0	3.3	3.4		2.7	4.9	2.3			
SC-22	1.1									
SC-23	1.3		3.3		4.3	4.8	4.7	3.4	4.8	3.3
SC-24	1.2	1.1	0.7		0.7, 0.9					
SC-25	1.3	2.0 to 2.5			2.5, 3.0					
SC-26	1.4									
SC-27	1.4	1.5 to 2 .6						1.4	1.2	0.9
SC-28	1.4									
SC-29	1.4	0.6	0.4							
SC-30	1.6	1.1								
SC-31	1.7			12.2	1.0, 1.2, 1.5					
SC-32	1.7	1.7 to 2.4	1.9		2.0, 2.5					
SC-33	1.9	2.9			3.0, 3.8			2.6	0.8 to 1.7	0.9, 1.4
SC-34	1.9		2.2							
SC-35	2.0		3.5	2.8, 3.7						
SC-36	2.1	2.8	2.2							
SC-37	2.1	1.8	1.8		2.0, 2.6	1.0	2.3			

Table F-3 Net Sedimentation Rates in the LDW Estimated from Physical and Chemical Time Markers (continued)

Subsurface Core ID	Approx. River Mile	Net Sedimentation Rates (cm/year) Estimated from Time Markers and Event Horizons[a]								
		Physical[b]			Contaminant (1-ft, 2-ft Intervals)			Contaminant (6-in Intervals) from a Subset of 2006 Cores		
		Interface between Lower Alluvium and Upper Alluvium[c]	Interface between Upper Alluvium and Recent Sediments[d]	Dredge Horizon[e]	Lead/ PCB/ Phthalate Introduction	PCB Peak Usage/ Spill	Control Sources	PCB Introduction	PCB Peak Usage/ Spill	Control Sources
		1916	1961	Variable	1920/1935/ 1950	1960/ 1974	1980	1935	1960/ 1974	1980
RI 2006 Cores (continued)										
SC-38	2.1									
SC-39	2.2	2.9								
SC-40	2.2	0.7								
SC-41	2.4	2.6								
SC-42	2.5		2.7							
SC-43	2.6	3.0	0.5							
SC-44	2.7				1.4, 1.1			1.3	0.5	0.3
SC-45	2.8									
SC-46	2.7	2.3		7.6, 1.8						
SC-47	3.1	1.0			1.3, 1.4, 2.2	1.0	1.2			
SC-48	3.3				0.4 to 0.5					
SC-49	3.5		2.4		4.3					
SC-50	3.8	0.9			1.0, 1.2, 1.5					
SC-51	3.8									0.6
SC-52	3.9				0.5, 0.7, 0.9					
SC-53	4.2	3.1	3.3							
SC-54	4.3	1.8	2.7							
SC-55	4.9	1.0	0.3							
SC-56	4.7				0.8 to 1.0					
Historical Cores[f]										
B3 (T105 1985)[g]	0.2	4.9	5.1							
DUD006[g]	0.4								3.1, 1.9	2.7, 0.7
DR18 (PSDDA99)[g]	1.8	2.2	3.2							
DR39 (PSDDA99)[g]	2.2	1.5								
SC11 (Slip 4 2004)[g]	2.8	1.5	2.2							
S3 (PSDDA98)[g]	3.8	3.0	3.3							
SC04	2.8	2.7	1.6							
SC05	2.8	3.2			1.8					
SC06	2.8	2.0	2.3							
SC07	2.8	2.8								
SC09	2.8	2.7								
SL-4-5A	2.8	2.9	2.1							
SD-DUW06	3.2	3.0	7.0							
SD-DUW13D	3.5	2.9	1.5							

Table F-3 Net Sedimentation Rates in the LDW Estimated from Physical and Chemical Time Markers (continued)

Subsurface Core ID	Approx. River Mile	Net Sedimentation Rates (cm/year) Estimated from Time Markers and Event Horizons[a]								
		Physical[b]			Contaminant (1-ft, 2-ft Intervals)			Contaminant (6-in Intervals) from a Subset of 2006 Cores		
		Interface between Lower Alluvium and Upper Alluvium[c]	Interface between Upper Alluvium and Recent Sediments[d]	Dredge Horizon[e]	Lead/ PCB/ Phthalate Introduction	PCB Peak Usage/ Spill	Control Sources	PCB Introduction	PCB Peak Usage/ Spill	Control Sources
		1916	1961	Variable	1920/1935/ 1950	1960/ 1974	1980	1935	1960/ 1974	1980
Historical Cores[f] (continued)										
SD-DUW-144	3.1	2.4	1.5		1.8					
SD-DUW-146	3.2	1.5			1.8					
SD-DUW-148	3.2	0.5								
SD-DUW-149	3.2	1.8			1.3					
SD-DUW-150D	3.2	1.4	0.5							
SD-208	3.6	2.7								
SD-214	3.7	2.9	1.4							
T117-SE-25-SC	3.6	2.8			3.6					
T117-SE-31-SC	3.6	3.3			0.9					
T117-SE-35-SC	3.6	3.2			3.6	2.1				
T117-SE-37-SC	3.6	0.7			0.4		3.6			

Notes:

▨ = no strong markers in core; therefore no calculation of net sedimentation rates could be made for the core.

1. Blank cells indicate that markers were not present or core was not clearly indicative of a strong time marker.

a. All net sedimentation rate estimates are based on recovered core depths.

b. Sediments were grouped into three stratigraphic units identified for the LDW, primarily based on density, color, sediment type, texture, and marker bed horizons. The three sediment stratigraphy units were identified as follows: Recent, Upper Alluvium, Lower (Native) Alluvium.

c. Lower (Native) Alluvium is defined by top of dense sand unit. Assumed to be the marker at the time of LDW creation (1916).

d. This interface is defined by the presence of recent sediments (organic silt) above the interface and is assumed to be the marker at the time of completion of the Howard Hanson Dam (1961).

e. Dredging event rates show rate from dredging event to top of core and rate from stratigraphic marker to dredging effects marker.

f. Only the 25 cores where rates were calculated are presented in this section of the table.

g. These six historical cores were included in Appendix F of the Sediment Transport Analysis Report (STAR; Windward and QEA 2008) along with the 56 RI cores, for a total of 62 cores described in the STAR. Rates could be calculated for 55 of these 62 cores.

EAA = early action area; LDW = Lower Duwamish Waterway; PCBs = polychlorinated biphenyls; RI = remedial investigation; RM = river mile

See Subsurface Sediment Data Report (Windward and RETEC 2007) for core logs.

Table F-4a Change in Risk-Driver Concentrations in Resampled Surface Sediment Populations

Risk Driver and Metric	Older Data (1991–2006)	Newer (FS Baseline) Data (1998–2008)	Percent Change between Older and Newer Concentrations (%)
Total PCBs (µg/kg dw); N = 70			
Data Distribution	Non-parametric	Lognormal	n/a
Detection Frequency (%)	96	90	n/a
Minimum Detect	10	9.8	-2
25th Percentile	107	74	-31
Median	204	157	-23
Mean	1,057	688	-35
75th Percentile	928	473	-49
90th Percentile	2,363	961	-58
Maximum	9,400	13,000	38
Total PCBs (µg/kg dw); N = 67, excluding outliers			
Data Distribution	Non-parametric	Lognormal	n/a
Detection Frequency (%)	97	91	n/a
Minimum Detect	10	9.8	-2
25th Percentile	107	74	-31
Median	200	155	-23
Mean	939	354	-62
75th Percentile	561	415	-26
90th Percentile	2,141	776	-64
Maximum	9,400	5,100	-46
Arsenic (mg/kg dw); N = 56			
Data Distribution	Non-parametric	Non-parametric	n/a
Detection Frequency (%)	100	100	n/a
Minimum Detect	6.4	5.1	Minimal change; in equilibrium
25th Percentile	10	11	
Median	13	15	
Mean	40	35	
75th Percentile	17	19	
90th Percentile	41	40	
Maximum	1,130	807	

Table F-4a Change in Risk-Driver Concentrations in Resampled Surface Sediment Populations (continued)

Risk Driver and Metric	Older Data (1991–2006)	Newer (FS Baseline) Data (1998–2008)	Percent Change between Older and Newer Concentrations (%)
cPAHs (µg TEQ/kg dw); N = 53			
Data Distribution	Lognormal	Lognormal	n/a
Detection Frequency (%)	100	100	n/a
Minimum Detect	18	24	33
25th Percentile	200	145	-28
Median	505	265	-48
Mean	1,534	437	-72
75th Percentile	1,000	440	-56
90th Percentile	2,070	803	-61
Maximum	31,000	2,400	-92
BEHP (µg/kg dw); N = 53			
Data Distribution	Lognormal	Lognormal	n/a
Detection Frequency (%)	70	90	n/a
Minimum Detect	34	35	3
25th Percentile	230	92	-60
Median	505	160	-68
Mean	827	310	-63
75th Percentile	955	388	-59
90th Percentile	1,570	606	-61
Maximum	6,100	1,700	-72

Notes:

1. Newer data are co-located with older data (i.e., within 10 ft). Older data are not included in the FS baseline dataset.
2. Statistics calculated using ProUCL v.4.00.04.
3. Undetected data were set to the reporting limit.
4. Three PCB locations omitted in generating the n = 67 dataset: LDW-SS110/SD-323-S at 13,000 and 9,400 µg/kg dw; LDW-SS111/DR186 at 3,200 and 1,180 µg/kg dw; and SD-320-S/SD-DUW92 at 8,900 and 1,500 µg/kg dw. These are located within the Boeing Plant 2/Jorgensen Forge EAA. Outliers selected by Rosner test in ProUCL.

BEHP = bis(2-ethylhexyl)phthalate; cPAH = carcinogenic polycyclic aromatic hydrocarbon; µg/kg dw = microgram per kilogram dry weight; n/a = not applicable; p = probability; PCB = polychlorinated biphenyl; TEQ = toxic equivalent

Table F-4b Evaluation of Significant Differences in Resampled Surface Sediment Populations

Risk Driver	Number of Samples	Are Datasets Significantly Different?	Significance (p value)
Total PCBs – new vs. old	70	No	0.075
Total PCBs excluding outliers – new vs. old	67	Yes	0.023
Arsenic – new vs. old	56	No	0.474
cPAHs – new vs. old	53	Yes	0.002
BEHP – new vs. old	53	Yes	0.010

Notes:

1. Full datasets evaluated with 2-Tailed hypothesis testing using ProUCL v.4.00.04, two sample test (Wilcoxon-Mann-Whitney) with 95% confidence level (α=0.05).
2. Total PCB n=67 dataset evaluated with 2-Tailed hypothesis testing using SPSS v 13.0, two related sample test (Wilcoxon Signed Ranks Test) with 95% confidence level (α=0.05).
3. Three PCB locations omitted in generating the n=67 dataset: LDW-SS110/SD-323-S; LDW-SS111/DR186; and SD-320-S/SD-DUW92. These are located within the Boeing Plant 2/Jorgensen Forge EAA. Outliers selected by Rosner test in ProUCL.
4. Shaded cells indicate significantly different datasets.

BEHP = bis(2-ethylhexyl)phthalate; cPAH = carcinogenic polycyclic aromatic hydrocarbon; p = probability; PCB = polychlorinated biphenyl

Table F-5a Percent Change at Resampled Surface Sediment Locations — Total PCBs

		Older Station			Newer Station			Change in Total PCB Concentration from Older Station to Newer Station				
River Mile	Older Total PCB Concentration Range (µg/kg dw)	Station ID	Year Sampled	Total PCBs (µg/kg dw)	Station ID	Year Sampled	Total PCBs (µg/kg dw)	Years Elapsed	Concentration Change (µg/kg dw)	Percent Change[a]	Total PCB Concentration Change Rate (µg/kg dw/yr)	Recovery Category
3.7	>1,300	SD-323-S	2004	9,400	LDW-SS110	2005	13,000	1	3,600	38%	3600	EAA
4.7		DR271	1998	9,400	LDW-SS148	2005	520	7	-8,880	-94%	-1269	3
3.5		WST323	1997	7,900	T117-SE-10-G	2003	1,200	6	-6,700	-85%	-1117	EAA
3.6		SD-DUW90	1996	7,500	SD-343-S	2004	260	8	-7,240	-97%	-905	EAA
2.2		WIT280	1997	5,200	B5a-2	2004	1,730	7	-3,470	-67%	-496	2
1.4		DR030	1998	4,800	LDW-SS50	2005	590	7	-4,210	-88%	-601	3
0.8		EST219	1997	4,400	LDW-SS27	2005	97	8	-4,303	-98%	-538	3
3.9		EIT061	1997	2,400	LDW-SS121	2005	1,060	8	-1,340	-56%	-168	2
2.2		DR113	1998	2,030	LDW-SS81	2005	210	7	-1,820	-90%	-260	2
2.9		DR181	1998	1,670	DR-181	2006	460	8	-1,210	-72%	-151	3
3.7		SD-DUW92	1996	1,500	SD-320-S	2004	8,900	8	7,400	493%	925	EAA
3.9		EST144	1997	1,500	LDW-SS123	2005	149	8	-1,351	-90%	-169	2
3.9	>480 - 1,300	R30	1997	1,250	LDW-SS119	2005	880	8	-370	-30%	-46	2
2.0		R7	1997	1,200	LDW-SS75	2005	520	8	-680	-57%	-85	3
2.1		CH0023	1997	1,200	LDW-SS79	2005	68	8	-1,132	-94%	-142	3
3.7		DR186	1998	1,180	LDW-SS111	2005	3,200	7	2,020	171%	289	EAA
0.3		DUD042	1995	1,060	LDW-SS17	2005	120	10	-940	-89%	-94	3
1.2		DR088	1998	1,010	LDW-SS40	2005	510	7	-500	-50%	-71	3
1.5		DR123	1998	900	LDW-SS57	2005	750	7	-150	-17%	-21	3
1.0		DR087	1998	696	LDW-SS37	2005	5,100	7	4,404	633%	629	2
0.2		DR035	1998	516	LDW-SS12	2005	171	7	-345	-67%	-49	3
2.6	>240 - 480	EIT074	1997	450	LDW-SS88	2005	660	8	210	47%	26	3
0.9		DR085	1998	413	LDW-SSB2b	2005	790	7	377	91%	54	2
1.4		B4b	2004	400	B4B	2006	220	2	-180	-45%	-90	3
3.6		SD-SWY07	1995	320	SD-SWY17	2003	460	8	140	44%	18	EAA
0.3		LDW-SS16	2005	320	TRI-016	2006	190	1	-130	-41%	-130	1
2.1		DR111	1998	311	DR-111	2006	176	8	-135	-43%	-17	3
1.3		LDW-SS45	2005	290	TRI-045	2006	230	1	-60	-21%	-60	3
3.6		EST152	1997	290	SD-309-S	2004	570	7	280	97%	40	EAA
3.6		T117-SE-19-G	2003	270	107-G	2008	120	5	-150	-56%	-30	3
1.3		DR053	1998	260	LDW-SS44	2005	103	7	-157	-60%	-22	1
3.8		DR187	1998	246	LDW-SS115	2005	220	7	-26	-11%	-4	2
2.8	>100 - 240	EST180	1997	230	LDW-SS92	2005	970	8	740	322%	93	2
2.1		DR106	1998	227	LDW-SS76	2005	117	7	-110	-48%	-16	3
3.7		T117-SE-46-G	2003	210	117-G	2008	20	5	-190	-90%	-38	3
1.4		DR028	1998	207	B4b	2004	400	6	193	93%	32	3
0.0		K-11	1991	200	LDW-SS1	2005	161	14	-39	-20%	-3	3
3.7		R21	1997	200	LDW-SS113b	2005	18	8	-182	-91%	-23	3
3.7		R18	1997	200	114-G	2008	54	11	-146	-73%	-13	3
4.2		R42	1997	193	LDW-SS129	2005	10	8	-184	-95%	-23	1
3.7		R19	1997	190	113-G	2008	20	11	-170	-89%	-15	3
0.3		DR079	1998	187	LDW-SS15	2005	128	7	-59	-32%	-8	3
1.4		DR065	1998	185	LDW-SS52	2005	209	7	24	13%	3	2
1.0		DR020	1998	169	LDW-SS31	2005	96	7	-73	-43%	-10	2
1.0		DR019	1998	162	LDW-SS32	2005	122	7	-40	-25%	-6	2
1.4		LDW-SS51	2005	155	TRI-051	2006	132	1	-23	-15%	-23	3
3.6		EST154	1997	150	SD-334-S	2004	290	7	140	93%	20	EAA
3.9		LDW-SS123	2005	149	AN-019	2006	770	1	621	417%	621	2
0.9		DR021	1998	142	LDW-SS319	2006	350	8	208	146%	26	1
1.7		DR097	1998	126	LDW-SS63	2005	95	7	-31	-25%	-4	3
2.8		DR175	1998	120	LDW-SS94	2005	72	7	-48	-40%	-7	2
4.2		R40	1997	119	LDW-SS127	2005	58	8	-61	-51%	-8	3
1.4		DR160	1998	115	LDW-SS51	2005	155	7	40	35%	6	3
4.1		A11-05 avg	1994	109	LDW-SS126	2005	10	11	-99	-91%	-9	3
4.2		R45	1997	101	LDW-SS130	2005	26	8	-75	-74%	-9	1

Table F-5a Percent Change at Resampled Surface Sediment Locations — Total PCBs

		Older Station			Newer Station			Change in Total PCB Concentration from Older Station to Newer Station				
River Mile	Older Total PCB Concentration Range (µg/kg dw)	Station ID	Year Sampled	Total PCBs (µg/kg dw)	Station ID	Year Sampled	Total PCBs (µg/kg dw)	Years Elapsed	Concentration Change (µg/kg dw)	Percent Change[a]	Total PCB Concentration Change Rate (µg/kg dw/yr)	Recovery Category
3.2	≤100	DR202	1998	98	LDW-SS104	2005	75	7	-23	-23%	-3	3
1.9		DR131	1998	97	LDW-SS70	2005	96	7	-1	-1%	0	3
4.2		DR242	1998	93	SB-1	2004	170	6	77	83%	13	1
0.1		K-07	1991	87	LDW-SS4	2005	153	14	66	76%	5	2
3.1		DR198	1998	85	LDW-SS102	2005	74	7	-11	-13%	-2	3
0.2		K-05 avg	1991	83	LDW-SS10	2005	31	14	-52	-63%	-4	3
3.8		R24	1997	73	LDW-SS117	2005	79	8	6	8%	1	3
4.3		DR286	1998	54	B10b	2004	10	6	-44	-82%	-7	1
2.4		WST342	1997	38	DR141	1998	68	1	30	79%	30	1
0.2		LDW-SS10	2005	31	TRI-010	2006	159	1	128	413%	128	3
1.0		WST367	1997	29	DR048	1998	88	1	59	203%	59	3
2.8		LDW-SS96	2005	24	TRI-096	2006	220	1	196	817%	196	3
0.0		DR076	1998	20	LDW-SS5	2005	10	7	-10	-50%	-1	3
4.1		DR238	1998	20	LDW-SS125	2005	10	7	-11	-53%	-2	3
4.2		EST135	1997	10	B8b	2004	37	7	27	270%	4	1
								7	*Average Years Elapsed for All Locations*			

Concentration Averages by Reach - using locations with 5 or more years between sampling (n = 60)						
Reach 1 (RM 0 to 2.2; n = 28)		929		466		-50%
Reach 2 (RM 2.2 to 4.0; n = 23)		1,219		861		-29%
Reach 3 (RM 4.0 to 5.0; n = 9)		1,122		94		-92%
Concentration Averages by Recovery Category (n=70)						
Category 1 (n= 9)		135		107		-20%
Category 2 (n = 15)		989		835		-16%
Category 3 (n = 38)		807		195		-76%
EAAs (n = 8)		3,530		3,485		-1%

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.
2. Recovery categories are as follows:
   Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

a. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

🟥 Greater than or equal to 50% concentration increase, 5 or more years between events, and any data > 100 µg/kg dw.
⬜ Minimal change (< 50% change in concentration), less than 5 years between events, or no concentrations > 100 µg/kg dw.
🟦 Greater than or equal to 50% concentration decrease, 5 or more years between events, and any data > 100 µg/kg dw.

EAA = early action area; µg/kg dw = micrograms per kilogram dry weight; PCBs = polychlorinated biphenyls; RM = river mile

Table F-5b Percent Change at Resampled Surface Sediment Locations — Arsenic

River Mile	Older Arsenic Concentration Range (mg/kg dw)[a]	Older Station			Newer Station			Change in Arsenic Concentration from Older Station to Newer Station			Recovery Category
		Station ID	Year Sampled	Arsenic (mg/kg dw)	Station ID	Year Sampled	Arsenic (mg/kg dw)	Years Elapsed	Concentration Change (mg/kg dw)	Percent Change[b]	
1.3	>93 (CSL)	SS-2	1993	1130	LDW-SS48	2005	807	12	-323	-29%	1
1.4		SS-4	1993	140	LDW-SS55	2005	17.2	12	-123	-88%	1
1		DR020	1998	99.3	LDW-SS31	2005	122	7	23	23%	2
1.4	>25 - 93	SS-3	1993	66	LDW-SS49	2005	171	12	105	159%	1
1.5		DR123	1998	52.4	LDW-SS57	2005	35.4	7	-17	-32%	3
3.8		DR187	1998	48.1	LDW-SS115	2005	44.4	7	-3.7	-8%	2
1.3		DR053	1998	35.4	LDW-SS44	2005	46.8	7	11	32%	1
3.7		SD-323-S	2004	32	LDW-SS110	2005	24.7	1	-7.3	-23%	EAA
1.3		LDW-SS45	2005	26.2	TRI-045	2006	52.1	1	26	99%	3
3.7	>15 - 25	DR186	1998	24.9	LDW-SS111	2005	31.7	7	6.8	27%	EAA
1		DR019	1998	21.1	LDW-SS32	2005	15.7	7	-5.4	-26%	2
4.2		R42	1997	21.1	LDW-SS129	2005	10.6	8	-11	-50%	1
4.2		DR242	1998	20	SB-1	2004	22	6	2.0	10%	1
4.2		R40	1997	18.4	LDW-SS127	2005	13.2	8	-5.2	-28%	3
1.4		LDW-SS51	2005	16.9	TRI-051	2006	18.7	1	1.8	11%	3
1		DR087	1998	16.8	LDW-SS37	2005	13.6	7	-3.2	-19%	2
0.2		DR035	1998	16.7	LDW-SS12	2005	13	7	-3.7	-22%	3
0.9		DR085	1998	16.5	LDW-SSB2b	2005	16.5	7	0.0	0%	2
2.1		DR111	1998	16.5	DR-111	2006	15.1	8	-1.4	-8%	3
1.2		DR088	1998	15.4	LDW-SS40	2005	16.7	7	1.3	8%	3
0.3		LDW-SS16	2005	15.2	TRI-016	2006	16.2	1	1.0	7%	1
0.9		DR021	1998	15.2	LDW-SS319	2006	14.8	8	-0.4	-3%	1
0.3		DR079	1998	15.1	LDW-SS15	2005	11.5	7	-3.6	-24%	3
0.3	≤15	DUD042	1995	15	LDW-SS17	2005	14.9	10	-0.1	-1%	3
1.7		DR097	1998	14.6	LDW-SS63	2005	10.2	7	-4.4	-30%	3
4.2		R45	1997	13.9	LDW-SS130	2005	15	8	1.1	8%	1
1.4		DR030	1998	13.6	LDW-SS50	2005	16.3	7	2.7	20%	3
2.2		DR113	1998	13.4	LDW-SS81	2005	18.1	7	4.7	35%	2
2.1		DR106	1998	12.7	LDW-SS76	2005	14.5	7	1.8	14%	3
2.8		LDW-SS96	2005	12.7	TRI-096	2006	10.3	1	-2.4	-19%	3
0		K-11	1991	12.6	LDW-SS1	2005	6.2	14	-6.4	-51%	3
0.2		LDW-SS10	2005	12.4	TRI-010	2006	12.2	1	-0.2	-2%	3
3.9		R30	1997	12.4	LDW-SS119	2005	10.9	8	-1.5	-12%	2
2.8		DR175	1998	12.2	LDW-SS94	2005	26.5	7	14	117%	2
2.9		DR181	1998	12.2	DR-181	2006	19.6	8	7.4	61%	3
3.7		SD-DUW92	1996	12	SD-320-S	2004	20	8	8.0	67%	EAA
0.1		K-07	1991	11.6	LDW-SS4	2005	21.2	14	10	83%	2
3.7		R21	1997	10.8	LDW-SS113b	2005	8.3	8	-2.5	-23%	3
4.3		DR286	1998	10.7	B10b	2004	5.1	6	-5.7	-53%	1
0		DR076	1998	10.6	LDW-SS5	2005	6.5	7	-4.1	-39%	3
1.4		DR065	1998	10.3	LDW-SS52	2005	15.5	7	5.2	50%	2
1.4		B4b	2004	10.3	B4B	2006	14	2	3.7	36%	3
3.8		R24	1997	10.2	LDW-SS117	2005	14.4	8	4.2	41%	3
0.2		K-05	1991	10	LDW-SS10	2005	12.4	14	2.4	24%	3
1.4		DR028	1998	9.9	B4b	2004	10.3	6	0.4	4%	3
1.4		DR160	1998	9.6	LDW-SS51	2005	16.9	7	7.3	76%	3
4.1		DR238	1998	8.9	LDW-SS125	2005	8.6	7	-0.3	-3%	3
1.9		DR131	1998	8.1	LDW-SS70	2005	14.8	7	6.7	83%	3
3.2		DR202	1998	8.1	LDW-SS104	2005	11.5	7	3.4	42%	3
4.1		06-intsed-2	1996	8	SH-04	2004	8.8	8	0.8	10%	3
2		R7	1997	7.9	LDW-SS75	2005	8.3	8	0.4	5%	3

Table F-5b Percent Change at Resampled Surface Sediment Locations — Arsenic

River Mile	Older Arsenic Concentration Range (mg/kg dw)[a]	Older Station			Newer Station			Change in Arsenic Concentration from Older Station to Newer Station			Recovery Category
		Station ID	Year Sampled	Arsenic (mg/kg dw)	Station ID	Year Sampled	Arsenic (mg/kg dw)	Years Elapsed	Concentration Change (mg/kg dw)	Percent Change[b]	
3.9	≤15	LDW-SS123	2005	7.4	AN-019	2006	8.6	1	1.2	16%	2
4		07-intsed-1	1996	7	SH-02	2004	11	8	4.0	57%	3
3.1		DR198	1998	6.7	LDW-SS102	2005	6.6	7	-0.1	-1%	3
4.1		A11-05	1994	6.5	LDW-SS126	2005	7.3	11	0.8	12%	3
4.7		DR271	1998	6.4	LDW-SS148	2005	15.6	7	9.2	144%	3
								7	*Average Years Elapsed for All Locations*		

Concentration Averages by Reach - using locations with 5 or more years more between sampling (n = 48)					
Reach 1 (RM 0 to 2.2; n = 28)	65		54		-17%
Reach 2 (RM 2.2 to 4.0; n = 10)	16		19		19%
Reach 3 (RM 4.0 to 5.0; n = 10)	12		12		0%
Concentration Averages by Recovery Category (n=56)					
Category 1 (n= 10)	147		113		-23%
Category 2 (n = 11)	24		28		16%
Category 3 (n = 32)	13		14		8%
EAAs (n = 3)	23		25		11%

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.
2. Recovery categories are as follows:
   Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

a. Original concentrations are grouped by some of the remedial action levels discussed in Sections 6 and 8. There is no division for data between the SQS (57 mg/kg dw) and the CSL (93 mg/kg dw) because there would be only 1 sample in this group.

b. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

🟥 Greater than or equal to 50% concentration increase, 5 or more years between events, and any data > 25 mg/kg dw.

⬜ Minimal change (< 50% change in concentration), less than 5 years between events, or no concentrations > 25 mg/kg dw.

🟦 Greater than or equal to 50% concentration decrease, 5 or more years between events, and any data > 25 mg/kg dw.

CSL = cleanup screening level; EAA = early action area; mg/kg dw = milligram per kilogram dry weight; RM = river mile; SQS = sediment quality standards

Table F-5c Percent Change at Resampled Surface Sediment Locations — cPAHs

River Mile	Older cPAH Concentration Range (µg TEQ/kg dw)[a]	Older/Resampled Station			Newer Station			Change in cPAH Concentration from Resampled Station to Newer Station			Recovery Category
		Station ID	Year Sampled	cPAH (µg TEQ/kg dw)	Station ID	Year Sampled	cPAH (µg TEQ/kg dw)	Years Elapsed	Concentration Change (µg TEQ/kg dw)	Percent Change[b]	
4.2	>1,000	R40	1997	31000	LDW-SS127	2005	640	8	-30,360	-98%	3
4.2		R42	1997	8600	LDW-SS129	2005	860	8	-7,740	-90%	1
3.8		DR187	1998	5600	LDW-SS115	2005	2400	7	-3,200	-57%	2
4.2		R45	1997	4800	LDW-SS130	2005	370	8	-4,430	-92%	1
1.3		SS-2	1993	2160	LDW-SS48	2005	1400	12	-760	-35%	1
1		DR019	1998	2100	LDW-SS32	2005	340	7	-1,760	-84%	2
2.8		DR175	1998	2000	LDW-SS94	2005	100	7	-1,900	-95%	2
1		DR020	1998	1900	LDW-SS31	2005	600	7	-1,300	-68%	2
1.3		DR053	1998	1700	LDW-SS44	2005	670	7	-1,030	-61%	1
1		DR087	1998	1200	LDW-SS37	2005	210	7	-990	-83%	2
3.7		DR186	1998	1200	LDW-SS111	2005	1900	7	700	58%	EAA
0.3		DUD042	1995	1080	LDW-SS17	2005	440	10	-640	-59%	3
1.4		SS-3	1993	1080	LDW-SS49	2005	400	12	-680	-63%	1
0.1	>500 - 1,000	K-07	1991	1000	LDW-SS4	2005	270	14	-730	-73%	2
1.7		DR097	1998	1000	LDW-SS63	2005	190	7	-810	-81%	3
0.2		DR035	1998	840	LDW-SS12	2005	200	7	-640	-76%	3
0.9		DR021	1998	830	LDW-SS319	2006	560	8	-270	-33%	1
0.2		K-05	1991	800	LDW-SS10	2005	480	14	-320	-40%	3
1.5		DR123	1998	770	LDW-SS57	2005	350	7	-420	-55%	3
1.4		DR065	1998	700	LDW-SS52	2005	160	7	-540	-77%	2
2.1		DR111	1998	670	DR-111	2006	270	8	-400	-60%	3
1.4		DR028	1998	600	B4b	2004	300	6	-300	-50%	3
3.7		SD-323-S	2004	590	LDW-SS110	2005	250	1	-340	-58%	EAA
1.4		SS-4	1993	559	LDW-SS55	2005	190	12	-369	-66%	1
1.4		DR160	1998	540	LDW-SS51	2005	170	7	-370	-69%	3
0		K-11	1991	530	LDW-SS1	2005	130	14	-400	-75%	3
2.1		DR106	1998	510	LDW-SS76	2005	110	7	-400	-78%	3
1.9		DR131	1998	500	LDW-SS70	2005	410	7	-90	-18%	3
2.9		DR181	1998	500	DR-181	2006	320	8	-180	-36%	3
0.3	>250 - 500	LDW-SS16	2005	490	TRI-016	2006	440	1	-50	-10%	1
0.2		LDW-SS10	2005	480	TRI-010	2006	670	1	190	40%	3
4.2		DR242	1998	470	SB-1	2004	2300	6	1,830	389%	1
0.3		DR079	1998	460	LDW-SS15	2005	140	7	-320	-70%	3
4.7		DR271	1998	430	LDW-SS148	2005	230	7	-200	-47%	3
3.9		R30	1997	420	LDW-SS119	2005	260	8	-160	-38%	2
1.4		DR030	1998	400	LDW-SS50	2005	410	7	10	3%	3
0.9		DR085	1998	390	LDW-SSB2b	2005	260	7	-130	-33%	2
1.3		LDW-SS45	2005	350	TRI-045	2006	1400	1	1,050	300%	3
1.4		B4b	2004	300	B4B	2006	470	2	170	57%	3

Table F-5c Percent Change at Resampled Surface Sediment Locations — cPAHs

		Older/Resampled Station			Newer Station			Change in cPAH Concentration from Resampled Station to Newer Station			
River Mile	Older cPAH Concentration Range (µg TEQ/kg dw)[a]	Station ID	Year Sampled	cPAH (µg TEQ/kg dw)	Station ID	Year Sampled	cPAH (µg TEQ/kg dw)	Years Elapsed	Concentration Change (µg TEQ/kg dw)	Percent Change[b]	Recovery Category
1.2	≤250	DR088	1998	230	LDW-SS40	2005	95	7	-135	-59%	3
3.7		R21	1997	190	LDW-SS113b	2005	190	8	0	0%	3
1.4		LDW-SS51	2005	170	TRI-051	2006	370	1	200	118%	3
2		R7	1997	170	LDW-SS75	2005	130	8	-40	-24%	3
4.1		DR238	1998	160	LDW-SS125	2005	170	7	10	6%	3
3.1		DR198	1998	150	LDW-SS102	2005	61	7	-89	-59%	3
2.2		DR113	1998	140	LDW-SS81	2005	270	7	130	93%	2
3.2		DR202	1998	130	LDW-SS104	2005	52	7	-78	-60%	3
4.1		A11-05	1994	130	LDW-SS126	2005	180	11	50	38%	3
3.8		R24	1997	100	LDW-SS117	2005	78	8	-22	-22%	3
4.3		DR286	1998	100	B10b	2004	24	6	-76	-76%	1
2.8		LDW-SS96	2005	62	TRI-096	2006	130	1	68	110%	3
3.9		LDW-SS123	2005	21	AN-019	2006	67	1	46	219%	2
0		DR076	1998	18	LDW-SS5	2005	89	7	71	394%	3
								7	*Average Years Elapsed for All Locations*		

Concentration Averages by Reach - using locations with 5 or more years more between sampling (n = 45)						
Reach 1 (RM 0 to 2.2; n = 28)		817		330		-60%
Reach 2 (RM 2.2 to 4.0; n = 9)		1,143		596		-48%
Reach 3 (RM 4.0 to 5.0; n = 8)		5,711		597		-90%
Concentration Averages by Recovery Category (n=53)						
Category 1 (n= 10)		2,079		721		-65%
Category 2 (n = 11)		1,406		449		-68%
Category 3 (n = 30)		1,442		296		-79%
EAAs (n = 2)		895		1,075		20%

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.
2. Recovery categories are as follows:
   Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

a. Original concentrations grouped by multiples of 250 µg TEQ/kg dw because the lowest site-wide RAL is 1,000 µg TEQ/kg dw, and the majority of these data fall below this concentration; therefore, RAL-based divisions are not appropriate here.

b. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

🟥 Greater than or equal to 50% concentration increase, 5 or more years between events, and any data > 250 µg TEQ/kg dw.
⬜ Minimal change (< 50% change in concentration), less than 5 years between events, or no concentrations > 250 µg TEQ/kg dw.
🟦 Greater than or equal to 50% concentration decrease, 5 or more years between events, and any data > 250 µg TEQ/kg dw.

cPAH = carcinogenic polycyclic aromatic hydrocarbon; EAA = early action area; µg TEQ/kg dw = microgram per kilogram toxic equivalent dry weight; RAL = remedial action level; RM = river mile

Table F-5d Percent Change at Resampled Surface Sediment Locations — Bis(2-ethylhexyl)phthalate

River Mile	Older BEHP Concentration Range (µg/kg dw)[a]	Older Station			Newer Station			Change in BEHP Concentration from Older Station to Newer Station			Recovery Category
		Station ID	Year Sampled	BEHP (µg/kg dw)	Station ID	Year Sampled	BEHP (µg/kg dw)	Years Elapsed	Concentration Change (µg/kg dw)	Percent Change[b]	
0	>2,100	DR076	1998	6100	LDW-SS5	2005	20	7	-6,080	-100%	3
1.3		DR053	1998	3800	LDW-SS44	2005	120	7	-3,680	-97%	1
1.4		SS-4	1993	2200	LDW-SS55	2005	98	12	-2,102	-96%	1
0.3	>460 - 2,100	DUD042	1995	2000	LDW-SS17	2005	1100	10	-900	-45%	3
1.4		DR160	1998	1900	LDW-SS51	2005	120	7	-1,780	-94%	3
1.3		SS-2	1993	1600	LDW-SS48	2005	770	12	-830	-52%	1
1.4		DR030	1998	1500	LDW-SS50	2005	560	7	-940	-63%	3
1.9		DR131	1998	1500	LDW-SS70	2005	1700	7	200	13%	3
3.8		DR187	1998	1500	LDW-SS115	2005	330	7	-1,170	-78%	2
4.2		R40	1997	1400	LDW-SS127	2005	140	8	-1,260	-90%	3
1.7		DR097	1998	1200	LDW-SS63	2005	150	7	-1,050	-88%	3
4.2		R45	1997	1200	LDW-SS130	2005	72	8	-1,128	-94%	1
0.3		DR079	1998	1100	LDW-SS15	2005	64	7	-1,036	-94%	3
1.4		SS-3	1993	960	LDW-SS49	2005	160	12	-800	-83%	1
3.8		R24	1997	940	LDW-SS117	2005	140	8	-800	-85%	3
4.2		R42	1997	930	LDW-SS129	2005	170	8	-760	-82%	1
2.2		DR113	1998	910	LDW-SS81	2005	190	7	-720	-79%	2
2.9		DR181	1998	790	DR-181	2006	584	8	-206	-26%	3
0.1		K-07	1991	740	LDW-SS4	2005	83	14	-657	-89%	2
0.2		DR035	1998	720	LDW-SS12	2005	180	7	-540	-75%	3
0.2		K-05	1991	710	LDW-SS10	2005	82	14	-628	-88%	3
0.9		DR021	1998	710	LDW-SS319	2006	520	8	-190	-27%	1
1		DR019	1998	710	LDW-SS32	2005	93	7	-617	-87%	2
4.2		DR242	1998	620	SB-1	2004	1600	6	980	158%	1
1		DR087	1998	570	LDW-SS37	2005	760	7	190	33%	2
1.5		DR123	1998	560	LDW-SS57	2005	290	7	-270	-48%	3
1		DR020	1998	550	LDW-SS31	2005	160	7	-390	-71%	2
2.1		DR106	1998	460	LDW-SS76	2005	59	7	-401	-87%	3
3.9		R30	1997	460	LDW-SS119	2005	280	8	-180	-39%	2
1.2	>210 - 460	DR088	1998	410	LDW-SS40	2005	270	7	-140	-34%	3
1.4		DR065	1998	410	LDW-SS52	2005	95	7	-315	-77%	2
2.1		DR111	1998	410	DR-111	2006	340	8	-70	-17%	3
3.7		SD-323-S	2004	410	LDW-SS110	2005	170	1	-240	-59%	EAA
1.4		DR028	1998	390	B4b	2004	140	6	-250	-64%	3
0.3		LDW-SS16	2005	360	TRI-016	2006	504	1	144	40%	1
0.9		DR085	1998	340	LDW-SSB2b	2005	350	7	10	3%	2
1.3		LDW-SS45	2005	300	TRI-045	2006	592	1	292	97%	3
0		K-11	1991	290	LDW-SS1	2005	67	14	-223	-77%	3
2.8		DR175	1998	270	LDW-SS94	2005	46	7	-224	-83%	2
4.7		DR271	1998	260	LDW-SS148	2005	160	7	-100	-38%	3
3.7		R21	1997	220	LDW-SS113b	2005	200	8	-20	-9%	3
3.7		DR186	1998	210	LDW-SS111	2005	580	7	370	176%	EAA

Table F-5d Percent Change at Resampled Surface Sediment Locations — Bis(2-ethylhexyl)phthalate

River Mile	Older BEHP Concentration Range (µg/kg dw)[a]	Older Station			Newer Station			Change in BEHP Concentration from Older Station to Newer Station			Recovery Category
		Station ID	Year Sampled	BEHP (µg/kg dw)	Station ID	Year Sampled	BEHP (µg/kg dw)	Years Elapsed	Concentration Change (µg/kg dw)	Percent Change[b]	
2	≤210	R7	1997	180	LDW-SS75	2005	74	8	-106	-59%	3
3.1		DR198	1998	150	LDW-SS102	2005	130	7	-20	-13%	3
4.3		DR286	1998	150	B10b	2004	35	6	-115	-77%	1
1.4		B4b	2004	140	B4B	2006	612	2	472	337%	3
4.1		DR238	1998	130	LDW-SS125	2005	97	7	-33	-25%	3
1.4		LDW-SS51	2005	120	TRI-051	2006	400	1	280	233%	3
0.2		LDW-SS10	2005	82	TRI-010	2006	508	1	426	520%	3
4.1		A11-05	1994	81	LDW-SS126	2005	92	11	11	14%	3
3.2		DR202	1998	80	LDW-SS104	2005	36	7	-44	-55%	3
2.8		LDW-SS96	2005	70	TRI-096	2006	243	1	173	247%	3
3.9		LDW-SS123	2005	34	AN-019	2006	86	1	52	153%	2
								7	*Average Years Elapsed for All Locations*		

Concentration Averages by Reach - using locations with 5 or more years more between sampling (n = 45)						
Reach 1 (RM 0 to 2.2; n = 28)		1,176		308		-74%
Reach 2 (RM 2.2 to 4.0; n = 9)		513		258		-50%
Reach 3 (RM 4.0 to 5.0; n = 8)		596		296		-50%
Concentration Averages by Recovery Category (n=53)						
Category 1 (n= 10)		1,253		405		-68%
Category 2 (n = 11)		590		225		-62%
Category 3 (n = 30)		806		305		-62%
EAAs (n = 2)		310		375		21%

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.

2. The SQS criteria for bis(2-ethylhexyl)phthalate is 47 mg/kg oc.

2. Recovery categories are as follows:
Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

a. Original concentrations grouped by FS baseline dataset percentiles (95, 75, and 50) as presented in Section 2.

b. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

🟥	Greater than or equal to 50% concentration increase, 5 or more years between events, and any data > 210 µg/kg dw.
⬜	Minimal change (< 50% change in concentration), less than 5 years between events, or no concentrations > 210 µg/kg dw.
🟦	Greater than or equal to 50% concentration decrease, 5 or more years between events, and any data > 210 µg/kg dw.

BEHP = bis(2-ethylhexyl)phthalate; EAA = early action area; FS = feasibility study; µg/kg dw = microgram per kilogram dry weight; mg/kg oc = milligram per kilogram organic carbon; RM = river mile; SQS = sediment quality standards

Table F-5e Percent Change at Resampled Surface Sediment Locations — SMS Contaminants: Pairs Where Older Data Have SQS Exceedances

		Older Station				Newer Station				Change in Concentration from Older Station to Newer Station		
SQS Exceedance Contaminant for Older Sample Location	Units	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Years Elapsed	Concentration Change	Percent Change[a]
2,4-Dimethylphenol	µg/kg dw	B4b	2004	28	1.9	B4B	2006	65	2.2	2	38	136%
4-Methylphenol	µg/kg dw	DR053	1998	910	1.4	LDW-SS44	2005	29	0.1	7	-881	-97%
Acenaphthene	µg/kg dw	R40	1997	3,300	8.1	LDW-SS127	2005	24	0.0	8	-3,276	-99%
		R42	1997	520	1.4	LDW-SS129	2005	34	0.1	8	-486	-93%
		R45	1997	420	1.1	LDW-SS130	2005	10	0.0	8	-410	-98%
		DR019	1998	580	1.4	LDW-SS32	2005	23	0.1	7	-557	-96%
		DR087	1998	530	2	LDW-SS37	2005	10	0.1	7	-520	-98%
		DR053	1998	690	1.6	LDW-SS44	2005	29	0.2	7	-661	-96%
		DR065	1998	1,800	4.7	LDW-SS52	2005	10	0.1	7	-1,790	-99%
		DR175	1998	740	2.7	LDW-SS94	2005	10	0.1	7	-730	-99%
Anthracene	µg/kg dw	R40	1997	9,300	1.6	LDW-SS127	2005	60	0.0	8	-9,240	-99%
Benzo(a)anthracene	µg/kg dw	R40	1997	21,000	7.4	LDW-SS127	2005	400	0.1	8	-20,600	-98%
		R42	1997	5,000	1.9	LDW-SS129	2005	490	0.2	8	-4,510	-90%
		R45	1997	3,000	1.1	LDW-SS130	2005	220	0.1	8	-2,780	-93%
		DR175	1998	3,000	1.5	LDW-SS94	2005	95	0.0	7	-2,905	-97%
Benzo(a)pyrene	µg/kg dw	R40	1997	21,000	8.2	LDW-SS127	2005	450	0.1	8	-20,550	-98%
		R42	1997	5,700	2.4	LDW-SS129	2005	580	0.2	8	-5,120	-90%
		R45	1997	3,400	1.4	LDW-SS130	2005	260	0.1	8	-3,140	-92%
Benzo(g,h,i)perylene	µg/kg dw	R40	1997	14,000	17	LDW-SS127	2005	170	0.2	8	-13,830	-99%
		R42	1997	3,900	5.2	LDW-SS129	2005	300	0.4	8	-3,600	-92%
		R45	1997	1,300	1.7	LDW-SS130	2005	86	0.1	8	-1,214	-93%
Benzofluoranthenes (total-calc'd)	µg/kg dw	R40	1997	32,000	5.2	LDW-SS127	2005	1,150	0.2	8	-30,850	-96%
		R42	1997	11,200	2	LDW-SS129	2005	1,430	0.3	8	-9,770	-87%
Benzyl alcohol	µg/kg dw	B4b	2004	70	1.2	B4B	2006	10.5	0.2	2	-60	-85%
		DR238	1998	130	2.3	LDW-SS125	2005	16.5	0.6	7	-114	-87%
		DR019	1998	1,700	30	LDW-SS32	2005	10	0.4	7	-1,690	-99%
		DR106	1998	80	1.4	LDW-SS76	2005	10	0.4	7	-70	-88%
Butyl benzyl phthalate	µg/kg dw	R30	1997	290	4.9	LDW-SS119	2005	140	1.9	8	-150	-52%
		DR271	1998	300	2.2	LDW-SS148	2005	24	0.2	7	-276	-92%
		DUD042	1995	140	1.1	LDW-SS17	2005	54	0.6	10	-86	-61%
		DR131	1998	460	6.3	LDW-SS70	2005	90	1.2	7	-370	-80%

Table F-5e Percent Change at Resampled Surface Sediment Locations — SMS Contaminants: Pairs Where Older Data Have SQS Exceedances

SQS Exceedance Contaminant for Older Sample Location	Units	Older Station				Newer Station				Change in Concentration from Older Station to Newer Station		
		Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Years Elapsed	Concentration Change	Percent Change[a]
Cadmium	mg/kg dw	K-05	1991	7.3	1.4	LDW-SS10	2005	0.5	0.1	14	-6.8	-93%
Chrysene	µg/kg dw	R40	1997	21,000	7.4	LDW-SS127	2005	690	0.2	8	-20,310	-97%
		R42	1997	6,800	2.5	LDW-SS129	2005	910	0.3	8	-5,890	-87%
		DR187	1998	4,100	2.0	LDW-SS115	2005	2,500	1.2	7	-1600	-39%
		R45	1997	3,700	1.4	LDW-SS130	2005	400	0.1	8	-3,300	-89%
		DR175	1998	3,400	1.8	LDW-SS94	2005	120	0.1	7	-3,280	-96%
Dibenzo(a,h)anthracene	µg/kg dw	R40	1997	7,200	23	LDW-SS127	2005	28	0.1	8	-7,172	-100%
		R42	1997	2,000	6.9	LDW-SS129	2005	110	0.4	8	-1,890	-95%
		DR187	1998	950	4.2	LDW-SS115	2005	240	1.1	7	-710	-75%
		R45	1997	640	2.2	LDW-SS130	2005	10	0.1	8	-630	-98%
		DR087	1998	210	1.1	LDW-SS37	2005	49	0.4	7	-161	-77%
Dibenzofuran	µg/kg dw	R40	1997	2,300	5.9	LDW-SS127	2005	10	0.0	8	-2,290	-100%
		R42	1997	470	1.3	LDW-SS129	2005	10	0.1	8	-460	-98%
		DR019	1998	500	1.3	LDW-SS32	2005	10	0.1	7	-490	-98%
		DR053	1998	480	1.1	LDW-SS44	2005	29	0.3	7	-451	-94%
		DR065	1998	1,300	3.6	LDW-SS52	2005	10	0.1	7	-1,290	-99%
		DR175	1998	750	2.9	LDW-SS94	2005	10	0.1	7	-740	-99%
Fluoranthene	µg/kg dw	R40	1997	62,000	15	LDW-SS127	2005	1,100	0.2	8	-60,900	-98%
		R42	1997	17,000	4.4	LDW-SS129	2005	1,500	0.4	8	-15,500	-91%
		DR187	1998	8,800	2.9	LDW-SS115	2005	5,200	1.7	7	-3600	-41%
		R45	1997	8,200	2.1	LDW-SS130	2005	700	0.2	8	-7,500	-91%
		DR053	1998	5,500	1.3	LDW-SS44	2005	940	0.4	7	-4,560	-83%
		DR065	1998	4,200	1.1	LDW-SS52	2005	250	0.1	7	-3,950	-94%
		DR175	1998	18,000	6.3	LDW-SS94	2005	200	0.1	7	-17,800	-99%
Fluorene	µg/kg dw	R40	1997	4,400	7.4	LDW-SS127	2005	32	0.0	8	-4,368	-99%
		R42	1997	730	1.3	LDW-SS129	2005	42	0.1	8	-688	-94%
		R45	1997	440	0.78	LDW-SS130	2005	10	0.0	8	-430	-98%
		DR065	1998	2,100	3.8	LDW-SS52	2005	10	0.0	7	-2,090	-100%
		DR175	1998	1,700	4.3	LDW-SS94	2005	10	0.0	7	-1,690	-99%

Table F-5e Percent Change at Resampled Surface Sediment Locations — SMS Contaminants: Pairs Where Older Data Have SQS Exceedances

		Older Station				Newer Station				Change in Concentration from Older Station to Newer Station		
SQS Exceedance Contaminant for Older Sample Location	Units	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Years Elapsed	Concentration Change	Percent Change[a]
Hexachlorobenzene	µg/kg dw	DR198	1998	690	120	LDW-SS102	2005	2	0.6	7	-688	-100%
Indeno(1,2,3-cd)pyrene	µg/kg dw	R40	1997	15,000	17	LDW-SS127	2005	200	0.2	8	-14,800	-99%
		R42	1997	4,300	5.3	LDW-SS129	2005	340	0.4	8	-3,960	-92%
		R45	1997	2,700	3.2	LDW-SS130	2005	100	0.1	8	-2,600	-96%
		DR019	1998	920	1	LDW-SS32	2005	49	0.1	7	-871	-95%
		DR087	1998	620	1.1	LDW-SS37	2005	80	0.1	7	-540	-87%
		DR175	1998	660	1.1	LDW-SS94	2005	20	0.0	7	-640	-97%
Lead	mg/kg dw	SD-323-S	2004	2,350	5.20	LDW-SS110	2005	870	1.9	1	-1,480	-63%
Mercury	mg/kg dw	DR035	1998	0.52	1.3	LDW-SS12	2005	0.24	0.6	7	-0.28	-54%
		DR020	1998	0.47	1.1	LDW-SS31	2005	0.33	0.8	7	-0.14	-30%
		DR087	1998	0.55	1.3	LDW-SS37	2005	0.69	1.7	7	0.14	25%
		DR030	1998	0.62	1.5	LDW-SS50	2005	0.41	1.0	7	-0.21	-34%
		DR123	1998	0.45	1.1	LDW-SS57	2005	0.31	0.8	7	-0.14	-31%
Phenanthrene	µg/kg dw	R40	1997	43,000	17	LDW-SS127	2005	530	0.2	8	-42,470	-99%
		R42	1997	8,300	3.5	LDW-SS129	2005	790	0.3	8	-7,510	-90%
		R45	1997	4,900	2	LDW-SS130	2005	280	0.1	8	-4,620	-94%
		DR019	1998	3,000	1.1	LDW-SS32	2005	180	0.1	7	-2,820	-94%
		DR187	1998	6,300	3.3	LDW-SS115	2005	2,400	1.3	7	-3900	-62%
		DR065	1998	8,900	3.7	LDW-SS52	2005	74	0.0	7	-8,826	-99%
		DR175	1998	16,000	9.2	LDW-SS94	2005	79	0.0	7	-15,921	-100%
Phenol	µg/kg dw	K-11	1991	1,200	2.9	LDW-SS1	2005	10	0.0	14	-1,191	-99%
		K-05	1991	2,000	4.8	LDW-SS10	2005	24	0.1	14	-1,976	-99%
		DR202	1998	1,400	3.3	LDW-SS104	2005	29	0.1	7	-1,371	-98%
		K-07	1991	3,600	8.6	LDW-SS4	2005	10	0.0	14	-3,590	-100%
		DR053	1998	570	1.4	LDW-SS44	2005	29	0.1	7	-541	-95%
		R40	1997	48,000	1.8	LDW-SS127	2005	910	0.0	8	-47,090	-98%

Table F-5e Percent Change at Resampled Surface Sediment Locations — SMS Contaminants: Pairs Where Older Data Have SQS Exceedances

		Older Station				Newer Station				Change in Concentration from Older Station to Newer Station		
SQS Exceedance Contaminant for Older Sample Location	Units	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Years Elapsed	Concentration Change	Percent Change[a]
Total HPAH (calc'd)	µg/kg dw	R40	1997	241,000	9.7	LDW-SS127	2005	5,100	0.2	8	-235,900	-98%
		R42	1997	69,000	3	LDW-SS129	2005	6,800	0.3	8	-62,200	-90%
		R45	1997	34,000	1.5	LDW-SS130	2005	2,940	0.1	8	-31,060	-91%
		DR187	1998	45,000	2.5	LDW-SS115	2005	19,000	1.0	7	-26,000	-58%
		DR175	1998	41,000	2.5	LDW-SS94	2005	860	0.0	7	-40,140	-98%
		R40	1997	60,000	6.2	LDW-SS127	2005	650	0.1	8	-59,350	-99%
		R42	1997	10,800	1.2	LDW-SS129	2005	930	0.1	8	-9,870	-91%
		DR065	1998	14,800	1.7	LDW-SS52	2005	110	0.0	7	-14,690	-99%
		DR175	1998	20,000	3	LDW-SS94	2005	105	0.0	7	-19,895	-99%
Zinc	mg/kg dw	DR020	1998	1,060	2.6	LDW-SS31	2005	997	2.4	7	-63	-6%

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.
2. All older samples with SQS exceedances shown in this table; if the location has an exceedance in the newer sample, it is also shown in Table F-5f.
3. Data for total PCBs, arsenic, and BEHP not shown because they are included in Tables F-5a, F-5b, and F-5c, respectively.

🟥	Greater than or equal to 50% concentration increase and 5 or more years between events.
⬜	Minimal change (<50% change in concentration) or less than 5 years between events.
🟦	Greater than or equal to 50% concentration decrease and 5 or more years between events.

a. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

BEHP = bis(2-ethylhexyl)phthalate; HPAH = high-molecular-weight polycyclic aromatic hydrocarbon; µg/kg dw = microgram per kilogram dry weight; mg/kg dw = milligram per kilogram dry weight; SMS = Sediment Management Standards; SQS = sediment quality standards; U = undetected value

Table F-5f Percent Change at Resampled Surface Sediment Locations — SMS Contaminants - Pairs Where Newer Data Have SQS Exceedances

SQS Exceedance Contaminant for Newer Sample Locations	Units	Older Station				Newer Station					Change in Concentration from Older Station to Newer Station		
		Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Station ID	Year Sampled	Concentration	SQS Exceedance Factor	Toxicity Exceedance Status	Years Elapsed	Concentration Change	Percent Change[a]
2,4-Dimethylphenol	µg/kg dw	B4b	2004	27.5	1.9	B4B	2006	65	2.2	pass	2	37.5	136%
		DR111	1998	10	0.69	DR-111	2006	54	1.9	pass	8	44	440%
		LDW-SS10	2005	7	0.48	TRI-010	2006	45	1.6	SQS	1	38	543%
		LDW-SS16	2005	3.3	0.23	TRI-016	2006	44	1.5	pass [b]	1	40.7	1233%
		LDW-SS45	2005	3.3	0.23	TRI-045	2006	45	1.6	pass	1	41.7	1264%
		LDW-SS51	2005	3.3	0.23	TRI-051	2006	46	1.6	pass	1	42.7	1294%
		LDW-SS96	2005	3.3	0.23	TRI-096	2006	52	1.8	pass	1	48.7	1476%
Benzo(g,h,i)perylene	µg/kg dw	DR242	1998	20 U	undetected	SB-1	2004	1,100	1.3	no data	6	1,090	10900%
Benzyl alcohol	µg/kg dw	DR028	1998	50	0.9	B4b	2004	70	1.2	pass	6	20	40%
		DR111	1998	25	0.88	DR-111	2006	74	1.3	pass	8	49	196%
		DR181	1998	25	0.88	DR-181	2006	70	1.2	pass	8	45	180%
		LDW-SS16	2005	16.5	0.58	TRI-016	2006	64	1.1	pass [b]	1	47.5	288%
Butyl benzyl phthalate	µg/kg dw	R30	1997	290	4.9	LDW-SS119	2005	140	1.9	pass	8	-150	-52%
Chromium	mg/kg dw	DR186	1998	180	0.69	LDW-SS111	2005	455	1.8	no data	7	275	153%
Chrysene	µg/kg dw	DR187	1998	4,100	2.0	LDW-SS115	2005	2,500	1.2	pass	7	-1,600	-39%
Dibenzo(a,h)anthracene	µg/kg dw	DR187	1998	950	4.2	LDW-SS115	2005	240	1.1	pass	7	-710	-75%
		DR242	1998	100	0.24	SB-1	2004	700	2.2	no data	6	600	600%
Fluoranthene	µg/kg dw	DR187	1998	8,800	2.9	LDW-SS115	2005	5,200	1.7	pass	7	-3,600	-41%
		DR242	1998	2,000	0.36	SB-1	2004	4,800	1.1	no data	6	2,800	140%
Fluorene	µg/kg dw	DR186	1998	300	0.65	LDW-SS111	2005	640	1.2	no data	7	340	113%
Indeno(1,2,3-cd)pyrene	µg/kg dw	DR242	1998	180	0.15	SB-1	2004	1,200	1.3	no data	6	1,020	567%
Lead	mg/kg dw	SD-323-S	2004	2,350	5.20	LDW-SS110	2005	870	1.9	no data	1	-1,480	-63%
		DR186	1998	152	0.34	LDW-SS111	2005	635	1.4	no data	7	483	318%
Mercury	mg/kg dw	DR079	1998	0.25	0.61	LDW-SS15	2005	0.6	1.5	SQS	7	0.35	140%
		DR021	1998	0.29	0.71	LDW-SS319	2006	0.88	2.1	no data	8	0.59	203%
		DR087	1998	0.55	1.3	LDW-SS37	2005	0.69	1.7	CSL	7	0.14	25%
Phenanthrene	µg/kg dw	DR186	1998	1,700	0.85	LDW-SS111	2005	3,200	1.4	no data	7	1,500	88%
		DR187	1998	6,300	3.3	LDW-SS115	2005	2,400	1.3	pass	7	-3,900	-62%
Phenol	µg/kg dw	LDW-SS16	2005	240	0.57	TRI-016	2006	573	1.4	pass [b]	1	333	139%
Total HPAH (calc'd)	µg/kg dw	DR187	1998	45,000	2.5	LDW-SS115	2005	19,000	1	pass	7	-26,000	-58%
Zinc	mg/kg dw	DR186	1998	240	0.59	LDW-SS111	2005	460	1.1	no data	7	220	92%
		DR020	1998	1,060	2.6	LDW-SS31	2005	997	2.4	CSL	7	-63	-6%
		DR019	1998	359	0.88	LDW-SS32	2005	414	1	SQS	7	55	15%

🟥 Greater than or equal to 50% concentration increase, 5 or more years between events.
⬜ Minimal change (<50% change in concentration) or less than 5 years between events.
🟦 Greater than or equal to 50% concentration decrease, 5 or more years between events.

Notes:

1. Resampled locations are those where older stations are within 10 ft of newer stations.
2. All newer samples with SQS exceedances shown in this table; if the location has an exceedance in the older sample, it is also shown in Table F-5e.
3. Data for total PCBs, arsenic, and BEHP not shown because they are included in Tables F-5a, F-5b, and F-5c, respectively.

a. Percent change = 100 x (Newer Concentration - Older Concentration)/Older Concentration

b. Older station had an SQS exceedance for toxicity.

BEHP = bis(2-ethylhexyl)phthalate; HPAH = high-molecular-weight polycyclic aromatic hydrocarbon; µg/kg dw = microgram per kilogram dry weight; mg/kg dw = milligram per kilogram dry weight; PCBs = polychlorinated biphenyls; SMS = Sediment Management Standards; SQS = sediment quality standards; U = undetected value

Table F-6 Duwamish / Diagonal Perimeter Data – Total PCBs, Arsenic, cPAHs, and BEHP

Station ID	Total PCBs (µg/kg dw) 2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]	Total PCBs (mg/kg oc) 2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]
DUD_1C	621	241	196	605	147	263	95	-85%	18.5	35.4	15.8	30.3	6.27	9.1	4.27	-77%
DUD_2C	382	368	340	274	158	142	93	-76%	16.2	47.2	20.6	14	7.36	5.87	4.47	-72%
DUD_8C	4,610	1,902	774	316	435	290	2970	-36%	251	163	71.7	51.5	39.5	n/a	132	-47%
DUD_9C	103	734	945	269	311	282	167	62%	13.2	95	85.1	n/a	39.2	41.9	15.2	15%
DUD_10C	373	665	328	319	134	159	142	-62%	36.6	64.6	38.1	33.8	11.4	17.2	14.2	-61%
DUD_11C	378	12	18.8	40.2	110	60	66.9	-82%	27.8	n/a	n/a	6.84	9.09	8.98	6.03	-78%
DUD_12C	263	644	334	383	309	246	240	-9%	19.9	79.7	45	57.9	37.6	19.5	20.3	2%
DUD_13C	n/a	n/a	710	355	371	241	91.5	-87%	n/a	n/a	38	21.6	24.4	14.1	4.82	-87%

Station ID	Arsenic (mg/kg dw) 2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]
DUD_1C	29	1.8	6.1	11	14	15.2	14	-52%
DUD_2C	28	1.85	7.5	13	13	14.6	12	-57%
DUD_8C	35.7	1.85	6.4	5.2	7.3	5.5	15.6	-56%
DUD_9C	14	1.75	7.9	5.1	6.9	6.2	7.4	-47%
DUD_10C	24.4	7.4	10	9.9	10	9.62	8.9	-64%
DUD_11C	23.9	1.65	1.5	4.4	8.7	5.5	7.4	-69%
DUD_12C	23.1	1.75	4.8	6.9	7.2	12	9.1	-61%
DUD_13C	n/a	n/a	10	12	11	9.9	11	10%

Table F-6 Duwamish / Diagonal Perimeter Data – Total PCBs, Arsenic, cPAHs, and BEHP

	cPAH (µg TEQ/kg dw)							
Station ID	2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]
DUD_1C	1050	142	339	463	n/a	430	230	-78%
DUD_2C	1020	258	513	847	n/a	620	250	-75%
DUD_8C	275	228	215	131	n/a	84	100	-64%
DUD_9C	246	179	202	136	n/a	100	49	-80%
DUD_10C	337	264	249	271	n/a	160	120	-64%
DUD_11C	558	48.4	30.6	144	n/a	140	84	-85%
DUD_12C	478	266	206	183	n/a	290	65	-86%
DUD_13C	n/a	n/a	485	350	n/a	250	54	-89%

	BEHP (µg/kg dw)								BEHP (mg/kg oc)							
Station ID	2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]	2003 (pre-cap)	2004 (post-cap)	Jan 2005 (post-cap)	2006 (post-cap and ENR)	2007 (post-cap and ENR)	2008 (post-cap and ENR)	2009 (post-cap and ENR)	Percent Change (2003 to 2009)[a]
DUD_1C	5,940	676	877	2,360	1,440	2,330	591 U	-95%	177	99.3	70.7	118	61.5	80.6	26.6 U	-92%
DUD_2C	2,700	896	1,040	1,770	805	1,580	482 U	-91%	114	115	63	90.3	37.6	65.6	23.1 U	-90%
DUD_8C	2,420	1,110	763	405	255	400a	948	-61%	132	94.9	70.6	66.1	23.2	n/a	42	-68%
DUD_9C	473	681	695	348	156	393	464 U	-51%	60.9	88.1	62.6	n/a	19.7	58.4	42.2 U	-65%
DUD_10C	463	540	301	450	249	329	305 U	-68%	45.4	52.4	35	47.7	21.3	35.5	30.5 U	-67%
DUD_11C	1,610	52	62	755	517	559	1,150	-29%	118	n/a	n/a	128	42.7	84.1	104	-12%
DUD_12C	988	770	441	668	468	958	466 U	-76%	74.8	95.3	59.4	101	56.9	76	39.4 U	-73%
DUD_13C	n/a	n/a	770	592	342	484	148	-81%	n/a	n/a	41	36.1	22.5	28.3	15.6	-62%

Notes:

1. Underlined oc-normalized data for total PCBs and BEHP exceed the sediment quality standards of 12 and 47 mg/kg oc, respectively.
2. Unpublished 2010 data show further decreases in risk driver concentrations, including those from location DUD_8C (Williston 2010, personal communication).

a. Percent change for locations DUD_12C and DUD_13C is from 2005 to 2009 because samples were not collected at these locations in 2003 or 2004.

🟥	Greater than or equal to 50% concentration increase, more than 5 years between events.
⬜	Minimal change (<50% change in concentration) or less than 5 years between events.
🟦	Greater than or equal to 50% concentration decrease, more than 5 years between events.

n/a = not applicable because total organic carbon was not within appropriate range for normalizing concentrations or because location was not sampled.

BEHP = bis(2-ethylhexyl)phthalate; cPAH = carcinogenic polycyclic aromatic hydrocarbon; ENR = enhanced natural recovery; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; mg/kg oc = milligram per kilogram organic carbon; PCBs = polychlorinated biphenyls; RM = river mile; TEQ = toxic equivalent quotient; U = undetected at reporting limit, one-half of this value was used in the percent change calculation

Table F-7a Subsurface Sediment Total PCB Trends — Trend Present with Subsurface Peak (N=24) – Low Resolution and High Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Concentration Change (µg/kg dw)[a]	Percent Change (µg/kg dw)[b]	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
						Total PCBs	Other SMS Contaminants		
LDW-SC1	RM 0.0, by marina	0–0.5	85	-6,615	-99%	Decrease	Mixed	3	3
		0.5–1	350						
		1–1.5	6,700						
		1.5–2	4,300						
LDW-SC4	RM 0.2 E	0–1	143	-457	-76%	Decrease	Mixed	1	4
		1–2	490						
		2–4	600						
		4–6	3.9 U						
LDW-SC6	RM 0.3 W	0–0.5	167	-2,433	-94%	Below SQS	Sample resolution too coarse	1	4
		0.5–1	97						
		1–1.5	101						
		1.5–2	94						
		2–2.5	176						
		2.5–3	350						
		3–3.5	490						
		3.5–4	1,590						
		4–4.5	2,600						
LDW-SC8	RM 0.35 in Navigation Channel	0–1	290	-5,210	-95%	Decrease	Mixed	3	5
		1–2	1,030						
		2–4	2,900						
		4–6	5,500						
		6–8	3,800						
		8–10	540						
LDW-SC10	RM 0.55 E	0–1	260	-860	-77%	Equilibrium	Decrease	3	3
		1–2	290						
		2–4	1,120						
		4–5	410						
		6–8	350						
LDW-SC12	RM 0.6 W	0–0.5	64	-1,936	-97%	Equilibrium	Increase	2	4
		0.5–1	106						
		1–1.5	134						
		1.5–2	320						
		2–2.5	2,000						
		2.5–3	630						
		3–3.5	138						
		3.5–4	790						
LDW-SC15	NW Corner of Slip 1	0–1	360	-1,590	-82%	Equilibrium	No contaminants other than PCBs exceed the SQS	2	3
		1–2	340 J						
		2–4	510						
		4–6	1,950						
		8–10	4.0 U						
LDW-SC16	Mouth of Slip 1	0–2	330	-5,070	-94%	Equilibrium	Decrease	1	4
		2–4	5,400						
		4–6	3,400						
		8–10	18 J						

Table F-7a Subsurface Sediment Total PCB Trends — Trend Present with Subsurface Peak (N=24) – Low Resolution and High Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Concentration Change (µg/kg dw)[a]	Percent Change (µg/kg dw)[b]	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
						Total PCBs	Other SMS Contaminants		
LDW-SC17	Head of Slip 1	0–1	1,220	-8,580	-88%	Decrease	Mixed	2	2
		1–2	1,040						
		2–4	9,800						
		6–8.2	1,900						
LDW-SC19	RM 1.0, South of Kellogg Island	0–1	280	-2,120	-88%	Equilibrium	No contaminants other than PCBs exceed the SQS	2	5
		1–2	233						
		2–4	250						
		4–6	440						
		6–7	2,400						
		9–11.9	3.9 U						
LDW-SC21	RM 1.0 W	0–1	250	-1,430	-85%	Increase	No contaminants other than PCBs exceed the SQS	1	2
		1–2	145						
		2–4	380 J						
		4–6.2	1,680						
		6.2-8	4U						
		10–11.3	3.9 U						
LDW-SC23	RM 1.2 E	0–2	177	-703	-80%	Sample resolution too coarse	No contaminants other than PCBs exceed the SQS	2	6
		2–4	219						
		4–6	880						
		6–8	400						
		8–10.2	41						
LDW-SC25	RM 1.3 W	0–1	310	-490	-61%	Equilibrium	Equilibrium	1	2
		1–2	360						
		2–4	430						
		4–6	800						
		8–9.1	3.9 U						
LDW-SC26	RM 1.35 W	0–1	280	-2,020	-88%	Equilibrium	No contaminants other than PCBs exceed the SQS	1	2
		1–2	226						
		2–4	310						
		6–8	2,300						
		11.1–12.1	140						
LDW-SC27	RM 1.4 E	0–0.5	250	-2,950	-92%	Decrease	Equilibrium	3	3
		0.5–1	2,000						
		1–1.5	3,200						
		1.5–2	1,510						
		2–2.5	840						
		2.5–3	290						
		3–3.5	60						
		3.5–4	3.9 U						
		4–4.5	3.9 U						
LDW-SC28	RM 1.4 W	0–1	440	-2,760	-86%	Equilibrium	Increase	1	2
		1–2	360 J						
		2–4	290						
		5.5–7.5	3,200						
		12–12.6	540						
LDW-SC32	Slip 2	0–1	1,010	-1,440	-59%	Decrease	Mixed	3	5
		1–2	1,720						
		2–4	2,450						
		5.2–8	3.8 U						

Table F-7a Subsurface Sediment Total PCB Trends — Trend Present with Subsurface Peak (N=24) – Low Resolution and High Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Concentration Change (µg/kg dw)[a]	Percent Change (µg/kg dw)[b]	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
						Total PCBs	Other SMS Contaminants		
LDW-SC33	RM 1.9 E	0–0.5	490	-4,210	-90%	Equilibrium	Sample resolution too coarse	3	3
		0.5–1	790						
		1–1.5	4,700						
		1.5–2	2,500						
		2–2.5	210						
		2.5–3	940						
LDW-SC37	SE Corner of Slip 3	0–1	450	-500	-53%	Decrease	Mixed	2	3
		1–2	950						
		2–4	550						
		5.3–6.9	3.9 U						
LDW-SC38	RM 2.1 W	0–1	450	-2,950	-87%	Equilibrium	No chemicals other than PCBs exceed the SQS	3	5
		1–2	710						
		2–3	3,400						
		3–3.3	14						
LDW-SC39	RM 2.15 W	0–1	208	-232	-53%	Equilibrium	No contaminants other than PCBs exceed the SQS	3	4
		1–2	440						
		2–4	220						
		4–6	150						
LDW-SC44	RM 2.7 E	0–0.5	260	-620	-70%	Decrease	Sample resolution too coarse	3	3
		0.5–1	880						
		1–1.5	200						
		1.5–2	140						
		2–2.5	270						
		2.5–3	150						
		3–3.5	4.0 U						
LDW-SC47	RM 3.05 W	0–1	72	-1,928	-96%	Decrease	No contaminants other than PCBs exceed the SQS	3	5
		1–2	2,000						
		2–3	490 J						
		3–4	4.0 UJ						
LDW-SC49a	RM 3.55 in Navigation Channel	0–1	75	-735	-91%	Below SQS	Increase	1	4
		1–2	150						
		2–4	420						
		4–6	780						
		6–8	810						
		8–10	130						

Notes:

1. Subsurface peak is defined where the maximum concentration is at least twice the concentration of that in the surface interval, and the peak exceeds 240 µg/kg dw.

2. Recovery categories are defined as:

Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain; Recovery Category 3 = predicted to recover.

3. See Table F-8 for trends for other SMS contaminants.

a. Concentration change = Peak concentration in subsurface - concentration in top interval.

b. Percent change = 100 * Concentration change / Peak concentration in subsurface.

▨ Peak concentration in subsurface used in percent change calculation.

E = east; EAA = early action area; J = qualified value; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; PCBs = polychlorinated biphenyls; RI = remedial investigation; RM = river mile; SMS = Sediment Management Standards; SQS = sediment quality standard; U = undetected value; W = west

Table F-7b Subsurface Sediment Total PCB Trends — No Strong Trend (N=17, plus 1 replicate) - Low and High Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
				Total PCBs	Other SMS Contaminants		
LDW-SC3	RM 0.1 E	0–2	4.0 U	Sample resolution too coarse	Sample resolution too coarse	3	Outside of AOPC
		2–4	3.9 U				
LDW-SC13	RM 0.85 E	0–0.5	460	Equilibrium	Sample resolution too coarse	3	5
		0.5–1	470				
		1–1.5	280				
		1.5–2	360				
		2–2.5	120				
		2.5–3	3.9 U				
		3–3.5	3.8 U				
LDW-SC18	RM 1.0 E	0–1	182	Increase, using a co-located surface sediment sample at 650 µg/kg dw	Increase	1	2
		1–2	19.6				
		2–4	3.9 U				
LDW-SC22	RM 1.1 E	0–1.1	56	Below SQS	Below SQS	3	3
		1.1–2	26 J				
		2–4	7.8 J				
LDW-SC29	RM 1.4 W	0–1	33 J	Below SQS	Equilibrium	3	2
		1–2	3.9 UJ				
		2–3.6	3.9 U				
LDW-SC30	RM 1.55 E	0–2.5	12.9	Sample resolution too coarse	Sample resolution too coarse	3	4
		2.5–4	3.9 U				
LDW-SC34	RM 1.85 W	0–1	210	Below SQS	Mixed	1	2
		1–2	280				
		2–4	250				
LDW-SC36	RM 2.1 E	0–1	75	Below SQS	Below SQS	3	6
		1–2	4.0 U				
		2–4	3.8 U				
LDW-SC202	RM 2.1 E, replicate of SC36	0–1	30	Below SQS	Mixed	3	6
		1–2	3.8 UJ				
		2–4	3.9 UJ				
LDW-SC40	RM 2.2 W	0–1.3	160 J (21 mg/kg oc)	Increase	No contaminants other than PCBs exceed the SQS	2	2
		1.3–2	4.0 UJ				
		2–4	3.9 UJ				
LDW-SC42	RM 2.4 W	0–1	107	Below SQS	Below SQS	1	6
		1–2	163 J				
		2–4	88 J				
LDW-SC43	RM 2.6 E	0–2	4.0 UJ	Sample resolution too coarse	Sample resolution too coarse	3	2
		2–4	3.9 UJ				

Table F-7b Subsurface Sediment Total PCB Trends — No Strong Trend (N=17, plus 1 replicate) - Low and High Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
				Total PCBs	Other SMS Contaminants		
LDW-SC45[a]	RM 2.8 E	0–1	230 J	Equilibrium	No contaminants other than PCBs exceed the SQS	2	5
		1–2	270				
		2–4	570				
		5–6	122				
LDW-SC46	RM 2.7 W	0–1	214	Equilibrium	Mixed	1	2
		1–2	185 J				
		2–4	270				
		4–6.8	195				
LDW-SC48	RM 3.3 Navigation Channel	0–1	77	Below SQS	Below SQS	3	6
		1–2	3.8 U				
		2–4	3.9 U				
LDW-SC53	Head of Slip 6	0–2	68	Sample resolution too coarse	Sample resolution too coarse	1	2
		2–4	77				
LDW-SC54	RM 4.2 W	0–2	109	Sample resolution too coarse	Sample resolution too coarse	1	6
		2–4	111				
LDW-SC55	RM 4.85 E	0–1	13.5	Increase, using a co-located surface sediment sample at 2,700 µg/kg dw	Below SQS	Upstream of STM domain; no category assigned	2
		1–2	59 U				
		2–3	4.0 U				

Notes:

1. Cores with no strong trends have similar low level concentrations throughout the profile, or all concentrations are below 240 µg/kg dw.
2. Recovery categories are as follows:
   Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain;
   Recovery Category 3 = predicted to recover.
3. See Table F-8 for trends for other SMS contaminants.

[a] The concentration in the 2- to 4-ft interval, 570 µg/kg dw, is two times that in the shallowest interval, 230 µg/kg dw; but the concentration of the interval in between suggests that there is no real strong "peak" in this core. The concentrations are more diffuse.

AOPC = area of potential concern; E = east; J = qualified value; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; PCBs = polychlorinated biphenyls; RI = Remedial Investigation; RM = river mile; SMS = Sediment Management Standards; SQS = sediment quality standards; STM = Sediment Transport Model; U = undetected value; W = west

Table F-7c Subsurface Sediment Total PCB Trends — High Concentration in Surface Interval (N=15, plus 2 replicates) - Low Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Potential Explanation for High Concentration in Surface	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
					Total PCBs	Other SMS Contaminants		
LDW-SC2	RM 0.0 E	surface - LDW-SS6	1,920	Low sedimentation rate; active berthing area; concentration increase with co-located surface	Equilibrium	Mixed	2	3
		0–2	1,380					
		2–4	2,900					
		4–6	209					
		8-10	237					
		10.7–12	3.8 U					
LDW-SC5	RM 0.15 W	0–1	510	Nearby outfalls (in tributary)	Increase	Equilibrium	2	4
		1–2.2	66					
		2.2–4	3.9 U					
LDW-SC7	RM 0.4 E	surface - DUD043	570	Co-located surface show concentration decrease	Decrease	Mixed	3	5
		0–1	1,300					
		1–1.7	1,270 J					
		1.7–4	5.5 U					
LDW-SC9	RM 0.5 in Navigation Channel, by D/D EAA cap	surface - DUD_8C (2009)[a]	2,970	Co-located surface show concentration decrease of 18% (equilibrium)	Equilibrium	Mixed	3	5
		0–1	3,600					
		1–2.6	2,700					
		2.6–4	67					
LDW-SC11	RM 0.55 W	0–0.8	3,000	Nearby outfalls (not modeled)	Increase	Mixed	1	2
		0.8–2	3.9 U					
		2–3.4	3.9 U					
		3.4–4.1	4.0 U					
LDW-SC14	RM 0.85 in Navigation Channel	surface - LDW-SSB2b	790	0-2 cm high-flow scour	Decrease	Decrease	2	3
		0–1.4	4,500					
		1.4–2	2,060					
		2–4.1	1,550					
		4.1–6	420					
		6–8.7	70					
		10–11	3.9 U					
LDW-SC20	RM 1.05 in Navigation Channel	surface - LDW-SS37	5,100	Area of elevated dioxins/furans	Increase	Equilibrium	2	2
		0–2	3,200					
		2–4	600					
		4–6	400					
		8–10	95					
LDW-SC24	RM 1.25 W	0–1	280	Evidence of vessel scour	Increase	No contaminants other than PCBs exceed the SQS	1	4
		1–2	36					
		2–4	3.9 U					
LDW-SC31	RM 1.65 E	0–1	370	Evidence of vessel scour; in maintenance dredging footprint where 3 of 5 DMMUs not suitable for open water disposal	Sample resolution too coarse	Sample resolution too coarse	1	4
		1–2.8	330					
		2.8–4	2.7 J					

Table F-7c Subsurface Sediment Total PCB Trends — High Concentration in Surface Interval (N=15, plus 2 replicates) - Low Resolution Data from 2006 LDW RI Cores

Subsurface Core ID	Location	Recovered Depth Interval (ft)	Total PCBs (µg/kg dw)	Potential Explanation for High Concentration in Surface	Trends in Top Two Intervals		Recovery Category	Remedial Alternative When First Active
					Total PCBs	Other SMS Contaminants		
LDW-SC203	RM 1.85 W, replicate of SC-34	0–1	250	0-2 cm high flow scour; near modeled discharge location and near two maintenance dredging events; SC-34 (parent core) has similar concentration in top interval (210 µg/kg dw)	Below SQS	Mixed	1	2
		1–2	110					
		2–4	174					
		4–6	181					
LDW-SC201	RM 1.9 E, replicate of SC33	0–1.5	1,450	Downstream of modeled discharge location; berthing and cable area	Sample resolution too coarse	Sample resolution too coarse	3	3
		1.5–4	530 J					
		4–6	340					
		8–10	3.9 U					
LDW-SC35	RM 1.95 W	0–2	370 J	0-2 cm high-flow scour; upstream of maintenance dredging event	Sample resolution too coarse	Sample resolution too coarse	3	3
		2–4	150 J					
LDW-SC41	R 2.35 E	0–1	370 J	Nearby storm drains; evidence of vessel scour	Equilibrium	No contaminants other than PCBs exceed the SQS	1	4
		1–2	256					
		2–4	270					
		4–6	510					
		6–7.9	190					
LDW-SC50a	RM 3.75 E	surface - LDW-SS114	820	Near hot spot at RM 3.8 E	Increase	Increase	2	2
		0–1	510					
		1–2	780					
		2–2.8	75 J					
		2.8–4	3.8 UJ					
LDW-SC51	RM 3.8 E	surface - LDW-SS115	220	Near hot spot at RM 3.8 E; by modeled discharge location	Decrease	Mixed	2	2
		0–2	1,290					
		2–3.8	700					
		3.8–5.8	3.9 U					
LDW-SC52	RM 3.9 E	0–1	3,000 J	0-2 cm high-flow scour	Decrease	Increase	2	2
		1–2	65					
		2–4	4.0 U					
LDW-SC56	RM 4.75 W	0–2	330	Nearby resampled station for PCBs had 94% reduction, but newer sample still above SQS	Sample resolution too coarse	Sample resolution too coarse	1	3
		2–4	3.9 U					

Notes:

1. Table F-6 includes cores with highest concentration and total PCBs greater than 240 µg/kg dw in surface interval.
2. Recovery categories are as follows:
   Recovery Category 1 = recovery predicted to be limited; Recovery Category 2 = recovery less certain;
   Recovery Category 3 = predicted to recover.
3. Only low resolution sample intervals (1- to 2-ft) were available for these cores.
4. See Table F-8 for trends for other SMS contaminants.

a. Unpublished 2010 data show further decreases in total PCB concentrations (Williston 2010, personal communication).

D/D = Duwamish/Diagonal; E = east; EAA = early action area; DMMU = dredged material management unit; J = qualified value; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; PCBs = polychlorinated biphenyls; RI = remedial investigation; RM = river mile; SMS = Sediment Management Standards; SQS = sediment quality standards; U = undetected value; W = west

▨ highest concentration in surface interval or top two intervals is approximately twice that in the deeper intervals, and is greater than 240 µg/kg dw.

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Shallow Sediment / Top Layer								Deeper Sediment								Percent Change for SMS Contaminant	Core Trend for:	
						Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor		Total PCBs	Other SMS Contaminants
LDW-SC1	LDW Subsurface Sediment 2006	0	2006	—	Bis(2-ethylhexyl) phthalate	0	0.5	700	µg/kg dw	No	0.68	No	0.41	0.5	1	400	µg/kg dw	No	0.43	No	0.26	75	Decrease	Mixed
						1	1.5	2400	µg/kg dw	Yes	2.6	Yes	1.5	1.5	2	1000	µg/kg dw	No	0.89	No	0.54	—		
					Butyl benzyl phthalate	0	0.5	46	µg/kg dw	No	0.43	No	0.033	0.5	1	38	µg/kg dw	No	0.39	No	0.03	21		
						1	1.5	98	µg/kg dw	Yes	1	No	0.078	1.5	2	93	µg/kg dw	No	0.8	No	0.061	—		
					Mercury	0	0.5	0.27	mg/kg dw	No	0.66	No	0.46	0.5	1	0.33	mg/kg dw	No	0.8	No	0.56	-18		
						1	1.5	1.27	mg/kg dw	Yes	3.1	Yes	2.2	1.5	2	1.22	mg/kg dw	Yes	3	Yes	2.1	—		
					PCBs (total calc'd)	0	0.5	85	µg/kg dw	No	0.33	No	0.06	0.5	1	350	µg/kg dw	Yes	1.5	No	0.28	-76		
						1	1.5	6700	µg/kg dw	Yes	28	Yes	5.2	1.5	2	4300	µg/kg dw	Yes	15	Yes	2.8	—		
LDW-SC2	LDW Subsurface Sediment 2006	0.1	2006	2005	Arsenic	Surface	—	82.9	mg/kg dw	Yes	1.5	No	0.89	0	2	190	mg/kg dw	Yes	3.3	Yes	2	-56	Equilibrium	Mixed
					Bis(2-ethylhexyl) phthalate	Surface	—	850	µg/kg dw	Yes	1.7	Yes	1	0	2	900	µg/kg dw	Yes	2.1	Yes	1.3	-6		
					Lead	Surface	—	573	mg/kg dw	Yes	1.3	Yes	1.1	0	2	569	mg/kg dw	Yes	1.3	Yes	1.1	1		
					N-Nitrosodi-phenylamine	Surface	—	24	µg/kg dw	No	0.21	No	0.21	0	2	135	µg/kg dw	Yes	2.7	Yes	2.7	-91		
					PCBs (total calc'd)	Surface	—	1920	µg/kg dw	Yes	15	Yes	2.8	0	2	1380	µg/kg dw	Yes	13	Yes	2.3	39		
					Total PAH (calc'd)	Surface	—	1400	µg/kg dw	—	—	—	—	0	2	1850	µg/kg dw	—	—	—	—	-24		
					Zinc	Surface	—	553	mg/kg dw	Yes	1.3	No	0.58	0	2	748	mg/kg dw	Yes	1.8	No	0.78	-26		
LDW-SC4	LDW Subsurface Sediment 2006	0.2	2006	—	Arsenic	0	1	18	mg/kg dw	No	0.32	No	0.19	1	2	63	mg/kg dw	Yes	1.1	No	0.68	-71	Decrease	Mixed
					Mercury	0	1	0.53	mg/kg dw	Yes	1.3	No	0.9	1	2	0.43	mg/kg dw	Yes	1	No	0.73	23		
					PCBs (total calc'd)	0	1	143	µg/kg dw	No	0.78	No	0.14	1	2	490	µg/kg dw	Yes	2.1	No	0.38	-71		
LDW-SC5	LDW Subsurface Sediment 2006	0.2	2006	—	Mercury	0	1	0.27	mg/kg dw	No	0.66	No	0.46	1	2.2	0.51	mg/kg dw	Yes	1.2	No	0.86	-47	Increase	Equilibrium
					PCBs (total calc'd)	0	1	510	µg/kg dw	Yes	2.5	No	0.46	1	2.2	66	µg/kg dw	No	0.14	No	0.026	673		
LDW-SC6	LDW Subsurface	0.3	2006	2005	Total PAH (calc'd)	Surface	—	4490	µg/kg dw	—	—	—	—	0	2	4360	µg/kg dw	—	—	—	—	3	Below SQS	Below SQS
DR068	EPA SI	0.3	1998	1998	PCBs (total calc'd)	Surface	—	93	µg/kg dw	No	0.33	No	0.06	0	2	2600	µg/kg dw	Yes	13	Yes	2.5	-96	Decrease	Below SQS
					Total PAH (calc'd)	Surface	—	4780	µg/kg dw	—	—	—	—	0	2	5900	µg/kg dw	—	—	—	—	-19		
LDW-SC7	LDW Subsurface Sediment 2006	0.4	2006	1995	1,2-Dichlorobenzene	Surface	—	1.6	µg/kg dw	No	0.033	No	0.033	0	1	10	µg/kg dw	No	0.43	No	0.43	-92	Decrease	Mixed
						1	1.7	10	µg/kg dw	Yes	1	Yes	1	—	—	—	—	—	—	—	—	—		
					Bis(2-ethylhexyl) phthalate	Surface	—	2600	µg/kg dw	Yes	2.6	Yes	1.5	0	1	1200	µg/kg dw	Yes	1.3	No	0.76	117		
						1	1.7	240	µg/kg dw	No	0.62	No	0.37	—	—	—	—	—	—	—	—	—		
					Butyl benzyl phthalate	Surface	—	130	µg/kg dw	Yes	1.3	No	0.097	0	1	73	µg/kg dw	No	0.73	No	0.056	78		
						1	1.7	18	µg/kg dw	No	0.45	No	0.034	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.29	mg/kg dw	No	0.71	No	0.49	0	1	0.47	mg/kg dw	Yes	1.1	No	0.8	-38		
						1	1.7	0.17	mg/kg dw	No	0.41	No	0.29	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	570	µg/kg dw	Yes	2.3	No	0.42	0	1	1300	µg/kg dw	Yes	5.3	No	0.98	-56		
						1	1.7	1270	µg/kg dw	Yes	13	Yes	2.3	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	7100	µg/kg dw	—	—	—	—	0	1	3200	µg/kg dw	—	—	—	—	122		
						1	1.7	490	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
LDW-SC8	LDW Subsurface Sediment 2006	0.4	2006	—	Hexachloro-benzene	0	1	0.49	µg/kg dw	No	0.13	No	0.021	1	2	2.45	µg/kg dw	Yes	1.1	No	0.19	-80	Decrease	Mixed
					Mercury	0	1	0.32	mg/kg dw	No	0.78	No	0.54	1	2	0.48	mg/kg dw	Yes	1.2	No	0.81	-33		
					PCBs (total calc'd)	0	1	290	µg/kg dw	Yes	1.3	No	0.23	1	2	1030	µg/kg dw	Yes	7.5	Yes	1.4	-72		
LDW-SC9	LDW Subsurface Sediment 2006	0.5	2006	2009	1,2,4-Trichlorobenzene	Surface	—	0.08	µg/kg dw	No	0.0088	No	0.0039	0	1	18	µg/kg dw	Yes	1.4	No	0.61	-100	Equilibrium	Mixed
					Benzyl alcohol	Surface	—	1.6	µg/kg dw	No	0.056	No	0.044	0	1	140	µg/kg dw	Yes	2.5	Yes	1.9	-99		
					Bis(2-ethylhexyl) phthalate	Surface	—	948	µg/kg dw	No	0.89	No	0.54	0	1	1700	µg/kg dw	Yes	2.1	Yes	1.3	-44		
					Mercury	Surface	—	0.61	mg/kg dw	Yes		Yes		0	1	0.42	mg/kg dw	Yes	1	No	0.71	45		
					PCBs (total calc'd)	Surface	—	2970	µg/kg dw	Yes	11	Yes	2	0	1	3600	µg/kg dw	Yes	18	Yes	3.4	-18		
					Total PAH (calc'd)	Surface	—	1600	µg/kg dw	—	—	—	—	0	1	1730	µg/kg dw	—	—	—	—	-8		
LDW-SC10	LDW Subsurface Sediment 2006	0.5	2006	—	Bis(2-ethylhexyl) phthalate	0	1	1200	µg/kg dw	Yes	1.4	No	0.83	1	2	2800	µg/kg dw	Yes	2.8	Yes	1.7	-57	Equilibrium	Decrease
					Butyl benzyl phthalate	0	1	29	µg/kg dw	No	0.33	No	0.025	1	2	160	µg/kg dw	Yes	1.5	No	0.11	-82		
					PCBs (total calc'd)	0	1	260	µg/kg dw	Yes	1.2	No	0.22	1	2	290	µg/kg dw	Yes	1.1	No	0.2	-10		
LDW-SC11	LDW Subsurface Sediment 2006	0.5	2006	—	1,2,4-Trichlorobenzene	0	0.8	4.5	µg/kg dw	No	0.15	No	0.088	0.8	2	2.9	µg/kg dw	Yes	1.1	No	0.5	-22	Increase	Mixed
					Benzo(a) anthracene	0	0.8	3600	µg/kg dw	Yes	2.8	Yes	2.3	0.8	2	9.5	µg/kg dw	No	0.026	No	0.011	18847		
					Benzo(a)pyrene	0	0.8	3100	µg/kg dw	Yes	1.9	Yes	1	0.8	2	9.5	µg/kg dw	No	0.029	No	0.014	16216		
					Benzofluoranthenes (total-calc'd)	0	0.8	7600	µg/kg dw	Yes	2.4	Yes	2.1	0.8	2	9.5	µg/kg dw	No	0.013	No	0.0064	39900		
					Chrysene	0	0.8	4300	µg/kg dw	Yes	3.1	Yes	1.5	0.8	2	9.5	µg/kg dw	No	0.026	No	0.0063	22532		
					Fluoranthene	0	0.8	8100	µg/kg dw	Yes	4.8	Yes	3.2	0.8	2	9.5	µg/kg dw	No	0.018	No	0.0024	42532		
					Indeno(1,2,3-cd) pyrene	0	0.8	670	µg/kg dw	Yes	1.1	No	0.97	0.8	2	9.5	µg/kg dw	No	0.085	No	0.033	3426		
					Lead	0	0.8	639	mg/kg dw	Yes	1.4	Yes	1.2	0.8	2	3	mg/kg dw	No	0.0067	No	0.0057	21200		
					Mercury	0	0.8	0.64	mg/kg dw	Yes	1.6	Yes	1.1	0.8	2	0.03	mg/kg dw	No	0.15	No	0.1	967		
					PCBs (total calc'd)	0	0.8	3000	µg/kg dw	Yes	23	Yes	3	0.8	2	1.95	µg/kg dw	No	0.05	No	0.0092	76823		
					Pyrene	0	0.8	6700	µg/kg dw	Yes	2.6	Yes	2	0.8	2	13	µg/kg dw	No	0.002	No	0.0014	51438		
					Total HPAH (calc'd)	0	0.8	34700	µg/kg dw	Yes	2.9	Yes	2	0.8	2	13	µg/kg dw	No	0.0021	No	0.00038	266823		
					Zinc	0	0.8	482	mg/kg dw	Yes	1.2	No	0.5	0.8	2	26.2	mg/kg dw	No	0.064	No	0.027	1740		
DR008	EPA SI	0.5	1998	1998	1,2-Dichlorobenzene	Surface	—	520	µg/kg dw	Yes	15	Yes	10	0	2	10	µg/kg dw	No	0.24	No	0.24	2500	Equilibrium	Mixed
					Benzo(g,h,i) perylene	Surface	—	1000	µg/kg dw	Yes	1.5	Yes	1.4	0	2	580	µg/kg dw	No	0.52	No	0.21	72		
					Bis(2-ethylhexyl) phthalate	Surface	—	11000	µg/kg dw	Yes	8.5	Yes	5.8	0	2	6900	µg/kg dw	Yes	4	Yes	2.4	59		
					Butyl benzyl phthalate	Surface	—	940	µg/kg dw	Yes	15	Yes	1	0	2	550	µg/kg dw	Yes	3.1	No	0.23	71		
					Chrysene	Surface	—	1700	µg/kg dw	Yes	1.2	No	0.61	0	2	1400	µg/kg dw	No	0.35	No	0.085	21		
					Fluoranthene	Surface	—	3300	µg/kg dw	Yes	1.9	Yes	1.3	0	2	2400	µg/kg dw	No	0.42	No	0.056	38		
					Indeno(1,2,3-cd) pyrene	Surface	—	1000	µg/kg dw	Yes	1.7	Yes	1.4	0	2	630	µg/kg dw	No	0.53	No	0.2	59		
					Mercury	Surface	—	0.29	mg/kg dw	No	0.71	No	0.49	0	2	0.92	mg/kg dw	Yes	2.2	Yes	1.6	-68		
					PCBs (total calc'd)	Surface	—	430	µg/kg dw	Yes	3.3	No	0.43	0	2	750	µg/kg dw	Yes	1.8	No	0.32	-43		
					Pyrene	Surface	—	2700	µg/kg dw	Yes	1	No	0.82	0	2	3800	µg/kg dw	No	0.11	No	0.079	-29		
					Total HPAH (calc'd)	Surface	—	14500	µg/kg dw	Yes	1.2	No	0.85	0	2	13900	µg/kg dw	No	0.41	No	0.074	4		
					Total PAH (calc'd)	Surface	—	16200	µg/kg dw	—	—	—	—	0	2	16000	µg/kg dw	—	—	—	—	1		
					Zinc	Surface	—	360	mg/kg dw	No	0.88	No	0.38	0	2	420	mg/kg dw	Yes	1	No	0.44	-14		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
DUD006	Duw/Diag-1	0.5	1994	1997	1,4-Dichlorobenzene	Surface	—	34	µg/kg dw	No	0.31	No	0.28	0.49	0.98	100	µg/kg dw	Yes	2.9	Yes	1	-66	Decrease	Mixed
						0.98	1.48	120	µg/kg dw	Yes	3.5	Yes	1.2	1.48	1.97	260	µg/kg dw	Yes	11	Yes	3.7	—		
						1.97	2.46	120	µg/kg dw	Yes	2.4	No	0.83	—	—	—	—	—	—	—	—	—		
					Bis(2-ethylhexyl) phthalate	Surface	—	6180	µg/kg dw	Yes	4.8	Yes	3.3	0.49	0.98	2200	µg/kg dw	Yes	4.3	Yes	2.6	181		
						0.98	1.48	1700	µg/kg dw	Yes	3.2	Yes	1.9	1.48	1.97	2400	µg/kg dw	Yes	6.4	Yes	3.8	—		
						1.97	2.46	2500	µg/kg dw	Yes	3.4	Yes	2.1	—	—	—	—	—	—	—	—	—		
					Butyl benzyl phthalate	Surface	—	263	µg/kg dw	Yes	4.2	No	0.29	0.49	0.98	62	µg/kg dw	Yes	1.1	No	0.088	324		
						0.98	1.48	44	µg/kg dw	No	0.82	No	0.063	1.48	1.97	49	µg/kg dw	Yes	1.2	No	0.095	—		
						1.97	2.46	1300	µg/kg dw	Yes	17	Yes	1.3	—	—	—	—	—	—	—	—	—		
					Cadmium	Surface	—	1.4	mg/kg dw	No	0.27	No	0.21	0.49	0.98	1.9	mg/kg dw	No	0.37	No	0.28	-26		
						0.98	1.48	3.7	mg/kg dw	No	0.73	No	0.55	1.48	1.97	7.9	mg/kg dw	Yes	1.5	Yes	1.2	—		
						1.97	2.46	13	mg/kg dw	Yes	2.5	Yes	1.9	—	—	—	—	—	—	—	—	—		
					Copper	Surface	—	75.6	mg/kg dw	No	0.19	No	0.19	0.49	0.98	420	mg/kg dw	Yes	1.1	Yes	1.1	-82		
						0.98	1.48	76	mg/kg dw	No	0.19	No	0.19	1.48	1.97	90	mg/kg dw	No	0.23	No	0.23	—		
						1.97	2.46	150	mg/kg dw	No	0.38	No	0.38	—	—	—	—	—	—	—	—	—		
					Lead	Surface	—	101	mg/kg dw	No	0.22	No	0.19	0.49	0.98	290	mg/kg dw	No	0.64	No	0.55	-65		
						0.98	1.48	370	mg/kg dw	No	0.82	No	0.7	1.48	1.97	870	mg/kg dw	Yes	1.9	Yes	1.6	—		
						1.97	2.46	910	mg/kg dw	Yes	2	Yes	1.7	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.17	mg/kg dw	No	0.41	No	0.29	0.49	0.98	0.26	mg/kg dw	No	0.63	No	0.44	-35		
						0.98	1.48	0.42	mg/kg dw	Yes	1	No	0.71	1.48	1.97	0.68	mg/kg dw	Yes	1.7	Yes	1.2	—		
						1.97	2.46	1.1	mg/kg dw	Yes	2.7	Yes	1.9	—	—	—	—	—	—	—	—	—		
					N-Nitrosodiphenylamine	Surface	—	42	µg/kg dw	No	0.15	No	0.15	0.49	0.98	16.5	µg/kg dw	No	0.27	No	0.27	27		
						1.97	2.46	190	µg/kg dw	Yes	1.1	Yes	1.1	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	250	µg/kg dw	Yes	1.9	No	0.25	0.49	0.98	509	µg/kg dw	Yes	3.8	No	0.71	-51		
						0.98	1.48	820	µg/kg dw	Yes	6.3	Yes	1.2	1.48	1.97	238	µg/kg dw	Yes	2.5	No	0.46	—		
						1.97	2.46	730	µg/kg dw	Yes	3.8	No	0.71	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	6500	µg/kg dw	—	—	—	—	0.49	0.98	3580	µg/kg dw	—	—	—	—	82		
						0.98	1.48	2280	µg/kg dw	—	—	—	—	1.48	1.97	2950	µg/kg dw	—	—	—	—	—		
						1.97	2.46	6070	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
					Zinc	Surface	—	240	mg/kg dw	No	0.59	No	0.25	0.49	0.98	450	mg/kg dw	Yes	1.1	No	0.47	-47		
						0.98	1.48	240	mg/kg dw	No	0.59	No	0.25	1.48	1.97	310	mg/kg dw	No	0.76	No	0.32	—		
						1.97	2.46	350	mg/kg dw	No	0.85	No	0.36	—	—	—	—	—	—	—	—	—		
DUD020	Duw/Diag-1	0.5	1994	1994	Bis(2-ethylhexyl) phthalate	Surface	—	6200	µg/kg dw	Yes	3.8	Yes	2.3	0.49	0.98	11000	µg/kg dw	Yes	7.2	Yes	4.4	-44	Equilibrium	Mixed
						0.98	1.48	3900	µg/kg dw	Yes	3	Yes	2.1	1.48	1.97	3300	µg/kg dw	Yes	3.8	Yes	2.3	—		
						1.97	2.46	3800	µg/kg dw	Yes	3	Yes	1.8	—	—	—	—	—	—	—	—	—		
					Butyl benzyl phthalate	Surface	—	180	µg/kg dw	Yes	1.1	No	0.083	0.49	0.98	970	µg/kg dw	Yes	6.1	No	0.47	-81		
						0.98	1.48	80	µg/kg dw	Yes	1.3	No	0.089	1.48	1.97	63	µg/kg dw	No	0.71	No	0.055	—		
						1.97	2.46	72	µg/kg dw	No	0.53	No	0.041	—	—	—	—	—	—	—	—	—		
					Lead	Surface	—	110	mg/kg dw	No	0.24	No	0.21	0.49	0.98	230	mg/kg dw	No	0.51	No	0.43	-52		
						0.98	1.48	500	mg/kg dw	Yes	1.1	No	0.94	1.48	1.97	430	mg/kg dw	No	0.96	No	0.81	—		
						1.97	2.46	360	mg/kg dw	No	0.8	No	0.68	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.23	mg/kg dw	No	0.56	No	0.39	0.49	0.98	1.2	mg/kg dw	Yes	2.9	Yes	2	-81		
						0.98	1.48	0.6	mg/kg dw	Yes	1.5	Yes	1	1.48	1.97	0.22	mg/kg dw	No	0.54	No	0.37	—		
						1.97	2.46	1.2	mg/kg dw	Yes	2.9	Yes	2	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	506	µg/kg dw	Yes	1.3	No	0.23	0.49	0.98	760	µg/kg dw	Yes	2	No	0.37	-33		
						0.98	1.48	158	µg/kg dw	Yes	1.2	No	0.16	1.48	1.97	441	µg/kg dw	Yes	2.1	No	0.38	—		
						1.97	2.46	3020	µg/kg dw	Yes	9.2	Yes	1.7	—	—	—	—	—	—	—	—	—		
					Phenol	Surface	—	870	µg/kg dw	Yes	2.1	No	0.73	0.49	0.98	390	µg/kg dw	No	0.93	No	0.33	123		
						0.98	1.48	85	µg/kg dw	No	0.4	No	0.14	1.48	1.97	110	µg/kg dw	No	0.52	No	0.18	—		
						1.97	2.46	85	µg/kg dw	No	0.4	No	0.14	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	9600	µg/kg dw	—	—	—	—	0.49	0.98	11100	µg/kg dw	—	—	—	—	-14		
						0.98	1.48	6400	µg/kg dw	—	—	—	—	1.48	1.97	2480	µg/kg dw	—	—	—	—	—		
						1.97	2.46	8300	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
DR044	EPA SI	0.6	1998	1998	Chrysene	Surface	—	4600	µg/kg dw	Yes	2	No	0.48	0	2	50	µg/kg dw	No	0.017	No	0.0041	9100	Lack of Data Density	Increase
					Fluoranthene	Surface	—	23000	µg/kg dw	Yes	6.9	No	0.92	0	2	120	µg/kg dw	No	0.028	No	0.0038	19067		
					Phenanthrene	Surface	—	3000	µg/kg dw	Yes	1.4	No	0.29	0	2	60	µg/kg dw	No	0.022	No	0.0046	4900		
					Total HPAH (calc'd)	Surface	—	51000	µg/kg dw	Yes	2.6	No	0.47	0	2	560	µg/kg dw	No	0.022	No	0.004	9007		
					Total PAH (calc'd)	Surface	—	55000	µg/kg dw	—	—	—	—	0	2	660	µg/kg dw	—	—	—	—	8233		
LDW-SC12	LDW Subsurface Sediment 2006	0.6	2006	1998	PCBs (total calc'd)	0.5	1	106	µg/kg dw	No	0.45	No	0.083	1	1.5	134	µg/kg dw	No	0.6	No	0.11	-21	Equilibrium	Increase
						1.5	2	320	µg/kg dw	Yes	1.3	No	0.25	2	2.5	2000	µg/kg dw	Yes	7.4	Yes	1.4	—		
					Chrysene	Surface	—	4600	µg/kg dw	Yes	2	No	0.48	0	2	210	µg/kg dw	No	0.1	No	0.024	2090		
					Fluoranthene	Surface	—	23000	µg/kg dw	Yes	6.9	No	0.92	0	2	350	µg/kg dw	No	0.11	No	0.015	6471		
					Phenanthrene	Surface	—	3000	µg/kg dw	Yes	1.4	No	0.29	0	2	100	µg/kg dw	No	0.052	No	0.011	2900		
					Total HPAH (calc'd)	Surface	—	51000	µg/kg dw	Yes	2.6	No	0.47	0	2	2090	µg/kg dw	No	0.11	No	0.021	2340		
					Total PAH (calc'd)	Surface	—	55000	µg/kg dw	—	—	—	—	0	2	2240	µg/kg dw	—	—	—	—	2355		
LDW-SC13	LDW Subsurface Sediment 2006	0.9	2006	—	PCBs (total calc'd)	0	0.5	460	µg/kg dw	Yes	2.5	No	0.46	0.5	1	470	µg/kg dw	Yes	1.2	No	0.22	-2	Equilibrium	Lack of Data Density
						1	1.5	280	µg/kg dw	No	0.92	No	0.17	1.5	2	360	µg/kg dw	No	0.92	No	0.17	—		
						2	2.5	120	µg/kg dw	No	0.29	No	0.054	—	—	—	—	—	—	—	—	—		
LDW-SC14	LDW Subsurface Sediment 2006	0.9	2006	2005	Bis(2-ethylhexyl) phthalate	Surface	—	350	µg/kg dw	No	0.45	No	0.27	0	1.4	1200	µg/kg dw	Yes	1.5	No	0.9	-71	Decrease	Decrease
						1.4	2	470	µg/kg dw	No	0.62	No	0.37	—	—	—	—	—	—	—	—	—		
					Butyl benzyl phthalate	Surface	—	21	µg/kg dw	No	0.47	No	0.036	0	1.4	100	µg/kg dw	Yes	1.2	No	0.091	-79		
						1.4	2	51	µg/kg dw	No	0.63	No	0.048	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.26	mg/kg dw	No	0.63	No	0.44	0	1.4	0.71	mg/kg dw	Yes	1.7	Yes	1.2	-63		
						1.4	2	0.51	mg/kg dw	Yes	1.2	No	0.86	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	790	µg/kg dw	Yes	3.8	No	0.71	0	1.4	4500	µg/kg dw	Yes	22	Yes	4	-82		
						1.4	2	2060	µg/kg dw	Yes	11	Yes	2	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	1920	µg/kg dw	—	—	—	—	0	1.4	2310	µg/kg dw	—	—	—	—	-17		
						1.4	2	1000	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
LDW-SC15	LDW Subsurface Sediment 2006	0.9	2006	—	PCBs (total calc'd)	0	1	360	µg/kg dw	Yes	1.3	No	0.23	1	2	340	µg/kg dw	Yes	1.4	No	0.26	6	Equilibrium	Below SQS
DR021	EPA SI	0.9	1998	2006	Mercury	Surface	—	0.88	mg/kg dw	Yes	2.1	Yes	1.5	0	2	0.38	mg/kg dw	No	0.93	No	0.64	132	Equilibrium	Increase
					PCBs (total calc'd)	Surface	—	350	µg/kg dw	Yes	1.1	No	0.2	0	2	520	µg/kg dw	Yes	1.7	No	0.31	-33		
					Total PAH (calc'd)	Surface	—	4260	µg/kg dw	—	—	—	—	0	2	5600	µg/kg dw	—	—	—	—	-24		
LDW-SC16	LDW Subsurface Sediment 2006	1	2006	2006	Fluoranthene	Surface	—	860	µg/kg dw	No	0.28	No	0.038	0	2	4700	µg/kg dw	Yes	1.4	No	0.19	-82	Equilibrium	Decrease
					PCBs (total calc'd)	Surface	—	390	µg/kg dw	Yes	1.8	No	0.32	0	2	330	µg/kg dw	Yes	1.3	No	0.25	18		
					Total PAH (calc'd)	Surface	—	4910	µg/kg dw	—	—	—	—	0	2	12200	µg/kg dw	—	—	—	—	-60		
LDW-SC17	LDW Subsurface Sediment 2006	1	2006	2005	Arsenic	Surface	—	122	mg/kg dw	Yes	2.1	Yes	1.3	0	1	110	mg/kg dw	Yes	1.9	Yes	1.2	11	Decrease	Mixed
						1	2	170	mg/kg dw	Yes	3	Yes	1.8	—	—	—	—	—	—	—	—	—		
					Benzyl alcohol	0	1	140	µg/kg dw	Yes	2.5	Yes	1.9	1	2	38	µg/kg dw	No	0.67	No	0.52	268		
					Cadmium	Surface	—	3.2	mg/kg dw	No	0.63	No	0.48	0	1	4.5	mg/kg dw	No	0.88	No	0.67	-29		
						1	2	7.6	mg/kg dw	Yes	1.5	Yes	1.1	—	—	—	—	—	—	—	—	—		
					Fluoranthene	Surface	—	670	µg/kg dw	No	0.19	No	0.026	0	1	2000	µg/kg dw	No	0.41	No	0.054	-67		
						1	2	5600	µg/kg dw	Yes	1.1	No	0.14	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.33	mg/kg dw	No	0.8	No	0.56	0	1	0.5	mg/kg dw	Yes	1.2	No	0.85	-34		
						1	2	0.6	mg/kg dw	Yes	1.5	Yes	1	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	96	µg/kg dw	No	0.37	No	0.068	0	1	1220	µg/kg dw	Yes	3.3	No	0.62	-92		
						1	2	1040	µg/kg dw	Yes	2.7	No	0.49	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	4480	µg/kg dw	—	—	—	—	0	1	14200	µg/kg dw	—	—	—	—	-68		
						1	2	22800	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
					Zinc	Surface	—	997	mg/kg dw	Yes	2.4	Yes	1	0	1	1260	mg/kg dw	Yes	3.1	Yes	1.3	-21		
						1	2	2050	mg/kg dw	Yes	5	Yes	2.1	—	—	—	—	—	—	—	—	—		
LDW-SC18	LDW Subsurface Sediment 2006	1	2006	2005	2-Methyl-naphthalene	Surface	—	3300	µg/kg dw	Yes	4.2	Yes	2.5	0	1	29.5	µg/kg dw	No	0.087	No	0.052	5493	Increase	Increase
						1	2	10	µg/kg dw	No	0.055	No	0.033	—	—	—	—	—	—	—	—	—		
					Acenaphthene	Surface	—	5200	µg/kg dw	Yes	16	Yes	4.6	0	1	48	µg/kg dw	No	0.17	No	0.047	10733		
						1	2	10	µg/kg dw	No	0.13	No	0.037	—	—	—	—	—	—	—	—	—		
					Benzo(a) anthracene	Surface	—	3200	µg/kg dw	Yes	1.5	No	0.59	0	1	490	µg/kg dw	No	0.25	No	0.1	553		
						1	2	16	µg/kg dw	No	0.015	No	0.0063	—	—	—	—	—	—	—	—	—		
					Benzo(a)pyrene	Surface	—	2000	µg/kg dw	Yes	1	No	0.48	0	1	340	µg/kg dw	No	0.19	No	0.09	488		
						1	2	27	µg/kg dw	No	0.028	No	0.013	—	—	—	—	—	—	—	—	—		
					Benzofluoranthenes (total-calc'd)	Surface	—	5100	µg/kg dw	Yes	1.1	No	0.56	0	1	970	µg/kg dw	No	0.24	No	0.12	426		
						1	2	70	µg/kg dw	No	0.032	No	0.016	—	—	—	—	—	—	—	—	—		
					Chrysene	Surface	—	3700	µg/kg dw	Yes	1.6	No	0.39	0	1	740	µg/kg dw	No	0.38	No	0.091	400		
						1	2	17	µg/kg dw	No	0.016	No	0.0039	—	—	—	—	—	—	—	—	—		
					Dibenzofuran	Surface	—	3500	µg/kg dw	Yes	11	Yes	2.9	0	1	29.5	µg/kg dw	No	0.22	No	0.057	5832		
						1	2	10	µg/kg dw	No	0.14	No	0.036	—	—	—	—	—	—	—	—	—		
					Fluoranthene	Surface	—	17000	µg/kg dw	Yes	5.3	No	0.71	0	1	2600	µg/kg dw	No	0.94	No	0.13	554		
						1	2	36	µg/kg dw	No	0.023	No	0.0031	—	—	—	—	—	—	—	—	—		
					Fluorene	Surface	—	4900	µg/kg dw	Yes	10	Yes	3	0	1	36	µg/kg dw	No	0.087	No	0.025	13511		
						1	2	10	µg/kg dw	No	0.091	No	0.027	—	—	—	—	—	—	—	—	—		
					Mercury	Surface	—	0.46	mg/kg dw	Yes	1.1	No	0.78	0	1	0.11	mg/kg dw	No	0.27	No	0.19	318		
						1	2	0.025	mg/kg dw	No	0.12	No	0.085	—	—	—	—	—	—	—	—	—		
					Naphthalene	Surface	—	5300	µg/kg dw	Yes	2.6	Yes	1.5	0	1	35	µg/kg dw	No	0.02	No	0.012	15043		
						1	2	10	µg/kg dw	No	0.021	No	0.012	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	650	µg/kg dw	Yes	2.7	No	0.49	0	1	182	µg/kg dw	No	0.83	No	0.15	257		
						1	2	19.6	µg/kg dw	No	0.17	No	0.031	—	—	—	—	—	—	—	—	—		
					Phenanthrene	Surface	—	15000	µg/kg dw	Yes	7.5	Yes	1.6	0	1	290	µg/kg dw	No	0.16	No	0.033	5072		
						1	2	10	µg/kg dw	No	0.021	No	0.0044	—	—	—	—	—	—	—	—	—		
					Total HPAH (calc'd)	Surface	—	42000	µg/kg dw	Yes	2.2	No	0.4	0	1	7000	µg/kg dw	No	0.42	No	0.075	500		
						1	2	242	µg/kg dw	No	0.026	No	0.0047	—	—	—	—	—	—	—	—	—		
					Total LPAH (calc'd)	Surface	—	34000	µg/kg dw	Yes	4.6	Yes	2.2	0	1	560	µg/kg dw	No	0.086	No	0.041	5971		
						1	2	10	µg/kg dw	No	0.0057	No	0.0027	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	76000	µg/kg dw	—	—	—	—	0	1	7600	µg/kg dw	—	—	—	—	900		
						1	2	242	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
LDW-SC19	LDW Subsurface Sediment 2006	1	2006	—	PCBs (total calc'd)	0	1	280	µg/kg dw	No	1	No	0.18	1	2	233	µg/kg dw	Yes	1.2	No	0.22	20	Equilibrium	Below SQS
LDW-SC20	LDW Subsurface Sediment 2006	1	2006	2005	Mercury	Surface	—	0.69	mg/kg dw	Yes	1.7	Yes	1.2	0	2	0.65	mg/kg dw	Yes	1.6	Yes	1.1	6	Increase	Equilibrium
					PCBs (total calc'd)	Surface	—	5100	µg/kg dw	Yes	18	Yes	3.4	0	2	3200	µg/kg dw	Yes	18	Yes	3.2	59		
					Total PAH (calc'd)	Surface	—	1300	µg/kg dw	—	—	—	—	0	2	1360	µg/kg dw	—	—	—	—	-4		
LDW-SC21	LDW Subsurface Sediment 2006	1	2006	—	PCBs (total calc'd)	0	1	250	µg/kg dw	Yes	1.1	No	0.2	1	2	145	µg/kg dw	No	0.81	No	0.15	72	Increase	Below SQS
LDW-SC22	LDW Subsurface Sediment 2006	1.1	2006	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
LDW-SC23	LDW Subsurface Sediment 2006	1.2	2006	—	Total PAH (calc'd)	0	0.5	5230	µg/kg dw	—	—	—	—	0.5	1	3560	µg/kg dw	—	—	—	—	47	Lack of Data Density	Below SQS
						1	1.5	4800	µg/kg dw	—	—	—	—	1.5	2	4800	µg/kg dw	—	—	—	—	—		
LDW-SC24	LDW Subsurface Sediment 2006	1.2	2006	—	PCBs (total calc'd)	0	1	280	µg/kg dw	Yes	1.2	No	0.22	1	2	36	µg/kg dw	No	0.28	No	0.036	678	Increase	Below SQS
DR025	EPA SI	1.2	1998	1998	Total PAH (calc'd)	Surface	—	5600	µg/kg dw	—	—	—	—	0	2	5000	µg/kg dw	—	—	—	—	12	Lack of Data Density	Below SQS
LDW-SC25	LDW Subsurface Sediment 2006	1.3	2006	—	Arsenic	0	1	50	mg/kg dw	No	0.88	No	0.54	1	2	91	mg/kg dw	Yes	1.6	No	0.98	-45	Equilibrium	Equilibrium
					PCBs (total calc'd)	0	1	310	µg/kg dw	Yes	1.3	No	0.25	1	2	360	µg/kg dw	Yes	2	No	0.37	-14		
					Zinc	0	1	263	mg/kg dw	No	0.64	No	0.27	1	2	503	mg/kg dw	Yes	1.2	No	0.52	-48		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
DR054	EPA SI	1.3	1998	1998	Arsenic	Surface	—	24	mg/kg dw	No	0.42	No	0.26	0	2	280	mg/kg dw	Yes	4.9	Yes	3	-91	Decrease	Decrease
					Bis(2-ethylhexyl) phthalate	Surface	—	450	µg/kg dw	No	0.4	No	0.24	0	2	1200	µg/kg dw	Yes	1.3	No	0.77	-63		
					Copper	Surface	—	140	mg/kg dw	No	0.36	No	0.36	0	2	800	mg/kg dw	Yes	2.1	Yes	2.1	-83		
					PCBs (total calc'd)	Surface	—	97	µg/kg dw	No	0.34	No	0.063	0	2	250	µg/kg dw	Yes	1.1	No	0.2	-61		
					Total PAH (calc'd)	Surface	—	4210	µg/kg dw	—	—	—	—	0	2	9500	µg/kg dw	—	—	—	—	-56		
					Zinc	Surface	—	170	mg/kg dw	No	0.41	No	0.18	0	2	1600	mg/kg dw	Yes	3.9	Yes	1.7	-89		
LDW-SC26	LDW Subsurface Sediment 2006	1.4	2006	—	PCBs (total calc'd)	0	1	280	µg/kg dw	Yes	1.7	No	0.31	1	2	226	µg/kg dw	No	0.92	No	0.17	24	Equilibrium	Below SQS
LDW-SC27	LDW Subsurface Sediment 2006	1.4	2006	2005	Mercury	Surface	—	0.41	mg/kg dw	No	1	No	0.69	0	2	0.52	mg/kg dw	Yes	1.3	No	0.88	-21	Decrease	Equilibrium
					PCBs (total calc'd)	0	0.5	250	µg/kg dw	Yes	1.3	No	0.25	0.5	1	2000	µg/kg dw	Yes	9.2	Yes	1.7	-88		
						1	1.5	3200	µg/kg dw	Yes	22	Yes	4	1.5	2	1510	µg/kg dw	Yes	6.9	Yes	1.3	—		
					Total PAH (calc'd)	Surface	—	3410	µg/kg dw	—	—	—	—	0	2	2670	µg/kg dw	—	—	—	—	28		
LDW-SC28	LDW Subsurface Sediment 2006	1.4	2006	—	Arsenic	0	1	114	mg/kg dw	Yes	2	Yes	1.2	1	2	18	mg/kg dw	No	0.32	No	0.19	533	Equilibrium	Increase
					Benzyl alcohol	0	1	110	µg/kg dw	Yes	1.9	Yes	1.5	1	2	15	µg/kg dw	No	0.53	No	0.41	267		
					PCBs (total calc'd)	0	1	440	µg/kg dw	Yes	1.4	No	0.26	1	2	360	µg/kg dw	Yes	1.4	No	0.26	22		
LDW-SC29	LDW Subsurface Sediment 2006	1.4	2006	—	Hexachlorobenzene	0	1	5.9	µg/kg dw	No	0.87	No	0.14	1	2	2.95	µg/kg dw	Yes	1.5	No	0.24	0	Below SQS	Equilibrium
LDW-SC32	LDW Subsurface Sediment 2006	1.7	2006	2006	Acenaphthene	0	1	29	µg/kg dw	No	0.2	No	0.056	1	2	1400	µg/kg dw	Yes	7.5	Yes	2.1	-96	Decrease	Mixed
					Bis(2-ethylhexyl) phthalate	Surface	—	210	µg/kg dw	No	0.23	No	0.14	0	1	200	µg/kg dw	No	0.23	No	0.14	5		
						1	2	650	µg/kg dw	Yes	1.2	No	0.72	—	—	—	—	—	—	—	—	—		
					Dibenzofuran	0	1	29	µg/kg dw	No	0.21	No	0.055	1	2	1200	µg/kg dw	Yes	6.7	Yes	1.7	-95		
					Fluoranthene	Surface	—	240	µg/kg dw	No	0.081	No	0.011	0	1	210	µg/kg dw	No	0.075	No	0.01	14		
						1	2	2500	µg/kg dw	Yes	1.4	No	0.18	—	—	—	—	—	—	—	—	—		
					Fluorene	0	1	29	µg/kg dw	No	0.14	No	0.041	1	2	1900	µg/kg dw	Yes	7	Yes	2	-97		
					PCBs (total calc'd)	Surface	—	211	µg/kg dw	No	0.92	No	0.17	0	1	1010	µg/kg dw	Yes	4.7	No	0.86	-79		
						1	2	1720	µg/kg dw	Yes	13	Yes	2.3	—	—	—	—	—	—	—	—	—		
					Phenanthrene	Surface	—	78	µg/kg dw	No	0.042	No	0.0088	0	1	88	µg/kg dw	No	0.049	No	0.01	-11		
						1	2	3700	µg/kg dw	Yes	3.2	No	0.67	—	—	—	—	—	—	—	—	—		
					Total LPAH (calc'd)	Surface	—	117	µg/kg dw	No	0.017	No	0.0082	0	1	130	µg/kg dw	No	0.019	No	0.0092	-10		
						1	2	7500	µg/kg dw	Yes	1.8	No	0.83	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	1480	µg/kg dw	—	—	—	—	0	1	1700	µg/kg dw	—	—	—	—	-13		
						1	2	14900	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
DR101	EPA SI	1.7	1998	1998	Total PAH (calc'd)	Surface	—	4730	µg/kg dw	—	—	—	—	0	2	700	µg/kg dw	—	—	—	—	576	Lack of Data Density	Below SQS
LDW-SC33	LDW Subsurface Sediment 2006	1.9	2006	—	PCBs (total calc'd)	0	0.5	490	µg/kg dw	Yes	2.3	No	0.43	0.5	1	790	µg/kg dw	Yes	3.1	No	0.57	-38	Equilibrium	Lack of Data Density
						1	1.5	4700	µg/kg dw	Yes	16	Yes	2.9	1.5	2	2500	µg/kg dw	Yes	8.3	Yes	1.5	—		
						2	2.5	210	µg/kg dw	Yes	1.3	No	0.25	—	—	—	—	—	—	—	—	—		
LDW-SC34	LDW Subsurface Sediment 2006	1.9	2006	—	Benzyl alcohol	0	1	34	µg/kg dw	No	0.6	No	0.47	1	2	210	µg/kg dw	Yes	3.7	Yes	2.9	-84	Below SQS	Mixed
					Bis(2-ethylhexyl)phthalate	0	1	920	µg/kg dw	No	0.68	No	0.41	1	2	3900	µg/kg dw	Yes	2.8	Yes	1.7	-76		
					Butyl benzyl phthalate	0	1	440	µg/kg dw	Yes	3.1	No	0.23	1	2	400	µg/kg dw	Yes	2.7	No	0.2	10		
LDW-SC203	LDW Subsurface Sediment 2006	1.9	2006	—	Benzyl alcohol	0	1	66	µg/kg dw	Yes	1.2	No	0.9	1	2	41	µg/kg dw	No	0.72	No	0.56	61	Below SQS	Mixed
					Bis(2-ethylhexyl) phthalate	0	1	1800	µg/kg dw	Yes	1.2	No	0.71	1	2	2600	µg/kg dw	Yes	1.9	Yes	1.1	-31		
					Butyl benzyl phthalate	0	1	380	µg/kg dw	Yes	2.4	No	0.19	1	2	400	µg/kg dw	Yes	2.9	No	0.22	-5		
LDW-SC36	LDW Subsurface Sediment 2006	2.1	2006	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
LDW-SC37	LDW Subsurface Sediment 2006	2.1	2006	—	Arsenic	0	1	150	mg/kg dw	Yes	2.6	Yes	1.6	1	2	121	mg/kg dw	Yes	2.1	Yes	1.3	24	Decrease	Mixed
					Benzo(a) anthracene	0	1	1100	µg/kg dw	No	0.45	No	0.18	1	2	3100	µg/kg dw	Yes	1.1	No	0.44	-65		
					Benzo(a)pyrene	0	1	2000	µg/kg dw	No	0.9	No	0.42	1	2	5300	µg/kg dw	Yes	2	No	0.95	-62		
					Benzo(g,h,i) perylene	0	1	530	µg/kg dw	No	0.77	No	0.31	1	2	1000	µg/kg dw	Yes	1.2	No	0.47	-47		
					Benzofluoranthenes (total-calc'd)	0	1	5100	µg/kg dw	No	1	No	0.51	1	2	10200	µg/kg dw	Yes	1.7	No	0.84	-50		
					Chrysene	0	1	1600	µg/kg dw	No	0.65	No	0.15	1	2	4800	µg/kg dw	Yes	1.6	No	0.39	-67		
					Dibenzo(a,h) anthracene	0	1	170	µg/kg dw	No	0.63	No	0.23	1	2	360	µg/kg dw	Yes	1.1	No	0.39	-53		
					Fluoranthene	0	1	1600	µg/kg dw	No	0.44	No	0.059	1	2	4500	µg/kg dw	Yes	1.1	No	0.14	-64		
					Indeno(1,2,3-cd) pyrene	0	1	750	µg/kg dw	No	0.97	No	0.38	1	2	1500	µg/kg dw	Yes	1.6	No	0.64	-50		
					Mercury	0	1	0.26	mg/kg dw	No	0.63	No	0.44	1	2	0.45	mg/kg dw	Yes	1.1	No	0.76	-42		
					PCBs (total calc'd)	0	1	450	µg/kg dw	Yes	1.7	No	0.31	1	2	950	µg/kg dw	Yes	3	No	0.55	-53		
					Total HPAH (calc'd)	0	1	15800	µg/kg dw	No	0.73	No	0.13	1	2	40000	µg/kg dw	Yes	1.6	No	0.28	-61		
					Zinc	0	1	386	mg/kg dw	No	0.94	No	0.4	1	2	490	mg/kg dw	Yes	1.2	No	0.51	-21		
LDW-SC38a	LDW Subsurface Sediment 2006	2.1	2006	—	PCBs (total calc'd)	0	1	450	µg/kg dw	Yes	1.9	No	0.35	1	2	710	µg/kg dw	Yes	4.3	No	0.8	-37	Equilibrium	Below SQS
LDW-SC202	LDW Subsurface Sediment 2006	2.1	2006	—	Benzyl alcohol	0	1	15	µg/kg dw	No	0.53	No	0.41	1	2	29	µg/kg dw	Yes	1	No	0.79	-48	Below SQS	Mixed
					Hexachlorobenzene	0	1	3	µg/kg dw	Yes	1.2	No	0.2	1	2	6	µg/kg dw	Yes	1.8	No	0.3	-50		
DR106	EPA SI	2.1	1998	2005	Total PAH (calc'd)	Surface	—	820	µg/kg dw	—	—	—	—	0	2	1220	µg/kg dw	—	—	—	—	-33	Lack of Data Density	Below SQS
DR112	EPA SI	2.1	1998	1998	Fluoranthene	Surface	—	5300	µg/kg dw	Yes	1.3	No	0.17	0	2	550	µg/kg dw	No	0.14	No	0.018	864	Lack of Data Density	Increase
					Total PAH (calc'd)	Surface	—	15800	µg/kg dw	—	—	—	—	0	2	3150	µg/kg dw	—	—	—	—	402		
LDW-SC39	LDW Subsurface Sediment 2006	2.2	2006	1997	PCBs (total calc'd)	Surface	—	110	µg/kg dw	No	0.45	No	0.083	0	1	208	µg/kg dw	Yes	1.7	No	0.31	-47	Equilibrium	Below SQS
						1	2	440	µg/kg dw	Yes	5.8	Yes	1.1	—	—	—	—	—	—	—	—	—		
DR137	EPA SI	2.2	1998	1998	PCBs (total calc'd)	Surface	—	181	µg/kg dw	No	0.68	No	0.13	0	2	470	µg/kg dw	Yes	1.6	No	0.29	-61	Decrease	Below SQS
					Total PAH (calc'd)	Surface	—	2760	µg/kg dw	—	—	—	—	0	2	570	µg/kg dw	—	—	—	—	384		
LDW-SC40	LDW Subsurface Sediment 2006	2.3	2006	—	PCBs (total calc'd)	0	1.3	160	µg/kg dw	Yes	1.8	No	0.32	1.3	2	2	µg/kg dw	No	0.031	No	0.004	3900	Increase	Below SQS
LDW-SC41	LDW Subsurface Sediment 2006	2.4	2006	—	PCBs (total calc'd)	0	1	370	µg/kg dw	Yes	1.3	No	0.23	1	2	256	µg/kg dw	No	0.92	No	0.17	45	Equilibrium	Below SQS
LDW-SC42	LDW Subsurface Sediment 2006	2.5	2006	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
WRC-SS-B1	Boyer Towing	2.5	2004	2004	Total PAH (calc'd)	Surface	—	1370	µg/kg dw	—	—	—	—	1	2	9.5	µg/kg dw	—	—	—	—	7111	Lack of Data Density	Below SQS

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used^a	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
WRC-SS-B2	Boyer Towing	2.5	2004	2004	Total PAH (calc'd)	Surface	—	4400	µg/kg dw	—	—	—	—	1	2	16	µg/kg dw	—	—	—	—	27400	Lack of Data Density	Below SQS
						1	2	9.5	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
WRC-SS-B3	Boyer Towing	2.5	2004	2004	Total PAH (calc'd)	Surface	—	490	µg/kg dw	—	—	—	—	1	2	10	µg/kg dw	—	—	—	—	2350	Lack of Data Density	Increase
					Zinc	Surface	—	479	mg/kg dw	Yes	1.2	No	0.5	1	2	23.8	mg/kg dw	No	0.058	No	0.025	1913		
DR171	EPA SI	2.5	1998	1998	Total PAH (calc'd)	Surface	—	4100	µg/kg dw	—	—	—	—	0	2	2270	µg/kg dw	—	—	—	—	81	Lack of Data Density	Below SQS
LDW-SC44	LDW Subsurface Sediment 2006	2.7	2006	—	PCBs (total calc'd)	0	0.5	260	µg/kg dw	Yes	1.3	No	0.23	0.5	1	880	µg/kg dw	Yes	4.3	No	0.8	-70	Decrease	Lack of Data Density
						1	1.5	200	µg/kg dw	No	1	No	0.18	1.5	2	140	µg/kg dw	No	0.61	No	0.11	—		
						2	2.5	270	µg/kg dw	Yes	1.2	No	0.22	—	—	—	—	—	—	—	—	—		
LDW-SC46	LDW Subsurface Sediment 2006	2.7	2006	2005	Acenaphthene	Surface	—	4600	µg/kg dw	Yes	11	Yes	3	0	1	96	µg/kg dw	No	0.33	No	0.093	4692	Equilibrium	Mixed
						1	2	63	µg/kg dw	No	0.28	No	0.077	—	—	—	—	—	—	—	—	—		
					Anthracene	Surface	—	10000	µg/kg dw	Yes	1.7	No	0.32	0	1	360	µg/kg dw	No	0.091	No	0.017	2678		
						1	2	350	µg/kg dw	No	0.11	No	0.021	—	—	—	—	—	—	—	—	—		
					Benzo(a) anthracene	Surface	—	4000	µg/kg dw	Yes	1.4	No	0.56	0	1	940	µg/kg dw	No	0.47	No	0.19	326		
						1	2	1200	µg/kg dw	No	0.77	No	0.31	—	—	—	—	—	—	—	—	—		
					Benzyl alcohol	0	1	18	µg/kg dw	No	0.32	No	0.25	1	2	64	µg/kg dw	Yes	1.1	No	0.88	-72		
					Chrysene	Surface	—	5700	µg/kg dw	Yes	2	No	0.48	0	1	1100	µg/kg dw	No	0.55	No	0.13	418		
						1	2	1500	µg/kg dw	No	1	No	0.24	—	—	—	—	—	—	—	—	—		
					Dibenzofuran	Surface	—	4000	µg/kg dw	Yes	10	Yes	2.6	0	1	92	µg/kg dw	No	0.34	No	0.088	4248		
						1	2	49.5	µg/kg dw	No	0.47	No	0.12	—	—	—	—	—	—	—	—	—		
					Fluoranthene	Surface	—	17000	µg/kg dw	Yes	4	No	0.53	0	1	3900	µg/kg dw	Yes	1.4	No	0.18	336		
						1	2	2900	µg/kg dw	Yes	1.3	No	0.17	—	—	—	—	—	—	—	—	—		
					Fluorene	Surface	—	6800	µg/kg dw	Yes	11	Yes	3.3	0	1	150	µg/kg dw	No	0.36	No	0.11	4433		
						1	2	67	µg/kg dw	No	0.2	No	0.059	—	—	—	—	—	—	—	—	—		
					Hexachloro-benzene	0	1	3	µg/kg dw	No	0.87	No	0.14	1	2	10	µg/kg dw	Yes	1.8	No	0.3	-40		
					Indeno(1,2,3-cd) pyrene	Surface	—	970	µg/kg dw	Yes	1.1	No	0.42	0	1	140	µg/kg dw	No	0.23	No	0.088	593		
						1	2	190	µg/kg dw	No	0.38	No	0.15	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	198	µg/kg dw	No	0.63	No	0.12	0	1	214	µg/kg dw	No	1	No	0.18	-7		
						1	2	185	µg/kg dw	Yes	1.1	No	0.2	—	—	—	—	—	—	—	—	—		
					Phenanthrene	Surface	—	22000	µg/kg dw	Yes	8.3	Yes	1.7	0	1	1400	µg/kg dw	No	0.77	No	0.16	1471		
						1	2	380	µg/kg dw	No	0.27	No	0.056	—	—	—	—	—	—	—	—	—		
					Total HPAH (calc'd)	Surface	—	48000	µg/kg dw	Yes	1.9	No	0.34	0	1	10500	µg/kg dw	No	0.6	No	0.11	357		
						1	2	13700	µg/kg dw	No	1	No	0.18	—	—	—	—	—	—	—	—	—		
					Total LPAH (calc'd)	Surface	—	44000	µg/kg dw	Yes	4.6	Yes	2.2	0	1	2100	µg/kg dw	No	0.32	No	0.15	1995		
						1	2	1290	µg/kg dw	No	0.25	No	0.12	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	92000	µg/kg dw	—	—	—	—	0	1	12600	µg/kg dw	—	—	—	—	630		
						1	2	15000	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
LDW-SC45	LDW Subsurface Sediment 2006	2.8	2006	—	PCBs (total calc'd)	0	1	230	µg/kg dw	Yes	1.3	No	0.25	1	2	270	µg/kg dw	Yes	1.6	No	0.29	-15	Equilibrium	Below SQS
SC01	Slip4-EarlyAction	2.8	2004	2004	PCBs (total calc'd)	Surface	—	1620	µg/kg dw	Yes	12	Yes	1.6	0	0	35000	µg/kg dw	Yes	130	Yes	23	-95	Decrease	Lack of Data Density
SC03	Slip4-EarlyAction	2.8	2004	2004	PCBs (total calc'd)	Surface	—	470	µg/kg dw	Yes	1.3	No	0.23	0	2	560	µg/kg dw	Yes	1.5	No	0.28	-16	Equilibrium	Lack of Data Density
SC04	Slip4-EarlyAction	2.8	2004	2004	PCBs (total calc'd)	Surface	—	710	µg/kg dw	Yes	1.9	No	0.35	0	2	14000	µg/kg dw	Yes	39	Yes	7.2	-95	Decrease	Lack of Data Density
SC05	Slip4-EarlyAction	2.8	2004	2004	PCBs (total calc'd)	Surface	—	310	µg/kg dw	No	0.78	No	0.14	0	2	1300	µg/kg dw	Yes	4.1	No	0.75	-76	Decrease	Lack of Data Density
SC06	Slip4-EarlyAction	2.8	2004	2004	PCBs (total calc'd)	Surface	—	200	µg/kg dw	No	0.6	No	0.11	0	2	350	µg/kg dw	Yes	1.3	No	0.23	-43	Equilibrium	Lack of Data Density
SLP4-08-01	Slip 4-Landau 2008	2.8	2008	—	PCBs (total calc'd)	0	0.5	1300	µg/kg dw	Yes	10	Yes	1.3	0.5	1	3300	µg/kg dw	Yes	25	Yes	3.3	-61	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	1.5	28000	µg/kg dw	Yes	220	Yes	28	1.5	2	37000	µg/kg dw	Yes	280	Yes	37	-24		
SLP4-08-02	Slip 4-Landau 2008	2.8	2008	—	PCBs (total calc'd)	0	0.5	4000	µg/kg dw	Yes	31	Yes	4	0.5	1	13400	µg/kg dw	Yes	100	Yes	13	-70	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	1.5	1700	µg/kg dw	Yes	13	Yes	1.7	1.5	2	110	µg/kg dw	No	0.85	No	0.11	1445		
SLP4-08-03	Slip 4-Landau 2008	2.8	2008	—	PCBs (total calc'd)	0	0.5	1600	µg/kg dw	Yes	12	Yes	1.6	0.5	1	2600	µg/kg dw	Yes	20	Yes	2.6	-38	Equilibrium	No SMS Contaminants other than PCBs Analyzed
						1	1.5	6200	µg/kg dw	Yes	48	Yes	6.2	1.5	2	210	µg/kg dw	Yes	1.6	No	0.21	2852		
SC07	Slip4-EarlyAction	2.9	2004	2004	PCBs (total calc'd)	Surface	—	300	µg/kg dw	No	0.92	No	0.17	0	2	6900	µg/kg dw	Yes	24	Yes	4.5	-96	Decrease	Lack of Data Density
LDW-SC47	LDW Subsurface Sediment 2006	3	2006	—	PCBs (total calc'd)	0	1	72	µg/kg dw	No	0.56	No	0.1	1	2	2000	µg/kg dw	Yes	9.2	Yes	1.7	-96	Decrease	Below SQS
DR224	EPA SI	3	1998	1998	Total PAH (calc'd)	Surface	—	820	µg/kg dw	—	—	—	—	0	2	100	µg/kg dw	—	—	—	—	720	Lack of Data Density	Below SQS
LDW-SC48	—	3.3	2006	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-DUW07	Plant 2 RFI-2b	3.3	1996	1995	PCBs (total calc'd)	Surface	—	1100	µg/kg dw	Yes	4.2	No	0.77	0	1.9	4400	µg/kg dw	Yes	26	Yes	4.8	-75	Decrease	No SMS Contaminants other than PCBs Analyzed
SD-DUW34	Plant 2 RFI-2b	3.3	1996	1995	PCBs (total calc'd)	Surface	—	3500	µg/kg dw	Yes	27	Yes	4.9	0	1.9	11300	µg/kg dw	Yes	63	Yes	12	-69	Decrease	No SMS Contaminants other than PCBs Analyzed
					Total PAH (calc'd)	Surface	—	330	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-04107	Plant 2 RFI-1	3.3	1995	1995	Cadmium	Surface	—	0.6	mg/kg dw	No	0.12	No	0.09	0.3	1.5	18	mg/kg dw	Yes	3.5	Yes	2.7	-97	Decrease	Decrease
					PCBs (total calc'd)	Surface	—	9600	µg/kg dw	Yes	28	Yes	5.2	0.3	1.5	22000	µg/kg dw	Yes	92	Yes	17	-56		
					Total PAH (calc'd)	Surface	—	5750	µg/kg dw	—	—	—	—	0.3	1.5	12300	µg/kg dw	—	—	—	—	-53		
SB-04117	Plant 2 RFI-1	3.3	1994	1995	Benzo(g,h,i) perylene	Surface	—	700	µg/kg dw	Yes	1	No	0.41	0.5	1	90	µg/kg dw	No	0.27	No	0.25	289	No PCBs Analyzed	Increase
					Chrysene	Surface	—	2800	µg/kg dw	Yes	1.2	No	0.28	0.5	1	390	µg/kg dw	No	0.28	No	0.14	618		
						2	2.5	460	µg/kg dw	No	0.33	No	0.16	—	—	—	—	—	—	—	—	—		
					Dibenzo(a,h) anthracene	Surface	—	330	µg/kg dw	Yes	1.3	No	0.45	0.5	1	90	µg/kg dw	No	0.78	No	0.33	83		
						2	2.5	200	µg/kg dw	Yes	1.7	No	0.74	—	—	—	—	—	—	—	—	—		
					Indeno(1,2,3-cd) pyrene	Surface	—	830	µg/kg dw	Yes	1.1	No	0.43	0.5	1	90	µg/kg dw	No	0.3	No	0.26	361		
						2	2.5	200	µg/kg dw	No	0.67	No	0.58	—	—	—	—	—	—	—	—	—		
					Total HPAH (calc'd)	Surface	—	21600	µg/kg dw	Yes	1	No	0.18	0.5	1	2750	µg/kg dw	No	0.23	No	0.16	685		
						2	2.5	4400	µg/kg dw	No	0.37	No	0.26	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	22200	µg/kg dw	—	—	—	—	0.5	1	2750	µg/kg dw	—	—	—	—	707		
						2	2.5	4400	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
SD-UB-009	Boeing P2 Under Bldg	3.4	2008	—	PCBs (total calc'd)	0	1	171	µg/kg dw	Yes	1	No	0.19	1	2	27	µg/kg dw	No	0.092	No	0.017	533	Increase	No SMS Contaminants other than PCBs Analyzed
LDW-SC49	LDW Subsurface Sediment 2006	3.5	2006	—	Benzoic acid	0	1	750	µg/kg dw	Yes	1.2	Yes	1.2	1	2	100	µg/kg dw	No	0.15	No	0.15	650	Below SQS	Increase
					Benzyl alcohol	0	1	200	µg/kg dw	Yes	3.5	Yes	2.7	1	2	30	µg/kg dw	Yes	1.1	No	0.82	233		
T117-SE-70-SC	T-117 Boundary Definition	3.5	2004	2004	PCBs (total calc'd)	Surface	—	34000	µg/kg dw	Yes	120	Yes	22	0.5	1	11000	µg/kg dw	Yes	46	Yes	8.5	209	Increase	Below SQS
						1	2	1380	µg/kg dw	Yes	6.1	Yes	1.1	—	—	—	—	—	—	—	—	—		
T117-SE-71-SC	T-117 Boundary Definition	3.5	2004	2003	PCBs (total calc'd)	Surface	—	1200	µg/kg dw	Yes	5	No	0.92	0	1	730	µg/kg dw	Yes	4.7	No	0.86	64	Increase	Below SQS
						1	2	9.5	µg/kg dw	No	0.15	No	0.019	—	—	—	—	—	—	—	—	—		
T117-SE-72-SC	T-117 Boundary Definition	3.5	2004	—	PCBs (total calc'd)	0	1	540	µg/kg dw	Yes	2	No	0.38	1	2	1410	µg/kg dw	Yes	6.2	Yes	1.1	-62	Decrease	Below SQS
						2	2.4	2200	µg/kg dw	Yes	9.2	Yes	1.7	—	—	—	—	—	—	—	—	—		
DUW102	DSOAvertchar	3.5	2001	1995	PCBs (total calc'd)	Surface	—	1100	µg/kg dw	Yes	7.7	Yes	1.4	0	0.6	1080	µg/kg dw	Yes	5.3	No	0.98	2	Equilibrium	No SMS Contaminants other than PCBs Analyzed
						1	2	590	µg/kg dw	Yes	4.5	No	0.59	—	—	—	—	—	—	—	—	—		
DUW103	DSOAvertchar	3.5	2001	—	PCBs (total calc'd)	0	0.7	1600	µg/kg dw	Yes	6.7	Yes	1.2	1	1.7	610	µg/kg dw	Yes	10	Yes	1.8	162	Increase	No SMS Contaminants other than PCBs Analyzed
DR206	EPA SI	3.5	1998	1998	Bis(2-ethylhexyl) phthalate	Surface	—	280	µg/kg dw	No	0.2	No	0.12	0	2	520	µg/kg dw	Yes	1.4	No	0.85	-46	Decrease	Equilibrium
					Butyl benzyl phthalate	Surface	—	40	µg/kg dw	No	0.27	No	0.02	0	2	40	µg/kg dw	Yes	1	No	0.08	0		
					PCBs (total calc'd)	Surface	—	210	µg/kg dw	No	0.59	No	0.11	0	2	1250	µg/kg dw	Yes	13	Yes	2.5	-83		
					Total PAH (calc'd)	Surface	—	1260	µg/kg dw	—	—	—	—	0	2	2880	µg/kg dw	—	—	—	—	-56		
SD-DUW28	Plant 2 RFI-2b	3.5	1996	1995	Mercury	Surface	—	0.51	mg/kg dw	Yes	1.2	No	0.86	0	1.9	0.25	mg/kg dw	No	0.61	No	0.42	104	Equilibrium	Lack of Data Density
					PCBs (total calc'd)	Surface	—	11000	µg/kg dw	Yes	38	Yes	7.1	0	1.9	13000	µg/kg dw	Yes	49	Yes	9.1	-15		
					Total PAH (calc'd)	Surface	—	830	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-04402	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	190	µg/kg dw	No	0.58	No	0.11	0.3	1	600	µg/kg dw	Yes	4.6	No	0.6	-68	Decrease	No SMS Contaminants other than PCBs Analyzed
SD-04405	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	170	µg/kg dw	Yes	1.3	No	0.17	0.3	1.5	120	µg/kg dw	Yes	1.5	No	0.28	42	Equilibrium	No SMS Contaminants other than PCBs Analyzed
SD-04901	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	3800	µg/kg dw	Yes	39	Yes	7.2	0.3	1.5	350	µg/kg dw	Yes	3.6	No	0.66	986	Increase	No SMS Contaminants other than PCBs Analyzed
SD-04902	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	2100	µg/kg dw	Yes	39	Yes	7.2	0.3	1.5	370	µg/kg dw	Yes	3.5	No	0.65	468	Increase	No SMS Contaminants other than PCBs Analyzed
SD-04903	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	280	µg/kg dw	Yes	39	Yes	7.2	0.3	1.5	3000	µg/kg dw	Yes	23	Yes	3	-91	Decrease	No SMS Contaminants other than PCBs Analyzed
SD-04904	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	10200	µg/kg dw	Yes	38	Yes	7.1	0.3	1.5	8300	µg/kg dw	Yes	32	Yes	5.8	23	Equilibrium	No SMS Contaminants other than PCBs Analyzed
SD-04905	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	26000	µg/kg dw	Yes	70	Yes	13	0.3	1.5	890000	µg/kg dw	Yes	2400	Yes	450	-97	Decrease	No SMS Contaminants other than PCBs Analyzed
SD-04920	Plant 2 RFI-1	3.5	1995	1995	PCBs (total calc'd)	Surface	—	2300	µg/kg dw	Yes	7.1	Yes	1.3	0.3	2	950	µg/kg dw	Yes	3.6	No	0.66	142	Increase	No SMS Contaminants other than PCBs Analyzed
SD-201	Jorgensen April 2004	3.6	2004	—	PCBs (total calc'd)	0	1	340	µg/kg dw	Yes	1.3	No	0.25	1	2	2500	µg/kg dw	Yes	8.3	Yes	1.5	-86	Decrease	Below SQS
SD-202	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-203	Jorgensen April 2004	3.6	2004	—	PCBs (total calc'd)	0	1	7100	µg/kg dw	Yes	43	Yes	7.8	1	2	6500	µg/kg dw	Yes	52	Yes	9.5	9	Equilibrium	Decrease
					Zinc	0	1	183	mg/kg dw	No	0.45	No	0.19	1	2	567	mg/kg dw	Yes	1.4	No	0.59	-68		
SD-204	Jorgensen April 2004	3.6	2004	—	PCBs (total calc'd)	0	1	125	µg/kg dw	No	0.46	No	0.085	1	2	240	µg/kg dw	Yes	1.1	No	0.2	-48	Equilibrium	Below SQS
SD-205	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-205D	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-206	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-207	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-208	Jorgensen April 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	340	µg/kg dw	Yes	1.9	No	0.35	0	1	94	µg/kg dw	No	0.4	No	0.074	262	Increase	Below SQS
						1	2	137	µg/kg dw	No	0.58	No	0.11	—	—	—	—	—	—	—	—	—		
SD-213	Jorgensen April 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	610	µg/kg dw	Yes	2.3	No	0.43	0	1	35	µg/kg dw	No	0.13	No	0.025	1643	Increase	Below SQS
						1	2	186	µg/kg dw	No	0.74	No	0.14	—	—	—	—	—	—	—	—	—		
SD-215	Jorgensen April 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	880	µg/kg dw	Yes	4.5	No	0.83	0	1	121	µg/kg dw	No	0.51	No	0.094	627	Increase	Below SQS
						1	2	420	µg/kg dw	Yes	1.6	No	0.29	—	—	—	—	—	—	—	—	—		
SD-301	Jorgensen April 2004	3.6	2004	—	Mercury	0	1	0.22	mg/kg dw	No	0.54	No	0.37	1	2	0.43	mg/kg dw	Yes	1	No	0.73	-49	Decrease	Equilibrium
					PCBs (total calc'd)	0	1	550	µg/kg dw	Yes	2.6	No	0.48	1	2	1340	µg/kg dw	Yes	7	Yes	1.3	-59		
					Zinc	0	1	243	mg/kg dw	No	0.59	No	0.25	1	2	1050	mg/kg dw	Yes	2.6	Yes	1.1	-77		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
SD-302	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-303	Jorgensen April 2004	3.6	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-317-C	Jorgensen August 2004	3.6	2004	1998	PCBs (total calc'd)	Surface	—	75	µg/kg dw	No	0.32	No	0.058	1	2	1529	µg/kg dw	Yes	6.4	Yes	1.2	-95	Decrease	Lack of Data Density
					Total PAH (calc'd)	Surface	—	6100	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-318-C	Jorgensen August 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	930	µg/kg dw	Yes	3.8	No	0.69	0	1.5	6.5	µg/kg dw	No	0.13	No	0.025	7054	Increase	Lack of Data Density
					Phenol	Surface	—	800	µg/kg dw	Yes	1.9	No	0.7	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	6900	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-319-C	Jorgensen August 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	3100	µg/kg dw	Yes	15	Yes	2.8	1	2	120	µg/kg dw	No	0.56	No	0.1	2483	Increase	Lack of Data Density
					Total PAH (calc'd)	Surface	—	860	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-321-C	Jorgensen August 2004	3.6	2004	2004	PCBs (total calc'd)	Surface	—	570	µg/kg dw	Yes	2.1	No	0.38	1	2	750	µg/kg dw	Yes	3.7	No	0.68	-24	Equilibrium	Lack of Data Density
					Total PAH (calc'd)	Surface	—	1310	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-DUW158	Plant 2-Transformer Phase 1	3.6	2003	1997	PCBs (total calc'd)	Surface	—	1700	µg/kg dw	Yes	7	Yes	1.3	0	1	5000	µg/kg dw	Yes	23	Yes	4.3	-66	Decrease	Lack of Data Density
SD-DUW165	Plant 2-Transformer Phase 1	3.6	2003	1996	PCBs (total calc'd)	Surface	—	2700	µg/kg dw	Yes	10	Yes	1.8	0	0.7	4800	µg/kg dw	Yes	17	Yes	3.1	-44	Equilibrium	Lack of Data Density
					Zinc	Surface	—	3500	mg/kg dw	Yes	8.5	Yes	3.6	—	—	—	—	—	—	—	—	—		
T117-SE-15-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	132	µg/kg dw	No	0.48	No	0.088	0	1	310	µg/kg dw	Yes	1.3	No	0.25	-57	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	2	320	µg/kg dw	Yes	1.4	No	0.26	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	767	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
T117-SE-16-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	2800	µg/kg dw	Yes	13	Yes	2.5	0	0.9	3400	µg/kg dw	Yes	17	Yes	3.1	-18	Equilibrium	No SMS Contaminants other than PCBs Analyzed
						0.9	1.3	2900	µg/kg dw	Yes	12	Yes	2.2	1.3	2	590	µg/kg dw	Yes	3.5	No	0.65	—		
T117-SE-17-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	12000	µg/kg dw	Yes	46	Yes	8.5	0	1	3700	µg/kg dw	Yes	16	Yes	2.9	224	Increase	No SMS Contaminants other than PCBs Analyzed
						1	2	3200	µg/kg dw	Yes	13	Yes	2.3	—	—	—	—	—	—	—	—	—		
T117-SE-20-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	1300	µg/kg dw	Yes	8.3	Yes	1.5	0	1	2800	µg/kg dw	Yes	21	Yes	3.8	-54	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	2	420	µg/kg dw	Yes	2.5	No	0.46	—	—	—	—	—	—	—	—	—		
T117-SE-21-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	38000	µg/kg dw	Yes	180	Yes	34	0	1	16000	µg/kg dw	Yes	63	Yes	12	138	Increase	No SMS Contaminants other than PCBs Analyzed
						1	2	280	µg/kg dw	Yes	1.3	No	0.25	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	3700	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
T117-SE-23-SC	T-117 Boundary Definition	3.6	2003	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	No SMS Contaminants other than PCBs Analyzed
T117-SE-24-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	3500	µg/kg dw	Yes	19	Yes	3.5	0	1	1310	µg/kg dw	Yes	9.2	Yes	1.7	167	Increase	No SMS Contaminants other than PCBs Analyzed
						1	2	122	µg/kg dw	No	0.83	No	0.15	—	—	—	—	—	—	—	—	—		
T117-SE-25-SC	T-117 Boundary Definition	3.6	2003	2003	Acenaphthene	Surface	—	250	µg/kg dw	Yes	1.1	No	0.32	—	—	—	—	—	—	—	—	—	Increase	No SMS Contaminants other than PCBs Analyzed
					Indeno(1,2,3-cd) pyrene	Surface	—	520	µg/kg dw	Yes	1.1	No	0.42	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	4000	µg/kg dw	Yes	24	Yes	4.5	0	1	2000	µg/kg dw	Yes	22	Yes	4	100		
						1	2	380	µg/kg dw	Yes	1.6	No	0.29	—	—	—	—	—	—	—	—	—		
					Phenanthrene	Surface	—	1900	µg/kg dw	Yes	1.4	No	0.29	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	11900	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
T117-SE-30-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	320	µg/kg dw	Yes	1.6	No	0.29	0	1	990	µg/kg dw	Yes	6.9	Yes	1.3	-68	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	2	158	µg/kg dw	No	1	No	0.18	—	—	—	—	—	—	—	—	—		
T117-SE-31-SC	T-117 Boundary Definition	3.6	2003	—	PCBs (total calc'd)	0	1	51000	µg/kg dw	Yes	220	Yes	40	1	2	26	µg/kg dw	No	0.14	No	0.026	196054	Increase	Below SQS
T117-SE-35-SC	T-117 Boundary Definition	3.6	2003	2003	PCBs (total calc'd)	Surface	—	47	µg/kg dw	No	0.17	No	0.031	0	1	135	µg/kg dw	No	0.53	No	0.098	-65	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	2	480	µg/kg dw	Yes	2.1	No	0.38	—	—	—	—	—	—	—	—	—		
T117-SE-36-SC	T-117 Boundary Definition	3.6	2003	2003	Total PAH (calc'd)	Surface	—	1314	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	No SMS Contaminants other than PCBs Analyzed
T117-SE-37-SC	T-117 Boundary Definition	3.6	2003	2003	2-Methyl-naphthalene	Surface	—	1400	µg/kg dw	Yes	1.9	Yes	1.2	1	2	10	µg/kg dw	No	0.03	No	0.014	6900	Equilibrium	Increase
					Acenaphthene	Surface	—	3900	µg/kg dw	Yes	13	Yes	3.7	1	2	10	µg/kg dw	No	0.04	No	0.027	19400		
					Anthracene	Surface	—	4300	µg/kg dw	Yes	1	No	0.19	1	2	10	µg/kg dw	No	0.021	No	0.0045	21400		
					Benzo(a) anthracene	Surface	—	8400	µg/kg dw	Yes	4	Yes	1.6	1	2	10	µg/kg dw	No	0.015	No	0.013	41900		
					Benzo(a)pyrene	Surface	—	7900	µg/kg dw	Yes	4.2	Yes	2	1	2	10	µg/kg dw	No	0.013	No	0.0067	39400		
					Benzo(g,h,i) perylene	Surface	—	1200	µg/kg dw	Yes	2	No	0.81	—	—	—	—	—	—	—	—	—		
					Benzofluoranthenes (total-calc'd)	Surface	—	17000	µg/kg dw	Yes	3.9	Yes	2	1	2	10	µg/kg dw	No	0.0063	No	0.0056	84900		
					Chrysene	Surface	—	7700	µg/kg dw	Yes	3.7	No	0.89	1	2	10	µg/kg dw	No	0.014	No	0.0071	38400		
					Dibenzo(a,h) anthracene	Surface	—	640	µg/kg dw	Yes	2.8	Yes	1	1	2	10	µg/kg dw	No	0.087	No	0.037	3100		
					Dibenzofuran	Surface	—	4200	µg/kg dw	Yes	15	Yes	3.8	1	2	10	µg/kg dw	No	0.037	No	0.029	20900		
					Fluoranthene	Surface	—	24000	µg/kg dw	Yes	8.1	Yes	1.1	1	2	10	µg/kg dw	No	0.012	No	0.008	119900		
					Fluorene	Surface	—	5500	µg/kg dw	Yes	13	Yes	3.7	1	2	10	µg/kg dw	No	0.037	No	0.02	27400		
					Indeno(1,2,3-cd) pyrene	Surface	—	1900	µg/kg dw	Yes	2.9	Yes	1.1	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	4300	µg/kg dw	Yes	19	Yes	3.5	0	1	3100	µg/kg dw	Yes	24	Yes	3.1	39		
						1	2	9.5	µg/kg dw	No	0.15	No	0.019	—	—	—	—	—	—	—	—	—		
					Phenanthrene	Surface	—	28000	µg/kg dw	Yes	15	Yes	3.1	1	2	10	µg/kg dw	No	0.013	No	0.0037	139900		
					Total HPAH (calc'd)	Surface	—	85000	µg/kg dw	Yes	4.7	No	0.85	1	2	10	µg/kg dw	No	0.0017	No	0.0012	424900		
					Total LPAH (calc'd)	Surface	—	43000	µg/kg dw	Yes	6.2	Yes	2.9	1	2	10	µg/kg dw	No	0.0038	No	0.0015	214900		
					Total PAH (calc'd)	Surface	—	128000	µg/kg dw	—	—	—	—	1	2	10	µg/kg dw	—	—	—	—	639900		
SD-209	Jorgensen April 2004	3.7	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-210	Jorgensen April 2004	3.7	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concentration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
SD-210D	Jorgensen April 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	130	µg/kg dw	No	0.41	No	0.075	0	1	10	µg/kg dw	No	0.1	No	0.018	550	Increase	Below SQS
						1	2	300	µg/kg dw	Yes	1.3	No	0.25	—	—	—	—	—	—	—	—	—		
SD-211	Jorgensen April 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	610	µg/kg dw	Yes	2.3	No	0.43	0	1	1170	µg/kg dw	Yes	4.9	No	0.91	-48	Equilibrium	Below SQS
						1	2	670	µg/kg dw	Yes	2.9	No	0.54	—	—	—	—	—	—	—	—	—		
SD-212	Jorgensen April 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	48.9	µg/kg dw	No	0.18	No	0.032	0	1	26	µg/kg dw	No	0.11	No	0.02	88	Increase	Below SQS
						1	2	230	µg/kg dw	Yes	1.2	No	0.22	—	—	—	—	—	—	—	—	—		
SD-214	Jorgensen April 2004	3.7	2004	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	Below SQS
SD-216	Jorgensen April 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	360	µg/kg dw	Yes	1.5	No	0.28	0	1	62	µg/kg dw	No	0.33	No	0.06	481	Increase	Below SQS
						1	2	230	µg/kg dw	Yes	1.3	No	0.23	—	—	—	—	—	—	—	—	—		
SD-217	Jorgensen April 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	293	µg/kg dw	Yes	1.3	No	0.24	0	0.9	400	µg/kg dw	Yes	1.9	No	0.35	-27	Equilibrium	Below SQS
						1	1.9	690	µg/kg dw	Yes	3.8	No	0.71	—	—	—	—	—	—	—	—	—		
SD-312-C	Jorgensen August 2004	3.7	2004	2004	Dibenzofuran	Surface	—	460	µg/kg dw	Yes	1.2	No	0.31	—	—	—	—	—	—	—	—	—	Equilibrium	Decrease
					Fluorene	Surface	—	940	µg/kg dw	Yes	1.6	No	0.46	—	—	—	—	—	—	—	—	—		
					Lead	Surface	—	196	mg/kg dw	No	0.44	No	0.37	1	2	514	mg/kg dw	Yes	1.1	No	0.97	-62		
					PCBs (total calc'd)	Surface	—	1200	µg/kg dw	Yes	3.9	No	0.72	1	2	1870	µg/kg dw	Yes	14	Yes	2.6	-36		
					Phenanthrene	Surface	—	3800	µg/kg dw	Yes	1.5	No	0.31	—	—	—	—	—	—	—	—	—		
					Phenol	Surface	—	610	µg/kg dw	Yes	1.5	No	0.51	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	17400	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
					Zinc	Surface	—	174	mg/kg dw	No	0.42	No	0.18	1	2	457	mg/kg dw	Yes	1.1	No	0.48	-62		
SD-314-C	Jorgensen August 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	760	µg/kg dw	Yes	3.8	No	0.69	1	2	10	µg/kg dw	No	0.067	No	0.012	3700	Increase	Lack of Data Density
					Total PAH (calc'd)	Surface	—	5600	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-315-C	Jorgensen August 2004	3.7	2004	2004	Butyl benzyl phthalate	Surface	—	140	µg/kg dw	Yes	1.8	No	0.14	—	—	—	—	—	—	—	—	—	Increase	Lack of Data Density
					PCBs (total calc'd)	Surface	—	260	µg/kg dw	Yes	1.4	No	0.26	1	2	11.3	µg/kg dw	No	0.17	No	0.023	1050		
					Total PAH (calc'd)	Surface	—	10300	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-320-C	Jorgensen August 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	8900	µg/kg dw	Yes	46	Yes	8.5	1	2	1480	µg/kg dw	Yes	5.5	Yes	1	501	Increase	Lack of Data Density
					Total PAH (calc'd)	Surface	—	1850	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-322-C	Jorgensen August 2004	3.7	2004	2004	PCBs (total calc'd)	Surface	—	110	µg/kg dw	No	0.45	No	0.083	1	2	960	µg/kg dw	Yes	4.3	No	0.78	-89	Decrease	Lack of Data Density
					Total PAH (calc'd)	Surface	—	1400	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SD-323-C	Jorgensen August 2004	3.7	2004	2005	Lead	Surface	—	870	mg/kg dw	Yes	1.9	Yes	1.6	1	2	171	mg/kg dw	No	0.38	No	0.32	409	Increase	Increase
					PCBs (total calc'd)	Surface	—	13000	µg/kg dw	Yes	48	Yes	8.9	1	2	792	µg/kg dw	Yes	4.2	No	0.77	1541		
						1	2	285	µg/kg dw	Yes	1.4	No	0.27	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	2240	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
T117-SE-42-SC	T-117 Boundary Definition	3.7	2003	2003	PCBs (total calc'd)	Surface	—	136	µg/kg dw	No	0.49	No	0.091	0	1	470	µg/kg dw	Yes	3	No	0.55	-71	Decrease	No SMS Contaminants other than PCBs Analyzed
						1	2	47	µg/kg dw	No	0.24	No	0.045	—	—	—	—	—	—	—	—	—		
T117-SE-43-SC	T-117 Boundary Definition	3.7	2003	—	No SQS Exceedances	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Below SQS	No SMS Contaminants other than PCBs Analyzed
LDW-SC50a	LDW Subsurface Sediment 2006	3.8	2006	2005	Arsenic	Surface	—	1100	mg/kg dw	Yes	19	Yes	12	0	1	707	mg/kg dw	Yes	12	Yes	7.6	56	Increase	Increase
						1	2	281	mg/kg dw	Yes	4.9	Yes	3	—	—	—	—	—	—	—	—	—		
					Bis(2-ethylhexyl) phthalate	Surface	—	1200	µg/kg dw	Yes	1.7	No	1	0	1	680	µg/kg dw	Yes	2.3	Yes	1.4	76		
						1	2	64	µg/kg dw	No	0.17	No	0.1	—	—	—	—	—	—	—	—	—		
					Chrysene	Surface	—	1900	µg/kg dw	Yes	1.1	No	0.26	0	1	330	µg/kg dw	No	0.47	No	0.11	476		
						1	2	160	µg/kg dw	No	0.18	No	0.043	—	—	—	—	—	—	—	—	—		
					Fluoranthene	Surface	—	3100	µg/kg dw	Yes	1.3	No	0.17	0	1	770	µg/kg dw	No	0.75	No	0.1	303		
						1	2	200	µg/kg dw	No	0.16	No	0.021	—	—	—	—	—	—	—	—	—		
					Indeno(1,2,3-cd) pyrene	Surface	—	560	µg/kg dw	Yes	1.1	No	0.42	0	1	100	µg/kg dw	No	0.47	No	0.18	460		
						1	2	35	µg/kg dw	No	0.13	No	0.049	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	Surface	—	820	µg/kg dw	Yes	4.5	No	0.83	0	1	510	µg/kg dw	Yes	6.8	Yes	1.2	61		
						1	2	780	µg/kg dw	Yes	8	Yes	1.5	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	15600	µg/kg dw	—	—	—	—	0	1	3410	µg/kg dw	—	—	—	—	357		
						1	2	1110	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
LDW-SC51	LDW Subsurface Sediment 2006	3.8	2006	2005	Acenaphthene	0	0.5	350	µg/kg dw	Yes	1.4	No	0.39	0.5	1	180	µg/kg dw	No	0.69	No	0.19	94	Decrease	Mixed
						1	1.5	250	µg/kg dw	No	0.5	No	0.34	1.5	2	84	µg/kg dw	No	0.81	No	0.23	—		
					Benzo(g,h,i) perylene	0	0.5	590	µg/kg dw	Yes	1.2	No	0.47	0.5	1	130	µg/kg dw	No	0.25	No	0.1	354		
						1	1.5	31	µg/kg dw	No	0.093	No	0.086	1.5	2	31	µg/kg dw	No	0.31	No	0.12	—		
					Benzyl alcohol	0	0.5	180	µg/kg dw	Yes	3.2	Yes	2.5	0.5	1	15	µg/kg dw	No	0.53	No	0.41	500		
						1	1.5	15.5	µg/kg dw	No	0.54	No	0.42	1.5	2	15.5	µg/kg dw	No	0.54	No	0.42	—		
					Bis(2-ethylhexyl) phthalate	0	0.5	970	µg/kg dw	Yes	1.3	No	0.77	0.5	1	1800	µg/kg dw	Yes	2.3	Yes	1.4	-46		
						1	1.5	31	µg/kg dw	No	0.048	No	0.033	1.5	2	75	µg/kg dw	No	0.26	No	0.15	—		
					Chrysene	0	0.5	1900	µg/kg dw	Yes	1.1	No	0.26	0.5	1	490	µg/kg dw	No	0.27	No	0.065	288		
						1	1.5	120	µg/kg dw	No	0.086	No	0.043	1.5	2	67	µg/kg dw	No	0.091	No	0.022	—		
					Dibenzo(a,h) anthracene	0	0.5	160	µg/kg dw	No	0.83	No	0.3	0.5	1	38	µg/kg dw	No	0.19	No	0.07	321		
						1	1.5	4.3	µg/kg dw	No	0.019	No	0.008	1.5	2	3.7	µg/kg dw	No	0.048	No	0.018	—		
					Dibenzofuran	0	0.5	230	µg/kg dw	No	0.93	No	0.24	0.5	1	89	µg/kg dw	No	0.36	No	0.093	158		
						1	1.5	130	µg/kg dw	No	0.24	No	0.19	1.5	2	92	µg/kg dw	No	0.93	No	0.24	—		
					Fluoranthene	0	0.5	4000	µg/kg dw	Yes	1.6	No	0.21	0.5	1	1200	µg/kg dw	No	0.46	No	0.061	233		
						1	1.5	720	µg/kg dw	No	0.42	No	0.29	1.5	2	730	µg/kg dw	No	0.69	No	0.092	—		
					Indeno(1,2,3-cd) pyrene	0	0.5	690	µg/kg dw	Yes	1.3	No	0.49	0.5	1	160	µg/kg dw	No	0.29	No	0.11	331		
						1	1.5	31	µg/kg dw	No	0.1	No	0.09	1.5	2	31	µg/kg dw	No	0.28	No	0.11	—		
					PCBs (total calc'd)	Surface	—	220	µg/kg dw	No	0.92	No	0.17	0	2	1290	µg/kg dw	Yes	7.3	Yes	1.4	-83		
					Phenanthrene	0	0.5	2300	µg/kg dw	Yes	1.4	No	0.29	0.5	1	840	µg/kg dw	No	0.51	No	0.11	174		
						1	1.5	120	µg/kg dw	No	0.08	No	0.022	1.5	2	97	µg/kg dw	No	0.15	No	0.031	—		
					Total HPAH (calc'd)	0	0.5	16100	µg/kg dw	Yes	1	No	0.19	0.5	1	4500	µg/kg dw	No	0.28	No	0.051	258		
						1	1.5	1570	µg/kg dw	No	0.13	No	0.092	1.5	2	1380	µg/kg dw	No	0.22	No	0.04	—		
					Total PAH (calc'd)	0	0.5	19900	µg/kg dw	—	—	—	—	0.5	1	5800	µg/kg dw	—	—	—	—	243		
						1	1.5	1990	µg/kg dw	—	—	—	—	1.5	2	1600	µg/kg dw	—	—	—	—	—		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
DR220	EPA SI	3.8	1998	1998	PCBs (total calc'd)	Surface	—	77	µg/kg dw	No	0.23	No	0.043	0	2	830	µg/kg dw	Yes	2.8	No	0.52	-91	Decrease	Below SQS
					Total PAH (calc'd)	Surface	—	1710	µg/kg dw	—	—	—	—	0	2	860	µg/kg dw	—	—	—	—	99		
AN-042	8801 EMW Core 2008	3.9	2008	—	Butyl benzyl phthalate	0	1	130	µg/kg dw	Yes	1.7	No	0.13	—	—	—	—	—	—	—	—		Equilibrium	No SMS Contaminants other than PCBs Analyzed
					PCBs (total calc'd)	0	1	1500	µg/kg dw	Yes	8.1	Yes	1.5	1	2	1400	µg/kg dw	Yes	5.6	Yes	1	7.14		
AN-043	8801 EMW Core 2008	3.9	2008	—	Butyl benzyl phthalate	0	1	57	µg/kg dw	Yes	1.1	No	0.084	—	—	—	—	—	—	—	—		Decrease	Decrease
					PCBs (total calc'd)	0	1	270	µg/kg dw	Yes	2.1	No	0.38	1	2	1800	µg/kg dw	Yes	5.3	No	0.97	-85.00		
					2,4-Dimethylphenol	—	—	—	—	—	—	—	—	1	2	54	µg/kg dw	Yes	1.9	Yes	1.9			
					Cadmium	0	1	0.6	mg/kg dw	No	0.12	No	0.09	1	2	16.9	mg/kg dw	Yes	3.3	Yes	2.5	-96.45		
					Chromium	0	1	30	mg/kg dw	No	0.12	No	0.11	1	2	514	mg/kg dw	Yes	2	Yes	1.9	-94.16		
					Lead	0	1	1	mg/kg dw	No	0.0022	No	0.0019	1	2	2530	mg/kg dw	Yes	5.6	Yes	4.8	-99.96		
					Mercury	0	1	0.09	mg/kg dw	No	0.22	No	0.15	1	2	1.51	mg/kg dw	Yes	3.7	Yes	2.6	-94.04		
					Zinc	0	1	112	mg/kg dw	No	0.27	No	0.12	1	2	1250	mg/kg dw	Yes	3	Yes	1.3	-91.04		
AN-044	8801 EMW Core 2008	3.9	2008	—	Butyl benzyl phthalate	0	1	240	µg/kg dw	Yes	2	No	0.16	1	2	8	µg/kg dw	No	0.15	No	0.012	2900.00	Increase	Increase
					PCBs (total calc'd)	0	1	3000	µg/kg dw	Yes	11	Yes	2	1	2	420	µg/kg dw	Yes	1.4	No	0.26	614		
LDW-SC52	LDW Subsurface Sediment 2006	3.9	2006	—	2-Methylphenol	0	1	160	µg/kg dw	Yes	2.5	Yes	2.5	1	2	6	µg/kg dw	No	0.19	No	0.19	1233	Increase	Increase
					Butyl benzyl phthalate	0	1	610	µg/kg dw	Yes	5.3	No	0.41	1	2	6	µg/kg dw	No	0.09	No	0.0069	4983		
					Mercury	0	1	0.67	mg/kg dw	Yes	1.6	Yes	1.1	1	2	0.25	mg/kg dw	No	0.61	No	0.42	168		
					PCBs (total calc'd)	0	1	3000	µg/kg dw	Yes	11	Yes	2	1	2	65	µg/kg dw	No	0.2	No	0.037	4515		
AN-041	8801 EMW Core 2008	4	2008	—	PCBs (total calc'd)	0	1	1060	µg/kg dw	Yes	5.6	Yes	1	1	2	210	µg/kg dw	No	1	No	0.18	405	Increase	No SMS Contaminants other than PCBs Analyzed
SB-12	Rhône Poulenc 2004	4.1	2004	2004	Benzoic acid	Surface	—	1300	µg/kg dw	Yes	2	Yes	2	0.33	0.69	1300	µg/kg dw	Yes	2	Yes	2	0	Below SQS	Mixed
					Bis(2-ethylhexyl) phthalate	0.33	0.69	550	µg/kg dw	Yes	1.3	No	0.78	—	—	—	—	—	—	—	—	—		
					Dibenzo(a,h) anthracene	Surface	—	420	µg/kg dw	Yes	2.2	No	0.79	0.33	0.69	380	µg/kg dw	Yes	1.8	No	0.64	11		
					Di-n-octyl phthalate	0.33	0.69	550	µg/kg dw	Yes	1.1	No	0.014	—	—	—	—	—	—	—	—	—		
					Fluoranthene	Surface	—	5300	µg/kg dw	Yes	2.1	No	0.28	0.33	0.69	2700	µg/kg dw	No	0.94	No	0.13	96		
					Pentachloro-phenol	0.33	0.69	1150	µg/kg dw	Yes	6.4	Yes	3.3	—	—	—	—	—	—	—	—	—		
					Total HPAH (calc'd)	Surface	—	16100	µg/kg dw	Yes	1	No	0.19	0.33	0.69	11100	µg/kg dw	No	0.65	No	0.12	45		
					Total PAH (calc'd)	Surface	—	17200	µg/kg dw	—	—	—	—	0.33	0.69	11500	µg/kg dw	—	—	—	—	50		
SH-03	Rhône Poulenc 2004	4.1	2004	2004	Benzoic acid	Surface	—	940	µg/kg dw	Yes	1.4	Yes	1.4	0.33	0.82	800	µg/kg dw	Yes	2.5	Yes	2.5	-41	Below SQS	Mixed
						0.33	0.82	800	µg/kg dw	Yes	2.5	Yes	2.5	—	—	—	—	—	—	—	—	—		
					Dibenzo(a,h) anthracene	Surface	—	220	µg/kg dw	No	0.96	No	0.41	0.33	0.82	405	µg/kg dw	Yes	3.5	Yes	1.5	-73		
					Dibenzo(a,h) anthracene	0.33	0.82	410	µg/kg dw	Yes	3.6	Yes	1.5	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	1080	µg/kg dw	—	—	—	—	0.33	0.82	405	µg/kg dw	—	—	—	—	33		
						0.33	0.82	410	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
SH-06	Rhône Poulenc 2004	4.1	2004	2004	Benzoic acid	Surface	—	840	µg/kg dw	Yes	1.3	Yes	1.3	0.33	0.82	750	µg/kg dw	Yes	2.3	Yes	2.3	-44	Increase	Equilibrium
					PCBs (total calc'd)	Surface	—	94	µg/kg dw	Yes	1.6	No	0.29	0.33	0.82	44	µg/kg dw	No	0.34	No	0.044	114		
					Total PAH (calc'd)	Surface	—	370	µg/kg dw	—	—	—	—	0.33	0.82	370	µg/kg dw	—	—	—	—	-50		
DR284	EPA SI	4.1	1998	—	Total HPAH (calc'd)	Surface	—	1530	µg/kg dw	No	0.071	No	0.013	0	2	1630	µg/kg dw	No	0.076	No	0.014	7	Below SQS	Below SQS
					Total LPAH (calc'd)	Surface	—	210	µg/kg dw	No	0.025	No	0.012	0	2	130	µg/kg dw	No	0.016	No	0.0074	-56		
SB-1	Rhône Poulenc 2004	4.2	2004	2004	Benzo(g,h,i) perylene	Surface	—	1100	µg/kg dw	Yes	1.3	No	0.51	0.33	0.69	860	µg/kg dw	Yes	1.1	No	0.44	28	Lack of Data Density	Equilibrium
					Benzoic acid	0.33	0.69	1350	µg/kg dw	Yes	4.2	Yes	4.2	—	—	—	—	—	—	—	—	—		
					Bis(2-ethylhexyl) phthalate	Surface	—	1600	µg/kg dw	Yes	1.3	No	0.76	0.33	0.69	1600	µg/kg dw	Yes	1.4	No	0.82	0		
					Dibenzo(a,h) anthracene	Surface	—	700	µg/kg dw	Yes	2.2	No	0.79	0.33	0.69	630	µg/kg dw	Yes	2.1	No	0.76	11		
					Fluoranthene	Surface	—	4800	µg/kg dw	Yes	1.1	No	0.15	0.33	0.69	3500	µg/kg dw	No	0.88	No	0.12	37		
					Indeno(1,2,3-cd) pyrene	Surface	—	1200	µg/kg dw	Yes	1.3	No	0.5	0.33	0.69	970	µg/kg dw	Yes	1.1	No	0.44	24		
					Total PAH (calc'd)	Surface	—	22300	µg/kg dw	—	—	—	—	0.33	0.69	17100	µg/kg dw	—	—	—	—	30		
SB-3	Rhône Poulenc 2004	4.2	2004	2004	Benzoic acid	0.33	0.69	2000	µg/kg dw	Yes	3.1	Yes	3.1	—	—	—	—	—	—	—	—	—	Lack of Data Density	Mixed
					Bis(2-ethylhexyl) phthalate	Surface	—	2100	µg/kg dw	Yes	1.6	No	0.99	0.33	0.69	2100	µg/kg dw	Yes	1.5	No	0.91	0		
					Dibenzo(a,h) anthracene	Surface	—	630	µg/kg dw	Yes	1.9	No	0.7	0.33	0.69	540	µg/kg dw	Yes	1.5	No	0.55	17		
					Indeno(1,2,3-cd) pyrene	Surface	—	950	µg/kg dw	Yes	1	No	0.4	0.33	0.69	800	µg/kg dw	No	0.79	No	0.31	19		
					Phenol	Surface	—	1400	µg/kg dw	Yes	3.3	Yes	1.2	0.33	0.69	3100	µg/kg dw	Yes	7.4	Yes	2.6	-55		
					Total PAH (calc'd)	Surface	—	15900	µg/kg dw	—	—	—	—	0.33	0.69	12400	µg/kg dw	—	—	—	—	28		
SB-4	Rhône Poulenc 2004	4.2	2004	2004	Benzoic acid	Surface	—	1900	µg/kg dw	Yes	2.9	Yes	2.9	0.33	0.69	1700	µg/kg dw	Yes	2.6	Yes	2.6	12	Lack of Data Density	Mixed
					Bis(2-ethylhexyl) phthalate	Surface	—	1900	µg/kg dw	Yes	1.3	No	0.77	0.33	0.69	1700	µg/kg dw	Yes	1	No	0.63	12		
					Dibenzo(a,h) anthracene	Surface	—	460	µg/kg dw	Yes	1.3	No	0.45	0.33	0.69	490	µg/kg dw	Yes	1.2	No	0.42	-6		
					Phenol	Surface	—	1400	µg/kg dw	Yes	3.3	Yes	1.2	0.33	0.69	140	µg/kg dw	No	0.67	No	0.23	400		
					Total PAH (calc'd)	Surface	—	7500	µg/kg dw	—	—	—	—	0.33	0.69	8000	µg/kg dw	—	—	—	—	-6		
SB-5	Rhône Poulenc 2004	4.2	2004	—	Benzoic acid	0.33	0.69	1800	µg/kg dw	Yes	2.8	Yes	2.8	—	—	—	—	—	—	—	—	—	Equilibrium	Lack of Data Density
					PCBs (total calc'd)	Surface	—	150	µg/kg dw	Yes	1.2	No	0.15	0.33	0.69	190	µg/kg dw	No	0.55	No	0	-21		
					Pentachlorophenol	0.33	0.69	1350	µg/kg dw	Yes	8.5	Yes	4.9	—	—	—	—	—	—	—	—	—		
SB-8	Rhône Poulenc 2004	4.2	2004	2004	Benzoic acid	Surface	—	1700	µg/kg dw	Yes	2.6	Yes	2.6	0.33	0.69	1500	µg/kg dw	Yes	2.3	Yes	2.3	13	Lack of Data Density	Equilibrium
					Dibenzo(a,h) anthracene	Surface	—	440	µg/kg dw	Yes	1.3	No	0.45	0.33	0.69	410	µg/kg dw	Yes	1.4	No	0.52	7		
					Total PAH (calc'd)	Surface	—	4610	µg/kg dw	—	—	—	—	0.33	0.69	4560	µg/kg dw	—	—	—	—	1		
SH-09	Rhône Poulenc 2004	4.2	2004	2004	Total PAH (calc'd)	Surface	—	410	µg/kg dw	—	—	—	—	0.33	0.82	490	µg/kg dw	—	—	—	—	-16	Below SQS	Below SQS
DR246	EPA SI	4.2	1998	1998	Total PAH (calc'd)	Surface	—	1930	µg/kg dw	—	—	—	—	0	2	1860	µg/kg dw	—	—	—	—	4	Lack of Data Density	Below SQS
DR269	EPA SI	4.6	1998	1998	Total PAH (calc'd)	Surface	—	880	µg/kg dw	—	—	—	—	0	2	1090	µg/kg dw	—	—	—	—	-19	Lack of Data Density	Below SQS
LDW-SC55	LDW Subsurface Sediment 2006	4.9	2006	2005	PCBs (total calc'd)	Surface	—	2700	µg/kg dw	Yes	33	Yes	6	0	1	13.5	µg/kg dw	No	0.075	No	0.014	19900	Increase	Below SQS
						1	2	1.95	µg/kg dw	No	0.047	No	0.0086	—	—	—	—	—	—	—	—	—		
					Total PAH (calc'd)	Surface	—	550	µg/kg dw	—	—	—	—	0	1	24	µg/kg dw	—	—	—	—	2192		
						1	2	10	µg/kg dw	—	—	—	—	—	—	—	—	—	—	—	—	—		
NFK008	Norfolk-cleanup2	4.9	1995	—	Mercury	0	0.98	0.16	mg/kg dw	No	0.39	No	0.27	0.98	1.97	37	mg/kg dw	Yes	90	Yes	63	-100	Decrease	Decrease
					PCBs (total calc'd)	0	0.98	710	µg/kg dw	Yes	3.1	No	0.57	0.98	1.97	81700	µg/kg dw	Yes	330	Yes	60	-99		

Table F-8 SMS Contaminant Trends by Depth in the Top Two Intervals of Cores

						Shallow Sediment / Top Layer								Deeper Sediment									Core Trend for:	
Core Location Name	Event Name	River Mile	Year Core Collected	Year Surface Grab Collected, if Used[a]	SMS Contaminant with Detected SQS Exceedance (and Total PAHs)	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Upper Depth (ft)	Lower Depth (ft)	Concen-tration or Half if Undetected	Units	Exceeds SQS?	SQS Exceedance Factor	Exceeds CSL?	CSL Exceedance Factor	Percent Change for SMS Contaminant	Total PCBs	Other SMS Contaminants
NFK207	Norfolk-cleanup2	4.9	1995	—	1,4-Dichlorobenzene	0	0.98	750	µg/kg dw	Yes	6.8	Yes	6.3	0.98	1.97	17	µg/kg dw	No	0.15	No	0.14	4312	Below SQS	Mixed
					Bis(2-ethylhexyl) phthalate	0	0.98	1400	µg/kg dw	Yes	1.1	No	0.74	0.98	1.97	130	µg/kg dw	No	0.1	No	0.068	977		
					Butyl benzyl phthalate	0	0.98	130	µg/kg dw	Yes	2.1	No	0.14	0.98	1.97	9	µg/kg dw	No	0.29	No	0.02	622		
					Indeno(1,2,3-cd) pyrene	0	0.98	630	µg/kg dw	Yes	1.1	No	0.91	0.98	1.97	150	µg/kg dw	No	0.25	No	0.22	320		
					N-Nitrosodi-phenylamine	0	0.98	33	µg/kg dw	Yes	1.2	No	0.83	0.98	1.97	15	µg/kg dw	Yes	1.1	No	0.75	10		
NFK009	Norfolk-cleanup1	4.9	1994	—	1,4-Dichlorobenzene	0.49	0.98	1400	µg/kg dw	Yes	23	Yes	7.8	0.98	1.48	2800	µg/kg dw	Yes	160	Yes	56	-50	Increase	Mixed
						1.48	1.97	550	µg/kg dw	Yes	32	Yes	11	—	—	—	—	—	—	—	—	—		
						0	0.98	80	µg/kg dw	Yes	3.9	Yes	1.3	0.98	1.97	91	µg/kg dw	No	0.83	No	0.76	—		
					Bis(2-ethylhexyl) phthalate	0.49	0.98	390	µg/kg dw	No	0.43	No	0.26	0.98	1.48	840	µg/kg dw	Yes	3.2	Yes	1.9	-54		
						0	0.98	570	µg/kg dw	Yes	1.8	Yes	1.1	0.98	1.97	29	µg/kg dw	No	0.022	No	0.015	—		
					Butyl benzyl phthalate	1.48	1.97	93	µg/kg dw	Yes	3.5	No	0.27	—	—	—	—	—	—	—	—	—		
					Mercury	0.49	0.98	0.85	mg/kg dw	Yes	2.1	Yes	1.4	0.98	1.48	0.11	mg/kg dw	No	0.27	No	0.19	673		
						1.48	1.97	0.03	mg/kg dw	No	0.073	No	0.051	—	—	—	—	—	—	—	—	—		
						0	0.98	0.55	mg/kg dw	Yes	1.3	No	0.93	0.98	1.97	0.03	mg/kg dw	No	0.073	No	0.051	—		
					N-Nitrosodi-phenylamine	0.49	0.98	120	µg/kg dw	No	0.55	No	0.55	0.98	1.48	16	µg/kg dw	No	0.52	No	0.52	275		
						1.48	1.97	16.5	µg/kg dw	No	0.55	No	0.55	—	—	—	—	—	—	—	—	—		
					PCBs (total calc'd)	0.49	0.98	296	µg/kg dw	Yes	1.3	No	0.23	0.98	1.48	7.5	µg/kg dw	No	0.23	No	0.042	3847		
						0	0.98	247	µg/kg dw	Yes	3	No	0.55	0.98	1.97	7	µg/kg dw	No	0.11	No	0.014	—		

🟥	Greater than or equal to 50% concentration increase.
⬜	Minimal change (<50% change in concentration).
🟦	Greater than or equal to 50% concentration decrease.

Notes:

1. This table contains all cores with the appropriate sampling intervals for assessing empirical trends (165 cores). For each core, the SMS contaminants with detected SQS exceedances are included. Total PAHs are also included to provide additional information about core trends. However, total PAH trends were not used for other SMS contaminant trend assignments (last column).
2. Core locations were included if the following criteria were met: a) proper vertical resolution, and b) one or more contaminants were analyzed or suites of contaminants were analyzed, and c) the sample was not a composite sample. The following core locations were not added: DUD206, S12, SB-2, SB-6, SB-7, SB-11, SB-13, SB-17, SC08, SC09, SC10, SH-01, SH-02, SH-04, SH-05, SH-07, SH-08, T117-SE-91-SC, T117-SE-93-SC, and T117-SE-COMP4-SC.

a. A surface sediment sample was used to represent the shallow interval if it was within 10 ft of the core.

CSL = cleanup screening level; HPAH = high molecular weight polycyclic aromatic hydrocarbon; LDW = Lower Duwamish Waterway; LPAH = low molecular weight polycyclic aromatic hydrocarbon; µg/kg dw = microgram per kilogram dry weight; mg/kg dw = milligram per kilogram dry weight; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; SMS = Sediment Management Standards; SQS = sediment quality standards

Table F-9 Summary of SMS Contaminant Trends in the Top Two Intervals of Cores

SMS Contaminant	Total Number of Cores Analyzed for SMS Contaminant	Number of Cores Evaluated for SMS Contaminant (Detected SQS Exceedances)	Number of Cores with Increasing Trends	Number of Cores in Equilibrium	Number of Cores with Decreasing Trends
1,2,4-Trichlorobenzene	259	2	0	1	1
1,2-Dichlorobenzene	253	2	1	0	1
1,4-Dichlorobenzene	252	3	1	1	1
2-Methylnaphthalene	261	2	2	0	0
2-Methylphenol	258	1	1	0	0
Acenaphthene	280	6	4	1	1
Anthracene	281	2	2	0	0
Arsenic	290	8	2	3	3
Benzo(a)anthracene	281	3	2	0	1
Benzo(a)pyrene	278	4	3	0	1
Butyl benzyl phthalate	262	15	4	8	3
Bis(2-ethylhexyl)phthalate	282	17	5	9	3
Benzo(g,h,i)perylene	281	4	3	1	0
Benzofluoranthenes (total-calc'd)	281	4	3	1	0
Benzoic acid	280	9	1	8	0
Benzyl alcohol	258	9	5	1	3
Cadmium	334	4	0	2	2
Chromium	274	1	0	0	1
Chrysene	281	11	9	1	1
Copper	341	2	0	0	2
Dibenzo(a,h)anthracene	278	11	3	6	2
Dibenzofuran	267	6	4	1	1
Fluoranthene	281	16	10	3	3
Fluorene	281	5	3	1	1
Hexachlorobenzene	244	2	0	2	0
Indeno(1,2,3-cd) pyrene	281	12	7	5	0
Lead	340	7	2	1	4
Mercury	336	23	6	12	5
Naphthalene	262	1	1	0	0
N-Nitrosodiphenylamine	474	3	1	1	1
PCBs (total calc'd)	518	119	38	38	43
Phenanthrene	281	9	6	3	0
Phenol	281	5	2	2	1
Pyrene	281	2	1	1	0
Total LPAH (calc'd)	281	5	3	1	1
Total HPAH (calc'd)	281	12	8	3	1
Zinc	341	14	2	7	5

Notes:

1. See Table F-8 for data.

Increasing = Greater than or equal to 50% concentration increase.
Equilibrium = Minimal change (<50% change in concentration).
Deceasing = Greater than or equal to 50% concentration decrease.

2. SMS contaminant data summarized here are only for detected SQS exceedances in the top two intervals of cores, if those intervals are within the top 2 feet of the core. Data could also be from a co-located surface sediment location and a 0- to1-ft or a 0- to 2-ft interval in a core. Trends for concentration changes from the deeper to the shallower sample. Data are in Table F-8.

ft = foot; HPAH = high molecular weight polycyclic aromatic hydrocarbon; LPAH = low molecular weight polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; SMS = Sediment Management Standards; SQS = sediment quality standards

Table F-10 Average Total PCB Concentrations in English Sole Fillet Samples Collected in the LDW

Event and/or Source	Year	Season	Location	Size or Age	Sample Size	Number of Fish per Composite	Avg Total PCBs (µg/kg ww)	Avg Lipid (%)	Avg Total PCBs (mg/kg lipid)[a]
Butler and Schutzmann (1978)	1972	Fall	Duwamish River	yearling	1	25	1,760[b]	nr	n/a
	1973	Spring/Fall	Duwamish River	yearling	2	25	998[b]	nr	n/a
	1974	Spring/Fall	Duwamish River	yearling	2	25	963[b]	nr	n/a
	1975	Spring	Duwamish River	yearling	1	25	1,337[b]	nr	n/a
	1976	Spring	Duwamish River	yearling	1	25	1,120[b]	nr	n/a
Malins et al. (1982)	1979 or 1980	Unknown	Duwamish River/ Elliott Bay	nr	5	appears to be 1	1,000[c]	nr	n/a
EBAP (PTI Environmental & Tetra Tech 1988)	1985	September	RM 0 – 2	7 – 11 yrs	2	1	395[d]	1.9	21
PSAMP (West et al. 2001)	1992	May	RM 0.4 – 1.3	>200 mm	3	20	111[d]	0.48	23
PSAMP (West et al. 2001)	1995	May	RM 0.4 – 1.3	>200 mm	3	20	227[d]	0.35	69
EVS-95 (Battelle 1996)	1995[d]	December	RM 1.1 – 1.4	nr	3	6	207[d]	11	1.9
KCWQA (King County 1999)	1997	July	RM 0.5 – 0.9	>200 mm	3	20	220[d]	0.30	74
WSOU (ESG 1999)	1998	October	RM 2.1 – 4.4	>200 mm	3	5	370[d]	nr	n/a
LDW RI (Windward 2010)	2004	August	RM 0.2 – 4.4	>200 mm	7	5	1,400[c]	2.9	49
LDW RI (Windward 2010)	2005	Aug/Sept	RM 0.2 – 4.4	>200 mm	10	5	920[c]	3.53	26
KC fish tissue (Anchor and King County 2007)	2006	September	RM 0.2 – 1.0	>200 mm	6	5	490[b]	3.67	14
LDW RI (Windward 2010)	2007	September	RM 0.2 – 4.4	>200 mm	9	5	350[c]	2.99	12

Notes:

a. Lipid-normalized total PCB concentrations were calculated on a sample-by-sample basis. Average values and standard deviations were then calculated for each dataset.

b. Whole-body concentration reported in original source was converted to an equivalent fillet concentration assuming the LDW RI-derived fillet-to-whole body ratio of 0.526.

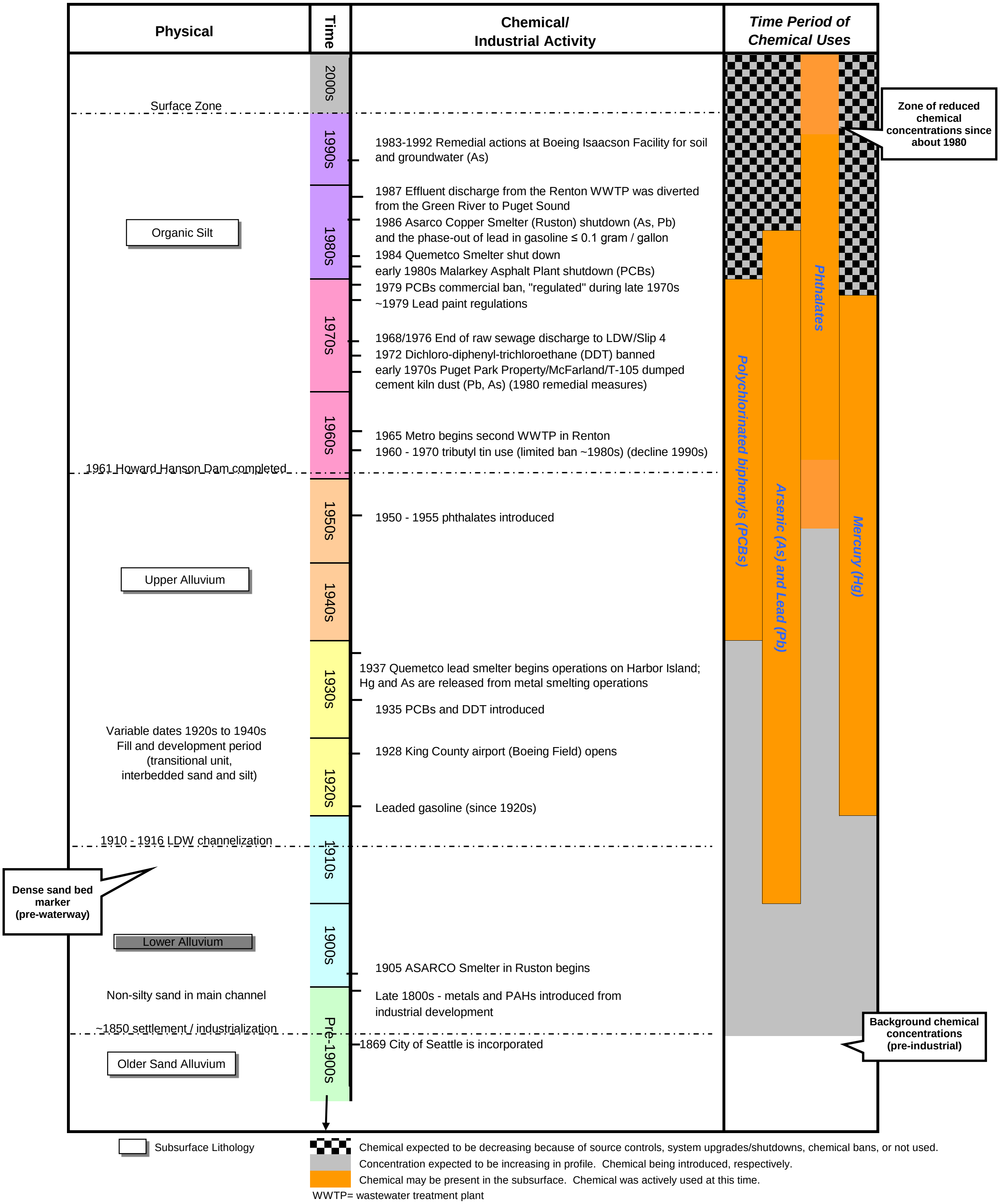
c. Skin-on fillet.

d. Skin-off fillet.

e. The average concentration from December 1995 was graphed as 1996 in Figures F-14 and F-15.

EBAP = Elliott Bay Action Program; ESG = Environmental Solutions Group; KCWQA = King County Water Quality Assessment; LDW = Lower Duwamish Waterway; mm = millimeters; n/a = not available; nr = not reported; PCB = polychlorinated biphenyl; PSAMP = Puget Sound Ambient Monitoring Program; RI = remedial investigation; RM = river mile; WSOU = Waterway Sediment Operable Unit

Figure F-1 Example Schematic of Historical Events, Chemical Uses, and Source Control Evidenced through Stratigraphic Units and Chemical Profiles in Cores



1983-1992 Remedial actions at Boeing Isaacson Facility for soil and groundwater (As)

1987 Effluent discharge from the Renton WWTP was diverted from the Green River to Puget Sound

1986 Asarco Copper Smelter (Ruston) shutdown (As, Pb) and the phase-out of lead in gasoline ≤ 0.1 gram / gallon

1984 Quemetco Smelter shut down

early 1980s Malarkey Asphalt Plant shutdown (PCBs)

1979 PCBs commercial ban, "regulated" during late 1970s

~1979 Lead paint regulations

1968/1976 End of raw sewage discharge to LDW/Slip 4

1972 Dichloro-diphenyl-trichloroethane (DDT) banned

early 1970s Puget Park Property/McFarland/T-105 dumped cement kiln dust (Pb, As) (1980 remedial measures)

1965 Metro begins second WWTP in Renton

1960 - 1970 tributyl tin use (limited ban ~1980s) (decline 1990s)

1950 - 1955 phthalates introduced

1937 Quemetco lead smelter begins operations on Harbor Island; Hg and As are released from metal smelting operations

1935 PCBs and DDT introduced

1928 King County airport (Boeing Field) opens

Leaded gasoline (since 1920s)

1905 ASARCO Smelter in Ruston begins

Late 1800s - metals and PAHs introduced from industrial development

1869 City of Seattle is incorporated

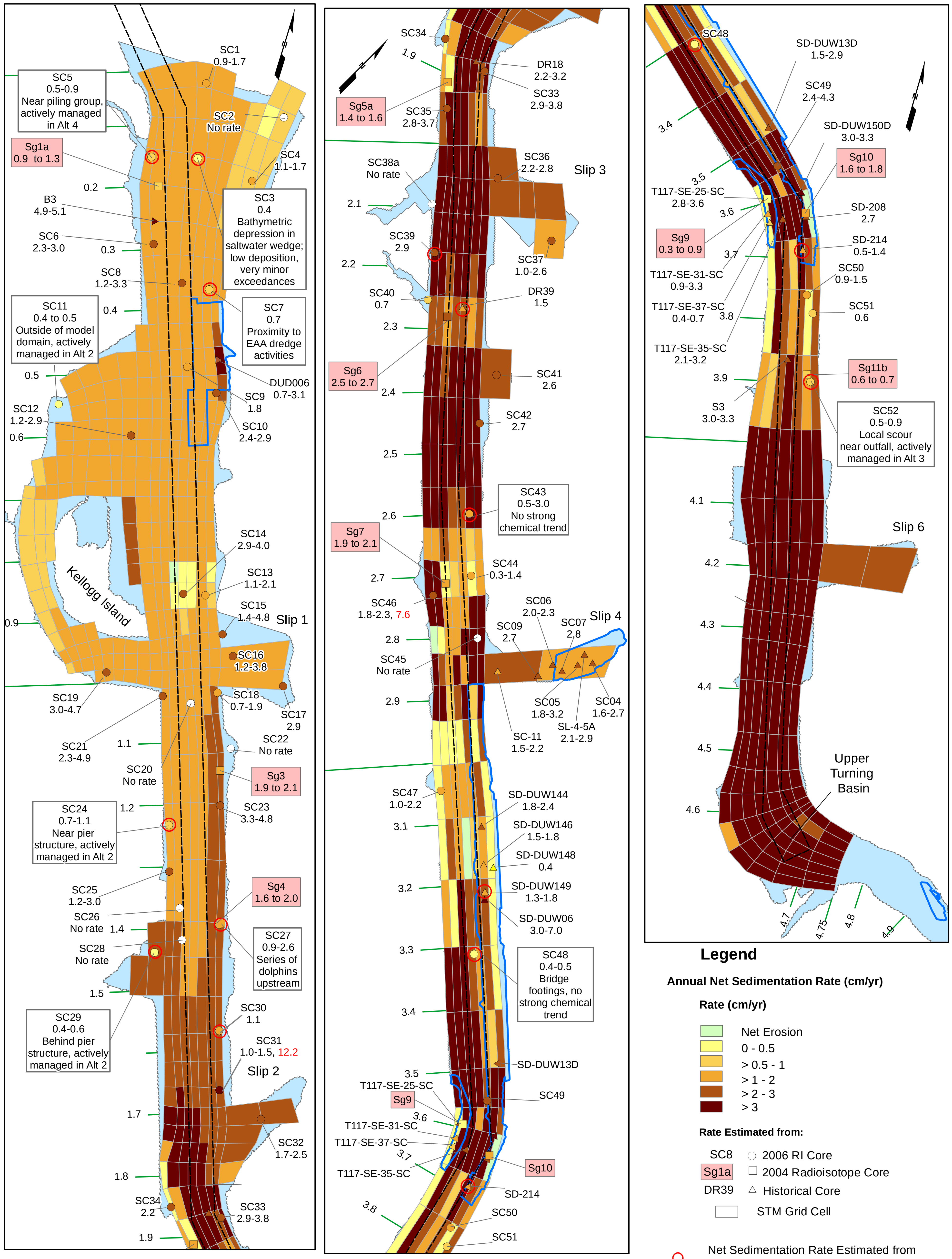
☐ Subsurface Lithology

▦ Chemical expected to be decreasing because of source controls, system upgrades/shutdowns, chemical bans, or not used.

▨ Concentration expected to be increasing in profile. Chemical being introduced, respectively.

🟧 Chemical may be present in the subsurface. Chemical was actively used at this time.

WWTP= wastewater treatment plant



Legend

Annual Net Sedimentation Rate (cm/yr)

Rate (cm/yr)

🟩	Net Erosion
🟨	0 - 0.5
🟨	> 0.5 - 1
🟧	> 1 - 2
🟫	> 2 - 3
🟥	> 3

Rate Estimated from:

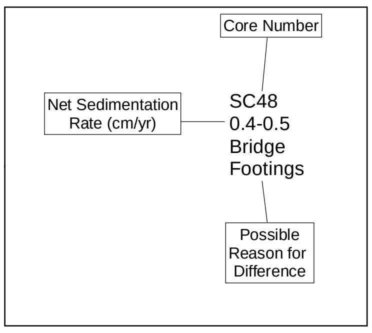
SC8	○	2006 RI Core
Sg1a	☐	2004 Radioisotope Core
DR39	△	Historical Core
	☐	STM Grid Cell

○	Net Sedimentation Rate Estimated from Core is Less than Rate from STM
🟦	Outside Model Domain
☐	Early Action Area
- - -	Navigation Channel
—	River Mile Marker

0 400 800 Feet

Notes:

1. Net sedimentation rates estimated from radioisotope core data, 2006 core chemistry data and historical core data in FS project database.
2. Numerous time markers used to estimate net sedimentation rates are from radioisotope, physical, and chemical geochronology profiles.
3. Ranges shown are calculated from recovered depths.
4. Red font represents rate from dredging event marker outside range of other rates.
5. STM GIS shapefile from 30-year run (QEA Feb. 2009).
6. Seven RI cores for which rates could not be calculated are displayed as white circles. Historical cores for which rates could not be calculated are not shown.
7. Cores SC11, SC40 and SC42 are outside of the model domain and therefore are not circled. Core SC46 has interference from a dredge event and was not circled. Historical core SC11 (in Slip 4) range matched model predictions. Core SC51 straddled two grid cells and therefore was not circled.



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Comparison of Net Sedimentation Rates Estimated from the STM and from Sediment Cores

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FIGURE F-2

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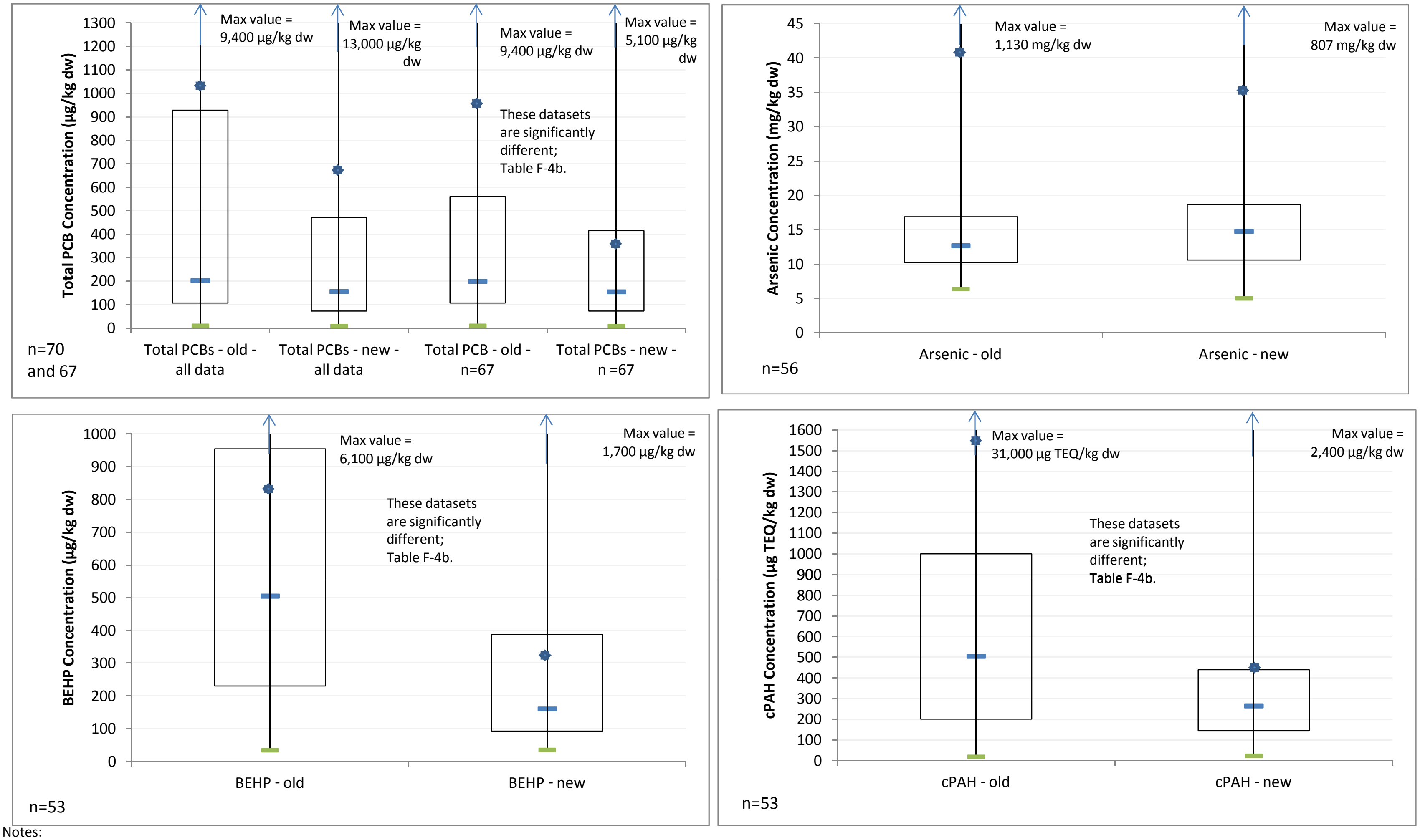
Figure F-3a Population Statistics for Resampled Surface Sediment Locations



n=70 and 67

Max value = 9,400 µg/kg dw

Max value = 13,000 µg/kg dw

Max value = 9,400 µg/kg dw

Max value = 5,100 µg/kg dw

These datasets are significantly different; Table F-4b.

n=56

Max value = 1,130 mg/kg dw

Max value = 807 mg/kg dw

n=53

Max value = 6,100 µg/kg dw

Max value = 1,700 µg/kg dw

These datasets are significantly different; Table F-4b.

n=53

Max value = 31,000 µg TEQ/kg dw

Max value = 2,400 µg/kg dw

These datasets are significantly different; **Table F-4b.**

Notes:

1. Newer data are co-located with older data (i.e., within 10 ft). Older data are not included in the FS baseline dataset.
2. Statistics calculated using ProUCL v.4.00.04 (Table F-3).
3. Undetected data were set to the reporting limit.
4. The n=67 total PCB dataset omitted these samples: LDW-SS110/SD-323-S; LDW-SS111/DR186; and SD-320-S/SD-DUW92.
5. BEHP = bis(2-ethyhexyl)phthalate; cPAH =carcinogenic polycyclic aromatic hydrocarbon;

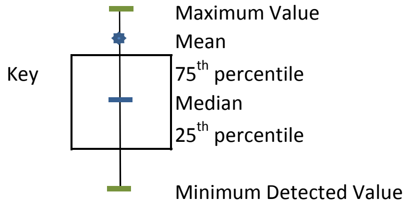
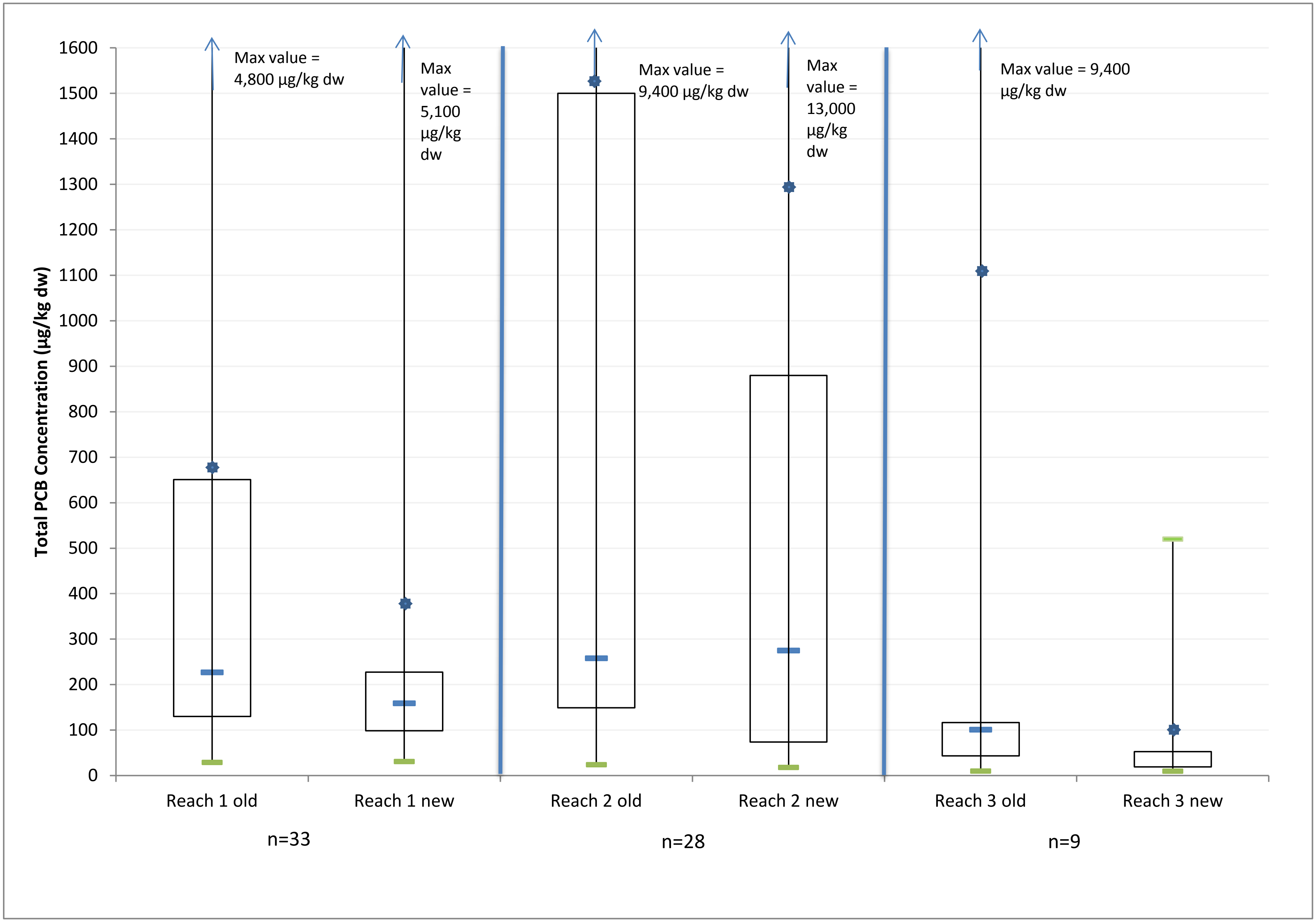
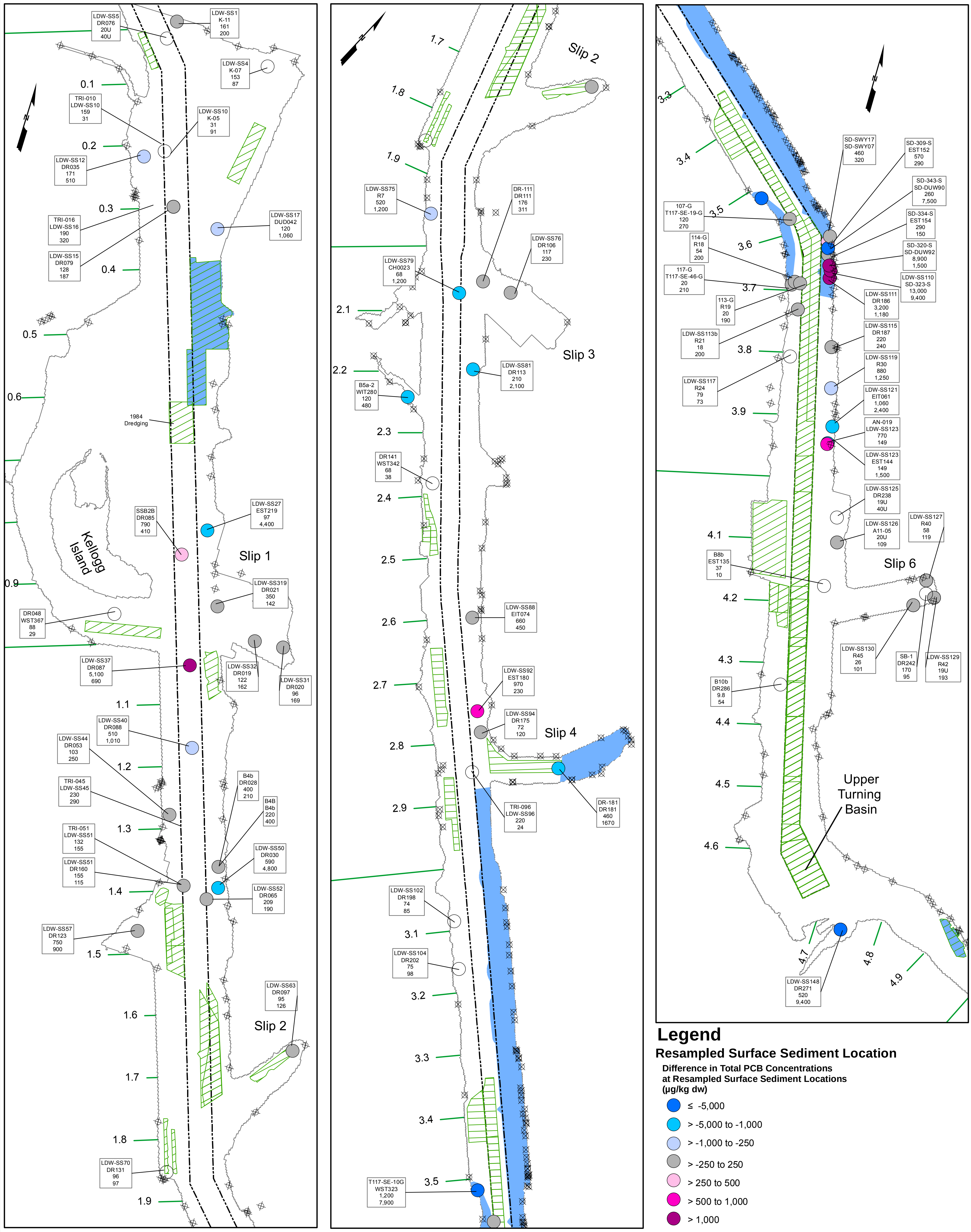


Figure F-3b Total PCB Population Statistics by Reach at Resampled Surface Sediment Locations





Legend

Resampled Surface Sediment Location

Difference in Total PCB Concentrations at Resampled Surface Sediment Locations (µg/kg dw)

- ● ≤ -5,000
- ● > -5,000 to -1,000
- ● > -1,000 to -250
- ● > -250 to 250
- ● > 250 to 500
- ● > 500 to 1,000
- ● > 1,000
- ○ Older Data < 100 and Concentration Change < 250
- ⌖ Outfall Location
- ▨ Early Action Area
- ▨ Dredging Event within Last 30 Years
- -·-·- Navigation Channel
- — River Mile Marker

New Location ID
Old Location ID
LDW-SS104
DR202
75
98
New Total PCB Value
Old Total PCB Value

Notes:

1. Resampled locations are those trumped for both the RI and FS baseline datasets.
2. Locations were considered to have been resampled if the new location was within 10 ft of the old location.
3. Average time between sample collection dates for the newer and older datasets is 7 years.
4. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.

Feet
0 200 400 800

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Empirical Total PCB Trends at Resampled Surface Sediment Locations

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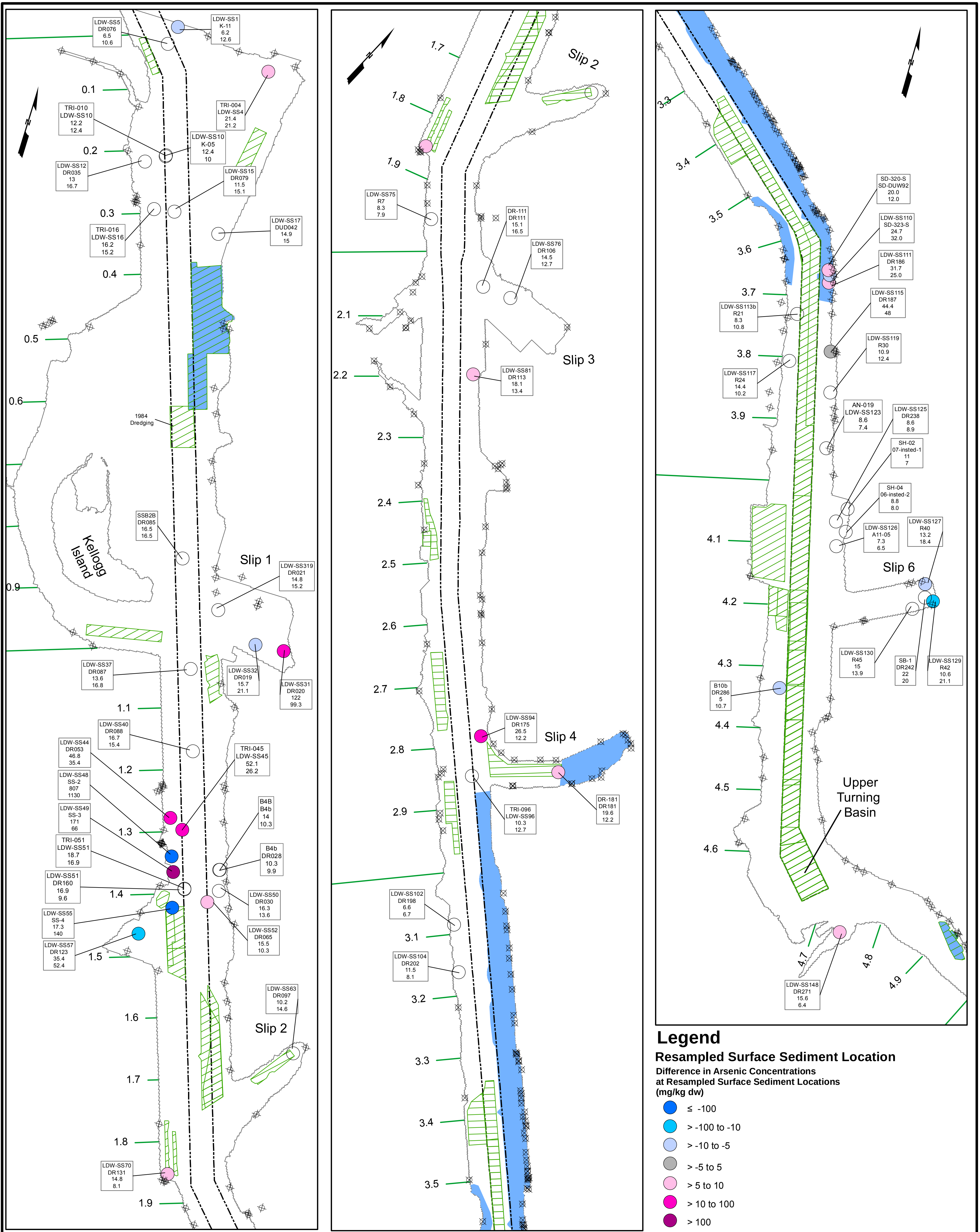
FIGURE F-4



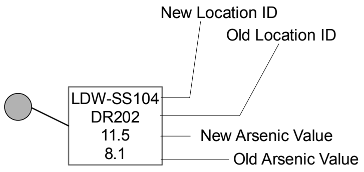
Legend

Resampled Surface Sediment Location

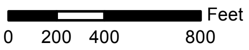
Difference in Arsenic Concentrations at Resampled Surface Sediment Locations (mg/kg dw)

- ● ≤ -100
- ● > -100 to -10
- ● > -10 to -5
- ● > -5 to 5
- ● > 5 to 10
- ● > 10 to 100
- ● > 100
- ○ Older Data < 25 and Concentration Change < 5

- ⌖ Outfall Location
- ▨ Early Action Area
- ▨ Dredging Event within Last 30 Years
- Navigation Channel
- River Mile Marker



Notes:
1. Resampled locations are those trumped in both the RI and FS baseline datasets.
2. Locations were considered to have been resampled if the new location was within 10 ft of the old location.
3. Average time between sample collection dates for the newer and older datasets is 7 years.
4. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.



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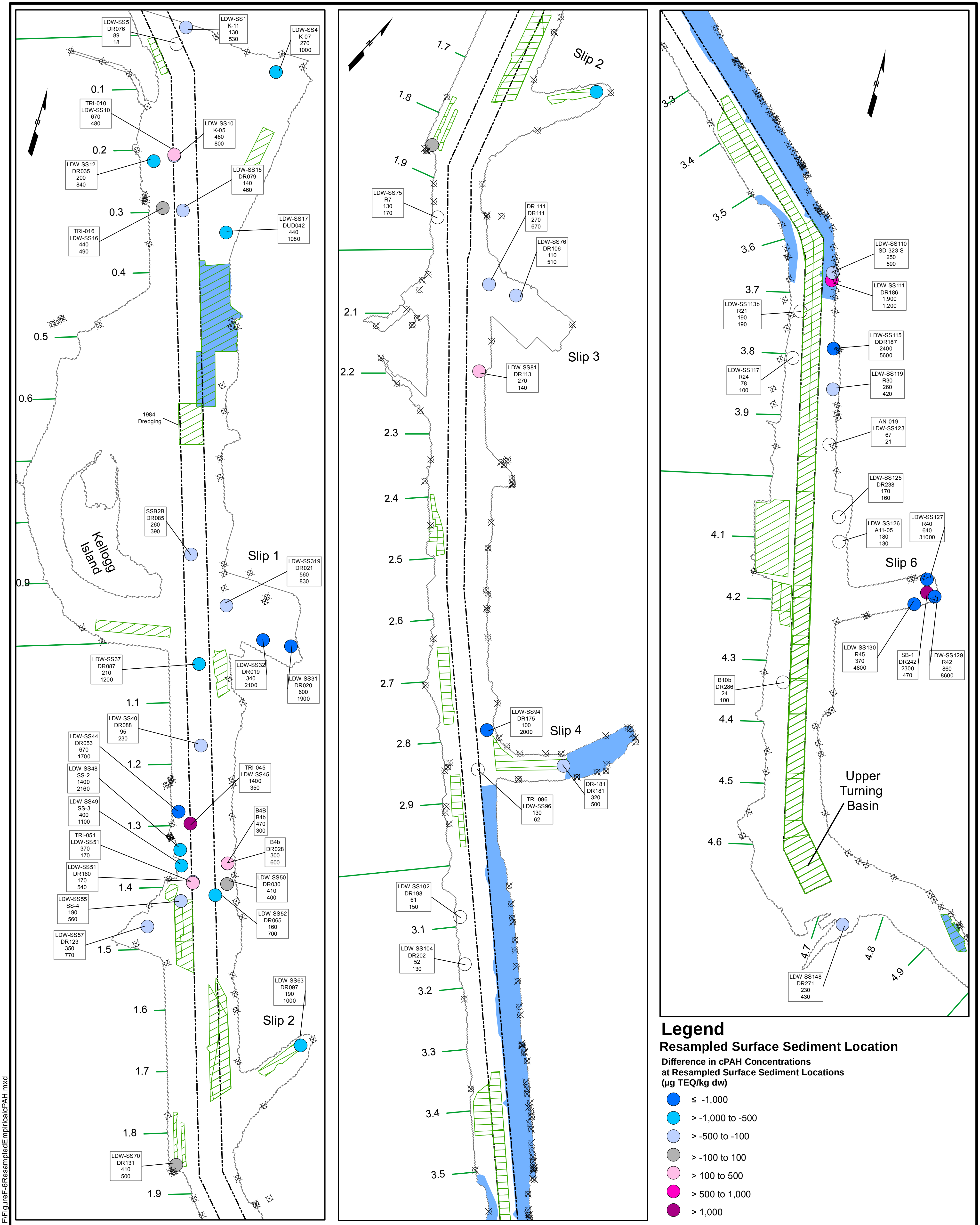
DATE: 10/31/12 | DWRN:MVI/sea | Revision: 0

Empirical Arsenic Trends at Resampled Surface Sediment Locations

FIGURE F-5



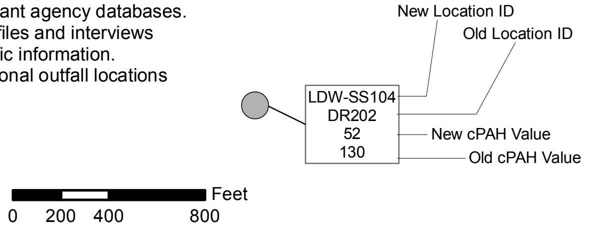
Legend

Resampled Surface Sediment Location

Difference in cPAH Concentrations at Resampled Surface Sediment Locations (µg TEQ/kg dw)

- ● ≤ -1,000
- ● > -1,000 to -500
- ● > -500 to -100
- ● > -100 to 100
- ● > 100 to 500
- ● > 500 to 1,000
- ● > 1,000
- ○ Older Data < 250 and Concentration Change < 100
- ⌖ Outfall Location
- 🟦 Early Action Area
- ▨ Dredging Event within Last 30 Years
- -·- Navigation Channel
- — River Mile Marker

Notes:
1. Resampled locations are those trumped in both the RI and FS baseline datasets.
2. Locations were considered to have been resampled if the new location was within 10 ft of the old location.
3. Average time between sample collection dates for the newer and older database is 7 years.
4. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.



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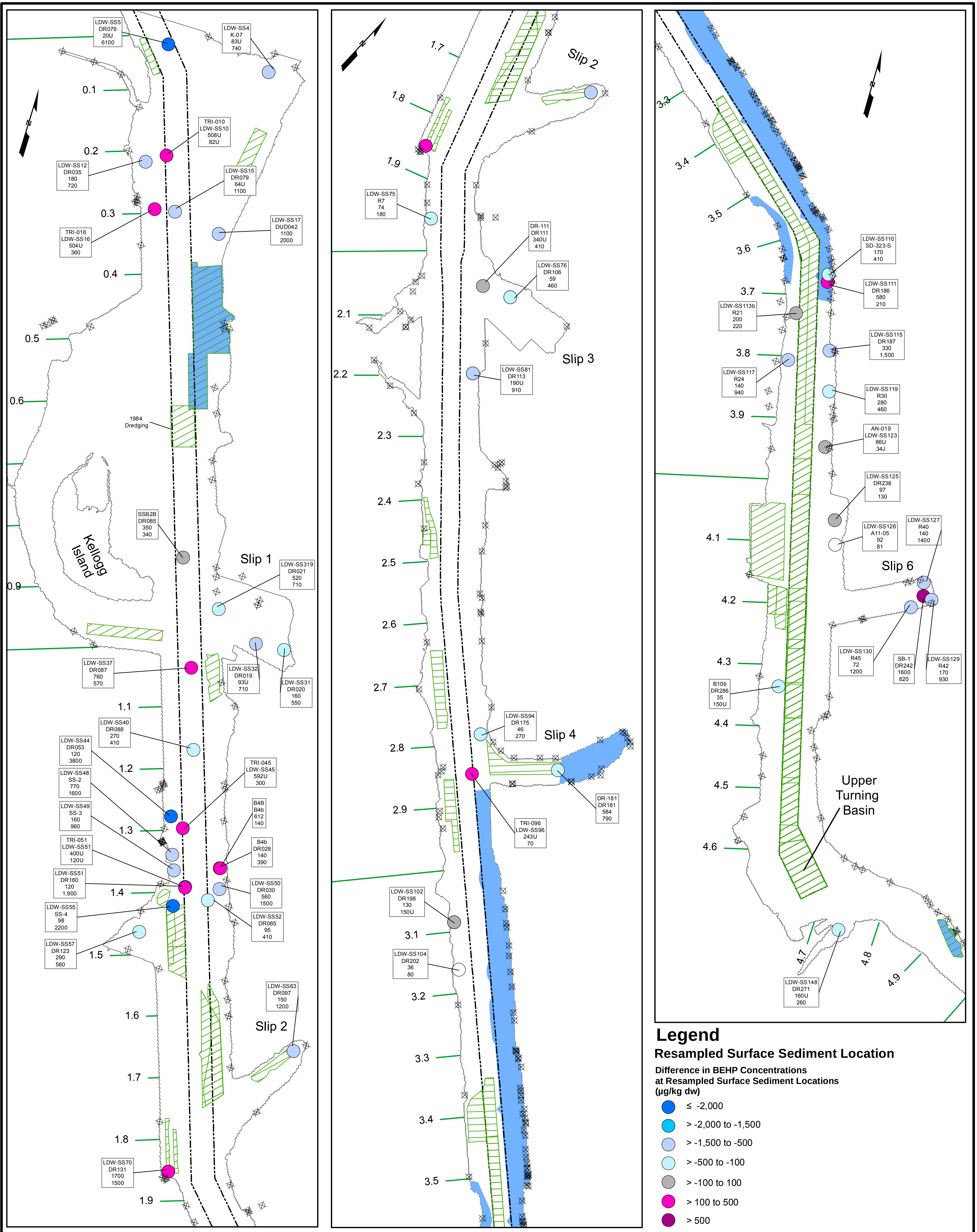
Empirical cPAH Trends at Resampled Surface Sediment Locations

DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	FIGURE F-6



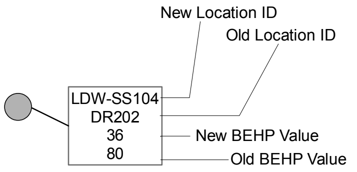
Legend

Resampled Surface Sediment Location

Difference in BEHP Concentrations at Resampled Surface Sediment Locations (µg/kg dw)

- ● ≤ -2,000
- ● > -2,000 to -1,500
- ● > -1,500 to -500
- ● > -500 to -100
- ● > -100 to 100
- ● > 100 to 500
- ● > 500
- ○ Older data < 100 and Concentration Change < 100
- ⊕ Outfall Location
- 🟦 Early Action Area
- ▨ Dredging Event within Last 30 Years
- -·-· Navigation Channel
- — River Mile Marker

Notes:
1. Resampled locations are those trumped in the RI and FS baseline datasets.
2. Locations were considered to have been resampled if the new location was within 10 ft of the old location.
3. Average time between sample collection for the newer and older datasets is 7 years.
4. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.



0 200 400 800 Feet

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-7ResampledEmpiricalBEHP.mxd

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Empirical BEHP Trends at Resampled Surface Sediment Locations

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FIGURE F-7

Legend

Recovery Category

🟧 Category 1: Recovery Presumed to be Limited (77 acres)

🟩 Category 2: Recovery Less Certain (44 acres)

■ Category 3: Predicted to Recover (281 acres)

▨ Early Action Area (29 acres)

Resampled Surface Sediment Location

Total PCBs ◎ Other SMS Contaminants

🟩 Below SQS

🟥 Data that do not Support Recovery
(≥50% Concentration Increase)

🟦 Data that Support Recovery
(≥50% Concentration Decrease)

■ Station in Equilibrium or Mixed Result

⌖ Outfall Location

— River Mile Marker

-·-·- Navigation Channel

Notes:
1. Resampled locations are those trumped in both the RI and FS datasets.
2. Locations were considered to have been resampled if the new location was within 10 ft of the old location.
3. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.
4. Locations in EAAs are not shown.

0 200 400 800 Feet

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-8RecoveryCatsEmp.mxd

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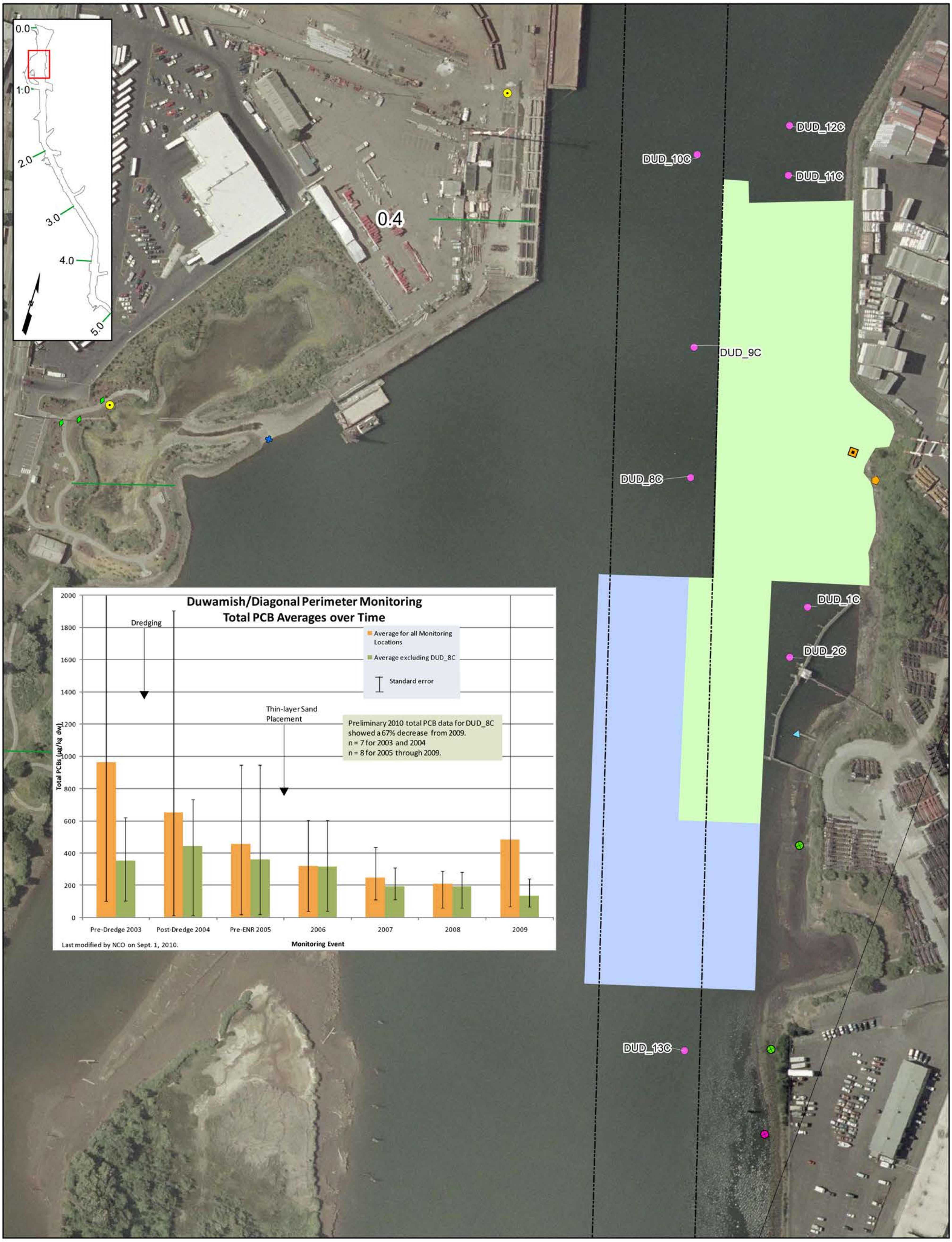
Recovery Categories and Resampled Surface Sediment Locations

FIGURE F-8



Notes:
1. USGS 2002 photograph provided by Windward Environmental.
2. CSO= combined sewer overflow; EOF= emergency overflow.
3. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.

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Surface Sediment Total PCB Trends at Duwamish/Diagonal Perimeter Locations

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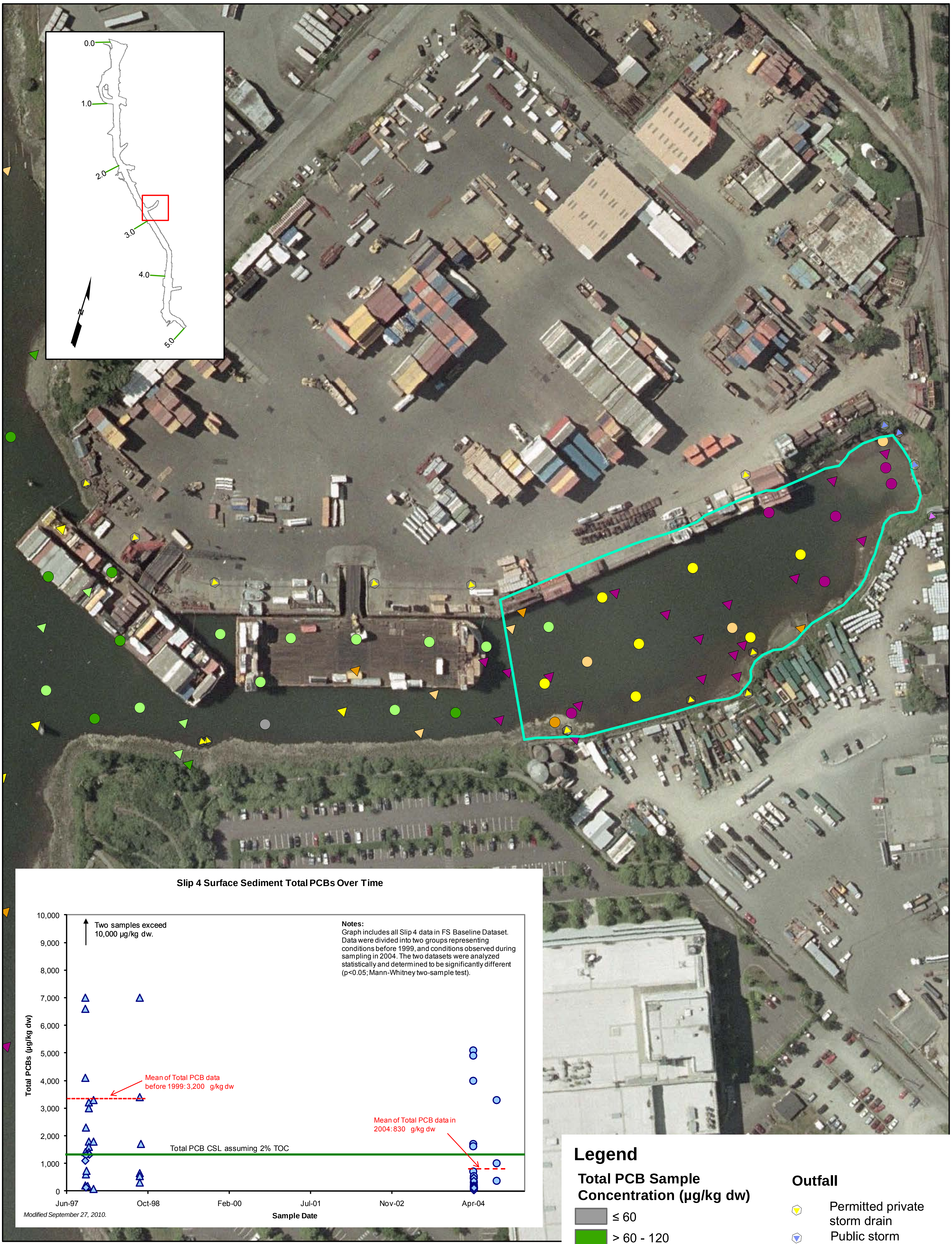
FIGURE F-9

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-9SurfsedDD.mxd



Legend

Total PCB Sample Concentration (µg/kg dw)

- ▨ ≤ 60
- 🟩 > 60 - 120
- 🟩 >120 - 240
- 🟨 >240 - 480 (> SQS)
- 🟧 > 480 - 720
- 🟧 >720 - 1,300
- 🟪 > 1,300 (> CSL)
- ○ In 2004
- △ Before 1999

Outfall

- ⬡ Permitted private storm drain
- ⬡ Public storm drain
- ▭ 2011 Cleanup Action Boundary

Notes:
1. USGS 2002 photograph provided by Windward Environmental.
2. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.
3. SQS value of 240 µg/kg dw based on conversion of 12 mg/kg oc to a dry weight value using 2% TOC.

N

Feet
0 50 100 200

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-xSlip4EAA.mxd

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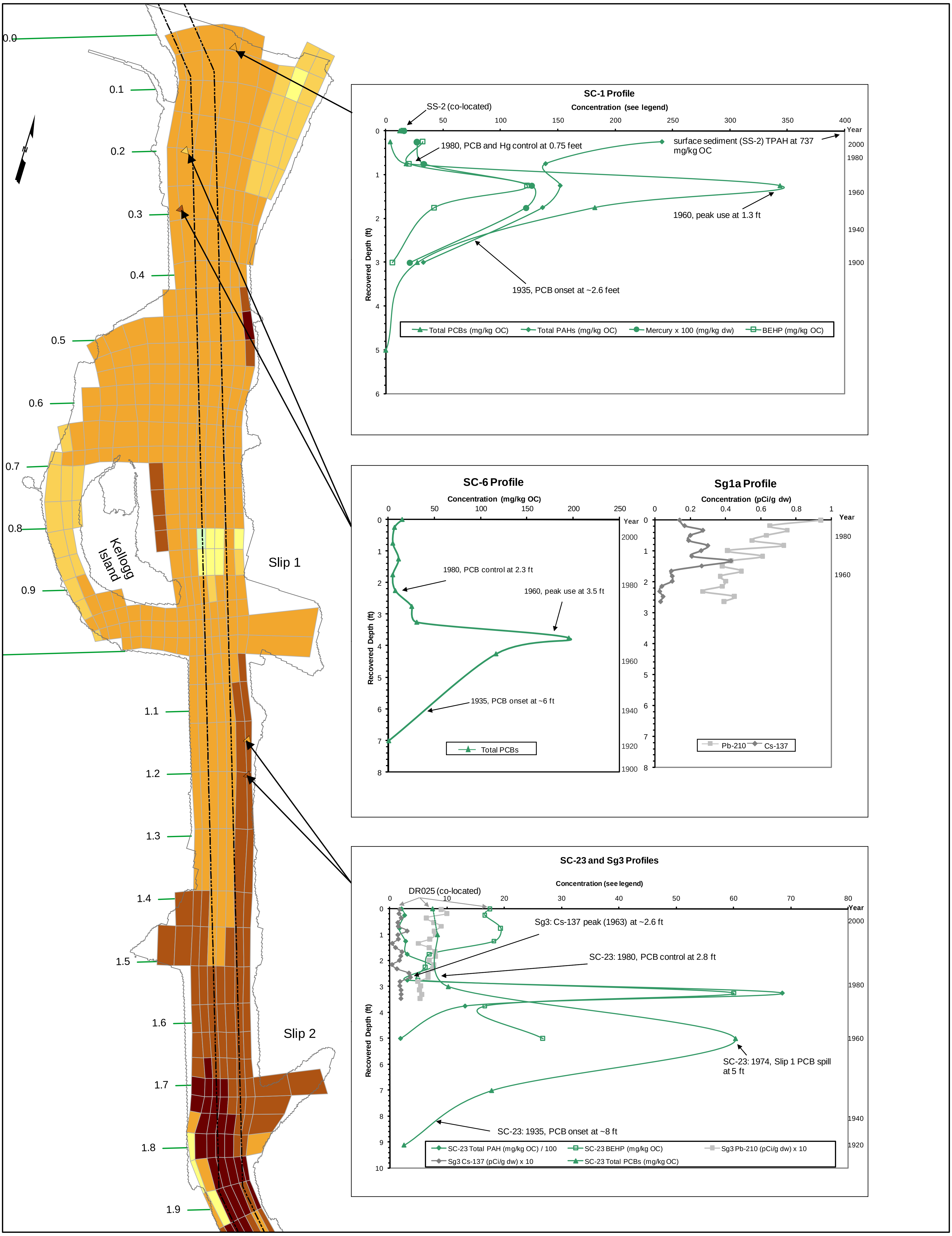
Surface Sediment Total PCB Trends in Slip 4

FIGURE F-10



Notes:
1. STM GIS shapefile from 30-year run (QEA Feb. 2009).
2. Empirical net sedimentation rates estimated using multiple time markers in cores.
   The example profiles shown on this map were used to identify the chemical markers.
   Physical markers (changes in lithology) were also used to estimate net sedimentation rates.

Legend

-·-·- Navigation Channel
— River Mile Marker

Estimated Annual Net Sedimentation Rate (cm/yr)

🟩	Net Erosion
🟨	0 - 0.5
🟨	> 0.5 - 1.0
🟧	> 1.0 - 2.0
🟫	> 2.0 - 3.0
🟥	> 3.0

Rate Estimated from:

△ 2006 RI or Radioisotope Core
☐ STM Grid Cell

0 200 400 800 Feet

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Example Core Profiles Used as Empirical Data (RM 0.0 to 1.9)

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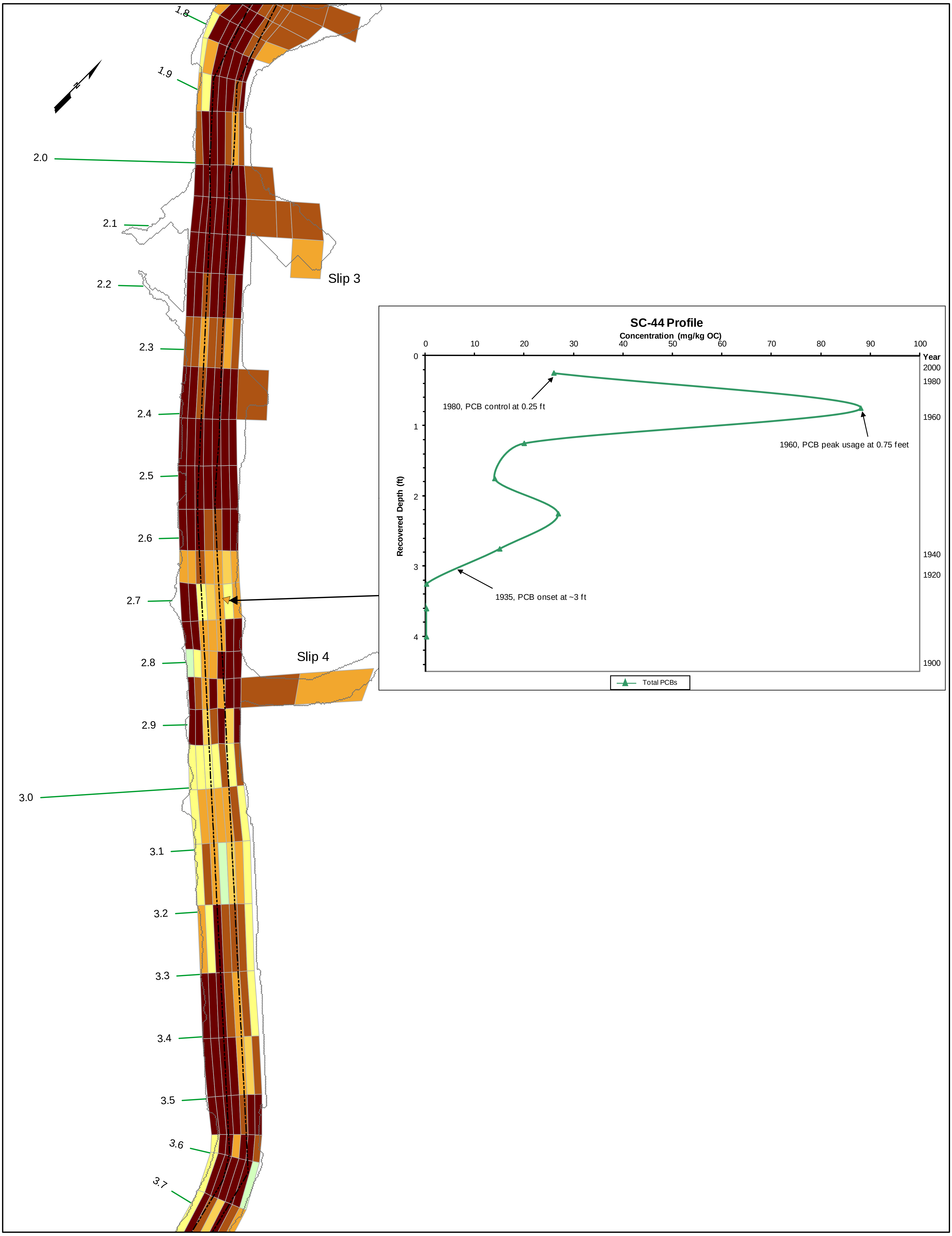
FIGURE F-11a

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-11aSedratePCB_RadioReach1.mxd



Notes:
1. STM GIS shapefile from 30-year run (QEA Feb. 2009).
2. Empirical net sedimentation rates estimated using multiple time markers in cores.
The example profiles shown on this map were used to identify the chemical markers.
Physical markers (changes in lithology) were also used to estimate net sedimentation rates.

Legend

-·-·- Navigation Channel
— River Mile Marker

Estimated Annual Net Sedimentation Rate (cm/yr)

🟩	Net Erosion
🟨	0 - 0.5
🟧	> 0.5 - 1.0
🟧	> 1.0 - 2.0
🟫	> 2.0 - 3.0
🟥	> 3.0

Rate Estimated from:

△	2006 RI Core
☐	STM Grid Cell

Feet
0 200 400 800

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Example Core Profiles Used as Empirical Data (RM 1.9 to 3.6)

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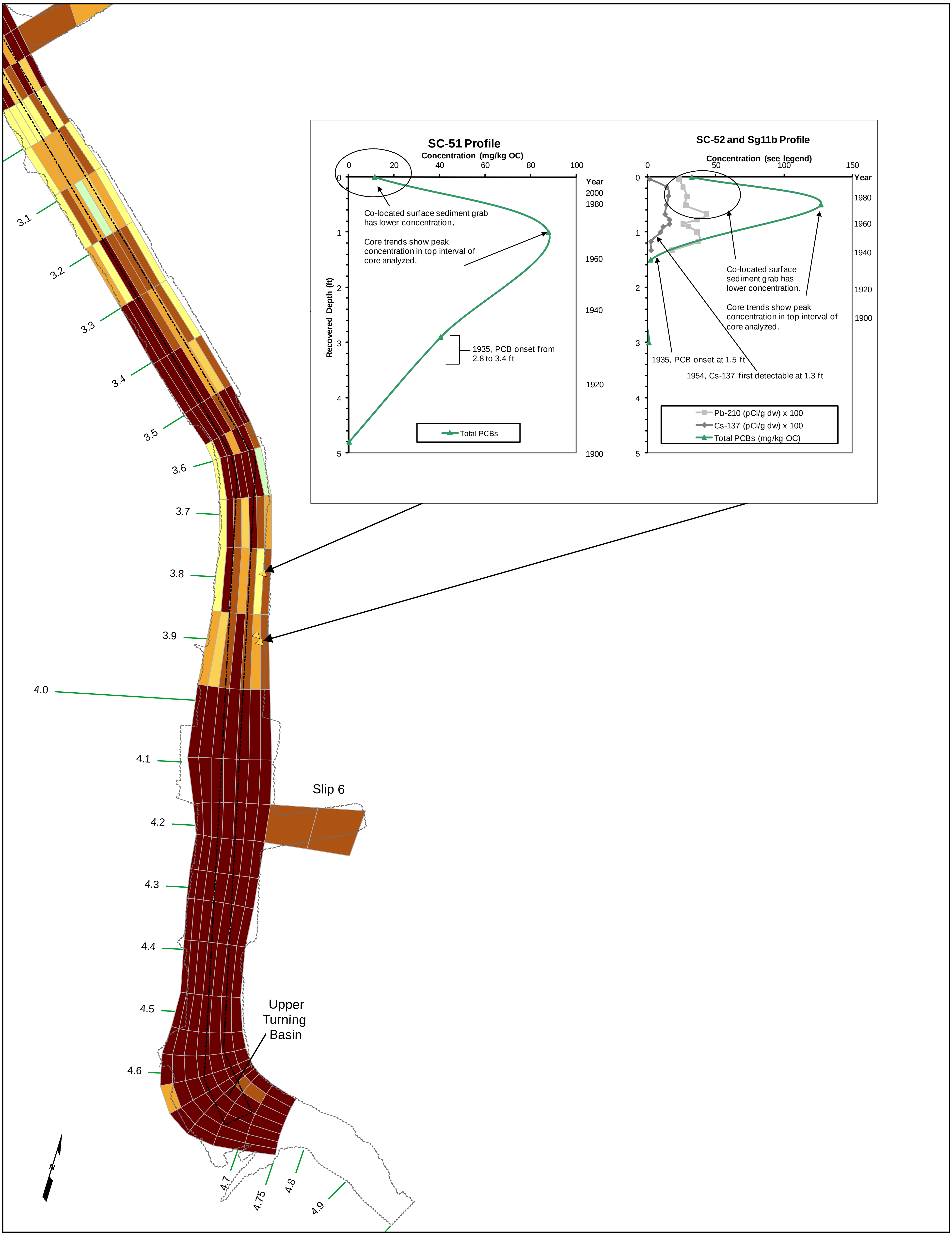
FIGURE F-11b

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-11bSedratePCB_RadioReach2.mxd



L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-11cSedratePCB_RadioReach3.mxd

Notes:
1. STM GIS shapefile from 30-year run (QEA Feb. 2009).
2. Empirical net sedimentation rates estimated using multiple time markers in cores.
The example profiles shown on this map were used to identify the chemical markers.
Physical markers (changes in lithology) were also used to estimate net sedimentation rates.

Legend

-·-·- Navigation Channel
— River Mile Marker

Estimated Annual Net Sedimentation Rate (cm/yr)

🟩	Net Erosion
🟨	0 - 0.5
🟧	> 0.5 - 1.0
🟧	> 1.0 - 2.0
🟫	> 2.0 - 3.0
🟥	> 3.0

Rate Estimated from:

△	2006 RI or Radioisotope Core
☐	STM Grid Cell

Feet
0 200 400 800

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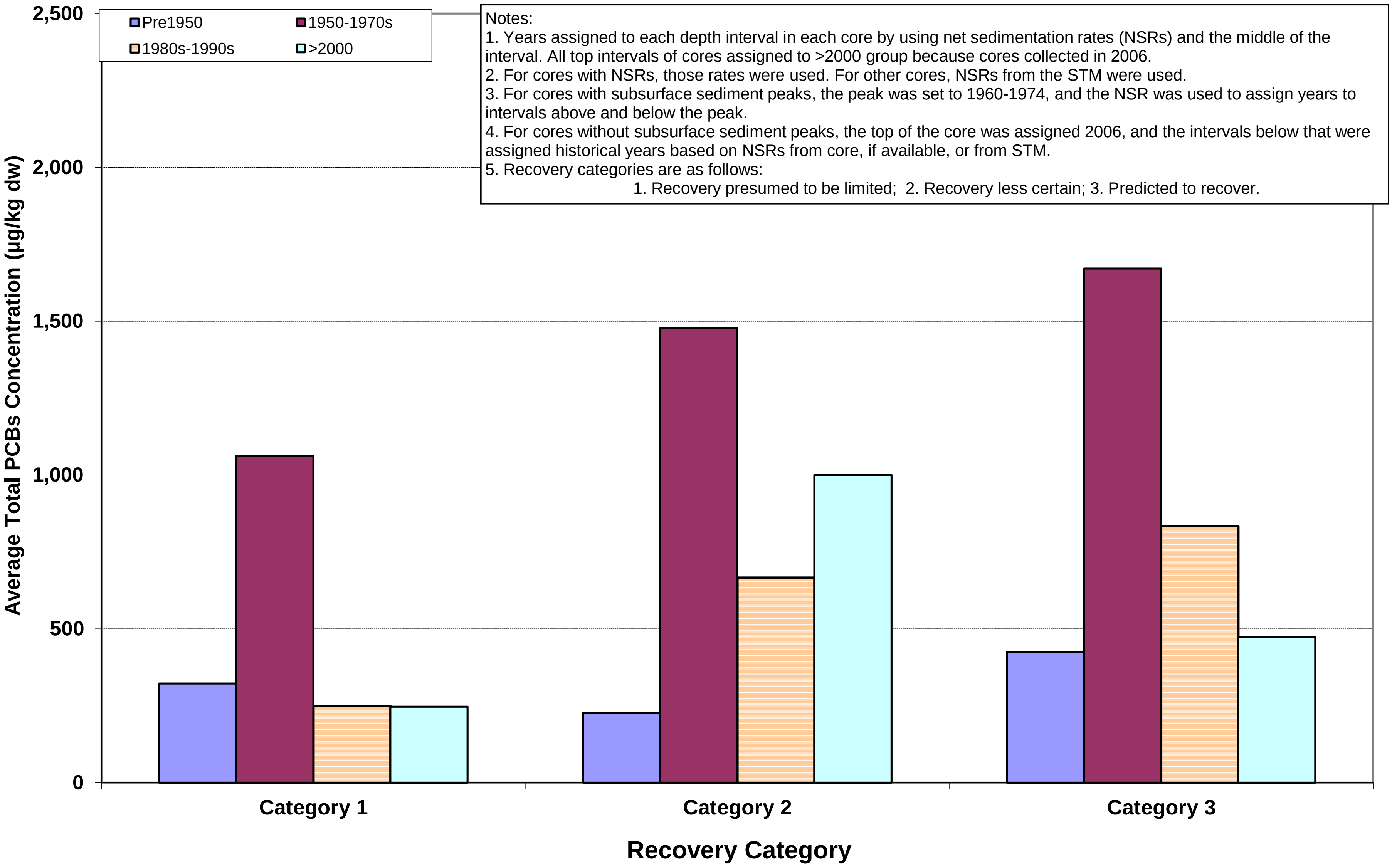
Example Core Profiles Used as Empirical Data (RM 3.6 to 5.0)

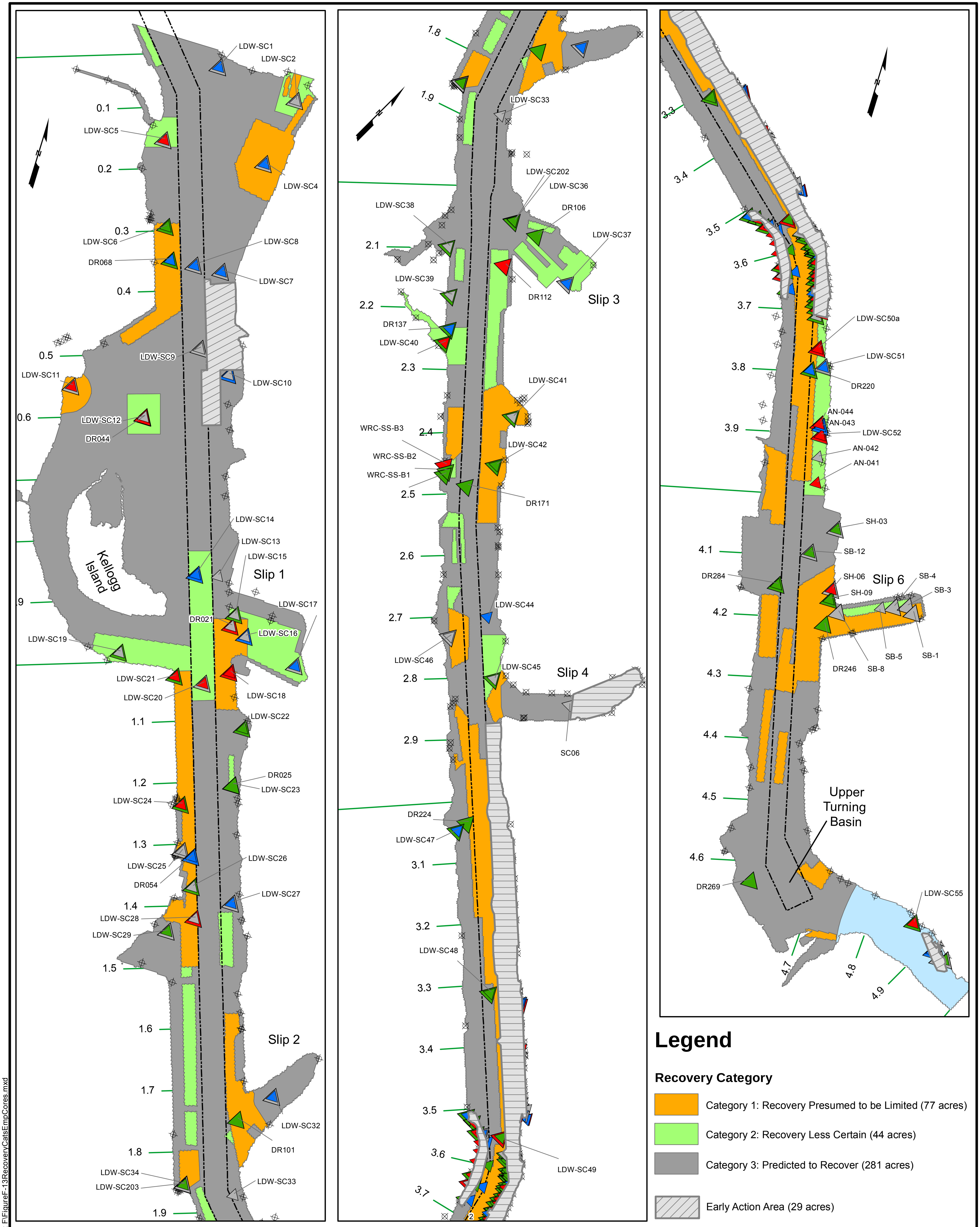
DATE: 10/31/12 DWRN: MVI/sea Revision: 1

FIGURE F-11c

Figure F-12 Average Total PCB Concentrations by Decade (using core depths) and by Recovery Category



Notes:
1. Years assigned to each depth interval in each core by using net sedimentation rates (NSRs) and the middle of the interval. All top intervals of cores assigned to >2000 group because cores collected in 2006.
2. For cores with NSRs, those rates were used. For other cores, NSRs from the STM were used.
3. For cores with subsurface sediment peaks, the peak was set to 1960-1974, and the NSR was used to assign years to intervals above and below the peak.
4. For cores without subsurface sediment peaks, the top of the core was assigned 2006, and the intervals below that were assigned historical years based on NSRs from core, if available, or from STM.
5. Recovery categories are as follows:
1. Recovery presumed to be limited; 2. Recovery less certain; 3. Predicted to recover.



Legend

Recovery Category

🟧 Category 1: Recovery Presumed to be Limited (77 acres)

🟩 Category 2: Recovery Less Certain (44 acres)

⬛ Category 3: Predicted to Recover (281 acres)

▨ Early Action Area (29 acres)

⌖ Outfall Location

— River Mile Marker

-·-·- Navigation Channel

Trends in Top Two Invervals of Cores

Total PCBs — △ — Other SMS Contaminants

🟩 Below SQS

🟥 Data that do not Support Recovery (≥50% Concentration Increase)

🟦 Data that Support Recovery (≥50% Concentration Decrease)

⬜ Station in Equilibrium or Mixed Result

0 200 400 800 Feet

Notes:

1. If a core symbol does not appear, the core did not have samples at the appropriate intervals to evaluate trends for either total PCBs or other SMS contaminants. For example, there is no total PCB symbol for SC23 because PCBs were only analyzed in the 2-ft samples. Other SMS contaminants were analyzed at finer depth intervals.
2. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.
3. Core locations were included if the following criteria were met:
   a) proper vertical resolution, and b) one or more contaminants were analyzed or suites of contaminants were analyzed, and c) the sample was not a composite sample. Surrounding data were also considered. The following core locations were not added to the map: DUD206, S12, SB-2, SB-6, SB-7, SB-11, SB-13, SB-17, SC08, SC09, SC10, SH-01, SH-02, SH-04, SH-05, SH-07, SH-08, T117-SE-91-SC, T117-SE-93-SC, and T117-SE-COMP4-SC.

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Recovery Categories and Trends in Top Two Invervals of Cores

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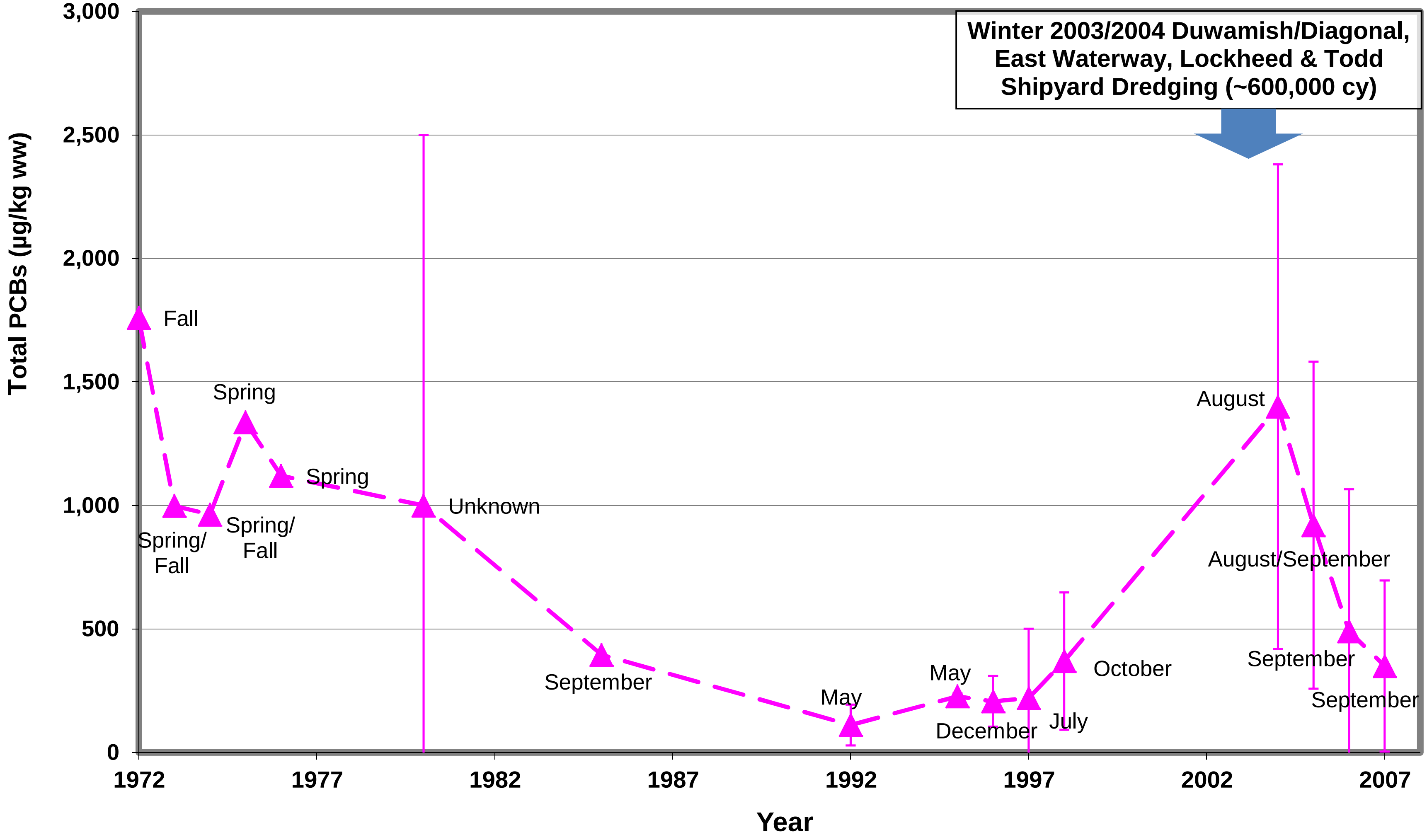
FIGURE F-13

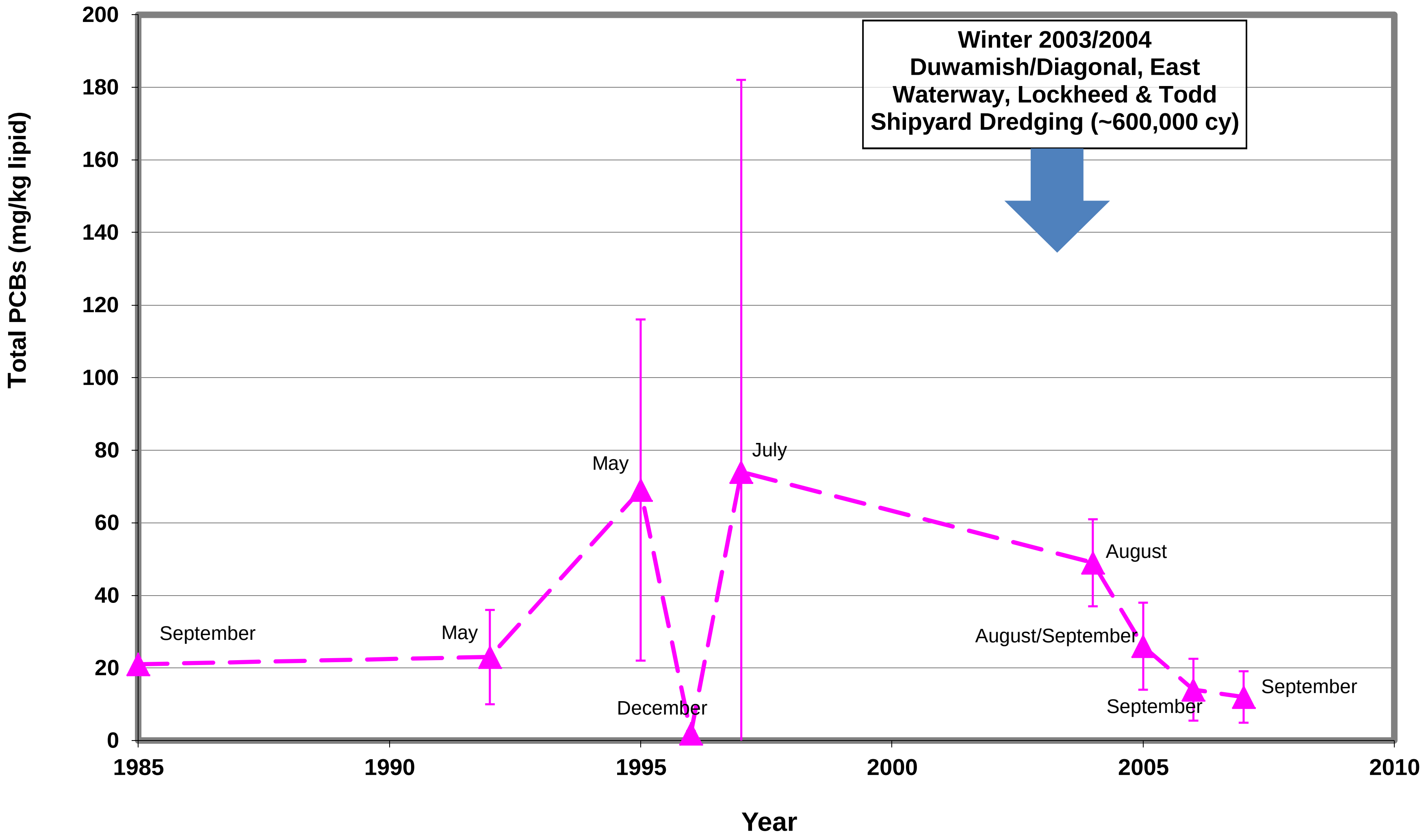
L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-13RecoveryCatsEmpCores.mxd

Figure F-14 Trends in Total PCB Concentrations in English Sole Fillets in the LDW

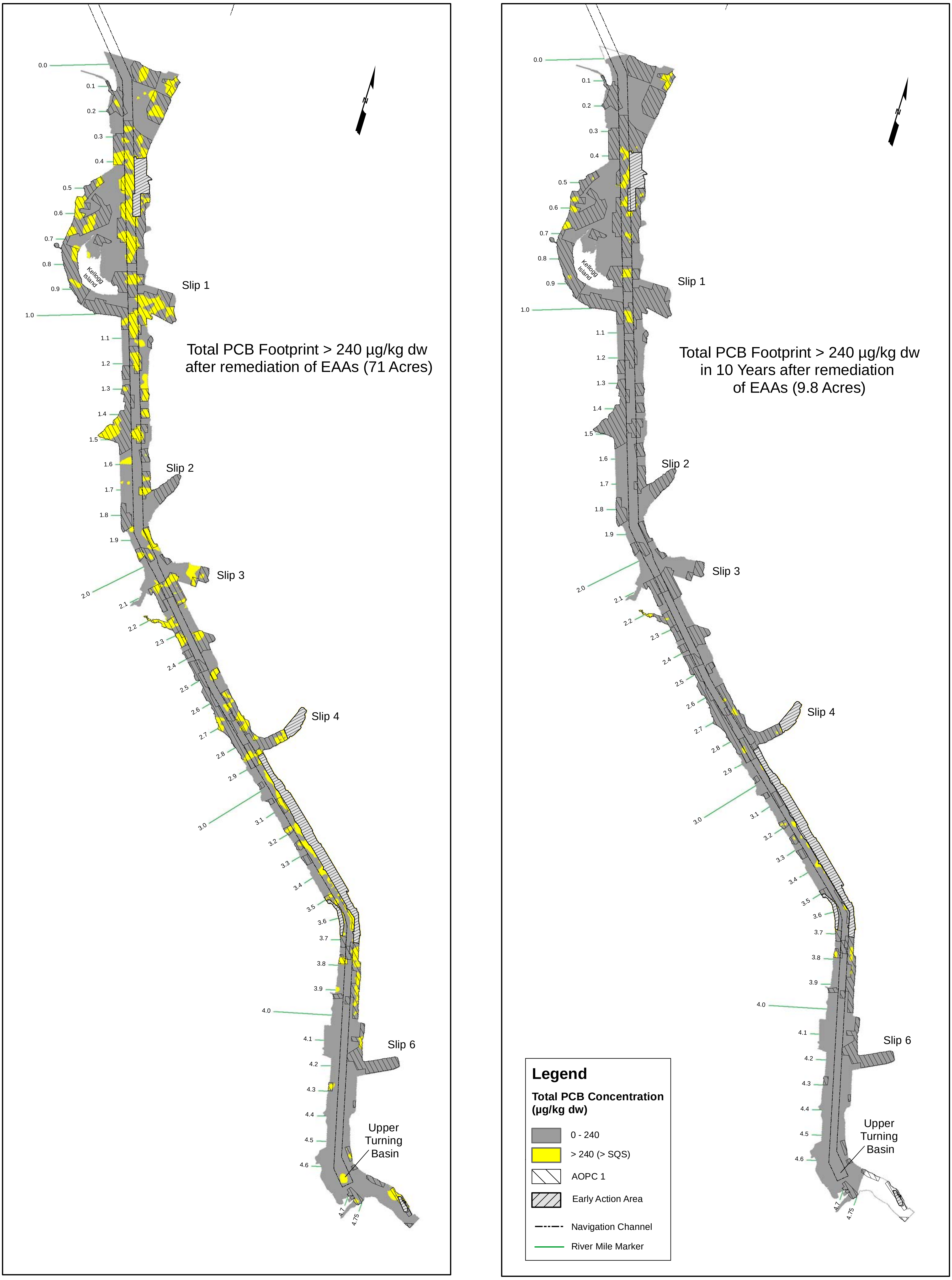


Notes: 1. Months/seasons listed represent sample collection. Samples collected in December 1995 are graphed as 1996.
2. Triangles represent average values. Error bars represent two standard deviations from the mean. Standard deviation could not be calculated for the 1970s and 1985 data.
3. The 1980 average concentration represents combined Duwamish River and Elliott Bay data.

Figure F-15 Trends in Lipid-Normalized Total PCB Concentrations in English Sole Fillets in the LDW



Notes: 1. Months/seasons listed represent sample collection. Samples collected in December 1995 are graphed as 1996.
2. Triangles represent average values. Error bars represent two standard deviations from the mean. No standard deviation could be calculated for 1985 data.



Notes:
1. Ten-year run from STM base-case run (QEA Feb. 2009) using recommended upstream and lateral input parameters.
2. SQS value of 240 µg/kg dw based on conversion of 12 mg/kg oc to a dry weight value using 2% TOC.
3. A concentration of 240 µg/kg dw is displayed because it is the threshold for delineating Area of Potential Concern 1 (AOPC 1), and is one of the remedial action levels considered in this FS.
4. Surface sediment concentrations at year 10 were predicted using the BCM with best estimate inputs and starting sediment concentrations at year 0 (post-EAAs), then allowing natural recovery to occur for 10 years with no further active remediation.

Feet
0 625 1,250 2,500

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF_16T0vsT10PCBs.mxd

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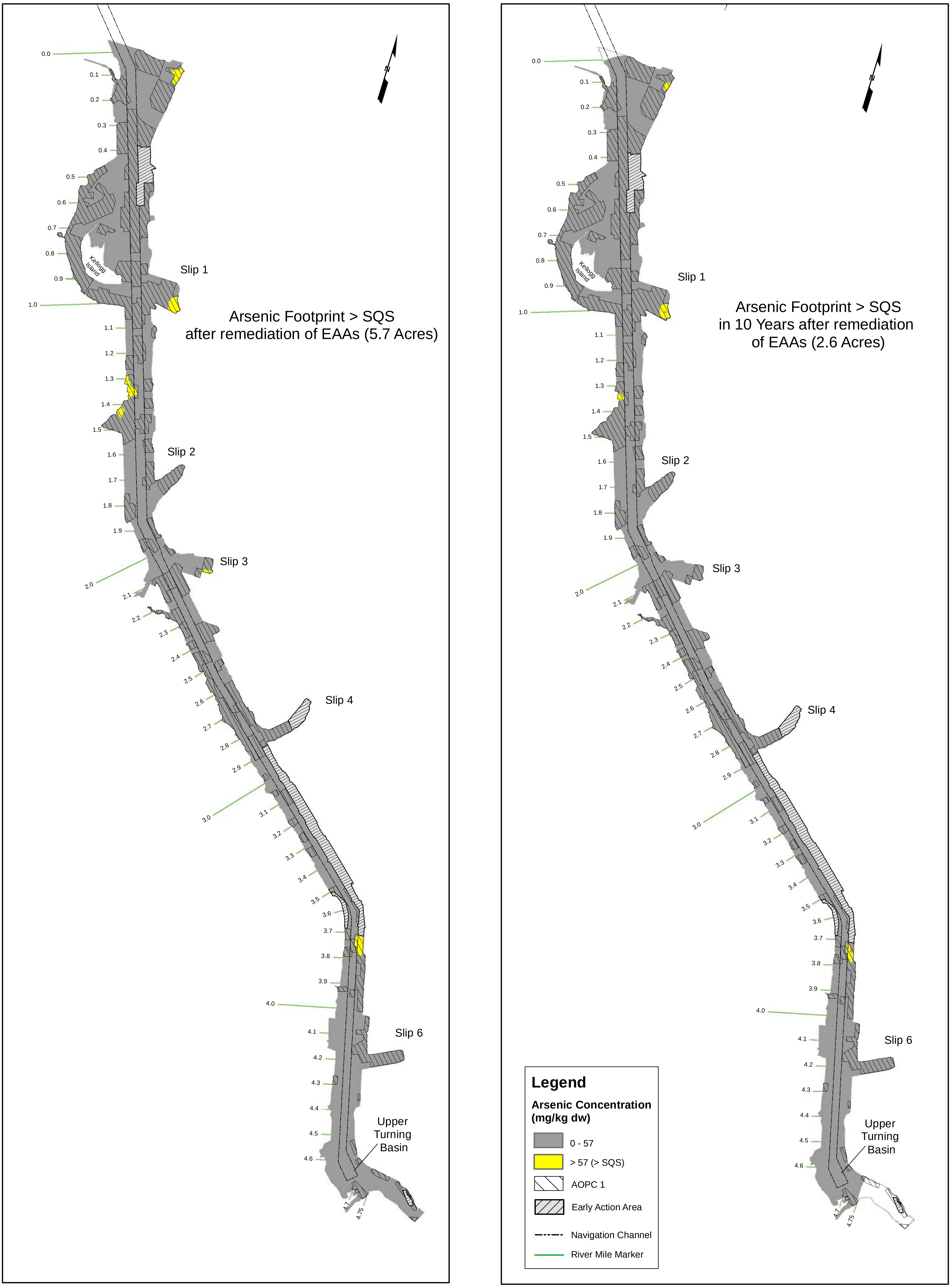
Predicted Reduction in Footprint of Total PCBs > 240 µg/kg dw in 10 Years

FIGURE F-16



Notes:
1. Ten-year run from STM base-case run (QEA Feb. 2009) using recommended upstream and lateral input parameters.
2. A concentration of 57 mg/kg dw is displayed because it is the threshold for delineating Area of Potential Concern 1 (AOPC 1), and is one of the remedial action levels considered in this FS.
3. Surface sediment concentrations at year 10 were predicted using the BCM with best estimate inputs and starting sediment concentrations at year 0 (post-EAAs), then allowing natural recovery to occur for 10 years with no further active remediation.

Feet
0 900 1,800 3,600

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF_17T0vsT10As.mxd

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Predicted Reduction in Footprint of Arsenic > SQS in 10 Years

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FIGURE F-17

Notes:
1. Ten-year run from STM base-case run (QEA Feb. 2009) using recommended upstream and lateral input parameters.
2. A concentration of 1,000 µg TEQ/kg dw is displayed because it is the threshold for delineating Area of Potential Concern 1 (AOPC 1), and is one of the remedial action levels considered in this FS.
3. Surface sediment concentrations at year 10 were predicted using the BCM with best estimate inputs and starting sediment concentrations at year 0 (post-EAAs), then allowing natural recovery to occur for 10 years with no further active remediation.

Feet
0 650 1,300 2,600

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF_18T0vsT10cPAH.mxd

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Predicted Reduction in Footprint of cPAHs > 1,000 µg TEQ/kg dw in 10 Years

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FIGURE F-18

Legend

Dioxin Furan Concentration (ng TEQ/kg dw)

- ■ 0 - 25
- 🟨 > 25
- ▧ AOPC 1
- ▨ Early Action Area
- -·-·- Navigation Channel
- — River Mile Marker

Notes:
1. Ten-year run from STM base-case run (QEA Feb. 2009) using recommended upstream and lateral input parameters.
2. A concentration of 25 ng TEQ/kg dw is displayed because it is the threshold for delineating Area of Potential Concern 1 (AOPC 1), and is one of the remedial action levels considered in this FS.
3. Surface sediment concentrations at year 10 were predicted using the BCM with best estimate inputs and starting sediment concentrations at year 0 (post-EAAs), then allowing natural recovery to occur for 10 years with no further active remediation.

Feet
0 700 1,400 2,800

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF_19T0vsT10PCBs.mxd

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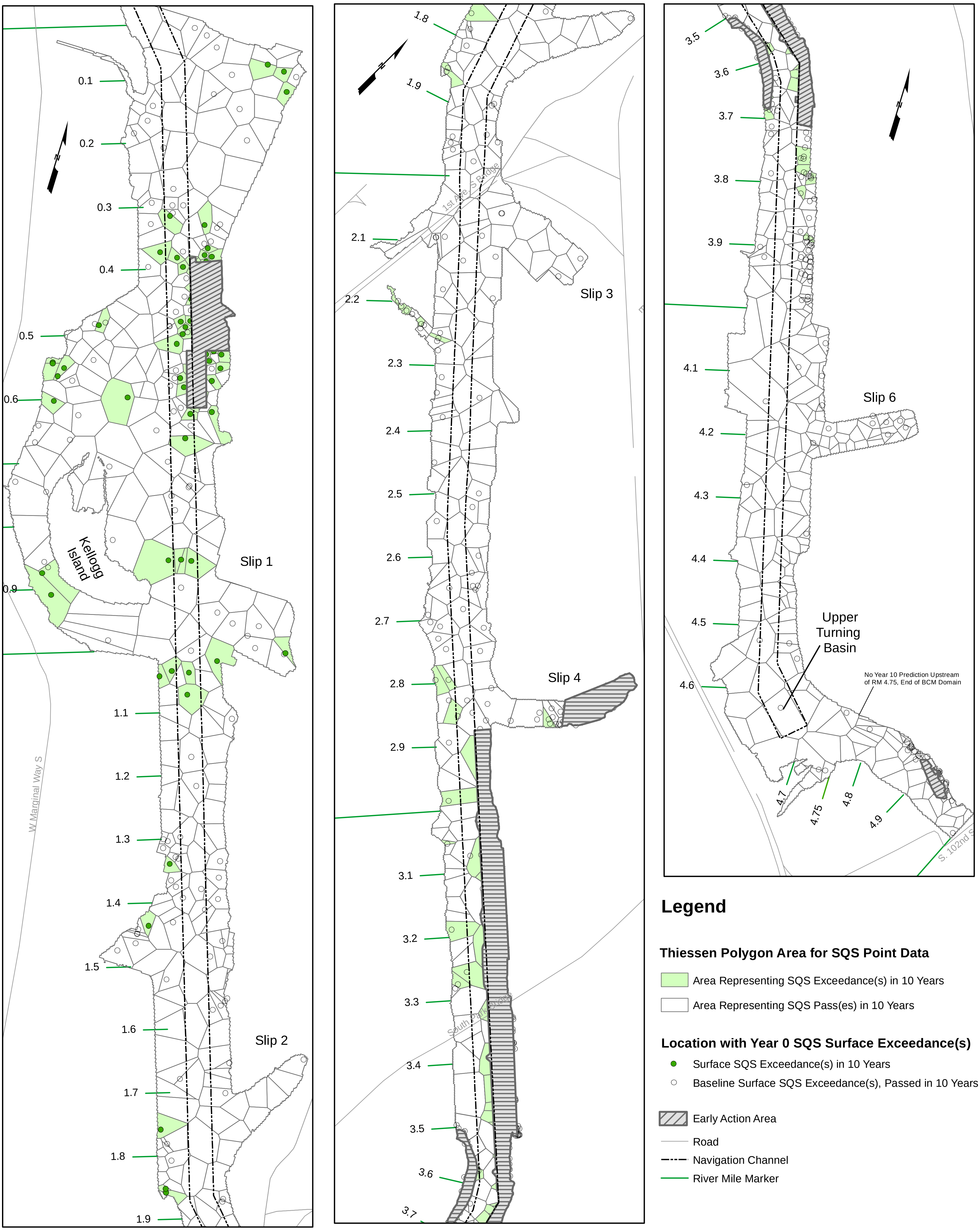
Lower Duwamish Waterway Final Feasibility Study 60150279-14.49	**Predicted Reduction in Footprint of Dioxin/Furan > 25 ng TEQ/kg dw in 10 Years**
DATE: 10/31/12 DWRN: MVI/sea Revision: 0	**FIGURE F-19**



Legend

Thiessen Polygon Area for SQS Point Data

🟩 Area Representing SQS Exceedance(s) in 10 Years

☐ Area Representing SQS Pass(es) in 10 Years

Location with Year 0 SQS Surface Exceedance(s)

● Surface SQS Exceedance(s) in 10 Years

○ Baseline Surface SQS Exceedance(s), Passed in 10 Years

▨ Early Action Area

— Road

-·-·- Navigation Channel

— River Mile Marker

Notes:
1. Baseline exceedances are for any detected SMS contaminant.
2. Exceedances in 10 years were calculated by using representative chemicals described in Section 5.
3. Baseline locations with sediment toxicity test passes are not considered SQS exceedances.
4. Ten-year run from STM base-case run (QEA Feb. 2009).
5. Surface sediment concentrations at year 10 were predicted using the BCM with best estimate inputs and starting sediment concentrations at year 0 (post-EAAs), then allowing natural recovery to occur for 10 years with no further active remediation.

Feet
0 200 400 800

L:\Lower Duwamish FS\FS_Final_GISOct2012\FS_GIS_MXDs_Oct12\Appendix F\FigureF-20T10SQSExceed.mxd

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Predicted SQS Exceedances After 10 Years

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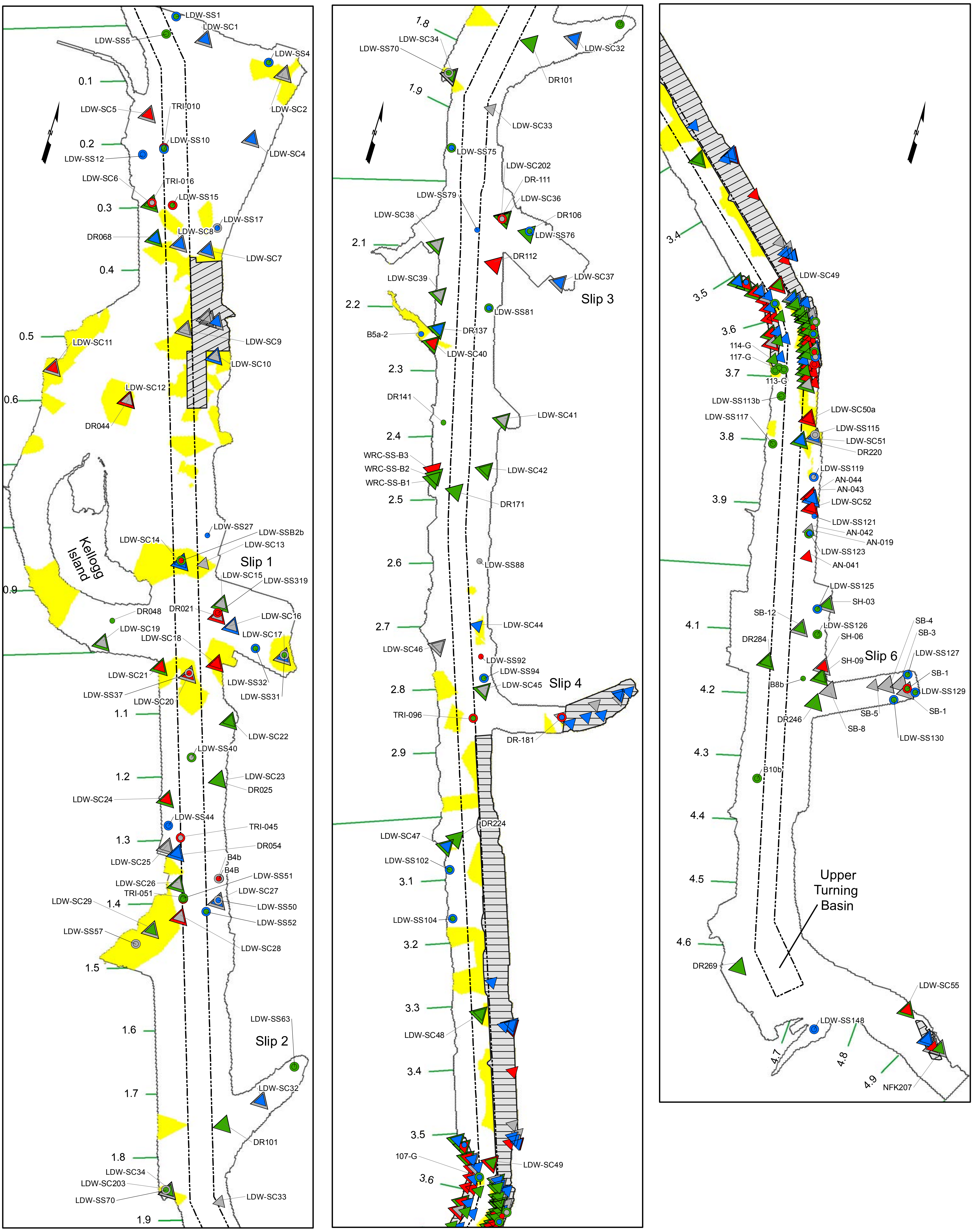
FIGURE F-20



Notes:
1. Exceedance defined as total PCBs, arsenic, or any SMS contaminants above SQS, or cPAHs or dioxins/furans above 1,000 μg TEQ/kg dw or 25 ng TEQ/kg dw, respectively.
2. BCM predictions for the 10-year run use recommended inputs, base case BCM run (QEA Feb. 2009).
3. SQS value of 240 μg/kg dw for total PCBs based on conversion of 12 mg/kg oc to a dry weight value using 2% TOC.
4. If a core symbol does not appear, the core did not have samples at the appropriate intervals to evaluate trends for either total PCBs or other SMS contaminants. For example, there is no total PCB symbol for LDW-SC23 because PCBs were only analyzed in the 2-ft samples. Other SMS contaminants were analyzed at finer depth intervals.

Legend

Natural Recovery Empirical Data

Resampled Surface Sediment Location Total PCBs ◎ Resampled Surface Sediment Location Other SMS Contaminants

Top Two Intervals in Cores Total PCBs △ Top Two Intervals in Cores Other SMS Contaminants

🟩 Below SQS

🟥 Data that do not Support Recovery (≥ 50% Concentration Increase)

🟦 Data that do Support Recovery (≥ 50% Concentration Decrease)

▒ Station in Equilibrium or Mixed Result

Exceedance Predicted by BCM in 10 Years

🟨 Total PCBs, Arsenic, or cPAHs by Interpolation (IDW) or Dioxins/Furans or SMS Contaminants by Thiessen Polygon

▨ Early Action Area

-·-·- Navigation Channel

— River Mile Marker

0 200 400 800 Feet

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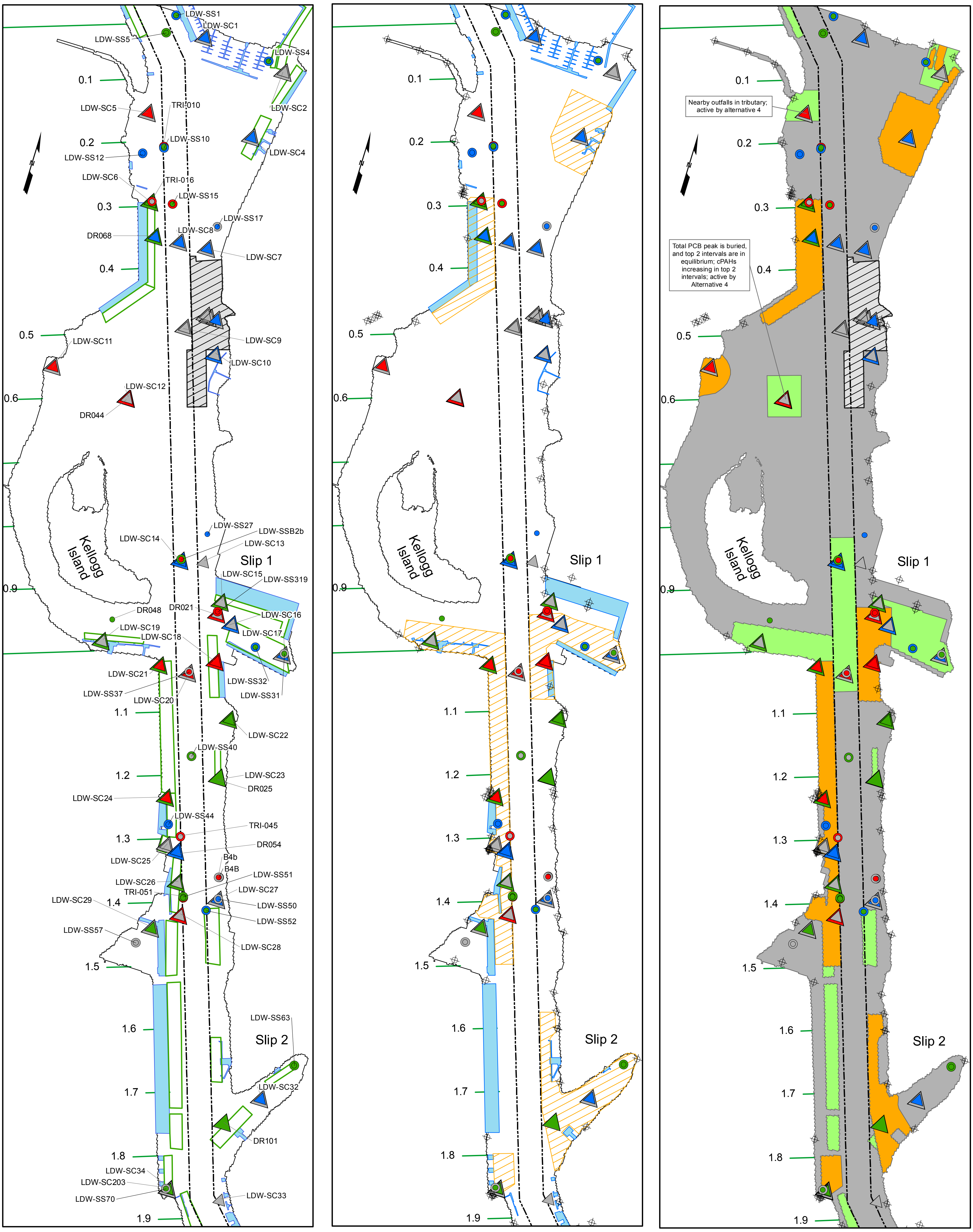
Comparison of BCM Predictions of Year 10 Exceedances and Empirical Trends

DATE: 10/31/12 | DWRN:MVI/sea | Revision: 0

FIGURE F-21



Notes:

1. If a core symbol does not appear, the core did not have samples at the appropriate intervals to evaluate trends for either total PCBs or other SMS contaminants. For example, there is no total PCB symbol for SC23 because PCBs were only analyzed in the 2-ft samples. Other SMS contaminants were analyzed at finer depth intervals.
2. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.

Legend

Natural Recovery Empirical Data

Resampled Surface Sediment Location Total PCBs — ◎ — Resampled Surface Sediment Location Other SMS Contaminants

Top Two Intervals in Cores Total PCBs — △ — Top Two Intervals in Cores Other SMS Contaminants

- 🟩 Below SQS
- 🟥 Data that do not Support Recovery (≥ 50% Concentration Increase)
- 🟦 Data that do Support Recovery (≥ 50% Concentration Decrease)
- ⬜ Station in Equilibrium or Mixed Result

Physical Lines of Evidence Used in Assigning Recovery Categories

- ▨ STM Predicted 100-Year High-flow Scour ≥ 10 cm
- ▨ Evidence of Propeller Wash Scour
- ☐ Berthing Area
- 🟦 Overwater Structure

Recovery Category

- 🟧 Category 1: Recovery Presumed to be Limited
- 🟩 Category 2: Recovery Less Certain
- ⬜ Category 3: Predicted to Recover
- ▨ Early Action Area
- -·-·- Navigation Channel
- — River Mile Marker
- ⌖ Outfall Location

Feet
0 200 400 800

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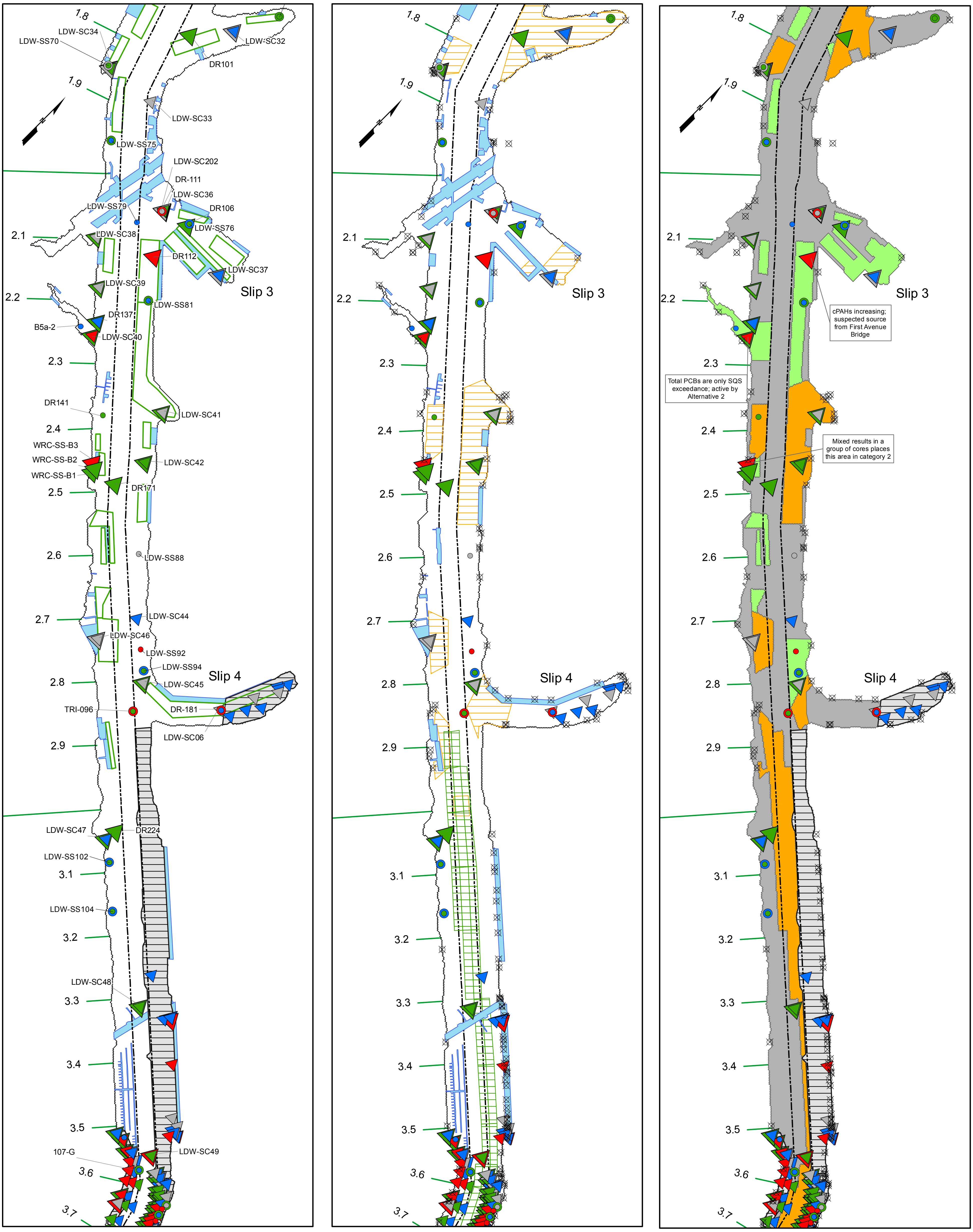
Empirical Trends, Scour Areas, and Recovery Categories (RM 0.0 to 1.9)

DATE: 10/31/12 | DWRN:MVI/sea | Revision: 0

FIGURE F-22a



Notes:
1. If a core symbol does not appear, the core did not have samples at the appropriate intervals to evaluate trends for either total PCBs or other SMS contaminants. For example, there is no total PCB symbol for SC23 because PCBs were only analyzed in the 2-ft samples. Other SMS contaminants were analyzed at finer depth intervals.
2. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.

Legend

Natural Recovery Empirical Data

Resampled Surface Sediment Location Total PCBs ◐ Resampled Surface Sediment Location Other SMS Contaminants

Top Two Intervals in Cores Total PCBs ◭ Top Two Intervals in Cores Other SMS Contaminants

🟩 Below SQS

🟥 Data that do not Support Recovery (≤ 50% Concentration Increase)

🟦 Data that do Support Recovery (≥ 50% Concentration Increase)

⬜ Station in Equilibrium or Mixed Result

Physical Lines of Evidence Used in Assigning Recovery Categories

▨ STM Predicted 100-Year High-flow Scour ≥ 10 cm

▨ Evidence of Propeller Scour

☐ Berthing Area

🟦 Overwater Structure

Recovery Category

🟧 Category 1: Recovery Presumed to be Limited

🟩 Category 2: Recovery Less Certain

⬜ Category 3: Predicted to Recover

▨ Early Action Area

-·-·- Navigation Channel

— River Mile Marker

⌖ Outfall Location

Feet
0 200 400 800

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Empirical Trends, Scour Areas, and Recovery Categories (RM 1.9 to 3.6)

DATE: 10/31/12 | DWRN:MVI/sea | Revision: 0

FIGURE F-22b

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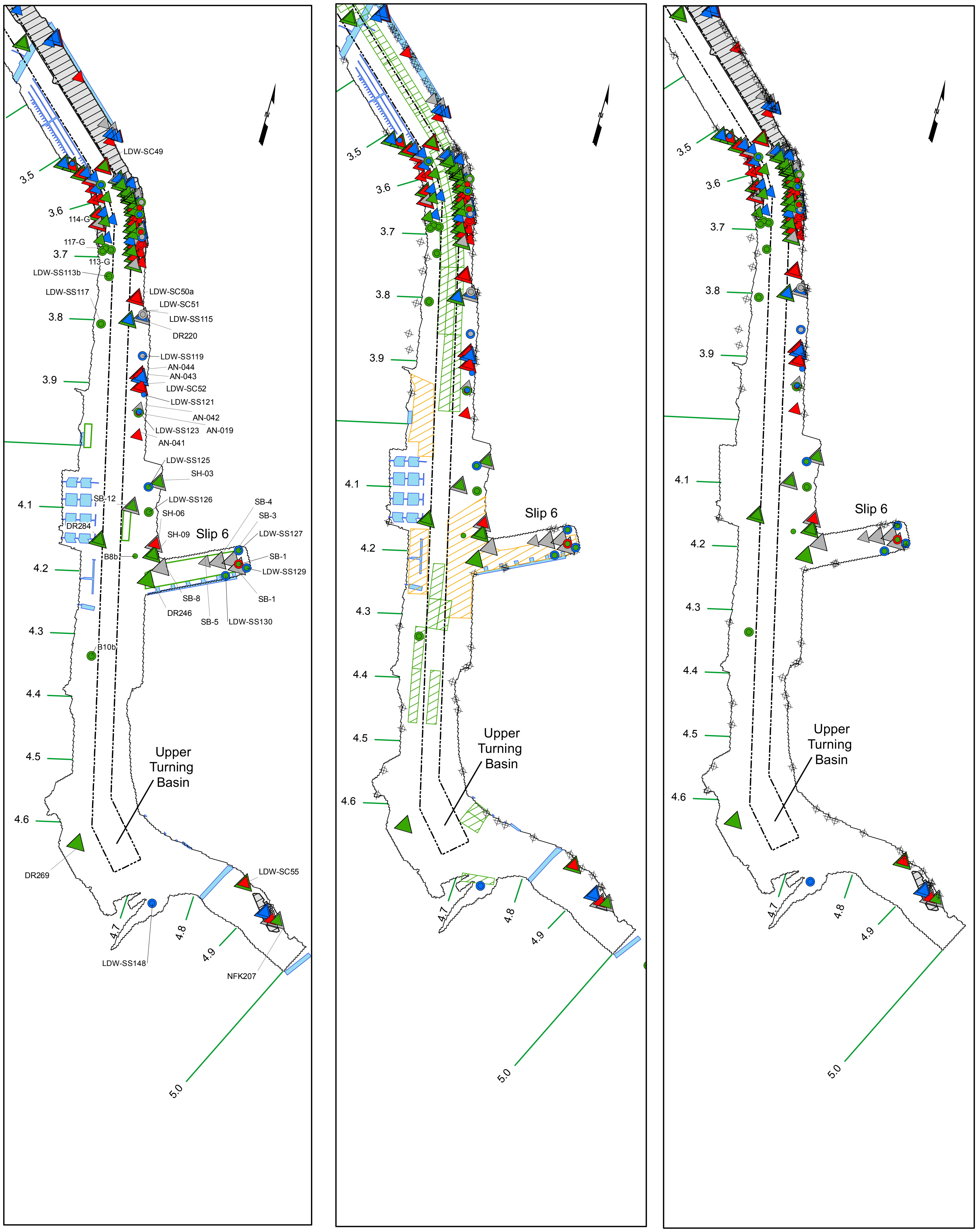

Notes:
1. If a core symbol does not appear, the core did not have samples at the appropriate intervals to evaluate trends for either total PCBs or other SMS contaminants. For example, there is no total PCB symbol for SC23 because PCBs were only analyzed in the 2-ft samples. Other SMS contaminants were analyzed at finer depth intervals.
2. Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and LDWG personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications.

Feet
0 200 400 800

Legend

Natural Recovery Empirical Data

Resampled Surface Sediment Location Total PCBs ◎ Resampled Surface Sediment Location Other SMS Contaminants

Top Two Intervals in Cores Total PCBs △ Top Two Intervals in Cores Other SMS Contaminants

🟩 Below SQS

🟥 Data that do not Support Recovery (≤ 50% Concentration Increase)

🟦 Data that do Support Recovery (≥ 50% Concentration Increase)

⬜ Station in Equilibrium or Mixed Result

Physical Lines of Evidence Used in Assigning Recovery Categories

▨ STM Predicted 100-Year High-flow Scour ≥ 10 cm

▨ Evidence of Propeller Wash Scour

☐ Berthing Area

🟦 Overwater Structure

Recovery Category

🟧 Category 1: Recovery Presumed to be Limited

🟩 Category 2: Recovery Less Certain

⬜ Category 1: Predicted to Recover

▨ Early Action Area

-·-·- Navigation Channel

— River Mile Marker

⌖ Outfall Location

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Empirical Trends, Scour Areas, and Recovery Categories (RM 3.6 to 5.0)

DATE: 10/31/12 | DWRN:MVI/sea | Revision: 0 | **FIGURE F-22c**

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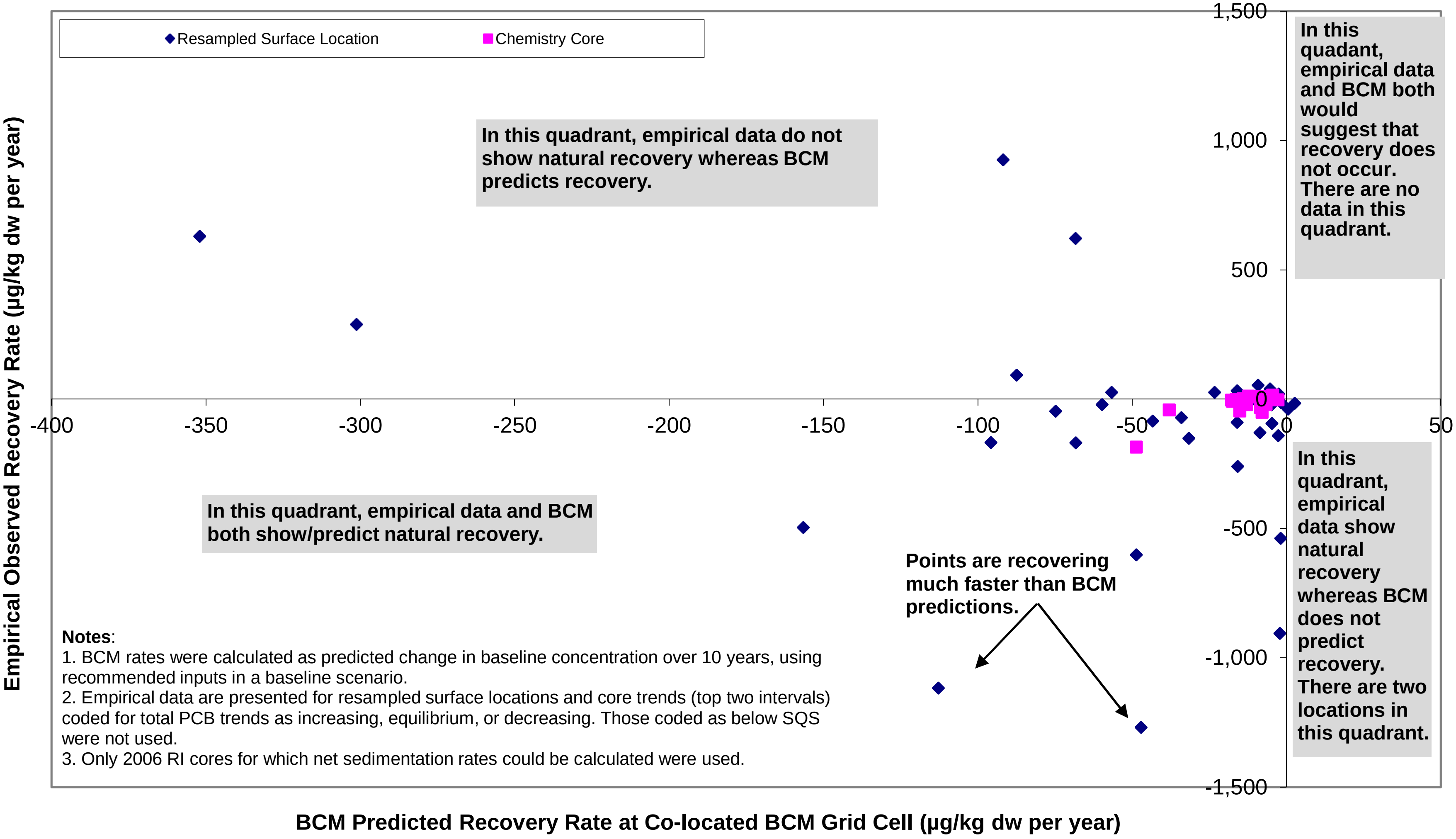
Figure F-23 Comparison of BCM and Empirical Data Recovery Rates for Total PCBs



In this quadrant, empirical data do not show natural recovery whereas BCM predicts recovery.

In this quadrant, empirical data and BCM both would suggest that recovery does not occur. There are no data in this quadrant.

In this quadrant, empirical data and BCM both show/predict natural recovery.

Points are recovering much faster than BCM predictions.

In this quadrant, empirical data show natural recovery whereas BCM does not predict recovery. There are two locations in this quadrant.

Notes:
1. BCM rates were calculated as predicted change in baseline concentration over 10 years, using recommended inputs in a baseline scenario.
2. Empirical data are presented for resampled surface locations and core trends (top two intervals) coded for total PCB trends as increasing, equilibrium, or decreasing. Those coded as below SQS were not used.
3. Only 2006 RI cores for which net sedimentation rates could be calculated were used.