Lower Duwamish Waterway

Source Tracing Data Evaluation: Stormwater Pathway

Volume 1: Text and Tables

Prepared for

DEPARTMENT OF ECOLOGY
State of Washington

Toxics Cleanup Program
Northwest Regional Office
Washington State Department of Ecology
Bellevue, Washington

Prepared by

SAIC
From Science to Solutions

Science Applications International Corporation
18912 North Creek Parkway, Suite 101
Bothell, WA 98011

and

NEWFIELDS

NewFields
115 2nd Ave N
Suite 100
Edmonds, WA 98020

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LIMITATIONS

SAIC's investigation was restricted to collection and analysis of a limited number of environmental samples, visual observations, and/or field data, in addition to summarizing available information from previous site documents. Because the current investigation consisted of evaluating a limited supply of information, SAIC may not have identified all potential items of concern. This report is intended to be used in its entirety; taking or using excerpts from this report is discouraged.

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List of Acronyms

2LAET	Second Lowest Apparent Effects Threshold
BBP	butyl benzyl phthalate
BDC	Boeing Developmental Center
BEHP	bis(2-ethylhexyl)phthalate
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	Cleanup Screening Level
CSO	combined sewer overflow
DW	dry weight
EAA	Early Action Area
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
EOF	Emergency Overflow
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GIS	geographic information system
GTSP	Georgetown Steam Plant
HPAH	high molecular weight PAH
KCIA	King County International Airport
LAET	Lowest Apparent Effects Threshold
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LPAH	low molecular weight PAH
MDL	method detection limit
mg/kg	milligrams per kilogram
MHHW	mean higher high water
MLLW	mean lower low water
MRL	method reporting limit
ng/kg	nanograms per kilogram
NBF	North Boeing Field
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PCA	Principle Components Analysis
PCB	polychlorinated biphenyl
pg/L	pictograms per liter
RAL	remedial action level
RI	Remedial Investigation
RM	river mile
ROW	right-of-way
SAIC	Science Applications International Corporation
SCA	source control area
SCAP	Source Control Action Plan
SD	storm drain
SL	screening level

SMS	Sediment Management Standards
SPU	Seattle Public Utilities
SQS	Sediment Quality Standard
SVOC	semivolatile organic compound
TEF	toxic equivalent factor
TEQ	toxic equivalent quotient
TOC	total organic carbon
TSS	total suspended solids
ug/kg	micrograms per kilogram
ug/L	micrograms per liter
UCL	upper concentration limit
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code
WQC	Water Quality Criteria

1.0 Introduction

The Lower Duwamish Waterway (LDW) is located south of Elliott Bay in Seattle, Washington. The LDW Site consists of 5.5 miles of the Duwamish Waterway as measured from the southern tip of Harbor Island to just south of the Norfolk Combined Sewer Overflow (CSO) (Figure 1-1). As part of the cleanup of contaminated sediment at the Site, the Washington State Department of Ecology (Ecology) is leading efforts to control sources of pollution, including polychlorinated biphenyls (PCBs), metals, polycyclic aromatic hydrocarbons (PAHs), phthalates, and dioxins/furans, into the LDW. Source control is the process of finding and stopping or reducing releases of pollution to the waterway. The goal of source control is to minimize contamination or recontamination of sediments by controlling the sources of pollutants to the maximum extent practicable.

Contaminants may be transported to LDW sediments by the following transport mechanisms: direct discharge via storm drain and CSO outfalls, surface runoff (sheet flow), groundwater discharge, bank erosion, atmospheric deposition, and spills directly to the LDW. This data evaluation addresses only the storm drain and CSO direct discharge pathway; other pathways may have a significant impact on LDW sediment concentrations.

The evaluation presented in this report was conducted over a two-month period in October and November 2011; while Science Applications International Corporation (SAIC) believes the data presented in this report is accurate, the accelerated schedule imposed some limitations and required the adoption of simplifying assumptions as described in Section 1.4 below. This evaluation should be considered preliminary and is intended to supplement other sources of information available to Ecology.

1.1 Purpose and Objectives

In November 2010, Ecology tasked SAIC with documenting what is known about LDW sediments around the approximately 250 stormwater outfalls that discharge to the LDW Site. As part of this effort, SAIC compiled information about each outfall and reviewed available data about the quality of effluent and storm drain solids in the basins draining to each outfall. Based on the data gaps identified during this exercise, SAIC developed and implemented a sediment sampling plan to address data gaps. Results were published in *Data Report, Surface Sediment Sampling at Outfalls in the Lower Duwamish Waterway* (SAIC 2011a).

The data evaluation presented in this draft *LDW Source Tracing Data Evaluation Report* is a follow-on to the outfall study; it attempts to combine available sediment, stormwater, and storm drain solids data collected by various LDW stakeholders to gain a better understanding of the relationship between contaminants in stormwater and contaminant concentrations in sediments; to identify areas where additional data are needed in order to identify and control contaminant sources; to assist Ecology with the prioritization of source control efforts; and to compare stormwater and storm drain solids sampling methods so that future data collection efforts can provide needed information in a timely and cost-effective manner.

Ecology and other agencies have conducted sampling and data collection concurrent with this outfall study. These new data provide additional information about the nature and concentration of contaminants in stormwater and storm drain solids in combined sewer systems, municipal storm drain lines, and storm drain lines associated with private outfalls covered under a National Pollutant Discharge Elimination System (NPDES) permit.

For this Data Evaluation Report, SAIC and its subcontractor, NewFields, have consolidated data compiled during the outfall study with other available sediment and storm drain sampling data. These data include:

- LDW Draft Final Feasibility Study (FS) dataset;
- Seattle Public Utilities (SPU) source tracing data through June 2011, including sediment trap solids, in-line solids, and catch basin solids data (SPU 2010; Schmoyer 2011);
- Data collected during the Stormwater Lateral Loading Study (SAIC and NewFields 2011a);
- Data collected during the Accelerated Source Tracing Study (SAIC and NewFields 2011b);
- Data collected during stormwater monitoring at North Boeing Field (NBF) (SAIC 2010a, 2010b, 2011b); and
- Data from other studies conducted by the city of Seattle, King County, the Port of Seattle, the Boeing Company, or NPDES permittees in the LDW basin.

Data tables have been prepared to summarize information about the numbers and types of samples collected in LDW sediments and storm drains, organized by chemical and by source control area. Maps depict sampling locations and exceedances of screening levels. This report also notes observations relevant to source control, identifies data gaps, and presents recommendations for further evaluation.

1.2 Report Organization

Section 1 summarizes the purpose and objectives, defines terminology used, and identifies important assumptions and limitations. Section 2 describes the data that were compiled for this evaluation, including data sources, data selection rationale, selection of chemicals for evaluation, and data reduction criteria. Section 3 describes the spatial distribution of chemicals in storm drain solids and river sediments, and identifies relationships between them, if any. Section 4 evaluates whether chemical concentration ratios can be useful for identifying potential sources of PCBs and PAHs, and assesses the relationship between PCB, PAH, and dioxin concentrations, if any. Section 5 compares different storm drain sampling methods, including sediment trap sampling, grab sampling, filtered suspended solids sampling, bedload sediment trap sampling, and whole water sampling. Section 6 presents results and conclusions, and Section 7 lists documents referenced in this report.

Text and tables are presented in Volume 1. Figures are presented in a separately bound Volume 2.

1.3 Terminology

This section defines terminology used in this report that may differ from how these terms have been used in other documents. These definitions were applied to simplify the text, tables, and figures, and to improve the readability of this report.

As used in this report, storm drain solid means any sample of solid material collected in a storm drain structure or pipe, including catch basins, maintenance holes, oil/water separators, or vault. Storm drain solids, as defined in this report, include samples collected by various methods, including grab samples, sediment trap samples, filtered suspended solids samples, bedload sediment trap samples, and centrifuged solids samples.

Sediment refers to a sample collected from the waterway; storm drain solids may become sediments after they are discharged through an outfall and settle to the river bottom. Larger storm drain solids particles will settle nearer to the outfall, while smaller particles may be transported some distance downstream prior to settling. Tidal effects, particularly near the downstream end of the LDW and in slips/inlets, may result in "blurring" of this effect. Additional information about sediment deposition and transport is provided in the LDW Remedial Investigation (RI) Report (Windward 2010).

Screening level refers to the values used for comparison of environmental samples to assess whether a given concentration may be of potential concern. For most chemicals, two screening levels are defined: a lower screening level (lower SL) and an upper screening level (upper SL). The screening levels used in this report are summarized in Table 1-1.

- The screening levels used for metals and phenols are the Washington State Sediment Management Standards (SMS) benthic risk criteria; the Sediment Quality Standard (SQS) is used as the lower SL, and the Cleanup Screening Level (CSL) is used as the upper SL (Ecology 2008). Concentrations below the SQS are expected to have no adverse effects on biological resources and no significant human health risk. The CSL is considered a minor effects level used to identify areas of potential concern. The applicability of these sediment standards to storm drain solids is discussed in Section 1.4 below.
- For PCBs, PAHs, phthalates, and most other organic compounds, the SMS criteria are normalized to organic carbon content of the sediment. However, total organic carbon (TOC) was not always measured in storm drain solids samples; therefore, for these chemicals, measured concentrations are compared to the lowest apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET), which are functionally equivalent to the SQS and CSL. LAET and 2LAET criteria, used to represent a lower SL and upper SL, respectively, are presented on a dry weight (DW) basis (PTI 1988).
- No benthic risk criteria exist for carcinogenic PAH (cPAH) and dioxin/furan toxic equivalent quotient (TEQ). Concentrations of these chemicals are compared to the remedial action levels (RALs) and upper concentration limits for enhanced natural recovery (ENR) from the Lower Duwamish Waterway Group (LDWG) Key Elements technical memorandum (LDWG 2011).
- Marine water quality criteria (WQC) for metals and total PCBs were taken from Washington Administrative Code (WAC) 173-201A-240 (Table 1-1). The marine chronic

WQC was used to represent a lower SL; the marine acute WQC was used to represent an upper SL. The marine WQC values apply to dissolved metals; the values in Table 1-1 were converted to total metals using conversion factors provided in WAC 173-201A-240. Actual partitioning between the total and dissolved phases varies by location and conditions. The WQC in Table 1-1 represent conservative criteria.

A stormwater chemical of potential concern (COPC) is a chemical that exceeds a screening level in both storm drain solids and surface sediments within a given source control area. A chemical identified as a stormwater COPC may or may not represent a sediment recontamination risk, depending on the specific locations of screening level exceedances. Alternatively, a chemical that was not identified as a stormwater COPC (using the definition above) may nevertheless pose a sediment recontamination risk. For example, if a chemical was detected above screening levels in surface sediment but few or no storm drain samples have been collected, it may be impossible to determine whether it is a stormwater COPC at this time.

1.4 Limitations and Assumptions

Significant limitations and assumptions used in this evaluation are identified below:

- Available surface sediment and storm drain data collected since January 1, 2000 were used, and include data received by SAIC as of November 1, 2011. Additional data, if available, may be included in an updated version of this report. Reviewers are encouraged to identify and provide any other data that should be included in this evaluation. Data should be sent to Dan Cargill, Washington State Department of Ecology, 3190 160th Avenue SE, Bellevue, WA 98008.
- Source control area boundaries have been delineated for purposes of this data evaluation exercise and are approximate. In general, they match closely with source control area boundaries defined in Data Gaps Reports that have been completed to date, and include public and private storm drain basins but not CSO basins, except as they overlap with public and private storm drain basins. In addition, source control area boundaries include properties adjacent to the LDW and generally use East Marginal Way S (on the east side of the LDW) and West Marginal Way SW (on the west side of the LDW) to bound areas that are not within a public storm drain basin.
- All storm drain solids samples within the boundaries of a source control area, as defined in this report, were assigned to that source control area. This includes samples with stormwater drainage to a public or private storm drain or to a combined sewer. Due to time constraints, it was not possible to distinguish sample locations where stormwater drains to a combined sewer from those where stormwater drains to a public or private storm drain.
- Stormwater outfalls that discharge to the LDW are often submerged at high tide stages, allowing river water to flow up into the storm drain lines. The effect of tidal intrusion on contaminant concentrations measured in storm drain solids was not evaluated in this report. Figure 1-2 identifies the extent of tidal intrusion into storm drain lines in the LDW basin at mean higher high water (MHHW). MHHW for the LDW is +11 feet of mean lower low water (MLLW). Lateral lines and private storm drain lines are not included on this figure. Large areas where no structures are displayed on Figure 1-2 generally indicate

areas drained by private lines, areas that drain to combined sewers, or areas where public storm drain lines do not have associated elevation data.

- This report assumes that contaminants in LDW surface sediments reflect stormwater inputs from nearby outfalls and properties. Other contaminant sources and pathways are not included in this evaluation.
- Sediments were assigned to a source control area based on the northern and southern source control area boundaries along the adjacent shoreline and to the edge of but not including the navigation channel. Contaminants in river water or sediments that are transported downstream and out of the source control area, or that enter a source control area from upstream, may not be reflected in the discussion specific to each source control area.
- This data evaluation assumes that storm drain solids are transported through the storm drain or combined sewer system and are discharged to the LDW, and that solids samples collected from the storm drain piping, catch basins, oil/water separators, and other structures are representative of the solids that are discharged.
- Figures and tables that show storm drain solids sample results include all storm drain solids samples (with the exception of bedload sediment trap samples and other specific exceptions as noted in Sections 2 and 3). Due to time constraints, figures and tables do not distinguish between inline samples and catch basin samples.
- It is recognized that different types of storm drain solids samples (e.g., sediment traps, inline solids, catch basin solids, filtered solids) may represent different particle size distributions, which may or may not match the particle size distribution of the solids discharged to the LDW. Evaluation of particle size distributions is beyond the scope of this report.
- Inline and catch basin solids samples provide different information about potential contaminant sources and transport pathways; separating inline and catch basin solids data and evaluating them as different sample types would be useful to refine the results provided in this report.
- Due to the short timeframe of this data evaluation exercise, limited quality control review has been performed. Some errors may be present in the database, and some data may have been inadvertently excluded.
- There are no regulatory standards for catch basin solids, inline solids, and sediment trap samples. As described in Section 1.3, results were compared to Washington State SMS. Although these standards do not apply to storm drain sediments, they are used as benchmarks in this report to provide a rough indication of storm drain solids quality.
- Comparison of storm drain solids collected from catch basins, manholes, and sediment traps to SMS is considered conservative. If source sample concentrations in a stormwater drainage basin are below the SMS, there is little chance that sediment near the storm drain outfall will be recontaminated as a result of stormwater discharges. However, a concentration above the SMS does not necessarily indicate that sediment near the outfall will exceed standards, because solids discharged from a storm drain are dispersed in the receiving environment and mix with sediment from other sources before depositing.

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2.0 LDW Source Tracing Data

Accomplishing the objectives outlined in Section 1.0 first required the creation of a comprehensive Microsoft Access database containing physical and chemical parameter data from all available sources. Results from selected chemicals were extracted from the Access database and incorporated into a geodatabase format more conducive to data analysis and mapping. This section summarizes the data included in the Access database and geodatabase and describes the fields and sample types present in both versions of the database.

2.1 Data Source Compilation

Extensive sediment and storm drain investigations have been conducted in the LDW and surrounding drainage basin. These investigations have spanned upwards of 30 years. During this time, various remediation and source control efforts, as well as changes in sampling and analytical methodology, have made many of the older samples obsolete. For this reason, only data collected from the year 2000 and later have been incorporated into the database. The following sections provide a brief summary of each source from which the data were compiled for this study. Individual data sources are presented in order of largest to smallest spatial extent.

2.1.1 Surface Sediment Sampling Data

LDW Remedial Investigation/Feasibility Study (2001 to 2010)

The majority of surface sediment data used in this evaluation were taken from the databases associated with the LDW RI and FS documents.

The LDW RI Report (Windward 2010) provided a history and description of the LDW, presented a sediment transport model for the waterway, compiled historical and RI sampling data, and displayed distributions of contaminants in sediment, river water, and biological tissues. The RI database is dated July 19, 2010.

The LDW Draft Final FS was submitted to the U.S. Environmental Protection Agency (EPA) in October 2010 (AECOM 2010). The objectives of the FS were to evaluate alternatives to environmental remediation for the LDW (AECOM 2010). The database used to prepare the FS (dated November 5, 2010) was based on the RI dataset but included results from more recent sampling. Because the FS database contained the most recent data, it was used to represent the full RI/FS data set.

All unique records for surface sediment grab samples, typically collected from the top 0 to 10 cm, from January 1, 2000 and later, were included in the Access database.

Surface Sediment Sampling at LDW Outfalls (2011)

In 2011, SAIC collected surface sediment grab samples from the vicinity of 85 outfalls on the LDW for Ecology. All known outfalls on the LDW were considered for sampling; the study targeted sediment collection near stormwater outfalls and CSOs at locations where data had not previously been collected. Samples were collected with the intent to better understand the relationship between storm drain outfall discharges and sediment contamination.

Results from this sampling program are summarized in *Data Report, Surface Sediment Sampling at Outfalls in the Lower Duwamish Waterway* (SAIC 2011a), which was submitted to Ecology in October 2011. All of the surface sediment results from the outfall survey were included in the Access database.

Slip 4 Sediment Sampling (2010)

In 2010, as part of the RI/FS for the North Boeing Field/Georgetown Steam Plant (NBF-GTSP) site near Slip 4, SAIC sampled surface sediments in Slip 4. These samples were collected to support sediment recontamination modeling for contaminants in stormwater from the NBF-GTSP site. Results of this sampling program are summarized in *Slip 4 Sediment Recontamination Modeling Report* (SAIC 2010c). All of the surface sediment analytical data from the Slip 4 sediment sampling effort were included in the Access database. Cleanup of sediments in Slip 4 is currently in progress.

2.1.2 Storm Drain Sampling Data

SPU Source Tracing Program (2005 to 2011)

SPU is responsible for conducting source tracing and source control activities in city-owned storm drain lines. Additional sampling has been conducted by SPU under an interagency agreement with Ecology. SPU has collected inline sediment trap samples, inline grab samples, and catch basin grab samples. Catch basin grab samples were collected from either a specific site or property (on site) or from public rights-of-way (ROW). In addition, SPU has collected opportunistic samples, such as surface soil and surface debris.

Results of SPU's source tracing and source control efforts between July 2005 and September 2010 are summarized in a December 2010 progress report (SPU 2010). Additional data have been collected in late 2010 and 2011. SPU provided a spreadsheet containing all SPU LDW storm drain sampling data collected between 2005 and June 2011 to SAIC during preparation of this data evaluation report (Schmoyer 2011).

Several storm drain solids samples collected by SPU during 2010 and 2011 were analyzed for dioxin/furan congeners as part of an interagency agreement with Ecology. A spreadsheet containing these results was compiled by SPU and provided to SAIC by Ecology (Personal communication with Dan Cargill, October 7, 2011).

All of the sample data from SPU source tracing activities collected from 2000 and later was included in the Access database.

LDW Stormwater Lateral Loading Study (2010 to 2011)

The LDW Stormwater Lateral Loading Study was conducted by SAIC and NewFields for Ecology to estimate lateral contaminant loadings from four significant stormwater outfalls within the LDW. One objective of the study was to collect samples using multiple collection methods; sample types included whole water, filtered solids, sediment traps, and bedload sediment traps. All sampling and analysis was conducted during the 2010–2011 wet season.

Lateral loading results are summarized in the *Stormwater Lateral Loading Study Data Report* (SAIC and NewFields 2011a). All stormwater, filtered solids, and sediment trap sample analytical data from this project were included in the Access database.

LDW Accelerated Source Tracing Study (2010 to 2011)

The LDW Accelerated Source Tracing Study was conducted by SAIC and NewFields for Ecology to measure contaminant concentrations associated with stormwater and storm drain solids at multiple locations in a major storm drain basin. One objective of the study was to collect samples using multiple collection methods; sample types included whole water, filtered solids, sediment traps, and bedload sediment traps. All sampling and analysis was conducted during the 2010/2011 wet season.

Results are summarized in the *Accelerated Source Tracing Study Data Report* (SAIC and NewFields 2011b). All of the stormwater, filtered solids, and sediment trap sample analytical data from this project were included in the Access database.

Storm Drain Sampling at North Boeing Field (2000 to 2011)

As part of the NBF-GTSP RI/FS being conducted for Ecology, SAIC has compiled all data collected from NBF-GTSP site into a single project database. This database includes samples collected at NBF, GTSP, and those portions of King County International Airport (KCIA) with stormwater drainage to Slip 4. Samples collected from the Georgetown Flume, which was replaced in 2009, were excluded.

The NBF-GTSP database includes sediment trap, filtered solids, and storm drain grab samples collected by Boeing and its contractors, and filtered solids, whole water samples, and centrifuge samples collected by SAIC for Ecology (SAIC 2010a, 2010b, 2011b).

Samples included in the NBF-GTSP database that were collected from the storm drain system between 2000 and 2011 were included as part of the Access database.

Boeing Developmental Center Annual Sampling (2010)

Beginning in 2002, voluntary source control monitoring has been conducted at the Boeing Developmental Center (BDC) to evaluate the effectiveness of remediation measures implemented. Monitoring activities in 2010 included the collection of backfill material samples from the sediment remediation area, stormwater filtered solids samples, and sediment trap samples from the south storm drain line at BDC (Calibre 2011). All of the 2010 monitoring data from BDC were included in the Access database.

Boeing Isaacson-Thompson Storm Drain Monitoring (2011)

As a result of an agreed order with Ecology, Boeing is required to monitor the storm drain system at the Boeing Isaacson-Thompson facility. The 2011 monitoring activities included the collection of storm drain solids samples from several catch basins, as well as two oil/water separators and treatment vaults at the facility. All results are available in the *2011 Progress Report: Boeing Isaacson-Thompson Site* (Boeing 2011). All of the storm drain solids sample results from September 2011 were included in the Access database.

SPU NPDES Phase I Monitoring

The City of Seattle is required by its NPDES permit to collect and analyze stormwater discharge samples from three municipal outfalls. One of the three locations sampled for the 2009–2010 wet season was located in the LDW basin; the Norfolk storm drain monitoring location was representative of an industrial basin. Eleven whole water samples and one sediment trap sample were collected during this time. Results are reported in *City of Seattle 2010 NPDES Phase I Municipal Stormwater Permit Stormwater Monitoring Report* (SPU 2011). Data from the relevant location were added to the Access database.

King County CSO Sampling (2007 to 2009)

Water samples were collected from CSOs at seven locations in the LDW basin during 2007 to 2009 (King County 2009). Samples were analyzed for PCBs, semivolatile organic compounds (SVOCs), selected metals, and conventional parameters. Because of the difficult in sampling actual CSO events, samples were collected to represent partially- to near-full conditions of the combined sewer collection system. Sampling locations included the Michigan Street Regulator, the West Michigan Regulator, the Brandon Street CSO, the Duwamish Siphon Forebay, the Hanford #2 CSO, the Lander II Regulator, and the Kingdome Regulator. Results from samples collected within the LDW source control area boundaries were included in the Access database.

Additional Data Sources

Other data were added to the Access database, as available, if they were not included in another dataset identified above. These include the following:

- Two intertidal surface sediment samples were collected near South Park Marina in 2008 (SAIC 2008a).
- Two stormwater samples were collected by King County in March 2009 at KCIA SD#2 and the KCIA South Pump Station. Both samples were analyzed for metals and results were provided to Ecology (Dumaliang 2009). Results from both samples have been included in the Access database.
- Catch basin samples were collected by the Port of Seattle in June/July 2010 at Terminal 117 (Kuroiwa 2010).

The following storm drain samples were not included in the Access database:

- Samples collected in 2002 from BDC oil/water separators were not included due to issues with data quality and questions regarding the sampling locations and identification (SAIC 2010d).
- One storm drain solids sample and one water sample were collected from the 2nd Avenue S SD outfall pipe in 2007 (SAIC 2009a). It was not clear whether these samples represented material traveling downstream in the storm drain pipe, or were inlet sediments that had been transported to the discharge pipe due to tidal effects. Sediment samples collected during this sampling event were included in the LDW FS dataset.

Stormwater (whole water) data for chemicals of interest with respect to sediment recontamination in the LDW are limited. Composite stormwater sampling data that were co-located with storm drain solids samples were included in the Access database. These stormwater data were used to compare sample collection methods in Section 5. Recent King County CSO sampling data and SPU NPDES Phase I monitoring data were also included in the Access database.

Due to time constraints for this project, however, other NPDES stormwater monitoring data were not included. The following water sampling data are not currently included in the Access database:

- NPDES monitoring data for facilities covered under the industrial stormwater general permit. Monitoring data typically includes few of the chemicals of greatest interest with respect to sediment recontamination. Monitoring for copper and zinc is required for all facilities; other metals may be required depending on the facility type.
- NPDES monitoring data for facilities covered under individual permits. These may include monitoring parameters specific to the activities conducted at the site, including chemicals of interest with respect to sediment recontamination. Seattle Iron & Metals, Lafarge Corporation, Nucor Steel Seattle, and Ash Grove Cement currently hold active individual NPDES permits.

Relevant data will be added to an updated version of the Access database, if schedule and budget allow.

2.2 Access Database Structure

The Access database was constructed using data from the sources listed above, consistent with the following criteria:

- Data were collected in the year 2000 or later.
- Only surface sediment grab samples (generally 0 to 10 cm) were included.
- Storm drain solids and whole water samples were included as available.

The Access database was kept as simple as possible. Table 2-1 presents the data entry fields, a short description of each field, and example input. State plane X and Y coordinates were usually available in electronic format. When necessary, coordinates were digitized from maps.

The list of available sample types is presented in Table 2-2. Catch basin grab samples, ROW catch basin grab samples, and inline grab samples are collectively referred to as *SD Grab*. The individual grab sample types are described in the *Grab Type* field (Table 2-1).

Parameter names include compound group sums such as total PCBs, total high molecular weight PAH (HPAH), and total low molecular weight PAH (LPAH), and TEQ-based concentrations for cPAH and dioxin/furan congeners. Sums were calculated following Ecology guidance (Ecology 2008). TEQ values were calculated using the toxicity equivalent factors (TEF) from *Evaluating the Toxicity and Assessing the Carcinogenic Risk of Environmental Mixtures Using Toxicity Equivalency Factors* (Ecology 2007) and substituting one-half the detection limit for non-detected concentrations.

Units were reported as milligrams per kilogram (mg/kg) for most chemicals in sediment and storm drain solids, and as ug/L for most chemicals in the whole water samples. Table 2-3 lists chemicals parameter groups and the units of measure used in this report.

Qualifiers were reported as given. No assumptions were made about the validation level of data from each source. Data qualified as U, UJ, or Y all represented non-detected concentrations and were assigned a Y value in the *Undetect_Flag* field. Non-detected values may have been listed at the method reporting limit (MRL) or method detection limit (MDL). Results with J qualifiers denoting estimated concentrations were listed at the reported value.

Due to overlap between datasets incorporated into the Access database, and inconsistencies in labeling of field replicates between projects, several of the samples entered into the Access database were duplicates. Most of these duplicates are believed to have been removed from the database during the initial spatial analysis. However, it is likely that some remain.

An electronic copy of the Access database is available on CD as Appendix A.

2.3 Geodatabase Structure

The Access database was built to serve as the master copy for all LDW data. However, the structure of data in Access and the over 400 possible parameters present in the database complicated spatial and statistical evaluations. A subset of relevant parameters was exported from Access into the geodatabase format required for geographic information system (GIS) data entry.

The geodatabase is a transposed copy of the Access database, where the *StudyID*, *LocationID*, *SCA*, *X_coord*, *Y_coord*, *CollectionDate*, *Matrix*, and *Sample Type* fields are listed in the first eight columns, respectively. The parameter names are listed across the top row. A data user can look vertically down the first column to find a location of interest, and look horizontally across the row to find the coordinates, sample type, and chemical results associated with that location. The *Undetect_Flag* for each location and parameter was included to differentiate non-detected results from detected results.

Parameters exported to the geodatabase included metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), all PAH compounds, total HPAH, total LPAH, cPAH TEQ, all phthalates, all phenols, all PCB Aroclors, total PCBs, all dioxin/furan congeners, and total dioxin TEQ. Arsenic, cPAH, total PCBs, and dioxin/furan TEQ were included in the geodatabase because of their status as the primary human health risk drivers in the LDW RI (Windward 2010). The remaining parameters were included in the geodatabase due to frequent exceedances of screening levels; selection of chemical parameters for evaluation is discussed further in Section 3.1.

Two versions of the geodatabase were created. To minimize confusion during preparation of this data evaluation report, different names were assigned to the two geodatabase versions. The larger and more comprehensive version was called the Sherlock database, while the smaller and more concise version was called the Watson database. The contents of each are described below. Both versions of the geodatabase are presented electronically in Appendix A.

2.3.1 Sherlock Geodatabase

All of the sample types presented in Table 2-2 and all of the parameters presented in Table 1-1 were exported from the Access database to create Sherlock. The Sherlock database contains results from a total of 2,883 samples. These samples are broken down by sample type and source control area in Table 2-4. These sample totals include multiple samples collected at an individual location over time.

Of the 1,202 grab samples included in Sherlock (Table 2-4), 320 are inline samples, 208 are ROW catch basin samples, and 674 are onsite catch basin samples. Inline grab samples collected between 2002 and 2004 in the Duwamish/Diagonal Way source control area were removed from Sherlock, per request from SPU, because extensive storm drain line cleaning activities conducted in 2004 invalidated these results.

2.3.2 Watson Geodatabase

The Watson geodatabase is a subset of the data included in Sherlock. Watson contains only sample types associated with the sediment/solids matrix. Base flow water, stormwater, and tide water sample types are not included. In addition, only samples associated with storm events were retained in Watson; base flow filters, tide filters, and surface debris samples were not included.

Water samples were removed from Watson partly because of the difficulties in directly comparing water results to sediment results. Another reason for the exclusion of water samples was because there were relatively few samples collected from even fewer locations. A total of 117 stormwater samples were exported to the Sherlock database. However, most of these samples were collected at the same locations as part of discrete storm events. In total, only 26 unique locations in the Access database contained water data. Section 5.2 presents a comparison of whole water results from 20 of these locations with various solids sample types.

Watson contains only the most recent samples at locations where multiple samples were collected over time. This applies to the *SD Grab*, *Sediment Trap*, and *Surface Sediment Grab* sample types. The Sherlock database contains results for individual filtered suspended solids per storm event. In Watson, filtered solids samples at a given location were averaged over the course of a wet season (approximately October through April/May) to provide a single season result.

The Watson database contains 1,734 unique samples. These samples are broken down by sample type and source control area in Table 2-5. Most of the tables and figures in this report were constructed using Watson, including summary statistics tables, exceedance summary figures, and spatial distribution figures.

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3.0 Spatial Evaluation of Data

This section describes the spatial distribution of storm drain solids and surface sediment data in the Watson database by chemical parameter and by source control area. While there is overlap between these two approaches to data evaluation, they address complementary objectives. Section 3.1 provides an overview of the spatial evaluation and discusses the selection of chemicals included in the Watson database. Section 3.2 provides a "big picture" assessment of similarities and differences in screening level exceedances across the LDW basin, by chemical. Section 3.3 provides a more targeted evaluation of chemicals with exceedances of screening levels in storm drain solids and surface sediments in each individual source control area.

3.1 Overview of Spatial Evaluation

Figure 3-1 depicts the detection and screening level exceedance frequencies of chemicals in surface sediment and storm drain solids samples included in the Watson geodatabase. Figure 3-1 includes exceedance summaries for total HPAH, total LPAH, and cPAH; Figure 3-1b provides exceedance summaries for individual PAH compounds. The dark blue and medium blue bars indicate the percentage of samples that exceeded the higher SL and lower SL values listed in Table 1-1, respectively. The light blue/gray bars indicate the percent of samples in which a chemical was detected but did not exceed screening levels. The light brown bars represent the percent of samples in which a chemical was not detected. Total parameters such as PCBs or dioxin/furan TEQ were listed as non-detects if all constituent parameters were non-detect. Screening levels for total PCBs were applied to the individual Aroclors in this figure.

The following chemicals exceeded a screening level in at least half of storm drain solids or surface sediment samples included in the Watson geodatabase:

Chemical	No. of Samples	Percent of Samples that Exceed the Lower SL	Percent of Samples that Exceed the Upper SL
Storm Drain Solids			
Bis(2-ethylhexyl)phthalate (BEHP)	515	74	68
Total PCBs	900	69	24
Zinc	765	68	36
Butyl benzyl phthalate (BBP)	515	65	23
Cadmium	306	64	56
Aroclor 1254	900	51	16
Dioxins/Furans	75	50	16
Surface Sediments			
Total PCBs	727	51	11

Chemicals were generally detected more often in storm drain samples than in surface sediment samples; screening level exceedances were also more common in storm drain solids. This is as expected; storm drain solids are diluted and dispersed after they are discharged to the LDW. In addition, not all storm drain solids are discharged. Some storm drain structures for which grab sampling data are included in the Watson geodatabase were designed to capture solids and therefore reduce the potential for transport to a storm drain outfall and the LDW.

Chemicals with large differences between storm drain and surface sediment exceedances include the following:

Chemical	Percent of Samples that Exceed the Lower SL in Storm Drain Solids	Percent of Samples that Exceed the Lower SL in Surface Sediments
BEHP	74	4.6
BBP	65	9.9
Cadmium	64	0.3
Zinc	68	4.5

Dimethyl phthalate, diethyl phthalate, dibutylphthalate, and all of the phenols (including 4-methylphenol and 2,4-dimethylphenol) were detected in less than 50 percent of samples. Aroclors 1016, 1221, 1232, 1242, and 1248 have few detections, and were therefore not included in Figure 3-1. All detected Aroclors are included in the total PCB calculations.

Based on the detection and exceedance frequencies shown in Figure 3-1, and incorporating discussions with Ecology, the following 16 chemicals were selected for evaluation in this report:

Arsenic	Total LPAH	PCBs
Cadmium	Total HPAH	Dioxins/furans
Chromium	cPAH	
Copper	BEHP	
Lead	BBP	
Mercury	Di-n-octyl phthalate	
Zinc	Phenol	

3.2 LDW Data Coverage

Table 3-1 lists the 24 LDW source control areas identified by Ecology. This table includes the river mile (RM) location of each source control area relative to the southern tip of Harbor Island; it also lists the area encompassed within the source control area and lists the outfalls and public storm drain basins associated with each source control area. The Duwamish/Diagonal is the largest source control area, with over 2,700 acres, while KC Lease Parcels is the smallest at just 15 acres.

The total numbers of samples included in the Sherlock geodatabase are presented in Table 2-4. Samples are sorted by sample type and by source control area. Surface sediment grab samples were assigned to the nearest source control area. Sample numbers for the LDW main navigation channel, the combined sewer area on the east side of the LDW between the Duwamish/Diagonal Avenue and Slip 4 source control areas, and other samples not included within a source control area boundary are also listed in Table 2-4.

In all of the tables and figures associated with this section, source control areas are presented from north to south, first along the east side of the LDW and then along the west side.

In the Sherlock geodatabase, storm drain solids samples are primarily grab samples (1,202 samples), followed by sediment trap samples (276 samples), and filtered solids samples (145 samples). Surface sediment data consists almost exclusively of sediment grab samples (921 samples). Only four bedload solids sediment trap samples and only three centrifuge samples have been collected in the LDW. There are also substantial differences in sample counts between source control areas. Over 1,000 samples are associated with the Slip 4 source control area and 407 samples are associated with the Duwamish/Diagonal Way source control area. There 13 source control areas with 50 or fewer samples.

The total numbers of samples included in the Watson geodatabase are presented in Table 2-5, sorted by sample type and source control area. As discussed in Section 2.3.2, several sample types, including water samples, were not included in Watson. Seasonal averages were calculated for all filtered solids samples. Of the 145 discrete filtered solids sample listed in Table 2-4, only 26 seasonal averages are included in Watson (Table 2-5).

Fifteen percent of surface sediment grab samples were from locations sampled repeatedly since 2000, compared to 40 percent of storm drain grab samples and 74 percent of sediment traps.

Please note that not all samples were analyzed for all parameters; therefore the number of samples listed in Tables 2-4 and 2-5 may not match the number of samples for an individual analyte in a given source control area.

Five source control areas have no storm drain solids data: Spokane Street to Ash Grove Cement; Slip 1; King County Lease Parcels; St. Gobain to Glacier NW; and Slip 2 to Slip 3.

3.3 Basin-Wide Spatial Evaluation

This section describes basin-wide distributions of the chemicals selected for evaluation. Tables 3-2 through 3-17 provide a summary of the data for each of the 16 chemicals, sorted by source control area. The tables include frequency of detection, minimum and maximum concentrations, average concentration, and standard deviation for each chemical in each source control area. Concentrations that exceed screening levels (from Table 1-1) are highlighted.

Figures 3-2 through 3-17 provide maps that show detections and exceedances for each of the 16 chemicals listed in Section 3.1. Each map consists of three panels that depict the LDW basin from north to south. The southern portions of the Sea King Industrial Park and Restoration Areas source control areas are not included in these figures; however, no sampling has been conducted in these areas.

Figures 3-18 through 3-32 present bar graphs summarizing exceedance percentages for surface sediment and storm drain solids data, by chemical and by source control area. As described for Figure 3-1, the dark blue and medium blue bars represent the percent exceedance of the higher SL and lower SL, respectively. The gray bars indicate the percent of samples where the parameter was detected but did not exceed a screening level, and the light brown bar indicates the percentage of non-detects.

These figures include the same data as Figures 3-2 through 3-17, but provide a more quantitative assessment of LDW exceedances. These figures also complement the information in Tables 3-2 through 3-17 in that they allow the reader to compare storm drain and surface sediment concentrations of each chemical by source control area, and provide a comparison of screening level exceedances based on RM location. As noted previously, source control areas are listed from north to south, and east side then west side of the LDW.

Ratios between the frequency of lower SL exceedances in surface sediments and storm drain solids were calculated, as shown below. For example, the exceedance frequency ratio between PCBs in surface sediment and PCBs in storm drain solids is 0.75. This ratio was calculated as follows: 51 percent of sediment samples and 68 percent of storm drain solids samples exceeded the lower SL for PCBs; 51 / 68 = 0.75. If the exceedance frequencies in sediments and storm drains were the same, the ratio would be 1.0. A ratio greater than 1 indicates that a higher proportion of sediment samples exceeded screening levels than did storm drain samples. A ratio less than 1 indicates that a higher proportion of storm drain solids samples exceeded screening levels than did sediment samples. Due to dilution effects, a ratio significantly less than 1.0 is expected if storm drain solids represent the sole contributor to sediment contaminant concentrations.

Chemical	Frequency of Lower SL Exceedance in Surface Sediments	Frequency of Lower SL Exceedance in Storm Drain Solids	Exceedance Frequency Ratio (Surface Sediment to Storm Drain Solids
Arsenic	2.7%	2.8%	0.97
Total PCBs	51%	69%	0.74
Mercury	4.8%	14.5%	0.33
Phenol	3.2%	10%	0.32
cPAH	8.0%	27%	0.30
Lead	2.1%	7.2%	0.29
Total HPAH	5.2%	19%	0.28
Dioxins/furans	10%	50%	0.20
Total LPAH	1.9%	11%	0.17
BBP	9.9%	65%	0.15
Chromium	0.7%	5.4%	0.13
Copper	1.2%	12%	0.10
Zinc	4.5%	68%	0.07
BEHP	4.6%	74%	0.06
Cadmium	0.3%	64%	0.005
Di-n-octyl phthalate	0%	2.4%	0.00

Exceedance frequency ratios are most commonly in the range of 0.15 to 0.33. Arsenic has an unusually high exceedance frequency ratio; almost as many surface sediment samples exceed the lower SL as do storm drain samples. This implies that one or more other sources of arsenic, such as air deposition or contaminated groundwater, must be present. Total PCBs also have a high exceedance frequency ratio. Several chemicals have very low exceedance frequency ratios: di-n-octyl phthalate (with no exceedances in surface sediment), cadmium, BEHP, zinc, and copper. These frequently exceed screening levels in storm drain solids but not in surface sediment.

3.3.1 Polychlorinated Biphenyls

Figures 3-2a through 3-2c show total PCB concentrations by sample location. Summary statistics are provided in Table 3-2, and a summary of exceedance percentages is presented in Figure 3-18.

Total PCBs exceeded the lower SL (0.13 mg/kg DW) in 69 percent of storm drain solids samples and in 51 percent of surface sediment samples. Total PCBs exceeded the upper SL (1.0 mg/kg DW) in 24 percent of storm drain solids samples and in 11 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.74; this indicates a very high correlation between PCB concentrations in sediments and in storm drain solids.

PCBs are widely distributed throughout the LDW; the lower SL was exceeded in at least one surface sediment sample in every source control area except the 1st Avenue S SD, and 10 of the 24 source control areas had at least one surface sediment sample that exceeded the upper SL. In storm drain solids, PCBs exceeded the lower SL in 17 of the 19 source control areas for which samples have been collected, and exceeded the upper SL 13 of the 19 source control areas. Only the Slip 6 and Restoration Areas source control areas did not exceed the PCB lower SL in at least one storm drain solids sample.

The highest concentration of PCBs in surface sediments was detected in the Trotsky Inlet (2,930 mg/kg DW); the highest concentration of PCBs in storm drain solids was 2,200 mg/kg DW in the Duwamish/Diagonal Way source control area.

3.3.2 Polycyclic Aromatic Hydrocarbons

Figures 3-3a through 3-3c show total LPAH concentrations by sample location; Figures 3-4a through 3-4c and 3-5a through 3-5c show similar information for total HPAH and total cPAH (TEQ) concentrations. Summary statistics are provided in Tables 3-3 through 3-5, and summaries of exceedance percentages are presented in Figures 3-19 through 3-21.

Concentrations of total LPAHs, HPAHs, and cPAHs were calculated from the individual PAH compounds. Please note that Figures 3-3 through 3-5 depict total HPAH, LPAH, or cPAH concentrations and exceedances; the bar graphs in Figures 3-19 through 3-21, however, show an exceedance if any one of the constituent PAH compounds exceeds a screening level. As a result, Figure 3-20 shows a greater percentage of exceedances for HPAHs than is visible on Figure 3-4.

LPAH

Total LPAH exceeded the lower SL (5.2 mg/kg DW) in 11 percent of storm drain solids samples and in 1.9 percent of surface sediment samples. Total LPAH exceeded the upper SL (13 mg/kg DW) in 5.9 percent of storm drain solids samples and in 0.7 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.17; this indicates a moderate correlation between total LPAH concentrations in sediments and in storm drain solids.

If individual LPAH compounds are considered, 25 percent of storm drain solids samples exceeded a lower SL for one or more of the LPAH compounds, and 5.3 percent of surface sediment samples exceeded the lower SL for one or more LPAH compounds. Individual LPAH compounds exceeded an upper SL in 10 percent of storm drain solids samples and in 1.4 percent of surface sediment samples.

Surface sediments exceeded the lower SL for total LPAH in only six source control areas; storm drain solids exceeded the lower SL in 13 of the 24 source control areas. The highest storm drain concentration of total LPAH was 1,250 mg/kg DW at Terminal 115.

HPAH

Total HPAH exceeded the lower SL (12 mg/kg DW) in 19 percent of storm drain solids samples and in 5.2 percent of surface sediment samples. Total HPAH exceeded the upper SL (17 mg/kg DW) in 14 percent of storm drain solids samples and in 3.0 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.28; this indicates a moderate correlation between total HPAH concentrations in sediments and in storm drain solids.

If individual HPAH compounds are considered, 39 percent of storm drain solids samples exceeded a lower SL for one or more of the HPAH compounds, and 12 percent of surface sediment samples exceeded the lower SL for one or more HPAH compounds. Individual LPAH compounds exceeded an upper SL in 29 percent of storm drain solids samples and in 7.1 percent of surface sediment samples.

HPAH exceedances are more widely distributed in the LDW basin than LPAH exceedances. Surface sediments exceeded the lower SL for total HPAH in 14 of the 24 source control areas; storm drain solids exceeded the lower SL in 16 of the 19 source control areas for which samples have been collected. The highest storm drain concentration of total HPAH was 3,830 mg/kg DW at Terminal 117; the highest surface sediment concentration (85 mg/kg DW) was also in the Terminal 117 source control area.

cPAH

Total cPAH exceeded the lower SL (1.0 mg TEQ/kg DW) in 27 percent of storm drain solids samples and in 8.0 percent of surface sediment samples. Total cPAH exceeded the upper SL (3.0 mg TEQ/kg DW) in 9.6 percent of storm drain solids samples and in 1.2 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.30; this indicates a moderate correlation between total cPAH concentrations in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for cPAH in 15 of the source control areas; storm drain solids exceeded the lower SL in 17 of the 19 source control areas for which storm drain samples are available. The distribution of cPAH exceedances is similar to total HPAH but with somewhat fewer exceedances of the upper SL. This similarity is likely due to the overlap in PAH compounds included between total HPAH and total cPAH.

The highest storm drain concentration of cPAH was 462 mg/kg DW at Terminal 117; the highest surface sediment concentration (11 mg/kg DW) was also in the Terminal 117 source control area.

3.3.3 Phthalates

Figures 3-6a through 3-6c show BEHP concentrations by sample location; Figures 3-7a through 3-7c and 3-8a through 3-8c show similar information for BBP and di-n-octyl phthalate concentrations. Summary statistics are provided in Tables 3-6 through 3-8, and summaries of exceedance percentages are presented in Figures 3-22 through 3-24.

BEHP

BEHP exceeded the lower SL (1.3 mg/kg DW) in 74 percent of storm drain solids samples and in 4.6 percent of surface sediment samples. BEHP exceeded the upper SL (1.9 mg/kg DW) in 69 percent of storm drain solids samples and in 3.4 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.06; this indicates a poor correlation between BEHP concentrations in sediments and in storm drain solids. This relationship can also be observed in Figure 3-22, which shows that the frequency of exceedances differs greatly between sediments and storm drain solids.

BEHP exceeds screening levels in storm drain samples throughout the LDW basin, indicating multiple and widespread sources; exceedances in surface sediment, however, are rare. Storm drain samples exceeded the lower SL in all 19 source control areas for which storm drain solids data were available, and exceeded the upper SL in 18 of them. The maximum detected concentration of BEHP in storm drain solids was 1,400 mg/kg DW in the Riverside Drive source control area.

In sediments, samples exceeded the lower SL in 10 of 24 source control areas, but exceedances were sporadic except for the head of Slip 4, where BEHP exceedances in sediment are prominent (Figure 3-6c). The frequency of BEHP exceedances in Slip 4 sediments, in relation to storm drain exceedances, can also be observed in Figure 3-22; this pattern is different at Slip 4 than for all other source control areas.

BBP

The spatial distribution of BBP, shown in Figures 3-7a through 3-7c, is similar to that of BEHP, but with fewer exceedances of the upper SL.

BBP exceeded the lower SL (0.063 mg/kg DW) in 65 percent of storm drain solids samples and in 9.9 percent of surface sediment samples. BBP exceeded the upper SL (0.90 mg/kg DW) in 23 percent of storm drain solids samples and in 0.54 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.15; this indicates a relatively poor correlation between BBP exceedances in sediments and in storm drain solids.

BBP also exceeds screening levels in storm drain samples throughout the LDW basin, indicating multiple and widespread sources; exceedances in surface sediment, however, are somewhat less frequent. Storm drain samples exceeded the lower SL in all 19 source control areas for which storm drain solids data were available, and exceeded the upper SL in 17 of them. The maximum detected concentration of BBP in storm drain solids was 150 mg/kg DW in the Duwamish/ Diagonal Way source control area.

In sediments, samples exceeded the lower SL in 18 of 24 source control areas, but exceedances of the upper SL were rare, occurring in only three source control areas.

Di-n-Octyl Phthalate

Di-n-octyl phthalate exceeded the lower SL (6.2 mg/kg DW) in 2.4 percent of storm drain solids samples and none of the surface sediment samples. The upper SL for di-n-octyl phthalate is the same as the lower SL. There is a poor correlation between BBP exceedances in sediments and in storm drain solids.

Di-n-octyl phthalate was analyzed in fewer samples than BEHP and BBP (Figure 3-8a through 3-8c). Most surface sediment and storm drain solids samples were non-detected or less than the lower SL. Di-n-octyl phthalate did not exceed the lower SL in any of the surface sediment samples, and it only exceeded the lower SL in storm drain solids from four source control areas (Figure 3-24).

3.3.4 Phenol

Figures 3-10a through 3-10c show phenol concentrations by sample location. Summary statistics are provided in Table 3-9; a summary of exceedance percentages is presented in Figure 3-25.

Phenol exceeded the lower SL (0.42 mg/kg DW) in 10 percent of storm drain solids samples and in 3.2 percent of surface sediment samples. Phenol exceeded the upper SL (1.2 mg/kg DW) in 3.3 percent of storm drain solids samples and in 1.2 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.32; this indicates a moderate correlation between phenol exceedances in sediments and in storm drain solids.

HPAH exceedances are more widely distributed in the LDW basin than LPAH exceedances. Surface sediments exceeded the lower SL for phenol in seven of the 24 source control areas; storm drain solids exceeded the lower SL in 13 of the 19 source control areas for which samples have been collected. The highest storm drain concentration of phenol was 13 mg/kg DW in the Duwamish/Diagonal source control area; the highest surface sediment concentration (3.1 mg/kg DW) was in the Trotsky Inlet source control area.

3.3.5 Dioxins/Furans

Figures 3-9a through 3-9c present the locations where samples were collected and analyzed for dioxins/furans. Summary statistics for dioxins/furans are provided in Table 3-10; a summary of exceedance percentages is presented in Figure 3-26. The general coverage area of dioxin data is limited in both storm drains and sediments.

In addition to the five source control areas with no storm drain solids samples (listed in Section 3.2), storm drain samples have not been analyzed for dioxins/furans in the Slip 3 to Seattle Boiler Works, Seattle Boiler Works to Slip 4, Boeing Plant 2 to Jorgensen Forge, Kellogg Island to Lafarge, Glacier Bay, Trotsky Inlet, or Terminal 117 source control areas.

Dioxins/furans exceeded the lower SL (25 nanograms [ng] TEQ/kg DW) in 50 percent of storm drain solids samples and in 10 percent of surface sediment samples. Dioxins/furans exceeded the upper SL (50 ng TEQ/kg DW) in 26 percent of storm drain solids samples and in 5.5 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.20; this indicates a moderate correlation between dioxin/furan exceedances in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for dioxins/furans in nine of the 22 source control areas with samples available; storm drain solids exceeded the lower SL in five of the 12 source control areas for which samples have been collected and analyzed for dioxins/furans. The highest storm drain concentration of dioxins/furans was 274 ng TEQ/kg DW in the Slip 4 source control area; the highest surface sediment concentration (2,100 ng TEQ/kg DW) was in the Glacier Bay source control area.

3.3.6 Metals

Mercury

Figures 3-11a through 3-11c show mercury concentrations by sample location. Summary statistics are provided in Table 3-11; a summary of exceedance percentages is presented in Figure 3-27.

Mercury exceeded the lower SL (0.41 mg/kg DW) in 14.5 percent of storm drain solids samples and in 4.8 percent of surface sediment samples. Mercury exceeded the upper SL (0.59 mg/kg DW) in 12 percent of storm drain solids samples and in 2.8 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.33; this indicates a moderate correlation between mercury exceedances in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for mercury in 13 of the 24 source control areas; storm drain solids exceeded the lower SL in 10 of the 19 source control areas for which data are available. The highest storm drain concentration of mercury was 173 mg/kg DW in the Slip 4 source control area; the highest surface sediment concentration (247 mg/kg DW) was in the Trotsky Inlet.

Arsenic

Figures 3-12a through 3-12c show arsenic concentrations by sample location. Summary statistics are provided in Table 3-12; a summary of exceedance percentages is presented in Figure 3-28.

Arsenic exceeded the lower SL (57 mg/kg DW) in 2.8 percent of storm drain solids samples and in 2.7 percent of surface sediment samples. Arsenic exceeded the upper SL (93 mg/kg DW) in 1.5 percent of storm drain solids samples and in 1.5 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.97; this indicates an unusually high correlation between arsenic exceedances in sediments and in storm drain solids. It is likely that one or more other sources of arsenic, besides stormwater, represent a source of contaminants to LDW surface sediments.

Surface sediments exceeded the lower SL for arsenic in seven of the 24 source control areas; storm drain solids exceeded the lower SL in six of the 17 source control areas for which data are available. The highest storm drain concentration of arsenic was 1,420 mg/kg DW in the Slip 3 to Seattle Boiler Works source control area; the highest surface sediment concentration (1,100 mg/kg DW) was in the Boeing Isaacson/Central KCIA source control area.

Cadmium

Figures 3-13a through 3-13c show cadmium concentrations by sample location. Summary statistics for cadmium are provided in Table 3-13; a summary of exceedance percentages is presented in Figure 3-29.

Cadmium exceeded the lower SL (5.1 mg/kg DW) in 64 percent of storm drain solids samples and in 0.3 percent of surface sediment samples. Cadmium exceeded the upper SL (6.7 mg/kg DW) in 46 percent of storm drain solids samples and in 0.2 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.005; this indicates a very poor correlation between cadmium exceedances in sediments and in storm drain solids.

Very few storm drain solids samples have been analyzed for cadmium in the LDW basin, with the exception of the Slip 4 and the Boeing Isaacson/Central KCIA source control areas; no storm drain sample results for cadmium are available for 18 of the 24 source control areas. However, sediment samples associated with all 24 source control areas show few cadmium screening level exceedances.

Surface sediments exceeded the lower SL for cadmium in only one source control area (Trotsky Inlet). Storm drain solids exceeded the lower SL in four of the six source control areas for which data are available. The highest storm drain concentration of cadmium was 154 mg/kg DW in the Boeing Isaacson/Central KCIA source control area; the highest surface sediment concentration (36 mg/kg DW) was in the Trotsky Inlet.

Chromium

Figures 3-14a through 3-14c show chromium concentrations by sample location. Summary statistics for chromium are provided in Table 3-14. Chromium exceeded the lower SL (260 mg/kg DW) in 5.4 percent of storm drain solids samples and in 0.7 percent of surface sediment samples. Chromium exceeded the upper SL (270 mg/kg DW) in 5.0 percent of storm drain solids samples and in 0.7 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.13; this indicates a relatively poor correlation between chromium exceedances in sediments and in storm drain solids.

Very few storm drain solids samples have been analyzed for chromium in the LDW basin, with the exception of the Slip 4 and the Boeing Isaacson/Central KCIA source control areas; no storm drain sample results for chromium are available for 18 of the 24 source control areas. However, sediment samples associated with all 24 source control areas show relatively few chromium screening level exceedances.

Surface sediments exceeded the lower SL for chromium in two source control areas (Trotsky Inlet and Boeing Plant 2 to Jorgensen Forge). Storm drain solids exceeded the lower SL in two of the six source control areas for which data are available. The highest storm drain concentration of chromium was 821 mg/kg DW in the Boeing Isaacson/Central KCIA source control area; the highest surface sediment concentration (1,680 mg/kg DW) was in the Trotsky Inlet.

Copper

Figures 3-15a through 3-15c show copper concentrations by sample location. Summary statistics for copper are provided in Table 3-15; a summary of exceedance percentages is presented in Figure 3-30.

Copper exceeded the lower SL (390 mg/kg DW) in 12 percent of storm drain solids samples and in 1.2 percent of surface sediment samples. The upper SL for copper is the same as the lower SL. The exceedance frequency ratio between surface sediments and storm drain solids is 0.10; this indicates a relatively poor correlation between copper exceedances in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for copper in four of the 24 source control areas. Storm drain solids exceeded the lower SL in 11 of the 19 source control areas for which data are available. The highest storm drain concentration of copper was 7,990 mg/kg DW in the Seattle Boiler Works to Slip 4 source control area; the highest surface sediment concentration (1,420 mg/kg DW) was in the Glacier Bay source control area.

Lead

Figures 3-16a through 3-16c show lead concentrations by sample location. Summary statistics for lead are provided in Table 3-16; a summary of exceedance percentages is presented in Figure 3-31.

Lead exceeded the lower SL (450 mg/kg DW) in 7.2 percent of storm drain solids samples and in 2.1 percent of surface sediment samples. Lead exceeded the upper SL (530 mg/kg DW) in 5.2 percent of storm drain solids samples and in 1.9 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.29; this indicates a moderate correlation between lead exceedances in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for lead in six of the 24 source control areas. Storm drain solids exceeded the lower SL in eight of the 19 source control areas for which data are available. The highest storm drain concentration of lead was 3,690 mg/kg DW in the Trotsky Inlet source control area; sediments also contained high concentrations of lead with a maximum detected concentration of 10,400 mg/kg DW. The highest surface sediment concentration was 12,300 mg/kg DW in the Slip 6 source control area.

Zinc

Figures 3-17a through 3-17c show arsenic concentrations by sample location. Summary statistics for zinc are provided in Table 3-17; a summary of exceedance percentages is presented in Figure 3-32.

Zinc exceeded the lower SL (410 mg/kg DW) in 68 percent of storm drain solids samples and in 4.5 percent of surface sediment samples. Zinc exceeded the upper SL (960 mg/kg DW) in 36 percent of storm drain solids samples and in 1.9 percent of surface sediment samples. The exceedance frequency ratio between surface sediments and storm drain solids is 0.07; this indicates a poor correlation between zinc exceedances in sediments and in storm drain solids.

Surface sediments exceeded the lower SL for zinc in 12 of the 24 source control areas. Storm drain solids exceeded the lower SL in 18 of the 19 source control areas for which data are available. The highest storm drain concentration of zinc was 22,900 mg/kg DW in the Slip 4 source control area; the highest surface sediment concentration was 4,580 mg/kg DW in the Trotsky Inlet source control area.

3.4 Spatial Evaluation by Source Control Area

This section summarizes chemical exceedances of screening levels in storm drain solids and surface sediments by source control area.

A chemical is identified as a stormwater COPC if it was detected at concentrations above screening levels in both storm drain solids and surface sediments in a given source control area. These chemicals are of primary interest for source tracing and control. As discussed in the following sections, storm drain discharges in these source control areas may represent a source of contaminants to nearby surface sediments. In some case, elevated sediment concentrations are upstream of storm drain outfalls and therefore are unlikely to be related to contaminants in stormwater, if any, from those outfalls.

Chemicals that are identified as a COPC in surface sediments only may originate from some other source besides storm drain discharges, or insufficient information may be available to make an assessment. Chemicals that are identified as a COPC in storm drain solids only may not reach LDW sediments, or they may reach LDW sediments but not accumulate to a level that results in a screening level exceedance.

Figures 3-33 through 3-56 depict sample locations and chemical screening level exceedances by source control area. Tables 3-18 through 3-41 provide summary statistics for surface sediment and storm drain solids data in each source control area.

3.4.1 RM 0.0 to 0.1 East: Spokane Street to Ash Grove Cement

The RM 0.0–0.1 East (Spokane Street to Ash Grove Cement) source control area is shown in Figure 3-33a; it extends from approximately the West Seattle Bridge to the southern tip of Harbor Island and to the southern boundary of Ash Grove Cement on the east side of the LDW. No public storm drain outfalls are located within the Spokane Street to Ash Grove Cement source control area. Facilities within this source control area include the Harbor Marina Corporate Center (Port of Seattle Terminal 102), Port of Seattle Terminal 104, and Ash Grove Cement. Stormwater from the Ash Grove Cement facility discharges to the East Waterway, not the LDW.

A total of 19 surface sediment grab samples have been collected near RM 0.0 to 0.1 East. No storm drain solids samples have been collected in this source control area.

Sediment sampling locations are shown in Figure 3-33a; summary statistics for selected analytes are provided in Table 3-18. Zinc, total HPAH, total cPAH, and BBP exceeded the lower SL in at least one sample, while arsenic, lead, mercury, and total PCBs exceeded both the SQS/LAET and the CSL/2LAET in at least one sample. Concentrations of total PCBs in 14 of the 16 surface sediment samples exceeded the LAET.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2008c).

Stormwater COPCs

No storm drain solids samples have been collected in this source control area, therefore there is insufficient information to identify chemicals present at concentrations above screening levels in both sediments and storm drains.

Chemicals with Exceedances in Surface Sediment Only

Concentrations of arsenic, lead, mercury, and PCBs exceeded the upper SL in surface sediment; zinc, total HPAH, cPAH, and BBP exceeded the lower SL.

- Almost 90 percent of surface sediment samples exceeded the lower SL for PCBs (0.13 mg/kg DW); the average concentration of PCBs is approximately 2.5 times the lower SL, and the maximum detected concentration (1.9 mg/kg DW) exceeded the upper SL (1.0 mg/kg DW).
- Over 30 percent of surface sediment samples exceeded the lower SL for mercury (0.41 mg/kg DW), mainly near the southern tip of Harbor Island (Figure 3-33b); the maximum detected concentration slightly exceeded the upper SL (0.59 mg/kg DW).

Chemicals with Exceedances in Storm Drain Solids Only

No storm drain samples have been collected in this source control area. The presence of COPCs in storm drains, if any, is therefore unknown.

Data Gaps

Storm drain samples are needed to assess whether concentrations of PCBs, mercury, and other contaminants in surface sediments originate from sources in the Spokane Street to Ash Grove Cement source control area.

3.4.2 RM 0.1 to 0.9 East (EAA-1): Duwamish/Diagonal Way

The RM 0.1 to 0.9 East (Duwamish/Diagonal Way) source control area is shown in Figure 3-34a; it extends from the southern boundary of Ash Grove Cement to Federal Center South, on the east side of the LDW. The Diagonal Avenue S SD, the Nevada Street SD, and the Duwamish/Diagonal CSO discharge to the LDW within this source control area. Facilities within this source control area that are adjacent to the LDW include Port of Seattle’s Terminal 108, ConGlobal Industries (formerly Container Care International), and Federal Center South. Upland facilities within this source control area include Rainier Commons, North Star Casteel, Seattle Barrel & Cooperage, and Alaskan Copper Works.

A total of 79 surface sediment grab samples, 284 storm drain solids samples, and 40 water samples have been collected in the Duwamish/Diagonal Way source control area and sediments near RM 0.1 to 0.9 East. Sediment and storm drain solids sampling locations are shown in Figure 3-34a; summary statistics for selected analytes are provided in Table 3-19. Cadmium and di-n-octyl phthalate exceeded the lower SL in at least one sample; arsenic, copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, phenol, and PCBs exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Source Control Action Plan (SCAP) for this source control area (Ecology 2004).

Stormwater COPCs

Mercury, BBP, phenol, and PCBs were identified as COPCs in the Duwamish/Diagonal Way source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Total PCBs

PCB concentrations in storm drain solids samples exceeded the upper SL (1.0 mg/kg DW), and concentrations in surface sediment samples exceeded the lower SL (0.13 mg/kg DW). The average storm drain PCB concentration (28 mg/kg DW) exceeded the upper SL by a factor of 28; the average surface sediment concentration exceeded the lower SL. Almost 50 percent of storm drain samples exceeded the lower SL. Storm drain exceedances are generally found along Rainier Avenue S (Figure 3-34b [North]), and in the vicinity of the former Rainier Brewery site west of I-5 and north of S Spokane Street, the S Snoqualmie Street and S Dakota Street subdrainages, and the general area west of the BNSF yard (Figure 3-34b [South]). Sediment exceedances are near and downstream of the Diagonal Avenue S CSO/SD (Outfall 2155).

BBP

BBP concentrations in storm drain solids samples exceeded the upper SL (0.90 mg/kg DW), and concentrations in surface sediment samples exceeded the lower SL (0.063 mg/kg DW). The average BBP concentration in storm drain solids (3.4 mg/kg DW) exceeded the upper SL by a factor of 3.8; one of 18 surface sediment samples contained BBP above the lower SL. Approximately 70 percent of storm drain samples exceeded the lower SL; these are distributed throughout the storm drain basin (Figure 3-34c).

Phenol

Both surface sediment and storm drain solids samples exceeded the upper SL for phenol (1.2 mg/kg DW). The average phenol concentration in storm drain solids (0.49 mg/kg DW) exceeded the lower SL by a factor of 1.3; concentrations of phenol exceeded the lower SL in 25 percent of storm drain solids samples that have been collected. Storm drain exceedances appear to be centered around Rainier Avenue S (Figure 3-34d [North]) and Airport Way S (Figure 3-34d [South]), with isolated exceedances in other areas. One of 18 surface sediment samples also contained phenol above the upper SL; this sediment sample was collected near the Diagonal Avenue S CSO/SD (Outfall 2155). The Duwamish/Diagonal Way source control area is one of only four source control areas where phenol was detected in surface sediment at a concentration above the upper SL.

Mercury

Mercury concentrations in storm drain solids samples exceeded the upper SL (0.59 mg/kg DW), and concentrations in surface sediment samples exceeded the lower SL (0.41 mg/kg DW). Exceedances were relatively uncommon, and average concentrations did not exceed the lower SL. All of the storm drain exceedances were in the S Snoqualmie Street and S Dakota Street subdrainages (Figure 3-34e), with the exception of two exceedances in the area southwest of the BNSF yard. One sediment sample, located just upstream of the Diagonal Avenue S CSO/SD, exceeded the lower SL for mercury.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of arsenic, copper, lead, zinc, total LPAH, total HPAH, total cPAH, BEHP, and dioxins/furans exceeded the upper SL in storm drain solids; cadmium and di-n-octyl phthalate exceeded the lower SL.

- Over 80 percent of storm drain samples exceeded the lower SL for BEHP (1.3 mg/kg DW), and 76 percent exceeded the upper SL (1.9 mg/kg DW). The average BEHP concentration (15 mg/kg DW) exceeded the upper SL by a factor of 8. Surface sediment concentrations of BEHP did not exceed a screening level in any of the 18 samples collected.
- Zinc exceeded the lower SL (410 mg/kg DW) in over 50 percent of storm drain samples; 19 of 136 samples exceeded the upper SL (960 mg/kg DW). The average zinc concentration (549 mg/kg) exceeded the lower SL by a factor of 1.3. Surface sediment concentrations of zinc did not exceed screening levels in any of the 18 samples collected.
- Over 65 percent of storm drain samples exceeded the lower SL for dioxins/furans (25 ng TEQ/kg DW); 35 percent, or 7 of 20, samples exceeded the upper SL (50 ng TEQ/kg DW). The average dioxin/furan concentration (41 ng TEQ/kg) exceeded the lower SL. Most of the storm drain exceedances were found along the S Snoqualmie Street and S Dakota Street subdrainages; however, this may be a result of the low sampling coverage in other parts of the source control area. Only four surface sediment samples have been analyzed for dioxins/furans, but the maximum detected concentration of dioxins/furans was 14 ng TEQ/kg, well below the lower SL.

Data Gaps

A large number of samples have been collected in this source control area, and the COPCs are well established. Source tracing has resulted in the identification of many contaminant sources, including PCB contamination at the former Rainier Brewery site. Additional source tracing is needed to identify specific sources of PCBs in the S Snoqualmie and S Dakota Street subdrainages and other locations within the source control area with exceedances of PCB screening levels.

Based on results on a survey of potential PCB sources in building materials in the Diagonal Avenue S SD basin, conducted by SAIC in 2011, the highest concentrations of PCBs in building caulk (920 mg/kg PCBs in building caulk from composite sample area 15) were found in areas where storm drain solids exceeded the upper SL for PCBs. Due to the nature of the composite sampling conducted for the building material survey study, it is not possible to identify specific contaminant sources based on these data. However, additional PCB source tracing should consider the collection of building caulk samples in areas where PCB sources are suspected.

3.4.3 RM 0.9 to 1.0 East: Slip 1

The RM 0.9–1.0 East (Slip 1) source control area is shown in Figure 3-35a; it extends from Diagonal Way to just south of Slip 1, on the east side of the LDW. No public storm drain outfalls are located within the Slip 1 source control area. Facilities within this source control area include Federal Center South, the former Snopac Products site, and Manson Construction.

No storm drain solids samples have been collected in this source control area.

Sediment sampling locations near RM 0.9 to 1.0 East are shown in Figure 3-35a; summary statistics for selected analytes are provided in Table 3-20. Total PCBs and total cPAH exceeded the lower SL in at least one sample; arsenic, copper, mercury, zinc, total LPAH, and total HPAH exceeded both the lower SL and upper SL.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2008d).

Stormwater COPCs

No storm drain solids samples have been collected in this source control area, therefore there is insufficient information to identify stormwater COPCs.

<u>Chemicals with Exceedances in Surface Sediment Only</u>

Concentrations of arsenic, copper, mercury, zinc, total LPAH, and total HPAH exceeded the upper SL in storm drain solids; total cPAH and total PCBs exceeded the lower SL.

- Two of 15 surface sediment samples exceeded the upper SL for arsenic (93 mg/kg DW). The maximum arsenic concentration (725 mg/kg DW) exceeded the upper SL by a factor of 8, and the average concentration (73 mg/kg DW) exceeded the lower SL. Both sediment samples with arsenic exceedances were located at the head of Slip 1, near the former Snopac Products facility (Figure 3-35c).
- About 80 percent of surface sediment samples exceeded the lower SL for PCBs; the average concentration of PCBs (0.23 mg/kg DW) is approximately 1.8 times the lower SL. Total PCBs exceeded the lower SL in 12 of the 15 surface sediment samples that have been collected in this area. Exceedances are located mostly in the northern portion of Slip 1, near the Federal Center South facility (Figure 3-35b).
- Copper (one sample), mercury (one sample), and zinc (two samples) exceeded the upper SLs in surface sediments in Slip 1.

- Total LPAH and total HPAH exceeded the upper SL in a sediment sample located at the very south end of the source control area, at the Manson Construction property.

<u>Chemicals with Exceedances in Storm Drain Solids Only</u>

No storm drain samples have been collected in this source control area. The presence of COPCs in storm drains, if any, is therefore unknown.

Data Gaps

Storm drain samples are needed to assess whether concentrations of PCBs, metals, and PAHs in surface sediments originate from sources in Slip 1 source control area. At a minimum, storm drain samples for PCB analysis should be collected at Federal Center South. Although no storm drain outfalls are located near the former Snopac Products and Manson Construction facilities, additional investigation of potential sources of arsenic at these properties is also needed.

3.4.4 RM 1.0 to 1.2 East: King County Lease Parcels

The RM 1.0–1.2 East (King County Lease Parcels) source control area is shown in Figure 3-36; it extends from just south of Slip 1 to the north end of Saint-Gobain Containers, on the east side of the LDW. The S Brandon Street CSO discharges to the LDW within this source control area. Facilities within this source control area include Cadman Seattle, Lehigh Northwest, United Western Supply, and J.A. Jack & Sons.

No storm drain solids samples have been collected in this source control area.

Sediment sampling locations in the vicinity are shown in Figure 3-36; summary statistics for selected analytes are provided in Table 3-21. Seven surface sediment samples have been collected near RM 1.0 to 1.2 East. Total PCBs and total LPAH exceeded the lower SL in at least one sample; mercury exceeded both the lower SL and upper SL in one sample. The highest chemical concentrations were found at a sediment sampling location just upstream of the S Brandon Street CSO. None of the average concentrations exceeded a screening level.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2010e).

Stormwater COPCs

No storm drain solids samples have been collected in this source control area, therefore there is insufficient information to identify stormwater COPCs.

<u>Chemicals with Exceedances in Surface Sediment Only</u>

Concentrations of mercury exceeded the upper SL in one sample; total LPAH (one sample) and total PCBs (two samples) exceeded the lower SL.

- Two of seven surface sediment samples exceeded the lower SL for PCBs; the average concentration of PCBs (0.12 mg/kg DW) is close to the lower SL value of 0.13 mg/kg DW. In surface sediment samples collected by SAIC in 2011, PCBs were detected at 0.13

mg/kg DW near Outfall 2223 and at 0.11 mg/kg DW near Outfall 2244. Outfall 2223 is the S Brandon Street CSO.

Chemicals with Exceedances in Storm Drain Solids Only

No storm drain samples have been collected in this source control area. The presence of COPCs in storm drains, if any, is therefore unknown.

Data Gaps

Relatively minor exceedances of the lower SL for PCBs in surface sediment may indicate a source of PCBs within the King County Lease Parcels source control area or within the S Brandon Street CSO basin. Storm drain samples, collected at the Cadman Seattle/Lehigh Northwest property[1] and analyzed for PCBs, would be helpful to assess whether concentrations of PCBs in surface sediments originate from sources in the King County Lease Parcels source control area.

3.4.5 RM 1.2 to 1.7 East: St. Gobain to Glacier NW

The RM 1.2–1.7 East (St. Gobain to Glacier NW) source control area is shown in Figure 3-37; it extends from Saint-Gobain Containers to just north of Glacier Northwest on the east side of the LDW. No public storm drain outfalls are located within the St. Gobain to Glacier NW source control area. Facilities within this source control area include Saint-Gobain Containers, Longview Fibre Company, and CertainTeed Gypsum.

Although King County and SPU have collected storm drain solids samples in the Michigan Street CSO basin, no solids samples have been collected in storm drains in this source control area.

Sediment sampling locations near RM 1.2 to 1.7 East are shown in Figure 3-37; summary statistics for selected analytes are provided in Table 3-22. Mercury and total cPAH exceeded the lower SL in one sample each; zinc, total LPAH, and total HPAH exceeded both the lower SL and upper SL in one sample each. PCBs exceeded the lower SL in 12 samples.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2009).

Stormwater COPCs

No storm drain solids samples have been collected in this source control area; therefore, there is insufficient information to identify stormwater COPCs.

Chemicals with Exceedances in Surface Sediment Only

Concentrations of zinc, total LPAH, and total HPAH exceeded the upper SL; mercury, total cPAH, and total PCBs exceeded the lower SL.

[1] Stormwater drainage from this facility discharges to Outfall 2244 (Figure 3-30).

- Twelve of 28 surface sediment samples exceeded the lower SL of 0.13 mg/kg DW; the average concentration of PCBs (0.16 mg/kg DW) exceeded the lower SL by a factor of 1.2. Most of the exceedances are located in the central portion of the source control area, near Outfall 2010. Stormwater from the Saint-Gobain Containers facility drains to this outfall.
- Zinc, total LPAH, and total HPAH exceeded the upper SLs in one sediment sample each.

Chemicals with Exceedances in Storm Drain Solids Only

No storm drain samples have been collected in this source control area. The presence of COPCs in storm drains, if any, is therefore unknown.

Data Gaps

Storm drain samples are needed to assess whether concentrations of PCBs in surface sediments originate from sources in the St. Gobain to Glacier Northwest source control area. At a minimum, storm drain solids samples collected from the portion of the Saint Gobain Containers facility that drains to Outfalls 2010 and 2011 are needed to evaluate whether storm drain discharges from this property are a source of PCB contamination to LDW sediments.

3.4.6 RM 1.7 to 2.0 East: Slip 2 to Slip 3

The RM 1.7–2.0 East (Slip 2 to Slip 3) source control area is shown in Figure 3-38a; it extends from just north of Slip 2 to the 1st Avenue S Bridge, on the east side of the LDW. One public storm drain (1st Avenue S Bridge SD), the Michigan Street CSO, and several private outfalls discharge to the LDW within RM 1.7 to 2.0 East. Facilities within this source control area include Glacier Northwest, Samson Tug & Barge, and Duwamish Marine Center.

No samples have been collected from storm drains in this source control area. SPU has collected six ROW catch basin samples in areas draining to the Michigan Street CSO; zinc, PCBs, and BBP were detected above screening levels in at least one sample. King County has conducted inline storm drain solids sampling in the Michigan Street CSO basin; results were not available.

Sediment sampling locations in the vicinity are shown in Figure 3-38a; summary statistics for selected analytes are provided in Table 3-23. BBP and total PCBs exceeded the SQS/LAET in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2009b).

Stormwater COPCs

No storm drain solids samples have been collected in this source control area; therefore, there is insufficient information to identify stormwater COPCs.

Chemicals with Exceedances in Surface Sediment Only

Concentrations of BBP and PCBs exceeded the lower SL in surface sediments in the Slip 2 to Slip 3 source control area.

- Seven of 19 surface sediment samples exceeded the lower SL for PCBs of 0.13 mg/kg DW (Figure 3-38b); none of the samples exceeded the upper SL value. The average concentration of PCBs (0.16 mg/kg DW) exceeded the lower SL by a factor of 1.2. Exceedances are located near the Michigan Street CSO, 1st Avenue S Bridge SD, and Glacier Northwest outfalls. In addition, two samples collected in Slip 2 exceeded the PCB screening level.

Chemicals with Exceedances in Storm Drain Solids Only

No storm drain samples have been collected in this source control area. The presence of COPCs in storm drains, if any, is therefore unknown.

Data Gaps

Relatively minor exceedances of the lower SL for PCBs in surface sediment may indicate a source of PCBs within the Slip 2 to Slip 3 source control area or within the Michigan Street CSO basin. PCBs above screening levels have been detected in ROW catch basins within the Michigan Street CSO basin.

Storm drain samples from the Glacier Northwest and Duwamish Marine Center properties and within the 1st Avenue S Bridge sub-basin, analyzed for PCBs, would be helpful to assess whether concentrations of PCBs in surface sediments originate from sources in the Slip 2 to Slip 3 source control area, or whether they more likely originate from within the Michigan Street CSO basin.

3.4.7 RM 2.0 to 2.3 East: Slip 3 to Seattle Boiler Works

The RM 2.0 to 2.3 East (Slip 3 to Seattle Boiler Works) source control area is shown in Figure 3-39a; it extends from just south of the 1st Avenue S Bridge to and including Glacier Marine Services, on the east side of the LDW. The S River Street SD and S Brighton Street CSO/SD outfalls discharge to the LDW within RM 2.0 to 2.3 East. In addition, two private storm drains discharge to the head of Slip 3. Facilities within this source control area include Muckleshoot Seafood Products, SCS Refrigerated Products, V. Van Dyke, Riverside Industrial Park, Seattle Distribution Center, and Glacier Marine Services.

Sediment and storm drain solids sampling locations are shown in Figure 3-39a; summary statistics for selected analytes are provided in Table 3-24. Arsenic, copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, and PCBs exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2008b).

Stormwater COPCs

Arsenic, zinc, HPAH, cPAH, and PCBs were identified as COPCs in the Slip 3 to Seattle Boiler Works source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Arsenic

Over one-third of storm drain solids samples exceeded the lower SL of 57 mg/kg DW for arsenic (Figure 3-39d). The maximum detected concentration was 1,420 mg/kg DW at MH223 within the S Brighton Street SD; this represents an upper SL exceedance factor of 15, and it is the highest detected arsenic concentration in any LDW storm drain solids sample. Other arsenic screening level exceedances were located in the S River Street SD.

Arsenic exceedances in the storm drain system do not appear to be correlated with exceedances in LDW surface sediments. Arsenic did not exceed the lower SL in sediments near either the S Brighton Street CSO/SD or S River Street SD outfalls. The only screening level exceedances for arsenic were found in two samples collected near Outfall 2025 at the head of Slip 3. This outfall is owned by Glacier Marine Services, but it may also convey stormwater drainage from the Seattle Distribution Center. A seep has also been reported in this area, which is reportedly near the location of a historical dry dock.

Zinc

Over 90 percent of storm drain solids samples (12 of 14 samples) exceeded the lower SL of 410 mg/kg DW in this source control area (Figure 3-39e). The average concentration of zinc in storm drain solids was 991 mg/kg DW, which is 2.4 times the lower SL and slightly higher than the upper SL (960 mg/kg DW). One surface sediment sample exceeded the lower SL.

Similar to arsenic, the zinc exceedances in the storm drain system do not appear to be correlated with surface sediment concentrations. No exceedances were observed for zinc in surface sediments near the S Brighton Street CSO/SD or S River Street SD outfalls. The one zinc exceedance in sediment was located near Outfall 2025 at the head of Slip 3; this is the same location as the observed arsenic screening level exceedances.

Total HPAH and cPAH

Storm drain and sediment exceedances for total HPAH and cPAH TEQ showed similar patterns and are therefore discussed together. Concentrations of cPAH in storm drain solids and surface sediments are shown in Figure 3-39c. The highest concentrations of cPAH and HPAH were found at location MH110, with concentrations of 12 mg TEQ/kg and 110 mg/kg DW (which represent exceedance factors of 12 and 9, respectively). This location represents combined sewer drainage from the S Brighton CSO basin, across East Marginal Way S. Additional screening level exceedances were observed in the storm drain line downstream of this location and in one surface sediment sample near the S Brighton Street CSO/SD outfall.

The surface sediment sample near Outfall 2025 also exceeded screening levels for cPAH and total HPAH; this is the same location with arsenic and zinc exceedances, as discussed above. Two additional exceedances for cPAH (but not total HPAH) were observed in the S River Street SD basin; however, nearby surface sediments did not exceed screening levels for cPAH.

Total PCBs

Surface sediment samples exceeded the lower SL (0.13 mg/kg DW), and storm drain solids samples exceeded the upper SL (1.0 mg/kg DW) for PCBs (Figure 3-39b). The average PCB concentrations in both storm drain and surface sediment samples exceeded the lower SL. Over

60 percent of storm drain solids samples and 40 percent of surface sediment samples contained PCBs at concentrations above the lower SL. PCB exceedances in storm drain solids were distributed throughout the source control area, including the S Brighton Street CSO/SD basin and in the S River Street SD basin. Concentrations of PCBs in surface sediments near the S Brighton Street outfall did not exceed screening levels; however, surface sediment PCB exceedances were identified near the S River Street SD outfall and in Slip 3.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of copper, lead, mercury, total LPAH, BBP, and BEHP exceeded the upper SL in storm drain solids in the Slip 3 to Seattle Boiler Works source control area.

- Copper exceeded the screening level (390 mg/kg DW) in three of 13 storm drain solids samples, including one sample in the S River Street SD and two samples in the S Brighton Street SD. Two samples in the S Brighton Street SD exceeded the upper SL (530 mg/kg DW) for lead.
- Three of 14 storm drain solids samples exceeded the lower SL for mercury of 0.41 mg/kg DW. The maximum detected concentration (3.4 mg/kg DW) exceeded the upper SL. The average concentration of mercury (0.48 mg/kg DW) slightly exceeded the lower SL. Exceedances were located in storm drain structures along S Brighton Street and Fox Avenue; the Fox Avenue Building and Shultz Distributing properties discharge to the S Brighton Street SD in this area. Surface sediment concentrations of mercury did not exceed the lower SL in any of the 14 samples collected.
- Almost 80 percent of storm drain solids samples contained BEHP at a concentration above the lower SL (1.3 mg/kg DW) and over 70 percent exceeded the upper SL (1.9 mg/kg DW). BEHP was detected in storm drain solids at a maximum concentration of 24 mg/kg DW, which exceeded the upper SL by a factor of 13. The average concentration of BEHP (5.2 mg/kg DW) also exceeded the upper SL. Surface sediment concentrations of BEHP did not exceed the lower SL in any of the 14 samples collected.
- Over 60 percent, or nine of 15, storm drain solids samples contained BBP at a concentration above the lower SL (0.063 mg/kg DW); one sample also exceeded the upper SL value (0.9 mg/kg DW). BBP was detected in storm drain solids at a maximum concentration of 3.0 mg/kg DW, which exceeded the upper SL value by a factor of 3. The average concentration of BBP (0.39 mg/kg DW) exceeded the lower SL. Surface sediment concentrations of BBP did not exceed the lower SL in any of the 14 samples collected.

Data Gaps

The following data gaps were identified for the Slip 3 to Seattle Boiler Works source control area:

- Surface sediments at the head of Slip 3, and more specifically near Outfalls 2024 and 2025, contain several contaminants at concentrations above screening levels, including PCBs, total HPAH, total cPAH, arsenic, and zinc. Samples of storm drain solids in areas that drain to these private outfalls are needed to assess identify the sources of these contaminants.
- Collection of additional storm drain solids samples in the S River Street SD is recommended to identify sources of PCBs that may be transported to LDW sediments.
- Collection of additional storm drain solids samples in the S Brighton Street SD/CSO basin is recommended to identify sources of HPAH and cPAH that may be transported to LDW sediments.
- Only two surface sediment samples and no storm drain solids samples have been analyzed for dioxins/furans in this source control area. While dioxins/furans did not exceed the screening level in the two surface sediment samples, additional data would be useful to confirm that dioxins/furans are not a concern in this area.

Arsenic and zinc (as well as copper and lead), while present in relatively high concentrations in storm drain solids in the S River Street SD basin and the S Brighton Street CSO/SD Basin, do not show exceedances of screening levels in associated surface sediments in these areas.

3.4.8 RM 2.3 to 2.8 East: Seattle Boiler Works to Slip 4

The RM 2.3 to 2.8 East (Seattle Boiler Works to Slip 4) source control area is shown in Figure 3-40a; it extends from Bunge Foods (Guimont Parcel) to 8th Avenue Terminals (formerly Crowley Marine Services), on the east side of the LDW. The S Myrtle Street SD and S Garden Street SD outfalls discharge to the LDW within RM 2.3 to 2.8 East. In addition, 14 private storm drains discharge to the LDW in this area. Facilities within this source control area include Seattle Boiler Works, Seattle Iron and Metals, Puget Sound Truck Lines, and a portion of the 8th Avenue Terminals property.

A total of 32 surface sediment grab samples and 19 storm drain solids samples have been collected in the Seattle Boiler Works to Slip 4 source control area and sediments near RM 2.3 to 2.8 East. Sediment and storm drain solids sampling locations are shown in Figure 3-40a; summary statistics for selected analytes are provided in Table 3-25. Arsenic and dioxins/furans exceeded the lower SL in at least one sample; copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, di-n-octyl phthalate, phenol, and PCBs exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2008b).

Stormwater COPCs

Arsenic, mercury, zinc, BBP, BEHP, and PCBs were identified as COPCs in the Seattle Boiler Works to Slip 4 source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Mercury

Over 65 percent of storm drain solids samples exceeded the lower SL for mercury of 0.41 mg/kg DW, and over 50 percent exceeded the upper SL of 0.59 mg/kg DW (Figure 3-40e). The maximum detected concentration of 4.3 mg/kg DW, at MH240 on the Seattle Iron and Metals site, represents an upper SL exceedance factor of 7. Other mercury screening level exceedances were located in the S Myrtle Street and S Garden Street SD basins. In surface sediment, two samples exceeded the lower SL; one was located near the S Myrtle Street SD outfall, and the other was upstream of Outfall 2038, near the Puget Sound Truck Lines property.

Zinc

All 19 storm drain solids samples exceeded the lower SL of 410 mg/kg DW in this source control area (Figure 3-40f). The highest concentrations of zinc (13,300 mg/kg and 8,960 mg/kg) were found at CB207 and MH240, respectively, in the portion of the Seattle Iron and Metals site that drains to the S Garden Street SD. Surface sediment samples in this area did not exceeded a screening level. Zinc exceedances in surface sediment were limited to two samples in the S Myrtle Street Embayment.

BEHP and BBP

Storm drain and sediment exceedances for BEHP and BBP showed similar patterns and are therefore discussed together. Concentrations of BEHP and BBP in storm drain solids and surface sediments are shown in Figure 3-40c and 3-40d. All BEHP storm drain samples and almost 90 percent of BBP storm drain samples exceeded the upper SL; average concentrations of both chemicals also exceeded screening levels. The highest concentrations of phthalates in storm drain solids, with upper SL exceedance factors of 13 to 110, were found at locations MH240 (in the S Garden Street SD basin) and RCB189F (in the S Myrtle Street SD basin). Only one surface sediment sample exceeded screening levels for BEHP and BBP; this sample was located near the S Myrtle Street SD outfall. This sediment sample exceeded the lower SLs for BEHP and BBP by factors of 28 and 25, respectively.

Total PCBs

Surface sediment and storm drain solids samples exceeded the upper SL (1.0 mg/kg DW) (Figure 3-40b). Storm drain solids concentrations exceeded the lower SL in all samples, with a maximum detected concentration of 25 mg/kg DW, located at MH240 on the Seattle Iron and Metals site. This structure is located along the S Garden Street SD; surface sediments adjacent to and downstream of the S Garden Street SD outfall also exceeded the lower SL for PCBs.

Surface sediments exceeded the lower SL at several locations along the shoreline in this area, including the S Myrtle Street Embayment and sediments near outfalls 2034, 2035 (S Garden Street SD), and 2038/2039. The highest PCB concentrations in surface sediments were detected near RM 2.6 to 2.75, near the Puget Sound Truck Lines property. No storm drain samples have been collected at this property.

Surface sediments in the S Myrtle Street Embayment contained PCBs at 0.89 mg/kg DW, which exceeds the lower SL by a factor of 7 but does not exceed the upper SL.

Chemicals with Exceedances in Surface Sediment Only

Dioxins/furans exceeded the lower SL (25 ng TEQ/kg DW) in one of five surface sediment samples collected in this area, with a concentration of 33 ng TEQ/kg DW. This sample was located in the S Myrtle Street Embayment. No storm drain solids samples in this source control area have been analyzed for dioxins/furans.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of copper, lead, total LPAH, total HPAH, and total cPAH exceeded the upper SL in storm drain solids; di-n-octyl phthalate exceeded the lower SL.

- Copper: Copper exceeded the screening level (390 mg/kg DW) in over 55 percent of the storm drain solids samples collected in this source control area. The maximum copper concentration (7,990 mg/kg DW in CB207, in the portion of the Seattle Iron and Metals property that drains to the S Garden Street SD) was the highest detected in any LDW storm drain solids samples that have been collected. Copper exceedances have not been observed in any of the 32 surface sediment samples collected near RM 2.3 to 2.8 East.
- Lead: Eleven of 19 storm drain solids samples exceeded the lower SL for lead (450 mg/kg DW), and nine samples exceeded the upper SL (530 mg/kg DW). The maximum concentration of lead (2,240 mg/kg DW) was detected at CB207, in the portion of the Seattle Iron and Metals property that drains to the S Garden Street SD basin. None of the 32 surface sediment samples contained lead at a concentration above a screening level.
- Total cPAH: Six of 19 storm drain samples (over 30 percent of samples) exceeded the lower SL for cPAH (1.0 mg TEQ/kg), and one sample exceeded the upper SL (3.0 mg TEQ/kg). None of the 32 surface sediment samples exceeded the lower SL.

Data Gaps

In general, few screening level exceedances were identified in surface sediments in this area, with the exception of PCBs, which exceeded a screening level in 12 of 32 surface sediment samples and 20 of 21 storm drain solids samples. The following data gaps were identified for the Seattle Boiler Works to Slip 4 source control area:

- Exceedances of upper SLs for surface sediments in the S Myrtle Street Embayment have been observed, including mercury, zinc, phthalates, PCBs, and dioxins/furans. Additional source tracing and/or source control is needed in the S Myrtle Street SD to prevent sediment recontamination for these chemicals.
- Dioxins/furans were detected above the lower SL in one sample near the S Myrtle Street SD outfall. No storm drain samples in this area have been analyzed for dioxins/furans. Data on dioxin/furan concentrations in this storm drain would be useful to assess the potential for sediment recontamination associated with stormwater discharges from this outfall.

3.4.9 RM 2.8 East (EAA-3): Slip 4

The RM 2.8 East (Slip 4) source control area is shown in Figure 3-35a; it includes Slip 4 and properties that discharge stormwater to Slip 4 along the east side of the LDW. Public outfalls that discharge to Slip 4 include the I-5 SD, King County International Airport (KCIA) SD#3/PS44 Emergency Overflow (EOF), and the former Georgetown Flume. Private outfalls are located on both sides of the slip. Facilities within the Slip 4 source control area include 8th Avenue Terminals, NBF, GTSP, and the northern portion of KCIA.

A total of 61 surface sediment grab samples and 389 storm drain solids samples have been collected in the Slip 4 source control area and sediments in and near Slip 4; many of these samples were analyzed for PCBs only. Sediment and storm drain solids sampling locations are shown in Figure 3-41a; summary statistics for selected analytes are provided in Table 3-26. Di-n-octyl phthalate exceeded the lower SL in at least one sample; arsenic, cadmium, chromium, copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, phenol, PCBs, and dioxins/furans exceeded both the lower SL and the upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the SCAP and Data Gaps Reports for this source control area (Ecology 2006; SAIC 2007b, 2009d).

Stormwater COPCs

Lead, mercury, zinc, HPAH, cPAH, BBP, BEHP, PCBs, and dioxins/furans were identified as COPCs in the Slip 4 source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments. In general, screening level exceedances were concentrated near the head of Slip 4.

Lead

Lead exceeded the upper SL (530 mg/kg DW) in 14 of 298 storm drain solids samples in the Slip 4 source control area (5 percent of samples), with a maximum detected concentration of 2,780 mg/kg DW at NBF MH652. In surface sediments, lead exceeded the lower SL (450 mg/kg DW) in one sample.

Mercury

Mercury exceeded the upper SL (0.59 mg/kg DW) in 48 of 299 storm drain solids samples collected in the Slip 4 source control area (Figure 3-41h). The highest concentration of mercury was 173 mg/kg DW at NBF MH652, which exceeds the upper SL by a factor of 293. Only one of 57 surface sediment samples (approximately 2 percent) exceeded the lower SL for mercury (0.41 mg/kg DW) in Slip 4, and none of the sediment samples exceeded the upper SL.

Zinc

Zinc concentrations exceeded the lower SL (410 mg/kg DW) in 85 percent of storm drain solids samples (254 of 298 samples) collected in this source control area, and exceeded upper SL (960 mg/kg DW) in over half of the samples (168 of 298 samples). Exceedances were observed at NBF, GTSP, KCIA, and 8th Avenue Terminals (Figure 3-41i). In surface sediments, only one of 27 samples exceeded the lower SL for zinc, and no samples exceeded the upper SL.

HPAH and cPAH

Total HPAH and cPAH were detected at concentrations above the upper SL in both storm drain solids and surface sediments (Figures 3-41c, 3-41d). Total HPAH concentrations exceeded the upper SL (17 mg/kg DW) in 32 of the 77 storm drain solids samples that have been analyzed for PAHs. Exceedances were observed in storm drain structures at NBF, the GTSP, KCIA, and 8th Avenue Terminals Site. Total cPAH exceeded the upper SL (3.0 mg/kg DW) in 25 of 77 storm drain solids samples. The highest concentrations of both chemicals were detected in stormwater vaults at KCIA. Specifically, vaults 1757 and 1756 contained 630 mg/kg DW and 530 mg/kg DW HPAH, respectively, which represent upper SL exceedance factors of 37 and 31, respectively. These vaults, located in the southeast corner of the KCIA SD#3 SD basin, also contained the highest concentrations of total cPAH, at 74 mg/kg DW and 65 mg/kg DW, respectively. These cPAH concentrations exceeded the upper SL for cPAH by factors of 25 and 22. Some storm drain structures downstream of these vaults in NBF's south lateral storm drain line also showed exceedances of total HPAH and cPAH.

In Slip 4 surface sediment, two of 27 samples exceeded the upper SL for total HPAH, and one sample exceeded the upper SL for cPAH, with maximum concentrations of 40 mg/kg DW and 6.6 mg/kg DW, respectively. Six additional surface sediment samples exceeded the lower SL for cPAH (1.0 mg/kg DW).

BEHP

Concentrations of BEHP in storm drain solids exceeded the upper SL (1.9 mg/kg DW) in almost two-thirds of samples included in the dataset used to prepare this report (37 of 64 samples). Exceedances were found throughout the area that drains to Slip 4, including the I-5 SD basin, KCIA, NBF, and properties adjacent to the slip (Figure 3-41e). The highest concentration of BEHP (232 mg/kg DW) was detected in KCIA vault 1757; this exceeds the upper SL by a factor of 122. CB72, located in the area of Boeing Plant 2 adjacent to Slip 4, contained 120 mg/kg DW BEHP, about 63 times the upper SL.

In surface sediment, BEHP exceeded the upper SL in 9 of 27 samples, with a maximum concentration of 5.0 mg/kg DW.

BBP

BBP exceeded the upper SL (0.90 mg/kg DW) in storm drain samples collected from KCIA stormwater vaults and from properties adjacent to Slip 4 (Figure 3-41f). Over half of the storm drain samples included in the dataset used to prepare this report exceeded the lower SL (0.063 mg/kg DW) for BBP, and 12 samples exceeded the upper SL. None of the surface sediment samples in Slip 4 exceeded the upper SL.

PCBs

PCBs are present at concentrations above the upper SL (1.0 mg/kg DW) in storm drain solids and surface sediments (Figure 3-41b). Extensive storm drain sampling for PCBs has been conducted at NBF; the presence of PCBs in the storm drain system at this facility has been well established. Source control activities conducted by Boeing and others are summarized in the Slip

4 Interim Source Control Status Report (Ecology 2011), and an RI is currently being conducted by Ecology.

PCBs have been detected in over 95 percent of storm drain samples collected in this source control area, with maximum and average concentrations of 330 mg/kg DW and 4.8 mg/kg DW, respectively. A total of 148 of 389 storm drain solids samples exceeded the upper SL for PCBs.

In surface sediments, PCBs were detected in all 61 samples; maximum and average concentrations were 8.2 mg/kg DW and 1.4 mg/kg DW, respectively. Twenty one samples exceeded the upper SL in surface sediments.

Dioxins/Furans

Three storm drain solids samples exceeded the upper SL (50 ng TEQ/kg DW) for dioxins/furans (Figure 3-41g); two samples were located in the NBF north lateral storm drain line, upstream of the KCIA SD#3 lift station, and one sample was in the NBF parking lot drainage area. The highest detected dioxin/furan concentration was 330 ng TEQ/kg DW in a filtered solids sample collected at CB173.

Of the seven surface sediment samples that have been analyzed for dioxins/furans, none exceeded the upper SL and two exceeded the lower SL (25 ng TEQ/kg DW).

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of arsenic, cadmium, chromium, copper, total LPAH, and phenol exceeded the upper SL in storm drain solids; di-n-octyl phthalate exceeded the lower SL.

- Arsenic, chromium, and phenol exceeded screening levels in less than 5 percent of storm drain solids samples in the Slip 4 source control area; no exceedances were observed in Slip 4 sediments.
- Cadmium exceeded the upper SL (6.7 mg/kg DW) in 147 of 244 storm drain solids samples, with a maximum concentration of 110 mg/kg DW and an average concentration of 14 mg/kg DW. Cadmium did not exceed screening levels in surface sediment samples.
- Copper exceeded the screening level (390 mg/kg DW) in 46 of 298 storm drain solids samples. The highest concentration of copper was 6,320 mg/kg DW, which exceeded the SL by a factor of 16. Copper did not exceed screening levels in surface sediment samples.
- Total LPAH exceeded the upper SL (13 mg/kg DW) in 13 of 77 storm drain solids samples. No exceedances were observed in the surface sediment samples included in the dataset used to prepare this report.

Data Gaps

Storm drain solids and surface sediment data indicate that stormwater discharges to Slip 4 represent a potential source of sediment recontamination, particularly for PCBs, HPAH, cPAH, BEHP, BBP, and dioxins/furans.

Source control activities have been underway in the Slip 4 source control area since approximately 2008, including the recent construction by Boeing of a long-term stormwater treatment system near the KCIA SD#3 lift station. Ecology is conducting an RI for the NBF-GTSP site, which will identify and fill remaining data gaps. Sediment cleanup in Slip 4 is currently progress. No additional data gaps have been identified at this time.

3.4.10 RM 2.8 to 3.7 East (EAA-4): Boeing Plant 2 to Jorgensen Forge

The RM 2.8 to 3.7 East (Boeing Plant 2 to Jorgensen Forge) source control area is shown in Figure 3-42a. This source control area includes stormwater that discharges to the LDW from private outfalls, from the 16th Avenue S outfall, and from those portions of central KCIA that discharge through the KCIA-Jorgensen SD.

Sediment and storm drain solids sampling locations are shown in Figure 3-42a; summary statistics for selected analytes are provided in Table 3-27. Total LPAHs exceeded the lower SL in at least one sample; chromium, copper, lead, mercury, zinc, total HPAH, cPAH, BBP, BEHP, phenol, PCBs, and dioxins/furans exceeded both the lower SL and upper SL in at least one sample.

It should be noted that only one surface sediment sample near the 16th Avenue S SD outfall is included in the dataset used to prepare this report, and it was analyzed for dioxins/furans only. Other surface sediment samples were collected in this area during the 1990s but were not included in this data evaluation. Section 2 provides additional information on the criteria used to select data for inclusion in this report.

It is also important to note that the dataset used to prepare this report did not include any storm drain solids data from the Boeing Plant 2 or Jorgensen Forge facilities. These data, if any, should be provided to SAIC for inclusion in an update to this report.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2007a).

Stormwater COPCs

Mercury, zinc, HPAH, cPAH, BBP, phenol, and PCBs were identified as COPCs in the Boeing Plant 2 to Jorgensen Forge source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

<u>Mercury</u>

Mercury was detected in one of seven storm drain solids sample at a concentration above the upper SL (0.59 mg/kg DW). A sample collected from location MH201, in the 16th Avenue S SD, contained 7.7 mg/kg DW mercury. No surface sediment samples in this area were included in the dataset used to prepare this report.

One surface sediment sample, located near the KCIA-Jorgensen SD, contained mercury at 0.53 mg/kg DW, just below the upper SL.

Zinc

Zinc concentrations exceeded the upper SL in both storm drain solids and surface sediment samples in this source control area (Figure 3-42e). Similar to mercury, the storm drain exceedances were in the 16th Avenue S SD, while the sediment exceedances were upstream, near the KCIA-Jorgensen SD. Maximum concentrations were 1,640 mg/kg DW and 1,690 mg/kg DW in storm drain solids and surface sediments, respectively.

HPAH and cPAH

Total HPAH and cPAH concentrations exceeded the upper SL in surface sediments and exceeded the lower SL in storm drain solids. One surface sediment sample (SD-307-S), located at RM 3.6 East (near the KCIA-Jorgensen SD outfall), exceeded the upper SL for both total HPAH and cPAH, with concentrations of 35.1 mg/kg DW and 3.3 mg/kg DW, respectively. One grab sample from location KCIAJ-ST1 exceeded the lower SL in storm drain solids.

BBP

Concentrations of BBP exceeded the lower SL in six storm drain solids samples and the upper SL in one of these samples (Figure 3-42c), with a concentration of 2.6 mg/kg DW, in the 16th Avenue S SD basin. No surface sediment data for the area near the 16th Avenue S SD outfall were available.

Phenol

Phenol in storm drain solids exceeded the upper SL (1.2 mg/kg DW) in one sample, with a concentration of 3.5 mg/kg DW at sampling location MH202 in the 16th Avenue S SD. No surface sediment data for the area near the 16th Avenue S SD outfall were available. In surface sediments, phenol exceeded the upper SL at 2.8 mg/kg DW near outfall 3017 (Figure 3-42d).

PCBs

Maximum and average concentrations of total PCBs exceeded the upper SL (1.0 mg/kg DW) in both storm drain solids and surface sediment samples (Figure 3-42b). Over 90 percent of surface sediment samples (45 of 49 samples) exceeded the lower SL for PCBs (0.13 mg/kg DW) and 18 samples exceeded the upper SL. The highest sediment PCB concentration was 110 mg/kg DW, over 100 times the upper SL. Most of the exceedances were located near the Jorgensen Forge property and the KCIA-Jorgensen SD outfall (Figure 3-42b); however, data from only one surface sediment sample near Boeing Plant 2 was available.

In storm drain solids, over 95 percent of samples exceeded the lower SL (23 of 24 samples), and six samples exceeded the upper SL; these were located in areas of KCIA with stormwater drainage to the KCIA-Jorgensen SD. Storm drain samples in the 16th Avenue S SD exceeded the lower SL for PCBs.

Chemicals with Exceedances in Surface Sediment Only

Concentrations of chromium, copper, lead, and dioxins/furans exceeded the upper SL in surface sediment; total LPAH exceeded the lower SL.

- Chromium exceeded the upper SL (270 mg/kg DW) in two of 21 surface sediment samples. No storm drain samples have been analyzed for chromium.
- Copper and lead exceeded the upper SL in one and four surface sediment samples, respectively. Lead exceeded the upper SL (450 mg/kg DW) in four surface sediment samples.
- One surface sediment sample contained 101 ng TEQ/kg dioxins/furans, about twice the upper SL, near the KCIA-Jorgensen SD outfall. No storm drain solids samples have been analyzed for dioxins/furans.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of BEHP exceeded the lower SL in six of seven storm drain solids samples, and exceeded the upper SL in four samples; these were located in the 16^{th} Avenue S SD. The maximum detected concentration of 44 mg/kg DW exceeds the upper SL (1.9 mg/kg DW) by a factor of 23. Surface sediments did not exceed a screening level for BEHP.

Data Gaps

The following data gaps were identified for the Boeing Plant 2 to Jorgensen Forge source control area:

- While many surface sediment samples have been collected near the Jorgensen Forge facility, sediment data near Boeing Plant 2 are over 10 years old and were not included in the dataset used to prepare this report. Additional sediment sampling near Boeing Plant 2 and the 16^{th} Avenue S SD outfall is needed to identify potential contaminant sources in storm drain solids.
- Storm drain solids data have been collected in the 16^{th} Avenue S SD and in the area of KCIA that drains to the KCIA-Jorgensen SD outfall. However, no storm drain solids data were available from the Boeing Plant 2 or Jorgensen Forge facilities. Storm drain solids data are needed to assess whether contaminants detected in surface sediments in this source control area have sources at one or both of these facilities.
- Dioxins/furans were detected in a surface sediment sample near the KCIA-Jorgensen SD outfall at two times the upper SL. No storm drain solids samples in the dataset used to prepare this report were analyzed for dioxins/furans. Source tracing for dioxins/furans is needed in this area.

3.4.11 RM 3.7 to 3.9 East (EAA-6): Boeing Isaacson/Central KCIA

The RM 3.7 to 3.9 East (Boeing Isaacson/Central KCIA) source control area is shown in Figure 3-43a. This source control area includes the Boeing Isaacson and Thompson properties and central areas of KCIA within the KCIA SD#2/PS45 EOF drainage area.

Sediment and storm drain solids sampling locations are shown in Figure 3-43a; summary statistics for selected analytes are provided in Table 3-28. Phenol exceeded the lower SL in at least one sample; arsenic, cadmium, chromium, copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, total PCBs, and dioxins/furans exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for Boeing Isaacson/Central KCIA source control area (SAIC 2008c).

Stormwater COPCs

Arsenic, HPAH, cPAH, BBP, and total PCBs were identified as COPCs in the Boeing Isaacson/Central KCIA source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

<u>Arsenic</u>

Arsenic exceeded the upper SL in two of 10 surface sediment samples and exceeded the lower SL in storm drain solids (Figure 3-43f). The highest concentration in surface sediments (1,100 mg/kg DW) exceeded the upper SL (93 mg/kg DW) by a factor of 12; the two samples with upper SL exceedances were located along the former Boeing Isaacson facility shoreline. High concentrations of arsenic have been detected in soil and groundwater at the Boeing Isaacson-Thompson site. In storm drain solids, arsenic was detected at 90 mg/kg DW, above the lower SL (57 mg/kg DW), in KCIA SD#2, which discharges to the LDW at outfall 2062.

<u>HPAH</u>

Total HPAH exceeded the upper SL in both storm drain solids (5 of 42 samples) and surface sediments (one of 10 samples). In storm drain solids, the highest concentration of total HPAH (284 mg/kg DW) was detected at CB40 (Figure 3-43a), an onsite catch basin at an airplane loading equipment repair facility near the upstream end of KCIA SD#2 (SPU 2010). This represents an upper SL exceedance factor of 17. Other total HPAH screening level exceedances were located in a sediment trap near the downstream end of KCIA SD#2 and in catch basins on the Boeing Isaacson/Thompson property (Figure 3-43c). In sediment, total HPAH was detected at 19 mg/kg DW in a sample near the KCIA SD#2 outfall (outfall 2062).

<u>cPAH</u>

Total cPAH shows a similar pattern to HPAH. Two of 42 storm drain samples exceeded the upper SL, including a catch basin sample at CB40 with 38 mg/kg DW total cPAH. This exceeds the upper SL (3.0 mg/kg DW) by a factor of 13. Other screening level exceedances of cPAH were detected near the downstream end of KCIA SD#2 and in catch basins on the Boeing Isaacson/Thompson property (Figure 3-43d). In sediment, total cPAH exceeded the lower SL in four samples located near and downstream of the KCIA SD#2 outfall.

<u>BBP</u>

BBP concentrations exceeded the lower SL (0.063 mg/kg DW) in 31 of 41 storm drain solids samples, and exceeded the upper SL (0.90 mg/kg DW) in 13 storm drain solids samples in this source control area (Figure 3-43e). The highest concentration of BBP was 7.9 mg/kg DW at IT-CB60/61, in the southeast corner of the Boeing Thompson site. Five surface sediment samples exceeded the lower SL for BBP.

PCBs

PCBs exceeded the lower SL (0.13 mg/kg DW) in 31 of 43 storm drain solids samples (Figure 3-43b); the average concentration of total PCBs in this source control area was 0.35 mg/kg DW. The highest concentration was 3.4 mg/kg DW, above the upper SL (1.0 mg/kg DW) at CB40, near the upstream end of KCIA SD#2 (Figure 3-43a). In surface sediments, PCBs exceeded the lower SL in nine of 12 samples.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of cadmium, chromium, copper, led, mercury, zinc, total LPAH, BEHP, and dioxins/furans exceeded the upper SL in storm drain solids; phenol exceeded the lower SL.

- Cadmium and zinc exceeded the upper SL in over half of the 42 storm drain samples collected in this source control area. Cadmium concentrations are shown in Figure 3-43g. Maximum concentrations (154 mg/kg cadmium, 821 mg/kg chromium, 606 mg/kg copper, 568 mg/kg lead, 1.2 mg/kg mercury, and 6,640 mg/kg zinc) were found in catch basins at the Boeing Thompson/Isaacson property. Surface sediments in this area did not exceed screening levels for these metals.
- BEHP exceeded the upper SL in 31 of 41 storm drain solids samples but did not exceed screening levels in surface sediments along RM 3.7 to 3.9 East.
- Total LPAH was detected at 32 mg/kg DW in CB40, located near the upstream end of KCIA SD#2.
- Dioxins/furans were detected at concentrations above the lower SL (25 ng TEQ/kg) in three storm drain solids samples at the Boeing Isaacson/Thompson facility, and above the upper SL (50 ng TEQ/kg) at location IT-CG74, along the southern border of the property. Dioxins/furans were detected at 60 ng TEQ/kg DW at this location. No surface sediment samples in this area have been analyzed for dioxins/furans.

Data Gaps

The following data gaps were identified for the Boeing Isaacson/Central KCIA source control area:

- Arsenic, HPAH, cPAH, BBP, and PCBs exceeded screening levels in storm drain solids collected from KCIA SD#2, which drains the central portion of KCIA, and in catch basins and other structures at the Boeing Isaacson/Thompson facility. These chemicals were also detected at concentrations above screening levels in surface sediments in the RM 3.7 to 3.9 East area. Source tracing is needed to evaluate whether storm drain discharges from the Boeing Isaacson/Thompson facility and/or central KCIA represent sources of sediment recontamination for these chemicals.

- Dioxins/furans were detected at the Boeing Isaacson/Thompson property at concentrations above screening levels in three of six samples collected in storm drain structures at the site. No surface sediment samples in this area have been analyzed for dioxins; surface sediment samples are needed to evaluate whether dioxins/furans at this site represent a sediment recontamination source.

3.4.12 RM 3.9 to 4.3 East: Slip 6

The RM 3.9 to 4.3 East (Slip 6) source control area is shown in Figure 3-44a. This source control area extends from Boeing Thompson to the northern portion of the BDC. Facilities within this source control area include the 8801 Site, the former Rhone-Poulenc site, the portion of BDC with stormwater drainage to Slip 6, the Museum of Flight, and the south-central portion of KCIA which discharges to Slip 6 through KCIA SD#1.

Sediment and storm drain solids sampling locations are shown in Figure 3-44a; summary statistics for selected analytes are provided in Table 3-29. Total LPAH exceeded the lower SL in at least one sample; copper, lead, mercury, zinc, total HPAH, cPAH, BBP, BEHP, phenol, and total PCBs exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2008a).

Stormwater COPCs

Zinc, HPAH, cPAH, BBP, and BEHP were identified as COPCs in the Slip 6 source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments. Storm drain samples have been collected from only two locations in the Slip 6 source control area: sediment trap and inline grab samples from KCIA1-ST1 and an onsite catch basin (CB41B) near the KCIA entrance gate.

<u>Zinc</u>

Zinc was detected in one of 66 surface sediment samples at a concentration of 1,000 mg/kg DW, slightly above the upper SL of 960 mg/kg DW (Figure 3-44d); this sample was located near outfall 2075, at the very north end of the Slip 6 source control area. In storm drain solids, zinc was detected at concentrations above the lower SL in all three samples; concentrations ranged from 596 to 740 mg/kg DW.

<u>HPAH and cPAH</u>

Total HPAH and cPAH concentrations exceeded the upper SL at KCIA-ST1 (Figure 3-44b), at concentrations of 83 mg/kg DW and 8.5 mg/kg DW, respectively. These concentrations exceed the upper SLs by factors of three to five. Surface sediment concentrations in Slip 6, near the KCIA SD#1 outfall, also exceeded screening levels for HPAH and cPAH. Total HPAH was detected at a maximum concentration of 20 mg/kg DW (above the upper SL of 17 mg/kg DW) near the head of Slip 6; total cPAH was detected at 2.1 mg/kg DW (above the lower SL of 1.0

mg/kg DW) in the same area. Outfalls 2081 and 2078 also discharge to Slip 6; no storm drain samples have been collected in areas that drain to these outfalls.

<u>BBP</u>

BBP was detected at a concentration of 2.6 mg/kg DW, above the upper SL (0.90 mg/kg DW), at location CB41B (Figure 3-44c). In addition, BBP exceeded the lower SL (0.063 mg/kg DW) in the sediment trap sample at KCIA-ST1. Surface sediments in Slip 6 did not exceed screening levels for BBP. However, sediment samples at the north end of the source control area downstream of outfall 2073 and near outfall 2075 exceeded the lower SL in 15 samples and exceeded the upper SL in one sample at 2.2 mg/kg DW. These sediment samples are adjacent to the 8801 Site; no storm drain solids samples are available in this area.

<u>BEHP</u>

Concentrations of BEHP exceeded the upper SL in both surface sediments and storm drain solids (Figure 3-44c). The highest concentration of BEHP (41 mg/kg DW), which exceeded the upper SL (1.9 mg/kg DW) by a factor of 22, was detected at location CB41B. Surface sediment concentrations of BEHP in Slip 6 exceeded the lower SL in three samples and also exceeded the upper SL in two of them. Outfalls 2081 and 2078 also discharge to Slip 6; no storm drain samples have been collected in areas that drain to these outfalls.

<u>Chemicals with Exceedances in Surface Sediment Only</u>

Concentrations of lead, mercury, phenol, and PCBs exceeded the upper SL in surface sediment.

- Lead was detected at 12,300 mg/kg DW in one of 66 surface sediment samples located near the 8801 Site northern property boundary. This is the same sample with the high concentration of zinc described above.
- Mercury was detected at 6.8 mg/kg DW in one of 66 surface sediment samples, at a location in the northern part of the site, above the upper SL by a factor of 12.
- Phenol slightly exceeded the upper SL in two of 55 sediment samples.
- Total PCBs exceeded the upper SL in three of 55 sediment samples and exceeded the lower SL in 28 samples. Exceedances were observed in Slip 6 and along the shoreline to the north, near the 8801 Site.

<u>Chemicals with Exceedances in Storm Drain Solids Only</u>

Concentrations of copper exceeded the upper SL in storm drain solids; total LPAH exceeded the lower SL.

- Copper was detected above the screening level (390 mg/kg DW) in the sediment trap sample at KCIA-ST1, at a concentration of 429 mg/kg DW. Surface sediments in Slip 6 did not exceed the screening level for copper.

Data Gaps

The following data gaps were identified for the Slip 6 source control area:

- HPAH, cPAH, and BEHP were detected in storm drain solids in KCIA SD#1, and in surface sediments near the head of Slip 6, at concentrations above screening levels. No samples have been collected from areas with stormwater drainage to outfalls 2078 (Container Properties LLC) or 2081 (BDC). Additional data are needed to identify sources of PAHs and phthalates to Slip 6.
- Zinc, lead, mercury, BBP, and PCBs were detected at concentrations above the upper SL in surface sediments at the north end of the Slip 6 source control area, near outfalls 2073 and 2075. No storm drain solids have been collected in this area; source tracing is needed.

3.4.13 RM 4.3 to 4.9 East: Boeing Developmental Center

The RM 4.3 to 4.9 East (BDC) source control area is shown in Figure 3-45. This source control area extends from approximately RM 4.3 East to the Boeing pedestrian bridge, just past RM 4.8 East. The central portion of the BDC is the only facility located within this source control area.

Sediment and storm drain solids sampling locations are shown in Figure 3-45; summary statistics for selected analytes are provided in Table 3-30. BBP, di-n-octyl phthalate, phenol, and total PCBs exceeded the lower SL in at least one sample; zinc, total LPAH, total HPAH, cPAH, and BEHP exceeded both the lower SL and upper SL in at least one sample.

Storm drain solids samples have been collected at one location in this source control area, including filtered solids from one to three storm events (depending on the analyte) and one sediment trap sample (analyzed for PAHs only). Filtered solids data presented in Table 3-30 reflect the average of the 2010–2011 storm sampling events at this location (SAIC and NewFields 2011a). While some sampling of oil/water separators was conducted at this facility in 2002, original data were not available, data quality issues were identified, and sample locations were unclear (SAIC 2010d). Therefore, while these data indicate the presence of PCBs in the BDC storm drain system, the data were not included in the dataset used to prepare this report.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2010d).

Stormwater COPCs

PCBs were identified as COPCs in the BDC source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Total PCBs

PCBs were detected at an average concentration of 0.48 mg/kg DW in filtered solids samples collected at BDC2088, approximately 150 feet upstream of outfall 2088 (Boeing outfall DC12). PCBs were detected in 15 of 18 surface sediment samples in the RM 4.3 to 4.8 East area, with two samples above the lower SL (0.13 mg/kg DW). The maximum detected concentration of PCBs in surface sediments was 0.27 mg/kg DW.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of zinc, total LPAH, total HPAH, total cPAH, and BEHP exceeded the upper SL in storm drain solids; BBP, di-n-octyl phthalate, and phenol exceeded the lower SL.

- Zinc was detected in 1,520 mg/kg DW in a filtered solids sample at BDC2088; this exceeded the upper SL (960 mg/kg DW) by a factor of 1.6.
- Total LPAH, total HPAH, and cPAH exceeded the upper SL in filtered solids samples and a sediment trap sample collected at BDC2088. Maximum detected concentrations were 15 mg/kg DW (exceedance factor of 1.2) for total LPAH, 120 mg/kg DW (exceedance factor of 7) for total HPAH, and 14 mg/kg DW (exceedance factor of 4.7) for total cPAH.
- BEHP was detected in one sediment trap sample collected at BDC2088, with a concentration of 6.3 mg/kg DW, which exceeds the upper SL by a factor of 3.3.

Data Gaps

The following data gaps were identified for the BDC source control area:

- In general, surface sediments in this area did not exceed screening levels for the contaminants included in this evaluation; however, PCBs exceeded the lower SL in one sediment sample. Only one storm drain solids sample was analyzed for PCBs in this area, and historical data indicates that PCBs may be present in the storm drain system. Additional storm drain samples would be helpful to evaluate whether PCBs associated with this facility may contribute to future sediment recontamination.

3.4.14 RM 4.9 East (EAA-7): Norfolk CSO/SD

The RM 4.9 East (Norfolk CSO/SD) source control area is shown in Figure 3-46a. This source control area includes the southern portion of the BDC from RM 4.85 to approximately RM 5.0 East and the large drainage basin for the Norfolk CSO/SD.[2] Facilities within this source control area include the portion of BDC with stormwater drainage to the BDC south storm drain line, the Boeing Military Flight Center, Associated Grocers, Northwest Auto Wrecking, and the southern portion of KCIA.

Sediment and storm drain solids sampling locations are shown in Figure 3-46a; summary statistics for selected analytes are provided in Table 3-31. Cadmium and phenol exceeded the lower SL in at least one sample; zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, total PCBs, and dioxins/furans exceeded both the lower SL and upper SL in at least one sample.

[2] Please note that the source control area boundaries as depicted in Figures 3-40a through 3-40e do not match the boundaries shown in the EAA-7 SCAP. The properties immediately adjacent to the LDW near RM 5.0 to 5.4 were not included as part of this source control area in the SCAP. This area includes the Ryan Way SD.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (E&E 2007b).

Stormwater COPCs

BEHP, BBP, cPAH, and PCBs were identified as COPCs in the Norfolk CSO/SD source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Total cPAH

Three of 41 storm drain solids samples exceeded the upper SL (3.0 mg/kg DW); all were located in the Norfolk SD basin on the east side of Interstate 5 (Figure 3-46c). One surface sediment sample near the Norfolk CSO/SD outfall exceeded the lower SL.

BBP

BBP exceeded the upper SL (0.90 mg/kg DW) in six storm drain solids samples in the Norfolk CSO/SD basin (Figure 3-46e); the maximum detected concentration was 4.4 mg/kg DW. In surface sediments, only one sample exceeded the lower SL, and none of the samples exceeded the upper SL.

BEHP

Exceedances of the upper SL for BEHP are widespread in storm drain solids in the Norfolk CSO/SD source control area (Figure 3-46d). Over sixty percent (25 of 40) storm drain samples exceeded the upper SL (1.9 mg/kg DW), with a maximum detected concentration of 59 mg/kg DW at CB213, located along Martin Luther King Jr Way S. The average concentration of BEHP in storm drain solids also exceeded the upper SL. Only one surface sediment sample, located near the Norfolk CSO/SD outfall, exceeded a screening level for BEHP.

Total PCBs

PCBs exceeded the upper SL (1.0 mg/kg DW) in storm drain solids samples (15 mg/kg DW) and surface sediment samples (1.1 to 8.4 mg/kg DW) near the Norfolk CSO/SD outfall (Figure 3-46b). Over one-third of surface sediment samples in this area exceeded the lower SL for total PCBs. However, storm drain and surface sediment samples collected in this area in 2011 did not detect PCBs above screening levels.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Concentrations of zinc, total LPAH, total HPAH, and dioxins/furans exceeded the upper SL in storm drain solids; cadmium and phenol exceeded the lower SL.

- Zinc exceeded the upper SL (960 mg/kg DW) in nine storm drain solids samples but did not exceed screening levels in surface sediments. The maximum concentration of zinc was detected in catch basin CB72 at 9,980 mg/kg DW.
- Total LPAH exceeded the upper SL (13 mg/kg DW) in two storm drain solids samples. The highest concentration was 66 mg/kg DW in catch basin CB78. No surface sediment samples exceeded a screening level for total LPAH.
- Total HPAH exceeded the upper SL in storm drain solids in seven samples; the maximum detected concentration was 585 mg/kg DW at location CB78, which exceeds the upper SL (17 mg/kg DW) by a factor of 34. No surface sediment samples exceeded a screening level for total HPAH.
- Dioxins/furans exceeded the upper SL (50 mg/kg DW) in one of two storm drain samples collected in this source control area, with a concentration of 53 mg/kg DW. Only two surface sediment samples have been analyzed for dioxins/furans in this area.

Data Gaps

The following data gaps were identified for the Norfolk CSO/SD source control area:

- One storm drain sample exceeded the upper SL for dioxins/furans; only two surface sediment samples have been analyzed for dioxins/furans. Additional source tracing is needed.

3.4.15 RM 0.0 to 1.0 West: Spokane Street to Kellogg Island

The RM 0.0 to 1.0 West (Spokane Street to Kellogg Island) source control area is shown in Figure 3-47a. This source control area extends from approximately the West Seattle Bridge to just north of Lafarge Cement. It includes the SW Dakota Street and SW Idaho Street storm drain basins. Facilities within this source control area include Port of Seattle Terminals 105 and 107.

Sediment and storm drain solids sampling locations are shown in Figure 3-47a; summary statistics for selected analytes are provided in Table 3-32. Total LPAH and phenol exceeded the lower SL in at least one sample; mercury, zinc, total HPAH, total cPAH, BBP, BEHP, total PCBs, and dioxins/furans exceeded both the lower SL and the upper SL in at least one sample.

Stormwater COPCs

Zinc, LPAH, HPAH, cPAH, BBP, BEHP, and PCBs were identified as COPCs in the Spokane Street to Kellogg Island source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments. Total LPAH exceeded the lower SL only, in one storm drain solids sample and one surface sediment sample.

<u>Zinc</u>

Zinc was detected in one storm drain solids sample at 3,740 mg/kg DW, above the upper SL (960 mg/kg DW) by a factor of four. This sample (CB41C) was from an onsite catch basin in the SW Dakota Street SD basin (Figure 3-47d). Two additional storm drain solids samples in the SW Dakota Street SD basin exceeded the lower SL (410 mg/kg DW). Stormwater in this area discharges to the SW Dakota Street ditch near outfall 2149 (Figure 3-47a); a surface sediment sample near this outfall contained zinc at 478 mg/kg DW, above the lower SL.

Total HPAH

Concentrations of total HPAH exceeded the upper SL (17 mg/kg DW) in both storm drain solids and surface sediments. One sediment trap sample (ID-ST1), in the Idaho Street SD, contained total HPAH at 89 mg/kg DW. Surface sediment samples near the Idaho Street SD outfall did not exceed screening levels.

Three surface sediment samples, all located between RM 0.5 and 0.6 near the north end of Terminal 107, contained total HPAH at concentrations between 21 and 26 mg/kg DW, above the upper SL.

Total cPAH

One storm drain solids sample (ID-ST1) exceeded the upper SL for cPAH (3.0 mg/kg DW), with a concentration of 9.5 mg/kg DW. Surface sediment samples near the Idaho Street SD outfall did not exceed cPAH screening levels. One surface sediment sample, located near RM 0.6 (the north end of Terminal 107), slightly exceeded the upper SL with a concentration of 4.1 mg/kg DW.

BBP and BEHP

BBP and BEHP concentrations exceeded the upper SL in four storm drain solids samples collected in the SW Dakota Street SD basin (Figures 3-47c). BBP concentrations in these locations ranged from 1.3 to 19 mg/kg DW; the highest concentration, at RCB185, exceeded the upper SL (0.90 mg/kg DW) by a factor of 21. BEHP concentrations at these sampling locations ranged from 1.6 to 37 mg/kg DW, with the highest concentration detected in catch basin CB41C. Stormwater in this area discharges to the LDW at outfall 2149; a sediment sample at this location exceeded the lower SLs for both BBP and BEHP. No other samples in this source control area exceeded a screening level for BBP.

Total PCBs

Total PCBs exceeded the lower SL (0.13 mg/kg DW) in 11 surface sediment samples and seven storm drain solids samples in the Spokane Street to Kellogg Island source control area (Figure 3-47b). One surface sediment sample, at a location near RM 0.6 West, contained PCBs at the upper SL (1.0 mg/kg DW).

Chemicals with Exceedances in Surface Sediment Only

Concentrations of mercury and dioxins/furans exceeded the upper SL in surface sediment; phenol exceeded the lower SL.

- Mercury exceeded the upper SL (0.59 mg/kg DW) in three surface sediment samples. The maximum concentration of 1.8 mg/kg DW was detected near outfall 2157. Two additional surface sediment sample locations exceeded the upper SL concentrations at 0.60 to 0.63 mg/kg DW; these samples are located near RM 0.6 West.
- Dioxins/furans were detected at 75 ng TEQ/kg, above the upper SL (50 ng TEQ/kg), in one surface sediment sample near Terminal 107 at RM 0.6 West. Only one storm drain

solids sample has been analyzed for dioxins/furans; no information on dioxin/furan concentrations in areas with stormwater discharge to this portion of the river is available.

<u>Chemicals with Exceedances in Storm Drain Solids Only</u>

All chemicals that exceeded screening levels in storm drain solids also exceeded screening levels in surface sediments.

Data Gaps

The following data gaps were identified for the Spokane Street to Kellogg Island source control area:

- Zinc, BEHP, and BBP exceeded screening levels in both storm drain solids and surface sediment samples associated with the SW Dakota Street SD; additional source tracing and control is needed in this area.
- PCBs, HPAH, cPAH, mercury, and dioxins/furans exceeded the upper SL in surface sediments near RM 0.6 West, near the Port of Seattle Terminal 107 property. No storm drain samples have been collected in this area. Source tracing is needed in this area.

3.4.16 RM 1.0 to 1.3 West: Kellogg Island to Lafarge

The RM 1.0 to 1.3 West (Kellogg Island to Lafarge) source control area is shown in Figure 3-48a. Lafarge Cement is the only facility included in this source control area. There are no public storm drains that discharge to the LDW within the RM 1.0 to 1.3 West source control area.

Sediment and storm drain solids sampling locations are shown in Figure 3-48a; summary statistics for selected analytes are provided in Table 3-33. Arsenic, zinc, total HPAH, total cPAH, BBP, phenol, and dioxins/furans exceeded the lower SL in at least one sample; copper, BEHP, and total PCBs exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2011c).

Stormwater COPCs

Total HPAH, total cPAH, BBP, and PCBs were identified as COPCs in the Kellogg Island to Lafarge source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments. Total HPAH, total cPAH, and BBP exceeded the lower SLs only.

<u>Total HPAH and cPAH</u>

One storm drain sample exceeded the lower SL for total HPAH (14 mg/kg DW), and three storm drain samples exceeded the lower SL for cPAH (1.0 mg/kg DW), all on the southern portion of the site near the Chemithon facility. One surface sediment sample (TRI-036) exceeded the lower SLs for both compounds; this sediment sample was located near the north end of the Lafarge facility.

<u>BBP</u>

BBP was also detected at concentrations above the lower SL (0.063 mg/kg DW) in catch basin samples near the Chemithon property. One sediment sample near the north end of the Lafarge facility slightly exceeded the lower SL.

<u>Total PCBs</u>

PCBs exceeded the lower SL in two storm drain solids samples collected near the Chemithon site (Figure 3-48b), at concentrations up to 0.81 mg/kg DW. LDW surface sediments exceed the lower SL for PCBs in six samples, five of which were located along the eastern boundary of the Lafarge Cement facility and are therefore downstream of the Chemithon outfall.

<u>Chemicals with Exceedances in Surface Sediment Only</u>

Arsenic and dioxins/furans exceeded the lower SL in surface sediments only. Only four storm drain samples were analyzed for arsenic. Sediment exceedances (to 86 mg/kg DW) were found near outfalls 5003/5004 (Figure 3-48a). No storm drain samples have been analyzed for dioxins/furans, which were detected at 27 ng TEQ/kg in a sediment sample along the northern Lafarge boundary.

<u>Chemicals with Exceedances in Storm Drain Solids Only</u>

Copper and BEHP exceeded the upper SL in storm drains but not in surface sediments. Zinc exceeded the lower SL in storm drain solids. Copper exceeded the upper SL (390 mg/kg DW) in three storm drain solids samples (to 1,730 mg/kg DW), located at the northern Chemithon property boundary. BEHP exceeded the upper SL (1.9 mg/kg DW) in three catch basin samples near Chemithon at a maximum concentration to 3.6 mg/kg DW.

Data Gaps

A SCAP was published for this source control area by Ecology in May 2011. The SCAP identified data gaps and outlined action items needed to assess and control potential contaminant sources. While only four storm drain solids samples have been collected at the Lafarge facility, no exceedances of upper SLs have been observed in surface sediments in this area.

Data gaps associated with the Chemithon facility are discussed in Section 3.3.17 below. No additional data gaps have been identified as a result of the current review.

3.4.17 RM 1.3 to 1.6 West: Glacier Bay

The RM 1.3 to 1.6 West (Glacier Bay) source control area is shown in Figure 3-49a; it extends from Lafarge Cement to the southern end of the Glacier Bay inlet, just north of Terminal 115. It includes most of the SW Kenny Street SD basin, although the SW Kenny Street SD outfall is located in the Terminal 115 source control area (see Section 3.3.18). Facilities within this source control area include Glacier Northwest/Reichhold Chemicals, Duwamish Shipyard, Alaska Marine Lines, and Chemithon.

Sediment and storm drain solids sampling locations are shown in Figure 3-49a; summary statistics for selected analytes are provided in Table 3-34. Total LPAH exceeded the lower SL in at least one sample; arsenic, copper, lead, mercury, zinc, total HPAH, cPAH, BBP, BEHP, phenol, PCBs, and dioxins/furans exceeded both the lower SL and the upper SL in at least one sample. Most storm drain solids samples were collected at or near the Chemithon property. Stormwater drainage from this area is believed to discharge to the LDW through outfall 5005.

Because stormwater drainage from the Chemithon property is believed to discharge to the LDW at outfall 5005, and surface sediments in the vicinity of this outfall are included in the Kellogg Island to Lafarge source control area (Section 3.3.16), storm drain solids collected at or near Chemithon are compared to surface sediments collected at the south end of the Kellogg Island to Lafarge source control area.

Storm drain solids samples from two ROW catch basins in the SW Kenny Street SD (RCB52 and RCB53) discharge to the SW Kenny Street SD/Terminal 115 CSO outfall discussed in Section 3.3.18 below (Terminal 115 source control area).

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2007c).

Stormwater COPCs

Storm drain solids samples collected within this source control area discharge to the LDW either to the north (Chemithon) or south (Terminal 115) of Glacier Bay. No storm drain sample data were available for Alaska Marine Lines, Duwamish Shipyard, or Glacier Northwest, which are located adjacent to Glacier Bay. Therefore, identification of stormwater COPCs as those chemicals with exceedances in both storm drain solids and surface sediments is not relevant in the Glacier Bay source control area. The available storm drain sample data are not likely to represent sources of contaminants to surface sediments along RM 1.3 to 1.6 West.

Chemicals with exceedances in storm drains and surface sediments are discussed separately below.

Chemicals with Exceedances in Surface Sediment Only

Concentrations of arsenic, copper, lead, mercury, zinc, total HPAH, and dioxins/furans exceeded the upper SL in surface sediment.

- Arsenic exceeded the upper SL in four surface sediment samples (Figure 3-49e), with a maximum detected concentration of 807 mg/kg DW; this exceeds the upper SL (93 mg/kg DW) by a factor of nine. The average concentration of arsenic (107 mg/kg DW) also exceeded the upper SL.
- Copper exceeded the upper SL[3] in four surface sediment samples (Figure 3-49f). The maximum detected concentration of 1,420 mg/kg DW exceeds the screening level (390 mg/kg DW) by a factor of 3.6. Exceedances were general located along the Alaska Marine Lines/Duwamish Shipyard shoreline. High copper concentrations in surface sediments in Glacier Bay may be a result of sandblasting activities at Duwamish Shipyard.

[3] Note that the lower and upper SLs for copper are both 390 mg/kg DW.

- Lead, mercury, and zinc exceeded the upper SL in one surface sediment sample (LDW-SS48), with concentrations of 780 mg/kg DW, 0.79 mg/kg DW, and 2,830 mg/kg DW, respectively (Figures 3-49g, 3-43h). This sample was located near the former Duwamish Shipyard graving dock.
- Total HPAH exceeded the upper SL in one surface sediment sample (B4a), located near Glacier Northwest and just upstream of outfall 2130. The maximum detected concentration of total HPAH was 26 mg/kg DW, which exceeds the upper SL (17 mg/kg DW) by a factor of 1.5.
- Dioxins/furans were detected in three samples at concentrations above the upper SL (50 ng TEQ/kg DW). Concentrations ranged from 463 to 2,100 ng TEQ/kg DW, which represent upper SL exceedance factors of 9 to 42. The maximum detected concentration of 2,100 ng TEQ/kg DW was the highest dioxin concentration in any of the LDW surface sediment samples in the dataset used to prepare this report. All three samples were located within the Glacier Bay inlet. No storm drain solids data collected at the Glacier Northwest/Reichhold facility were available at this time this report was prepared.

<u>Chemicals with Exceedances in Storm Drain Solids Only</u>

Arsenic, copper, lead, mercury, zinc, total HPAH, total cPAH, BBP, BEHP, phenol, and total PCBs exceeded the upper SL in storm drain solids samples collected near the Chemithon property (Figure 3-49a). Surface sediments near the Chemithon outfall (outfall 5005) did not exceed the upper SL for these chemicals.

Mercury was detected at 9.4 mg/kg DW at sample location CB97 (Figure 3-49g), which represents an upper SL exceedance factor of 16. This sample was a large paint chunk removed from Chemithon CB#20 (SPU 2010). BEHP was detected at 65 mg/kg DW at sample location CB95, which exceeds the upper SL by a factor of 34. This sample was collected from a pump wet well near the southeast corner of the Chemithon property (SPU 2010).

In addition, BEHP, total HPAH, and total cPAH exceeded the upper SL in sample RCB53, located along West Marginal Way SW (Figure 3-49c, Figure 3-49d). Surface sediment samples collected near the SW Kenny Street SD outfall did not exceed the upper SL for these chemicals (see Section 3.3.18 below).

Data Gaps

The following data gaps were identified for the Glacier Bay source control area:

- Dioxins/furans were detected above at up to 2,100 ng TEQ/kg DW in surface sediment samples collected in the Glacier Bay inlet. No storm drain solids in this source control area have been analyzed for dioxins/furans. Sampling of storm drains at the Glacier Bay/Reichhold facility is needed to identify potential sources of dioxins/furans. An RI is currently underway at this facility under an Agreed Order with Ecology.
- A surface sediment sample located near the former Duwamish Shipyard graving dock contained arsenic, lead, mercury, and zinc at concentrations above the upper SL. Source tracing is needed in this area. An RI is currently being conducted at this facility under an Agreed Order with Ecology.

- Metals, PAHs, and phthalates exceeded the upper SLs in storm drain solids samples collected at or near the Chemithon property. Source control activities have been underway at this facility; verification is needed that contaminant sources have been adequate controlled.

3.4.18 RM 1.6 to 2.1 West: Terminal 115

The RM 1.6 to 2.1 West (Terminal 115) source control area is shown in Figure 3-50a; it extends from the south end of the Glacier Bay inlet to the 1st Avenue S bridge, on the west side of the LDW. The Highland Park Way SW SD, portions of the SW Kenny Street SD, and the Terminal 115 CSO discharge to the LDW in this source control area. Facilities include Terminal 115, Northland Services, Seafreeze Cold Storage, Icicle Seafoods, Gene Summy Lumber/Commercial Fence, and Northwest Container Services.

Sediment and storm drain solids sampling locations are shown in Figure 3-50a; summary statistics for selected analytes are provided in Table 3-35. Di-n-octyl phthalate and total PCBs exceeded the lower SL in at least one sample; copper, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, and dioxins/furans exceeded both the lower SL and upper SL in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2011d).

Stormwater COPCs

LPAH, BBP, BEHP, PCBs, and dioxins/furans were identified as COPCs in the Terminal 115 source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments. Only one surface sediment sample in this source control area exceeded an upper SL: BEHP near the West Michigan CSO (see below).

<u>Total LPAH</u>

Total LPAH concentrations exceeded the upper SL (13 mg/kg DW) in three of 13 storm drain solids samples, and exceeded the lower SL in one of 25 surface sediment samples. The maximum concentration of total LPAH in storm drain solids (1,250 mg/kg DW) was detected in 2006 at CB91, located at the Northland Services facility on Terminal 115. This catch basin is described by SPU as “adjacent to sweepings disposal area” (Ecology 2011; Terminal 115 SCAP), and is in an area of the site that discharges to outfall 2220 (also known as Port of Seattle outfall 6153, at the north end of Berth 1). This is the highest concentration of total LPAH in any LDW storm drain solids sample in the dataset used to prepare this report. Two additional storm drain solids samples exceeded the upper SL; these were located at Port of Seattle MH540, approximately 265 feet upstream of the outfall 2220. A sediment trap sample collected at MH540 during the Lateral Loading Study (SAIC and NewFields 2011b) contained 34 mg/kg DW total LPAH, and filtered solids samples from the 2010–2011 wet season at this same location contained an average of 14 mg/kg DW total LPAH.

Surface sediment samples near outfall 2220 did not exceed a screening level for total LPAH. Only one surface sediment sample exceeded the lower SL, with a concentration of 10 mg/kg

DW. This sample was located just upstream of the abandoned PortSF outfall, near the Seafreeze facility on Terminal 115.

BBP

BBP concentrations slightly exceeded the upper SL (0.90 mg/kg DW) in two storm drain samples. In the SW Kenny Street SD, one sample (RCB154) exceeded the upper SL and two samples exceeded the lower SL. Surface sediment near the SW Kenny Street SD outfall exceeded the lower SL. A sediment trap sample from a manhole in an area that drains to outfall 2220 also exceeded the upper SL; surface sediments in this area exceeded the lower SL.

BEHP

BEHP concentrations exceeded the upper SL (1.9 mg/kg DW) in six of 12 storm drain solids samples, in various locations within the source control area (Figure 3-50c). The average concentration of BEHP in storm drain solids (4.3 mg/kg DW) also exceeded the upper SL. The highest storm drain concentration of BEHP (13 mg/kg DW) was found in the sediment trap sample located upstream of outfall 2220. Surface sediment concentrations in this area did not exceed a screening level.

One surface sediment sample, located downstream of the West Michigan CSO, exceeded the upper SL for BEHP, with a concentration of 4.9 mg/kg DW.

One surface sediment sample near the Highland Park Way SW SD exceeded the lower SL; several exceedances of screening levels were detected in the Highland Park Way SW SD (Figure 3-50c).

Total PCBs

Concentrations of PCBs exceeded the lower SL in both storm drain solids and surface sediments (Figure 3-50b). Sediment trap and storm drain grab samples from locations HP-ST6 (in the Highland Park Way SW SD basin) and KN-ST1 (in the SW Kenny Street SD Basin) contained PCBs between 0.15 and 0.42 mg/kg DW. In surface sediments, 7 of 25 samples exceeded the lower SL of 0.13 mg/kg DW; these were fairly evenly distributed through the RM 1.5 to 2.1 West area.

Dioxins/furans

Dioxins/furans were detected at concentrations above the upper SL in two storm drain solids samples and above the lower SL in one surface sediment sample (Figure 3-50d). Sediment trap and filtered solids samples collected from a manhole near outfall 2220 (Port of Seattle outfall 6153) contained 67 ng TEQ/kg DW and 73 ng TEQ/kg DW, respectively. Surface sediment concentrations in this area were below the lower SL (25 ng TEQ/kg DW) for dioxins/furans. One surface sediment sample, near the SW Kenny Street SD, contained 49 ng TEQ/kg DW dioxins/furans, just below the upper SL (50 ng TEQ/kg DW).

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Copper, zinc, total HPAH, and total cPAH exceeded the upper SL in storm drains but not in surface sediments. Di-n-octyl phthalate exceeded the lower SL in storm drain solids.

- Copper exceeded the upper SL in one storm drain solids sample, with a concentration of 697 mg/kg DW. This sample was collected from CB91 at Northland Services.
- Zinc exceeded the upper SL in two storm drain solids samples: CB91 at Northland Services (1,720 mg/kg DW) and filtered solids at PS2220. Both are located in an area that drains to outfall 2220 (Port of Seattle outfall 6153).
- Total HPAH exceeded the upper SL in three storm drain solids samples, in the filtered solids and sediment trap samples from PS2220 and in CB91. The maximum detected concentration was 2,060 mg/kg DW in CB91, which exceeded the upper SL by a factor of 120.
- The highest concentrations of total cPAH were found in these same locations; the highest concentration of cPAH (77 mg/kg DW) was also detected at CB91. This represents an upper SL exceedance factor of 26.

Data Gaps

The following data gaps were identified for the Terminal 115 source control area:

- Storm drain solids samples collected in the Port of Seattle storm drain system near outfall 2220 (Port of Seattle outfall 6153) contained PAHs, phthalates, dioxins/furans, copper, and zinc above the upper SLs. Although surface sediment samples in this area did not exceed an upper SL, current activities in this area may represent a source of future sediment contamination to the LDW. Additional source tracking is needed.
- A surface sediment sample near the West Michigan CSO exceeded the upper SL for BEHP; no source has been identified.

3.4.19 RM 2.1 West: 1st Avenue S SD

The RM 2.1 West (1st Avenue S SD) source control area is shown in Figure 3-51a; it consists of the 1st Avenue S SD basin, which drains to a series of engineered wetlands that discharge to the LDW under the 1st Avenue S bridge, along the west side of the LDW. Facilities within the 1st Avenue S SD source control area include Samson Tug and Barge Maintenance Shop, former South Park Landfill, Seattle South Transfer Station, Waste Management, and former Northwest Enviroservice.

Sediment and storm drain solids sampling locations are shown in Figure 3-51a; summary statistics for selected analytes are provided in Table 3-36. Mercury, total cPAH, and total PCBs exceeded the lower SL in at least one sample; zinc, total HPAH, BBP, and BEHP exceeded both the lower SL and upper SL in at least one sample.

Stormwater COPCs

BBP and BEHP were identified as COPCs in the 1st Avenue S SD source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

BBP

BBP concentrations exceeded the upper SL (0.90 mg/kg DW) in one of 14 storm drain solids samples, at a concentration of 3.3 mg/kg DW in sediment trap sample 1ST-ST1, located in the engineered wetland area near the WA-509 onramp (Figure 3-51c). BBP exceeded the lower SL in six samples. In surface sediment, two of seven samples contained BBP above the lower SL, with a maximum concentration of 0.14 mg/kg DW.

BEHP

BEHP concentrations exceeded the upper SL (1.9 mg/kg DW) in both storm drain and surface sediment samples. BEHP exceeded the upper SL in nine of 14 storm drain solids samples (Figure 3-51b). The maximum detected concentration of 26 mg/kg DW exceeded the upper SL by a factor of 14. In surface sediment, one sample (located under the 1st Avenue S bridge) contained 2.5 mg/kg DW BEHP, slightly above the upper SL.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drain Solids Only

Zinc and total HPAH exceeded the upper SL in storm drain solids only. Mercury, total cPAH, and total PCBs exceeded the lower SL in storm drain solids.

- Zinc was detected at 3,770 mg/kg DW at sample location CB158 at 7901 1st Avenue S (Intermountain Supply). This concentration exceeds the upper SL (960 mg/kg DW) by a factor of 4. No other samples exceeded the upper SL for zinc.
- Total HPAH exceeded the upper SL (19 mg/kg DW) in a ROW catch basin on 6th Avenue SW (Figure 3-51a); this catch basin contained total HPAH at 25 mg/kg DW. No other samples exceeded the upper SL for total HPAH.

Data Gaps

Very few screening level exceedances were identified in surface sediments associated with the 1st Avenue S SD source control area. Only BEHP was detected in surface sediments at a concentration above the upper SL. While only 14 storm drain locations have been sampled in this 609-acre source control area (including three locations where both sediment trap and grab samples were collected), results indicate that BEHP exceeds screening levels throughout the source control area. No specific data gaps were identified for this source control area.

3.4.20 RM 2.1 to 2.2 West (EAA-2): Trotsky Inlet

The RM 2.1 to 2.2 West (Trotsky Inlet) source control area is shown in Figure 3-52a; it extends from the 1st Avenue S bridge, past the Trotsky Inlet and to the southern end of the Boyer Towing property, on the west side of the LDW. The 2nd Avenue S SD outfall discharges to the Trotsky Inlet; several private outfalls are also located within this source control area. Facilities within the Trotsky Inlet source control area include Douglas Management Company, Industrial Container Services, and Boyer Towing.

Sediment and storm drain solids sampling locations are shown in Figure 3-52a; summary statistics for selected analytes are provided in Table 3-37. Total LPAH and di-n-octyl phthalate exceeded the lower SL in at least one sample; cadmium, chromium, copper, lead, mercury, zinc, total HPAH, cPAH, BBP, BEHP, phenol, PCBs, and dioxins/furans exceeded both the lower SL and upper SL in at least one sample.

Concentrations of cadmium, chromium, mercury, zinc, PCBs, BBP, and phenol in Trotsky Inlet surface sediments were the highest detected anywhere in the LDW in the dataset used to prepare this report. Most of the sediment exceedances were found in the inlet; storm drains solids samples were all collected in the upstream portion of the 2nd Avenue S SD basin. One solids sample was collected from the 2nd Avenue S SD outfall pipe in May 2007; this sample (EAA2-SED-5) was inadvertently excluded from the dataset used to prepare this report. PCBs (3.6 mg/kg DW), BEHP (2.2 mg/kg DW), and BBP (0.88 mg/kg DW) exceeded screening levels in this sample; it is not known whether this sample represents solids transported along the 2nd Avenue S SD pipe or whether it is a build-up of sediments from tidal influences (SAIC 2009a).

RIs are in currently progress under Agreed Orders with Ecology at two properties adjacent to the Trotsky Inlet: Industrial Container Services and Douglas Management Company.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the Data Gaps Report for this source control area (SAIC 2007a).

Stormwater COPCs

Copper, lead, mercury, total cPAH, BBP, BEHP, phenol, and PCBs were identified as COPCs in the Trotsky Inlet source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

Copper

Copper concentrations in one storm drain solids sample (CB116) and one surface sediment sample (EAA2-SED-1) exceeded the upper SL (390 mg/kg DW). The maximum detected concentrations were 806 mg/kg DW and 1,090 mg/kg DW, respectively; average concentrations did not exceed the screening level. Sampling location CB116 is near the upstream end of the 2nd Avenue S SD; the 2nd Avenue S SD outfall (also known as outfall 2118) discharges to the Trotsky Inlet.

Lead

Lead exceeded the upper SL (530 mg/kg DW) in three of 20 surface sediment (all in the Trotsky Inlet) and two of 14 storm drain solids samples in this source control area. Lead was detected in one surface sediment sample at 10,400 mg/kg DW, which represents an exceedance factor of 20, and is the second highest concentration of lead detected in any surface sediment sample in the data used to prepare this report. The maximum storm drain solids concentration of 3,690 mg/kg DW (at RCB139 on S Austin Street) is the highest concentration of lead in a storm drain solids sample in the LDW basin.

Mercury

Mercury concentrations in two storm drain solids and three surface sediment samples exceeded the upper SL; average concentrations also exceeded the upper SL. The sediment mercury concentration of 247 mg/kg DW was the highest in the LDW surface sediment dataset used to prepare this report, and exceeds the upper SL (0.59 mg/kg DW) by a factor of 420.

Zinc

Zinc concentrations in exceeded the upper SL in two storm drain and two surface sediment samples; average concentrations exceeded the lower SL (Figure 3-52e). The sediment zinc concentration of 4,580 mg/kg DW was the highest in the LDW surface sediment dataset used to prepare this report and exceeded the upper SL (960 mg/kg DW) by a factor of 4.8. Almost two-thirds of storm drain solids concentrations exceeded the lower SL for zinc.

cPAH

Total cPAH concentrations exceeded the upper SL (3.0 mg/kg DW) in one Trotsky Inlet surface sediment sample (4.7 mg/kg DW) and exceeded the lower SL in one storm drain solids sample (1.0 mg/kg DW) in the 2nd Avenue S SD basin.

BBP

BBP was detected at concentrations above the upper SL in both storm drain solids and surface sediments. BBP was detected in one of 20 surface sediment samples, at a concentration of 3.3 mg/kg DW, which is the highest BBP concentration in any surface sediment sample in the dataset used to prepare this report. This samples was collected in the Trotsky Inlet in 2007 (Figure 3-52d). In storm drain solids, BBP was detected above the upper SL in 3 of 14 samples, all located near the upstream end of the 2nd Avenue S SD; the highest concentration was 11 mg/kg DW, which exceeded the upper SL (0.9 mg/kg DW) by a factor of 12.

BEHP

BEHP was detected at concentrations above the upper SL in both storm drain solids and surface sediments. BEHP exceeded the upper SL in 13 of 14 storm drain solids samples, and exceeded the lower SL in all samples collected (Figure 3-52c). In surface sediment, three samples, all located in the Trotsky Inlet, exceeded the upper SL for BEHP. The maximum detected concentrations in storm drain solids and surface sediment were 39 mg/kg DW and 17 mg/kg DW, respectively, which represents exceedance factors of 21 and 9 over the upper SL (1.9 mg/kg DW).

Phenol

Phenol exceeded the lower SL (0.42 mg/kg DW) in three storm drain solids samples in the 2nd Avenue S SD and in one surface sediment sample in the Trotsky Inlet. Average concentrations did not exceed screening levels.

Total PCBs

The maximum and average concentration of PCBs in Trotsky Inlet surface sediments exceeded the upper SL (Figure 3-52b). The maximum concentration was 2,930 mg/kg DW; this exceeds the upper SL (1.0 mg/kg DW) by a factor of almost 3,000, and it is the highest LDW concentration of PCBs in surface sediments in the data evaluated for this report. The average concentration of PCBs in surface sediments in the Trotsky Inlet source control area is 139 mg/kg DW. Two surface sediment samples near the Boyer Towing property and one surface sediment sample near the Douglas Management Company property exceeded the lower SL for PCBs (0.13 mg/kg DW).

Six storm drain sampling locations in the 2nd Avenue S SD basin exceeded the lower SL, and one of these (RCB139, located on S Austin Street near 2nd Avenue S) also exceeded the upper SL, with a concentration of 3.2 mg/kg DW.

Chemicals with Exceedances in Surface Sediment Only

Cadmium (two samples), chromium (two samples), total HPAH (one sample), and dioxins/furans (one sample) were detected at concentrations above the upper SL in surface sediments. All upper SL exceedances were in the Trotsky Inlet.

- Maximum concentrations of cadmium and chromium (36 mg/kg DW and 1,680 mg/kg DW, respectively) were the highest LDW surface sediment concentrations in the dataset used to prepare this report.
- Total HPAH was detected at 39 mg/kg DW in one Trotsky Inlet sample.
- Dioxins/furans were detected at 412 ng TEQ/kg in one Trotsky Inlet sample in 2005. Site characterization samples collected in 2007 (SAIC 2009a) were not analyzed for dioxins/furans. A surface sediment sample collected near the mouth of the inlet in 2009 detected dioxins/furans at 1.7 ng TEQ/kg.

Chemicals with Exceedances in Storm Drain Solids Only

All chemicals that exceeded screening levels in storm drain solids also exceeded screening levels in surface sediments.

Data Gaps

The following data gaps were identified for the Trotsky Inlet source control area:

- RIs are underway at two properties adjacent to the Trotsky Inlet. These investigations will provide additional information on sources of contaminants to the inlet. Review of results, when available, is needed to assess the potential for sediment recontamination associated with these properties.
- BEHP, BBP, and PCBs were detected at concentrations above screening levels in storm drain solids samples collected in the 2nd Avenue S SD basin and in three sediment samples in the Trotsky Inlet near the 2nd Avenue S SD outfall. All storm drain samples were collected in the upstream portion of the 2nd Avenue S SD basin. A solids sample collected from the outfall pipe in 2007 contained PCBs and BEHP above the upper SL and BBP above the lower SL. The 2nd Avenue S SD may be a source of PCBs and

phthalates to the Trotsky Inlet; additional samples are needed to evaluate whether discharges from the 2nd Avenue S SD represent a sediment recontamination source.

- PCBs were detected at concentrations above the lower SL in surface sediments adjacent to the Douglas Management Company and Boyer Towing properties. No storm drain samples have been collected in areas with stormwater drainage to private outfalls along RM 2.1 to 2.5 West. Source tracing samples are needed in these areas to assess whether discharges to the LDW from these properties represents a potential source of sediment recontamination.

3.4.21 RM 2.2 to 3.4 West: Riverside Drive

The RM 2.2 to 3.4 West (Riverside Drive) source control area is shown in Figure 3-53a; it extends from the southern end of the Boyer Towing property to just north of the former South Park Bridge, on the west side of the LDW. The 7th Avenue S SD and 8th Avenue S CSO basins discharge to the Riverside Drive source control area.

Sediment and storm drain solids sampling locations are shown in Figure 3-53a; summary statistics for selected analytes are provided in Table 3-38. Dioxins/furans exceeded the lower SL in at least one sample; copper, lead, mercury, zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, phenol, and total PCBs exceeded both the lower and upper SLs in at least one sample.

Stormwater COPCs

Mercury, LPAH, HPAH, cPAH, BBP, BEHP, and PCBs were identified as COPCs in the Riverside Drive source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

<u>Mercury</u>

Mercury concentrations exceeded the upper SL in three of 33 storm drain solids samples and one of 31 surface sediment samples. Average concentrations did not exceed screening levels. In storm drain solids, the maximum detected concentration of mercury (3.8 mg/kg DW) was found at location RCB229, a ROW catch basin at S Chicago Street and 8th Avenue S. A nearby onsite catch basin (CB206 at Independent Metals) also exceeded the upper SL. These catch basins are located in an area with surface drainage directly to the LDW and are believed to discharge at outfall 2110. A surface sediment sample near outfall 2110, collected in 2005, did not contain mercury at concentrations above screening levels.

Exceedances of the upper SL were also found at RCB183, along 14th Avenue S in the combined sewer area.

Mercury was detected at a concentration above the lower SL in one ROW catch basin sample within the 7th Avenue S SD basin, located at S Monroe Street and 7th Avenue S. In surface sediments, one surface sediment sample, located adjacent to the 7th Avenue S SD outfall (outfall 2112), contained mercury at 6.5 mg/kg DW, which exceeds the upper SL by a factor of 11.

<u>LPAH</u>

Total LPAH exceeded the upper SL in two of 32 surface sediment samples and exceeded the lower SL in one of 34 storm drain solids samples. The maximum detected concentration of (44 mg/kg DW) was the highest surface sediment concentration of total LPAH in the data set used to prepare this report. Surface sediment samples just upstream and downstream of the 7th Avenue S SD outfall (outfall 2112) exceeded an LPAH screening level. An onsite catch basin (CB206 at Independent Metals) contained total LPAH at 8.6 mg/kg DW; stormwater in this area is believed to discharge to the LDW at outfall 2110, not the 7th Avenue S SD outfall.

HPAH

Total HPAH exceeded the upper SL in three surface sediment samples and one storm drain solids sample; average concentrations did not exceed a screening level. All HPAH SL exceedances in surface sediment were located near the 7th Avenue S SD outfall (outfall 2112). Total HPAH was detected at 28 mg/kg DW in CB206 (near Independent Metals), above the upper SL (17 mg/kg DW).

cPAH

Total cPAH was detected at concentrations above the upper SL in surface sediments and above the lower SL in storm drain solids; average cPAH concentrations did not exceed a screening level. Two surface sediment samples, located near the 7th Avenue S SD outfall, exceeded the upper SL (3.0 mg/kg DW), with a maximum detected concentration of 4.2 mg/kg DW. Three storm drain solids samples in the 7th Avenue S SD basin exceeded the lower SL for cPAH; the highest concentration (3.0 mg/kg DW) was detected in RCB131, located on S Cloverdale Street at least a mile from the LDW.

BBP

The maximum and average BBP concentrations in storm drain solids (73 mg/kg DW and 2.7 mg/kg DW, respectively) exceeded the upper SL. One upper SL exceedance was located in the 7th Avenue S SD, two were located in an area that drains to outfall 2110, and two were located 16th Avenue S, within the 8th Avenue S CSO basin. In surface sediments, two sample locations exceeded the lower SL; both were located near the 7th Avenue S SD.

BEHP

The maximum detected concentration of BEHP in storm drain solids was 1,400 mg/kg DW at RCB227 (Figure 3-53a); this is the highest BEHP concentration detected in any storm drain sample in the LDW and exceeds the upper SL by a factor of 740. This sample was collected from a ROW catch basin located near 7th Avenue S and S Monroe Street. The BEHP upper SL (1.9 mg/kg DW) was exceeded in 24 of 34 storm drain solids samples (Figure 3-53c). Many of these exceedances were found in samples located near and along 7th Avenue S, and near and along 16th Avenue S, in the southeastern portion of the source control area.

In surface sediment, two sample locations exceeded a screening level, and both were located near the 7th Avenue S SD outfall; the maximum detected concentration of BEHP in surface sediment was 2.6 mg/kg DW, which exceeds the lower SL by a factor of two, and exceeds the upper SL by a factor of 1.4. BEHP in surface sediments at this location appears likely to originate from sources in the 7th Avenue S SD basin.

PCBs

Total PCB concentrations exceeded the upper SL (1.0 mg/kg DW) in both storm drain solids and surface sediments; average concentrations exceeded the lower SL (0.13 mg/kg DW). Storm drain solids samples collected at CB206 (near Independent Metals) and RCB183 (along 14th Avenue S) exceeded the upper SL at concentrations of 2.5 mg/kg DW and 1.3 mg/kg DW, respectively. Stormwater drainage in the area near CB206 discharges to the LDW at outfall 2110; stormwater in the area near RCB183 drains to the combined sewer. Several PCB screening level exceedances were detected in surface sediments near the 8th Avenue S CSO, including one sample at 1.2 mg/kg DW, above the upper SL. Elevated PCB concentrations along 14th Avenue S may contribute to surface sediment PCB concentrations near the 8th Avenue S CSO.

Exceedances of the lower SL for PCBs were also observed at sample locations along 7th Avenue S and in the surface sediments near the 7th Avenue S SD outfall (Figure 3-53b).

Chemicals with Exceedances in Surface Sediment Only

Only three surface sediment samples along the Riverside Drive source control area shoreline have been analyzed for dioxins/furans; one of these samples exceeded the lower SL (25 ng TEQ/kg DW) with a concentration of 36 ng TEQ/kg DW at SS530, located near the 7th Avenue S SD outfall. Only two storm drain solids samples have been analyzed for dioxins/furans, at CB206 and RCB240; these did not exceed a screening level.

Chemicals with Exceedances in Storm Drains Solids Only

Zinc concentrations in storm drain solids samples exceeded the lower SL for zinc (410 mg/kg DW) in 20 of 33 storm drain solids samples and exceeded the upper SL for zinc (960 mg/kg DW) in four samples. The highest concentration of zinc (4,150 mg/kg DW) was detected at CB206 at the Independent Metals property; the nearby RCB229 also exceeded the upper SL for zinc. Other upper SL exceedances were found in ROW catch basins in the 7th Avenue S SD basin. Surface sediment samples near RM 2.6 to 3.4 West did not exceed the screening levels for zinc.

Data Gaps

The following data gaps were identified for the Riverside Drive source control area:

- Mercury was detected at a concentration above the upper SL in storm drain sediments near the 7th Avenue S SD outfall, and in one ROW catch basin in the 7th Avenue S drainage basin. MH20, the last inline access point before the outfall, has not been sampled since April 2005; mercury concentrations did not exceed screening levels at that time. Additional storm drain sampling is needed to identify the source of mercury in surface sediments near the 7th Avenue S SD outfall.
- Recent (2011) exceedances of screening levels for mercury, PAHs, phthalates, and PCBs have been observed in storm drain structures (CB206 and RCB229) located in the area that is believed to discharge to outfall 2110. Only one surface sediment samples has been collected near this outfall since the year 2000; this sample did not exceed screening levels. No sample was collected in this area during SAIC's 2011 outfall sampling study due to the presence of obstructions (dock, crane, and catwalk); sampling at this location

may be possible from the shore during a low-low tide. One or more surface sediment samples in this area are needed to evaluate whether storm drain structure exceedances of these contaminants are resulting in contamination of LDW sediments.

- LPAH, HPAH, and cPAH compounds have been detected in surface sediments at concentrations above the upper SL near the 7th Avenue S SD outfall. Potential sources of PAHs in the 7th Avenue S SD basin have not been identified; additional source tracing is needed in this area.
- Phthalates (BEHP and BBP) have been detected in surface sediments at concentrations above the upper SL near the 7th Avenue S SD outfall. Exceedances of screening levels for phthalates have been observed in at least 14 locations within the 7th Avenue S SD basin, including very high concentrations detected in the area of 7th Avenue S and S Monroe Street. Source control is needed in this area.
- PCBs exceeded the upper SL near the 8th Avenue S CSO (also identified as outfall 2107); storm drain solids collected along and near 14th Avenue S, in the CSO basin, also exceeded PCB screening levels. Additional source tracing is needed to determine whether PCBs in surface sediments in this area are related to CSO discharges, or whether they are related to outfalls 2106 or 2108, both identified as “unknown outfalls” that may carry stormwater drainage from nearby properties.
- Dioxins/furans exceeded the lower SL at 35 ng TEQ/kg DW in a single surface sediment sample near the 7th Avenue S SD outfall. Only two samples have been analyzed for dioxins/furans in this storm drain basin. Additional sampling of storm drain solids for dioxins/furans in the 7th Avenue S SD basin is needed to identify potential sources of dioxins/furans to LDW sediments.

3.4.22 RM 3.4 to 3.8 West (EAA-5): Terminal 117

The RM 3.4 to 3.8 West (Terminal 117) source control area is shown in Figure 3-54a. This source control area includes stormwater that discharges to the LDW from private outfalls. Facilities within this source control area include Terminal 117, Boeing South Park, Basin Oil, and South Park Marina.

Sediment and storm drain solids sampling locations are shown in Figure 3-54a; summary statistics for selected analytes are provided in Table 3-39. Zinc, total LPAH, total HPAH, cPAH, BBP, BEHP, di-n-octyl phthalate, phenol, and total PCBs also exceeded both the lower and upper SLs in at least one sample.

Historical or ongoing releases from adjacent properties may represent a source of sediment contamination. Additional information on adjacent properties is provided in the SCAP for this source control area (Ecology 2005).

Stormwater COPCs

Zinc, LPAH, HPAH, cPAH, BBP, phenol, and PCBs were identified as COPCs in the Terminal 117 source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

<u>Zinc</u>

Zinc concentrations (Figure 3-54e) exceeded the upper SL (960 mg/kg DW) in both storm drain solids and surface sediments, with maximum concentrations of 1,040 and 1,440 mg/kg DW, respectively. The average concentration of zinc in storm drain solids (722 mg/kg DW) exceeded the lower SL. Five storm drain samples at the Basin Oil property exceeded the lower SL. One storm drain sample identified as a “tank” sample from the Terminal 117 Temporary Storm Drain System (SPU 2010) exceeded the upper SL for zinc. One surface sediment sample, located at the south end of the source control area, near Boeing South Park outfall SP-3, exceeded the upper SL. No storm drain samples were available from the area that drains to SP-3.

<u>LPAH</u>

Total LPAH exceeded the upper SL in both storm drain solids and surface sediments (Figure 3-54c), including two storm drain sampling locations on the former Basin Oil property. The highest concentration (556 mg/kg DW at CB42) was collected from an area drain at the southwest corner of the property. Storm drainage in this area is transported to a combined sewer. The average total LPAH concentration in storm drain solids also exceeded the upper SL. In surface sediments, one of 32 samples exceeded the upper SL; this sample is located near Terminal 117 outfalls 2209 and 2210. No other total LPAH screening level exceedances were identified in surface sediments.

<u>HPAH and cPAH</u>

Total HPAH and total cPAH exceeded the upper SL in both storm drain solids and surface sediments, including one storm drain solids sample, collected from an area drain on the southwest corner of the former Basin Oil property (CB42). These total HPAH and cPAH concentrations (3,380 mg/kg DW and 462 mg/kg DW, respectively) are the highest detected in any storm drain samples in the LDW and represent upper SL exceedance factors of 225 and 154 for HPAH and cPAH. The Basin Oil area discharges to the combined sewer (SPU 2010). One surface sediment sample, located near Terminal 117 outfalls 2209 and 2210, exceeded the upper SL for HPAH and cPAH, with concentrations of 85 and 11 mg/kg DW, respectively. These are the highest LDW surface sediment concentrations for total HPAH and cPAH in the data set used to prepare this report.

<u>BBP</u>

BBP exceeded the upper SL in storm drain solids and exceeded the lower SL in surface sediments. In storm drain solids samples, one sample exceeded the upper SL (PortCB6) with a concentration of 7.4 mg/kg DW; this sample was located on a vacant lot near the southern end of Terminal 117 in an area that drains to a Port of Seattle outfall at Terminal 117 (SPU 2010). One sample, located near Boeing South Park outfall SP-3, exceeded the lower SL in surface sediments, with a concentration of 0.071 mg/kg DW.

<u>PCBs</u>

Total PCBs exceeded the upper SL in both storm drain solids and surface sediments (Figure 3-54b). PCB concentrations exceeded the lower SL at all 11 storm drain solids sampling locations, and four storm drain solids samples exceeded the upper SL. Almost two-thirds of surface sediment samples within this source control area exceeded the lower SL, and 29 percent (24 of 83 samples) exceeded the upper SL. Sources of PCBs in this area are well-documented, and extensive investigation and cleanup of PCBs has been conducted.

Phenol

Phenol exceeded the upper SL in surface sediments in two samples just downstream of outfall 2211, near the north end of Terminal 117. Phenol was detected in only one storm drain solids sample; however, several samples had elevated detection limits, including two samples at the Basin Oil property with reporting levels above the upper SL.

Chemicals with Exceedances in Surface Sediment Only

All chemicals with exceedances in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drains Solids Only

- BEHP exceeded the upper SL in seven of eight storm drain solids samples, with a maximum detected concentration of 74 mg/kg DW; the average BEHP concentration (23 mg/kg DW) also exceeded the upper SL. No screening level exceedances of BEHP were observed in surface sediment samples in this area.

Data Gaps

The following data gaps were identified for the Terminal 117 source control area:

- Surface sediment samples near Boeing South Park outfall SP-3 contained zinc at concentrations above the upper SL and BBP at concentrations above the lower SL. No storm drain solids have been collected in the area that drains to outfall SP-3. Samples of storm drain solids from this area are needed to identify potential sources of zinc and BBP to LDW sediments.
- Surface sediments near Terminal 117 outfalls 2209 and 2210 exceeded the upper SL for total LPAH, total HPAH, and cPAH. Samples of storm drain solids from this drainage area, specifically from Port of Seattle catch basins CB-3, CB-4, and CB-5, are needed to identify potential sources of PAHs to LDW sediments.
- Surface sediments near Terminal 117 outfall 2211 exceeded the upper SL for phenol. Samples of storm drain solids from this drainage area, specifically from Port of Seattle catch basin CB-1, are needed to identify potential sources of phenols to LDW sediments.

3.4.23 RM 3.8 to 4.2 West: Sea King Industrial Park

The RM 3.8 to 4.2 West (Sea King Industrial Park) source control area is shown in Figure 3-55; it extends from Terminal 117 to just south of S 96th Street, on the west side of the LDW. The S 96th Street SD outfall discharges to the LDW within this source control area.

Sediment and storm drain solids sampling locations are shown in Figure 3-55; summary statistics for selected analytes are provided in Table 3-40. Phenol and total PCBs exceeded the lower SL in at least one sample; zinc, BBP, and BEHP exceeded both the lower and upper SLs in at least one sample.

Stormwater COPCs

PCBs were identified as COPCs in the Sea King Industrial Park source control area because concentrations exceeded screening levels in both storm drain solids and surface sediments.

PCBs

Total PCBs exceeded the lower SL in two surface sediment samples and one inline storm drain solids sample (MH239, near the corner of S 96th Street and 8th Avenue S) in the Sea King Industrial Park source control area. The average concentrations of total PCBs in surface sediment and storm drain solids (0.066 mg/kg DW and 0.030 mg/kg DW, respectively) did not exceed the lower SL. The two PCB screening level exceedances in sediments were located near Boeing South Park outfalls SP-1 and SP-2, downstream of the S 96th Street SD outfall.

Chemicals with Exceedances in Surface Sediment Only

All chemicals that exceeded screening levels in surface sediment also exceeded screening levels in storm drain solids.

Chemicals with Exceedances in Storm Drains Solids Only

Zinc, BBP, and BEHP were detected in storm drain solids at concentrations above the upper SL.

- Zinc was detected in storm drain solids at a maximum concentration of 2,530 mg/kg DW, which is approximately three times the upper SL (960 mg/kg DW). Six of 18 samples exceeded the lower SL and 3 of 18 samples exceeded the upper SL.
- BBP was detected at a maximum concentration of 25 mg/kg DW, above the upper SL of 0.90 mg/kg DW by a factor of 25. The average BBP concentration was 1.6 mg/kg DW, also above the upper SL. Twelve of 19 storm drain solids samples (all detections) exceeded the lower SL, and three samples exceeded the upper SL.
- BEHP was detected at a maximum concentration of 20 mg/kg DW, above the upper SL of 1.9 mg/kg DW by more than a factor of 10. The average BEHP concentration (2.3 mg/kg DW) also exceeded the upper SL. Five of 19 storm drain solids samples exceeded the lower SL, and four exceeded the upper SL.

Phenol concentrations in storm drain solids samples exceeded the lower SL in two samples, with a maximum concentration of 0.91 mg/kg DW.

Data Gaps

Storm drain solids samples have been collected in only 19 locations (including three locations where both sediment trap and grab samples were collected) in this 1,063-acre source control area; additional storm drain solids samples, including analysis for PCBs, would be helpful to assess the potential for sediment recontamination associated with stormwater discharges to the LDW.

However, few screening level exceedances have been observed in surface sediments in the Sea King Industrial Park source control area. Based on available data, it is considered unlikely that PCBs measured at MH239, located over a mile from the LDW in the S 96th Street SD basin, are related to PCBs measured in surface sediments near the Boeing South Park outfalls. Based on available data, this source control area is believed to represent a low probability of sediment recontamination.

3.4.24 RM 4.2 to 4.8 West: Restoration Areas

The RM 4.2 to 4.8 West (Restoration Areas) source control area is shown in Figure 3-56; it extends from just south of S 96th Street to about RM 5.0, on the west side of the LDW. The Hamm Creek SD discharges to the LDW in this source control area.

Sediment and storm drain solids sampling locations are shown in Figure 3-56; summary statistics for selected analytes are provided in Table 3-41. A total of 26 surface sediment samples have been collected along the Restoration Areas shoreline; however, only limited storm drain data (one sediment trap, one inline, and one ROW catch basin sampling location) are available in this 829-acre source control area. BEHP, phenol, and total PCBs exceeded the lower SL in at least one sample; no chemicals exceeded the upper SL.

Stormwater COPCs

No chemicals exceeded screening levels in both storm drain solids and surface sediments in the Restoration Areas source control area, and therefore no COPCs were identified. Additional information on chemicals with screening level exceedances is provided below.

Chemicals with Exceedances in Surface Sediment Only

No chemicals exceeded the upper SL in surface sediments in this area. Phenol and total PCBs exceeded the lower SL in at least one surface sediment sample; average concentrations were below the lower SL, and exceedance frequencies were low.

Chemicals with Exceedances in Storm Drains Solids Only

No chemicals exceeded the upper SL in storm drain solids. BEHP was detected in one of three samples, at 1.5 mg/kg DW, slightly above the lower SL (1.3 mg/kg DW).

Data Gaps

Storm drain solids samples have been collected in only three locations; additional storm drain solids samples, including analysis for phenol and PCBs, would be helpful to assess the potential for sediment recontamination associated with stormwater discharges to the LDW.

However, few screening level exceedances have been observed in surface sediments in the Restoration Areas source control area. Based on available data, this source control area is believed to represent a low probability of sediment recontamination.

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4.0 PCB, PAH, and Dioxin Correlations and Ratios

PCB Aroclors, PAH compounds, and dioxin/furan congener data are often represented as a sum of detected concentrations or as a TEQ-based total concentration. While these totals are useful for presenting locations with concentrations that exceed benthic or human health risk criteria, they can often conceal patterns within the individual compound or congener data. Differences between the relative amounts of PCB Aroclors or various PAH compounds may indicate areas that are potential sources of these COPCs. This section evaluates the ratio of PCB Aroclor 1254 to Aroclor 1260, as well as the ratios of several PAH compounds, with the goal of finding unique source areas. This section also explores a possible correlation between PCBs and dioxin/furan congeners, and between PAH and dioxin/furan congeners, on the assumption that emissions of these compounds may be related to the same source.

4.1 PCB Aroclor Ratios

PCB Aroclors are mixtures of PCB congeners that are roughly grouped by molecular mass. The first two numbers of an Aroclor mixture represent the number of carbon atoms, while the second two numbers represent the percentage of chlorine by mass. Following this arrangement, Aroclor 1254 has 12 carbon atoms, and contains 54 percent chlorine by mass. The exception to this rule is Aroclor 1016, which contains 12 carbon atoms and is 42 percent chlorine by mass.

When PCBs were in use, each Aroclor mixture had a different application. These differences can be used in source tracing efforts to identify groups of samples that are enriched with a particular Aroclor. Aroclors 1254 and 1260 were detected with the greatest frequency in the LDW. Figures 4-1a through 4-1c present the ratios of Aroclor 1254 to Aroclor 1260. Samples where only Aroclor 1260 was detected are shown as a dark blue diamond, while samples where only Aroclor 1254 was detected are shown as a dark red diamond. Ratios of 1.0 are shown as white circles. All other ratios are displayed on a gradient of red to blue. Samples where neither Aroclor was detected are not presented on the figures.

Most of the samples collected had 1254/1260 ratios greater than one, with 1.0 to 2.0 the most common range for LDW river sediments. This indicates that Aroclor 1254 is more prevalent in the LDW sediments than Aroclor 1260. In general, the Aroclor ratios in storm drain solids samples are similar to those in surface sediment samples. Areas that have concentrations consistently above the upper SL criterion in Figure 3-2 tend to have Aroclor ratios outside of the 1.0 to 2.0 range.

Slip 4 storm drain sample ratios were often above 2 and frequently above 5. Sediment samples collected from the head of Slip 4 also had high ratios, which is consistent with deposition of solids from the storm drain lines. Aroclor 1254/1260 ratios in Slip 4 are lower closer to the LDW channel, in the 1 to 2 range (Figure 4-1). This suggests either the dilution of solids from Slip 4 storm drains or the influx of LDW river sediment near the mouth of Slip 4. In addition to the high Aroclor 1254/1260 ratios in Slip 4 storm drain samples, a significant number of storm drain samples had ratios less than 0.8, indicating a higher proportion of Aroclor 1260. These low ratios were observed primarily in the north lateral storm drain line at NBF and to a lesser extent in the south lateral storm drain line and KCIA offsite areas. The presence of storm drain solids with both high and low Aroclor 1254/1260 ratios suggest the possibility of two different types of PCB sources in the Slip 4 source control area. While not specifically evaluated in this report, Aroclor 1248 concentrations at NBF are localized to specific areas of the site. The RI/FS for the NBF-GTSP site, currently in progress, should include additional evaluation of the relationship between PCB Aroclors and potential contaminant sources in the Slip 4 source control area.

Two other areas with high PCB concentrations have distinct ratios. Concentrations exceed the upper SL in most of the sediment samples collected from Terminal 117 and from sediment samples collected from the southernmost portion of the Boeing Plant 2 to Jorgensen Forge source control area. Only Aroclor 1260 was detected in the Terminal 117 samples. Samples near the Jorgensen Forge property had ratios greater than 5 or consisted entirely of Aroclor 1254. Though difficult to visualize in Figure 4-1c, samples collected from the waterway midway between these two source control areas had more moderate Aroclor ratios between 1 and 2, suggesting mixing from the two sources.

In storm drains, Aroclor ratios were lower (e.g., mostly Aroclor 1260) on the west side of the LDW in the Trotsky Inlet, Riverside Drive, Terminal 117, and Sea King Industrial Park source control areas. On the east side of the LDW, lower Aroclor ratios were observed at KCIA and NBF, with isolated low ratios in other locations.

Care should be taken to avoid over-interpretation of the Aroclor ratios. As mentioned, Aroclors are not a single compound, and several issues can impact the precision and accuracy of their measurement. In the laboratory, Aroclors elute as a mass of peaks, and proper quantitation requires an experienced analyst. Aroclor identification can vary by laboratory and analyst. In addition, heavier PCB congeners degrade to lighter PCBs over time. The combined effects of weathering and mixing of sources in a river only make analysis more difficult.

4.2 PAH Ratios

PAHs are a class of contaminants composed of multiple aromatic rings. Naphthalene, consisting of two rings, is the simplest PAH. In general, increasing the number of rings on a PAH compound increases the environmental stability of that compound. PAH may also contain carbon side chains, referred to as alkyl groups. PAH compounds which do not contain alkyl groups are referred to as nonalkylated, or parent PAHs (Stout 2003).

PAHs in urban sediments are separated into two primary categories, petrogenic and pyrogenic. Petrogenic PAHs are directly derived from fossil fuels, particularly petroleum and its distillates. Sources of petrogenic PAH include crude oil, fuel oils, lubricating oils, refined fuels such as diesel, and coal. Pyrogenic PAHs are formed during the incomplete or inefficient combustion of fossil fuels and other organic matter at high temperatures. Sources of pyrogenic PAH include wood-burning emissions, automobile exhaust, and highway dust. Creosote and coal tar are also considered pyrogenic PAHs since they are created using controlled pyrolytic processes (Zemo 2009). Although there are natural sources of petrogenic and pyrogenic PAHs, as well as other biogenic PAHs created from microbial processes, anthropogenic sources dominate in industrial areas such as the LDW.

There are a variety of pathways for PAH to enter LDW storm drains and sediments. One of these is stormwater runoff. Other pathways include atmospheric deposition of combustion particles, surface runoff from adjacent roads, parking lots and bridges, and discharges or spills of petroleum products from industry or boat traffic (Stout et al. 2004). Together these sources constitute an urban background for PAH. For typical urban background sediments, pyrogenic PAHs are dominant and comprise around 75 percent of total PAH concentrations. Pyrogenic PAHs come from a wider variety of sources and contain more PAH by mass than petroleum; pyrogenic PAHs are typically particle-bound and settle in the water column, while petrogenic PAHs are often present as a sheen on surface waters (Stout 2003).

Several statistical methods have been used to differentiate petrogenic and pyrogenic PAHs and to further identify individual sources. Most of these methods rely on the evaluation of a suite of 40 or more PAH compounds, many of which are the alkylated compounds that are almost exclusively petrogenic in origin. Samples collected from storm drain and LDW sediments for this evaluation were analyzed by EPA Method 8270 and only contain the 16 “priority pollutant” parent PAH compounds. Statistical methods are more limited with this subset of data. Determining potential sources using the parent PAH compounds focuses on differences in ratios between isomer pairs.

Four isomeric ratios (Zemo 2009) were calculated from the PAH data available in the Watson geodatabase:

- Anthracene (An) / Phenanthrene (Ph); 3-ring PAHs, mass 178
- Fluoranthene (Fl) / Pyrene (Py); 4-ring PAHs, mass 202
- Benzo[a]anthracene (BaA) / Chrysene (Cr); 4-ring PAHs, mass 228
- Indeno[1,2,3-cd]pyrene (IP) / Benzo[g,h,i]perylene (Bghi); 6-ring PAH, mass 276

Ratios were calculated between PAHs with the same molecular weight and number of rings to avoid the effects of environmental weathering on dissimilar structures (i.e. anthracene and phenanthrene degrade at similar rates by similar processes). Pyrogenic input from each ratio pair was determined as the increase in the proportion of the less stable PAH isomer from the more stable isomer. In short, higher ratios were assumed to indicate pyrogenic sources.

Ratios for each of the four isomer pairs were calculated when both PAHs were detected. As part of the initial LDW evaluation, maps of the PAH ratios, similar to those for PCB ratios in Section 4.1, were created. These maps failed to reveal any groups of samples with consistently high or low ratios that would indicate a potential source. Efforts were made to refine the gradients depicted on the maps, but given the wide range of PAH sources, it was difficult to find consistent literature values for ratios that would indicate petrogenic or pyrogenic origin.

Instead, minimum, maximum, and average PAH ratio values were determined for both the storm drain solids and surface sediment grab samples from each source control area. These summary statistics were plotted on bar graphs. Figure 4-2 presents the BaA/Cr ratio, and Figure 4-3 presents the IP/Bghi ratio.

For reference, these figures contain a shaded area that represents urban background ratios typical of two Washington sites (Stout et al 2004). The Stout study determined a range of PAH ratios in sediments classified as urban background from nine different waterways on the east and west coasts of the United States, including two locations in Washington State (Thea Foss Waterway, Tacoma; Eagle Harbor, Bainbridge Island). These PAH ratios are listed in Table 4-1. The ratios that represented urban background were inconsistent between locations, implying there was no single ratio signature for urban background PAH. However, the range of ratios from all sites serves as a guideline for evaluating the LDW PAH data. The minimum, maximum, and average PAH ratios for all nine locations and the two Washington locations are shown in Table 4-1 for the four ratios used in this evaluation.

Most of the average BaA/Cr ratios in Figure 4-2 are within the Washington State urban background range, and all are within the national urban background range. None of the average ratios for the source control areas indicate obvious outliers. There are differences between the ratios for the storm drain solids and surface sediment samples. With the exception of Slip 6, which only had three storm drain solids samples, the ratios from the surface sediment samples are higher by an average of 26 percent.

A similar but more pronounced pattern is observed for IP/Bghi in Figure 4-3. The Washington State urban background range is narrow. Many of the source control areas have ratios that are outside of this range in either direction. Fewer source control area average ratios are outside the national urban background range. With the exception of Slip 4, the average ratio for surface sediment samples was higher than storm drain solids by an average of nearly 95 percent.

The similarities between the BaA/Cr and IP/Bghi figures indicate that the surface sediment samples are more pyrogenic than the storm drain solids. Similar figures were created for the An/Ph and Fl/Py ratios, but did not show the differences between storm drain solids and surface sediment samples. The average An/Ph ratios were lower than the Washington State urban background, but within the national range. The average Fl/Py ratios were often higher than the Washington State and national urban background ranges.

4.3 Correlations Between Dioxins and Other COPCs

There is some overlap between sources of PCBs, PAHs, and dioxin/furan congeners. Because of this overlap, it is possible that concentrations of dioxin/furan congeners and PCBs or dioxin/furan congeners and PAHs are related.

Burning of transformer oils contaminated with PCBs is a known source of dioxin/furan congeners (USEPA 2004). Transformer oils were burned at the GTSP facility (located in the Slip 4 source control area) and in other areas of the LDW. Atmospheric deposition from these activities may be responsible for some of the existing dioxin/furan contamination. Ongoing sources of PAHs also contribute dioxin/furan contamination. Automobile combustion is a known source of both PAHs and dioxin/furan congeners (USEPA 2004).

All samples analyzed for dioxin/furan congeners and paired with either total PCBs and cPAH analyses were extracted from the Watson database. All results that were qualified as non-detects were removed from the correlation. One dioxin sample had a TEQ of over 2,000 ng TEQ/kg. This sample was a clear outlier and was removed from the correlations. Storm drain solids and surface sediment samples are presented as separate series in the figures. Linear trend lines were applied to each data series. There were too few samples to show source control area specific correlations.

The correlations between dioxin/furan TEQ and total cPAHs are presented in Figure 4-4. While there appears to be a general increase in dioxin/furan TEQ with increasing cPAH concentrations for storm drain solids, the R^2 value was only 0.0082. The relationship for surface sediment grabs was not much better.

The correlations between dioxin/furan TEQ and total PCBs are presented in Figure 4-5. Two PCB outliers with concentrations of 23.1 and 110 mg/kg were removed from this correlation. The Y-axis was rescaled in this figure to reduce the focus on dioxin/furan TEQ concentrations above 400 nanograms per kilogram (ng/kg). The low R^2 values (both below 0.05) indicate there is no relationship between dioxin/furan TEQ and total PCBs.

The lack of correlation between these COPCs is not surprising. Not all PAH compounds or dioxin/furan congeners are produced in equal amounts during combustion. Rather, combustion produces a unique fingerprint for both classes of compounds. Comparing TEQ values, which are weighted totals, removes the uniqueness of this fingerprint and reduces the likelihood of correlation. The same principle applies to PCBs and dioxin/furan congeners. There may be a correlation between certain PCB congeners and dioxin/furan congeners that can’t be visualized using PCB Aroclor data.

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5.0 Comparison of Sample Collection Methods

Several sample collection methods were used in the LDW basin to evaluate contaminant concentrations in both storm drain solids and stormwater. As previously discussed, these sample types included whole water, filtered suspended solids, sediment traps, inline and catch basin grabs, plus a limited number of centrifuge solids samples. In this section, the chemical results from these different sample types are evaluated with the intent of determining whether or not different methods are equivalent for source tracing purposes.

Previous investigations, including the LDW Lateral Loading Study (SAIC and NewFields 2011a), the Accelerated Source Tracing Study (SAIC and NewFields 2011b), and various efforts at NBF, have attempted to compare these sample types. However, the utility of the comparisons from these investigations were often limited by sample size.

In addition, the sample type comparisons conducted in previous studies were often qualitative in nature. For example, the comparisons presented in the Accelerated Source Tracing Study were made by determining the relative percent difference between concentrations from different sample types. Low percent differences implied a match between sample types, but lacked a statistical threshold. Another downside of the earlier comparisons was the inability to directly compare whole water and solids samples due to the difference in units between solid and liquid sample types. Attempts were made in the Accelerated Source Tracing study to normalize whole water to a solids basis using TSS measurements, but this method may have introduced significant error if all whole water contaminants were not bound to TSS.

In this section, all co-located sample types from the LDW basin are incorporated to increase the sample size, and more rigorous statistical methods are applied to provide a more definitive comparison. Spearman rank order correlations are used to evaluate whether concentrations between sample types follow the same pattern between locations. This method is unitless and allows for a direct comparison between whole water and solids samples. The Wilcoxon signed-rank test is used to evaluate whether there is a difference between the median concentrations of different solids sample types.

5.1 Sample Type Comparison Data Selection

Mercury, copper, total HPAHs, BEHP, and total PCBs were selected for sample type comparisons. Concentrations of each COPC were compared between sample types at up to 20 locations. These sample type comparisons are presented as bar charts in Figures 5-1 through 5-6. The bar charts for the solids samples (filtered solids, sediment traps, and grab samples) are presented on the same scale for direct comparison.

Filtered solids and whole water results from individual storm events were averaged and treated as a single wet-season sample to strengthen comparability between sample types. Non-detected concentrations in these averages were treated at one-half the detection limit in this calculation. For all figures, non-detected concentrations were included at one-half the detection limit. Results from individual samples are highlighted to designate criteria exceedances (Table 1-1) or to indicate whether the result was a non-detect.

The data used in these comparisons were extracted from the Sherlock database and include only the most recent 2009–2011 wet season chemistry results. The filtered solids and whole water results presented in these comparisons were all collected by SAIC or SAIC and NewFields and share the same field sampling and analytical methods (SAIC and NewFields 2011a, 2011b; SAIC 2010a, 2010b, 2011b).

Whenever possible, the various sample type results from a given location were obtained from the same sampling season. In select cases, results from a preceding season or samples from nearby comparable locations were needed to supplement the available results. These cases are identified in Table 5-1.

There were many additional locations that were sampled between 2005 and 2011 with co-located sediment trap and grab samples, but with no associated filtered solids or whole water samples. PCB results from these locations were also extracted from the Sherlock database. Sediment trap and grab sample pairs were preferentially selected from the same wet season. In some cases it was necessary to group a wet season sample with a dry season sample (Table 5-1). All sample pairs were grouped by hydrologic year and are presented in Figure 5-2.

5.2 Spearman's Rank Order Correlations

Spearman's rank order correlations and Wilcoxon signed-rank tests were used to make comparisons between the sample types. Both tests are considered non-parametric, meaning they are not dependent on the data having a normal distribution. In the Spearman rank order correlation, concentrations were sorted from largest to smallest and numbered accordingly beginning with a rank of one for the highest concentration. The Spearman coefficient (r_s) is analogous to the common correlation coefficient, r, but should not be used interchangeably. A higher value of r_s indicates that site-to-site concentration variability among paired independent measurements is closely linked. Spearman correlation coefficients among different sample types are reported in Table 5-2, with the two-tailed 95 percent confidence level indicated by light blue and the 99 percent confidence levels indicated by dark blue.

The Spearman rank order correlations do not take the magnitude of concentration differences between sample types into account. The Wilcoxon signed-rank test was applied to evaluate whether one sampling method resulted in higher analyte concentrations compared to another. In this respect, the Wilcoxon signed-rank test is a non-parametric equivalent to the more common paired t-test. Both tests were applied when a sample size was greater than five co-located sample types with detected concentrations.

PCBs

Filtered solids and whole water concentrations were correlated at the 95 percent confidence level for total PCBs (Table 5-2). This significant correlation is not surprising given that these sample types were often collected during the same storm events. A correlation (r_s of 0.76) was noted between whole water and sediment trap concentrations.

No correlations were found between filtered solids and sediment traps, or filtered solids and grab samples. The co-located sediment trap and grab samples presented in Figure 5-1 were not correlated; however, the ranked concentrations presented in the extended comparison (Figure 5-2) were correlated at 99 percent. The correlation from this larger data set yielded an r_s of 0.89 (Table 5-2). With a sample size of 26, this high statistical correlation between grab samples and sediment traps was the most robust relationship tested. This distinction shows that an increase in sample size would benefit all sample type comparisons.

HPAH

A limited number of grab samples were analyzed for HPAH, preventing statistical comparisons with this sample type. Spearman correlations between the remaining sample types were all significant. The filtered solids and whole water correlation was significant at 95 percent, while sediment trap ranked concentrations were correlated to both filtered solids and whole water at the 99 percent level (Figure 5-3, Table 5-2).

HPAH, more than any other COPC in this comparison, shows similar trends in concentration across all sample types. These results are consistent with previous observations that demonstrated similarities between these sample types using less rigorous statistical methods (SAIC and NewFields 2011b).

BEHP

BEHP could not be analyzed in filtered solids due to the possibility of interference with filter bag material. A limited number of sediment grab samples were analyzed for BEHP, making comparisons with this sample type more difficult. No correlations were noted between whole water and sediment trap BEHP or between sediment traps and storm drain grab samples (Figure 5-4).

Mercury

Mercury was only detected in one of the whole water samples. No comparisons could be made to this sample type. Co-located samples were limited for sediment traps and grab samples. Correlations were only possible between filtered solids and sediment traps and filtered solids and grab samples. Both sets of correlations were significant. The correlation between filtered solids and traps had a r_s of 0.93, the highest observed for any Spearman correlation (Table 5-2).

Despite the significant correlations, there are cases where mercury exceeded a screening level in one sample type and not another. At MH226, mercury exceeded the criteria in the grab sample, but not the sediment trap or filtered solids average. At MH108, the filtered solids average concentration exceeded the criteria but the sediment trap did not (Figure 5-5).

Copper

Copper correlations were made between most sample types. Much like total PCBs and HPAH, concentrations were correlated between filtered solids and whole water (Table 5-2). No correlations were noted between the remaining sample types. Though correlations were weak, there was only one case where copper exceeded a screening level in one of the storm drain solids samples and not in the others (SQ2; Figure 5-6).

Results of the Wilcoxon signed-rank test for all paired sample types did not demonstrate a significant difference between the measured concentrations of the paired sample types at a 95 percent confidence level. A difference in median BEHP concentration between storm drain grab samples and sediment trap samples may exist based on visual observation of Figure 5-4, but could not be determined due to sample size. The sample size in this comparison was limited to five locations. Further sampling would need to be collected to demonstrate the relationship with greater confidence.

This pattern seems to be present with total PCBs as well. PCBs exceed screening levels in all three solids sample types from SQ3 and MH108, but concentrations are two to three times higher in filtered solids samples (Figure 5-1). The elevated concentrations in filtered solids may be due to the discrete nature of these samples. The seasonal average concentration for filtered solids consists of three to 10 samples. Additional filter samples per location may produce an average concentration more similar to the sediment traps and grab samples.

5.3 Filtered Solids and Centrifuge Sample Comparison

In the spring of 2011, three co-located centrifuge and filtered solids samples were collected at location LS431 at NBF. Both sample types were discrete sample types collected during the same storm events sampled on March 25, April 28, and May 26, 2011. Due to limited sample volumes, not all parameters could be analyzed for each storm event.

Table 5-3 summarizes available results for copper, mercury, zinc, LPAH, HPAH, cPAH, total PCBs, and dioxin/furan congener TEQ. Though the sample size is small, there is a pattern of higher concentrations from the centrifuge solids samplers. With the exception of mercury, metals concentrations from the centrifuge sampler were 4 to 95 percent higher than the filtered solids results, although none of the concentrations from either sample type exceeded their respective screening levels.

PAH, as represented by total LPAH, total HPAH, and cPAH were 300 to 600 percent higher in the centrifuge solids samples. HPAH exceeded the upper SL in the centrifuge sample from May 26, but not the corresponding filtered solids sample. Total cPAH exceeded the lower SL in the centrifuge solids sample but not the filtered solids sample. This large difference in concentration between the two methods is inconsistent with the similarities noted between HPAH concentrations in Section 5.2, though it should be noted that only one sample was available for comparison in Table 5-3.

All PCB concentrations exceeded the lower SL. PCBs in the centrifuge solids sample from May 26 also exceeded the upper SL. PCB concentrations were 25 to 626 percent higher in the centrifuge solids samples. Dioxin/furan TEQ concentrations were similar between sample types.

Although grain size data were unavailable for corresponding samples, the difference in concentrations may be due to preferential sampling of the finer suspended solids by the centrifuge.

6.0 Summary and Data Gaps

This report presents a compilation of chemical data from readily available sources for LDW surface sediments, stormwater, and storm drain solids. The purpose of this study was to develop a better understanding of the relationship between stormwater discharges and sediment contamination in the LDW; to identify areas where additional data are needed to identify and control contaminant sources; to assist Ecology with prioritization of source control efforts; and to compare stormwater and storm drain solids sample collection methods. Data sources are listed in Section 2.1. Data were entered into an Access database; selected data and parameters were exported to a geodatabase for use in generating the figures and tables presented in this report. Due to time constraints associated with this project, the evaluation focused on a subset of 16 chemicals that were selected based on their frequency of screening level exceedances in LDW sediments and storm drain samples. Screening levels are listed in Table 1-1.

6.1 Spatial Evaluation

Concentration and screening level exceedance data for the 16 chemicals selected for evaluation were summarized and concentrations were presented on maps in Section 3. Chemicals with the highest screening level exceedance frequencies storm drain solids include BEHP (75 percent of samples), zinc (68 percent of samples), total PCBs (68 percent of samples), BBP (65 percent of samples), cadmium (64 percent of samples), and dioxins/furans (50 percent of samples). In surface sediments, PCBs exceeded a screening level in 51 percent of samples.

The following five source control areas did not have any available storm drain solids data: Spokane Street to Ash Grove Cement; Slip 1; King County Lease Parcels; St. Gobain to Glacier NW; and Slip 2 to Slip 3. Comparisons between storm drain and sediment concentrations for these source control areas were therefore not possible.

Concentrations and screening level exceedances were summarized in Tables 3-2 through 3-17 for each of the 16 chemicals that were evaluated. Chemicals were generally detected more often in storm drain samples than in surface sediment samples, and at higher concentrations. For some chemicals, such as arsenic and PCBs, the frequency of screening level exceedances was similar in sediments and storm drain solids. Other chemicals, including BEHP and cadmium, frequently exceeded screening levels in storm drain solids but not in river sediments. For most chemicals, screening level exceedances in storm drain samples occurred three to five times more frequently than in river sediments.

PCBs, total HPAH, cPAH, BBP, and zinc were widely distributed throughout the LDW, with exceedances in most source control areas. Other metals, such as mercury, arsenic, and lead, were more localized to specific areas within the LDW.

Chemical concentrations and exceedance frequencies were summarized by source control area in Tables 3-18 through 3-41. Key observations are summarized below.

Source Control Area	Key Observations	Data Gaps (Priority)
RM 0.0–0.1 East: Spokane Street to Ash Grove Cement	Upper SL exceedances for arsenic, lead, mercury, and PCBs in one surface sediment sample. No storm drain samples collected.	Storm drain solids data are needed to assess whether PCBs, mercury, and other contaminants in surface sediments originate from sources in this source control area. (Medium)
RM 0.1–0.9 East: Duwamish/Diagonal Way	Hundreds of samples have been collected in this source control area; mercury, BBP, phenol and PCBs exceeded screening levels in both sediment and storm drains.	None identified; source control in progress at several locations. (Low)
RM 0.9–1.0 East: Slip 1	Upper SL exceedances for metals and PAHs in surface sediment samples; lower SL exceedances for PCBs. No storm drain samples collected.	Storm drain samples are needed for PCBs at Federal Center South. Source tracing for arsenic near the former Snopac Products and Manson Construction facilities is needed. (Medium)
RM 1.0–1.2 East: King County Lease Parcels	Upper SL exceedance for mercury and lower SL exceedance for PCBs in sediment samples. No storm drain solids collected.	Data on PCBs in storm drains at Cadman/Lehigh Northwest property would be helpful to identify potential sources. (Medium)
RM 1.2–1.7 East: St. Gobain to Glacier NW	Upper SL exceedances for zinc and PAHs in sediment; lower SL exceedances for PCBs. No storm drain solids samples collected.	Storm drain solids data for PCBs in storm drains that discharge to Outfalls 2010 and 2011 are needed. (Medium)
RM 1.7–2.0 East: Slip 2 to Slip 3	No upper SL exceedances in sediment; lower SL exceedances for PCBs. No storm drain samples collected.	Storm drain solids samples from Glacier Northwest and Duwamish Marine Center for PCBs would be helpful to identify potential sources. (Medium)
RM 2.0–2.3 East: Slip 3 to Seattle Boiler Works	Arsenic, zinc, HPAH, cPAH, and PCBs exceeded screening levels in storm drain and sediment samples.	Storm drain solids samples for PCBs, PAHs, arsenic, and zinc needed near Outfalls 2024 and 2025; additional source tracing needed for PCBs in the S River Street SD; additional source tracing needed for PAHs in the S Brighton Street SD/CSO basin; dioxin/furan samples in storm drains would be useful. (High)
RM 2.3–2.8 East: Seattle Boiler Works to Slip 4	Mercury, zinc, BBP, BEHP, and PCBs exceeded screening levels in storm drain and sediment samples.	Additional source tracing for mercury, zinc, PCBs, and dioxins/furans is needed in the S Myrtle Street SD. (High)
RM 2.8 East: Slip 4	Lead, mercury, zinc, HPAH, cPAH, BBP, BEHP, PCBs, and dioxins/furans exceeded screening levels in storm drain and sediment samples.	None identified; RI/FS in progress at NBF-GTSP Site.
RM 2.8–3.7 East: Boeing Plant 2 to Jorgensen Forge	Mercury, zinc, HPAH, cPAH, BBP, phenol, and PCBs exceeded screening levels in storm drain and sediment samples. Sediment sampling data near Boeing Plant 2 are over 10 years old and were not included in the dataset for this project.	Sediment and upland cleanup in this area is scheduled to begin in 2012. Storm drain solids samples are needed in the 16th Avenue S SD and KCIA-Jorgensen SD. Source tracing for dioxins/furans is needed in the KCIA-Jorgensen SD. (High)

Source Control Area	Key Observations	Data Gaps (Priority)
RM 3.7–3.9 East: Boeing Isaacson/Central KCIA	Arsenic, HPAH, cPAH, BBP, and PCBs exceeded screening levels in storm drain and sediment samples.	Source tracing for arsenic, PAHs, BBP, and PCBs in KCIA SD#2 and at the Boeing Isaacson/Thompson facility is needed. Surface sediment samples for dioxins/furans are needed near the Boeing Thompson/Isaacson property. (High)
RM 3.9–4.3 East: Slip 6	Zinc, PAHs, and phthalates exceeded screening levels in storm drain and sediment samples.	Additional source tracing needed for PAHs and phthalates, particularly in areas with drainage to outfalls 2078 and 2081. Storm drain data needed for zinc, lead, mercury, BBP, and PCBs near outfalls 2073 and 2075. (Medium)
RM 4.3–4.9 East: Boeing Developmental Center	PCBs exceeded screening levels in storm drain and sediment samples.	Storm drain samples for PCBs are needed from BDC property. (Medium)
RM 4.9 East: Norfolk CSO/SD	BEHP, BBP, cPAH, and PCBs exceeded screening levels in storm drain and sediment samples.	Storm drain and surface sediment samples needed for dioxins/furans. (Low)
RM 0.0–1.0 West: Spokane Street to Kellogg Island	Zinc, PAHs, phthalates, and PCBs exceeded screening levels in storm drain and sediment samples.	Source tracing is needed for zinc and phthalates in the SW Dakota Street SD; storm drain samples for PCBs, HPAH, cPAH, mercury, and dioxins/furans needed near Port of Seattle Terminal 107. (Medium)
RM 1.0–1.3 West: Kellogg Island to Lafarge	HPAH, cPAH, BBP, and PCBs exceeded screening levels in storm drain and sediment samples.	None identified.
RM 1.3–1.6 West: Glacier Bay	Metals, PAHs, phthalates, and dioxins/furans have exceeded screening levels.	Source tracing for dioxins/furans is needed near Glacier Bay inlet. Source tracing for metals needed near the former Duwamish Shipyard graving dock. RIs being conducted at Glacier Northwest and Duwamish Shipyard. (High)
RM 1.6–2.1 West: Terminal 115	LPAH, BBP, BEHP, PCBs, and dioxins/furans exceeded screening levels in storm drain and sediment samples.	Source tracing is needed near outfall 2220 (Port of Seattle outfall 6153). (Medium)
RM 2.1 West: 1st Avenue S SD	BBP and BEHP exceeded screening levels in storm drain and sediment samples.	None identified.
RM 2.1–2.2 West: Trotsky Inlet	Copper, lead, mercury, cPAH, BBP, BEHP, phenol, and PCBs exceeded screening levels in storm drain and sediment samples.	Additional source tracing is needed for PCBs and phthalates in the 2nd Avenue S SD. Storm drain samples for PCBs needed at Douglas Management and Boyer Towing properties. RIs are being conducted at the Industrial Container Services and Douglas Management Company properties. (High)
RM 2.2–3.4 West: Riverside Drive	Mercury, PAHs, phthalates, and PCBs exceeded screening levels in storm drain and sediment samples.	Source tracing is needed for mercury, PAHs, phthalates, and dioxins/furans in the7th Avenue S SD; surface sediment samples near outfall 2110 are needed; source tracing for PCBs is needed in the 8th Avenue S CSO. (Low)

Source Control Area	Key Observations	Data Gaps (Priority)
RM 3.4–3.8 West: Terminal 117	Zinc, PAHs, BBP, and PCBs exceeded screening levels in storm drain and sediment samples.	Cleanup of sediments and upland sources is scheduled for 2013.
RM 3.8–4.2 West: Sea King Industrial Park	PCBs exceeded screening levels in storm drain and sediment samples.	Few storm drain samples have been collected; additional sampling would be helpful. (Low)
RM 4.2–4.8 West: Restoration Areas	Few screening level exceedances.	None identified.

6.2 Ratios and Correlations

Section 4 included an evaluation of PCB, PAH, and dioxin correlations and ratios. Ratios of Aroclor 1254 to Aroclor 1260 were mapped in Figure 4-1; ratios of 1.0 to 2.0 were most common for LDW sediments and storm drain solids. PCBs in some areas, such as Terminal 117, were predominantly Aroclor 1260; in others, such as the Jorgensen Forge area, were predominantly Aroclor 1254. Further evaluation of Aroclor ratios, including Aroclor 1248, is recommended.

PAH ratios were examined in an attempt to distinguish petrogenic from pyrogenic sources. Ratios were generally within the range of Washington State urban background values. Based on the available data for individual PAH compounds, the ratios do not appear to be useful for source identification.

Dioxin/furan data were also compared to concentrations of PCBs and cPAHs. Very little correlation was observed based on the available data.

One data evaluation method that may be useful for future consideration is Principle Components Analysis (PCA). PCA is a statistical method that is used to reduce the number of variables in complex data sets. In the case of PAH compounds, there are 16 possible initial variables. The goal of PCA is to find the correlation between the individual compounds and group all compounds that share the same pattern together on one variable, or principal component. In an ideal case, the end result would be two or three principal components that explain the majority of the original dataset’s variability. Each component explains some portion of the PAH compound profile for each sample. Groups of samples with similar congener profiles can be determined when the components are plotted against each other. In short, PCA would enable the simultaneous correlation of all PAH compounds rather than the few selected for PAH ratio comparisons in this report.

Performing PCA for dioxin congeners would do much the same thing. It could help to find areas with unique dioxin fingerprints. If conducted in conjunction with cPAH, the analysis could find areas where specific PAH compounds and dioxin congeners are correlated.

6.3 Sample Collection Methods

Sample collection methods for storm drain samples were compared in Section 5. Results vary by chemical and indicate the following:

- PCBs showed good correlation between filtered solids and whole water samples (Table 5-2). Sediment trap and grab samples (Figure 5-2) also showed good correlation. Filtered solids data were not highly correlated with sediment trap or grab sample data. Concentrations were generally highest in filtered solids samples. Whole water samples exceeded screening levels less frequently.
- Total HPAH showed good correlation between filtered solids, sediment traps, and whole water samples; however, water samples did not exceed screening levels and would therefore not identify total HPAH as a COPC. Insufficient grab samples were co-located with other samples types to evaluate. Concentrations were generally highest in sediment traps.
- BEHP concentrations were poorly correlated between sample collection methods. No filtered solids samples have been analyzed for BEHP. Concentrations were highest in sediment traps.
- Mercury showed good correlation between filtered solids, sediment trap, and grab samples. Water samples were generally below the detection limit and therefore are not a useful sample collection method for mercury source tracing purposes.
- Copper in filtered solids was correlated with whole water sample results. However, copper in water samples generally exceeded a screening level, while filtered solids samples did not. No other correlations were identified.

Due to time constraints, SPU grab sample and sediment trap sample concentrations were compared for PCBs only. Identification and comparison of paired samples for other contaminants is needed.

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Tables

Table 1-1
Screening Levels for Chemicals
in LDW Storm Drain and Sediment Samples

Parameter	Lower SL	Upper SL
Surface Sediment and Storm Drain Solids		
PCB Aroclors (mg/kg DW)	**LAET**	**2LAET**
Total PCBs	0.13	1.0
PAHs (mg/kg DW)	**LAET**	**2LAET**
Naphthalene	2.1	2.4
Acenaphthylene	1.3	1.3
Acenaphthene	0.50	0.73
Fluorene	0.54	1.0
Phenanthrene	1.5	5.4
Anthracene	0.96	4.4
2-Methylnaphthalene	0.67	1.4
Total LPAH	5.2	13
Fluoranthene	1.7	2.5
Pyrene	2.6	3.3
Benzo(a)anthracene	1.3	1.6
Chrysene	1.4	2.8
Total Benzofluoranthenes	3.2	3.6
Benzo(a)pyrene	1.6	3.0
Indeno(1,2,3-cd)pyrene	0.6	0.69
Dibenz(a,h)anthracene	0.23	0.54
Benzo(g,h,i)perylene	0.67	0.72
Total HPAH	12	17
cPAH (mg TEQ/kg)	**RAL**	**UCL-ENR**
Total cPAH	1.0	3.0
Phthalates (mg/kg DW)	**LAET**	**2LAET**
Dimethylphthalate	0.071	0.16
Diethylphthalate	0.20	1.2
Di-n-Butylphthalate	1.4	5.1
Butylbenzylphthalate	0.063	0.90
Bis(2-ethylhexyl)phthalate	1.3	1.9
Di-n-octyl phthalate	6.2	6.2
Phenols (mg/kg DW)	**SQS**	**CSL**
Phenol	0.42	1.2
2-Methylphenol	0.063	0.063
4-Methylphenol	0.67	0.67
2,4-Dimethylphenol	0.029	0.029
Pentachlorophenol	0.36	0.69
Dioxin/Furan (ng TEQ/kg)	**RAL**	**UCL-ENR**
Dioxin/Furan Congeners	25	50
Metals (mg/kg DW)	**SQS**	**CSL**
Arsenic	57	93
Cadmium	5.1	6.7
Chromium	260	270
Copper	390	390

Table 1-1
Screening Levels for Chemicals
in LDW Storm Drain and Sediment Samples

Parameter	Lower SL	Upper SL
Lead	450	530
Mercury	0.41	0.59
Silver	6.1	6.1
Zinc	410	960
Stormwater		
PCB Aroclors (ug/L)	**WQC Chronic**	**WQC Acute**
Total PCBs	0.030	10
Total Metals (ug/L)	**WQC Chronic**	**WQC Acute**
Arsenic	36	69
Cadmium	9.3	42
Copper	3.1	4.8
Lead	8.1	210
Mercury	0.025	1.8
Silver	--	1.9
Zinc	81	90

Notes:

2LAET - second lowest apparent effects threshold
cPAH - carcinogenic PAH
CSL - cleanup screening level
DW - dry weight
HPAH - high molecular weight PAH
LAET - lowest apparent effects threshold
LDW - Lower Duwamish Waterway
LPAH - low molecular weight PAH
mg/kg - milligrams per kilogram
ng - nanogram
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
RAL - LDW Feasibility Study Remedial Action Level
SQS - Sediment Quality Standard
SL - screening level
TEQ - toxic equivalent quotient
UCL-ENR - Upper concentration limit for enhanced natural recovery
WQC Chronic - Washington State Marine Water Quality Criteria (chronic)
WQC Acute - Washington State Marine Water Quality Criteria (acute)

Table 2-1
Data Fields in Access Database

Field Name	Description	Example
ResultID	Unique integer value for each record	
StudyID	Name of data source	BDC 2010 Sediment Report
LocationID	Name of sample	MH108
LocationDescription	Address or building name if readily available	Snoqualmie and 6th
SCA	Name of the source control area	Slip 6
X_coord	WA state plane (ft)	1273409.64
Y_coord	WA state plane (ft)	199194.9
CollectionDate	Collection Date	5/5/2010
Matrix	Sample material	Sediment or Water
Sample Type	Collection method	See Table 2-2
Grab Type	Additional description for SD Grab sample type. Mainly applies to SPU data.	Catch Basin Grab, Right-of-way Catch Basin Grab, Inline Grab
Parameter	Analyte name	anthracene
Result	Result	29.4
Units	Units of result	See Table 2-3
Qualifier	lab or validation qualifier	U, J, B
Undetect_Flag	Y if not detected	
Fraction	Distinguishes whole water results as total or dissolved	Total or Dissolved
Basis	Wet or dry weight for solids samples	Dry or Wet
Notes	Additional notes if available	

Notes:
SCA - source control area
SD - storm drain
SPU - Seattle Public Utilities

Table 2-2
Source Tracing Sample Types Included in the Database

Matrix	Sample Type	Description	Advantages/Disadvantages
Water	Stormwater	Whole water sample collected from a storm drain or outfall. Includes CSOs. Sample consists of dissolved contaminants, suspended solids, and possibly some bedload solids.	Samples represent a single storm (or base flow/tide) event.
	Baseflow Water	Base flow water sample collected from a storm drain. Samples may indicate contamination due to infiltration of groundwater to the storm drain line.	
	Tide Water	Tidal water sample collected from a storm drain. Includes some input from base flow (if present), but no stormwater.	
Storm Drain Solids	Sediment Trap	A sample collected using a conventional one-liter bottle sediment trap. Samples accumulate over a period of several months and represent a seasonal composite.	Sediment trap samples are composites and can take months to collect. Samples may be impacted by base flow and tidal water.
	Bedload Trap	Specially-constructed stainless steel sediment trap for capturing bed load solids in storm drains.	
	SD Grab	A catch-all term for catch basin grab, right-of-way catch basin grab, inline grab, or any sample refered to as grab and collected from a storm drain. SD Grabs are further differentiated by the Grab Type field (Table 2-1).	Catch basin grabs represent a single source area, while inline grabs sample a wider area. Grabs can only be collected from locations with sufficient solids present.
	Filter	A storm sample collected by capturing solids on a filter, either by actively pumping stormwater through the filter or passively installing the filter in the flow.	Samples represent a single storm (or base flow/tide) event.
	Baseflow Filter	A solids sample collected by actively pumping baseflow water through a filter.	
	Tide Filter	A solids sample collected by actively pumping tidal water through a filter.	
	Centrifuge	A sample collected by centrifuging solids from stormwater.	Samples represent a single event.
	Treatment Vault Sediment	Sample of solids collected at the bottom of a treatment vault.	Depending on the location, captured solids may not be representative of contaminants entering the
	Oil/Water Separator Sediment	Sample of solids collected at the bottom of an oil/water separator.	
Sediment	Backfill Surface Sediment	LDW surface sediment grab collected from an area previously capped with clean fill.	May not be similar to adjacent native sediments.
	Surface Sediment Grab	LDW surface sediment grab.	Samples may provide a link to upstream source tracing information. The contaminants in river sediments may have undergone weathering and dilution.

Notes:
CSO - combined sewer overflow
LDW - Lower Duwamish Waterway
SD - storm drain

Table 2-3
Units of Measure for Relevant Parameters

Matrix	Parameter	Units
Water	Metals	ug/L
	PCB Aroclors	ug/L
	SVOC[a]	ug/L
	PBDEs	pg/L
	TSS	mg/L
	TOC (water)	mg/L
	Aqueous Conventionals[b]	mg/L
	Gasoline-Range Hydrocarbons	mg/L
	Diesel-Range Hydrocarbons	mg/L
	Fecal Coliform	CFU/100 mL
	Nitrate	mg-N/L
	Phosphate	mg-P/L
	pH	pH units
	Turbidity	NTU
Solids/Sediment	Metals	mg/kg
	PCB Aroclors	mg/kg
	SVOC[a]	mg/kg
	Dioxin/Furan congeners	ng/kg
	Grain Size	percent
	TOC (solids)	percent
	Total Solids	percent
	Conductivity	umho/cm
	Hardness as CaCO3	mg/L CaCO3

Notes:

a - includes phenols, phthalates, PAHs, etc.
b - includes chloride, alkalinity, dissolved organic carbon, etc.
TOC - total organic carbon
TSS - total suspended solids
SVOC - semivolatile organic compound
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
ug/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
CFU - coliform forming unit
NTU - nephelometric turbidity unit

Table 2-4
Number of Samples Included in Sherlock Database
by Sample Type and Source Control Area

v	Baseflow Water	Storm-water	Tide Water	Baseflow Filter	Filter	Tide Filter	Centri-fuge	Bedload Sediment Trap	Oil/Water Separator Solids	SD Grab	Sediment Trap	Treatment Vault Solids	Surface Debris	Backfill Surface Sediment	Surface Sediment Grab	Total Number of Samples
LDW East Side																
Spokane Street to Ash Grove Cement															19	19
Duwamish/Diagonal Way	13	22	5	7	21	5		4		166	81		4		79	407
Slip 1															17	17
KC Lease Parcels		3													8	11
St Gobain to Glacier NW															29	29
Slip 2 to Slip 3															20	20
Slip 3 to Seattle Boiler Works		5								20					17	42
Seattle Boiler Works to Slip 4										19			7		32	58
Slip 4	9	42		10	104		3		52	642	125		59		68	1114
Boeing Plant 2 to Jorgensen Forge										27	2				52	81
Boeing Isaacson/Central KCIA	3	4	1	2	5	1			2	42	4	2			12	78
Slip 6										3	2				71	76
Boeing Developmental Center		4	1		4						1				20	30
Norfolk CSO/SD	3	15	1	3	7				1	56	26			4	41	157
LDW West Side																
Spokane St to Kellogg Island		3								21	6				42	72
Kellogg Island to Lafarge										4					14	18
Glacier Bay										10			2		17	29
Terminal 115	2	5	1	2	4	1				13	7				26	61
1st Avenue S SD										17	8				7	32
Trotsky Inlet										18					23	41
Riverside Drive										39	6		11		32	88
Terminal 117										17			1		84	102
Sea King Industrial Park										23	6				12	41
Restoration areas										4	2				26	32
Other Locations																
Combined Sewer Areas										18						18
LDW Main Navigational Channel															146	146
Outside of SCAs		14								43					7	64
Total	30	117	9	24	145	7	3	4	55	1202	276	2	84	4	921	2,883

Notes:

CSO - combined sewer overflow

KCIA - King Coutny Internatinal Airport

KC - King County

SD - storm drain

Table 2-5
Number of Samples Included in Watson Database by Sample Type and Source Control Area

Source Control Area	Filter	Centri-fuge	Bedload Sediment Trap	Oil/Water Separator Solids	SD Grab	Sediment Trap	Treatment Vault Solids	Backfill Surface Sediment	Surface Sediment Grab	Total Number of Samples
LDW East Side										
Spokane Street to Ash Grove Cement									19	19
Duwamish/Diagonal Way	8		3		135	25			22	193
Slip 1									17	17
KC Lease Parcels									8	8
St Gobain to Glacier NW									29	29
Slip 2 to Slip 3									20	20
Slip 3 to Seattle Boiler Works					19				17	36
Seattle Boiler Works to Slip 4					19				32	51
Slip 4	12	1		30	362	18			68	491
Boeing Plant 2 to Jorgensen Forge					23	1			52	76
Boeing Isaacson/Central KCIA	1			2	38	2	2		12	57
Slip 6					2	1			66	69
Boeing Developmental Center	1					1			20	22
Norfolk CSO/SD	3			1	34	9		4	35	86
LDW West Side										
Spokane St to Kellogg Island					18	3			42	63
Kellogg Island to Lafarge					4				14	18
Glacier Bay					10				17	27
Terminal 115	1				8	4			26	39
1st Avenue S SD					10	4			7	21
Trotsky Inlet					14				23	37
Riverside Drive					31	3			32	66
Terminal 117					14				84	98
Sea King Industrial Park					16	3			12	31
Restoration Areas					2	1			26	29
Other Locations										
CSO					12					12
LDW Main Navigational Channel									74	74
Outside of SCAs					38				7	45
Total	26		3	33	809	75	2	4	781	1,734

Notes:

Filter samples represent seasonal averages.

CSO - combined sewer overflow

KCIA - King Coutny International Airport

KC - King County

SD - storm drain

Table 3-1
Lower Duwamish Waterway Source Control Areas

Source Control Area	River Mile	Adjacent Outfalls	Public SD/CSO Basins	Total Area (sq. ft.)	Total Area (acres)
LDW East Side					
Spokane St to Ash Grove Cement	0.0 - 0.1	2151, 2154, 2156, HRE1	None	2,239,032	51.3
Duwamish/Diagonal Way (EAA-1)	0.1 - 0.9	2002, 2003, 2005, 2006, 2153, 2155, 2225, 2246, 2247, Nevada Street SD	Diagonal Avenue S SD; Nevada Street SD; Duwamish/Diagonal CSO	119,001,406	2,726
Slip 1	0.9 - 1.0	2004, 2245, 5000, 5001	None	1,890,089	43.3
KC Lease Parcels	1.0 - 1.2	2007, 2223, 2244	S Brandon Street CSO	655,385	15.0
St Gobain to Glacier NW	1.2 - 1.7	2008 - 2011, 2013 - 2017	None	1,398,583	32.0
Slip 2 to Slip 3	1.7 - 2.0	2018, 2019, 2021, 2022, 2501 - 2503	1st Avenue S Bridge SD; Michigan Street CSO	3,073,153	70.4
Slip 3 to Seattle Boiler Works	2.0 - 2.3	2024, 2025, S Brighton St. SD, S River St. SD	S River Street SD; S Brighton Street CSO/SD	1,468,225	33.6
Seattle Boiler Works to Slip 4	2.3 - 2.8	2026 - 2030, 2032 - 2042	S Myrtle Street SD; S Garden Street SD	2,490,218	57.0
Slip 4 (EAA-3)	2.8	2046 - 2053, 2216, 2217, 2219, 5006 - 5009, East Marginal Way EOF	KCIA SD#3/PS44 EOF; I-5 SD	23,569,183	540
Boeing Plant 2 to Jorgensen Forge (EAA-4)	2.8 - 3.7	2054 - 2059, 2063 - 2072, 3000 - 3007, 3009 - 3019, 3022 - 3028, 3030 - 3032, 3034, 3035	16th Avenue S SD; KCIA-Jorgensen SD	7,060,403	162
Boeing Isaacson/Central KCIA (EAA-6)	3.7 - 3.9	2061, 2062, 2077	KCIA SD#2/PS45 EOF	10,240,879	235
Slip 6	3.9 - 4.3	2073 - 2076, 2078 - 2084, Former Rhone-Poulenc	KCIA SD#1	5,576,342	128
Boeing Developmental Center	4.3 - 4.9	2085 - 2091, BDC-1, BDC-2, BDC-3, BDC-4	None	3,174,898	72.7
Norfolk CSO/SD (EAA-7)	4.9	2092 - 2097	Norfolk CSO/SD	38,162,636	874
LDW West Side					
Spokane St to Kellogg Island	0.0 - 1.0	2140 - 2150, 2157, 2226, 2232, 2233, 8132 - 8135, Siphon-West CSO	SW Dakota Street SD; SW Idaho Street SD	28,679,886	657
Kellogg Island to Lafarge	1.0 - 1.3	2137 - 2139, 5002 - 5005, Lafarge 004	None	858,566	19.7
Glacier Bay	1.3 - 1.6	2128 - 2136	SW Kenny Street SD	6,797,202	156

Table 3-1
Lower Duwamish Waterway Source Control Areas

Source Control Area	River Mile	Adjacent Outfalls	Public SD/CSO Basins	Total Area (sq. ft.)	Total Area (acres)
Terminal 115	1.6 - 2.1	2122 - 2125, 2127, 2220, 2506, 6146, Port-SF	Highland Park Way SW SD; Terminal 115 CSO; West Michigan CSO	16,523,699	379
1st Avenue S SD	2.1 - 2.2	2121, 2505, 2507 - 2510, 2512	1st Avenue S SD	26,599,571	609
Trotsky Inlet (EAA-2)	2.1 - 2.2	2114 - 2118, 2120, Boyer-Unknown	2nd Avenue S SD	2,191,107	50.2
Riverside Drive	2.2 - 3.4	2106 - 2113, 3037	7th Avenue S SD; 8th Avenue S CSO	19,322,782	443
Terminal 117 (EAA-5)	3.4 - 3.8	2103(SP4), 2209 - 2215, SP3, SP5	None	1,354,595	31.0
Sea King Industrial Park	3.8 - 4.2	2100(A), 2100(B), 2101, 2102(SP1), SP2	S 96th Street SD	46,391,103	1,063
Restoration Areas	4.2 - 4.8	2098, 2099, 2200, 2201, 2205	Hamm Creek SD	36,164,026	829

Notes:

CSO - combined sewer overflow

EAA - Early Action Area

KCIA - King County International Airport

KC - King County

SD - storm drain

Table 3-2
Summary Statistics for Total PCBs by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	0.061	1.9	0.33	0.44	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/19	0.0004	0.82	0.14	0.20	112/147	0.009	2,200	28	212
RM 0.9-1.0 East: Slip 1	15/15	0.096	0.65	0.23	0.15	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	0.030	0.23	0.12	0.062	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	26/28	0.010	0.69	0.16	0.16	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	0.012	0.67	0.16	0.18	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	0.070	0.42	0.16	0.092	14/14	0.028	2.9	0.44	0.74
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	0.013	1.8	0.23	0.059	18/19	0.36	25	4.2	5.7
RM 2.8 East: Slip 4	61/61	0.036	8.2	1.4	2.0	373/389	0.0095	330	4.8	23
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	49/49	0.0087	110	4.8	16	24/24	0.13	18	1.9	3.9
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	12/12	0.024	0.88	0.34	0.27	40/43	0.0095	3.4	0.35	0.53
RM 3.9-4.3 East: Slip 6	51/55	0.0095	2.9	0.25	0.44	1/3	0.0095	0.11	0.049	0.055
RM 4.3-4.9 East: Boeing Developmental Center	15/18	0.0020	0.27	0.051	0.068	1/1	0.48	0.48	0.48	--
RM 4.9 East: Norfolk CSO/SD	30/34	0.0027	8.4	0.97	2.2	27/44	0.0090	15	0.52	2.3
RM 0.0-1.0 West: Spokane St to Kellogg Island	37/41	0.0031	1.0	0.13	0.18	9/16	0.0095	0.61	0.16	0.19
RM 1.0-1.3 West: Kellogg Island to Lafarge	11/12	0.0095	0.75	0.21	0.25	4/4	0.037	0.81	0.34	0.36
RM 1.3-1.6 West: Glacier Bay	17/17	0.024	0.81	0.27	0.25	9/10	0.043	7.0	1.8	2.2
RM 1.6-2.1 West: Terminal 115	20/25	0.0095	0.52	0.10	0.12	6/12	0.0095	0.40	0.095	0.13
RM 2.1 West: 1st Avenue S SD	6/7	0.0020	0.097	0.039	0.036	7/13	0.0090	0.78	0.17	0.27
RM 2.1-2.2 West: Trotsky Inlet	23/23	0.010	2,930	139	610	14/14	0.025	3.2	0.43	0.82
RM 2.2-3.4 West: Riverside Drive	30/32	0.010	1.2	0.16	0.24	25/33	0.0095	2.5	0.32	0.47
RM 3.4-3.8 West: Terminal 117	79/83	0.010	38	2.4	6.2	11/11	0.14	5.4	1.2	1.60
RM 3.8-4.2 West: Sea King Industrial Park	9/11	0.0085	0.37	0.066	0.12	7/18	0.0090	0.17	0.030	0.042
RM 4.2-4.8 West: Restoration Areas	18/26	0.0020	0.52	0.051	0.11	1/3	0.0090	0.11	0.043	0.058
LDW Main Navigation Channel	61/65	0.0095	5.1	0.36	0.74	--	--	--	--	--

Notes:

Exceeds LAET (0.13 mg/kg DW)
Exceeds 2LAET (1.0 mg/kg DW)
Exceeds 10x 2LAET (10 mg/kg DW)
Exceeds 100x 2LAET (100 mg/kg DW)
Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-3
Summary Statistics for Total LPAH by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	0.071	2.3	0.75	0.73	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/19	0.0024	0.84	0.20	0.24	126/136	0.0095	80	3.0	11
RM 0.9-1.0 East: Slip 1	15/15	0.17	34	2.9	8.6	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	0.18	8.9	1.7	3.2	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	0.021	20	0.98	3.7	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	18/19	0.010	1.1	0.33	0.31	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	0.045	2.0	0.50	0.55	13/14	0.085	14	1.9	3.5
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	29/32	0.010	4.0	0.39	0.17	18/19	0.22	30	3.4	6.5
RM 2.8 East: Slip 4	27/27	0.12	3.7	0.59	0.74	70/77	0.019	54	6.4	11
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	18/18	0.089	11	2.2	2.9	7/7	0.19	2.6	0.70	0.83
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	0.024	3.1	1.0	1.1	40/42	0.023	32	2.1	4.9
RM 3.9-4.3 East: Slip 6	50/51	0.024	2.3	0.33	0.43	3/3	1.4	9.6	4.6	4.4
RM 4.3-4.9 East: Boeing Developmental Center	18/18	0.040	0.85	0.21	0.24	2/2	15	15	15	0.017
RM 4.9 East: Norfolk CSO/SD	14/15	0.015	1.3	0.20	0.34	36/41	0.010	66	3.3	11
RM 0.0-1.0 West: Spokane St to Kellogg Island	39/41	0.0095	5.2	0.65	1.2	16/16	0.0099	8.3	0.80	2.0
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	0.054	4.5	0.80	1.3	4/4	0.60	3.0	2.1	1.0
RM 1.3-1.6 West: Glacier Bay	17/17	0.16	3.1	1.1	0.94	10/10	0.069	9.8	2.4	2.8
RM 1.6-2.1 West: Terminal 115	25/25	0.036	10	0.73	2.0	13/13	0.034	1,250	100	346
RM 2.1 West: 1st Avenue S SD	7/7	0.016	1.0	0.22	0.36	14/14	0.035	3.5	1.2	1.3
RM 2.1-2.2 West: Trotsky Inlet	20/22	0.0090	4.3	0.59	0.94	12/14	0.044	6.4	1.1	1.7
RM 2.2-3.4 West: Riverside Drive	30/32	0.010	44	2.1	8.0	28/34	0.010	8.6	0.84	1.6
RM 3.4-3.8 West: Terminal 117	32/32	0.013	43	1.6	7.6	8/8	0.11	556	93	198
RM 3.8-4.2 West: Sea King Industrial Park	3/11	0.0080	0.15	0.045	0.063	15/19	0.0095	1.7	0.33	0.49
RM 4.2-4.8 West: Restoration Areas	22/26	0.0077	0.45	0.069	0.10	3/3	0.017	0.12	0.054	0.057
LDW Main Navigation Channel	47/48	0.010	1.1	0.23	0.25	--	--	--	--	--

Notes:

Exceeds LAET (5.2 mg/kg DW)

Exceeds 2LAET (13 mg/kg DW)

Exceeds 10x 2LAET (130 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-4
Summary Statistics for Total HPAH by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	0.57	12	5.2	3.8	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/19	0.0048	3.6	1.3	1.0	134/136	0.0095	262	8.8	28
RM 0.9-1.0 East: Slip 1	15/15	1.4	42	7.0	11	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	1.1	5.7	3.0	1.8	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	0.20	49	3.9	9.1	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	0.16	5.4	2.1	1.7	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	0.76	13.4	3.6	3.4	14/14	1.5	110	13	28
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	0.0096	8.9	2.1	0.94	18/19	0.38	56	10	12
RM 2.8 East: Slip 4	27/27	1.3	40	6.0	7.7	77/77	0.12	630	55	116
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	18/18	0.77	35	7.1	8.1	7/7	1.5	15	5.6	4.6
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	0.38	19	7.7	6.6	41/42	0.21	284	13	43
RM 3.9-4.3 East: Slip 6	55/55	0.23	20	3.0	3.8	3/3	2.8	83	35	43
RM 4.3-4.9 East: Boeing Developmental Center	18/18	0.25	3.3	1.2	1.0	2/2	111	120	115	6.5
RM 4.9 East: Norfolk CSO/SD	15/15	0.026	8.6	1.4	2.2	39/41	0.010	585	22	91
RM 0.0-1.0 West: Spokane St to Kellogg Island	41/41	0.019	26	4.1	6.5	15/16	0.11	89	7.8	22
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	0.64	13	3.9	3.4	4/4	1.4	14	7.8	5.1
RM 1.3-1.6 West: Glacier Bay	17/17	1.6	26	6.4	6.1	10/10	1.4	58	16	18
RM 1.6-2.1 West: Terminal 115	25/25	0.38	7.7	2.2	1.8	13/13	0.36	2,060	171	569
RM 2.1 West: 1st Avenue S SD	7/7	0.096	2.1	0.89	0.77	14/14	0.31	25	7.1	7.5
RM 2.1-2.2 West: Trotsky Inlet	21/22	0.0090	39	4.0	8.1	14/14	0.58	11	3.7	3.3
RM 2.2-3.4 West: Riverside Drive	32/32	0.049	48	4.5	11	31/34	0.010	28	4.3	5.5
RM 3.4-3.8 West: Terminal 117	32/32	0.11	85	3.9	15	10/11	0.17	3,830	352	1,154
RM 3.8-4.2 West: Sea King Industrial Park	10/11	0.0080	1.5	0.35	0.56	18/19	0.010	8.7	2.2	2.7
RM 4.2-4.8 West: Restoration Areas	26/26	0.028	4.2	0.62	0.90	3/3	0.12	1.0	0.43	0.51
LDW Main Navigation Channel	48/48	0.020	4.8	1.6	1.2	--	--	--	--	--

Notes:

Exceeds LAET (12 mg/kg DW)

Exceeds 2LAET (17 mg/kg DW)

Exceeds 10x 2LAET (170 mg/kg DW)

Exceeds 100x 2LAET (1,700 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-5
Summary Statistics for cPAH TEQ by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	0.053	2.1	0.60	0.48	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/19	0.0034	0.42	0.15	0.12	131/136	0.0070	35	1.0	3.5
RM 0.9-1.0 East: Slip 1	15/15	0.16	3.0	0.67	0.79	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	0.12	0.65	0.30	0.17	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	0.017	2.4	0.30	0.44	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	0.018	0.67	0.23	0.20	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	0.091	1.8	0.50	0.48	13/14	0.104	12	1.5	3.0
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	0.013	0.83	0.20	0.093	18/19	0.077	5.7	1.0	1.2
RM 2.8 East: Slip 4	27/27	0.16	6.6	0.85	1.3	76/77	0.028	74	6.6	14
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	18/18	0.097	3.3	0.82	0.80	7/7	0.15	2.0	0.70	0.59
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	0.060	2.3	0.92	0.85	41/42	0.033	38	1.6	5.8
RM 3.9-4.3 East: Slip 6	55/55	0.025	2.1	0.35	0.38	3/3	1.2	8.5	3.9	4.1
RM 4.3-4.9 East: Boeing Developmental Center	18/18	0.028	0.34	0.13	0.11	2/2	13	14	14	0.51
RM 4.9 East: Norfolk CSO/SD	13/15	0.013	1.1	0.17	0.27	35/41	0.0071	81	3.0	13
RM 0.0-1.0 West: Spokane St to Kellogg Island	39/41	0.0059	4.1	0.48	0.87	15/16	0.020	9.5	0.87	2.3
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	0.069	1.0	0.42	0.25	4/4	0.20	1.8	0.95	0.68
RM 1.3-1.6 West: Glacier Bay	17/17	0.17	1.6	0.72	0.48	10/10	0.16	7.0	1.8	2.2
RM 1.6-2.1 West: Terminal 115	25/25	0.036	0.56	0.23	0.17	13/13	0.045	77	6.7	21
RM 2.1 West: 1st Avenue S SD	7/7	0.014	0.21	0.095	0.073	14/14	0.035	3.0	0.85	0.91
RM 2.1-2.2 West: Trotsky Inlet	20/22	0.0060	4.7	0.47	1.00	14/14	0.057	1.0	0.40	0.32
RM 2.2-3.4 West: Riverside Drive	32/32	0.011	4.2	0.41	0.93	31/34	0.014	3.0	0.53	0.66
RM 3.4-3.8 West: Terminal 117	32/32	0.015	11	0.49	1.9	10/11	0.030	462	43	139
RM 3.8-4.2 West: Sea King Industrial Park	8/11	0.0057	0.15	0.041	0.054	16/19	0.013	0.99	0.29	0.35
RM 4.2-4.8 West: Restoration Areas	22/26	0.0061	0.37	0.072	0.091	3/3	0.018	0.11	0.050	0.054
LDW Main Navigation Channel	47/48	0.0061	0.65	0.21	0.17	--	--	--	--	--

Notes:

Exceeds 1 mg TEQ/kg
Exceeds 3 mg TEQ/kg
Exceeds 30 mg TEQ/kg
Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-6
Summary Statistics for BEHP by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	11/15	0.028	0.85	0.42	0.27	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	13/18	0.026	1.2	0.42	0.37	132/132	0.13	200	15	29
RM 0.9-1.0 East: Slip 1	12/15	0.015	0.55	0.21	0.16	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	5/7	0.055	0.38	0.21	0.13	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	24/28	0.010	0.612	0.16	0.16	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	16/19	0.014	0.71	0.20	0.19	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	11/15	0.059	0.59	0.23	0.16	14/14	0.16	24	5.2	6.1
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	24/32	0.011	37	1.3	0.052	19/19	3.0	210	40	47
RM 2.8 East: Slip 4	26/27	0.16	5.0	1.5	1.2	63/64	0.059	232	17	35
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	18/18	0.094	0.61	0.26	0.15	7/7	0.59	44	10	16
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	9/10	0.017	1.2	0.45	0.41	39/41	0.034	23	6.4	6.2
RM 3.9-4.3 East: Slip 6	41/55	0.022	2.1	0.32	0.43	2/3	0.080	41	15	23
RM 4.3-4.9 East: Boeing Developmental Center	16/18	0.060	0.24	0.11	0.053	1/1	6.3	6.3	6.3	--
RM 4.9 East: Norfolk CSO/SD	8/15	0.011	2.0	0.29	0.55	39/40	0.011	59	9.6	12
RM 0.0-1.0 West: Spokane St to Kellogg Island	34/40	0.0075	1.7	0.18	0.29	16/16	0.16	37	4.8	9.3
RM 1.0-1.3 West: Kellogg Island to Lafarge	9/12	0.034	0.45	0.19	0.14	4/4	1.1	3.6	2.9	1.2
RM 1.3-1.6 West: Glacier Bay	13/17	0.090	1.6	0.32	0.36	9/9	0.90	65	12.0	20
RM 1.6-2.1 West: Terminal 115	16/24	0.044	4.9	0.47	1.0	11/12	0.19	13	4.3	4.2
RM 2.1 West: 1st Avenue S SD	7/7	0.012	2.5	0.42	0.92	14/14	0.22	26	9.4	8.8
RM 2.1-2.2 West: Trotsky Inlet	12/20	0.0090	17	1.5	4.0	14/14	1.6	39	10	10
RM 2.2-3.4 West: Riverside Drive	21/31	0.010	2.6	0.26	0.53	34/34	0.017	1,400	61	248
RM 3.4-3.8 West: Terminal 117	28/32	0.0095	0.34	0.12	0.066	8/8	1.6	74	23	28
RM 3.8-4.2 West: Sea King Industrial Park	8/11	0.0095	0.27	0.051	0.079	17/19	0.020	20	2.3	4.8
RM 4.2-4.8 West: Restoration Areas	6/25	0.012	0.10	0.037	0.027	1/3	0.015	1.5	0.52	0.85
LDW Main Navigation Channel	25/48	0.010	0.95	0.24	0.19	--	--	--	--	--

Notes:

Exceeds LAET (1.3 mg/kg DW)

Exceeds 2LAET (1.9 mg/kg DW)

Exceeds 10x 2LAET (19 mg/kg DW)

Exceeds 100x 2LAET (190 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-7
Summary Statistics for BBP by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	10/16	0.0032	0.066	0.026	0.022	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	7/18	0.00065	0.12	0.030	0.029	100/132	0.0095	150	3.4	16
RM 0.9-1.0 East: Slip 1	12/15	0.0033	0.050	0.025	0.014	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	5/7	0.0033	0.050	0.026	0.015	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	17/38	0.0015	0.033	0.012	0.011	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	13/19	0.0015	0.072	0.020	0.019	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	11/15	0.0032	0.057	0.021	0.016	9/14	0.010	3.0	0.39	0.77
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	30/32	0.0024	1.6	0.070	0.019	19/19	0.66	12	3.5	2.8
RM 2.8 East: Slip 4	24/27	0.011	0.34	0.091	0.093	35/64	0.0095	4.1	0.65	0.95
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	15/18	0.0070	0.14	0.052	0.035	6/7	0.029	2.6	0.66	0.89
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	8/10	0.024	0.22	0.095	0.070	34/41	0.010	7.9	0.89	1.4
RM 3.9-4.3 East: Slip 6	39/45	0.0032	2.2	0.11	0.33	2/3	0.031	2.6	0.93	1.5
RM 4.3-4.9 East: Boeing Developmental Center	15/18	0.0028	0.044	0.0093	0.0096	1/1	0.38	0.38	0.38	--
RM 4.9 East: Norfolk CSO/SD	8/15	0.0023	0.12	0.020	0.031	17/40	0.010	4.4	0.54	0.91
RM 0.0-1.0 West: Spokane St to Kellogg Island	22/40	0.0023	0.22	0.018	0.036	13/16	0.016	19	1.6	4.7
RM 1.0-1.3 West: Kellogg Island to Lafarge	9/12	0.0033	0.065	0.021	0.018	4/4	0.060	0.51	0.38	0.22
RM 1.3-1.6 West: Glacier Bay	8/17	0.0033	0.075	0.029	0.025	9/9	0.14	1.8	0.78	0.7
RM 1.6-2.1 West: Terminal 115	16/24	0.0033	0.13	0.030	0.035	7/12	0.020	7.5	0.96	2.1
RM 2.1 West: 1st Avenue S SD	6/7	0.0024	0.14	0.040	0.052	7/14	0.011	3.3	0.63	1.1
RM 2.1-2.2 West: Trotsky Inlet	7/20	0.0023	3.3	0.24	0.76	12/14	0.095	11	1.3	2.9
RM 2.2-3.4 West: Riverside Drive	14/31	0.0032	0.20	0.018	0.039	23/34	0.010	73	2.7	13
RM 3.4-3.8 West: Terminal 117	18/32	0.0033	0.071	0.022	0.019	4/8	0.12	7.4	2.2	3.1
RM 3.8-4.2 West: Sea King Industrial Park	9/11	0.0032	0.035	0.012	0.0099	12/19	0.0095	25	1.6	5.7
RM 4.2-4.8 West: Restoration Areas	12/25	0.0024	0.024	0.0058	0.0055	0/3	--	--	--	--
LDW Main Navigation Channel	24/48	0.00080	0.35	0.025	0.050	--	--	--	--	--

Notes:

Exceeds LAET (0.063 mg/kg DW)

Exceeds 2LAET (0.9 mg/kg DW)

Exceeds 10x 2LAET (9 mg/kg DW)

Exceeds 100x 2LAET (90 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-8
Summary Statistics for Di-n-Octyl Phthalate by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	--	--	--	--	--	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	--	--	--	--	--	85/132	0.019	16	1.0	2.0
RM 0.9-1.0 East: Slip 1	0/7	--	--	--	--	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	0/4	--	--	--	--	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	1/11	0.018	0.021	0.019	0.000874	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	2/8	0.016	0.14	0.033	0.043	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	0/6	--	--	--	--	9/14	0.041	2.9	0.43	0.74
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	3/23	0.021	0.74	0.042	0.0056	15/19	0.029	23	2.9	5.1
RM 2.8 East: Slip 4	19/20	0.030	0.43	0.17	0.11	25/61	0.019	34	2.8	6.7
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	--	--	--	--	--	5/7	0.058	3.9	0.78	1.4
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	--	--	--	--	--	25/41	0.020	4.4	0.79	1.1
RM 3.9-4.3 East: Slip 6	2/6	0.0078	0.020	0.016	0.0050	0/3	--	--	--	--
RM 4.3-4.9 East: Boeing Developmental Center	1/13	0.011	0.020	0.019	0.0023	1/1	7.3	7.3	7.3	--
RM 4.9 East: Norfolk CSO/SD	0/7	--	--	--	--	13/40	0.010	4.5	0.45	0.86
RM 0.0-1.0 West: Spokane St to Kellogg Island	0/14	--	--	--	--	6/16	0.020	3.7	0.37	0.91
RM 1.0-1.3 West: Kellogg Island to Lafarge	1/5	0.008	0.014	0.010	0.0026	4/4	0.031	0.34	0.20	0.13
RM 1.3-1.6 West: Glacier Bay	--	--	--	--	--	7/9	0.056	4.3	0.75	1.4
RM 1.6-2.1 West: Terminal 115	0/10	--	--	--	--	3/12	0.054	15	1.4	4.3
RM 2.1 West: 1st Avenue S SD	0/4	0.019	0.020	0.020	0.000577	3/14	0.020	1.8	0.43	0.51
RM 2.1-2.2 West: Trotsky Inlet	0/5	--	--	--	--	10/14	0.087	18	2.3	4.7
RM 2.2-3.4 West: Riverside Drive	1/11	0.018	0.031	0.020	0.0036	11/34	0.020	4.9	0.40	0.87
RM 3.4-3.8 West: Terminal 117	2/12	0.012	0.11	0.025	0.027	3/8	0.021	7.0	1.7	2.7
RM 3.8-4.2 West: Sea King Industrial Park	1/6	0.011	0.017	0.015	0.0022	4/19	0.019	5.7	0.45	1.3
RM 4.2-4.8 West: Restoration Areas	0/11	--	--	--	--	0/3	--	--	--	--
LDW Main Navigation Channel	--	--	--	--	--	--	--	--	--	--

Notes:

Exceeds LAET (6.2 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-9
Summary Statistics for Phenol by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	5/16	0.0095	0.22	0.057	0.060	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	8/18	0.0027	1.3	0.094	0.30	60/132	0.0095	13	0.49	1.4
RM 0.9-1.0 East: Slip 1	8/15	0.010	0.064	0.032	0.014	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	5/7	0.029	0.18	0.077	0.064	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	16/28	0.0040	0.17	0.031	0.037	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	12/19	0.0095	0.28	0.052	0.062	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	9/15	0.010	0.28	0.097	0.077	1/14	0.010	0.28	0.077	0.068
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	28/32	0.0095	0.37	0.056	0.036	8/19	0.055	1.4	0.38	0.39
RM 2.8 East: Slip 4	13/27	0.014	0.15	0.051	0.042	7/57	0.0095	1.7	0.18	0.28
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	15/18	0.028	2.8	0.54	0.66	3/7	0.029	3.5	0.63	1.3
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	1/10	0.010	0.11	0.054	0.031	27/41	0.010	0.50	0.19	0.13
RM 3.9-4.3 East: Slip 6	18/55	0.0037	1.4	0.086	0.26	0/3	--	--	--	--
RM 4.3-4.9 East: Boeing Developmental Center	12/18	0.0095	0.050	0.019	0.011	1/1	0.49	0.49	0.49	--
RM 4.9 East: Norfolk CSO/SD	4/15	0.0070	0.080	0.027	0.025	12/40	0.0010	1.1	0.16	0.20
RM 0.0-1.0 West: Spokane St to Kellogg Island	19/40	0.0090	0.60	0.086	0.15	3/16	0.0095	0.23	0.065	0.059
RM 1.0-1.3 West: Kellogg Island to Lafarge	4/12	0.0080	0.058	0.030	0.020	4/4	0.10	0.64	0.34	0.22
RM 1.3-1.6 West: Glacier Bay	7/17	0.012	0.37	0.11	0.11	8/10	0.041	1.5	0.53	0.57
RM 1.6-2.1 West: Terminal 115	10/24	0.0055	0.20	0.051	0.048	3/12	0.020	0.35	0.74	2.1
RM 2.1 West: 1st Avenue S SD	3/7	0.0095	0.063	0.028	0.024	0/14	--	--	--	--
RM 2.1-2.2 West: Trotsky Inlet	7/20	0.0090	3.1	0.23	0.70	3/14	0.030	0.69	0.20	0.21
RM 2.2-3.4 West: Riverside Drive	14/31	0.0065	0.14	0.041	0.036	8/34	0.010	9.3	0.39	1.6
RM 3.4-3.8 West: Terminal 117	14/32	0.0095	1.9	0.14	0.41	1/8	0.11	7.0	1.1	2.4
RM 3.8-4.2 West: Sea King Industrial Park	2/11	0.0080	0.034	0.012	0.0075	4/19	0.0095	0.91	0.14	0.26
RM 4.2-4.8 West: Restoration Areas	8/25	0.0050	1.1	0.059	0.22	1/3	0.010	0.058	0.026	0.028
LDW Main Navigation Channel	12/48	0.0026	0.21	0.033	0.046	--	--	--	--	--

Notes:

Exceeds SQS (0.42 mg/kg DW)

Exceeds CSL (1.2 mg/kg DW)

Exceeds 10x CSL (12 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-10
Summary Statistics for Dioxins/Furans by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (ng TEQ/kg)	Maximum Conc'n (ng TEQ/kg	Average Conc'n (ng TEQ/kg)	Standard Deviation	Frequency of Detection	Minimum Conc'n (ng TEQ/kg)	Maximum Conc'n (ng TEQ/kg)	Average Conc'n (ng TEQ/kg)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	3/3	2.0	14	8.4	6.1	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	4/4	4.3	14	7.6	4.4	20/20	2.1	93	41	30
RM 0.9-1.0 East: Slip 1	3/3	7.2	23	17	8.9	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	3/3	7.2	12	10	2.5	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	2/2	9.0	11	9.9	1.3	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	6/6	0.97	13	7.3	4.1	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	2/2	5.6	16	11	7.3	--	--	--	--	--
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	5/5	0.56	33	9.5	3.1	--	--	--	--	--
RM 2.8 East: Slip 4	7/7	7.9	41	21	12	13/13	6.6	274	58	68
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	4/4	2.9	101	31	47	--	--	--	--	--
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	--	--	--	--	--	6/6	0.51	60	28	22
RM 3.9-4.3 East: Slip 6	14/14	4.4	21	9.4	4.6	1/1	1.2	1.2	1.2	--
RM 4.3-4.9 East: Boeing Developmental Center	4/4	0.34	3.1	1.9	1.2	1/1	20	20	20	--
RM 4.9 East: Norfolk CSO/SD	2/2	2.5	4.7	3.6	1.6	2/2	22	53	37	22
RM 0.0-1.0 West: Spokane St to Kellogg Island	6/6	1.6	75	18	28	1/1	14	14	14	--
RM 1.0-1.3 West: Kellogg Island to Lafarge	6/6	5.2	27	15	8.1	--	--	--	--	--
RM 1.3-1.6 West: Glacier Bay	3/3	463	2,100	1,041	915	--	--	--	--	--
RM 1.6-2.1 West: Terminal 115	13/13	3.2	49	12	13	2/2	67	73	70	4.1
RM 2.1 West: 1st Avenue S SD	--	--	--	--	--	2/2	0.51	12	6.4	8.3
RM 2.1-2.2 West: Trotsky Inlet	5/5	0.55	412	87	181	--	--	--	--	--
RM 2.2-3.4 West: Riverside Drive	3/3	1.9	36	14	19	2/2	7.2	10	8.7	2.2
RM 3.4-3.8 West: Terminal 117	12/12	1.1	9.4	4.3	2.4	--	--	--	--	--
RM 3.8-4.2 West: Sea King Industrial Park	2/2	2.4	16	8.9	9.3	5/5	0.35	8.9	2.9	3.4
RM 4.2-4.8 West: Restoration Areas	5/5	0.29	3.8	1.5	1.4	3/3	0.66	3.9	1.8	1.9
LDW Main Navigation Channel	13/13	1.5	124	15	33	--	--	--	--	--

Notes:

Exceeds 25 ng TEQ/kg

Exceeds 50 ng TEQ/kg

Exceeds 500 ng TEQ/kg

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-11
Summary Statistics for Mercury by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	0.049	0.59	0.32	0.17	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/18	0.022	0.47	0.17	0.13	87/136	0.010	21	0.34	1.8
RM 0.9-1.0 East: Slip 1	15/15	0.059	0.88	0.30	0.20	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	0.14	1.1	0.32	0.34	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	19/20	0.035	0.41	0.16	0.10	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	18/18	0.021	0.34	0.13	0.084	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	0.080	0.30	0.15	0.066	13/14	0.00005	3.4	0.48	0.89
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	29/32	0.015	0.62	0.13	0.078	18/19	0.24	4.3	1.0	1.0
RM 2.8 East: Slip 4	53/57	0.025	0.41	0.18	0.084	274/299	0.010	173	1.6	11
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	19/19	0.090	0.53	0.18	0.11	7/7	0.050	7.7	1.2	2.9
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	8/10	0.030	0.16	0.093	0.040	35/42	0.010	1.2	0.17	0.22
RM 3.9-4.3 East: Slip 6	61/66	0.025	6.8	0.25	0.82	2/3	0.010	0.17	0.10	0.082
RM 4.3-4.9 East: Boeing Developmental Center	16/18	0.035	0.17	0.091	0.036	1/1	0.21	0.21	0.21	--
RM 4.9 East: Norfolk CSO/SD	11/15	0.015	0.15	0.060	0.036	22/41	0.015	0.33	0.084	0.079
RM 0.0-1.0 West: Spokane St to Kellogg Island	33/40	0.015	1.8	0.18	0.30	12/19	0.010	0.22	0.080	0.066
RM 1.0-1.3 West: Kellogg Island to Lafarge	11/12	0.030	0.32	0.21	0.092	2/4	0.020	0.070	0.039	0.023
RM 1.3-1.6 West: Glacier Bay	17/17	0.051	0.79	0.26	0.16	9/10	0.045	9.4	1.1	2.9
RM 1.6-2.1 West: Terminal 115	24/24	0.030	0.40	0.17	0.11	8/12	0.015	0.36	0.13	0.14
RM 2.1 West: 1st Avenue S SD	2/7	0.010	0.14	0.040	0.046	11/13	0.010	0.42	0.13	0.12
RM 2.1-2.2 West: Trotsky Inlet	14/20	0.015	247	16	56	13/14	0.040	48	3.6	13
RM 2.2-3.4 West: Riverside Drive	22/31	0.015	6.5	0.30	1.2	21/33	0.010	3.8	0.26	0.67
RM 3.4-3.8 West: Terminal 117	26/32	0.015	0.38	0.092	0.082	6/8	0.025	0.33	0.13	0.12
RM 3.8-4.2 West: Sea King Industrial Park	4/11	0.015	0.10	0.041	0.035	10/18	0.010	0.10	0.046	0.033
RM 4.2-4.8 West: Restoration Areas	15/25	0.010	0.16	0.063	0.039	2/3	0.010	0.11	0.053	0.051
LDW Main Navigation Channel	47/48	0.030	1.6	0.26	0.24	--	--	--	--	--

Notes:

Exceeds SQS (0.41 mg/kg DW)

Exceeds CSL (0.59 mg/kg DW)

Exceeds 10x CSL (5.9 mg/kg DW)

Exceeds 100x CSL (59 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-12
Summary Statistics for Arsenic by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	5.3	123	24	32	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	17/19	1.6	15	10	3.8	64/135	2.3	480	13	41
RM 0.9-1.0 East: Slip 1	15/15	12	725	73	182	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	9.5	31	19	6.4	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	1.2	30	11	7.5	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	18/19	2.4	21	11	5.0	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	14	81	27	21	12/14	0.10	1,420	144	369
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	30/32	3.5	61	16	11	19/19	6.3	208	27	46
RM 2.8 East: Slip 4	27/27	6.2	30	18	5.1	189/298	3.0	150	16	19
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	21/21	7.9	37	19	7.7	5/7	3.0	21	9.0	5.9
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	8.2	1,100	172	357	40/42	3.5	90	18	17
RM 3.9-4.3 East: Slip 6	66/66	4.5	33	13	5.8	1/3	4.0	13	7.4	5.0
RM 4.3-4.9 East: Boeing Developmental Center	18/18	5.9	20	11	3.8	0/1	--	--	--	--
RM 4.9 East: Norfolk CSO/SD	14/15	1.9	11	7.3	2.9	20/40	3.0	120	12.0	19.0
RM 0.0-1.0 West: Spokane St to Kellogg Island	41/41	3.1	36	13	8.0	7/19	3.5	30	9.5	6.9
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	3.1	86	31	25	2/4	15	30	20	7.1
RM 1.3-1.6 West: Glacier Bay	17/17	17	807	107	187	9/10	5.7	150	36	44
RM 1.6-2.1 West: Terminal 115	25/25	5.1	26	17	5.1	8/12	3.5	55	19	16
RM 2.1 West: 1st Avenue S SD	6/7	3.0	15	7.1	3.9	7/13	3.0	24	10	7.1
RM 2.1-2.2 West: Trotsky Inlet	18/22	2.6	49	11	12	11/14	4.0	50	18	16
RM 2.2-3.4 West: Riverside Drive	31/32	3.9	20	11	4.7	24/33	3.0	50	14	11
RM 3.4-3.8 West: Terminal 117	22/30	3.5	22	11	5.3	7/10	5.0	20	11	4.8
RM 3.8-4.2 West: Sea King Industrial Park	11/11	3.5	10	8.1	2.2	12/18	3.0	30	9.2	6.8
RM 4.2-4.8 West: Restoration Areas	24/26	3.0	16	7.8	2.7	0/3	--	--	--	--
LDW Main Navigation Channel	48/48	4.2	19	11	3.3	--	--	--	--	--

Notes:

Exceeds SQS (57 mg/kg DW)

Exceeds CSL (93 mg/kg DW)

Exceeds 10x CSL (930 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-13
Summary Statistics for Cadmium by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	13/16	0.071	3.8	0.76	0.87	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	15/18	0.065	1.2	0.50	0.28	7/7	1.0	5.8	2.5	1.7
RM 0.9-1.0 East: Slip 1	14/15	0.20	3.2	0.99	0.74	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	0.40	1.1	0.63	0.23	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	24/28	0.030	1.3	0.41	0.30	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	13/19	0.070	0.78	0.36	0.22	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	13/15	0.20	1.0	0.51	0.20	--	--	--	--	--
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	26/32	0.15	4.0	0.50	0.15	--	--	--	--	--
RM 2.8 East: Slip 4	27/27	0.19	3.1	1.4	0.75	243/244	0.50	110	14	18
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	19/21	0.25	3.6	1.2	0.71	--	--	--	--	--
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	8/10	0.15	1.6	0.75	0.53	37/37	0.80	154	18	31
RM 3.9-4.3 East: Slip 6	30/59	0.15	3.3	0.50	0.53	--	--	--	--	--
RM 4.3-4.9 East: Boeing Developmental Center	13/18	0.15	0.50	0.36	0.12	1/1	3.7	3.7	3.7	--
RM 4.9 East: Norfolk CSO/SD	3/15	0.11	0.51	0.20	0.11	2/2	1.2	5.5	3.4	3.0
RM 0.0-1.0 West: Spokane St to Kellogg Island	25/40	0.050	1.0	0.32	0.23	--	--	--	--	--
RM 1.0-1.3 West: Kellogg Island to Lafarge	10/12	0.10	1.1	0.55	0.28	--	--	--	--	--
RM 1.3-1.6 West: Glacier Bay	16/17	0.20	3.0	0.75	0.62	--	--	--	--	--
RM 1.6-2.1 West: Terminal 115	15/24	0.15	0.80	0.42	0.21	1/1	0.97	1.0	0.97	--
RM 2.1 West: 1st Avenue S SD	3/7	0.10	0.60	0.23	0.20	--	--	--	--	--
RM 2.1-2.2 West: Trotsky Inlet	9/20	0.10	36	2.4	8.1	--	--	--	--	--
RM 2.2-3.4 West: Riverside Drive	14/31	0.060	1.1	0.29	0.21	--	--	--	--	--
RM 3.4-3.8 West: Terminal 117	10/30	0.15	1.0	0.25	0.19	--	--	--	--	--
RM 3.8-4.2 West: Sea King Industrial Park	2/11	0.15	0.40	0.20	0.084	--	--	--	--	--
RM 4.2-4.8 West: Restoration Areas	6/25	0.068	0.80	0.22	0.16	--	--	--	--	--
LDW Main Navigation Channel	41/48	0.10	3.5	0.56	0.61	--	--	--	--	--

Notes:

Exceeds SQS (5.1 mg/kg DW)

Exceeds CSL (6.7 mg/kg DW)

Exceeds 10x CSL (67 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-14
Summary Statistics for Chromium by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	11	44	31	11	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/18	16	64	33	12	7/7	62	93	74	12
RM 0.9-1.0 East: Slip 1	15/15	23	55	37	7.0	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	28	40	35	4.2	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	4.8	45	24	11	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	10	36	25	6.9	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	24	63	34	8.7	--	--	--	--	--
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	11	88	30	11	--	--	--	--	--
RM 2.8 East: Slip 4	27/27	12	60	41	12	244/244	12	629	123	76
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	21/21	27	584	120	140	--	--	--	--	--
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	26	174	58	45	37/37	29	821	161	153
RM 3.9-4.3 East: Slip 6	66/66	9.2	200	30	30	--	--	--	--	--
RM 4.3-4.9 East: Boeing Developmental Center	18/18	14	31	25	4.0	1/1	122	122	122	--
RM 4.9 East: Norfolk CSO/SD	15/15	13	28	20	5.3	1/1	83	83	83	--
RM 0.0-1.0 West: Spokane St to Kellogg Island	40/40	9.1	61	26	13	--	--	--	--	--
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	9.9	39	32	8.2	--	--	--	--	--
RM 1.3-1.6 West: Glacier Bay	17/17	20	153	47	29	--	--	--	--	--
RM 1.6-2.1 West: Terminal 115	24/24	21	85	34	12	1/1	68	68	68	--
RM 2.1 West: 1st Avenue S SD	7/7	12	32	19	7.4	--	--	--	--	--
RM 2.1-2.2 West: Trotsky Inlet	20/20	11	1680	132	381	--	--	--	--	--
RM 2.2-3.4 West: Riverside Drive	31/31	12	61	25	10	--	--	--	--	--
RM 3.4-3.8 West: Terminal 117	30/30	15	160	29	26	--	--	--	--	--
RM 3.8-4.2 West: Sea King Industrial Park	11/11	14	31	21	5.7	--	--	--	--	--
RM 4.2-4.8 West: Restoration Areas	25/25	13	28	22	4.9	--	--	--	--	--
LDW Main Navigation Channel	48/48	11	89	31	14	--	--	--	--	--

Notes:

Exceeds SQS (260 mg/kg DW)

Exceeds CSL (270 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-15
Summary Statistics for Copper by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	15	137	83	37	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/18	37	158	74	31	136/136	13	2,670	211	338
RM 0.9-1.0 East: Slip 1	15/15	52	495	133	112	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	55	107	70	18	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	12	195	56	37	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	17	107	52	24	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	53	209	91	39	13/13	86	831	282	206
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	11	138	48	15	19/19	193	7,990	1,368	1,835
RM 2.8 East: Slip 4	27/27	21	127	77	25	298/298	12	6,320	291	540
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	21/21	46	454	102	94	7/7	76	158	125	31
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	35	100	57	21	42/42	12	606	142	111
RM 3.9-4.3 East: Slip 6	66/66	23	290	61	47	3/3	78	429	200	199
RM 4.3-4.9 East: Boeing Developmental Center	18/18	19	49	34	8	1/1	168	168	168	--
RM 4.9 East: Norfolk CSO/SD	15/15	12	66	29	15	41/41	18	3,960	189	607
RM 0.0-1.0 West: Spokane St to Kellogg Island	40/40	15	172	54	36	18/18	25	350	101	89
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	16	169	101	39	4/4	234	1,730	953	614
RM 1.3-1.6 West: Glacier Bay	17/17	88	1,420	411	455	10/10	99	1,820	613	566
RM 1.6-2.1 West: Terminal 115	24/24	33	171	68	31	12/12	29	697	140	186
RM 2.1 West: 1st Avenue S SD	7/7	13	44	24	11	13/13	20	180	93	56
RM 2.1-2.2 West: Trotsky Inlet	20/20	11	1,090	101	235	14/14	91	806	214	190
RM 2.2-3.4 West: Riverside Drive	31/31	17	180	49	33	33/33	8.9	701	166	171
RM 3.4-3.8 West: Terminal 117	30/30	15	334	48	56	10/10	51	284	171	67
RM 3.8-4.2 West: Sea King Industrial Park	11/11	15	49	25	12	18/18	8.6	297	61	73
RM 4.2-4.8 West: Restoration Areas	25/25	12	47	28	9	3/3	12	24	20	6.5
LDW Main Navigation Channel	48/48	14	110	65	24	--	--	--	--	--

Notes:

Exceeds SQS (390 mg/kg DW)
Exceeds CSL (390 mg/kg DW)
Exceeds 10x CSL (3,900 mg/kg DW)
Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-16
Summary Statistics for Lead by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	18	573	107	139	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/18	5.5	148	43	37	136/136	6.0	1,300	163	226
RM 0.9-1.0 East: Slip 1	15/15	26	437	81	106	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	21	79	41	21	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	9.0	134	41	30	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	9.0	170	36	35	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	19	156	58	39	14/14	0.40	977	294	286
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	7.0	142	31	9.2	19/19	174	2,240	723	584
RM 2.8 East: Slip 4	27/27	18	471	81	89	296/298	6.0	2,780	227	219
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	21/21	26	870	260	259	7/7	64	281	162	86
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	28	152	81	46	42/42	5.0	568	175	135
RM 3.9-4.3 East: Slip 6	66/66	6.3	12,300	235	1,510	3/3	34	232	125	100
RM 4.3-4.9 East: Boeing Developmental Center	18/18	8.0	21	13	3.2	1/1	173	173	173	--
RM 4.9 East: Norfolk CSO/SD	15/15	5.7	57	16	13	41/41	20	700	108	122
RM 0.0-1.0 West: Spokane St to Kellogg Island	40/40	4.0	400	56	66	19/19	18	203	71	49
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	7.0	166	67	45	3/4	5.0	120	64	47
RM 1.3-1.6 West: Glacier Bay	17/17	45	780	148	175	10/10	38	1,760	388	499
RM 1.6-2.1 West: Terminal 115	24/24	14	84	36	18	12/12	11	436	93	119
RM 2.1 West: 1st Avenue S SD	7/7	9.0	92	39	30	13/13	8.0	254	92	90
RM 2.1-2.2 West: Trotsky Inlet	20/20	5.0	10,400	804	2,450	14/14	40	3,690	454	1,010
RM 2.2-3.4 West: Riverside Drive	31/31	11	72	32	17	33/33	4.0	719	151	173
RM 3.4-3.8 West: Terminal 117	30/30	5.0	110	28	19	8/8	22	428	174	131
RM 3.8-4.2 West: Sea King Industrial Park	11/11	4.0	21	12	6	18/18	3.0	150	49	44.7
RM 4.2-4.8 West: Restoration Areas	25/25	3.0	95	16	18	3/3	8.0	34	20	13
LDW Main Navigation Channel	48/48	5.0	103	43	26	--	--	--	--	--

Notes:

Exceeds SQS (450 mg/kg DW)

Exceeds CSL (530 mg/kg DW)

Exceeds 10x CSL (5,300 mg/kg DW)

Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-17
Summary Statistics for Zinc by Source Control Area

Source Control Area	Surface Sediment					Storm Drain Solids				
	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation	Frequency of Detection	Minimum Conc'n (mg/kg DW)	Maximum Conc'n (mg/kg DW)	Average Conc'n (mg/kg DW)	Standard Deviation
RM 0.0-0.1 East: Spokane Street to Ash Grove Cement	16/16	37	553	182	123	--	--	--	--	--
RM 0.1-0.9 East: Duwamish/Diagonal Way	18/18	37	185	114	43	136/136	44	3,940	549	566
RM 0.9-1.0 East: Slip 1	15/15	88	2,080	353	528	--	--	--	--	--
RM 1.0-1.2 East: KC Lease Parcels	7/7	112	157	129	18	--	--	--	--	--
RM 1.2-1.7 East: St Gobain to Glacier NW	28/28	19	1,500	153	269	--	--	--	--	--
RM 1.7-2.0 East: Slip 2 to Slip 3	19/19	41	195	108	44	--	--	--	--	--
RM 2.0-2.3 East: Slip 3 to Seattle Boiler Works	15/15	106	919	215	208	13/13	247	4,000	991	942
RM 2.3-2.8 East: Seattle Boiler Works to Slip 4	32/32	39	1,180	171	52	19/19	763	13,300	3,418	3,227
RM 2.8 East: Slip 4	27/27	60	470	210	97	298/298	33	22,900	1,480	2,090
RM 2.8-3.7 East: Boeing Plant 2 to Jorgensen Forge	21/21	115	1,690	354	412	7/7	219	1,640	683	495
RM 3.7-3.9 East: Boeing Isaacson/Central KCIA	10/10	75	343	166	87	42/42	32	6,640	1,270	1,180
RM 3.9-4.3 East: Slip 6	66/66	36	1,000	124	123	3/3	596	740	648	80
RM 4.3-4.9 East: Boeing Developmental Center	18/18	50	98	79	13	1/1	1,520	1,520	1,520	--
RM 4.9 East: Norfolk CSO/SD	13/13	43	90	65	15	41/41	73	9,980	752	1,553
RM 0.0-1.0 West: Spokane St to Kellogg Island	40/40	31	478	132	95	18/18	80	3,740	523	944
RM 1.0-1.3 West: Kellogg Island to Lafarge	12/12	33	305	185	81	4/4	167	1,360	767	487
RM 1.3-1.6 West: Glacier Bay	17/17	150	2,830	516	641	10/10	314	3,290	1,456	1,120
RM 1.6-2.1 West: Terminal 115	24/24	79	297	143	57	12/12	78	1,720	604	574
RM 2.1 West: 1st Avenue S SD	7/7	44	130	69	31	13/13	108	3,770	679	968
RM 2.1-2.2 West: Trotsky Inlet	20/20	31	4,580	448	1,080	14/14	311	2,950	693	681
RM 2.2-3.4 West: Riverside Drive	31/31	52	348	110	70	33/33	50	4,150	714	905
RM 3.4-3.8 West: Terminal 117	30/30	38	1,440	136	247	8/8	237	1,040	722	254
RM 3.8-4.2 West: Sea King Industrial Park	11/11	38	113	69	22	18/18	38	2,530	532	666
RM 4.2-4.8 West: Restoration Areas	25/25	45	211	73	32	3/3	60	65	63	2.9
LDW Main Navigation Channel	48/48	42	220	118	39	--	--	--	--	--

Notes:

Exceeds SQS (410 mg/kg DW)
Exceeds CSL (960 mg/kg DW)
Exceeds 10x CSL (9,600 mg/kg DW)
Less than three samples collected

Frequency of Detection = number of detections / number of samples collected

Table 3-18
Summary Statistics - RM 0.0-0.1 East (Spokane Street to Ash Grove Cement)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	16	16	2	1	5.3	123	24
			SD Solid	0	--	--	--	--	--	--
Cadmium	5.1	6.7	Sediment	16	13	0	0	0.071	3.8	0.76
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	16	16	0	0	10.5	44	31
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	16	16	0	0	15	137	83
			SD Solid	0	--	--	--	--	--	--
Lead	450	530	Sediment	16	16	1	1	18	573	107
			SD Solid	0	--	--	--	--	--	--
Mercury	0.41	0.59	Sediment	16	16	5	1	0.049	0.59	0.32
			SD Solid	0	--	--	--	--	--	--
Zinc	410	960	Sediment	16	16	1	0	37	553	182
			SD Solid	0	--	--	--	--	--	--
Total LPAH	5.2	13	Sediment	16	16	0	0	0.071	2.3	0.75
			SD Solid	0	--	--	--	--	--	--
Total HPAH	12	17	Sediment	16	16	2	0	0.57	12	5.2
			SD Solid	0	--	--	--	--	--	--
Total cPAH	1.0	3.0	Sediment	16	16	1	0	0.053	2.1	0.60
			SD Solid	0	--	--	--	--	--	--
BBP	0.063	0.90	Sediment	16	10	1	0	0.0032	0.066	0.026
			SD Solid	0	--	--	--	--	--	--
BEHP	1.3	1.9	Sediment	15	11	0	0	0.028	0.85	0.42
			SD Solid	0	--	--	--	--	--	--
Di-n-Octyl phthalate	6.2	6.2	Sediment	0	--	--	--	--	--	--
			SD Solid	0	--	--	--	--	--	--
Phenol	0.42	1.2	Sediment	16	5	0	0	0.0095	0.22	0.057
			SD Solid	0	--	--	--	--	--	--
Total PCBs	0.13	1.0	Sediment	16	16	14	1	0.061	1.9	0.33
			SD Solid	0	--	--	--	--	--	--
Dioxins/Furans	25	50	Sediment	3	3	0	0	2.0	14	8.4
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-19
Summary Statistics - RM 0.1-0.9 East (Duwamish/Diagonal Way)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	19	17	0	0	1.6	15	10
			SD Solid	135	64	2	1	2.3	480	13
Cadmium	5.1	6.7	Sediment	18	15	0	0	0.065	1.2	0.50
			SD Solid	7	7	0	0	1.0	5.8	2.5
Chromium	260	270	Sediment	18	18	0	0	16	64	33
			SD Solid	7	7	0	0	62	93	74
Copper	390	390	Sediment	18	18	0	0	37	158	74
			SD Solid	136	136	10	10	13	2,670	211
Lead	450	530	Sediment	18	18	0	0	5.5	148	43
			SD Solid	136	136	9	6	6.0	1,300	163
Mercury	0.41	0.59	Sediment	18	18	1	0	0.022	0.47	0.17
			SD Solid	136	87	13	10	0.010	21	0.34
Zinc	410	960	Sediment	18	18	0	0	37	185	114
			SD Solid	136	136	65	19	44	3,940	549
Total LPAH	5.2	13	Sediment	19	18	0	0	0.0024	0.84	0.20
			SD Solid	136	126	13	5	0.0095	80	3.0
Total HPAH	12	17	Sediment	19	18	0	0	0.0048	3.6	1.3
			SD Solid	136	134	16	11	0.0095	262	8.8
cPAH	1.0	3.0	Sediment	19	18	0	0	0.0034	0.42	0.15
			SD Solid	136	131	27	6	0.0070	35	1.0
BBP	0.063	0.90	Sediment	18	7	1	0	0.00065	0.12	0.030
			SD Solid	132	100	113	26	0.0095	150	3.4
BEHP	1.3	1.9	Sediment	18	13	0	0	0.026	1.2	0.42
			SD Solid	132	132	107	100	0.13	200	15
Di-n-Octyl phthalate	6.2	6.2	Sediment	0	--	--	--	--	--	--
			SD Solid	132	85	4	0	0.019	16	1.0
Phenol	0.42	1.2	Sediment	18	8	1	1	0.0027	1.3	0.094
			SD Solid	132	60	33	8	0.0095	13	0.49
Total PCBs	0.13	1.0	Sediment	19	18	4	0	0.00040	0.82	0.14
			SD Solid	147	112	67	19	0.0090	2,200	28
Dioxins/Furans	25	50	Sediment	4	4	0	0	4.3	14	7.6
			SD Solid	20	20	13	7	2.1	93	41

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-20
Summary Statistics - RM 0.9-1.0 East (Slip 1)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	15	15	2	2	12	725	73
			SD Solid	0	--	--	--	--	--	--
Cadmium	5.1	6.7	Sediment	15	14	0	0	0.20	3.2	0.99
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	15	15	0	0	23	55	37
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	15	15	1	1	52	495	133
			SD Solid	0	--	--	--	--	--	--
Lead	450	530	Sediment	15	15	0	0	26	437	81
			SD Solid	0	--	--	--	--	--	--
Mercury	0.41	0.59	Sediment	15	15	2	1	0.059	0.88	0.30
			SD Solid	0	--	--	--	--	--	--
Zinc	410	960	Sediment	15	15	3	2	88	2,080	353
			SD Solid	0	--	--	--	--	--	--
Total LPAH	5.2	13	Sediment	15	15	1	1	0.17	34	2.9
			SD Solid	0	--	--	--	--	--	--
Total HPAH	12	17	Sediment	15	15	2	2	1.4	42	7.0
			SD Solid	0	--	--	--	--	--	--
Total cPAH	1.0	3.0	Sediment	15	15	2	0	0.16	3.0	0.67
			SD Solid	0	--	--	--	--	--	--
BBP	0.063	0.90	Sediment	15	12	0	0	0.0033	0.050	0.025
			SD Solid	0	--	--	--	--	--	--
BEHP	1.3	1.9	Sediment	15	12	0	0	0.015	0.55	0.21
			SD Solid	0	--	--	--	--	--	--
Di-n-Octyl phthalate	6.2	6.2	Sediment	7	0	0	0	--	--	--
			SD Solid	0	--	--	--	--	--	--
Phenol	0.42	1.2	Sediment	15	8	0	0	0.010	0.064	0.032
			SD Solid	0	--	--	--	--	--	--
Total PCBs	0.13	1.0	Sediment	15	15	12	0	0.096	0.65	0.23
			SD Solid	0	--	--	--	--	--	--
Dioxins/Furans	25	50	Sediment	3	3	0	0	7.2	23	17
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-21
Summary Statistics - RM 1.0-1.2 East (King County Lease Parcels)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	7	7	0	0	9.5	31	19
			SD Solid	0	--	--	--	--	--	--
Cadmium	5.1	6.7	Sediment	7	7	0	0	0.40	1.1	0.63
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	7	7	0	0	28	40	35
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	7	7	0	0	55	107	70
			SD Solid	0	--	--	--	--	--	--
Lead	450	530	Sediment	7	7	0	0	21	79	41
			SD Solid	0	--	--	--	--	--	--
Mercury	0.41	0.59	Sediment	7	7	1	1	0.14	1.1	0.32
			SD Solid	0	--	--	--	--	--	--
Zinc	410	960	Sediment	7	7	0	0	112	157	129
			SD Solid	0	--	--	--	--	--	--
Total LPAH	5.2	13	Sediment	7	7	1	0	0.18	8.9	1.7
			SD Solid	0	--	--	--	--	--	--
Total HPAH	12	17	Sediment	7	7	0	0	1.1	5.7	3.0
			SD Solid	0	--	--	--	--	--	--
Total cPAH	1.0	3.0	Sediment	7	7	0	0	0.12	0.65	0.30
			SD Solid	0	--	--	--	--	--	--
BBP	0.063	0.90	Sediment	7	5	0	0	0.0033	0.050	0.026
			SD Solid	0	--	--	--	--	--	--
BEHP	1.3	1.9	Sediment	7	5	0	0	0.055	0.38	0.21
			SD Solid	0	--	--	--	--	--	--
Di-n-Octyl phthalate	6.2	6.2	Sediment	4	0	0	0	--	--	--
			SD Solid	0	--	--	--	--	--	--
Phenol	0.42	1.2	Sediment	7	5	0	0	0.029	0.18	0.077
			SD Solid	0	--	--	--	--	--	--
Total PCBs	0.13	1.0	Sediment	7	7	2	0	0.030	0.23	0.12
			SD Solid	0	--	--	--	--	--	--
Dioxins/Furans	25	50	Sediment	3	3	0	0	7.2	12	10
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-22
Summary Statistics - RM 1.2-1.7 East (St. Gobain to Glacier NW)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	28	28	0	0	1.2	30	11
			SD Solid	0	--	--	--	--	--	--
Cadmium	5.1	6.7	Sediment	28	24	0	0	0.030	1.3	0.41
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	28	28	0	0	4.8	45	24
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	28	28	0	0	12	195	56
			SD Solid	0	--	--	--	--	--	--
Lead	450	530	Sediment	28	28	0	0	9.0	134	41
			SD Solid	0	--	--	--	--	--	--
Mercury	0.41	0.59	Sediment	20	19	1	0	0.035	0.41	0.16
			SD Solid	0	--	--	--	--	--	--
Zinc	410	960	Sediment	28	28	1	1	19	1,500	153
			SD Solid	0	--	--	--	--	--	--
Total LPAH	5.2	13	Sediment	28	28	1	1	0.021	20	0.98
			SD Solid	0	--	--	--	--	--	--
Total HPAH	12	17	Sediment	28	28	1	1	0.20	49	3.9
			SD Solid	0	--	--	--	--	--	--
Total cPAH	1.0	3.0	Sediment	28	28	1	0	0.017	2.4	0.30
			SD Solid	0	--	--	--	--	--	--
BBP	0.063	0.90	Sediment	28	17	0	0	0.0015	0.033	0.012
			SD Solid	0	--	--	--	--	--	--
BEHP	1.3	1.9	Sediment	28	24	0	0	0.01	0.61	0.16
			SD Solid	0	--	--	--	--	--	--
Di-n-Octyl phthalate	6.2	6.2	Sediment	11	1	0	0	0.018	0.021	0.019
			SD Solid	0	--	--	--	--	--	--
Phenol	0.42	1.2	Sediment	28	16	0	0	0.0040	0.17	0.031
			SD Solid	0	--	--	--	--	--	--
Total PCBs	0.13	1.0	Sediment	28	26	12	0	0.010	0.69	0.16
			SD Solid	0	--	--	--	--	--	--
Dioxins/Furans	25	50	Sediment	2	2	0	0	9.0	11	9.9
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-23
Summary Statistics - RM 1.7-2.0 East (Slip 2 to Slip 3)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	19	18	0	0	2.4	21	11
			SD Solid	0	--	--	--	--	--	--
Cadmium	5.1	6.7	Sediment	19	13	0	0	0.070	0.78	0.36
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	19	19	0	0	10	36	25
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	19	19	0	0	17	107	52
			SD Solid	0	--	--	--	--	--	--
Lead	450	530	Sediment	19	19	0	0	9.0	170	36
			SD Solid	0	--	--	--	--	--	--
Mercury	0.41	0.59	Sediment	18	18	0	0	0.021	0.34	0.13
			SD Solid	0	--	--	--	--	--	--
Zinc	410	960	Sediment	19	19	0	0	41	195	108
			SD Solid	0	--	--	--	--	--	--
Total LPAH	5.2	13	Sediment	19	18	0	0	0.0095	1.1	0.33
			SD Solid	0	--	--	--	--	--	--
Total HPAH	12	17	Sediment	19	19	0	0	0.16	5.4	2.1
			SD Solid	0	--	--	--	--	--	--
Total cPAH	1.0	3.0	Sediment	19	19	0	0	0.018	0.67	0.23
			SD Solid	0	--	--	--	--	--	--
BBP	0.063	0.90	Sediment	19	13	1	0	0.0015	0.072	0.020
			SD Solid	0	--	--	--	--	--	--
BEHP	1.3	1.9	Sediment	19	16	0	0	0.014	0.71	0.20
			SD Solid	0	--	--	--	--	--	--
Di-n-Octyl phthalate	6.2	6.2	Sediment	8	2	0	0	0.016	0.14	0.033
			SD Solid	0	--	--	--	--	--	--
Phenol	0.42	1.2	Sediment	19	12	0	0	0.0095	0.28	0.052
			SD Solid	0	--	--	--	--	--	--
Total PCBs	0.13	1.0	Sediment	19	19	7	0	0.012	0.67	0.16
			SD Solid	0	--	--	--	--	--	--
Dioxins/Furans	25	50	Sediment	6	6	0	0	0.97	13	7.3
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-24
Summary Statistics - RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	15	15	2	0	14	81	27
			SD Solid	14	12	5	4	0.10	1,420	144
Cadmium	5.1	6.7	Sediment	15	13	0	0	0.20	1.0	0.51
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	15	15	0	0	24	63	34
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	15	15	0	0	53	209	91
			SD Solid	13	13	3	3	86	831	282
Lead	450	530	Sediment	15	15	0	0	19	156	58
			SD Solid	14	14	3	2	0.40	977	294
Mercury	0.41	0.59	Sediment	15	15	0	0	0.080	0.30	0.15
			SD Solid	14	13	3	2	0.00005	3.4	0.48
Zinc	410	960	Sediment	15	15	1	0	106	919	215
			SD Solid	13	13	12	3	247	4,000	991
Total LPAH	5.2	13	Sediment	15	15	0	0	0.045	2.0	0.50
			SD Solid	14	13	1	1	0.085	14	1.9
Total HPAH	12	17	Sediment	15	15	1	0	0.76	13	3.6
			SD Solid	14	14	2	1	1.5	110	13
cPAH	1.0	3.0	Sediment	15	15	2	0	0.091	1.8	0.50
			SD Solid	14	13	5	1	0.10	12	1.5
BBP	0.063	0.90	Sediment	15	11	0	0	0.0032	0.057	0.02
			SD Solid	14	9	9	1	0.010	3.0	0.39
BEHP	1.3	1.9	Sediment	15	11	0	0	0.059	0.59	0.23
			SD Solid	14	14	11	10	0.16	24	5.2
Di-n-Octyl phthalate	6.2	6.2	Sediment	6	0	0	0	--	--	--
			SD Solid	14	9	0	0	0.041	2.9	0.43
Phenol	0.42	1.2	Sediment	15	9	0	0	0.010	0.28	0.097
			SD Solid	14	1	0	0	0.010	0.28	0.077
Total PCBs	0.13	1.0	Sediment	15	15	6	0	0.070	0.42	0.16
			SD Solid	14	14	9	1	0.028	2.9	0.44
Dioxins/Furans	25	50	Sediment	2	2	0	0	5.6	16	11
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-25
Summary Statistics - RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	32	30	1	0	3.5	61	16
			SD Solid	19	19	2	1	6.3	208	27
Cadmium	5.1	6.7	Sediment	32	26	0	0	0.15	4.0	0.50
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	32	32	0	0	11	88	30
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	32	32	0	0	11	138	48
			SD Solid	19	19	11	11	193	7,990	1,368
Lead	450	530	Sediment	32	32	0	0	7.0	142	31
			SD Solid	19	19	11	9	174	2,240	723
Mercury	0.41	0.59	Sediment	32	29	2	1	0.015	0.62	0.13
			SD Solid	19	18	13	10	0.24	4.3	1.0
Zinc	410	960	Sediment	32	32	2	1	39	1,180	171
			SD Solid	19	19	19	17	763	13,300	3,418
Total LPAH	5.2	13	Sediment	32	29	0	0	0.010	4.0	0.39
			SD Solid	19	18	1	1	0.22	30	3.4
Total HPAH	12	17	Sediment	32	32	0	0	0.0096	8.9	2.1
			SD Solid	19	18	4	1	0.38	56	10
Total cPAH	1.0	3.0	Sediment	32	32	0	0	0.013	0.83	0.20
			SD Solid	19	18	6	1	0.077	5.7	1.0
BBP	0.063	0.90	Sediment	32	30	1	1	0.0024	1.6	0.070
			SD Solid	19	19	19	17	0.66	12	3.5
BEHP	1.3	1.9	Sediment	32	24	1	1	0.011	37	1.3
			SD Solid	19	19	19	19	3.0	210	40
Di-n-Octyl phthalate	6.2	6.2	Sediment	23	3	0	0	0.021	0.74	0.042
			SD Solid	19	15	1	1	0.029	23	2.9
Phenol	0.42	1.2	Sediment	32	28	0	0	0.0095	0.37	0.056
			SD Solid	19	8	5	2	0.055	1.4	0.38
Total PCBs	0.13	1.0	Sediment	32	32	12	1	0.013	1.8	0.23
			SD Solid	19	18	19	15	0.36	25	4.2
Dioxins/Furans	25	50	Sediment	5	5	1	0	0.56	33	9.5
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-26
Summary Statistics - RM 2.8 East (Slip 4)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	27	27	0	0	6.2	30	18
			SD Solid	298	189	10	5	3.0	150	16
Cadmium	5.1	6.7	Sediment	27	27	0	0	0.19	3.1	1.4
			SD Solid	244	243	165	147	0.50	110	14
Chromium	260	270	Sediment	27	27	0	0	11.6	60	41
			SD Solid	244	244	10	9	11.7	629	123
Copper	390	390	Sediment	27	27	0	0	20.9	127	77
			SD Solid	298	298	46	46	12.0	6,320	291
Lead	450	530	Sediment	27	27	1	0	17.5	471	81
			SD Solid	298	296	22	14	6.0	2780	227
Mercury	0.41	0.59	Sediment	57	53	1	0	0.025	0.41	0.18
			SD Solid	299	274	57	48	0.010	173	1.6
Zinc	410	960	Sediment	27	27	1	0	60.3	470	210
			SD Solid	298	298	254	168	33.0	22,900	1,480
Total LPAH	5.2	13	Sediment	27	27	0	0	0.12	3.7	0.59
			SD Solid	77	70	22	13	0.019	54	6.4
Total HPAH	12	17	Sediment	27	27	2	2	1.3	40	6.0
			SD Solid	77	77	36	32	0.12	630	55
Total cPAH	1.0	3.0	Sediment	27	27	7	1	0.16	6.6	0.85
			SD Solid	77	76	40	25	0.028	74	6.6
BBP	0.063	0.90	Sediment	27	24	12	0	0.011	0.34	0.091
			SD Solid	64	35	34	12	0.0095	4.1	0.65
BEHP	1.3	1.9	Sediment	27	26	11	9	0.16	5.0	1.5
			SD Solid	64	63	40	37	0.059	232	17
Di-n-octyl phthalate	6.2	6.2	Sediment	20	19	0	0	0.030	0.43	0.17
			SD Solid	61	25	5	0	0.019	34	2.8
Phenol	0.42	1.2	Sediment	27	13	0	0	0.014	0.15	0.051
			SD Solid	57	7	2	0	0.0095	1.7	0.18
Total PCBs	0.13	1.0	Sediment	61	61	53	21	0.036	8.2	1.4
			SD Solid	389	373	351	148	0.0095	330	4.8
Dioxins/Furans	25	50	Sediment	7	7	2	0	7.9	41	21
			SD Solid	13	13	7	3	6.6	274	58

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-27
Summary Statistics - RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	21	21	0	0	7.9	37	19
			SD Solid	7	5	0	0	3.0	21	9.0
Cadmium	5.1	6.7	Sediment	21	21	0	0	0.25	3.6	1.2
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	21	21	2	2	27	584	120
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	21	21	1	1	46	454	102
			SD Solid	7	7	0	0	76	158	125
Lead	450	530	Sediment	21	21	4	4	26	870	260
			SD Solid	7	7	0	0	64	281	162
Mercury	0.41	0.59	Sediment	19	19	1	0	0.090	0.53	0.18
			SD Solid	7	7	1	1	0.050	7.7	1.2
Zinc	410	960	Sediment	21	21	4	2	115	1690	354
			SD Solid	7	7	4	2	219	1640	683
Total LPAH	5.2	13	Sediment	18	18	3	0	0.089	11	2.2
			SD Solid	7	7	0	0	0.19	2.6	0.70
Total HPAH	12	17	Sediment	18	18	2	1	0.77	35	7.1
			SD Solid	7	7	1	0	1.5	15	5.6
Total cPAH	1.0	3.0	Sediment	18	18	6	1	0.097	3.3	0.82
			SD Solid	7	7	1	0	0.15	2.0	0.70
BBP	0.063	0.90	Sediment	18	15	3	0	0.007	0.14	0.052
			SD Solid	7	6	6	1	0.029	2.6	0.66
BEHP	1.3	1.9	Sediment	18	18	0	0	0.094	0.61	0.26
			SD Solid	7	7	6	4	0.59	44	10
Di-n-octyl phthalate	6.2	6.2	Sediment	0	--	--	--	--	--	--
			SD Solid	7	5	0	0	0.058	3.9	0.78
Phenol	0.42	1.2	Sediment	18	15	7	2	0.028	2.8	0.54
			SD Solid	7	3	1	1	0.029	3.5	0.63
Total PCBs	0.13	1.0	Sediment	49	49	45	18	0.0087	110	4.8
			SD Solid	24	24	23	6	0.13	18	1.9
Dioxins/Furans	25	50	Sediment	4	4	1	1	2.9	101	31
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-28
Summary Statistics - RM 3.7 to 3.9 East (Boeing Isaacson/Central KCIA)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	10	10	2	2	8.2	1,100	172
			SD Solid	42	40	2	0	3.5	90	18
Cadmium	5.1	6.7	Sediment	10	8	0	0	0.15	1.6	0.75
			SD Solid	37	37	24	20	0.80	154	18
Chromium	260	270	Sediment	10	10	0	0	26	174	58
			SD Solid	37	37	6	6	29	821	161
Copper	390	390	Sediment	10	10	0	0	35	100	57
			SD Solid	42	42	1	1	12	606	142
Lead	450	530	Sediment	10	10	0	0	28	152	81
			SD Solid	42	42	1	1	5.0	568	175
Mercury	0.41	0.59	Sediment	10	8	0	0	0.030	0.16	0.093
			SD Solid	42	35	3	3	0.010	1.2	0.17
Zinc	410	960	Sediment	10	10	0	0	75	343	166
			SD Solid	42	42	32	24	32	6,640	1,270
Total LPAH	5.2	13	Sediment	10	10	0	0	0.024	3.1	1.0
			SD Solid	42	40	2	1	0.023	32	2.1
Total HPAH	12	17	Sediment	10	10	4	1	0.38	19	7.7
			SD Solid	42	41	6	5	0.21	284	13
cPAH	1.0	3.0	Sediment	10	10	4	0	0.060	2.3	0.92
			SD Solid	42	41	9	2	0.033	38	1.6
BBP	0.063	0.90	Sediment	10	8	5	0	0.024	0.22	0.095
			SD Solid	41	34	31	13	0.010	7.9	0.89
BEHP	1.3	1.9	Sediment	10	9	0	0	0.017	1.2	0.45
			SD Solid	41	39	32	31	0.034	23	6.4
Di-n-octyl phthalate	6.2	6.2	Sediment	0	--	--	--	--	--	--
			SD Solid	41	25	0	0	0.020	4.4	0.79
Phenol	0.42	1.2	Sediment	10	1	0	0	0.010	0.11	0.054
			SD Solid	41	27	4	0	0.010	0.50	0.19
Total PCBs	0.13	1.0	Sediment	12	12	9	0	0.024	0.88	0.34
			SD Solid	43	40	31	1	0.0095	3.4	0.35
Dioxins/Furans	25	50	Sediment	0	--	--	--	--	--	--
			SD Solid	6	6	3	1	0.51	60	28

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-29
Summary Statistics - RM 3.9 to 4.3 East (Slip 6)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	66	66	0	0	4.5	33	13
			SD Solid	3	1	0	0	4.0	13	7.4
Cadmium	5.1	6.7	Sediment	59	30	0	0	0.15	3.3	0.50
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	66	66	0	0	9.2	200	30
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	66	66	0	0	23	290	61
			SD Solid	3	3	1	1	78	429	200
Lead	450	530	Sediment	66	66	2	2	6.3	12,300	235
			SD Solid	3	3	0	0	34	232	125
Mercury	0.41	0.59	Sediment	66	61	1	1	0.025	6.8	0.25
			SD Solid	3	2	0	0	0.010	0.17	0.10
Zinc	410	960	Sediment	66	66	1	1	36	1,000	124
			SD Solid	3	3	3	0	596	740	648
Total LPAH	5.2	13	Sediment	51	50	0	0	0.024	2.3	0.33
			SD Solid	3	3	1	0	1.4	9.6	4.6
Total HPAH	12	17	Sediment	55	55	3	1	0.23	20	3.0
			SD Solid	3	3	2	2	2.8	83	35
Total cPAH	1.0	3.0	Sediment	55	55	3	0	0.025	2.1	0.35
			SD Solid	3	3	3	1	1.2	8.5	3.9
BBP	0.063	0.90	Sediment	45	39	15	1	0.0032	2.2	0.11
			SD Solid	3	2	2	1	0.031	2.6	0.93
BEHP	1.3	1.9	Sediment	55	41	3	2	0.022	2.1	0.32
			SD Solid	3	2	2	2	0.080	41	15
Di-n-octyl phthalate	6.2	6.2	Sediment	6	2	0	0	0.0078	0.020	0.016
			SD Solid	3	0	0	0	--	--	--
Phenol	0.42	1.2	Sediment	55	18	2	2	0.0037	1.4	0.086
			SD Solid	3	0	0	0	--	--	--
Total PCBs	0.13	1.0	Sediment	55	51	28	3	0.0095	2.9	0.25
			SD Solid	3	1	0	0	0.0095	0.11	0.049
Dioxins/Furans	25	50	Sediment	14	14	0	0	4.4	21	9.4
			SD Solid	1	1	0	0	1.2	1.2	1.2

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-30
Summary Statistics - RM 4.3 to 4.9 East (Boeing Developmental Center)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	18	18	0	0	5.9	20.0	11.2
			SD Solid	1	0	0	0	--	--	--
Cadmium	5.1	6.7	Sediment	18	13	0	0	0.15	0.50	0.36
			SD Solid	1	1	0	0	3.7	3.7	3.7
Chromium	260	270	Sediment	18	18	0	0	14	31	25
			SD Solid	1	1	0	0	122	122	122
Copper	390	390	Sediment	18	18	0	0	19	49	34
			SD Solid	1	1	0	0	168	168	168
Lead	450	530	Sediment	18	18	0	0	8.0	21	13
			SD Solid	1	1	0	0	173	173	173
Mercury	0.41	0.59	Sediment	18	16	0	0	0.035	0.17	0.091
			SD Solid	1	1	0	0	0.21	0.21	0.21
Zinc	410	960	Sediment	18	18	0	0	50	98	79
			SD Solid	1	1	1	1	1,520	1,520	1,520
Total LPAH	5.2	13	Sediment	18	18	0	0	0.040	0.85	0.21
			SD Solid	2	2	2	2	15	15	15
Total HPAH	12	17	Sediment	18	18	0	0	0.25	3.3	1.2
			SD Solid	2	2	2	2	111	120	115
Total cPAH	1.0	3.0	Sediment	18	18	0	0	0.028	0.34	0.13
			SD Solid	2	2	2	2	13	14	14
BBP	0.063	0.90	Sediment	18	15	0	0	0.0028	0.044	0.0093
			SD Solid	1	1	1	1	0.38	0.38	0.38
BEHP	1.3	1.9	Sediment	18	16	0	0	0.06	0.24	0.11
			SD Solid	1	1	1	0	6.3	6.3	6.3
Di-n-octyl phthalate	6.2	6.2	Sediment	13	1	0	0	0.011	0.02	0.019
			SD Solid	1	1	1	0	7.3	7.3	7.3
Phenol	0.42	1.2	Sediment	18	12	0	0	0.0095	0.050	0.019
			SD Solid	1	1	1	0	0.49	0.49	0.49
Total PCBs	0.13	1.0	Sediment	18	15	2	0	0.0020	0.27	0.051
			SD Solid	1	1	1	0	0.48	0.48	0.48
Dioxins/Furans	25	50	Sediment	4	4	0	0	0.34	3.1	1.9
			SD Solid	1	1	0	0	20	20	20

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-31
Summary Statistics - RM 4.9 East (Norfolk CSO/SD)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	15	14	0	0	1.9	11	7.3
			SD Solid	40	20	1	1	3.0	120	12
Cadmium	5.1	6.7	Sediment	15	3	0	0	0.11	0.51	0.20
			SD Solid	2	2	1	0	1.2	5.5	3.4
Chromium	260	270	Sediment	15	15	0	0	13	28	20
			SD Solid	1	1	0	0	83	83	83
Copper	390	390	Sediment	15	15	0	0	12	66	29
			SD Solid	41	41	1	1	18	3960	189
Lead	450	530	Sediment	15	15	0	0	5.7	57	16
			SD Solid	41	41	1	1	20	700	108
Mercury	0.41	0.59	Sediment	15	11	0	0	0.015	0.15	0.060
			SD Solid	41	22	0	0	0.015	0.33	0.084
Zinc	410	960	Sediment	13	13	0	0	43	90	65
			SD Solid	41	41	18	9	73	9,980	752
Total LPAH	5.2	13	Sediment	15	14	0	0	0.015	1.3	0.20
			SD Solid	41	36	4	2	0.010	66	3.3
Total HPAH	12	17	Sediment	15	15	0	0	0.026	8.6	1.4
			SD Solid	41	39	9	7	0.010	585	22
Total cPAH	1.0	3.0	Sediment	15	13	1	0	0.013	1.1	0.17
			SD Solid	41	35	14	3	0.0071	81	3.0
BBP	0.063	0.90	Sediment	15	8	1	0	0.0023	0.12	0.020
			SD Solid	40	17	28	6	0.010	4.4	0.54
BEHP	1.3	1.9	Sediment	15	8	1	1	0.011	2.0	0.29
			SD Solid	40	39	26	25	0.011	59	9.6
Di-n-octyl phthalate	6.2	6.2	Sediment	7	0	0	0	--	--	--
			SD Solid	40	13	0	0	0.010	4.5	0.45
Phenol	0.42	1.2	Sediment	15	4	0	0	0.0070	0.080	0.027
			SD Solid	40	12	4	0	0.010	1.1	0.16
Total PCBs	0.13	1.0	Sediment	34	30	12	6	0.0027	8.4	0.97
			SD Solid	44	27	13	2	0.0090	15	0.52
Dioxins/Furans	25	50	Sediment	2	2	0	0	2.5	4.7	3.6
			SD Solid	2	2	1	1	22	53	37

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-32
Summary Statistics - RM 0.0-1.0 West (Spokane Street to Kellogg Island)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	41	41	0	0	3.1	36	13
			SD Solid	19	7	0	0	3.5	30	9.5
Cadmium	5.1	6.7	Sediment	40	25	0	0	0.050	1.0	0.32
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	40	40	0	0	9.1	61	26
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	40	40	0	0	15	172	54
			SD Solid	18	18	0	0	25	350	101
Lead	450	450	Sediment	40	40	0	0	4.0	400	56
			SD Solid	19	19	0	0	18	203	71
Mercury	0.41	0.59	Sediment	40	33	3	3	0.015	1.8	0.18
			SD Solid	19	12	0	0	0.010	0.22	0.080
Zinc	410	960	Sediment	40	40	2	0	31	478	132
			SD Solid	18	18	4	1	80	3,740	523
Total LPAH	5.2	13	Sediment	41	39	1	0	0.0095	5.2	0.65
			SD Solid	16	16	1	0	0.0099	8.3	0.80
Total HPAH	12	17	Sediment	41	41	5	3	0.019	26	4.1
			SD Solid	16	15	1	1	0.11	89	7.8
Total cPAH	1.0	3.0	Sediment	41	39	5	1	0.0059	4.1	0.48
			SD Solid	16	15	1	1	0.020	9.5	0.87
BBP	0.063	0.90	Sediment	40	22	1	0	0.0023	0.22	0.018
			SD Solid	16	13	9	4	0.016	19	1.6
BEHP	1.3	1.9	Sediment	40	34	1	0	0.0075	1.7	0.18
			SD Solid	16	16	8	5	0.16	37	4.8
Di-n-Octyl phthalate	6.2	6.2	Sediment	14	0	0	0	--	--	--
			SD Solid	16	6	0	0	0.020	3.7	0.37
Phenol	0.42	1.2	Sediment	40	19	3	0	0.0090	0.60	0.086
			SD Solid	16	3	0	0	0.0095	0.23	0.065
Total PCBs	0.13	1.0	Sediment	41	37	11	1	0.0031	1.0	0.13
			SD Solid	16	9	7	0	0.0095	0.61	0.16
Dioxins/Furans	25	50	Sediment	6	6	1	1	1.6	75	18
			SD Solid	1	1	0	0	14	14	14

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids

Table 3-33
Summary Statistics - RM 1.0-1.3 West (Kellogg Island to Lafarge)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	12	12	2	0	3.1	86	31
			SD Solid	4	2	0	0	15	30	20
Cadmium	5.1	6.7	Sediment	12	10	0	0	0.10	1.1	0.55
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	12	12	0	0	9.9	39	32
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	12	12	0	0	16	169	101
			SD Solid	4	4	3	3	234	1,730	953
Lead	450	530	Sediment	12	12	0	0	7.0	166	67
			SD Solid	4	3	0	0	5.0	120	64
Mercury	0.41	0.59	Sediment	12	11	0	0	0.030	0.32	0.21
			SD Solid	4	2	0	0	0.020	0.070	0.039
Zinc	410	960	Sediment	12	12	0	0	33	305	185
			SD Solid	4	4	3	1	167	1,360	767
Total LPAH	5.2	13	Sediment	12	12	0	0	0.054	4.5	0.80
			SD Solid	4	4	0	0	0.60	3.0	2.1
Total HPAH	12	17	Sediment	12	12	1	0	0.64	13	3.9
			SD Solid	4	4	1	0	1.4	14	7.8
Total cPAH	1.0	3.0	Sediment	12	12	1	0	0.069	1.0	0.42
			SD Solid	4	4	3	0	0.20	1.8	0.95
BBP	0.063	0.90	Sediment	12	9	1	0	0.0033	0.065	0.021
			SD Solid	4	4	3	0	0.060	0.51	0.38
BEHP	1.3	1.9	Sediment	12	9	0	0	0.034	0.45	0.19
			SD Solid	4	4	3	3	1.1	3.6	2.9
Di-n-octyl phthalate	6.2	6.2	Sediment	5	1	0	0	0.008	0.014	0.010
			SD Solid	4	4	0	0	0.031	0.34	0.20
Phenol	0.42	1.2	Sediment	12	4	0	0	0.0080	0.058	0.030
			SD Solid	4	4	0	0	0.10	0.64	0.34
Total PCBs	0.13	1.0	Sediment	12	11	6	0	0.0095	0.75	0.21
			SD Solid	4	4	2	2	0.037	0.81	0.34
Dioxins/Furans	25	50	Sediment	6	6	1	0	5.2	27	15
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-34
Summary Statistics - RM 1.3-1.6 West (Glacier Bay)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	17	17	5	4	17	807	107
			SD Solid	10	9	2	1	5.7	150	36
Cadmium	5.1	6.7	Sediment	17	16	0	0	0.20	3.0	0.75
			SD Solid	0	--	0	0	--	--	--
Chromium	260	270	Sediment	17	17	0	0	20	153	47
			SD Solid	0	--	0	0	--	--	--
Copper	390	390	Sediment	17	17	4	4	88	1,420	411
			SD Solid	10	10	5	5	99	1,820	613
Lead	450	530	Sediment	17	17	1	1	45	780	148
			SD Solid	10	10	1	1	38	1,760	388
Mercury	0.41	0.59	Sediment	17	17	1	1	0.051	0.79	0.26
			SD Solid	10	9	2	2	0.045	9.4	1.1
Zinc	410	960	Sediment	17	17	5	1	150	2,830	516
			SD Solid	10	10	8	4	314	3,290	1,456
Total LPAH	5.2	13	Sediment	17	17	0	0	0.16	3.1	1.1
			SD Solid	10	10	1	0	0.069	9.8	2.4
Total HPAH	12	17	Sediment	17	17	2	1	1.6	26	6.4
			SD Solid	10	10	4	2	1.4	58	16
Total cPAH	1.0	3.0	Sediment	17	17	5	0	0.17	1.6	0.72
			SD Solid	10	10	6	2	0.16	7.0	1.8
BBP	0.063	0.90	Sediment	17	8	3	0	0.0033	0.075	0.029
			SD Solid	9	9	9	3	0.14	1.8	0.78
BEHP	1.3	1.9	Sediment	17	13	1	0	0.090	1.6	0.32
			SD Solid	9	9	7	7	0.90	65	12
Di-n-octyl phthalate	6.2	6.2	Sediment	0	--	--	--	--	--	--
			SD Solid	9	7	0	0	0.056	4.3	0.75
Phenol	0.42	1.2	Sediment	17	7	0	0	0.012	0.37	0.11
			SD Solid	10	8	4	2	0.041	1.5	0.53
Total PCBs	0.13	1.0	Sediment	17	17	12	0	0.024	0.81	0.27
			SD Solid	10	9	8	5	0.043	7.0	1.8
Dioxins/Furans	25	50	Sediment	3	3	3	3	463	2,096	1,041
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-35
Summary Statistics - RM 1.6-2.1 West (Terminal 115)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	25	25	0	0	5.1	26	17
			SD Solid	12	8	0	0	3.5	55	19
Cadmium	5.1	6.7	Sediment	24	15	0	0	0.15	0.80	0.42
			SD Solid	1	1	0	0	0.97	1.0	0.97
Chromium	260	270	Sediment	24	24	0	0	21	85	34
			SD Solid	1	1	0	0	68	68	68
Copper	390	390	Sediment	24	24	0	0	33	171	68
			SD Solid	12	12	1	1	29	697	140
Lead	450	530	Sediment	24	24	0	0	14	84	36
			SD Solid	12	12	0	0	11	436	93.3
Mercury	0.41	0.59	Sediment	24	24	0	0	0.030	0.40	0.17
			SD Solid	12	8	0	0	0.015	0.36	0.13
Zinc	410	960	Sediment	24	24	0	0	79	297	143
			SD Solid	12	12	6	2	78	1,720	604
Total LPAH	5.2	13	Sediment	25	25	1	0	0.036	10	0.73
			SD Solid	13	13	3	3	0.034	1,250	100
Total HPAH	12	17	Sediment	25	25	0	0	0.38	7.7	2.2
			SD Solid	13	13	3	3	0.36	2,060	171
Total cPAH	1.0	3.0	Sediment	25	25	0	0	0.036	0.56	0.23
			SD Solid	13	13	3	2	0.045	77	6.7
BBP	0.063	0.90	Sediment	24	16	3	0	0.0033	0.13	0.030
			SD Solid	12	7	7	2	0.020	7.5	0.96
BEHP	1.3	1.9	Sediment	24	16	2	1	0.044	4.9	0.47
			SD Solid	12	11	8	6	0.19	13	4.3
Di-n-octyl phthalate	6.2	6.2	Sediment	10	0	0	0	--	--	--
			SD Solid	12	3	0	0	0.054	15	1.4
Phenol	0.42	1.2	Sediment	24	10	0	0	0.0055	0.20	0.051
			SD Solid	12	3	0	0	0.020	0.35	0.74
Total PCBs	0.13	1.0	Sediment	25	20	7	0	0.0095	0.52	0.10
			SD Solid	12	6	4	0	0.0095	0.40	0.095
Dioxins/Furans	25	50	Sediment	13	13	1	0	3.2	49	12
			SD Solid	2	2	2	2	67	73	70

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-36
Summary Statistics - RM 2.1 West (1st Avenue S SD)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	7	6	0	0	3.0	15	7.1
			SD Solid	13	7	0	0	3.0	24	10
Cadmium	5.1	6.7	Sediment	7	3	0	0	0.10	0.60	0.23
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	7	7	0	0	12	32	19
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	7	7	0	0	13	44	24
			SD Solid	13	13	0	0	20	180	93
Lead	450	530	Sediment	7	7	0	0	9.0	92	39
			SD Solid	13	13	0	0	8.0	254	92
Mercury	0.41	0.59	Sediment	7	2	0	0	0.010	0.14	0.040
			SD Solid	13	11	1	1	0.010	0.42	0.13
Zinc	410	960	Sediment	7	7	0	0	44	130	69
			SD Solid	13	13	7	1	108	3,770	679
Total LPAH	5.2	13	Sediment	7	7	0	0	0.016	1.0	0.22
			SD Solid	14	14	0	0	0.035	3.5	1.2
Total HPAH	12	17	Sediment	7	7	0	0	0.096	2.1	0.89
			SD Solid	14	14	3	2	0.31	25	7.1
Total cPAH	1.0	3.0	Sediment	7	7	0	0	0.014	0.21	0.095
			SD Solid	14	14	4	0	0.035	3.0	0.85
BBP	0.063	0.90	Sediment	7	6	2	0	0.0024	0.14	0.040
			SD Solid	14	7	6	1	0.011	3.3	0.63
BEHP	1.3	1.9	Sediment	7	7	1	1	0.012	2.5	0.42
			SD Solid	14	14	10	9	0.22	26	9.4
Di-n-octyl phthalate	6.2	6.2	Sediment	4	0	0	0	0.019	0.020	0.020
			SD Solid	14	3	0	0	0.020	1.8	0.43
Phenol	0.42	1.2	Sediment	7	3	0	0	0.0095	0.063	0.028
			SD Solid	14	0	0	0	--	--	--
Total PCBs	0.13	1.0	Sediment	7	6	0	0	0.0020	0.097	0.039
			SD Solid	13	7	4	0	0.0090	0.78	0.17
Dioxins/Furans	25	50	Sediment	0	--	--	--	--	--	--
			SD Solid	2	2	0	0	0.51	12	6.4

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-37
Summary Statistics - RM 2.1-2.2 West (Trotsky Inlet)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	22	18	0	0	2.6	49	11
			SD Solid	14	11	0	0	4.0	50	18
Cadmium	5.1	6.7	Sediment	20	9	2	1	0.10	36	2.4
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	20	20	2	2	11	1680	132
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	20	20	1	1	11	1090	101
			SD Solid	14	14	1	1	91	806	214
Lead	450	530	Sediment	20	20	3	3	5.0	10,400	804
			SD Solid	14	14	2	2	40	3,690	454
Mercury	0.41	0.59	Sediment	20	14	3	3	0.015	247	16
			SD Solid	14	13	2	2	0.040	48	3.6
Zinc	410	960	Sediment	20	20	4	2	31	4,580	448
			SD Solid	14	14	9	2	311	2,950	693
Total LPAH	5.2	13	Sediment	22	20	0	0	0.0090	4.3	0.59
			SD Solid	14	12	1	0	0.044	6.4	1.1
Total HPAH	12	17	Sediment	22	21	1	1	0.0090	39	4.0
			SD Solid	14	14	0	0	0.58	11	3.7
Total cPAH	1.0	3.0	Sediment	22	20	2	1	0.0060	4.7	0.47
			SD Solid	14	14	1	0	0.057	1.0	0.40
BBP	0.063	0.90	Sediment	20	7	1	1	0.0023	3.3	0.24
			SD Solid	14	12	12	3	0.095	11	1.3
BEHP	1.3	1.9	Sediment	20	12	3	3	0.0090	17	1.5
			SD Solid	14	14	14	13	1.6	39	10
Di-n-octyl phthalate	6.2	6.2	Sediment	5	0	0	0	--	--	--
			SD Solid	14	10	1	0	0.087	18	2.3
Phenol	0.42	1.2	Sediment	20	7	1	0	0.0090	3.1	0.23
			SD Solid	14	3	2	0	0.030	0.69	0.20
Total PCBs	0.13	1.0	Sediment	23	23	12	6	0.010	2,930	139
			SD Solid	14	14	8	1	0.025	3.2	0.43
Dioxins/Furans	25	50	Sediment	5	5	1	1	0.55	412	87
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-38
Summary Statistics - RM 2.2-3.4 West (Riverside Drive)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	32	31	0	0	3.9	20	11
			SD Solid	33	24	0	0	3.0	50	14
Cadmium	5.1	6.7	Sediment	31	14	0	0	0.060	1.1	0.29
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	31	31	0	0	12	61	25
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	31	31	0	0	17	180	49
			SD Solid	33	33	4	4	8.9	701	166
Lead	450	450	Sediment	31	31	0	0	11	72	32
			SD Solid	33	33	3	2	4.0	719	151
Mercury	0.41	0.59	Sediment	31	22	1	1	0.015	6.5	0.30
			SD Solid	33	21	4	3	0.010	3.8	0.26
Zinc	410	960	Sediment	31	31	0	0	52	348	110
			SD Solid	33	33	20	4	50	4,150	714
Total LPAH	5.2	13	Sediment	32	30	2	1	0.010	44	2.1
			SD Solid	34	48	1	0	0.010	8.6	0.84
Total HPAH	12	17	Sediment	32	32	3	3	0.049	48	4.5
			SD Solid	34	31	2	1	0.010	28	4.3
Total cPAH	1.0	3.0	Sediment	32	32	4	2	0.011	4.2	0.41
			SD Solid	34	31	4	0	0.014	3.0	0.53
BBP	0.063	0.90	Sediment	31	14	2	0	0.0032	0.20	0.018
			SD Solid	34	23	22	5	0.010	73	2.7
BEHP	1.3	1.9	Sediment	31	21	2	1	0.010	2.6	0.26
			SD Solid	34	34	27	24	0.017	1,400	61
Di-n-Octyl phthalate	6.2	6.2	Sediment	11	1	0	0	0.018	0.031	0.020
			SD Solid	34	11	0	0	0.020	4.9	0.40
Phenol	0.42	1.2	Sediment	31	14	0	0	0.0065	0.14	0.041
			SD Solid	34	8	1	1	0.010	9.3	0.39
Total PCBs	0.13	1.0	Sediment	32	30	11	1	0.010	1.2	0.16
			SD Solid	33	25	17	2	0.0095	2.5	0.32
Dioxins/Furans	25	50	Sediment	3	3	1	0	1.9	36	14
			SD Solid	2	2	0	0	7.2	10	8.7

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids

Table 3-39
Summary Statistics - RM 3.4-3.8 West (Terminal 117)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	30	22	0	0	3.5	22	11
			SD Solid	10	7	0	0	5.0	20	11
Cadmium	5.1	6.7	Sediment	30	10	0	0	0.15	1.0	0.25
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	30	30	0	0	15	160	29
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	30	30	0	0	15	334	48
			SD Solid	10	10	0	0	51	284	171
Lead	450	530	Sediment	30	30	0	0	5.0	110	28
			SD Solid	8	8	0	0	22	428	174
Mercury	0.41	0.59	Sediment	32	26	0	0	0.015	0.38	0.092
			SD Solid	8	6	0	0	0.025	0.33	0.13
Zinc	410	960	Sediment	30	30	1	1	38	1,440	136
			SD Solid	8	8	7	1	237	1,040	722
Total LPAH	5.2	13	Sediment	32	32	1	1	0.013	43	1.6
			SD Solid	8	8	2	2	0.11	556	93
Total HPAH	12	17	Sediment	32	32	1	1	0.11	85	3.9
			SD Solid	11	10	1	1	0.17	3,830	352
Total cPAH	1.0	3.0	Sediment	32	32	2	1	0.015	11	0.49
			SD Solid	11	10	2	2	0.03	462	43
BBP	0.063	0.90	Sediment	32	18	1	0	0.0033	0.071	0.022
			SD Solid	8	4	8	3	0.12	7.4	2.2
BEHP	1.3	1.9	Sediment	32	28	0	0	0.0095	0.34	0.12
			SD Solid	8	8	8	7	1.6	74	23
Di-n-octyl phthalate	6.2	6.2	Sediment	12	2	0	0	0.012	0.11	0.025
			SD Solid	8	3	1	1	0.021	7.0	1.7
Phenol	0.42	1.2	Sediment	32	14	3	2	0.0095	1.9	0.14
			SD Solid	8	1	2	1	0.11	7.0	1.1
Total PCBs	0.13	1.0	Sediment	83	79	52	24	0.010	38	2.4
			SD Solid	11	11	11	4	0.14	5.4	1.2
Dioxins/Furans	25	50	Sediment	12	12	0	0	1.1	9.4	4.3
			SD Solid	0	--	--	--	--	--	--

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-40
Summary Statistics - RM 3.8-4.2 West (Sea King Industrial Park)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	11	11	0	0	3.5	10	8.1
			SD Solid	18	12	0	0	3.0	30	9.2
Cadmium	5.1	6.7	Sediment	11	2	0	0	0.15	0.40	0.20
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	11	11	0	0	14	31	21
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	11	11	0	0	15	49	25
			SD Solid	18	18	0	0	8.6	297	61
Lead	450	530	Sediment	11	11	0	0	4.0	21	12
			SD Solid	18	18	0	0	3.0	150	49
Mercury	0.41	0.59	Sediment	11	4	0	0	0.015	0.10	0.041
			SD Solid	18	10	0	0	0.010	0.10	0.046
Zinc	410	960	Sediment	11	11	0	0	38	113	69
			SD Solid	18	18	6	3	38	2,530	532
Total LPAH	5.2	13	Sediment	11	3	0	0	0.0080	0.15	0.045
			SD Solid	19	15	0	0	0.0095	1.7	0.33
Total HPAH	12	17	Sediment	11	10	0	0	0.0080	1.5	0.35
			SD Solid	19	18	0	0	0.010	8.7	2.2
Total cPAH	1.0	3.0	Sediment	11	8	0	0	0.0057	0.15	0.041
			SD Solid	19	16	0	0	0.013	0.99	0.29
BBP	0.063	0.90	Sediment	11	9	0	0	0.0032	0.035	0.012
			SD Solid	19	12	11	3	0.0095	25	1.6
BEHP	1.3	1.9	Sediment	11	8	0	0	0.0095	0.27	0.051
			SD Solid	19	17	5	4	0.020	20	2.3
Di-n-octyl phthalate	6.2	6.2	Sediment	6	1	0	0	0.011	0.017	0.015
			SD Solid	19	4	0	0	0.019	5.7	0.45
Phenol	0.42	1.2	Sediment	11	2	0	0	0.0080	0.034	0.012
			SD Solid	19	4	2	0	0.0095	0.91	0.14
Total PCBs	0.13	1.0	Sediment	11	9	2	0	0.0085	0.37	0.066
			SD Solid	18	7	1	0	0.0090	0.17	0.030
Dioxins/Furans	25	50	Sediment	2	2	0	0	2.4	16	8.9
			SD Solid	5	5	0	0	0.35	8.9	2.9

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 3-41
Summary Statistics - RM 4.2-4.8 West (Restoration Areas)

Chemical	Lower SL	Upper SL	Sample Matrix	No. of Samples	No. of Detections	No. Above Lower SL	No. Above Upper SL	Minimum	Maximum	Average
Arsenic	57	93	Sediment	26	24	0	0	3.0	16	7.8
			SD Solid	3	0	0	0	--	--	--
Cadmium	5.1	6.7	Sediment	25	6	0	0	0.068	0.80	0.22
			SD Solid	0	--	--	--	--	--	--
Chromium	260	270	Sediment	25	25	0	0	13	28	22
			SD Solid	0	--	--	--	--	--	--
Copper	390	390	Sediment	25	25	0	0	12	47	28
			SD Solid	3	3	0	0	12	24	20
Lead	450	530	Sediment	25	25	0	0	3.0	95	16
			SD Solid	3	3	0	0	8.0	34	20
Mercury	0.41	0.59	Sediment	25	15	0	0	0.010	0.16	0.063
			SD Solid	3	2	0	0	0.010	0.11	0.053
Zinc	410	960	Sediment	25	25	0	0	45	211	73
			SD Solid	3	3	0	0	60	65	63
Total LPAH	5.2	13	Sediment	26	22	0	0	0.0077	0.45	0.069
			SD Solid	3	3	0	0	0.017	0.12	0.054
Total HPAH	12	17	Sediment	26	26	0	0	0.028	4.2	0.62
			SD Solid	3	3	0	0	0.12	1.0	0.43
Total cPAH	1.0	3.0	Sediment	26	22	0	0	0.0061	0.37	0.072
			SD Solid	3	3	0	0	0.018	0.11	0.050
BBP	0.063	0.90	Sediment	25	12	0	0	0.0024	0.024	0.0058
			SD Solid	3	0	0	0	--	--	--
BEHP	1.3	1.9	Sediment	25	6	0	0	0.012	0.10	0.037
			SD Solid	3	1	1	0	0.015	1.5	0.52
Di-n-octyl phthalate	6.2	6.2	Sediment	11	0	0	0	--	--	--
			SD Solid	3	0	0	0	--	--	--
Phenol	0.42	1.2	Sediment	25	8	1	0	0.0050	1.1	0.059
			SD Solid	3	1	0	0	0.010	0.058	0.026
Total PCBs	0.13	1.0	Sediment	26	18	2	0	0.0020	0.52	0.051
			SD Solid	3	1	0	0	0.0090	0.11	0.043
Dioxins/Furans	25	50	Sediment	5	5	0	0	0.29	3.8	1.5
			SD Solid	3	3	0	0	0.66	3.9	1.8

All concentrations in mg/kg DW, except dioxins/furans which are reported in ng TEQ/kg DW.

Exceeds Lower SL
Exceeds Upper SL
Exceeds 10x Upper SL
Exceeds 100x Upper SL

-- No samples collected
Chemical name in **bold** indicates concentrations exceeded the upper SL in at least one sample.
Shaded chemical name indicates it exceeded a screening level in both surface sediments and storm drain solids
Statistics include nondetects at one-half the reporting limit.

Table 4-1
PAH Ratios Typical of Urban Background

PAH Ratio	Ratio Range	Urban Background Range for Nine Sites from the East and West US Coasts	Urban Background Range for Two Washington Sites
An/Ph	Minimum	0.10	0.54
	Maximum	1.97	1.81
	Average	0.47	0.92
Fl/Py	Minimum	0.15	0.15
	Maximum	1.32	1.07
	Average	0.91	0.64
BaA/Cr	Minimum	0.33	0.44
	Maximum	3.15	0.79
	Average	0.83	0.63
IP/Bghi	Minimum	0.71	1.04
	Maximum	1.59	1.21
	Average	1.03	1.12

Source: Stout 2004

Notes:

An/Ph - anthracene/phenanthrene

FL/Py - fluoranthene/pyrene

BaA/Cr - benzo(a)anthracene/chrysene

IP/Bghi - indeno(1,2,3-cd)pyrene/benzo(g,h,i)perylene

PAH - polycyclic aromatic hydrocarbons

WA - Washington

WA sites include: Thea Foss Waterway, Tacoma and Eagle Harbor, Bainbridge Island

Table 5-1
Exceptions to Co-Located Sample Type Comparison Data Selection Criteria

Exceptions for Figures 5-1 and Figures 5-3 through 5-6
2011 wet season filter samples from SQ2 compared to 2009 wet season grab from MH208
2011 wet season filter samples from SQ3 compared to 2008 wet season grab from MH18
2011 wet season filter samples from DK4 compared to 2009 wet season grab from MH233
2010 wet season filter from MH108 compared to 2009 dry season grab from CB108A, 25 meters upstream
2010 wet season filter from MH226 compared to 2010 sediment trap from MH221A, 80 meters downstream
2010 wet season filter from MH369 compared to 2009 dry season grab from MH368, 10 meters downstream
2010 wet season filter from MH369 compared to 2010 sediment trap from MH364, 100 meters downstream
2011 wet season filter data from LS431 excluded due to influence of treatment system at North Boeing Field.
2011 wet season filter data from MH108 excluded due to influence of treatment system at North Boeing Field.
Exceptions Unique to Figure 5-2
2009 wet season sediment trap from 7th-ST1 compared to 2008 dry season grab.
2009 wet season sediment trap from 7th-ST2 compared to 2008 dry season grab.
2008 wet season sediment trap from NST2 compared to 2008 dry season grab.
2008 wet season sediment trap from NST4 compared to 2007 dry season grab.
2005 wet season sediment trap from ST2 compared to 2007 dry season grab.

Table 5-2
Spearman Correlation Coefficient Matrix (r_s) for Sample Type Comparisons

Total PCB	**Filter**	**Water**	**Trap**	**Grab**
Filter				
Water	0.65			
Trap	0.26	0.76		
Grab	0.31	- -	0.29	
Grab-Extended[a]	- -	- -	0.89	- -
Total HPAH	**Filter**	**Water**	**Trap**	**Grab**
Filter				
Water	0.65			
Trap	0.84	0.84		
Grab	- -	- -	- -	
BEHP	**Filter**	**Water**	**Trap**	**Grab**
Filter	NA	NA	NA	NA
Water	NA			
Trap	NA	-0.050		
Grab	NA	- -	0.70	
Copper	**Filter**	**Water**	**Trap**	**Grab**
Filter				
Water	0.63			
Trap	-0.029	-0.49		
Grab	0.58	- -	- -	
Mercury	**Filter**	**Water**	**Trap**	**Grab**
Filter				
Water	- -			
Trap	0.93	- -		
Grab	0.75	- -	- -	

Notes:

5% Confidence Level

1% Confidence Level

[a] Extended grab analysis includes comparison between filtered solids and grab samples from Figure 5-2.

NA - analysis for BEHP was not conducted on filter samples.

-- correlation not determined due to 5 or fewer co-located or detected results.

PCB - polychlorinated biphenyl

HPAH - high molecular weight polycyclic aromatic hydrocarbon

BEHP - bis(2-ethylhexyl) phthalate

Table 5-3
Comparison of Results from Centrifuge and Filtered Solids Samples Collected at Location LS431V During Three Storm Events

Parameter	Collection Date	PCB Conc'n in Centrifuge Solids (mg/kg DW)	PCB Conc'n in Filtered Solids (mg/kg DW)	Ratio of PCB Conc'ns in Centrifuged Solids to Filtered Solids
Copper	3/25/2011	59	30	2.0
	4/28/2011	25	24	1.0
	5/26/2011	--	18	--
Mercury	3/25/2011	0.10 U	0.060	1.7
	4/28/2011	0.050	0.060	0.83
	5/26/2011	--	0.050	--
Zinc	3/25/2011	280	177	1.6
	4/28/2011	188	135	1.4
	5/26/2011	--	140	--
LPAH	3/25/2011	--	--	--
	4/28/2011	--	--	--
	5/26/2011	5.0	0.65	7.7
HPAH	3/25/2011	--	--	--
	4/28/2011	--	--	--
	5/26/2011	24	4.7	5.1
cPAH TEQ	3/25/2011	--	--	--
	4/28/2011	--	--	--
	5/26/2011	2.4	0.61	4.0
Total PCBs	3/25/2011	0.63	0.30	2.1
	4/28/2011	0.22	0.18	1.2
	5/26/2011	1.7	0.24	7.3
Dioxin/Furan TEQ	3/25/2011	--	--	--
	4/28/2011	4.4	4.1	1.1
	5/26/2011	--	--	--

Notes:
-- not available
Bold: Undetected result
Exceeds Lower SL (Table 1-1)
Exceeds Upper SL (Table 1-1)
LPAH - low molecular weight polycyclic aromatic hydrocarbons
HPAH - high molecular weight polycyclic aromatic hydrocarbons
cPAH - carcinogenic polycyclic aromatic hydrocarbons
TEQ - toxic equivalent quotient
PCB - polychlorinated biphenyl

Appendix A
LDW Source Tracing Database

(Provided on CD)

Lower Duwamish Waterway

Source Tracing Data Evaluation: Stormwater Pathway

Volume 2: Figures

Prepared for

Toxics Cleanup Program
Northwest Regional Office
Washington State Department of Ecology
Bellevue, Washington

Prepared by

Science Applications International Corporation
18912 North Creek Parkway, Suite 101
Bothell, WA 98011

and

NewFields
115 2nd Ave N
Suite 100
Edmonds, WA 98020

December 2011

Volume 2: Figures
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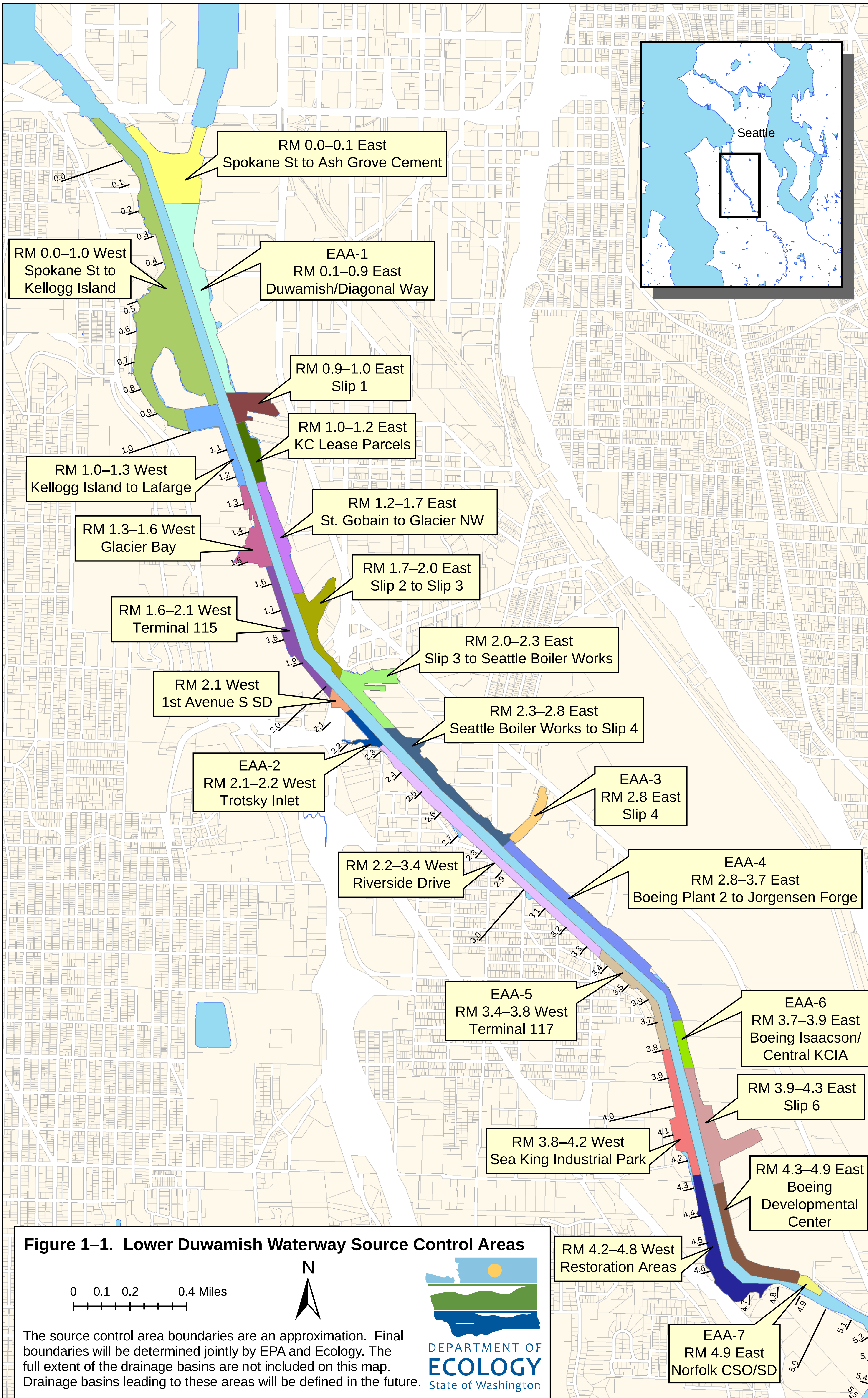

Figure 1–1. Lower Duwamish Waterway Source Control Areas

The source control area boundaries are an approximation. Final boundaries will be determined jointly by EPA and Ecology. The full extent of the drainage basins are not included on this map. Drainage basins leading to these areas will be defined in the future.

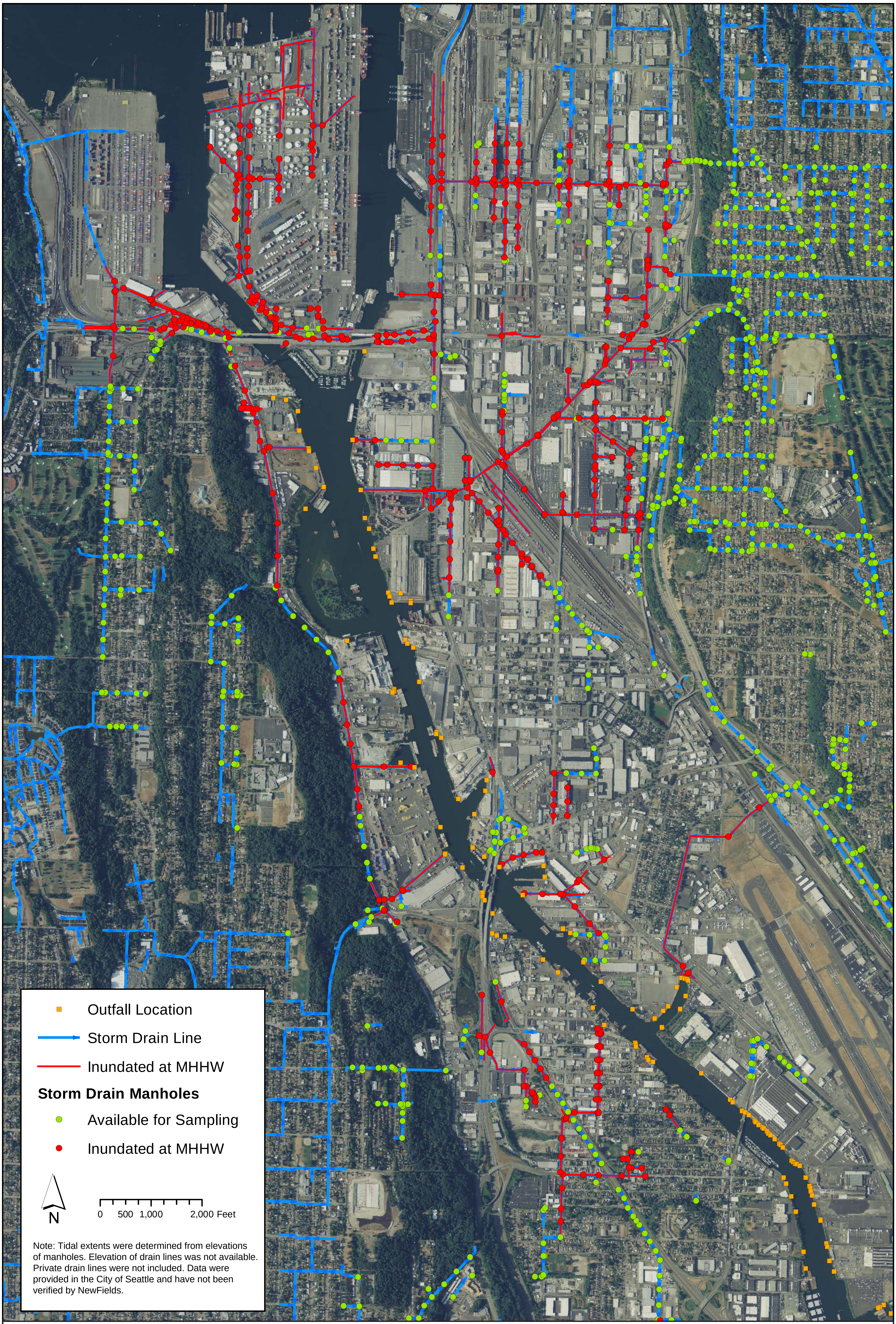

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Figure 1–2. Extent of LDW Storm Drain Tidal Water Inundation

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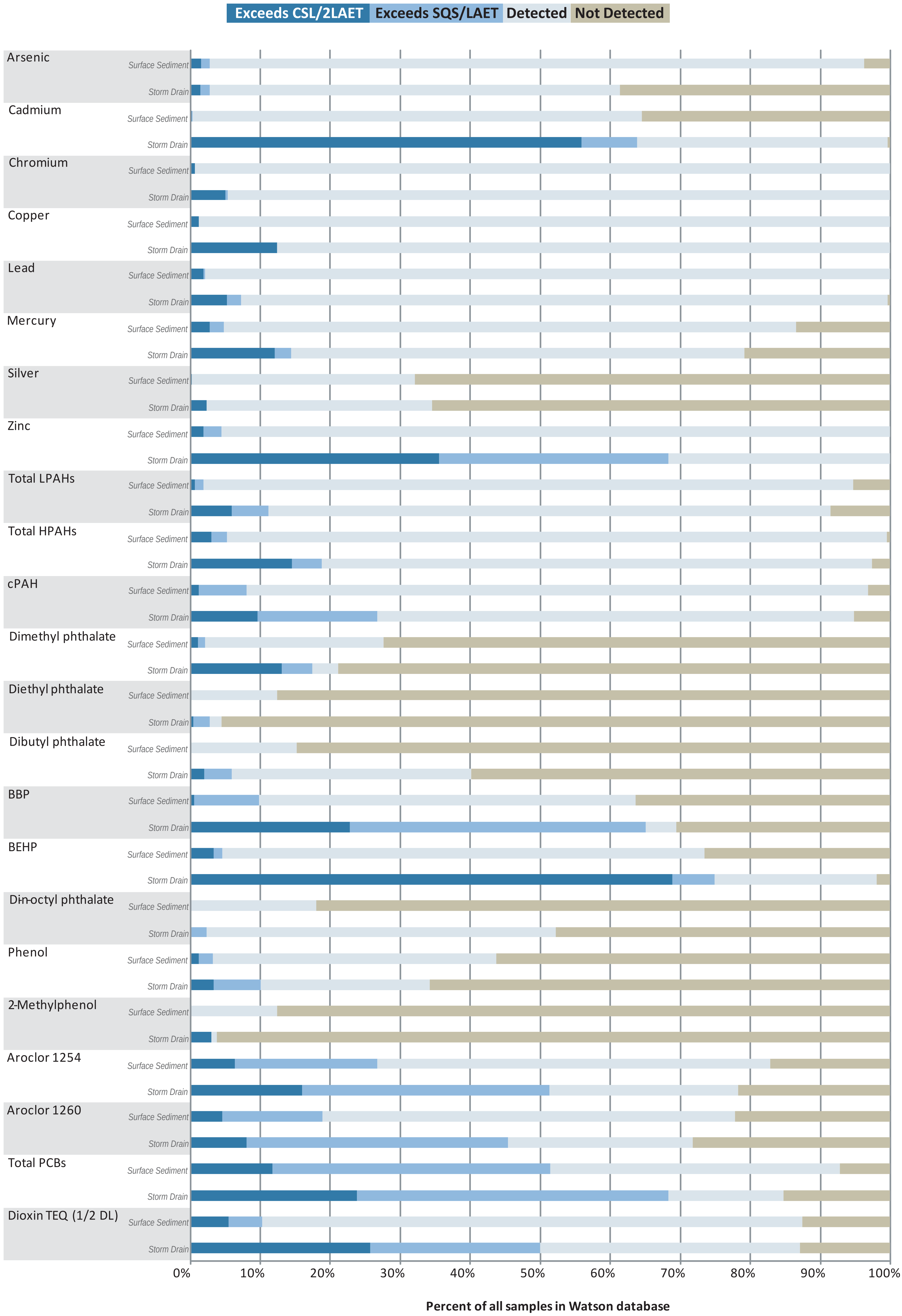

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Figure 3–1a. Summary of Screening Level Exceedances in Surface Sediment and Storm Drain Solids Samples

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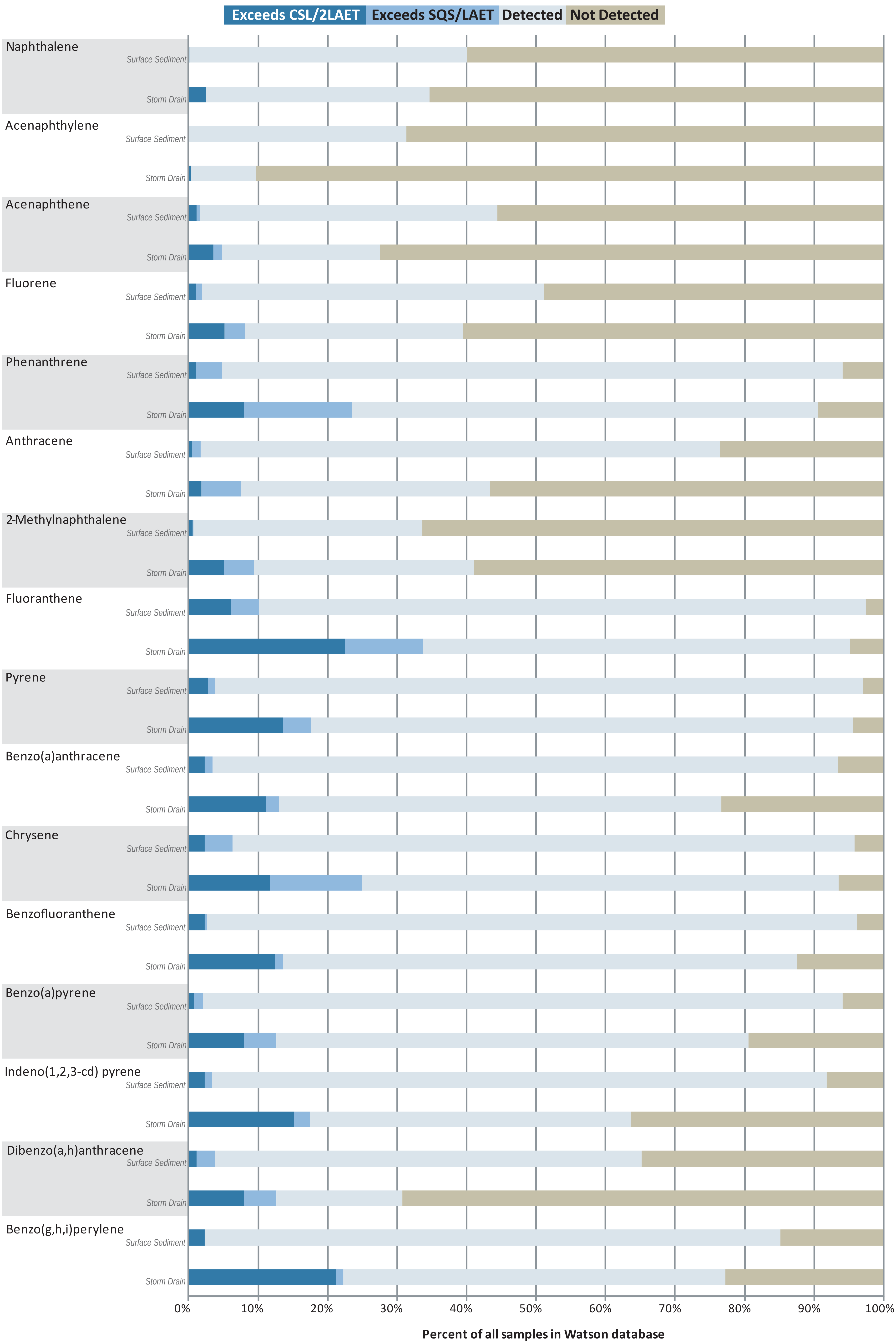

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Figure 3–1b. Summary of Screening Level Exceedances for Individual PAH Compounds

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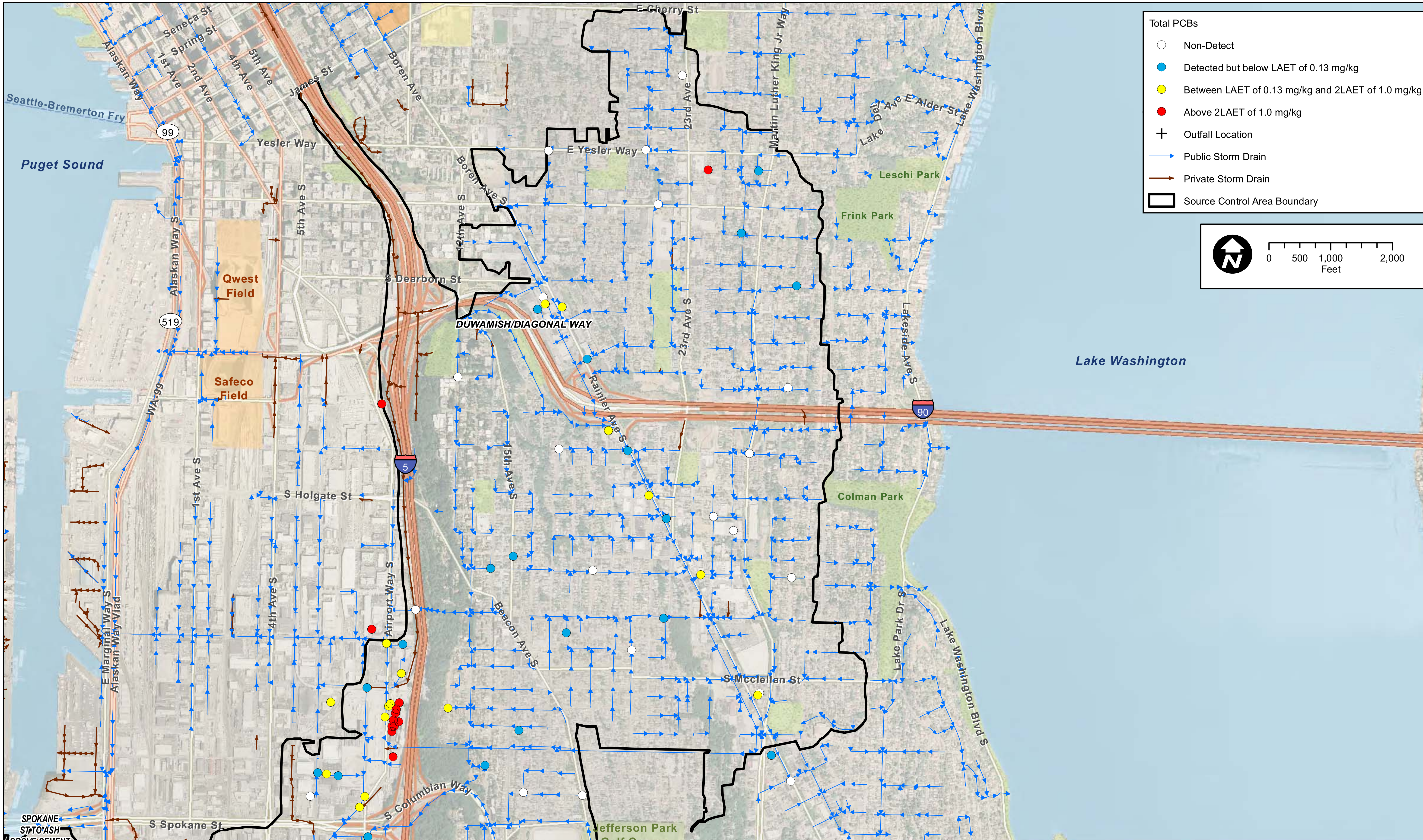

Figure 3-2a. Total PCB Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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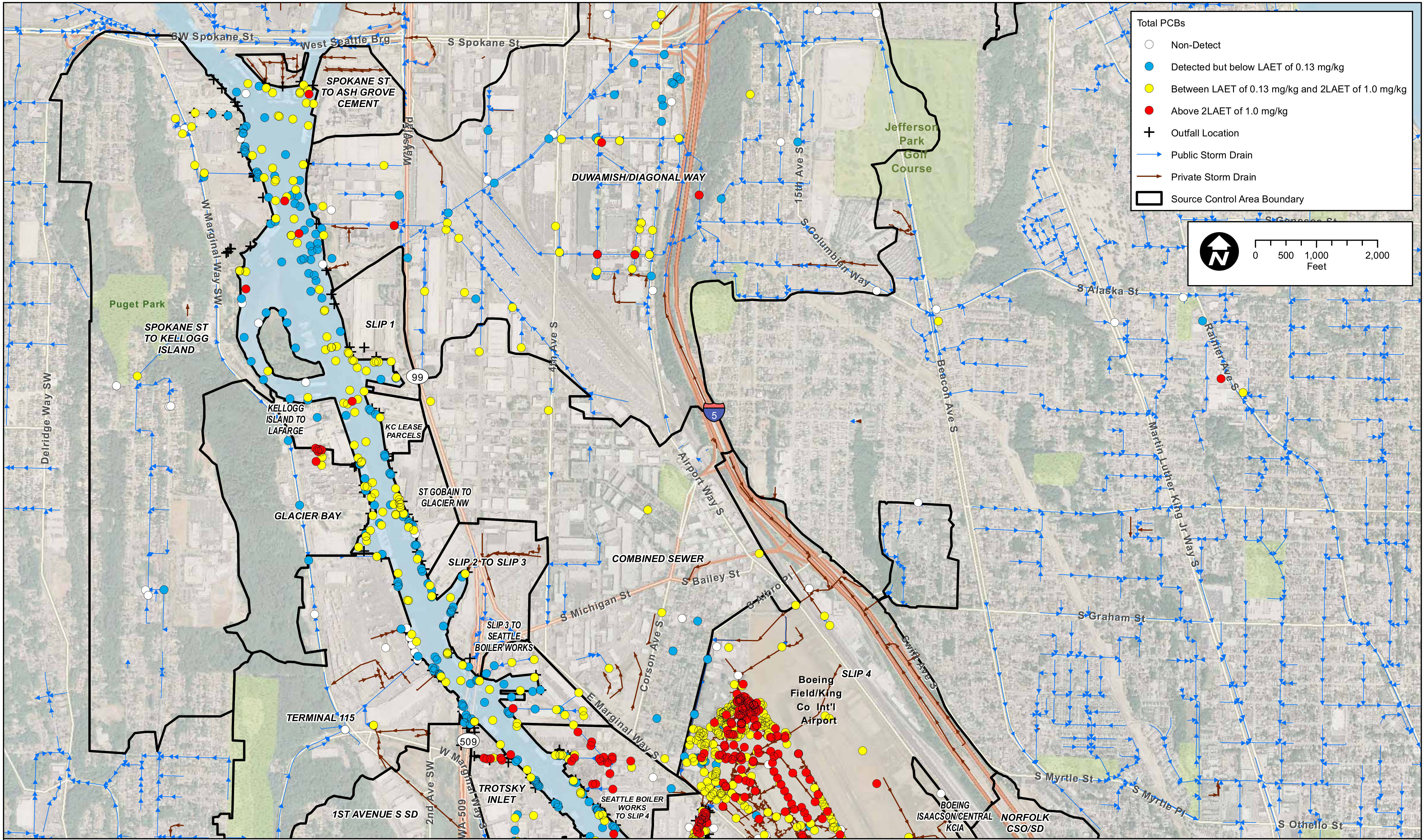

Figure 3-2b. Total PCB Concentrations in Sediment and Storm Drain Samples

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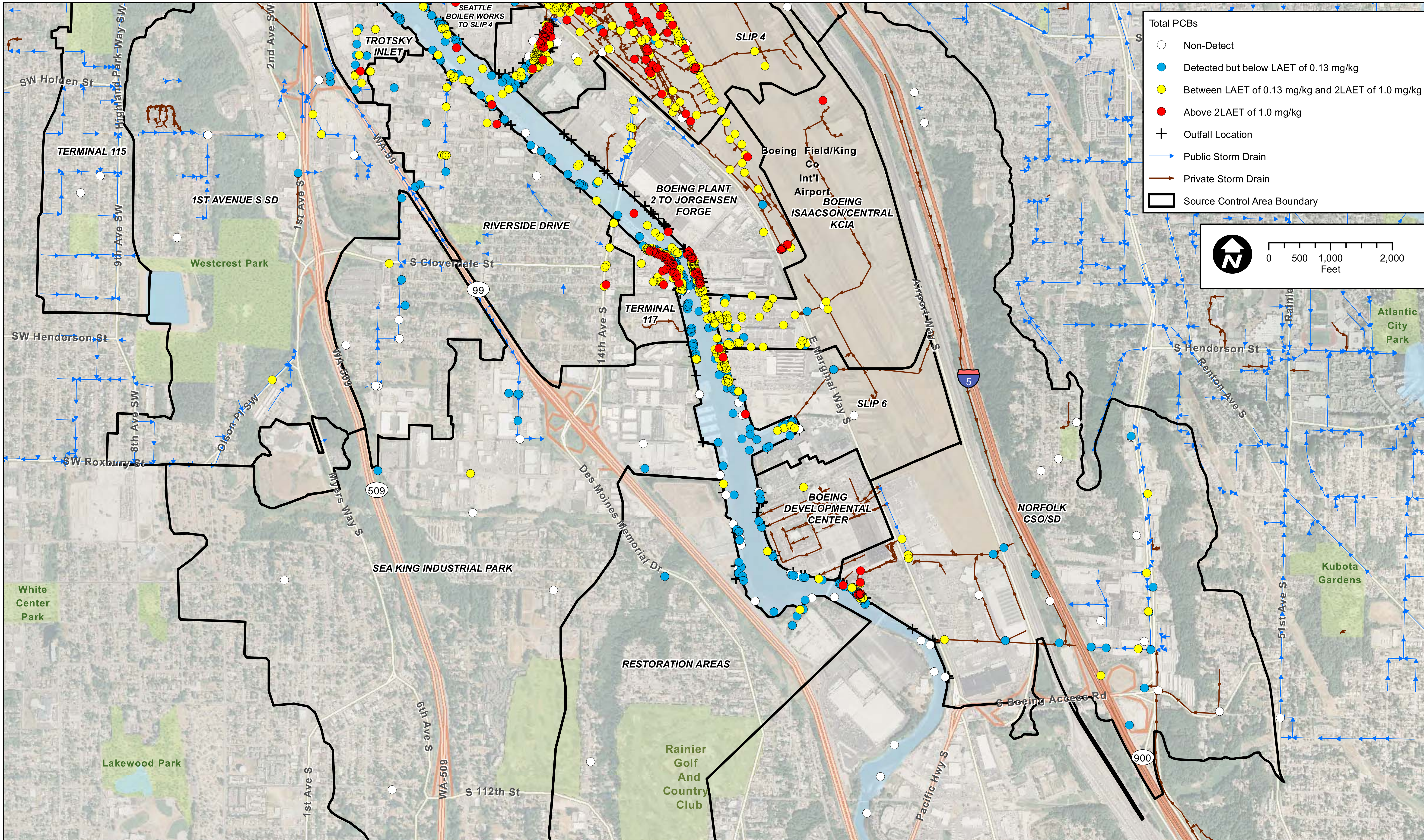

Figure 3-2c. Total PCB Concentrations in Sediment and Storm Drain Samples

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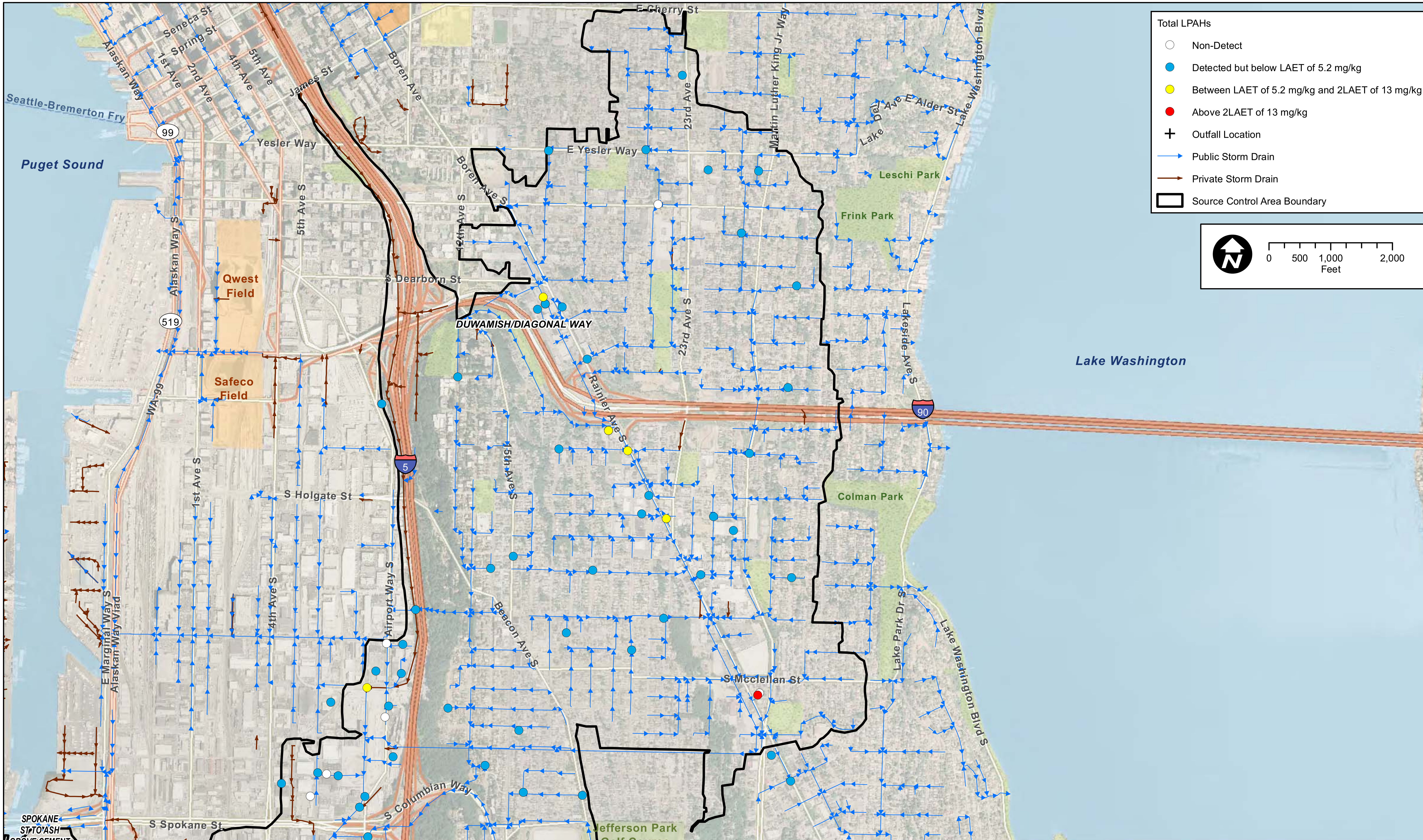

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Figure 3-3a. Total LPAH Concentrations in Sediment and Storm Drain Samples

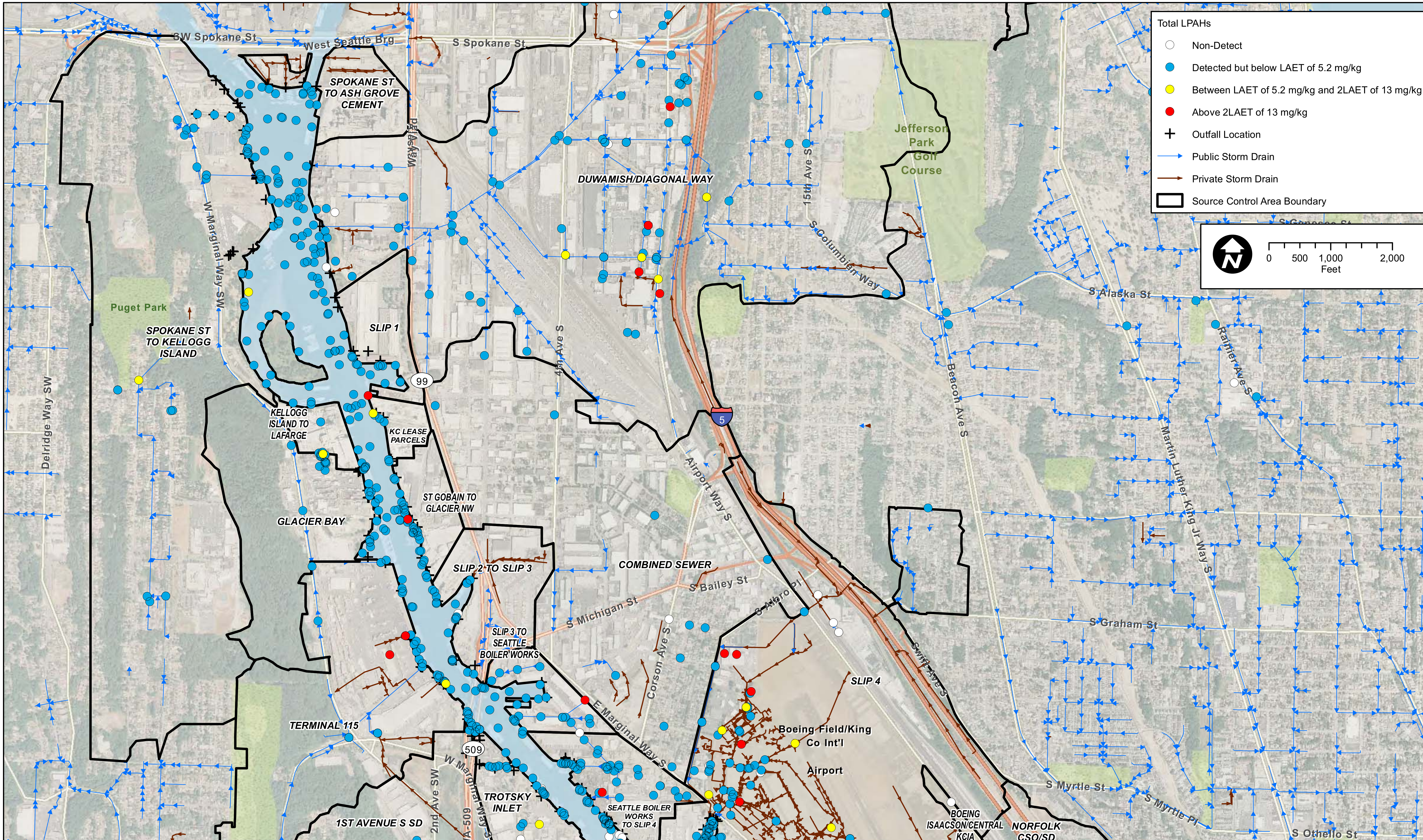

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Figure 3-3b. Total LPAH Concentrations in Sediment and Storm Drain Samples

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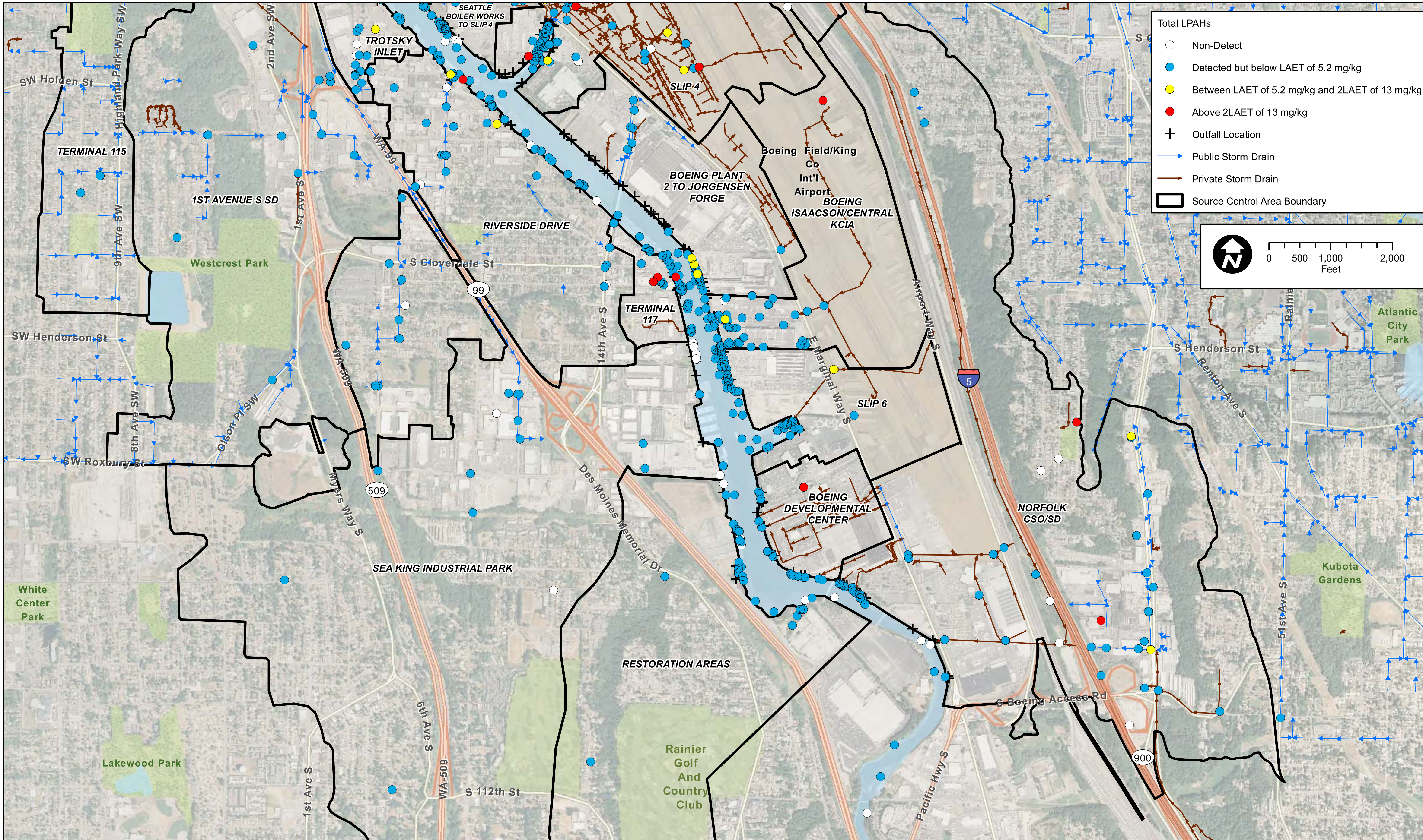

Figure 3-3c. Total LPAH Concentrations in Sediment and Storm Drain Samples

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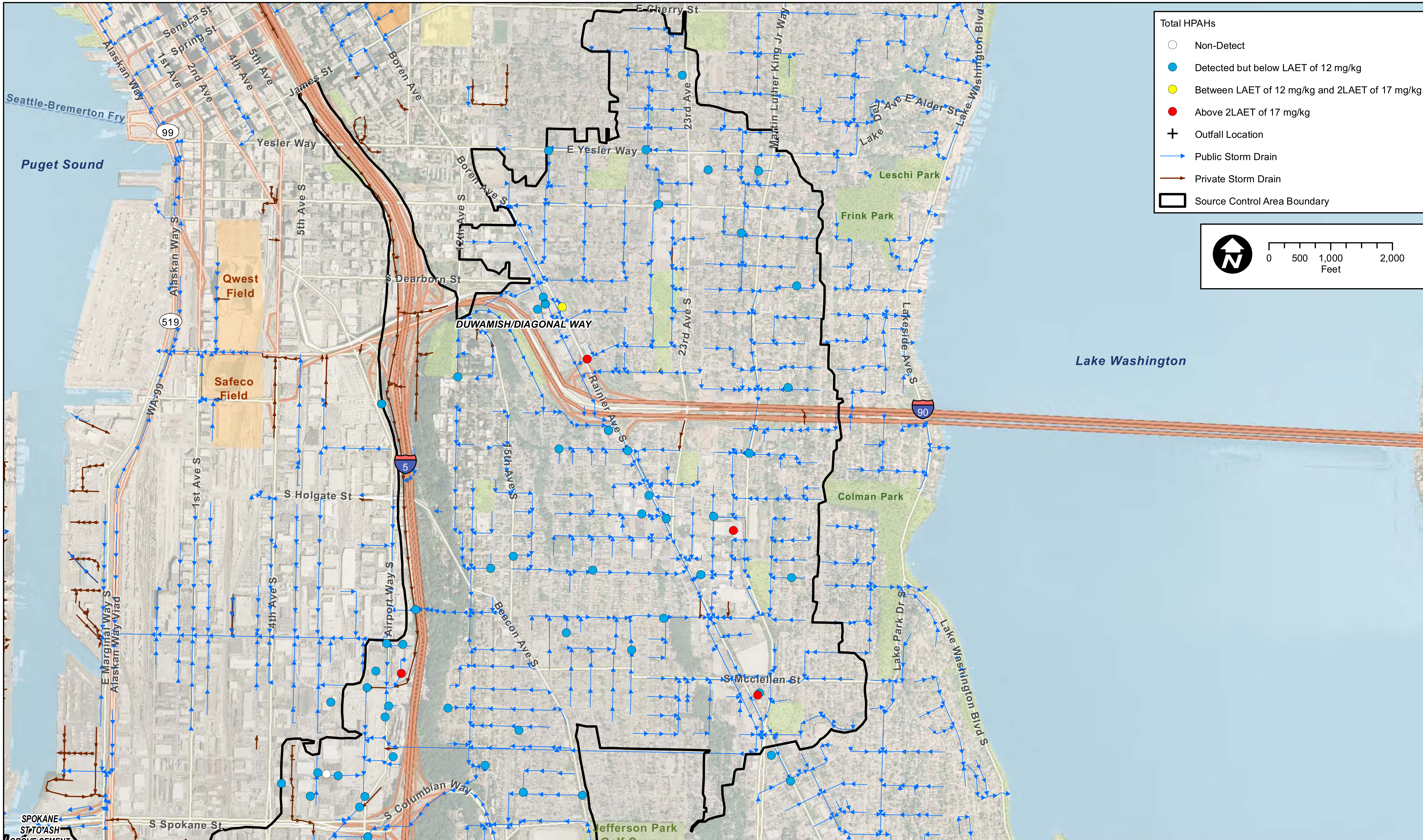

Figure 3-4a. Total HPAH Concentrations in Sediment and Storm Drain Samples

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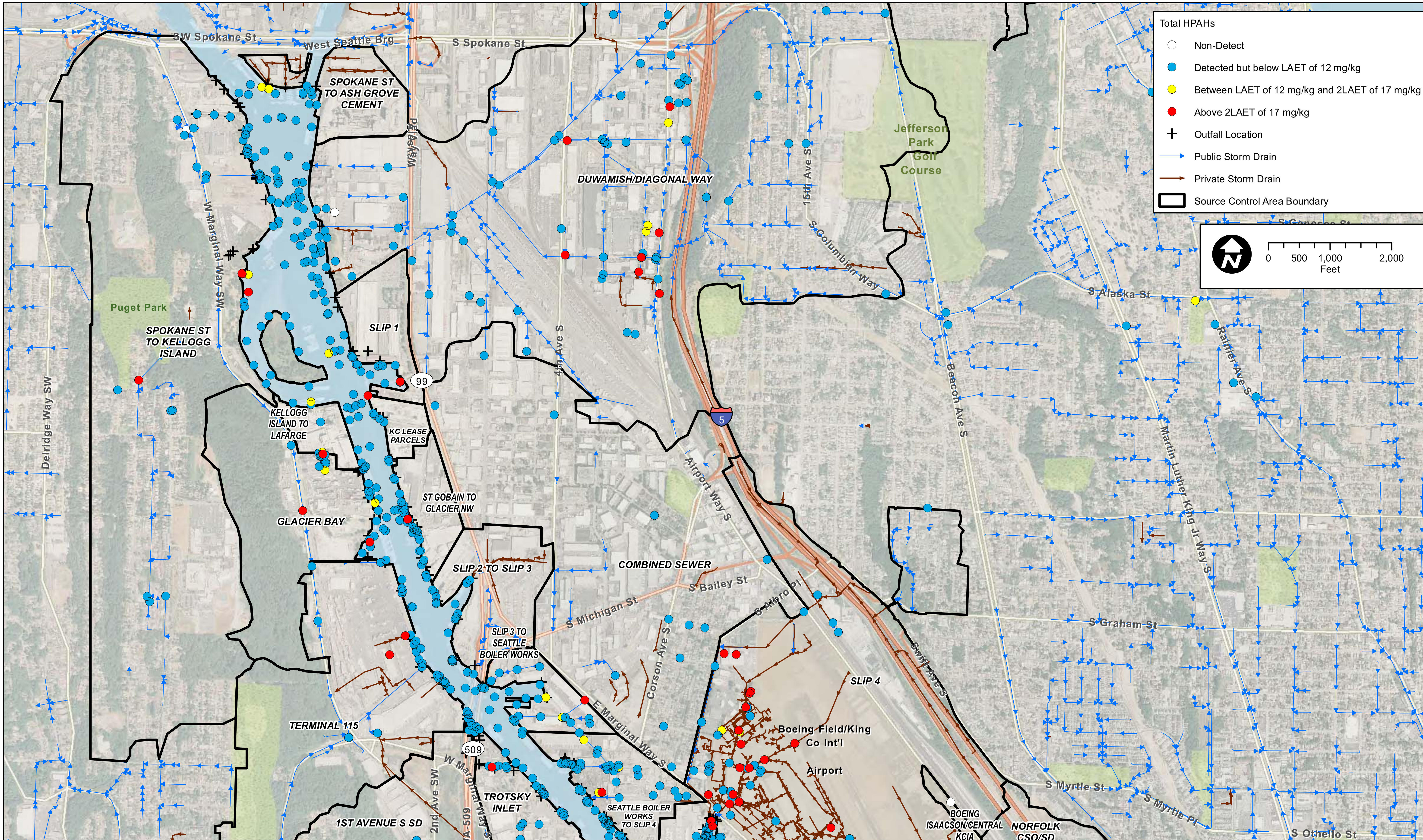

Figure 3-4b. Total HPAH Concentrations in Sediment and Storm Drain Samples

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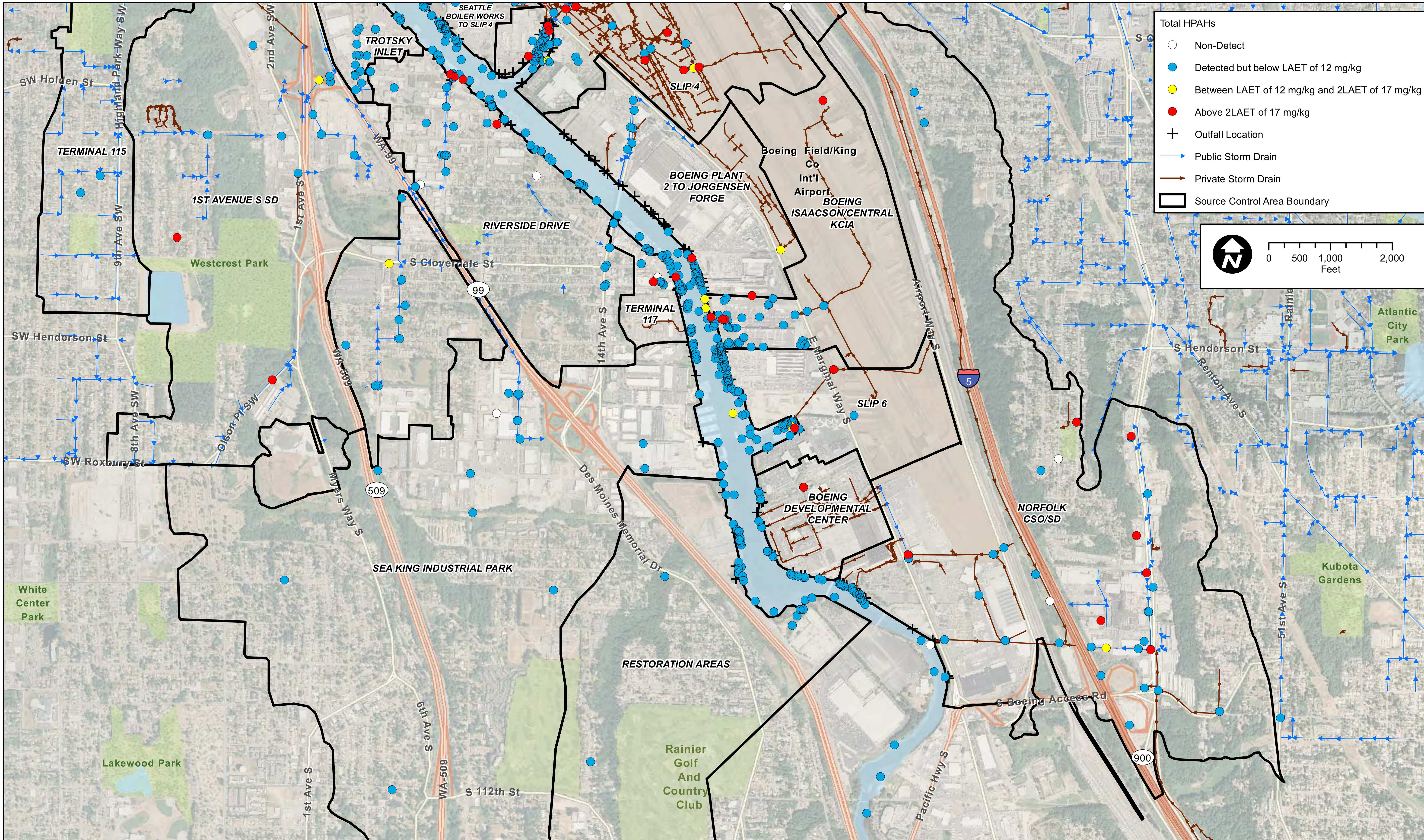

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Figure 3-4c. Total HPAH Concentrations in Sediment and Storm Drain Samples

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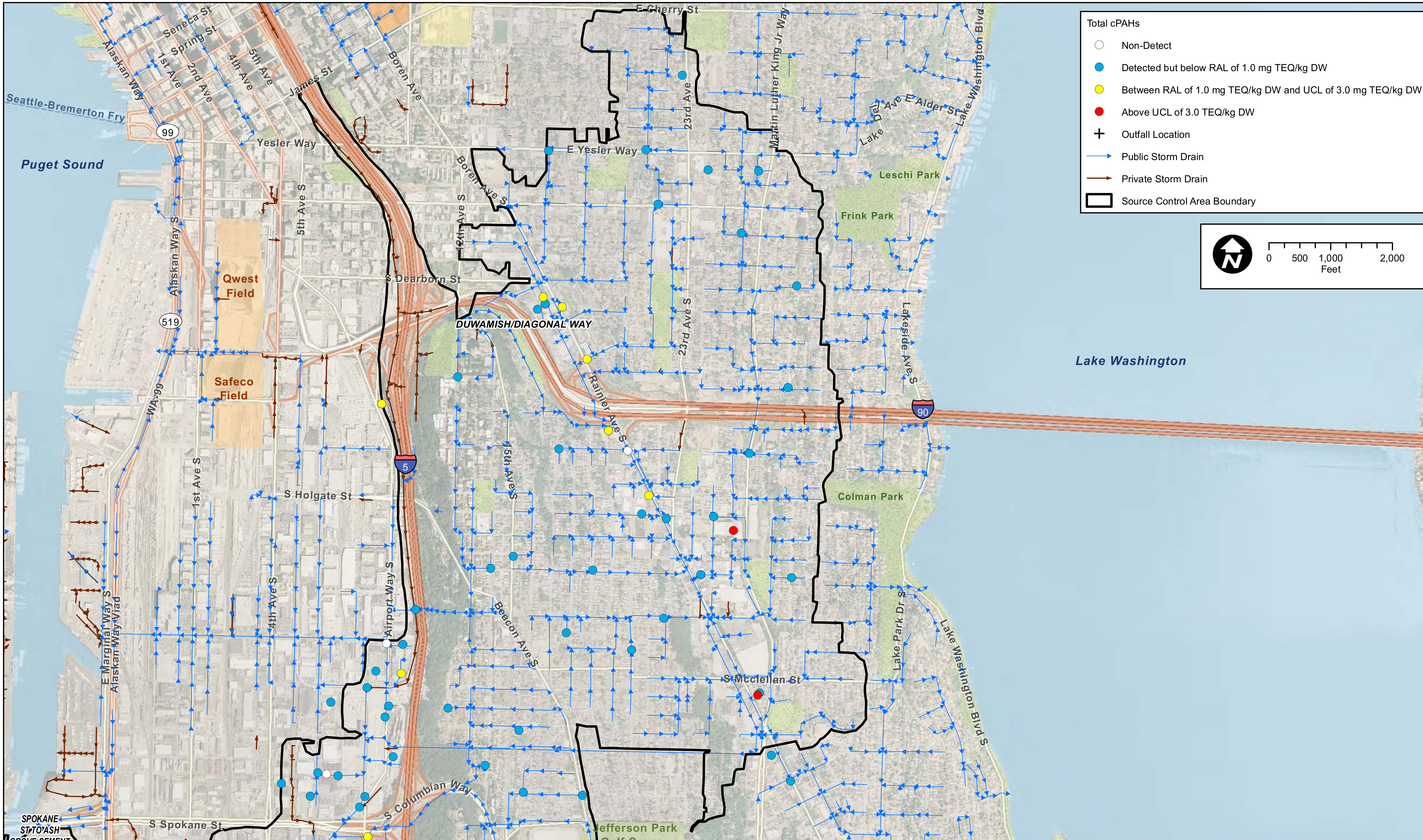

Figure 3-5a. Total cPAH Concentrations in Sediment and Storm Drain Samples

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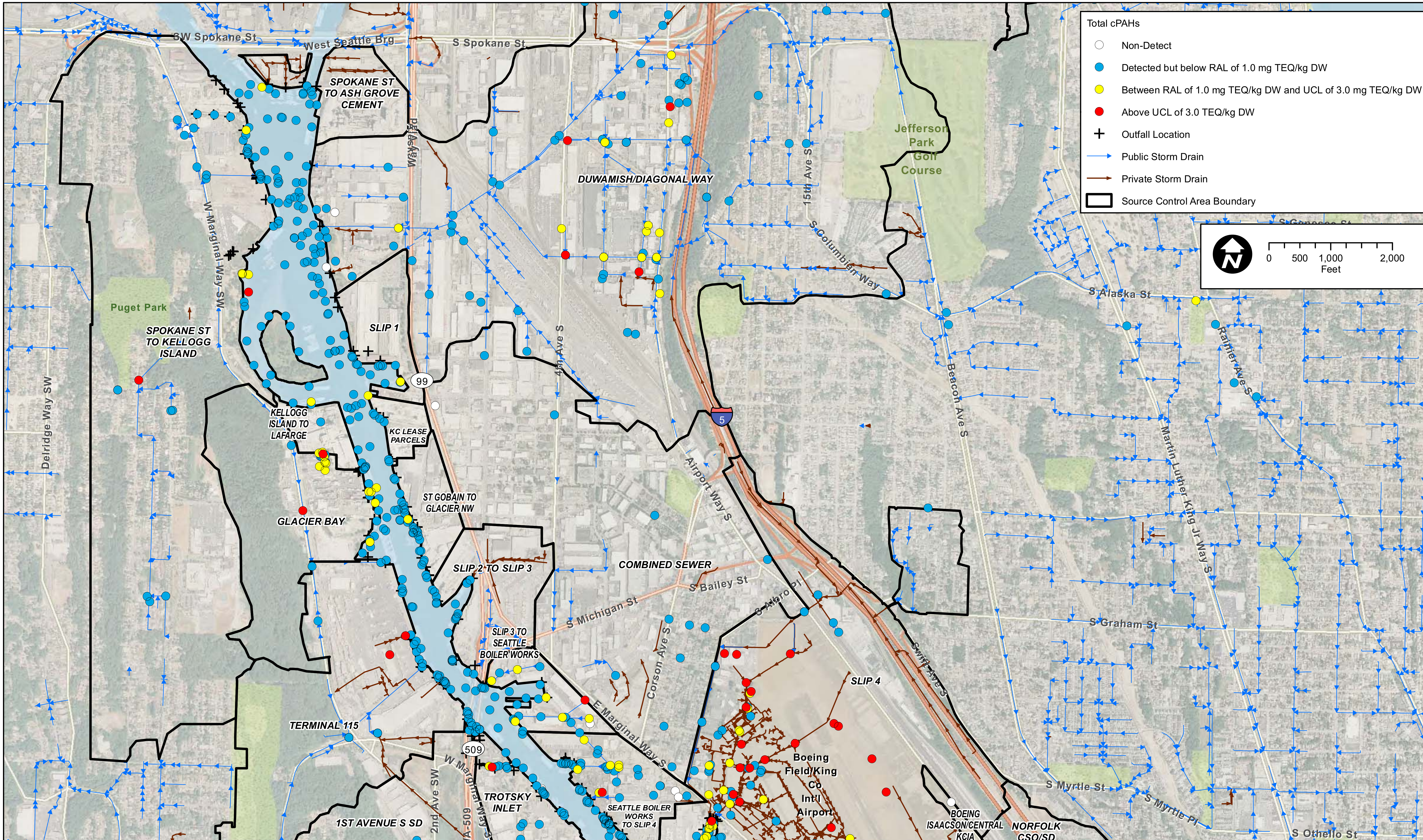

Figure 3-5b. Total cPAH Concentrations in Sediment and Storm Drain Samples

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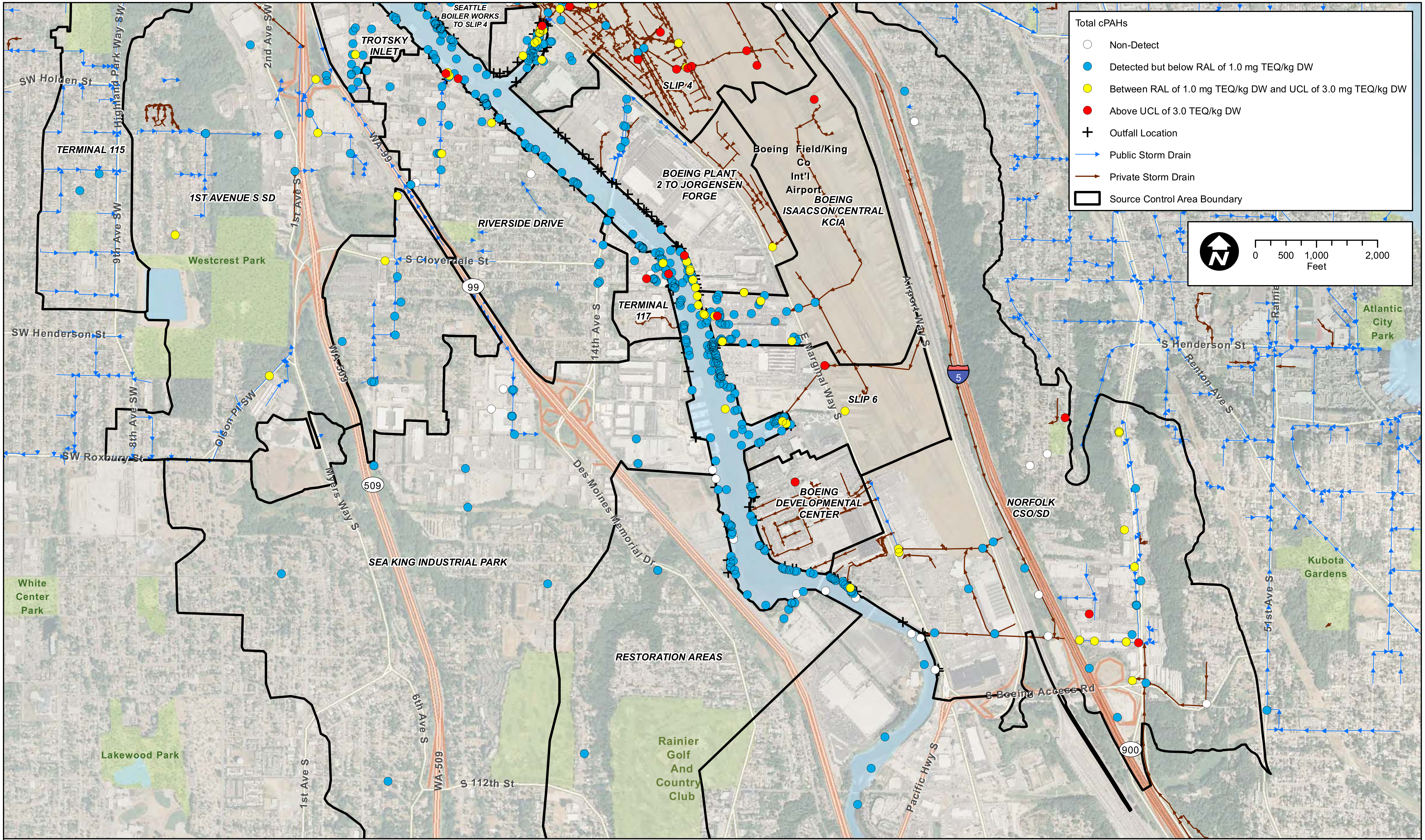

Figure 3-5c. Total cPAH Concentrations in Sediment and Storm Drain Samples

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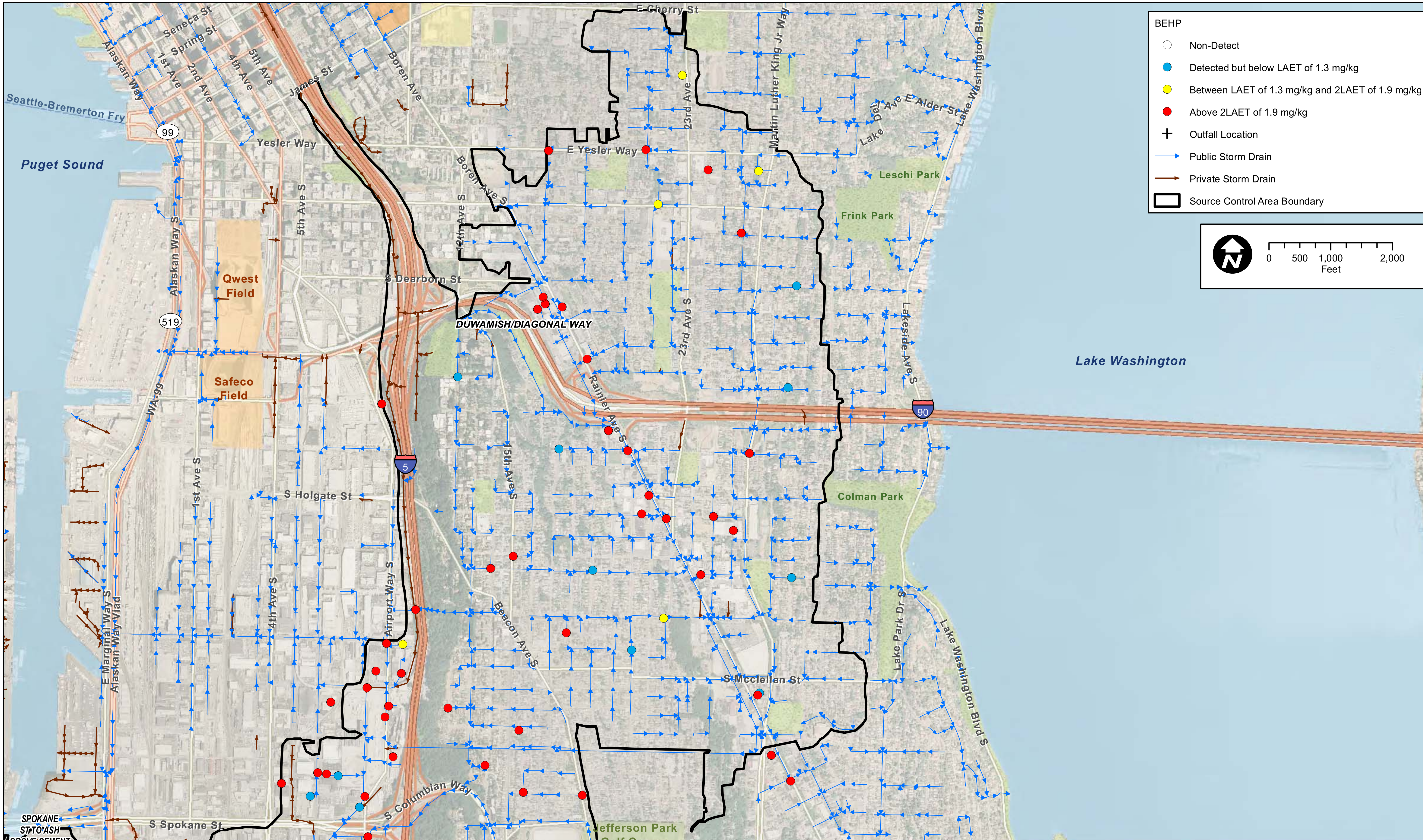

Figure 3-6a. BEHP Concentrations in Sediment and Storm Drain Samples

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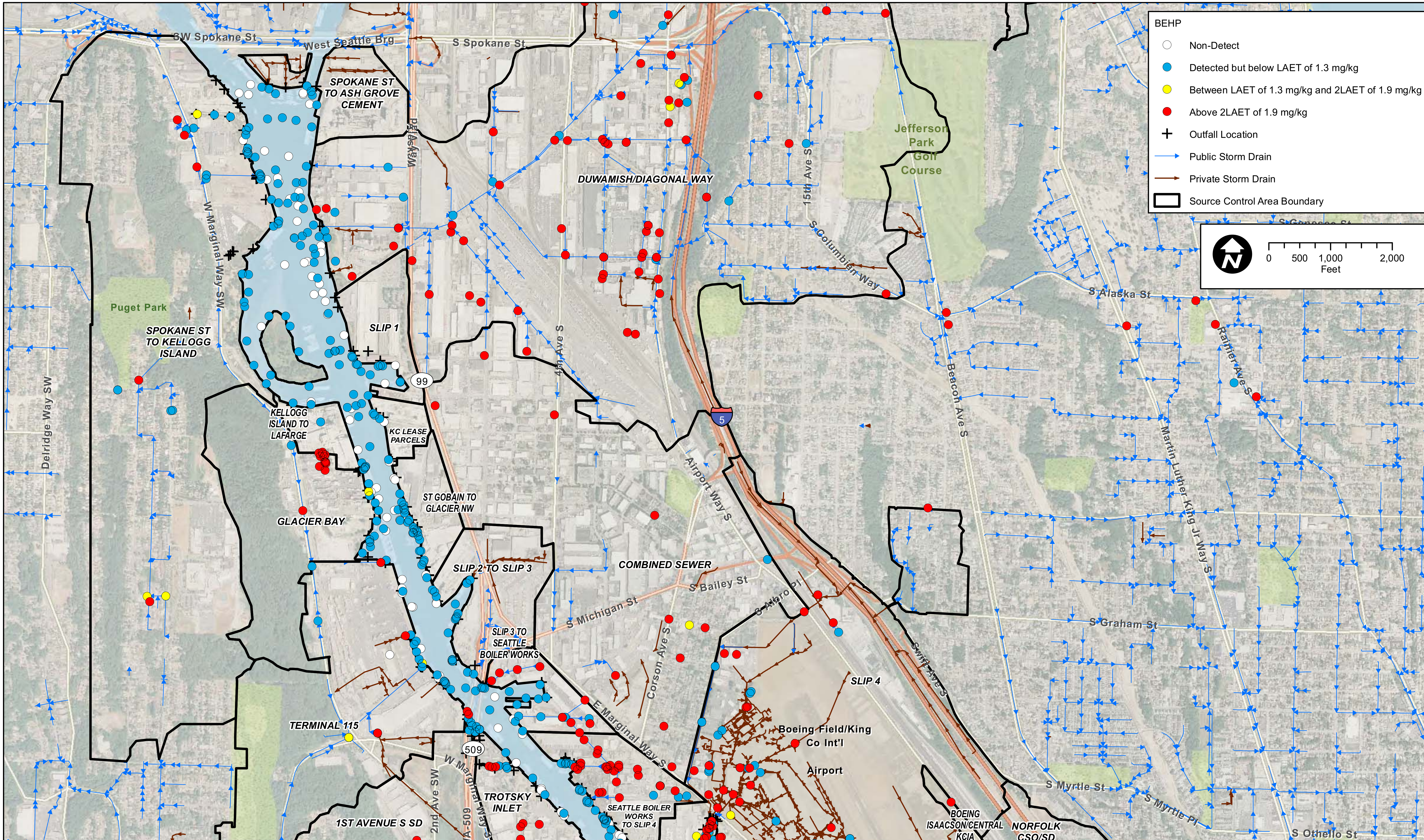

Figure 3-6b. BEHP Concentrations in Sediment and Storm Drain Samples

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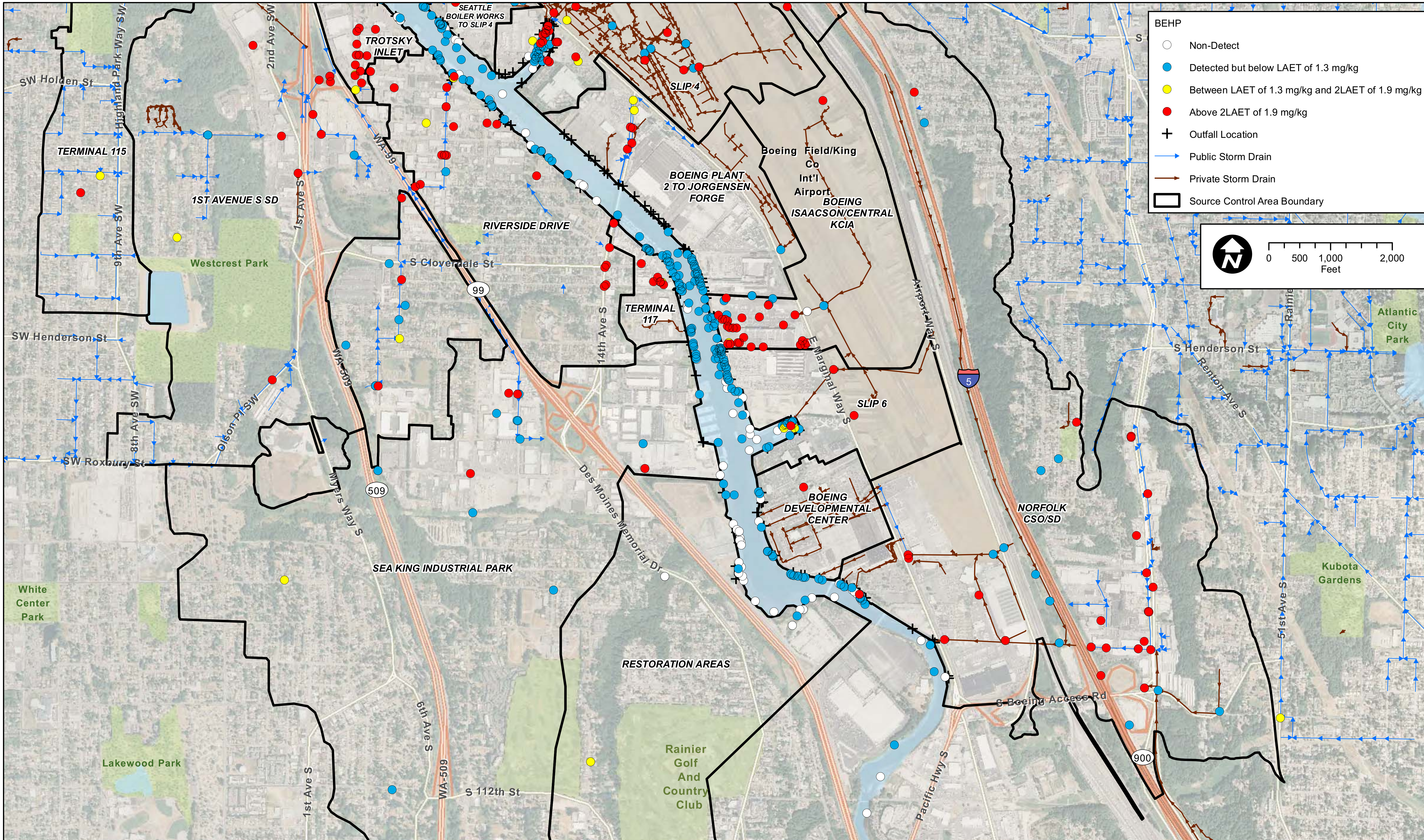

Figure 3-6c. BEHP Concentrations in Sediment and Storm Drain Samples

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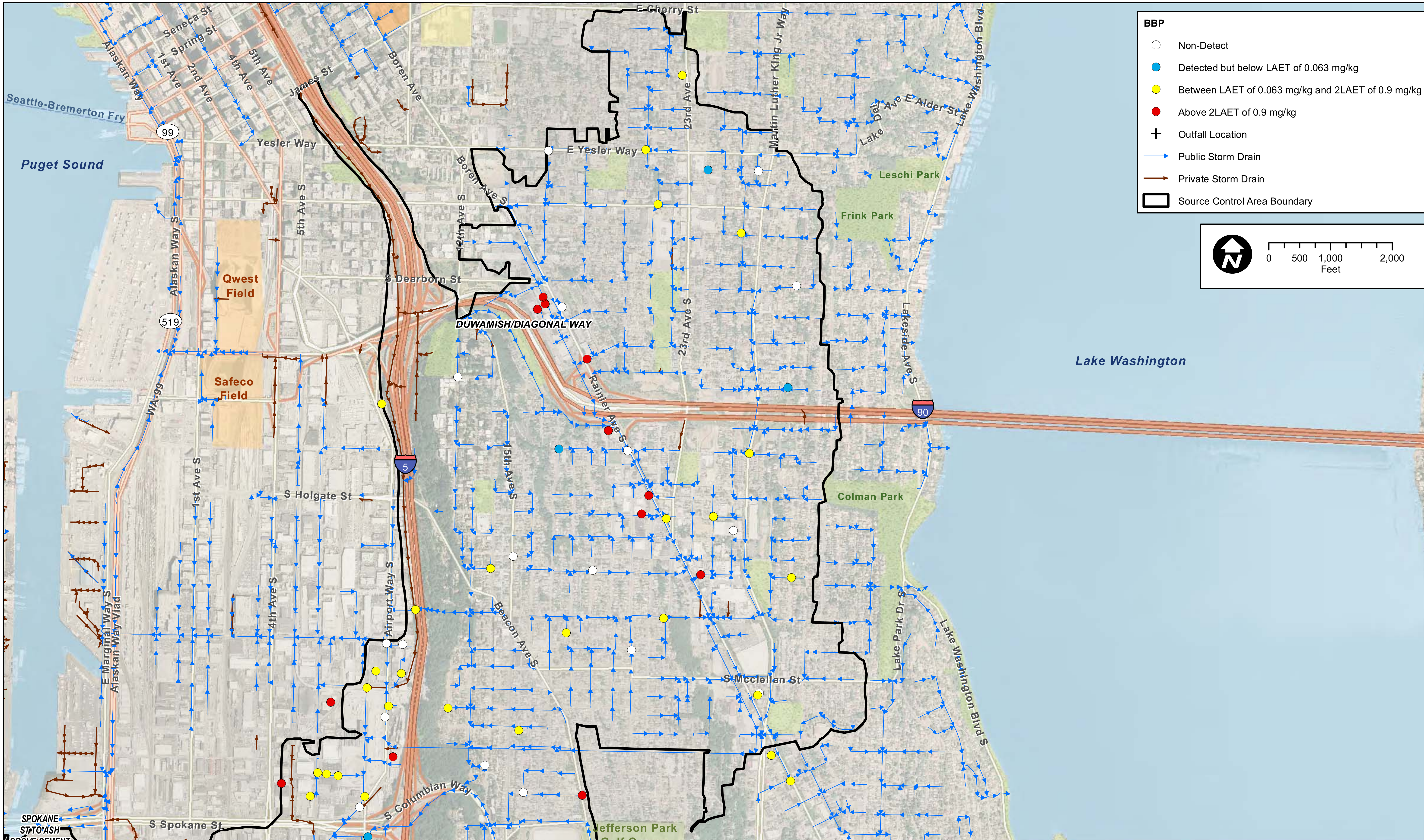

Figure 3-7a. BBP Concentrations in Sediment and Storm Drain Samples

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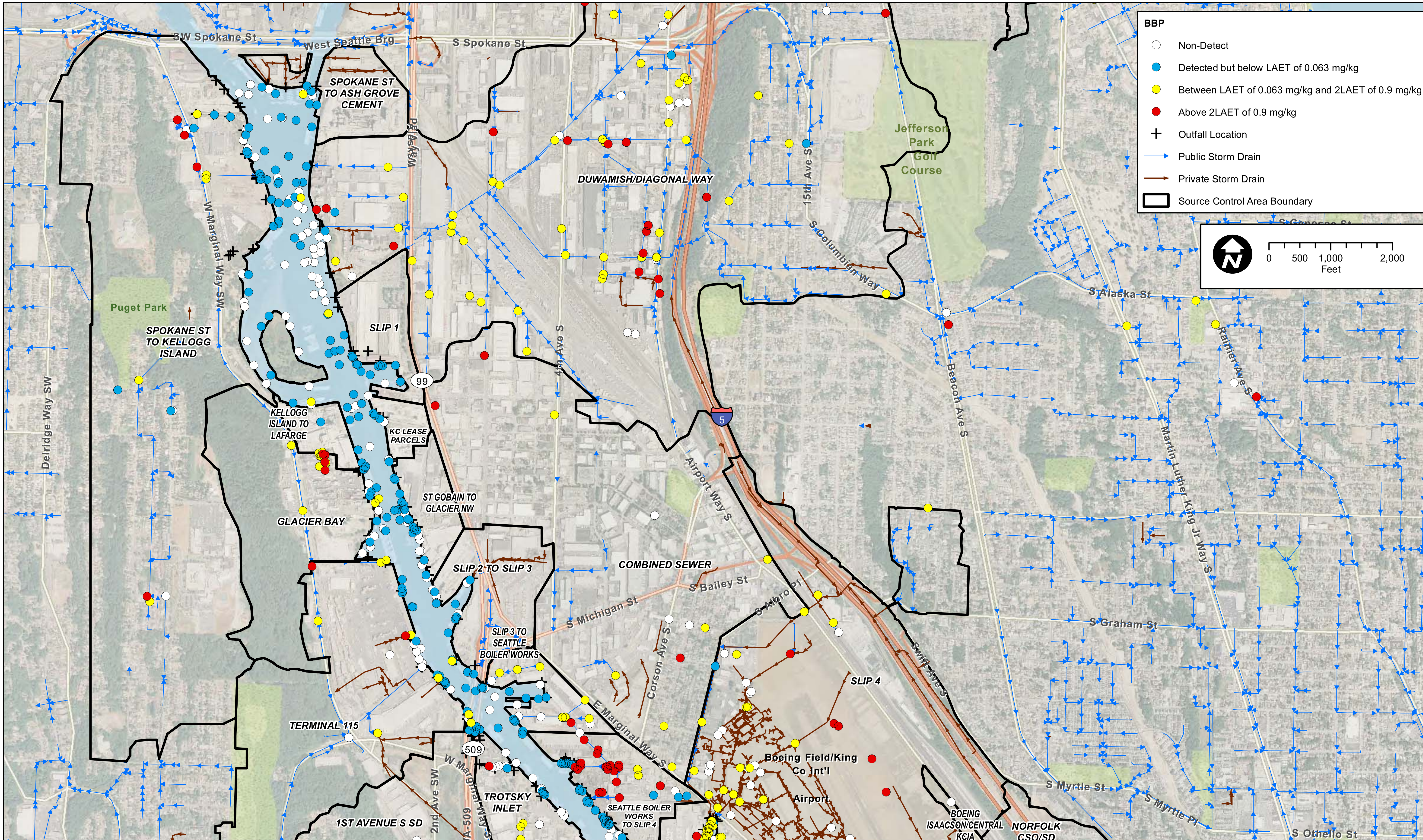

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Figure 3-7b. BBP Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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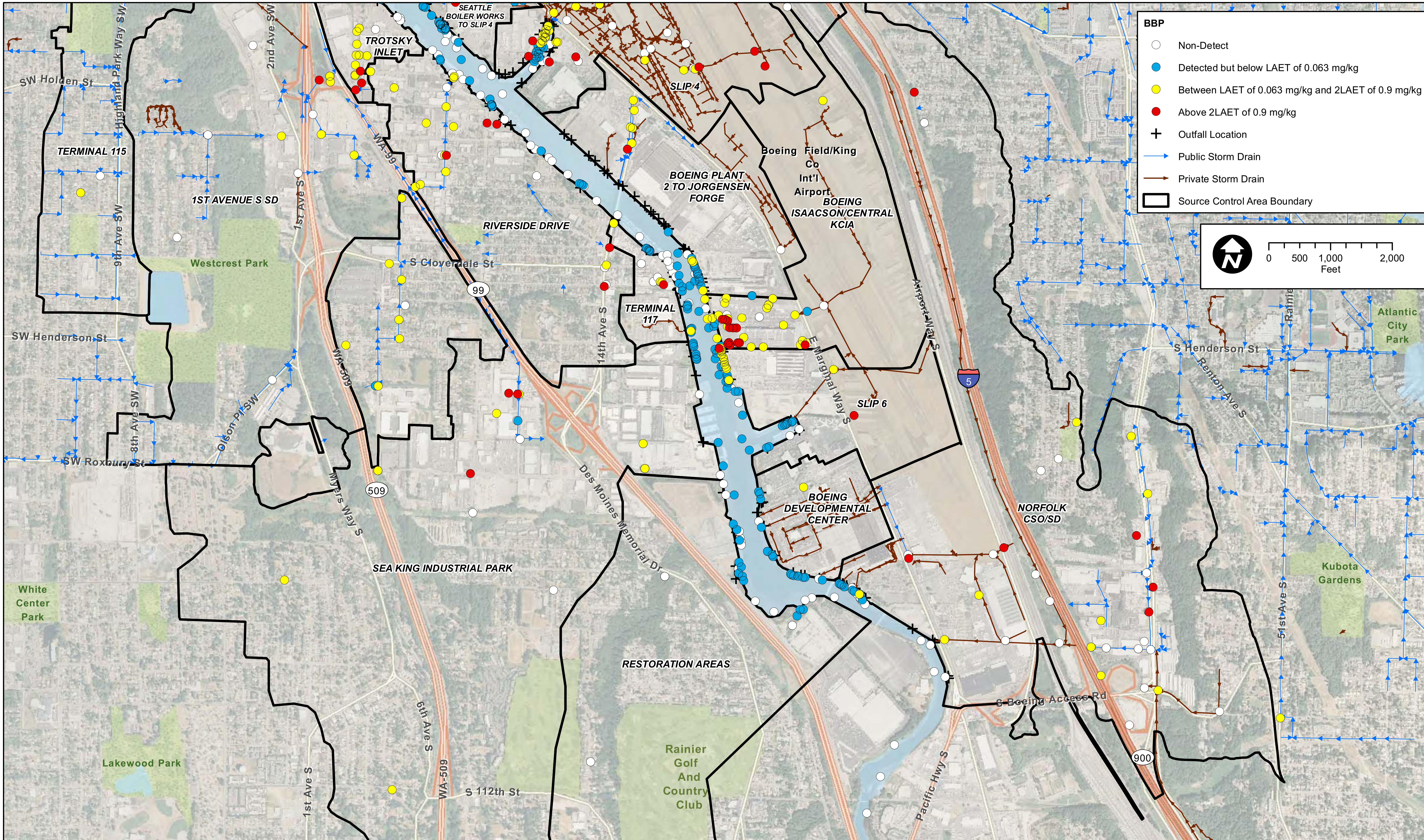

Figure 3-7c. BBP Concentrations in Sediment and Storm Drain Samples

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
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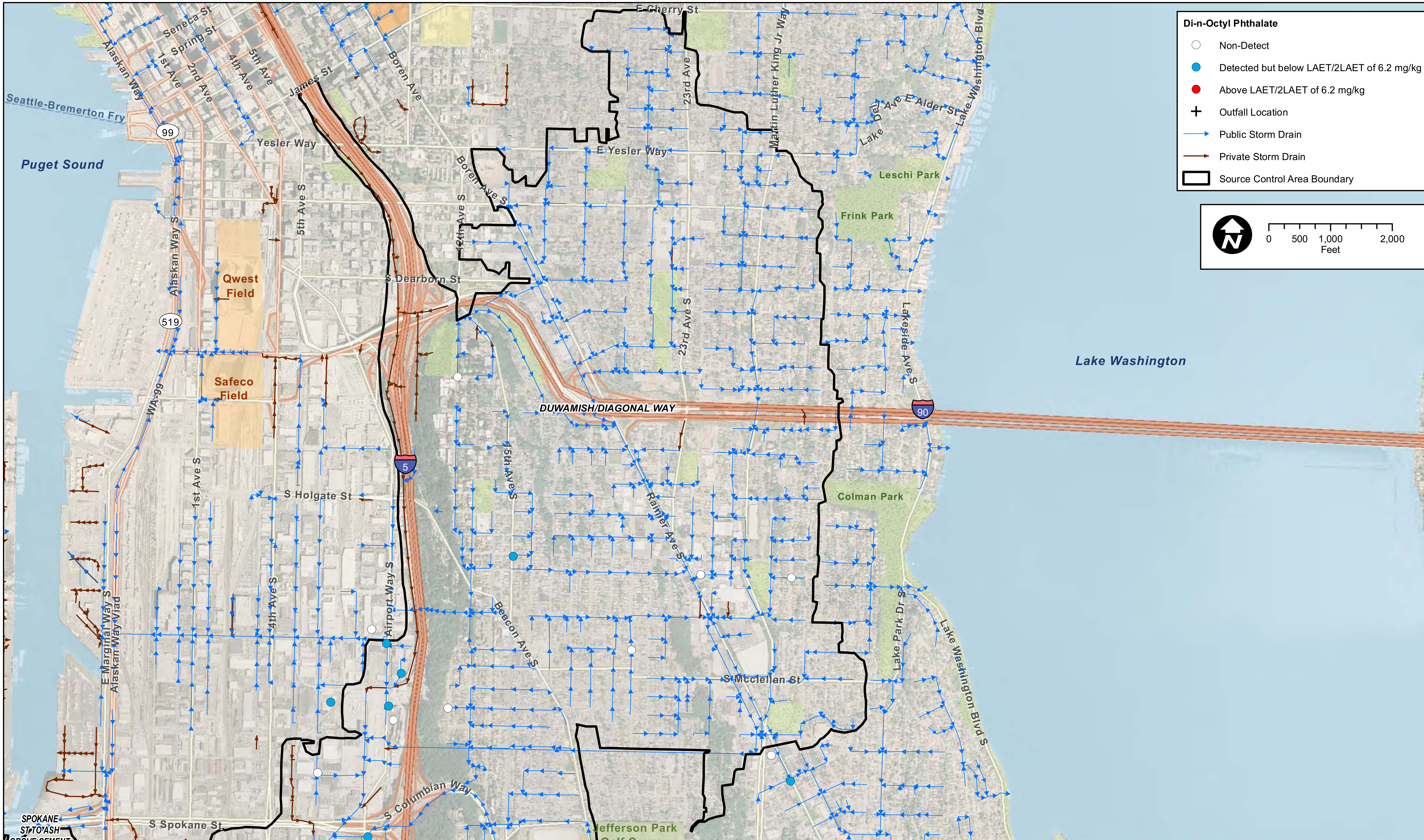

Figure 3-8a. Di-n-Octyl Phthalate Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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Prepared By: mlf
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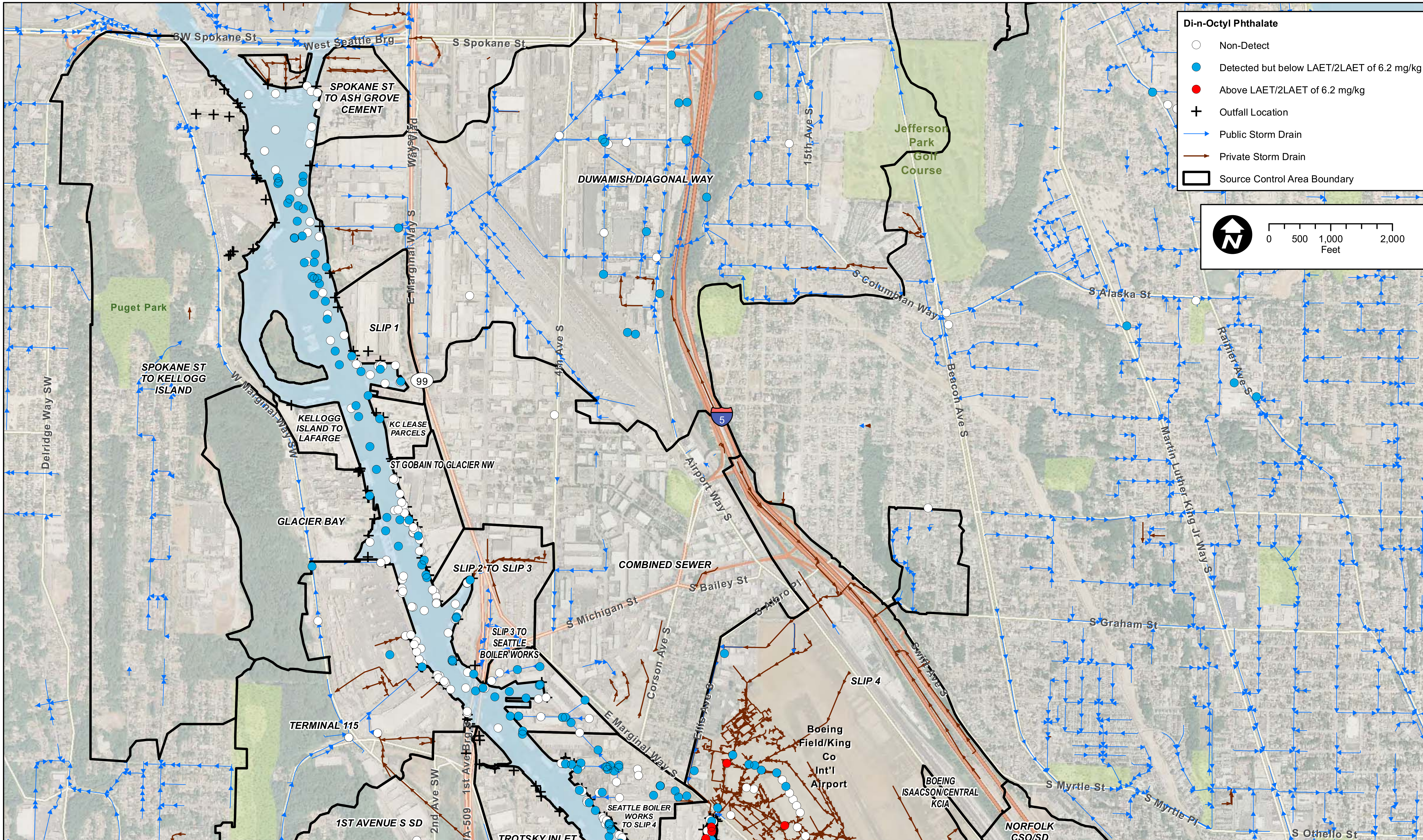

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Figure 3-8b. Di-n-Octyl Phthalate Concentrations in Sediment and Storm Drain Samples

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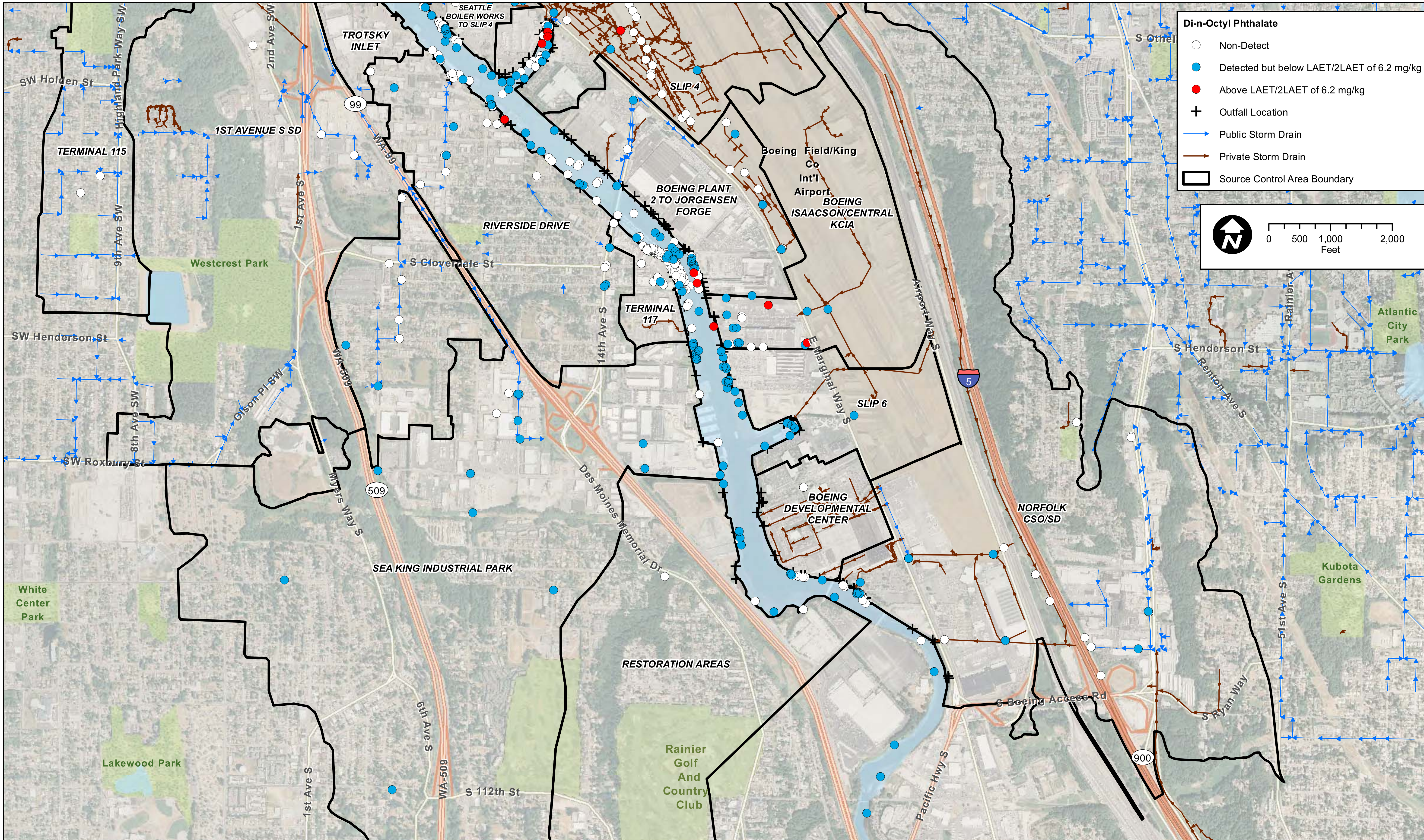

Figure 3-8c. Di-n-Octyl Phthalate Concentrations in Sediment and Storm Drain Samples

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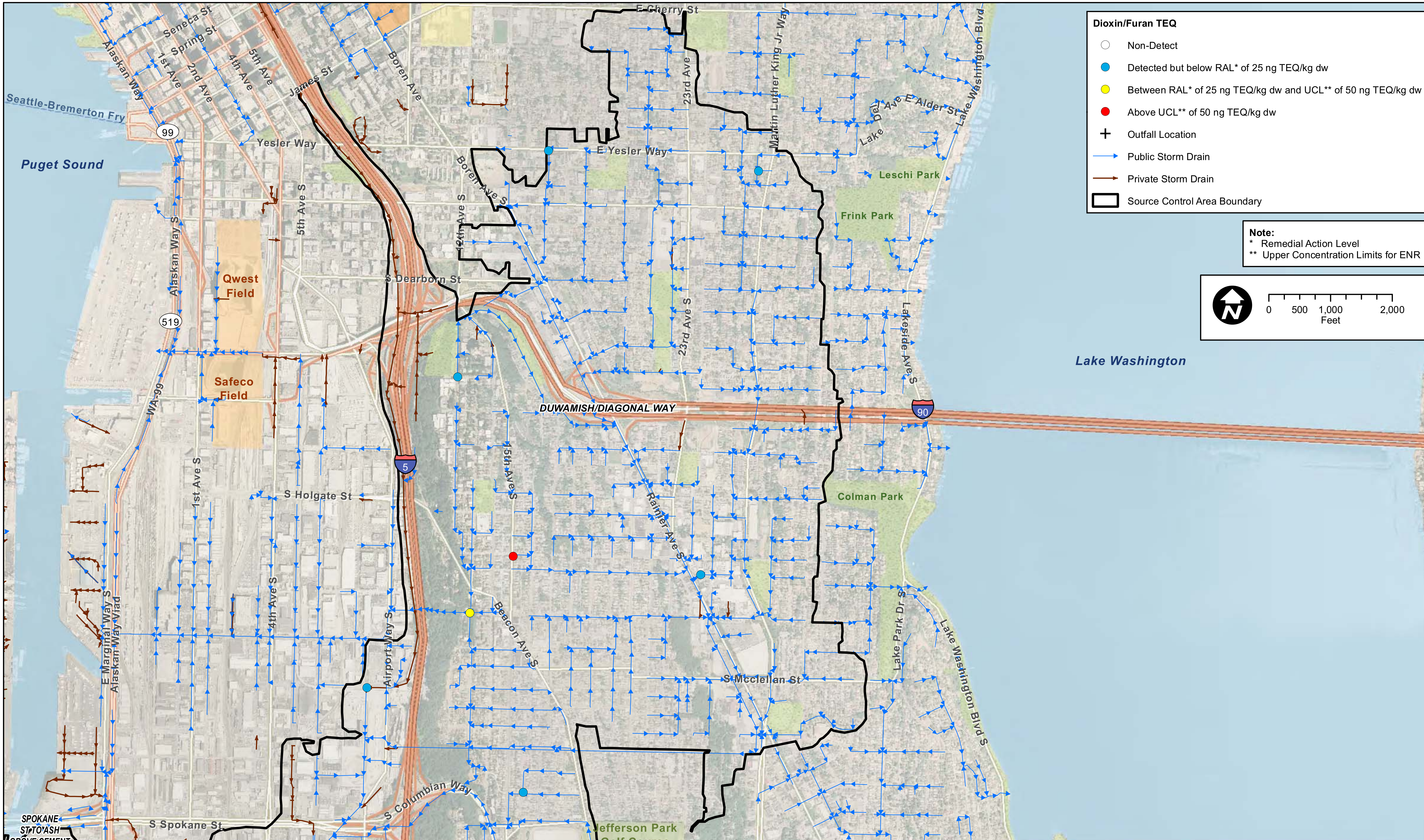

Figure 3-9a. Dioxin/Furan TEQ Concentrations in Sediment and Storm Drain Samples

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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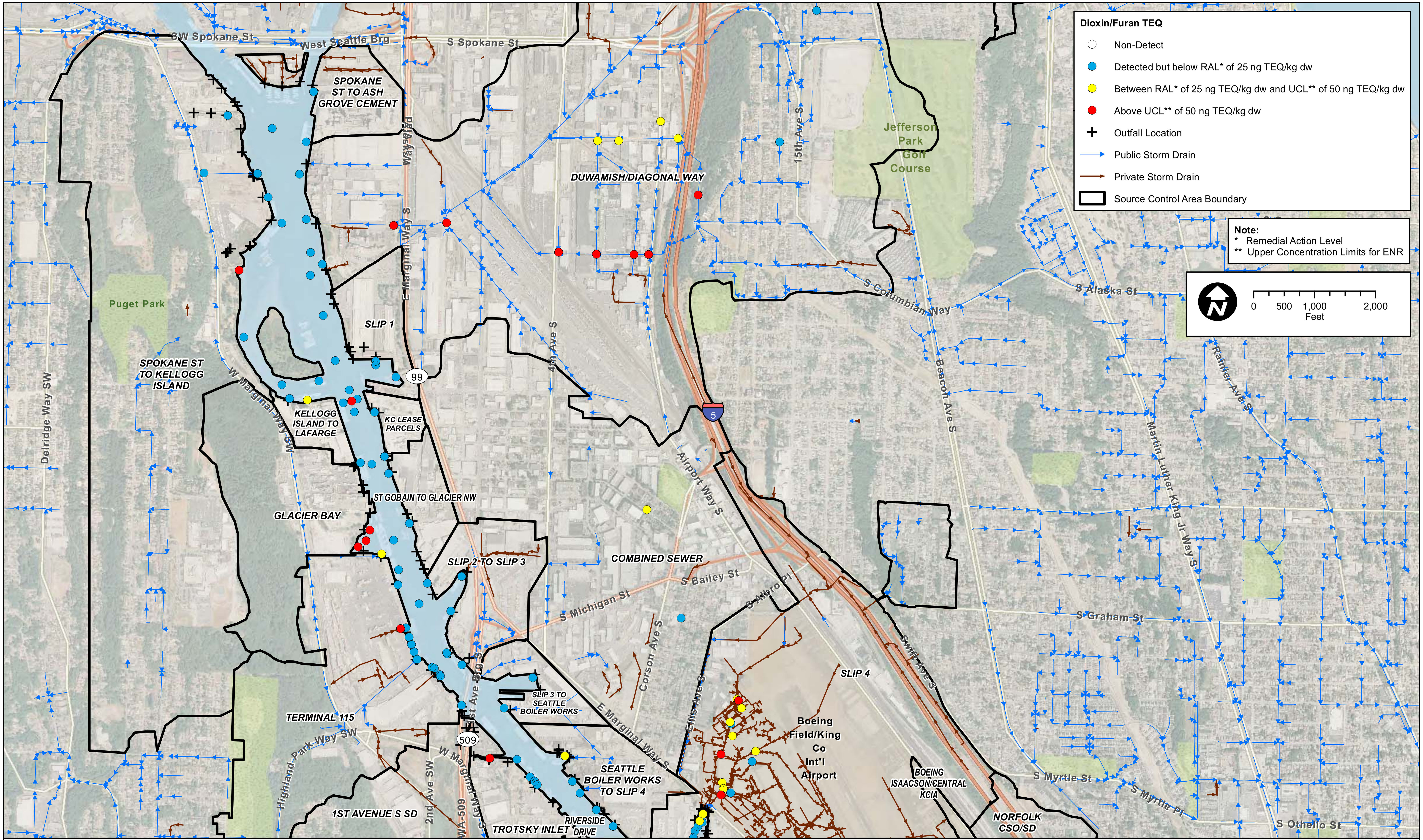

Figure 3-9b. Dioxin/Furan TEQ Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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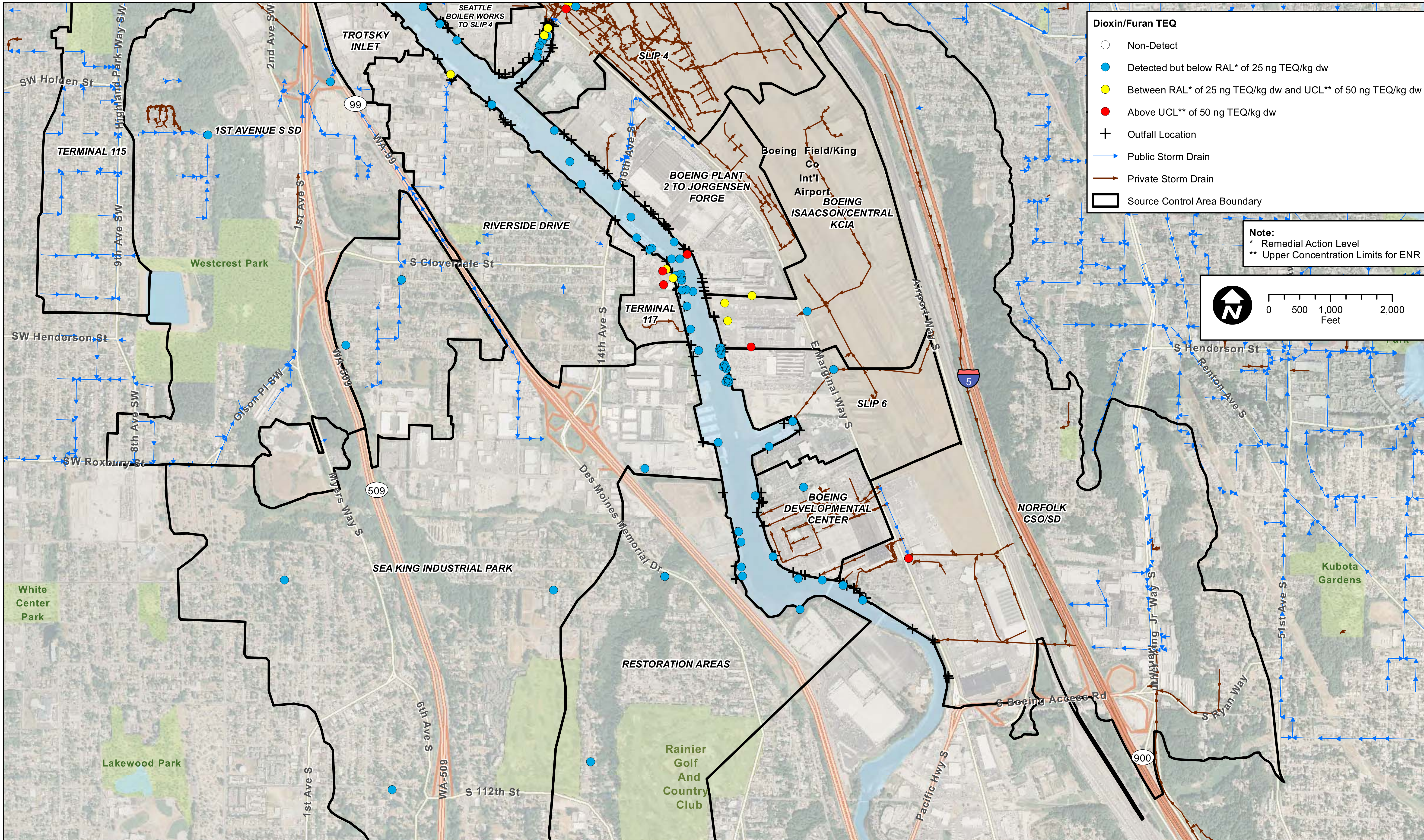

Figure 3-9c. Dioxin/Furan TEQ Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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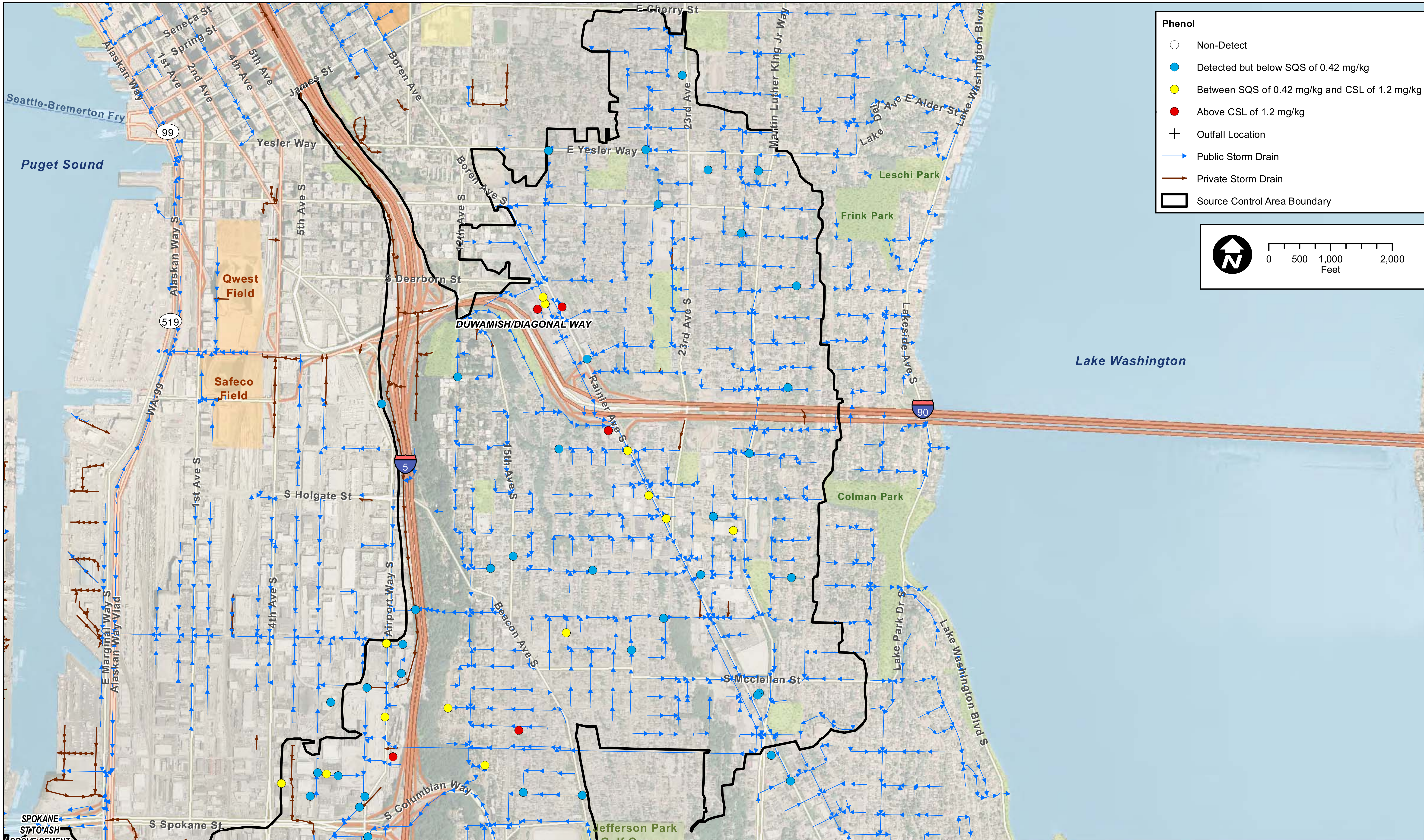

Figure 3-10a. Phenol Concentrations in Sediment and Storm Drain Samples

Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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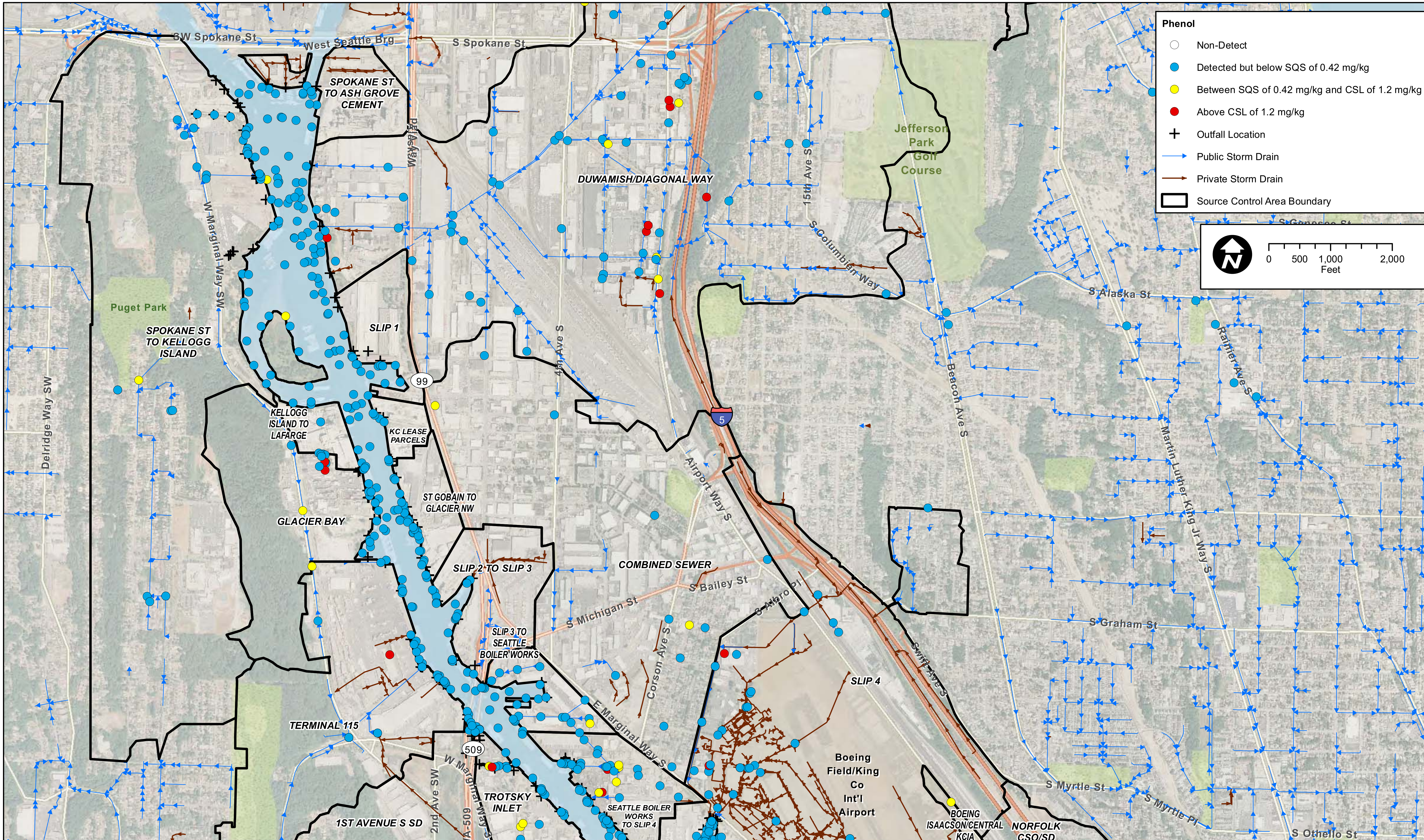

Figure 3-10b. Phenol Concentrations in Sediment and Storm Drain Samples

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
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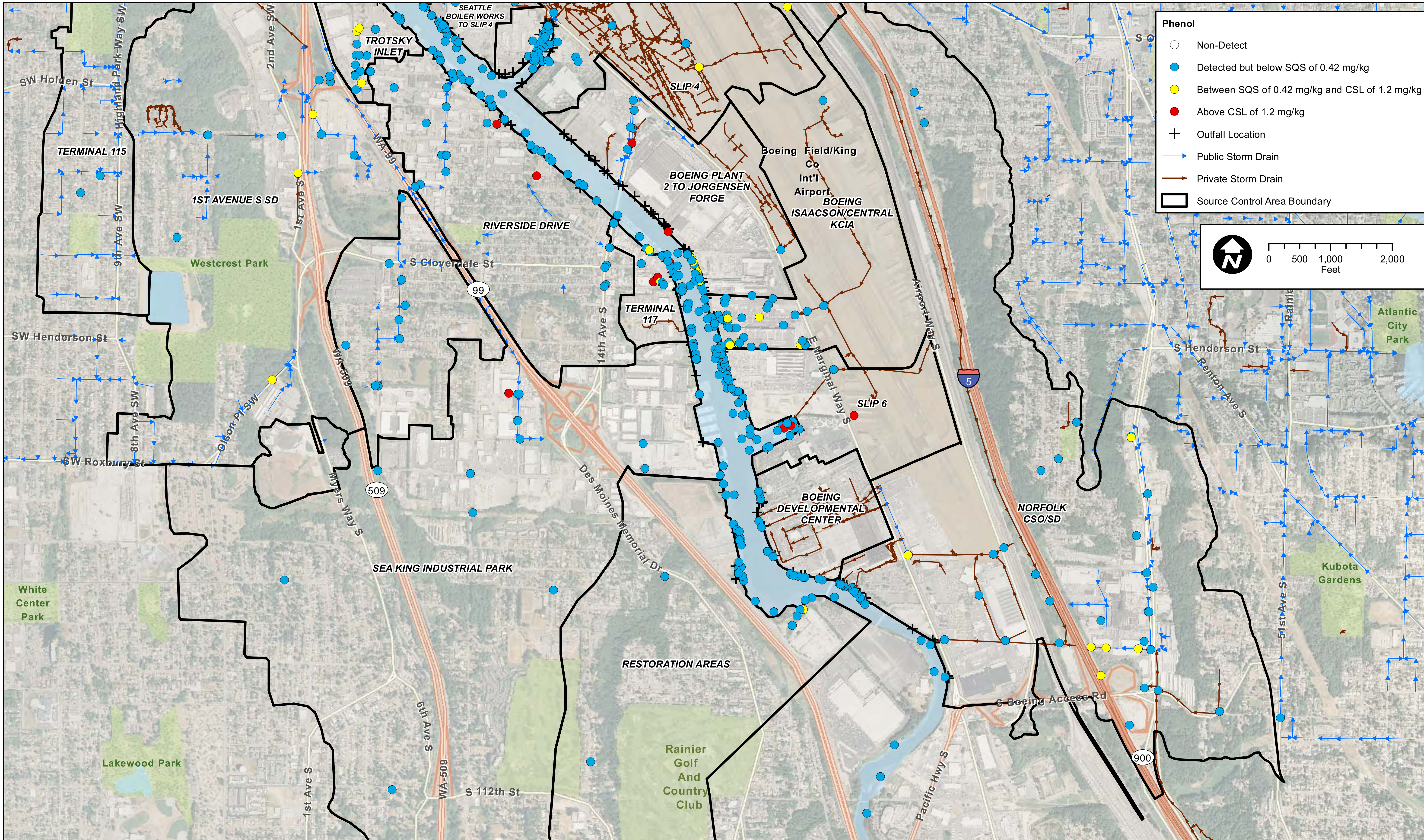

Figure 3-10c. Phenol Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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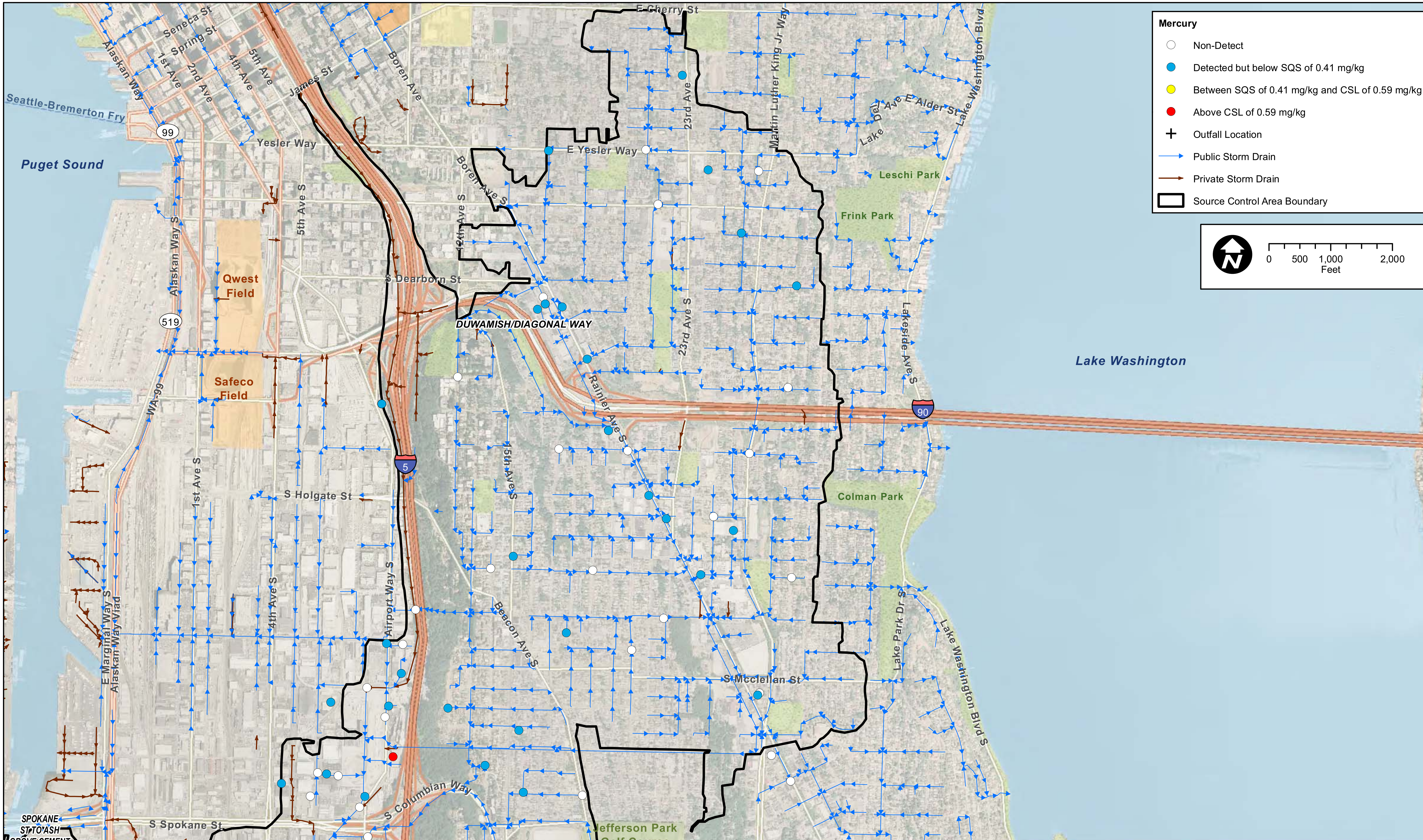

Figure 3-11a. Mercury Concentrations in Sediment and Storm Drain Samples

Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
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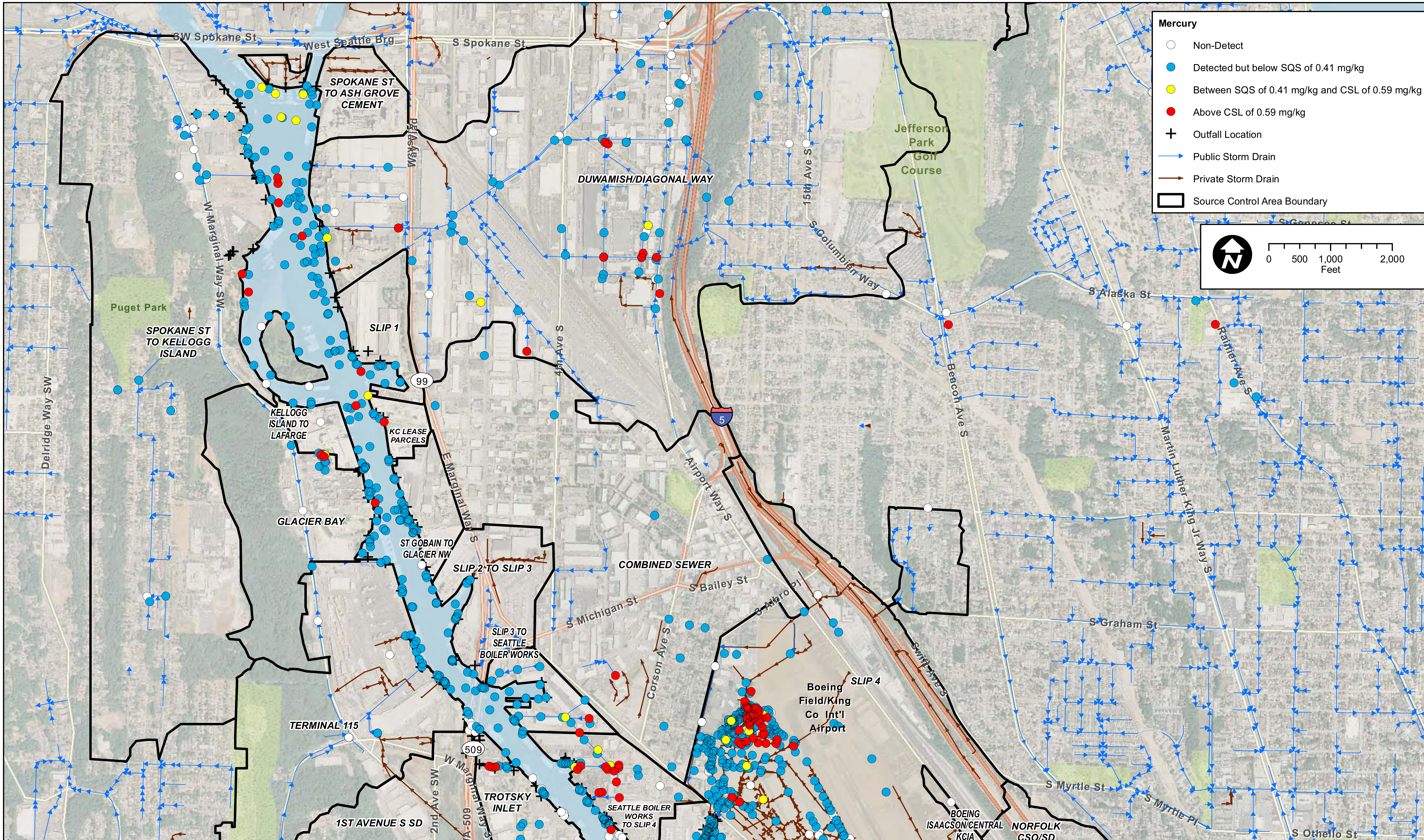

Figure 3-11b. Mercury Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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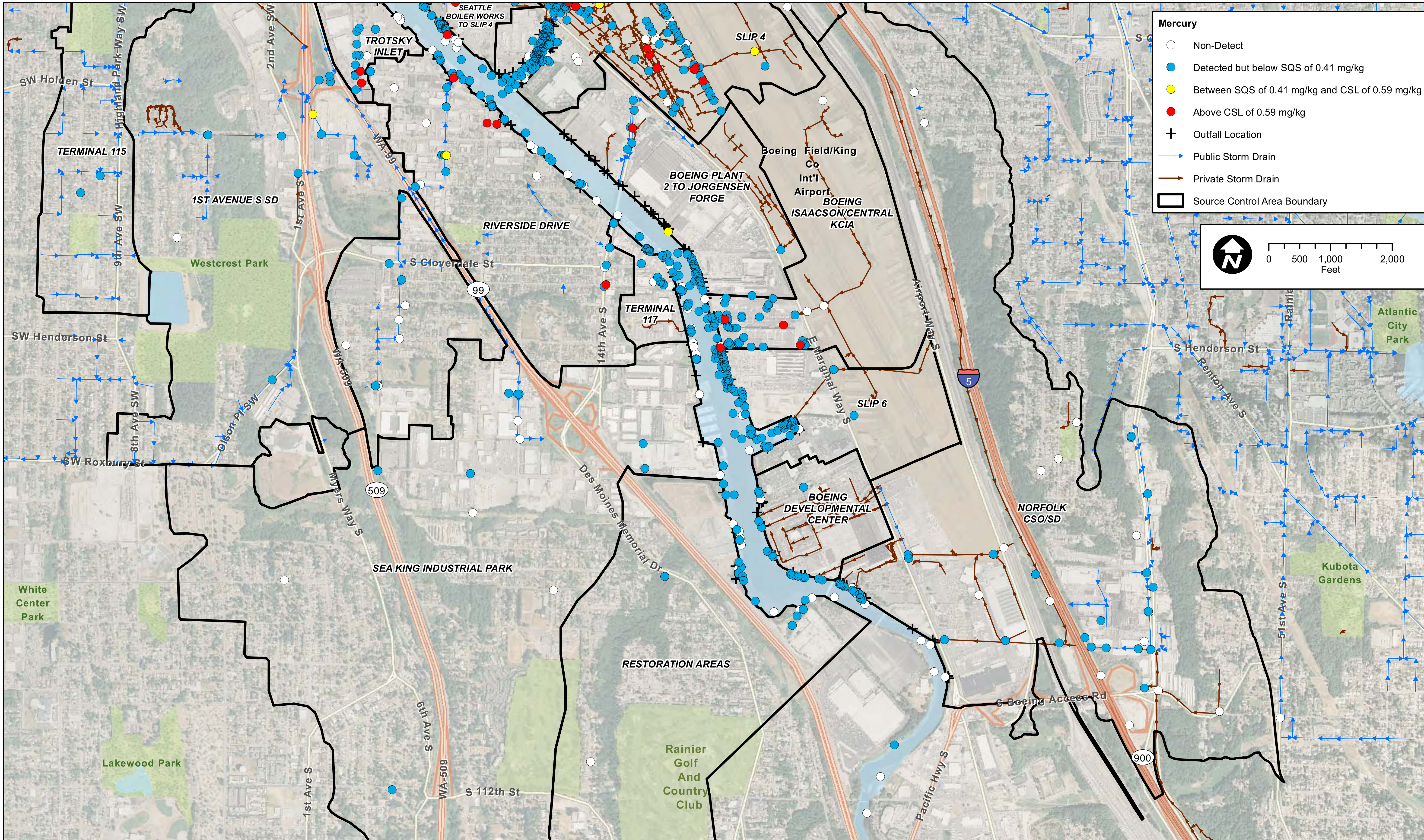

Figure 3-11c. Mercury Concentrations in Sediment and Storm Drain Samples

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Coordinate System:
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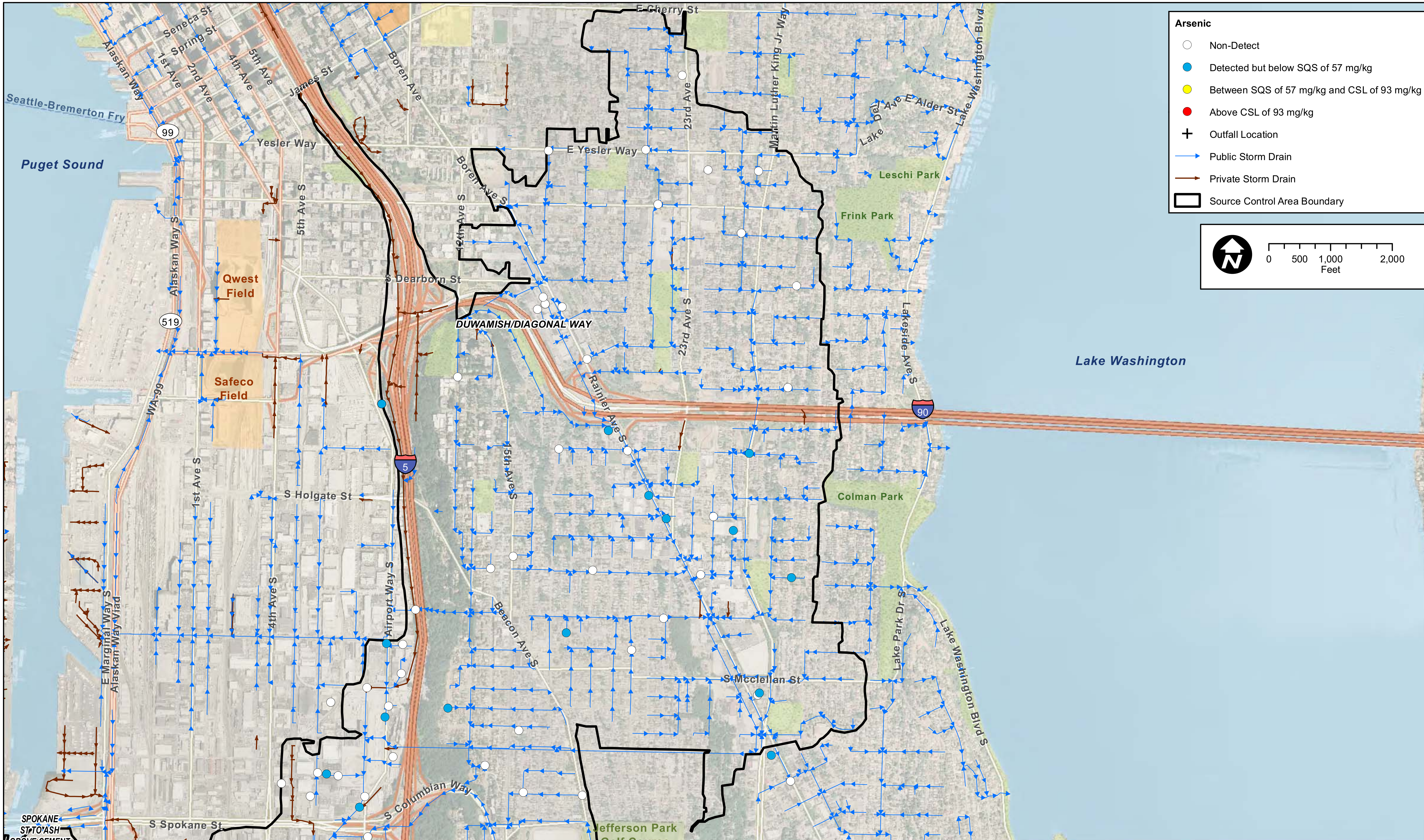

Figure 3-12a. Arsenic Concentrations in Sediment and Storm Drain Samples

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Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
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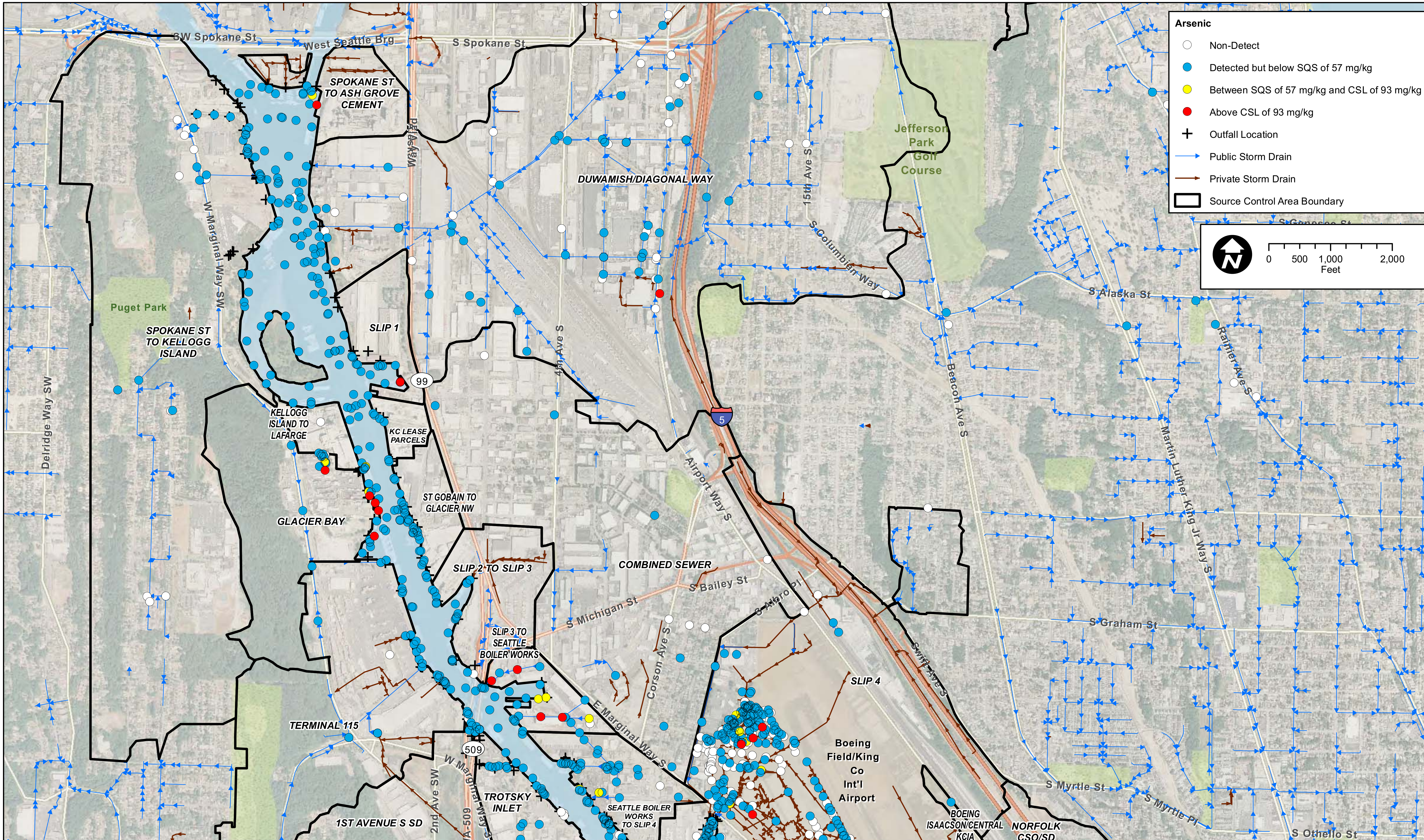

Figure 3-12b. Arsenic Concentrations in Sediment and Storm Drain Samples

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
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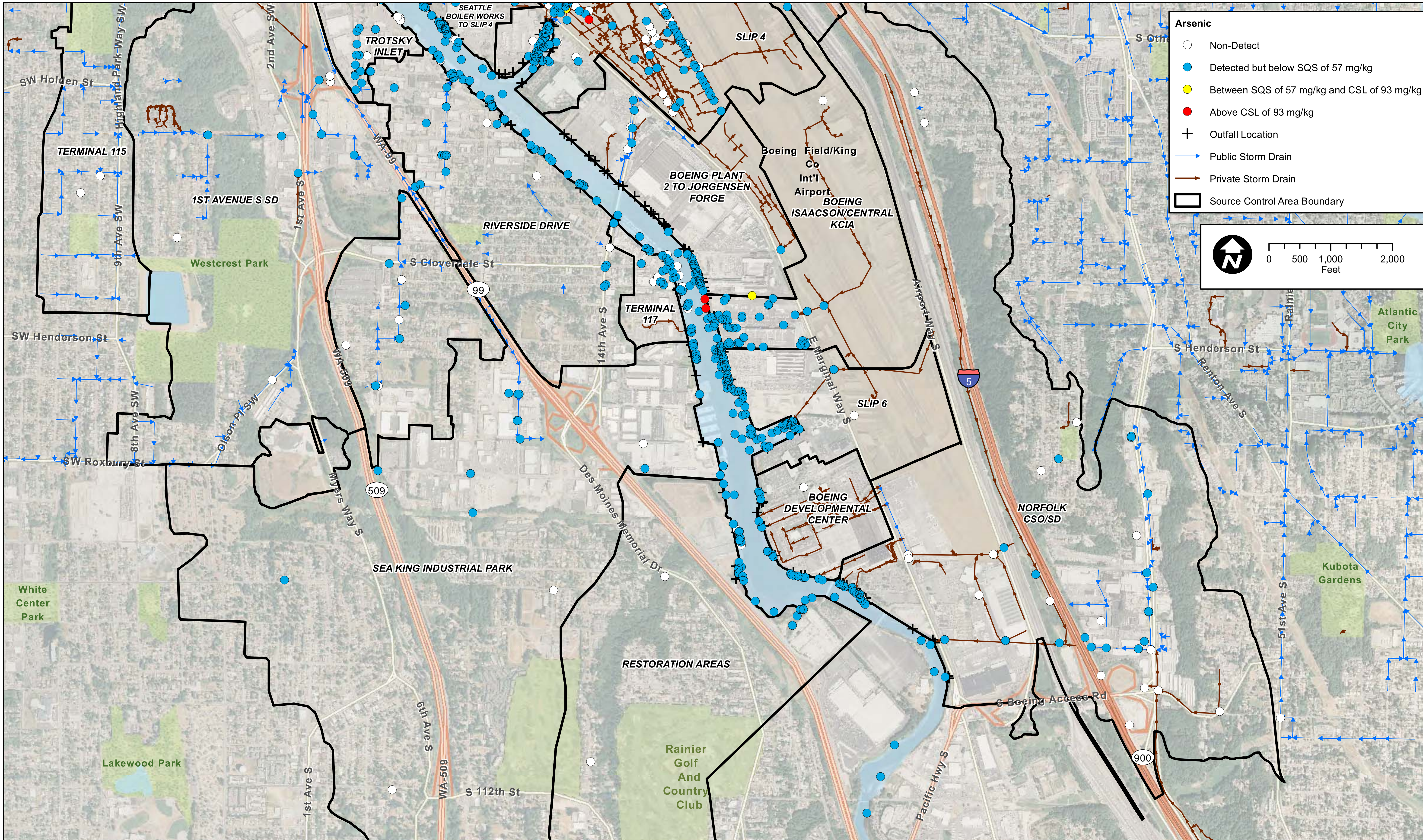

Figure 3-12c. Arsenic Concentrations in Sediment and Storm Drain Samples

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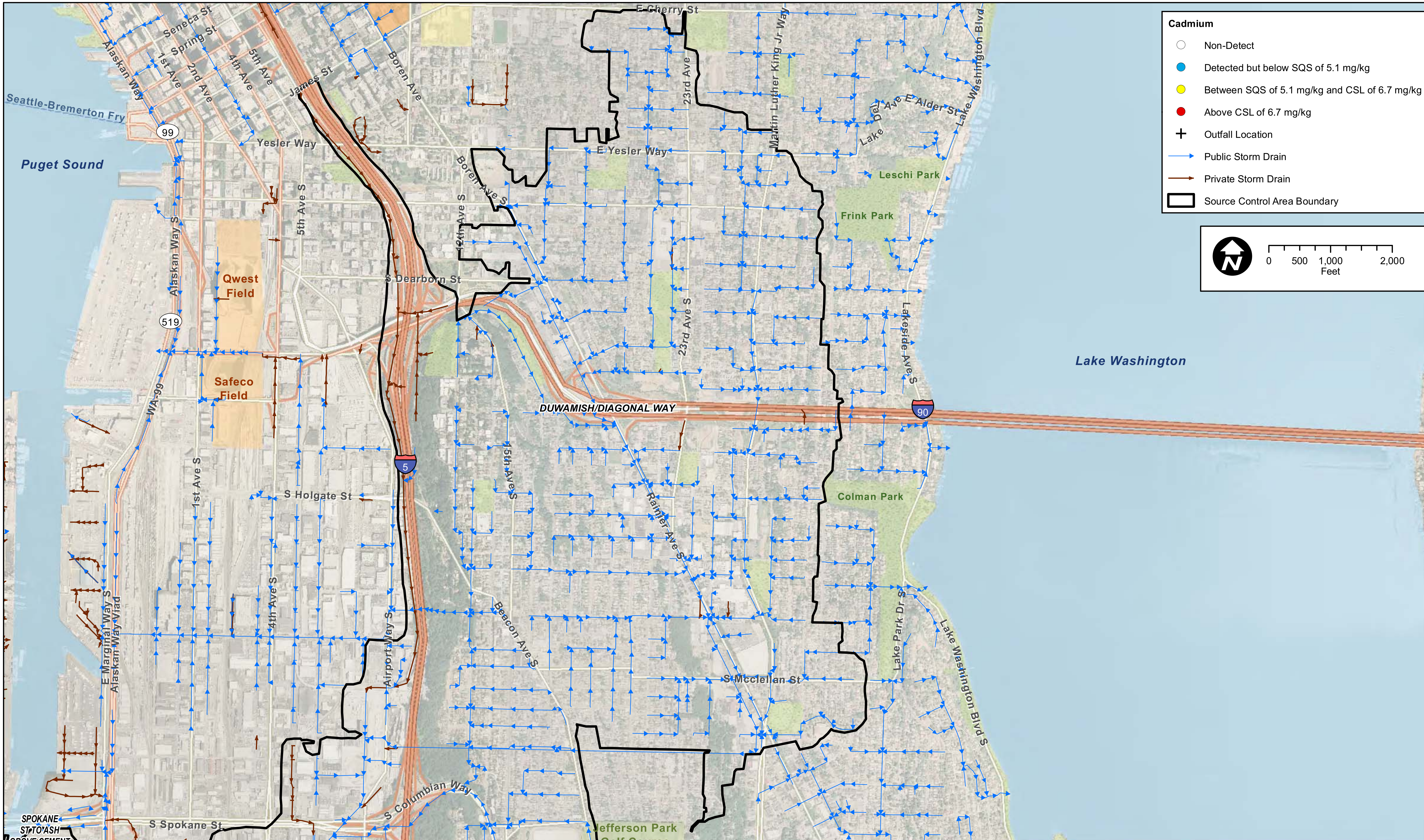

Figure 3-13a. Cadmium Concentrations in Sediment and Storm Drain Samples

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Coordinate System:
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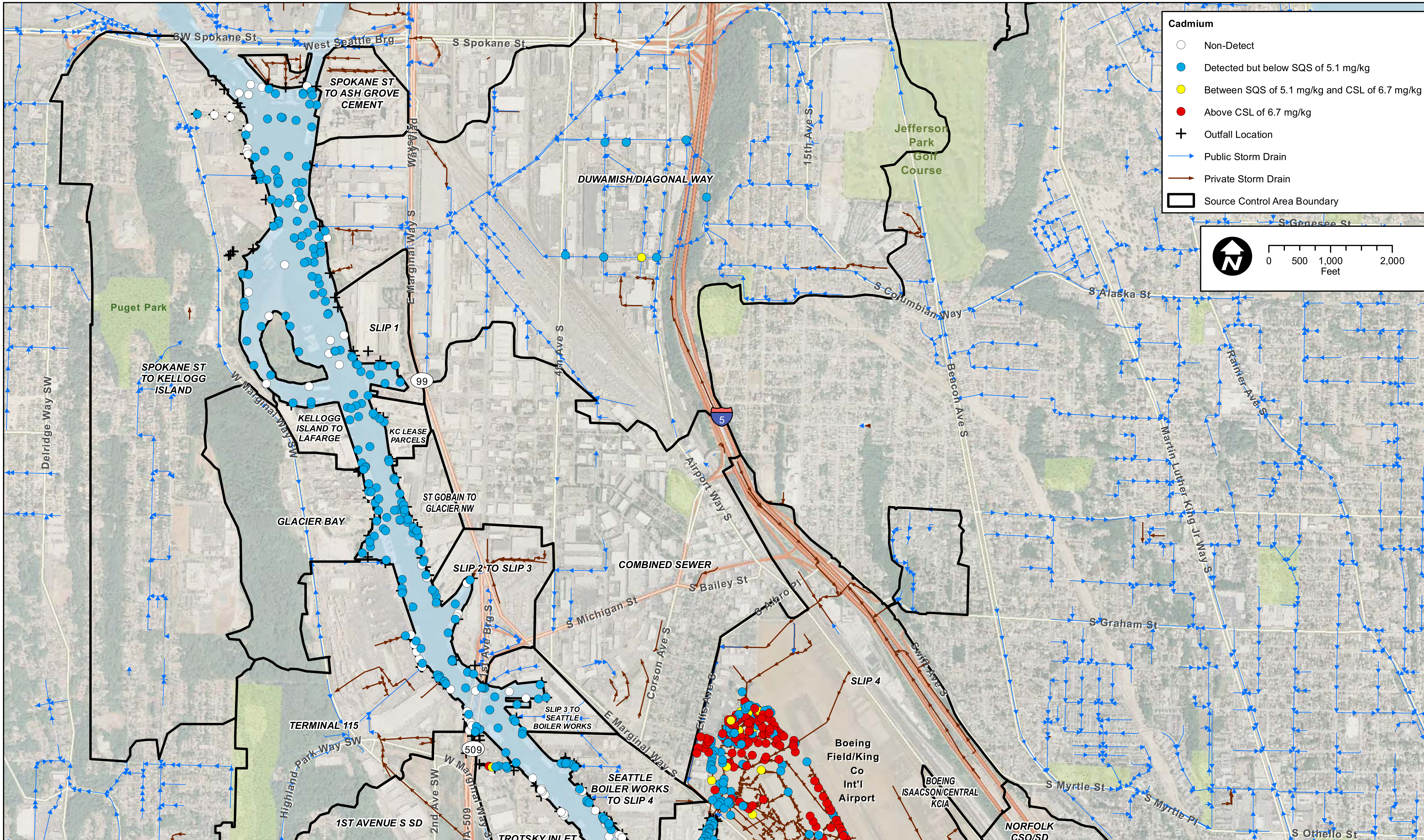

Figure 3-13b. Cadmium Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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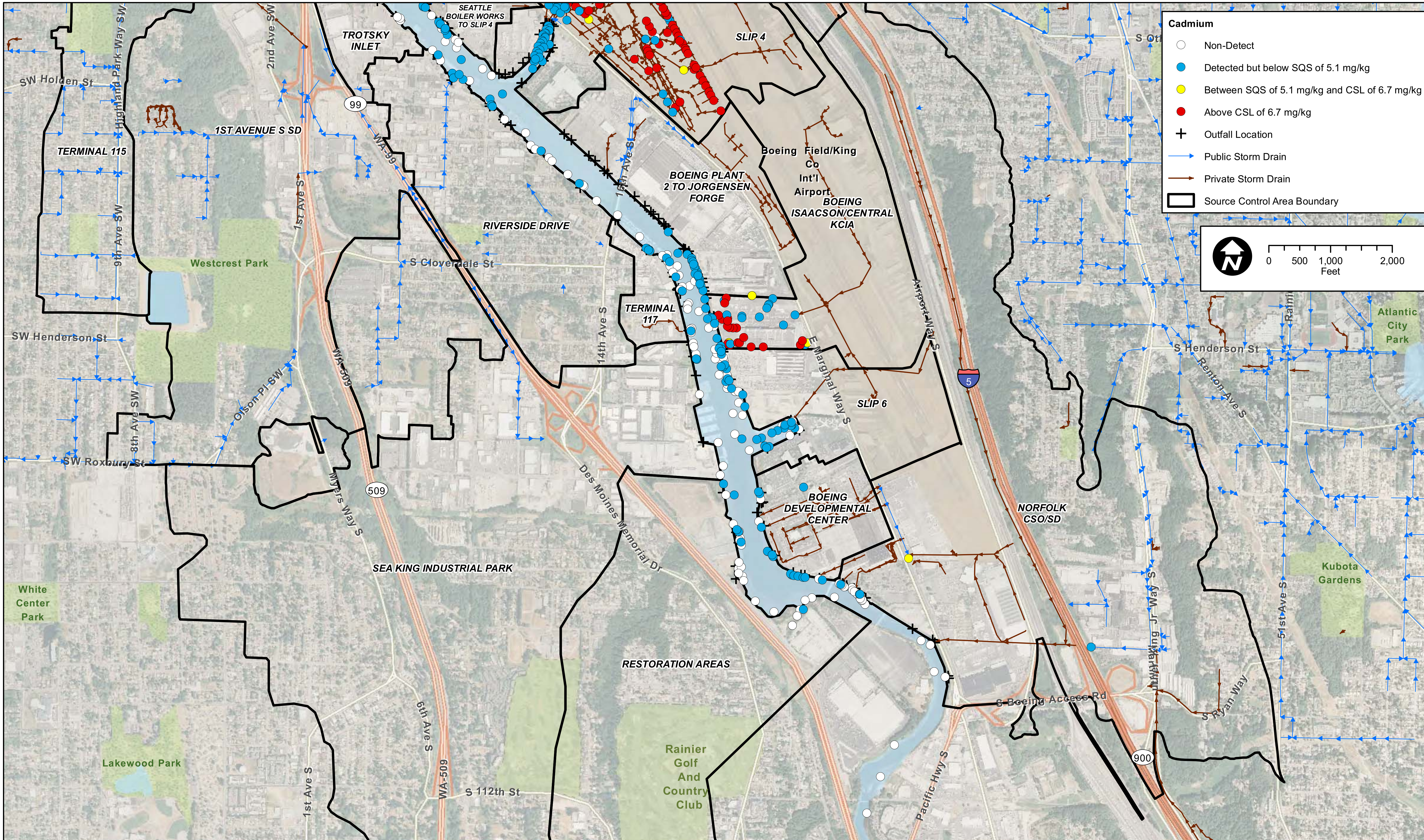

Figure 3-13c. Cadmium Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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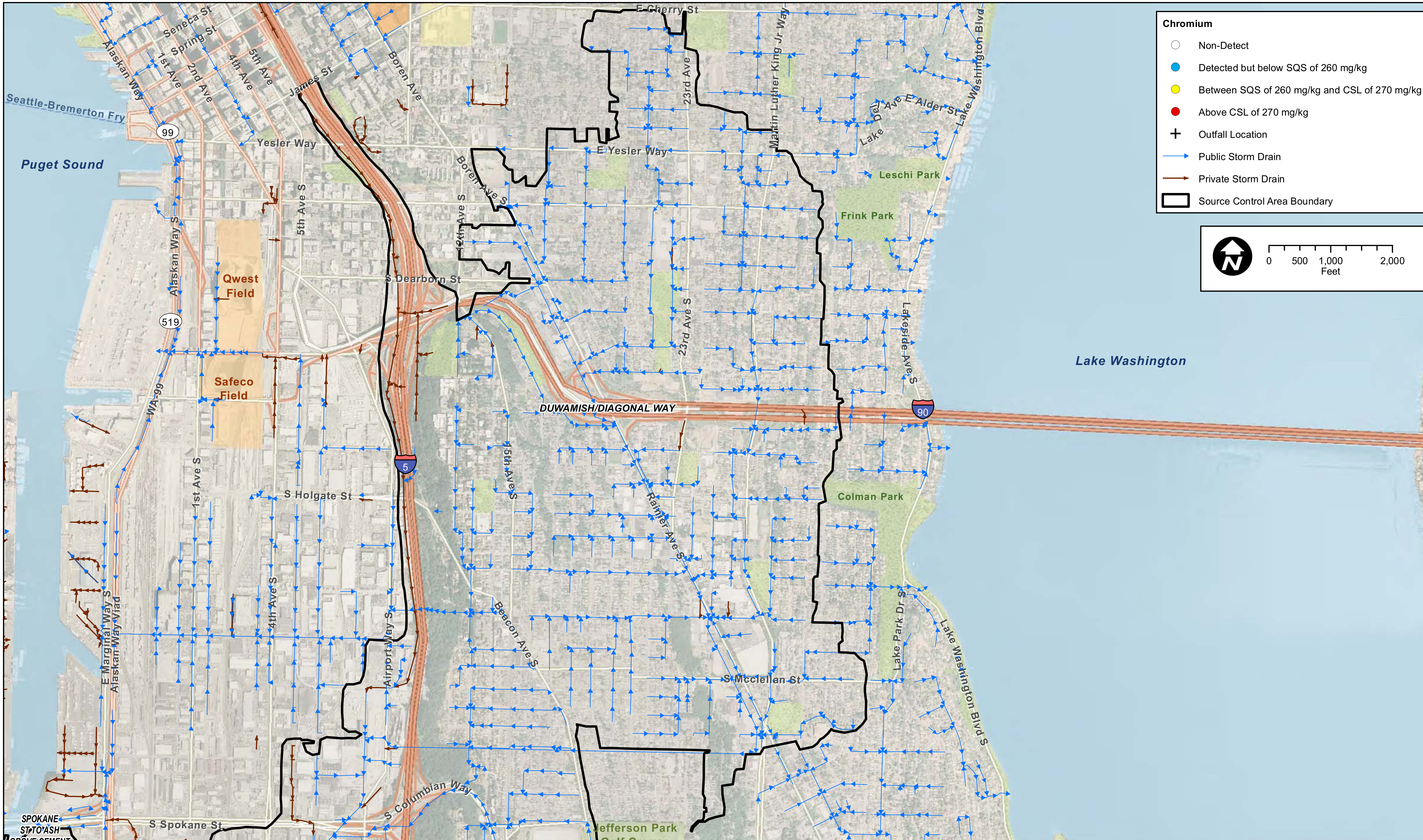

Figure 3-14a. Chromium Concentrations in Sediment and Storm Drain Samples

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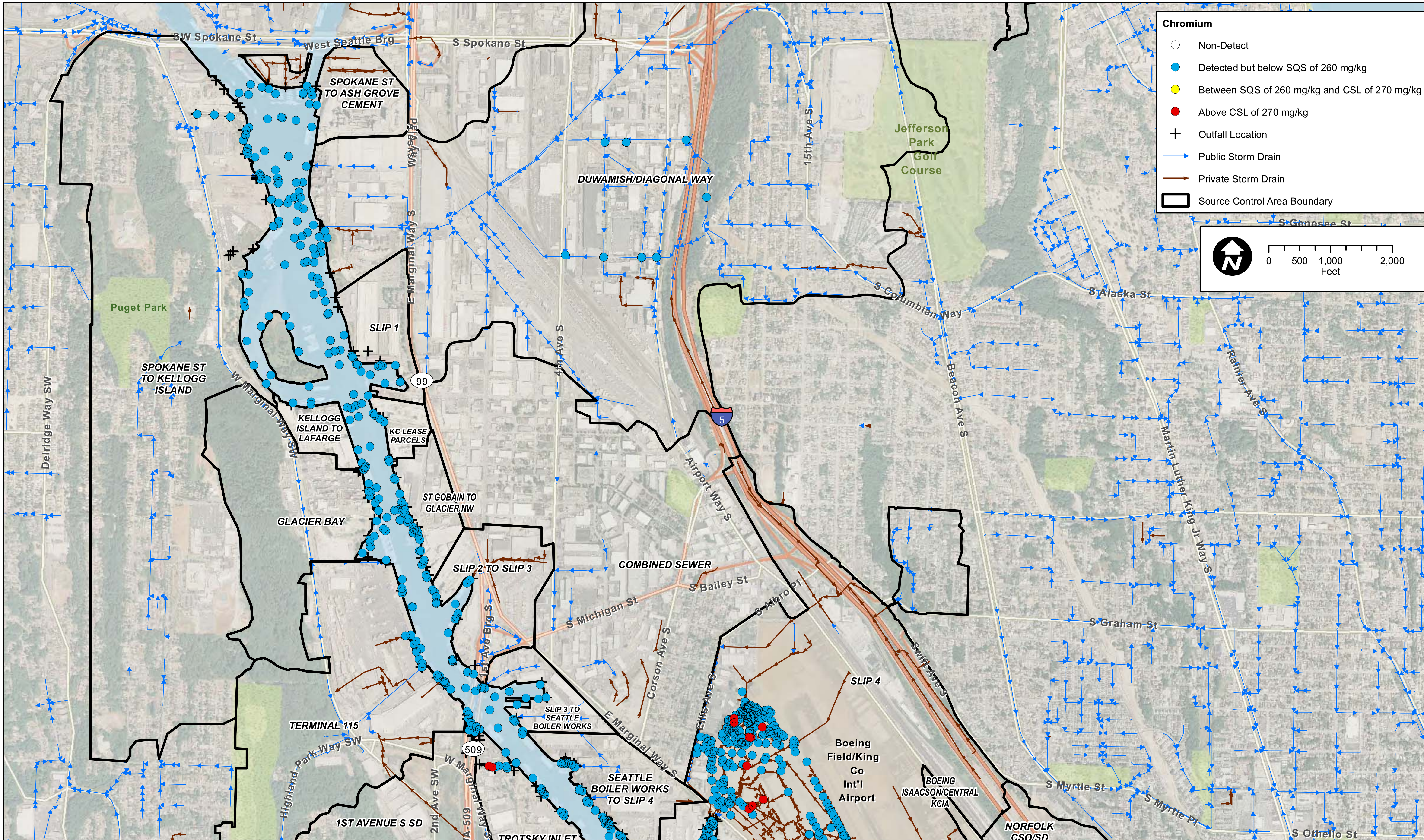

Figure 3-14b. Chromium Concentrations in Sediment and Storm Drain Samples

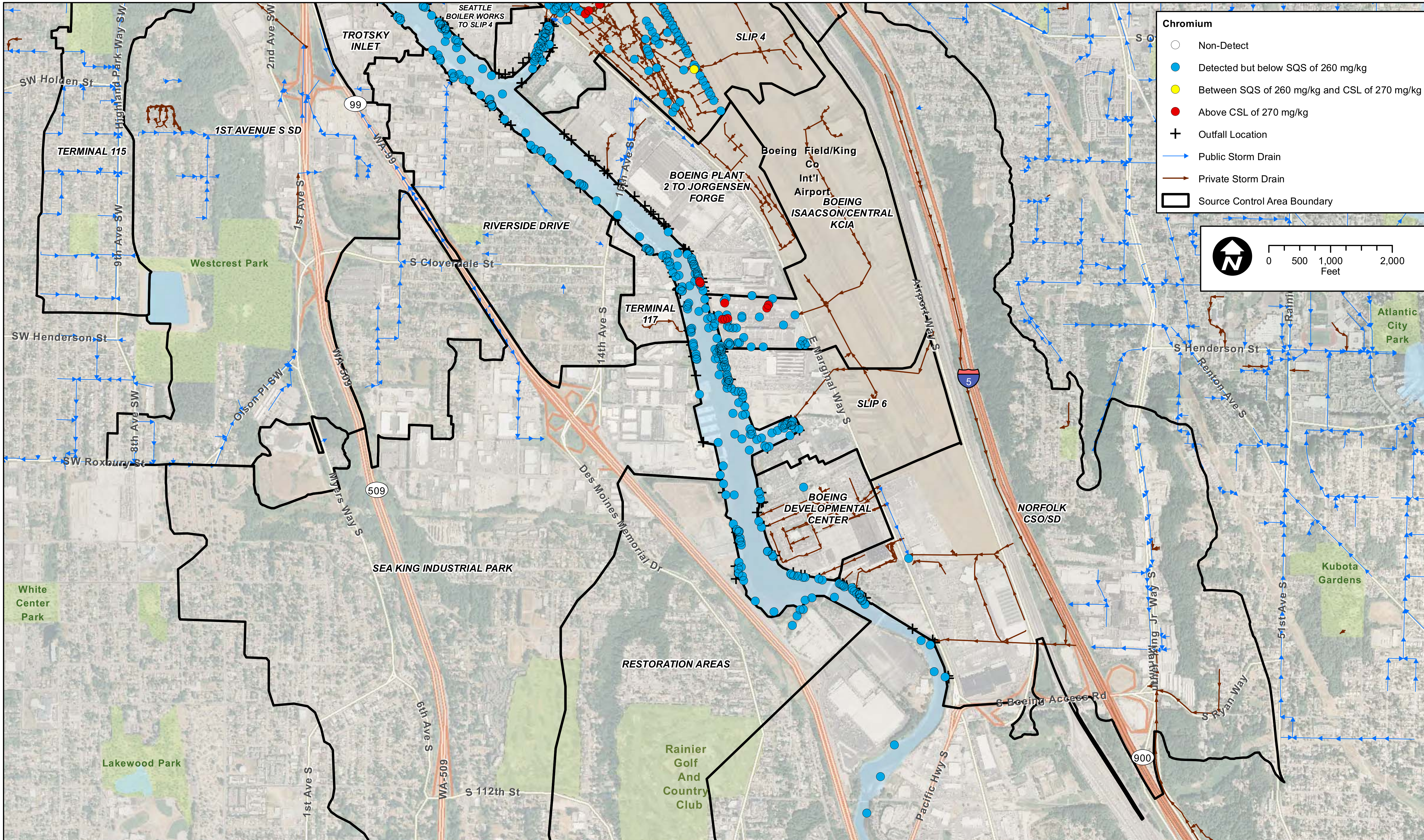

Figure 3-14c. Chromium Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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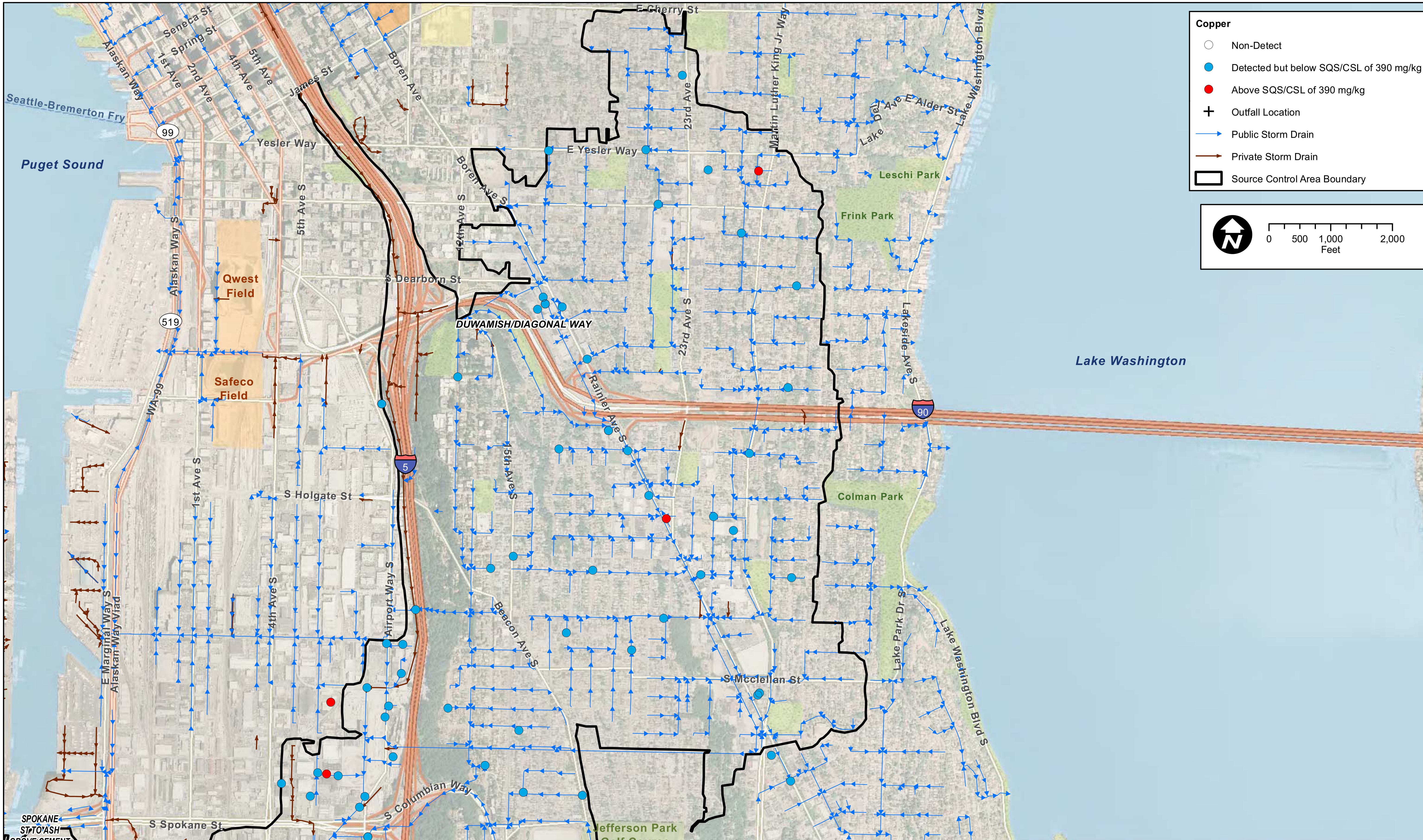

Figure 3-15a. Copper Concentrations in Sediment and Storm Drain Samples

Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
File: Figure_3-02_to_3-11_COC_Samples.mxd
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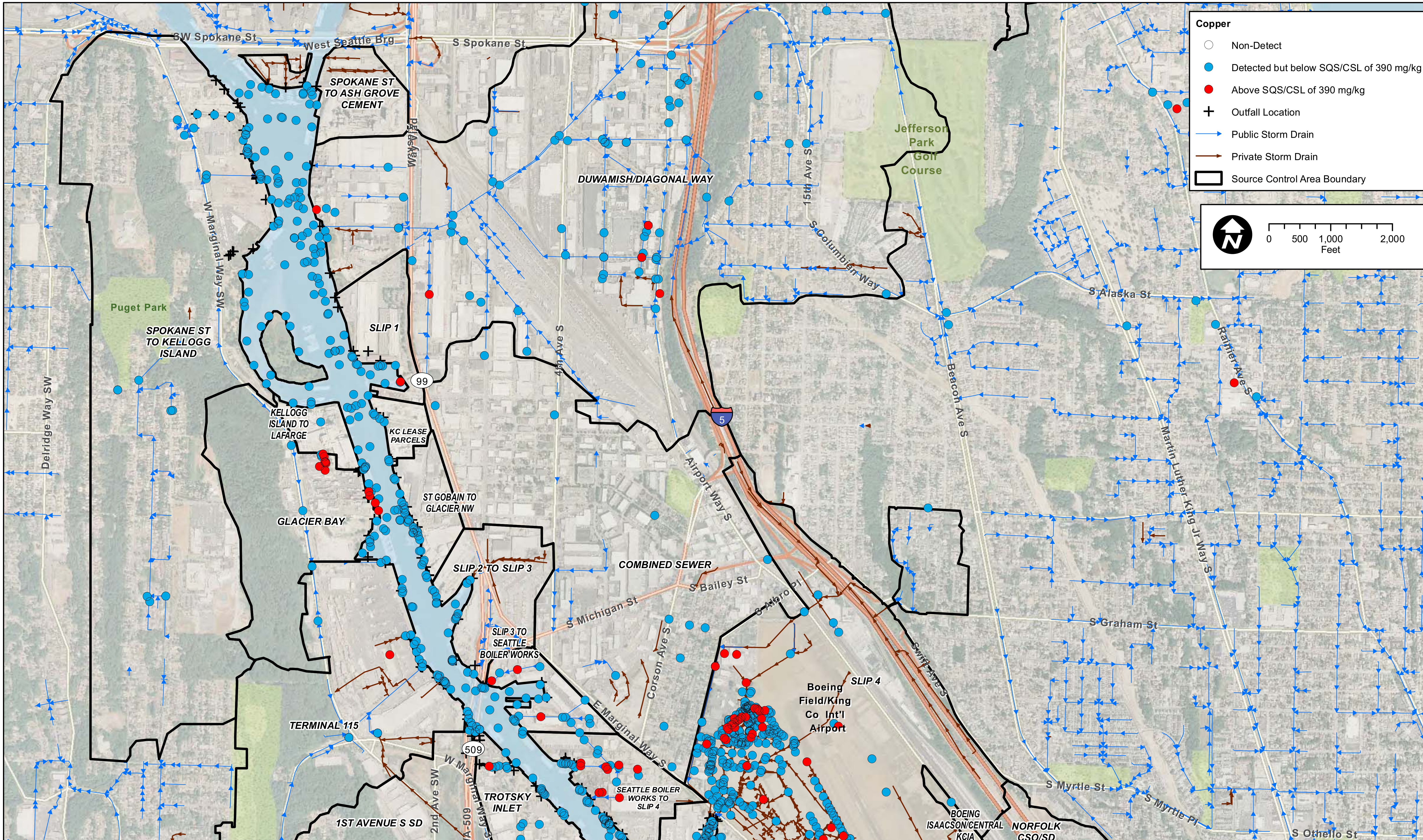

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Figure 3-15b. Copper Concentrations in Sediment and Storm Drain Samples

Coordinate System:
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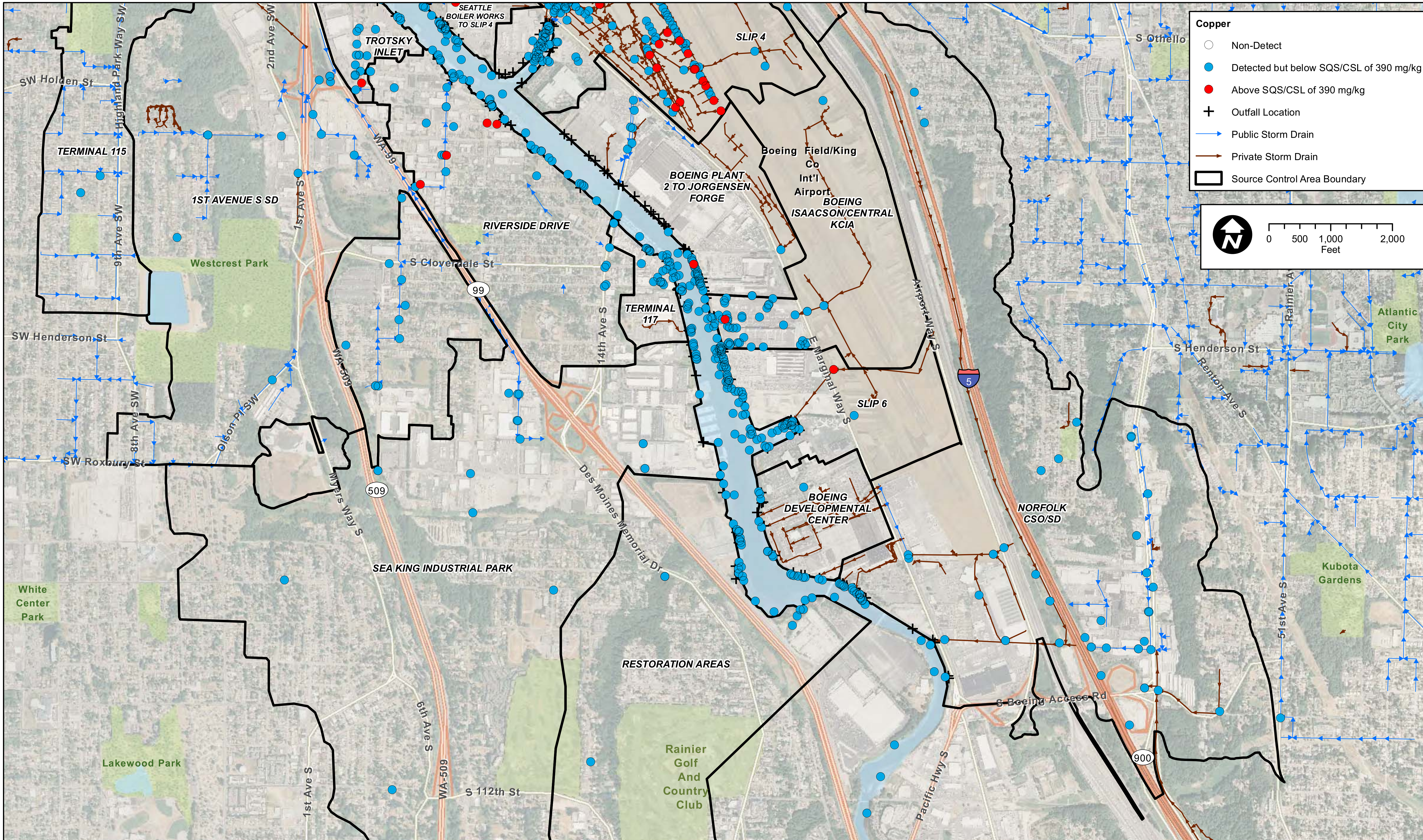

Figure 3-15c. Copper Concentrations in Sediment and Storm Drain Samples

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Coordinate System:
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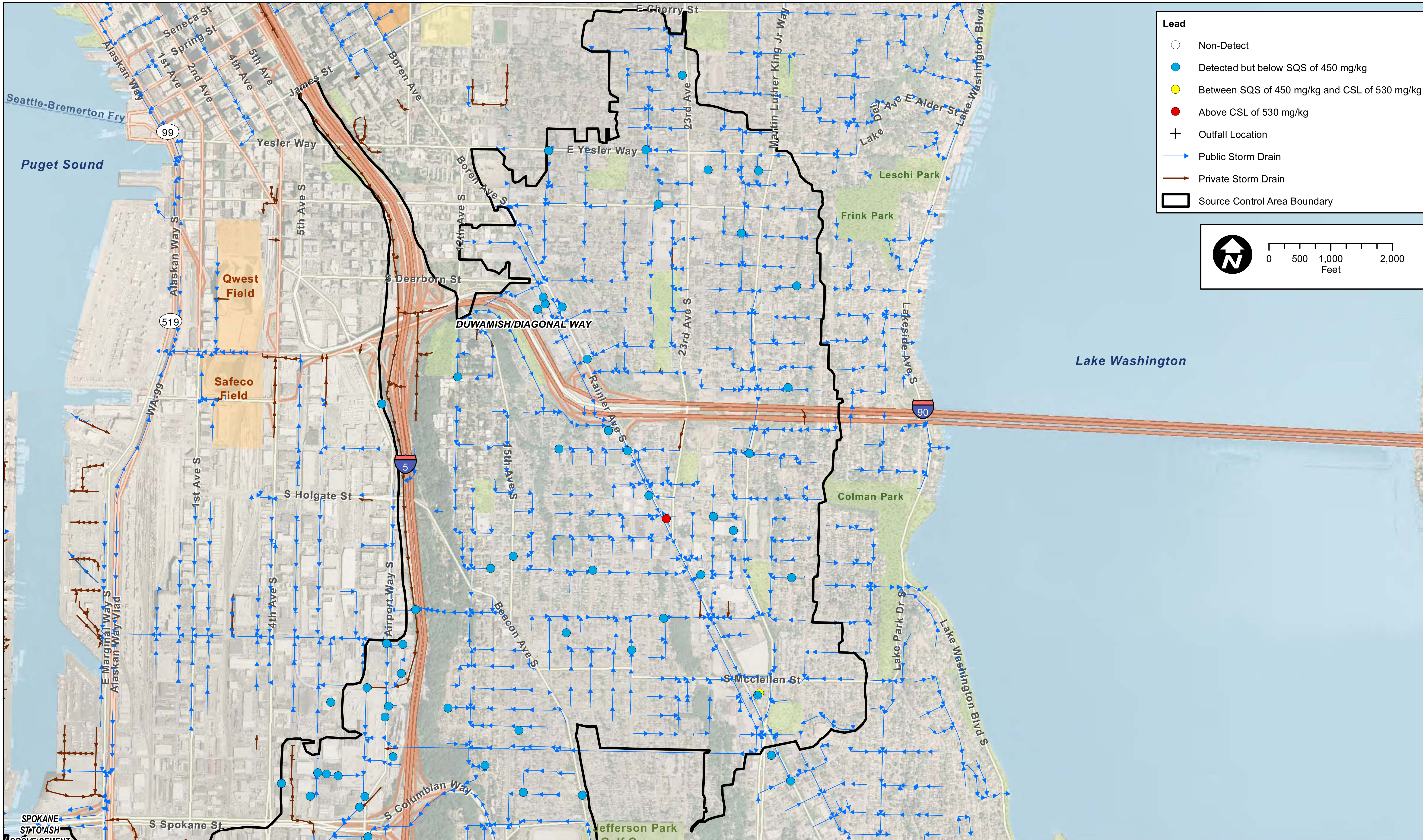

Figure 3-16a. Lead Concentrations in Sediment and Storm Drain Samples

Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
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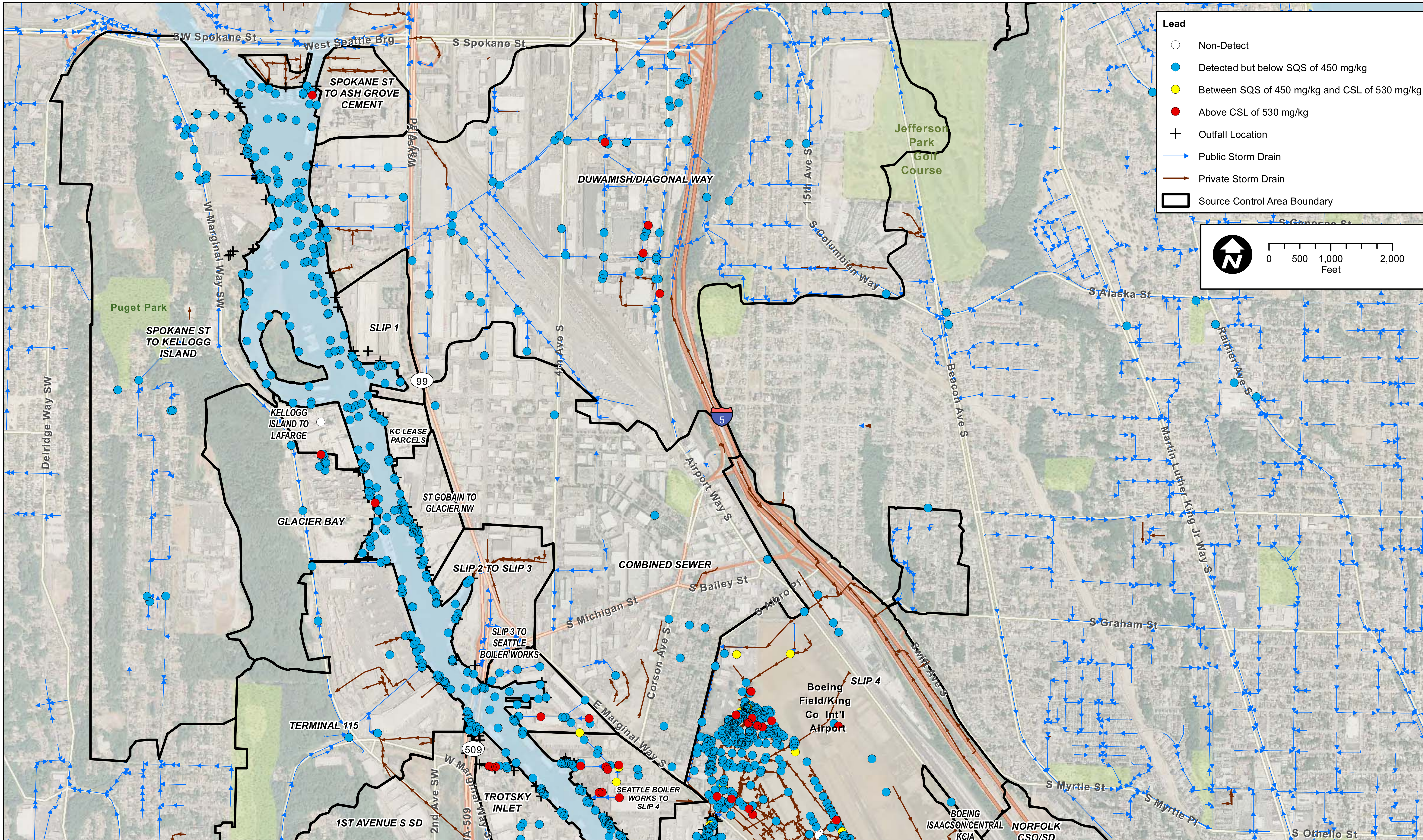

Figure 3-16b. Lead Concentrations in Sediment and Storm Drain Samples

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
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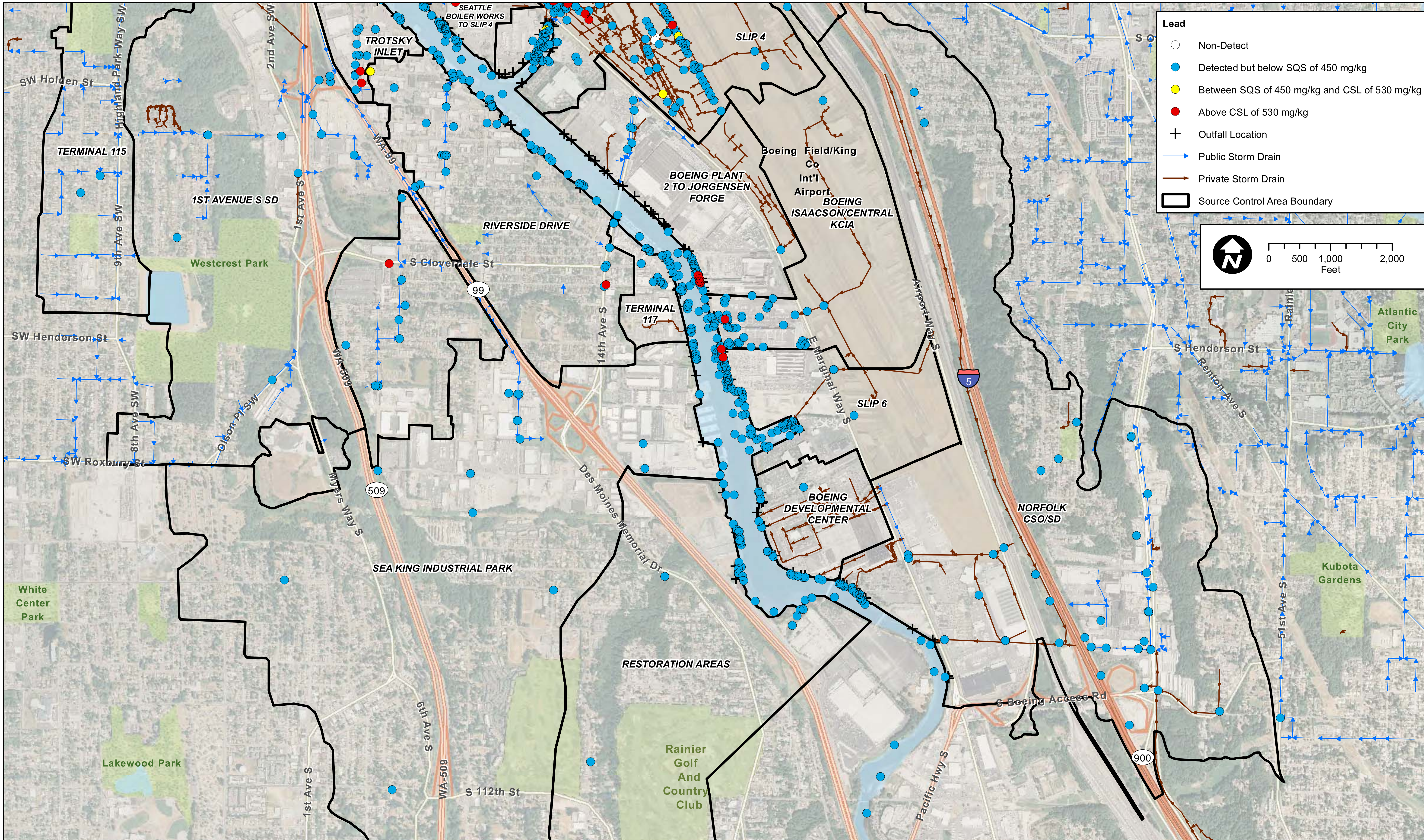

Figure 3-16c. Lead Concentrations in Sediment and Storm Drain Samples

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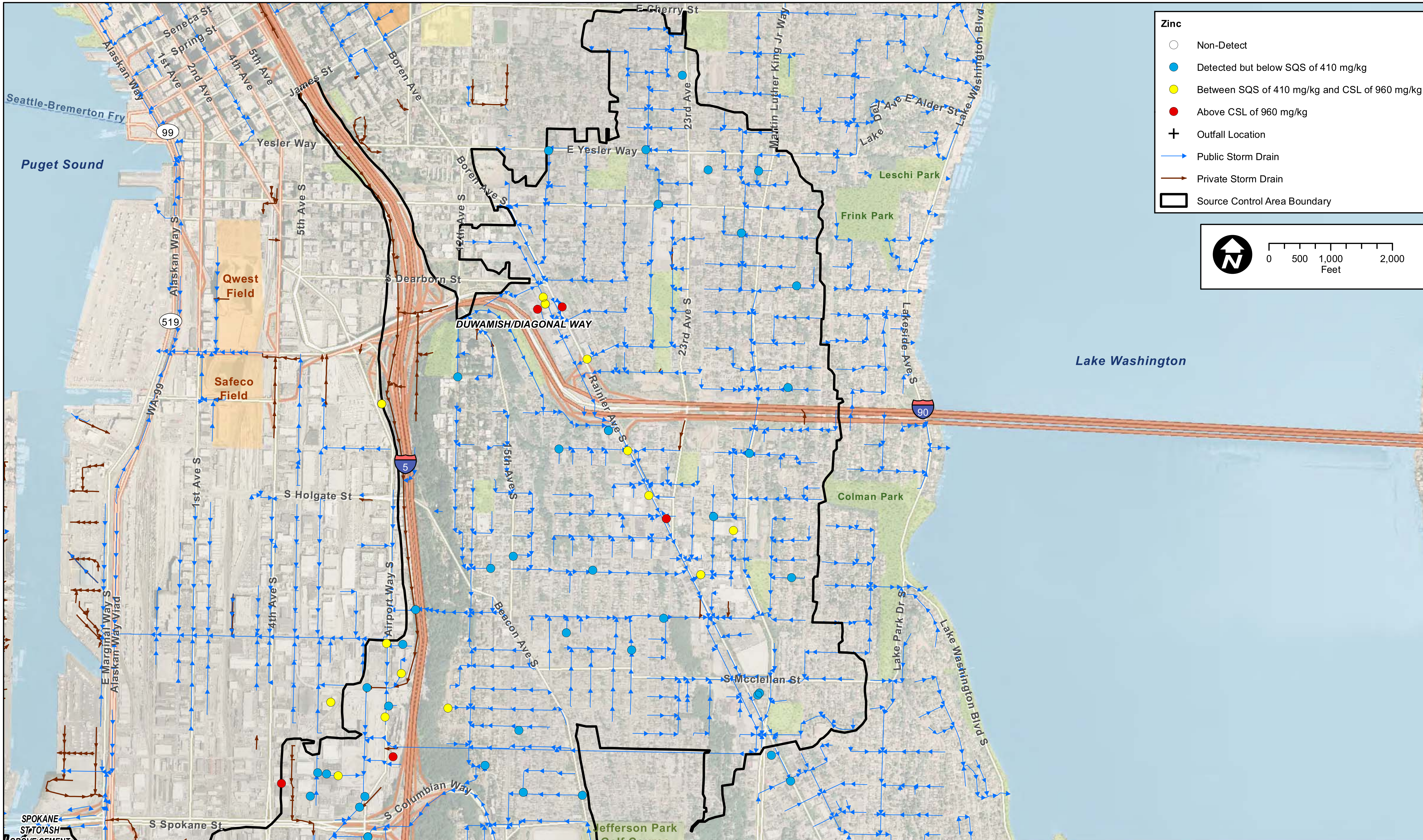

Figure 3-17a. Zinc Concentrations in Sediment and Storm Drain Samples

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Prepared By: mlf
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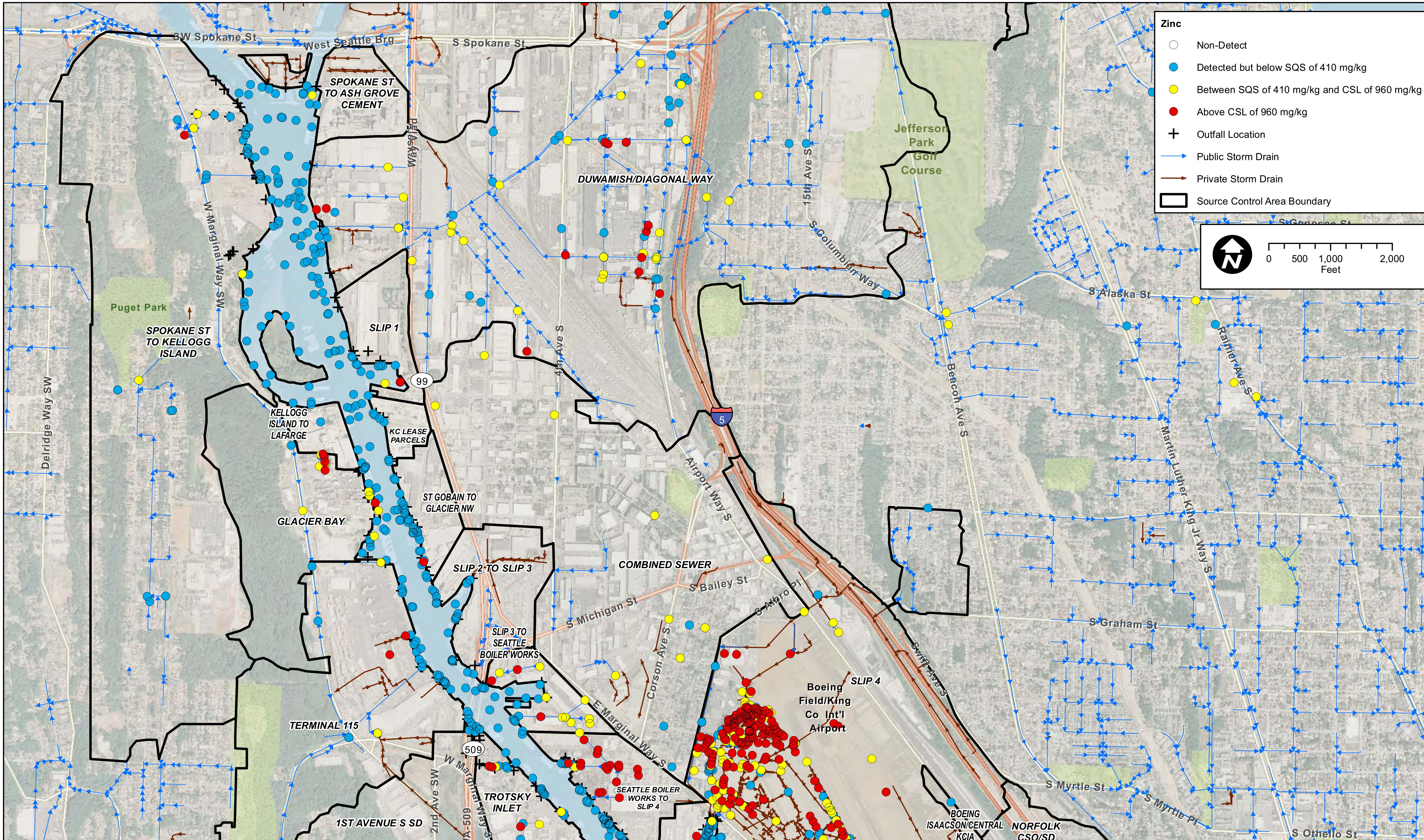

Figure 3-17b. Zinc Concentrations in Sediment and Storm Drain Samples

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
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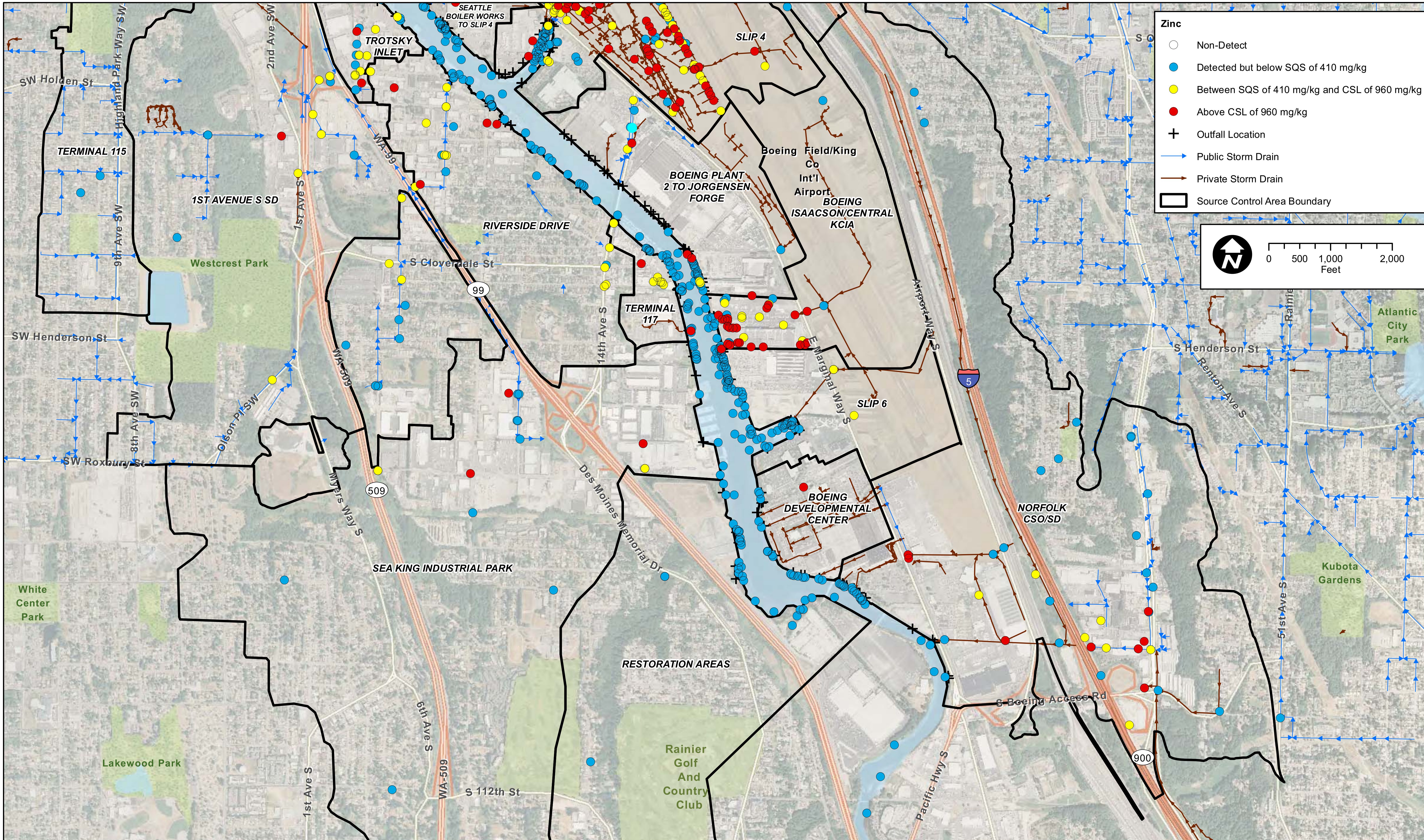

Figure 3-17c. Zinc Concentrations in Sediment and Storm Drain Samples

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Coordinate System:
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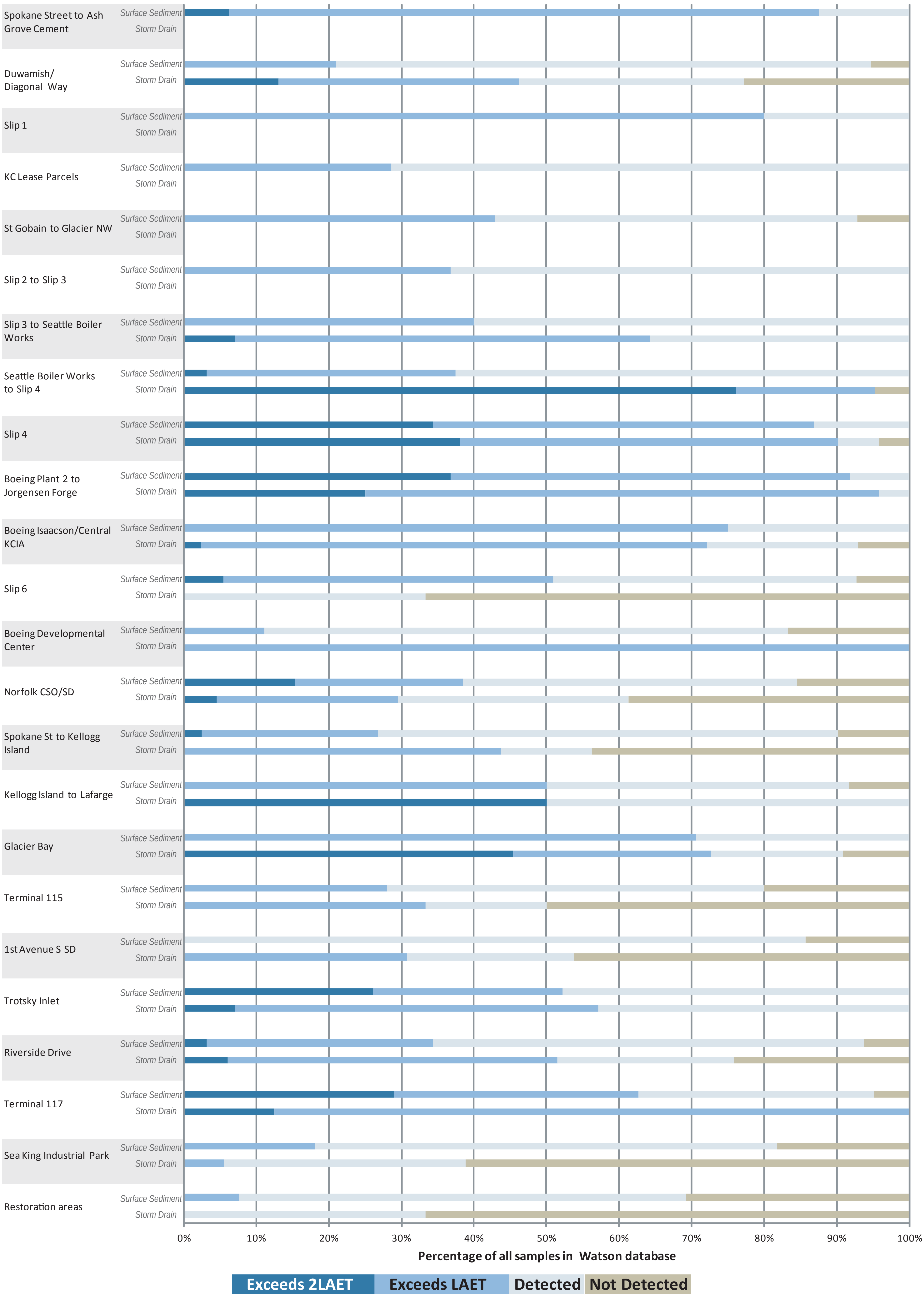

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Figure 3–18. Total PCB Exceedance Summary by Source Control Area

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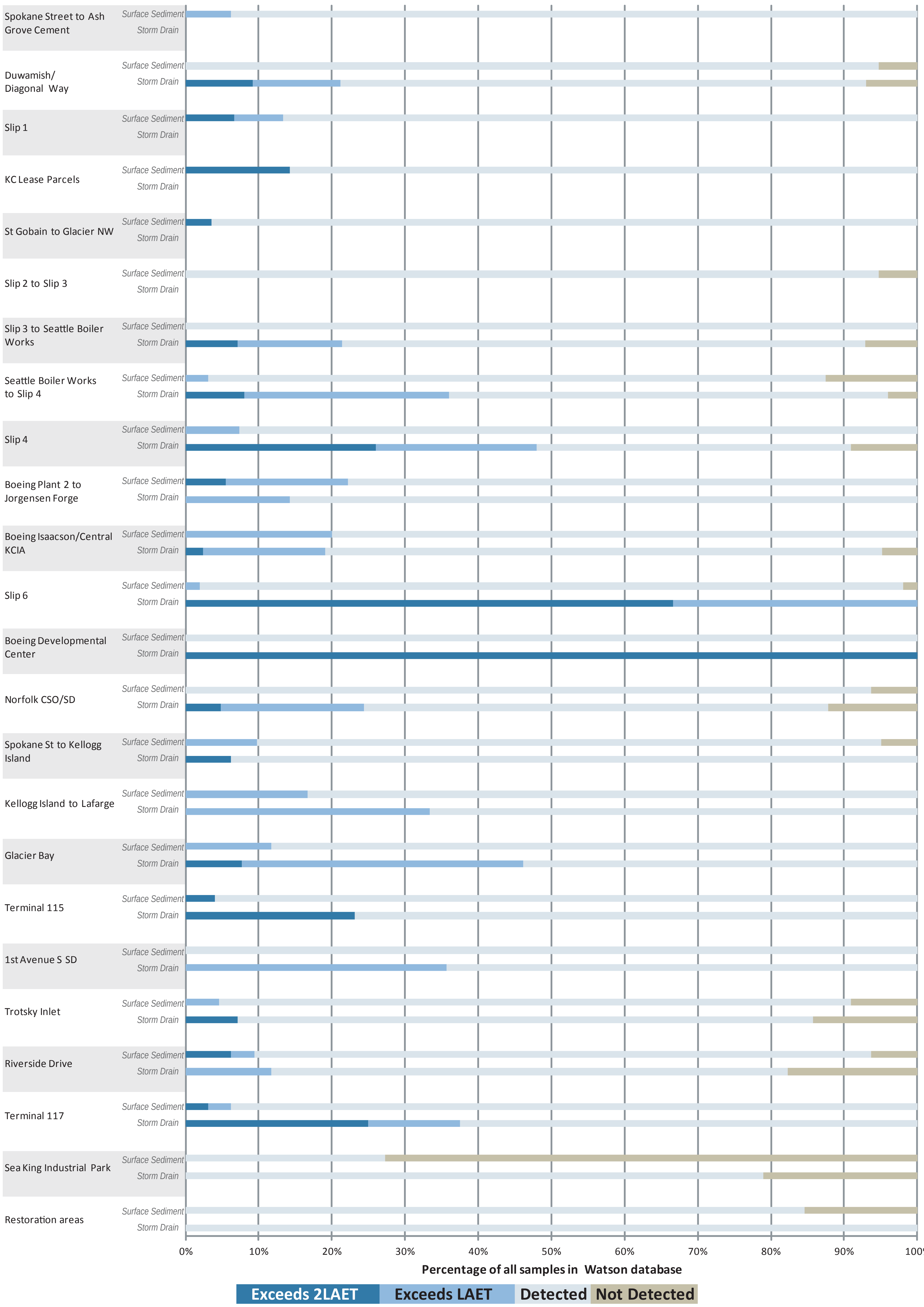

Figure 3–19. Total LPAH Exceedance Summary by Source Control Area

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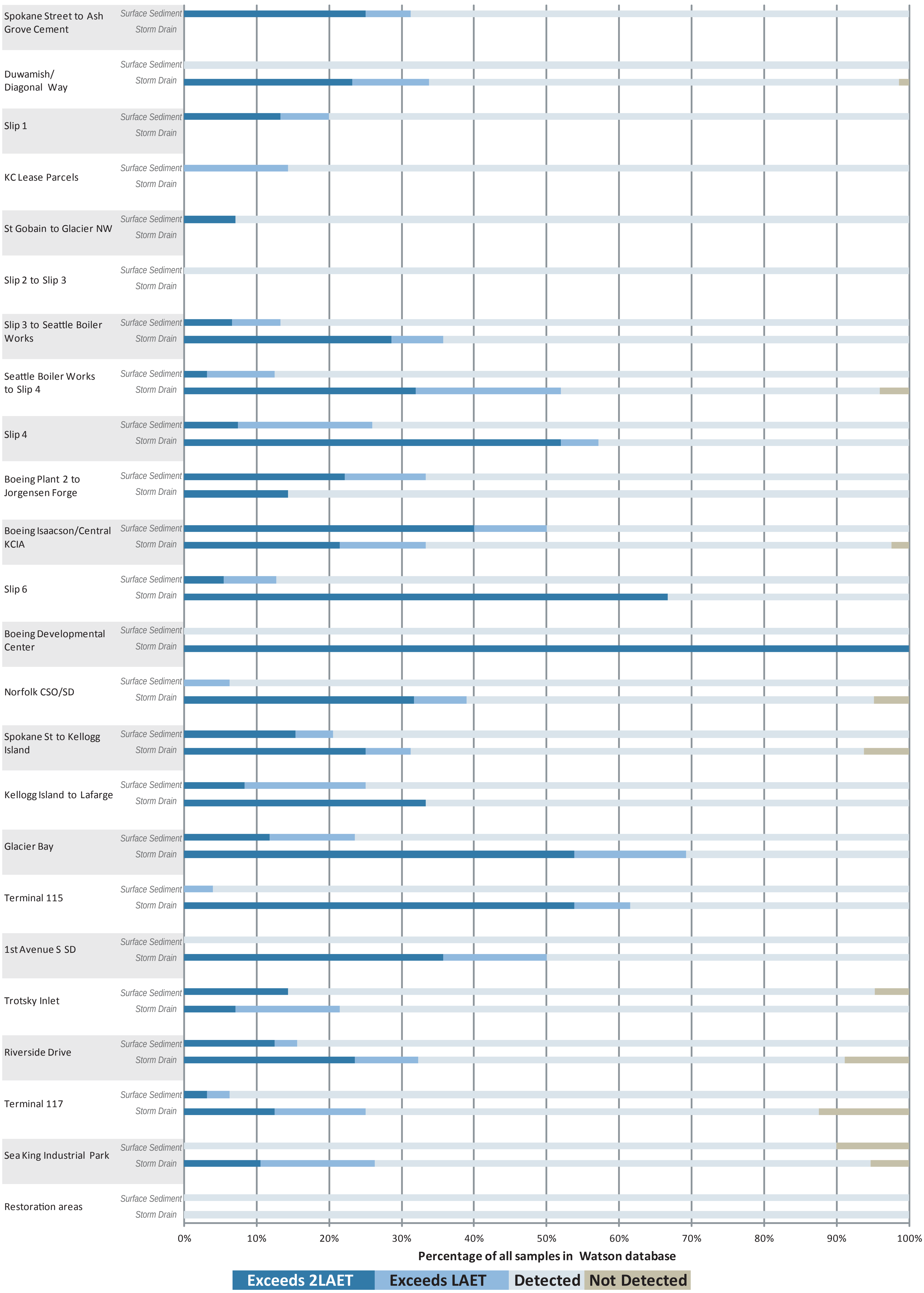

Figure 3–20. Total HPAH Exceedance Summary by Source Control Area

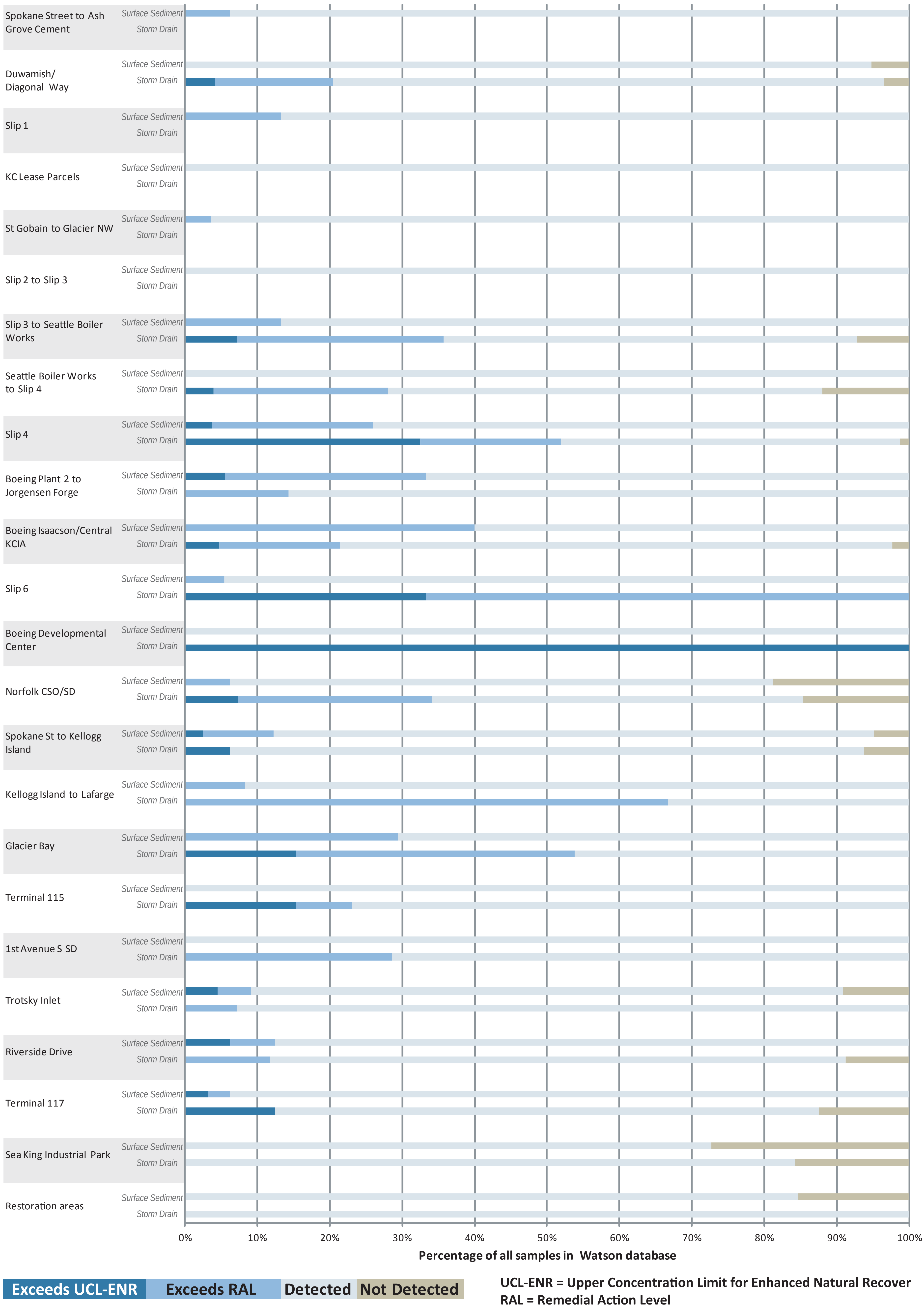

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Figure 3–21. Total cPAH Exceedance Summary by Source Control Area

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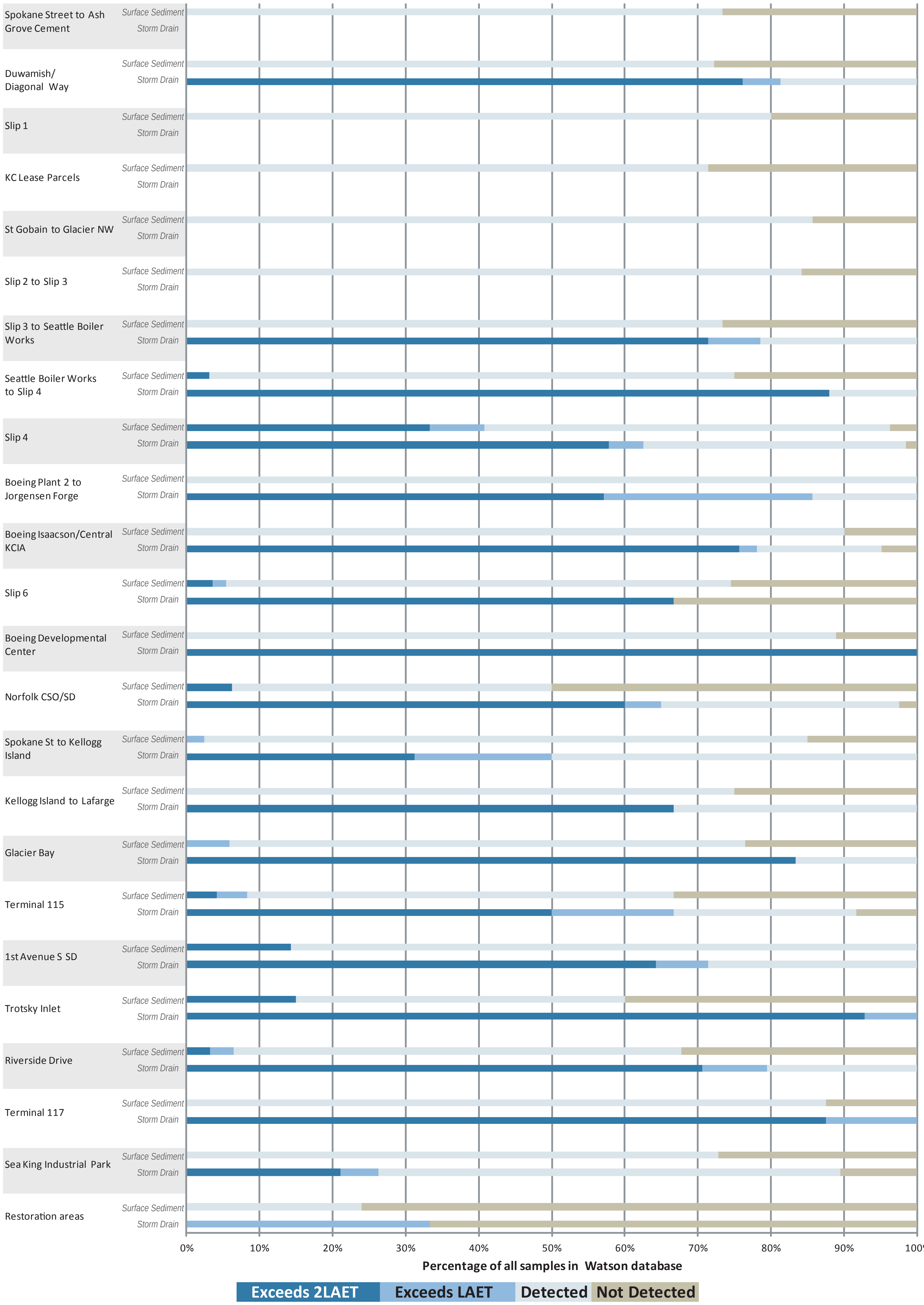

Figure 3–22. BEHP Exceedance Summary by Source Control Area

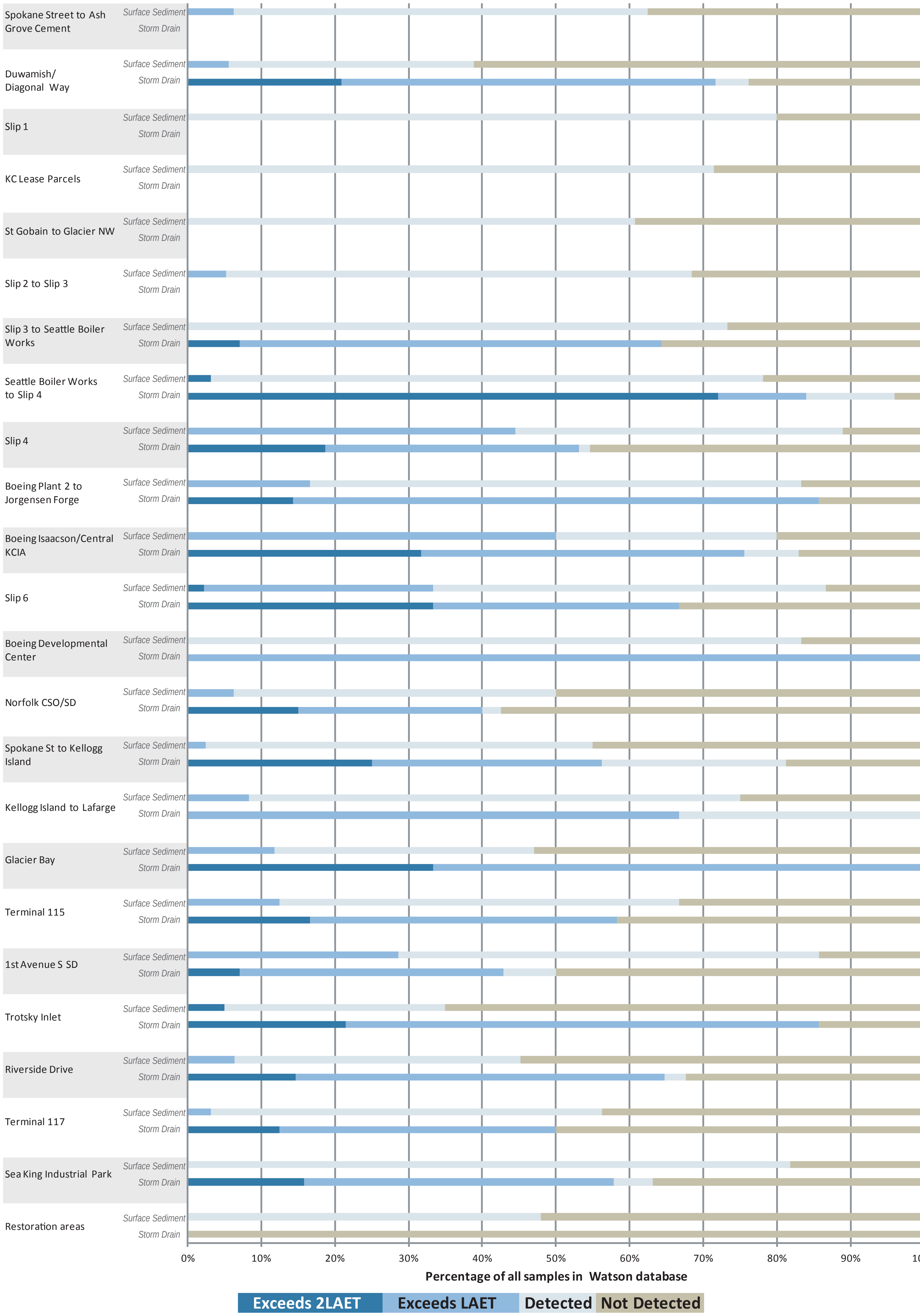

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Figure 3–23. BBP Exceedance Summary by Source Control Area

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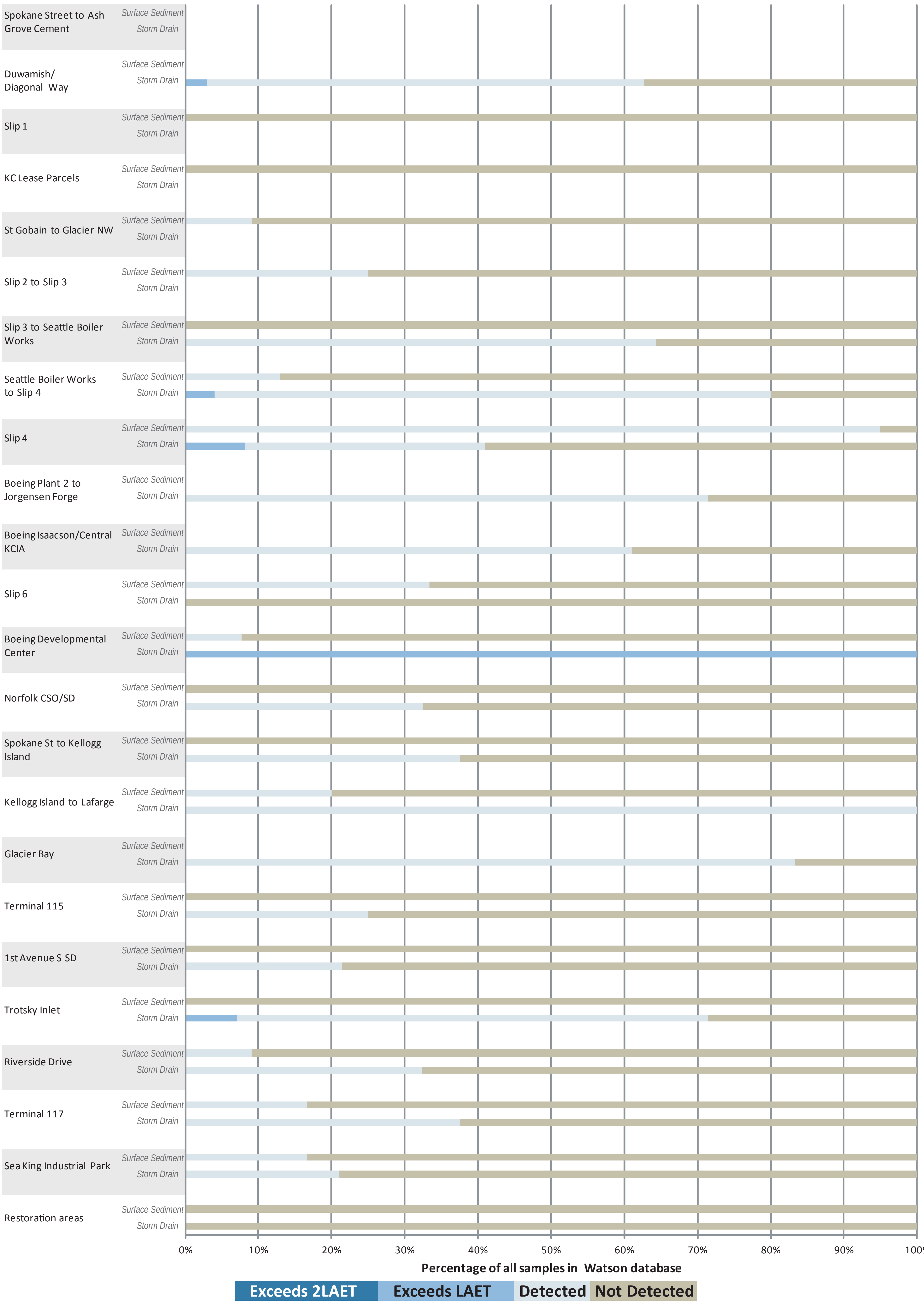

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Figure 3–24. Di-n-Octyl Phthalate Exceedance Summary by Source Control Area

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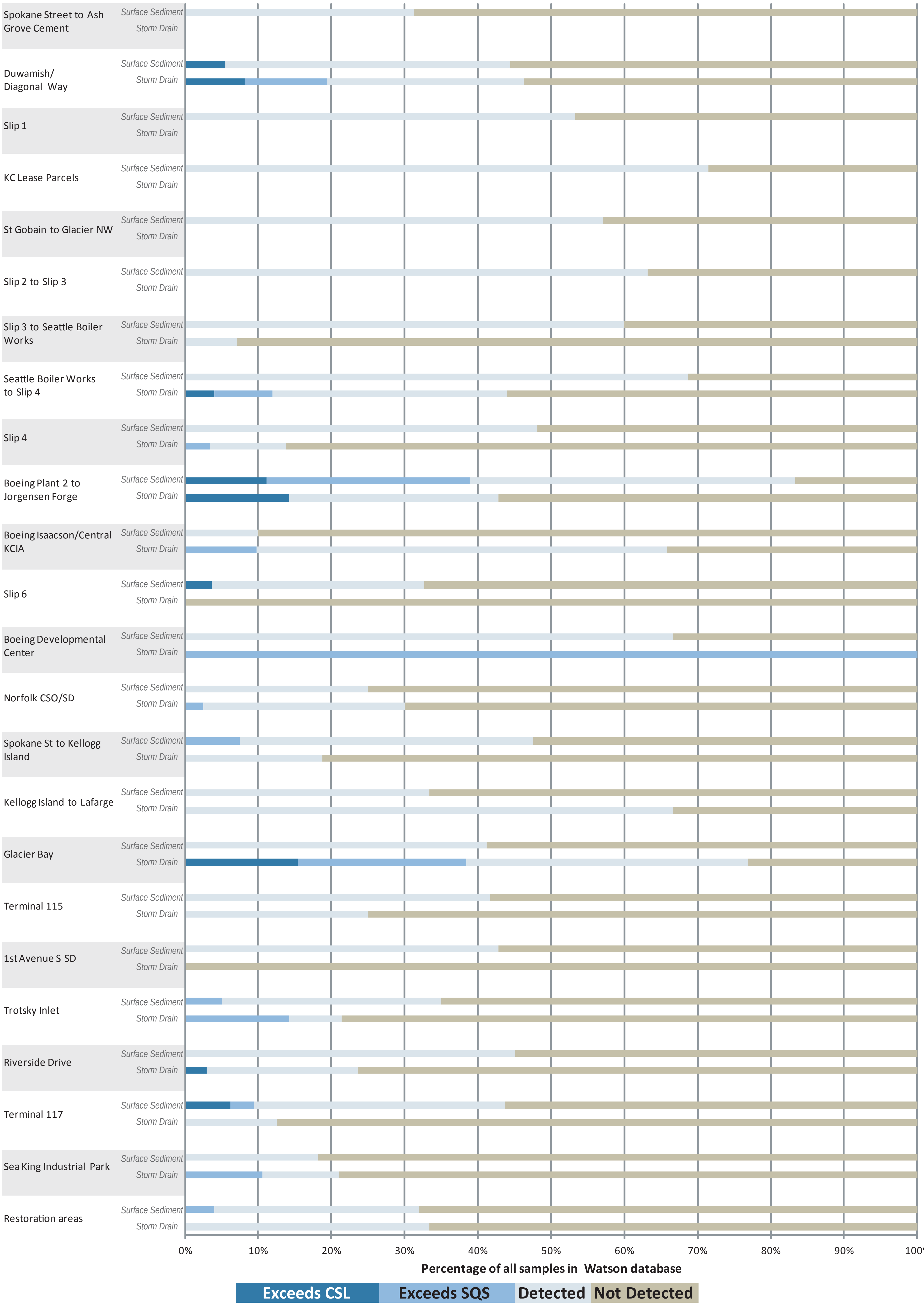

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Figure 3–25. Phenol Exceedance Summary by Source Control Area

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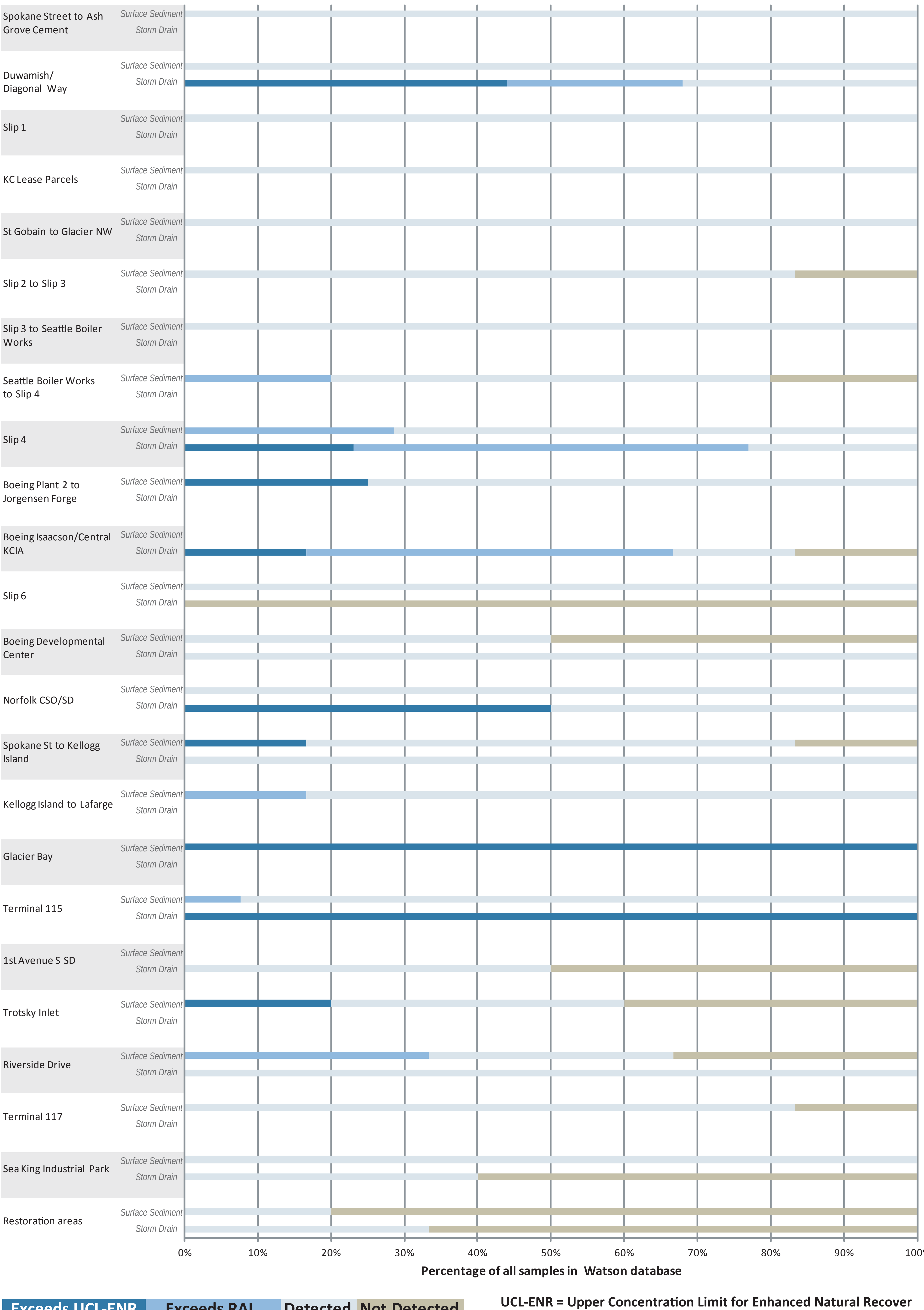

UCL-ENR = Upper Concentration Limit for Enhanced Natural Recover
RAL = Remedial Action Level

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Figure 3–26. Dioxin/Furan TEQ Exceedance Summary by Source Control Area

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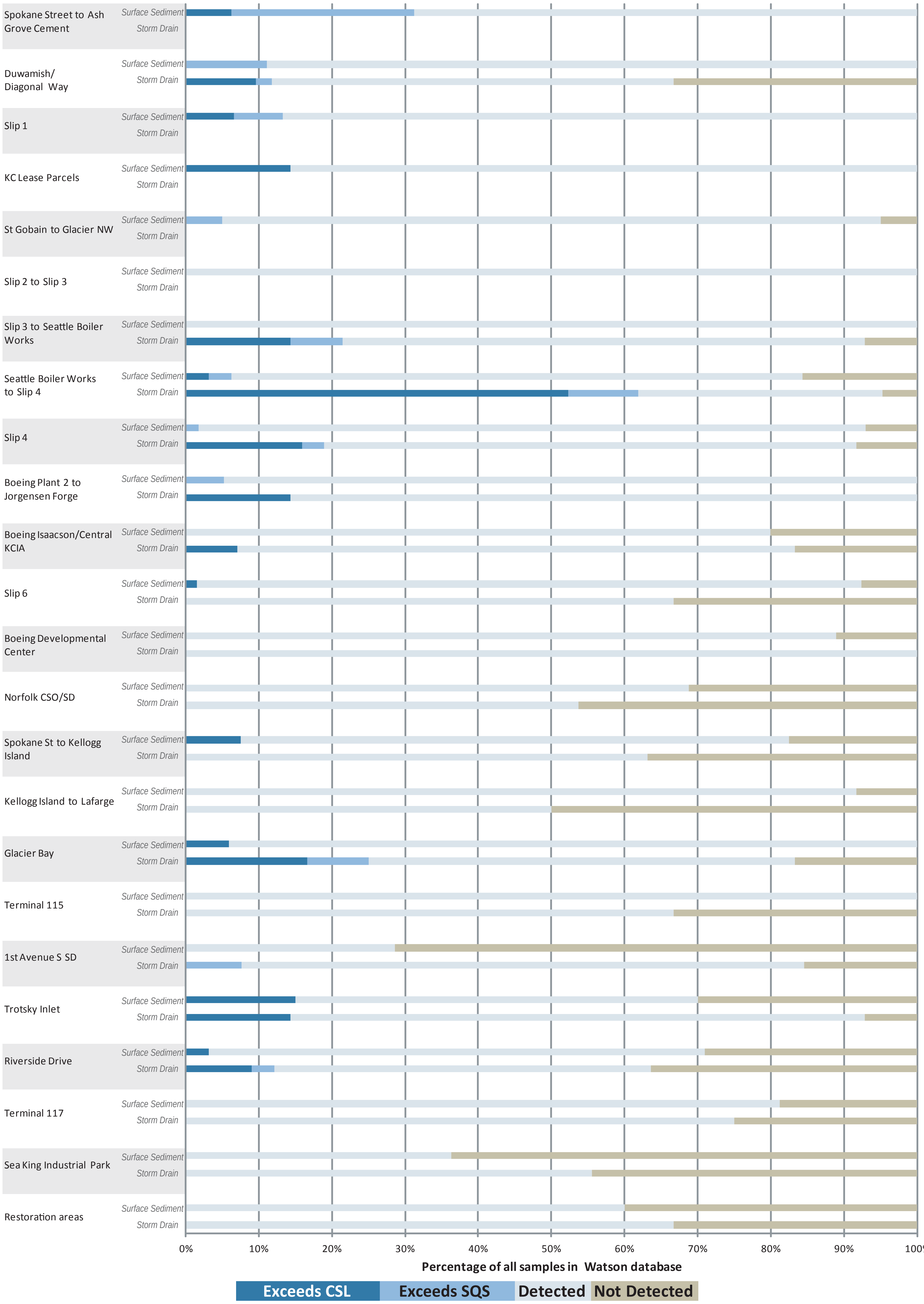

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Figure 3–27. Mercury Exceedance Summary by Source Control Area

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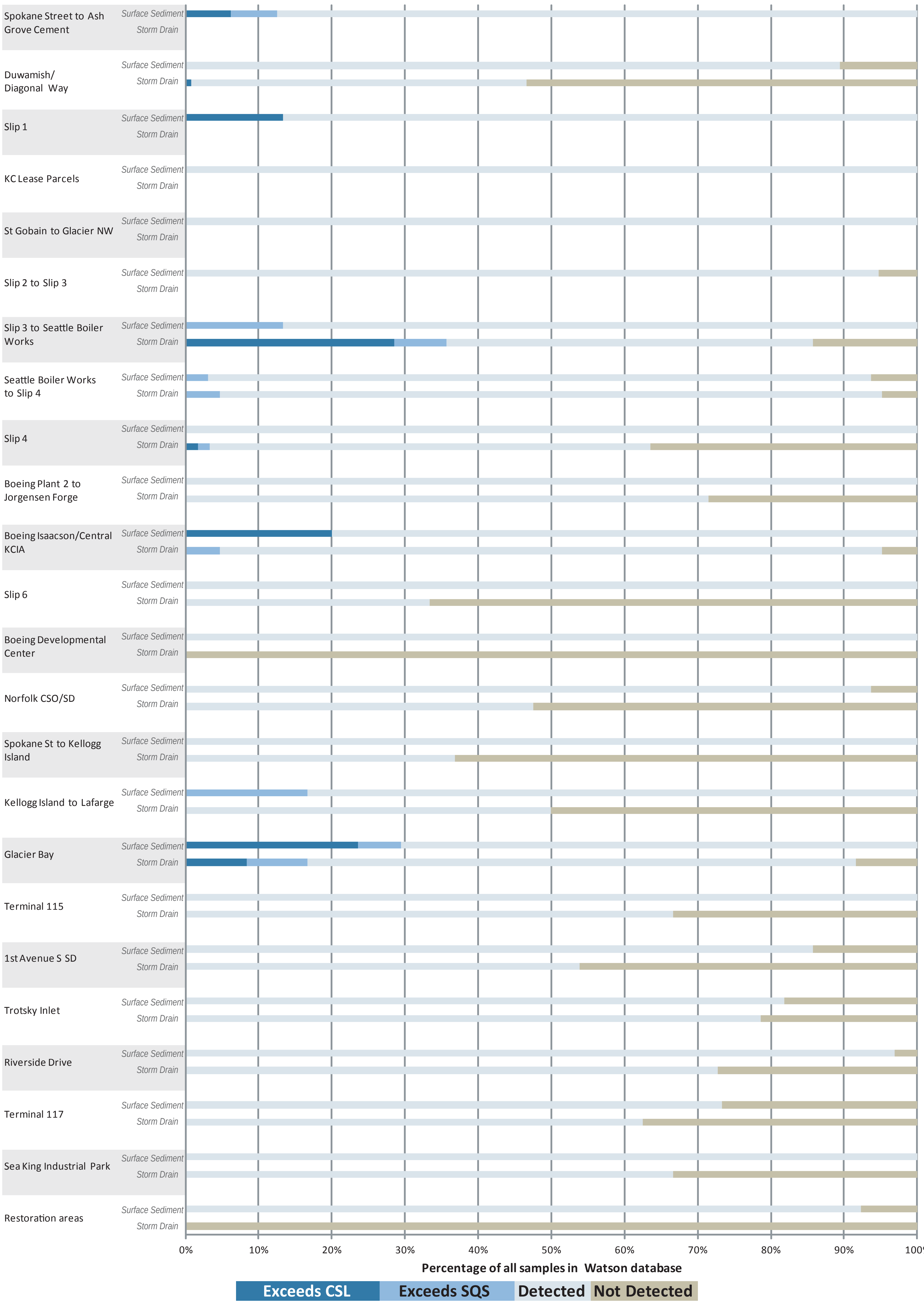

Figure 3–28. Arsenic Exceedance Summary by Source Control Area

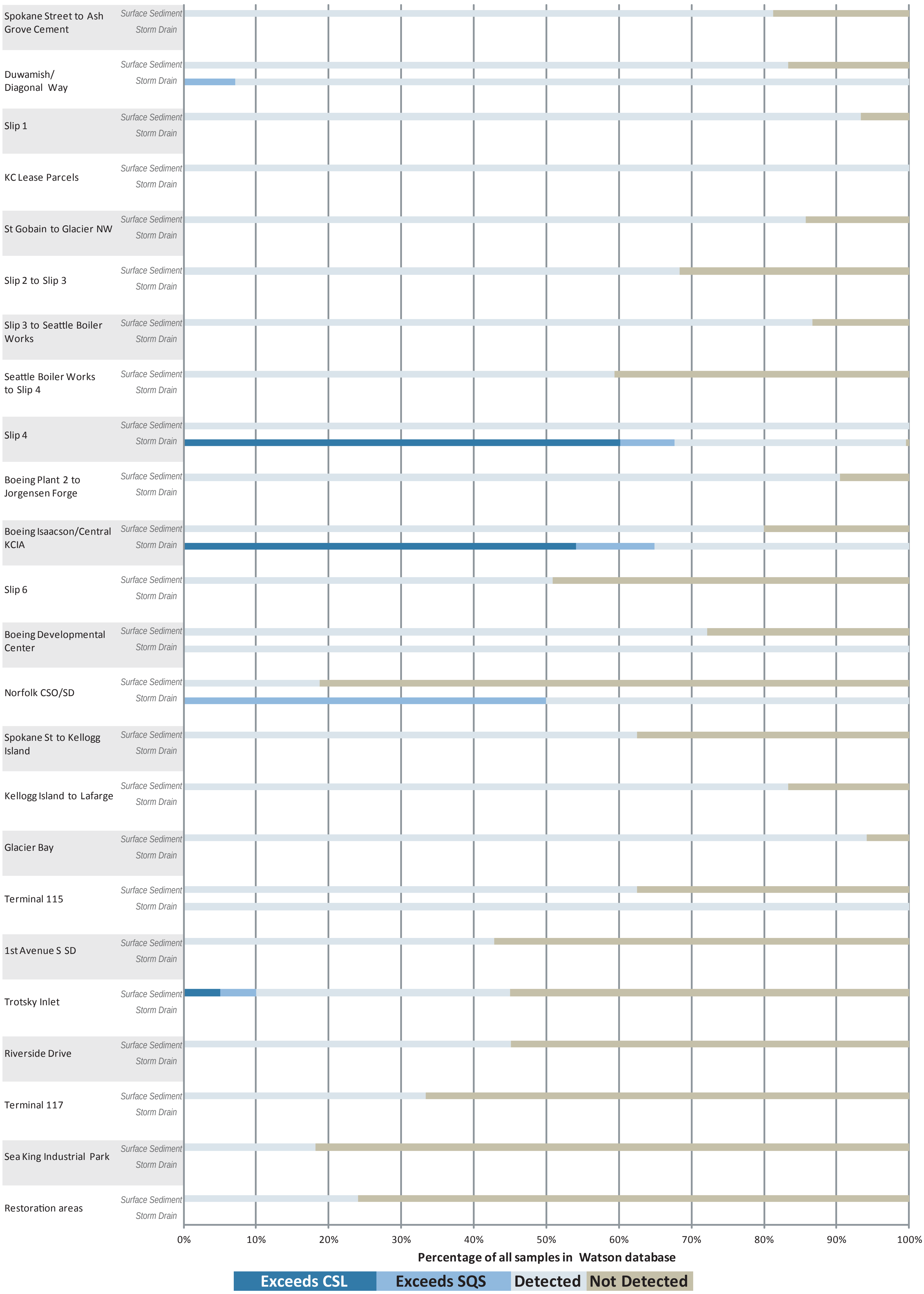

Figure 3–29. Cadmium Exceedance Summary by Source Control Area

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Figure 3–30. Copper Exceedance Summary by Source Control Area

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Figure 3–31. Lead Exceedance Summary by Source Control Area

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Figure 3–32. Zinc Exceedance Summary by Source Control Area

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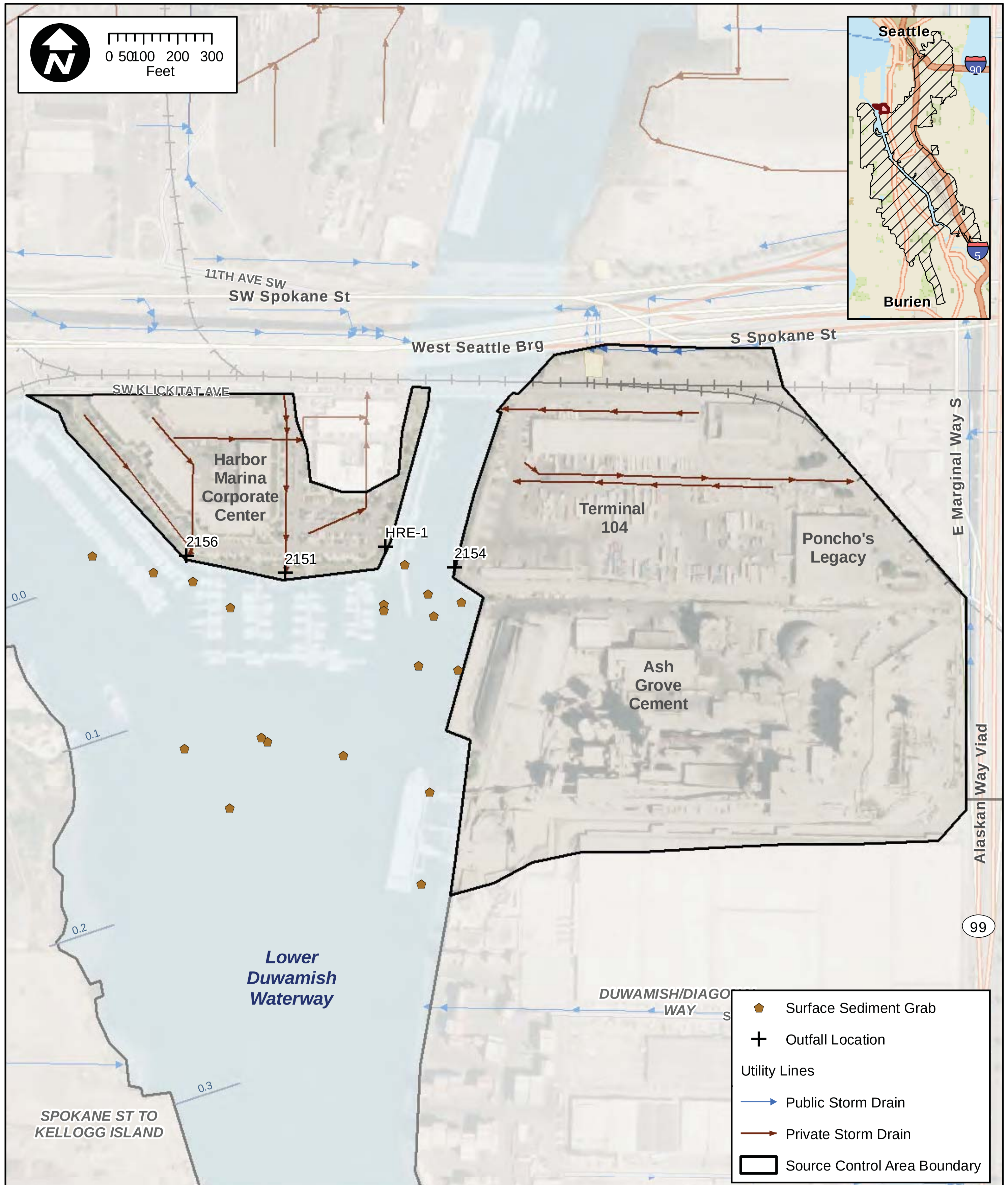

Figure 3-33a. Surface Sediment Sample Locations near RM 0.0-0.1 East (Spokane Street to Ash Grove Cement)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-33a_SCA_RM_0-0_to_0-1_East.mxd, Illustrative purposes only.

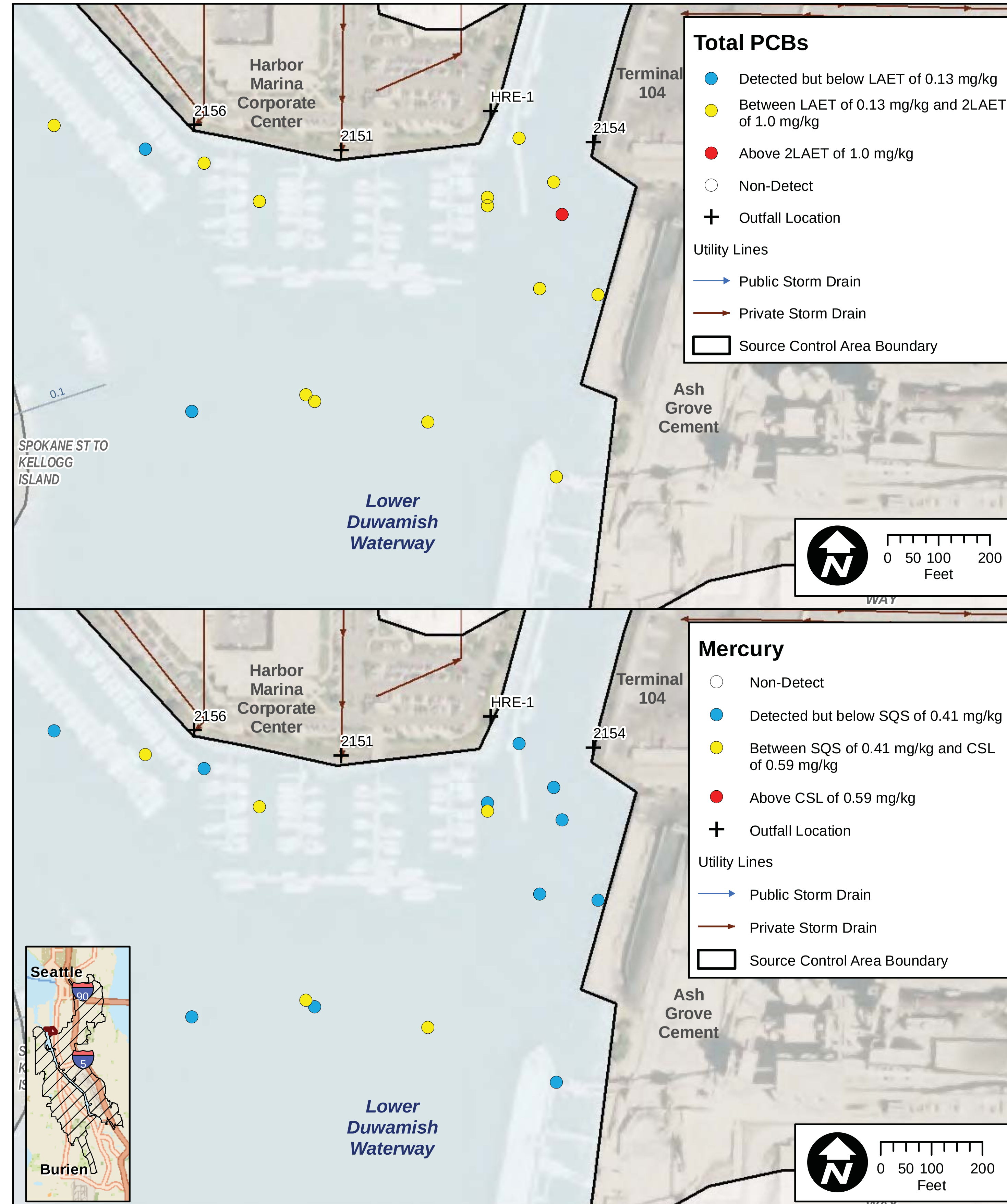

Figure 3-33b. COPC Concentrations in Surface Sediment near RM 0.0-0.1 East (Spokane Street to Ash Grove Cement)

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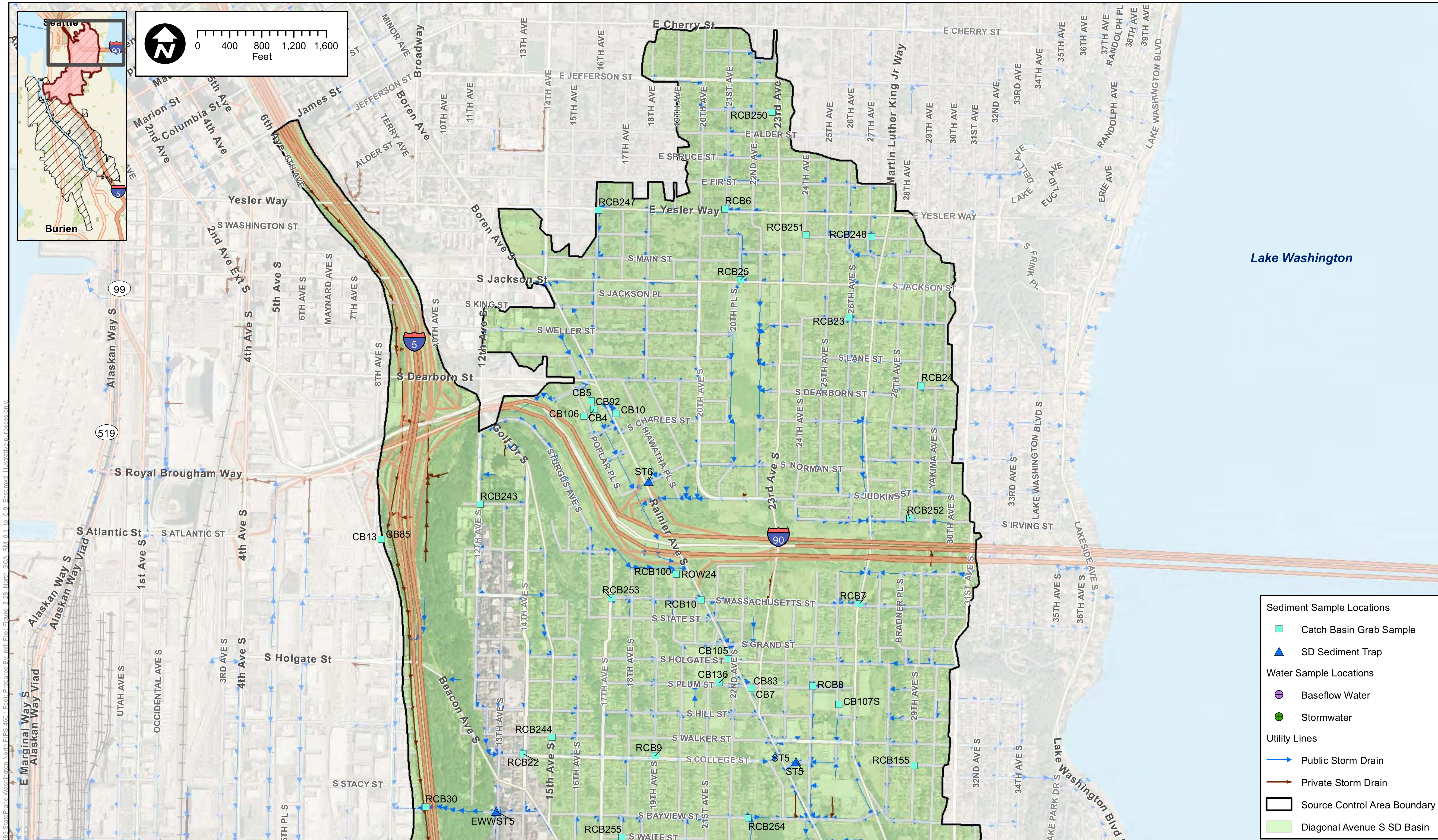

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-28_North_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

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Figure 3-34a (North). Sediment and Storm Drain Sample Locations near RM 0.1-0.9 (Duwamish/Diagonal Way)

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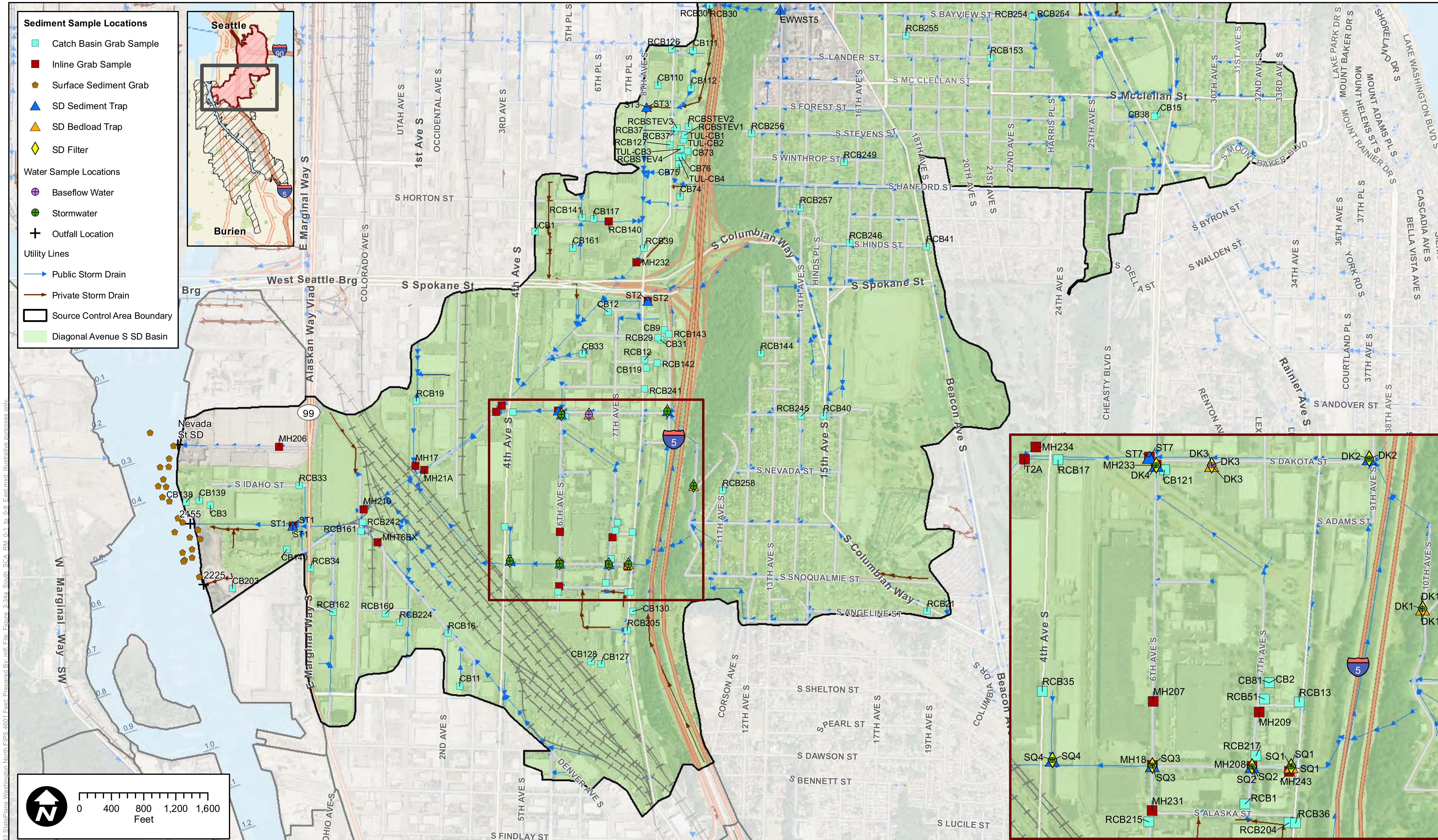

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-34a_South_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

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Figure 3-34a (South). Sediment and Storm Drain Sample Locations near RM 0.1-0.9 (Duwamish/Diagonal Way)

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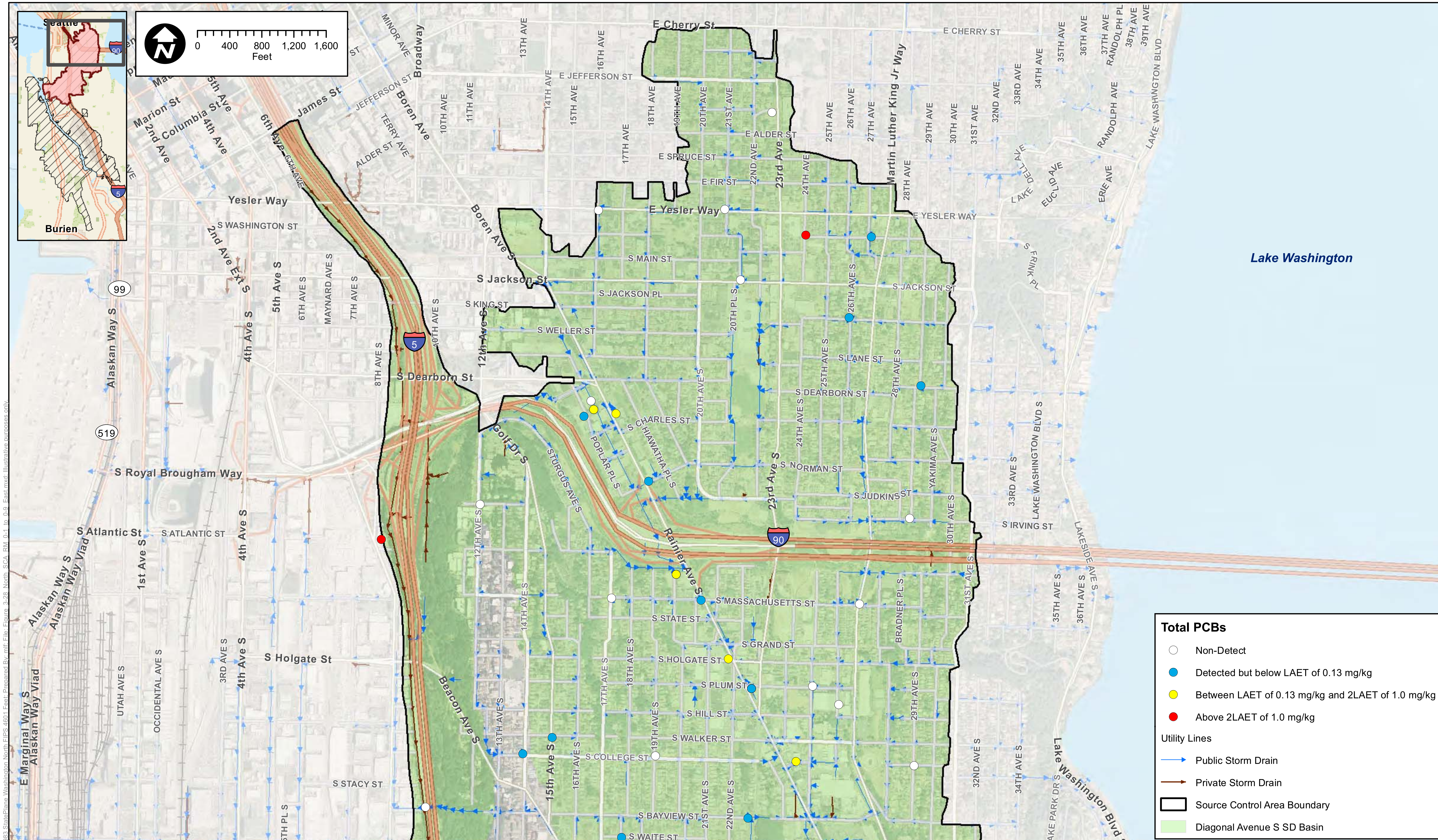

Figure 3-34b (North). Total PCB Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-28_North_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

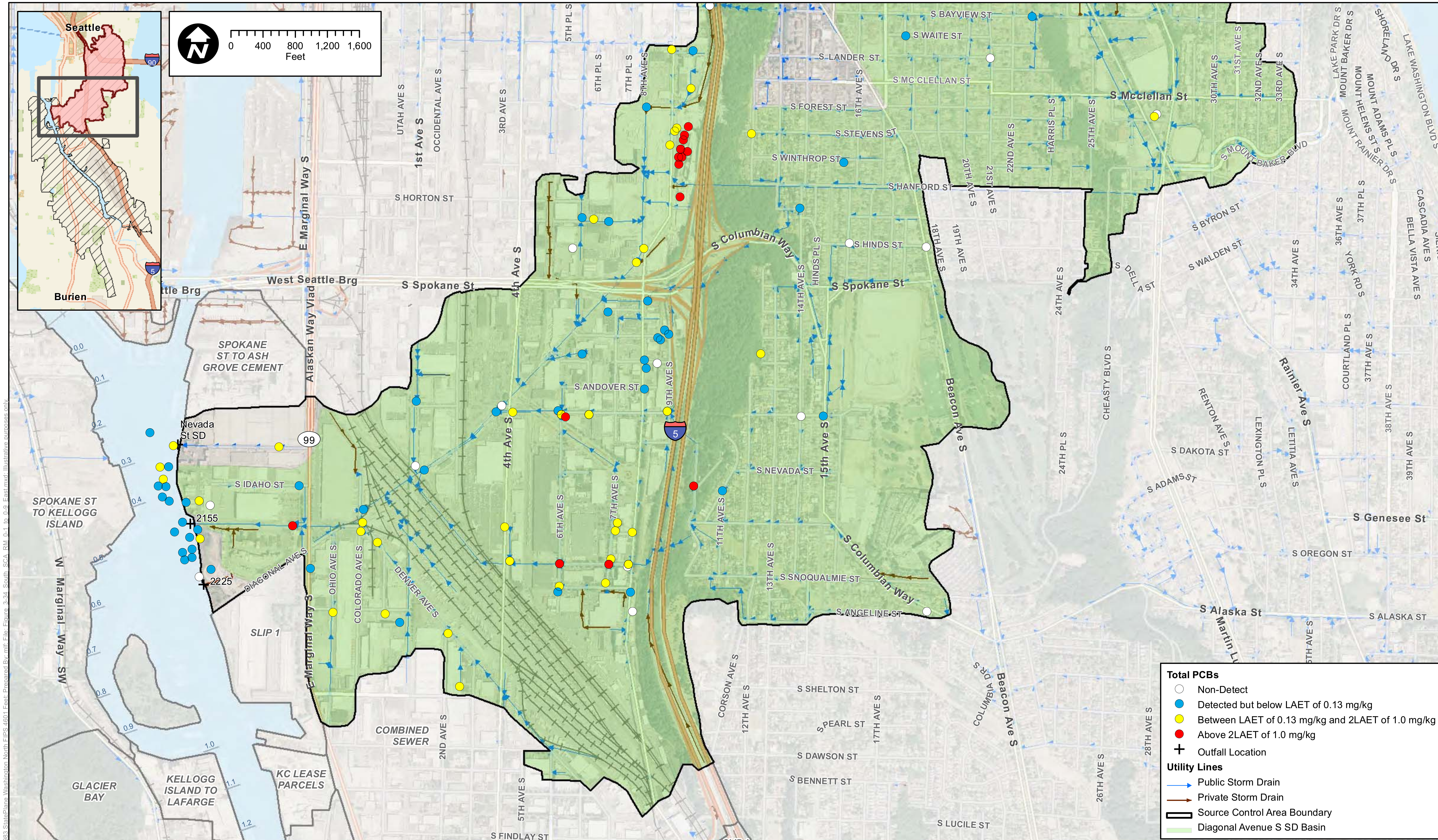

Figure 3-34b (South). Total PCB Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-34_South_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

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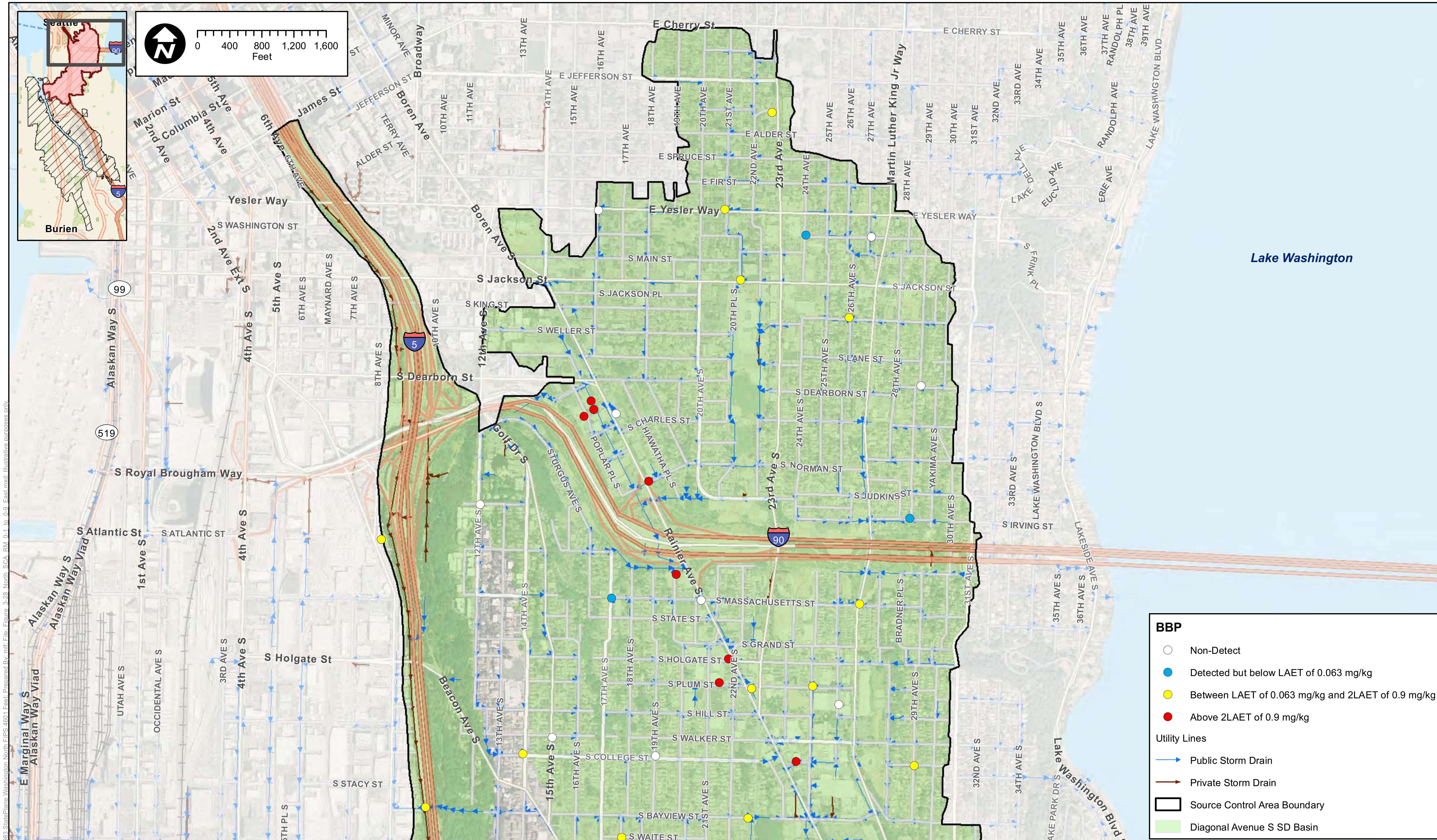

Figure 3-34c (North). BBP Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-28_North_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

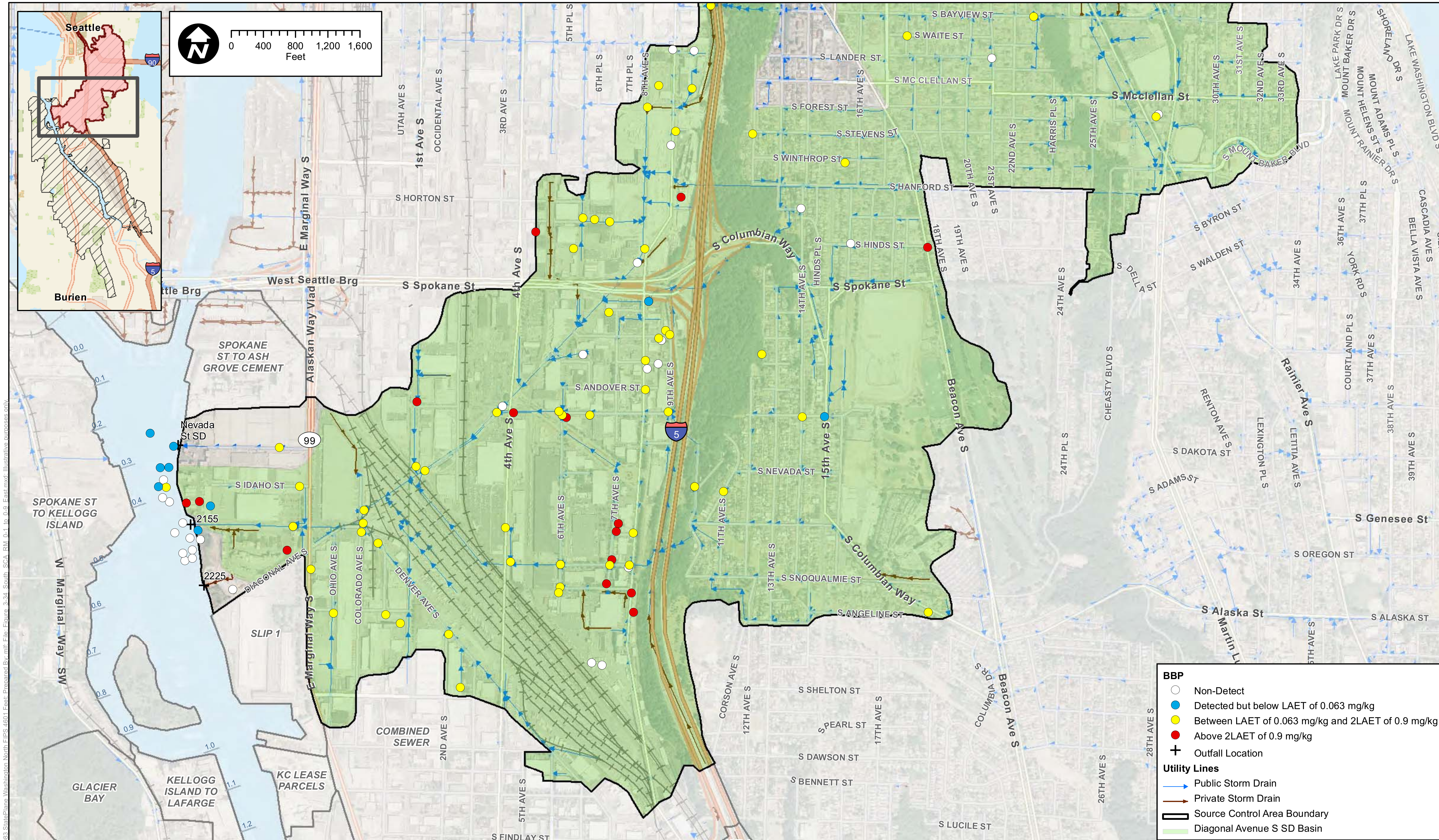

Figure 3-34c (South). BBP Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)

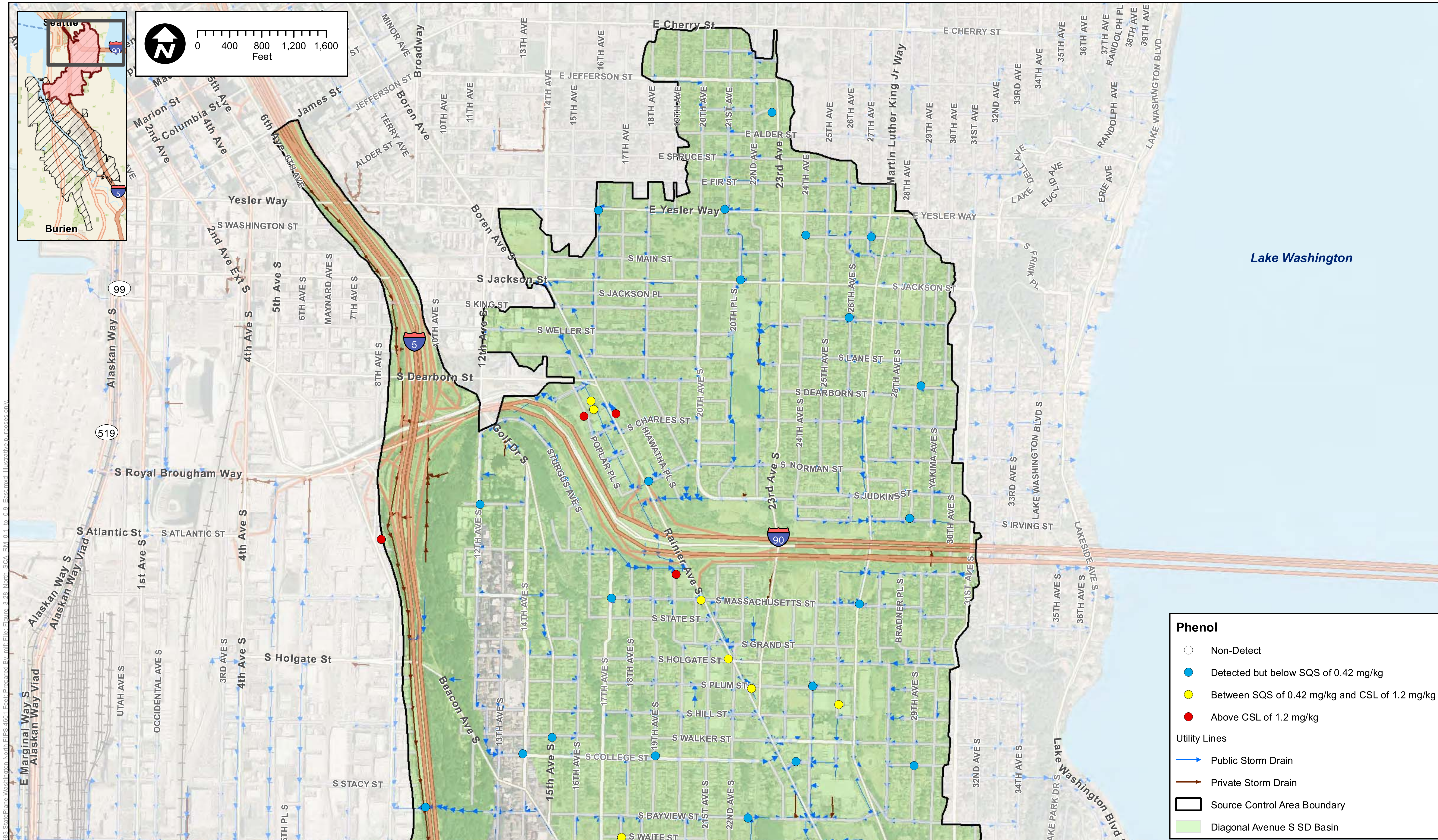

Figure 3-34d (North). Phenol Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-28_North_SCA_RM_0-1_to_0-9_East.mxd; Illustrative purposes only.

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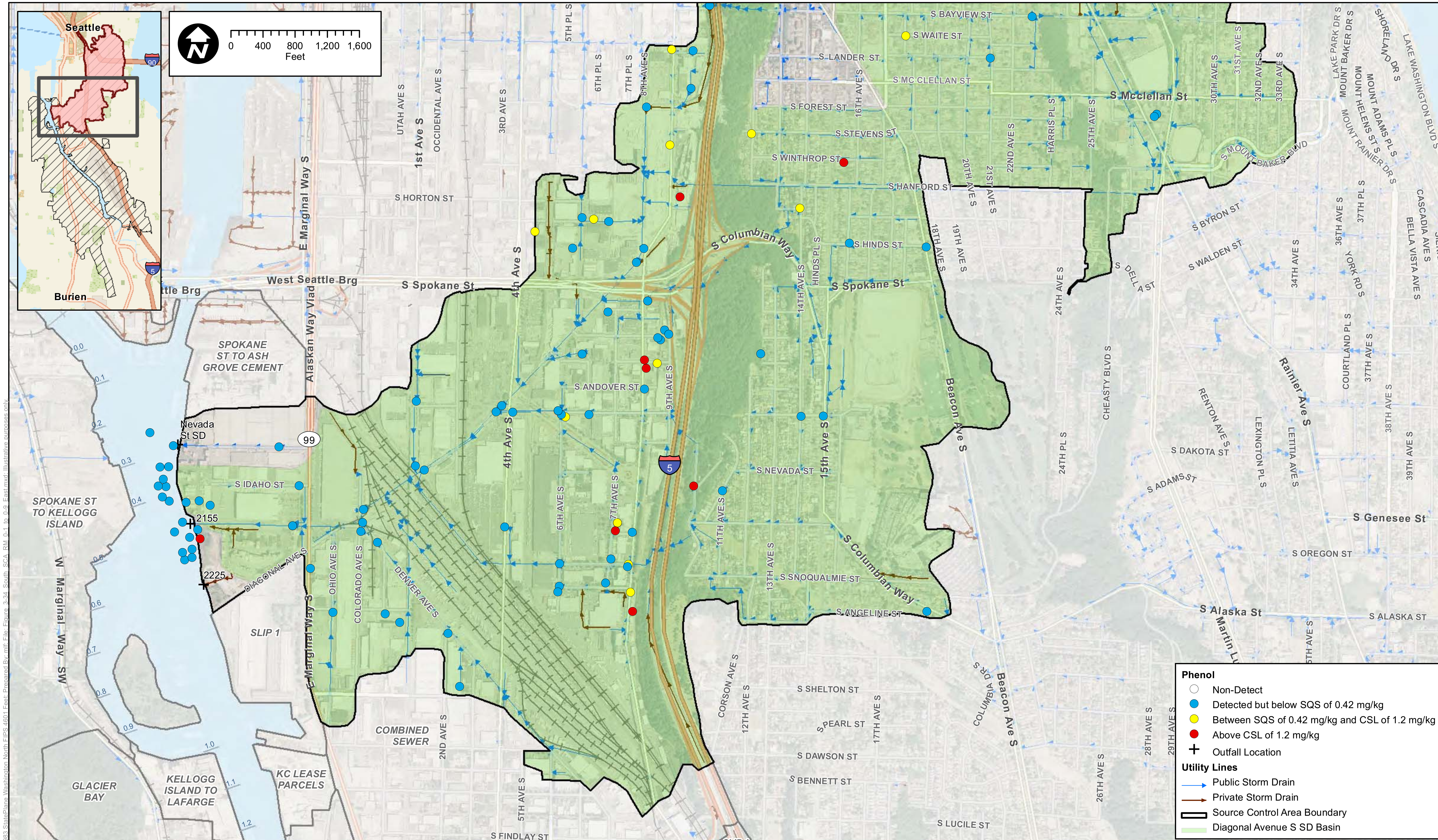


Figure 3-34d (South). Phenol Concentrations in Sediment and Storm Drain Samples
River Mile 0.1-0.9 (Duwamish/Diagonal Way)

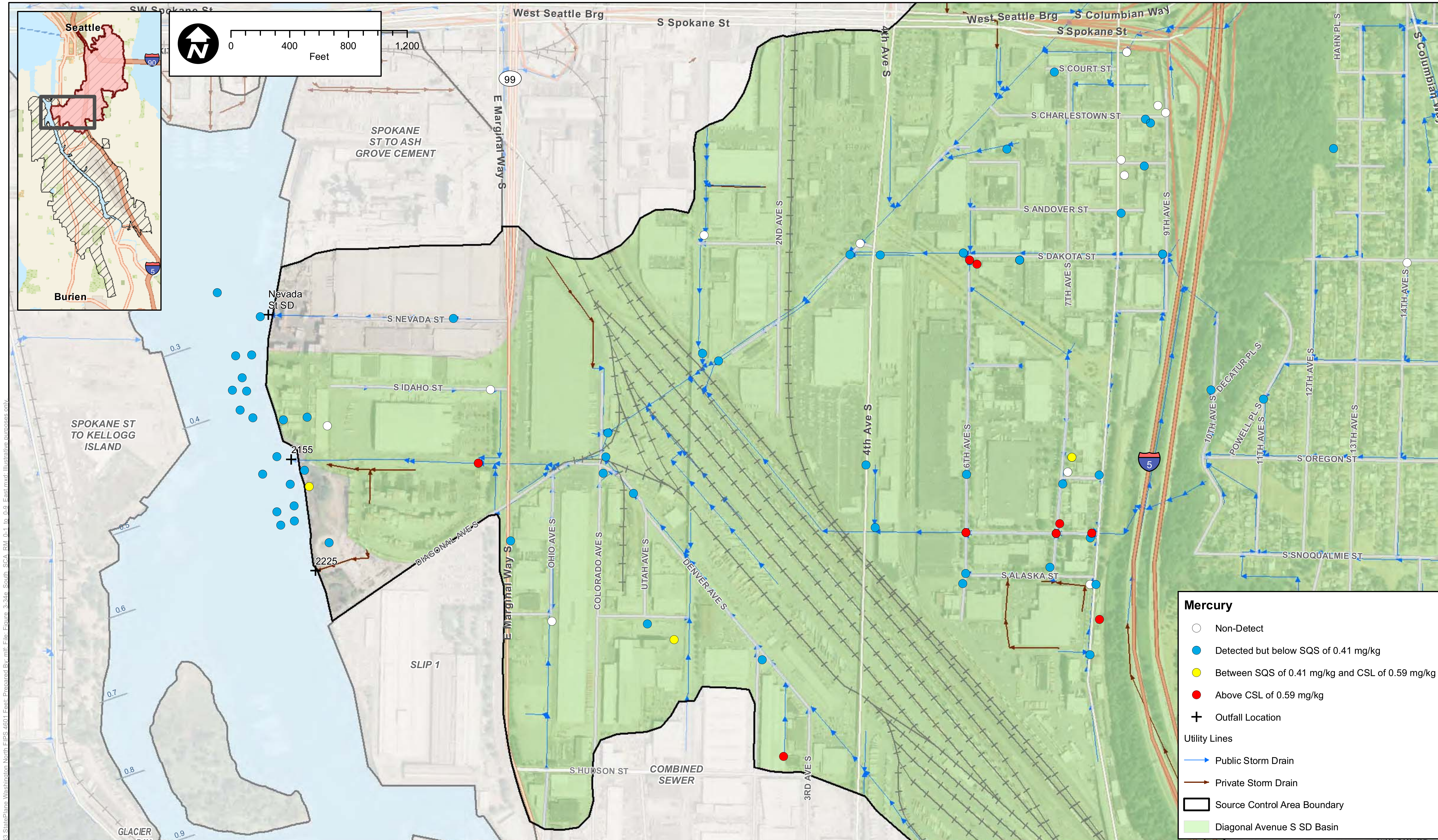
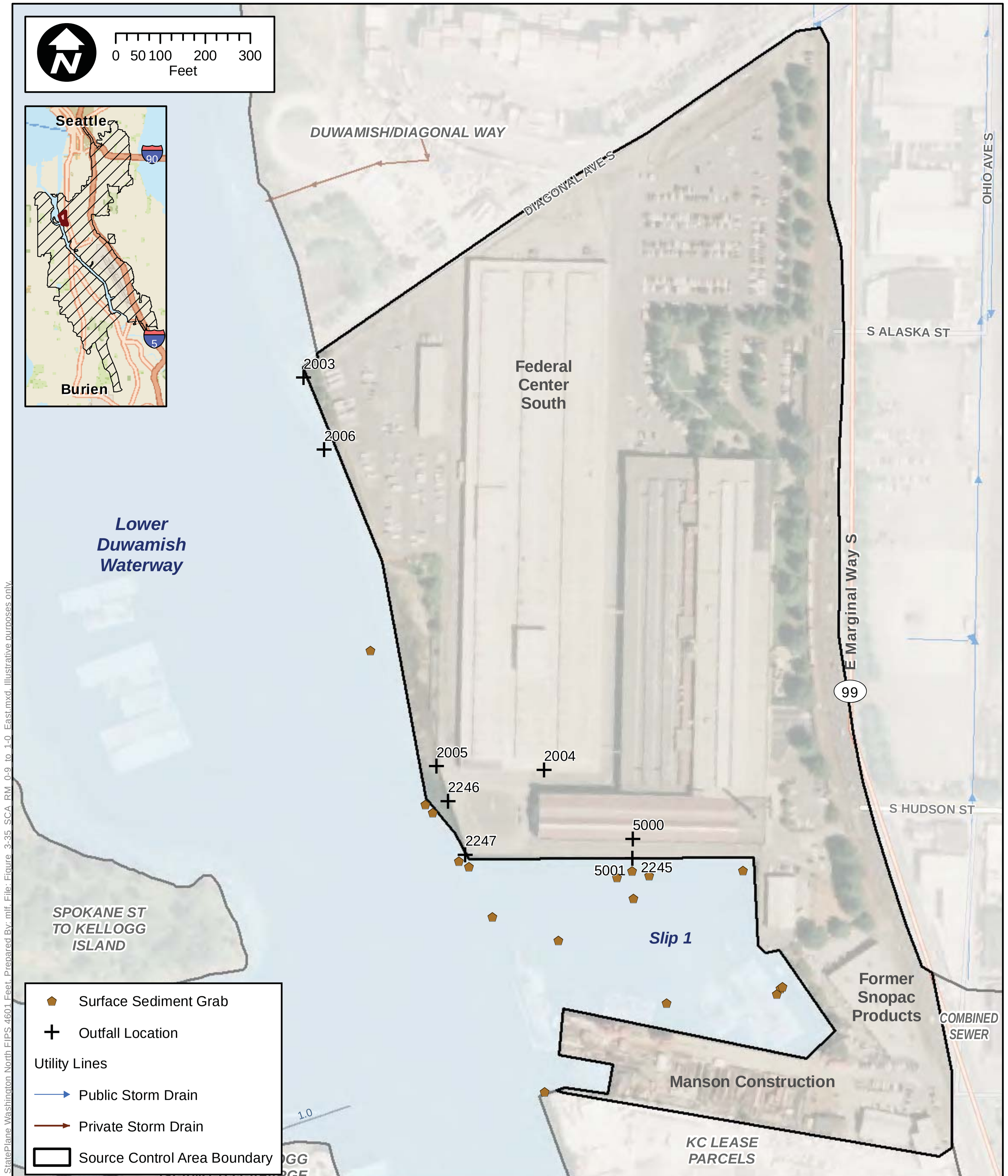


Figure 3-34e. Mercury Concentrations in Sediment and Storm Drain Samples near RM 0.1-0.9 (Duwamish/Diagonal Way)



Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-35_SCA_RM_0-9_to_1-0_East.mxd, Illustrative purposes only.

Figure 3-35a. Surface Sediment Sample Locations near RM 0.9-1.0 East (Slip 1)

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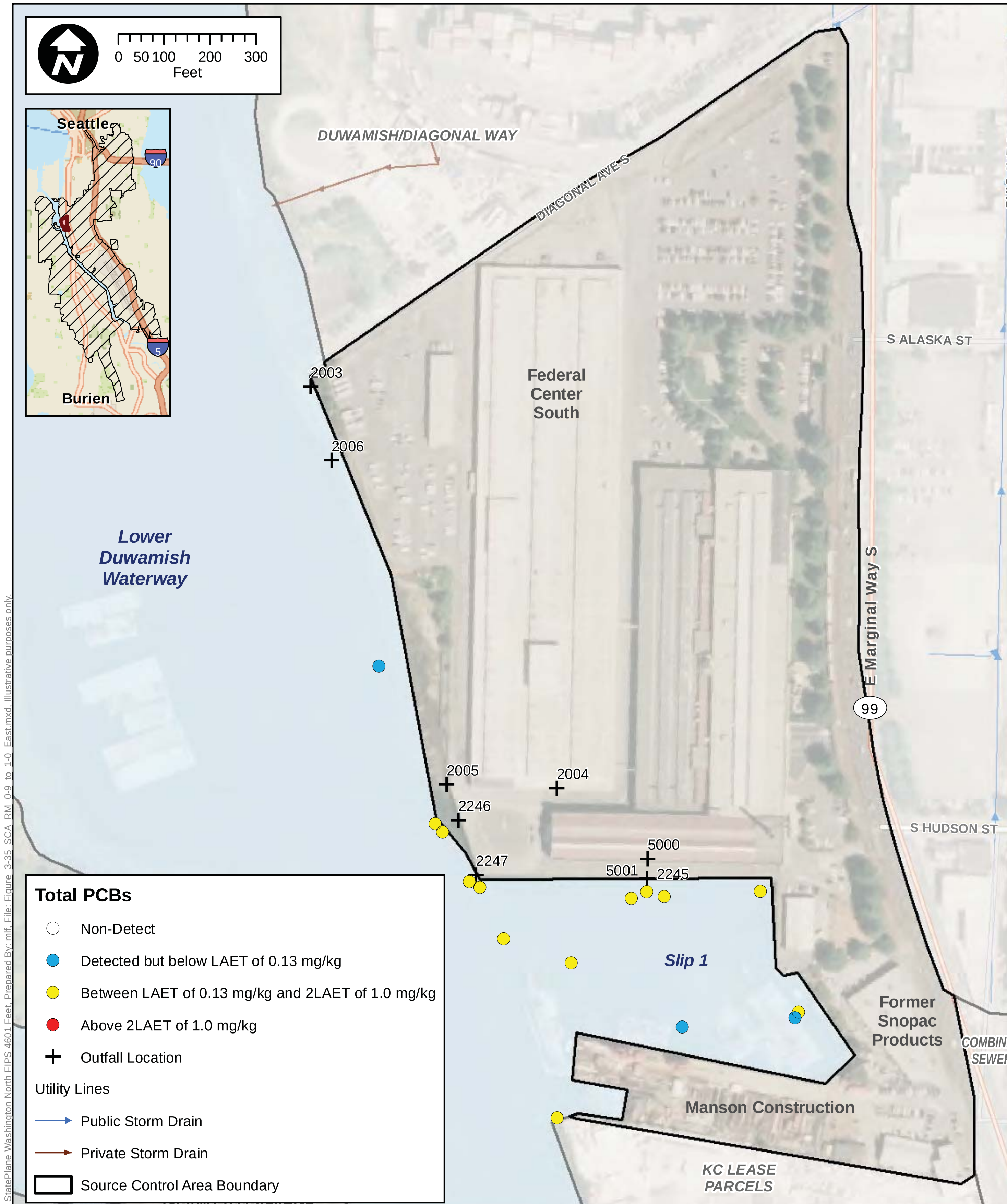

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Figure 3-35b. PCB Concentrations in Surface Sediment Samples near RM 0.9-1.0 East (Slip 1)

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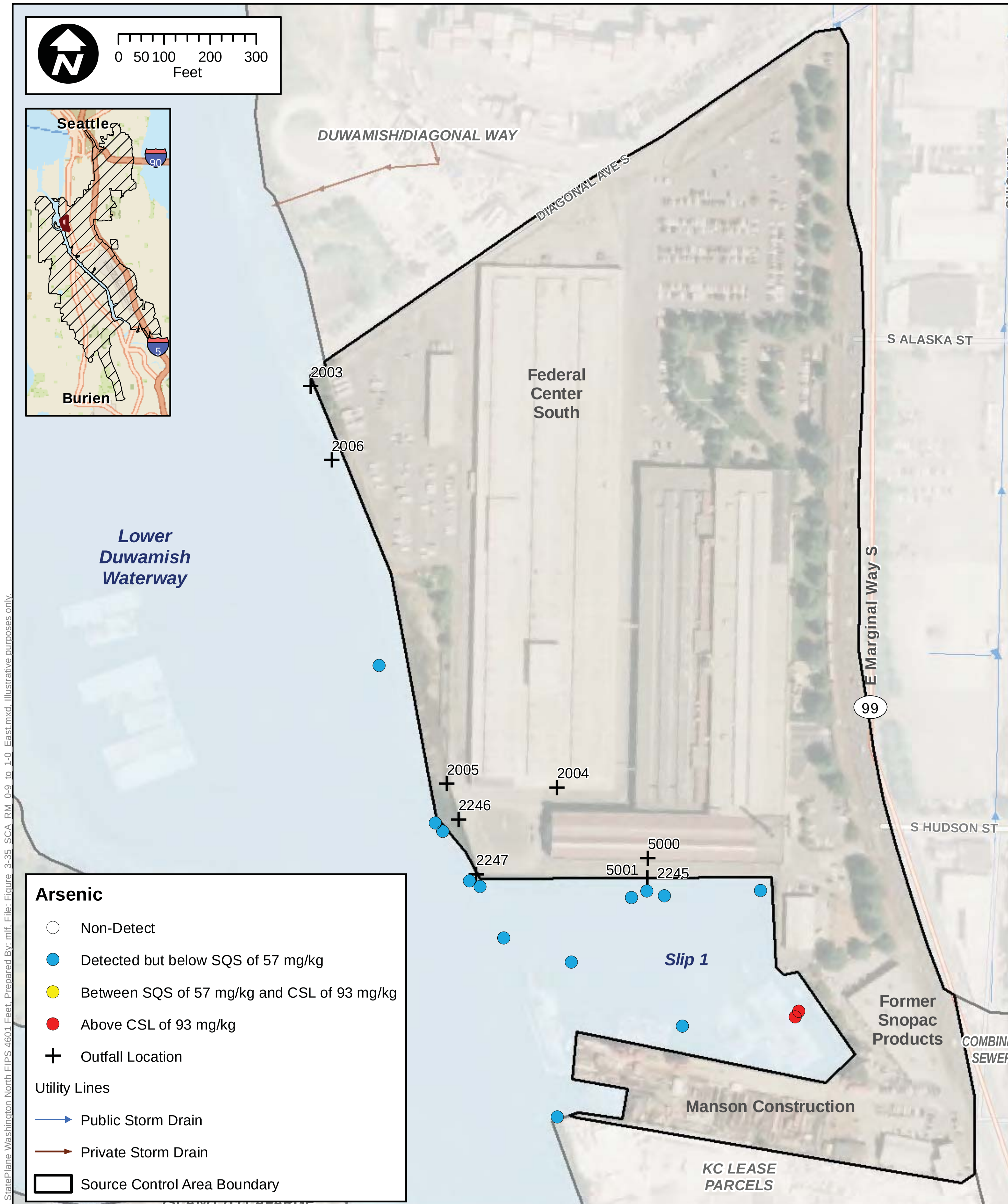

Figure 3-35c. Arsenic Concentrations in Surface Sediment Samples near RM 0.9-1.0 East (Slip 1)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet. Prepared By: mlf. File: Figure_3-35_SCA_RM_0-9_to_1-0_East.mxd. Illustrative purposes only.

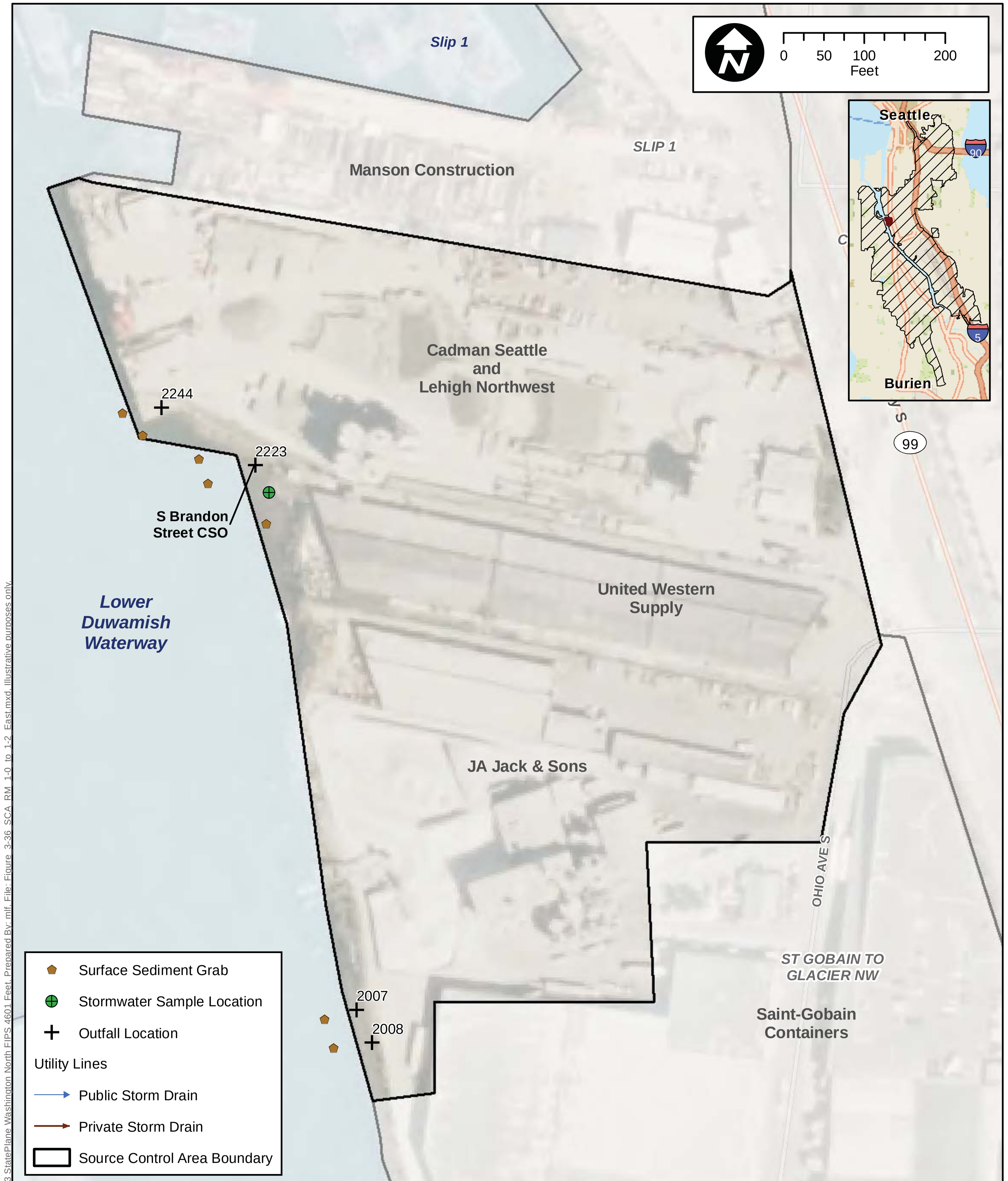

Figure 3-36. Surface Sediment Sample Locations near RM 1.0-1.2 East (King County Lease Parcels)

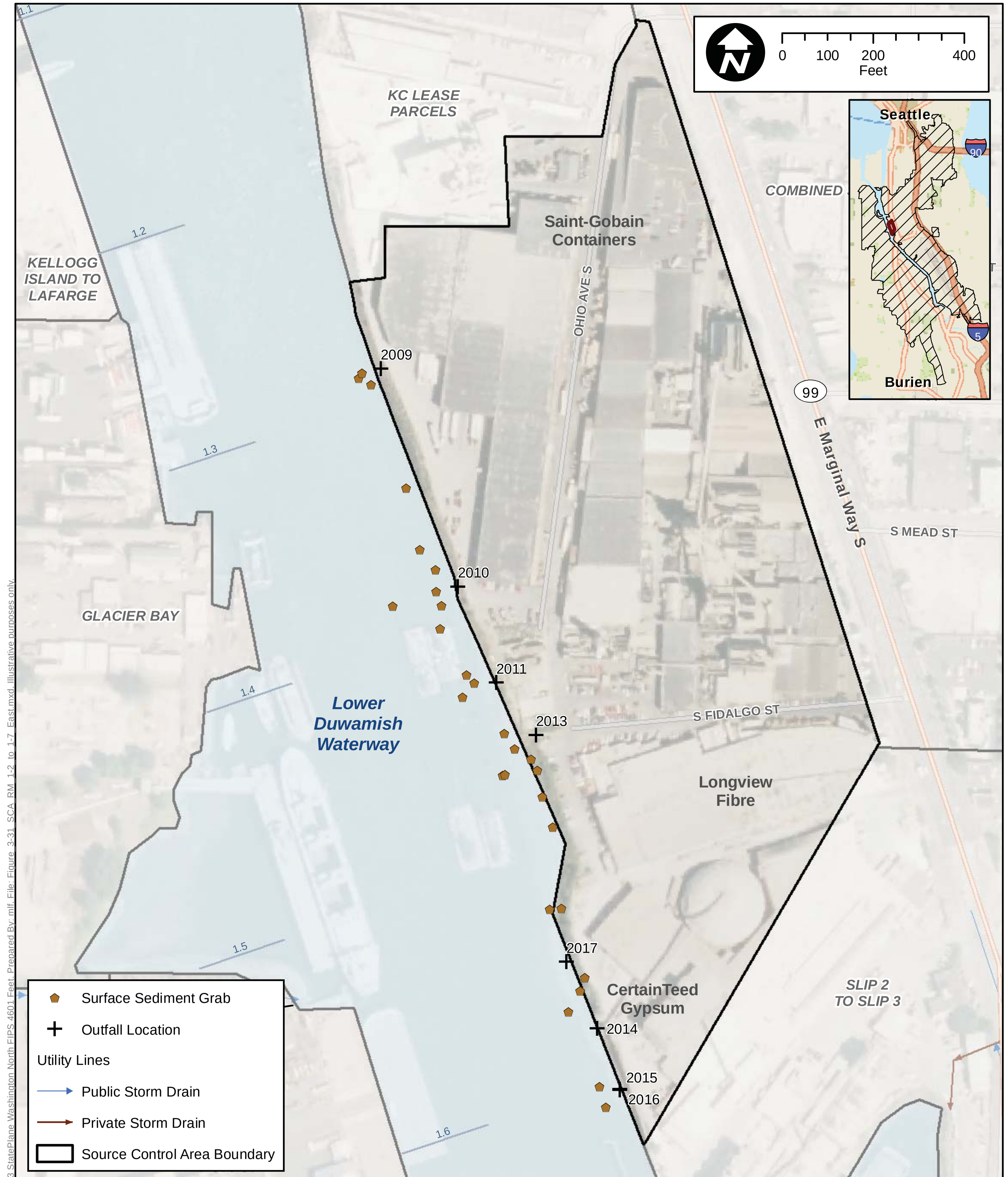

Figure 3-37. Surface Sediment Sample Locations near RM 1.2-1.7 East (St. Gobain to Glacier NW)

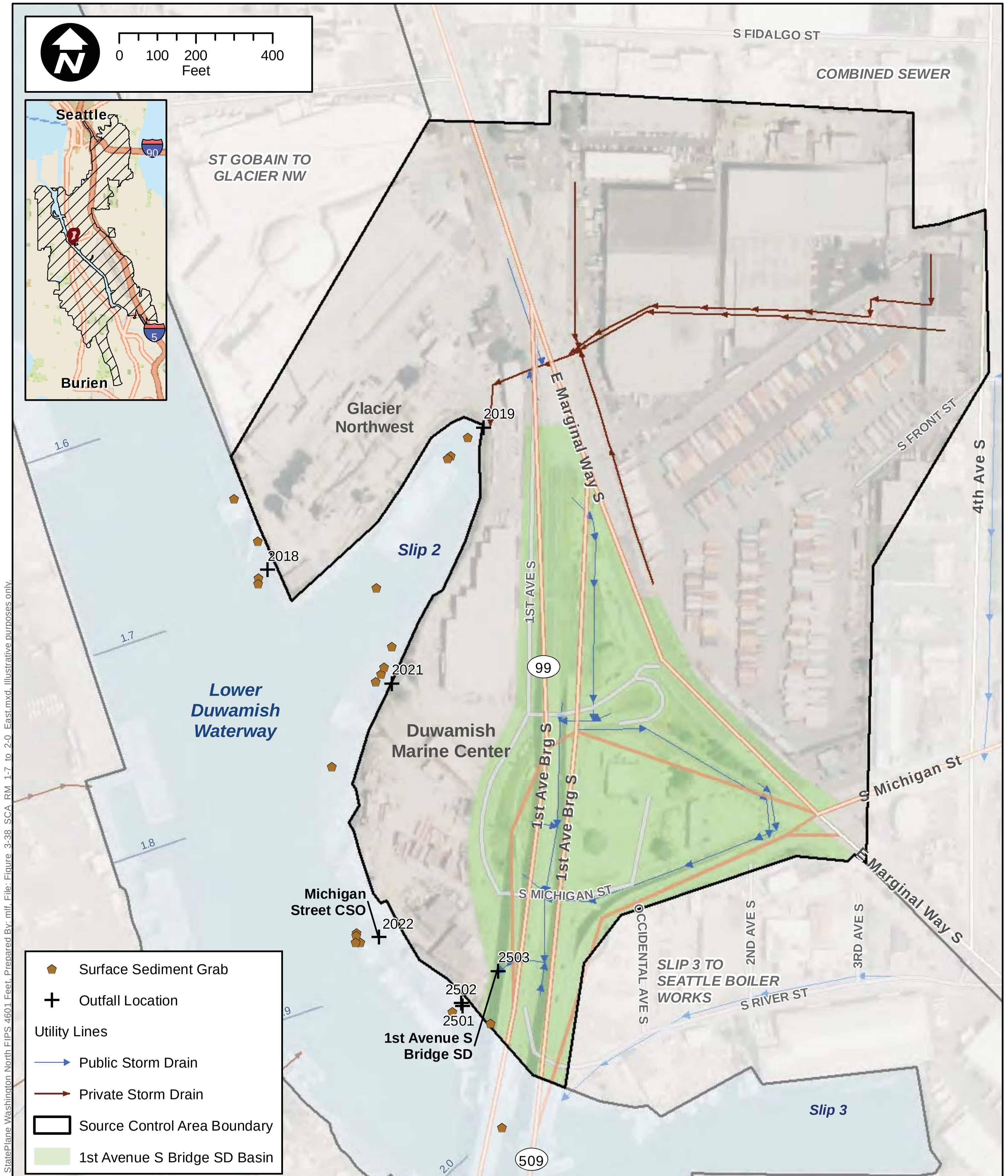

Figure 3-38a. Surface Sediment Sample Locations near RM 1.7-2.0 East (Slip 2 to Slip 3)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-38_SCA_RM_1-7_to_2-0_East.mxd, Illustrative purposes only.

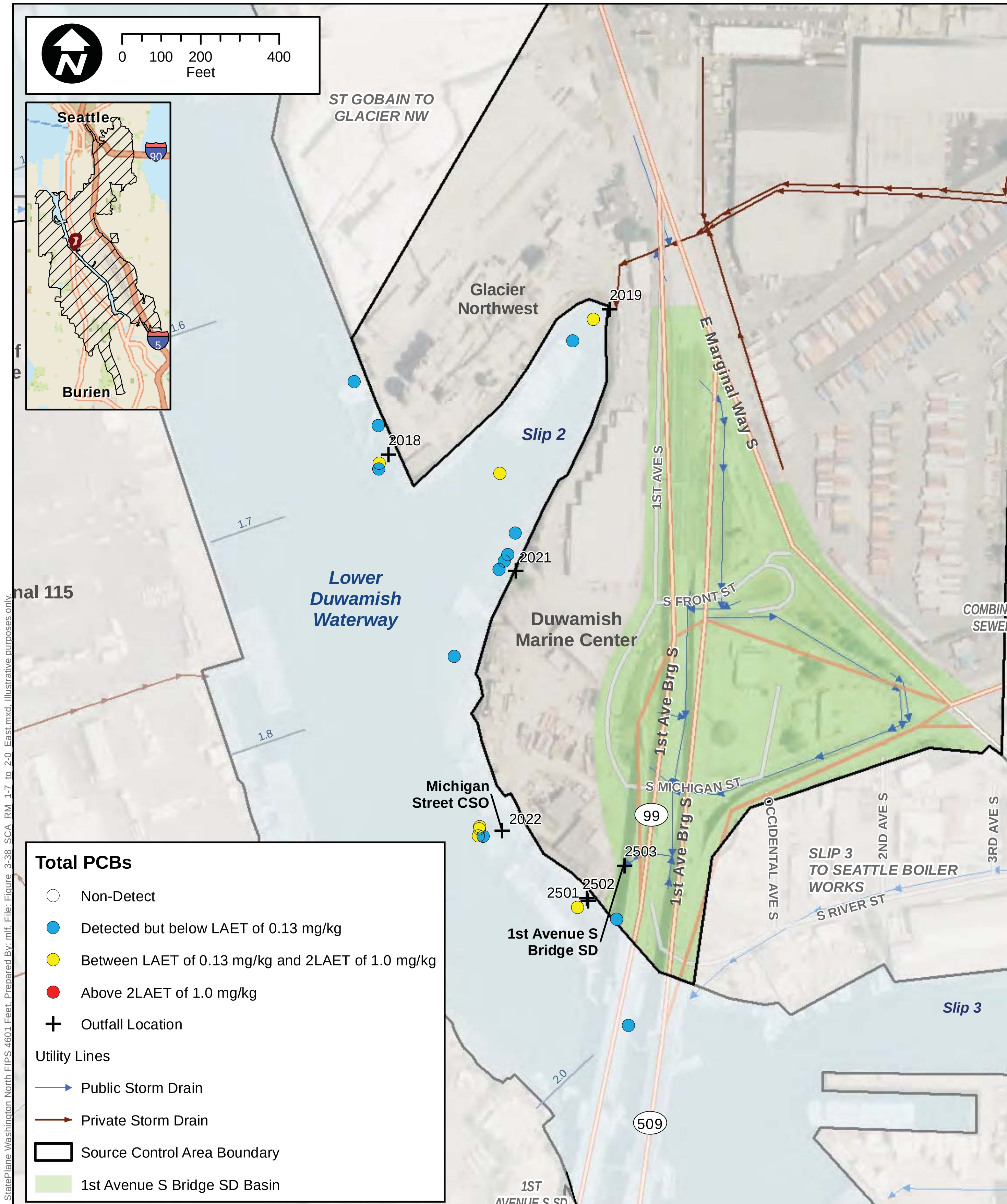

Figure 3-38b. Total PCB Concentrations in Surface Sediment Samples near RM 1.7-2.0 East (Slip 2 to Slip 3)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-38_SCA_RM_1-7_to_2-0_East.mxd, Illustrative purposes only.

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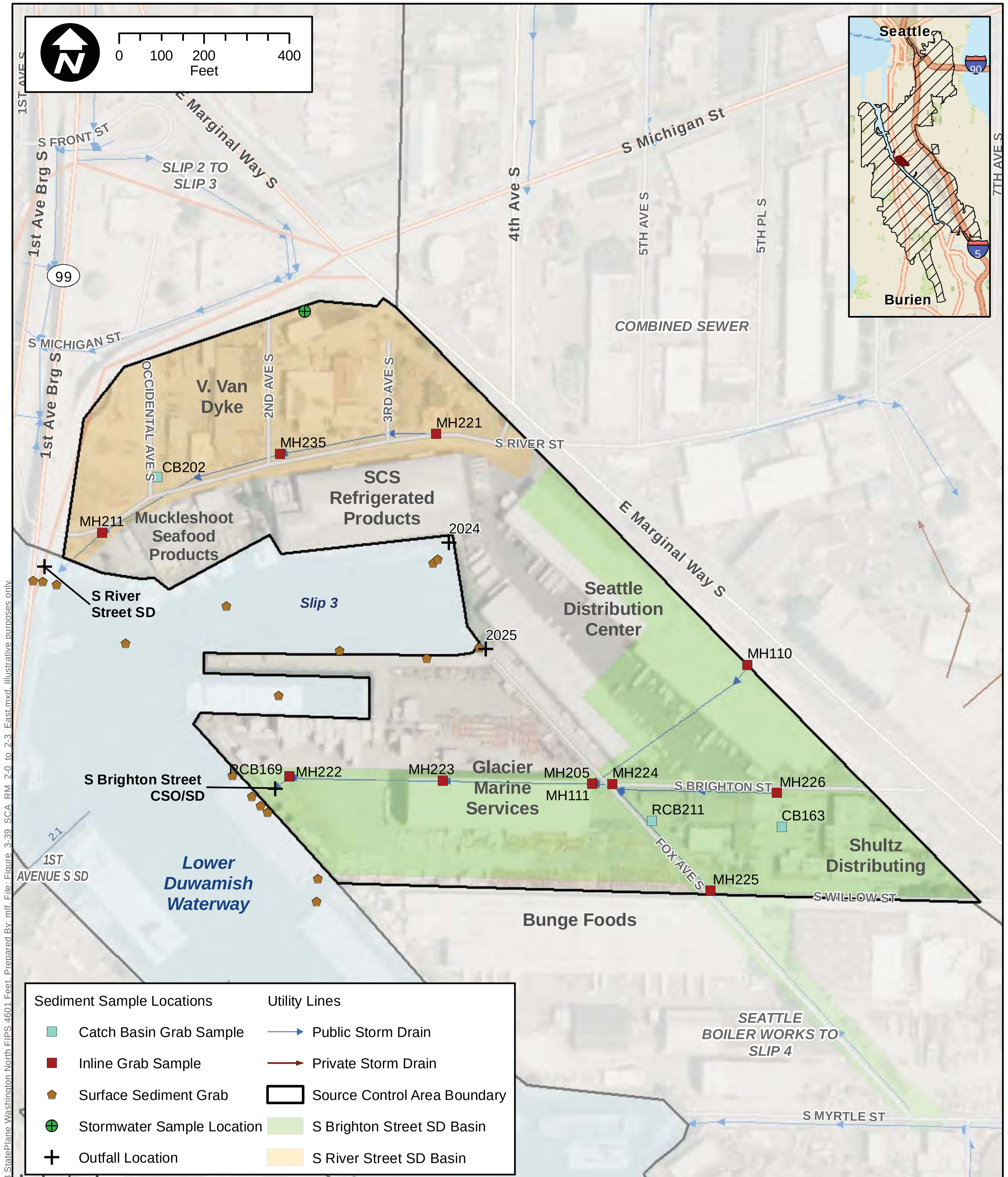

Figure 3-39a. Sediment and Storm Drain Sample Locations near RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)

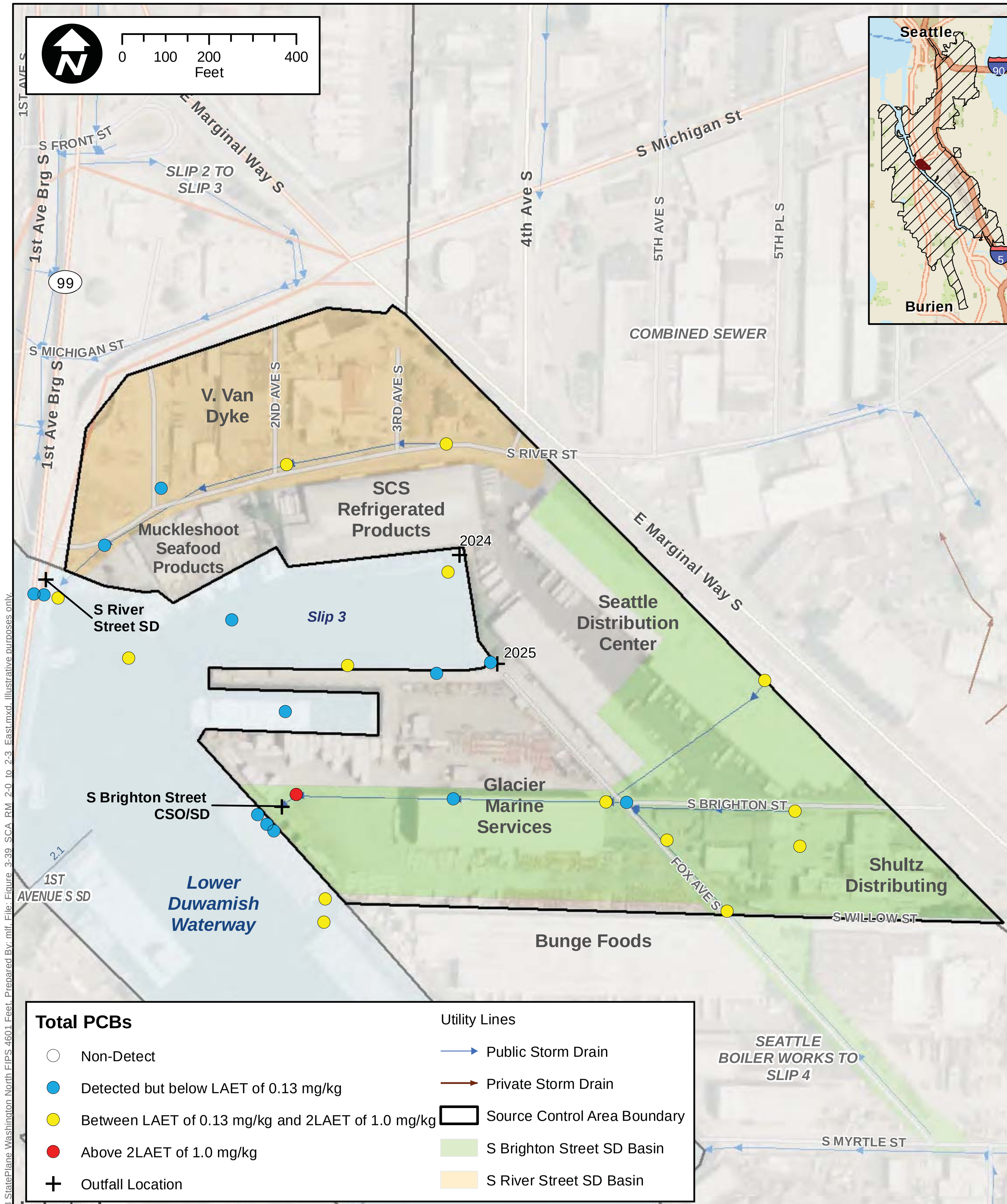

Figure 3-39b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-39_SCA_RM_2-0_to_2-3_East.mxd, Illustrative purposes only.

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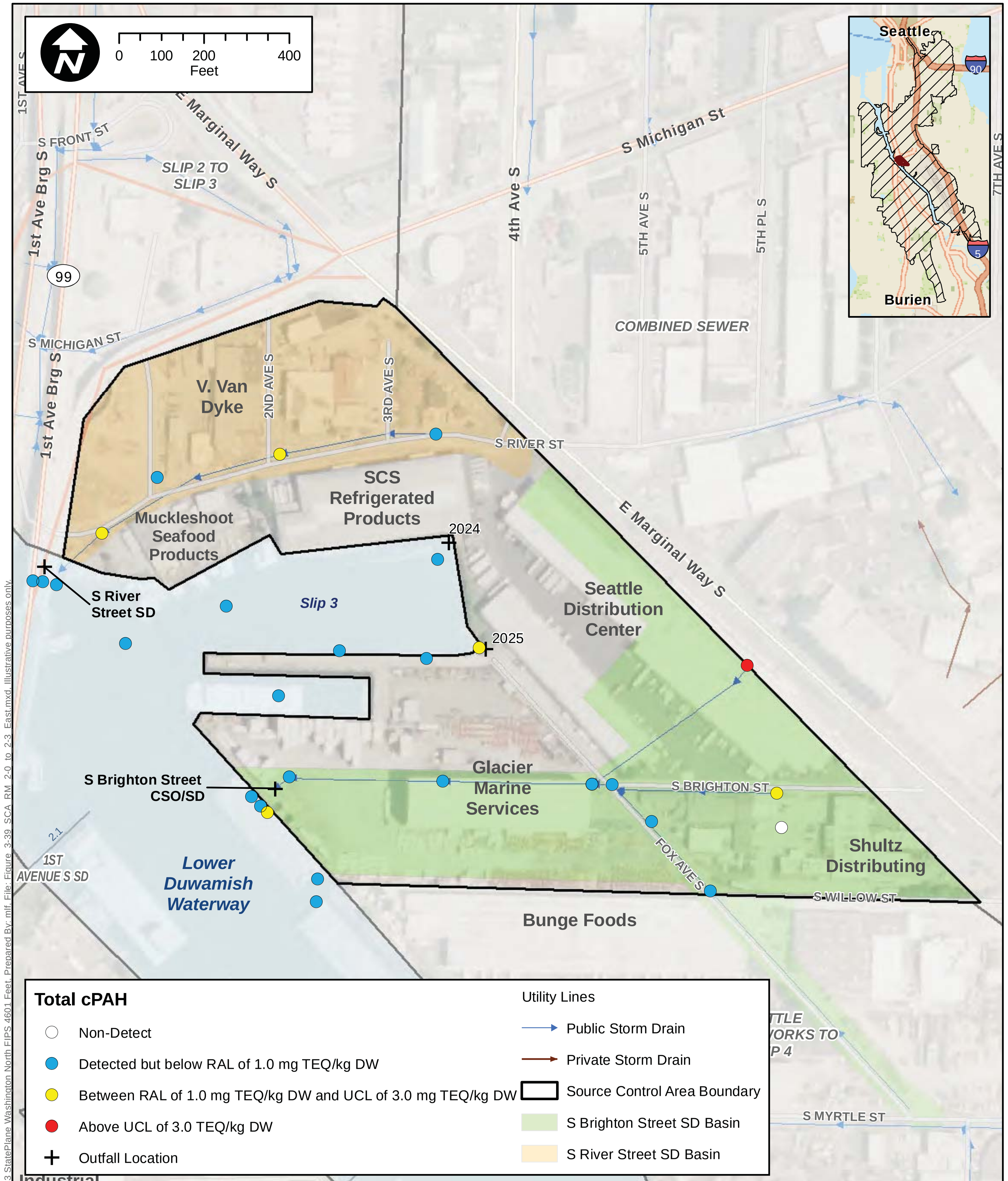


Figure 3-39c. Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)

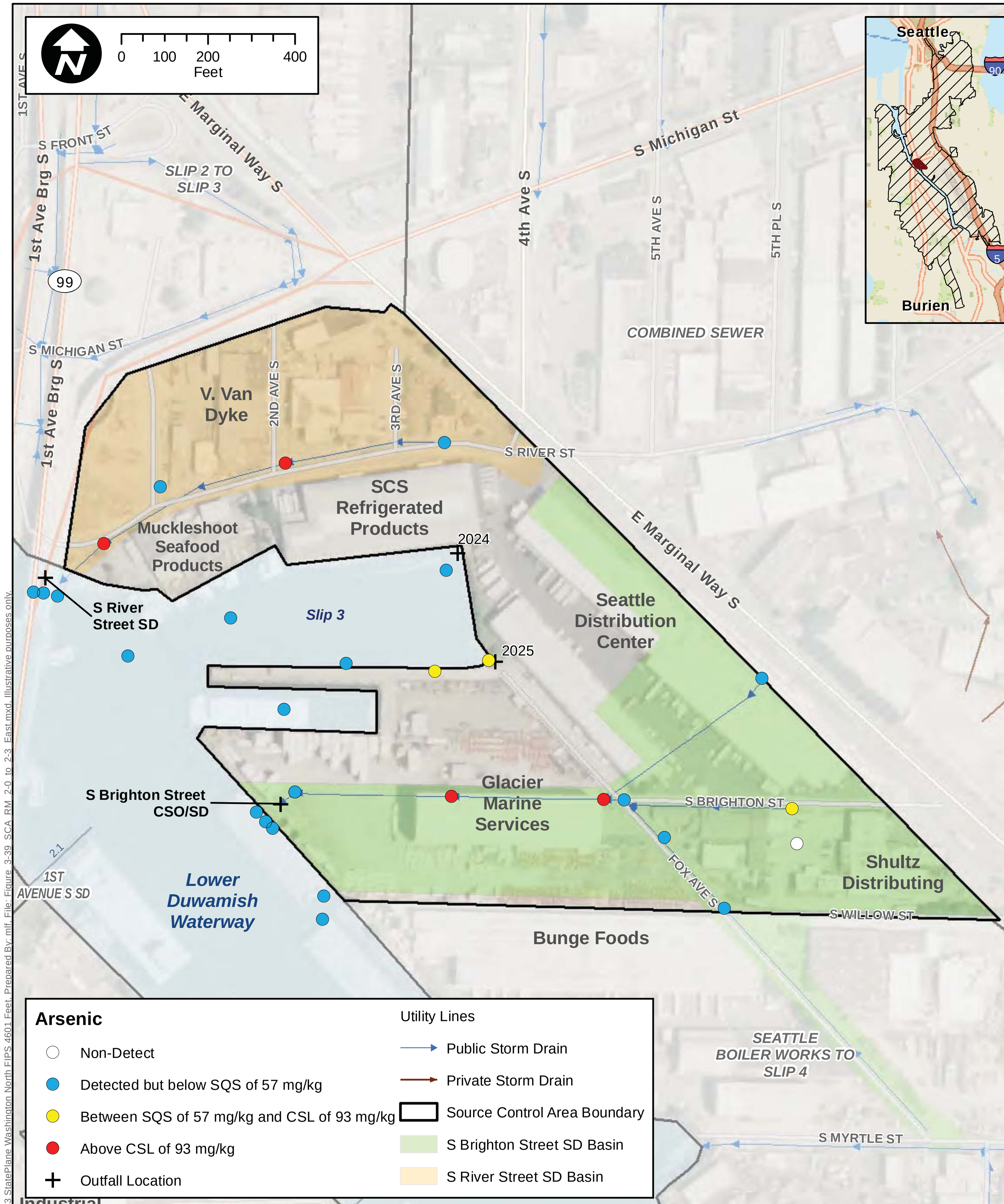
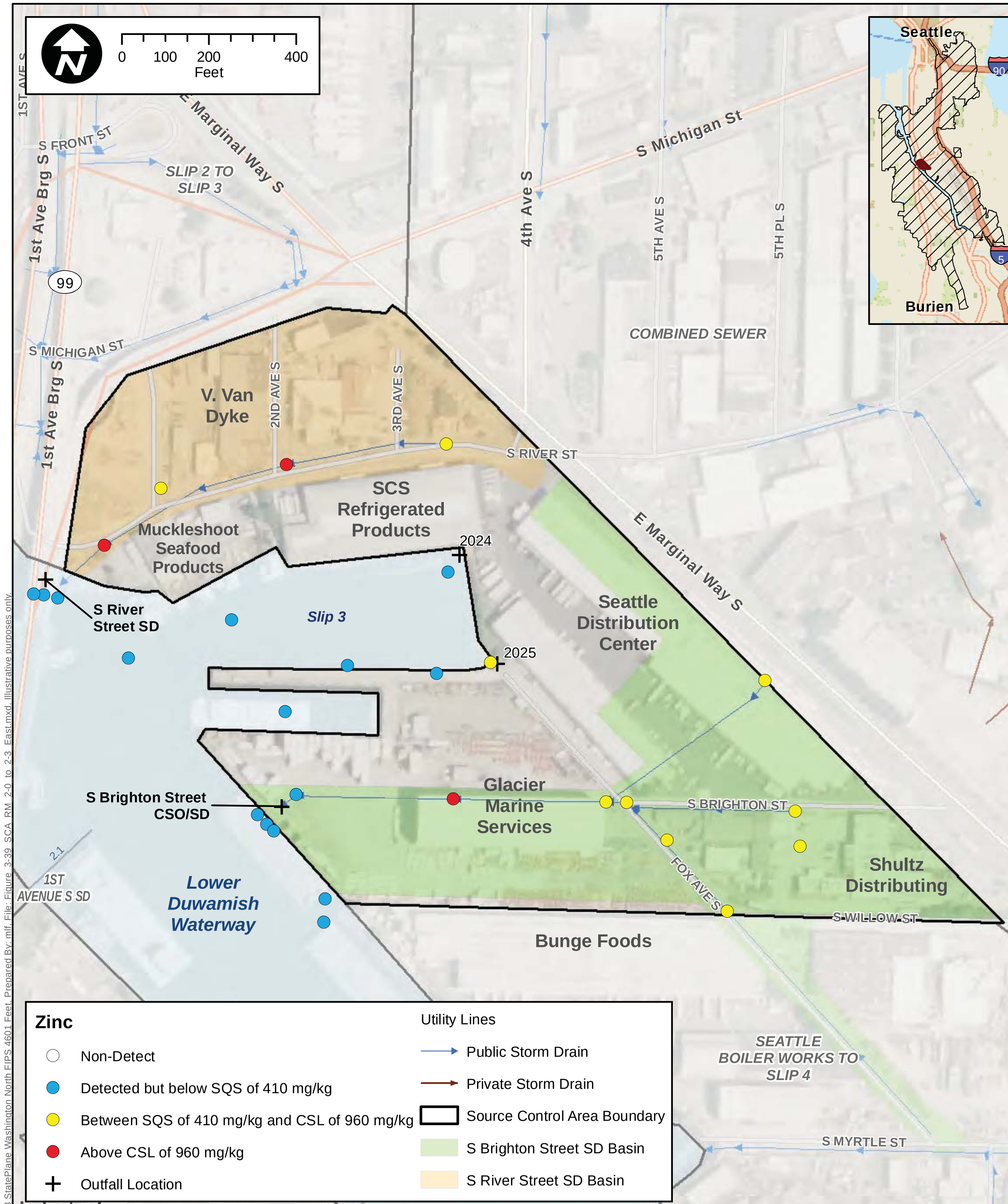


Figure 3-39d. Arsenic Concentrations in Sediment and Storm Drain Samples near RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)



Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-39_SCA_RM_2-0_to_2-3_East.mxd, Illustrative purposes only.

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Figure 3-39e. Zinc Concentrations in Sediment and Storm Drain Samples near RM 2.0-2.3 East (Slip 3 to Seattle Boiler Works)

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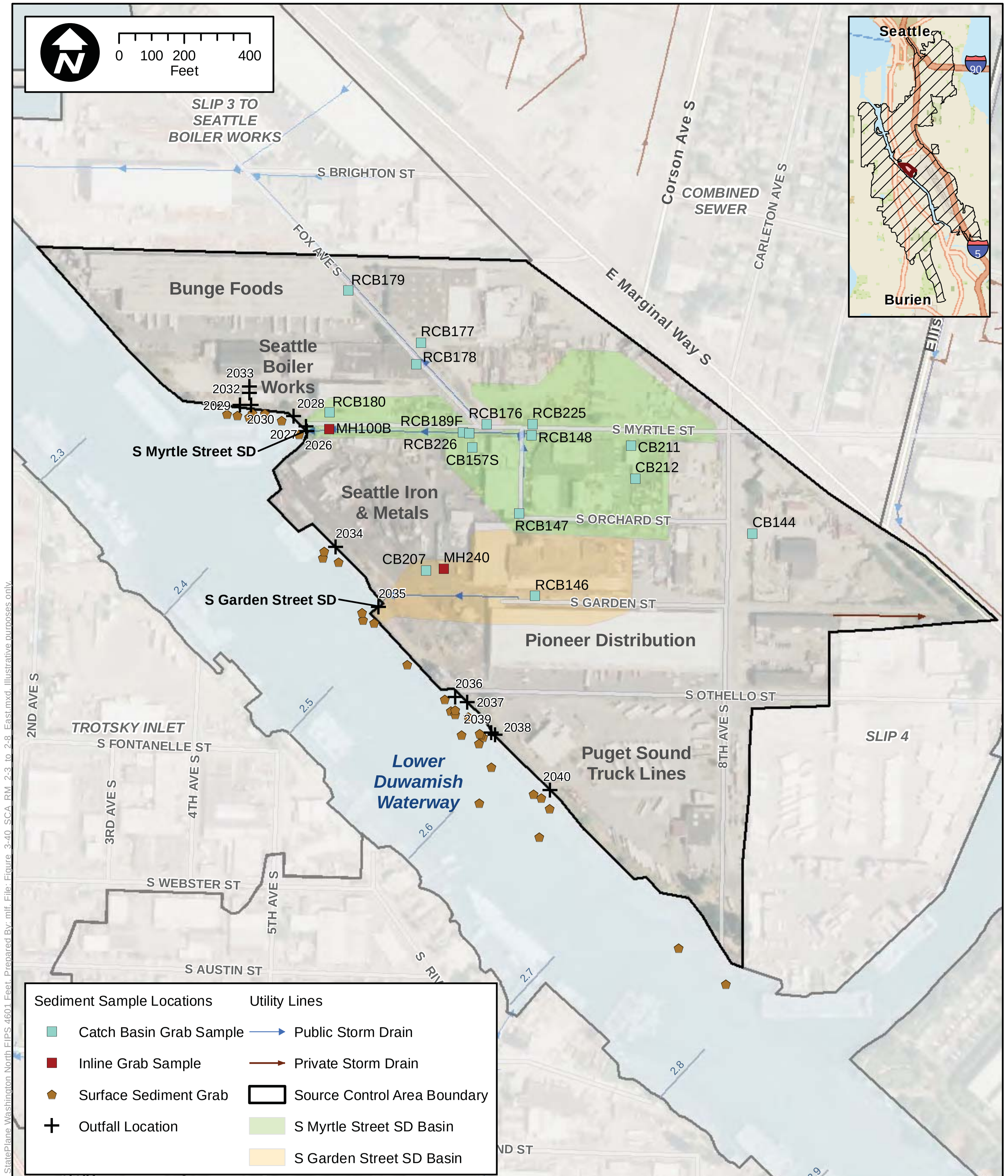

Figure 3-40a. Sediment and Storm Drain Sample Locations near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

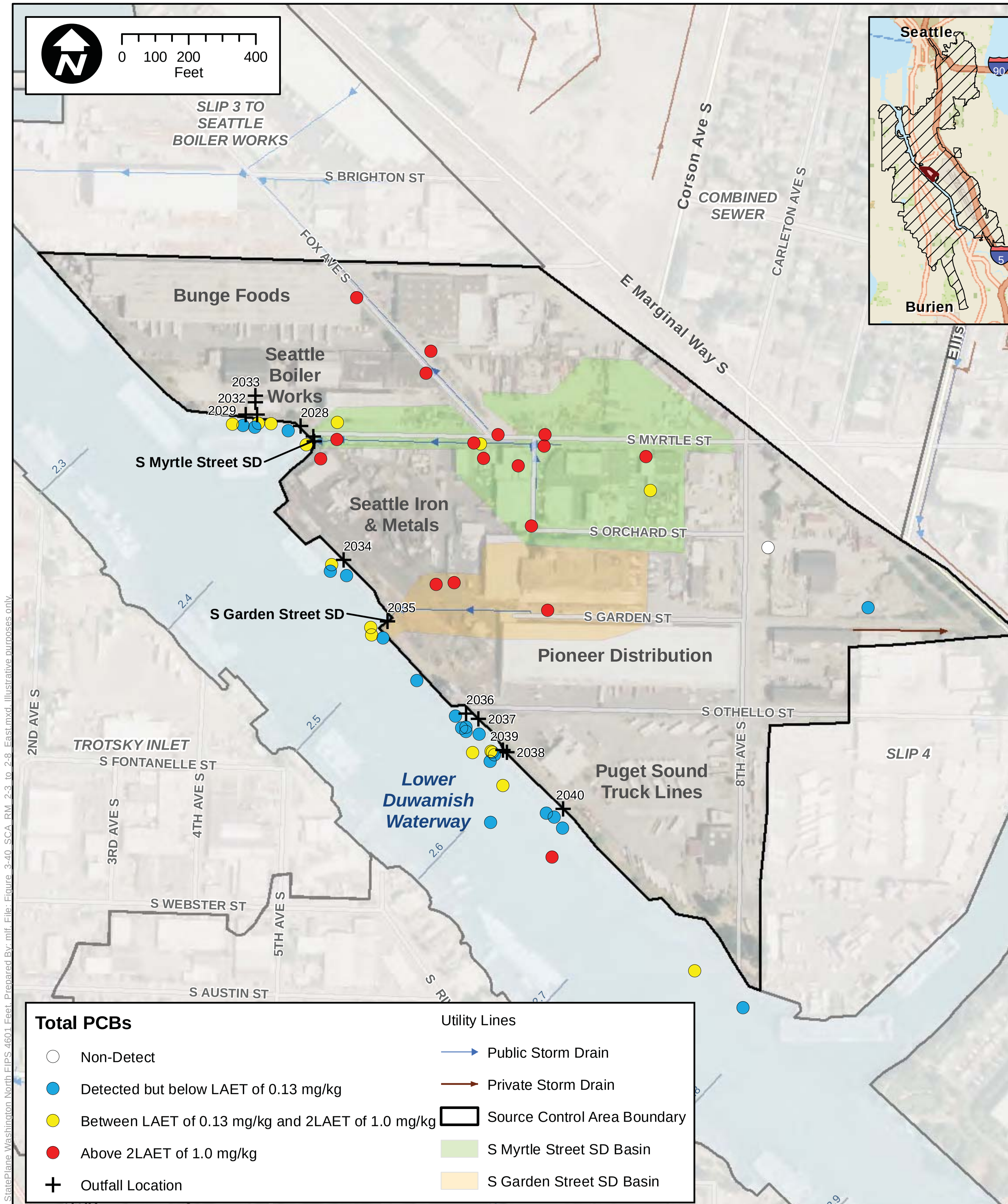

Figure 3-40b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

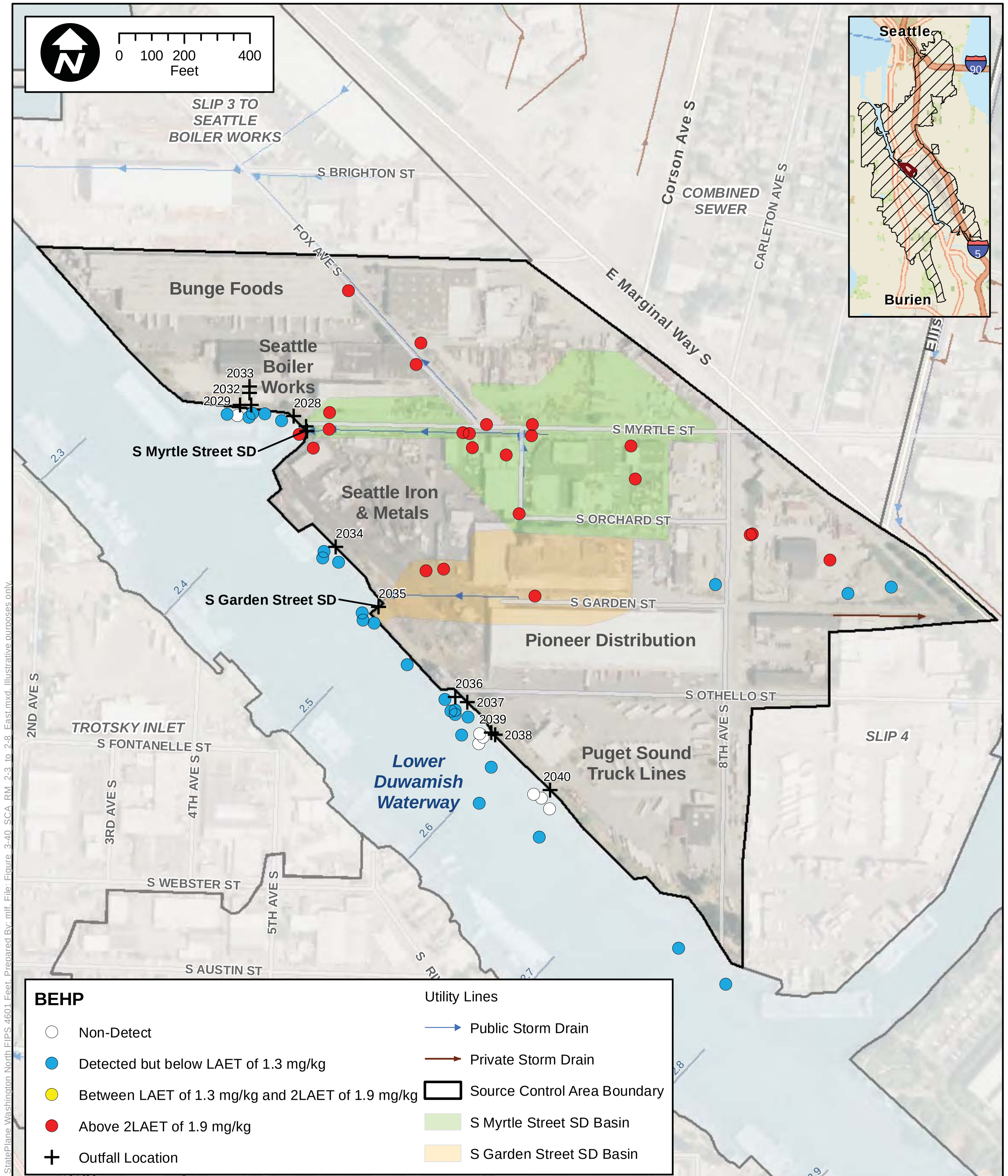

Figure 3-40c. BEHP Concentrations in Sediment and Storm Drain Samples near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

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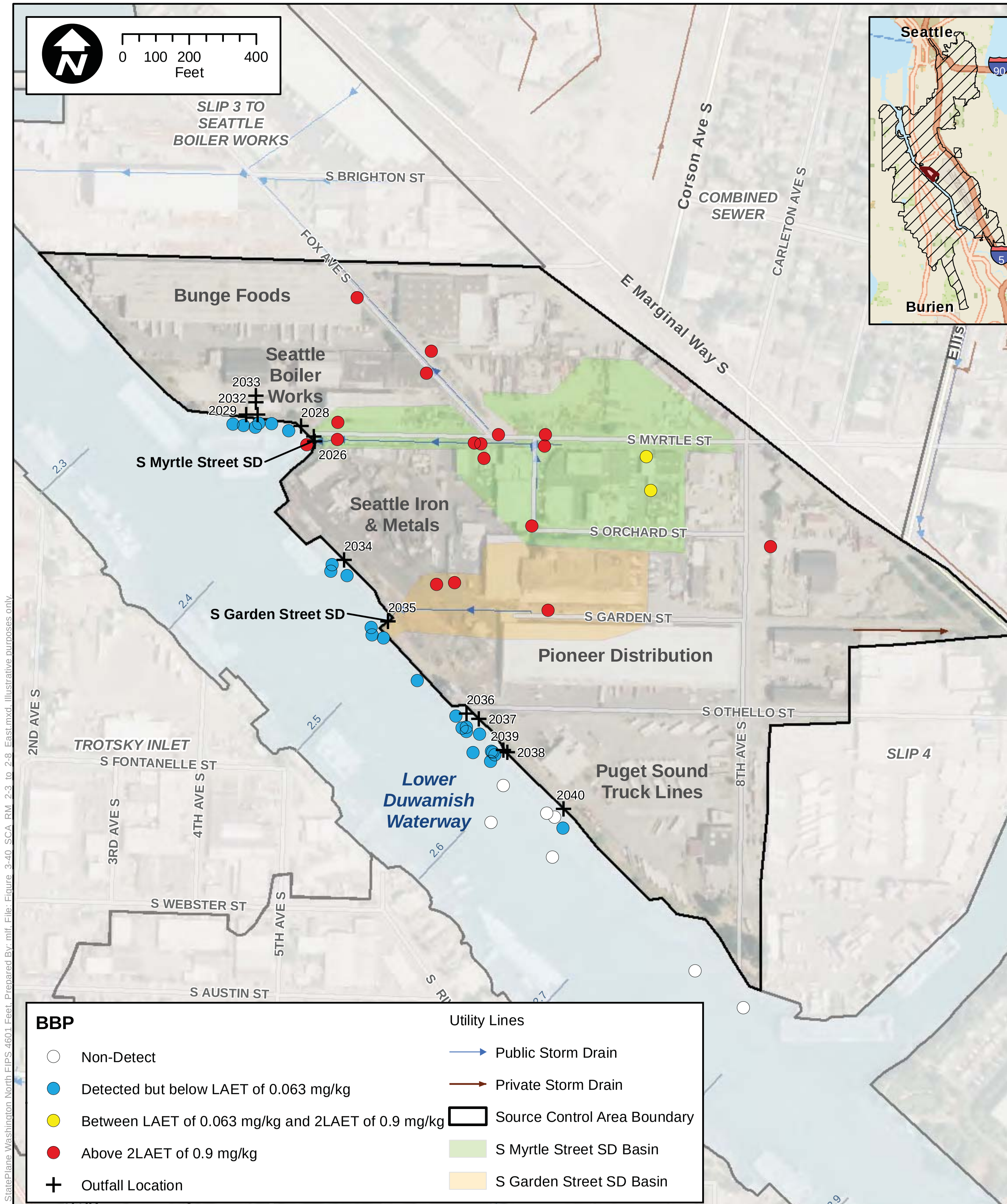

Figure 3-34d. BBP Concentrations in Sediment and Storm Drain Samples near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

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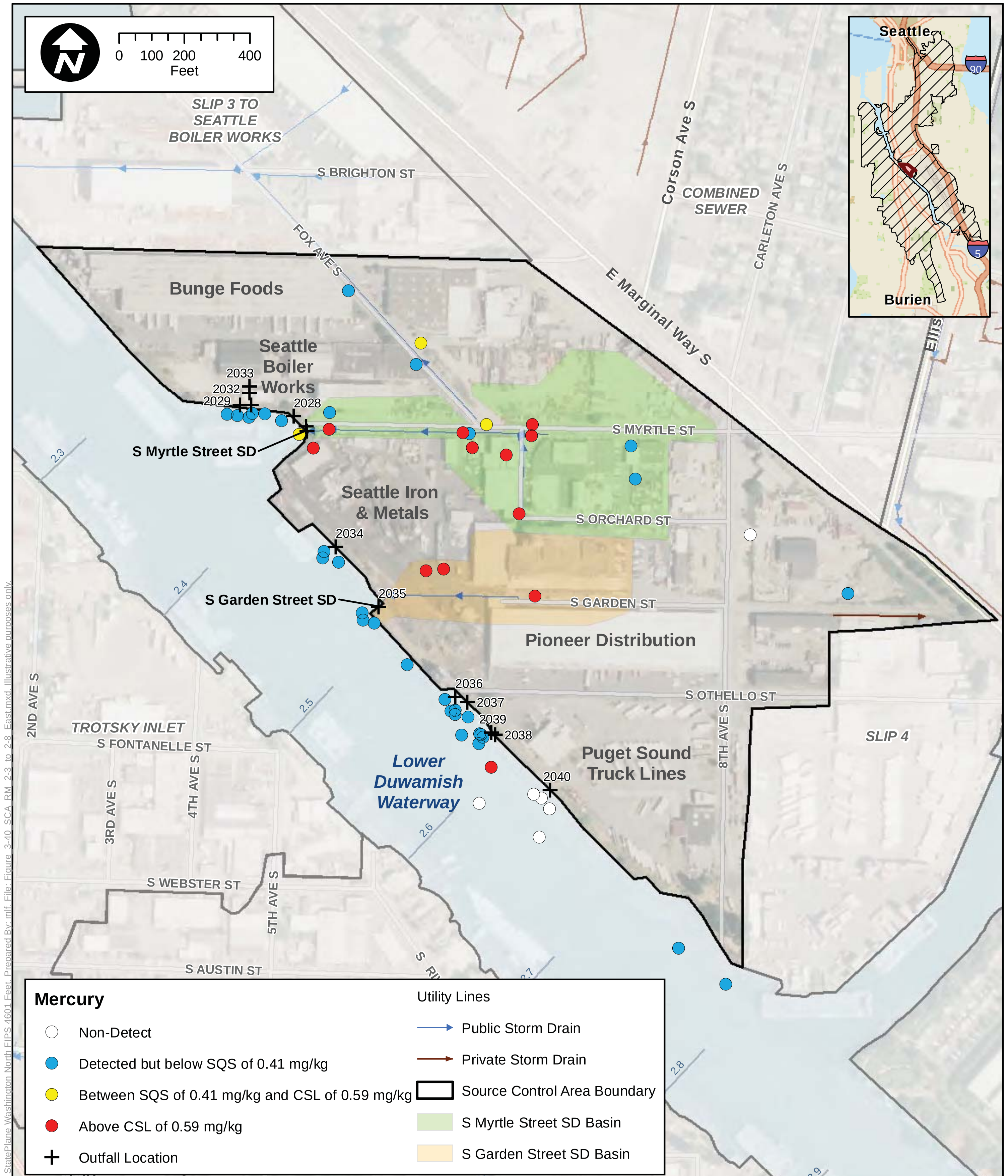

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet. Prepared By: mlf. File: Figure_3-40_SCA_RM_2-3_to_2-8_East.mxd. Illustrative purposes only.

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Figure 3-40e. Mercury Concentrations in Sediment and Storm Drain Samples near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

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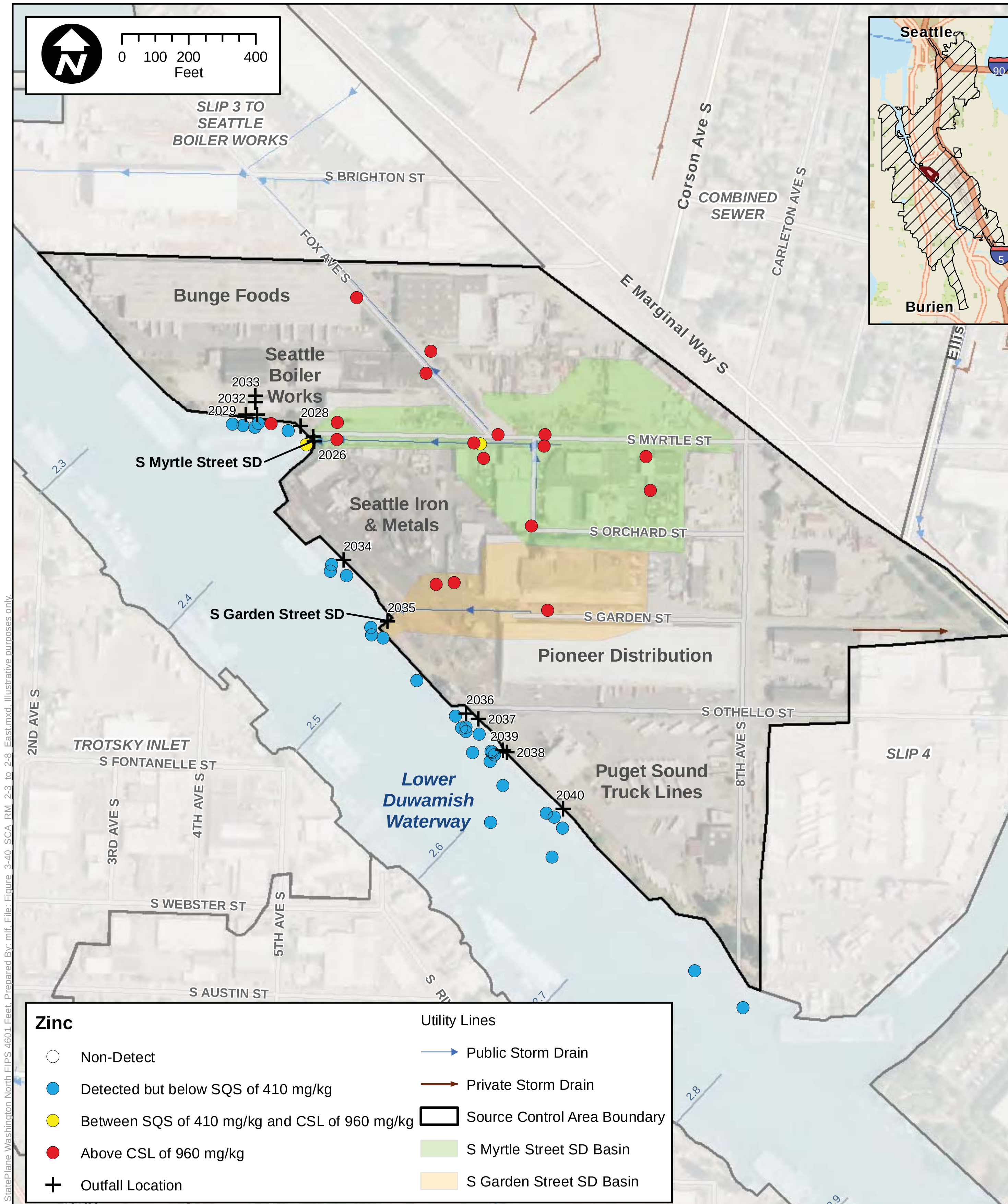

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet. Prepared By: mlf. File: Figure_3-40_SCA_RM_2-3_to_2-8_East.mxd. Illustrative purposes only.

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Figure 3-40f. Zinc Concentrations in Sediment and Storm Drain Samples near RM 2.3-2.8 East (Seattle Boiler Works to Slip 4)

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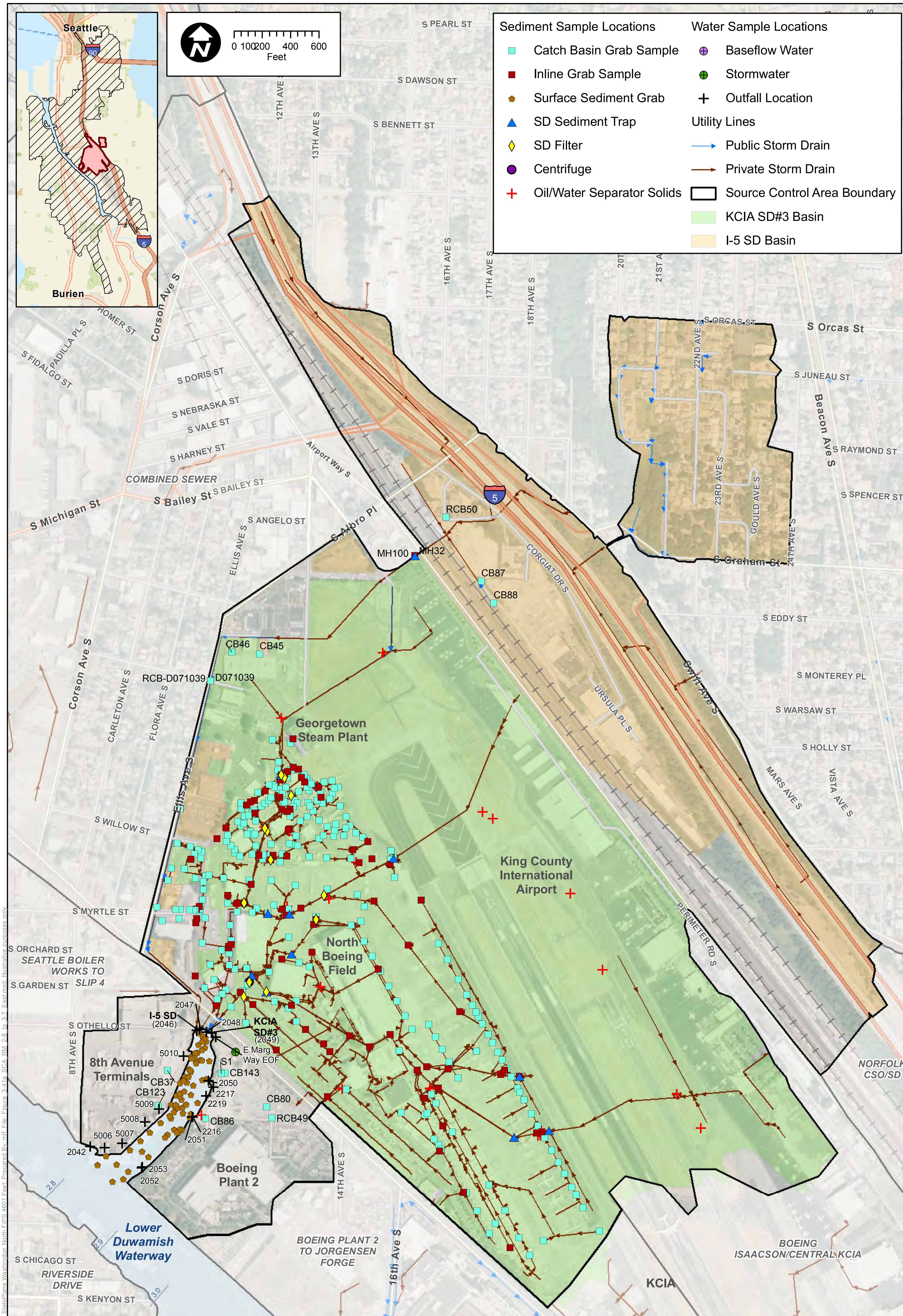

Figure 3-41a. Sediment and Storm Drain Sample Locations near RM 2.8 East (Slip 4)

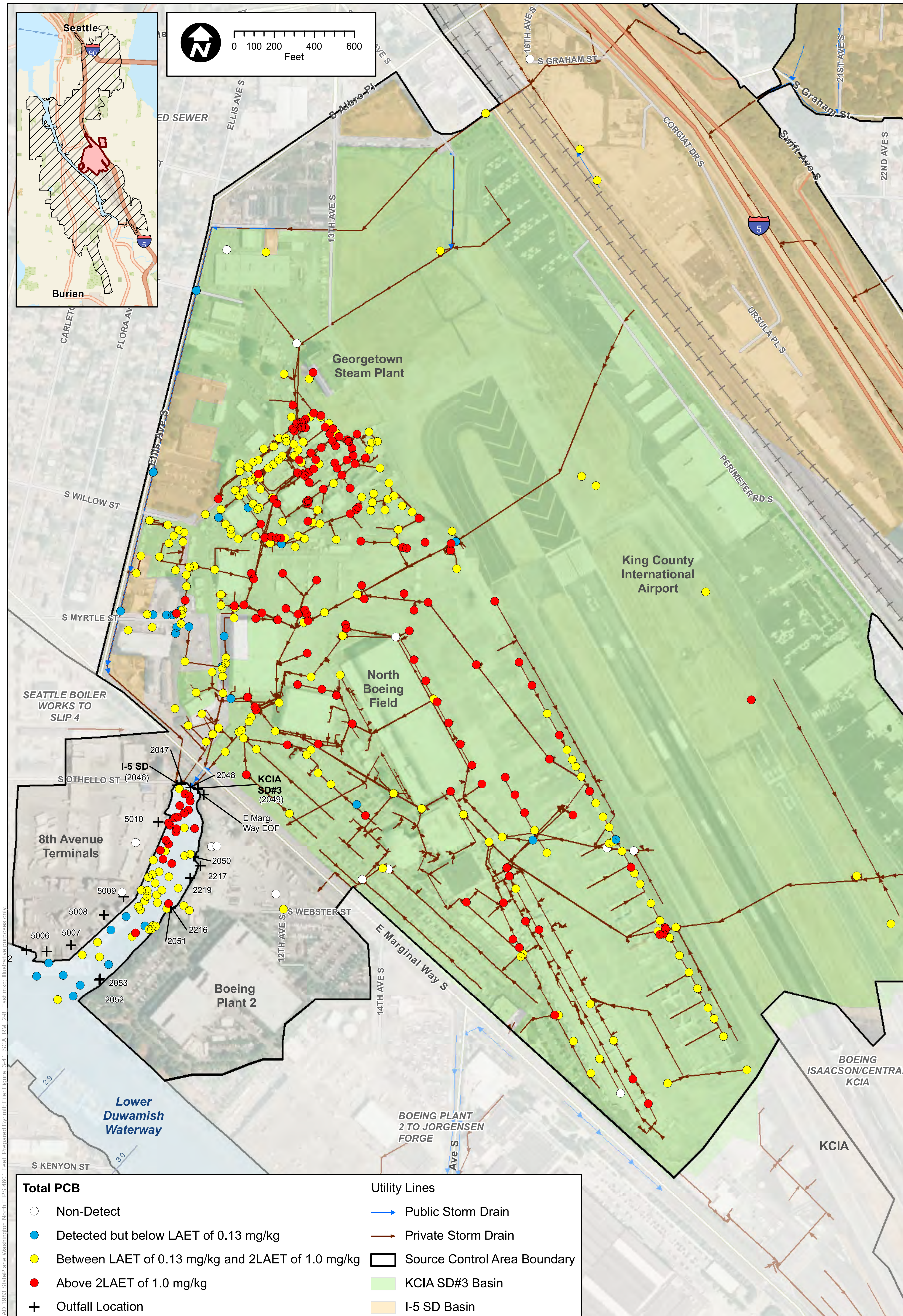

Figure 3-41b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

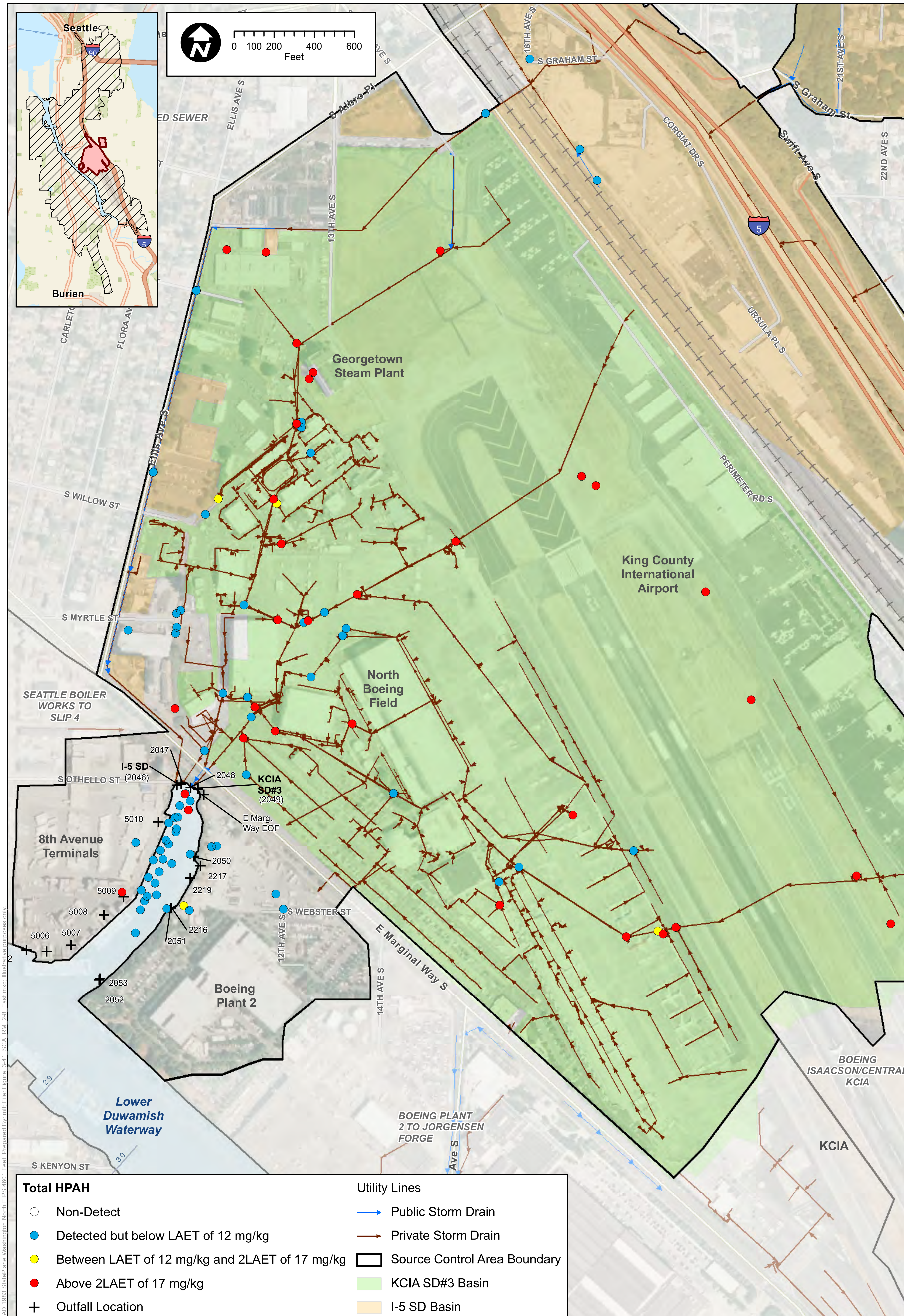

Figure 3-41c. Total HPAH Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

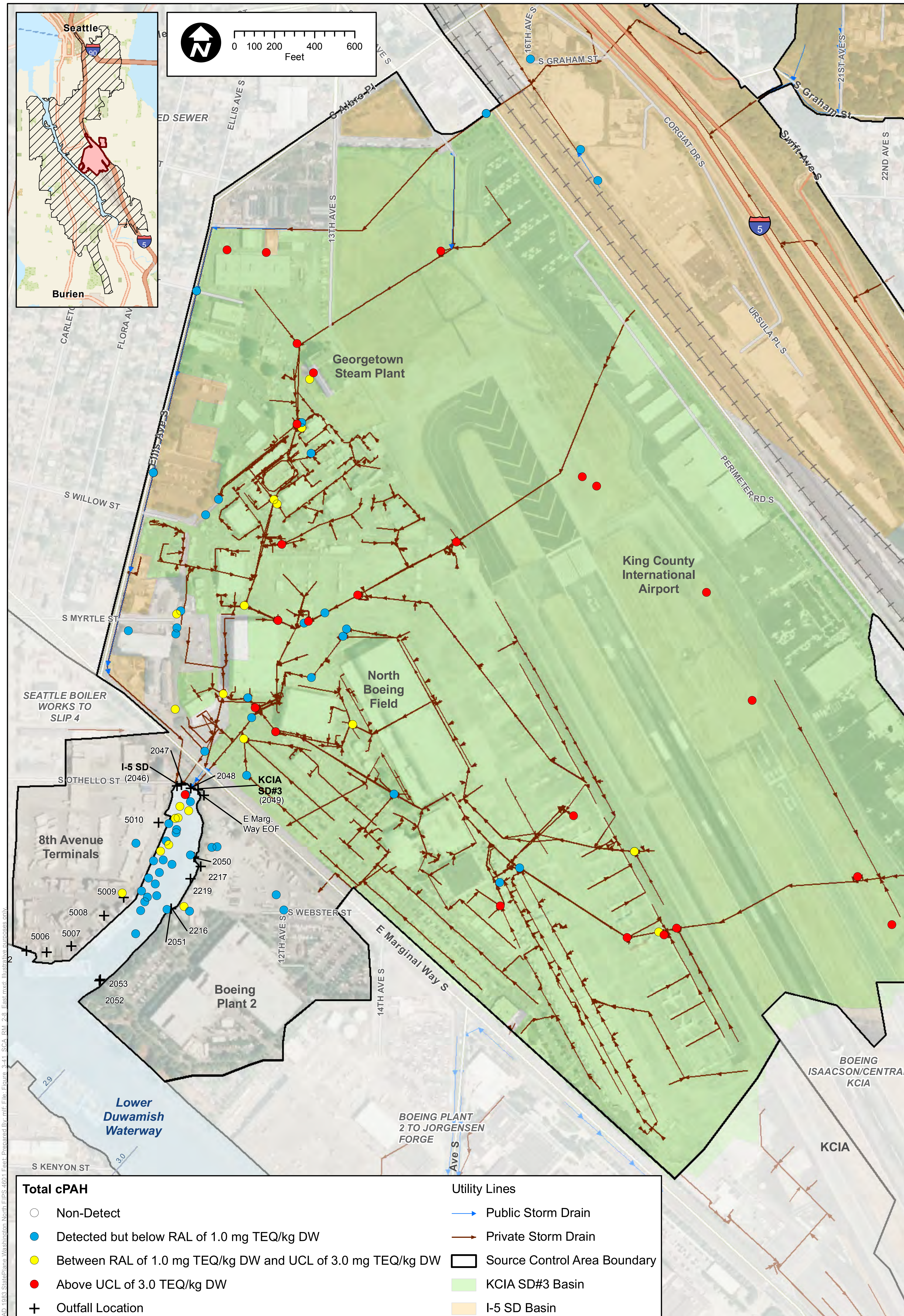

Figure 3-41d. Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

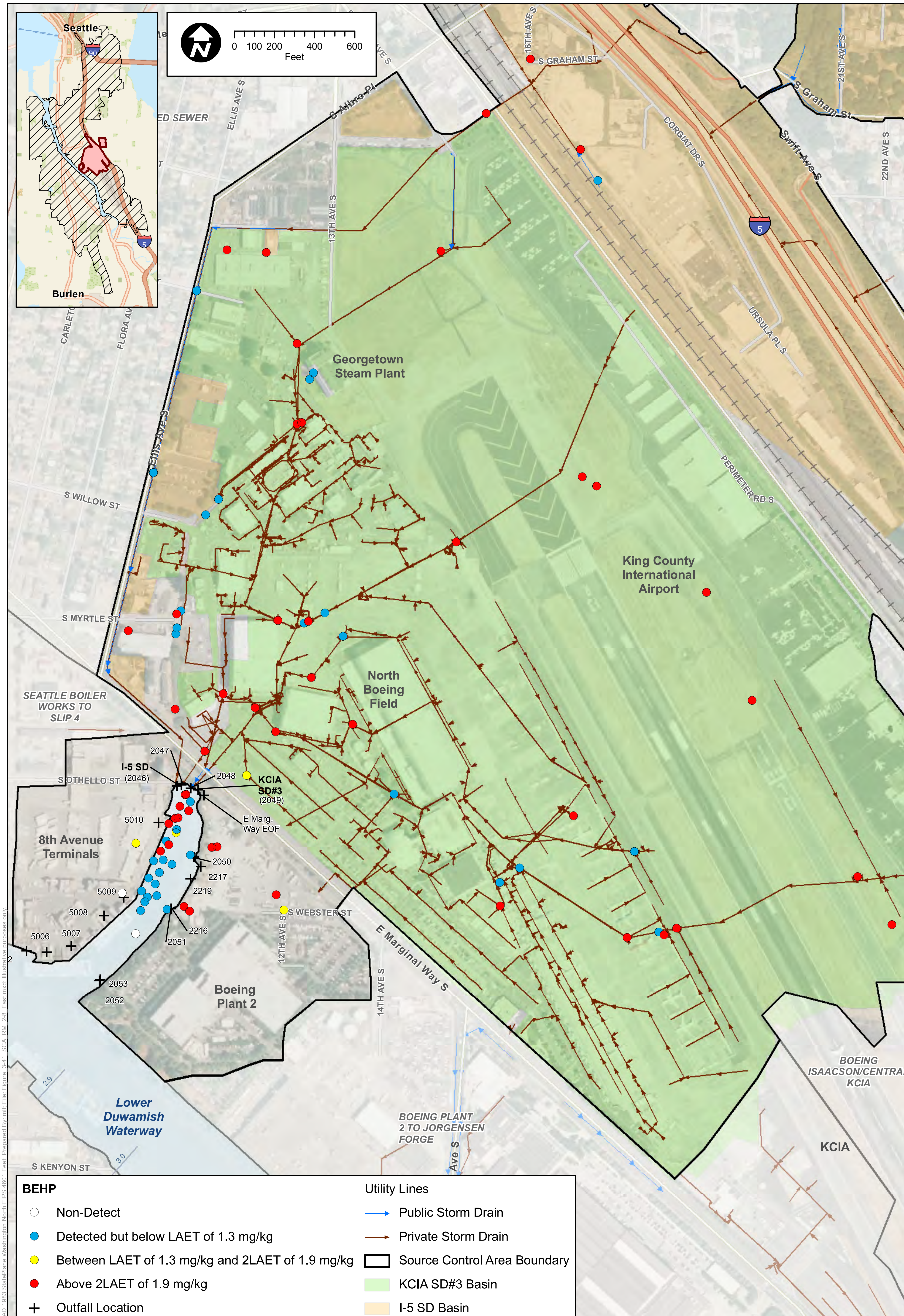

Figure 3-41e. BEHP Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

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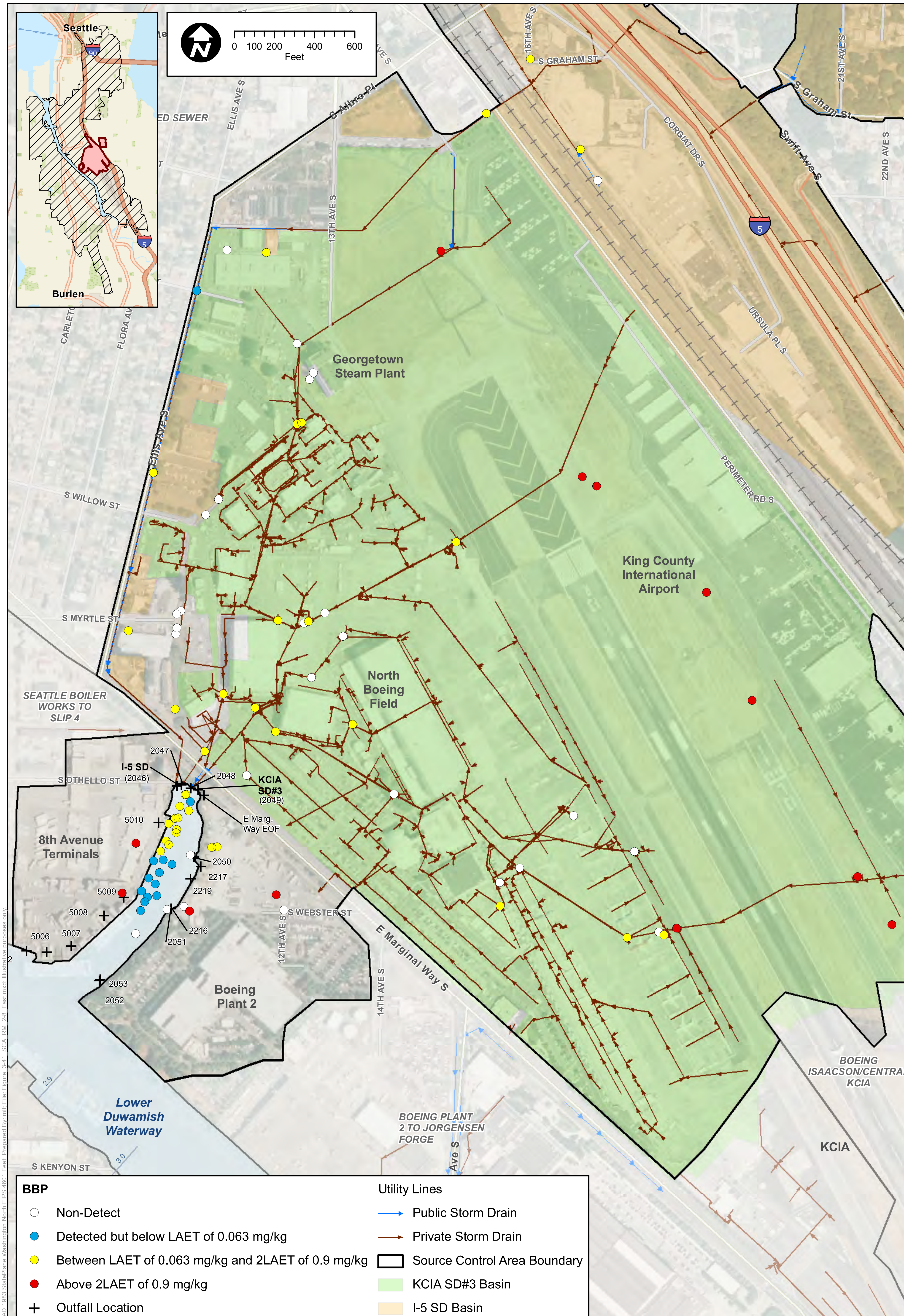

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-41_SCA_RM_2.8_East.mxd; Illustrative purposes only.

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Figure 3-41f. BBP Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

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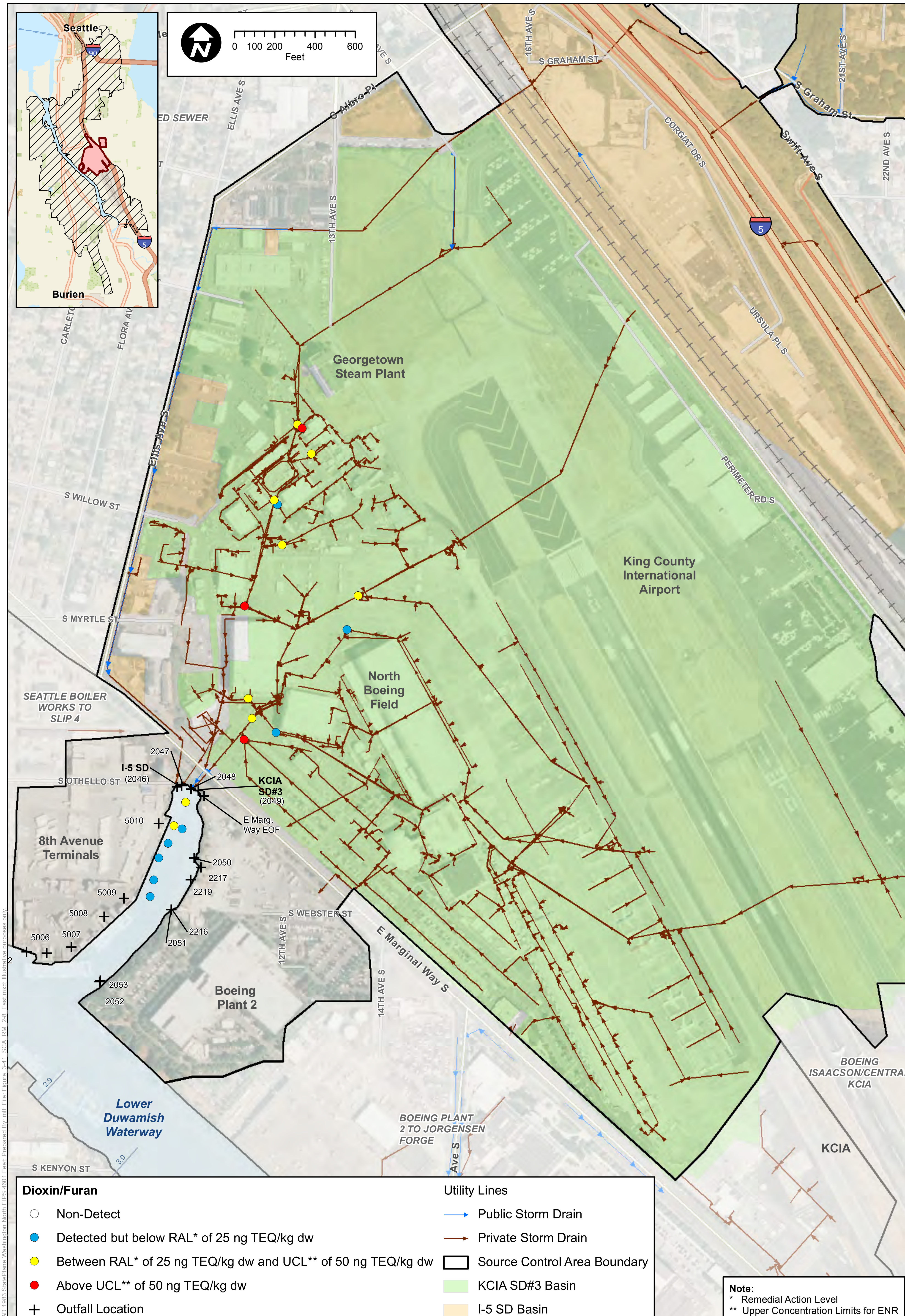

Figure 3-41g. Dioxin/Furan Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

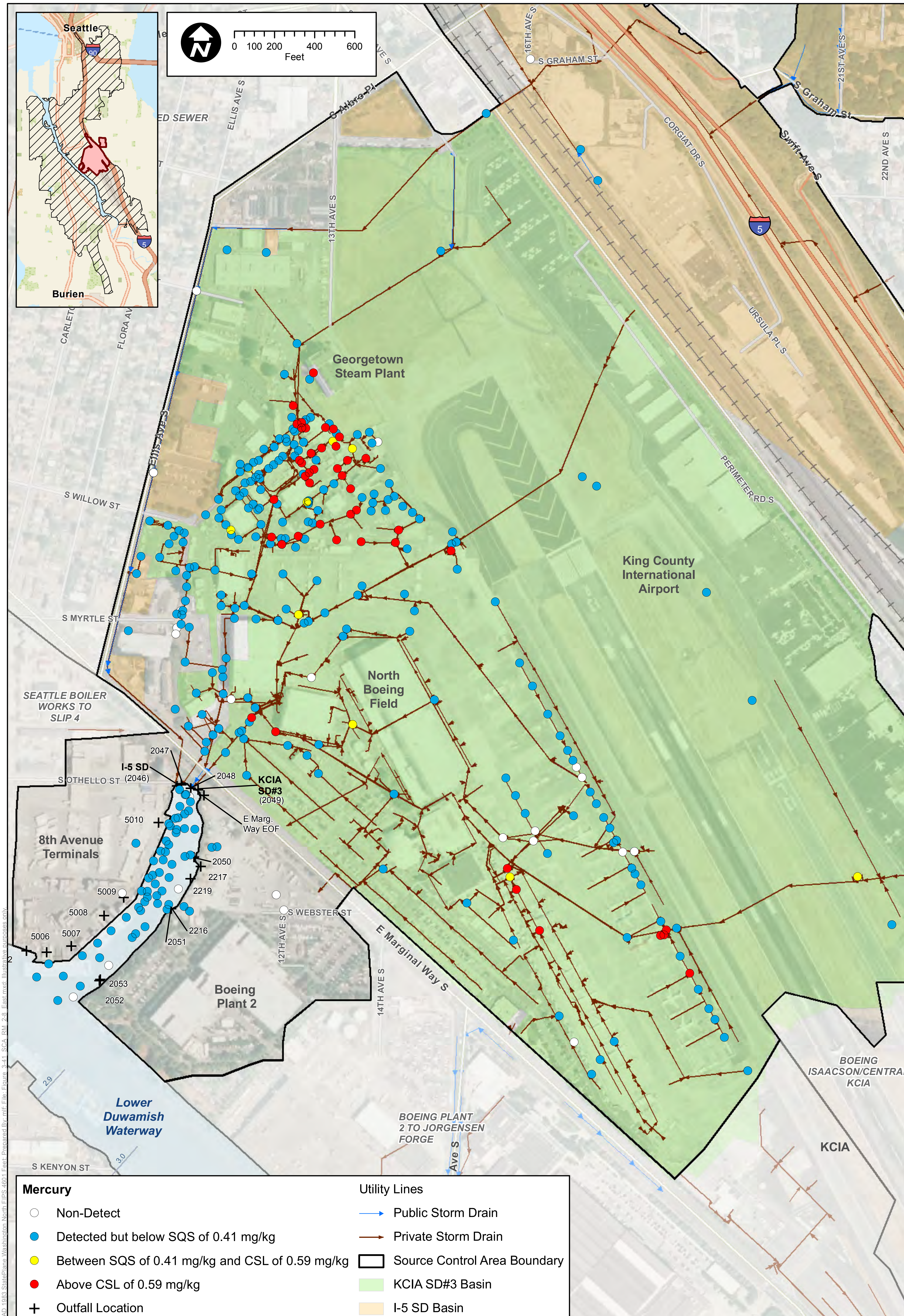

Figure 3-41h. Mercury Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

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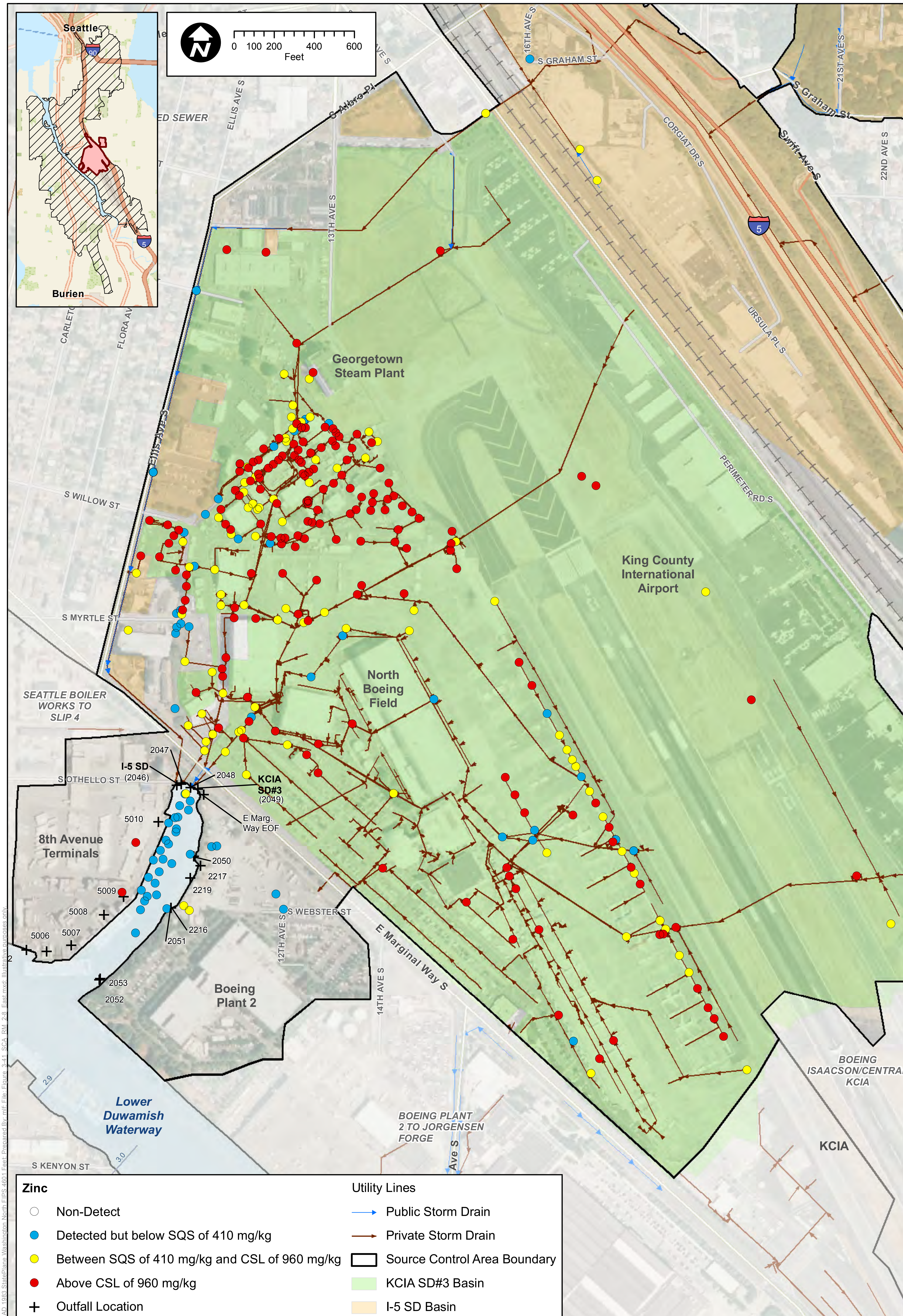

Figure 3-41i. Zinc Concentrations in Sediment and Storm Drain Samples near RM 2.8 East (Slip 4)

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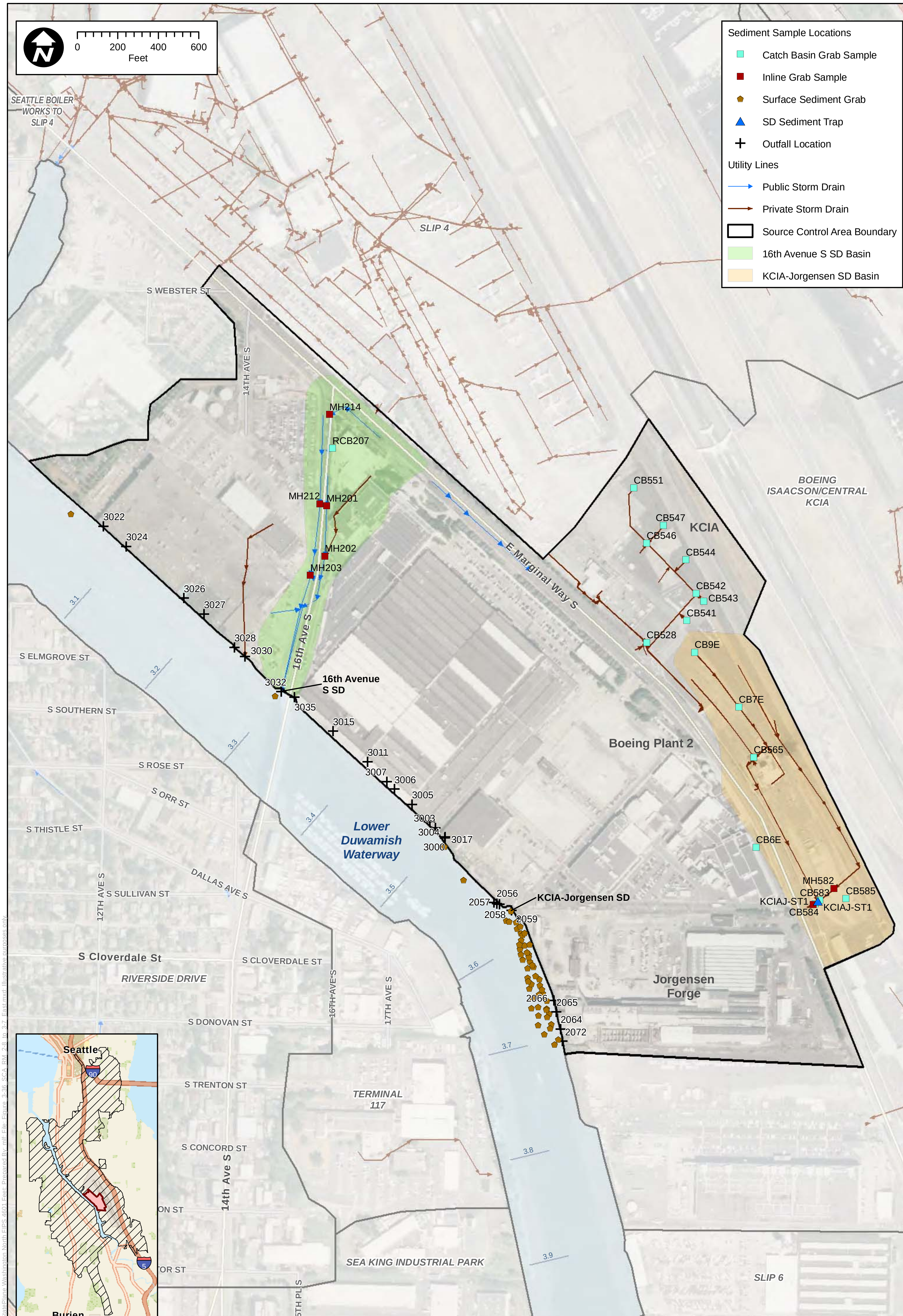

Figure 3-42a. Sediment and Storm Drain Sample Locations near RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

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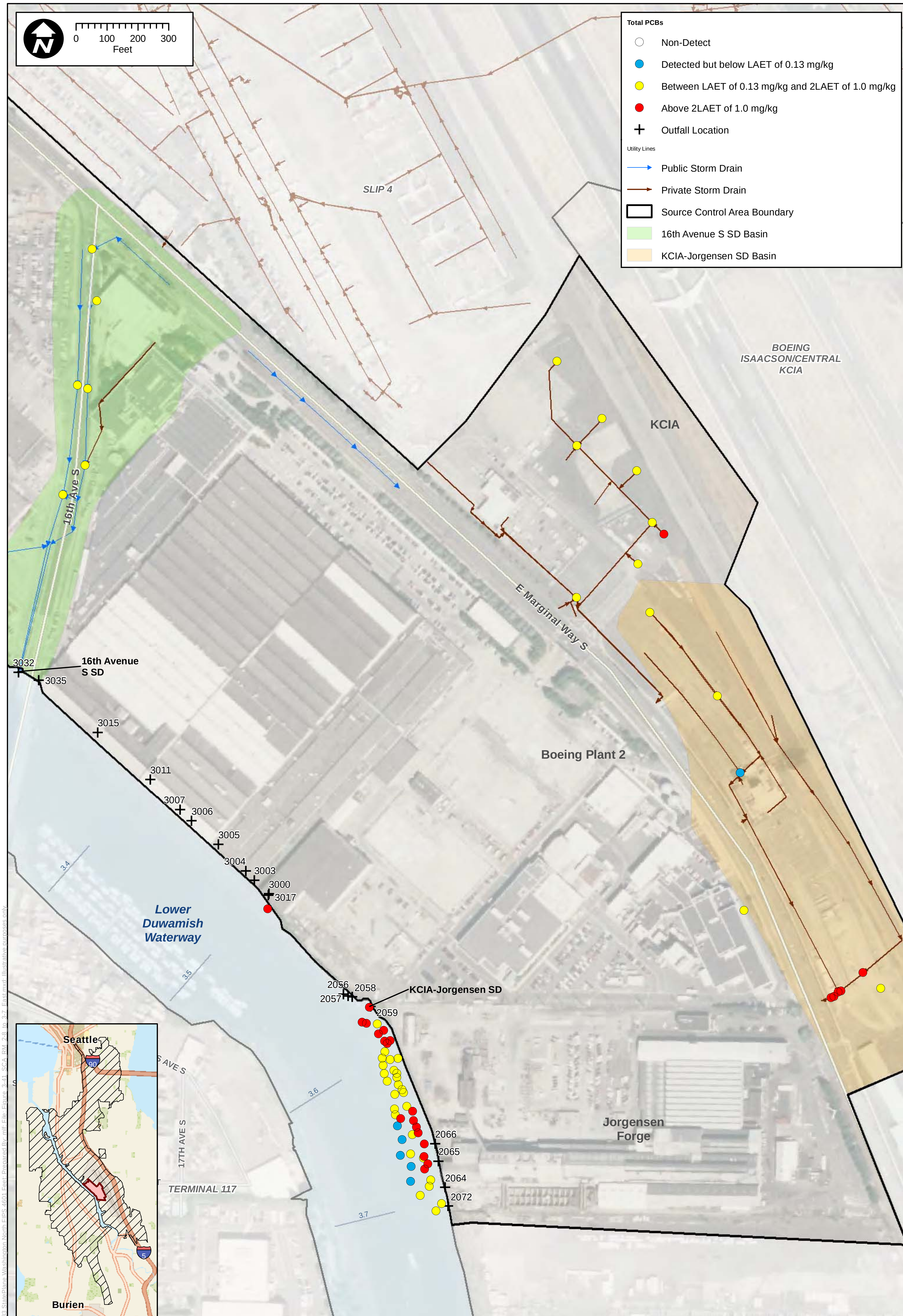

Figure 3-42b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

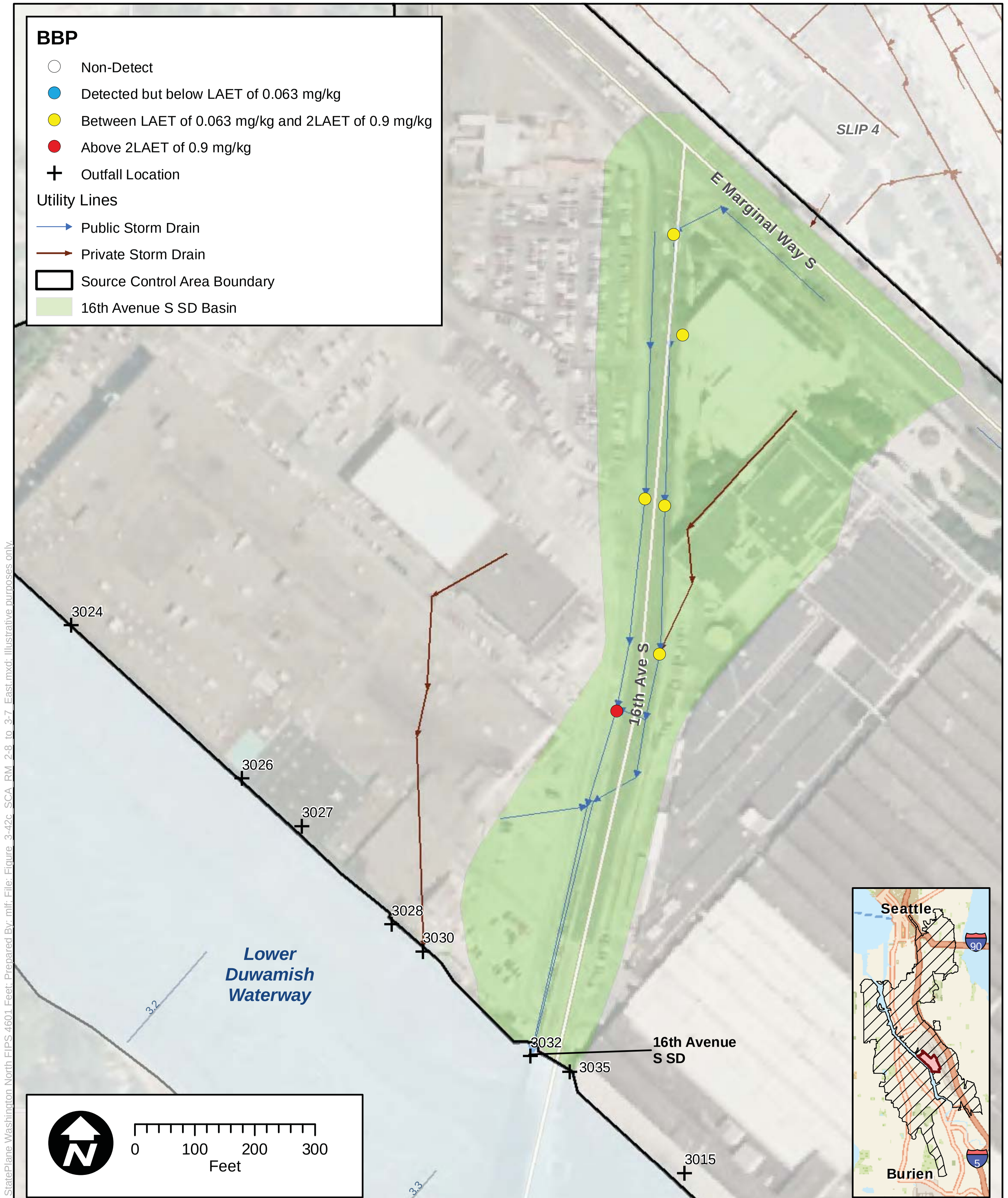

Figure 3-42c. BBP Concentrations in Sediment and Storm Drain Samples near RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

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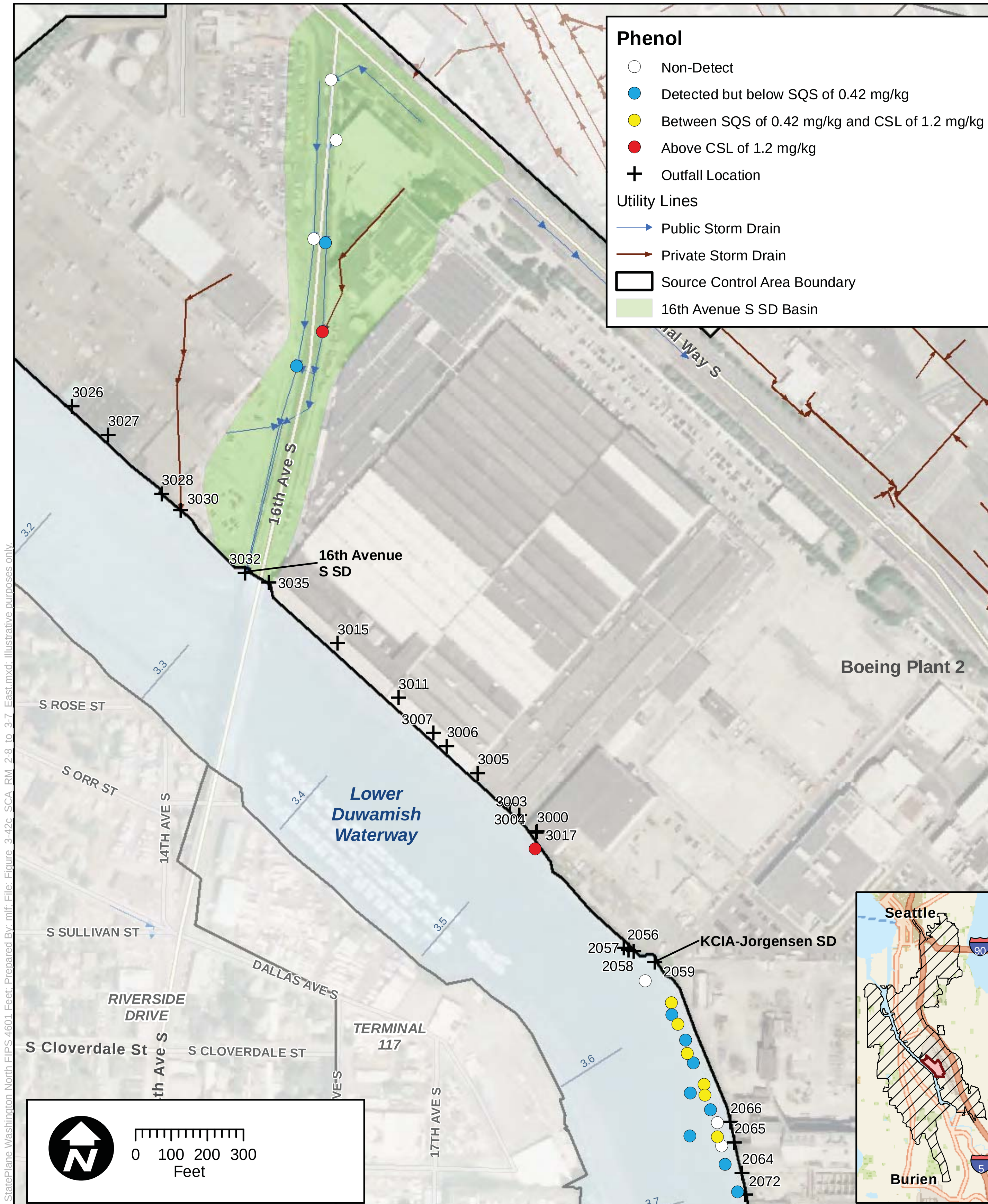

Figure 3-42d. Phenol Concentrations in Sediment and Storm Drain Samples near RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

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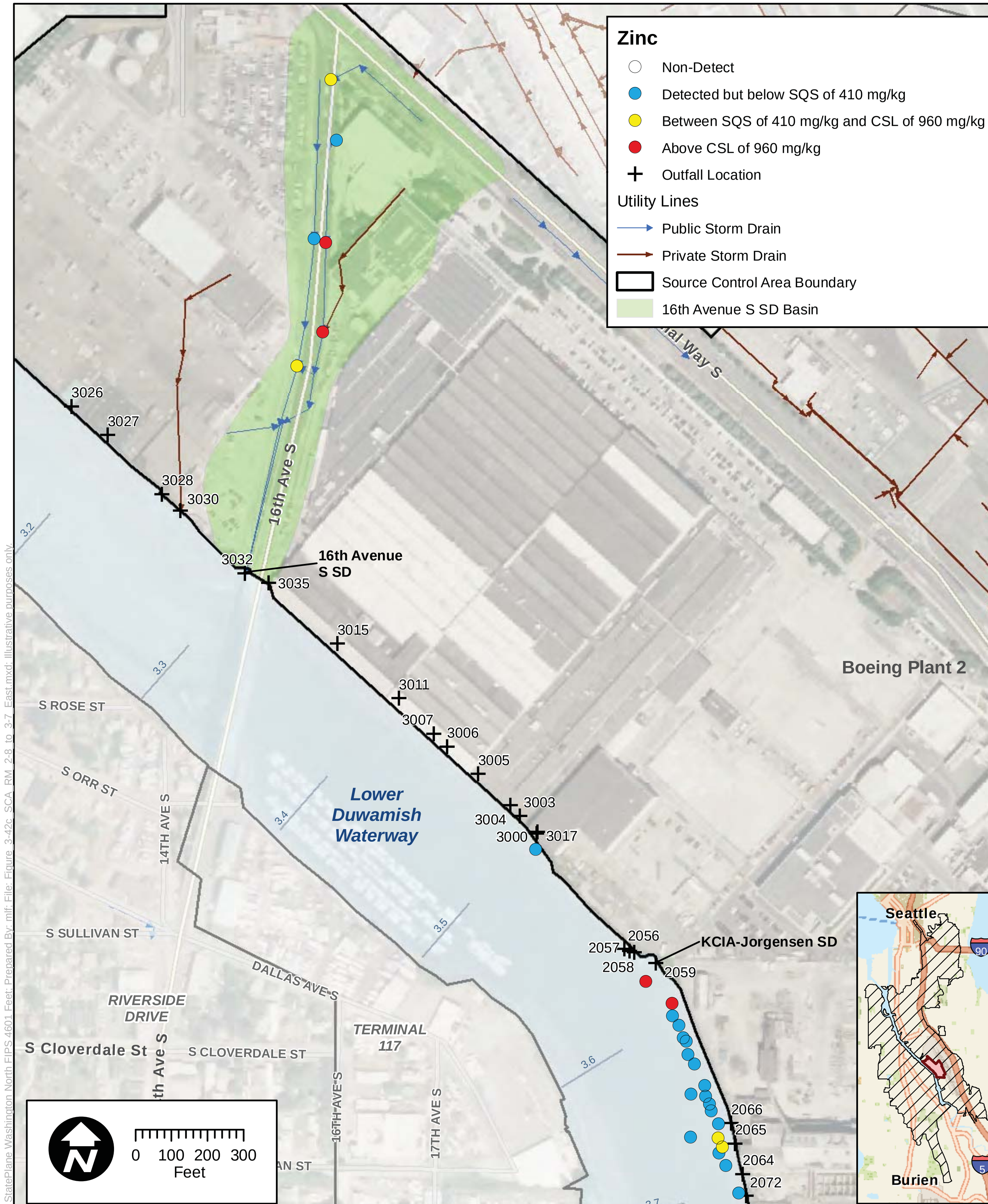

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Figure 3-42e. Zinc Concentrations in Sediment and Storm Drain Samples near RM 2.8-3.7 East (Boeing Plant 2 to Jorgensen Forge)

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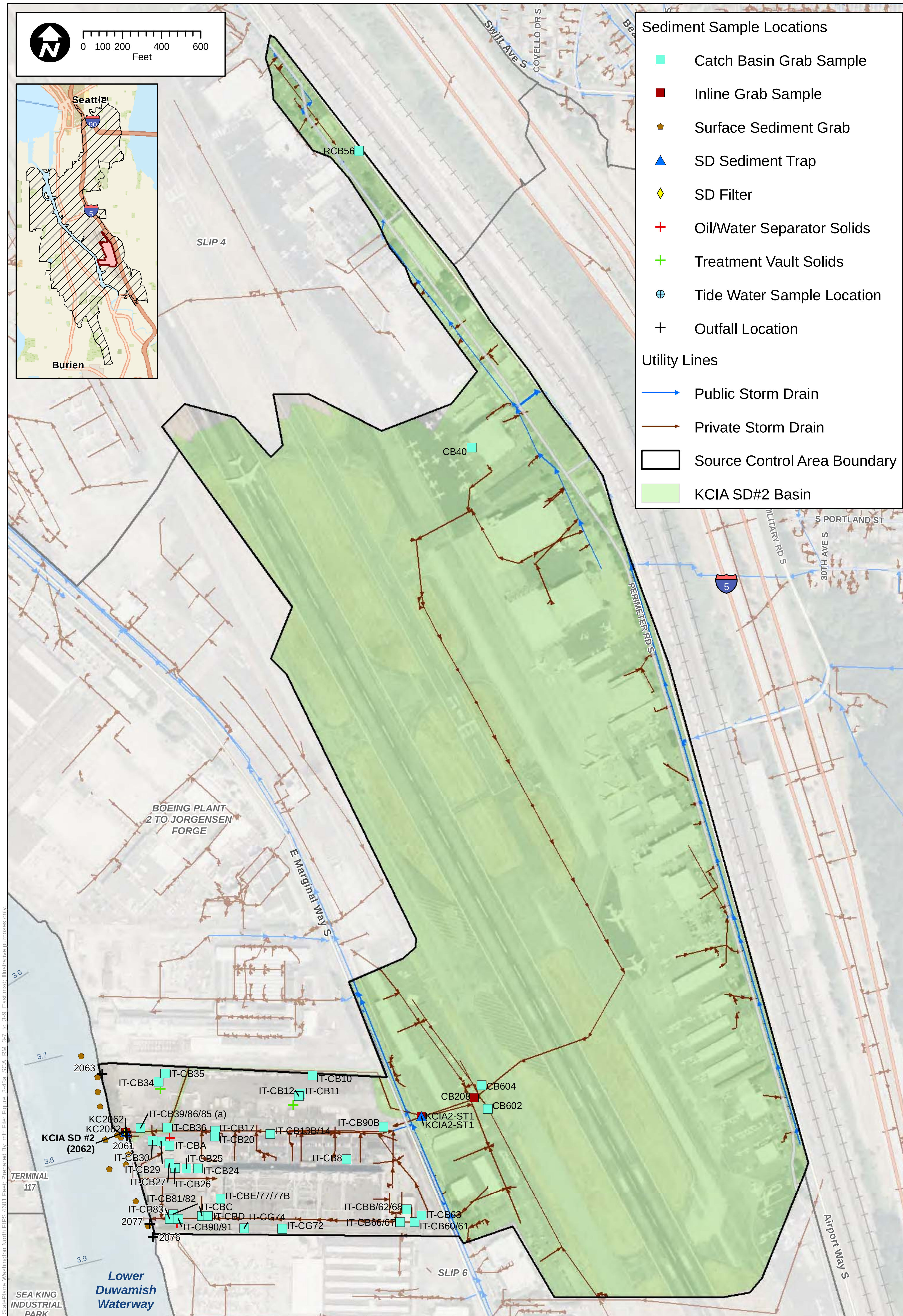

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet Prepared By: mjt File: Figure_3-43a_SCA_RM_3.7_to_3.9_East.mxd; Illustrative purposes only.

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Figure 3-43a. Sediment and Storm Drain Sample Locations near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

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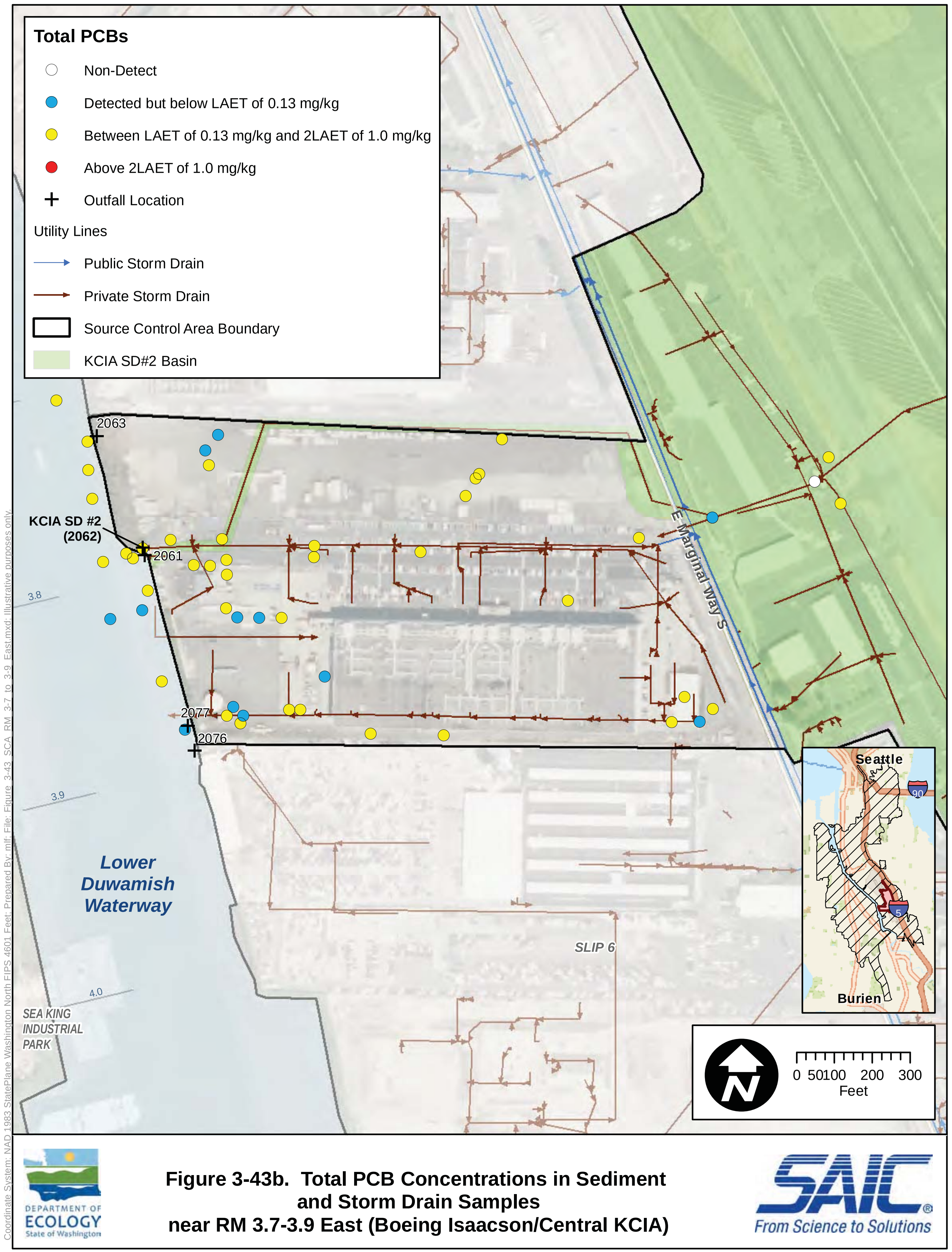

Figure 3-43b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

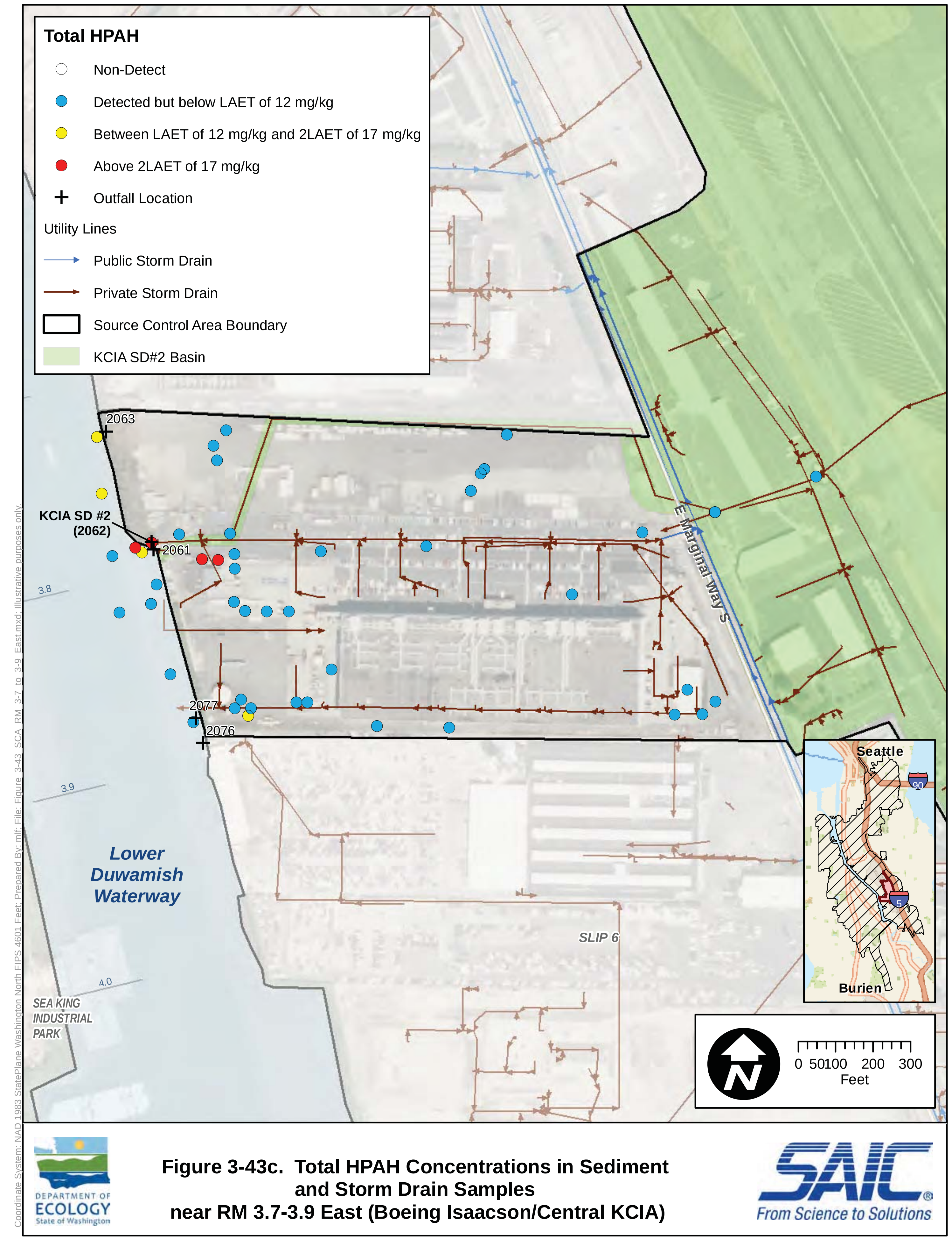

Figure 3-43c. Total HPAH Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

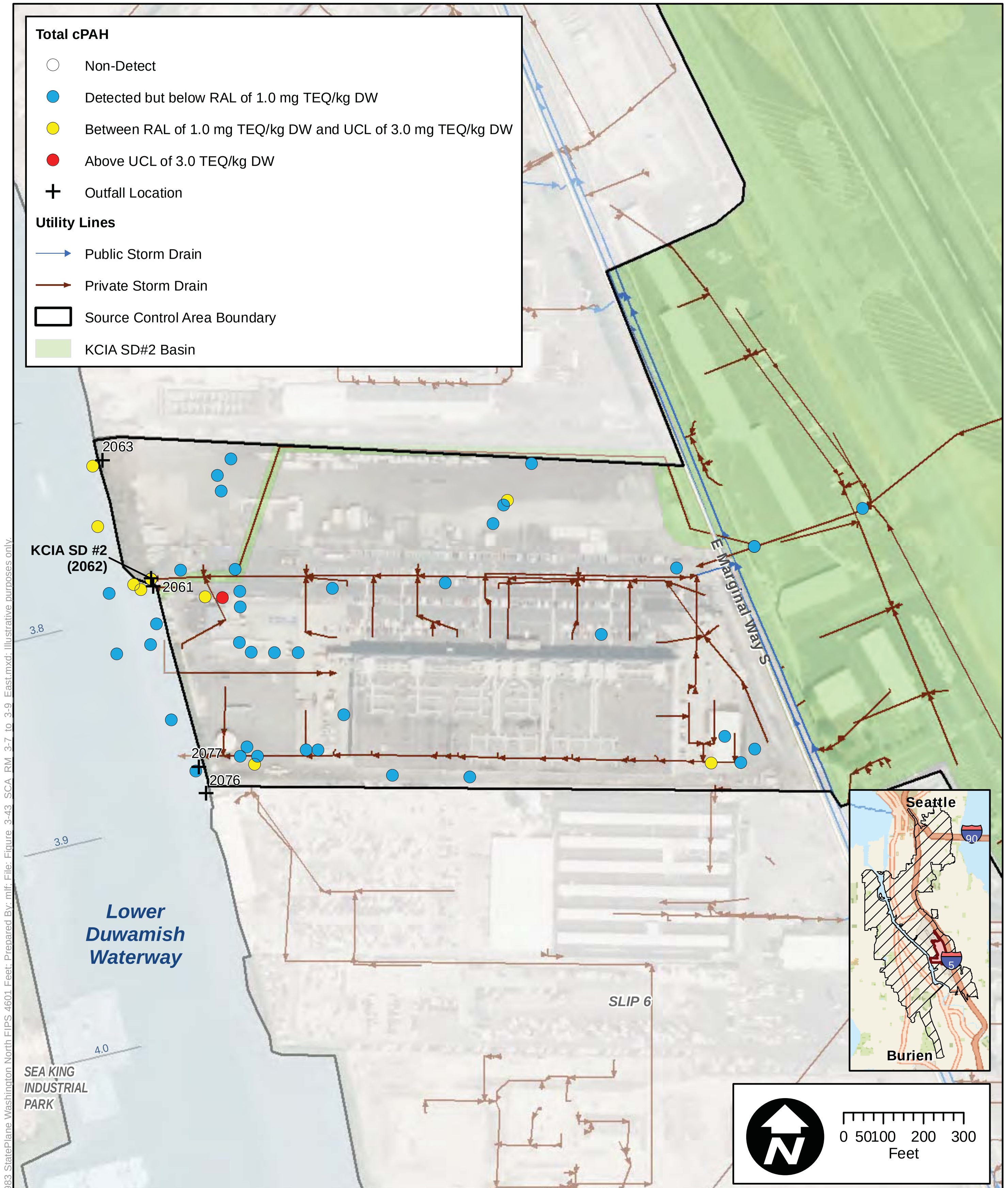

Figure 3-43d. Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

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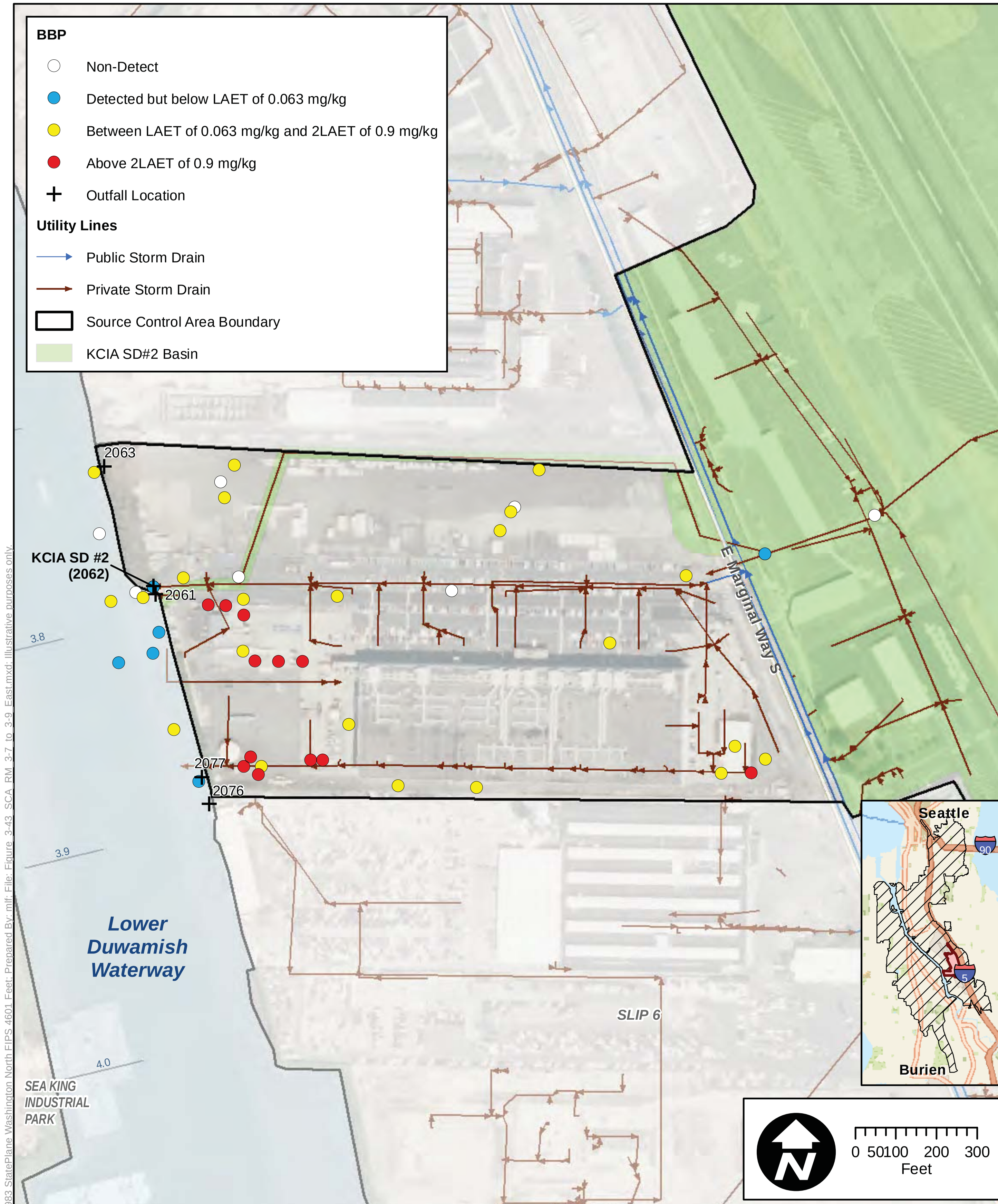

Figure 3-43e. BBP Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

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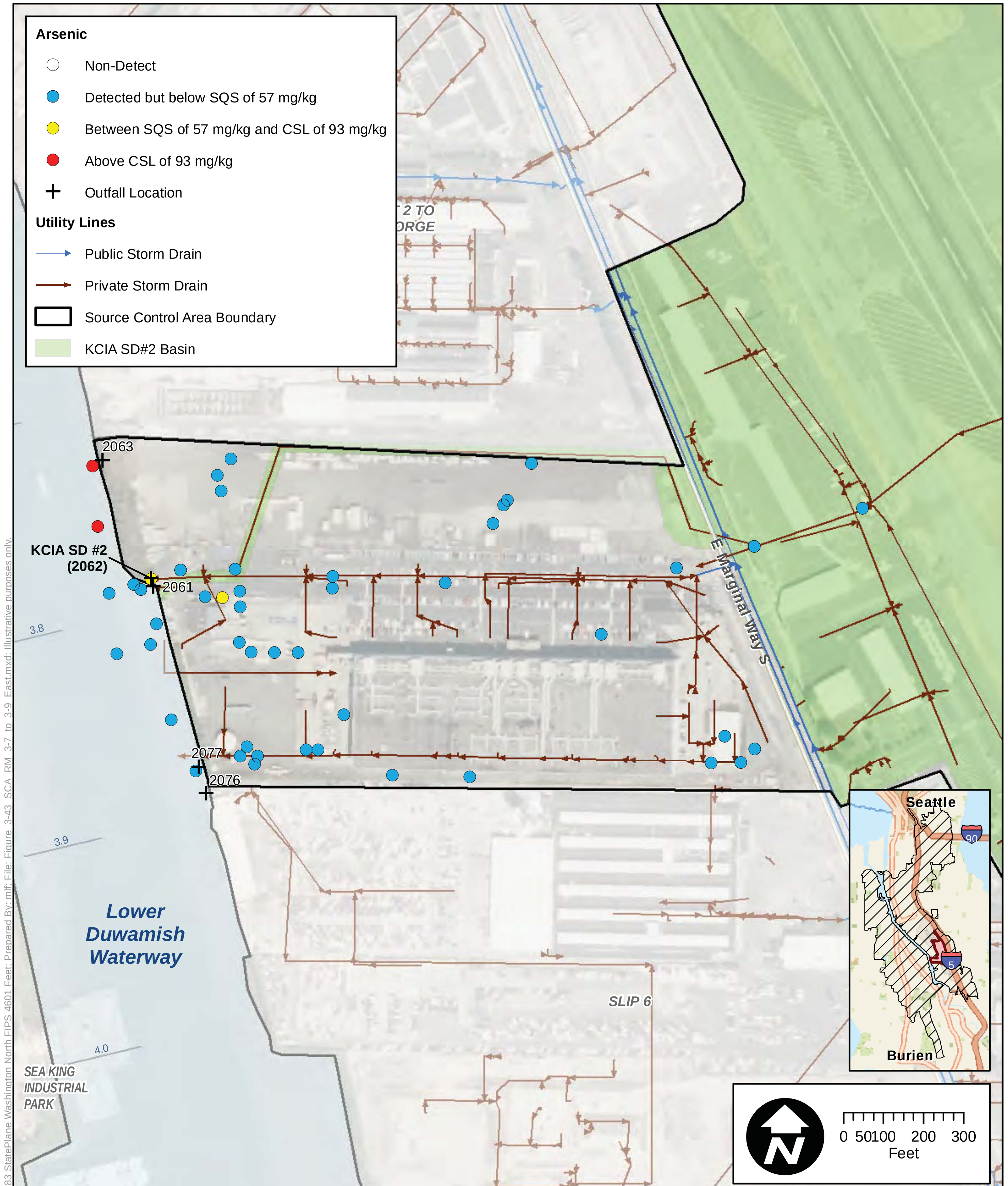

Figure 3-43f. Arsenic Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

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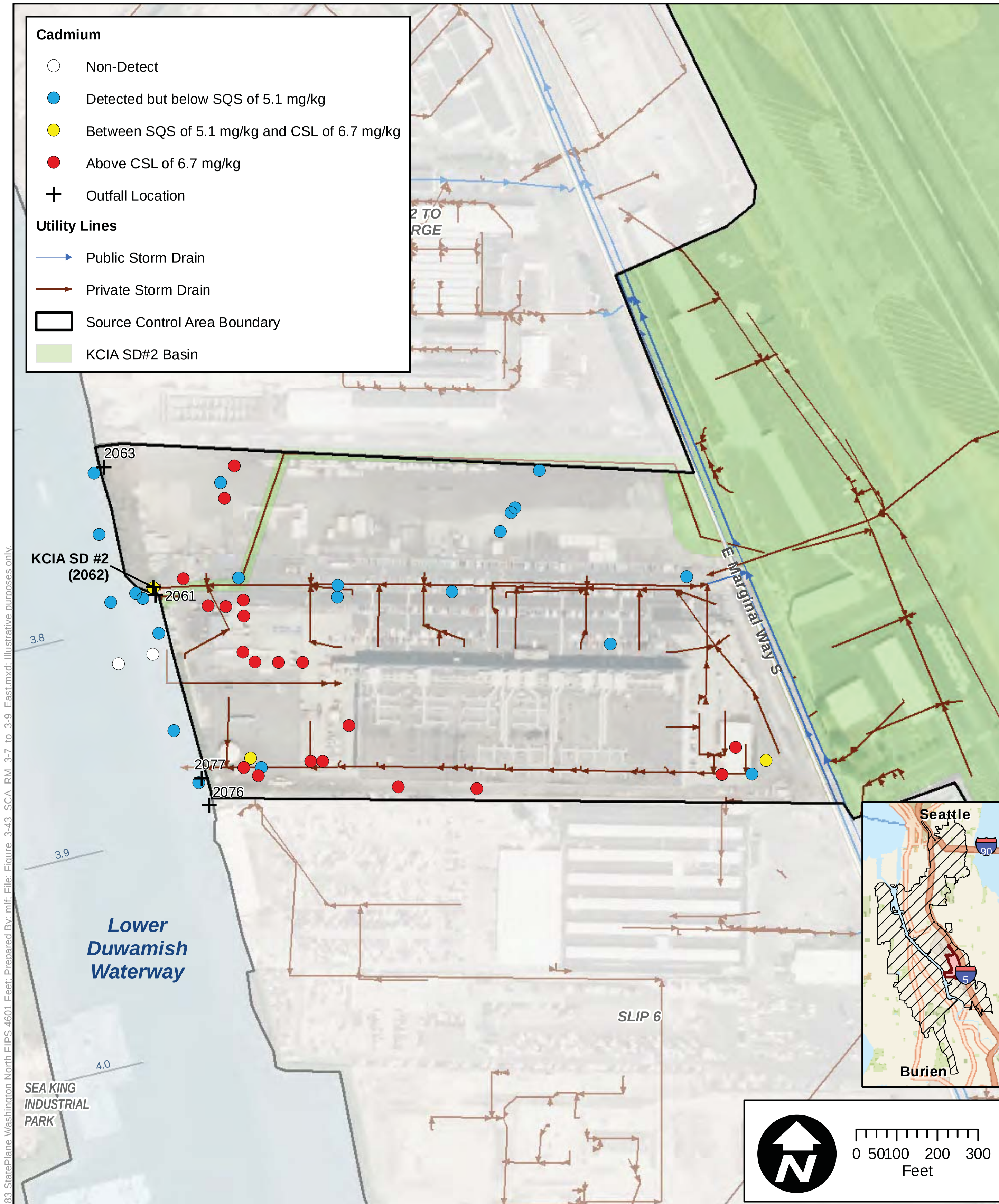

Figure 3-43g. Cadmium Concentrations in Sediment and Storm Drain Samples near RM 3.7-3.9 East (Boeing Isaacson/Central KCIA)

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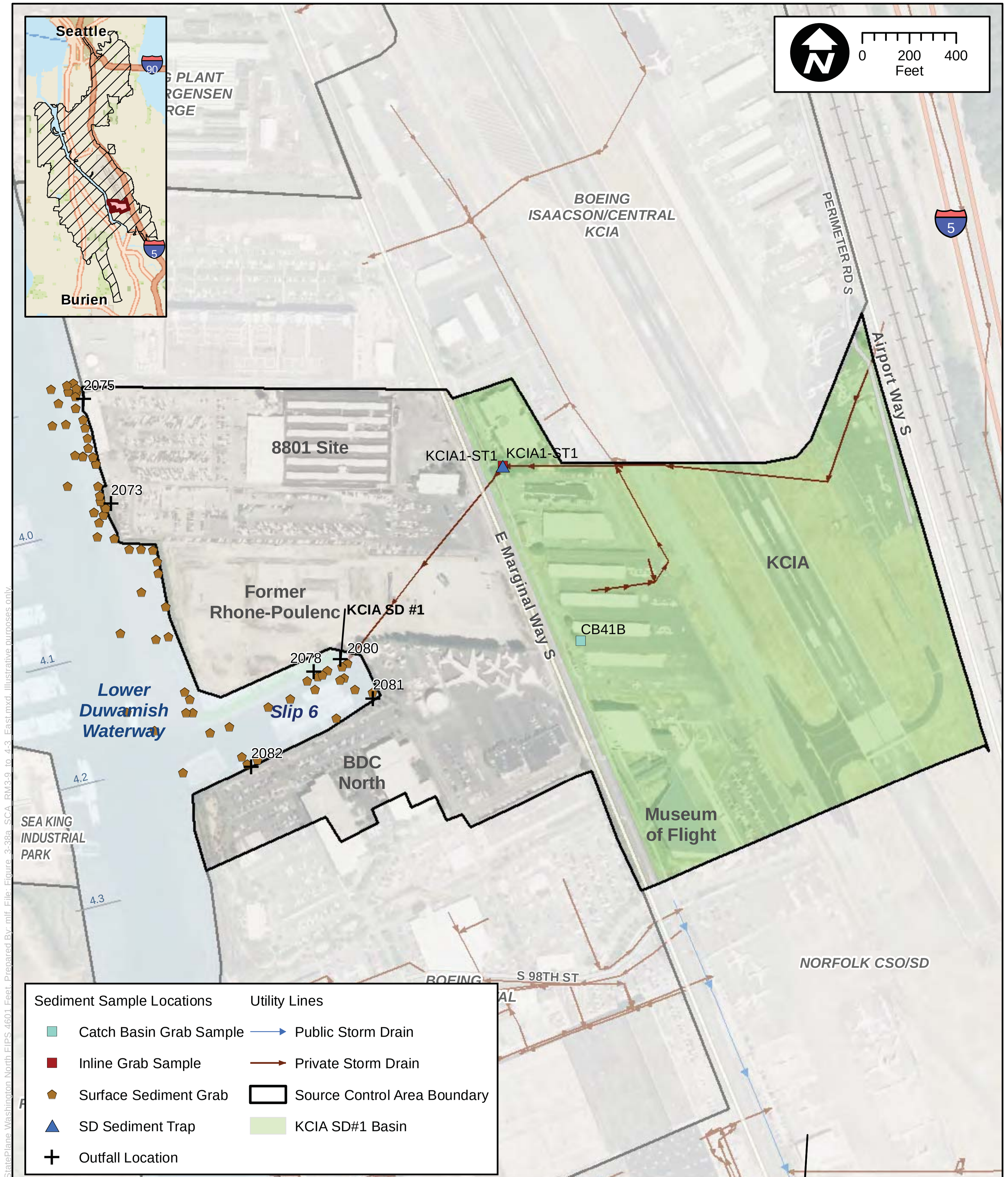
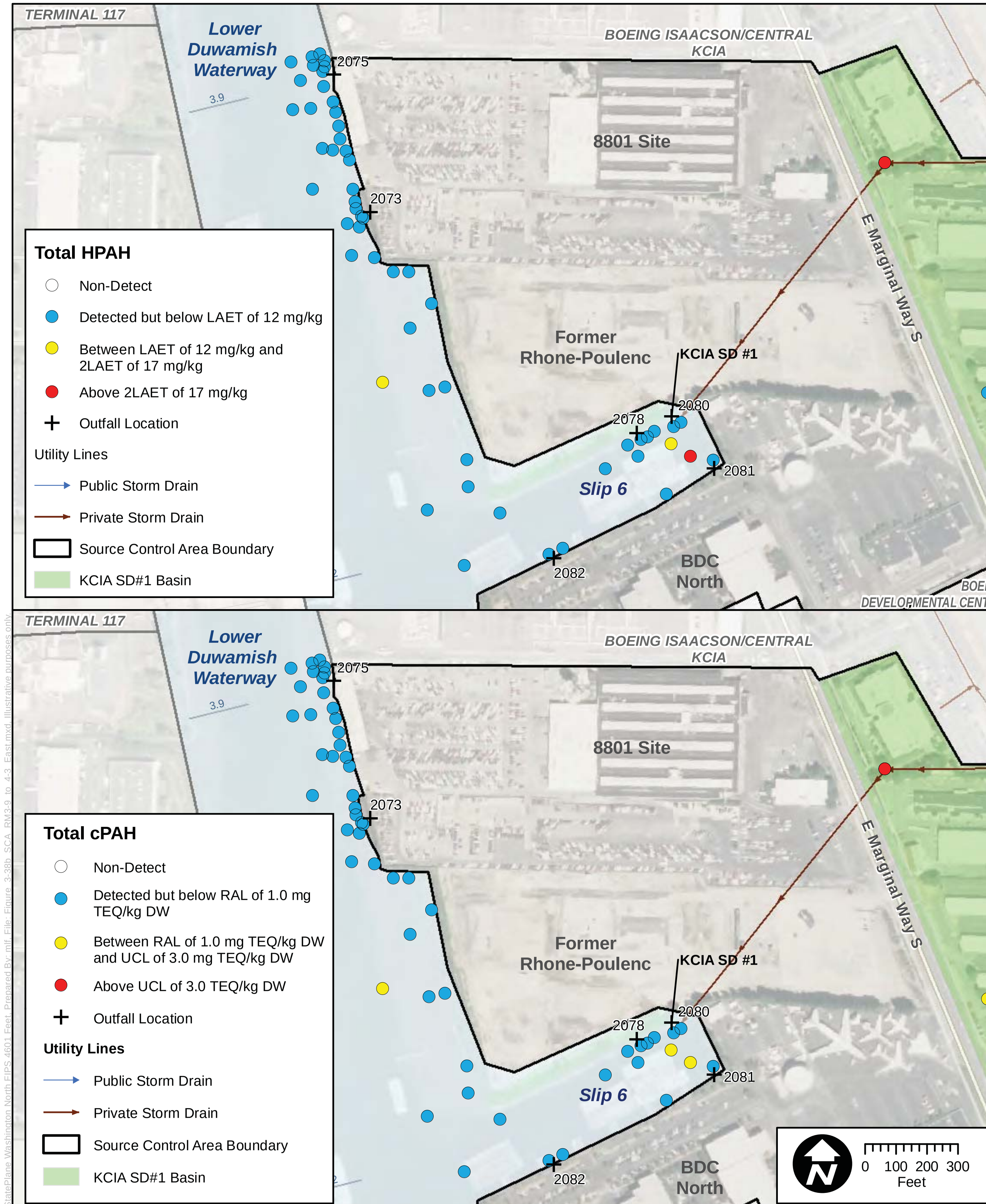


Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-38a_SCA_RM3-9_to_4-3_East.mxd, Illustrative purposes only.

Figure 3-44a. Sediment and Storm Drain Sample Locations near RM 3.9-4.3 East (Slip 6)



Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet, Prepared By: mlf, File: Figure_3-38b_SCA_RM3-9_to_4-3_East.mxd, Illustrative purposes only.

Figure 3-44b. Total HPAH and Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 3.9-4.3 East (Slip 6)

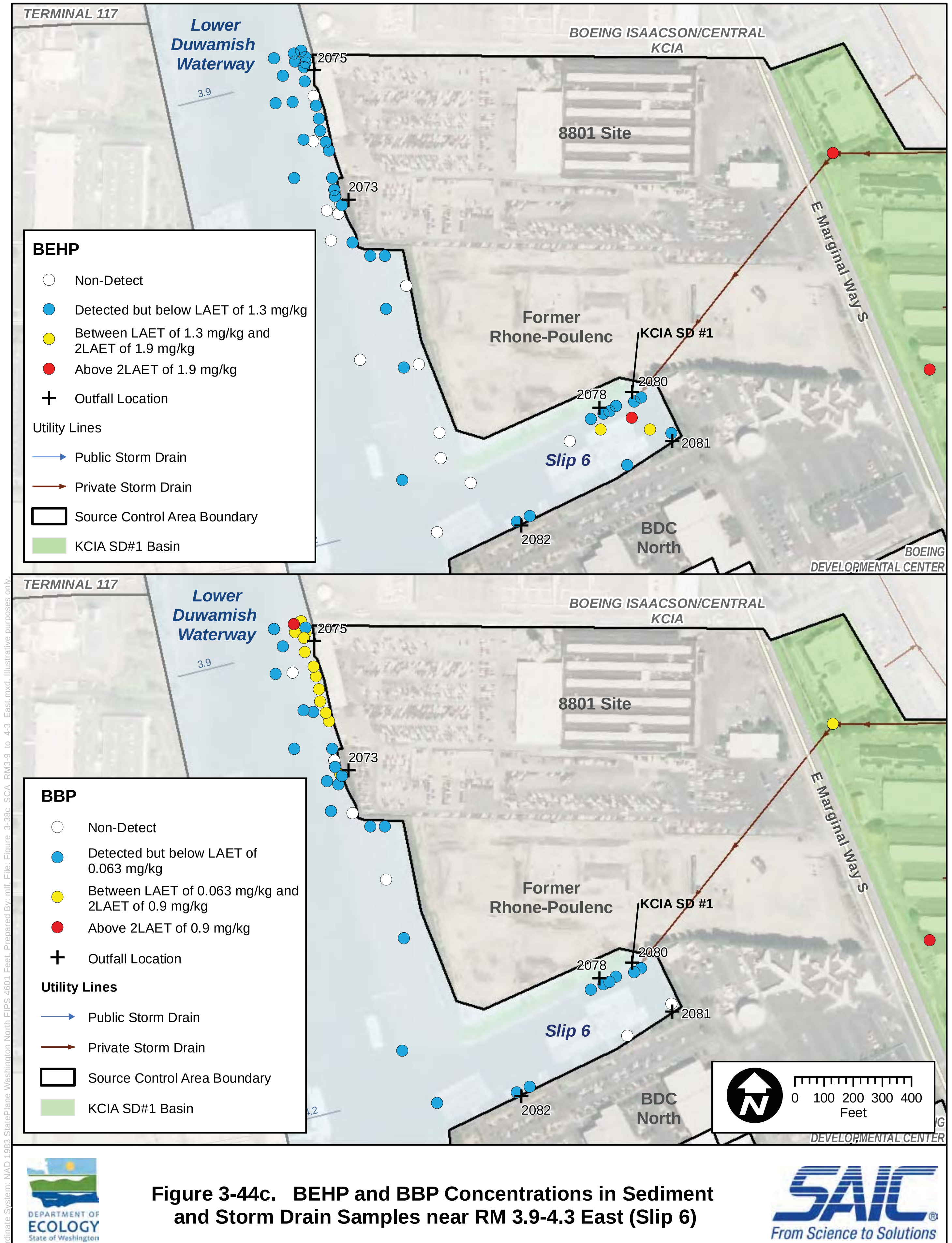


Figure 3-44c. BEHP and BBP Concentrations in Sediment and Storm Drain Samples near RM 3.9-4.3 East (Slip 6)

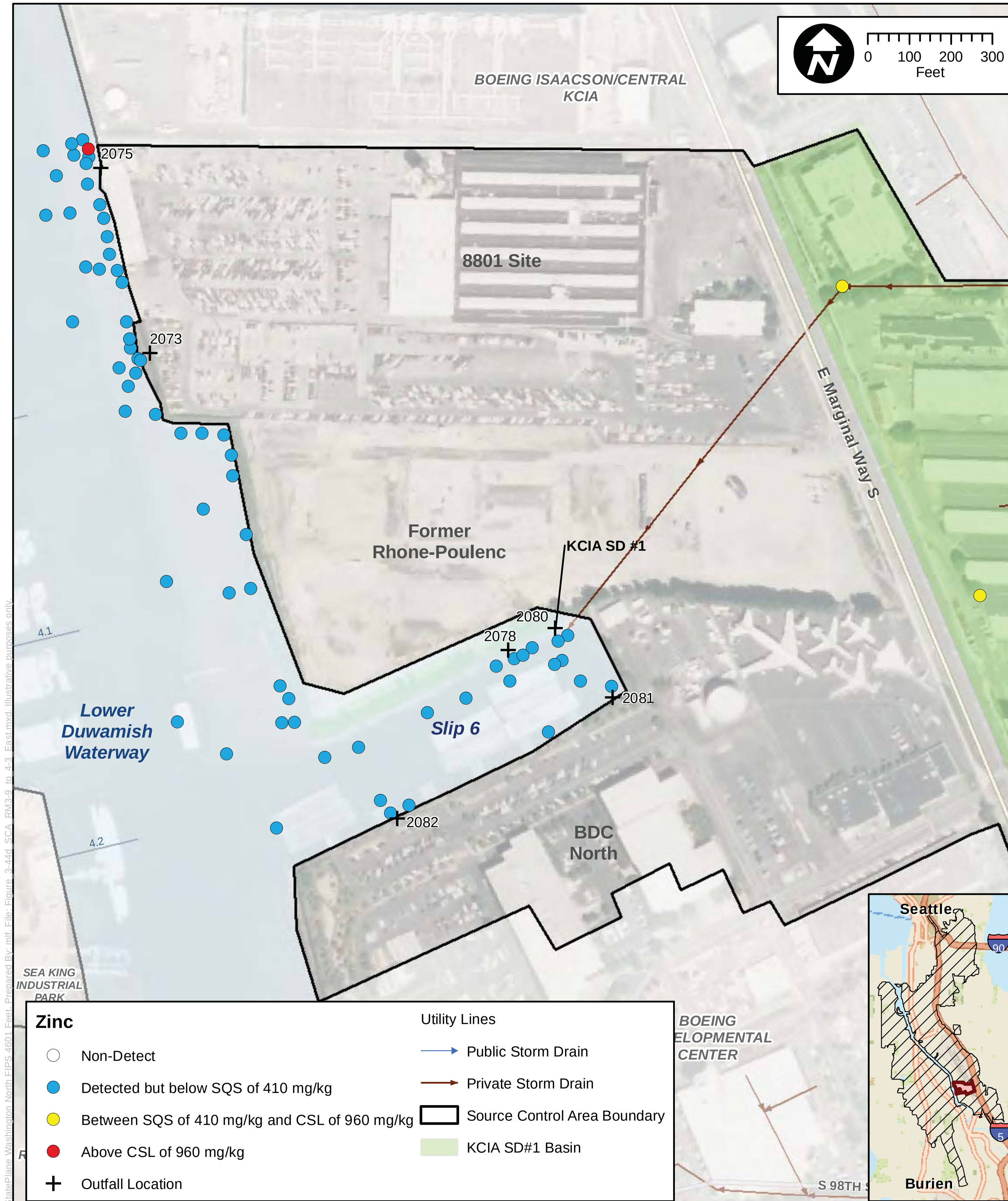


Figure 3-44d. Zinc Concentrations in Sediment and Storm Drain Samples near RM 3.9-4.3 East (Slip 6)

Figure 3-45. Sediment and Storm Drain Sample Locations near RM 4.3-4.9 East (Boeing Developmental Center)

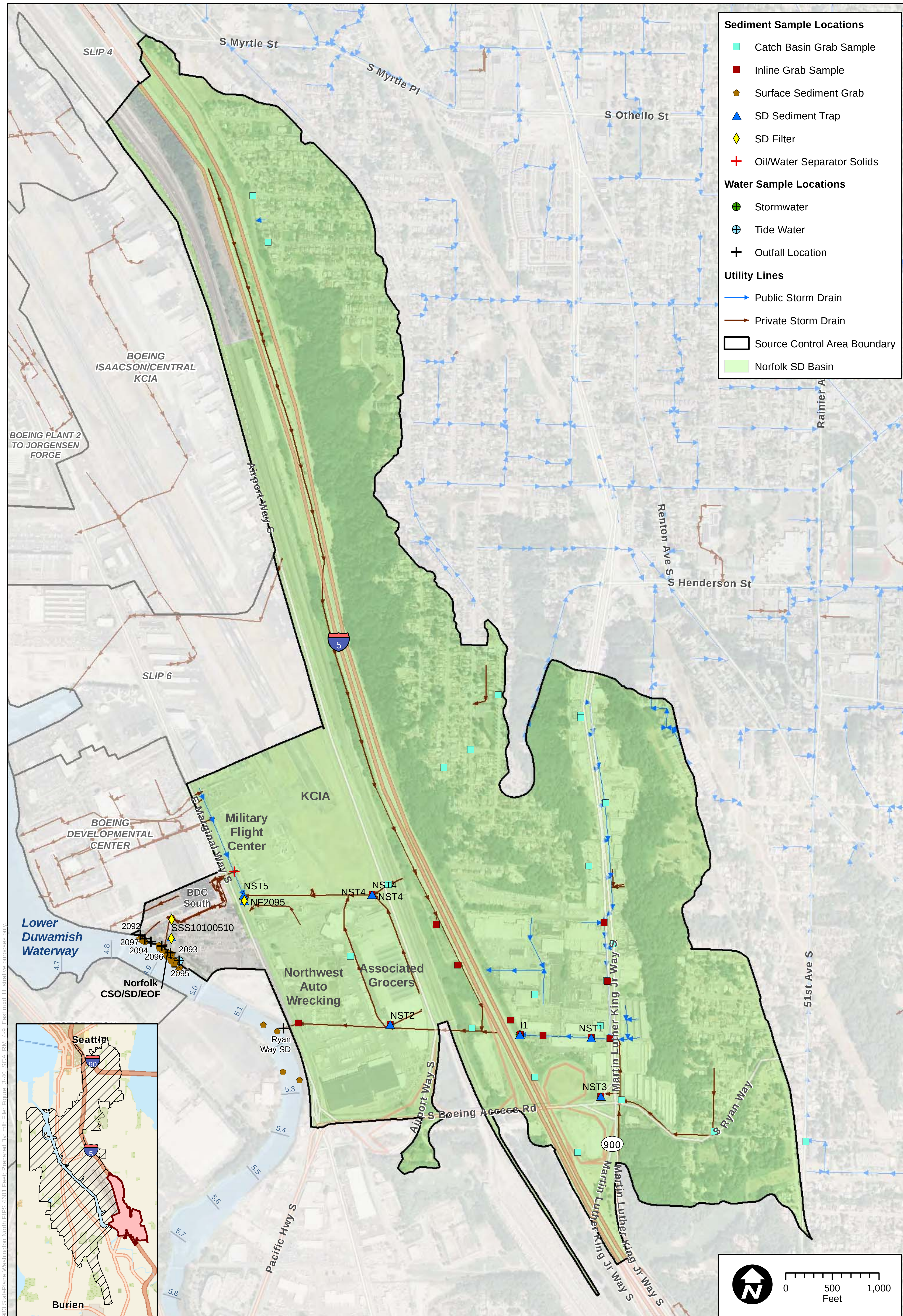


Figure 3-46a. Sediment and Storm Drain Sample Locations near RM 4.9 East (Norfolk CSO/SD)

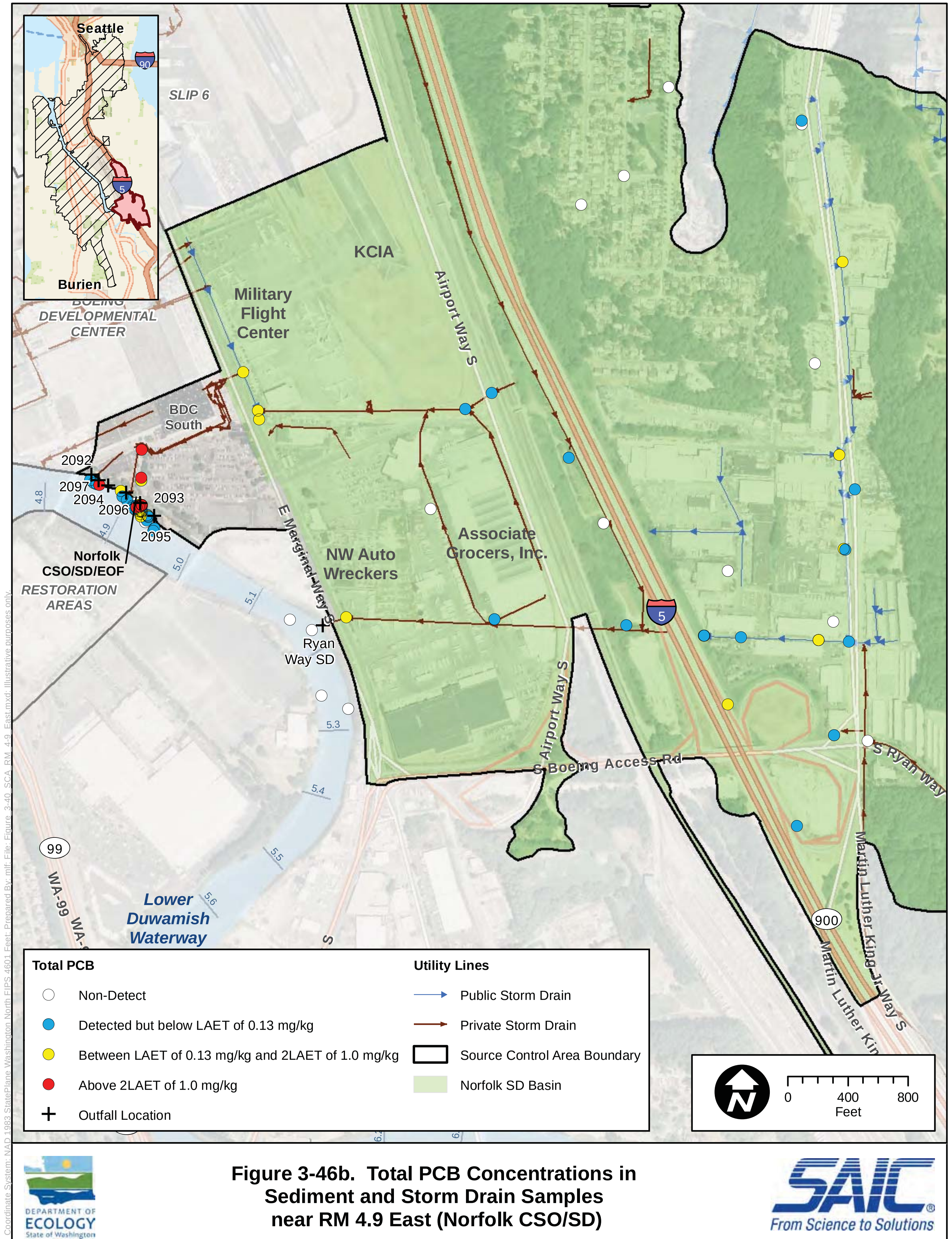


Figure 3-46b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 4.9 East (Norfolk CSO/SD)

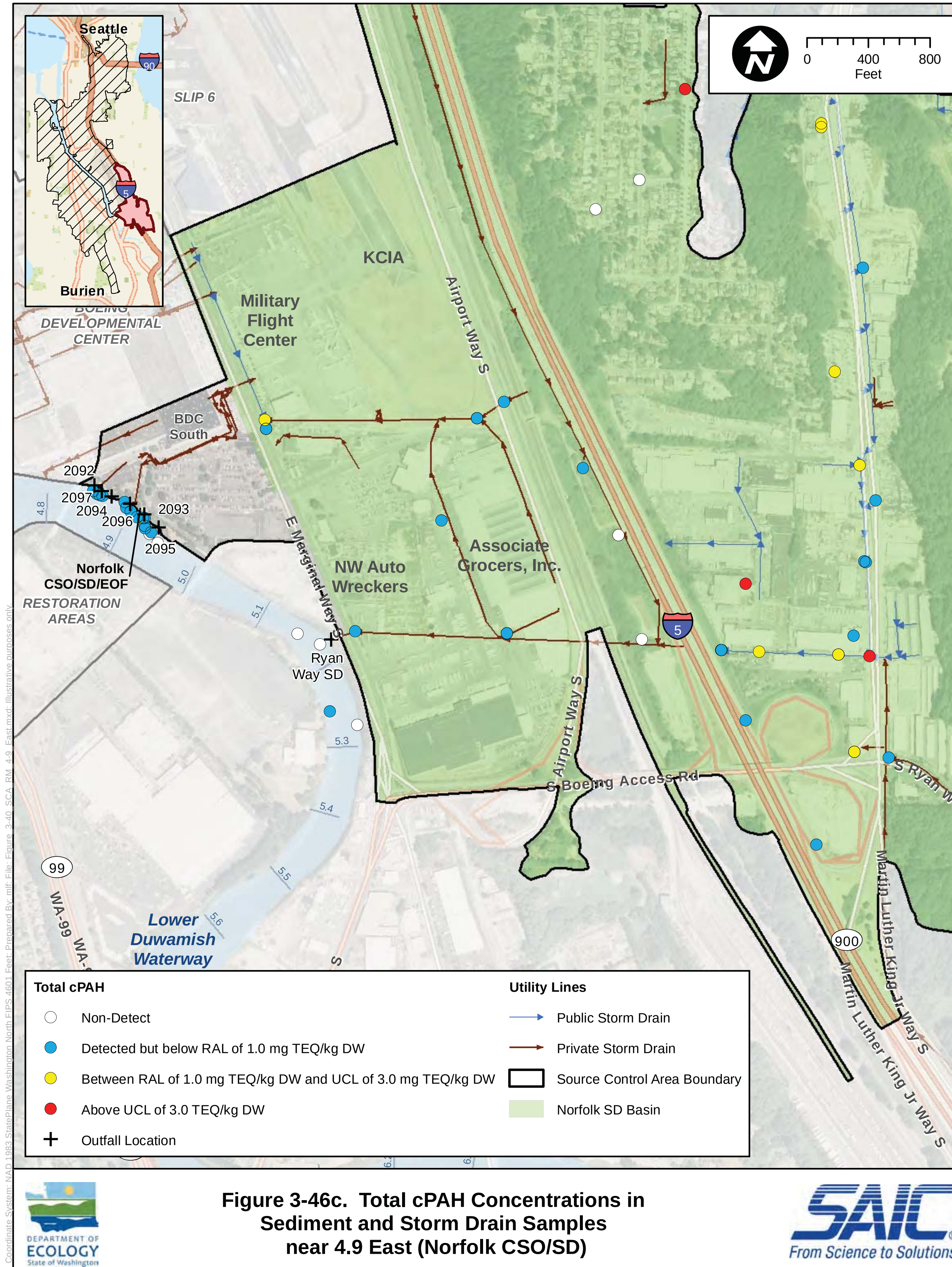


Figure 3-46c. Total cPAH Concentrations in Sediment and Storm Drain Samples near 4.9 East (Norfolk CSO/SD)

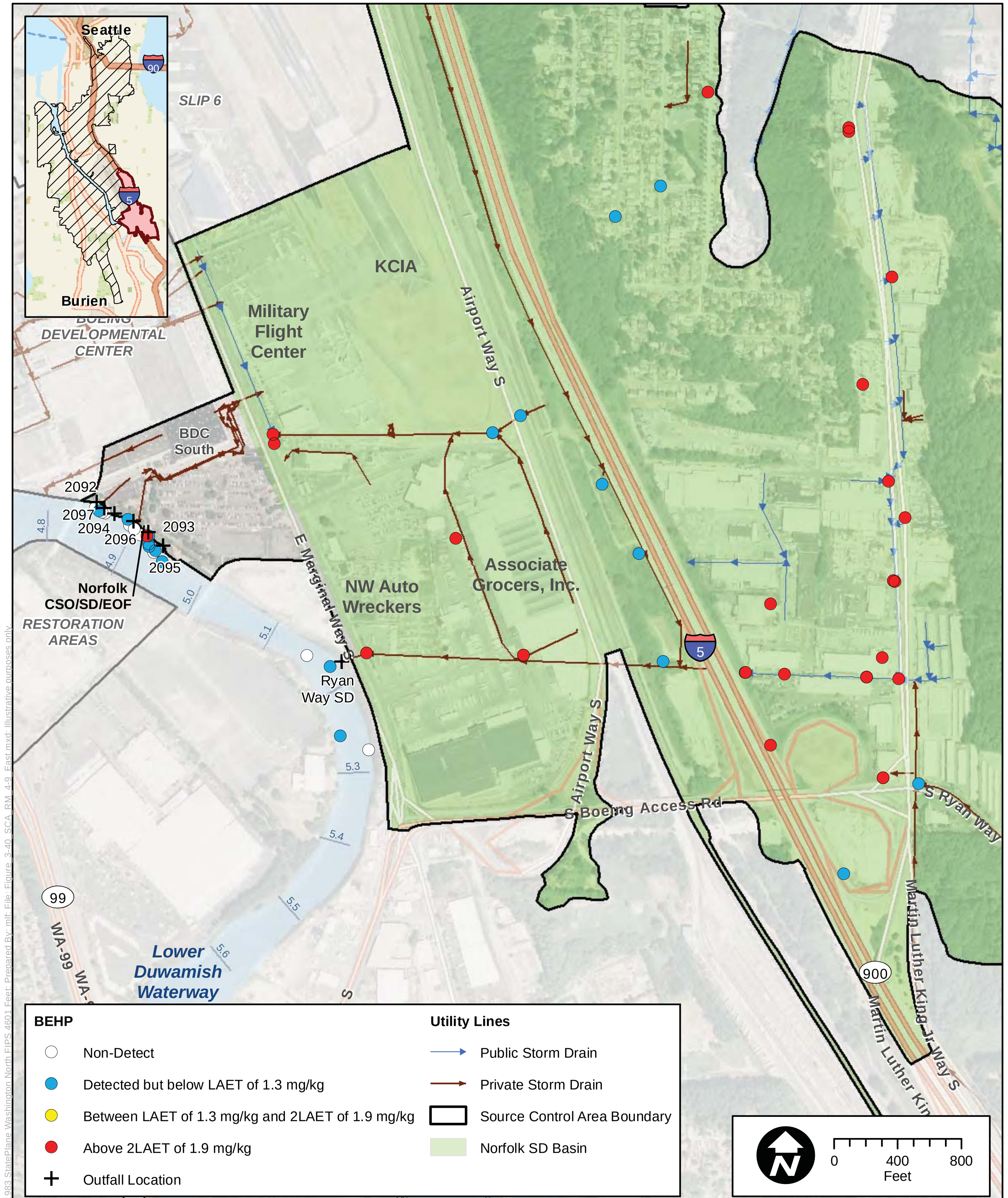


Figure 3-46d. BEHP Concentrations in Sediment and Storm Drain Samples near RM 4.9 East (Norfolk CSO/SD)

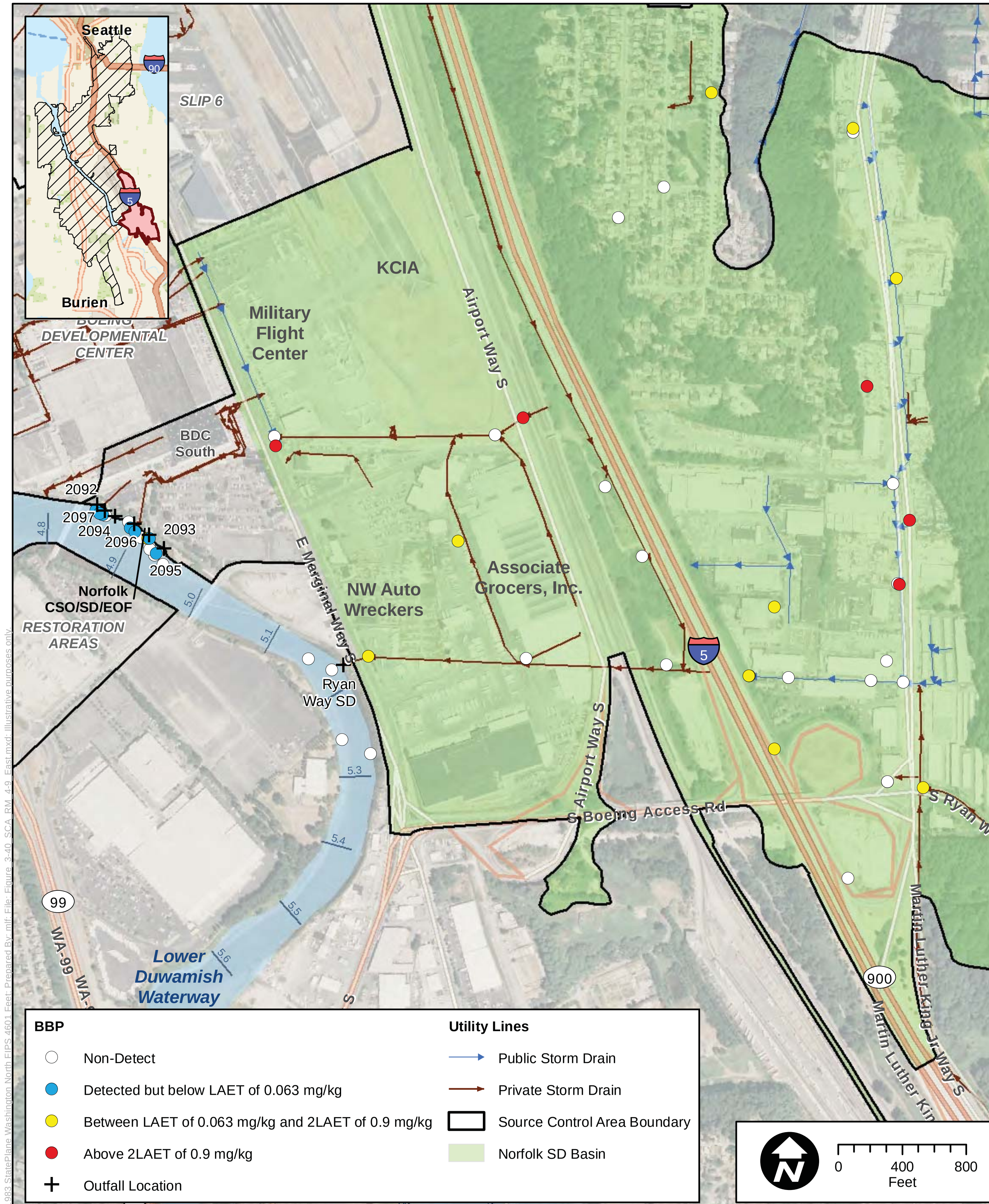


Figure 3-46e. BBP Concentrations in Sediment and Storm Drain Samples near RM 4.9 East (Norfolk CSO/SD)

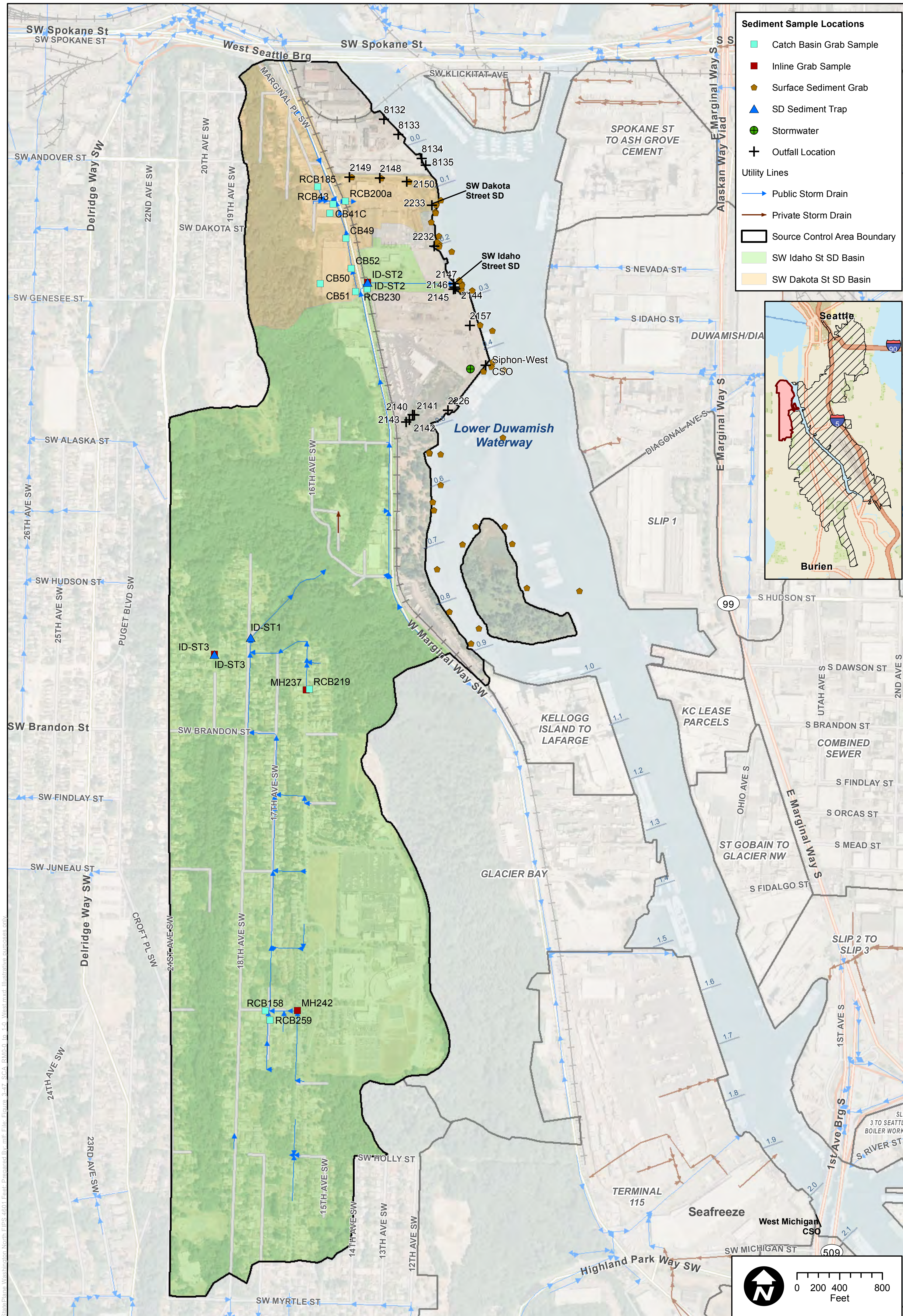


Figure 3-47a. Sediment and Storm Drain Sample Locations near RM 0.0-1.0 West (Spokane St to Kellogg Island)

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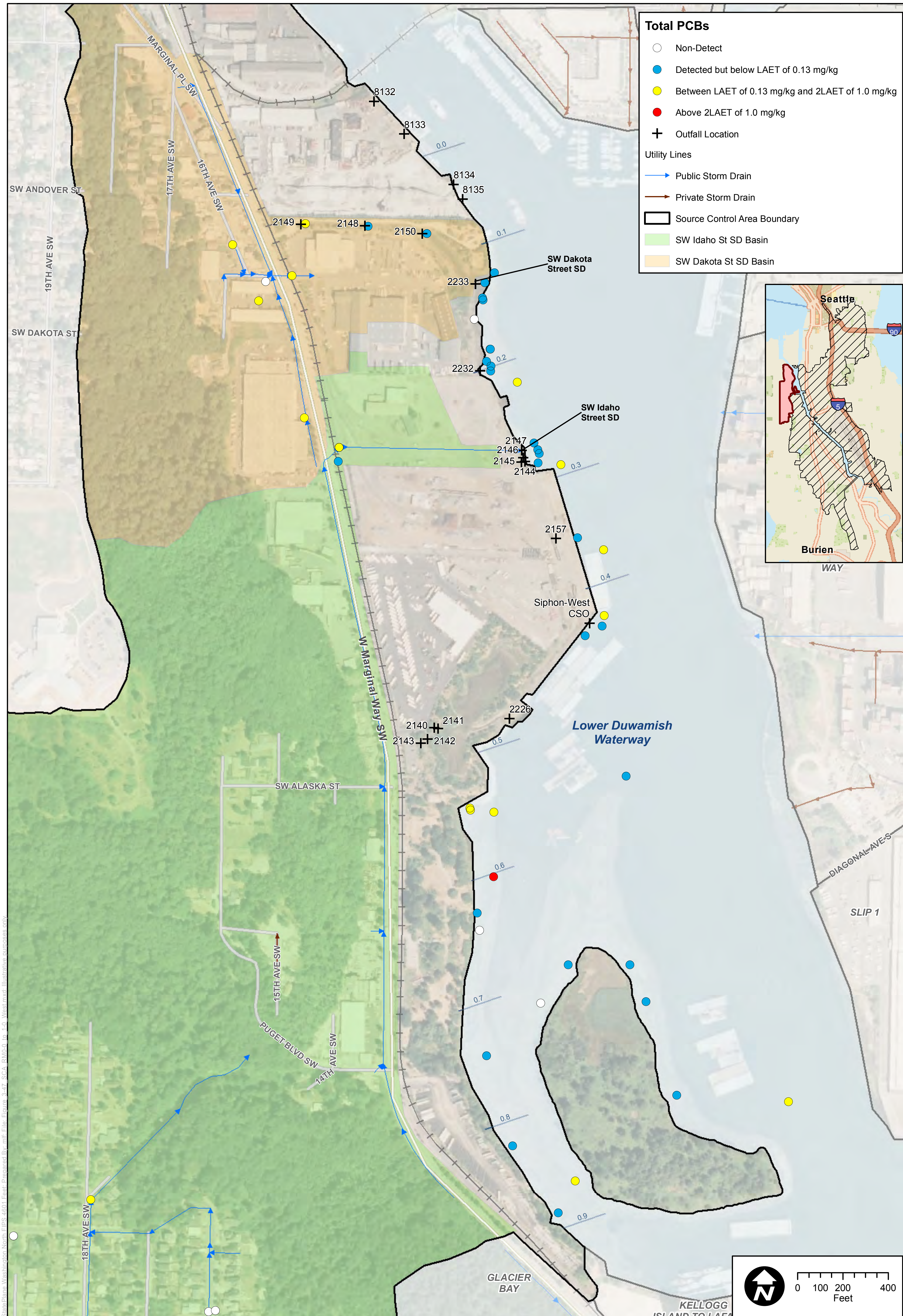

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Figure 3-47b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 0.0-1.0 West (Spokane St to Kellogg Island)

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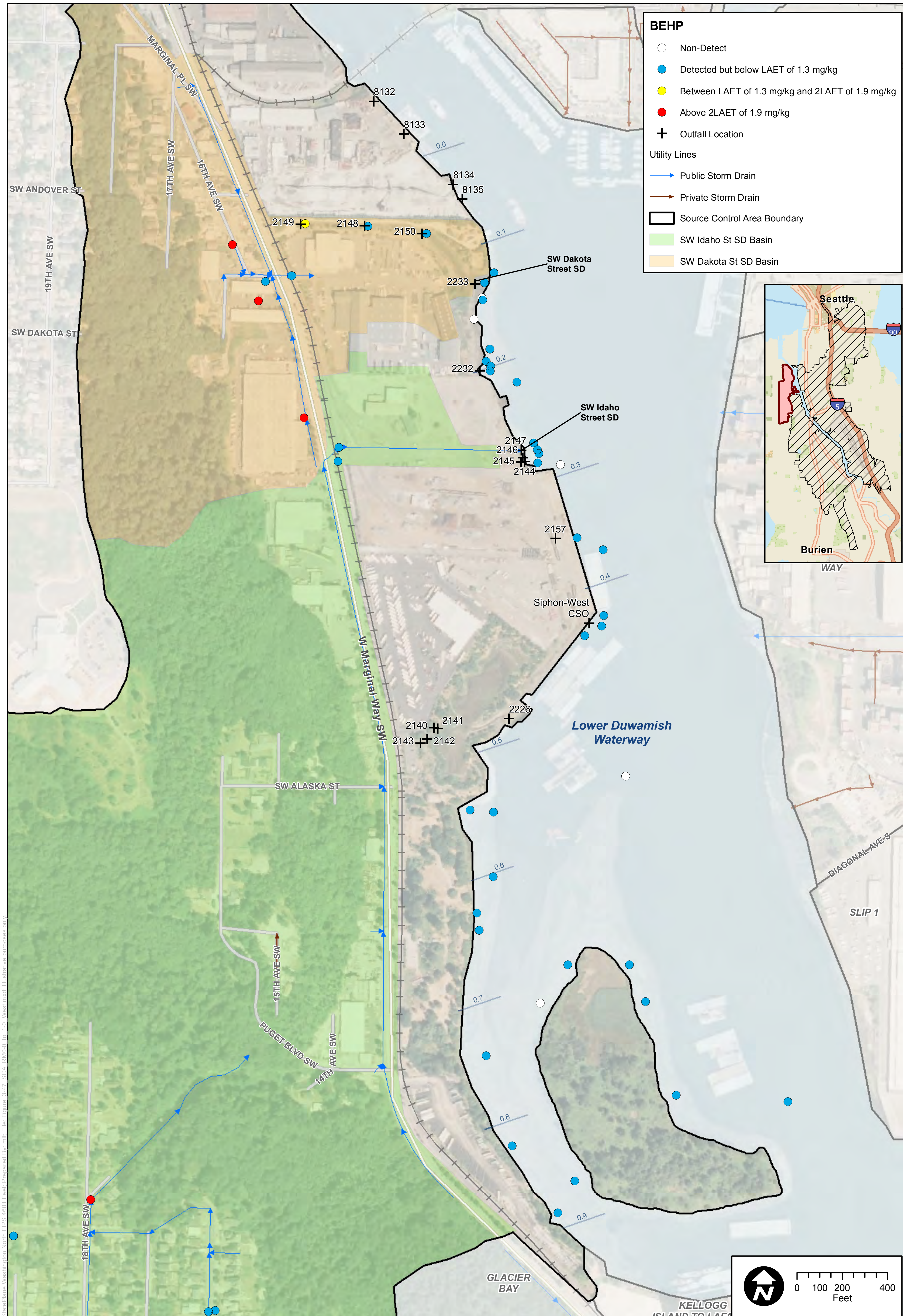

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Figure 3-47c. BEHP Concentrations in Sediment and Storm Drain Samples near RM 0.0-1.0 West (Spokane St to Kellogg Island)

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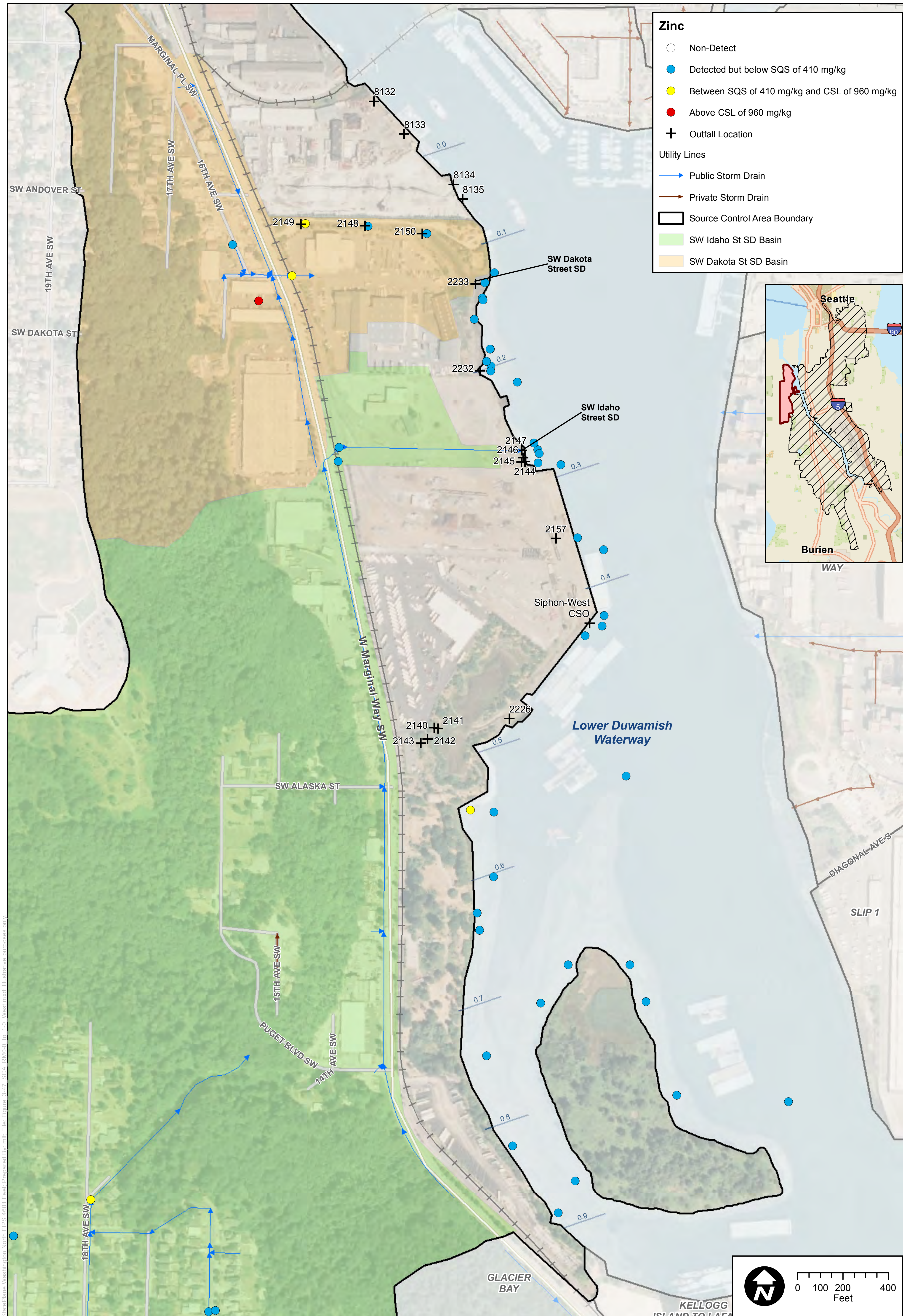

Figure 3-47d. Zinc Concentrations in Sediment and Storm Drain Samples near RM 0.0-1.0 West (Spokane St to Kellogg Island)

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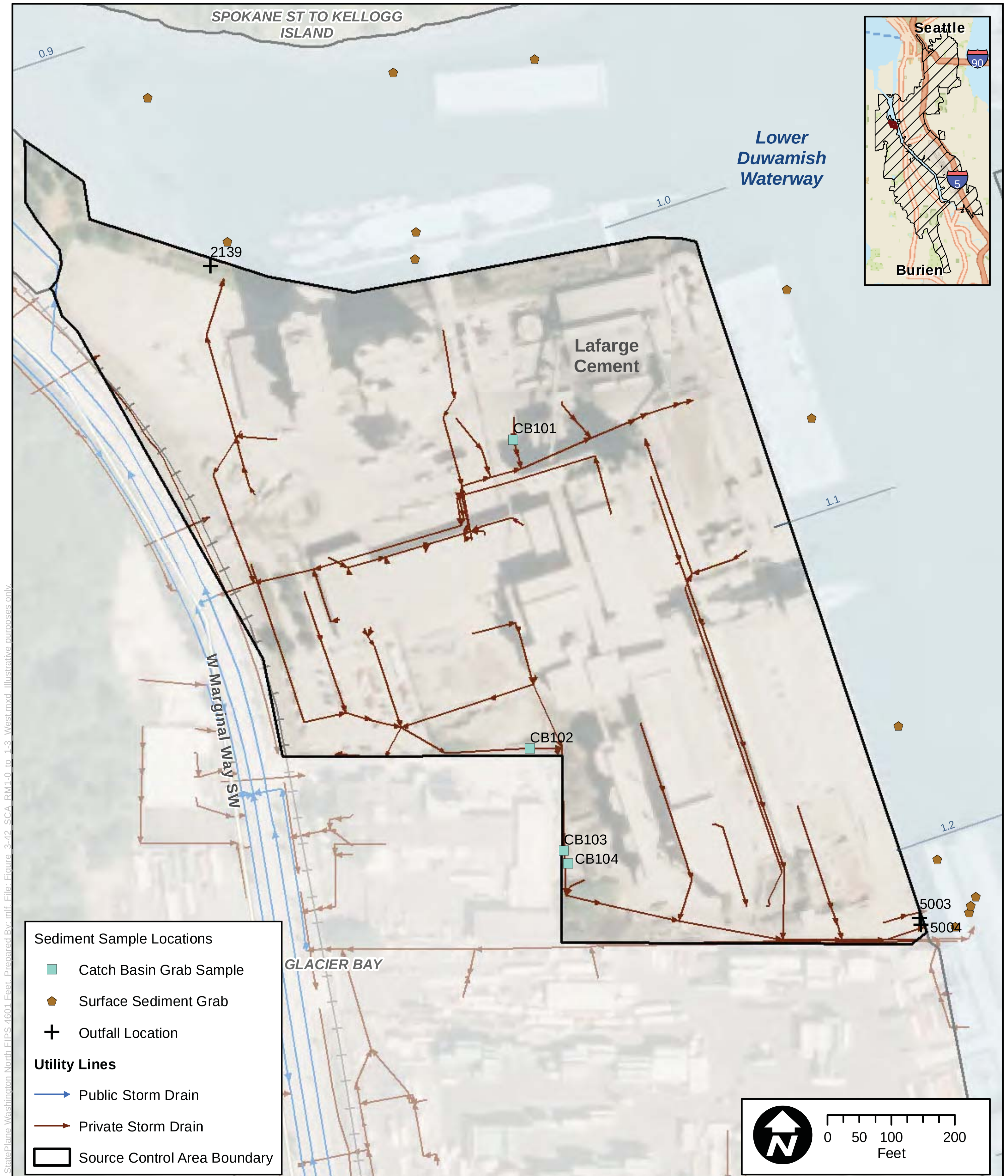

Figure 3-48a. Sediment and Storm Drain Sample Locations near RM 1.0-1.3 West (Kellogg Island to Lafarge)

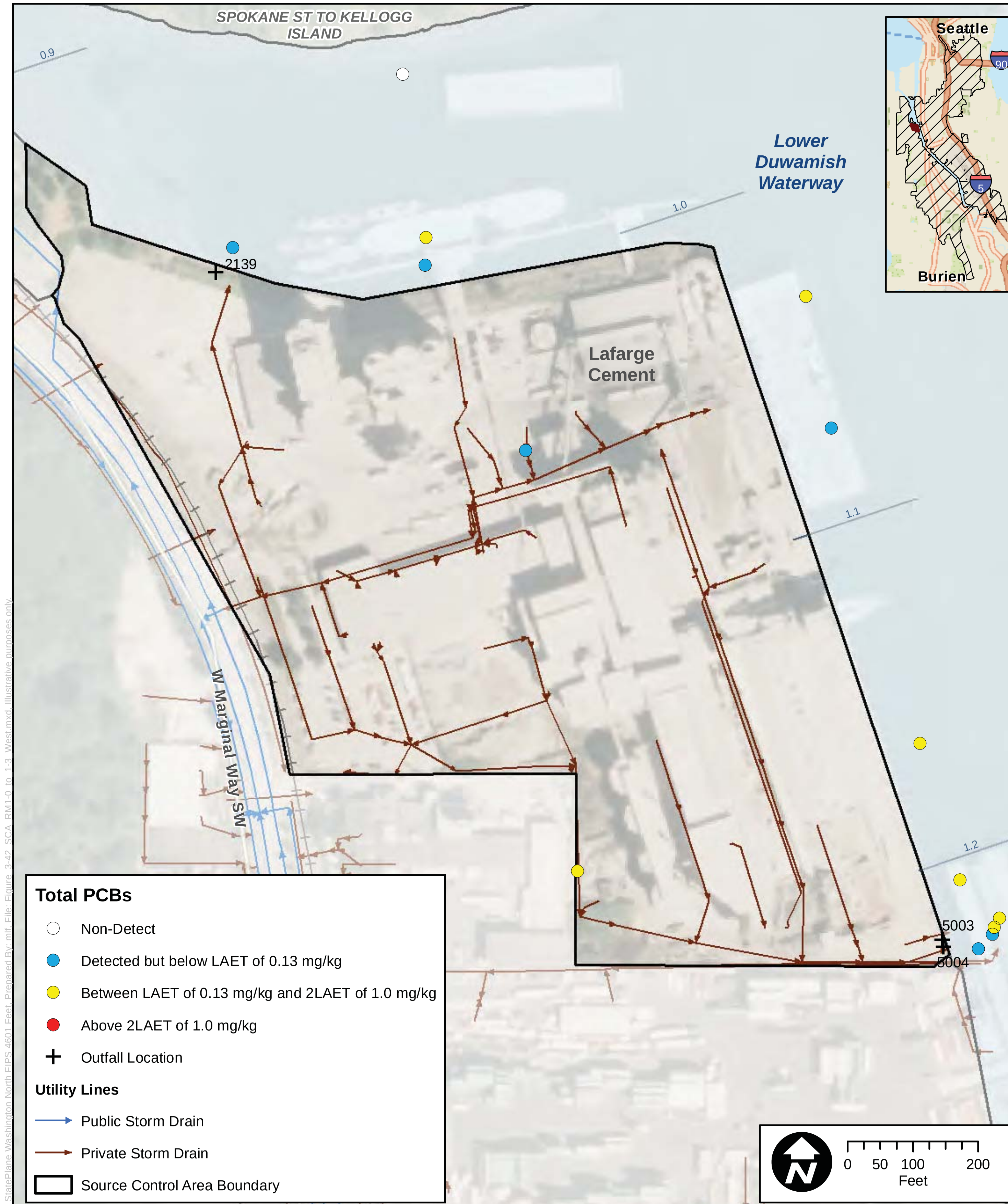

Figure 3-48b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 1.0-1.3 West (Kellogg Island to Lafarge)

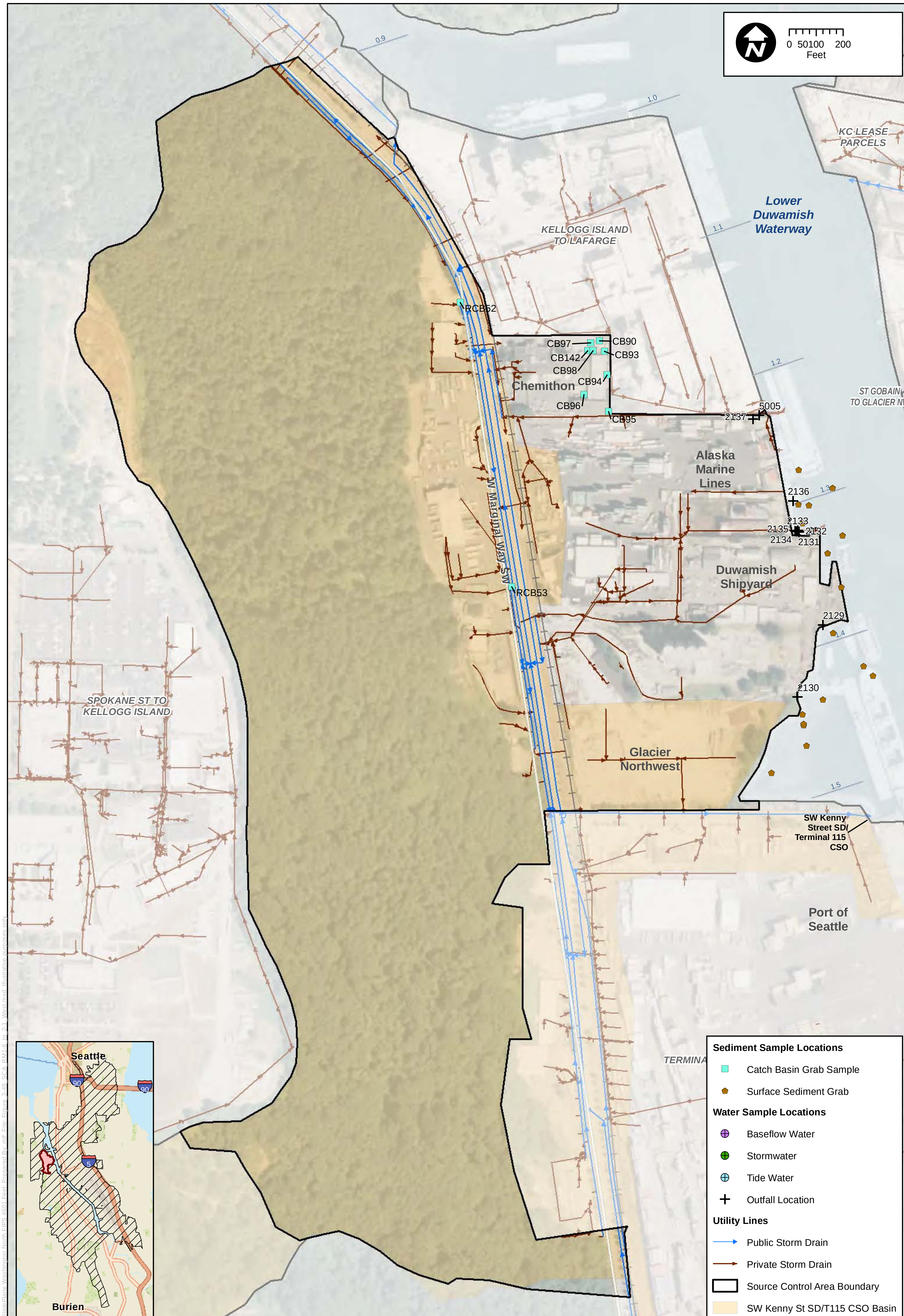

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Figure 3-49a. Sediment and Storm Drain Sample Locations near RM 1.3-1.6 West (Glacier Bay)

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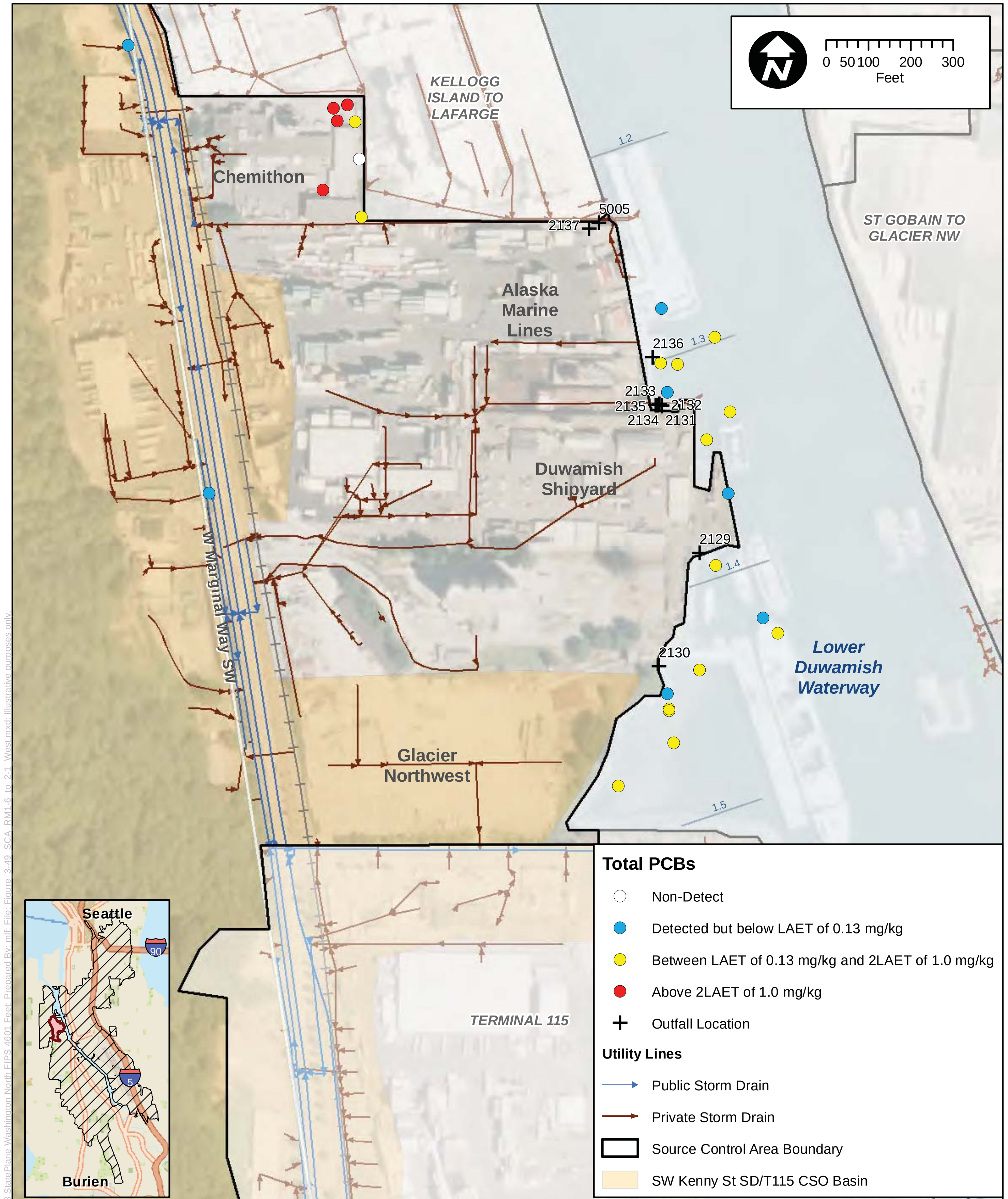

Figure 3-49b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

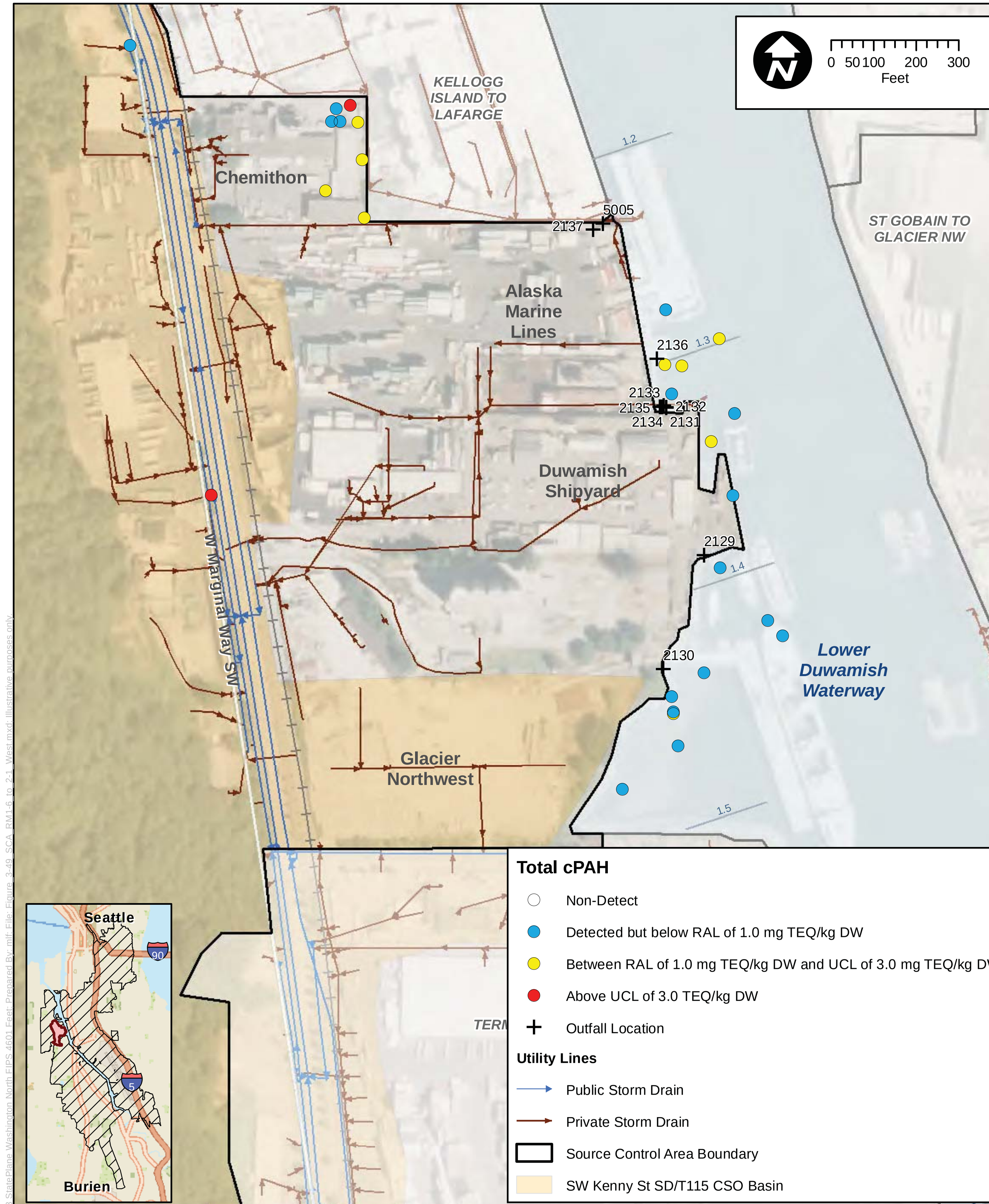

Figure 3-49c. Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

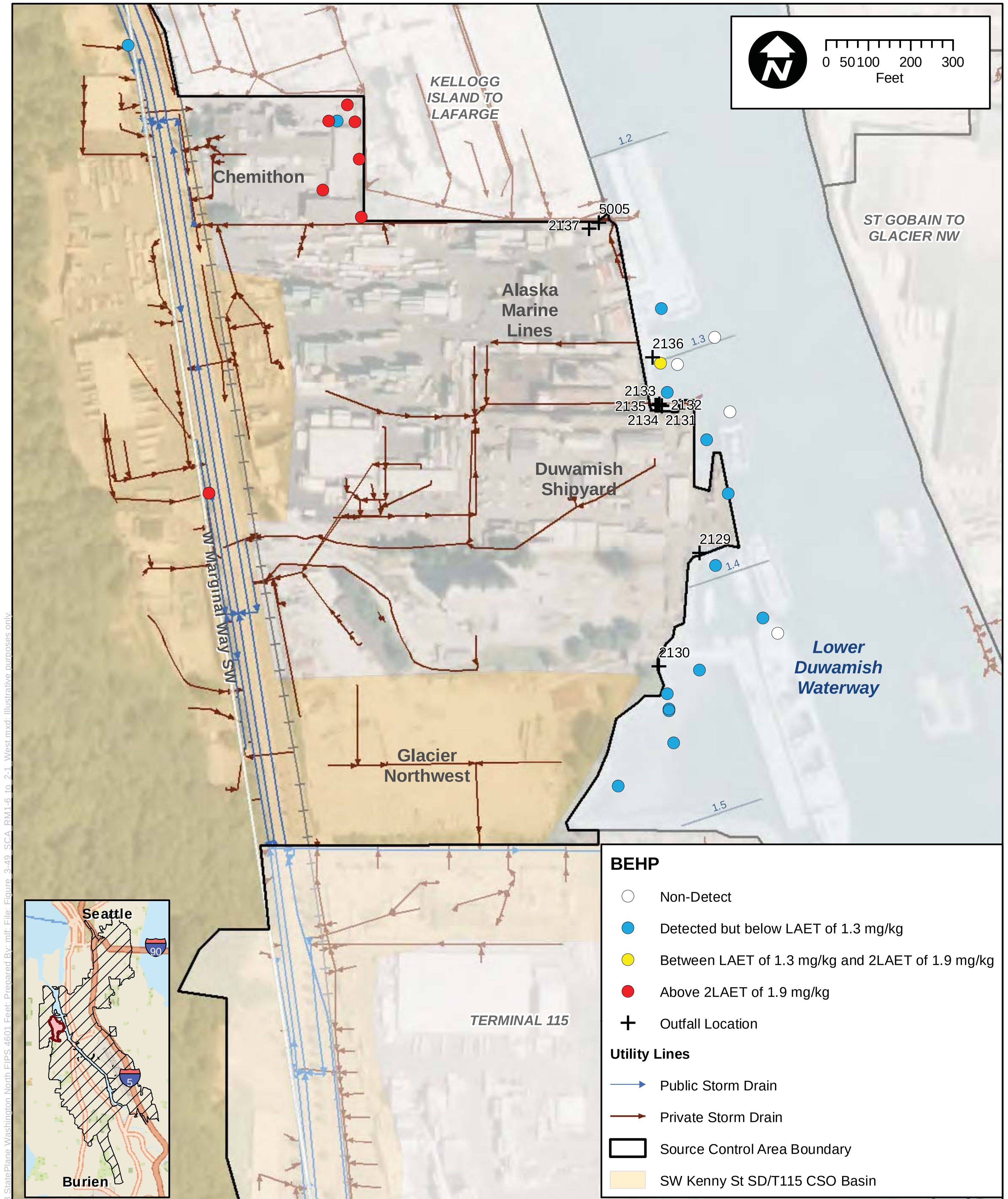

Figure 3-49d. BEHP Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

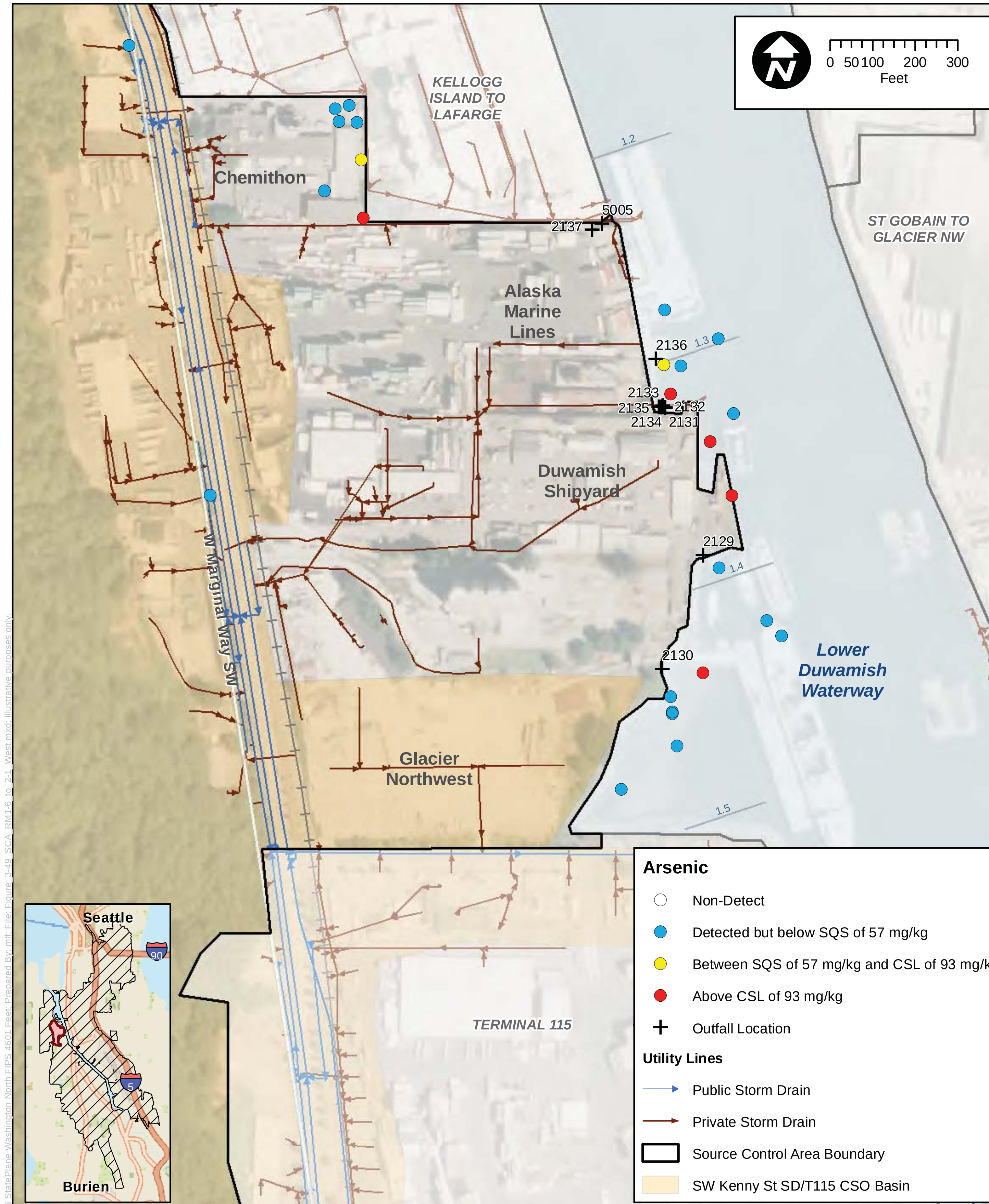

Figure 3-49e. Arsenic Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

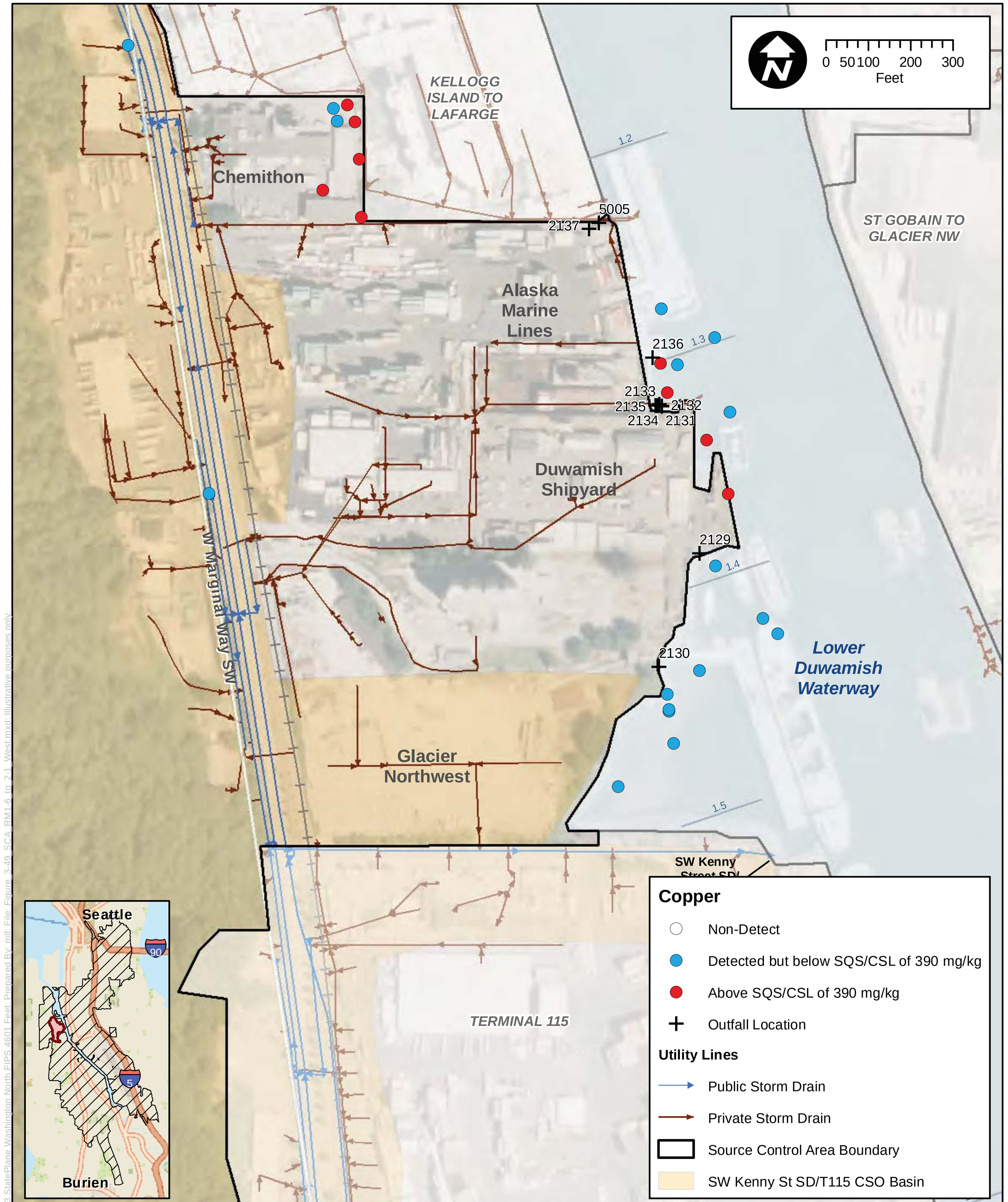

Figure 3-49f. Copper Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

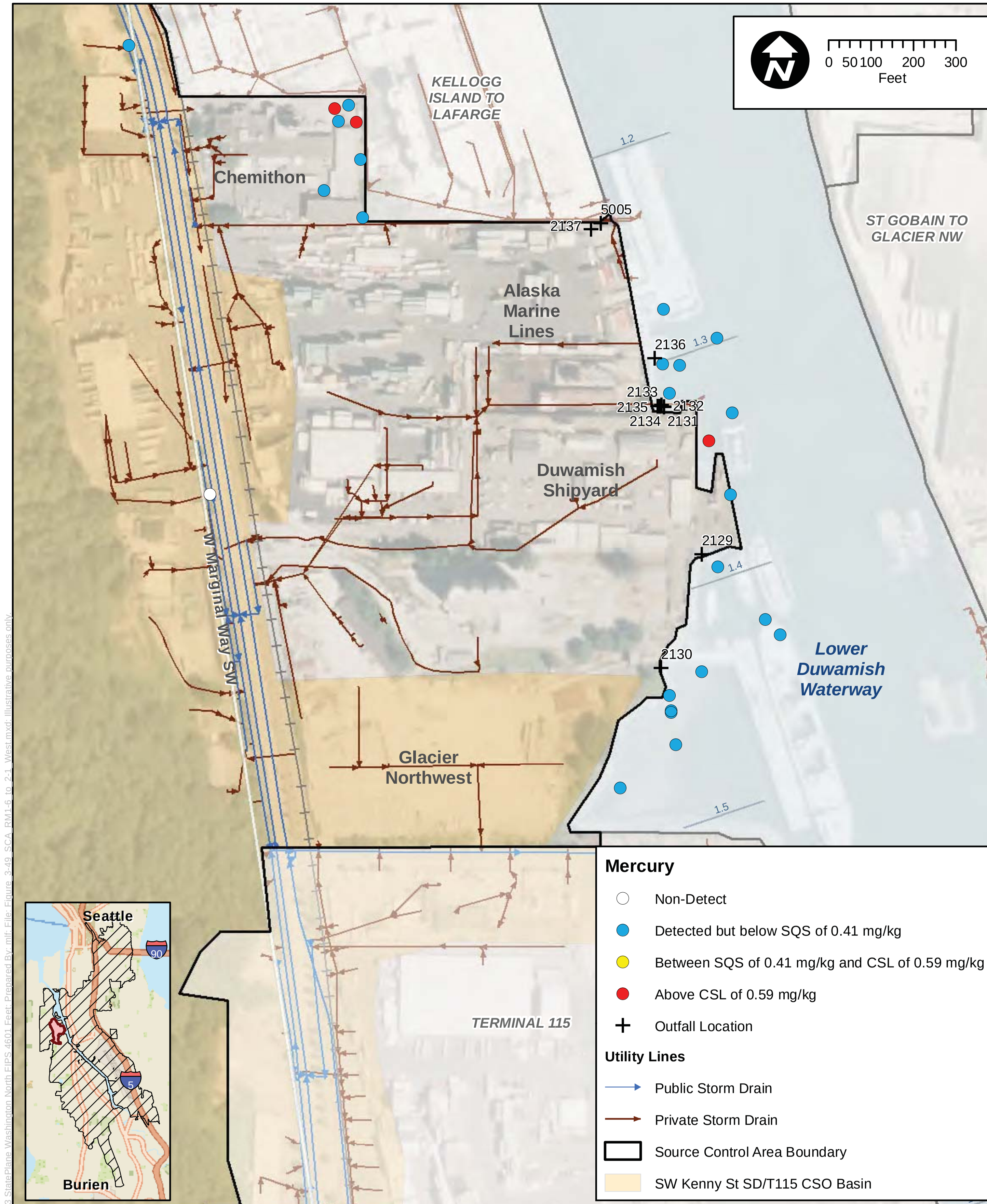

Figure 3-49g. Mercury Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

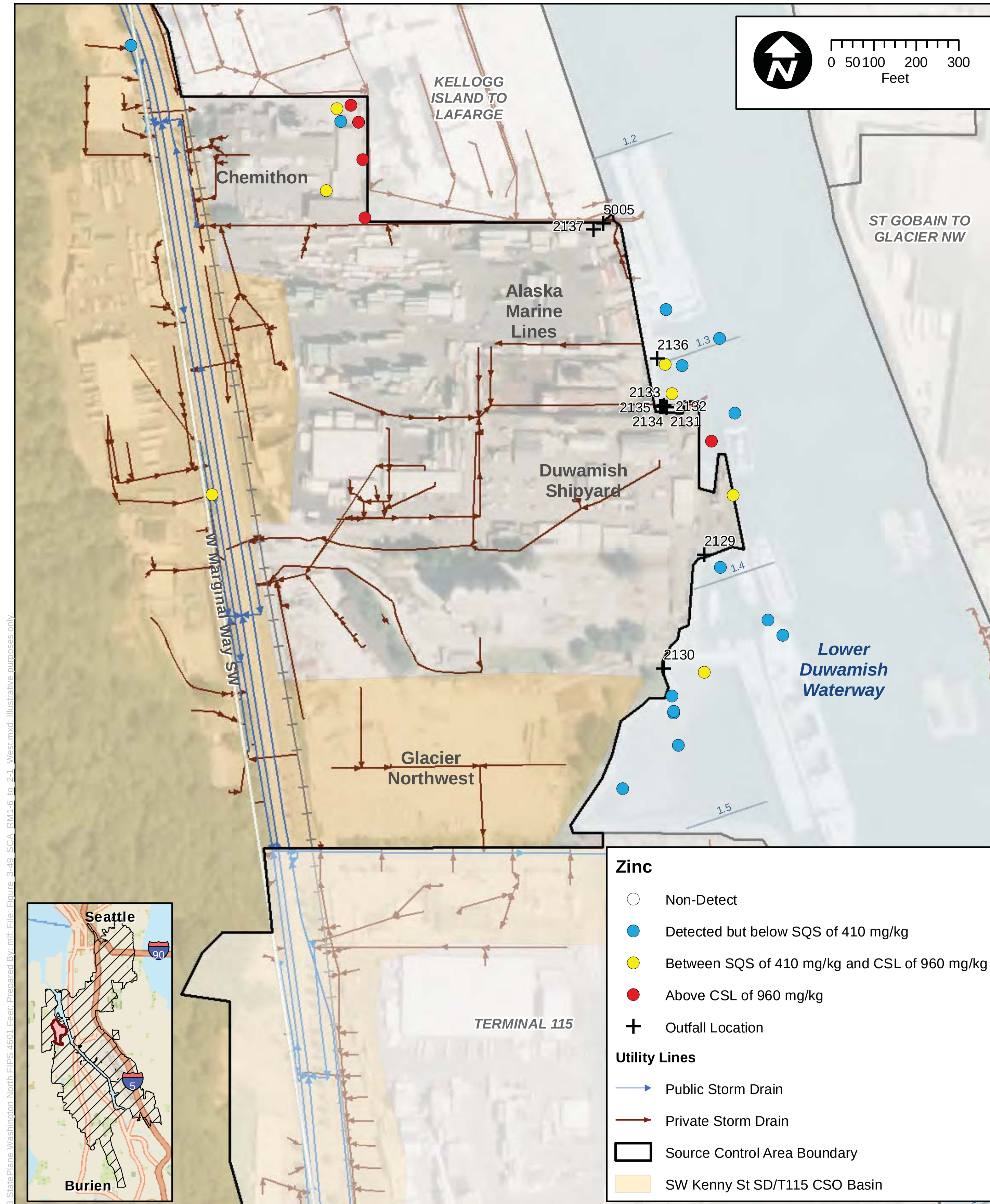

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Figure 3-49h. Zinc Concentrations in Sediment and Storm Drain Samples near RM 1.3-1.6 West (Glacier Bay)

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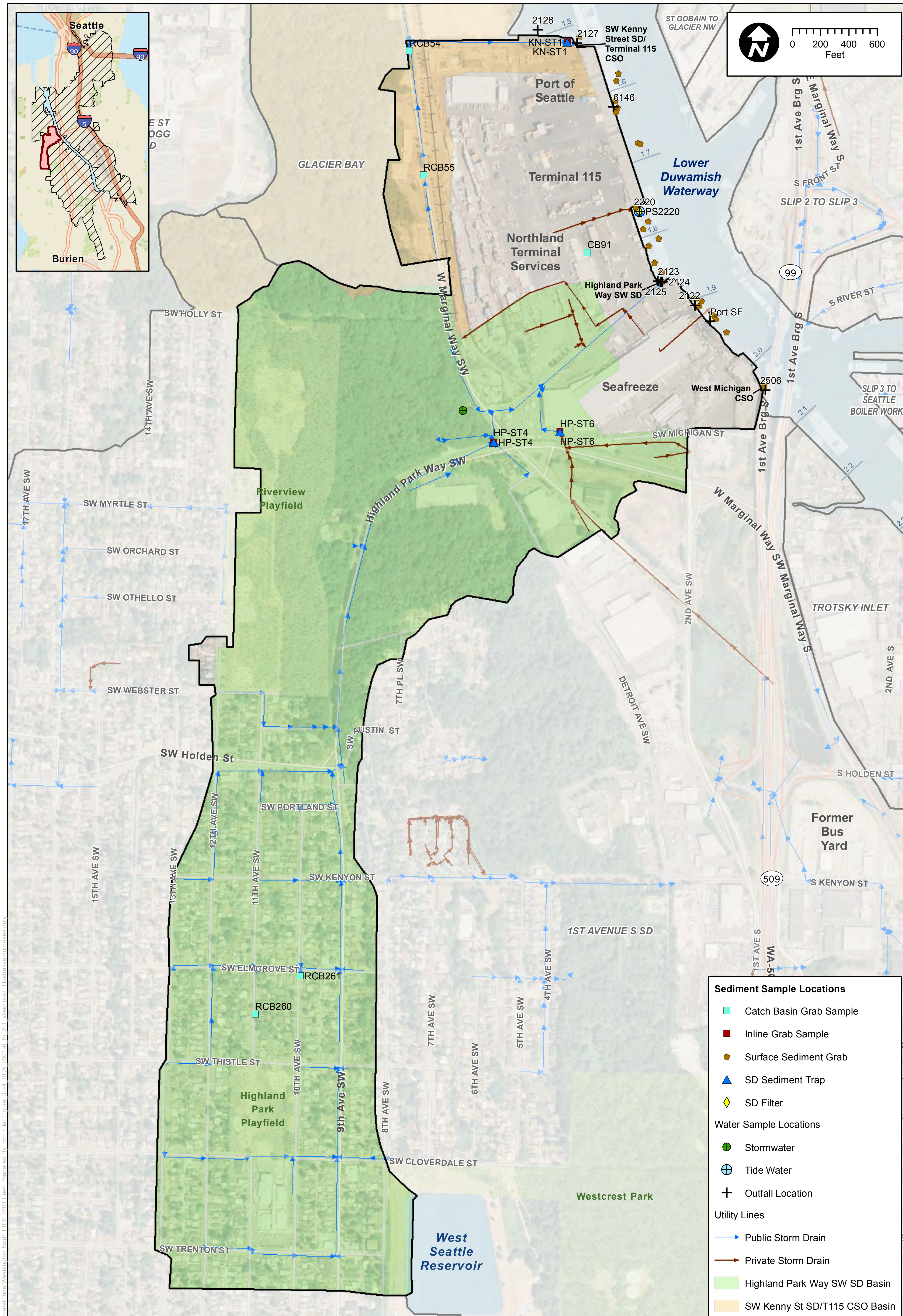

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Figure 3-50a. Sediment and Storm Drain Sample Locations near RM 1.6-2.1 West (Terminal 115)

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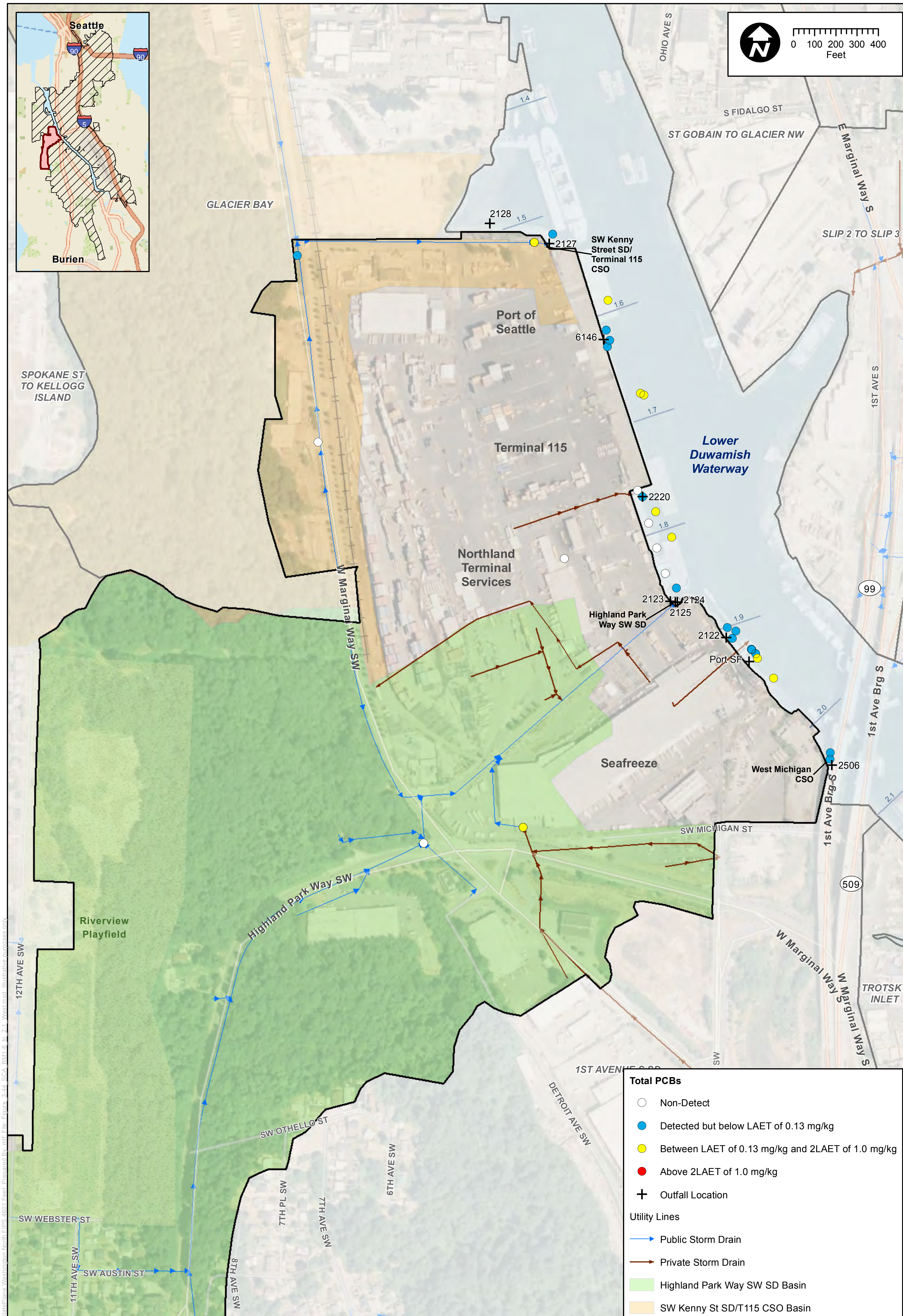

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Figure 3-50b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 1.6-2.1 West (Terminal 115)

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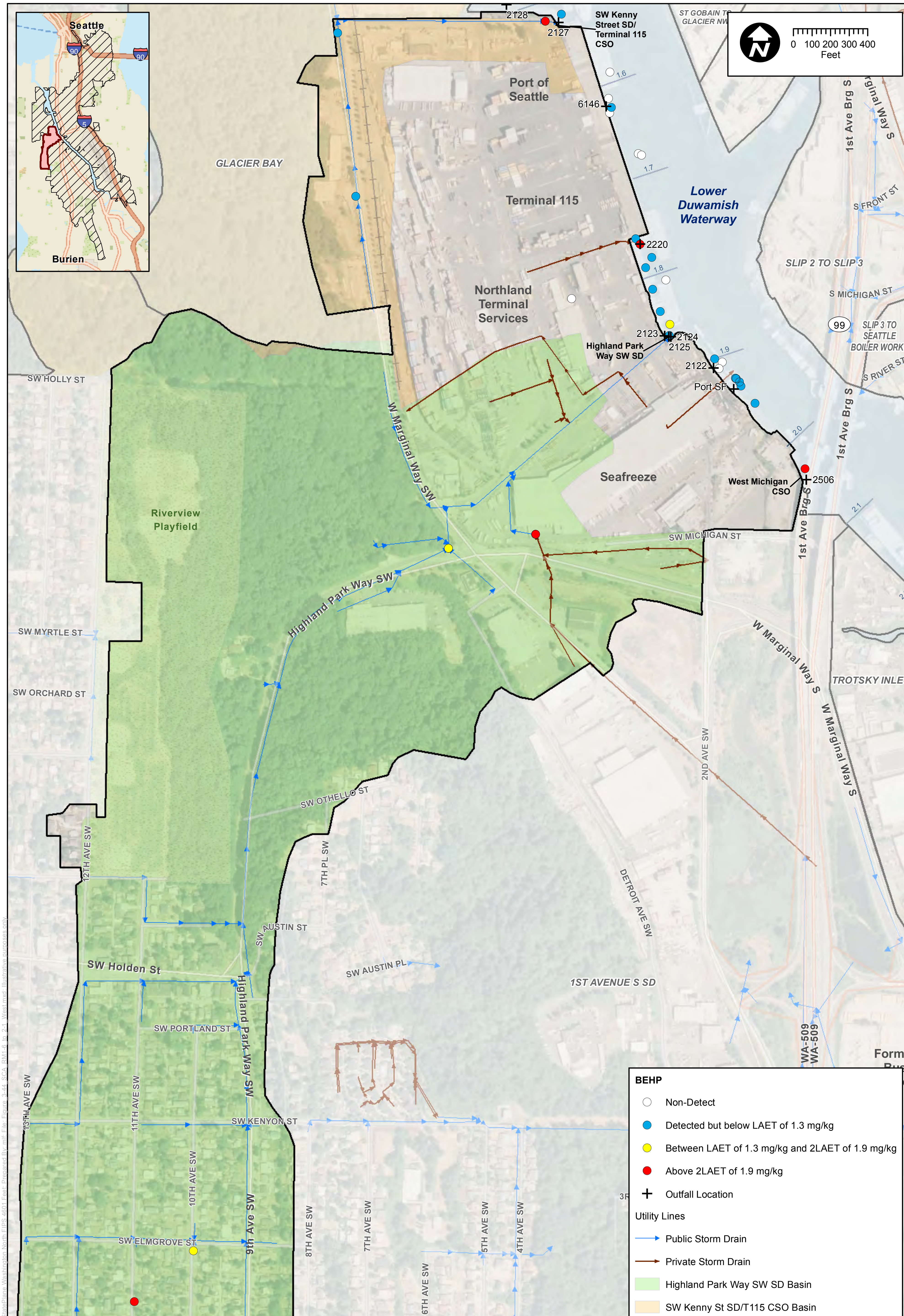

Figure 3-50c. BEHP Concentrations in Sediment and Storm Drain Samples near RM 1.6-2.1 West (Terminal 115)

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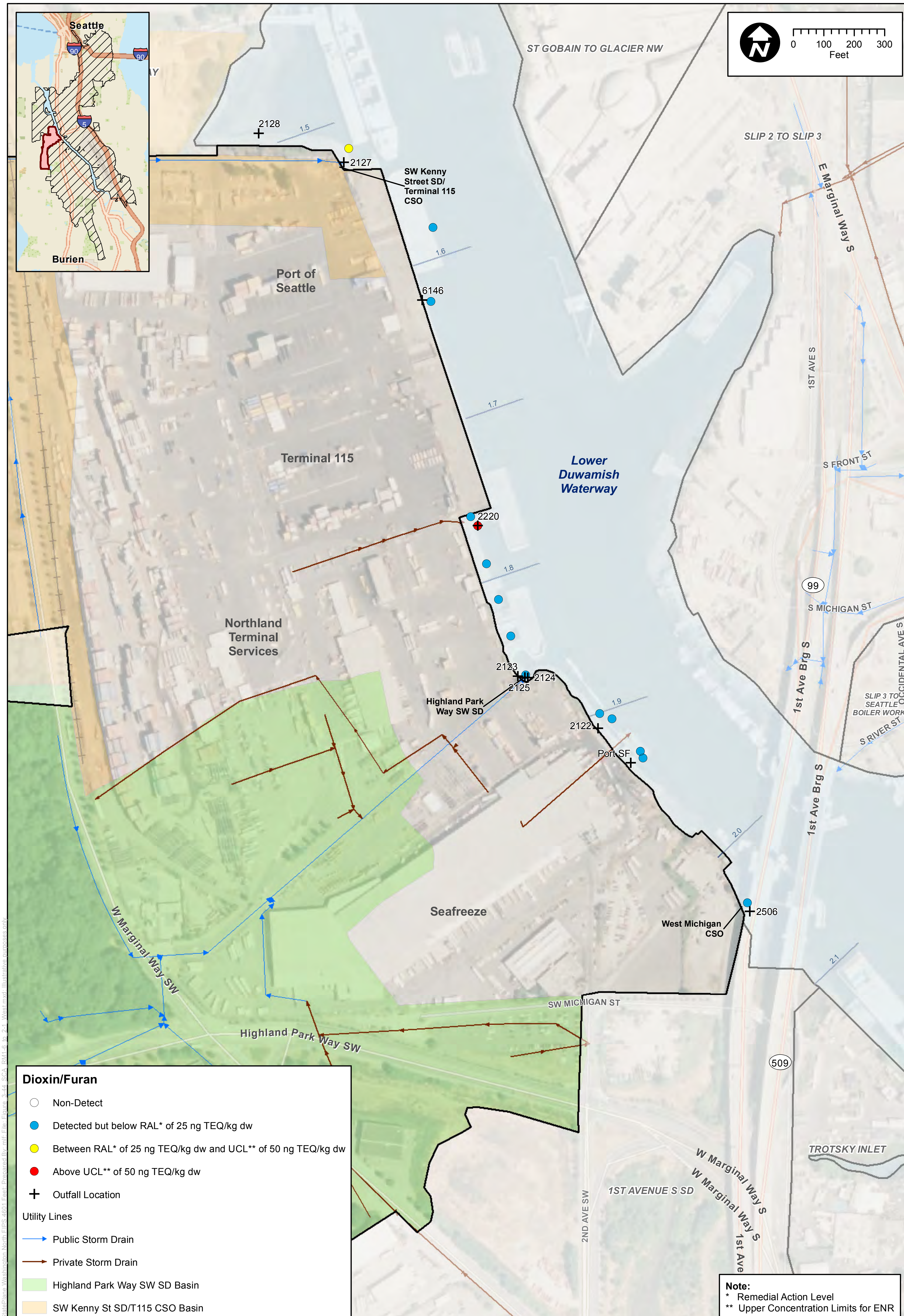


Dioxin/Furan

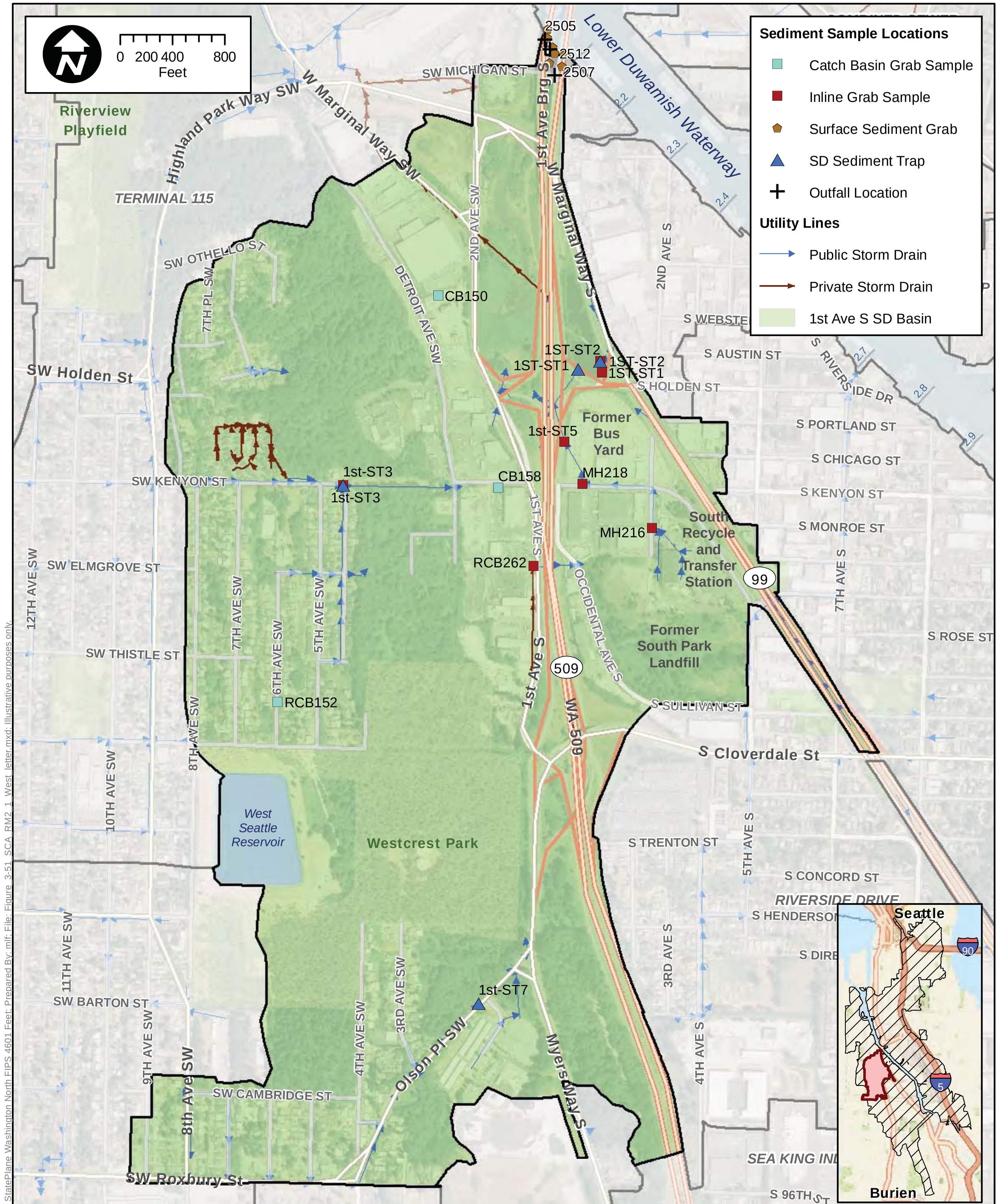
- Non-Detect
- Detected but below RAL* of 25 ng TEQ/kg dw
- Between RAL* of 25 ng TEQ/kg dw and UCL** of 50 ng TEQ/kg dw
- Above UCL** of 50 ng TEQ/kg dw
- Outfall Location

Utility Lines

- Public Storm Drain
- Private Storm Drain
- Highland Park Way SW SD Basin
- SW Kenny St SD/T115 CSO Basin

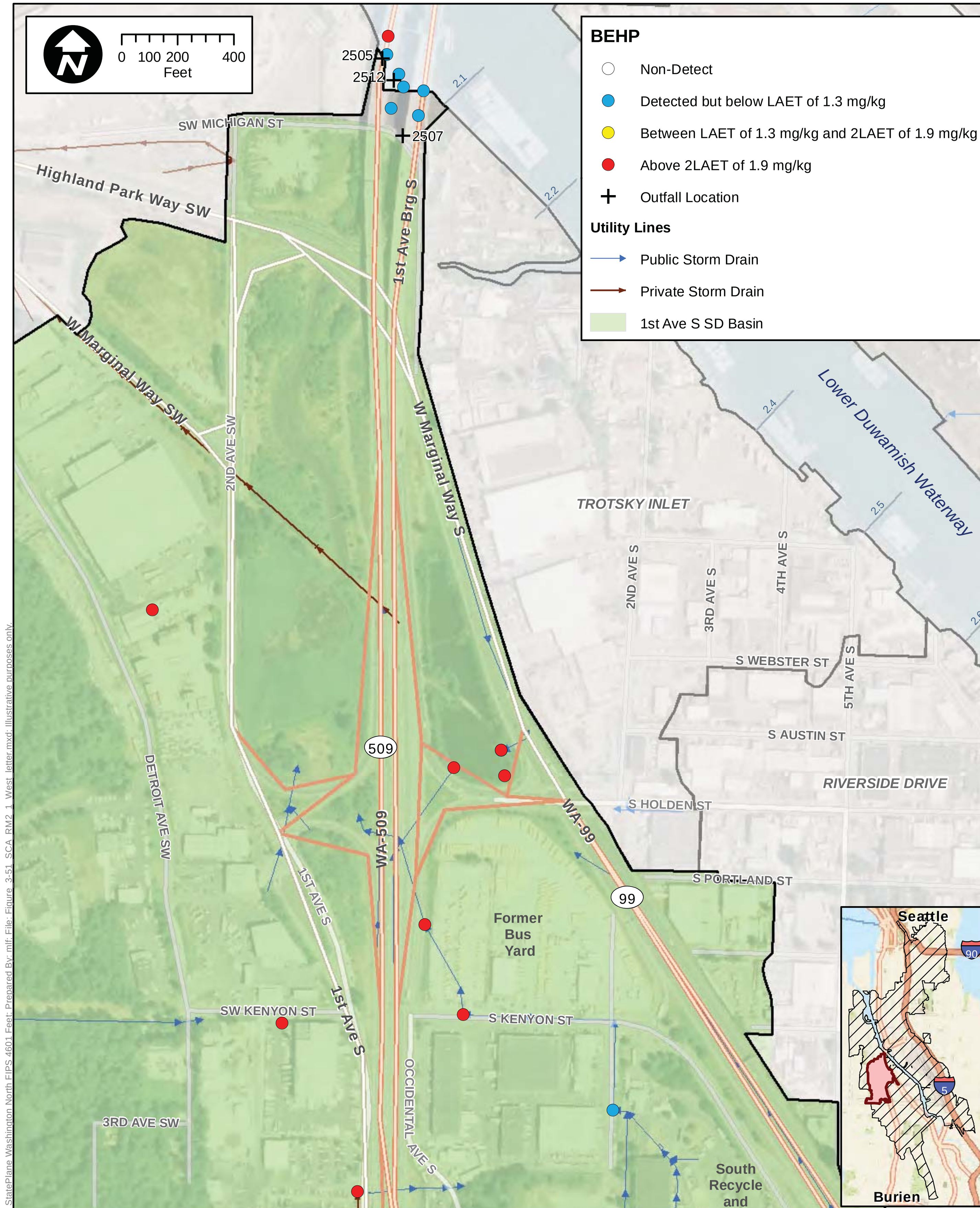
Note:
* Remedial Action Level
** Upper Concentration Limits for ENR

Figure 3-50d. Dioxin/Furan Concentrations in Sediment and Storm Drain Samples near RM 1.6-2.1 West (Terminal 115)



Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-51_SCA_RM2_1_West_letter.mxd; Illustrative purposes only.

Figure 3-51a. Sediment and Storm Drain Sample Locations near RM 2.1 West (1st Avenue S SD)



Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-51_SCA_RM2_1_West_letter.mxd; Illustrative purposes only.

Figure 3-51b. BEHP Concentrations in Sediment and Storm Drain Samples near RM 2.1 West (1st Avenue S SD)

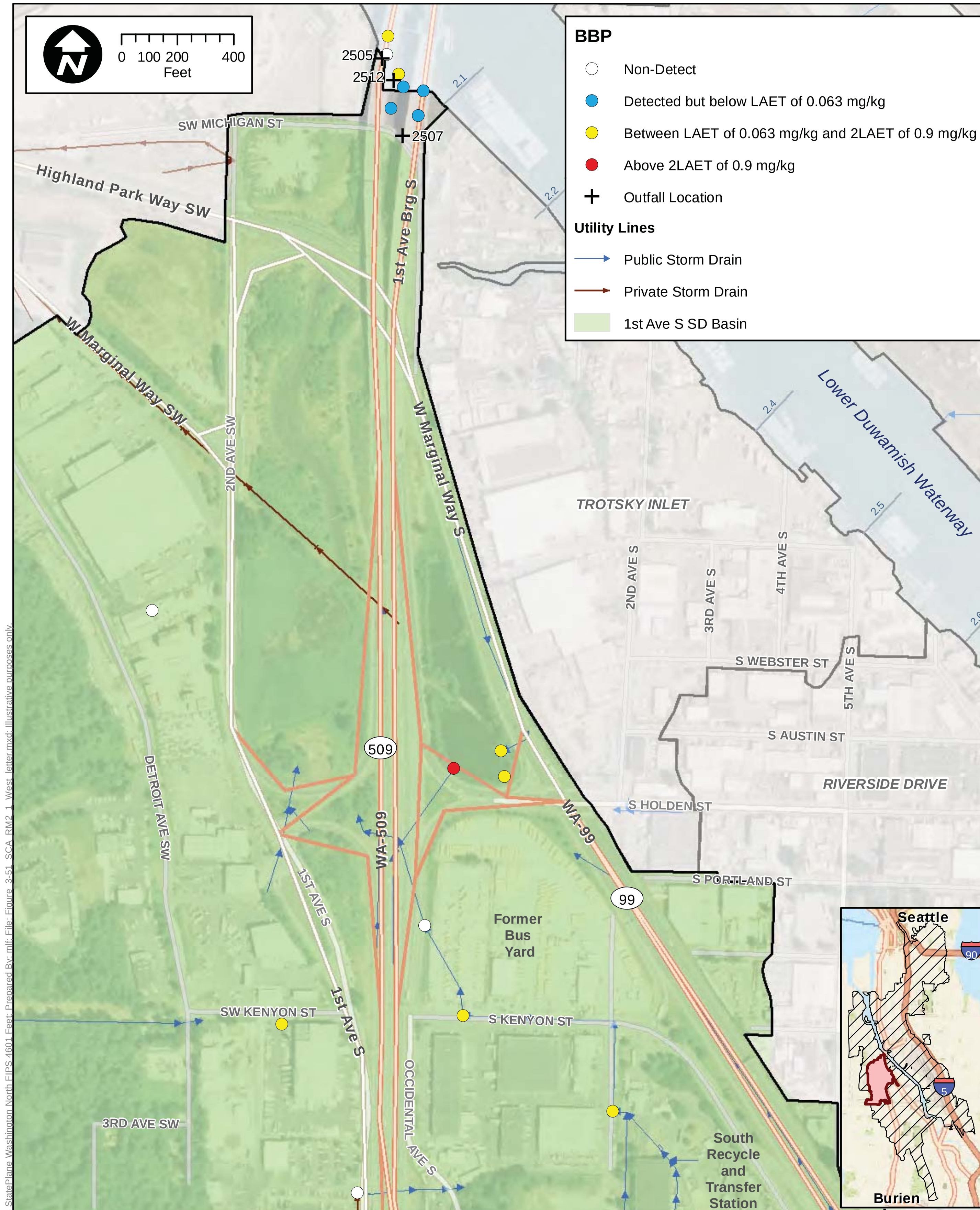


Figure 3-51c. BBP Concentrations in Sediment and Storm Drain Samples near RM 2.1 West (1st Avenue S SD)

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Prepared By: mlf; File: Figure_3-51_SCA_RM2_1_West_letter.mxd; Illustrative purposes only.

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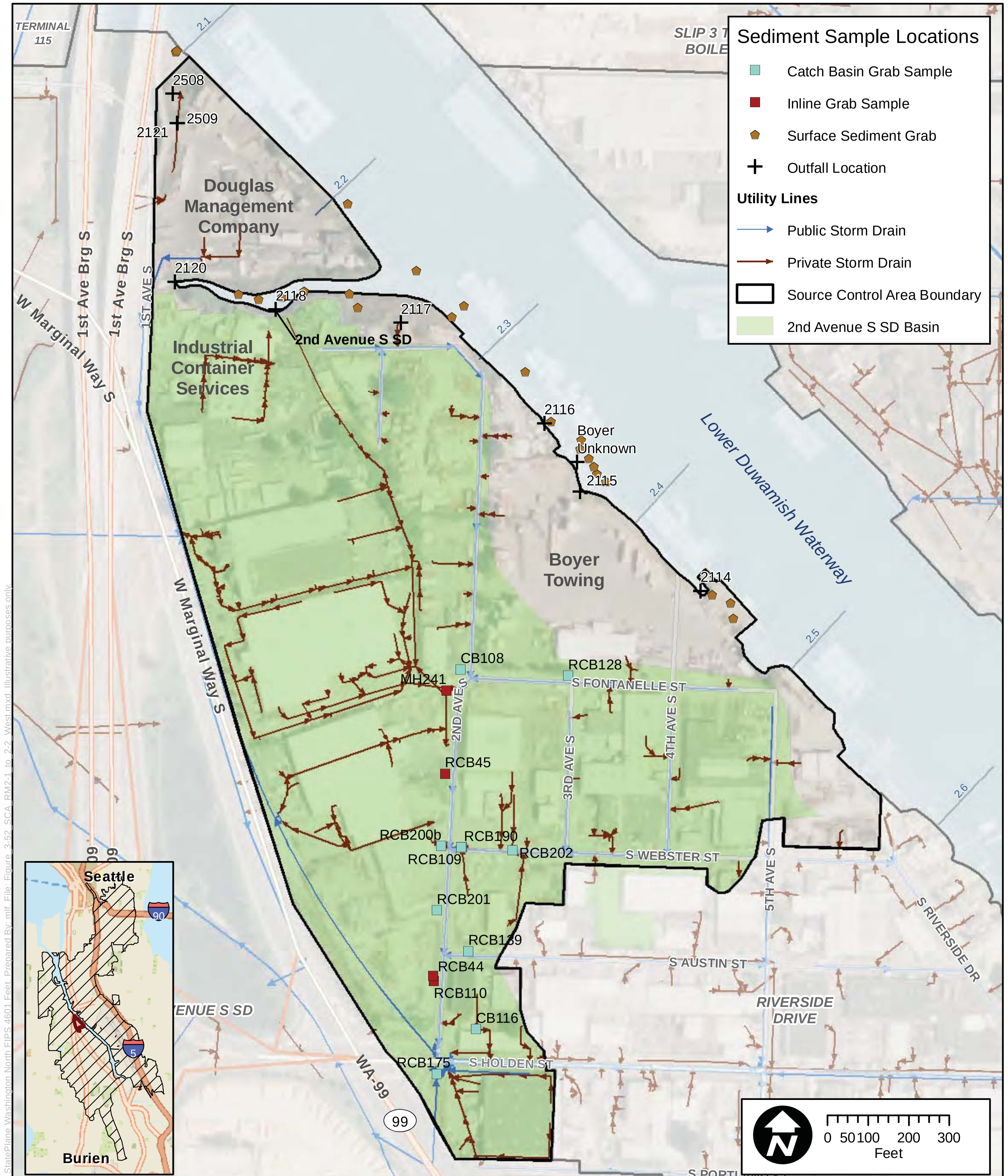

Figure 3-52a. Sediment and Storm Drain Sample Locations near RM 2.1-2.2 West (Trotsky Inlet)

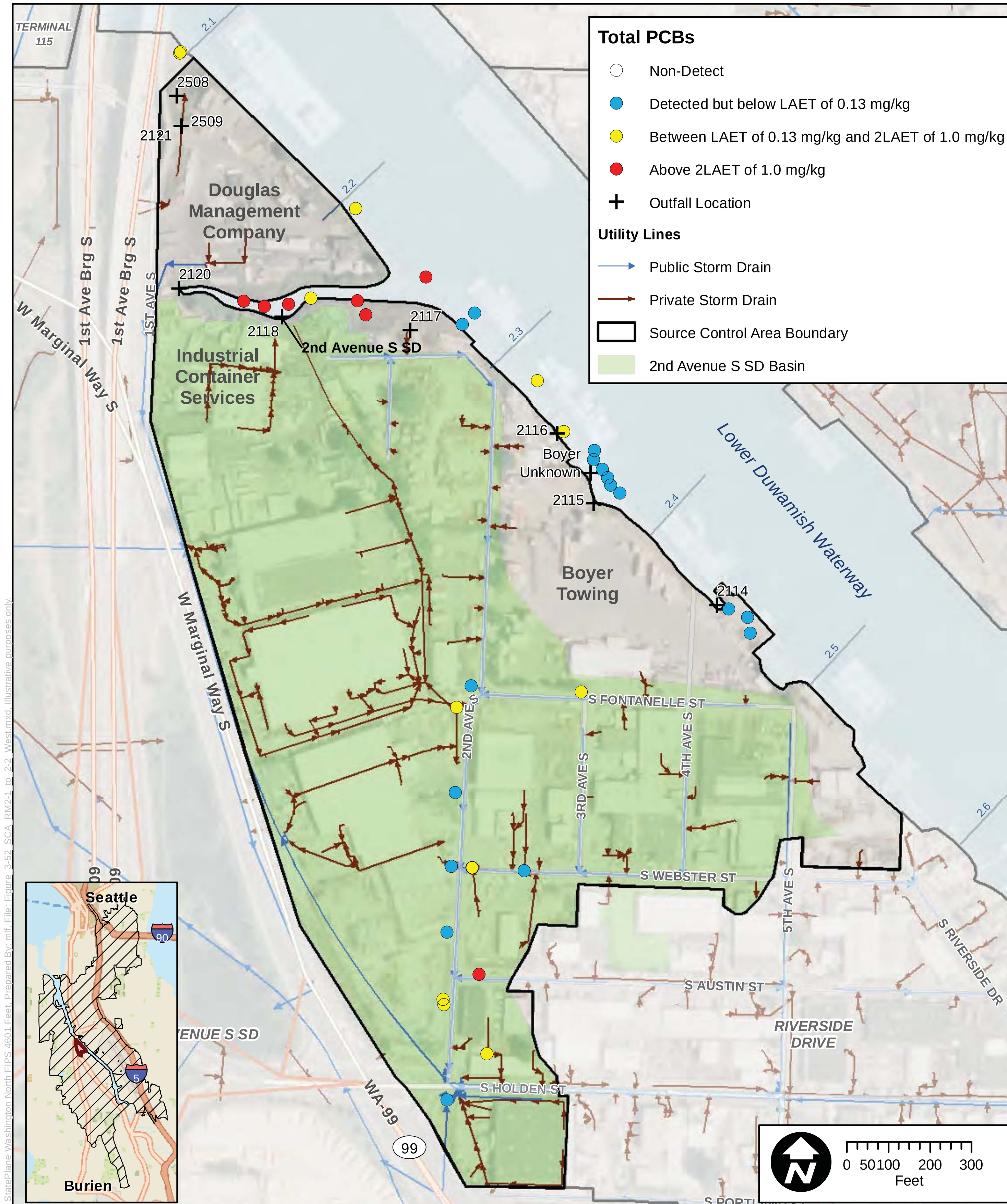

Figure 3-52b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.1-2.2 West (Trotsky Inlet)

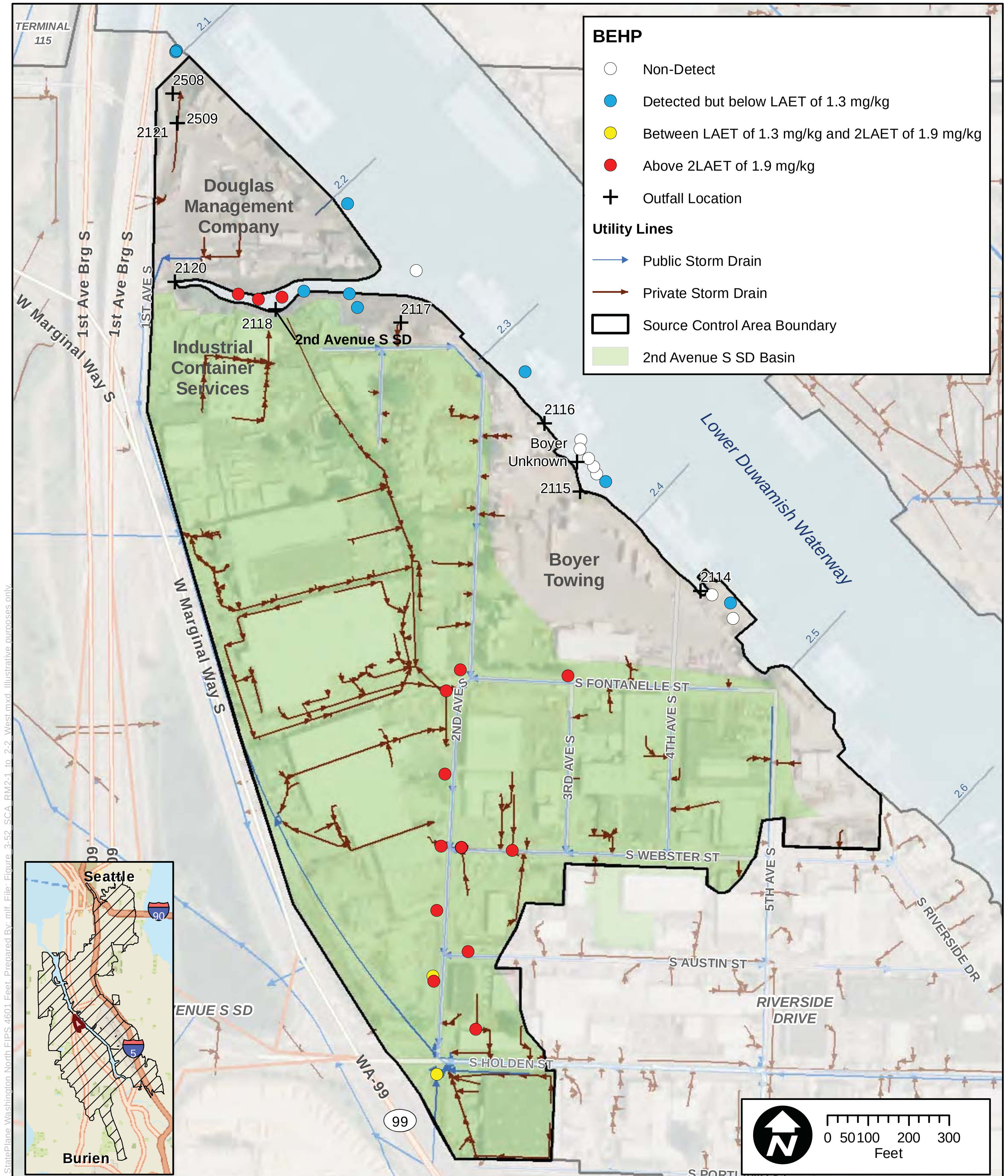

Figure 3-52c. BEHP Concentrations in Sediment and Storm Drain Samples near RM 2.1-2.2 West (Trotsky Inlet)

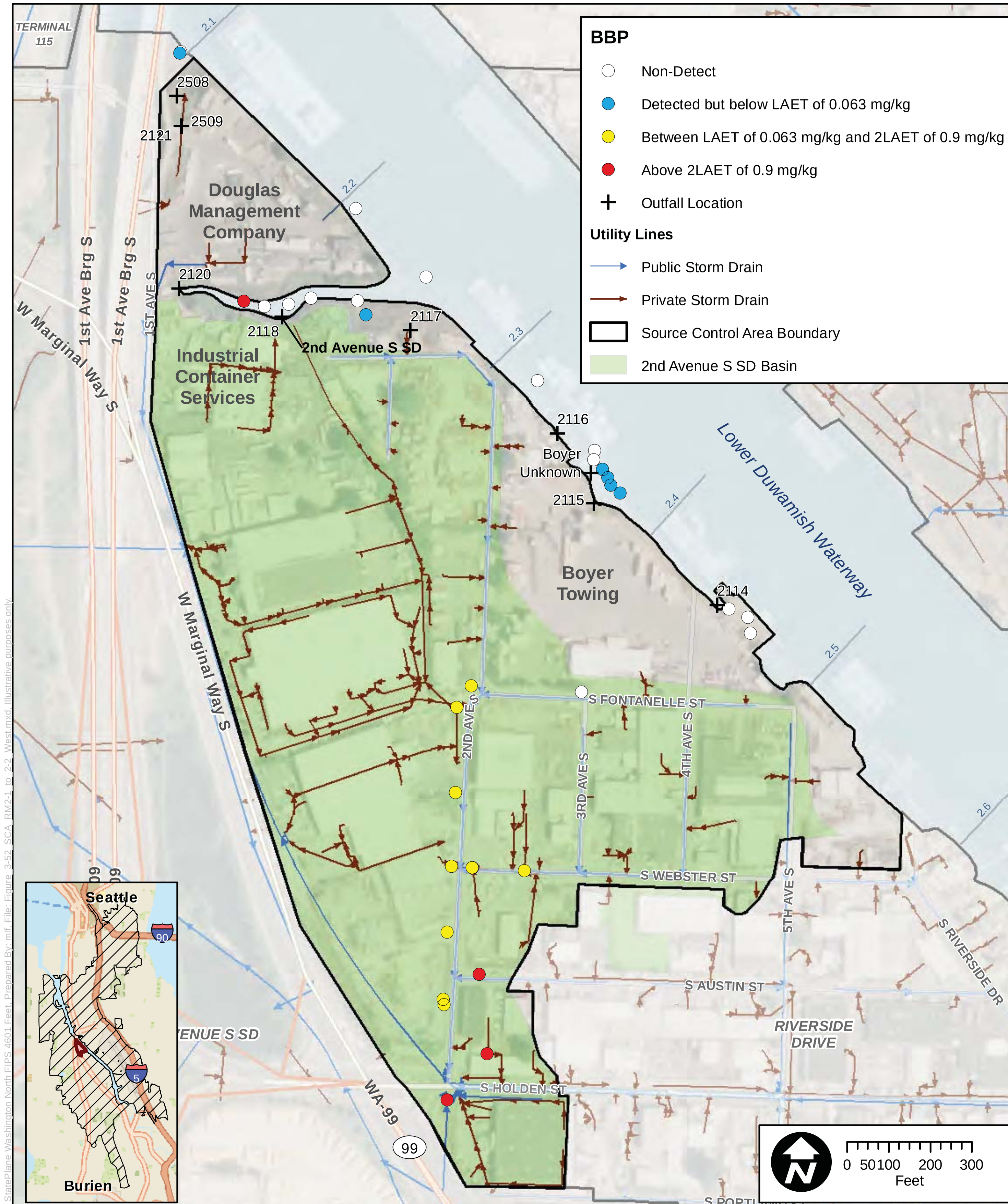

Figure 3-52d. BBP Concentrations in Sediment and Storm Drain Samples near RM 2.1-2.2 West (Trotsky Inlet)

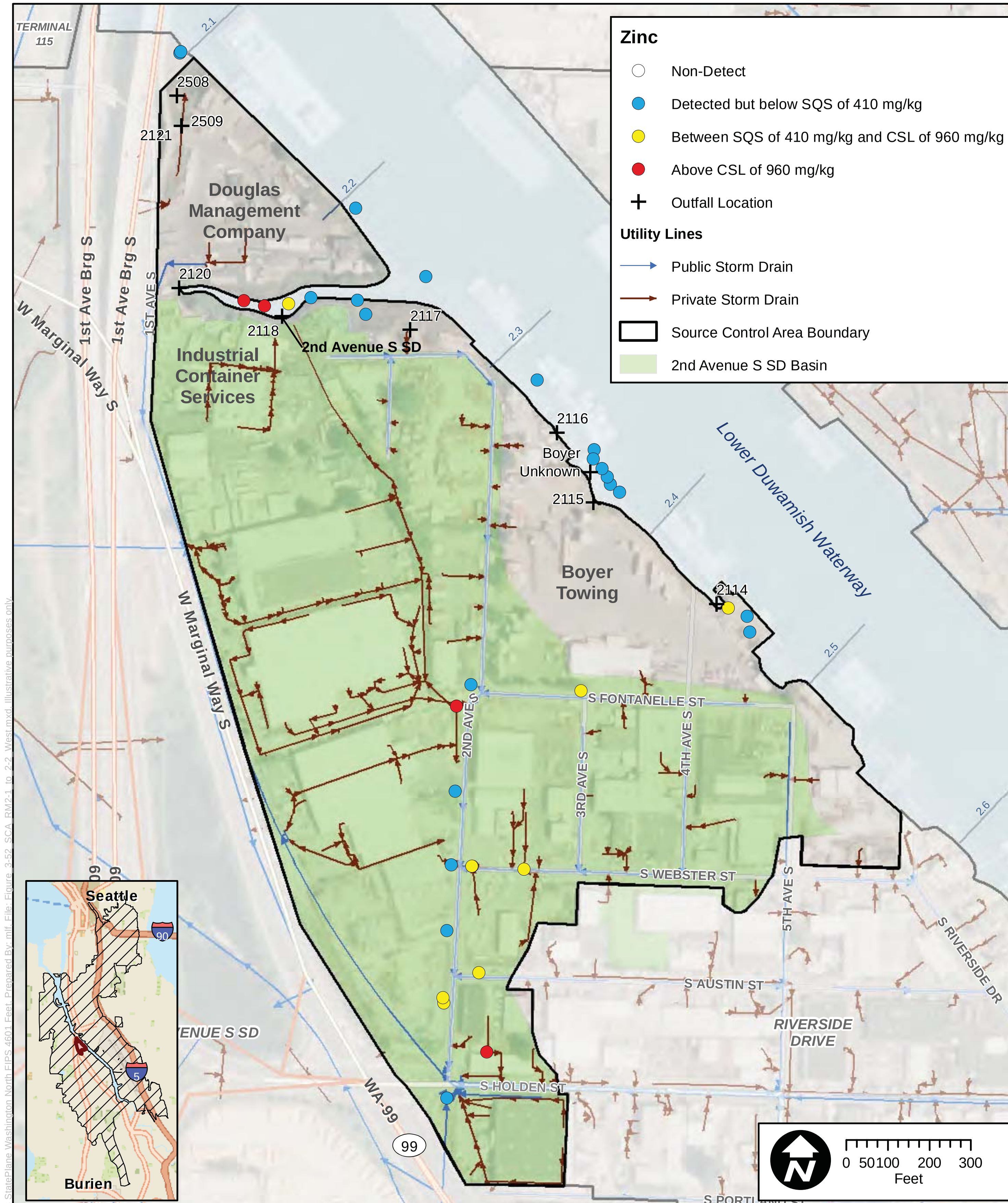

Figure 3-52e. Zinc Concentrations in Sediment and Storm Drain Samples near RM 2.1-2.2 West (Trotsky Inlet)

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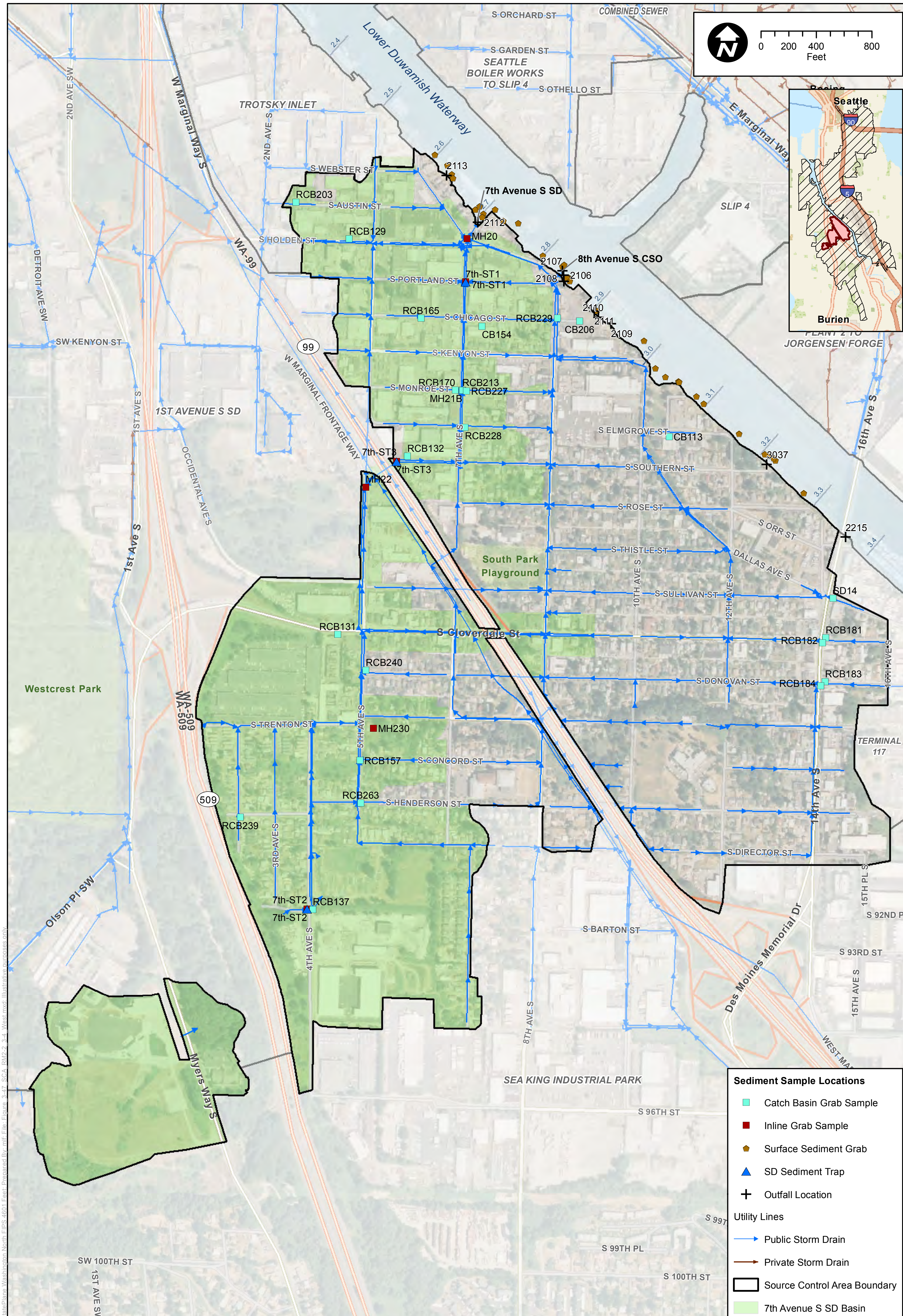

Figure 3-53a. Sediment and Storm Drain Sample Locations near RM 2.2-3.4 West (Riverside Drive)

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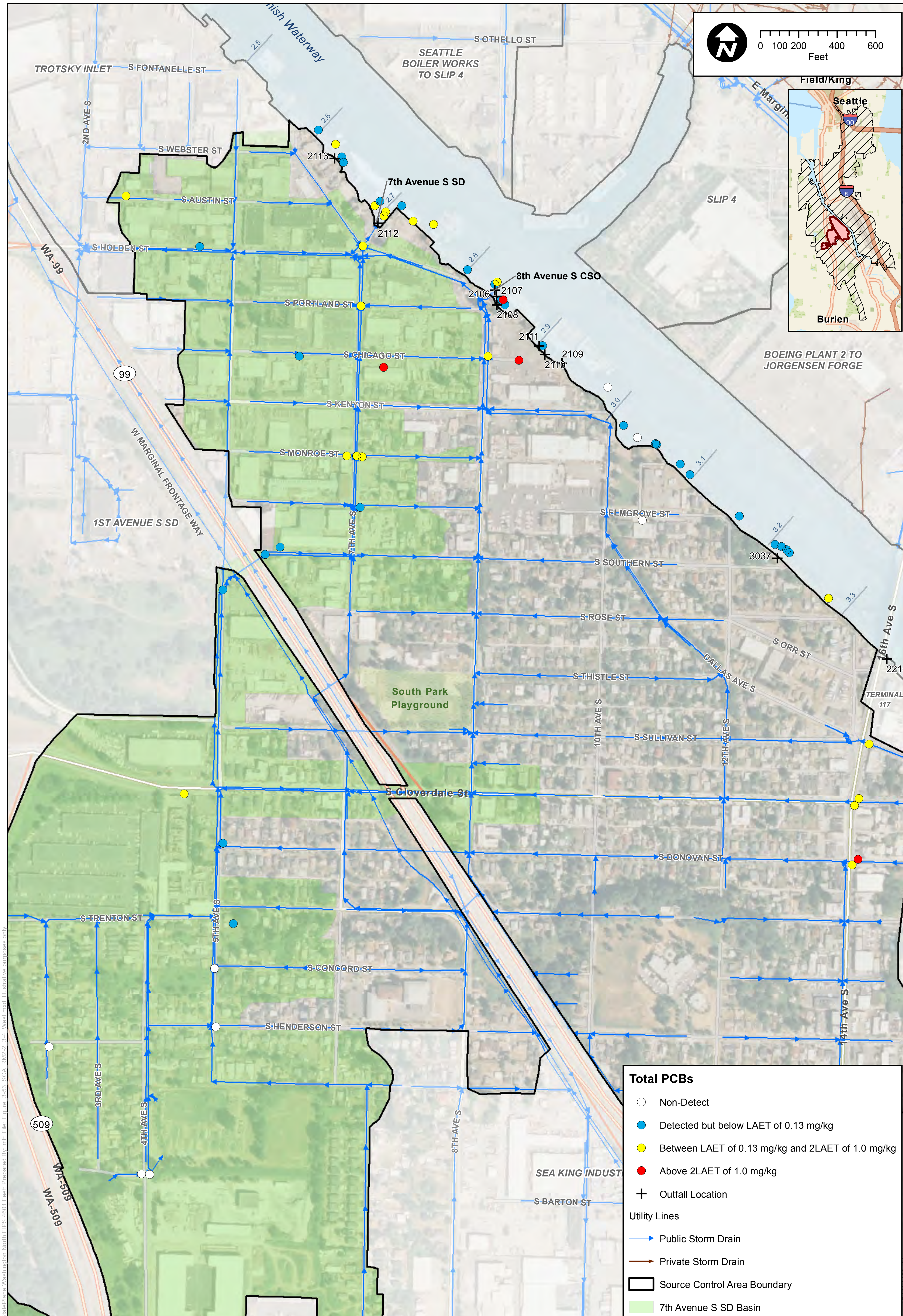

Figure 3-53b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 2.2-3.4 West (Riverside Drive)

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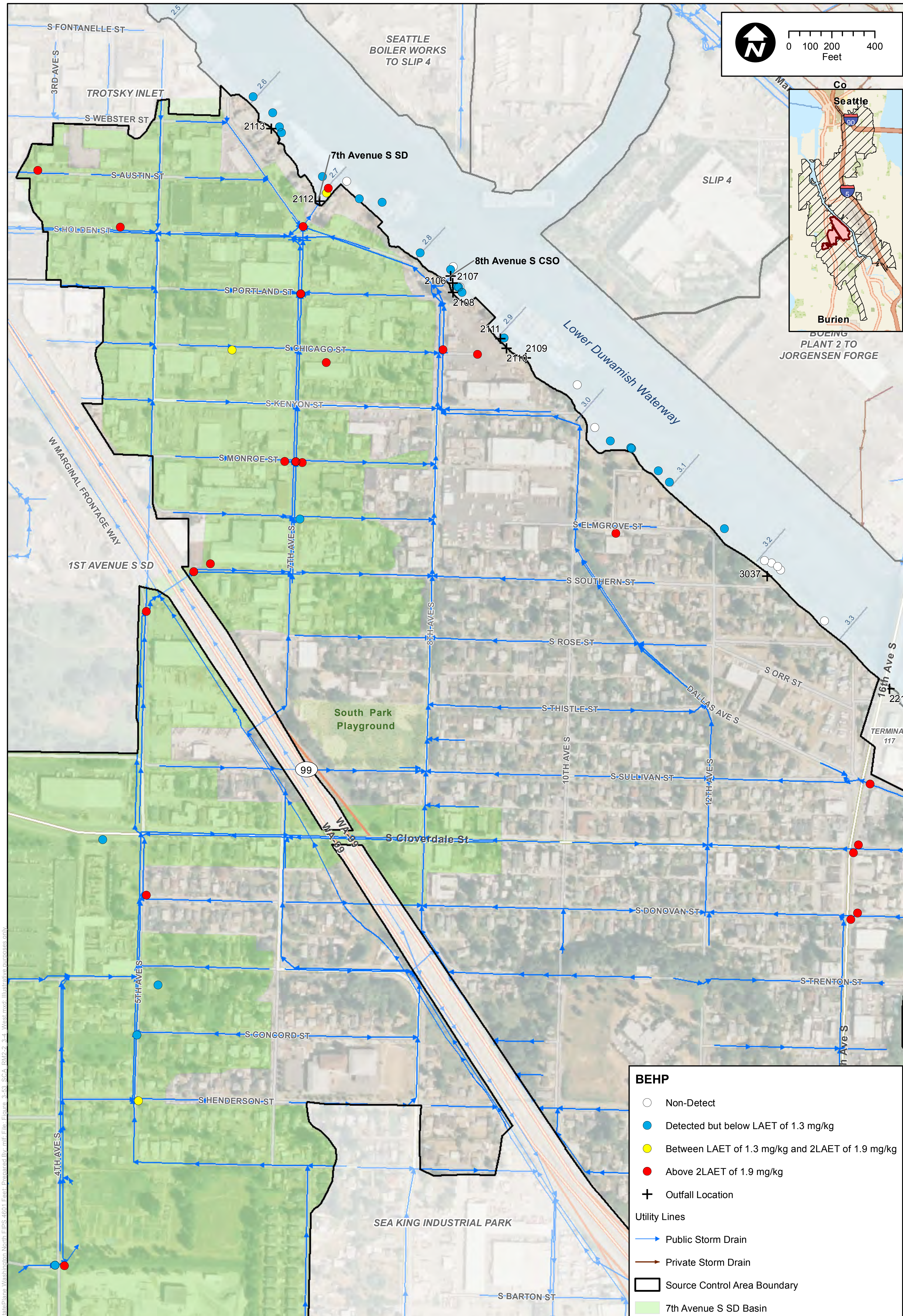

Figure 3-53c. BEHP Concentrations in Sediment and Storm Drain Samples near RM 2.2-3.4 West (Riverside Drive)

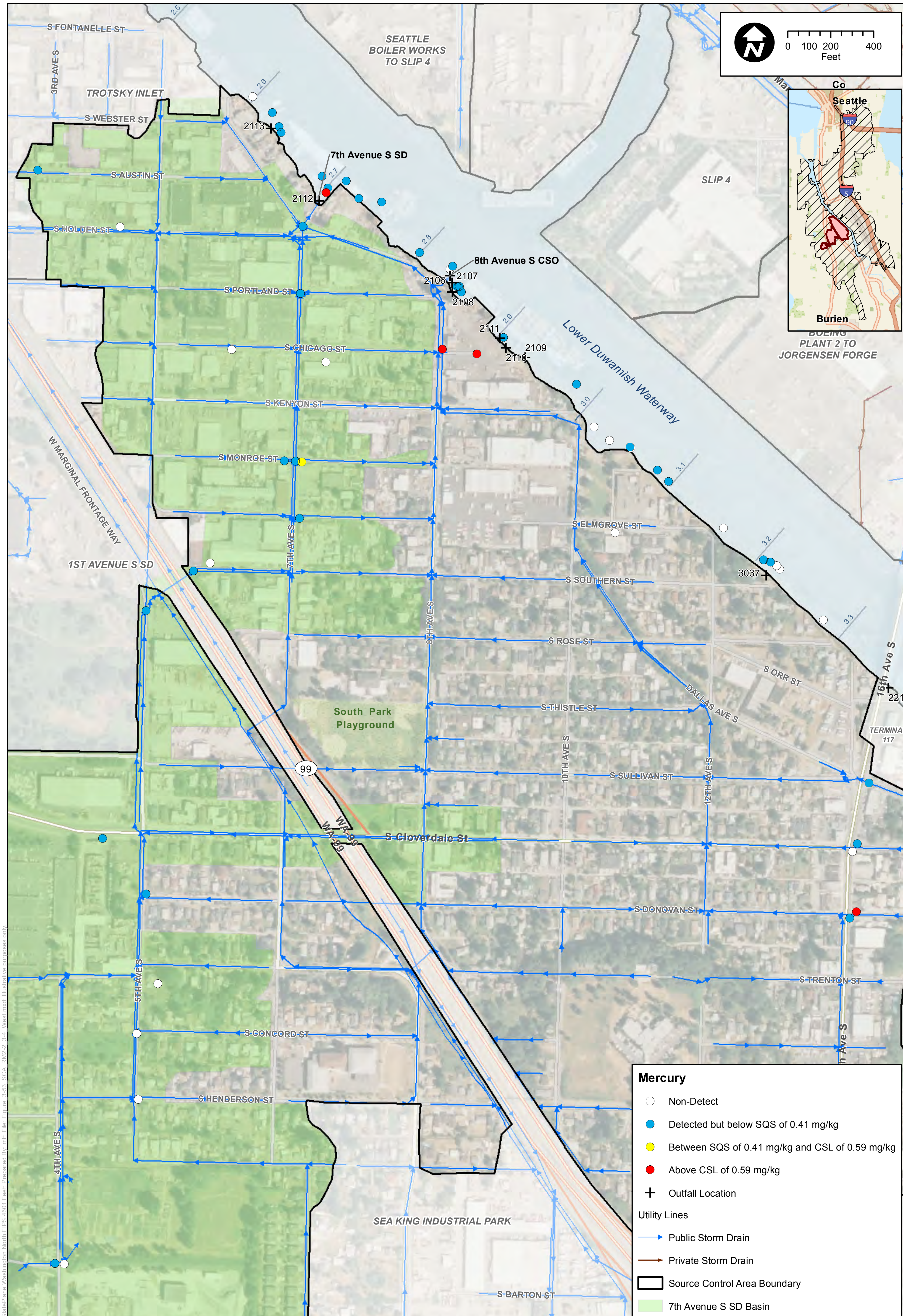

Figure 3-53d. Mercury Concentrations in Sediment and Storm Drain Samples near RM 2.2-3.4 West (Riverside Drive)

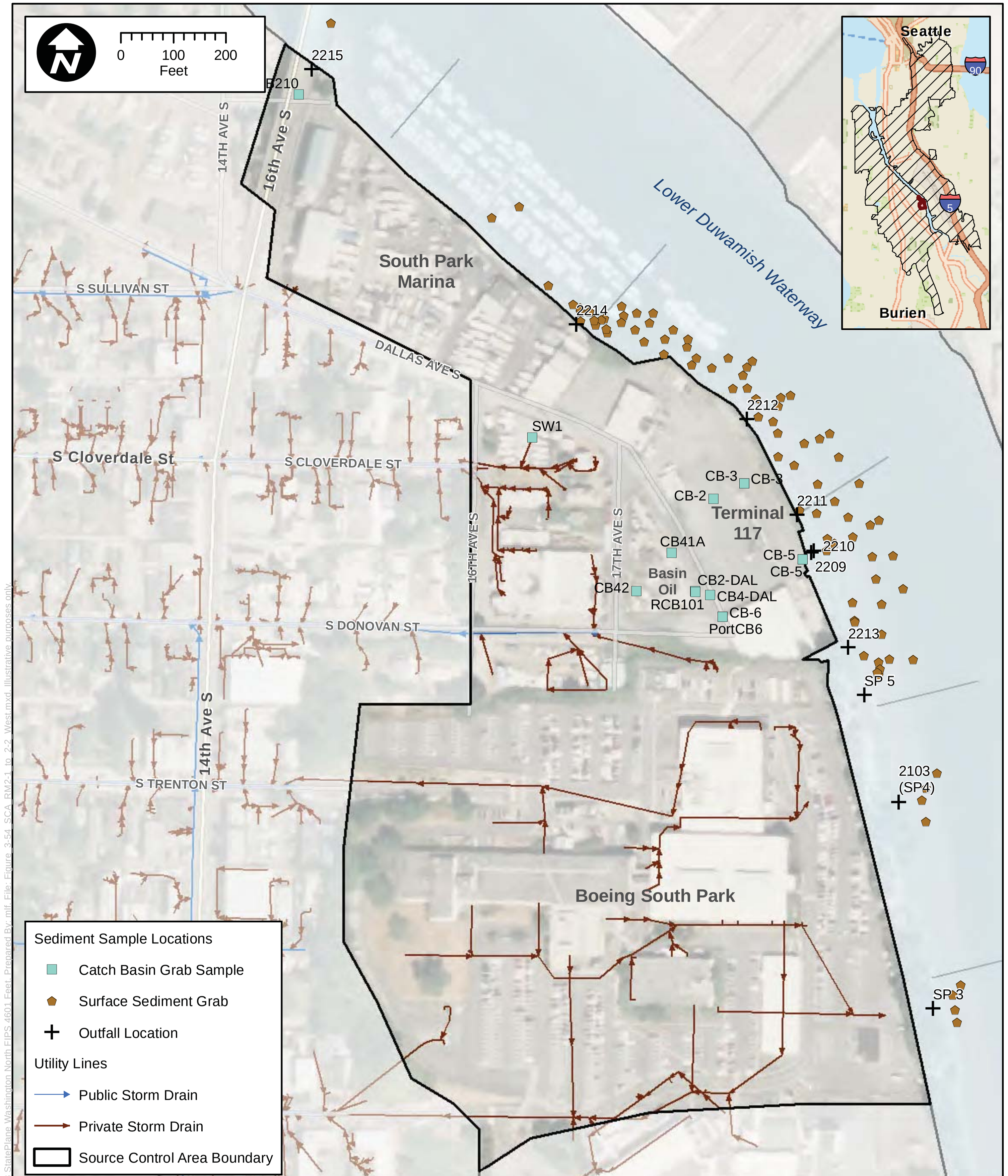

Figure 3-54a. Sediment and Storm Drain Sample Locations near RM 3.4-3.8 West (Terminal 117)

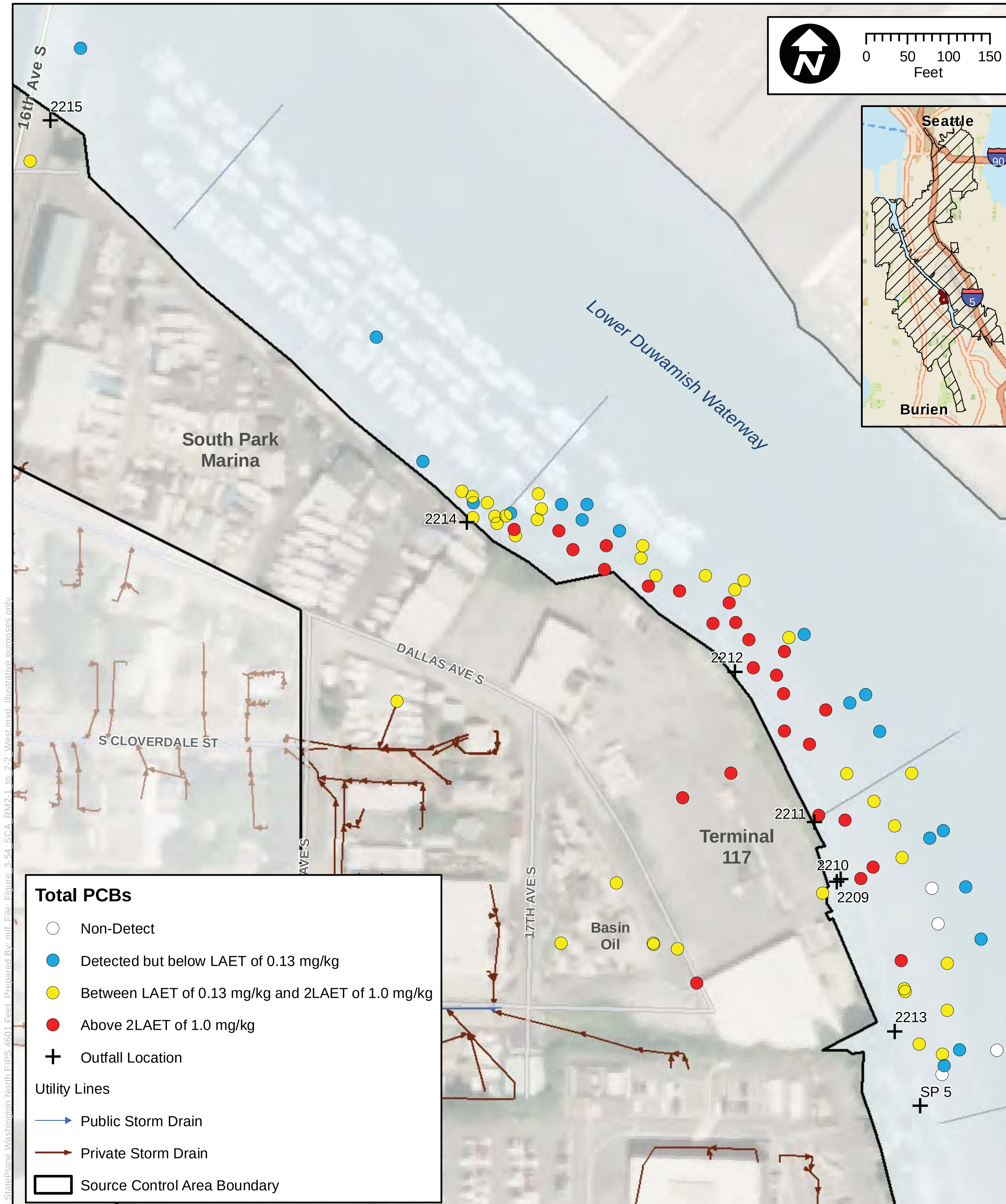

Figure 3-54b. Total PCB Concentrations in Sediment and Storm Drain Samples near RM 3.4-3.8 West (Terminal 117)

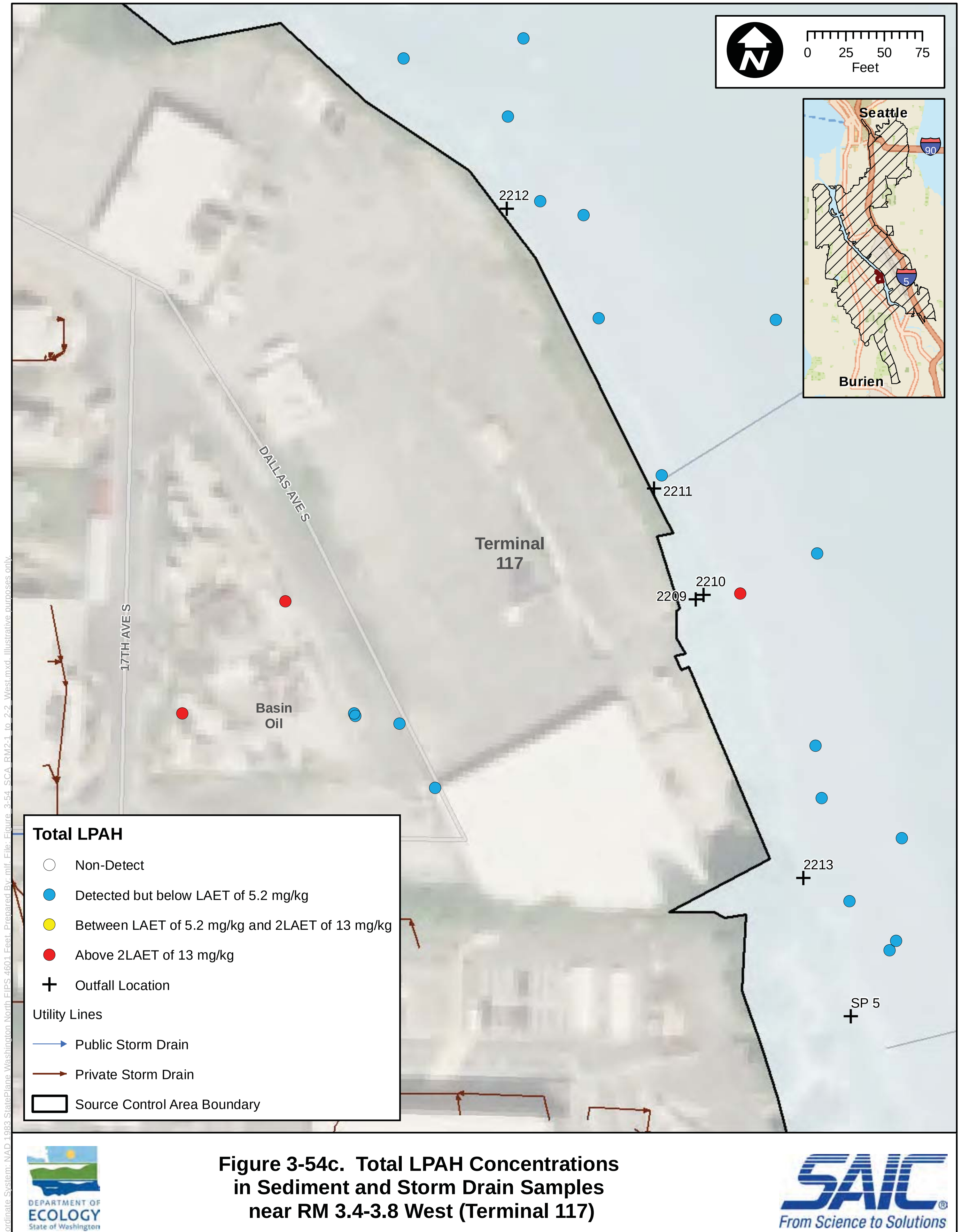

Figure 3-54c. Total LPAH Concentrations in Sediment and Storm Drain Samples near RM 3.4-3.8 West (Terminal 117)

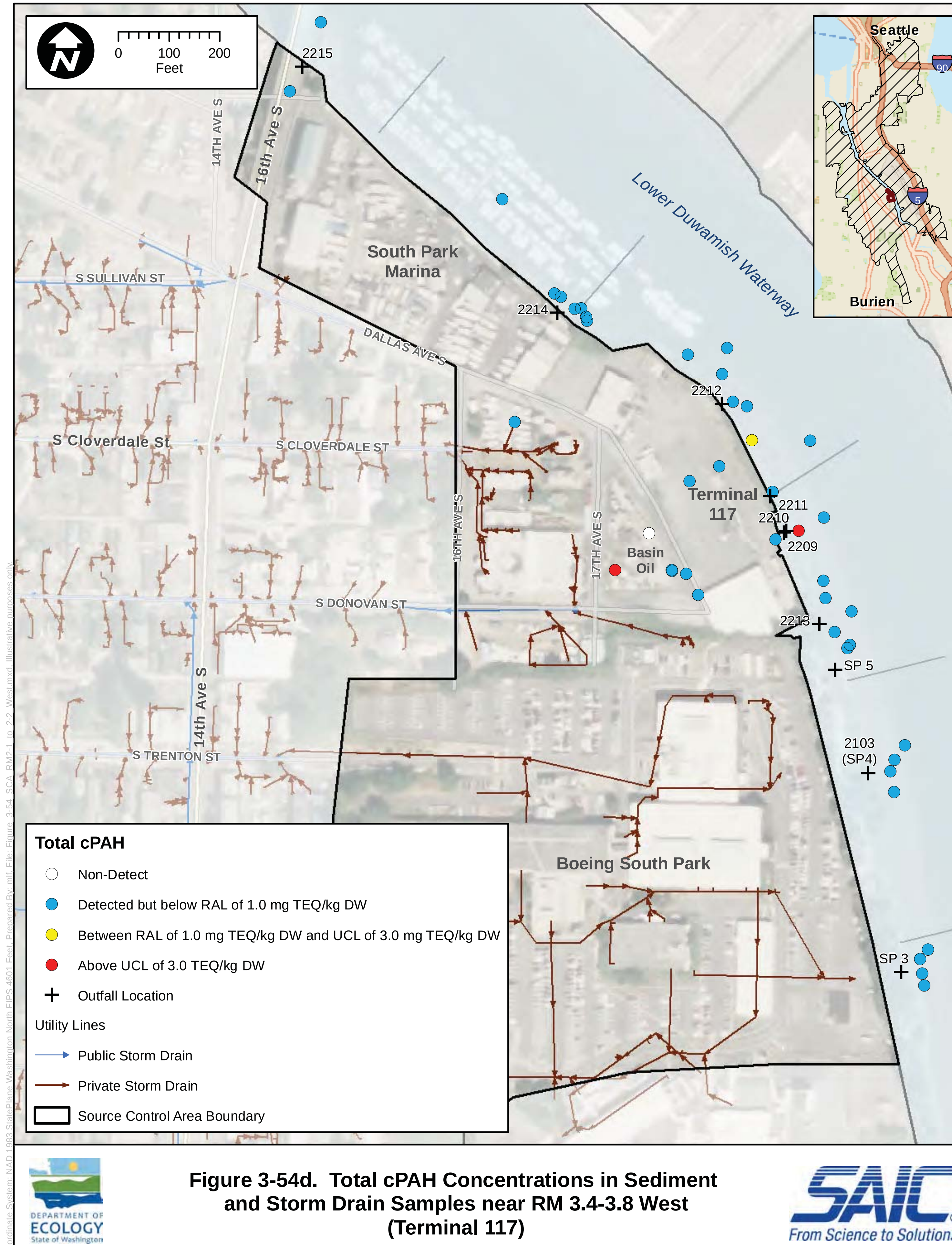

Figure 3-54d. Total cPAH Concentrations in Sediment and Storm Drain Samples near RM 3.4-3.8 West (Terminal 117)

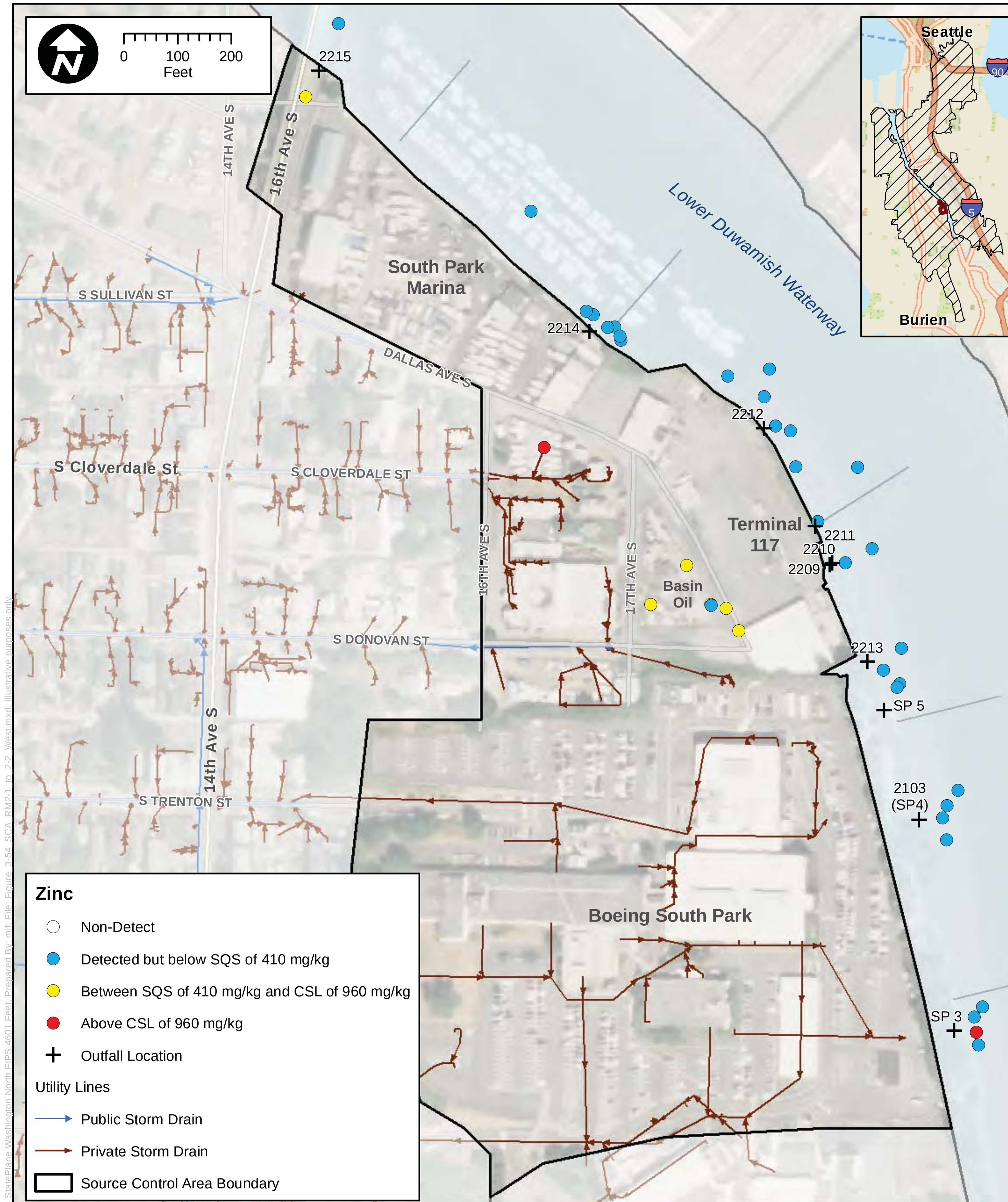

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Figure 3-54e. Zinc Concentrations in Sediment and Storm Drain Samples near RM 3.4-3.8 West (Terminal 117)

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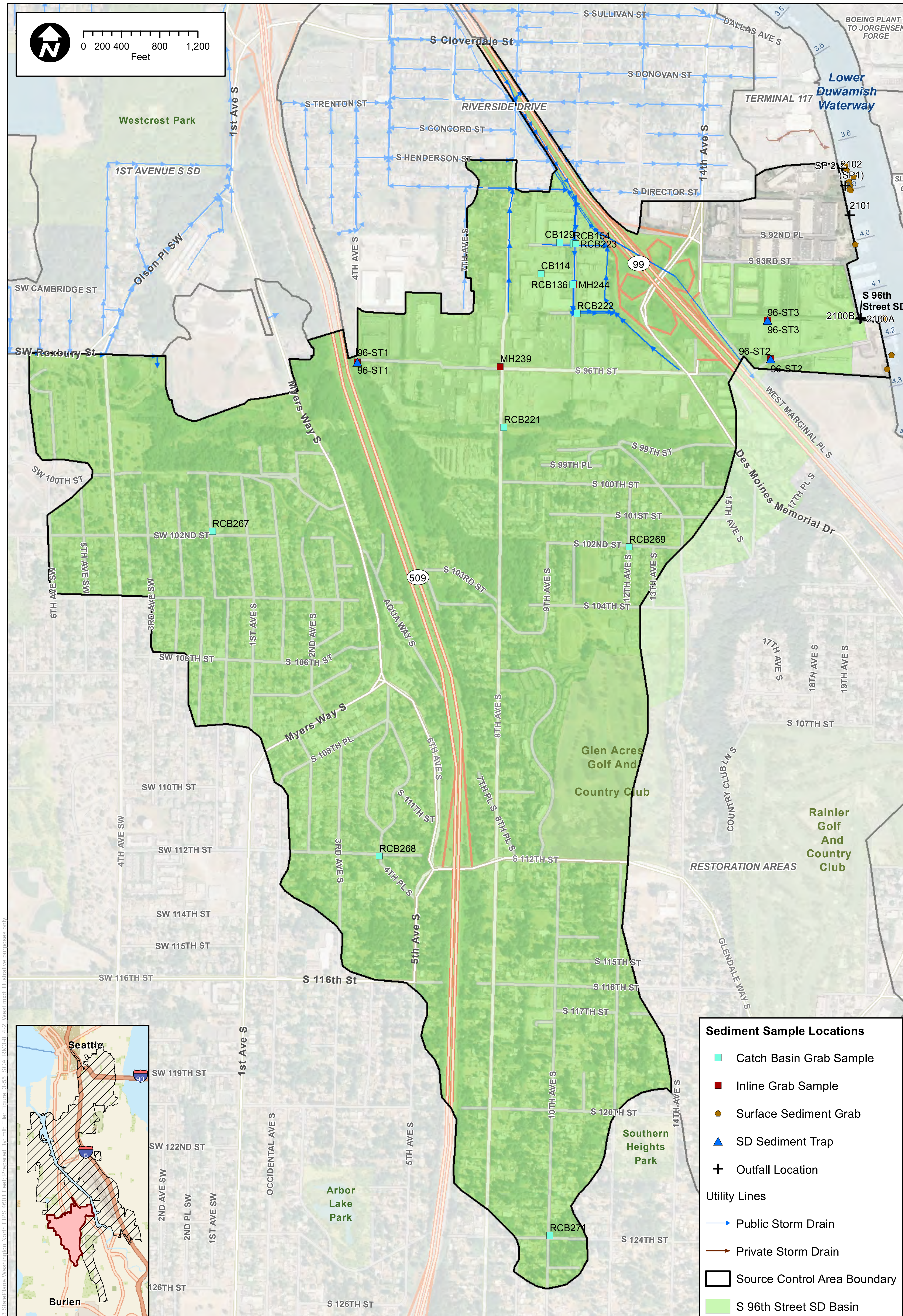

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Figure 3-55. Sediment and Storm Drain Sample Locations near RM 3.8-4.2 West (Sea King Industrial Park)

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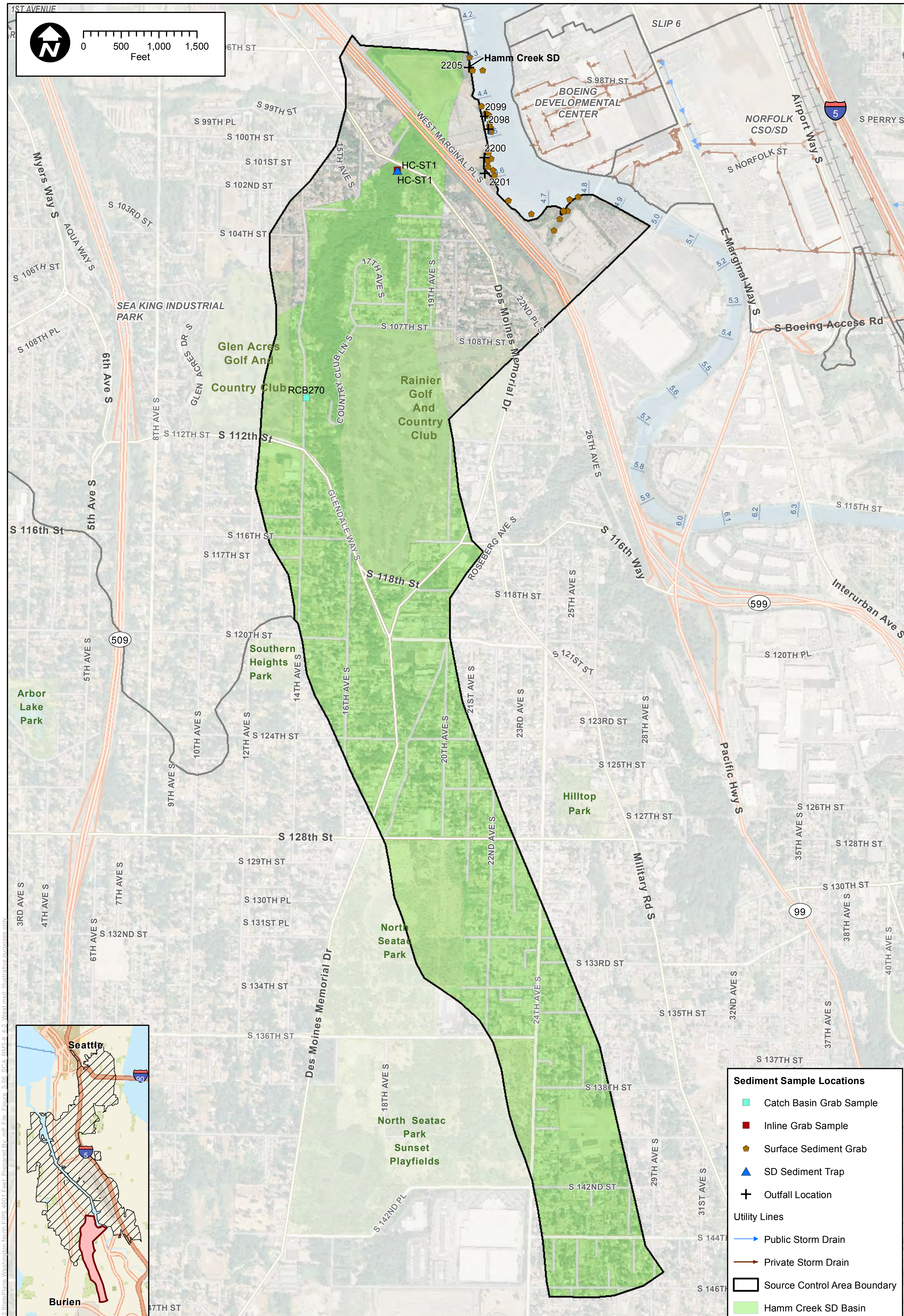

Figure 3-56. Sediment and Storm Drain Sample Locations near RM 4.2-4.8 West (Restoration Areas)

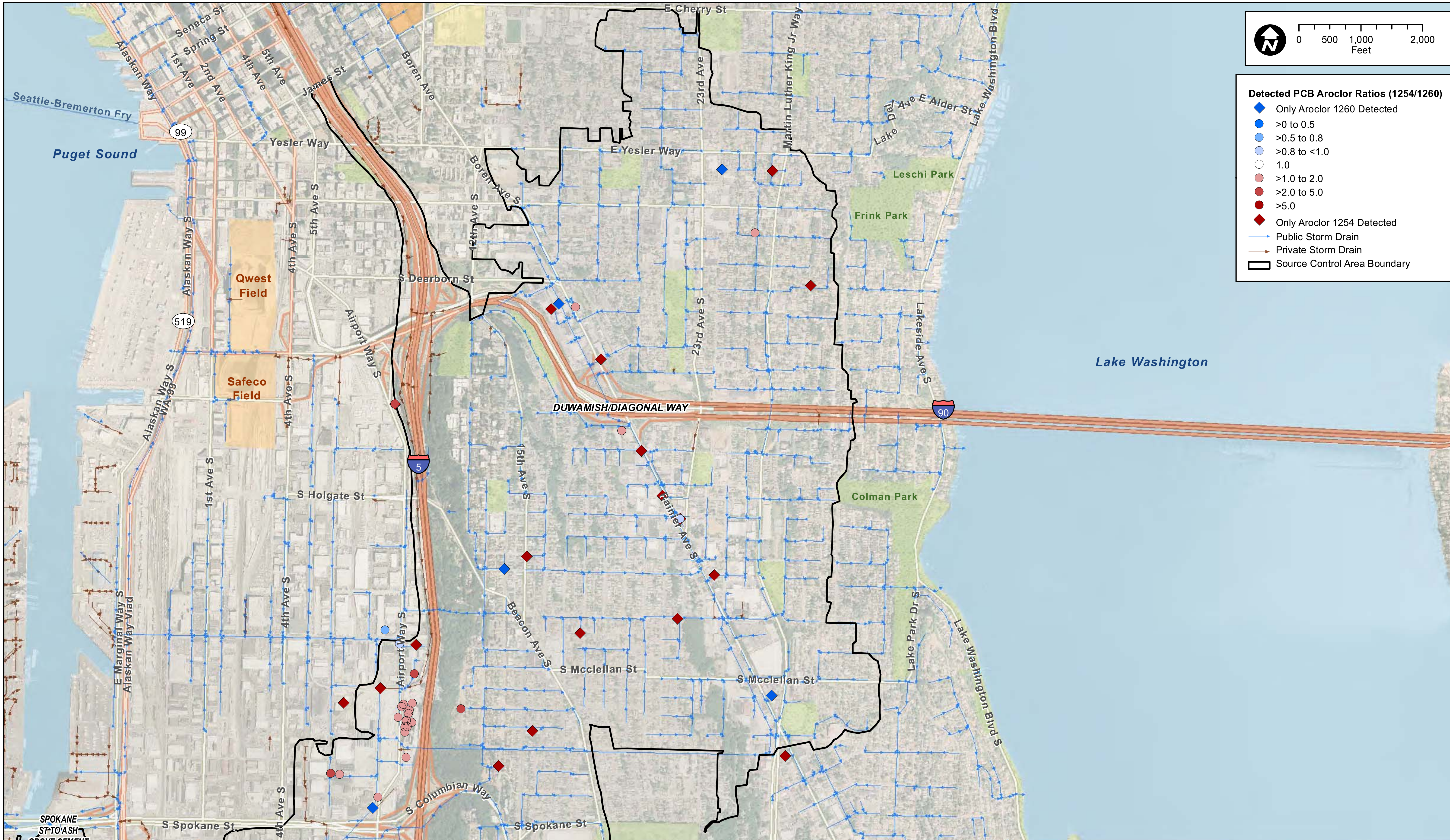

Figure 4-1a. Spatial Distribution of PCB Aroclor Ratios (1254/1260)

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Coordinate System:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet
Prepared By: mlf
File: Figure_4-1_PCB_Aroclor_Ratios.mxd
Illustrative purposes only.

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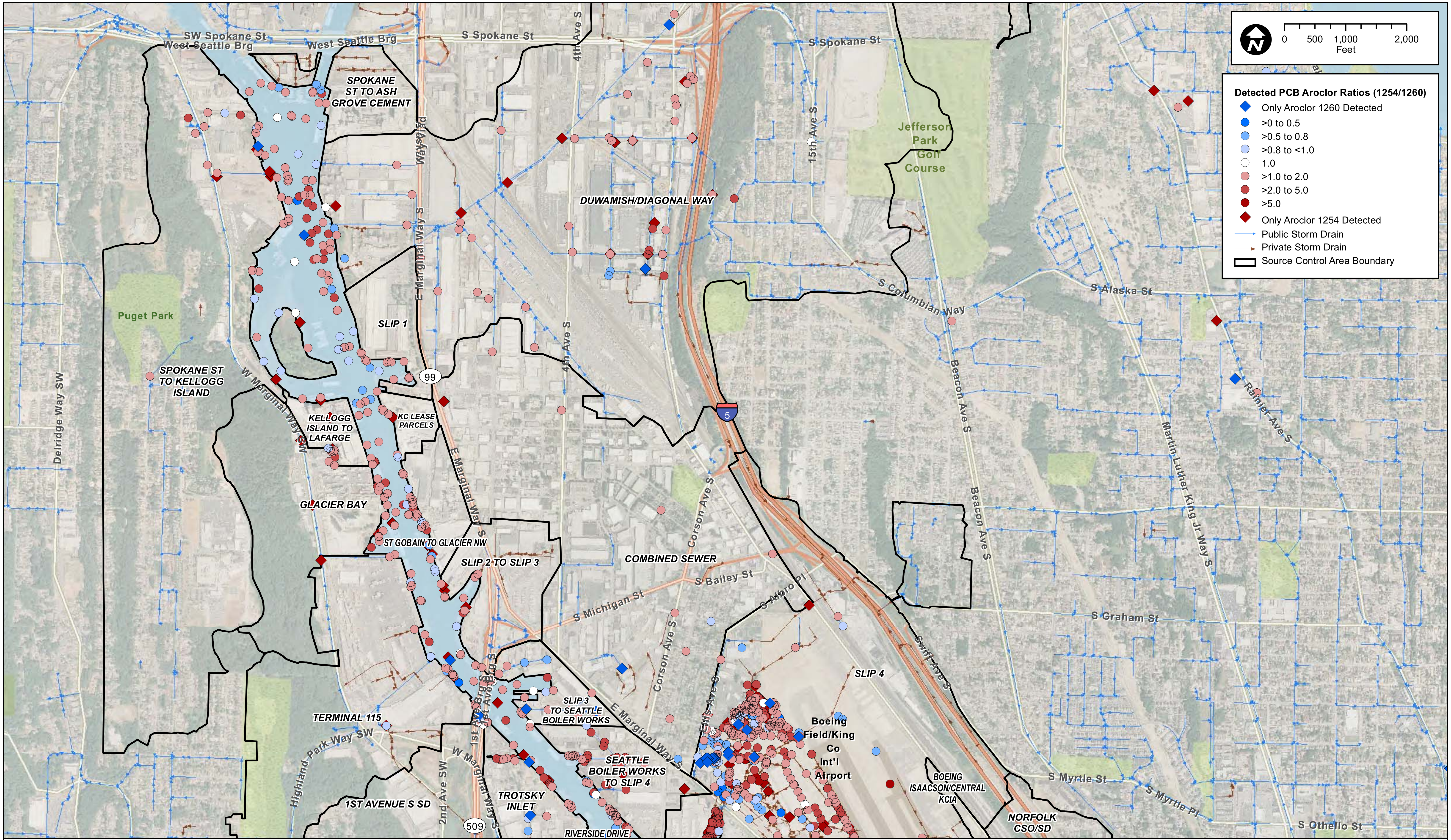

Figure 4-1b. Spatial Distribution of PCB Aroclor Ratios (1254/1260)

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Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mif
File: Figure_4-1_PCB_Aroclor_Ratios.mxd
Illustrative purposes only.

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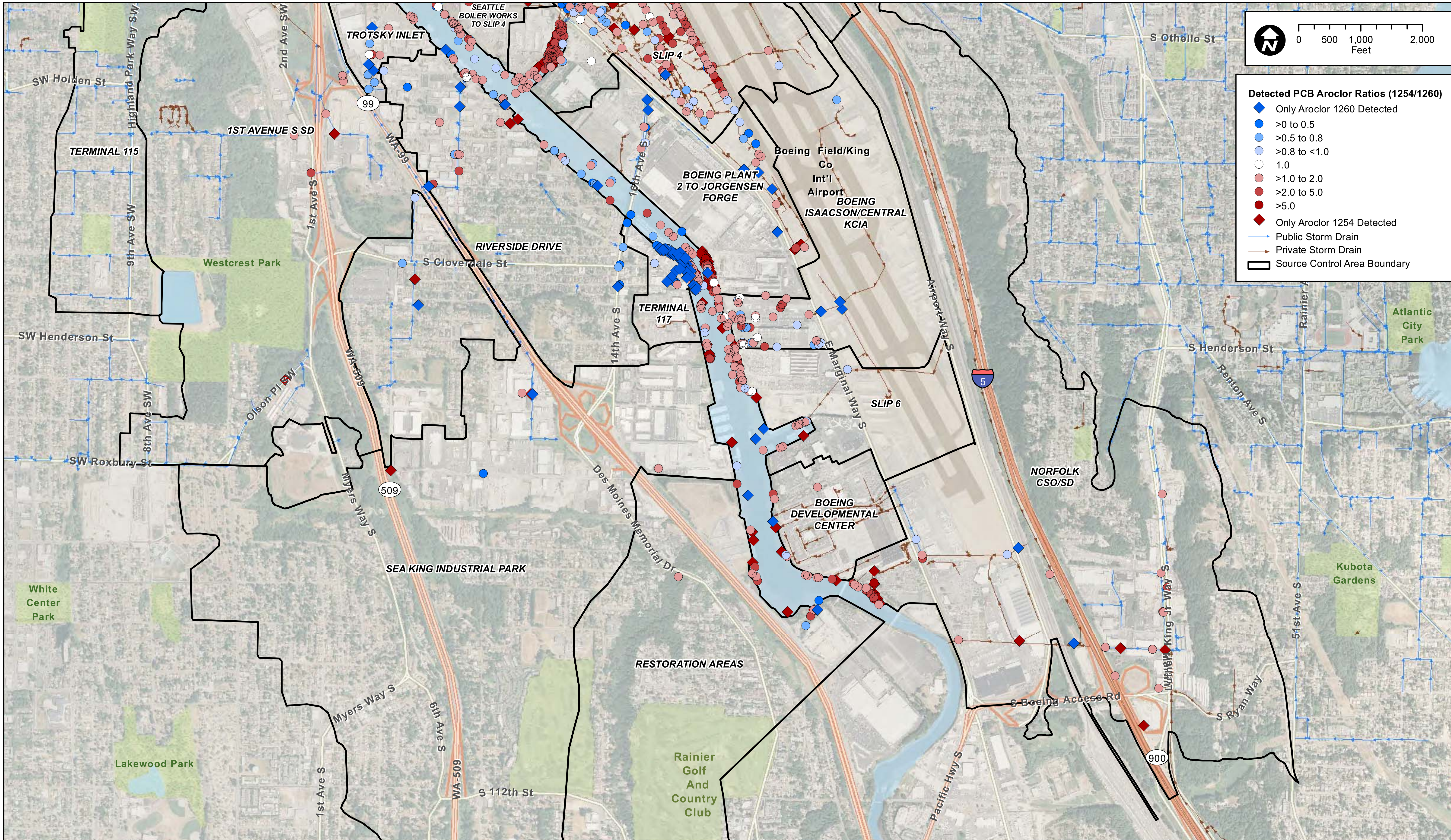

Figure 4-1c. Spatial Distribution of PCB Aroclor Ratios (1254/1260)

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Coordinate System:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet
Prepared By: mlf
File: Figure_4-1_PCB_Aroclor_Ratios.mxd
Illustrative purposes only.

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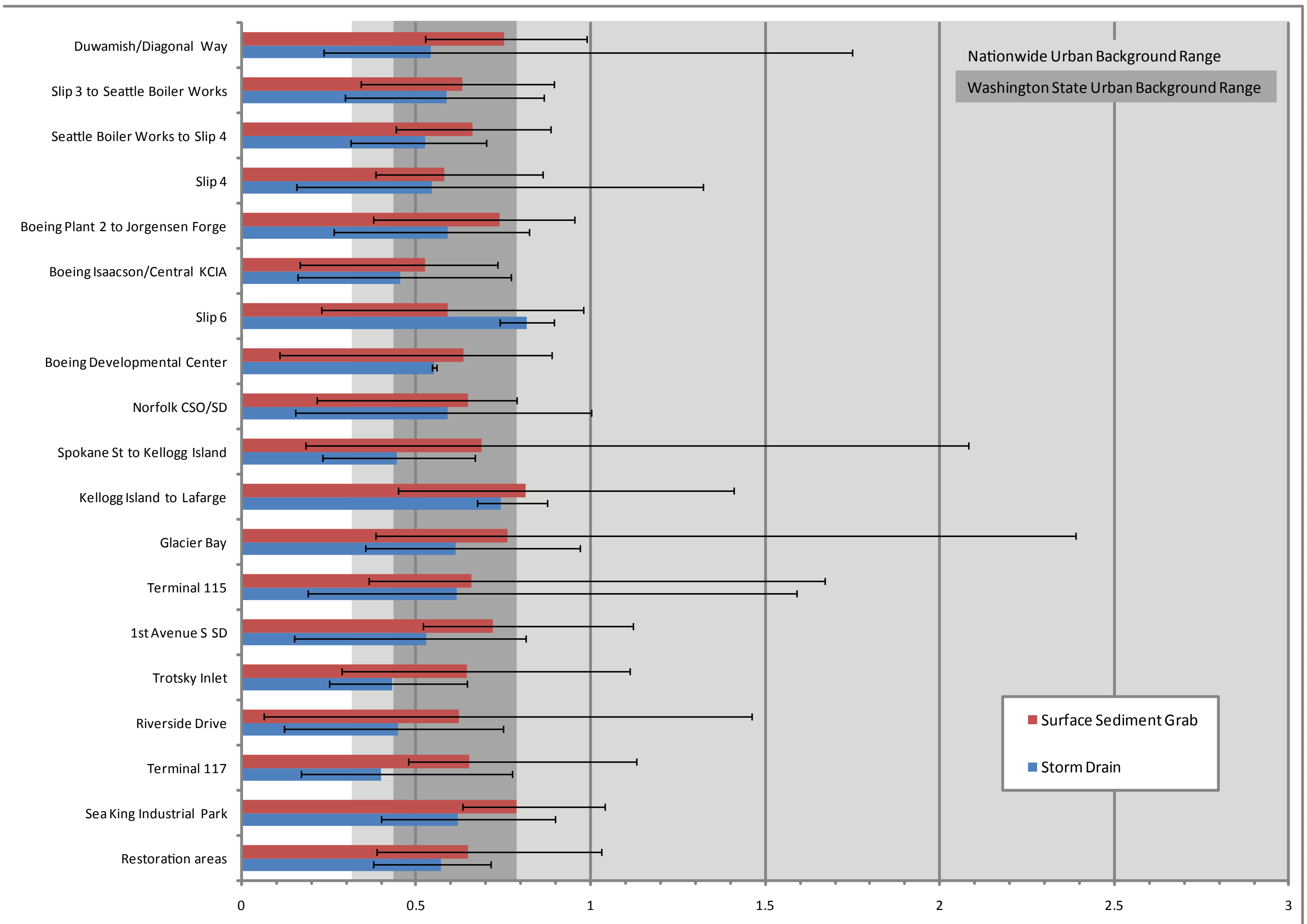

Figure 4–2. Average, Minimum, and Maximum Ratios of Benzo(a)anthracene to Chrysene by Source Control Area

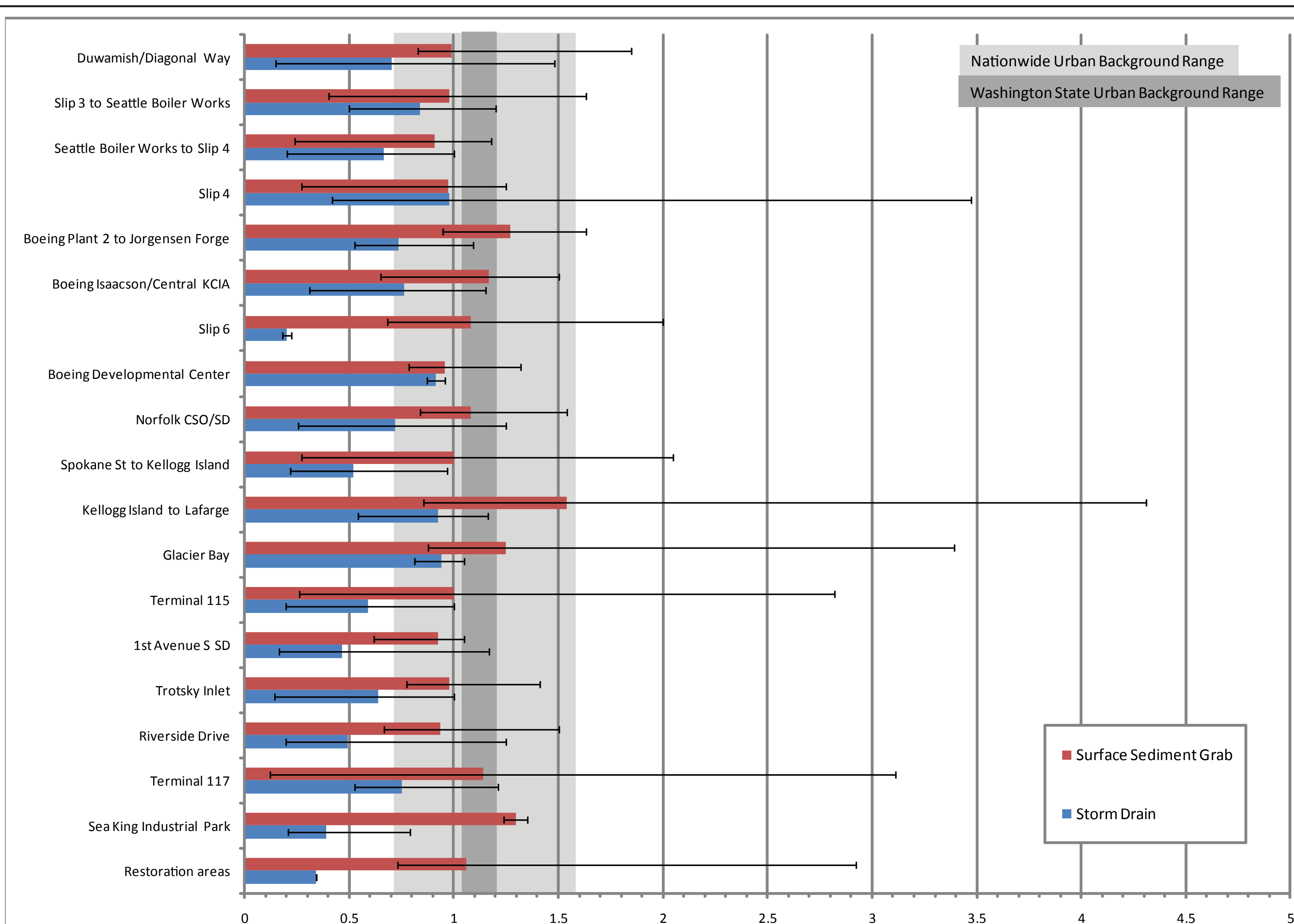

Figure 4–3. Average, Minimum, and Maximum Ratios of Indeno(1,2,3-cd)pyrene to Benzo(g,h,i)perylene by Source Control Area

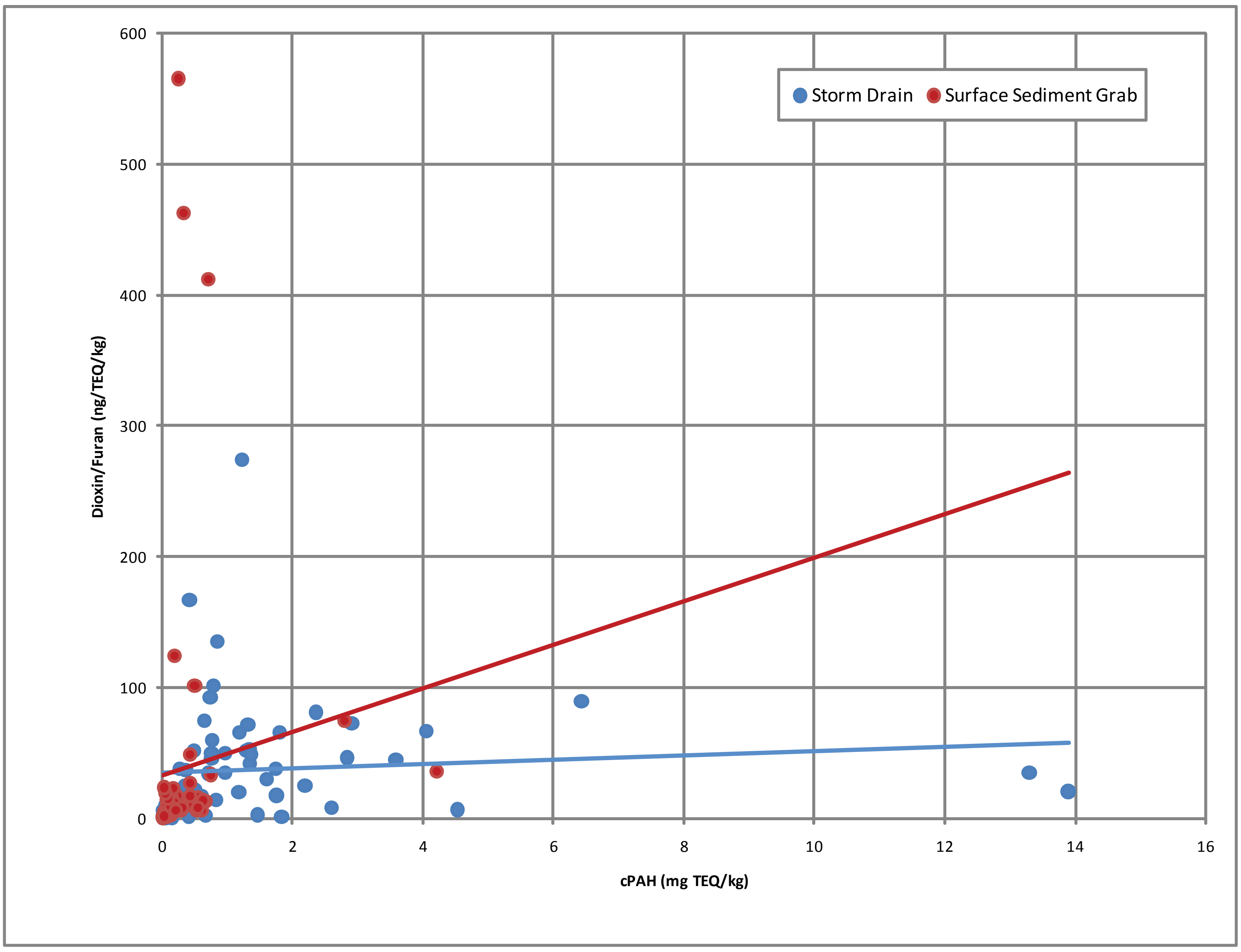

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Figure 4–4. Correlation of Dioxin/Furan TEQ to cPAH TEQ in Storm Drain Solids and Surface Sediment Samples

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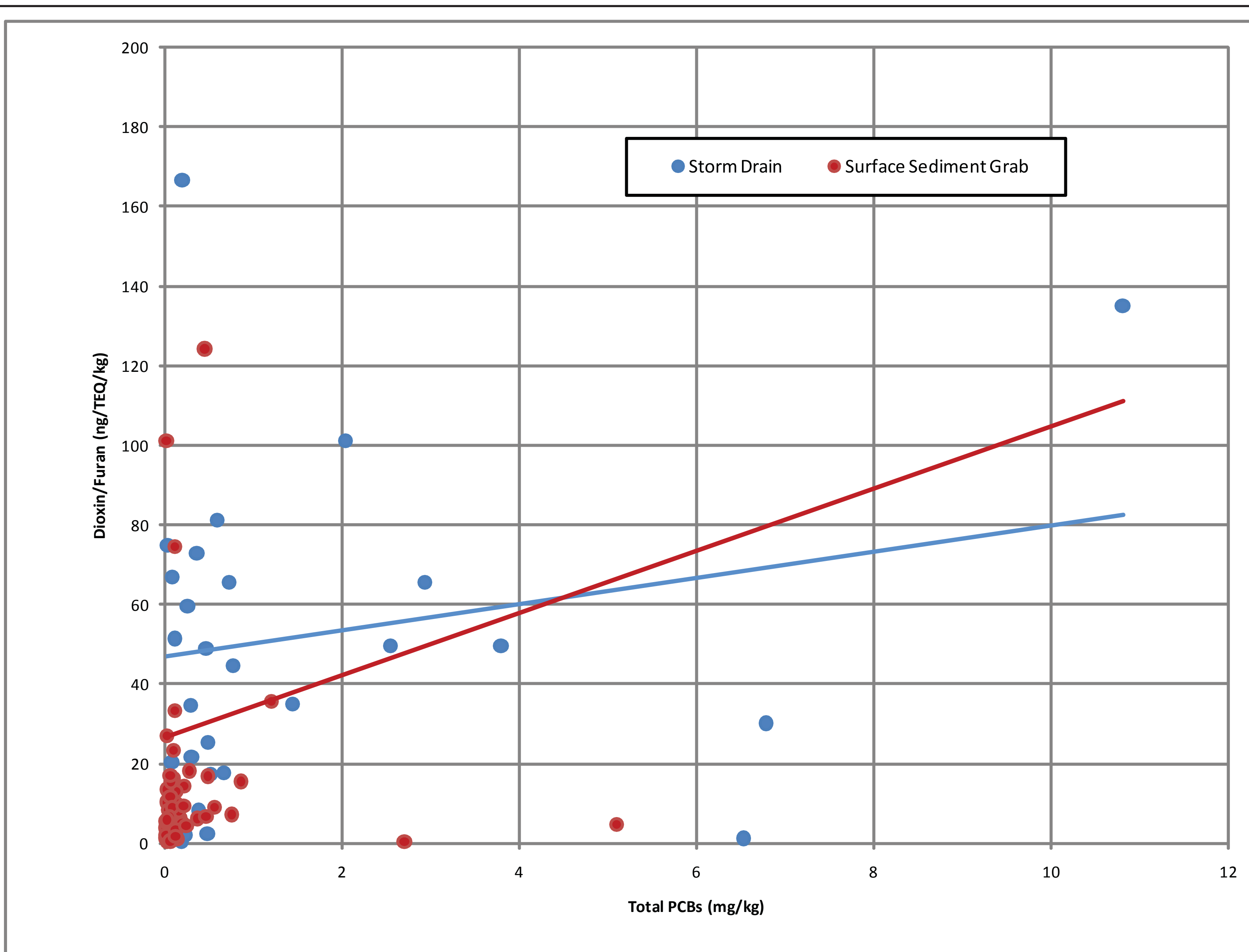

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Figure 4–5. Correlation of Dioxin/Furan TEQ to Total PCBs in Storm Drain Solids and Surface Sediment Samples

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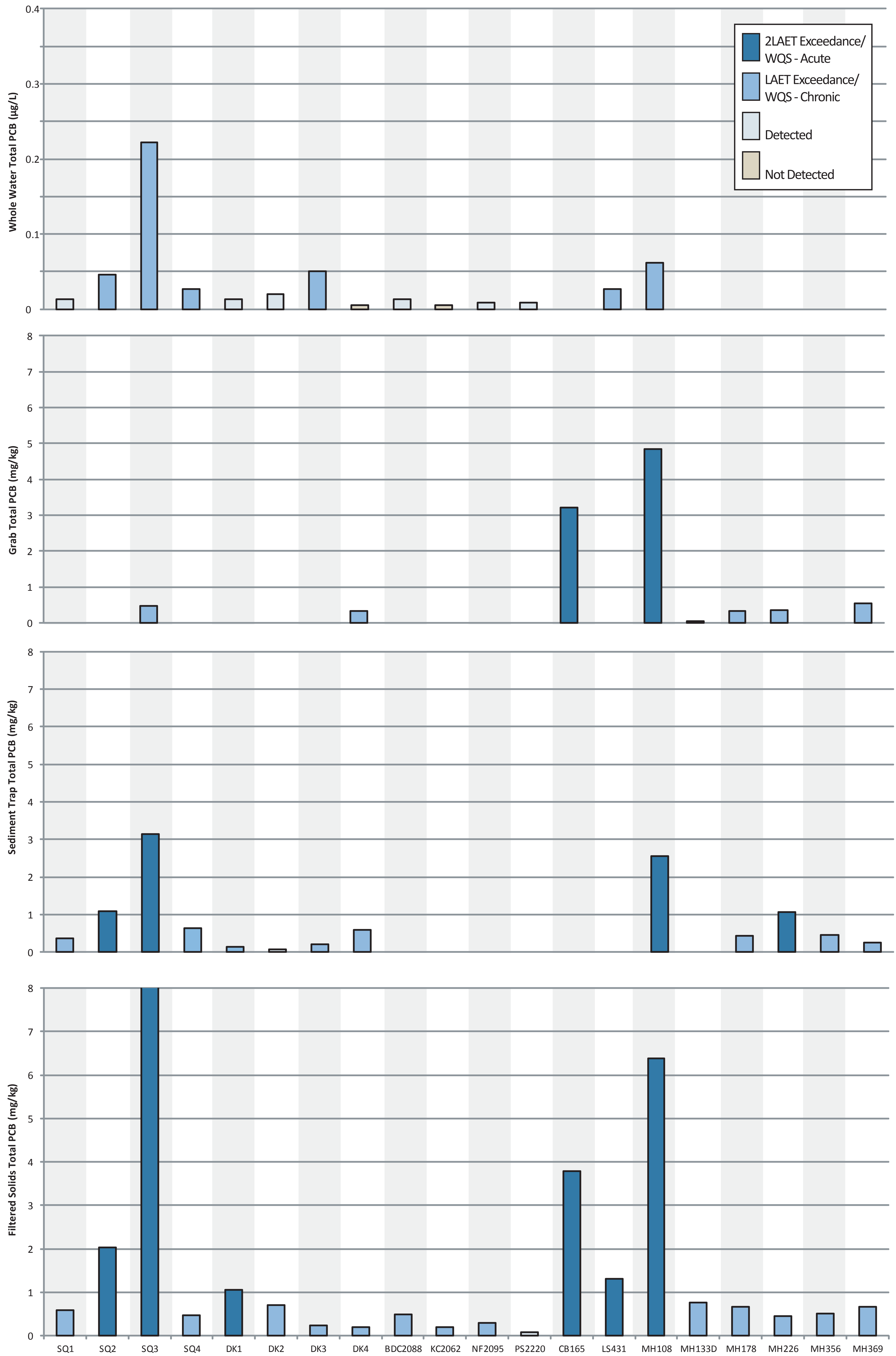

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Figure 5–1. Comparison of Total PCB Concentrations by Sample Collection Method

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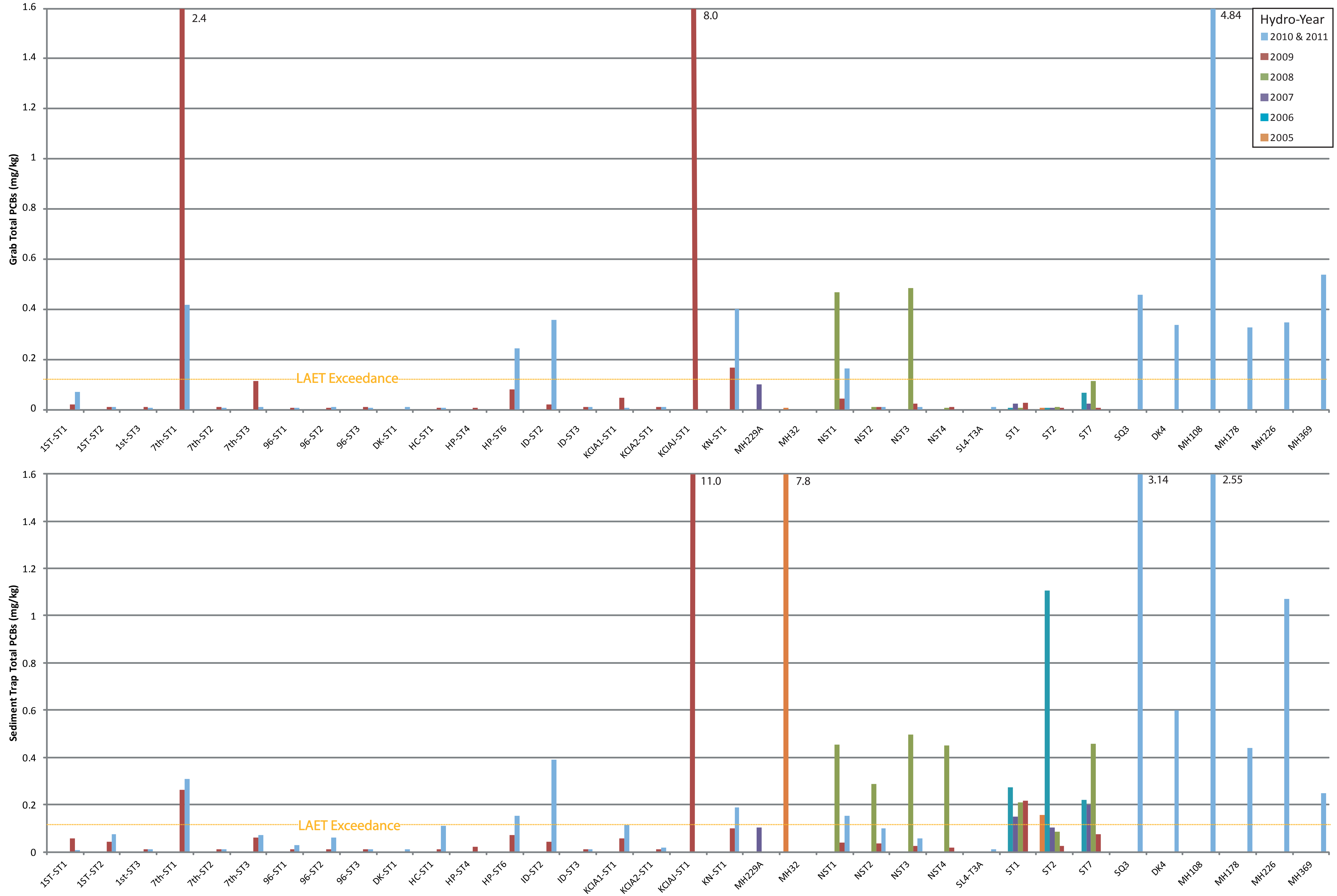

Figure 5–2. Comparison of Total PCB Concentrations in Sediment Trap and Storm Drain Samples

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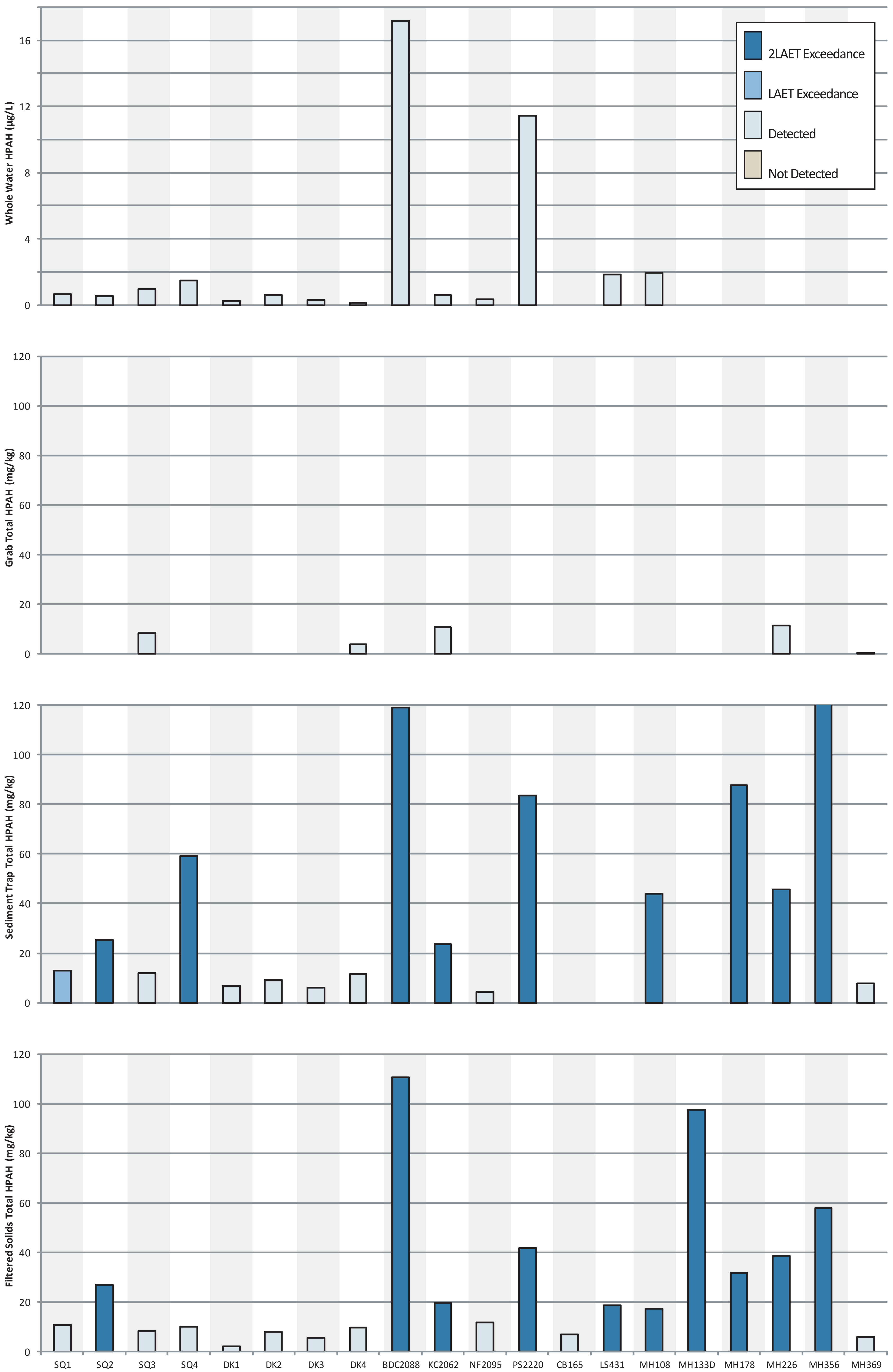

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Figure 5–3. Comparison of Total HPAH Concentrations by Sample Collection Method

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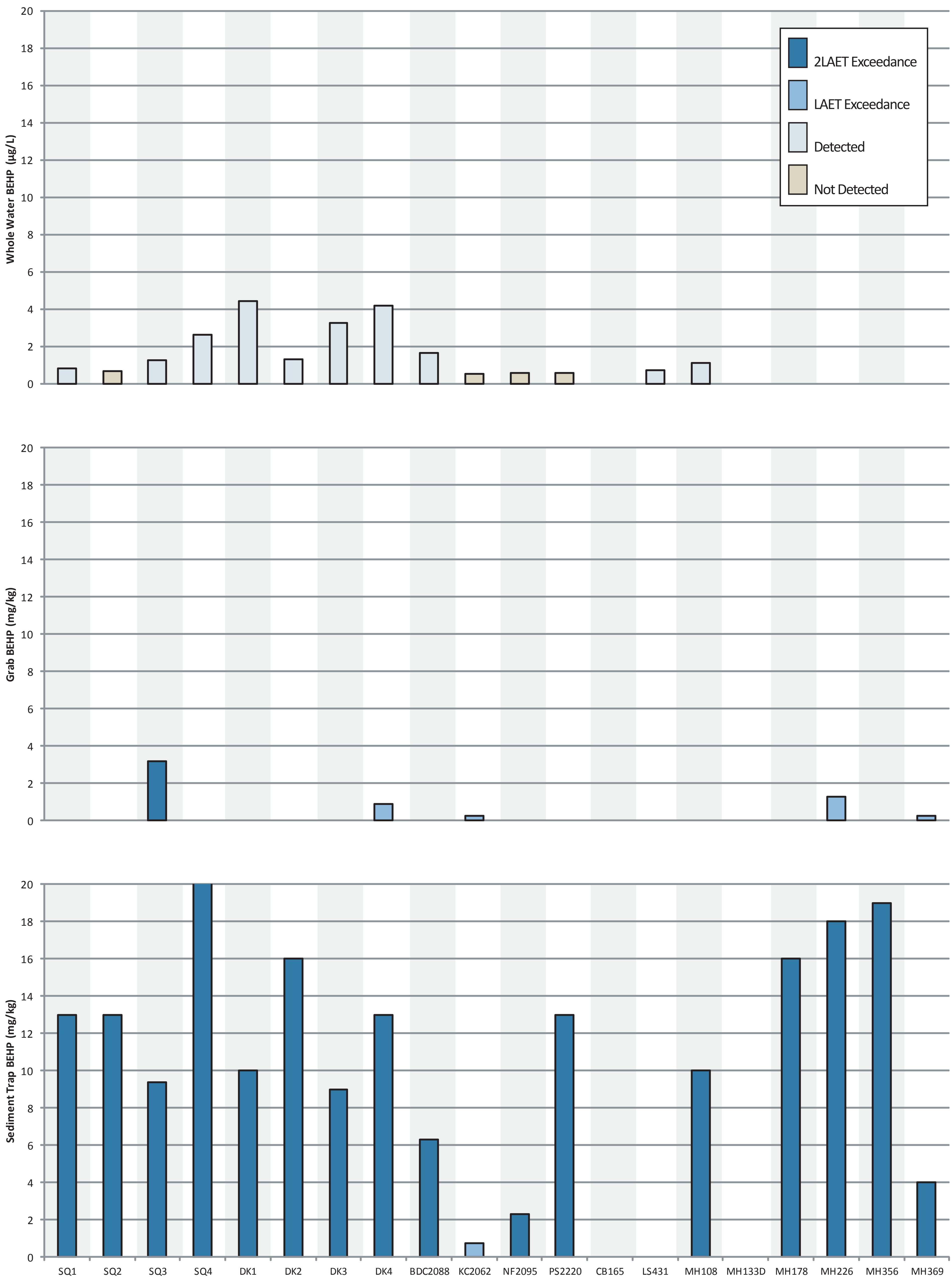

Figure 5–4. Comparison of BEHP Concentrations by Sample Collection Method

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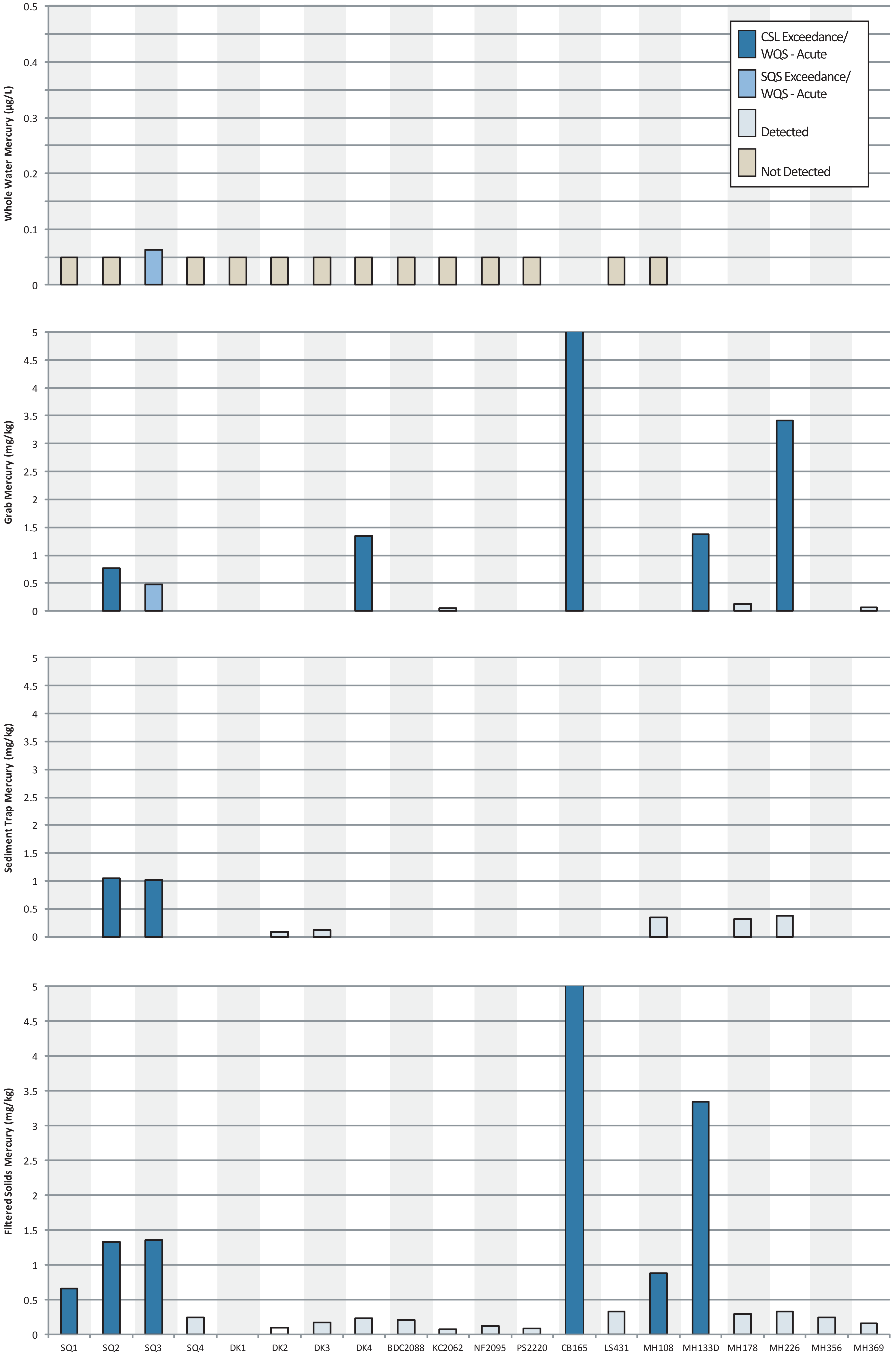

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Figure 5–5. Comparison of Mercury Concentrations by Sample Collection Method

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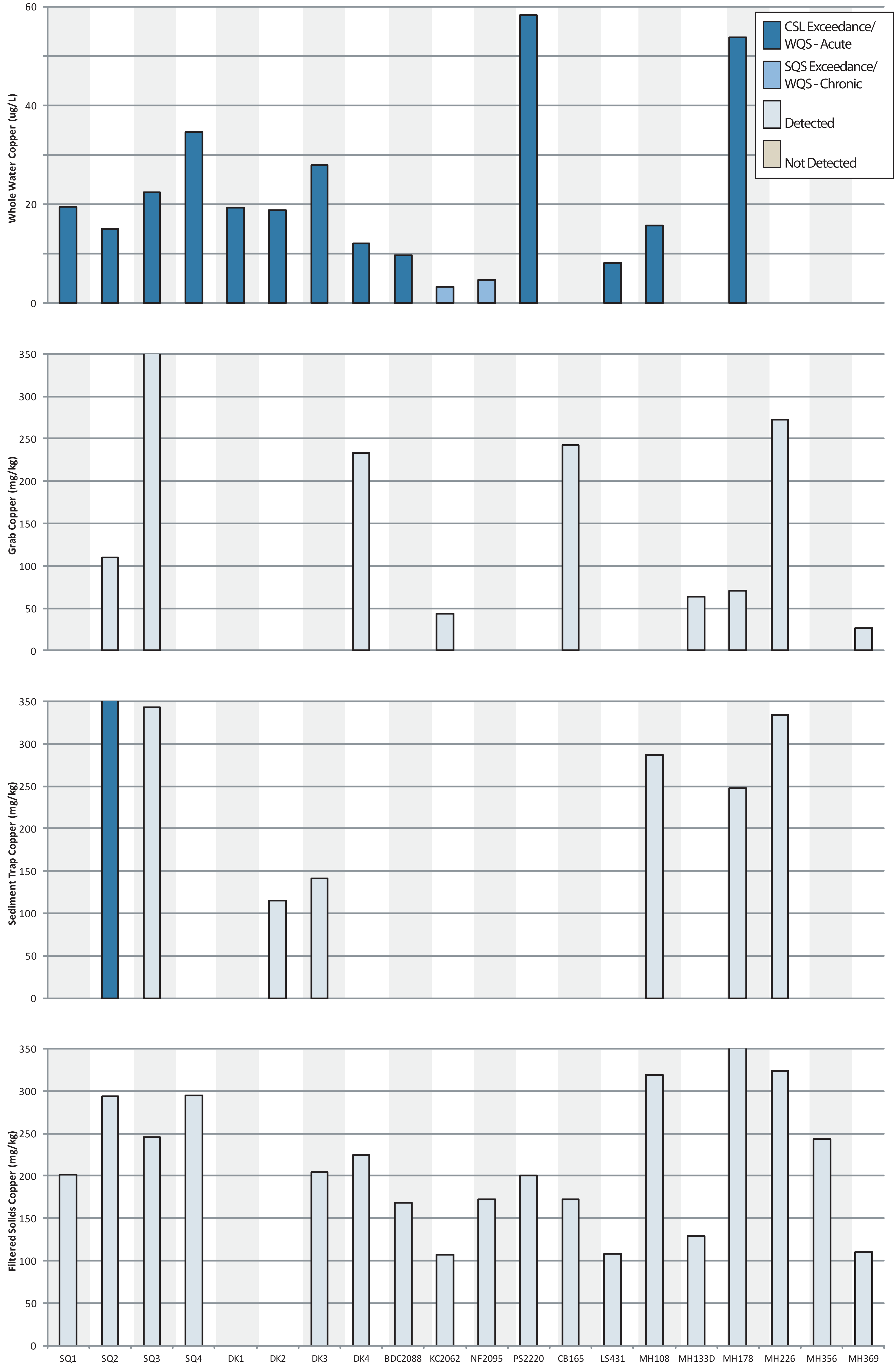

Figure 5–6. Comparison of Copper Concentrations by Sample Collection Method

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