North Boeing Field/ Georgetown Steam Plant Site Remedial Investigation/Feasibility Study

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Final

2011–2012 Stormwater Sampling Data Report

Prepared for

DEPARTMENT OF
ECOLOGY
State of Washington

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

Prepared by

SAIC®
From Science to Solutions

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LIMITATIONS

SAIC’s investigation was restricted to collection and analysis of a limited number of environmental samples, visual observations, and 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

ARI	Analytical Resources, Inc.
ASAOC	Administrative Settlement and Agreed Order on Consent
BF	base flow
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	Cleanup Screening Levels
DOC	dissolved organic carbon
DW	dry weight
EAP	Environmental Assessment Program
EcoChem	EcoChem, Inc.
Ecology	Washington State Department of Ecology
EOF	emergency overflow
EPA	U.S. Environmental Protection Agency
g	gram
gpm	gallons per minute
GTSP	Georgetown Steam Plant
HPAH	high molecular weight polycyclic aromatic hydrocarbon
KBFI	Seattle Boeing Field-King County International Airport rain gauge
KC	King County
KCIA	King County International Airport
kg	kilogram
L	liter
LAET	lowest apparent effects threshold
2LAET	second lowest apparent effects threshold
LDW	Lower Duwamish Waterway
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LS	lift station
LTST	long-term stormwater treatment
µg	microgram
mg	milligram
mL	milliliter
mm	millimeter
NBF	North Boeing Field
ng	nanogram
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSEP	Puget Sound Estuary Program
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RAL	remedial action level
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit

SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SD	storm drain
SIM	Selected Ion Monitoring
SMS	Sediment Management Standards
SOP	standard operating procedure
SPU	Seattle Public Utilities
SQS	Sediment Quality Standard
STST	short-term stormwater treatment
SVOC	semi-volatile organic compound
SW	stormwater
TEF	toxic equivalency factor
TEQ	toxic equivalent
TOC	total organic carbon
TSS	total suspended solids
WAC	Washington Administrative Code
WHO	World Health Organization
WQC	water quality criteria

1.0 Introduction

Stormwater discharge from the North Boeing Field-Georgetown Steam Plant (NBF-GTSP) Site is a potential source of contaminants to Slip 4 (Figure 1) on the Lower Duwamish Waterway (LDW). The Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) identified cleanup of contaminated sediment in Slip 4 as a high priority for the LDW Superfund Site.

A Remedial Investigation/Feasibility Study (RI/FS) and cleanup of this site is currently being conducted by Ecology to identify and address contaminant sources to Slip 4. In addition, there is an Administrative Settlement and Agreed Order on Consent (ASAOC) between EPA and The Boeing Company (Boeing). Under the ASAOC, Boeing installed a Short-Term Stormwater Treatment (STST) facility in September 2010, to treat stormwater on the northern portion of NBF. In October 2011, Boeing completed the Long-Term Stormwater Treatment (LTST) facility and discontinued use of the STST; this system treats most stormwater on the Site, prior to discharge to Slip 4 (Landau 2011). In 2012, the City of Seattle completed a non-time critical removal action to address contaminated sediment at the Slip 4 Early Action Area. The Slip 4 removal action construction occurred between October 3, 2011, and February 7, 2012. On July 26, 2012, the City of Seattle submitted a removal action completion report for the Slip 4 Early Action Area to EPA (Integral 2012).

To support the RI/FS, Ecology tasked Science Applications International Corporation (SAIC) with the collection of stormwater and continuous flow measurements from the storm drain (SD) line upstream of the King County International Airport (KCIA) SD#3/PS44 emergency overflow (EOF) outfall to Slip 4 (Figure 1). This sampling first began in 2009. Sampling conducted during the 2009–2010 wet season is summarized in the Preliminary and Expanded Stormwater Sampling Interim Data Reports (SAIC 2010a, 2011a). Sampling conducted during the 2010–2011 wet season is summarized in the 2010–2011 Stormwater Sampling Data Report (SAIC 2011b). The current report summarizes the stormwater sampling conducted during the 2011–2012 wet season.

During the 2011–2012 wet season, stormwater samples were collected at the following locations on the NBF property (Figures 2 and 3): three storm drain structures (manholes or catch basins) on the north lateral drainage lines; two structures on the north-central lateral, upstream and downstream; two structures on the south-central lateral (upstream and downstream); and two structures on the south lateral (upstream and downstream). It should be noted that the storm drain structures located upgradient of the NBF upstream sampling locations on the south and south-central laterals are not exclusively on KCIA property, and some are on NBF-leased property. In addition, some input sources from upstream of KCIA are also included in these lateral drainages. Filtered solids samples were collected at all nine locations; whole water samples were also collected at the upstream and downstream locations on the three southern laterals. An infiltrating groundwater grab sample was collected from the SD line on the north-central lateral (Figure 3). In addition, grab samples of storm drain solids were collected at five SD structures in the north lateral (Figure 2). Sampling began in September 2011 and ended in May 2012.

1.1 Site Description

The NBF property is located at 7500 East Marginal Way S, and the portion of the property that comprises the RI/FS Site encompasses approximately 113 acres. The property is located east of Slip 4, approximately 4 miles south of downtown Seattle (Figure 1). Boeing leases most of the property from King County, with the exception of a few acres on either side of the former GTSP flume, which are leased from the City of Seattle, and Building 3-390 and an adjacent parcel used for parking, which are owned by Boeing.

The NBF SD system drains a total area of approximately 328 acres, including 171 acres of KCIA (SAIC 2009b). Most areas of NBF drain to one of four main lateral SD lines (the north, north-central, south-central, and south lateral lines), which are directed to a trunk line that passes through a KC lift station (location referred to as LS431). During the 2011–2012 monitoring period, Boeing treated approximately 65 percent of all stormwater that was discharged from the lift station to Slip 4. All stormwater, whether treated or not, is discharged under East Marginal Way S, to the 60-inch KCIA SD#3/PS44 EOF outfall at Slip 4 (Figure 1). Additional stormwater drains to Slip 4 from an NBF parking area downstream of the lift station.

1.2 Project Scope and Study Objectives

The purpose of the 2011–2012 stormwater sampling effort included the following:

- Continue contaminant source tracing on three tributaries of the north lateral SD line, which contained higher concentrations of polychlorinated biphenyls (PCBs) and other contaminants during previous stormwater sampling events.
- Fill a data gap to evaluate the concentrations and mass loading of contaminants in stormwater associated with off-site upstream sources to the north-central, south-central, and south lateral storm drain lines.
- Compare upstream contaminant concentrations to downstream concentrations and mass loading.

Based on the Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) Addendum and its two supplements, the specific objectives for sampling during this season were as follows:

- Target two qualifying storm events at MH138, MH172, and CB175. Collect filtered solids samples at each location.
- Target two to three qualifying storm events at UNKCB27, MH362, MH461, MH368, MH482, and MH356. Collect whole water and filtered solids samples at all locations.
- Continue to assess contaminant concentrations in stormwater due to infiltration of groundwater to the SD system by sampling base flow where available at UNKCB27, MH362, MH461, MH368, MH482, and MH356. Collect whole water and filtered suspended solids during a period of baseflow at UNKCB27, MH362, MH461, and MH482. Evaluate flow data at MH368 and MH356 and collect whole water and filtered suspended solids during baseflow, if possible.
- Collect automated continuous flow measurements at these six locations.

- Target an additional qualifying storm event at UNKCB27 and MH482 to determine if air-drying filtered solids samples will affect polycyclic aromatic hydrocarbon (PAH) concentrations when compared to the wet filter analysis method.
- Collect one grab sample of storm drain solids from CB165 in the north lateral SD line.

Deviations from the SAP/QAPP are described below:

- Rinsate samples from filtered solids and whole water sampling equipment were collected in September and December 2011.
- In December 2011, an aqueous grab sample of infiltrating water containing unidentified white material was collected at MH362 (observations on a previous day showed a much more noticeable white coloration). SAIC oversaw Herrera Environmental Consultants (Herrera) as they performed a confined-space entry to collect the grab water sample.
- Filtered solids samples were collected from MH356 (in addition to MH482 as planned) and analyzed to determine if air-drying a filtered solids sample would affect PAH concentrations when compared to a wet filter analysis method. MH356 was selected instead of UNKCB27 because greater SD solids volumes were collected at this location.
- Filtered solids and whole water samples were not collected during base flow conditions due to low water levels in the storm drain system at all three upstream sampling locations. In addition, downstream locations were too close to LS431 to collect fully representative samples of baseflow, due to water regularly ponding behind LS431 at MH356 and MH368.
- Solids grab samples were collected from location MH181A (in addition to CB165, CB173, CB174, and MH179B) to determine the location of sources of contaminants previously identified in and near CB173. The supplement to the SAP Addendum had specified location MH181 to be sampled, but not enough solids material was present at MH181; therefore, location MH181A was substituted for MH181.
- Frequent fouling of flow sensors, caused by rapid biological precipitation from stormwater, resulted in erroneous flow readings or no readings at some locations. SAIC oversaw Herrera as they performed confined space-entry on a number of occasions to clean sensors prior to sampling storm events. Due to problems with proper functioning of flow sensors and other equipment difficulties, flow-weighted sampling could not be performed at all water sampling locations for all events.

1.3 Document Organization

The primary purpose of this report is to summarize and evaluate the results of the 2011–2012 NBF stormwater investigation. Section 1.0 describes the introduction to the report. Section 2.0 describes sample processing and analytical methods including those that differed from that described in the SAP/QAPP. Flow measurement data are summarized in Section 3.0. Analytical results for filtered solids and whole water are presented in Section 4.0. Section 5.0 summarizes the data validation reports, and a summary of findings is presented in Section 6.0. References are listed in Section 7.0. The appendices include totalizer logs, event flow and precipitation summaries, sampling results, laboratory data reports, and data validation report.

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2.0 Data Collection and Analytical Methods

This section describes the collection of flow measurement data and the sampling and analytical methods associated with filtered solids and whole water samples that were collected during storm flow conditions, and solids grab samples collected during base flow conditions.

Samples of stormwater and/or filtered suspended solids were collected at nine locations described below (Figures 2 and 3).

- MH138, located along the north lateral drainage, southwest of Building 3-626, was sampled only for filtered solids. MH138 was selected to evaluate contaminant sources in a tributary (N7) to the north lateral.
- MH172, located where a tributary joins the north lateral main line, west of Building 3-323, was sampled only for filtered solids. MH172 was selected to evaluate contaminant sources from tributary N11, at a time when the upstream north lateral storm water was being rerouted to the LTST.
- CB175, located along a tributary (N11) to the north lateral, northwest of Building 3-323, was sampled only for filtered solids. MH175 was selected to evaluate contaminant sources in this tributary to the north lateral, upstream of MH172.
- UNKCB27, located along the north-central lateral, straddling the lease property boundary between NBF and KCIA, was sampled for both filtered solids and stormwater (whole water). UNKCB27 was selected to evaluate off-site upstream contaminant sources along the north-central lateral. A schematic map of the drainage in the vicinity of UNKCB27 is presented in Appendix A.
- MH362, located along the north-central lateral, east of Building 3-380, was sampled for both filtered solids and stormwater (whole water). MH362 was selected to evaluate downstream contaminant concentrations in the north-central lateral. MH362 is located approximately 200 feet downstream of the connection between the north lateral and north-central lateral drainages.
- MH461, located along the south-central lateral in Concourse C, approximately 120 feet from the lease property boundary, was sampled for both filtered solids and whole water. MH461 was selected to evaluate off-site upstream contaminant sources along the south-central lateral.
- MH368, located along the south-central lateral, on the north side of Building 3-390, was sampled for both filtered solids and whole water. MH368 was selected to evaluate downstream contaminant concentrations in the south-central lateral.
- MH482, located along the south lateral in Concourse C approximately 180 feet from the lease property boundary, was sampled for both filtered solids and whole water. MH482 was selected to evaluate off-site upstream contaminant sources along the south lateral.
- MH356, located along the south lateral, southwest of Building 3-369, was sampled for both filtered solids and whole water. MH356 was selected to evaluate downstream contaminant concentrations in the south lateral. MH356 is located approximately 150 feet upstream of the lift station storage vault and the LTST system.

Solids grab samples were collected to aid in determining the location of the source(s) of contaminants previously identified in/near CB173 on tributary N11, and on tributary N10. Grab samples were collected from the following five north lateral locations (Figure 2):

- CB165, located along a tributary (N10) to the north lateral, southwest of Building 3-302.
- CB173, located along a tributary (N11) to the north lateral, west of Building 3-323.
- CB174, located along a tributary (N11) to the north lateral, west Building 3-323 and adjacent to a series of air tanks.
- MH179B, located along a tributary (N11) to the north lateral, northwest of Building 3-323.
- MH181A, located along a branch of tributary (N11) on the north lateral, east of Building 3-323 and west of a cooling tower.

SAIC performed all field sampling and coordinated all analytical services during the 2011–2012 stormwater season. Herrera provided support for confined-space operations, use of flow meter equipment, flow data management, and flow analysis.

2.1 Flow Measurements

During previous stormwater monitoring seasons, flow measurements were collected with Teledyne ISCO 6712 (ISCO) stormwater samplers equipped with a Model 750 area velocity module. At some locations, the area velocity modules malfunctioned and caused inaccurate level and velocity measurements, including negative flow values. During the 2011–2012 wet season, all stormwater flow measurements were collected using a Marsh-McBirney Flo-Tote 3 electromagnetic area/velocity flow meter sensor (Flo-Tote 3). The Flo-Tote 3 measured level and velocity of stormwater at the following six locations: UNKCB27, MH356, MH362, MH368, MH461, and MH482. Flow data were recorded on a Hach FL900 Flow Logger (FL900) with a 5-minute logging interval at these locations. The Flo-Tote 3 and FL900 operated with an internal power source.

On October 19, 2011, flow sensors were installed at two downstream locations, MH356 on the south lateral and MH368 on the south-central lateral. SAIC/Herrera collected flow data between October 19 and November 8, 2011, to determine whether stormwater backed up and reversed the flow at these two locations during storm events or between LS431 pumping cycles. After reviewing flow data from the evaluation period, SAIC/Herrera determined that MH356 and MH368 could be successfully sampled during large rain events. Flow sensors were left in place at MH356 and MH368 for the remainder of the monitoring season. On November 1 and 2, 2011, SAIC/Herrera installed flow monitoring equipment at four additional locations on the north-central lateral (UNKCB27 and MH362), south-central lateral (MH461), and south lateral (MH482).

Flow sensors were installed upstream of each access point (manhole or catch basin), with the following exceptions: the field team installed equipment downstream of MH368 to capture stormwater from a previously unknown inflow pipe; and equipment was installed downstream of MH461 to eliminate turbulence over the flow sensor from another upstream pipe. Herrera performed all confined-space entry necessary to install the Flo-Totes and the ISCO stormwater samplers (used for whole water sampling) at UNKCB27, MH356, MH362, MH368, MH461, and MH482. Flow measurements were collected from November 2011 through April 2012.

No flow measurements were collected at MH138, MH172, and CB175 in the north lateral, where only filtered solids were collected.

2.2 Sample Collection

Sampling efforts began in September 2011 and ended in May 2012. A summary of event type, sample location, and sample media is presented in Table 1. Rain event sampling was conducted in two phases. The first phase consisted of collecting filtered solids samples within the north lateral at locations MH138, MH172, and CB175 (Figure 2) during two rain events in September and November 2011. The second phase consisted of collecting filtered solids samples and whole water samples within the southern three laterals at locations UNKCB27, MH362, MH461, MH368, and MH356 (Figure 3) during one event in February 2012 and three events in March 2012.

Grab samples were collected during dry conditions at locations MH181A, MH179B, CB174, CB173, and CB165 (Figure 2) in May 2012.

Sample equipment for each location was stored in a locked polypropylene shed to ensure sample chain-of-custody compliance throughout the duration of sampling activities and to provide sample and equipment protection from the elements. When not in operation, the sheds at CB175, MH138, UNKCB27, MH362, MH461, MH482, and MH356 were moved to nearby storage locations to prevent interference with Boeing operations. Due to location-specific sampling equipment limitations, MH172 and MH368 were left in place on low-traffic flow driveways. Traffic cones and barricades were placed around the sampling equipment to increase visibility and reduce the possibility of damage from passing vehicles.

The start and end time for each sampling event are based on the times listed on the totalizer log sheets (Appendix A). These times are listed separately for each location and vary depending on when each sample unit was activated or deactivated.

2.2.1 Filtered Solids Samples

Filtered solids were collected in a manner consistent with methods outlined in the stormwater sampling SAP/QAPP and its Addenda (SAIC 2009a, 2010b, 2010c, 2011b). A schematic of a filtered solids sampler is provided in Figure 4. Events and locations where filtered solids were collected are listed in Table 1 of the current report and shown on Figures 2 and 3.

At the start of the monitoring season, a maximum 48-gallon per minute (gpm) pump was positioned in the adjacent SD beneath the manhole or catch basin cover at locations CB175, MH172, MH138, MH362, MH461, MH368, MH482, and MH356. Access to AC power at UNKCB27 was not available. Three 12-volt marine batteries provided power to a 33-gpm pump at UNKCB27. A generator provided power to the pump at MH362 because Boeing operations limited access to AC power. Pump rates were dependent on the amount of vertical lift associated with each location.

A float switch was set to trigger sampling when the water depth exceeded the pre-determined optimal depth at CB175, MH172, MH138, UNKCB27, MH461, MH368, and MH356. Manual pump activation was performed at MH362 and MH482 because low water levels limited the functionality of float switches at low flow. Once pumps were triggered, water was pumped up through the intake line and split into two parallel filter housings (Figure 4, labeled “A” and “B”).

The filter housings contained a 20-inch long, 4-inch diameter filter bag. All filter bags were constructed of 5-micron polypropylene felt mesh. During previous sampling seasons, concerns had been expressed that, due to high internal pressure, some SD solids material was bypassing the filter in the area where the filter top-ring seated against the filter housing. To mitigate this problem, SAIC tested different thicknesses of spacers and gaskets above and below the filter unit, to create a tighter seal. Testing was conducted by pumping turbid water through the filters for a set amount of time, using varying sizes of gaskets above the filter or spacers below. Following each test, visual observation was made of the accumulation of fine-grained bypassed material on the outer portion of the top filter ring (on the felt material). Each test condition was run at least twice. These tests resulted in the determination that a 1/8-inch neoprene gasket placed between the filter housing and top of the filter bag would best improve the seal. These tests and later field observations indicated that use of this gasket minimized any material bypass. Prior to each sampling event at NBF, a new clean gasket and a clean pre-weighed filter were installed in each of the two filter housings at a given location.

For these sampling events, low sample volumes of solids in the filters were reported by the laboratory for most locations. Given these low volumes, it is unlikely that the filter bags became clogged to the extent of greatly increasing the pressure to cause significant material bypass during these events. To constitute a meaningful sample, the filtered solids material only has to be representative of the suspended solids greater than 5 microns in the pumped stormwater. If material was bypassing the filter seal during sampling, it is likely that this material consisted of finer-grained particles, which are also passing through the filter mesh. Thus, it is believed that whatever bypassing did occur was not significantly affecting the intended representativeness of the filtered solids samples.

Totalizer readings were recorded at the start of a storm event (Appendix A). The outflow from each filter housing was piped into a totalizer to measure flow. Outflow from both totalizers was combined into a single line and piped back into the storm drain. Discharge pipes were installed in the storm drain line downstream of the influent pump to avoid the potential for re-circulation of water. After sampling was completed, the final totalizer readings were recorded, filter housings were drained, and filters were removed. Residual water in the filters was allowed to drain by gravity, or the water was gently squeezed through the filter bags. Filter samples were double bagged in clean, pre-labeled, Ziploc bags, and stored on ice for delivery to Analytical Resources, Inc. (ARI) for processing and analysis.

Exceptions to the methods above are described below:

- MH138: During periods of low flow at this location, use of the float switch caused the pump to cycle on/off too rapidly. An automated timer was used to activate the pump at 15-minute intervals to prevent damage to the pump from frequent on/off cycling.
- MH482: A float switch could not be positioned properly to activate the pump during periods of low flow at this location. The pump operated continuously throughout sampled events.

Filtered Solids Sample Equipment Decontamination

During previous stormwater sampling efforts, new filtered solids collection equipment was dedicated to a specific monitoring location. In September 2011, SAIC decontaminated eleven stormwater filtered solids sampling units within the portable sheds that were used during previous monitoring seasons. All previously used influent and effluent flex tubing was disposed of. The components (filter housing, totalizers, pumps, etc.) of each sampling unit were disassembled, rinsed with tap water, and scrubbed with a Liquinox/water solution. Components were re-assembled and underwent a series of 15-minute, 10-minute, and 5-minute tap water rinses. After the tap water rinse was completed, the system was purged with a final deionized water rinse. The eleven units were then transported to NBF and became dedicated at new locations. New flex tubing and PVC pipe were cut to fit at each location. Prior to subsequent sampling, the piping in each unit was purged with local stormwater at each location.

Filtered Solids Sample Equipment Rinse Blanks

In September 2011, SAIC collected two composite rinse blanks from the eleven decontaminated stormwater sampling units. Deionized water (provided by ARI) was poured through the pump, influent piping, and the filter housings of each unit. The spigots at the bottom of the filter housings were opened to allow rinsate water to drain into a decontaminated stainless steel basin. The rinsate water from each unit was composited into pre-labeled bottles for analysis of PCBs, PAHs, and metals. The rinsate blanks were stored on ice and delivered to ARI.

2.2.2 Whole Water Samples

Whole water samples were collected using ISCO 6712 stormwater sampling units at UNKCB27, MH362, MH461, MH368, MH482, and MH356 (Figure 3). A schematic of a whole water sampler is provided in Figure 4. The inlet for the ISCO samplers and the flow sensors were mounted adjacent to each other on stainless steel scissors brackets. The flow sensor and ISCO tubing inlet were installed upstream of the filtered solids pump at UNKCB27, MH362, MH482, and MH356. The field team installed equipment downstream at MH368 to capture stormwater from a previously unknown inflow pipe. As a result, some of the upstream flow was diverted and not measured by the flow sensor at MH368, as well as at MH461. All three sampling events at MH368 were changed to time-weighted sampling due to sensor fouling. Therefore, the diverted flow to the filtered solids unit was not a factor in the sample pacing for whole water. Equipment was installed downstream at MH461 to eliminate turbulence over the flow sensor from another upstream pipe. The configuration at MH461 resulted in approximately 10 percent diversion of flow to the filtered solids unit, which was not accounted for by the flow sensor. The flow sensor and pacing for whole water sampling were thus not adjusted to account for this loss, but this has only minimal impact on the results. The effluent flex tubing from the filtered solids sampler discharged downstream of the ISCO tubing and flow sensor at each location.

Flow-weighted sampling programs were selected for the ISCO units at all locations prior to each sampling event. The flow-weighted method consists of collecting equal volume aliquots at predetermined flow volume intervals. The aliquot volume was constant at 200 milliliters (mL) for all sampled events. The Flo-Tote was connected to the ISCO sampler to coordinate flow-weighted pacing of aliquot collection. The Flo-Tote sent an electrical signal to the ISCO to collect a sample after a preprogrammed volume of water passed over the flow sensor. The volume interval was calculated using forecasted rainfall totals and the relationship between rainfall and stormwater flow established from flow monitoring during previous rain events. The ISCO sampler recorded each time that a sample was collected. The data were downloaded following each storm event. AC power was available for the ISCO units at MH461, MH368, MH482, and MH356. Two 12-volt marine batteries were used to power ISCO units at MH362 and UNKCB27 (where AC power was not available).

During storm events SW-3, SW-4, and SW-6 (Table 1), whole-water sampling collection was changed from flow-weighted to time-weighted at some locations due to sensor fouling and related equipment malfunction. The sample collection method for each storm and location is summarized below. Additional information for each event is provided in Section 3.1.3.

Storm Event/ Date	Sampling Location and Collection Method					
	MH356	MH362	MH368	MH461	MH482	UNKCB27
SW-3 2/24/2012	FW	TW	TW	FW	TW	TW
SW-4 3/12–13/2012	FW	FW	TW	FW	FW	FW
SW-6 3/28–29/2012	FW	FW, TW	TW	TW	FW	FW

FW = flow-weighted TW = time-weighted

All whole water samples were collected in 5-gallon glass carboys. During sampling, the carboy and collected water were stored on ice in the base of the ISCO sampler. After sampling, the carboy was delivered to ARI, where the sample was split for analysis. The laboratory was also responsible for decontamination of the carboy as specified in the SAP/QAPP Addendum (SAIC 2010b). At some locations, two carboys were required for a single sample, due to an unexpectedly large amount of collected water.

Whole Water Sample Equipment Rinse Blanks

In October 2011, SAIC collected a single rinse blanks from factory-sealed Teflon-lined ISCO tubing, factory-sealed silicon ISCO tubing, and a lab-decontaminated carboy. Whole water samples come into contact with all three pieces of equipment in the field. Following receipt of results of this sample (see Section 5.0), additional equipment rinse samples were collected on each of the three pieces of equipment separately. For the Teflon-lined ISCO tubing, field staff poured deionized water (provided by ARI) through a purged aluminum foil funnel and then through the Teflon tubing. Rinsate water draining from the Teflon tubing was collected in pre-labeled sample jars. A similar process was repeated to collect the rinse blank from the silicon tubing. For the third rinse blank, field staff poured deionized water from the laboratory into a lab-decontaminated carboy. All sample containers were stored on ice and delivered to ARI.

2.2.3 Grab Samples

On November 2, 2011, a white “slimy” aqueous material was observed seeping through SD pipe joints on the downstream side of MH362 (Figure 3), and merging with stormwater in the pipe (Figure 3). On December 7, 2011, the field team collected an aqueous grab sample of this infiltrating water approximately 5 feet downstream of sampling equipment at MH362; however, at this time the white color was much diminished. Most of the sample of this infiltrating water was collected before it mixed with stormwater in the pipe. The sample was collected in a pre-labeled glass container, stored on ice, and delivered to ARI.

On May 17, 2012, five grab samples of storm drain solids were collected using a stainless steel scoop affixed to a 6-foot pole. These samples were collected at locations MH181A, MH179B, CB174, CB173, and CB165 (Figure 2). Multiple grabs were collected from a single manhole or catch basin and composited in a decontaminated stainless steel bowl. Composited material was homogenized and transferred to pre-labeled glass sample containers, which were then stored on ice and delivered to ARI.

Grab Sample Equipment Decontamination

Sample spoons and bowls used to composite SD solids were decontaminated prior to the sampling event and wrapped in aluminum foil. Each set of spoons and bowls were dedicated to a given sampling location. After completion of sampling at each location, the grab sampler was rinsed with tap water, scrubbed with a Liquinox/water solution, re-rinsed with tap water, and rinsed with deionized water (provided by ARI).

2.3 Sample Preparation and Chemical Analysis

Analytical procedures were performed by a subcontracted laboratory in accordance with Ecology guidelines as outlined in the SAP/QAPP and its Addenda (SAIC 2009a, 2010b, 2010c, 2011b), with the exceptions noted in Section 2.3.4. Analytical methods are listed in the sample analysis summary tables, Tables 2 and 3. A listing of samples, analytes, and laboratory sample delivery groups is tabulated in Appendix E.

2.3.1 Filtered Solids Samples

After sample collection, filter bags were delivered to ARI in Tukwila, Washington, for processing and analysis. In the lab, one of the filter bags (Filter A) in the parallel filtration setup was cut in half and solids were removed, or scraped from the sides of the bag, to obtain enough material for the analysis of metals and grain size. Approximately 10 grams of filtered solids were removed for metals analysis, and approximately 20 grams of filtered solids were removed for grain size analysis. The filter bag and remaining solids were then air dried and extracted for PCBs or PAHs (Table 2). In the condition of limited sample volumes, the lab was instructed to place higher priority on the organic analyses, while metals and especially grain size were lower priority. As a result, PCBs or PAHs were targeted for full representative sample aliquots, and metals and grain size analyses utilized the remainder. The scraping process may produce minor biasing in the segregation of average grain sizes between aliquots, with the material remaining on the filter being somewhat finer grained than the material removed. However, the proportional significance of this bias is expected to be small. For the second filter bag (Filter B), only a single analysis was performed on solids (PAHs, PCBs, or dioxins/furans).

2.3.2 Whole Water Samples

The 5-gallon carboys containing whole water samples were delivered to ARI for churn splitting and analysis. Stormwater samples were analyzed for semi-volatile organic compounds (SVOCs), PAHs by selected ion monitoring (SIM), PCBs, total and dissolved metals, and conventional parameters including hardness, pH, alkalinity, anions, total organic carbon (TOC), dissolved organic carbon (DOC), and total suspended solids (TSS) (Table 3). Samples for dissolved metals analysis were filtered by ARI prior to preservation and analysis.

2.3.3 Grab Samples

After sample collection, homogenized SD solids grab samples were delivered to ARI in glass jars for the analysis of SVOCs, PCBs, metals, TOC, and grain size for all five samples. Additionally, dioxin/furan congeners were analyzed in SD solids grab samples collected from CB173 and CB165 (Figure 2).

2.3.4 Analytical Deviations

Analytical procedures were conducted as outlined in the SAP/QAPP and SAP/QAPP Addenda (SAIC 2009a, 2010b, 2010c, 2011b), with the following exception: some targeted analyses (metals and/or grain size for some filtered solids samples) could not be performed due to insufficient sample volume.

3.0 Flow Measurement Results

This section presents a summary of flow measurements collected from sampling locations in the north-central, south-central, and south lateral drainage areas. Flow measurements were not conducted at locations in the north lateral area.

3.1 Flow Measurements and Precipitation

Herrera provided data management, flow analysis, and storm pacing guidance for the 2011–2012 stormwater monitoring season. Flow data logged by the FL900 were managed using software programs including Excel, Flo-Ware (Version 4.6.0.0), and Aquarius. All data incorporated into Flo-Ware were stored in an Excel database. Local precipitation data were added to the database to aid interpretation of the storm hydrographs during post processing.

3.1.1 Precipitation

Real-time precipitation data from the Seattle Boeing Field-King County International Airport rain gauge (identified as "KBFI") were accessed via the National Oceanic and Atmospheric Administration's website during sampling events at NBF. The field team compared the real-time precipitation data with forecasted storm totals to assist in sample planning and collection. The rain gage updates the precipitation totals on an hourly basis and more frequently during periods of heavy rainfall. Trace amounts of precipitation are reported as "T" and were interpreted to represent 0.001 inch (0.025 millimeter [mm]) of precipitation.

During post processing and analysis, Herrera used Seattle Public Utilities' (SPU) Rain Gage 16 (RG16) for precipitation data. The gage records precipitation at 5-minute intervals in increments of 0.01 inch. Precipitation data from RG16 were included in sample event summary figures for SW-3, SW-4, and SW-6 presented in Appendix B. Rainfall is shown at the top of these graphs, and whole water sample-collection aliquots are shown along the flow hydrograph.

3.1.2 Stormwater Flow Records

Stormwater flow measurements were collected from early-November 2011 through April 2012. A regression analysis between volume of stormwater (cubic feet) and precipitation amount (inches) for recorded rain events was performed for each location and updated as more data became available. The slope of each regression line is assumed to be constant, representing runoff from the area that drains to a specific sampling location. The relationship between precipitation and volume of stormwater for each event and location was highly variable. The variability is attributed to fluctuating rainfall intensity locally and across storm events, and to biological fouling of flow sensors that limited accuracy in flow measurements.

3.1.3 Event Summaries

A goal of each storm event was to meet criteria established by Ecology's Environmental Assessment Program (EAP) standard operating procedures (SOPs) for stormwater monitoring (Ecology 2009). Sample event summary figures for events SW-3, SW-4, and SW-6 are presented in Appendix B.

A qualifying storm event was defined as follows:

- At least 0.15 inch (3.8 mm) of rainfall
- Event duration of at least 5 hours
- No more than 0.04 inch (1 mm) of rainfall during the preceding 12 hours[1]
- Sampling duration that includes at least 75 percent of the storm event hydrograph, or at least 75 percent of the first 24 hours of the storm if the storm lasted more than 24 hours
- Collection of at least 25 sample aliquots, with a minimum volume of approximately 200 mL per aliquot.

Although all these qualifying storm event goals were attempted to be met, for a number of reasons some of them were not met for certain locations and storm events. A summary of stormwater sampling events is presented in Table 1, and a comparison to these qualifying storm event criteria is included in Table 4. The following text summarizes the qualifying storm event information for each event.

During event SW-1 on September 26, 2011, NBF received a total of 0.50 inch of precipitation. Rainfall did not occur during the preceding 12 hours, and the storm event lasted a total of 12 hours. Filtered solids sample units operated throughout event SW-1 at CB175, MH172, and MH138.

During event SW-2 on November 16, 2011, NBF received 0.79 inch of precipitation. Rainfall did not occur during the preceding 12 hours and the storm event lasted a total of 9 hours. Filtered solids sample units operated throughout event SW-2 at CB175, MH172, and MH138. Metals and grain size analyses were not performed at MH138 due to insufficient material on filter A.

Further sampling was not conducted at MH138, MH172, and CB175 after event SW-2. Whole water and filtered solids were collected during events SW-3, SW-4, and SW-6 at UNKCB27, MH362, MH461, MH368, MH482, and MH356. All storm events had durations of at least 5 hours and precipitation totals of more than 0.15 inch. Hydrographs for events SW-3, SW-4, and SW-6 are presented in Appendix B. Additional qualifying storm event criteria are presented in Table 4 and discussed below.

During event SW-3 on February 24, 2012, NBF received 0.34 inch of precipitation. Rainfall did not occur during the preceding 12 hours and the storm event lasted a total of 8 hours. Filtered solids sample units operated throughout event SW-3 at UNKCB27, MH362, MH461, MH368, MH482, and MH356. Approximately 2 hours after the start of precipitation, sampling locations UNKCB27, MH362, MH482, and MH368 were not collecting whole water aliquots at a pace consistent with observed flow in the storm drain. As a result, the sampling units were switched to a time-weighted program to ensure adequate stormwater volumes were collected for chemical analysis. Whole water sampling at MH461 and MH356 remained on a flow-weighted sampling program. Aliquots were collected at a much more rapid pace than expected at MH356, and the ISCO sampler filled two carboys by the midpoint in the storm. The first carboy was stored on ice in a locked polypropylene shed for the remainder of the storm. As a result of filling the second carboy, less than 50 percent of the event SW-3 hydrograph was sampled at MH356. Less than 75 percent of the storm hydrograph was sampled for whole water at MH461 and UNKCB27.

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[1] Ecology determined that this criterion of 0.04 inch was not critical to defining a qualifying storm.

More than 75 percent of the storm hydrograph was sampled for whole water at MH362, MH368, and MH482. In addition, a rain shower totaling 0.14 inch of precipitation occurred 3 hours after the sampling effort was terminated. The hydrographs for the event (Appendix B) indicate that flow was slightly above baseflow when the later rain shower began. The additional rainfall and flow are not considered part of the SW-3 storm hydrograph.

During event SW-4 on March 12–13, 2012, NBF received 0.74 inch of precipitation. Rainfall did not occur during the preceding 12 hours, and the storm event lasted a total of 18 hours. Filtered solids sample units operated throughout event SW-4 at UNKCB27, MH362, MH461, MH368, MH482, and MH356. The whole water sampling equipment at MH368 collected only a single aliquot of water during the first 2.5 hours of the storm hydrograph. The field team then switched the sampling unit to a time-weighted program to ensure that adequate stormwater was collected for chemical analysis. All other locations remained on a flow-weighted sampling program. Due to high variability in the stormwater discharge and precipitation relationship, ISCO samplers at MH356 and MH461 collected aliquots at higher rates than anticipated. Two carboys were filled at MH356 and sampling stopped early. At MH461, a power failure prevented a second carboy from being filled. The first carboy from each location was stored on ice in a locked polypropylene shed for the remainder of the storm. More than 75 percent of the hydrograph was sampled at MH368 and MH482. Due to sensor fouling or carboys being filled faster than expected, the other four locations did not meet the sampling goal criterion of 75 percent of the storm hydrograph for whole water. Hydrographs for all locations are presented in Appendix B.

During event SW-5 on March 19–20, 2012, NBF received 0.15 inch of precipitation. SAIC terminated the whole water sampling effort due to intermittent rainfall and the low precipitation volume. Filtered solids samplers remained in operation to collect SD solids at MH482, MH356 and MH368. Filter bags from MH482 and MH356 were sent to ARI to perform a methodology test to determine how air-drying a filtered solids sample affected PAH concentrations, as described in the SAP/QAPP Addendum #4 (SAIC 2011c). Results from the test are provided in Section 4.2.1.

During event SW-6 on March 28–29, 2012, NBF received 1.18 inches of precipitation. NBF received intermittent rain showers totaling 0.07 inch of precipitation in the 12-hour period prior to the start of the storm. The storm event lasted a total of 22 hours. Filtered solids sample units operated throughout event SW-6 at UNKCB27, MH362, MH461, MH368, MH482, and MH356. Whole water sampler pacing was set for a lower forecasted precipitation total (0.6 inch) and carboys reached capacity prior to completion of the storm. Two carboys each were filled at MH356 and MH482. Location MH362 started on a flow-weighted program and was switched to a time-weighted program after equipment malfunction. At locations MH461 and MH368, whole water samples could not be adequately collected using flow-weighted pacing, and so these were switched to a time-weighted program. More than 75 percent of the storm hydrograph was sampled at MH461. Due to sensor fouling or carboys being filled faster than expected, the other five locations did not meet the sampling goal criterion of 75 percent of the storm hydrograph for whole water.

Although some of the sampling locations during events SW-3, SW-4, and SW-6 did not meet the whole-water sampling goal criterion of 75 percent of the storm hydrograph, this is not believed to significantly impact the results of stormwater sampling. A substantial portion of the storm hydrograph was captured, and given the many other factors affecting sampling and analytical data, this qualifying storm event goal is likely not a major factor in affecting sample representativeness. These data are not being used to calculate contaminant loading values (in part because base flow could not be measured at these locations), and thus attaining 75 percent sampling of the storm hydrograph is not critical. Furthermore, according to data presented in Section 4.2.2, whole water analytical results between these three storm events for each location were quite consistent for each analyte, suggesting stable and representative results for these locations. Filtered solids samplers ran continuously throughout each storm event. The filtered solids portion of the sampling effort met the sampling goal criterion of 75 percent of the storm hydrograph for all storm events.

On January 24, February 20, and March 20, 2012, field personnel and equipment were mobilized to sample storm events where the predicted rainfall was greater than 0.15 inch. After mobilization, precipitation or increased stormwater flow failed to materialize at these predicted levels and these sampling efforts were abandoned. However, the event on March 20 was utilized for testing of laboratory sample preparation methods for analyzing PAHs on filtered solids (Section 4.2.1).

4.0 Analytical Results

This section presents and summarizes analytical results for the 2011–2012 stormwater sampling effort. Complete sampling results are provided in Appendix C. Laboratory data reports are provided in Appendix D (on CD); chemical data validation reports are included in Appendix E, and data validation results are summarized in Section 5.0.

4.1 North Lateral Area Sampling

4.1.1 Filtered Solids Samples

Filtered solids samples were collected during storm events SW-1 and SW-2 at locations CB175, MH172, and MH138 in the north lateral drainage area (Figure 2). Table 2 presents the chemical and physical analyses of filtered solids samples that were conducted for each sampling event. A complete table of results is presented in Appendix C, and laboratory data reports are provided in Appendix D.

Metals results were compared to the Washington State Sediment Management Standards (SMS) dry weight (DW) numeric Sediment Quality Standards (SQS) and Cleanup Screening Levels (CSL) criteria (Washington Administrative Code [WAC] 173-204). PCBs and PAH results were compared to the dry weight lowest apparent effects threshold (LAET) and the second LAET (2LAET) (PTI 1988). The LAET and 2LAET are functionally equivalent to the SQS and CSL values, respectively, but are not normalized to organic carbon. Collection of TOC data from the filters was not possible due to interference from the organic polypropylene filter bag; therefore, associated results could not be compared to the organic carbon normalized SMS criteria. Total dioxins/furans and total carcinogenic PAHs (cPAHs) are compared to Remedial Action Levels (RALs) from the LDW Feasibility Study (AECOM 2012).

Sample analytical results for individual sampling events and comparisons with relevant criteria are provided in Table 5. All results for filtered solids and catch basin solids samples are reported in dry weight (DW).

Physical Parameters

Grain size analyses were conducted when sufficient material could be scraped from the filter bags. The percent of solid material classified as fines (silt+clay) and clay (separately) are summarized below for each sampling location.

Location	Storm Drain Lateral	No. of Samples	% Fines (<62 microns)		% Clay (<3.9 microns)	
			Range	Average	Range	Average
MH172	North (N11)	2	14.0 – 22.1	18.1	3.1 – 3.9	3.5
CB175	North (N11)	2	0.3 – 1.1	0.7	0.3 – 0.5	0.4
MH138	North (N7)	1*	21.1	NA	3.4	NA

* Insufficient solids collected to conduct grain size analysis during SW-2.

MH172 and MH138 contained similar average percentages of total fines and clay fractions during storm events (approximately 20% and 3.5%, respectively). CB175 contained little to no fines (generally less than 1%).

The filtered solids samples were collected using a 5-micron mesh filter, but it is clear that a significant portion of the solids collected on the filters are smaller than 5 microns. Figure 5 shows the percent fines and percent clay for each sampling event by location; in addition, this figure shows the rainfall corresponding to each sampling event. There was no correlation between rainfall and percent fines.

PCBs

Total PCB concentrations were reported as micrograms (µg)/filter and converted to µg/kg by dividing the mass of PCBs by the mass of total dried extracted solids (and reported here as mg/kg DW). Total PCBs were calculated as the sum of detected Aroclors 1248, 1254, and 1260; however, Aroclor 1248 was only detected during event SW-2 at CB175 (2.0 mg/kg). Aroclors 1016, 1221, 1232, and 1242 were not detected in any samples. Aroclor 1254 was detected at higher concentrations than Aroclor 1260 and Aroclor 1248 in the north lateral area; with the exception of CB175 where Aroclor 1248 had the highest concentration during storm event SW-2. Aroclor 1248 was also identified in the 2010–2011 stormwater monitoring in four filtered solids samples at adjacent location CB173, at concentrations between 3.2 and 56 mg/kg DW (SAIC 2011a). These CB173 results were the primary trigger for continued sampling on tributary N11 during the 2011–2102 wet season.

Total PCBs exceeded the 2LAET criterion in one sample at MH138 (3.6 mg/kg) and both samples at MH172 (2.2 and 7.6 mg/kg) and CB175 (2.1 and 3.9 mg/kg). Total PCB concentrations in filtered solids samples collected in the north lateral area are summarized below. Sample results are presented in Table 5.

Location	**Storm Drain Lateral**	**No. of Samples**	**Total PCBs (mg/kg DW)**	
			Range	**Average**
MH172	North (N11)	2	2.2 – 7.6	4.9
CB175	North (N11)	2	2.1 – 3.9	2.5
MH138	North (N7)	2	1.0 – 3.6	2.3

Shaded cells indicate that the average concentration exceeds the LAET (0.13 mg/kg) or 2LAET (1.0 mg/kg).

During the first phase of sampling the highest PCB concentration was detected at MH172 (7.6 mg/kg) during event SW-2.

Metals

When sufficient material was collected in the filter bags, an aliquot was removed from the filter bag for metals analysis. Concentrations of cadmium, copper, mercury, and zinc in filtered solids samples are summarized below. Chromium, copper, and zinc were detected in every filtered solids sample that was collected. Sample results are presented in Table 5.

Location	Storm Drain Lateral	No. of Samples	Average Concentration (mg/kg DW) [Range of Concentrations]			
			Cadmium	Copper	Mercury	Zinc
		SQS:	5.1	390	0.41	410
		CSL:	6.7	390	0.59	960
MH172	North (N11)	2	4.7 [4.0 – 5.4]	210 [136 – 284]	0.40 [0.40]	715 [594 – 835]
CB175	North (N11)	2	2.7 [2.1 –3.2]	97 [73 – 121]	0.52 [0.30 – 0.73]	557 [520 – 594]
MH138	North (N7)	1	6.0 [NA]	454 [NA]	0.34 [NA]	1330 [NA]

Shaded cells indicate that the average concentration exceeds the SQS (░) or CSL (▓).
Average concentrations were calculated using half the reporting limit for non-detected results.
NA – not applicable

Arsenic did not exceed the SQS in any filtered solids samples. Cadmium exceeded the SQS (5.1 mg/kg) at locations MH138 and MH172. Copper exceeded the CSL at MH138 during SW-1. Mercury exceeded the CSL at CB175 during SW-1. Zinc exceeded the SQS at MH172 and CB175 during both events SW-1 and SW-2. Zinc exceeded the CSL at MH138 during SW-3. During SW-2, insufficient material was collected at MH138 to perform metals analysis.

PAHs

PAHs were analyzed in the filtered solids samples collected during SW-1 in the north lateral (Table 2). Sample results are presented in Table 5. Phenanthrene was the only low molecular weight polycyclic aromatic hydrocarbon (LPAH) compound detected in filtered solids samples at concentrations above the LAET (1.5 mg/kg), at both MH172 and CB175.

Several high molecular weight polycyclic aromatic hydrocarbon (HPAH) compounds were detected at concentrations above the LAET and 2LAET at MH172 and MH138. Fluoranthene was the only HPAH compound detected above the LAET (1.7 mg/kg) or 2LAET (2.5 mg/kg) at CB175 (3.3 mg/kg). Total HPAHs in the north lateral area exceeded the 2LAET during SW-1 at MH172 (34 mg/kg).

Concentrations of total cPAHs were identified between the lower and upper RALs (1.0 and 5.5 mg/kg) at locations MH172, CB175, and MH138 in the north lateral area.

Dioxins/Furans

Dioxin/furan congeners were analyzed on samples from event SW-2 (Table 2). Concentrations of each congener were normalized to the toxicity of 2,3,7,8-TCDD (tetrachlorodibenzodioxin) using toxic equivalency factors (TEFs) updated by the World Health Organization (WHO) in 2005 (Van den Berg et al. 2006). The toxic equivalent (TEQ) is equal to the sum of the concentrations of individual congeners multiplied by their TEF. TEQ values are reported using half the method detection limits for nondetected congeners.

Location	Storm Drain Lateral	No. of Samples	Total Dioxins/ Furans TEQ (ng/kg DW)
MH172	North (N11)	1	31.4
CB175	North (N11)	1	14.1
MH138	North (N7)	1	50.3

Shaded cells indicate that the average concentration exceeds the lower RAL (25 ng/kg) or upper RAL (50 mg/kg).

Filtered solids samples collected from MH138 exceeded the lower RAL and from MH138 exceeded the upper RAL, both in the north lateral area.

4.1.2 Storm Drain Solids Grab Samples

Storm drain solids grab samples were collected during base flow conditions at locations MH181A, MH179B, CB174, CB173, and CB165 in the north lateral area. Sample locations are presented on Figure 2.

Results were compared to the SQS and CSL and other criteria as described above. Grab samples were analyzed for TOC; however, associated PCB and PAH results were compared to dry weight LAET and 2LAET criteria to be comparable to filtered solids sample results. Sample results for detected chemicals are summarized in Table 6, with comparisons to relevant criteria.

Physical Parameters

Grain size analyses were conducted when sufficient material could be scraped from the bottom of each manhole or catch basin. The percent of solid material classified as total fines (silt/clay) and clay are summarized below for each sampling location. MH181A contained the highest percentage of fines and clay.

Location	Storm Drain Lateral	No. of Samples	% Fines (<62 microns)	% Clay (<3.9 microns)
MH181A	North (N11)	1	66.9	12.1
MH179B	North (N11)	1	6.1	2.4
CB174	North (N11)	1	19.2	6.1
CB173	North (N11)	1	41.2	8.8
CB165	North (N10)	1	11.1	4.1

PCBs

Total PCBs were calculated as the sum of detected Aroclors 1248, 1254, and 1260; however, Aroclor 1260 was not detected at MH181A, MH179B, and CB173. Aroclors 1016, 1221, 1232, and 1242 were not detected in any samples. Total PCBs exceeded the LAET in all SD solids grab samples. Total PCBs exceeded the 2LAET in grab samples at locations MH181A, MH179B, and CB173.

Total PCB concentrations in grab samples are summarized below:

Location	Storm Drain Lateral	No. of Samples	Total PCBs (mg/kg DW)
MH181A	North (N11)	1	54
MH179B	North (N11)	1	4.6
CB174	North (N11)	1	0.41
CB173	North (N11)	1	50
CB165	North (N10)	1	0.45

Shaded cells indicate that the average concentration exceeds the LAET (0.13 mg/kg) or 2LAET (1.0 mg/kg).

The highest total PCB concentrations were detected at MH181A (54 mg/kg) and CB173 (50 mg/kg).[2] Aroclor 1254 was detected at higher concentrations than Aroclors 1260 and 1248 in the solids grab samples, with the exception of MH179B where Aroclor 1248 had the highest concentration. Similar to filtered solids results in tributary N11 (Section 4.1.1), Aroclor 1248 forms a relatively high percentage of total PCBs in the four N11 solids grab samples, averaging 40 percent of total PCBs.

Metals

Cadmium, chromium, copper, lead, mercury, and zinc were detected in solids grab samples at all locations. Arsenic and silver concentrations were not detected at CB174 or CB165, and silver was not detected at MH179B. Cadmium, copper, mercury, and zinc concentrations exceeded the CSL at MH181A. Zinc concentrations exceeded the SQS at MH179B, CB174, and CB173 and exceeded the CSL at CB165. The mercury concentration at CB173 exceeded the CSL. Sample results are provided in Table 6.

PAHs

Phenanthrene was the only LPAH detected in solids grab samples. The phenanthrene concentration in the sample from MH181A was above the LAET. Total LPAH did not exceed the LAET in grab samples at any locations. Fluoranthene, chrysene, and dibenz(a,h)anthracene concentrations exceeded the LAET criteria at MH181A. Indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene concentrations exceeded the 2LAET at MH181A. Total HPAHs exceeded the LAET at MH181A. Total cPAHs (TEQ) exceeded the lower RAL at MH181A. PAHs were either not detected or detected below screening levels at all other locations.

Phthalates

Di-n-butylphthalate exceeded the LAET at MH179B and 2LAET at MH181A and CB173. Dimethylphthalate exceeded the 2LAET at MH181A. Butylbenzylphthalate exceeded the LAET at CB174 and 2LAET at MH181A. Bis(2-ethylhexyl) phthalate exceeded the LAET at CB173 and 2LAET at MH181A, CB174, and CB165. Di-n-octyl phthalate exceeded the 2LAET at CB174.

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[2] Landau Associates resampled MH181A and CB173 solids grab samples for PCBs on July 25, 2012. Total PCB concentrations were detected at 29 mg/kg for MH181A and 34 mg/kg for CB173.

Phenols

Phenol exceeded the LAET at MH181A and CB165. Concentrations of 2-methylphenol and 2,4-dimethylphenol were detected at levels 10 times the 2LAET at MH181A. Concentrations of 4-methyphenol exceeded the 2LAET at CB174 and was more than 10 times the 2LAET at CB165.

Dioxins/Furans

Sufficient solids were collected from locations CB173 and CB165 and analyzed for dioxin/furan congeners. The grab sample collected from CB173 (97.3 ng/kg TEQ) exceeded the upper RAL.

4.2 North-Central, South-Central, and South Lateral Area Sampling

4.2.1 Filtered Solids Samples

Filtered solids samples were collected during storm events at UNKCB27, MH362, MH461, MH368, MH482, and MH356 (Figure 3). Table 2 presents the chemical and physical analysis of filtered solids samples that was conducted for a given sampling event. A complete table of results is presented in Appendix C. Results were compared to criteria as described above in Section 4.1.1. Sample results for detected chemicals are summarized in Table 5 for individual sampling events and comparisons with relevant criteria.

Physical Parameters

Grain size analyses were conducted when sufficient material could be scraped from the filter bags; the percent of solid material classified as fines (silt/clay) and clay are summarized below for each sampling location.

Location	Storm Drain Lateral	No. of Samples	% Fines (<62 microns)		% Clay (<3.9 microns)	
			Range	Average	Range	Average
UNKCB27 (up)	North-Central	2	56.5 – 77.3	66.9	31.4 – 41.1	36.3
MH362 (down)		2	44.5 – 66.1	55.3	4.9 – 33.3	19.1
MH461 (up)	South-Central	2	63.6 – 65.9	64.8	37.8 – 62.3	50.1
MH368 (down)		2	32.1 – 60.8	46.5	12.0 – 53.2	32.6
MH482 (up)	South	2	20.8 – 31.4	26.1	14.0 – 16.3	15.2
MH356 (down)		2	54.9 – 57.7	56.3	31.5 – 38.8	35.2

The north-central and south-central lateral areas contained the highest percentage of total fines at upstream locations (averaging 66% at UNKCB27 and MH461). Average percent fines and clay decreased from the upstream to downstream locations in the north-central and south-central lateral, but increased significantly in the south lateral.

The filtered solids samples were collected using a 5-micron mesh filter, but it is clear that a significant portion of the solids collected on the filters are smaller than 5 microns. Figure 5 shows the percent fines and percent clay for each sampling event by location; in addition, this figure shows the rainfall corresponding to each sampling event. There was no correlation between rainfall and percent fines.

PCBs

Filtered solids samples collected during storm events SW-3 and SW-6 were analyzed for PCBs. Samples were analyzed for dioxins/furans during SW-4. Total PCBs were calculated as the sum of detected Aroclors 1254 and 1260. Aroclors 1016, 1221, 1232, 1242, and 1248 were not detected in any samples collected from the north-central, south-central, and south lateral drainage areas.

Total PCBs exceeded the LAET in all filtered solids samples with the exception of event SW-3 at MH461 and MH482. Total PCBs exceeded the 2LAET in two samples at MH362 (1.7 mg/kg and 2.1 mg/kg). Total PCB concentrations in filtered solids samples are summarized below.

Location	Storm Drain Lateral	No. of Samples	Total PCBs (mg/kg DW)	
			Range	Average
UNKCB27 (up)	North-Central	2	0.22 – 0.27	0.25
MH362 (down)		2	1.7 – 2.1	1.9
MH461 (up)	South-Central	2	<0.005 – 0.15	0.075
MH368(down)		2	0.20 – 0.29	0.25
MH482 (up)	South	2	0.015 – 0.36	0.19
MH356 (down)		2	0.17 – 0.44	0.31

Shaded cells indicate that the average concentration exceeds the LAET (0.13 mg/kg) or 2LAET (1.0 mg/kg).

For the second phase of sampling, the average concentrations of total PCBs were highest in the north-central lateral. Concentrations of total PCBs increased from the upstream location to the downstream location in the north-central, south-central, and south laterals. The highest downstream increase was in the north-central lateral. A comparison of total PCBs by storm drain lateral and event is presented in Figure 6.

Metals

Silver was detected in one sample at MH362 during storm event SW-6. Arsenic did not exceed the SQS in any filtered solids samples. Concentrations of cadmium, copper, mercury, and zinc in filtered solids samples are summarized below. Chromium, copper, and zinc were detected in every filtered solids sample that was collected. A full list of sampling results is presented in Table 5.

A comparison of cadmium by drainage area and event for the second phase of sampling is presented in Figure 7. Cadmium concentrations increased from upstream to downstream locations in the north-central and south-central lateral areas. Cadmium remained elevated at upstream and downstream locations in the south lateral, exceeding the CSL in all samples. Cadmium exceeded the SQS (5.1 mg/kg) at locations MH138 and MH172; and it exceeded the CSL (6.7 mg/kg) at locations UNKCB27, MH362, MH482, MH368, and MH356 during one or more events (Table 5).

Location	Storm Drain Lateral	No. of Samples	Average Concentration (mg/kg DW) [Range of Concentrations]				
			Cadmium	**Chromium**	**Copper**	**Mercury**	**Zinc**
		SQS:	5.1	260	390	0.41	410
		CSL:	6.7	270	390	0.59	960
UNKCB27 (up)	North-Central	3	7.7 [7.0 – 9.0]	122 [91 – 177]	343 [309 – 370]	0.28 [<0.30 – 0.40]	979 [818 – 1,120]
MH362 (down)		3	10 [8.7 – 11]	136 [92 – 186]	227 [166 – 250]	0.37 [0.32 – 0.40]	1,250 [1,070 – 1,360]
MH461 (up)	South-Central	3	2.8 [<3.0 – 5.0]	41 [20 – 62]	120 [28 – 182]	0.20 [<0.20 – 0.30]	190 [120 – 240]
MH368 (down)		3	6.0 [2.0 – 10]	51 [28 – 67]	70 [41 – 88]	0.11 [<0.06 – 0.19]	518 [264 – 800]
MH482 (up)	South	3	11 [8.9 – 13]	43 [33 – 50]	180 [149 – 214]	2.2 [0.20 – 6.1]	752 [714 – 819]
MH356 (down)		3	9.3 [8.0 –10]	1,210 [137 – 3,140]	315 [182 – 535]	0.30 [0.20 – 0.40]	1,020 [1,000 – 1,030]

Shaded cells indicate that the average concentration exceeds the SQS (░) or CSL (▓).
Average concentrations were calculated using half the reporting limit for non-detected results.

A comparison of chromium by drainage area and event for the second phase of sampling is presented in Figure 8. Chromium was detected in all filtered solids samples but only exceeded the SQS (260 mg/kg) and/or the CSL (270 mg/kg) at MH356 during storm events SW-3 and SW-4. Chromium was detected at 3,140 mg/kg in filtered solids at MH356 during event SW-3. To confirm this significantly elevated concentration, chromium was reanalyzed using the laboratory archived sample from event SW-3, and it was measured at 2,100 mg/kg. The source of this significantly elevated chromium concentration is not known. Chromium also exceeded the CSL at MH356 during event SW-4 (354 mg/kg), but did not exceed the SQS during event SW-6 (137 mg/kg) (Table 5).

A comparison of copper by drainage area and event for the second phase of sampling is presented in Figure 9. Copper concentrations decreased from upstream to downstream locations during all events in the north-central lateral area and during events SW-4 and SW-6 in the south-central lateral area; however, copper was detected below the SQS/CSL (390 mg/kg) at both locations. Copper concentrations increased from upstream to downstream locations in the south lateral area and exceeded the SQS/CSL during event SW-3 at MH356 (535 mg/kg) (Table 5).

A comparison of lead by drainage area and event for the second phase of sampling is presented in Figure 10. Lead concentrations decreased from upstream to downstream locations in the north-central lateral area, increased in the south-central lateral, and remained relatively constant in the south lateral. Lead exceeded the CSL (530 mg/kg) in the north lateral during event SW-4 at UNKCB27 (700 mg/kg), but was detected below SQS (450 mg/kg) at downstream location MH362 (190 mg/kg). All other detections were below the SQS/CSL (Table 5).

A comparison of mercury by drainage area and event for the second phase of sampling is presented in Figure 11. Mercury concentrations in the north-central and south-central lateral areas were below the SQS (0.41 mg/kg) and CSL (0.59 mg/kg) during all events. Mercury exceeded the CSL in the south lateral during event SW-4 at MH482 (6.1 mg/kg), but was detected below the SQS at downstream location MH356 (0.20 mg/kg) (Table 5).

A comparison of zinc by drainage area and event for the second phase of sampling is presented in Figure 12. Zinc concentrations in the north-central, south-central, and south lateral areas increased from the upstream to downstream locations. Zinc exceeded the SQS (410 mg/kg) at four locations (MH172, CB175, MH368, MH482) and the CSL (960 mg/kg) at four locations (MH138, UNKCB27, MH362, MH356) (Table 5).

PAHs

During previous stormwater monitoring seasons, concentrations of PAH compounds were reported as µg/filter and converted to µg/kg dry weight by dividing the analyzed mass of PAHs by the estimated dried mass of extracted solids (and reported as mg/kg). Because the samples were not dried before analysis (to minimize potential volatilization of lighter PAH compounds), assumptions regarding the dry mass of extracted solids were made based on the dry weight of solids collected on the second filter in each filter pair. This assumption may have resulted in under- or over-estimation of PAH concentrations.

In an attempt to obtain more accurate PAH concentrations, a test was conducted to evaluate how air-drying filtered solids samples affected PAH concentrations. On March 20, 2012 (event SW-5), filtered solids samples from MH356 and MH482 (two samples from each location) were submitted to ARI to evaluate how air-drying the samples affected concentrations of PAHs. One filtered solids sample used the air-dry method for PAH analysis. The second filtered solids sample used the wet filter method for PAH analysis (as described above). Sample results for the test preparation comparison are provided in Table 7 in terms of both concentration and mass per filter.

Percent-different averages for pairs of individual PAH concentrations were below the laboratory default quality control limit for precision of 30 percent. In some instances, PAH concentrations were higher on air-dried filters than wet filters. Test data indicate that air-drying the filters prior to PAH analysis results in minimal loss of PAHs, and LPAHs appear to be affected more than HPAHs, as expected. As a result, all filters for the 2011–2012 stormwater monitoring were analyzed using the air-drying method. Results for the PAH test conducted with air-dried filtered solids samples collected during event SW-5 are presented in Table 5, and in Figures 13 through 15. PAH results are discussed below.

Phenanthrene was the only LPAH detected in filtered solids samples at concentrations above the LAET (1.5 mg/kg) during events SW-3, SW-4, and SW-6 at MH356, MH362, MH482, and UNKCB27. Phenanthrene exceeded 2LAET (5.4 mg/kg), during events SW-3, SW-4 and SW-6 at UNKCB27, and SW-4 and SW-6 at MH482. Total LPAHs exceeded the LAET during all events at UNKCB27, and events SW-4 and SW-6 at MH482. Total LPAHs also exceeded the 2LAET (13 mg/kg) during events SW-3 and SW-4 at UNKCB27 (Figure 13). Total LPAHs decreased from upstream to downstream locations in the north-central and south lateral areas. Total LPAHs remained at low levels in the south-central lateral. A comparison of total LPAHs by drainage area and event for the second phase of sampling is presented in Figure 13.

Several HPAH compounds were detected at concentrations above the LAET and 2LAET at MH172, MH138, UNKCB27, MH362, MH482, and MH356. Fluoranthene was the only HPAH compound detected above the LAET (1.7 mg/kg) or 2LAET (2.5 mg/kg) at CB175 (3.3 mg/kg). HPAHs were not detected above the LAET in the south-central lateral (MH461 and MH368). Total HPAHs in the north-central and south lateral exceeded the 2LAET during all events at all locations, with the exception of SW-5 at MH356 where total HPAHs equaled the 2LAET. Total HPAHs were detected at concentrations 10 times the 2LAET at UNKCB27 during SW-3 and SW-4 and at MH482 during events SW-4 and SW-6. In general, concentrations of HPAHs decreased from upstream to downstream in the north-central and south laterals. Total HPAH exceedances were representative of individual HPAH compounds as presented in Table 5. A comparison of total HPAHs by drainage area and event for the second phase of sampling is presented in Figure 14.

In the north lateral area, total cPAHs exceeded the upper and lower RALs (1.0 and 5.5 mg/kg TEQ) at UNKCB27 during events SW-3, SW-4, and SW-6, and at MH362 during SW-3. Total cPAHs exceeded the lower criterion at MH362 during SW-4 and SW5. Total cPAHs did not exceed either criterion at any locations in the south-central lateral. Filtered solids were not collected from the north-central or south-central laterals during SW-5. In the south lateral, total cPAHs exceeded the upper criterion at MH482 during events SW-4, SW-5, and SW-6 and exceeded the lower criterion during SW-3. Total cPAHs exceeded the upper criterion at MH356 during SW-4 and SW-6 and exceeded the lower criterion during SW-3 and SW-5. Total cPAH concentrations decreased from upstream to downstream in the north-central and south lateral areas. A comparison of total cPAHs by drainage area and event for the second phase of sampling is presented in Figure 15.

Dioxins/Furans

Dioxin/furan congeners were analyzed from sampling event SW-4 (Table 5). All sample results exceeded the lower RAL (25 ng/mg TEQ). Total dioxins/furans in the upstream and downstream locations of the north-central and south lateral areas exceeded the upper RAL (50 ng/kg TEQ).

Location	Storm Drain Lateral	No. of Samples	Total Dioxin/ Furan TEQ (ng/kg DW)
UNKCB27 (up)	North-Central	1	88
MH362 (down)		1	70
MH461 (up)	South-Central	1	49
MH368(down)		1	33
MH482 (up)	South	1	59
MH356 (down)		1	84

Shaded cells indicate that the average concentration exceeds the lower RAL (░) or upper RAL (▓).

Total dioxins/furans concentrations decreased from upstream to downstream locations in the north-central and south-central lateral areas. Total dioxins/furans increased from upstream to downstream in the south lateral. A comparison of total dioxins/furans by drainage area for the second phase of sampling is presented in Figure 16.

4.2.2 Whole Water Samples

Whole water samples were collected at UNKCB27, MH362, MH461, MH368, MH482, and MH356 (Figure 3). Whole water samples were not collected at CB175, MH172, or MH138. Results are summarized in Table 8. Chemical and physical analyses of whole water samples conducted for each sampling event are presented in Table 3. Concentrations of PCBs and metals are compared to the state/federal marine chronic water quality criteria (WQC) for aquatic life (WAC 173-201A-240); the only exception is silver, which does not have a chronic value and the acute criterion is applied. The other organic contaminants lack aquatic life WQC and are instead compared to the federal human health-based marine WQC for consumption of organisms (EPA 2006). Full analytical results are listed in Appendix C.

Conventional Parameters

Conventional parameters, including pH, alkalinity, hardness, TSS, chloride, nitrate, sulfate, DOC and TOC, were measured in each of the whole water samples. The pH ranged from 6.5 to 6.9 at all sampling locations. Average TOC, DOC, and TSS are listed below.

Location	Storm Drain Lateral	pH	Average TOC (mg/L)	Average DOC (mg/L)	Average TSS (mg/L)
UNKCB27 (up)	North-Central	6.6 – 6.8	1.9	1.4	2.1
MH362 (down)		6.5 – 6.7	2.4	1.5	5.6
MH461 (up)	South-Central	6.6 – 6.7	3.2	2.2	8.9
MH368(down)		6.6 – 6.9	4.5	3.3	22.9
MH482 (up)	South	6.6 – 6.7	3.8	2.8	6.7
MH356 (down)		6.5 – 6.8	5.3	2.3	36.8

In general, TSS and TOC were lowest at upstream locations in the north-central, south-central, and south lateral areas.

PCBs

Total PCBs were calculated as the sum of detected Aroclors 1254 and 1260. Aroclors 1016, 1221, 1232, 1242, and 1248 were not detected in any samples; with the exception of Aroclor 1242 during SW-3 at MH362. During sampled storm events, total PCBs did not exceed the WQC (0.030 µg/L) at any sample location. Total PCBs were not detected at any of the upstream locations UNKCB27, MH461, or MH482. Total PCB concentrations in whole water samples are summarized below.

Location	Storm Drain Lateral	No. of Samples	Total PCBs (µg/L)	
			Range	**Average**
MH362 (down)	North-Central	3	0.011 – 0.024	0.018
MH368 (down)	South-Central	3	0.0060 – 0.015	0.011
MH356 (down)	South	3	0.013 – 0.024	0.019

In general, total PCB concentrations in the north-central, south-central, and south lateral areas increased from upstream to downstream locations during all sampling events. A comparison of total PCBs by drainage area for the second phase of sampling is presented in Figure 16.

Metals

Total lead was detected at above the WQC (8.5 µg/L) in one sample collected during SW-6 at MH356 (9.7 µg/L). Total mercury was detected above the WQC (0.029 µg/L) in one sample collected during SW-6 at MH368 (0.10 µg/L); dissolved mercury was below detection at all locations. Selenium and silver were not detected in any of the whole water samples. Sampling results are presented in Table 8.

Concentrations of total arsenic, copper, lead, and zinc in whole water samples are summarized below. These metals were detected in every water sample that was collected.

Location	Storm Drain Lateral	No. of Samples	Average Concentration (µg/L) [Range of Concentrations]			
			Total Arsenic	**Total Copper**	**Total Lead**	**Total Zinc**
		WQC:	36	3.7	8.5	86
UNKCB27 (up)	North-Central	3	0.23 [0.20 – 0.30]	3.0 [2.6 – 3.3]	0.97 [0.70 – 1.2]	25 [24 – 27]
MH362 (down)		3	0.53 [0.40 – 0.70]	3.4 [3.1 – 3.7]	1.3 [1.0 – 1.5]	34 [25 – 40]
MH461 (up)	South-Central	3	0.96 [0.90 – 1.0]	3.2 [3.1 – 3.2]	0.60 [0.50 – 0.70]	11 [10 – 12]
MH368 (down)		3	1.3 [1.2 – 1.5]	3.5 [2.7 – 4.2]	1.1 [0.70 – 1.5]	31 [25 – 36]
MH482 (up)	South	3	0.67 [0.60 – 0.70]	4.7 [4.6 – 4.8]	2.6 [2.1 – 3.1]	29 [28 – 29]
MH356 (down)		3	1.4 [0.80 – 1.9]	9.4 [7.7 – 11]	8.0 [6.8 – 9.7]	62 [54 – 71]

Shaded cells indicate that the average concentration exceeds the WQC (▨).

Average total copper concentrations exceeded the WQC (3.7 µg/L) in all storm event samples at locations MH482 and MH356 in the south lateral area and were significantly higher in the downstream samples. Total arsenic, cadmium, chromium, nickel, and zinc did not exceed the WQC in any whole water samples at any locations. No dissolved metals were detected above their respective WQC. A comparison of copper, lead, and zinc by drainage area and event for the second phase of sampling is presented in Figures 18, 19, and 20, respectively. Other metals were not detected or detected well below the WQC.

PAHs

HPAHs were detected more frequently than LPAHs (Table 8). Several HPAHs, including benzo(a)anthracene, chrysene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene, frequently exceeded the WQC criterion (0.018 µg/L) at UNKCB27, MH362, MH482, and MH356. Chrysene also exceeded the WQC at MH461 and MH368. The highest concentrations of HPAHs were detected at MH356. Dibenz(a,h)anthracene exceeded the WQC at MH482 and MH356. Concentrations of total HPAHs and total cPAHs are summarized below.

Location	**Storm Drain Lateral**	**No. of Samples**	**Average Total HPAHs (µg/L) [Range of Concentrations]**	**Average Total cPAHs (µg/L) [Range of Concentrations]**
UNKCB27 (up)	North-Central	3	0.72 [0.41 – 1.3]	0.062 [0.035 – 0.11]
MH362 (down)		3	0.49 [0.32 – 0.69]	0.046 [0.038 – 0.057]
MH461 (up)	South-Central	3	0.14 [0.076 – 0.18]	0.016 [0.011 – 0.019]
MH368 (down)		3	0.16 [0.032 – 0.34]	0.017 [0.0083 – 0028]
MH482 (up)	South	3	2.4 [2.2 – 2.8]	0.22 [0.21 – 0.25]
MH356 (down)		3	5.7 [4.9 – 6.2]	0.66 [0.54 – 0.74]

Shaded cells indicate that the max detected value exceeds the WQC (░) or 10x WQC (▒).

Total cPAHs (TEQ) exceeded the human health-based WQC of 0.018 µg/L during all events in the north-central lateral area and were more than ten times this criterion during all events in the south lateral. Total cPAHs exceeded this criterion at MH461 during event SW-4, and at MH368 during SW-3. Total cPAHs remained relatively constant from upstream to downstream locations in the north-central and south-central laterals. Total cPAHs in the south lateral were more than two times higher in the downstream location than upstream. A comparison of total HPAHs and total cPAHs by drainage area and event for the second phase of sampling is presented in Figures 21 and 22, respectively.

Other SVOCs

Additional SVOCs were analyzed but seldom detected. Di-n-octylphthalate and phenol were each detected during only one storm event, at concentrations below 1.0 µg/L (Table 8).

4.2.3 MH362 Infiltrating-Water Grab Sample

An aqueous grab sample was collected of seepage infiltrating into storm drain lines via pipe joints located several feet downstream of MH362 (Figure 3). Results for detected chemicals in this whole water sample are summarized in Table 9. Concentrations are compared to various WQC, as described in Section 4.2.2.

Aroclor 1254 was the only Aroclor detected in the grab sample. The total PCB concentration (0.020 µg/L) was below the WQC (0.030 µg/L). Total arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc exceeded the WQC. Dissolved metals did not exceed the WQC. PAHs were not detected in this grab sample. The source of the white coloration is not certain, but due to the relative lack of contamination, this material likely represents a bacterial-mediated product as groundwater oxidizes upon entering the stormwater system.

5.0 Quality Assurance/Quality Control

Analyses were conducted following the quality assurance/quality control (QA/QC) requirements specified in the project SAP/QAPP and its Addenda (SAIC 2009a, 2010b, 2010c, 2011b), and the referenced test methods. The QA/QC procedures ensure that the results of the investigation are defensible and usable for their intended purpose. Independent data validation was performed on all of the chemical results by EcoChem, Inc. (EcoChem) of Seattle, Washington, following EPA guidance (EPA 1994, 2005, 2008, 2009, 2010). Full-level EPA Stage 4 data validation was performed on all dioxin/furan results and summary-level EPA Stage 2b data validation was performed on all other sample results. The rinse blank samples underwent an EPA Stage 2a compliance level screening. All results were considered acceptable for use, as qualified. No data were rejected during data validation. Issues resulting in data qualification are summarized below. A full list of qualified results including the reason for data qualification is presented in the data validation report in Appendix E.

Results for various chemicals were J- or UJ-qualified as estimated because one or more of the following were outside of control limits: calibration verification, laboratory control sample, spiked compound, and/or reporting limit verification recoveries; or duplicate sample or second column confirmation results' relative percent difference; or qualitative identification parameters. The nickel results for sample NBF-UNKCB27-032912-W were J-qualified as estimated because the dissolved concentration of 1.1 µg/L was greater than the total nickel concentration of 0.5 µg/L. Three non-detect coarse silt grain size results were qualified as estimated because of high organic content in the samples.

Twenty-one results for three individual PCB Aroclors were Y-qualified by ARI as nondetect at elevated reporting limits (RLs) because chromatographic interferences prevented adequate resolution of the compound at the standard RL. A total of 21 results for various dioxin/furan congeners were EMPC-qualified by ARI as being estimated maximum possible concentrations because not all method-required compound identification parameters were met. These results were re-qualified as nondetect (U-qualified) by EcoChem at the reported concentrations.

Some planned analyses (e.g., metals and/or grain size on some specific samples) and/or project specific laboratory QA/QC samples could not be performed because of insufficient sample volume.

The initial metals analysis of sample NBF-MH356A-022412-S had an anomalously elevated chromium concentration of 3,410 mg/kg. Archived laboratory material from this sample was then reanalyzed for confirmation, which also yielded an usually elevated result of 2,110 mg/kg. The initial result was selected as the final reported value.

A total of six equipment rinse blank samples were collected as part of the 2011–2012 sampling program (Appendix C). Additional field QA/QC samples such as field replicates, whole water equipment rinse blank samples (i.e., rinsate from the ISCO samplers), and blank filter bag analyses were previously conducted as part of the preliminary and/or expanded stormwater sampling events (SAIC 2010a, 2011a).

Two filtered solids sampling equipment rinse blanks were collected in September 2011 and submitted for analysis. These rinse blank samples contained various chemicals apparently rinsed off the decontaminated pump and piping sections, the filter housings, and/or the new flexible tubing. Following receipt of results (see Appendix C), this equipment was further decontaminated within all sampling units. The contaminants identified in these equipment rinse samples are presumably dissolved or very finely divided particulates, and during sampling they would not likely be captured as solids on the filter bags. For this reason and because the units were further decontaminated, no filtered solids sample results were qualified based on these equipment rinse results.

A single whole water equipment rinse blank was collected in October 2011 on two types of sample tubing and on the sample carboy, and submitted for analysis (results in Appendix C). After qualification for method blank contamination, positive results remained for ten chemicals. This rinse blank was not used to qualify the results of any stormwater samples because the rinse was performed together on three pieces of equipment and thus was not specific. In addition, this rinse blank was collected in a field warehouse, where minor airborne contamination may have been entrained.

In order to isolate the potential source of contamination, in December 2011, three additional rinse blanks for the sampling equipment specific to both tubing types and the carboy were collected in an outdoor location away from potential sources. In these whole water equipment rinse samples, two results for PAHs were re-qualified as nondetect at elevated RLs because of method blank contamination, including naphthalene at 0.011 µg/L and fluoranthene at 0.016 µg/L. Following this adjustment, results for these three samples showed detected concentrations only in the carboy rinse blank, sample NBF-CARCS1-120111 (this equipment rinse included use of the churn splitter in the lab).

Based on this equipment blank contamination, thirteen results for three chemicals in whole water samples were re-qualified as nondetect at elevated RLs, including the following: six results for pyrene ranging from 0.015 to 0.054 µg/L, three results for chrysene ranging from 0.017 to 0.025 µg/L, and four results for bis(2-ethylhexyl) phthalate ranging from 1.0 to 3.5µg/L (PAHs were analyzed using method EPA 8270-SIM, and phthalates with EPA 8270D). These revised qualifiers are reflected in Table 8.

6.0 Summary

Stormwater sampling conducted at NBF between September 2011 and April 2012 was a continuation of the stormwater monitoring program that was initiated in 2009. During the first phase of the sampling effort, filtered suspended solids samples were collected during two storm events at CB175, MH172, and MH138 in the north lateral drainage area (Figure 2). These were located along storm drain tributaries with previously identified contamination.

During the second phase of the sampling effort, filtered suspended solids and whole water samples were collected during three storm events at UNKCB27 and MH368 on the north-central lateral, MH461 and MH362 on the south-central lateral, and MH482 and MH356 on the south lateral (Figure 3). These represent upstream and downstream locations on three major storm drain laterals at the NBF site. Continuous flow measurements were collected at these six locations during the sampling period.

In May 2012, five storm drain solids grab samples were collected from MH181A, MH179B, CB174, CB173, and CB165, to aid in source tracing for previously identified contamination.

For chemical comparisons in filtered solids samples, the lower and upper screening level criteria represent the SQS and CSL for metals and phenols, and the LAET and 2LAET for PCBs and PAHs. The lower and upper screening level values for total cPAHs (TEQ) and total dioxins/furans (TEQ) represent a range of LDW-wide remedial action levels for the preferred alternative and other alternatives in the LDW Feasibility Study and Proposed Plan. Results from sampling efforts for the 2011–2012 stormwater monitoring season are summarized below, and filtered solids results are also summarized in Table 10.

For chemical comparisons in whole water samples, screening level criteria for metals and PCBs include the state/federal marine ambient water quality criteria for aquatic life. PAHs and other SVOCs utilize the federal marine water quality criteria for protection of human health via consumption of organisms.

6.1 North Lateral Storm Drain Sampling

Filtered solids samples were collected during storm events SW-1 and SW-2 at CB175 and MH172 (both on tributary N11) and at MH138 (tributary N7) in the north lateral drainage area (Figure 2). In May 2012, storm drain solids grab samples were collected at MH181A, MH179B, CB174, and CB173 (all four on tributary N11), and at CB165 (tributary N10) (Figure 2).

Filtered Solids Results

Filtered solids results for the north lateral drainage area are summarized in the table below. The ranges for any chemicals exceeding the upper screening level at one or more locations are shown. A more complete listing of results for filtered solids samples is presented in Table 5.

Location	Chemical Concentrations in Filtered Solids Samples (mg/kg except as noted)					
	Total PCBs	**Copper**	**Mercury**	**Zinc**	**Total HPAHs**	**Total Dioxins/ Furans (ng/kg)**
Lower SL:	0.13	390	0.41	410	12	25
Upper SL:	1.0	390	0.59	960	17	50
MH138	1.0 – 3.6	454	0.34	1,330	12	50.3
MH172	2.2 – 7.6	136 – 84	0.4 – 0.4	594 – 835	34	31
CB175	2.1 – 3.8	73 – 121	0.30 – 0.73	520 – 594	12	14

Shaded cells indicate that the max detected value exceeds the Lower SL (░) or Upper SL (▓).

Total PCBs exceeded the upper screening level at CB175, MH172, and MH138 during both storm events. The highest concentration of PCBs was detected in MH172 during SW-2.

Copper, mercury, and zinc exceeded the upper screening level at MH138 during SW-1 (metals were not analyzed at MH138 during SW-2).

Total HPAHs exceeded the upper screening level at MH172 during SW-1 (PAHs were not analyzed during SW-2).

Total dioxins/furans exceeded the upper screening level at MH138 during SW-2 (dioxins/furans were not analyzed during SW-1).

Storm Drain Solids Grab Sample Results

Storm drain solids grab sample results for the north lateral are summarized in the tables below. The chemicals exceeding the upper screening level at one or more locations are shown. A more complete listing of results for storm drain solids grab samples is presented in Table 6.

Location	Chemical Concentrations in Filtered Solids Samples (mg/kg except as noted)					
	Total PCBs	**Cadmium**	**Copper**	**Mercury**	**Zinc**	**Total Dioxins/ Furans (ng/kg)**
Lower SL:	0.13	5.1	390	0.41	410	25
Upper SL:	1.0	6.7	390	0.59	960	50
MH181A	**54**	8.5 J	466	4.96 J	1,770 J	NA
MH179B	4.6	1.3 J	39.6	0.100 J	466 J	NA
CB174	0.41	2.1 J	71	0.170 J	767 J	NA
CB173	**50**	2.2 J	119	2.47 J	415 J	97.3 J
CB165	0.45	1.9 J	78.1	0.180 J	1,760 J	7.21 J

Location	Chemical Concentrations in Filtered Solids Samples (mg/kg)							
	Di-n-butyl phthalate	**Dimethylphthalate**	**Butylbenzylphthalate**	**Bis(2-ethylhexyl) phthalate**	**2-Methylphenol**	**4-Methylphenol**	**2,4-Dimethylphenol**	**N-Nitroso-diphenylamine**
Lower SL:	1.4	0.071	0.063	1.3	0.063	0.67	0.029	0.028
Upper SL:	5.1	0.16	0390	1.9	0.063	0.67	0.029	0.040
MH181A	8.1	0.38 J	1.7	17	**1.1**	0.52 J	**0.66 J**	0.34 J
MH179B	2.6	0.074 U	0.074 U	0.76	0.074 U	0.15 U	0.074 U	0.074 U
CB174	0.27 J	0.32 U	0.19 J	2.1	0.32 U	1.1	0.32 U	0.32 U
CB173	5.6	0.078 U	0.078 U	1.4	0.078 U	0.16 U	0.078 U	0.078 U
CB165	0.76	0.29 U	0.29 U	5.7	0.29 U	**7.8**	0.29 U	0.29 U

Shaded cells indicate that the max detected value exceeds the Lower SL (░), Upper SL (▒), or 10x Upper SL (█). NA – Not Analyzed

Total PCBs in the samples collected from MH181A and CB173 (tributary N11) were greater than 10 times the upper screening level.

Cadmium, copper, mercury, and zinc exceeded the upper screening level at MH181A.

In general, SVOCs had the most frequent and greatest exceedances at MH181A.

Total dioxins/furans exceeded the upper screening level at CB173.

6.2 North-Central Lateral Storm Drain Sampling

Filtered solids and whole water samples were collected during events SW-3, SW-4, and SW-6 at the upstream location UNKCB27 and downstream location MH362 on the north-central lateral (Figure 3).

Filtered Solids Results

Filtered solids results for the north-central lateral are summarized in the table below. The ranges for chemicals exceeding the upper screening level at one or both locations are shown. A more complete listing of results for filtered solids samples is presented in Table 5.

	Chemical Concentrations in Filtered Solids Samples (mg/kg except as noted)							
Location	**Total PCBs**	**Cadmium**	**Lead**	**Zinc**	**Total LPAHs**	**Total HPAHs**	**Total cPAHs**	**Total Dioxins/ Furans (ng/kg)**
Lower SL:	0.13	5.1	450	410	5.2	12	1.0	25
Upper SL:	1.0	6.7	530	960	13	17	5.5	50
UNKCB27 (up)	0.22 – 0.27	7.0 – 9.0	340 – 700	818 – 1,120	12 – 24	**135 – 300**	13 – 34	88
MH362 (down)	1.7 – 2.1	8.7 – 11	118 – 230	1,070 – 1,360	2.7 – 4.5	30 – 61	2.7 – 6.2	70

Shaded cells indicate that the max detected value exceeds the Lower SL (▢), Upper SL (🟧), or 10x Upper SL (🟫).

Total PCBs exceeded the upper screening level at MH362 during SW-3 and SW-6 and the lower screening level at UNKCB27. Total PCBs increased from upstream to downstream. Sampling results indicate that both KCIA and Boeing are sources of PCBs in the north-central lateral.

Cadmium and zinc exceeded the upper screening levels (with one exception) at UNKCB27 and MH362 during SW-3, SW-4, and SW-6. Cadmium and zinc increased from upstream to downstream in the north-central lateral, while lead decreased.

Total LPAHs exceeded the upper screening level at UNKCB27 during SW-3 and SW-4. Total HPAHs exceeded the upper screening level at UNKCB27 and MH362 during all three events. Total cPAHs exceeded the upper screening level at UNKCB27 during all events, while total cPAHs exceeded the upper screening level at MH362 during SW-3 and SW-4. Concentrations of LPAHs, HPAHs, and cPAHs decreased from upstream to downstream in the north-central lateral. Sampling results indicate that KCIA is a source of PAHs in the north-central lateral.

Total dioxins/furans exceeded the upper screening level at UNKCB27 and MH362 and had a slight decrease from upstream to downstream in the north-central lateral.

Whole Water Results

Whole water results the north-central lateral are summarized in the table below. The ranges for chemicals exceeding the water quality criteria at one or both locations are shown. A more complete listing of results for whole water samples is presented in Table 8.

	Chemical Concentrations in Whole Water Samples
Location	**Total cPAHs (µg/L)**
WQC:	0.018
UNKCB27 (up)	0.035 – 0.11
MH362 (down)	0.038 – 0.057

Shaded cells indicate that the max detected value exceeds the WQC (▢).

Total cPAHs exceeded the human health WQC at UNKCB27 and MH362 during all three events. Total cPAHs decreased from upstream to downstream during SW-3 and remained constant from upstream to downstream during events SW-4 and SW-6.

MH362 Infiltrating-Water Grab Sample

An aqueous grab sample was collected of seepage infiltrating into storm drain lines via pipe joints located several feet downstream of MH362 (Figure 3). Chemicals exceeding the ambient WQC for aquatic life are shown. Results for detected chemicals in this infiltrating water sample are summarized in Table 9.

	Chemical Concentrations in Whole Water Samples (µg/L)							
Location	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**
WQC:	36	9.4	57	3.1	8.1	0.029	8.2	81
Near MH362	93	17.3	90	143	62	0.50 J	56	2,230

Shaded cells indicate that the max detected value exceeds the WQC (░) or 10x WQC (🟧).

Total arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc exceeded the WQC, but dissolved metals did not. The source of the white coloration previously seen in this water is likely due to bacterial action during groundwater oxidization upon entering the stormwater.

6.3 South-Central Lateral Storm Drain Sampling

Filtered solids and whole water samples were collected during events SW-3, SW-4, and SW-6 at the upstream location MH461 and downstream location MH368 on the south-central lateral (Figure 3).

Filtered Solids Results

Filtered solids results for the south-central lateral are summarized in the table below. The ranges for chemicals exceeding the upper screening level at one or both locations are shown. A more complete listing of results for filtered solids samples is presented in Table 5.

	Chemical Concentrations in Filtered Solids Samples (mg/kg)
Location	**Cadmium**
Lower SL:	5.1
Upper SL:	6.7
MH461 (up)	<3.0 – 5.0
MH368 (down)	2.0 – 10

Shaded cells indicate that the max detected value exceeds the Lower SL (░) or Upper SL (🟧).

Total PCBs only exceeded the lower screening level and increased from MH461 (upstream) to MH368 (downstream) in the south-central lateral. Total PCBs did not exceed the upper screening level at either location.

In general, metals and PAHs increased from upstream to downstream in the south-central lateral; however, only cadmium exceeded the upper screening level at MH368.

Total dioxins/furans exceeded the lower screening levels at MH461 and MH368, and showed a slight decrease from upstream to downstream in the south-central lateral.

Whole Water Results

Whole water results for the south-central lateral are summarized in the table below. The ranges for chemicals exceeding the water quality criteria at one or both locations are shown. A more complete listing of results for whole water samples is presented in Table 8.

	Chemical Concentrations in Whole Water Samples (µg/L)	
Location	**Total Copper**	**Total cPAHs**
WQC:	3.7	0.018
MH461 (up)	3.1 – 3.4	0.011 – 0.019
MH368 (down)	2.7 – 4.2	0.0083 – 0.028

Shaded cells indicate that the max detected value exceeds the WQC (🟧).

Total copper exceeded WQC at MH368 during SW-6. In general, total metals had a slight increase from upstream to downstream in the south-central lateral.

Total cPAHs exceeded the human health WQC at MH461 during SW-4 and SW-6 and at MH368 during SW-3. Total cPAHs increased from upstream to downstream during SW-3 and SW-6, but decreased during SW-4.

6.4 South Lateral Storm Drain Sampling

Filtered solids and whole water samples were collected during events SW-3, SW-4, and SW-6 at the upstream location MH482 and downstream location MH356 on the south lateral.

Filtered Solids Results

Filtered solids results for the south lateral are summarized in the table below. The ranges for chemicals exceeding the upper screening level at one or both locations are shown. A more complete listing of results for filtered solids samples is presented in Table 5.

	Chemical Concentrations in Filtered Solids Samples (mg/kg except as noted)							
Location	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Zinc**	**Total HPAHs**	**Total cPAHs**	**Total Dioxins/ Furans (ng/kg)**
Lower SL:	5.1	260	390	0.41	410	12	1.0	25
Upper SL:	6.7	270	390	0.59	960	17	5.5	50
MH482 (up)	8.9 – 13	33 – 50	149 – 214	**0.20 – 6.1**	714 – 819	**43 – 230**	5.0 – 22	59
MH356 (down)	8.0 – 10	**137 – 3,140**	182 – 535	0.20 – 0.40	1,000 – 1,030	17 – 71	3.1 – 6.8	84

Shaded cells indicate that the max detected value exceeds the Lower SL (⬜), Upper SL (🟧), or 10x Upper SL (🟫).

Total PCBs exceeded the lower screening level at MH482 during SW-6 and at MH356 during SW-3 and SW-6. Total PCBs increased from upstream to downstream.

Cadmium concentrations exceeded the upper screening level at MH482 and MH356 during all three events. Cadmium remained constant from upstream to downstream. Chromium increased from upstream to downstream during all events. The spike in chromium concentrations at MH356 during SW-3 is attributed to an unknown source at the Boeing facility. The decrease in chromium to below the lower screening level over time indicates that the source was temporary. Copper and zinc increased from upstream to downstream during SW-3, SW-4, and SW-6, indicating that Boeing is a source. During SW-4, mercury was detected at greater than 10 times the upper screening level at MH482, but did not exceed screening levels during other storm events at either location.

Total HPAHs exceeded the upper screening level at MH482 and MH356 during SW-3, SW-4, and SW-6. Total cPAHs exceeded the upper screening level at both locations during SW-4 and SW-6. Total HPAHs and cPAHs decreased from upstream to downstream during all events. Sampling results indicate KCIA is a source of elevated HPAHs/cPAHs in the south lateral.

Total dioxins/furans exceeded the upper screening level at MH482 and MH356 during SW-4. Total dioxins/furans increased from upstream to downstream.

Whole Water Results

A comparison of whole water results for the south lateral is presented in the table below. The ranges for chemicals exceeding the WQC at one or both locations are shown. A more complete listing of results for whole water samples is presented in Table 8.

Location	**Chemical Concentrations in Whole Water Samples (µg/L)**		
	Total Copper	**Total Lead**	**Total cPAHs**
WQC:	3.7	8.5	0.018
MH482 (up)	4.6 – 4.8	2.1 – 3.1	0.21 – 0.25
MH356 (down)	7.7 – 11	6.8 – 9.7	0.54 – 0.74

Shaded cells indicate that the max detected value exceeds the WQC (▨) or 10x WQC (🟧).

Total copper exceeded the WQC at MH482 and MH356 during all three events. Total lead exceeded WQC at MH356 during SW-6. In general, total metals increased from upstream to downstream in the south lateral.

Total cPAHs exceeded the human health WQC at MH482 to MH356 during all three events. Total cPAHs increased from upstream to downstream in the south lateral.

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Tables

Table 1. 2011–2012 Stormwater Sampling Events

Event Type	Event Number	Sample Date	Event Precipitation (inches)	Sample Location	Whole Water	Filtered Solids	Solids Grab Sample	Filtered Solids PAH Analysis
Storm Event	SW-1	9/26/2011	0.50	MH172		●		
				CB175		●		
				MH138		●		
	SW-2	11/24/2011	0.79	MH172		●		
				CB175		●		
				MH138		●		
	SW-3	2/24/2012	0.34	MH356	●	●		
				MH362	●	●		
				MH368	●	●		
				MH461	●	●		
				MH482	●	●		
				UNKCB27	●	●		
	SW-4	3/12–3/13/2012	0.74	MH356	●	●		
				MH362	●	●		
				MH368	●	●		
				MH461	●	●		
				MH482	●	●		
				UNKCB27	●	●		
	SW-5	3/19–3/20/2012	0.15	MH356				●
				MH482				●
	SW-6	3/28–3/29/2012	1.18	MH356	●	●		
				MH362	●	●		
				MH368	●	●		
				MH461	●	●		
				MH482	●	●		
				UNKCB27	●	●		
Catch Basin/ Manhole Grab Solids Sampling	NA	5/17/2012	NA	MH181A			●	
				MH179B			●	
				CB174			●	
				CB173			●	
				CB165			●	

Table 2. Chemical and Physical Analysis of Filtered Solids Samples

Sampling Event	Sample ID	Lab ID	PCB Aroclors (SW8082)	Metals (SW6010B)	Mercury (SW7471A)	PAHs (SW8270D)	Low-Level PAHs (SW8270D-SIM)	Dioxin/Furan Congeners (MLA-017/ EPA1613B)	Grain Size (PSEP 1986)
SW-1	NBF-CB175A-092611-S	TO34A, TO34B	●	●					●
	NBF-CB175B-092611-S	TO34C				●	●		
	NBF-MH172A-092611-S	TOC34D, TOC34E	●	●					●
	NBF-MH172B-092611-S	TO34F				●	●		
	NBF-MH138A-092611-S	TO34G, TO34H	●	●					●
	NBF-MH138B-092611-S	TO34I				●	●		
SW-2	NBF-CB175A-111611-S	TX75A, TX75B	●	●					●
	NBF-CB175B-111611-S	TX75G						●	
	NBF-MH172A-111611-S	TX75C, TX75D	●	●					●
	NBF-MH172B-111611-S	TX75H						●	
	NBF-MH138A-111611-S	TX75E, TX75F	●						
	NBF-MH138B-111611-S	TX75I						●	
SW-3	NBF-MH356A-022412-S	UJ67A, UJ67B		●	●	●			●
	NBF-MH356B-022412-S	UJ67M	●						
	NBF-MH362A-022412-S	UJ67C, UJ67D		●	●	●			●
	NBF-MH362B-022412-S	UJ67N	●						
	NBF-MH368A-022412-S	UJ67E, UJ67F		●	●	●			●
	NBF-MH368B-022412-S	UJ67O	●						
	NBF-MH461A-022412-S	UJ67G, UJ67H		●	●	●			●
	NBF-MH461B-022412-S	UJ67P	●						
	NBF-MH482A-022412-S	UJ67I, UJ67J		●	●	●			●
	NBF-MH482B-022412-S	UJ67Q	●						
	NBF-UNKCB27A-022412-S	UJ67K, UJ67L		●	●	●			●
	NBF-UNKCB27B-022412-S	UJ67R	●						
SW-4	NBF-MH356A-031312-S	UM29A, UM29B		●	●	●			
	NBF-MH356B-031312-S	UM29M						●	
	NBF-MH362A-031312-S	UM29C, UM29D		●	●	●			
	NBF-MH362B-031312-S	UM29N						●	
	NBF-MH368A-031312-S	UM29E, UM29F		●	●	●			
	NBF-MH368B-031312-S	UM29O						●	
	NBF-MH461A-031312-S	UM29G, UM29H		●	●	●			
	NBF-MH461B-031312-S	UM29P						●	
	NBF-MH482A-031312-S	UM29I, UM29J		●	●	●			
	NBF-MH482B-031312-S	UM29Q						●	
	NBF-UNKCB27A-031312-S	UM29K, UM29L		●	●	●			
	NBF-UNKCB27B-031312-S	UM29R						●	
SW-5	NBF-MH356A-032012-S	UN47A				●			
	NBF-MH356B-032012-S	UN47B				●			
	NBF-MH482A-032012-S	UN47C				●			
	NBF-MH482B-032012-S	UN47D				●			

Table 2. Chemical and Physical Analysis of Filtered Solids Samples

Sampling Event	Sample ID	Lab ID	PCB Aroclors (SW8082)	Metals (SW6010B)	Mercury (SW7471A)	PAHs (SW8270D)	Low-Level PAHs (SW8270D-SIM)	Dioxin/Furan Congeners (MLA-017/ EPA1613B)	Grain Size (PSEP 1986)
SW-6	NBF-MH356A-032912-S	UO74E		●	●	●			●
	NBF-MH356B-032912-S	UO74K	●						
	NBF-MH362A-032912-S	UO74D		●	●	●			●
	NBF-MH362B-032912-S	UO74J	●						
	NBF-MH368A-032912-S	UO74C		●	●	●			●
	NBF-MH368B-032912-S	UO74K	●						
	NBF-MH461A-032912-S	UO74B		●	●	●			●
	NBF-MH461B-032912-S	UO74H	●						
	NBF-MH482A-032912-S	UO74A		●	●	●			●
	NBF-MH482B-032912-S	UO74G	●						
	NBF-UNKCB27A-032912-S	UO74F		●	●	●			●
	NBF-UNKCB27B-032912-S	UO74L	●						

SW - Storm Event
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
TOC - total organic carbon
SIM - selected ion monitoring

Analytical method numbers listed in parentheses.

Table 3. Chemical and Physical Analysis of Whole Water Samples

Sampling Event	Sample ID	Lab ID	SVOC (SW8270D)	Low-Level PAHs (SW8270D-SIM)	Low-Level PCB Aroclors (SW8082)	Total Metals (EPA 200.8, SW6010B, SW7470A)	Dissolved Metals (EPA200.8)	Low-Level Dissolved Mercury (SW7470A)	TOC/DOC (EPA 415.1)	TSS (EPA 160.2)	Other Conventionals (EPA 150.1, SM2320, EPA 300.0)
SW-3	NBF-MH356-022412-W	UJ55F, UJ55L, UJ56F	●	●	●	●	●	●	●	●	●
	NBF-MH362-022412-W	UJ55A, UJ55G, UJ56A	●	●	●	●	●	●	●	●	●
	NBF-MH368-022412-W	UJ55B, UJ55H, UJ56B	●	●	●	●	●	●	●	●	●
	NBF-MH461-022412-W	UJ55C, UJ55I, UJ56C	●	●	●	●	●	●	●	●	●
	NBF-MH482-022412-W	UJ55D, UJ55J, UJ56D	●	●	●	●	●	●	●	●	●
	NBF-UNKCB27-022412-W	UJ55E, UJ55K, UJ56E	●	●	●	●	●	●	●	●	●
SW-4	NBF-MH356-031312-W	UM12A, UM12G, UM13A	●	●	●	●	●	●	●	●	●
	NBF-MH362-031312-W	UM12B, UM12H, UM13B	●	●	●	●	●	●	●	●	●
	NBF-MH368-031312-W	UM12C, UM12I, UM13C	●	●	●	●	●	●	●	●	●
	NBF-MH461-031312-W	UM12D, UM12J, UM13D	●	●	●	●	●	●	●	●	●
	NBF-MH482-031312-W	UM12E, UM12K, UM13E	●	●	●	●	●	●	●	●	●
	NBF-UNKCB27-031312-W	UM12F, UM12L, UM13F	●	●	●	●	●	●	●	●	●
SW-6	NBF-MH356-032912-W	UO57A, UO57G, UO58A	●	●	●	●	●	●	●	●	●
	NBF-MH362-032912-W	UO57C, UO57I, UO58C	●	●	●	●	●	●	●	●	●
	NBF-MH368-032912-W	UO57D, UO57J, UO58D	●	●	●	●	●	●	●	●	●
	NBF-MH461-032912-W	UO57E, UO57K, UO58E	●	●	●	●	●	●	●	●	●
	NBF-MH482-032912-W	UO57B, UO57H, UO58B	●	●	●	●	●	●	●	●	●
	NBF-UNKCB27-032912-W	UO57F, UO57L, UO58F	●	●	●	●	●	●	●	●	●

SW = Storm event number
PAH = polycyclic aromatic hydrocarbon
SVOC = semivolatile organic compound
SIM = selected ion monitoring
PCB = polychlorinated biphenyl
TOC = total organic carbon
TSS = total suspended solids

Method numbers listed in parentheses.

Table 4. Comparison of Sampling Events to Stormwater Sampling Criteria

Criterion		Storm Event					
		SW-1 9/26/2011	**SW-2 11/16/2011**	**SW-3 2/24/2012**	**SW-4 3/12–13/2012**	**SW-5 3/19–20/2012**	**SW-6 3/28–29/2012**
Total Storm Event Precipitation (inches)	>0.15	KBFI: 0.50	KBFI: 0.79	KBFI: 0.34 RG16: 0.37	KBFI: 0.74 RG16: 0.84	KBFI: 0.15	KBFI: 1.18 RG16: 1.26
Storm Event Duration (hours)[1]	>5	12	9	8	18	NA	22
Precipitation during 12-Hour Period before Storm Event (inches)[2]	<0.04	0	0	0	0	NA	0.07
Percent of Storm Hydrograph Sampled for Whole Water[1]	>75%	100%	100%	UNKCB27: 65% MH362: 77% MH461: 73% MH368: 80% MH482: 88% MH356: 45%	UNKCB27: 55% MH362: 73% MH461: 32% MH368: 97% MH482: 94% MH356: 49%	NA	UNKCB27: 43% MH362: 37% MH461: 76% MH368: 63% MH482: 61% MH356: 45%
Number of Whole Water Sample Aliquots Collected	>10	NA	NA	UNKCB27: 86 MH362: 75 MH461: 96 MH368: 93 MH482: 96 MH356: 192	UNKCB27: 96 MH362: 94 MH461: 96 MH368: 96 MH482: 187 MH356: 192	NA	UNKCB27: 96 MH362: 96 MH461: 96 MH368: 93 MH482: 192 MH356: 192

Notes:

1 - Storm event duration and percent of storm hydrograph sampled are estimated values.

2 - Ecology determined in February 2012 that the 12-hour antecedent dry period amount (0.04 inch) was not critical to accurately representing storm events typical of this region.

KBFI - Seattle Boeing Field--King County International Airport rain gage

RG16 - Seattle Public Utilities, Rain Gage 16

NA - Not applicable to filtered solids sampling or to SW-5 PAH testing samples

Table 5. 2011–2012 Filtered Solids Sampling Results

Sample Location:			**CB175**	**CB175**	**MH172**	**MH172**	**MH138**	**MH138**	**UNKCB27**	**UNKCB27**	**UNKCB27**	**MH362**	**MH362**	**MH362**
Lateral:			**North**	**North**	**North**	**North**	**North**	**North**	**NC (Up)**	**NC (Up)**	**NC (Up)**	**NC (Down)**	**NC (Down)**	**NC (Down)**
Event:			**SW-1**	**SW-2**	**SW-1**	**SW-2**	**SW-1**	**SW-2**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**
Date:			**9/26/2011**	**11/16/2011**	**9/26/2011**	**11/16/2011**	**9/26/2011**	**11/16/2011**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**
Precipitation (inches):	**Lower SL**	**Upper SL**	**0.50**	**0.47**	**0.50**	**0.47**	**0.50**	**0.47**	**0.34**	**0.74**	**1.15**	**0.34**	**0.74**	**1.15**
Percent Fines			1.1	0.3	22.1	14.0	21.1	NA	56.5	NA	77.3	66.1	NA	44.5
PCB Aroclors (mg/kg)														
Aroclor 1248			2.3 U	**2.0**	0.78 U	5.9 U	0.48 U	0.94 U	0.062 U	NA	0.12 U	0.56 U	NA	1.2 U
Aroclor 1254			**2.1**	**1.7**	**2.2**	**6.7**	**1.0**	**2.9**	**0.074**	NA	**0.12**	**1.0**	NA	**2.1**
Aroclor 1260			0.58 U	**0.20**	0.52 J	**0.90**	0.40 U	**0.71**	**0.15**	NA	**0.15**	**0.73 J**	NA	0.48 U
PCBs, total	0.13	1.0	**2.1**	**3.9**	**2.2**	**7.6**	**1.0**	**3.6**	**0.22**	NA	**0.27**	**1.7 J**	NA	**2.1**
Total Metals (mg/kg)														
Arsenic	57	93	**9.0**	7.0 U	20 U	**30**	50 U	NA	70 U	30 U	40 U	60 U	**30**	**30**
Cadmium	5.1	6.7	**2.1**	**3.2 J**	**5.4**	**4.0 J**	**6.0**	NA	**7.0**	**9.0**	**7.0**	**11**	**11**	**8.7**
Chromium	260	270	**83.8**	**57.3**	**52.0**	**42.0**	**116**	NA	**91.0**	**177**	**99.0**	**131**	**186**	**92.0**
Copper	390	390	**73.4**	**121**	**284**	**136**	**454**	NA	**351**	**370**	**309**	**250**	**264**	**166**
Lead	450	530	**51.0**	**79.0 J**	**232**	**149 J**	**110**	NA	**360**	**700**	**340**	**230**	**190**	**118**
Mercury	0.41	0.59	**0.73**	**0.30 J**	**0.40**	**0.40 J**	**0.34**	NA	0.30 U	**0.30**	**0.40**	**0.40**	**0.40**	**0.32**
Silver	6.1	6.1	0.50 U	0.40 U	1.0 U	0.70 U	3.0 U	NA	4.0 U	2.0 U	2.0 U	3.0 U	2.0 U	**2.0**
Zinc	410	960	**520**	**594**	**835**	**594**	**1330**	NA	**1000**	**1120**	**818**	**1330**	**1360**	**1070**
PAHs (mg/kg)														
Naphthalene	2.1	2.4	0.078 U	NA	**0.12**	NA	0.17 U	NA	1.9 U	0.87 U	**0.26 J**	0.91 U	2.7 U	0.43 U
2-Methylnaphthalene	0.67	1.4	0.078 U	NA	0.11 U	NA	0.17 U	NA	1.9 U	0.87 U	0.41 U	0.91 U	2.7 U	0.43 U
1-Methylnaphthalene	NA	NA	**0.11**	NA	0.11 U	NA	0.17 U	NA	1.9 U	0.87 U	0.41 U	0.91 U	2.7 U	0.43 U
Acenaphthylene	1.3	1.3	0.078 U	NA	0.11 U	NA	0.17 U	NA	1.9 U	0.87 U	0.41 U	0.91 U	2.7 U	0.43 U
Acenaphthene	0.50	0.73	**0.19**	NA	0.11 U	NA	0.17 U	NA	1.9 U	0.87 U	0.41 U	0.91 U	2.7 U	0.43 U
Fluorene	0.54	1.0	**0.28**	NA	0.11 U	NA	0.17 U	NA	1.9 U	0.87 U	**0.23 J**	0.91 U	2.7 U	0.43 U
Phenanthrene	1.5	5.4	**2.5**	NA	**2.3**	NA	**0.85**	NA	**24**	**16**	**11**	**4.5**	**2.7**	**3.3**
Anthracene	0.96	4.4	**0.84**	NA	**0.14**	NA	0.17 U	NA	1.9 U	0.87 U	**0.43 J**	0.91 U	2.7 U	0.43 U
Total LPAHs	5.2	13	**3.8**	NA	**2.6**	NA	**0.85**	NA	**24**	**16**	**12 J**	**4.5**	**2.7**	**3.3**
Fluoranthene	1.7	2.5	**3.3**	NA	**7.7**	NA	**2.5**	NA	**66**	**39**	**34**	**14**	**8.7**	**9.2**
Pyrene	2.6	3.3	**2.6**	NA	**4.7**	NA	**1.6**	NA	**39**	**24**	**17**	**9.1**	**4.5**	**5.2**
Benzo(a)anthracene	1.3	1.6	**1.1**	NA	**1.0**	NA	**0.51**	NA	**8.9**	**5.1**	**3.0**	**1.5**	2.7 U	**1.0**
Chrysene	1.4	2.8	**1.4**	NA	**5.6**	NA	**1.7**	NA	**37**	**23**	**16**	**7.3**	**4.3**	**5.4**
Benzo(a)pyrene	1.6	3.0	**0.73**	NA	**1.8**	NA	**0.76**	NA	**23**	**13**	**8.1**	**4.1**	2.7 U	**2.3**
Indeno(1,2,3-cd)pyrene	0.60	0.69	**0.37**	NA	**2.3**	NA	**0.83**	NA	**24**	**14**	**10**	**4.5**	2.7 U	**2.8**
Dibenz(a,h)anthracene	0.23	0.54	**0.12**	NA	**0.43**	NA	**0.19**	NA	**7.2**	**3.0**	**1.9**	**1.4**	2.7 U	**0.55**
Benzo(g,h,i)perylene	0.67	0.72	**0.53**	NA	**2.6**	NA	**1.1**	NA	**29**	**17**	**11**	**5.5**	**2.7**	**3.1**
Dibenzofuran	0.54	0.70	**0.12**	NA	**0.17**	NA	0.17 U	NA	1.9 U	0.87 U	**0.53**	0.91 U	2.7 U	**0.24 J**
Benzofluoranthene	3.2	3.6	**1.5**	NA	**7.7**	NA	**2.8**	NA	**66**	**46**	**32**	**13**	**9.3**	**10**
Total HPAHs	12	17	**12**	NA	**34**	NA	**12**	NA	**300**	**180**	**130**	**60**	**30**	**40**
Total cPAHs (mg/kg)														
Total cPAHs (TEQ, NDx0.5)	1.0	5.5	**1.1**	NA	**3.0**	NA	**1.2**	NA	**34**	**20**	**13**	**6.2**	**2.7**	**3.8**
Total Dioxins and Furans (ng/kg)														
Total Dioxins and Furans (TEQ, NDx0.5)	25	50	NA	**14.1 J**	NA	**31.4 J**	NA	**50.3 J**	NA	**87.8 J**	NA	NA	**70.2 J**	NA

Total Dioxins/Furans are expressed as a 2,3,7,8-TCDD toxic equivalent (TEQ) concentration, using half the non-detect value.
Total cPAHs are expressed as a benzo(a)pyrene TEQ concentration, using half the non-detect value.
All units are for dry weight. Detected concentrations are shown in **Bold**.

Only chemicals that have been detected in at least one sample are shown.
NA = not analyzed
WW - adj. = wet weight adjacent

▨	Chemical detected at a concentration above the Lower Screening Level (SL)
🟧	Chemical detected at a concentration above the Upper SL
🟫	Chemical detected at a concentration at least 10x the Upper SL
🟩	Chemical not detected, but reporting limit is above the criterion

The Lower and Upper SL values represent the SQS and CSL for metals, and the LAET and 2LAET for PCBs and individual PAHs.
The Lower and Upper SL values for cPAHs (TEQ) and dioxins/furans (TEQ) represent the range of LDW-wide remedial action levels in the preferred alternative and other alternatives in the LDW Feasibility Study and Proposed Plan.

Table 5. 2011–2012 Filtered Solids Sampling Results

Sample Location:			**MH461**	**MH461**	**MH461**	**MH368**	**MH368**	**MH368**	**MH482**	**MH482**	**MH482**	**MH482**	**MH482**	**MH356**	**MH356**	**MH356**	**MH356**	**MH356**
Lateral:			**SC (Up)**	**SC (Up)**	**SC (Up)**	**SC (Down)**	**SC (Down)**	**SC (Down)**	**S (Up)**	**S (Up)**	**S (Up)**	**S (Up)**	**S (Up)**	**S (Down)**	**S (Down)**	**S (Down)**	**S (Down)**	**S (Down)**
Event:			**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-5**	**SW-5**	**SW-6**	**SW-3**	**SW-4**	**SW-5**	**SW-5**	**SW-6**
Date:			**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/20/2012**	**3/20/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/20/2012**	**3/20/2012**	**3/29/2012**
Precipitation (inches):	**Lower SL**	**Upper SL**	**0.34**	**0.74**	**1.15**	**0.34**	**0.74**	**1.15**	**0.34**	**0.74**	**NA**	**WW - adj.**	**1.15**	**0.34**	**0.74**	**NA**	**WW - adj.**	**1.15**
Percent Fines			63.6	NA	65.9	60.8	NA	32.1	20.8	NA	NA		31.4	54.9	NA	NA		57.7
PCB Aroclors (mg/kg)																		
Aroclor 1248			0.0053 U	NA	0.044 U	0.051 U	NA	0.030 U	0.0052 U	NA	NA		0.12 U	0.036 U	NA	NA		0.10 U
Aroclor 1254			0.0053 U	NA	**0.11**	**0.11**	NA	**0.11**	**0.0062**	NA	NA		**0.23**	**0.060**	NA	NA		**0.24**
Aroclor 1260			0.0053 U	NA	**0.039 J**	**0.18**	NA	**0.094**	**0.0083**	NA	NA		**0.13**	**0.11 J**	NA	NA		**0.20**
PCBs, total	0.13	1.0	0.0053 U	NA	**0.15 J**	**0.29**	NA	**0.20**	**0.015**	NA	NA		**0.36**	**0.17 J**	NA	NA		**0.44**
Total Metals (mg/kg)																		
Arsenic	57	93	100 U	80 U	90 U	90 U	50 U	30 U	30 U	**30**	NA		**20**	50 U	30 U	NA		30 U
Cadmium	5.1	6.7	**5.0**	3.0 U	4.0 U	**10**	**5.0**	**2.0**	**13**	**10**	NA		**8.9**	**10**	**8.0**	NA		**10**
Chromium	260	270	**20.0**	**62.0**	**42.0**	**57.0**	**67.0**	**28.0**	**33.0**	**45.0**	NA		**50.0**	**3140**	**354**	NA		**137**
Copper	390	390	**28.0**	**182**	**149**	**80.0**	**88.0**	**41.0**	**214**	**176**	NA		**149**	**535**	**227**	NA		**182**
Lead	450	530	40.0 U	**40.0**	40.0 U	**40.0**	**60.0**	**30.0**	**90.0**	**192**	NA		**147**	**120**	**180**	NA		**160**
Mercury	0.41	0.59	0.20 U	**0.30**	**0.20**	0.20 U	**0.19**	0.060 U	**0.20**	**6.1**	NA		**0.20**	**0.40**	**0.20**	NA		**0.30**
Silver	6.1	6.1	6.0 U	5.0 U	5.0 U	6.0 U	3.0 U	2.0 U	2.0 U	1.0 U	NA		0.90 U	3.0 U	2.0 U	NA		2.0 U
Zinc	410	960	**120**	**240**	**210**	**800**	**490**	**264**	**714**	**819**	NA		**724**	**1030**	**1020**	NA		**1000**
PAHs (mg/kg)																		
Naphthalene	2.1	2.4	**0.051**	0.23 U	0.16 U	**0.086**	0.44 U	0.086 U	**0.22**	0.65 U	**0.11 J**	**0.11 J**	**0.34 J**	1.1 U	0.38 U	0.54 U	0.61 U	0.26 U
2-Methylnaphthalene	0.67	1.4	**0.059**	0.23 U	0.16 U	**0.13**	0.44 U	0.086 U	**0.59**	0.65 U	**0.14**	**0.072 J**	0.34 U	1.1 U	0.38 U	0.54 U	0.61 U	**0.15 J**
1-Methylnaphthalene	NA	NA	**0.059 J**	0.23 U	**0.12 J**	**0.16**	0.44 U	0.086 U	**0.51**	0.65 U	**0.19**	**0.23**	**0.22 J**	1.1 U	0.38 U	0.54 U	0.61 U	0.26 U
Acenaphthylene	1.3	1.3	0.018 U	0.23 U	0.16 U	0.025 U	0.44 U	0.086 U	**0.048 J**	0.65 U	0.13 U	0.14 U	0.34 U	1.1 U	0.38 U	0.54 U	0.61 U	0.26 U
Acenaphthene	0.50	0.73	0.018 U	0.23 U	0.16 U	**0.015 J**	0.44 U	0.086 U	**0.096 J**	0.65 U	**0.14**	**0.17**	**0.23 J**	1.1 U	0.38 U	0.54 U	**0.35 J**	**0.15 J**
Fluorene	0.54	1.0	**0.033 J**	0.23 U	0.16 U	**0.041**	0.44 U	0.086 U	**0.22**	0.65 U	**0.14**	**0.18**	**0.32 J**	1.1 U	0.38 U	0.54 U	0.61 U	0.26 U
Phenanthrene	1.5	5.4	**0.084**	**0.53**	**0.37**	**0.28**	**0.71**	**0.23**	**3.3**	**8.7**	**3.0**	**4.1**	**11**	**2.0**	**4.4**	**1.2**	**1.5**	**3.3**
Anthracene	0.96	4.4	0.018 U	0.23 U	0.16 U	**0.020 J**	0.44 U	0.086 U	**0.17**	0.65 U	**0.25**	**0.39**	**0.53**	1.1 U	0.38 U	0.54 U	0.61 U	**0.19 J**
Total LPAHs	5.2	13	**0.17 J**	**0.53**	**0.37**	**0.44 J**	**0.71**	**0.23**	**4.1 J**	**8.7**	**3.6 J**	**5.0 J**	**12 J**	**2.0**	**4.4**	**1.2**	**1.9 J**	**3.6 J**
Fluoranthene	1.7	2.5	**0.19**	**1.2**	**0.99**	**0.49**	**1.5**	**0.51**	**11**	**37**	**10**	**12**	**50**	**6.0**	**17**	**4.2**	**4.5**	**12**
Pyrene	2.6	3.3	**0.084**	**0.69**	**0.57**	**0.32**	**1.1**	**0.29**	**3.9**	**18**	**5.1**	**6.7**	**19**	**3.6**	**8.2**	**2.2**	**2.4**	**6.1**
Benzo(a)anthracene	1.3	1.6	**0.022**	0.23 U	**0.11 J**	**0.086**	0.44 U	**0.083 J**	**2.2**	**5.0**	**2.2**	**2.7**	**6.9**	**1.1 J**	**2.5**	**0.76**	**0.86**	**1.8**
Chrysene	1.4	2.8	**0.12**	**0.98**	**0.83**	**0.31**	**1.2**	**0.34**	**5.1**	**29**	**5.5**	**7.7**	**38**	**3.5**	**11**	**2.2**	**2.2**	**9.2**
Benzo(a)pyrene	1.6	3.0	**0.040**	**0.30**	**0.28**	**0.14**	0.44 U	**0.12**	**3.4**	**9.5**	**3.2**	**4**	**13**	**2.0**	**4.1**	**1.1**	**1.4**	**3.2**
Indeno(1,2,3-cd)pyrene	0.60	0.69	**0.048**	**0.40**	**0.39**	**0.11**	0.44 U	**0.13**	**3.3**	**13**	**3.1**	**3.8**	**16**	**2.3**	**4.5**	**1.1**	**1.0**	**4.4**
Dibenzo(a,h)anthracene	0.23	0.54	**0.015 J**	0.23 U	0.16 U	**0.046 J**	0.44 U	0.086 U	**1.4 J**	**2.5**	**0.81**	**0.96**	**3.7**	**0.76 J**	**0.97**	0.54 U	0.61 U	**0.96**
Benzo(g,h,i)perylene	0.67	0.72	**0.059**	**0.55**	**0.49**	**0.16**	**0.49**	**0.17**	**3.5**	**14**	**3.5**	**4.2**	**17**	**2.6**	**5.1**	**1.3**	**1.2**	**4.8**
Dibenzofuran	0.54	0.70	**0.011 J**	0.23 U	0.16 U	**0.046**	0.44 U	**0.068 J**	**0.18**	0.65 U	**0.16**	**0.21**	**0.54**	1.1 U	0.38 U	0.54 U	0.61 U	**0.18 J**
Benzofluoranthene	3.2	3.6	**0.16**	**1.5**	**1.4**	**0.35**	**1.2**	**0.51**	**8.7**	**49**	**10**	**13**	**63**	**6.0**	**18**	**4.0**	**3.9**	**17**
Total HPAHs	12	17	**0.74 J**	**5.6**	**5.1 J**	**2.0 J**	**5.5**	**2.2 J**	**43 J**	**180**	**43**	**55**	**230**	**28 J**	**71**	**17**	**17**	**59**
Total cPAHs (mg/kg)																		
Total cPAHs (TEQ, NDx0.5)	1.0	5.5	**0.07**	**0.53**	**0.49**	**0.20**	**0.42**	**0.20**	**5.0**	**17**	**4.9**	**6.1**	**22**	**3.1**	**6.8**	**1.7**	**2.0**	**5.7**
Total Dioxins and Furans (ng/kg)																		
Total Dioxins and Furans (TEQ, NDx0.5)	25	50	NA	**48.8 J**	NA	NA	**33.1 J**	NA	NA	**59.5 J**	NA		NA	NA	**84.4 J**	NA		NA

Total Dioxins/Furans are expressed as a 2,3,7,8-TCDD toxic equivalent (TEQ) concentration, using half the non-detect value.
Total cPAHs are expressed as a benzo(a)pyrene TEQ concentration, using half the non-detect value.
Detected concentrations are shown in **Bold**.

Only chemicals that have been detected in at least one sample are shown.
NA = not analyzed
WW - adj. = wet weight adjacent

░	Chemical detected at a concentration above the Lower Screening Level (SL)
▒	Chemical detected at a concentration above the Upper SL
█	Chemical detected at a concentration at least 10x the Upper SL
🟩	Chemical not detected, but reporting limit is above the criterion

The Lower and Upper SL values represent the SQS and CSL for metals, and the LAET and 2LAET for PCBs and individual PAHs.
The Lower and Upper SL values for cPAHs (TEQ) and dioxins/furans (TEQ) represent the range of LDW-wide remedial action levels in the preferred alternative and other alternatives in the LDW Feasibility Study and Proposed Plan.

Table 6. May 2012 Storm Drain Solids Grab Sampling Results

Sample Location:			MH181A	MH179B	CB174	CB173	CB165
Lateral:			North	North	North	North	North
Date:			5/17/2012	5/17/2012	5/17/2012	5/17/2012	5/17/2012
	Lower SL	Upper SL					
Percent Fines			66.9	6.10	19.2	41.2	11.1
TOC (%)			2.45	2.54	2.48	2.20	1.33
PCBs (mg/kg)							
Aroclor 1248			**23**	**2.4**	**0.091**	**22**	**0.096**
Aroclor 1254			**31**	**2.2**	**0.20**	**28**	**0.24**
Aroclor 1260			3.0 U	0.13 U	**0.12**	2.7 U	**0.11**
PCBs, total	0.13	1.0	**54**	**4.6**	**0.41**	**50**	**0.45**
Metals (mg/kg)							
Arsenic	57	93	**20**	**10**	8.0 U	**31**	10 U
Cadmium	5.1	6.7	**8.5 J**	**1.3 J**	**2.1 J**	**2.2 J**	**1.9 J**
Chromium	260	270	**128**	**19.1**	**74.9**	**36.9**	**118**
Copper	390	390	**466**	**39.6**	**71.0**	**119**	**78.1**
Lead	450	530	**296**	**16.0**	**93.0**	**97.0**	**372**
Mercury	0.41	0.59	**4.96 J**	**0.100 J**	**0.170 J**	**2.47 J**	**0.180 J**
Silver	6.1	6.1	**1.2**	0.40 U	0.50 U	**0.60**	0.60 U
Zinc	410	960	**1770 J**	**466 J**	**767 J**	**415 J**	**1760 J**
PAHs (mg/kg)							
Naphthalene	2.1	2.4	**0.55 J**	0.074 U	0.32 U	**0.047 J**	0.29 U
2-Methylnaphthalene	0.67	1.4	**0.38 J**	0.074 U	0.32 U	**0.043 J**	0.29 U
Acenaphthylene	1.3	1.3	**0.38 J**	0.074 U	0.32 U	0.078 U	0.29 U
Acenaphthene	0.50	0.73	**0.34 J**	0.074 U	0.32 U	0.078 U	0.29 U
Fluorene	0.54	1.0	**0.41 J**	0.074 U	0.32 U	0.078 U	0.29 U
Phenanthrene	1.5	5.4	**1.7**	0.074 U	**0.72**	**0.097**	**0.38**
Anthracene	0.96	4.4	**0.48 J**	0.074 U	0.32 U	0.078 U	0.29 U
LPAH, total	5.2	13	**3.9 J**	0.074 U	**0.72**	**0.14 J**	**0.38**
Fluoranthene	1.7	2.5	**2.5**	0.074 U	**0.68**	**0.17**	**0.36**
Pyrene	2.6	3.3	**2.6**	**0.044 J**	**0.59**	**0.23**	**0.51**
Benzo(a)anthracene	1.3	1.6	**1.0**	0.074 U	0.32 U	**0.086**	0.29 U
Chrysene	1.4	2.8	**2.0**	**0.059 J**	**0.43**	**0.15**	**0.35**
Benzo(a)pyrene	1.6	3.0	**1.3**	0.074 U	0.32 U	**0.11**	0.29 U
Indeno(1,2,3-cd)pyrene	0.60	0.69	**1.0**	0.074 U	0.32 U	**0.062 J**	0.29 U
Dibenz(a,h)anthracene	0.23	0.54	**0.45 J**	0.074 U	0.32 U	0.078 U	0.29 U
Benzo(g,h,i)perylene	0.67	0.72	**1.6**	**0.041 J**	0.32 U	**0.074 J**	0.29 U
Dibenzofuran	0.54	0.70	**0.38 J**	0.074 U	0.32 U	0.078 U	0.29 U
Benzofluoranthenes, total	3.2	3.6	**2.8**	**0.052 J**	**0.37**	**0.22**	**0.29**
HPAH, total	12	17	**15 J**	**0.20 J**	**2.1**	**1.1 J**	**1.5**
Total cPAHs (mg/kg)							
Total cPAHs (TEQ, NDx0.5)	1.0	5.5	**1.8**	**0.054**	**0.25**	**0.15**	**0.22**
Phthalates (mg/kg)							
Di-n-butylphthalate	1.4	5.1	**8.1**	**2.6**	**0.27 J**	**5.6**	**0.76**
Dimethylphthalate	0.071	0.16	**0.38 J**	0.074 U	0.32 U	0.078 U	0.29 U
Butylbenzylphthalate	0.063	0.90	**1.7**	0.074 U	**0.19 J**	0.078 U	0.29 U
bis(2-Ethylhexyl)phthalate	1.3	1.9	**17**	**0.76**	**2.1**	**1.4**	**5.7**
Di-n-octyl phthalate	6.2		**1.8**	**0.096**	**7.6**	**2.2**	**1.2**
Phenols (mg/kg)							
Phenol	0.42	1.2	**0.69**	0.074 U	**0.21 J**	**0.062 J**	**0.74**
2-Methylphenol	0.063	0.063	**1.1**	0.074 U	0.32 U	0.078 U	0.29 U
4-Methylphenol	0.67	0.67	**0.52 J**	0.15 U	**1.1**	0.16 U	**7.8**
2,4-Dimethylphenol	0.029	0.029	**0.66 J**	0.074 U	0.32 U	0.078 U	0.29 U
2,4,5-Trichlorophenol			**0.79 J**	0.37 U	1.6 U	0.39 U	1.4 U
Other SVOCs (mg/kg)							
Bis-(2-chloroethyl)ether			0.69 U	0.074 U	**0.38**	0.078 U	0.29 U
N-Nitrosodiphenylamine	0.028	0.040	**0.34 J**	0.074 U	0.32 U	0.078 U	0.29 U
Carbazole			**0.52 J**	0.074 U	0.32 U	0.078 U	0.29 U
4-Chloroaniline			9.3 U	1.0 U	4.3 U	1.0 U	**0.83 J**
Total Dioxins/Furans (ng/kg)							
Total Dioxins/Furans (TEQ, NDx0.5)	25	50	NA	NA	NA	**97.3 J**	**7.21 J**

Total Dioxins/Furans are expressed as a 2,3,7,8-TCDD toxic equivalent (TEQ) concentration, using half the non-detect value.
Total cPAHs are expressed as a benzo(a)pyrene TEQ concentration, using half the non-detect value.
All units are for dry weight. Detected concentrations are shown in **Bold**.

⬜	Chemical detected at a concentration above the Lower Screening Level (SL)
🟧	Chemical detected at a concentration above the Upper SL
🟫	Chemical detected at a concentration at least 10x the Upper SL
🟩	Chemical not detected, but reporting limit is above the criterion

The Lower and Upper SL values represent the SQS and CSL for metals, and the LAET and 2LAET for PCBs and individual PAHs.
The Lower and Upper SL values for cPAHs (TEQ) and dioxins/furans (TEQ) represent the range of LDW-wide remedial action levels in the preferred alternative and other alternatives in the LDW Feasibility Study and Proposed Plan.

Table 7. PAH Preparation Method Test Results

	PAH Mass per Filter Comparison (ug/filter)						PAH Concentration Comparison (mg/kg)					
Storm Drain Location:	**MH356**			**MH482**			**MH356**			**MH482**		
Sampling Date:	**3/20/2012**			**3/20/2012**			**3/20/2012**			**3/20/2012**		
Filter:	**A**	**B**		**A**	**B**		**A**	**B**		**A**	**B**	
Preparation:	**air dried**	**wet**		**air dried**	**wet**		**air dried**	**wet**		**air dried**	**wet**	
Chemical	**ug/filter**		**%D**	**ug/filter**		**%D**	**mg/kg DW**		**%D**	**mg/kg DW**		**%D**
1-Methylnaphthalene	10 U	10 U	--	4.5	4.7	-4.3	0.54 U	0.61 U	--	0.19	0.23	-19
2-Methylnaphthalene	10 U	10 U	--	3.2	1.5 J	72	0.54 U	0.61 U	--	0.14	0.072 J	64
Acenaphthene	10 U	5.7 J	--	3.4	3.6	-5.7	0.54 U	0.35 J	--	0.14	0.17	-19
Acenaphthylene	10 U	10 U	--	3.0 U	3.0 U	--	0.54 U	0.61 U	--	0.13 U	0.14 U	--
Anthracene	10 U	10 U	--	5.9	8.2	-33	0.54 U	0.61 U	--	0.25	0.39	-44
Benzo(a)anthracene	14	14	0.0	51	56	-9.3	0.76	0.86	-12	2.2	2.7	-20
Benzo(a)pyrene	21	23	-9.1	75	83	-10	1.1	1.4	-24	3.2	4.0	-22
Benzo(g,h,i)perylene	24	19	23	82	87	-5.9	1.3	1.2	8.0	3.5	4.2	-18
Chrysene	41	36	13	130	160	-21	2.2	2.2	0.0	5.5	7.7	-33
Dibenz(a,h)anthracene	10 U	10 U	--	19	20	-5.1	0.54 U	0.61 U	--	0.81	0.96	-17
Dibenzofuran	10 U	10 U	--	3.7	4.3	-15	0.54 U	0.61 U	--	0.16	0.21	-27
Fluoranthene	77	74	4.0	240	260	-8.0	4.2	4.5	-6.9	10	12	-18
Fluorene	10 U	10 U	--	3.4	3.8	-11	0.54 U	0.61 U	--	0.14	0.18	-25
Indeno(1,2,3-cd)pyrene	21	17	21	73	80	-9.2	1.1	1.0	9.5	3.1	3.8	-20
Naphthalene	10 U	10 U	--	2.5 J	2.2 J	13	0.54 U	0.61 U	--	0.11 J	0.11 J	0.0
Phenanthrene	23	24	-4.3	71	85	-18	1.2	1.5	-22	3.0	4.1	-31
Pyrene	41	40	2.5	120	140	-15	2.2	2.4	-8.7	5.1	6.7	-27
Total Benzofluoranthenes	74	64	14	240	270	-12	4.0	3.9	3	10	13	-26
Total LPAH (detected)	23	30	-25	86	103	-18	1.2	1.9	-43	3.6	5.0	-31
Total HPAH (detected)	313	287	8.7	1030	1156	-12	16.9	17.5	-3.5	43	55	-24
Individual detected PAH average %D:			**+7.2**			**-5.7**			**-6.0**			**-18**

Note: Laboratory default quality control limit for precision is 30%
PAH - polynuclear aromatic hydrocarbon
LPAH - low molecular weight polynuclear aromatic hydrocarbons
HPAH - high molecular weight polynuclear aromatic hydrocarbons
%D - Percent difference between paired values (A & B filters)

Table 8. 2011–2012 Whole Water Sampling Results

Sample Location:		**UNKCB27**	**UNKCB27**	**UNKCB27**	**MH362**	**MH362**	**MH362**	**MH461**	**MH461**	**MH461**	**MH368**	**MH368**	**MH368**	**MH482**	**MH482**	**MH482**	**MH356**	**MH356**	**MH356**
Lateral:		**NC (Up)**	**NC (Up)**	**NC (Up)**	**NC (Down)**	**NC (Down)**	**NC (Down)**	**SC (Up)**	**SC (Up)**	**SC (Up)**	**SC (Down)**	**SC (Down)**	**SC (Down)**	**S (Up)**	**S (Up)**	**S (Up)**	**S (Down)**	**S (Down)**	**S (Down)**
Event:		**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**	**SW-3**	**SW-4**	**SW-6**
Date:	**Criteria**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**	**2/24/2012**	**3/13/2012**	**3/29/2012**
TSS (mg/L)		2.6	1.5	2.1	3.6	4.4	8.7	9.3	7.3	10.2	27.9	11.7	29.2	6.7	5.6	7.8	22.2	31.2	57.1
PCBs (ug/L)																			
Aroclor 1242		0.010 U	0.010 U	0.010 U	**0.0080 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1248		0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.015 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1254		0.010 U	0.010 U	0.010 U	**0.011**	**0.011**	**0.015**	0.010 U	0.010 U	0.010 U	**0.011**	**0.0060 J**	**0.0080 J**	0.010 U	0.010 U	0.010 U	**0.014**	**0.011**	**0.013**
Aroclor 1260		0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.0090 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.0070 J**	0.010 U	0.010 U	0.010 U	**0.010**	**0.0080 J**	0.010 U
PCBs, total	0.030	0.010 U	0.010 U	0.010 U	**0.019 J**	**0.011**	**0.024 J**	0.010 U	0.010 U	0.010 U	**0.011**	**0.0060 J**	**0.015 J**	0.010 U	0.010 U	0.010 U	**0.024**	**0.019 J**	**0.013**
Total Metals (ug/L)																			
Arsenic	36	**0.30**	**0.20**	**0.20**	**0.50**	**0.40**	**0.70**	**1.0**	**0.90**	**1.0**	**1.5**	**1.1**	**1.2**	**0.70**	**0.60**	**0.70**	**1.5**	**0.80**	**1.9**
Cadmium	9.4	**0.10**	0.10 U	0.10 U	**0.20**	**0.20**	**0.20**	0.10 U	0.10 U	**0.10**	**0.20**	**0.10**	**0.30**	**0.40**	**0.30**	**0.30**	**0.50**	**0.50**	**0.60**
Chromium	50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.70**	**0.60**	**0.80**	**0.60**	**1.1**	2.0 U	**1.0**	**0.70**	**0.60**	**0.90**	**2.8**	**1.8**	**4.0**
Copper	3.7	**3.3**	**3.0**	**2.6**	**3.1**	**3.3**	**3.7**	**3.1**	**3.2**	**3.4**	**3.6**	**2.7**	**4.2**	**4.7**	**4.6**	**4.8**	**9.1**	**7.7**	**11**
Lead	8.5	**1.2**	**0.70**	**1.0**	**1.3**	**1.0**	**1.5**	**0.60**	**0.50**	**0.70**	**1.5**	**0.70**	**1.1**	**2.6**	**2.1**	**3.1**	**7.5**	**6.8**	**9.7**
Mercury	0.029	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	**0.10**	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Nickel	8.3	0.50 U	**1.2 J**	0.50 U	**0.60**	**0.50 J**	**0.80**	**0.90**	**2.1 J**	**0.80**	**1.3**	**0.70 J**	**0.90**	**0.80**	**1.9 J**	**1.0**	**1.7**	**3.2 J**	**1.9**
Selenium	71	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Silver	1.9	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Zinc	86	**24**	**25**	**27**	**25**	**38**	**40**	**12**	**11**	**10**	**36**	**25**	**32**	**29**	**29**	**28**	**61**	**54**	**71**
Dissolved Metals (ug/L)																			
Arsenic	36	0.20 U	0.20 U	0.20 U	**0.40**	**0.30**	**0.40**	**0.60**	**0.50**	**0.50**	**0.70**	**0.70**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**	**0.30**	**0.30**
Cadmium	9.3	0.10 U	0.10 U	0.10 U	**0.10**	**0.10**	**0.10**	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	**0.20**	**0.20**	**0.20**	0.10 U	0.10 U	0.10 U
Chromium	50	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	2.0 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Copper	3.1	**2.1**	**2.1**	**1.8**	**1.9**	**2.0**	**2.1**	**1.8**	**2.0**	**1.9**	**1.4**	**1.2**	**1.5**	**2.7**	**3.0**	**2.6**	**2.1**	**1.8**	**1.7**
Lead	8.1	**0.10**	0.10 U	**0.10 J**	**0.10**	0.10 U	**0.10 J**	**0.10**	0.10 U	0.10 U	**0.20**	0.10 U	0.10 U	**0.40**	**0.30**	**0.60 J**	**0.30**	**0.20**	**0.20 J**
Mercury	0.025	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
Nickel	8.2	**0.60**	**0.90**	**1.1 J**	**0.70**	0.50 U	**0.80**	**0.90**	**2.0**	**0.60**	**1.0**	**0.80**	**0.50**	**0.70**	**1.7**	**0.90**	**0.70**	**1.0**	0.50 U
Selenium	71	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Silver	1.9	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Zinc	81	**25**	**22**	**23**	**23**	**28**	**30**	**9.0**	**8.0**	**7.0**	**19**	**18**	**13**	**23**	**20**	**16**	**18**	**15**	**11**
PAHs (ug/L)																			
Naphthalene		**0.016**	**0.010**	**0.010**	**0.018**	**0.012**	**0.010**	**0.017**	**0.0091 J**	**0.0064 J**	**0.018**	**0.0078 J**	**0.0081 J**	**0.20**	**0.016**	**0.030**	**0.087**	**0.022**	**0.028**
2-Methylnaphthalene		**0.0078 J**	**0.0063 J**	0.010 U	**0.0086 J**	**0.0086 J**	**0.0067 J**	**0.011**	**0.0080 J**	0.010 U	**0.013**	**0.0050 J**	**0.0058 J**	**0.31**	**0.013**	**0.042**	**0.11**	**0.017**	**0.058**
1-Methylnaphthalene		**0.0063 J**	**0.0064 J**	**0.0054 J**	**0.0065 J**	**0.0077 J**	**0.0062 J**	**0.0074 J**	**0.0071 J**	0.0037 U	**0.0097 J**	**0.0042 J**	**0.0052 J**	**0.26**	**0.012**	**0.044**	**0.092**	**0.015**	**0.066**
Acenaphthylene		0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.011**	**0.0064 J**	**0.0050 J**	**0.011**	**0.0084 J**	**0.0082 J**
Acenaphthene	990	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.0075 J**	0.010 U	**0.0076 J**	**0.032**	**0.018**	**0.025**
Fluorene	5300	**0.0058 J**	0.010 U	0.010 U	**0.0051 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.019**	**0.0097 J**	**0.012**	**0.028**	**0.019**	**0.027**
Phenanthrene		**0.10**	**0.040**	**0.034**	**0.061**	**0.044**	**0.030**	**0.019**	**0.017**	**0.012**	**0.035**	**0.013**	**0.016**	**0.18**	**0.14**	**0.15**	**0.42**	**0.37**	**0.28**
Anthracene	40000	**0.0068 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.015**	**0.0091 J**	**0.0095 J**	**0.052**	**0.031**	**0.023**
LPAH, total		**0.13 J**	**0.050**	**0.044**	**0.084 J**	**0.056**	**0.040**	**0.036**	**0.026 J**	**0.018 J**	**0.053**	**0.021 J**	**0.024 J**	**0.43 J**	**0.18 J**	**0.21 J**	**0.63**	**0.47 J**	**0.39 J**
Fluoranthene	140	**0.40**	**0.12**	**0.11**	**0.21**	**0.11**	**0.084**	**0.060**	**0.040**	**0.026**	**0.092**	**0.021**	**0.034**	**0.73**	**0.47**	**0.52**	**0.60 J**	**1.4**	**0.93**
Pyrene	4000	**0.22**	**0.074**	**0.060**	**0.13**	**0.074**	0.054* U	0.032* U	0.028* U	0.015* U	**0.065**	0.016* U	0.024* U	**0.41**	**0.28**	**0.28**	**1.1**	**0.71**	**0.60 J**
Benzo(a)anthracene	0.018	**0.044**	**0.012**	**0.010**	**0.024**	**0.016**	**0.013**	**0.0067 J**	0.010 U	0.010 U	**0.016**	0.010 U	0.010 U	**0.12**	**0.078**	**0.089**	**0.46**	**0.29**	**0.23**
Chrysene	0.018	**0.14**	**0.062**	**0.050**	**0.076**	**0.074**	**0.049**	**0.031**	**0.032**	0.017* U	**0.047**	0.018* U	0.025* U	**0.34**	**0.34**	**0.29**	**0.81**	**0.80**	**0.62**
Benzo(a)pyrene	0.018	**0.066**	**0.028**	**0.022 J**	**0.037**	**0.027**	**0.025 J**	**0.0095 J**	**0.012**	**0.0063 J**	**0.017**	**0.0059 J**	**0.011 J**	**0.15**	**0.13**	**0.13 J**	**0.48**	**0.45**	**0.35 J**
Indeno(1,2,3-cd)pyrene	0.018	**0.066**	**0.024**	**0.032**	**0.030**	**0.021**	**0.032**	**0.010**	**0.0094 J**	**0.0088 J**	**0.014**	0.010 U	**0.014**	**0.16**	**0.13**	**0.20**	**0.46**	**0.50**	**0.48**
Dibenz(a,h)anthracene	0.018	**0.0094 J**	0.010 U	**0.0059 J**	0.010 U	0.010 U	**0.0056 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.026**	**0.024**	**0.040**	**0.095**	**0.11**	**0.11**
Benzo(g,h,i)perylene		**0.093**	**0.027**	**0.040**	**0.055**	**0.033**	**0.039**	**0.015**	**0.012**	**0.012**	**0.023**	**0.0055 J**	**0.019**	**0.21**	**0.13**	**0.23**	**0.64**	**0.55**	**0.60**
Dibenzofuran		**0.0056 J**	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	**0.015**	**0.0088 J**	**0.0096 J**	**0.021**	**0.017**	**0.015**
Benzofluoranthenes, total	0.018	**0.26**	**0.11**	**0.079**	**0.13**	**0.11**	**0.076**	**0.046**	**0.047**	**0.023**	**0.065**	0.016 U	**0.035**	**0.70 J**	**0.58**	**0.46**	**1.5**	**1.4**	**1.0**
HPAH, total		**1.3 J**	**0.46**	**0.41 J**	**0.69**	**0.47**	**0.32 J**	**0.18 J**	**0.15 J**	**0.076 J**	**0.34**	**0.032 J**	**0.11 J**	**2.8 J**	**2.2**	**2.2 J**	**6.1 J**	**6.2**	**4.9 J**
Total cPAHs (ug/L)																			
Total cPAHs (TEQ, NDx0.5)	0.018	**0.11**	**0.044**	**0.035**	**0.057**	**0.043**	**0.038**	**0.017**	**0.019**	**0.011**	**0.028**	**0.0083**	**0.017**	**0.254**	**0.22**	**0.21**	**0.74**	**0.69**	**0.54**
Other SVOCs (ug/L)																			
bis(2-Ethylhexyl)phthalate	2.2	2.1* U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.2* U	1.0* U	1.0 U	3.5* U
Di-n-octyl phthalate		1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	**0.90 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Phenol	860000	**0.80 J**	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U

Total cPAHs are expressed as a benzo(a)pyrene TEQ concentration, using half the non-detect value.

🟨	Chemical detected at a concentration above the criterion
🟧	Chemical detected at a concentration at least 10X the criterion
🟩	Chemical not detected, but reporting limit is above the criterion

Screening level criteria for PCBs and metals are state/federal marine ambient water quality criteria for aquatic life; other organic chemicals apply federal marine WQC for protection of human health via consumption of organisms.

* Thirteen detected results were re-qualified as nondetected during data validation because of field blank (sample carboy) contamination, including six results for pyrene, three results for chrysene, and four results for bis(2-ethylhexyl)phthalate.

Table 9. December 2011 Infiltrating Water Grab Sampling Results

Sample Location:		Near MH362	
Date:	Criteria	12/9/2011	
TSS (mg/L)		NA	
Hardness ($CaCO_3$ mg/L)		150	
PCBs (ug/L)			
Aroclor 1248		0.015	U
Aroclor 1254		**0.020**	
Aroclor 1260		0.010	U
PCBs, total	0.030	**0.020**	
Total Metals (ug/L)			
Arsenic	36	**93**	
Cadmium	9.4	**17.3**	
Chromium	50	**90**	
Copper	3.7	**143**	
Lead	8.5	**62**	
Mercury	0.029	**0.50**	J
Nickel	8.3	**56**	
Selenium	71	5.0	U
Silver	1.9	**0.50**	
Zinc	86	**2230**	
Dissolved Metals (ug/L)			
Arsenic	36	**0.70**	
Cadmium	9.3	0.10	U
Chromium	50	0.50	U
Copper	3.1	**1.1**	
Lead	8.1	0.10	U
Mercury	0.025	0.020	U
Nickel	8.2	**1.5**	
Selenium	71	0.50	U
Silver	1.9	0.20	U
Zinc	81	**35**	
PAHs (ug/L)			
Benzo(a)anthracene	0.018	1.0	U
Chrysene	0.018	1.0	U
Benzo(a)pyrene	0.018	1.0	U
Indeno(1,2,3-cd)pyrene	0.018	1.0	U
Dibenz(a,h)anthracene	0.018	1.0	U
Total cPAHs (TEQ, NDx0.5)	0.018	**0.71**	
Other SVOCs (ug/L)			
Other SVOCs	--	All ND	
VOCs (ug/L)			
Methylene chloride	590	**0.60**	

Detected concentrations are shown in **Bold**.

Only chemicals that have been detected in at least one sample are shown.

Note: This sample of infiltrating groundwater was collected in the storm drain line approximately 5 feet downstream of MH362 (unmixed with stormwater when collected); this infiltrating water previously had a white viscous appearance when mixed with stormwater.

▒	Chemical detected at a concentration above the criterion
🟧	Chemical detected at a concentration at least 10X the criterion
🟩	Chemical not detected, but reporting limit is above the criterion

Figure 10. Summary of 2011–2012 Filtered Solids Results

Chemical	Lower SL	Upper SL	North Lateral			North-Central Lateral		South-Central Lateral		South Lateral	
			MH138	MH172	CB175	UNKCB27	MH362	MH461	MH368	MH482	MH356
			N7	N11	N11	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Total PCBs (mg/kg)	0.13	1.0	1.0 - 3.6	2.2 - 7.6	2.1 - 3.9	0.22 - 0.27	1.7 - 2.1	<0.005 - 0.15	0.20 - 0.29	0.015 - 0.36	0.17 - 0.44
Cadmium (mg/kg)	5.1	6.7	6.0	4.0 - 5.4	2.1 - 3.2	7.0 - 9.0	8.7 - 11	<3.0 - 5.0	2.0 - 10	8.9 - 13	8.0 - 10
Chromium (mg/kg)	260	270	116	42 - 52	57 - 84	91 - 177	92 - 186	20 - 62	28 - 67	33 - 50	**137 - 3,140**
Copper (mg/kg)	390	390	454	136 - 284	73 - 121	309 - 370	166 - 264	28 - 182	41 - 88	149 - 214	182 - 535
Lead (mg/kg)	450	530	110	149 - 232	51 - 79	340 - 700	118 - 230	<40 - 40	30 - 60	90 - 192	120 - 180
Mercury (mg/kg)	0.41	0.59	0.34	0.4 - 0.4	0.30 - 0.73	<0.30 - 0.40	0.32 - 0.40	<0.20 - 0.30	<0.06 - 0.19	**0.20 - 6.1**	0.20 - 0.40
Zinc (mg/kg)	410	960	1,330	594 - 835	520 - 594	818 - 1,120	1,070 - 1,360	120 - 240	264 - 800	714 - 819	1,000 - 1,030
Total LPAH (mg/kg)	5.2	13	0.85	2.6	3.8	12 - 24	2.7 - 4.5	0.17 - 0.53	0.23 - 0.71	3.6 - 12	1.2 - 4.4
Total HPAH (mg/kg)	12	17	12	34	12	**135 - 300**	30 - 61	0.74 - 5.6	2.0 - 5.5	**43 - 230**	17 - 71
Total cPAHs (mg/kg)	1.0	5.5	1.2	3	1.1	13 - 34	2.7 - 6.2	0.07 - 0.53	0.20 - 0.42	5.0 - 22	3.1 - 6.8
Total Dioxins/Furans (ng/kg)	25	50	50	31	14	88	70	49	33	59	84

SL = screening level

All units are for dry weight.

Total Dioxins/Furans are expressed as a 2,3,7,8-TCDD toxic equivalent (TEQ) concentration, using half the non-detect value.

Total cPAHs are expressed as a benzo(a)pyrene TEQ concentration, using half the non-detect value.

░	Max detected value exceeds lower SL
▒	Max detected value exceeds upper SL
▓	Max detected value exceeds 10x upper SL

The Lower and Upper SL values represent the SQS and CSL for metals, and the LAET and 2LAET for PCBs and individual PAHs.

The Lower and Upper SL values for cPAHs (TEQ) and dioxins/furans (TEQ) represent the range of LDW-wide remedial action levels in the preferred alternative and other alternatives in the LDW Feasibility Study and Proposed Plan.

Figures

Figure 1. NBF Site Vicinity Map

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Figure 2. 2011–2012 Stormwater Monitoring Sampling Locations – North Lateral SD Line

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Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: mlf
File: Figure2_NBFNorthernSamplingLocations.mxd
Illustrative purposes only.
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Figure 3. 2011–2012 Stormwater Monitoring Sampling Locations – North-Central, South-Central, and South-Lateral SD Lines

From Science to Solutions

Coordinate System:
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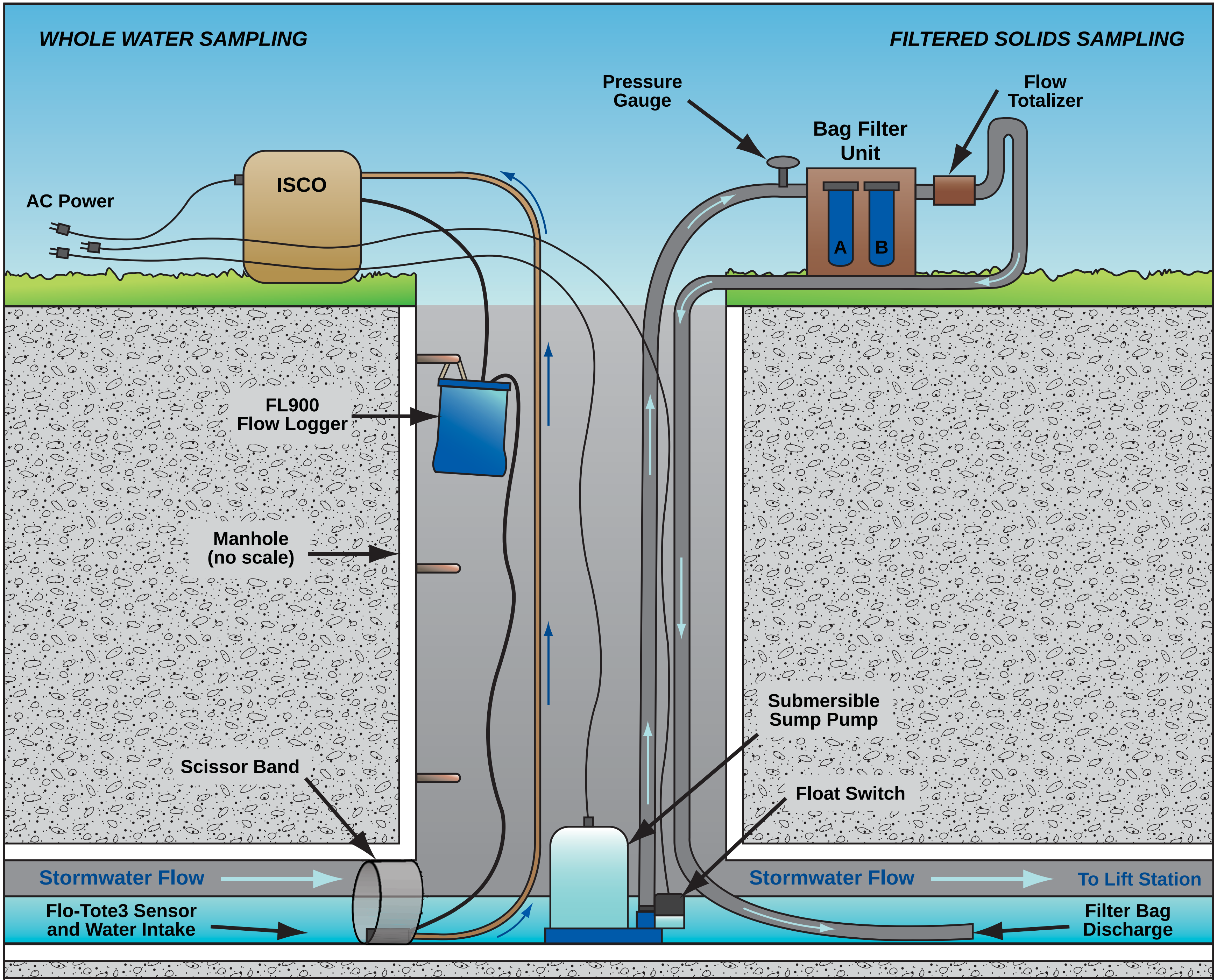

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Figure 4. Stormwater Sampling Schematic

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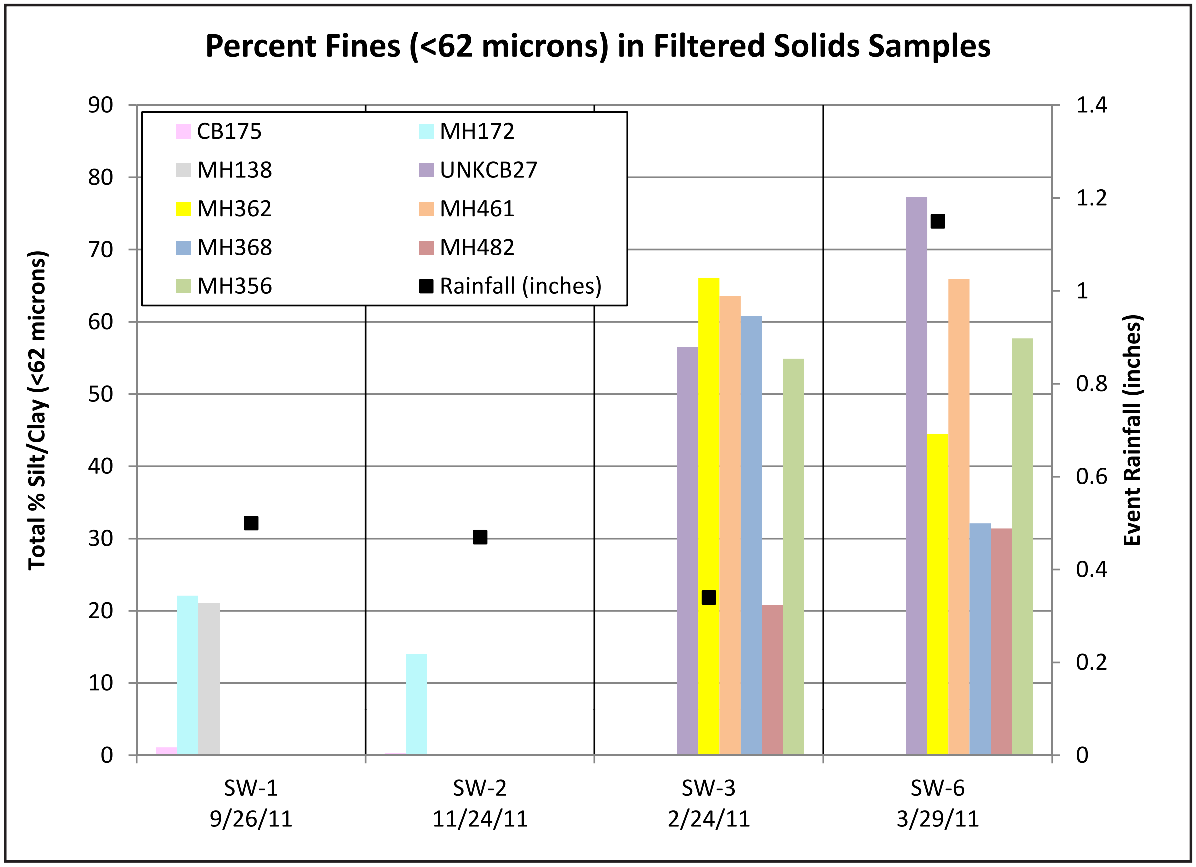

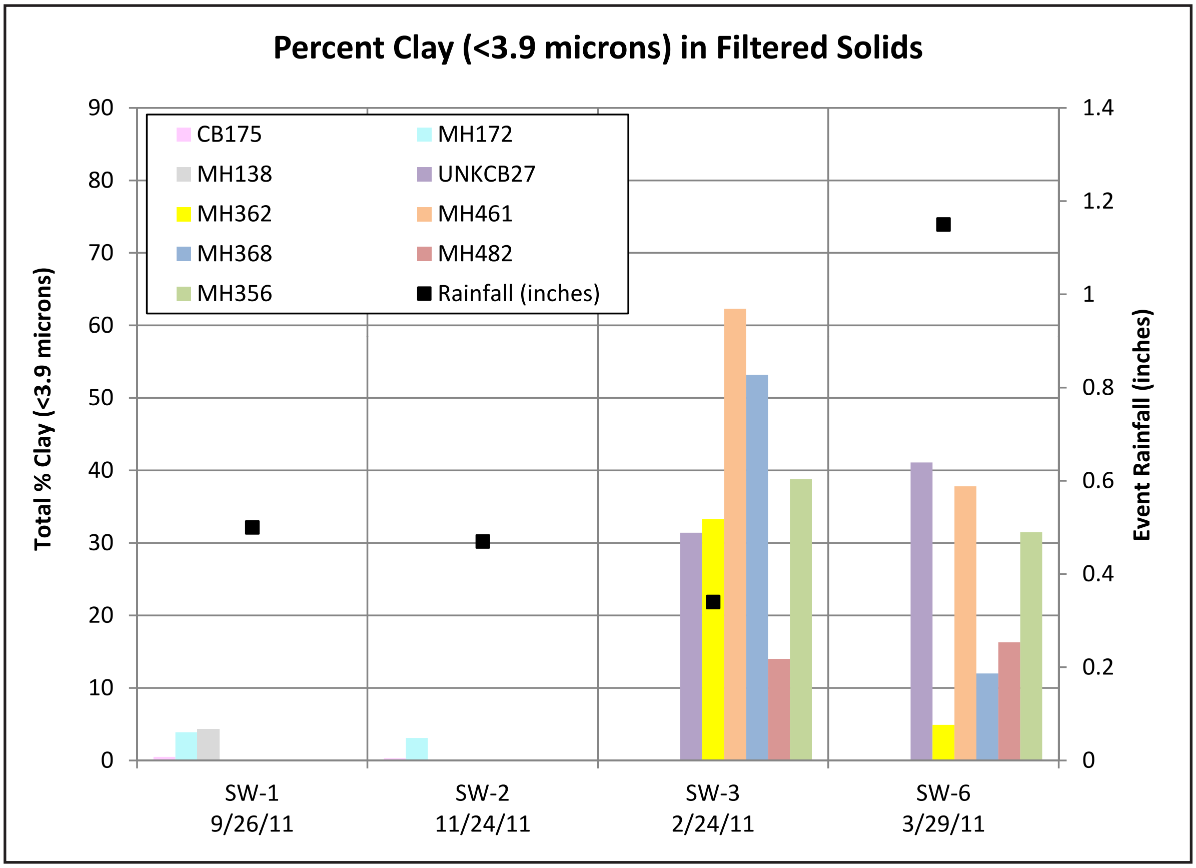

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Figure 5. Percent Fines/Clay in Filtered Solids Samples North, North-Central, South-Central, and South Lateral SD Lines

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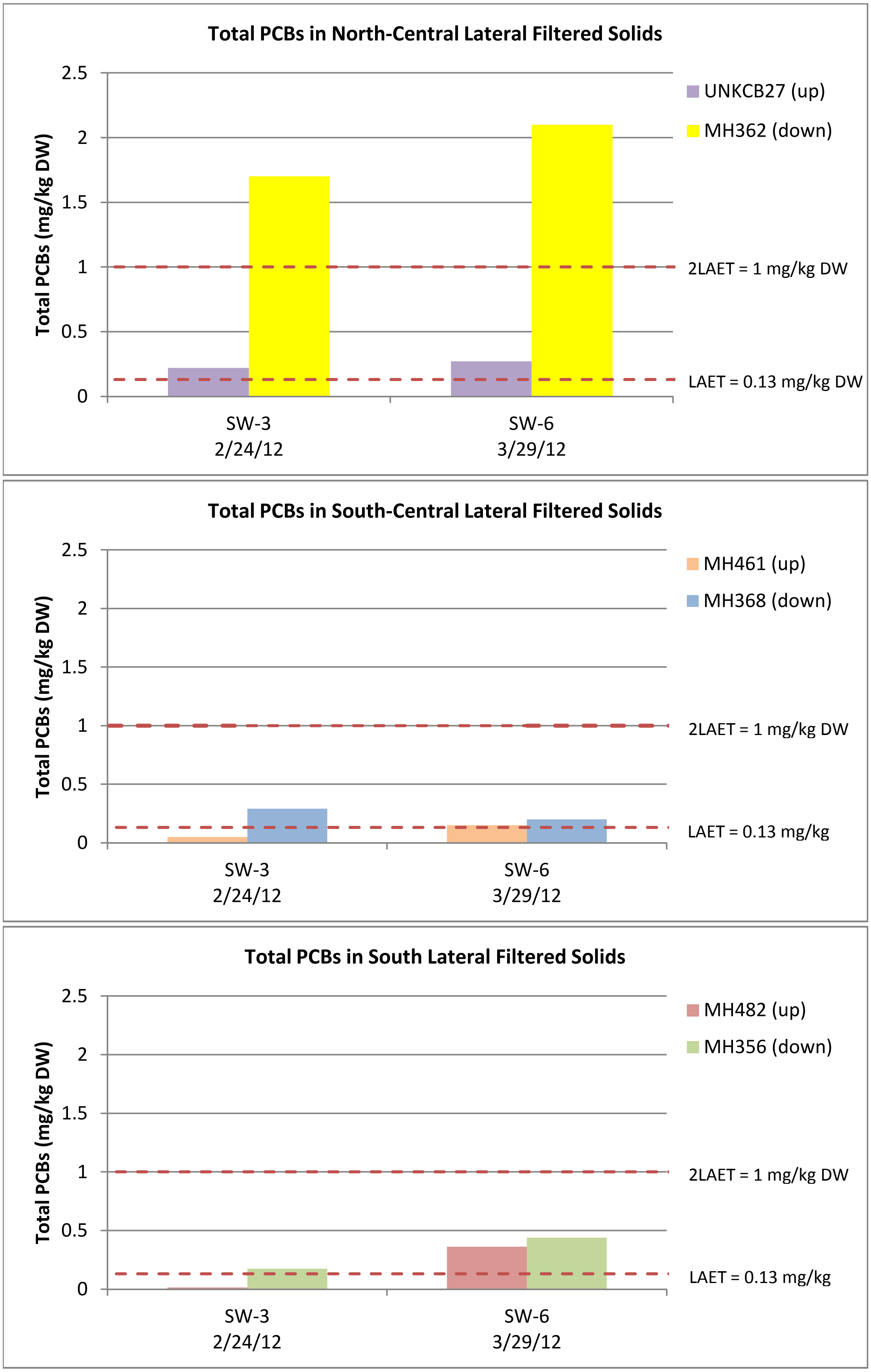
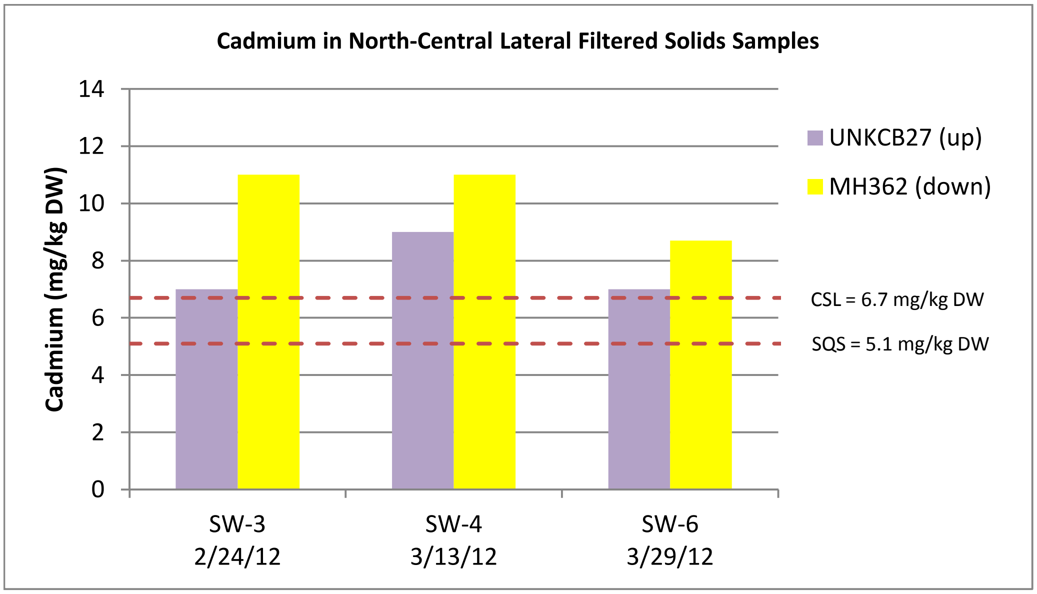

Total PCBs in North-Central Lateral Filtered Solids

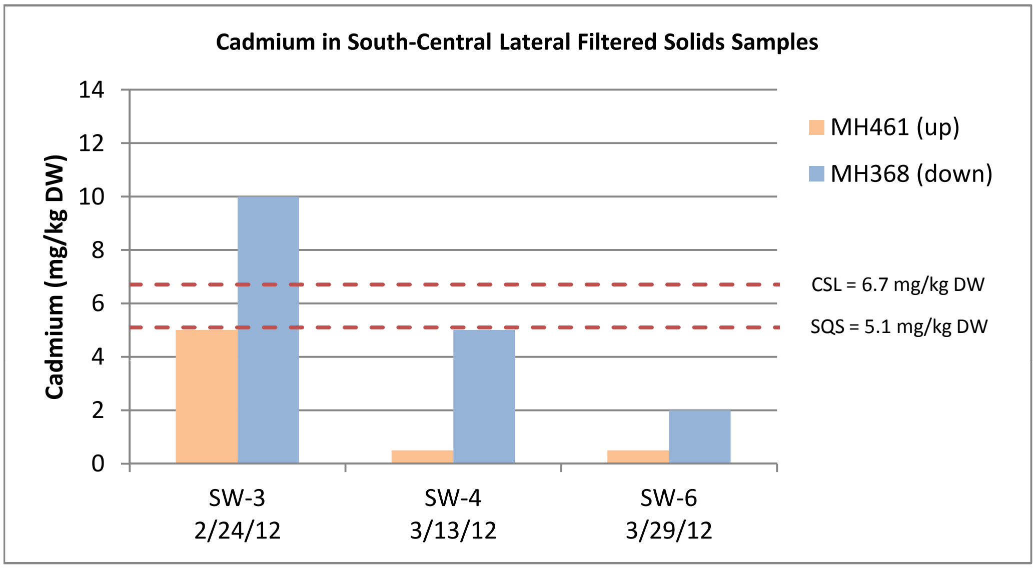
Total PCBs in South-Central Lateral Filtered Solids

Total PCBs in South Lateral Filtered Solids

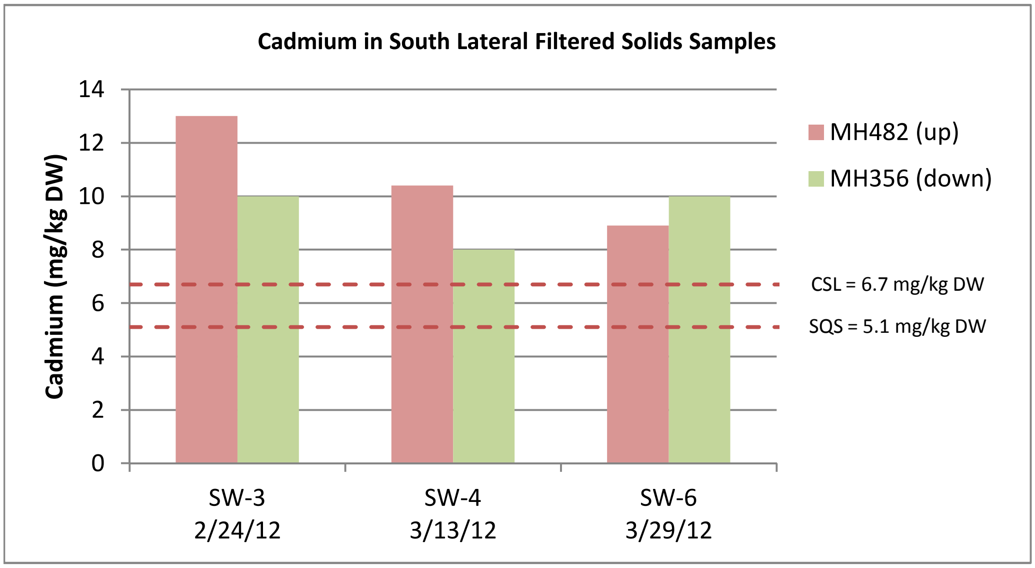
Figure 6. Total PCBs in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines



Cadmium in North-Central Lateral Filtered Solids Samples

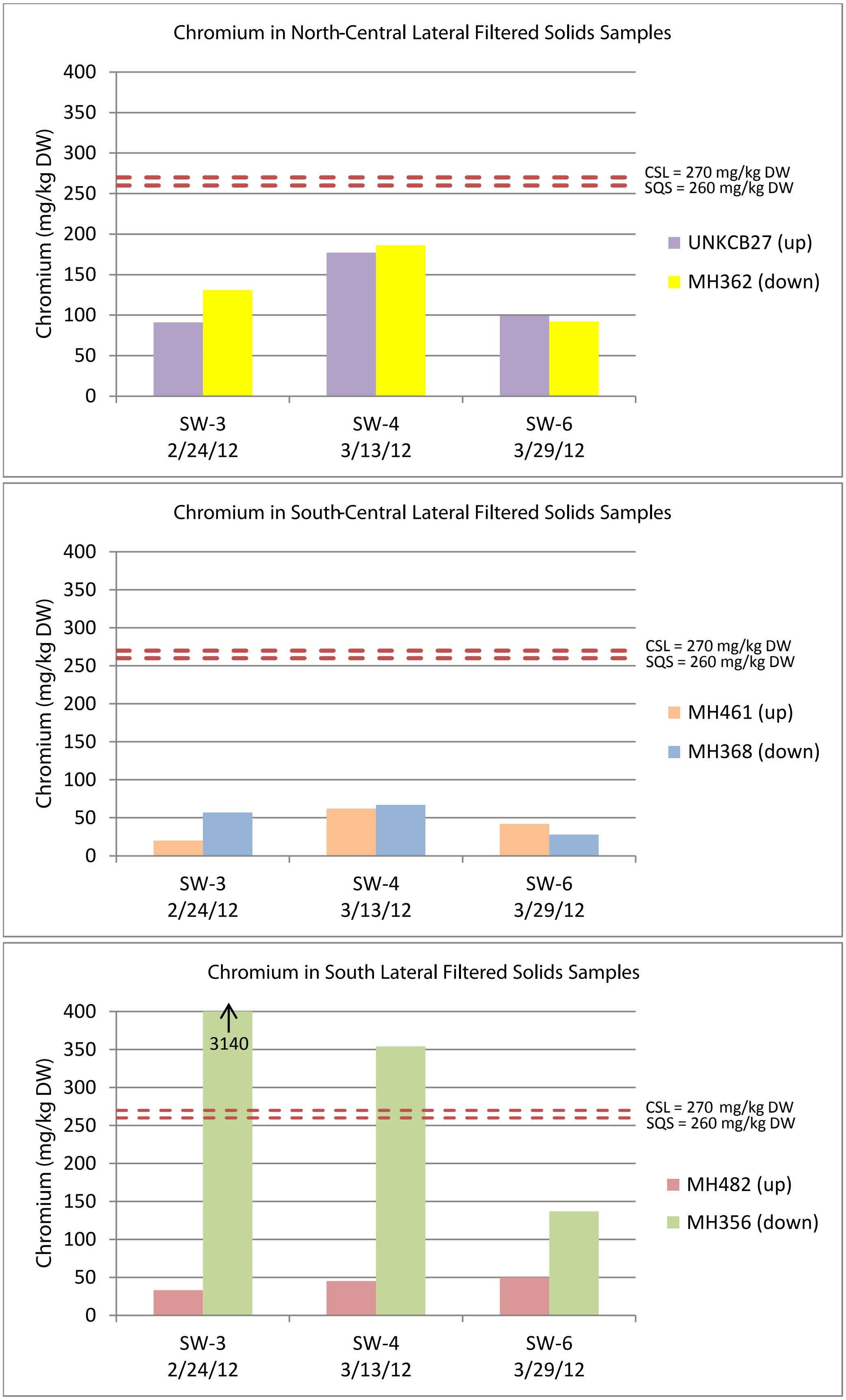


Cadmium in South-Central Lateral Filtered Solids Samples



Cadmium in South Lateral Filtered Solids Samples

Figure 7. Cadmium in Filtered Solids Samples North-Central, South-Central, and South Lateral SD Lines



Chromium in North-Central Lateral Filtered Solids Samples

Chromium in South-Central Lateral Filtered Solids Samples

Chromium in South Lateral Filtered Solids Samples

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Figure 8. Chromium in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines

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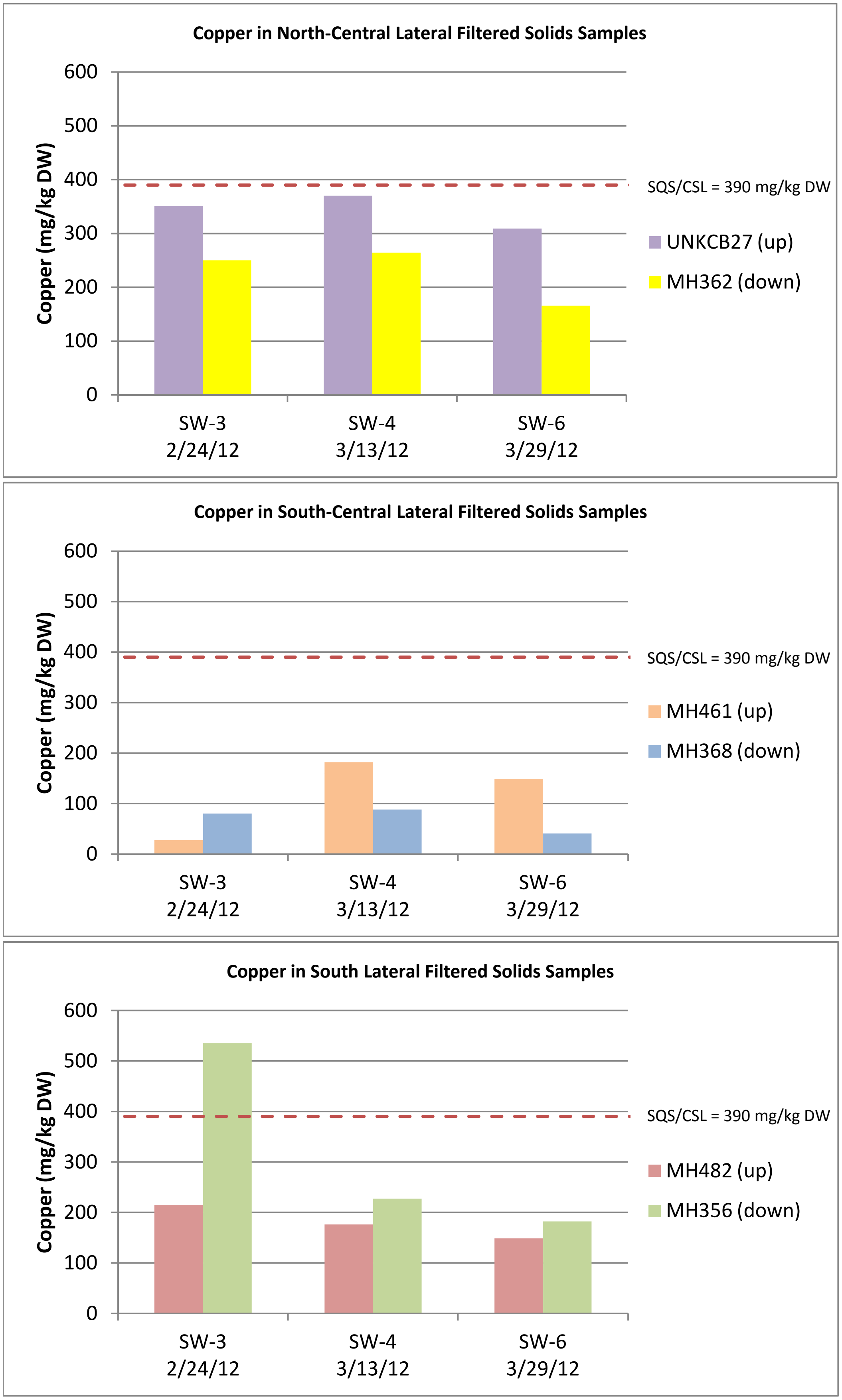
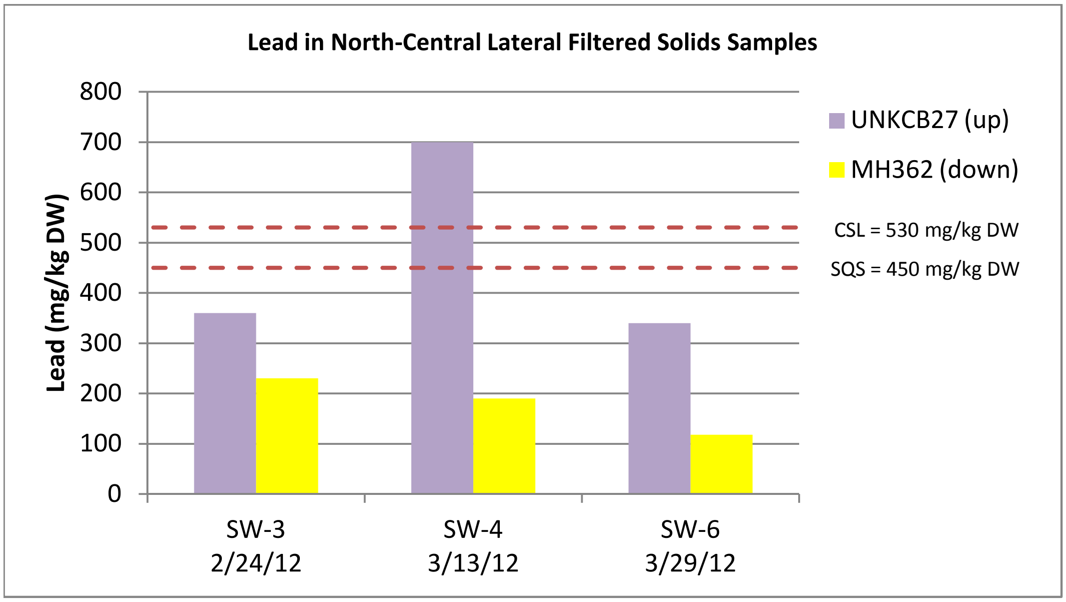
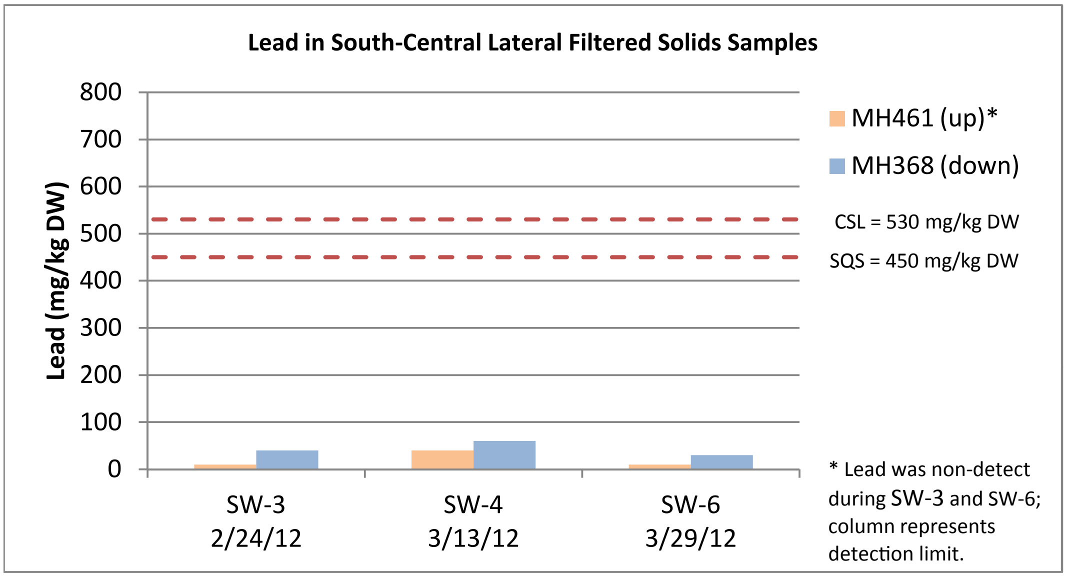


Figure 9. Copper in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines

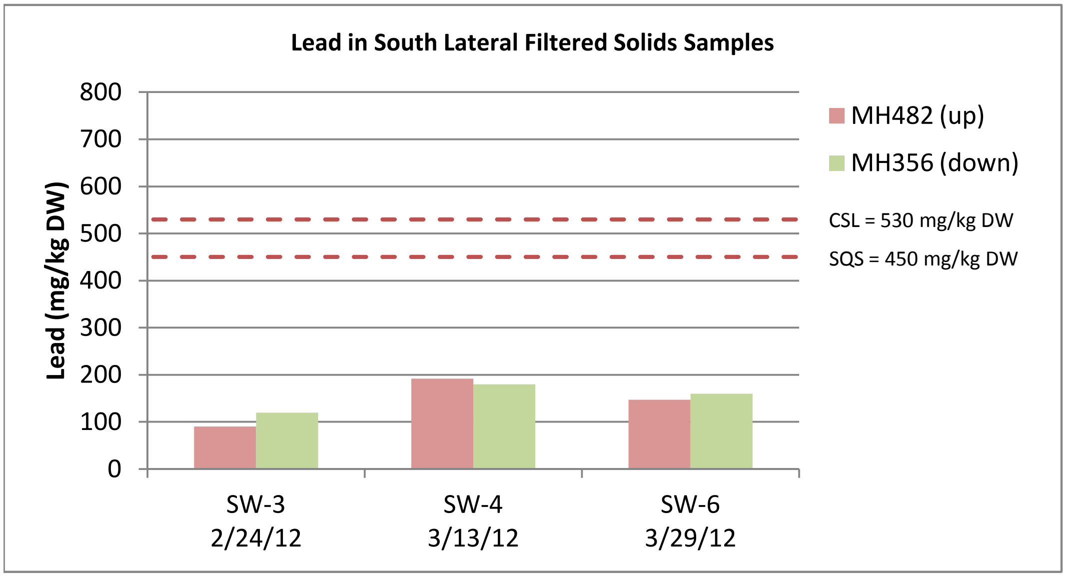


Lead in North-Central Lateral Filtered Solids Samples



Lead in South-Central Lateral Filtered Solids Samples

* Lead was non-detect during SW-3 and SW-6; column represents detection limit.



Lead in South Lateral Filtered Solids Samples

Figure 10. Lead in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines

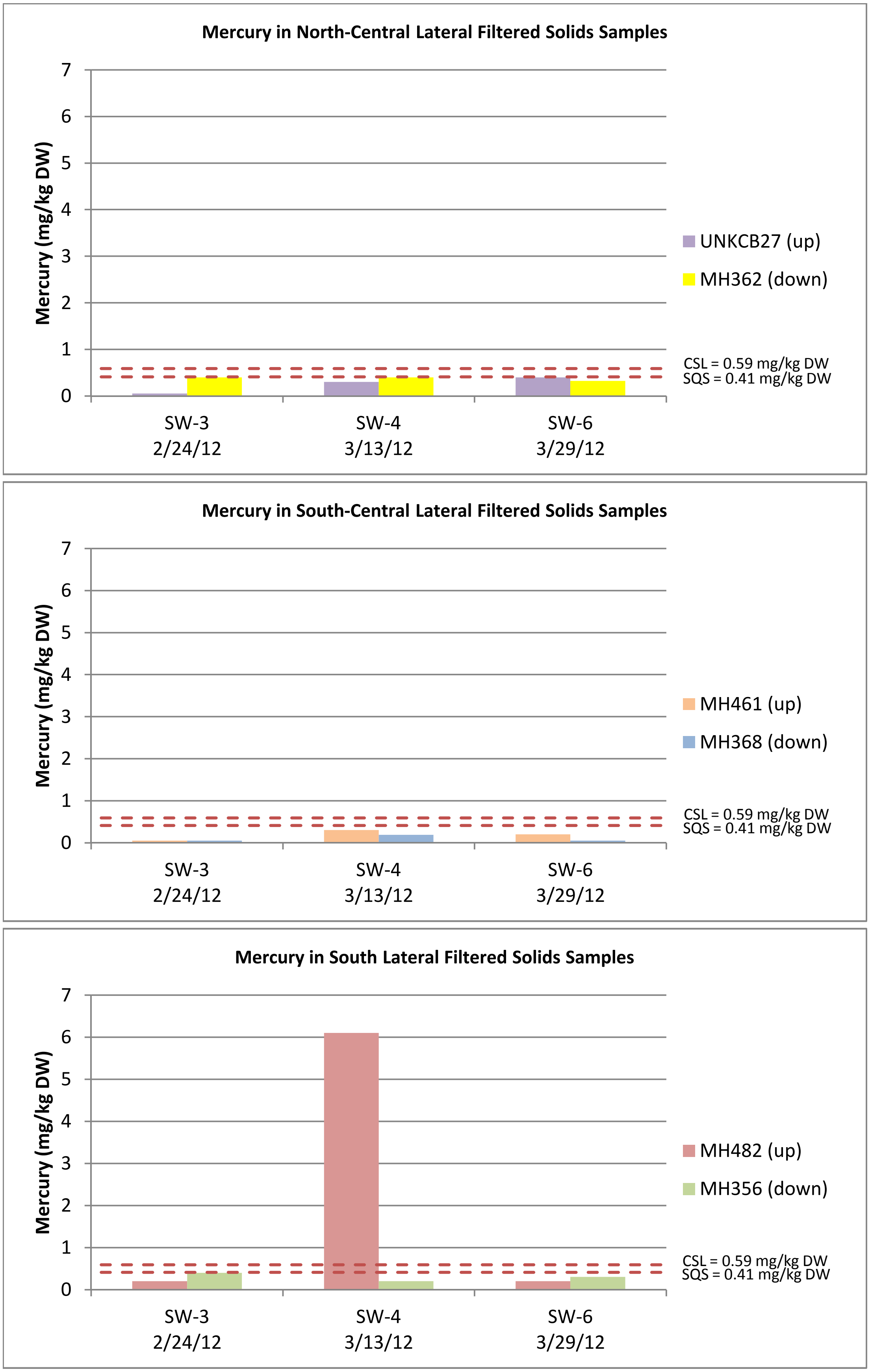
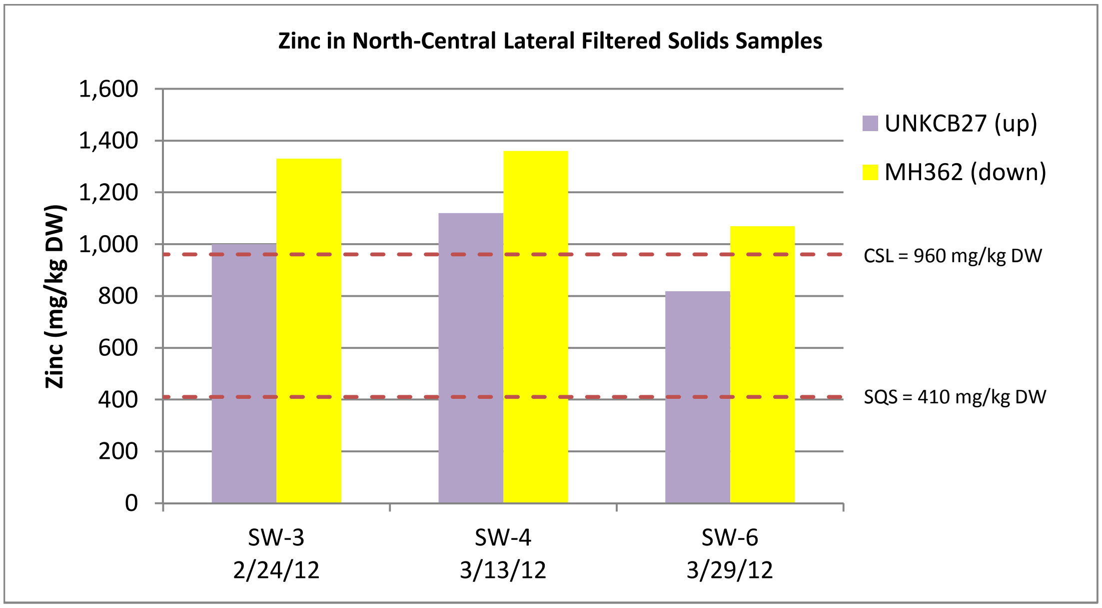
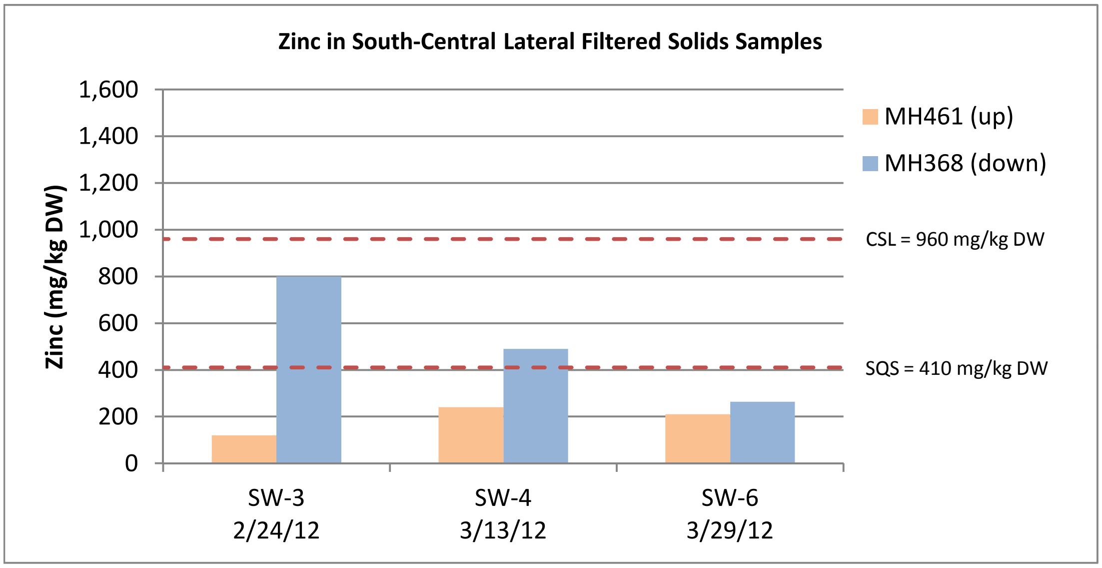


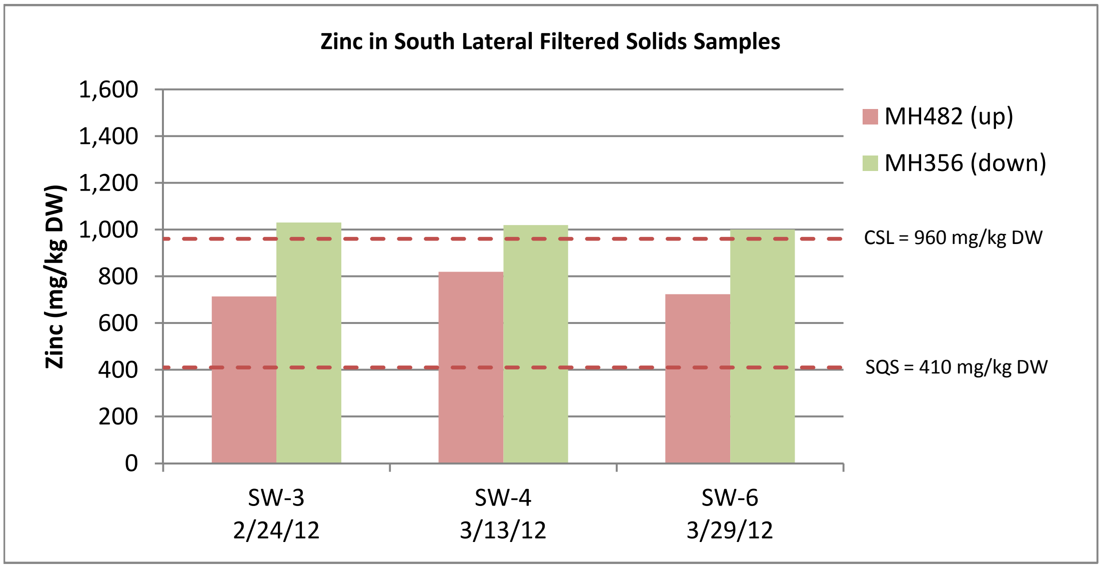
**Figure 11. Mercury in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines**



Zinc in North-Central Lateral Filtered Solids Samples

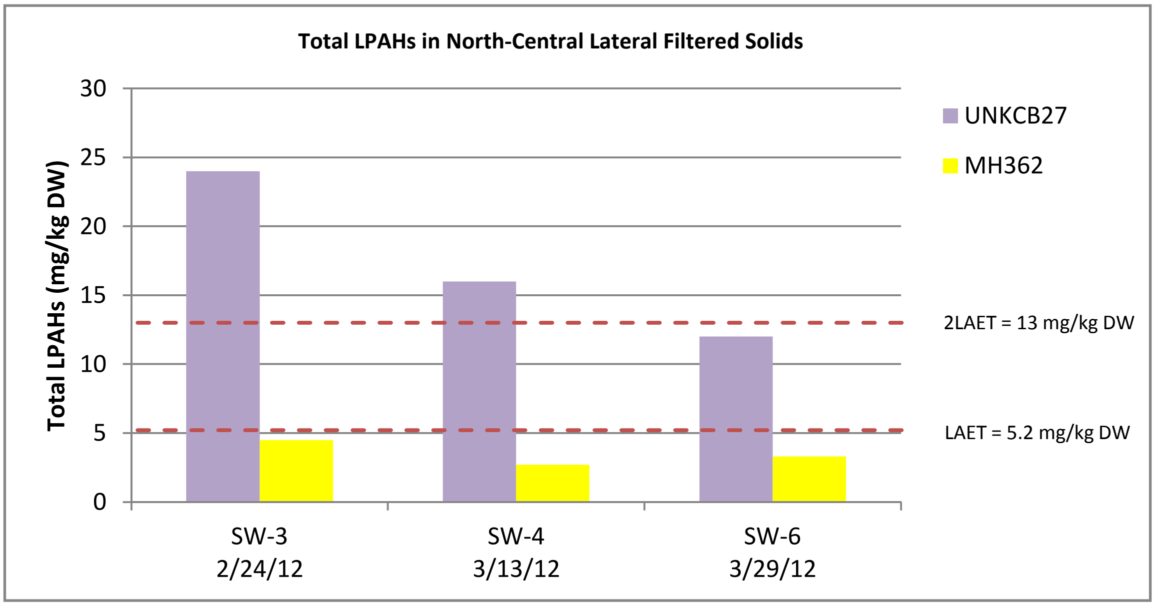


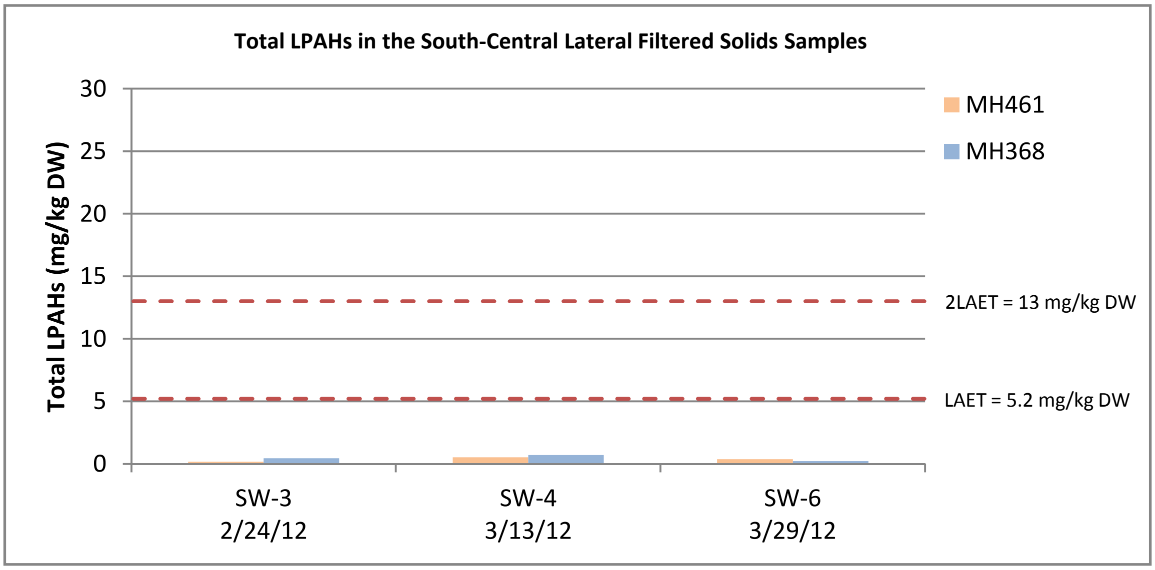
Zinc in South-Central Lateral Filtered Solids Samples



Zinc in South Lateral Filtered Solids Samples

Figure 12. Zinc in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines





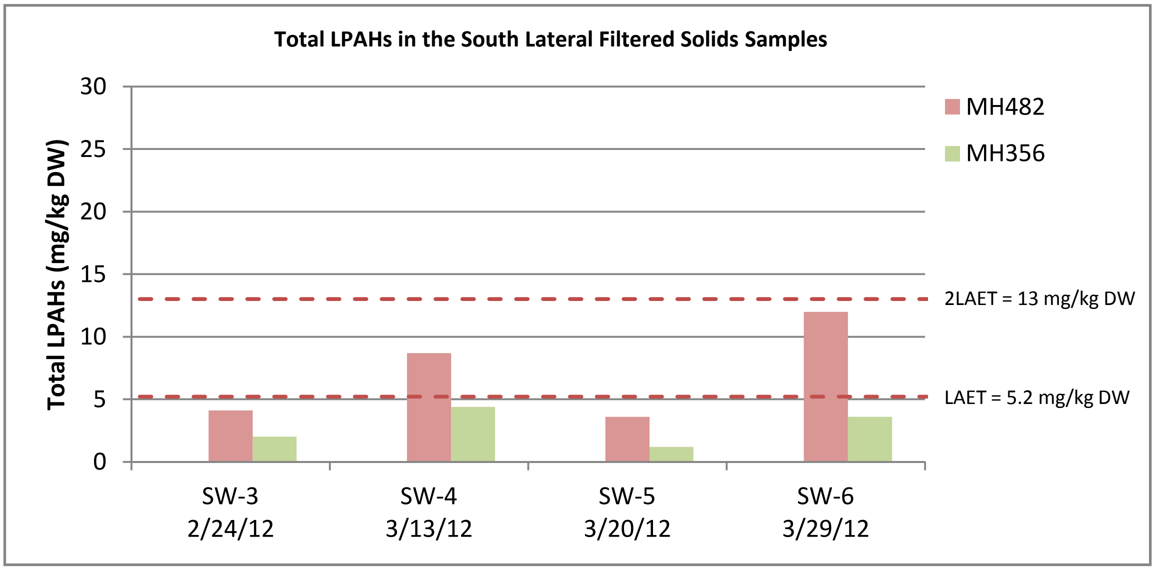


Figure 13. Total LPAHs in Filtered Solids Samples North-Central, South-Central, and South Lateral SD Lines

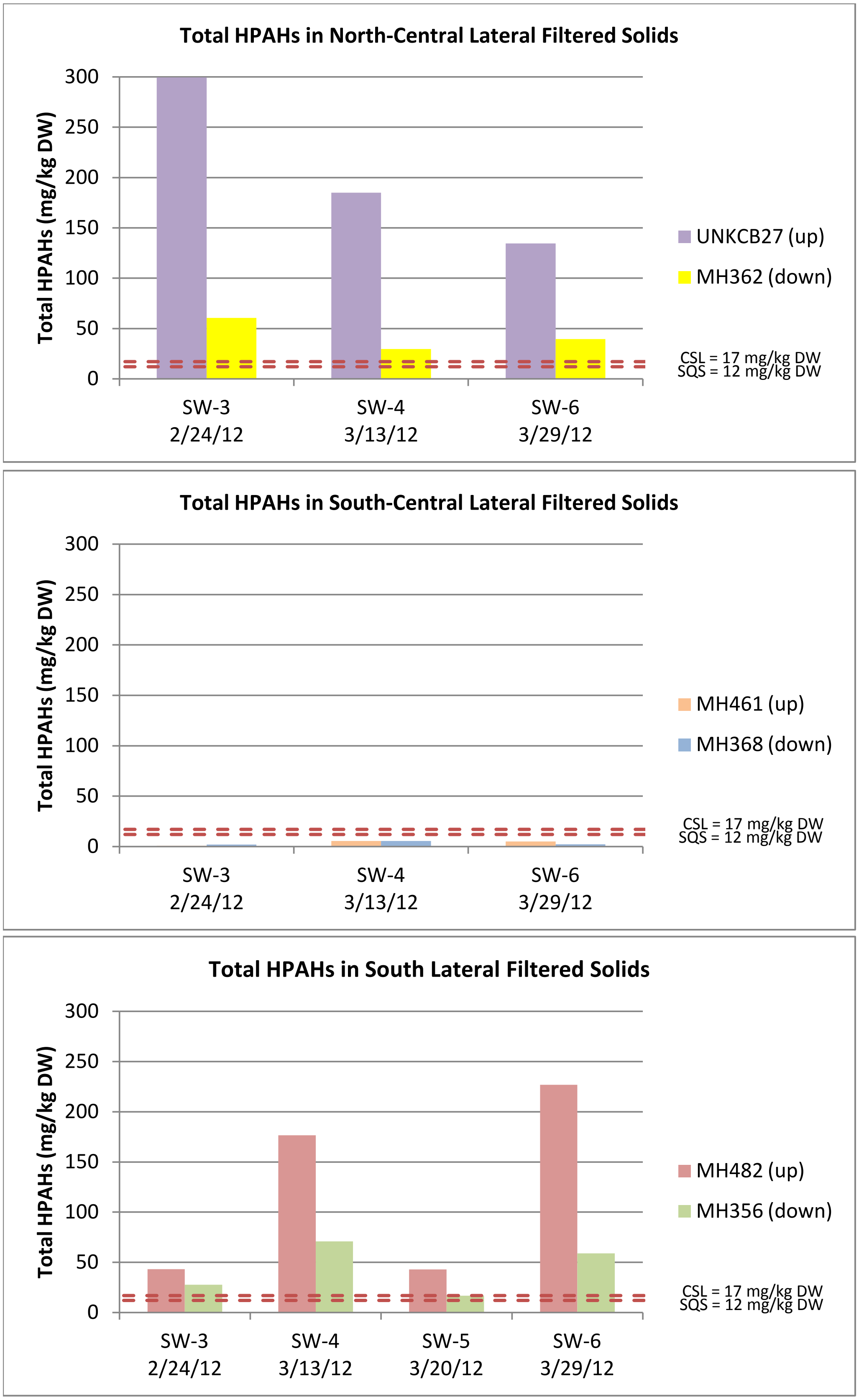


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Figure 14. Total HPAHs in Filtered Solids Samples
North-Central, South-Central, and South Lateral SD Lines

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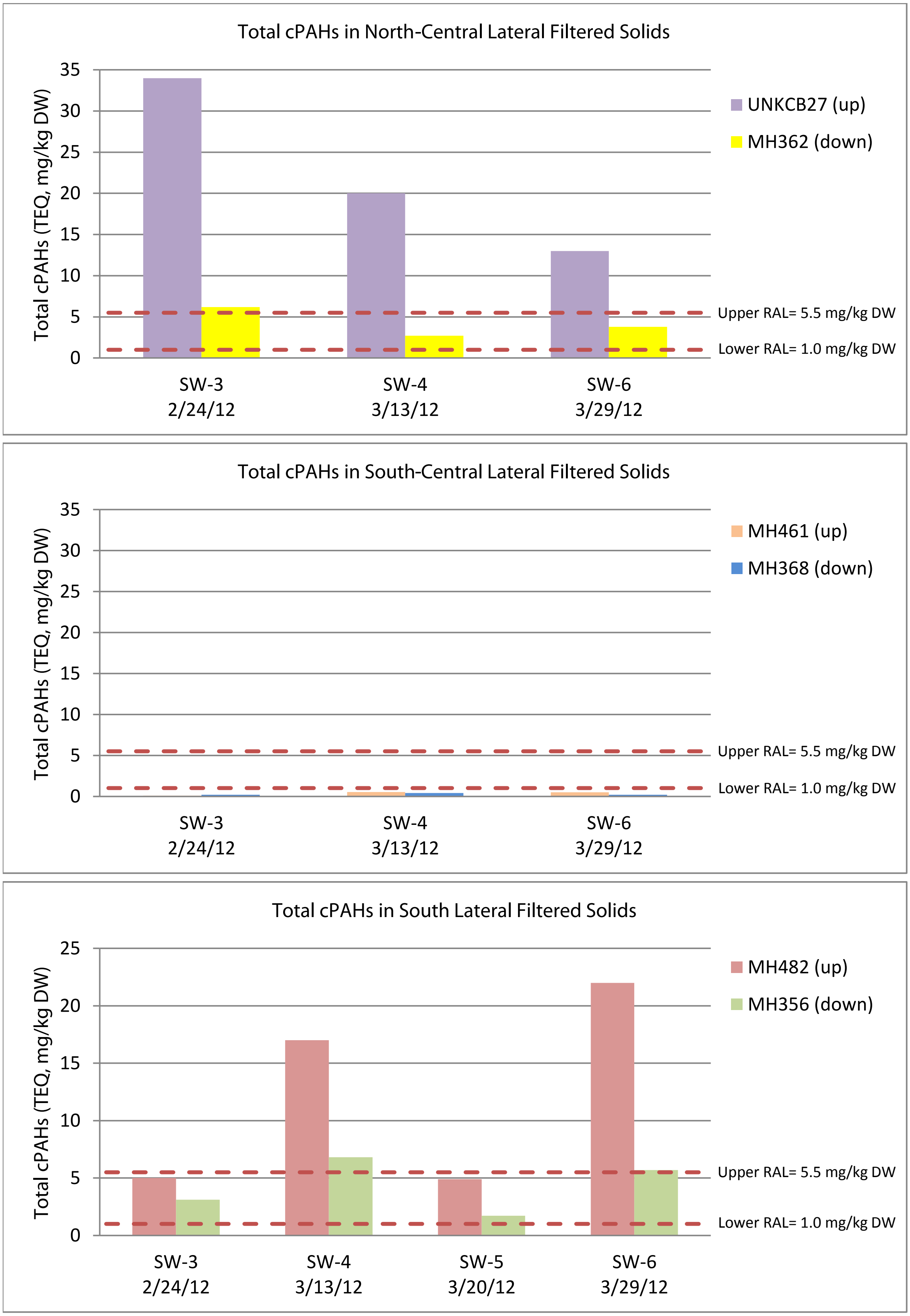


Total cPAHs in North-Central Lateral Filtered Solids

Total cPAHs in South-Central Lateral Filtered Solids

Total cPAHs in South Lateral Filtered Solids

Figure 15. Total cPAHs in Filtered Solids Samples North-Central, South-Central, and South Lateral SD Lines

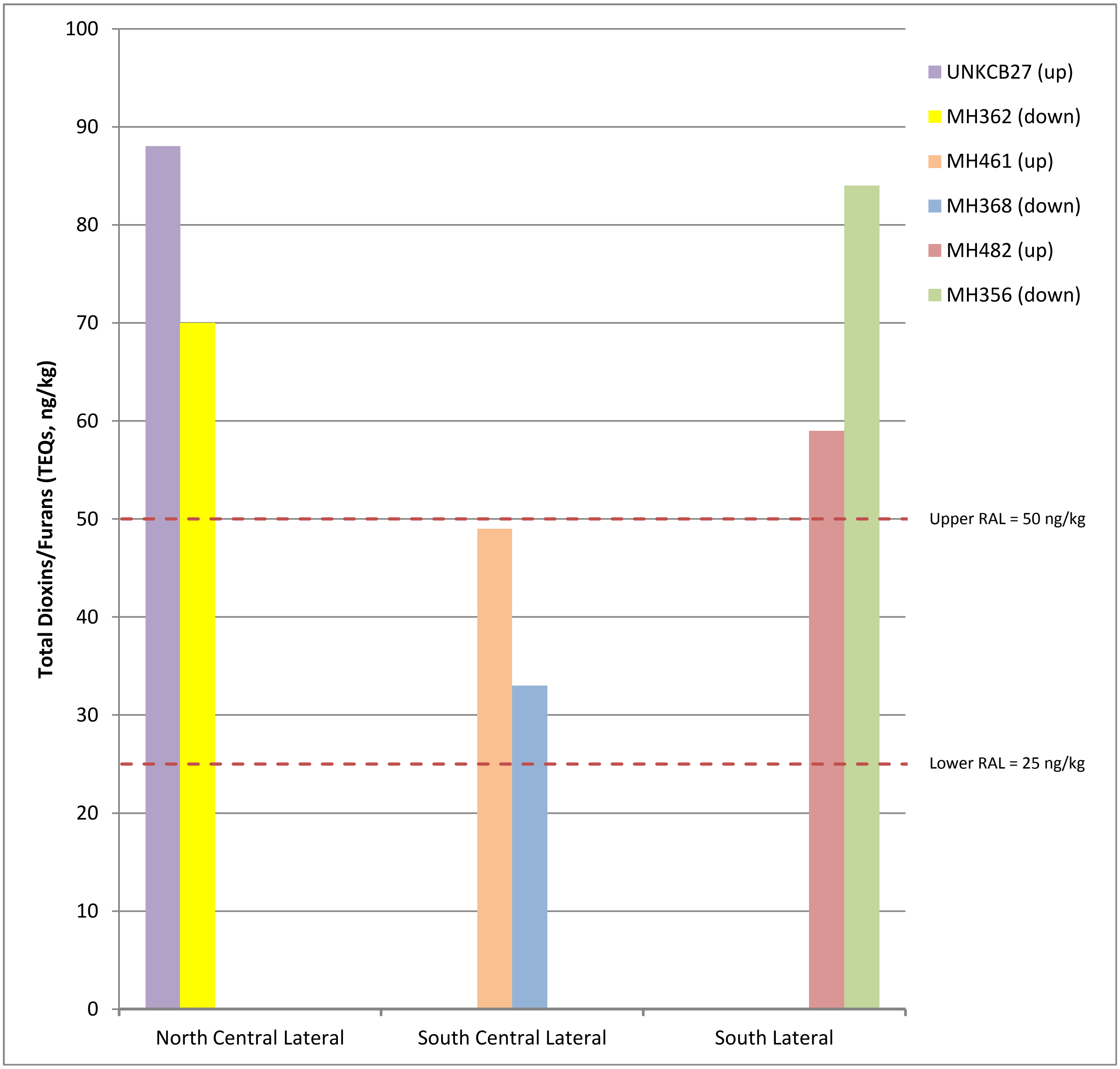
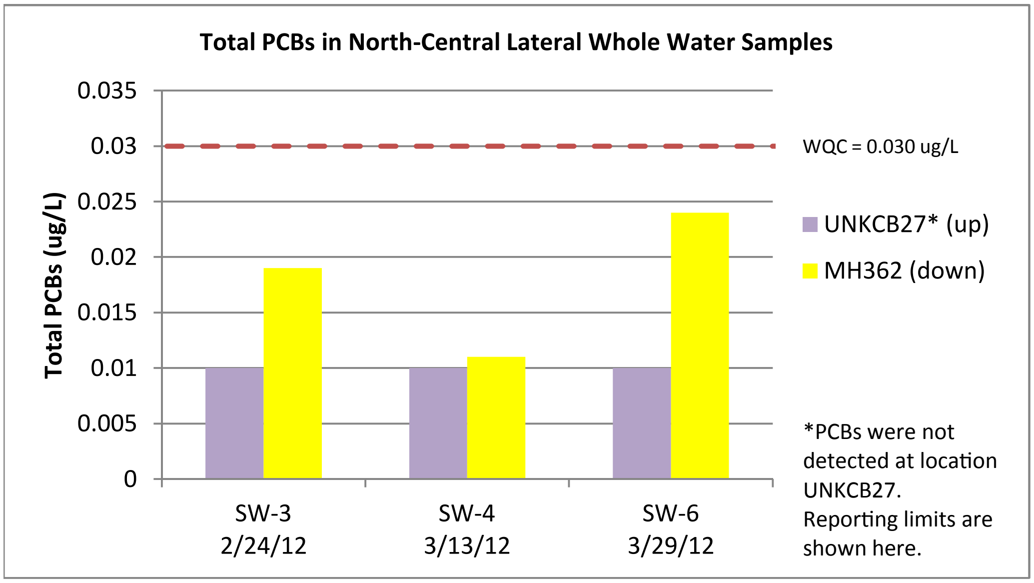
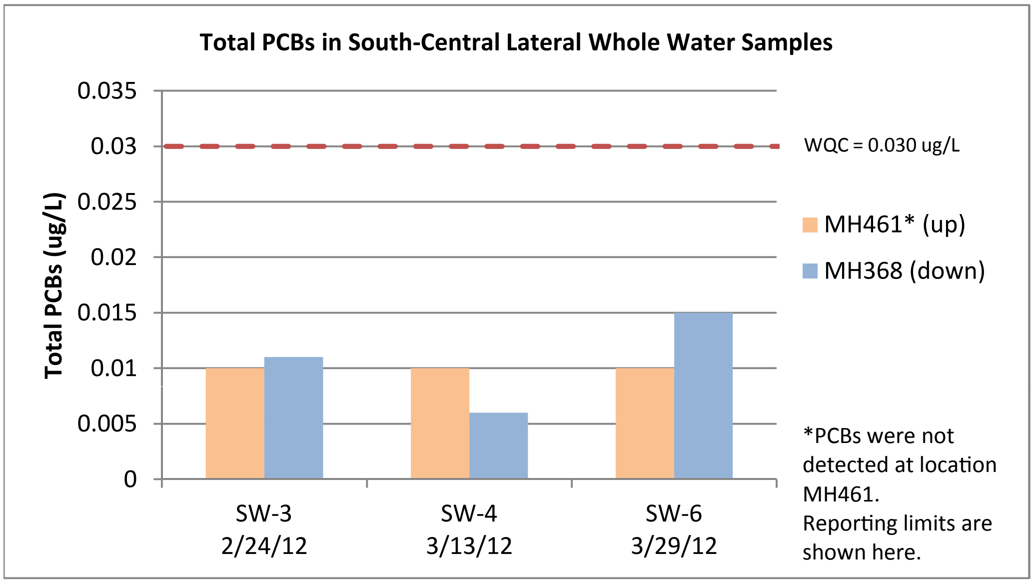


Figure 16. Total Dioxins/Furans in Filtered Solids Samples North-Central, South-Central, and South Lateral SD Lines Event SW-4 (3/13/12)



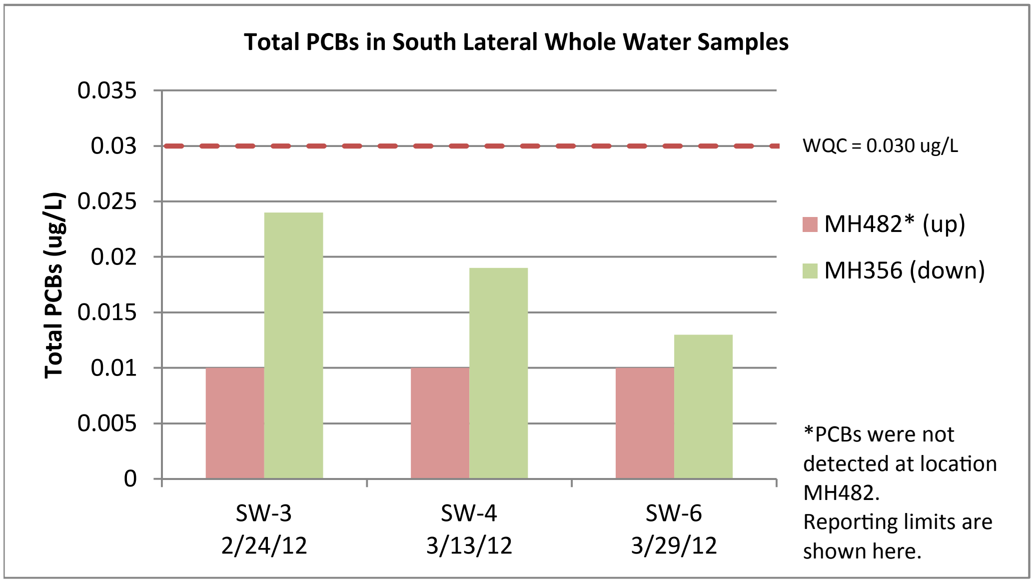
Total PCBs in North-Central Lateral Whole Water Samples

*PCBs were not detected at location UNKCB27. Reporting limits are shown here.



Total PCBs in South-Central Lateral Whole Water Samples

*PCBs were not detected at location MH461. Reporting limits are shown here.



Total PCBs in South Lateral Whole Water Samples

*PCBs were not detected at location MH482. Reporting limits are shown here.

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Figure 17. Total PCBs in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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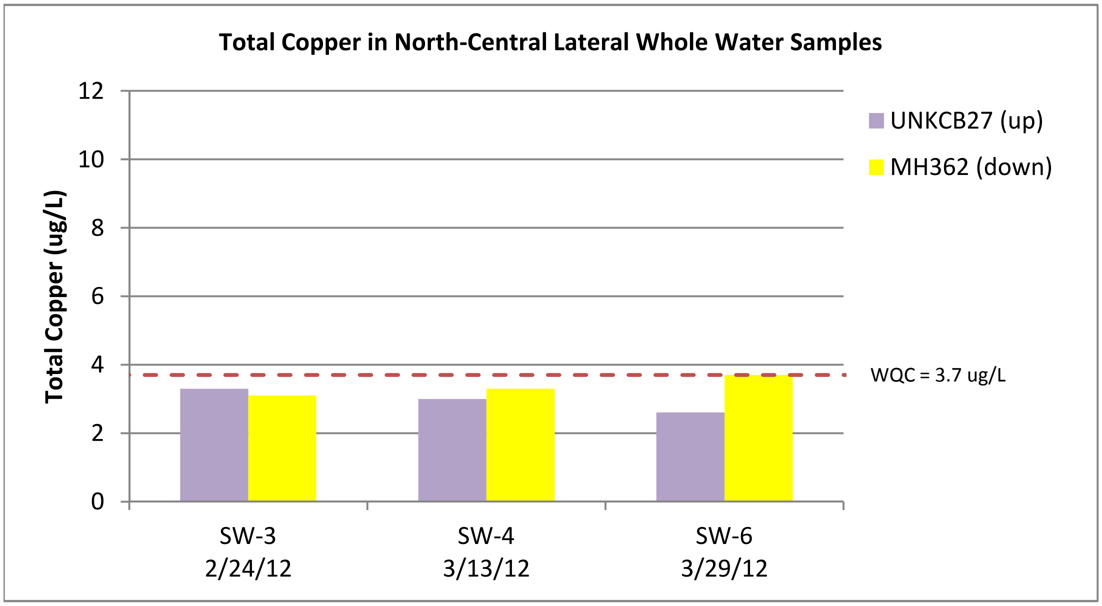

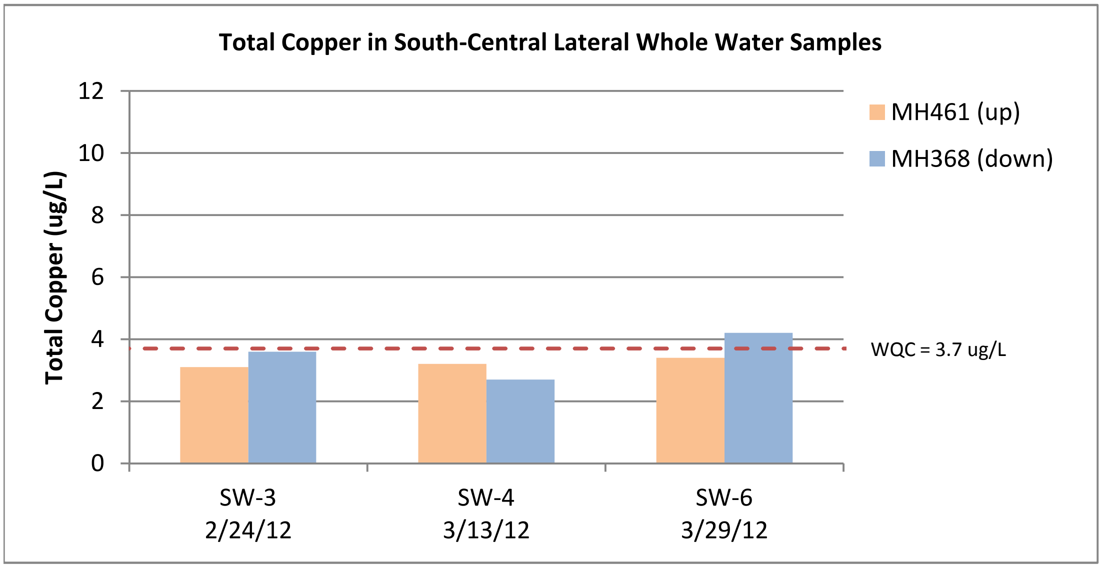

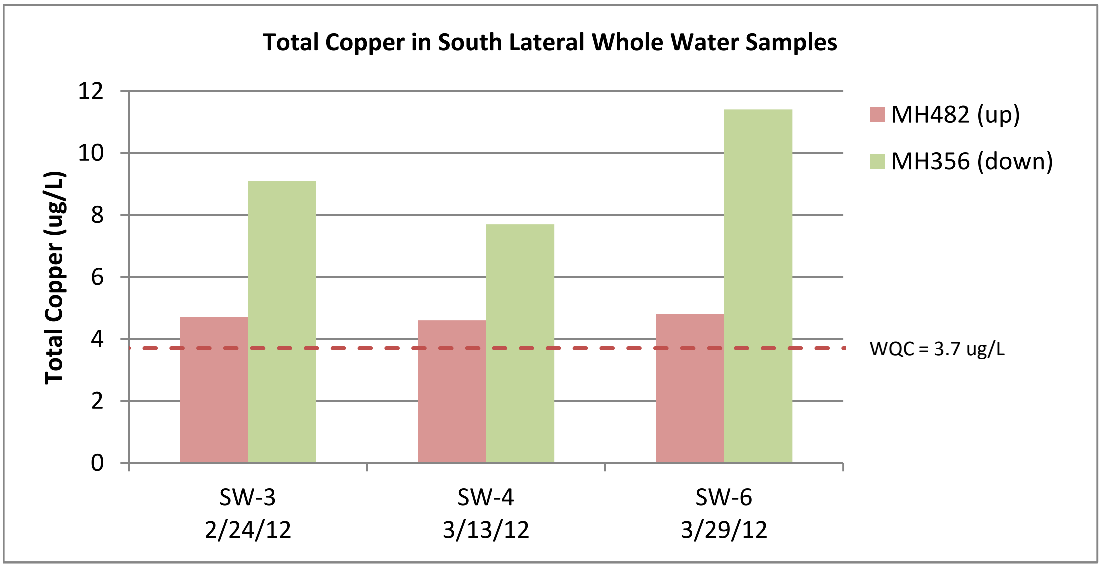

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Figure 18. Total Copper in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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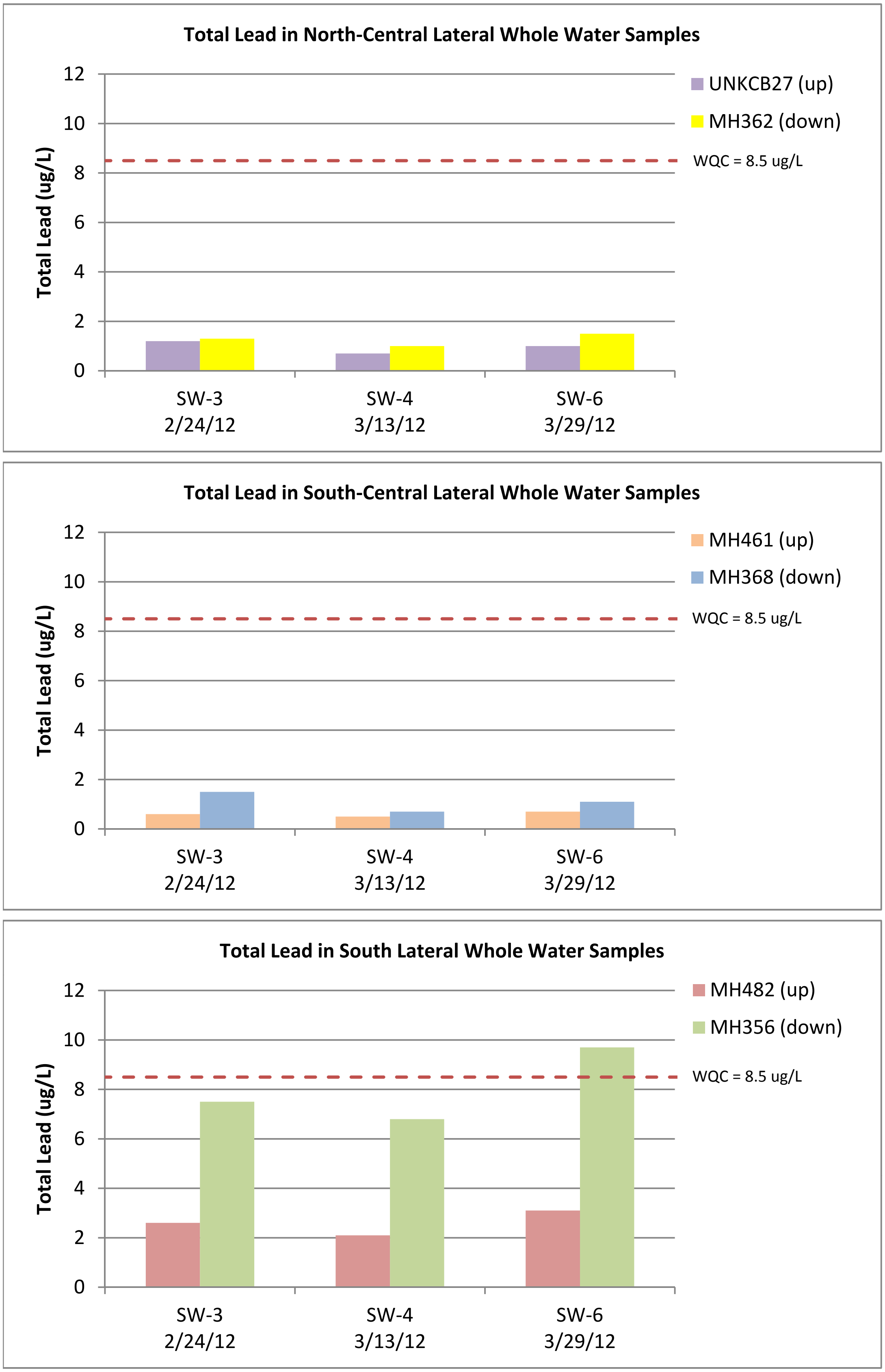

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Figure 19. Total Lead in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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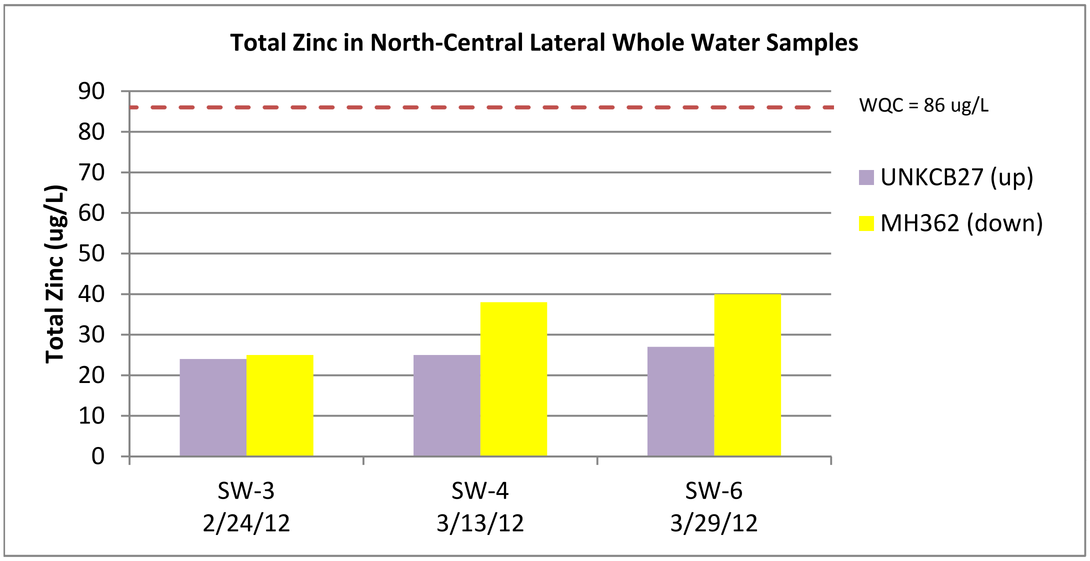
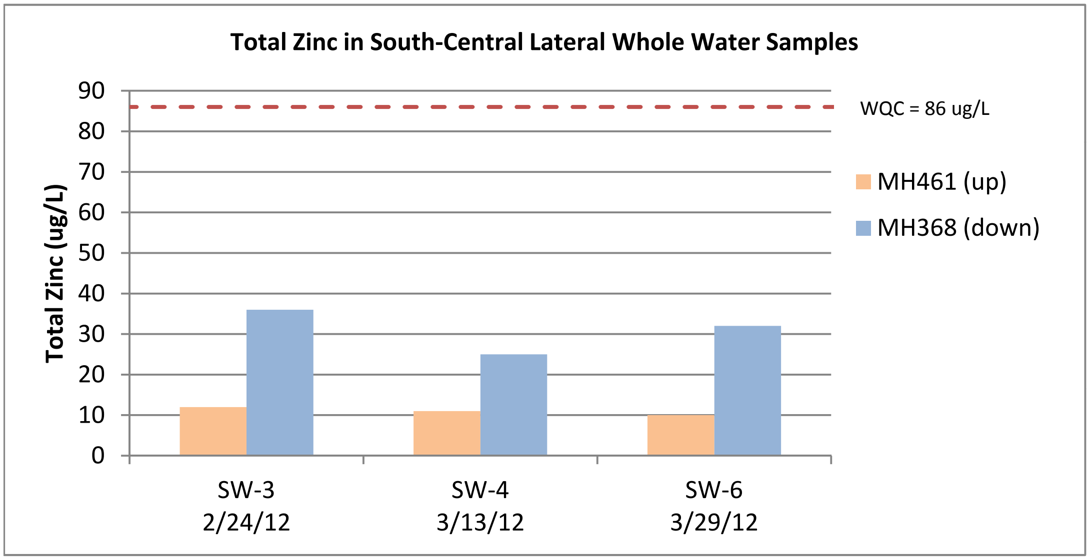
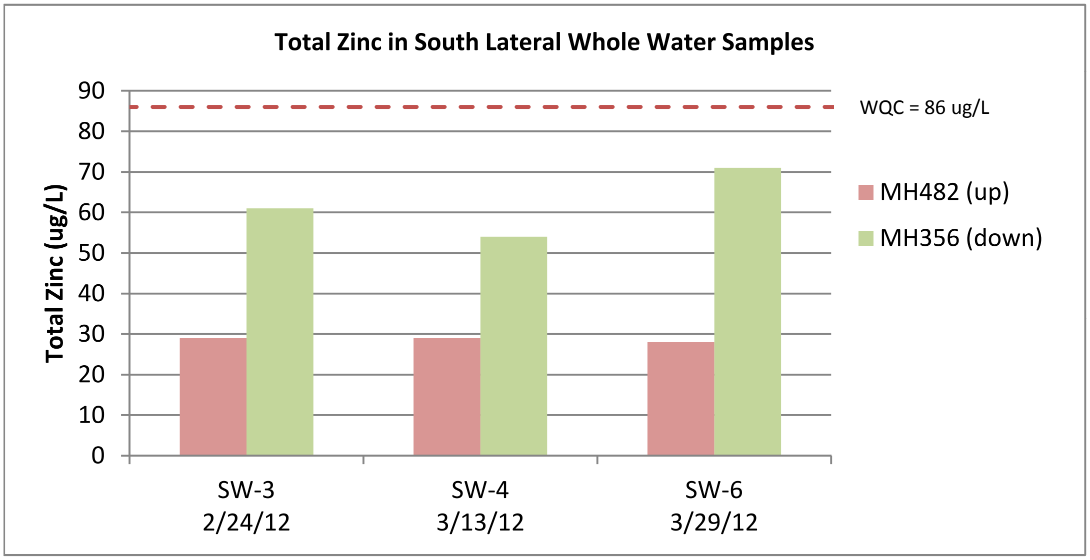


Total Zinc in North-Central Lateral Whole Water Samples



Total Zinc in South-Central Lateral Whole Water Samples



Total Zinc in South Lateral Whole Water Samples

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Figure 20. Total Zinc in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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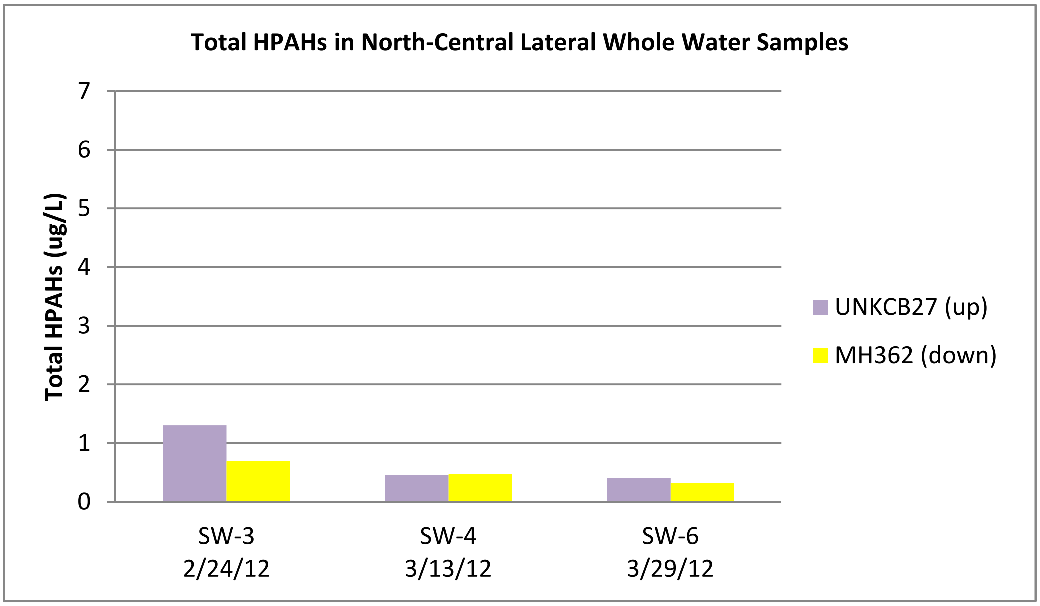

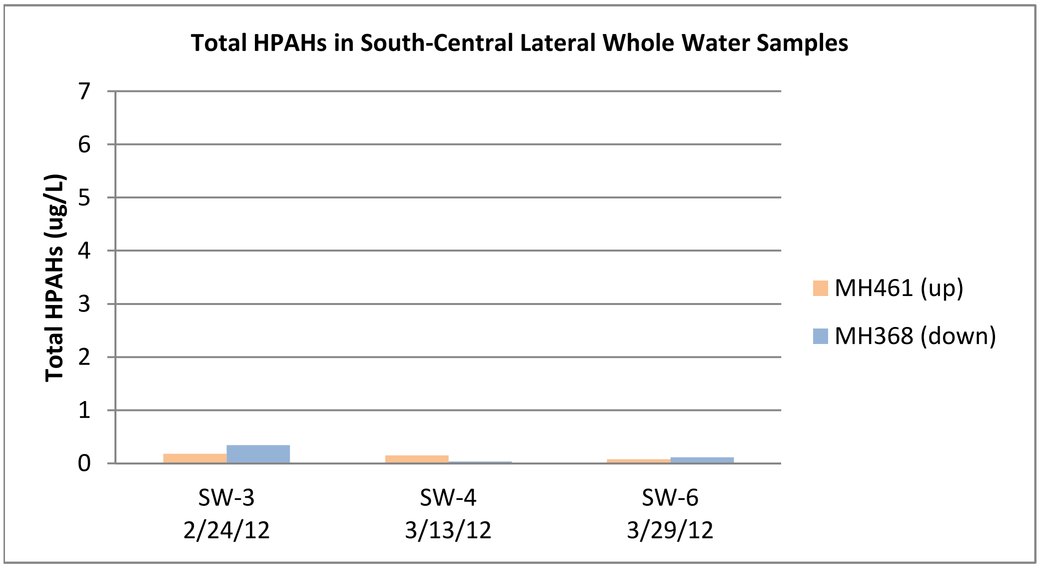

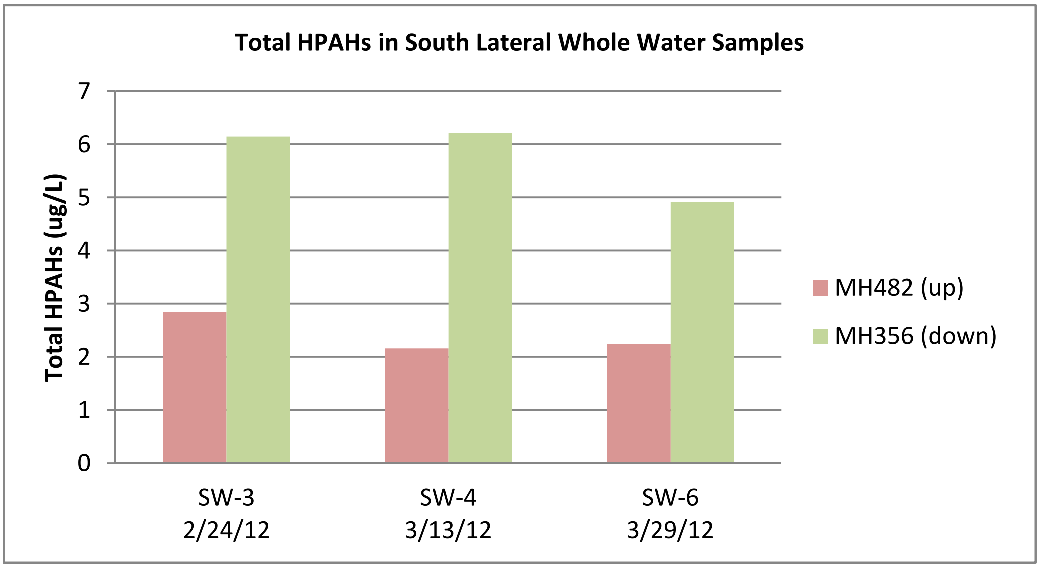

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Figure 21. Total HPAHs in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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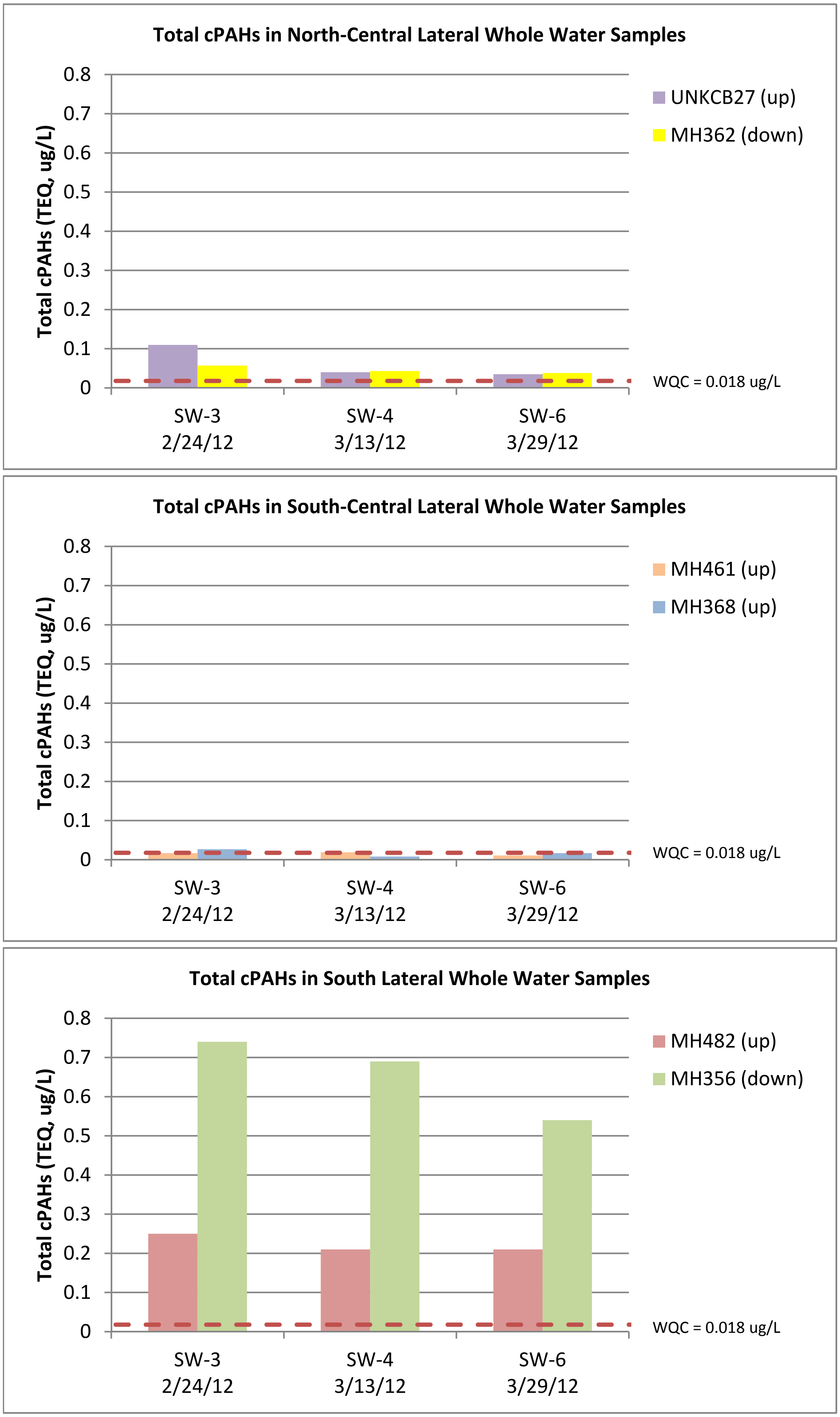

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Figure 22. Total cPAHs in Whole Water Samples
North-Central, South-Central, and South Lateral SD Lines

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