ATTACHMENT C

CITY OF SEATTLE
2009 NPDES PHASE I MUNICIPAL STORMWATER PERMIT
STORMWATER MONITORING REPORT

Prepared by
Seattle Public Utilities

March, 2010

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Certification

I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations.

Nancy Ahern

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2 INTRODUCTION

2.1 Introduction

This document serves as the City of Seattle's (City) water year 2009 monitoring report as required by Special Conditions S8.H and S9 of the 2007 National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit. The City was required to fully implement the monitoring program as described in Special Condition 8 (S8) of the permit on February 16, 2009. Special Condition S8.H of the permit requires the City to provide a report annually on the monitoring that occurred during the previous water year. A water year starts on October 1 and ends on September 30 of the following year. Draft Ecology guidance provided in February of 2010 instructs Permittees' to "only submit pollutant loading information for completed seasons (wet and/or dry)". Because the permit did not require implementation of monitoring until February 16, 2009, this report does not include data from a full water year, and therefore does not include pollutant loading information or a discussion of results. This information will be included in the appropriate sections of the WY2010 monitoring report.

2.2 Background

The Phase I Municipal Stormwater Permit, effective on February 16, 2007, and modified on June 17, 2009 by the Washington Department of Ecology (Ecology) under the NPDES and State Waste Discharge General Permit for discharges from Large and Medium Municipal Separate Storm Sewer Systems requires three types of monitoring under section S8.

Stormwater characterization (S8.D) – field monitoring which is intended to characterize stormwater runoff quantity and quality to allow analysis of loadings and changes in conditions over time and generalization across the Permittee's jurisdiction. Ecology stated in the permit Fact Sheet that the purpose of requiring Permittees to engage in stormwater characterization monitoring is to gain knowledge of pollutant loads from areas within the municipality.

Permittees are required to monitor in areas considered representative of their municipal storm sewer system (MS4) in the hope of determining if the comprehensive stormwater management program required by the permit is making progress toward the goal of reducing the amount of pollutants discharged from MS4s.

The City's implementation of this requirement consists of three in-pipe monitoring locations that are considered to be representative of the land uses that they are intended to characterize. To determine locations for stormwater monitoring, the City's geographic information system (GIS) was used to display the stormwater infrastructure and generate possible catchments in the MS4 areas of the City that are representative of a discernible type of land use as required by the permit. Field visits were conducted to evaluate hydrology (base flow and tidal influence) and feasibility of monitoring (access, potential for vandalism, safety of monitoring personnel, equipment installation needs) at various locations to meet the permit goal of obtaining a representative site. The first monitoring location is located in North Seattle in the Venema neighborhood and represents a predominantly residential land use. The second monitoring location, located in Northeast Seattle, is located adjacent to the University of Washington and represents predominantly commercial land use. The third monitoring location is in South Seattle near the City's border with Tukwila and represents a predominantly industrial land use.

Program effectiveness (S8.E) – The program effectiveness monitoring requirement is for the City to select two specific aspects of the Stormwater Management Program to evaluate. One aspect to be evaluated is to determine the effectiveness of a targeted action. A second aspect to be evaluated is the effectiveness of achieving a targeted environmental outcome. This monitoring is intended to improve stormwater management efforts by providing a feedback loop to help determine if a stormwater management program element is meeting the desired environmental outcome.

The potential impact of urban stormwater runoff on the water quality of receiving waters is of great concern in the Seattle area. While new development may have a large number of options for providing water quality treatment through structural controls, existing developed areas have limited choices for retrofitting their stormwater systems. Thus, nonstructural measures, also known as source control, offer perhaps the greatest potential for improvement of water quality. Roads and other transportation related surfaces make up 26 percent of the land use within the

City. Because of this, the City is focusing the evaluation of program effectiveness on street sweeping to meet this permit requirement and determine suitability of street sweeping as part of the source control program.

The targeted action of street sweeping should result in improvements in stormwater quality and quality of sediments in stormwater discharges or both. To determine if this action is being achieved, analytical analysis of transportation land use sediment sources will be performed to increase our understanding of the distribution of contaminants in varying size fractions for each of the waste streams; street dirt, sweeper waste, and catch basin sediment.

The targeted outcome reduces discharge of certain pollutants below a targeted annual load amount. A mass balance model will be developed to predict a targeted annual load reduction for varying conditions, such as sweeping frequency, road surface condition, and parking enforcement compliance. Existing data and a parking compliance survey will be used as a basis for the model.

BMP Effectiveness (S8.F) – The best management practice (BMP) effectiveness monitoring requires the City to monitor two types of BMPs required for use by project proponents in new development and re-development projects that trigger the Stormwater Code requirement for treatment or flow control of stormwater. Ecology designed the permit requirement to be full scale field monitoring to evaluate the effectiveness and operation and maintenance requirements of stormwater treatment and hydrologic management BMPs applied in Phase I jurisdictions.

The first treatment BMP monitored by the City is an "engineered" treatment BMP, the Catch Basin StormFilter™ (CBSF), manufactured by Contech® Construction Products Inc. The CBSF treatment BMP is frequently installed by the Seattle Department of Transportation (SDOT) to treat roadway stormwater runoff. The City is interested in monitoring the effectiveness of this BMP because the cartridge technology has received a basic treatment General Use Level Designation (GULD) by Ecology via testing within a vault, not as a catch basin device.

For the second treatment BMP, the City will be partnering with Washington State University (WSU) to satisfy the permit obligations for stormwater treatment BMP montitoring (S3.B). The City is participating in a WSU-LID research effort where WSU will be monitoring the pollution removal capacity of various bioretention soil mixes. The City has developed a Memorandum of Understanding (MOA) with WSU to obtain the monitoring results from four bioretention mesocosms at the WSU low impact development facility to meet the S8.F.2 permit monitoring requirements for a metals/phosphorus ("enhanced") treatment BMP. A copy of the MOA is included as Appendix C1 of this Attachment. The MOA specifies that WSU will conduct water quality monitoring on four mesocosms, which are identical in size and all contain a 60/40 mix of aggregate/compost, which is the City's current specified mix for bioretention facilities. This monitoring will begin in Water Year (WY) 2010 and monitoring information will be provided by the City in the March 2011 Annual Report.

Hydrologic Monitoring - The permit requires the City to monitor a flow reduction strategy that is in use or planned for installation within the city in a paired study or against a predicted outcome. To meet this requirement, the City has monitored one bioretention swale located in the High Point community in South West Seattle. Flow was monitored in the swale continuously for two years.

3 S.8.D Stormwater Monitoring

3.1 Overview

As stated in the introduction, stormwater characterization monitoring is a requirement of the 2007 NPDES Phase I Municipal Stormwater Permit (permit) Special Condition 8 (S8). Ecology designed the stormwater characterization monitoring requirements to characterize stormwater runoff quantity and quality to allow analysis of loadings and changes in conditions over time and generalization across the Permittees' jurisdiction.

The monitoring work as described in the permit was performed by Seattle Public Utilities (SPU) or contractors under the direction of SPU in accordance with a draft Quality Assurance Project Plan (QAPP) dated February 10, 2008, and approved by Ecology on September 26, 2008. The final QAPP was submitted to Ecology on February 12, 2009. A brief summary of information provided in the approved QAPP is presented below.

3.1.1 Monitoring Goals and Objectives

The goal of the stormwater characterization monitoring is to meet the requirements of Section S8.D of the permit. Ecology's purpose for requiring the City to conduct stormwater characterization monitoring is to obtain knowledge of pollutant loads and average event mean concentrations from representative areas drained by municipal storm sewer systems. In addition, Ecology hopes that the information will be useful for determining whether the comprehensive stormwater management programs are making progress toward the goal of reducing the amount of pollutants discharged and protecting water quality.

3.2 Sampling Location Descriptions

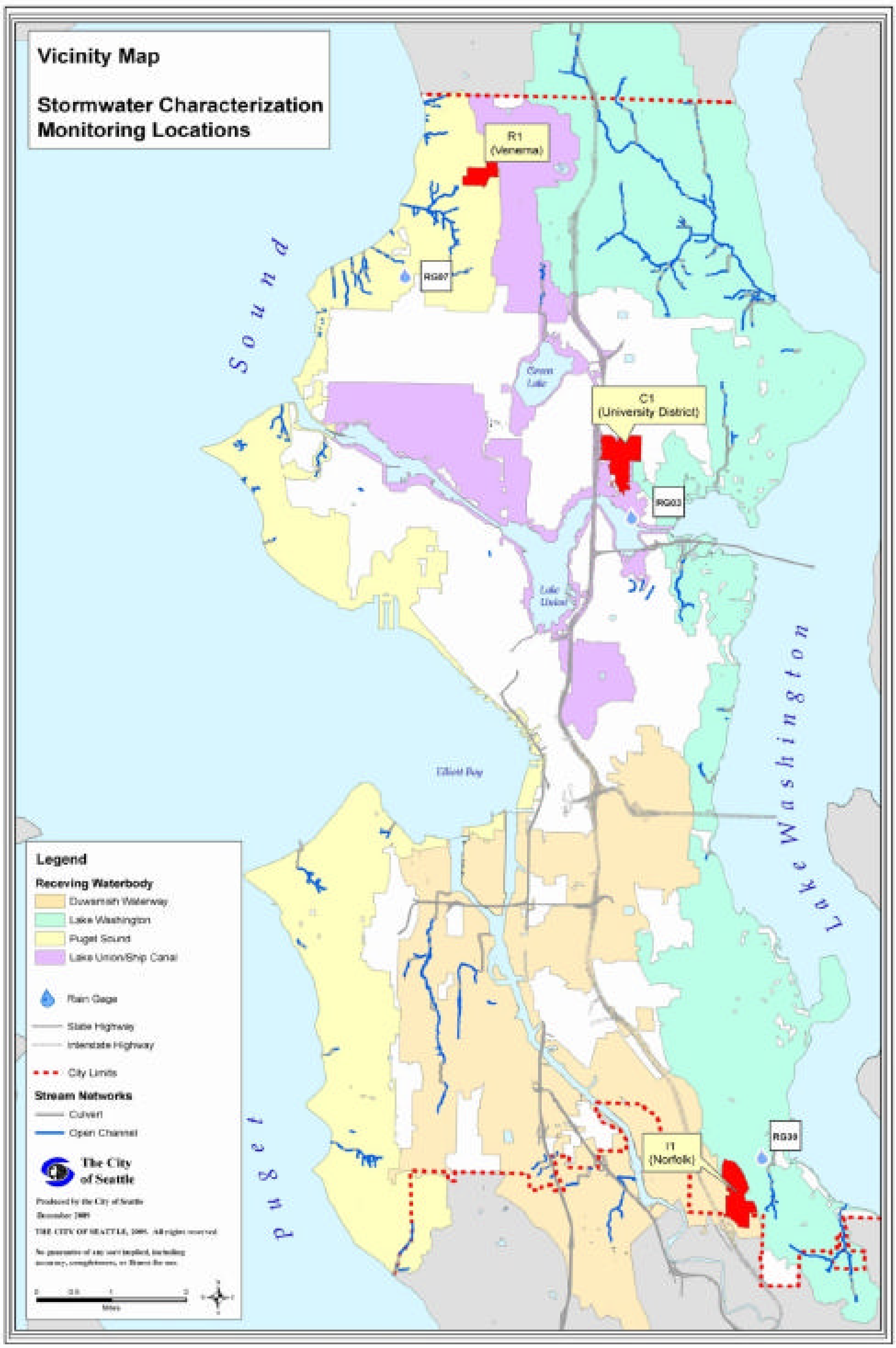
The permit requires each Permittee to select three monitoring sites within the municipal storm sewer system that represent the three types of land uses: residential, commercial and industrial.

The City proposed, and received approval from Ecology, for the three monitoring sites to meet these requirements. Details on the three monitoring sites are described below in Table 3.2 and presented visually in the Vicinity Map – Figure 3.2.

Table 3.2. Stormwater characterization monitoring sampling location summary

Land Use Category	Station ID (Basin Name)	Sewerage System Type
Residential	R1 (Venema)	Separated, ditch & culvert system
Commercial	C1 (University District)	Partially separated
Industrial	I1 (Norfolk)	Partially separated

Figure 3.2. Vicinity Map – Stormwater Characterization Monitoring Locations



City of Seattle

To determine locations for stormwater monitoring, the City's geographic information system (GIS) was used to display the stormwater infrastructure and identify possible catchments in the separated areas of the city that represent a discernible type of land use. Field visits were then conducted to evaluate hydrology (base flow, turbulent flow, and tidal influence), the feasibility of monitoring (access, potential for vandalism, safety of monitoring personnel, equipment installation needs), and the suitability of the site for long-term monitoring.

Following the initial site selection, a walking survey of each basin was performed to confirm or correct the drainage area maps.

3.2.1 Basin Descriptions

Information about the basins monitored is summarized in Table 3.2.1 below.

Table 3.2.1. Stormwater characterization monitoring sampling location summary.

Represented Land Use	Residential	Commercial	Industrial
Basin	**R1 (Venema)**	**C1 (U- District)**	**I1 (Norfolk)**
Surface Area Distribution			
Total Area (acres)	85.3	181.0	164.2
Area Draining to MS4 Estimate (acres)	85.3	152.0	137.2
Area Draining to Combined System Estimate (acres)	0.0	29.0	27.0
Impervious Area Estimate (%) - for area draining to MS4	50.2	61.1	51.2
Land Use Distribution Estimate - for area draining to MS4			
Residential (%)	95	37	32
Industrial (%)	0	0	37
Commercial (%)	5	61	13
Open Space (%)	0	2	18
Hydrologic Information			
Rain Gauge	RG07	RG03	RG30
Receiving Waterbody	Venema/Piper's Creek	Lake Union	Duwamish River

SPU used the following method to determine the land use area for each stormwater characterization monitoring basin to meet the permit goal of: "ideally, to represent a particular land use, no less than 80 percent of the area served by the conveyance will be classified as having that land use." The City was unable to find basins that met this goal due to the ultra-urban mixed use nature of Seattle. The City selected basins that best represented the land use type in the City and had infrastructure suitable for installation of monitoring equipment. The information on land use percentages for each monitoring sampling location was provided to

Ecology in the permit required summary description of the monitoring program (S8.G.1.a) in October, 2007 and approved by Ecology in December, 2007.

Land use data is derived using GIS from the King County Parcel Database, which classifies each parcel into one of the eight general following categories: single family, multi-family, commercial, schools, other/NA, government/public facility, industrial, parks/open space, and vacant. Land that is not classified as a parcel is considered right-of-way.

The King County Parcel Database further groups land use is into four general categories: (1) residential which includes single family and multi-family and may include other/NA; (2) commercial which includes commercial, schools, government/public facility and may include other/NA; (3) industrial which includes industrial and may include vacant; and (4) open which includes parks/open space and may include vacant.

SPU used GIS to determine the percentage of each land use type that drains to the MS4. The impervious area for each land use category is estimated using citywide averages based on GIS analysis. For basins that are partially separated, the equivalent area draining to the MS4 is less than the total basin area.

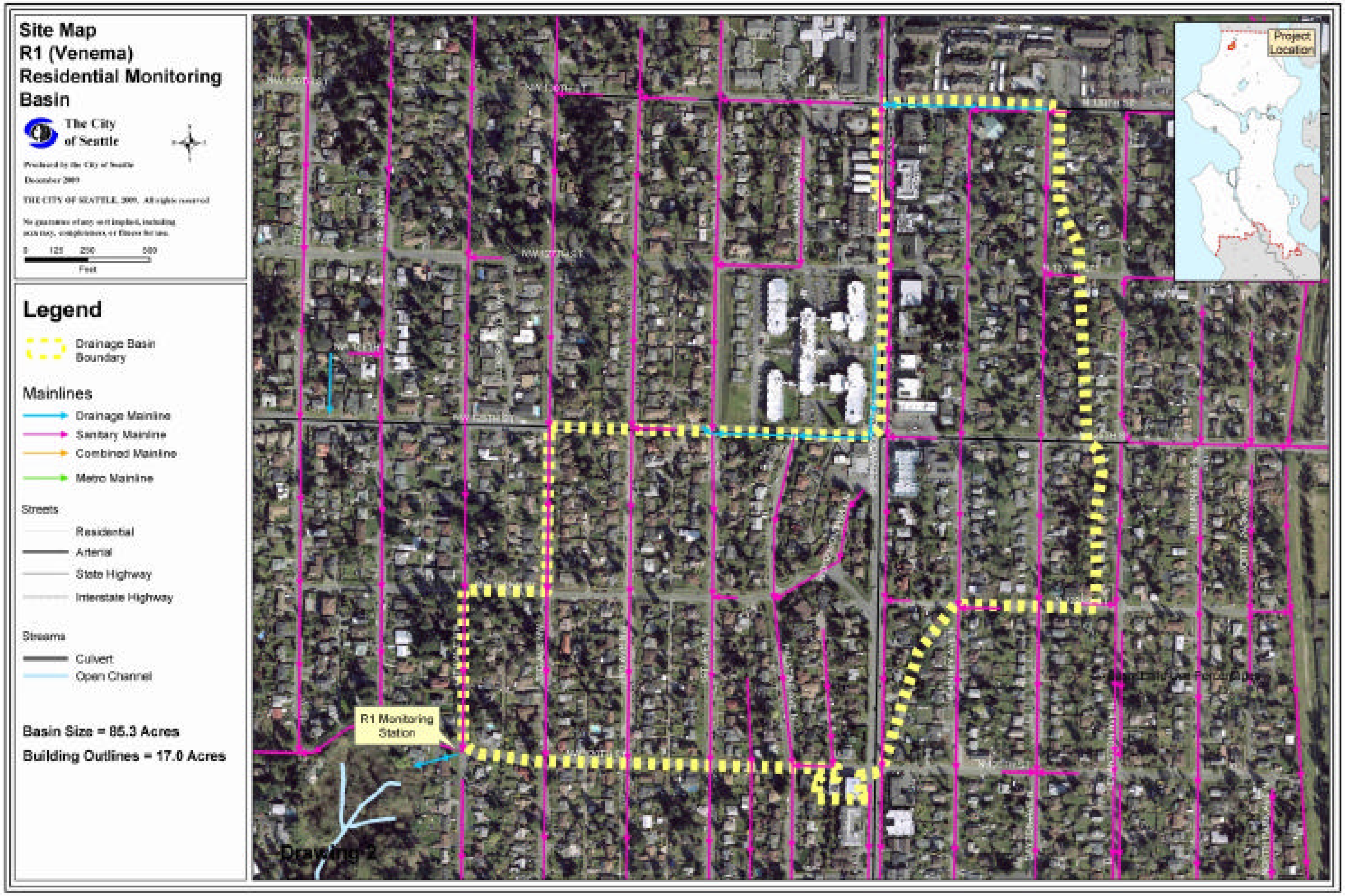
The three monitoring basins are briefly described below. A description of each related monitoring station is described in section 3.2.2.

3.2.1.1 R1 (Venema)

The R1 basin represents a typical residential area in the separated portion of the City. This basin is located in the northwest portion of Seattle and discharges to Piper's Creek and then Puget Sound. The basin is approximately 85.3 acres[1] in size with 95 percent residential land use. The basin's sewer system is 100 percent separated. The R1 basin is delineated on Figure 3.2.1.1.

[1] In the final QAPP, the R1 basin size was listed as 157 acres. In early February 2009, some of the stormwater that previously drained through the monitoring station was diverted to outfalls north of the monitoring station by plugging several 4-way catch basins in the original basin. The catch basin plugging was performed for two reasons: 1) to limit flows to a storm pipe downstream of the monitoring station which requires repair; and 2) to allow a constant known area to drain to the monitoring station (4-way catch basins distribute flows in two directions with the flow distribution being dependent on flow intensity, gradients, and the structural condition of the catch basin so the rainfall to runoff ratio is variable). The catch basin plugging reduced the size of the area draining to the R1 monitoring station to 85.3 acres.

Figure 3.2.1.1. Site Map – R1 (Venema)



3.2.1.2 C1 (University District)

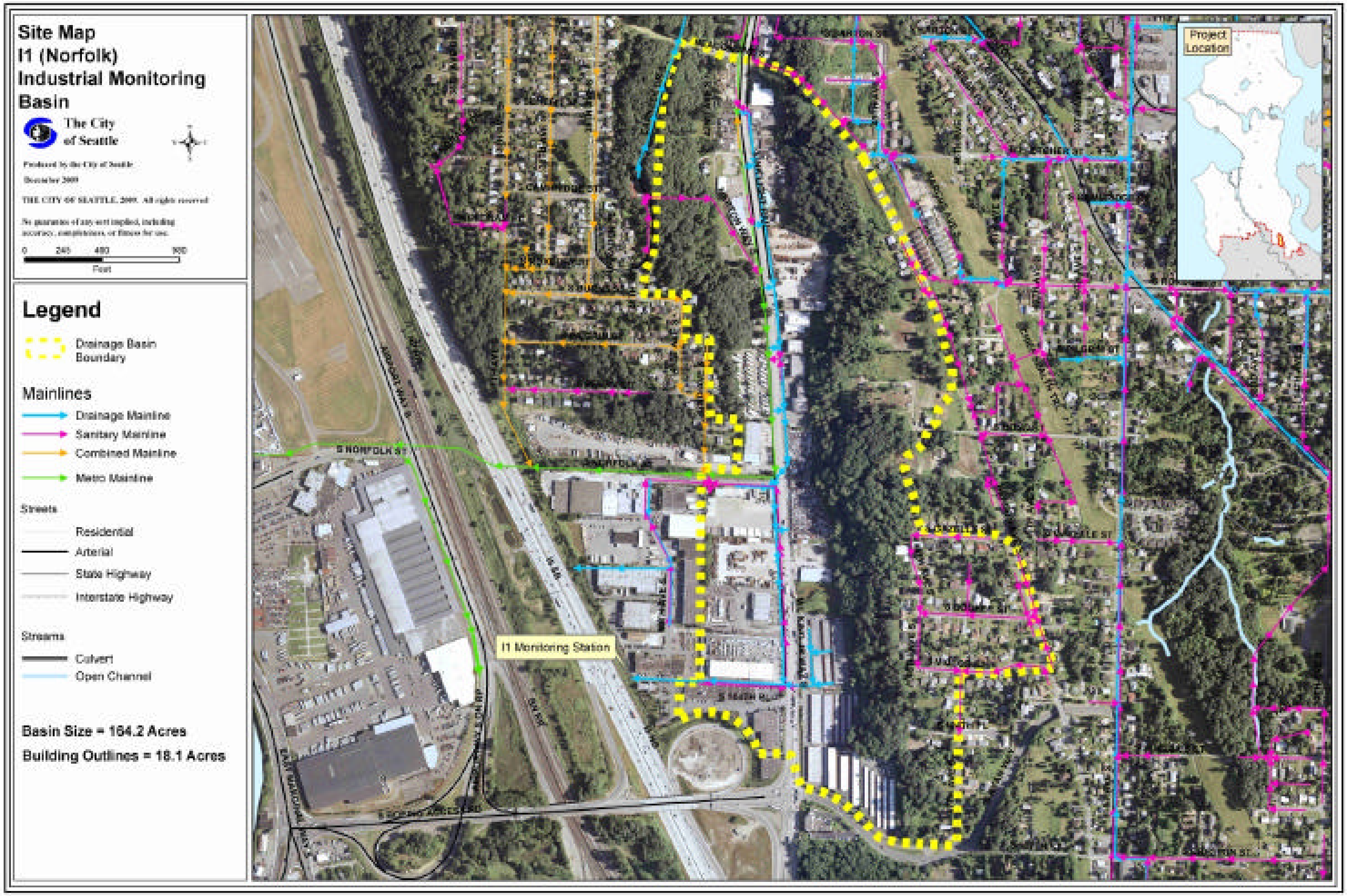
The C1 basin is located in a partially separated portion of the northeast portion of Seattle and represents a mix of commercial uses such as the University of Washington and neighborhood businesses that serve the surrounding residential population. This basin is located north of Lake Union and east of I-5 and drains to Lake Union. The majority land uses in the 181-acre basin are 61 percent commercial and 37 percent residential. The C1 basin is delineated on Figure 3.2.1.2.

3.2.1.3 I1 (Norfolk)

The I1 industrial basin is served by the partially separated stormwater system and contains business activities typical of industrial land uses in Seattle. It is one of the few industrial basins in Seattle that is not tidally influenced and therefore is considered the best industrial land use basin in the City for meeting the monitoring requirements even though the percent of industrial land use in this basin does not meet the permit goal of ideally no less than 80 percent industrial land use. The I1 basin is located in southern Seattle on the Seattle-Tukwila border and drains under I-5 to the west into the Duwamish waterway. The 164.2-acre basin is 37 percent industrial, 32 percent residential, 13 percent commercial and 18 percent open space. The I1 basin is delineated on Figure 3.2.1.3.

Figure 3.2.1.2. Site Map – C1 (University District)

Figure 3.2.1.3. Site Map – I1 (Norfolk)



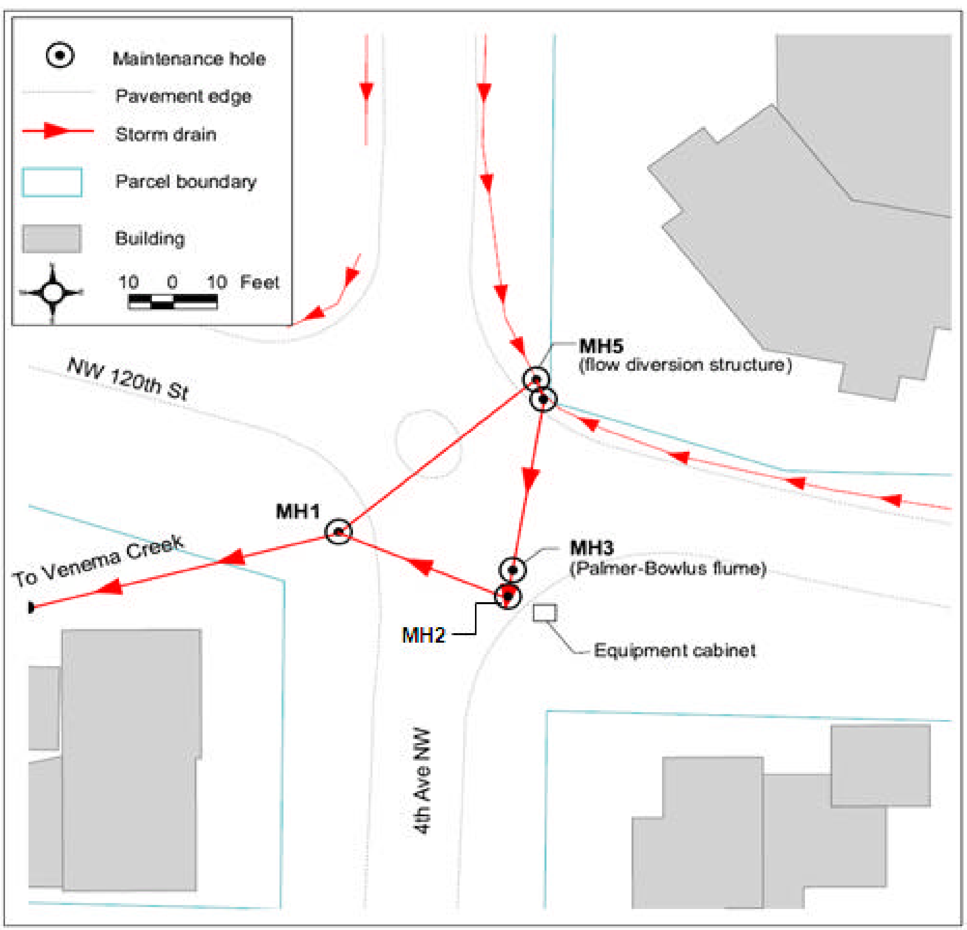
3.2.2 Monitoring Station Descriptions

Each of the three stormwater monitoring stations is configured with a flow monitor, automatic sampler, wireless telemetry and sediment traps. The specific monitor locations and equipment used at each site are detailed below with additional details being listed in the QAPP.

3.2.2.1 R1 (Venema)

The monitoring station R1 is composed of several maintenance holes, related storm drain piping, buried conduit and equipment enclosure at the intersection of NW 120th Street and 4th Avenue NW. The drainage system at this intersection was modified in June 2008 so that hydrologic conditions would be conducive to monitoring. Upgrades included adding a flow control weir (which acts as a diversion structure) in a new section of storm drain with reduced slope and installing a 24-inch Palmer-Bowlus flume as a primary flow measurement device (refer to Figure 3.2.2.1).

Figure 3.2.2.1 - R1 Monitoring Station Overview



All stormwater flows into Maintenance Hole (MH) 5. Most flows are directed to the 24-inch Palmer-Bowlus flume in MH3 and then flow back to the existing pipe via MH2 and MH1. High flow rates exceeding 14.6 cfs, which is expected with a frequency of less than one percent, will overtop the sharp crested flow-control weir in MH5 and will flow directly to MH1.

The Palmer-Bowlus flume is a hydraulic structure of rectangular cross-section that constricts and reshapes the flow, developing a hydraulic head proportional to flow. These flumes consist of a converging section at the inlet, a throat and diverging section at the outlet.

Flow is monitored at two points at this monitoring location:

- The primary flow measurement point is a 24-inch Palmer-Bowlus flume installed in MH3. The water level in the flume is measured using a Campbell Scientific, Inc (CSI) CS408 pressure transducer (sensor).

- The secondary flow measurement point utilizes the weir in MH5. A portion of the higher flows overtop the weir, bypassing the flume in MH3. The water level behind the weir is measured using a CSI CS448 pressure transducer.

A CSI CR1000 data logger logs level and flow at five minute intervals. The data logger calculates flow from the level data using flume and weir equations. The flow in the flume and the flow over the weir (if any) are summed into one overall flow rate for the residential site. The two pressure transducer cables are routed into MH3 and MH5, respectively, through buried conduits connecting the maintenance holes.

Water quality samples are collected at a single location in MH2. A modified Isco 6712 sampler collects volume-weighted stormwater composite samples as controlled by the CR1000 data logger. The sampler is enabled by a change in water level in the flume, and the sampler pacing is based on the flow calculated from the flume. The data logger and Isco sampler are installed in the enclosure and the sample lines are ran into MH2 through conduits. The sample line and strainer are mounted in MH2 and collect water quality samples from the sump just below the invert of the outlet pipe.

Wireless telemetry provides remote communications with the CR1000 and both the data logger and sampler are powered by AC power.

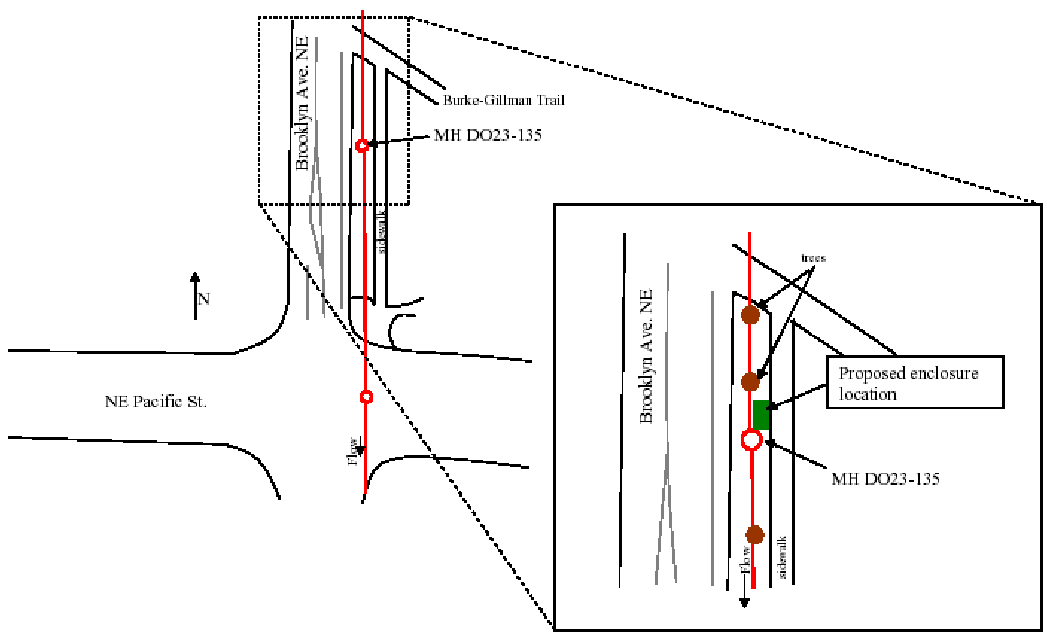
Two sediment traps are installed in MH-2 with the mouths of the bottles located approximately 1-inch above the invert of the outlet pipe.

SPU rain gauge RG07 (45-S007) is used to represent rainfall in the R1 basin. RG07 is located at Whitman Middle School which is located near the corner of 15th Avenue NW and NW 92nd Street, roughly 1.5 miles southwest of the monitoring station.

3.2.2.2 C1 (University District)

Monitoring station C1 is accessed via MH D023-135 on the east side of Brooklyn Ave NE, which is situated on a relatively straight section of 36-inch diameter concrete reinforced pipe installed in 1972 (refer to Figure 3.2.2.2). The straightness of the pipe produces a relatively linear flow path through the maintenance hole. The upstream pipe slope is approximately 6.4 percent and the downstream pipe slope is approximately 7.6 percent.

Figure 3.2.2.2 C1 sampling location (plan view)



Flow is measured using an Isco 2150 area-velocity (AV) type meter. The AV sensor is mounted upstream of the MH, at the invert of the 36-inch concrete pipe using stainless steel mounting rings. Flow is calculated at five minute intervals based on measured level and velocity data and site-specific information (pipe size and pipe shape) using the continuity equation.

A modified Isco 6712 sampler collects volume-weighted stormwater composite samples. The sampler's strainer is affixed to the AV sensor mounting ring, with the intake being positioned in the pipe invert just downstream of the sensor.

Wireless telemetry provides remote communications to both the flow meter and sampler via an Isco 2105c modem/controller. The 2105c controls the collection of samples by pacing the autosampler.

The sampler, logger and modem are housed in an enclosure installed in the parking strip adjacent to MH D023-135.

Two sediment traps are installed downstream of the MH with the trap housing mounted to the pipe's invert.

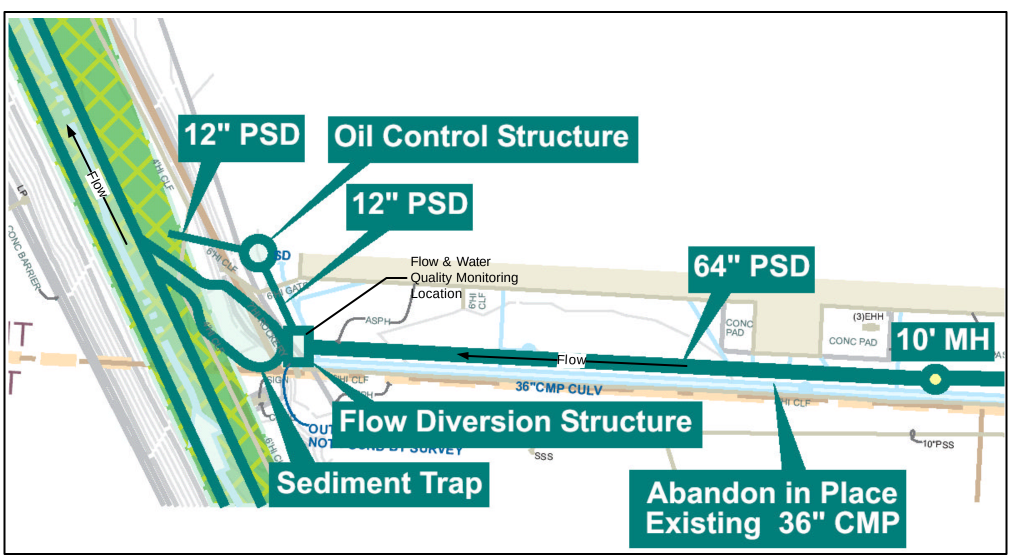
SPU rain gauge RG03 (45-S003) is used to represent rainfall in the C1 basin. RG03 located on the roof of the Harris Hydraulics Laboratory on the University of Washington Campus near Lake Union. It is approximately 0.3 miles southeast of the monitoring site.

3.2.2.3 I1 (Norfolk)

The I1 monitoring site is located within a flow diversion structure vault that was constructed as part of an upgrade to the drainage system in this basin. The former 36-inch storm drain pipe, which failed, was replaced during a construction project that was started in the winter of 2008/09 and finished in July 2009. The new storm drain is located between Martin Luther King Jr. Way and the Washington Department of Transportation (WSDOT) ditch located on the east side of Interstate 5. This pipeline runs along the south property boundary of the Papé Material Handling property (9892 40th Avenue South, Seattle, WA 98118) and parallels the boundary between the City of Seattle and the City of Tukwila.

The new pipe, which contains the flow monitor, is a 64-inch, ductile-iron pipe (DIP). A 6-foot by 10-foot precast vault is installed at the downstream end of the new 64-inch pipe. A high-flow outlet weir is installed at the downstream end of the vault with a crest elevation of 11.75 feet (NAVD88 datum). The purpose of the weir is to divert low flow to an oil control structure located under the Papé drive north of the new pipe. The weir, which discharges the WSDOT ditch, also helps to dissipate flow energy of higher flows by spreading flow over the length of the weir (Figure 3.2.2.3).

Figure 3.2.2.3 I1 site schematic.



Flow at the I1 station is measured using an Isco 2150 AV-type meter. The AV sensor is mounted upstream of the flow diversion vault, at the invert of the 64-inch DIP pipe using stainless steel mounting rings. Flow is calculated at five minute intervals based on measured level and velocity data and site-specific information (pipe size and pipe shape) using the continuity equation.

A modified Isco 6712 sampler collects volume-weighted stormwater composite samples. The sampler's strainer is affixed to the AV sensor mounting ring, with the intake being positioned in the pipe invert just downstream of the sensor.

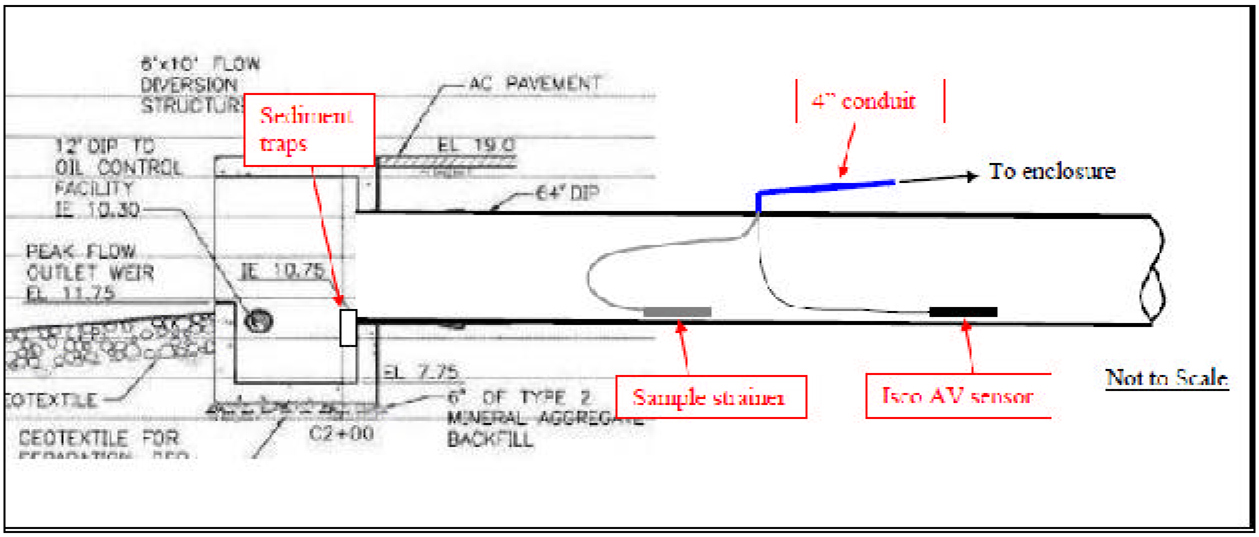
Wireless telemetry provides remote communications to both the flow meter and sampler via an Isco 2105c modem/controller. The 2105c controls the collection of samples by pacing the autosampler.

The sampling equipment, loggers and modems are housed in an enclosure installed in the Pape drive adjacent to the top of the diversion vault.

Two sediment traps are installed in diversion structure vault with the mouths of the bottles located approximately 2-inches above the standing water level inside the structure.

Figure 3.2.2.3 displays the locations of the monitoring equipment.

Figure 3.2.2.3. I1 water quality sampling equipment layout.



SPU rain gauge RG30 (45-S030) is used to represent rainfall in the I1 basin. RG30 is located on the roof of the Seattle Public Library at 9125 Rainier Ave. S. It is approximately miles 0.5 northeast of the monitoring site.

3.3 Sampling Procedures

Taylor Associates, Inc. (TAI) performed all weather tracking, flow monitoring and stormwater sampling activities. Sediment traps were installed, maintained and retrieved by a combination of TAI and City staff.

3.3.1 Weather Tracking/Storm Criteria

Weather and rainfall data were continuously monitored using multiple forecasting, radar and satellite sources to target storms that meet the criteria for a qualifying event, listed in the table below.

Table 3.3.1. Qualifying Event Criteria

Criteria	Wet season	Dry season	Base Flow
Period	October 1 through April 30	May 1 through September 30	October 1 through September 30
Rainfall volume	0.20” minimum, no fixed maximum	0.20” minimum, no fixed maximum	NA
Rainfall duration	No fixed minimum or maximum	No fixed minimum or maximum	NA
Antecedent dry period	= 0.02” rain in the previous 24 hours	= 0.02” rain in the previous 72 hours	= 0.02” rain in the previous 24 hours
Inter-event dry period	6 hours	6 hours	NA

TAI made recommendations for storms to target for sampling with the final “go/no-go” decision made by the City’s monitoring lead.

3.3.2 Flow Monitoring

Flow monitoring equipment type and configuration per each station are described in Section 2.2.2. Level, velocity (if applicable) and flow data were logged at five-minute intervals. Flow monitoring quality assurance/quality control procedures are discussed in Section 3.3.7.1.

3.3.3 Stormwater Grab Samples

Grab samples were collected by lowering a decontaminated stainless steel bailer, utilizing a swing arm sampler mounted on a telescoping pole, into the flow stream and pouring the contents into analyte-specific bottles.

3.3.4 Stormwater Composite Samples

Volume-proportioned stormwater composite samples were collected using modified Isco 6712 automatic samplers (autosamplers). The samplers utilize a peristaltic pump to draw stormwater from the strainer installed in the flow and distribute it to composite bottles in the sampler base. The samplers’ bases and distribution arms were modified to allow the use of eight discrete 2.5-gallon [9.46 Liter (L)] glass bottles which increases the volume of stormwater that can be collected. This increases the chances of obtaining sufficient volume, increases flexibility if storm sizes change and reduces staffing needed to visit stations to replace bottles.

The data loggers were programmed to trigger the samplers every time a specified volume (referred to as the "trigger volume") passes the monitoring location. Each trigger sent results in the collection of one stormwater aliquot deposited in the composite bottle. As each bottle is filled (after a discrete number of aliquots), the sampler's distributor arm advances to the next bottle. Bottles were removed and replaced as necessary over the course of the event.

Since stormwater samples, specifically stormwater solids concentrations and related contaminants, are readily biased without proper processing procedures; all composite samples were composited and split in the project analytical laboratory [Analytical Resources Inc. (ARI) in Tukwila, WA] using a combination of polytetrafluoroethylene (PTFE) cone splitters and 14L PTFE churn splitters. The cone splitters were used to evenly split the original composite samples into subsamples that are theoretically equal in chemical quality and sediment concentration to any other subsample. One of the subsamples from the cone splitter was then poured into the churn splitter to split the sample into analyte-specific containers.

3.3.5 Sediment Trap Samples

Two sediment traps were installed at each monitoring location by bolting the stainless steel trap mounting assembly directly to the pipe invert (C1), or wall of the catch basin or diversion structure (R1 and I1, respectively). One PTFE, 1L, wide-mouth sample bottle is placed in each mounting assembly and held in place by a retainer ring. When installed to the pipe invert (C1), the mouth of the bottle was approximately 9-inches above the invert. When the traps were installed in structures with standing water (R1 and I1), the mouths of the bottles were positioned 1-2 inches above the static water level.

Sediment traps were inspected on a monthly basis following installation, checking for damage, blockage or under- or over-accumulation. Inspections were adjusted to an as-needed basis when site characteristics were known.

Bottles were removed near the end of the water year and replaced with clean bottles for the following water year. The removed bottles were delivered to ARI where laboratory staff separate the solids and water by centrifuging. The solids from both bottles were composited in the laboratory to form one sample from each monitoring location and then transferred to analyte-specific containers for testing. The priority list in the permit was used to decide which analytical tests to perform if insufficient sediment quantity is captured to run all tests.

3.3.6 Decontamination Procedures

All water quality sampling equipment and sediment trap bottles - which includes stainless steel beakers, sampler tubing, sample bottles, and churn/cone splitters - were decontaminated with the following procedure:

1. Wash in a solution of laboratory-grade, non-phosphate soap and tap (city) water.
2. Rinse in tap water.
3. Wash in a 10 percent nitric acid/deionized water solution.*
4. Rinse in deionized water.
5. Wash with 10% methanol/isopropyl alcohol
6. Final rinse in deionized water.

** Nitric wash omitted for stainless steel beakers*

Sampling equipment was decontaminated prior to every use with the exception of sampler tubing. Following the initial wash, sampler tubing was rinsed with deionized water immediately prior to each sampling event and will be replaced at the onset of each water year.

3.3.7 Quality Assurance/Quality Control (QA/QC) Procedures

3.3.7.1 Flow Monitoring QA/QC Procedures

Routine flow monitor maintenance visits were performed on a monthly basis, during the setup for a sampling event, or as needed based on remote real-time monitor checks or data reviews. Each maintenance visit included visual inspection and cleaning of the sensors, calibration checks and calibration of the level sensor, if necessary. If the actual and measured level values differ than more than 0.02 feet, the level sensor was calibrated and the data was corrected for the drift. During storm event setups, the sensors were checked and calibrated as needed.

3.3.7.2 Analytical QA/QC Procedures

All laboratory data packages received included a hardcopy report and an electronic data deliverable (EDD). The laboratory case narratives were reviewed for quality control issues and corrective action taken for each sample delivery group. The data were evaluated for required method, holding time, reporting limit, accuracy, precision, and blank contamination.

Each EDD was imported into a review template where deviations from the Measurement Quality Objectives (MQO) were identified and associated samples were qualified accordingly.

3.3.7.3 Field QA/QC Procedures

For WY2009, two field blank samples were collected from the autosampler tubing by pumping deionized water through the strainer, intake, peristaltic and distributor arm tubing into a clean composite bottle. The two blanks were: 1) a field decontamination blank (FBS) – a blank sample collected in the field on decontaminated tubing (used to test the cleaning procedures), and 2) a field residual blank (FRB) - a blank sample collected on tubing that had previously collected samples and received a deionized water rinse only (used to assess the adequacy of not performing a complete decontamination prior to each sampling event). The FBS was collected on tubing installed at site C1 on February 20, 2009 and the FRB was collected on tubing installed at site R1 on February 23, 2009.

No duplicate grab or composite samples were collected in WY2009, due to the low number of stormwater samples collected.

3.4 Analytical Parameters, Methods and Reporting Limits

During the QA/QC it was determined that the laboratory (ARI) used analytical methods different than specified than those in the QAPP, or reported data under different methods from the QAPP for this project. The following table is provided to describe the method the laboratory (ARI) performed when analyzing the samples, the method nomenclature the laboratory used on the data reports provided to SPU, the method described in SPU's QAPP and the method Ecology has accredited the lab to perform. In addition, SPU has provided a written description that addresses any areas of non- conformance in this report. Reporting limits represent the minimum value the laboratory is able to report. Reporting limits can vary by individual samples, particularly for sediments where the quantity and dilution analyzed affect the minimum detectable value.

Table 3.4a Comparison Table of Water Sample Parameters, Methods and Reporting Limits Used for this Project

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
Bacteria	Fecal coliform bacteria	CFU/ 100 mL	SM9222D	SM9222D	SM 9221E	SM9222D	4	Membrane Filtration was alternatively performed.
Total Petroleum Hydrocarbons (TPH)	Diesel Range Organics - Diesel	mg/L	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	0.25	
	Diesel Range Organics - Oil						0.5	
	Gas Range Organics	mg/L	NWTPH-Gx	NWTPH-Gx	NWTPH-Gx	NWTPH-Gx	0.25	
Conventional	Biological Oxygen Demand (BOD5)	mg/L	SM5210-B	EPA405.1	SM5210-B	SM5210-B	3	Method reported is an old EPA number for Equivalent method
	Chloride	mg/L	EPA325.2 SM4110-B	EPA 325.2	SM4110-B	SM4110-B	1	EPA325.2 was run in error by the Lab. Corrective action was taken.
	Conductivity (Specific conductance)	umho/ cm @ 25°C	SM2510-B	EPA120.1	SM2510-B	EPA2120.1 & SM2510-B	1	methods are equivalent per 40 CFR 136 & both are Listed in Appendix 9

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
	Hardness (total)	mg/L $CaCO_3$	SM2340-B	SW6010B	SM2340-B or C	SM2340-B	0.33	Method reported is the analytical procedure for the SM2340-B
	pH	S.U.	EPA 150.2	EPA 150.2	EPA 150.2	EPA9045	0.01	Equivalent Electrometric method
	Surfactants	mg/L	SM 5540-C	SM 5540-C	SM 5540-C	SM 5540-C	0.025	
	Total Suspended Solids (TSS)	mg/L	SM2540-D	EPA160.2	SM2540-D	SM2540-D	1	Method reported is an old EPA number for Equivalent method
	Turbidity	NTU	SM2130-B	EPA180.1	SM2130-B	EPA180.1 & SM2130-B	0.025	methods are equivalent per 40 CFR 136 & both are Listed in Appendix 9
Metals (dissolved & total)	Cadmium	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.2	
	Copper	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.5	
	Lead	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	1	
	Mercury[1]	ug/L	NA	NA	EPA 1631E	EPA245.1	0.1	Mercury was not analyzed for water in WY2009
	Zinc	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	4	
Nutrients	Nitrate-nitrite	mg/L	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2	0.01	
	Nitrogen, Total Kjeldahl (TKN)	mg/L	EPA351.4	EPA351.4	EPA 351.2		0.6	

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
	Orthophosphate	as P mg/L	SM4500-P E	EPA365.2	SM4500-P E	SM4500-P E	0.004	Method reported is an old EPA number for Equivalent method
	Phosphorus, Total	as P mg/L	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	0.008	Method reported is an old EPA number for Equivalent method
Semi Volatile Organic Compounds (SVOCs)	Pentachlorophenol (fungicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.5	
	Polycyclic aromatic hydrocarbons (PAHs)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.1	
	Phthalates	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	1	
Pesticides, Chlorinated	2,4-D (herbicide)	ug/L	SW-846 8151	SW-846 8151	SW-846 8151	SW-846 8151	1	
	MCPP (herbicide)	ug/L	SW-846 8151	SW-846 8151	SW-846 8151	SW-846 8151	250	
	Triclopyr (herbicide)	ug/L	EPA8321B	EPA8321B	SW-846 8151	EPA8321B	0.08	
Pesticides, Organo-chlorine	Dichlobenil (herbicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.1	
Pesticides, Organo-nitrogen	Prometon (herbicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.3	
Pesticides, Organo-phosphorus	Chloropyrifos (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.08	
	Diazinon (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.08	
	Malathion (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.4	

During the QA/QC review, it was determined that the contract lab (ARI) analyzed samples using current analytical methods but reported some of the methods as an identical, but older method names/numbers. The deviations between the methods performed and the methods reported are displayed in the above table. In discussions with Stewart M. Lombard, Lab Accreditation Unit Supervisor, Department of Ecology, it was confirmed that the chemistries and analytical techniques used are identical between the analytical methods performed and the analytical methods reported for the parameters listed in the following table.

Table 3.4b – Comparison of Methods Performed to Methods Reported

Parameter	Analytical Method Performed	Analytical Method Reported	Analytical Technique
BOD	SM5210-B	EPA405.1	Potentiometric
Hardness	SM2340-B	SW6010B	ICP-calculation
TSS	SM2540-D	EPA160.2	Gravimetric
Orthophosphate	SM4500-P E	EPA365.2	Colorimetric
Phosphorous, Total	SM4500-P E	EPA365.2	Colorimetric

As a result of the QA/QC review, ARI has been directed by Ecology to discontinuing reporting data using the old method numbers.

For the chloride analysis, the EPA Method 325.2 (colorimetric) was erroneously performed on some samples. This error was corrected, and subsequent analyses were performed by Ion Chromatography (Method 300.0). Method 300.0 is equivalent to SM4110-B.

During the QA/QC review, it was discovered that ARI performed the fecal coliform analysis using the membrane filtration technique (SM9222D). The method listed in the QAPP was multiple tube fermentation (SM9221E). While these two methods utilize different analytical techniques, SPU currently feel that method performed (SM9222D) is preferable because membrane filtration provides direct enumeration of bacteria concentrations.

During the review, it was also discovered that ARI performed the TKN analysis using the potentiometric method (EPA351.4). The method listed in the QAPP is the colorimetric method (EPA351.2). ARI discovered this error and has since started to use the correct method.

For trichlopyr analysis, Pacific Agricultural Labs (subcontracted by ARI) could only achieve the required, lower reporting limit using method EPA8321B, for which Pacific Agricultural Labs is accredited by Ecology. The City elected to use this method, which was not originally listed in SPU's QAPP, to achieve the lower reporting limit.

Table 3.4c – Comparison Table of Sediment Sample Parameters, Methods and Reporting Limits Used for this Project

Stormwater Characterization – Sediment								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
Conventional	Total solids	%	SM2540B	EPA160.3	EPA160.3 or SM2540B	SM2540B	0.01%	Method reported is an old EPA number for Equivalent method
	Grain size		NA	(PSEP 1997) or ASTM F312-97 or ASTM D422	(PSEP 1997) or ASTM F312-97 or ASTM D422	PSEP & ASTMD422		Qualitative analysis was performed due to insufficient volume.
	Total organic carbon	%	SM5310 B	Pumb81TC	EPA 9060 or SM5310 B,C, or D	EPA 9060 & SM5310 B,C, or D	0.2	Plumb81TC is identical to 5310B (Combustion -IR)
Metals	Cadmium	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	0.5	
	Copper	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	1	
	Lead	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	2	
	Mercury	mg/kg	SW-846 7471A	SW-846 7471A	SW-846 7471A	SW-846 7471A	0.05	
	Zinc	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	10	
Persistent Organic Compounds	Polychlorinated biphenyls (PCBs)	ug/kg	SW-846 8082	SW-846 8082	SW-846 8082	SW-846 8082	100	
Semivolatile Organic Compounds	Pentachlorophenol (herbicide)	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	100	
	Phenols	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	20-200	

Stormwater Characterization – Sediment								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
	phthalates	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	70	
	Polycyclic aromatic hydrocarbons (PAHs)	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	20-100	
Pesticides, Organophosphorus	Diazinon	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	50	
	Malathion	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	25	
	Chloropyrifos	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	25	

3.5 Sampling Event Summary

This section presents a summary of events sampled during water year (WY) 2009. This was the first year collecting stormwater samples. The required sampling was for a partial sampling year that began on February 16, 2009 (per the permit) and ended on September 30, 2009 (with the end of the water year). A combination of factors, such as a reduced sampling season, which started after the significant winter storms had already occurred, beginning a new sampling program with related equipment startup and software programs, a prolonged dry period from mid-May to late September, and a delay in construction of the storm drain at one of the three monitoring sites, resulted in a limited amount of stormwater samples collected. The City was successful in the collection of two stormwater characterization samples during WY2009.

All three flow monitoring and water quality sampling stations were constructed and fully operational by the end of the WY2009. In-line sediment samples were collected using sediment traps at all three stations during WY2009.

During WY2009, resources were focused on activities to launch the permit-required stormwater monitoring program, which required ramping up the staff/consultants and installation of infrastructure to complete the monitoring work. These activities were successfully completed during WY2009. These efforts have resulted in the full implementation of the required monitoring thus far in WY2010 during which SPU is currently on track to meet the permit monitoring goals.

3.5.1 Weather and Qualifying Event Summary

The stormwater monitoring frequency in the permit is “sixty-seven percent of the forecasted qualifying storms which result in actual qualifying are required to be sampled, up to a maximum of eleven (11) storm events per water year.” Because this was a partial water year, this requirement does not apply to WY 2009 (per the Stormwater Monitoring Report Guidance draft from Ecology dated January 28, 2010).

The table below summarizes precipitation data for each of the three sampling locations for partial WY2009 based on a review of rain gauge data.

Table 3.5.1. Total Precipitation– February 16 to September 30, 2009

Monitoring Station	R1	C1	I1
Rain Gauge	RG07	RG03	RG30
Precipitation (inches)	15.46	15.01	17.94

3.5.2 Wet Season Stormwater Samples

Two storm events were successfully sampled at R1, with grab and composite samples collected for both events. The dates of the storm events (SE), identified as SE-01 and SE-02, were February 25, and March 5, 2009, respectively. The events qualified for all rainfall and sampling parameters with the exception of SE-02 which had a storm precipitation total of 0.18 inches. This is less than the minimum goal of 0.20 inches but allowable as a non-qualifying event per section S8.D 2a.

The storm hydrologic data for each R1 event, including precipitation, flow and sample information, is presented in Table 3.5.2. Event specific flow, rainfall and aliquot information are graphically presented in hydrographs - Figures 3.5.2a and b.

Table 3.5.2. R1 - Event Hydrologic Data Table

Analyte Name	Units	Goal	SE-01 R1 25-FEB-09	SE-02 R1 05-MAR-09
Storm Event Start	date/time	NA	2/25/2009 11:32	3/5/2009 5:30
Storm Event End	date/time	NA	2/25/2009 16:00	3/5/2009 14:00
Storm Event Duration	hours	>1	4:28	8:30
24-hour Antecedent Rainfall	inches	=0.02[a]	0.00	0.00
72-hour Antecedent Rainfall	inches	=0.02[b]	0.42	0.22
Precipitation Total	inches	=0.20	0.18 j	0.34
Mean Precipitation Intensity	in/hour	NA	0.06	0.07
Base Flow Rate	cfs	NA	0.00	0.00
Event Base Flow Volume	cf	NA	0.00	0.00
Total Flow Volume	cf	NA	2,396	11,450
Number of Aliquots	no.	=10[c]	26	69
Percent Storm Sampled	%	=75[d]	93%	92%

Notes:
NA - not applicable
j - did not meet storm criteria goal, conditional use only
(a) - applies to wet season (Oct 1 to Apr 30)
(b) - applies to dry season (May 1 to Sept 30)
(c) - 10 aliquots is the goal but greater than 7 is acceptable
(d) - if storm exceeds 24 hours, required to sample 75% of the first 24 hours

Sampling of several events was attempted at C1, but no successful samples were collected due to a combination of equipment and weather-related problems.

No stormwater sampling was attempted at I1 during WY2009 due to construction delays associated with the capital improvement project that replaced the storm drain system in this area. A new drainage pipe was installed, and the majority of the construction work was completed by February 2007. However, the installation of an oil control facility and work in the WSDOT swale downstream of the outfall for the new drainage pipe was delayed until July 2009 when the ground dried sufficiently to perform the final earth work.

The construction delay resulted in the new 64-inch storm pipe being half full of standing water until the work in the WSDOT swale was completed in July 2009, which delayed the installation of monitoring equipment. Ecology was verbally informed of the delay on March 9, 2009 and SPU formally reported the delay via a letter dated March 24, 2009. Due to the inaccessibility to the 64- inch pipe for installation of monitoring equipment, stormwater sampling work was postponed at this site until the start of WY2010. The monitoring equipment has been installed and the City is making progress towards meeting the sampling requirements for WY2010.

Figure 3.5.2a. – R1 Hydrograph – Storm Event 01, February 25, 2009

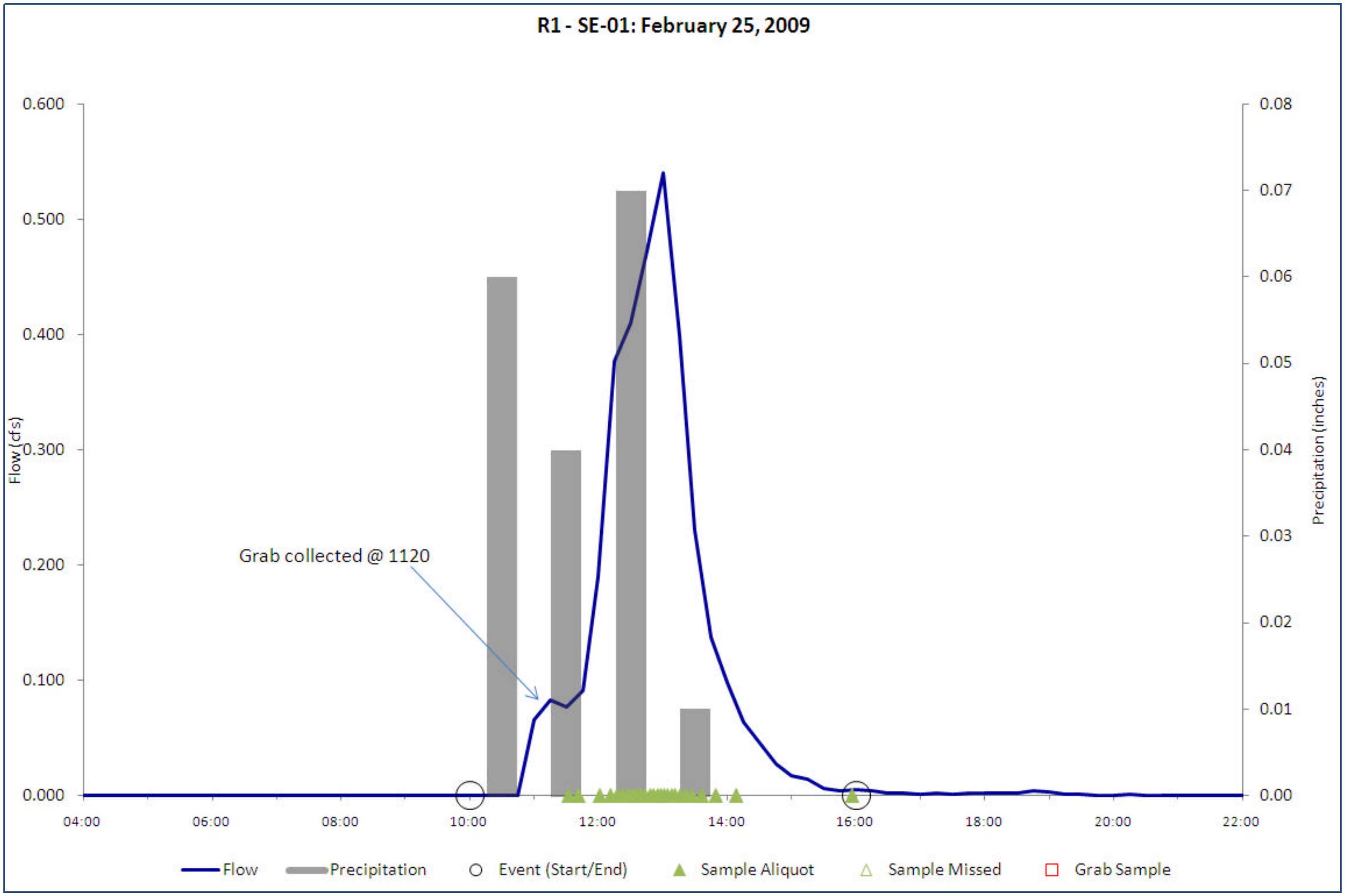
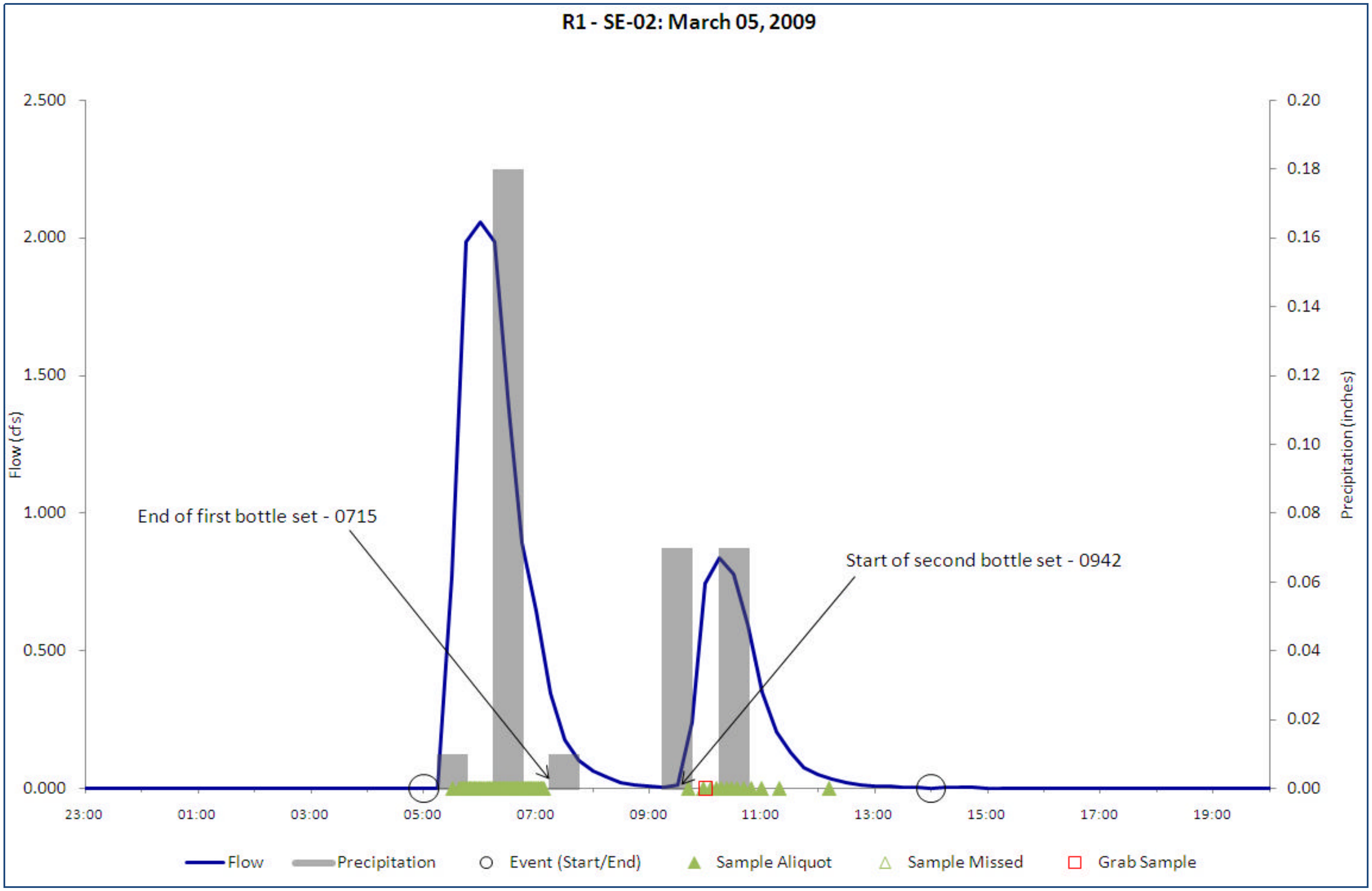


Figure 3.5.2b. – R1 Hydrograph – Storm Event 02, March 5, 2009



3.5.3 Dry Season Stormwater Samples

No dry weather stormwater samples were collected during WY2009.

3.5.4 Base Flow Samples

Base flow is present at only one (C1) of the three monitoring stations. No base flow samples were collected during WY2009.

3.5.5 Toxicity Sampling

The permit does not require the collection of toxicity samples by the City until the next water year (targeted for August-September 2010). Therefore, no toxicity samples were collected during WY2009.

3.5.6 Sediment Sampling

Sediment traps were installed in R1 and C1 on February 3, 2009. Traps were installed in I1 on July 9, 2009, immediately following the completion of the construction of the new storm drain. The traps were inspected several times between installation and removal. The only noteworthy observation was the rapid accumulation of trash (plastic bags, food wrappers, etc.) and organic debris on the traps in C1, which would often partially or completely cover the mouths of the bottles. Debris was removed during every confined space entry made for flow monitoring maintenance, storm setup and routine sediment trap checks, but its accumulation will likely be a long-term problem at this site even with increased site visits.

Bottles from all three locations were removed and new bottles were added on September 21, 2009. Accumulated sediment depths ranged from 0.1 inches at one bottle in C1 to up to 2-1/2 inches in an R1 bottle. Insufficient sediment quantity was captured at all sites to analyze for all the permit sediment parameters. Tested parameters were prioritized according to Section S8.D.2.g.iii of the permit.

3.6 Sampling Results

The following section briefly discusses results for samples collected during WY2009. Due to the limited amount of samples collected, no statistical evaluation of the data was performed. All analytical work for the stormwater characterization project was performed by ARI or their subcontractors.

3.6.1 Stormwater Samples

The results of the two events sampled are summarized in Table 3.6.1.

Table 3.6.1 – Analytical Summary – Stormwater Characterization Stormwater Samples

Analyte	Units	SE-01 R1 25-FEB-09		SE-02 R1 05-MAR-09	
Flow-weighted composite - automatic					
pH	std units	**6.88**		**6.62**	
Conductivity	umhos/cm	**32.9**		**31**	
Turbidity	NTU	**92.5**		**85**	
Biological Oxygen Demand	mg/L	**7**		**8**	
Chloride	mg/L	**2.4**		**3.7**	
Surfactants	mg/L	0.025	U	0.05	U
Solids, Total Suspended	mg/L	**94.7**		**133**	
Nitrogen, Total Kjeldahl	mg-N/L	**1.22**		**0.94**	
Nitrate + Nitrite	mg-N/L	**0.119**		**0.184**	
Phosphorus, Total	mg-P/L	**0.352**	J	**0.338**	J
Ortho-phosphate	mg-P/L	**0.013**		**0.012**	
Cadmium, Total	ug/L	**0.2**		**0.3**	
Cadmium, Dissolved	ug/L	0.2	U	0.2	U
Copper, Total	ug/L	**21.3**		**20.6**	
Copper, Dissolved	ug/L	**5**	J	**3**	J
Lead, Total	ug/L	**29**		**38**	
Lead, Dissolved	ug/L	1	U	1	U
Zinc, Total	ug/L	**79**		**81**	
Zinc, Dissolved	ug/L	**13**	J	**13**	J
Hardness	mg/L CaCO3	**18.8**		**19.1**	
bis(2-Ethylhexyl)phthalate	ug/L	**5.2**		**2.4**	
Butylbenzylphthalate	ug/L	1	U	1	U
Diethylphthalate	ug/L	1	U	1	U
Dimethylphthalate	ug/L	1	U	1	U
Di-n-Butylphthalate	ug/L	1	U	1	U
Di-n-Octyl phthalate	ug/L	1	U	1	U
1-Methylnaphthalene	ug/L	0.1	U	0.1	U
2-Methylnaphthalene	ug/L	0.1	U	0.1	U
Acenaphthene	ug/L	0.1	U	0.1	U
Acenaphthylene	ug/L	0.1	U	0.1	U
Anthracene	ug/L	0.1	U	0.1	U
Benzo(a)anthracene	ug/L	0.1	U	0.1	U
Benzo(a)pyrene	ug/L	0.1	U	0.1	U
Benzo(b)fluoranthene	ug/L	0.1	U	0.1	U
Benzo(g,h,i)perylene	ug/L	**0.13**		0.1	U
Benzo(k)fluoranthene	ug/L	0.1	U	0.1	U

Analyte	Units	SE-01 R1 25-FEB-09		SE-02 R1 05-MAR-09	
Chlorpyrifos	ug/L	0.08	U	0.08	U
Chrysene	ug/L	**0.13**		**0.13**	
Diazinon	ug/L	0.08	U	0.08	U
Dibenz(a,h)anthracene	ug/L	0.1	UJ	0.1	UJ
Dibenzofuran	ug/L	0.1	U	0.1	U
Fluoranthene	ug/L	**0.19**		**0.21**	
Fluorene	ug/L	0.1	U	0.1	U
Indeno(1,2,3-cd)pyrene	ug/L	0.1	U	0.1	U
Malathion	ug/L	0.4	U	0.4	U
Naphthalene	ug/L	0.1	U	0.1	U
Pentachlorophenol	ug/L	0.5	U	0.5	U
Phenanthrene	ug/L	0.1	U	0.1	U
Pyrene	ug/L	**0.18**		**0.19**	
2,4-D	ug/L	1	U	1	U
MCPP	ug/L	250	U	250	U
Triclopyr	ug/L	0.08	U	0.08	U
Dichlobenil	ug/L	0.3	U	0.3	U
Prometon	ug/L	0.3	U	0.3	U
Grab - manual					
Fecal Coliform	CFU/100 mL	**320**		**440**	
Diesel Range Hydrocarbons	mg/L	**0.61**		**0.44**	
Motor Oil	mg/L	**3.2**		**1.8**	
Gasoline Range Hydrocarbons	mg/L	0.25	U	0.25	U

Notes:

U - Analyte was not detected at or above the reported result.

J- Analyte was positively identified. The reported result is an estimate.

UJ- Analyte was not detected at or above the reported estimate.

3.6.2 Sediment Samples

The results of sediment trap samples collected from the three monitoring stations are summarized in Table 3.6.2. Insufficient sediment quantity was captured at all sites to analyze for all the permit sediment parameters so parameters were prioritized according to Section S8.D of the permit.

The permit allows that if insufficient sediment is available for grain size analysis per the Ecology sieve and pipette method (ASTM 1997) or PSEP 1986/2003, then the grain size can be characterized qualitatively. Below is the qualitative soil classification performed for sediment from each monitoring station by ARI per ASTM method D2488/D4427.

R1: “***Fibric Peat* -** The sample is medium brown and consists of approximately 90% course fibrous organics. The coarse organic matter consists of grass, pine needles, leaves and occasional inorganic gravel particles. Approximately 10% of the samples is silt sized organic particles.”

C1: “*Hemic Peat* – The sample is medium brown and consists of about 50% coarse, fibrous organics. These coarse organics included pine needles, grass and leaves. About 50% of the sample consisted of fine organic material.”

I1: “*Organic Soil* – The sample contains about 90% dark gray organic fines (OL); and 10% coarse fibrous particles. The coarse particles have broken down and the parent plant is unidentifiable.”

Table 3.6.2 – Analytical Summary – Stormwater Characterization Sediment Samples

Analyte	Units	C1 21-SEP-09		I1 21-SEP-09		R1 21-SEP-09	
Sediment trap							
Total Organic Carbon	%	**13.8**		**7.57**		**13.5**	
Solids, Total	%	**29.8**	J	**39.5**	J	**35.8**	J
Cadmium, Total	mg/kg	**1.9**		**1.6**		**1.3**	
Copper, Total	mg/kg	**361**	J	**131**	J	**81**	J
Lead, Total	mg/kg	**149**	J	**94**	J	**158**	J
Zinc, Total	mg/kg	**960**	J	**860**	J	**370**	J
Mercury, Total	mg/kg	**0.22**		**0.14**		NR	
2,4,5-Trichlorophenol	ug/kg	920	UJ	900	UJ	600	UJ
2,4,6-Trichlorophenol	ug/kg	920	UJ	900	UJ	600	UJ
2,4-Dichlorophenol	ug/kg	920	UJ	900	UJ	600	UJ
2,4-Dimethylphenol	ug/kg	180	U	180	U	120	U
2,4-Dinitrophenol	ug/kg	1800	U	1800	U	1200	U
2-Chlorophenol	ug/kg	180	UJ	180	UJ	120	UJ
2-Methylphenol	ug/kg	180	U	180	U	120	U
2-Nitrophenol	ug/kg	920	UJ	900	UJ	600	UJ
4,6-Dinitro-2-Methylphenol	ug/kg	1800	U	1800	U	1200	U
4-Chloro-3-methylphenol	ug/kg	920	U	900	U	600	U
4-Methylphenol	ug/kg	**860**		**170**	J	**7000**	
4-Nitrophenol	ug/kg	920	UJ	900	UJ	600	UJ
bis(2-Ethylhexyl)phthalate	ug/kg	**14000**		**12000**		**2600**	
Butylbenzylphthalate	ug/kg	400	UJ	890	UJ	120	UJ
Diethylphthalate	ug/kg	180	UJ	180	UJ	120	UJ
Dimethylphthalate	ug/kg	180	UJ	180	UJ	120	UJ
Di-n-Butylphthalate	ug/kg	**210**	J	180	UJ	120	UJ
Di-n-Octyl phthalate	ug/kg	180	U	**9400**		120	U
Pentachlorophenol	ug/kg	920	U	900	U	600	U
Phenol	ug/kg	180	U	180	U	**290**	
Chlorpyrifos	ug/kg	NM		710	UJ	330	UJ
Chrysene	ug/kg	**1300**	J	**1100**	J	**750**	J
Diazinon	ug/kg	NM		140	U	120	U
Dibenz(a,h)anthracene	ug/kg	**340**	J	**280**	J	**160**	J
Dibenzofuran	ug/kg	52	U	52	U	**56**	
Fluoranthene	ug/kg	**2700**	J	**1900**	J	**1500**	J
Fluorene	ug/kg	**100**	J	**88**	J	**83**	J
Indeno(1,2,3-cd)pyrene	ug/kg	**720**	J	**600**	J	**360**	J
Malathion	ug/kg	NM		140	U	120	U
Naphthalene	ug/kg	52	U	52	U	35	U
Phenanthrene	ug/kg	**1200**	J	**610**		**750**	J
Pyrene	ug/kg	**2000**	J	**1600**	J	**1200**	J

Analyte	Units	C1 21-SEP-09		I1 21-SEP-09		R1 21-SEP-09	
1-Methylnaphthalene	ug/kg	52	U	52	U	35	U
2-Methylnaphthalene	ug/kg	**52**		52	U	**35**	
Acenaphthene	ug/kg	**62**	J	**62**	J	**90**	J
Acenaphthylene	ug/kg	52	U	52	U	35	U
Anthracene	ug/kg	**200**	J	**130**	J	**94**	J
Benzo(a)anthracene	ug/kg	**810**	J	**580**	J	**430**	J
Benzo(a)pyrene	ug/kg	**930**	J	**760**	J	**480**	J
Benzo(b)fluoranthene	ug/kg	**1300**	J	**730**	J	**750**	J
Benzo(g,h,i)perylene	ug/kg	**1000**	J	**900**	J	**480**	J
Benzo(k)fluoranthene	ug/kg	**1100**	J	**880**	J	**490**	J
Aroclor 1016	ug/kg	54	U	32	U	NR	
Aroclor 1242	ug/kg	54	U	32	U	NR	
Aroclor 1248	ug/kg	54	U	32	U	NR	
Aroclor 1254	ug/kg	**180**		**87**		NR	
Aroclor 1260	ug/kg	**84**		**80**		NR	
Aroclor 1221	ug/kg	54	U	32	U	NR	
Aroclor 1232	ug/kg	54	U	32	U	NR	

Notes-

U - Analyte was not detected at or above the reported result.

J- Analyte was positively identified. The reported result is an estimate.

UJ- Analyte was not detected at or above the reported estimate.

NM - not measured. Insufficient sediment to perform analysis

NR - not required to be analyzed.

3.7 Annual Load Calculations

Due to the partial water year and the limited data set at one monitoring station, it was not possible to calculate a full season annual load for WY2009. Annual load calculations are planned for all sites for WY2010.

3.8 QA/QC Report

3.8.1 Flow Monitoring QA/QC Results

Flow data from R1, related to the successful sample events, were reviewed for gaps, sensor drift and outliers. The flume level was calibrated on January 30, March 2 and checked on March 10. The transducer drifted a total of -0.015 ft between February 3 and March 2 and did not drift between March 2 and March 10. The level data were adjusted for the slight sensor drift between February 3 and March 2 and the flow rate was recalculated for the flume. No corrections were made to the flow from March 2 through March 13 as there was no measured sensor drift.

The flume was clear of debris during the site visits and is assumed to be accurate to the manufacturer's specifications during the period of record. The final flow data (corrected for sensor drift as described above) collected during the sample collection events on February 25 and March 5 is believed to be accurate and of acceptable quality.

3.8.2 Analytical QA/QC Results

Refer to *Appendix C2 - Analytical QA/QC Report* for a discussion of the QA/QC results.

3.8.3 Field QA/QC Results

Results of the two tubing blank samples (FBS and FBR) are summarized in Table 3.8.3. Both samples were analyzed for the full suite of composite parameters.

The field blank sample (FBS) blank collected at C1 on February 20, 2009 after the complete decontamination had trace amounts of total phosphorus [0.01 milligrams phosphorus per liter (mg-P/L) compared to the reporting limit (RL) of 0.008 mg-P/L]; total copper [0.7 micrograms per liter (µg/L) compared to the RL of 0.5 µg/L]; nitrate + nitrite [0.012 milligrams – nitrogen per liter (mg-N/L) compared to the RL of 0.01mg-N/L]. Trace amounts of these three analytes are commonly found on sampling equipment blanks and are considered acceptable at the levels detected. Potential false-positive results due to field and/or laboratory contamination are indicated when pollutant concentrations in blank samples are detected at levels greater than ten percent of sample concentration – which did not occur with these low level blank results. No corrected action or data flagging is considered necessary per USEPA guidelines for data evaluation.

The final draft of Ecology's *Standard Operating Procedure (SOP) for Automatic Sampling for Stormwater Monitoring* does not require decontamination of automatic sampler tubing prior to each sampling event. Following an initial cleaning, the SOP is to "rinse tubing with de-ionized water, or site water (i.e., stormwater or ambient water such as base flow)."

The (field residual blank) FRB blank, collected on February 23, 2009, was collected at site R1 following a deionized rinse of the sampler tubing. This sample contained a total phosphorus result of 0.55 mg-P/L which is higher than the actual stormwater sample results of 0.352 and 0.338 mg-P/L. The source of the phosphorus in the blank is unknown and the corrective action was to increase the volume of the deionized water used for the tubing rinses and collect additional blanks. Total phosphorus results for the two stormwater composite samples are flagged 'J' to indicate that the contamination found in the blank may indicate cross contamination from the tubing that may have biased subsequent stormwater samples.

The FRB blank had nitrate + nitrite concentration of 0.012 mg-N/L, which was identical to the FBS blank and is 10 percent or less of the actual sample concentrations, so no corrective action was considered necessary. The second blank had no detections for total metals but had dissolved copper and dissolved zinc concentrations of 13.2 and 7.0 µg/L, respectively. Mean sample results for these two dissolved metals from stormwater samples collected at the same site were 4.0 and 13.0 µg/L, respectively. Since no total metals were detected in the blank sample, the source of the dissolved metals in the blank suggests laboratory contamination from either the filter blank or other lab equipment. No dissolved metals were detected in the related filter blank so the source was likely bottle contamination or resulted from analysis activities. Dissolved copper and dissolved zinc results for the two stormwater composite samples are flagged "J" to indicate that the contamination found in the blank may indicate cross contamination from the tubing that may have biased subsequent stormwater samples.

Table 3.8.3. Stormwater Characterization Sampler Tubing Blank Data

Analyte	Units	Reporting Limit	C1 - Field Blank Sample 20-Feb-09		R1 - Field Residual Blank 23-Feb-2009	
Orthophosphorus	mg-P/L	0.004	0.004	U	0.004	U
Phosphorus, Total	mg-P/L	0.008	0.01		0.55	
Dibenz(a,h)anthracene	ug/L	0.1	0.1	U	0.1	U
Benzo(g,h,i)perylene	ug/L	0.1	0.1	U	0.1	U
Dibenzofuran	ug/L	0.1	0.1	U	0.1	U
Pentachlorophenol	ug/L	0.5	0.5	U	0.5	U
Cadmium, Total	ug/L	0.2	0.2	U	0.2	U
Copper, Total	ug/L	0.5	0.7		0.5	U
Lead, Total	ug/L	1	1	U	1	U
Zinc, Total	ug/L	4	4	U	4	U
Nitrate + Nitrite	mg-N/L	0.01	0.012		0.012	
Nitrogen, Total Kjeldahl	mg-N/L	0.6	0.6	U	0.6	U
Cadmium, Dissolved	ug/L	0.2	0.2	U	0.2	U
Copper, Dissolved	ug/L	0.5	0.5	U	13.2	
Lead, Dissolved	ug/L	1	1	U	1	U
Zinc, Dissolved	ug/L	4	4	U	7	
Naphthalene	ug/L	0.1	0.1	U	0.1	U
2-Methylnaphthalene	ug/L	0.1	0.1	U	0.1	U
1-Methylnaphthalene	ug/L	0.1	0.1	U	0.1	U
Acenaphthylene	ug/L	0.1	0.1	U	0.1	U
Acenaphthene	ug/L	0.1	0.1	U	0.1	U
Benzo(k)fluoranthene	ug/L	0.1	0.1	U	0.1	U
Benzo(a)pyrene	ug/L	0.1	0.1	U	0.1	U
Indeno(1,2,3-cd)pyrene	ug/L	0.1	0.1	U	0.1	U
Dimethylphthalate	ug/L	1	1	U	1	U
Diethylphthalate	ug/L	1	1	U	1	U
Di-n-Butylphthalate	ug/L	1	1	U	1	U
Butylbenzylphthalate	ug/L	1	1	U	1	U
bis(2-Ethylhexyl)phthalate	ug/L	1	1	U	1	U
Di-n-Octyl phthalate	ug/L	1	1	U	1	U
Fluorene	ug/L	0.1	0.1	U	0.1	U
Phenanthrene	ug/L	0.1	0.1	U	0.1	U
Anthracene	ug/L	0.1	0.1	U	0.1	U

Analyte	Units	Reporting Limit				
Fluoranthene	ug/L	0.1	0.1	U	0.1	U
Pyrene	ug/L	0.1	0.1	U	0.1	U
Benzo(a)anthracene	ug/L	0.1	0.1	U	0.1	U
Chrysene	ug/L	0.1	0.1	U	0.1	U
Benzo(b)fluoranthene	ug/L	0.1	0.1	U	0.1	U

Notes-

U - Analyte was not detected at or above the reported result.

3.9 Explanation and Discussion of Results

Due to the partial water year and limited data set, no discussion of the results is attempted for data from WY2009.

3.9.1 SWMP Activities

The City's Stormwater Management Program (SWMP) Activities are described in Attachment A of the 2009 NPDES Annual Report. Because the requirements of the permit are programmatic, the City applies all of the activities in the SWMP in all areas of the City that are served by the MS4, which includes the R1, C1 and I1 monitoring stations drainage basin. The only exception to this is one planned capital improvement project located in the R1 monitoring station drainage basin, which is the Venema GSI project described in the SWMP Section III.6.

4 S8.E STORMWATER MANAGEMENT PROGRAM EFFECTIVENESS

4.1 Requirements

The program effectiveness monitoring requirement is for the City to select two specific aspects of the Stormwater Management Program to evaluate. One aspect to be evaluated is to determine the effectiveness of a targeted action. A second aspect to be evaluated is the effectiveness of achieving a targeted environmental outcome. This monitoring is intended to improve stormwater management efforts by providing a feedback loop to help determine if a stormwater management program element is meeting the desired environmental outcome.

4.2 Purpose, Design and Methods

The program effectiveness monitoring evaluates aspects of the stormwater management program; the effectiveness of a specific action and the effectiveness of achieving a targeted environmental outcome. The City proposes to address stormwater related problems associated with sediments by conducting a street sweeping study to determine if this BMP action helps to achieve the desired outcome of a reduced sediment load.

The Ecology fact sheet for the 2007 NPDES Phase I permit states:

> In both the "actions" and "outcomes" categories, permittees are required to select an issue for study that has significance for them.
>
> The "specific action" monitoring is aimed at having the permittees establish a feedback loop for a specific component or part of a component. The intent is to do sufficient investigation to determine if a specific action is making an effective contribution to achieving the overall stormwater program and permit goals. Examples could include: improvements in stormwater quality or quality of sediments in stormwater discharges; reduction in frequency of high flows; reduction in frequency of spills.
>
> The "targeted outcome" monitoring is intended to establish a feedback loop concerning the effectiveness of a subset or the entire stormwater program in achieving a specific environmental outcome. Examples of an outcome include: reopening an area to commercial shellfish harvesting; preventing recontamination of receiving water sediments; reducing discharge of certain pollutants by a targeted percentage, below a certain concentration, or below a targeted annual load amount; re-establishment of a sustaining native fish population.

The effect of urban stormwater runoff on the water quality of receiving waters is of great concern in the Seattle area. While new development may have a large number of options for providing water quality treatment through structural controls, existing developed areas have limited choices for retrofitting their stormwater systems. Thus, nonstructural measures for improving the quality of runoff have become increasingly important. One of the nonstructural measures that may be readily used throughout the city is street sweeping.

In 2006 and 2007, Seattle conducted a Street Sweeping Pilot Study in two residential areas and one industrial area to evaluate whether street sweeping with regenerative air sweepers can significantly reduce the mass of pollutants discharged to area receiving water bodies while reducing the frequency of catch basin cleaning by removing sediment/debris from the street before it is transported in stormwater runoff. The study was conducted in two residential areas and one industrial area using a paired basin approach (i.e., a swept and unswept basin in each area). The quantity and quality of street dirt, sweeper waste, and catch basin sediment were measured and evaluated. Conclusions from the study include:

- Sweeping streets every other week was effective in reducing the amount of sediment and pollutants that enters the storm drain system and the amount of dirt present on the streets.
- Sweeping streets every other week did not reduce the amount of sediment that accumulated in catch basins, which indicates that sweeping may not reduce the frequency that catch basins would need to be cleaned. However, because of the short time frame of the pilot study and the difficulty in accurately measuring sediment depth in the catch basins, there is still considerable uncertainty about the effect of sweeping on catch basin cleaning frequency.
- Street sweeping has the potential to be a cost-effective strategy for removing sediment and pollutants from the roadways of Seattle. Sweeping streets every other week is likely to be more cost-effective than annual catch basin cleaning or structural controls.

The *Seattle Street Sweeping Pilot Study – Monitoring Report* is available online at: http://www.seattle.gov/util/Services/Drainage_&_Sewer/Keep_Water_Safe_&_Clean/Street_Sweep_Project/QuestionsAnswers/

4.2.1 Targeted action

A targeted action results in improvements in stormwater quality or quality of sediments in stormwater discharges. Additional analytical analysis of the street dirt, sweeper waste, and catch basin sediment collected during the Seattle Street Sweeping Pilot Study will be performed to increase our understanding of the distribution of contaminants in varying size fractions in street dirt, sweeper waste, and catch basin sediments. Refer to Table 4.2.1 for more information on this program effectiveness monitoring of a targeted action.

Table 4.2.1. Program Effectiveness Monitoring Proposal 1a – Effectiveness of a Targeted Action.

Project	Seattle Street Sweeping Pilot
Significance	The application of street sweeping in highly built out urban area has the potential to be an effective non-structural BMP which addresses potentially toxic transport-derived contaminants.
Hypothesis to be tested	Regenerative air sweepers are effective at removing contaminants in the silt, clay, and/or dissolved sized fraction.
Parameters to be measured	Archived, frozen samples of street dirt, street sweeper waste, and catch basin sediment will be analyzed to determine the distribution of selected contaminants in sand, silt, and clay size fractions – or other fractions as appropriate to answer the question.
Management actions	If yes, consider employing street sweeping on streets drained by MS4. If no, use street sweeping where feasible.
Temporal Scale	Permit cycle
Feasibility Issues	There may not be adequate sample. The archived samples have been frozen - holding times may be an issue. Frozen samples may not sieve satisfactorily.

4.2.2 Targeted outcome

A targeted outcome reduces discharge of certain pollutants below a targeted annual load amount. A mass balance model will be developed to predict a targeted annual load reduction for varying conditions, such as sweeping frequency, road surface condition, and parking enforcement compliance (Table 4.2.). Existing data and a parking compliance survey will be used as a basis for the model.

Table 4.2.2. Program Effectiveness Monitoring Proposal 1b – Effectiveness of a Targeted Outcome.

Project	Seattle Street Sweeping Pilot
Significance	The application of street sweeping in highly built out urban area has the potential to be an effective non-structural BMP which addresses potential toxic transport-derived contaminants. Street sweeping effectiveness can generally be attributed to the sweeper's efficiency and the sediment deposition rate. A model that describes this relationship will allow prioritizing and optimizing a street sweeping program with the intent of providing the highest value.
Hypothesis to be tested	Street sweeping effectiveness can be described by a model which accounts for (1) sweeping efficiency, a function of the sweeper frequency, utilization, and availability, and (2) sediment deposition rate, a function of pollutant build up and wash off.
Parameters to be measured and modeled	• Sweeper efficiency o Planned frequency with which the streets were swept. o Utilization due to holidays, equipment breakdowns, communication failures. o Availability due to incomplete sweeping of streets from no parking violators. • Pollutant build up (Total Suspended Solids (TSS) loading)

	o National land use data will be used to estimate TSS runoff concentrations o WWHM3 will be used to estimate average annual runoff volumes. o Average annual pollutant load will be determined from above. • Pollutant wash off o Pavement roughness and street slopes will be measured to account for removal efficiencies affected by pavement conditions. o Precipitation intensity and frequency will be analyzed to account for "wash off" between sweepings.
Management actions	If yes, design a street sweeping program to optimize the sweeping efficiency using a mass balance model as a tool.
Temporal Scale	Permit cycle
Feasibility Issues	There may be inadequate data to calibrate the model.

4.3 Implementation Status

As indicated previously, the City has completed the report for the Street Sweeping Pilot Study. The additional physical and chemical analysis of the street dirt, sweeper waste, and catch basin sediment from the Street Sweeping Pilot Study has been completed. The results and conclusions from these additional analyses will be included in a future Annual Report.

5 S8.F Stormwater Treatment and Hydrologic Management BMP Evaluation

5.1 Overview

The permit requires full scale field monitoring to evaluate the effectiveness and operation and maintenance requirements of stormwater treatment and hydrologic management best management practice (BMPs) applied in Permittee's jurisdiction. Specifically, the permit requires that each Phase I Permittee select two treatment types that are standard technologies in their stormwater manuals, for detailed performance monitoring. Two BMPs per each BMP treatment type are required to be monitored. In addition, one hydrologic management (or "flow reduction") BMP is required to be monitored.

5.1.1 Treatment BMP Number One Overview

One of the two selected treatment types that the City is monitoring a proprietary or "engineered" treatment BMP - the Catch Basin StormFilter™ (CBSF), manufactured by Contech® Construction Products Inc. (Contech). The CBSF is becoming a frequently installed BMP by the Seattle Department of Transportation (SDOT) to treat roadway stormwater runoff. The City is interested in monitoring the effectiveness of this BMP because the cartridge technology has received a basic treatment General Use Level Designation (GULD) by Ecology via testing within a vault, not a catch basin device.

The CBSF monitoring work was performed in general accordance with the draft QAPP submitted to Ecology on February 10, 2008 and approved by Ecology on September 26, 2008. The final QAPP was submitted to Ecology on February 12, 2009. A brief summary of information provided in the QAPP is presented in Section 5.2 below.

5.1.2 Treatment BMP Number Two Overview

The second BMP project that the City proposed to monitor consisted of two bioretention swales located in the High Point redevelopment project of West Seattle. The final QAPP for the High Point bioretention swales project was submitted to Ecology on February 12, 2009. The City began implementation of monitoring the bioretention swales prior to February 2009, with the intent to collect the first water quality samples with the start of the partial water year on February 16, 2009. However, factors such as the complexity of this monitoring project coupled with concerns over the numerous assumptions and models required to make performance estimates, and the lack of transferability of findings from the project, resulted in the City changing its approach to the second BMP.

The City was still interested in evaluating the performance of bioretention systems and soils and pursued an opportunity to partner with the Washington State University (WSU) Puyallup Research and Extension Center to have WSU conduct BMP evaluation monitoring on the City's behalf by using Special Condition S8.B.1 of the permit. WSU, with the City of Puyallup, is constructing a green stormwater infrastructure (GSI) retrofit project at the WSU Puyallup Research and Extension Center. The project will contain many full-scale BMPs including bioretention cells, water gardens and porous pavements.

The City will use monitoring and results from four bioretention cells, referred to as mesocosms, which will meet Special Condition S8.F.2.b for monitoring a metals/phosphorus treatment BMP. The four mesocosms are identical (essentially one primary and three replicates) and all contain a 60/40 mix of aggregate/compost. The mix and configuration of the mesocosms is similar to the City's bioretention design standard. Stormwater will be pumped into each mesocosm and the water quality samples and flow data will be collected at the influent and effluent of each mesocosm to calculate pollutant reduction.

The City notified Ecology of its plan to replace the High Point BMP project by the collaboration with WSU verbally and followed with a letter dated September 15, 2009. Ecology gave the City approval to proceed with this plan. The City signed a Memorandum of Agreement (MOA) with WSU on November 12, 2009 (Appendix C1). The WSU project QAPP is expected to be completed in January 2010, and the monitoring will begin in the spring of 2010. Sampling results from this project will be summarized in the WY2010 annual report.

5.1.3 Hydrologic Management BMP Overview

The permit requires the city to monitor a flow reduction strategy that is in use in the City or planned for installation within the City in a paired study or against a predicted outcome. To meet this requirement, the City has monitored one bioretention swale located in the High Point community in South West Seattle. Flow was monitored in the swale continuously for two years.

5.2 Treatment BMP Number One Monitoring

5.2.1 Catch Basin StormFilter™ Description

The Contech® Catch Basin StormFilter™ (CBSF) is a passive, flow-through stormwater filtration system. It is engineered to replace the standard catch basin, and consists of a concrete or steel vault that houses rechargeable cartridges filled with a variety of filtration media.

Numerous CBSFs were installed along California Avenue SW in West Seattle in April 2007 as part of roadway improvements. Two of the units were selected for monitoring. The first unit, referred to as CBSF1, is located on the southeast corner of California Avenue SW and SW Spokane Street. The second unit, referred to as CBSF2, is located on the southeast corner of California Avenue SW and SW Manning Street. Refer to Figure 5.2.1a – Vicinity Map, and Figures 5.2.1b and c – Site Maps.

These units, which are model CBSF4, are four-cartridge steel units designed to treat 0.065 cubic feet per second. The CBSF is installed flush with the finished grade and is applicable for small drainage areas from roadways and parking lots, and retrofit applications.

Each model CBSF4 is designed with the following primary components: influent sump, scum baffle, two filter cartridge chambers containing two StormFilter™ cartridges each, internal bypass weir, and an effluent/bypass chamber (see Figure 5.2.1d – Design Details). Stormwater initially enters the influent sump where some treatment may occur via particle settling. It then passes under the scum baffle, leaving floatable pollutants behind in the influent sump. Next, the stormwater may be routed into one of two cartridge chambers for treatment via the StormFilters™ cartridges. Alternatively, if the treatment capacity of the StormFilters™ cartridges has been exceeded or the storm flow exceeds the design flow, the stormwater can bypass the cartridge chambers entirely by spilling over the bypass weir. Treated effluent from the StormFilters™ cartridges and bypassed stormwater enter the effluent/bypass chamber and are subsequently discharged out of the system via an 8-inch outlet pipe.

Figure 5.2.1a. Vicinity Map – CBSF Monitoring StormFilters

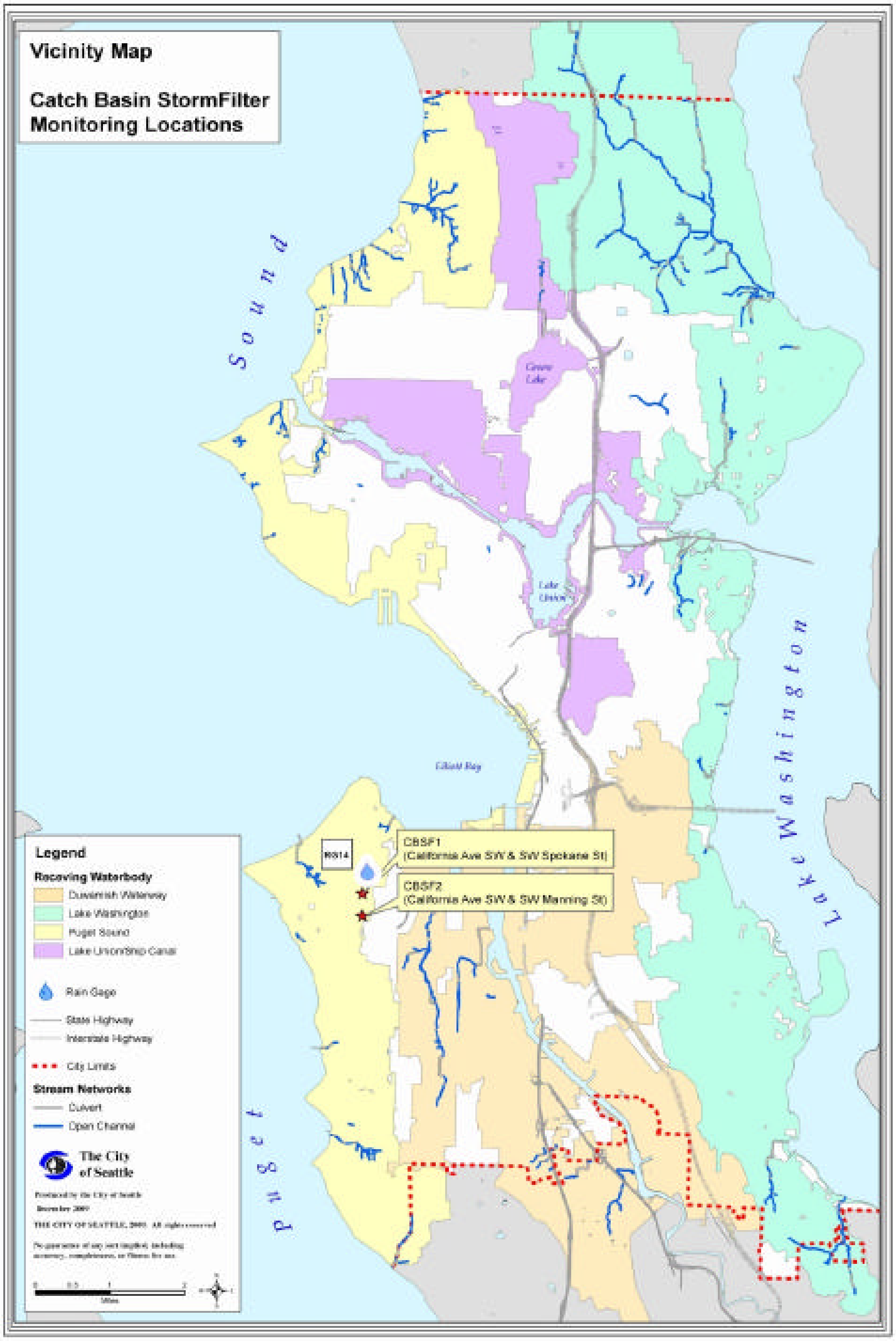


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Figure 5.2.1b. Site Map – CBSF1

Figure 5.2.1c. Site Map – CBSF2

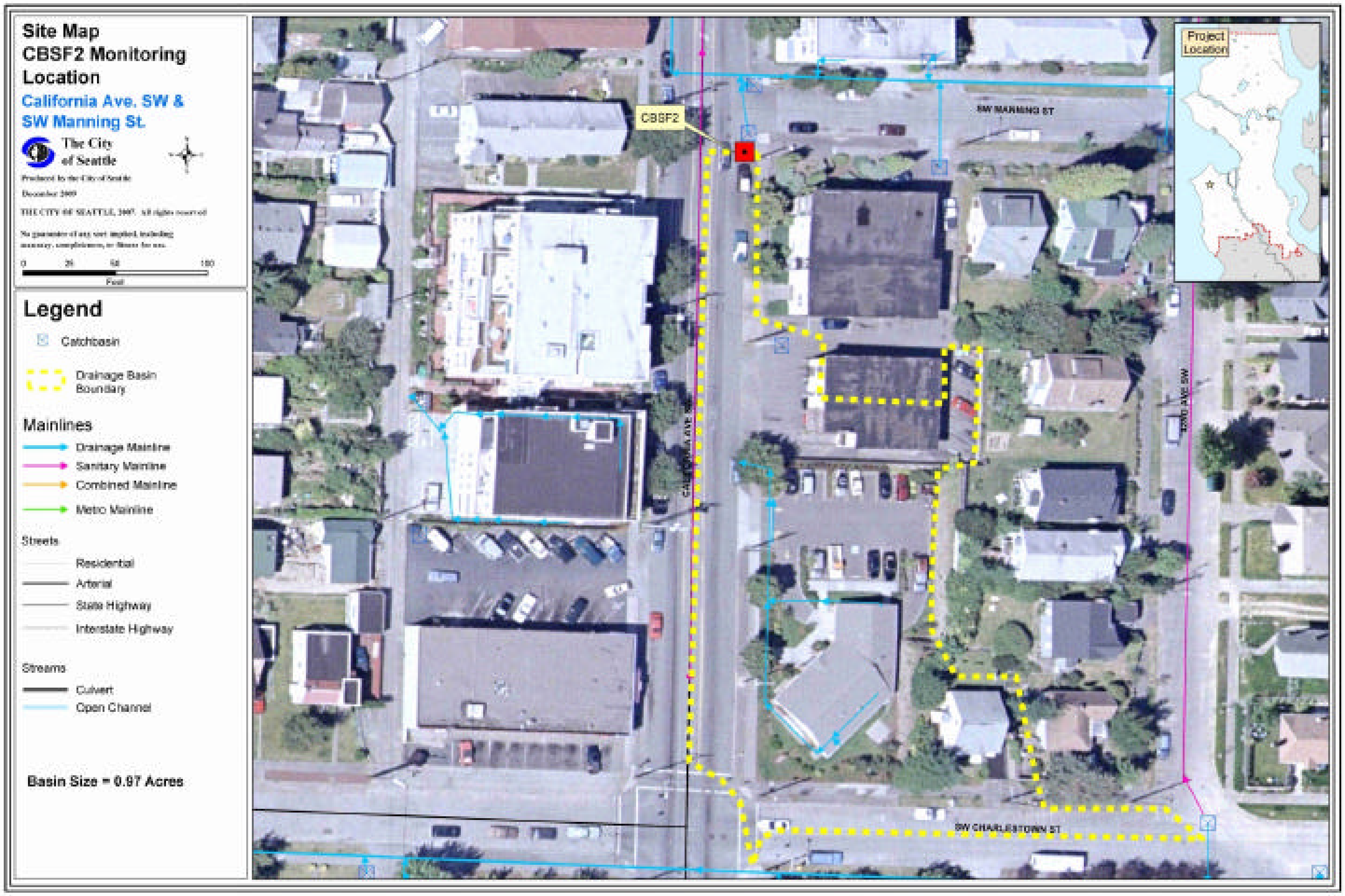
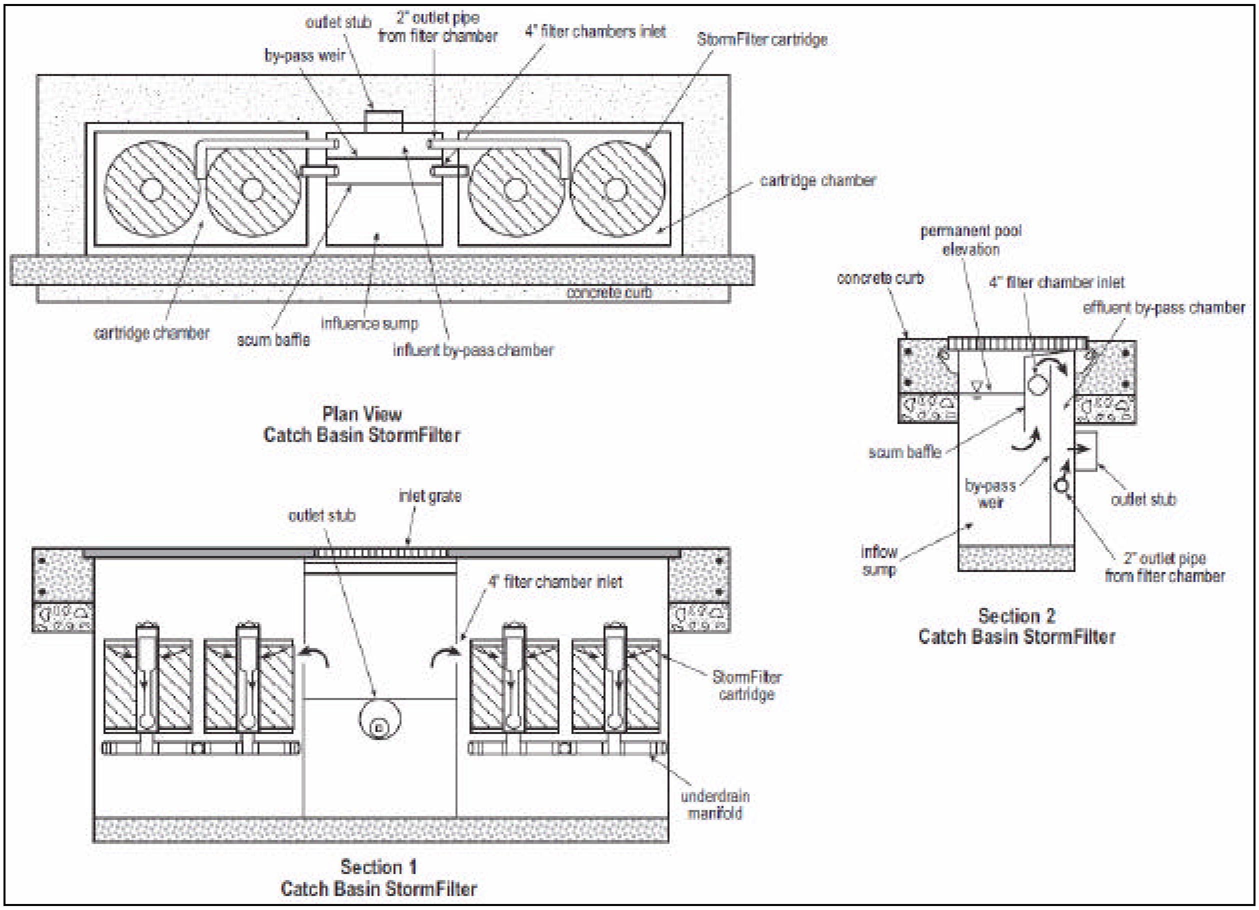


Figure 5.2.1d. Design detail for Catch Basin StormFilter



The CBSF is sized using the Western Washington Hydrology Model Version 3 (WWHM3), an Ecology-approved continuous runoff model. The unit is sized assuming an online, or flow-through facility, based on the manufacturer's recommendation and the definition provided in the Stormwater Management Manual for Western Washington (Ecology 2005), Section 4.5 Hydraulic Structures, .5.1 Flow Splitter Designs:

"*Many water quality (WQ) facilities can be designed as flow-through or on-line systems with flows above the WQ design flow or volume simply passing through the facility at lower pollutant removal efficiency. However, it is sometimes desirable to restrict flows to WQ treatment facilities and bypass the remaining higher flows around them through offline facilities. This can be accomplished by splitting flows in excess of the WQ design flow upstream of the facility and diverting higher flows to a bypass pipe or channel.*"

Because the CBSF is fitted with an internal bypass weir, all stormwater enters the unit and receives some treatment in the influent sump. At the design flow rate, stormwater flows from the sump into the filter cartridges for treatment and then discharges to the municipal storm sewer system. Flows bypass the cartridge when they either exceed the design flow rate or the cartridge capacity has been exhausted.

The cartridges tested in this study are zeolite-perlite-granular activated carbon (ZPG) cartridges. Each cartridge contains a total of approximately 2.6 cubic feet (CF) of media. The ZPG cartridge consists of an outer layer of perlite that is approximately 1.3 CF in volume and an inner layer, consisting of a mixture of 90% zeolite and 10% granular activated carbon, which is approximately 1.3 CF in volume. The ZPG cartridges are manufactured to meet the specifications described in Ecology's General Use Level Designation (GULD) for Basic Treatment issued January 2005 and updated December 2007.

To meet the conditions of the General Use Level Designation (Ecology 2007a) and prepare the units for monitoring the following tasks were performed prior to monitoring began in February 2009:

- The units were cleaned of sediment and cartridges removed,
- The media was converted from perlite to zeolite-perlite-granular activated carbon (ZPG),
- The individual cartridge flow rate was reduced from 15 gpm to 7.5 gpm by modifying the orifice-control disc placed at the base of the cartridge, and the CBSF1 unit was adapted to accommodate the expected flow rate (discussed below).

Due to the smaller basin and related expected flow rate in the CBSF1 basin, only the southern of the two cartridge filtration chambers is in use during the study. This is accomplished by installing plugs in both the 4-inch inlet orifice to the filtration chamber and the 2-inch outlet orifice from the filtration chamber in the northern of the chambers. No adaptation was necessary for CBSF2 since the expected flow rate is close to the water quality design flow rate for the entire unit with both filter chambers online[2].

5.2.2 Catch Basin StormFilter Monitoring Locations

To evaluate the effectiveness of the CBSFs, volume-weighted stormwater composite samples are collected from the influent and treated effluent of each unit. The treatment performance of each unit will subsequently be evaluated based on comparisons of concentrations measured at these stations (i.e., CBSF1-In versus CBSF1-Out, and CBSF1-In versus CBSF1-Out) to calculate percent removals for each unit.

Sediment samples are collected annually from influent, filter chamber and effluent chambers of each unit.

5.2.2.1 Flow and Water Quality Sampling Equipment

At each CBSF unit, flow is monitored at two locations: 1) in the 8-inch outlet pipe where in discharges into the downstream catch basin which measures the combination of treated and bypass flow, and 2) at the bypass weir within the CBSF unit which measures the flow bypassing the unit. Since the units have a low hydraulic residence time and do not infiltrate water, the outlet (also referred to as “effluent”) flow is considered to represent both the flow entering and leaving the unit.

To facilitate flow monitoring, a Thel-Mar volumetric weir was installed in each outlet pipe and the existing bypass weir was modified into sharp-crested, rectangular weir. The weirs are primary measurement devices which constrict and reshape the flow, developing a hydraulic head proportional to flow relationship. Stilling wells were connected to each weir to house Instrumentation Northwest PS9805 (0-1 psig) submerged pressure sensors for measuring water depth on the upstream face of each weir.

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[2] Since the final QAPP was submitted, the catchment size for the CBSF2 basin was increased from 0.23 to 0.97 acres due to addition area/runoff from SW Charlestown Street in the block east of California Ave SW which was not included in the original estimate.

A CSI CR1000 data logger logs level and flow at five minute intervals. The data logger calculates flow from level data using standard weir equations. The monitoring equipment layout is discussed below and show in plan view and side view on Figures 5.2.2.1a and b respectively.

Figure 5.2.2.1a. Schematic Details for Monitoring Stations in CBSF1 (plan view and side view)

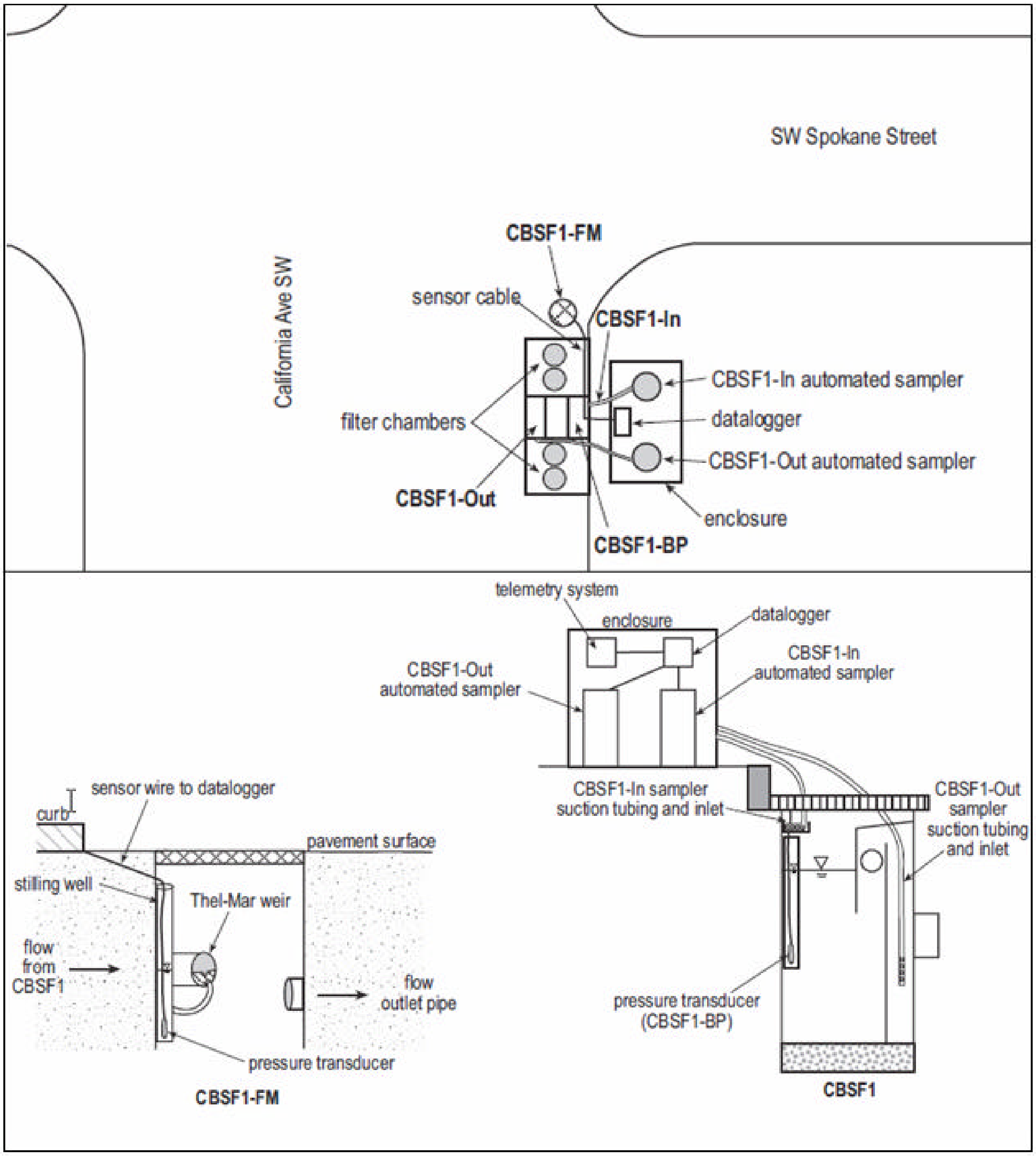
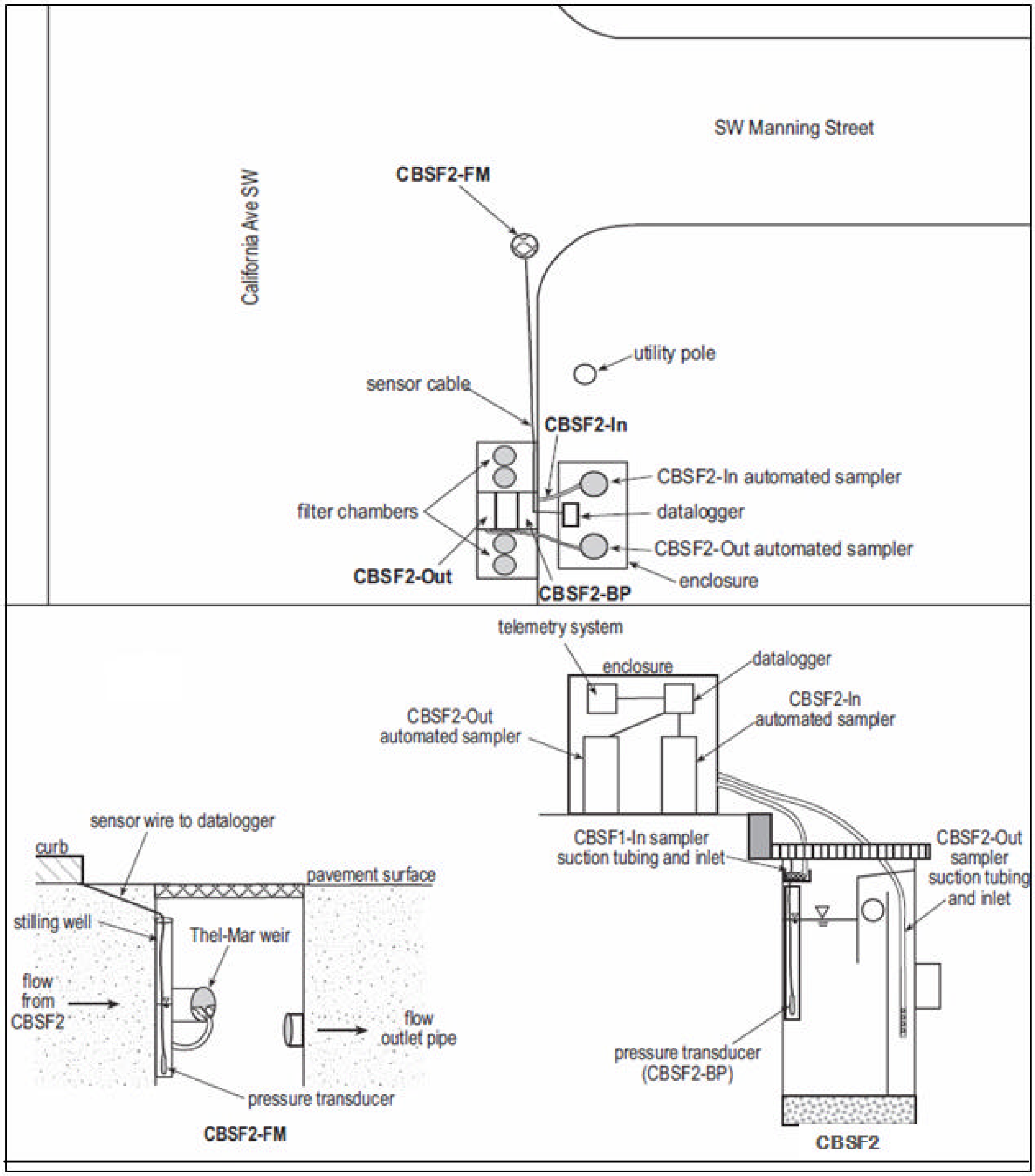


Figure 5.2.2.1b. Schematic Details for Monitoring Stations in CBSF2 (plan view and side view)



Isco 6712 samplers, controlled by the CR1000, collect volume-weighted influent and effluent stormwater composite samples from each unit. Polyethylene tubing (3/8-inch internal diameter) leads from the point of sample collection back to autosamplers. Influent samples are collected where the untreated runoff from the road enters each unit (designated CBSF1-In and CBSF2-In). Plastic trays are installed directly below the grate to allow pooling of roadway runoff to facilitate sampling. Similarly, effluent samples are collected where treated stormwater leaves the filter chamber (designated CBSF1-Out and CBSF2-Out). By inserting the sample tubing approximately 12-inches up the 2-inch outlet orifice from the filtration chamber, only treated effluent, as opposed to untreated stormwater bypassing the unit, is sampled. Since both filtration chambers are active in CBSF2, the effluent sampler tubing is alternated between each chamber's outlet pipe from event to event to evaluate the performance of the average effluent concentration of the unit.

The data logger and Isco samplers are housed in an enclosure on the sidewalk immediately adjacent to each unit, and the sample lines and sensor cables are ran in conduits to each sampling/monitoring location. Wireless telemetry provides remote communications with the CR1000. A combination of batteries and solar panels power the loggers and samplers.

SPU rain gauge RG14 (06-689) is used to represent rainfall for both CBSF sites. RG14 is located at Lafayette Elementary School which is located at the corner of California Avenue SW and SW Admiral Way, roughly 0.5 miles north of the monitoring stations.

5.2.2.2 Sediment Monitoring Locations

Sediment accumulation and sediment quality is monitored in each chamber of the two CBSFs to quantify the mass and chemical characteristics of particulates removed in each unit at the following locations:

Influent chamber (Stations CBSF1-Sed1 and CBSF2-Sed1)
Filter chamber (Stations CBSF1-Sed2 and CBSF2-Sed2)
Effluent chamber (Stations CBSF1-Sed3 and CBSF2-Sed3).

5.3 Sampling Procedures

Herrera Environmental Consultants (HEC) performed all weather tracking, flow monitoring and stormwater sampling activities. Sediment monitoring and sampling was performed by SPU staff.

5.3.1 Weather Tracking/Storm Criteria

Weather and rainfall data were continuously monitored using multiple forecasting, radar and satellite sources to target storms that meet the criteria for a qualifying event, listed in Table 5.3.1.

Table 5.3.1. Qualifying Event Criteria

Criteria	Requirements
Target storm depth	A minimum of 0.15 inches of precipitation over a 24-hour period
Rainfall duration	Target storms must have a duration of at least one hour
Antecedent dry period	A period of at least 6 hours preceding the event with less than 0.04 inches of precipitation.
End of storm	A continuous 6-hour period with less than 0.04 inches of precipitation.

HEC made recommendations for storms to target for sampling with the final "go/no-go" decision made by the City's monitoring lead.

5.3.2 Flow Monitoring

Flow monitoring equipment type and configuration at each station are described in Section 4.2.2.1. Level and flow data were logged at five-minute intervals. Flow monitoring quality assurance/quality control procedures are discussed in Section 5.3.6.1.

5.3.3 Stormwater Composite Samples

Volume-proportioned stormwater composite samples were collected using Isco 6712 automatic samplers (autosamplers). The samplers utilize a peristaltic pump to draw stormwater from the strainer installed at the sampling location and distribute it to one 20L polyethylene composite bottle in the sampler base.

The data loggers were programmed to trigger the samplers every time a specified volume (referred to as the "trigger volume") was measured at the outlet flow monitoring station of each CBSF. Each CBSF has one data logger which triggered the influent and effluent samplers simultaneously. Each trigger sent results in the collection of one stormwater aliquot collected by each sampler which was deposited in the composite bottle. Each aliquot is 200mL so the composite bottle can receive 100 aliquots before it is full. Bottles were removed and replaced as necessary over the course of the event.

Since stormwater samples, specifically stormwater solids concentrations and related contaminants, are readily biased without proper processing procedures; all composite samples were composited and split in the project analytical laboratory (ARI) using large, custom-made polyethylene churn splitters.

5.3.4 Sediment Monitoring and Sampling

Sediment accumulation was measured in each chamber of the two CBSFs to quantify the mass that was deposited over the monitoring period. Overlying water was removed using a City vactor truck and the sediment depth was measured using an engineer's tape measure. Sediment depth was measured at five locations (four corners and the center) in each chamber the depths were averaged to determine the average sediment depth per chamber.

One sediment composite sample was collected per each chamber that contained sampleable quantities of sediment. Since both filter chambers are active in CBSF2, one composite was generated from sediments collected from both chambers. Sediment from at least five locations in each chamber was collected using a stainless steel spoon. The sediment from each chamber was placed in a stainless bowl and homogenized by mixing and turning with the spoon. Any foreign debris (e.g., cigarette butts, trash, and inorganic debris greater than 2 centimeters) was removed. Remaining sediment was transferred into analytic-specific bottles.

For the first partial water year, sediment depth was measured only once at the end of the water year. Following sediment monitoring and sampling, all accumulated sediment was removed and the units maintained per the manufacturer's instructions. For subsequent years, sediment accumulation rates will be measured manually in each chamber on a quarterly basis.

5.3.5 Decontamination Procedures

All water quality and sediment sampling equipment - which includes sampler tubing, sample bottles, churn splitters, and stainless steel spoons and bowls - were decontaminated with the following procedure:

1. Wash in a solution of laboratory-grade, non-phosphate soap and tap (city) water.
2. Rinse in tap water.
3. Wash in a 10 percent nitric acid/deionized water solution.*
4. Rinse in deionized water.
5. Final rinse in deionized water.

** Nitric wash omitted for stainless steel equipment*

5.3.6 QA/QC Procedures

5.3.6.1 Flow Monitoring QA/QC Procedures

The project submerged pressure sensors were calibrated prior to each storm event. Sensors are adjusted to exact level based on manual measurements for the bypass sensors or by topping off the v-notch weirs and zeroing the transducers for the outlet sensors. As part of the calibration tracking procedure, level values before and after calibration are recorded. If the before and after values differ than more than 0.02 feet, the data was corrected for the drift. The difference between these values was also tracked over time to assess long-term drift which will trigger the need for sensor replacement.

5.3.6.2 Analytical QA/QC Procedures

Refer to *Appendix C2 - Analytical Data QA/QC* report for the procedures used to evaluate the analytical data.

5.3.6.3 Field QA/QC

For WY2009, four field blank samples were collected from the autosampler tubing by pumping deionized water through the strainer, intake, peristaltic and distributor arm tubing into a clean composite bottle. One field decontamination blank (FBS) – a blank sample collected in the field on decontaminated tubing - was collected the sampler tubing from each of the four water quality sampling stations on February 18, 2009.

One duplicate sediment sample was collected on September 23, 2009 from location CBSF2-Sed1. The duplicate sample was generated in the field by filling two sets of sample containers from the same bowl of homogenized sediment.

5.4 Analytical Parameters, Methods and Reporting Limits

During the QA/QC it was determined that the laboratory (ARI) used analytical methods, or reported data under different methods from the QAPP for this project. The following table is provided to describe the method the laboratory (ARI) performed when analyzing the samples, the method nomenclature the laboratory used on the data reports provided to SPU, the method described in SPU's QAPP and the method Ecology has accredited the lab to perform. In addition, SPU has provided a written description to addresses any areas of non-conformance. Reporting limits represent the minimum value the laboratory is able to report. Reporting limits can vary by individual samples, particularly for sediments where the quantity and dilution analyzed affect the minimum detectable value.

Table 5.4a Comparison Table of Water Sample Parameters, Methods and Reporting Limits Used for this Project

Catch Basin Storm Filter – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
Conventional	Hardness (total)	mg/L $CaCO_3$	SM2340-B	SW6010B	SM2340-B or C	SM2340-B	0.33	Method reported is the analytical procedure for the SM2340-B
	Particle Size Distribution	mg/L	TAPE/ASTMD 3977C	TAPE/ASTMD 3977C	TAPE	PSEP	0.01	
	pH	s.u.	SM 4500 - H^+ B	EPA 150.2	SM 4500 - H^+ B	EPA9045	0.01	Equivalent Electrometric method
	Total Suspended Solids (TSS)	mg/L	SM2540-D	EPA160.2	SM2540-D	SM2540-D	1	Method reported is an old EPA number for Equivalent method
Metals (dissolved & total)	Copper	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.5	
	Zinc	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	4	
Nutrients	Ortho-phosphate	as P mg/L	SM4500-P E	EPA365.2	SM4110-B	SM4500-P E	0.01	
	Phosphorus, Total	as P mg/L	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	0.02	Method reported is an old EPA number for Equivalent method

Ortho-phosphate was analyzed by SM4500-P, a colorimetric method for both the Catch Basin Storm Filter and the Stormwater Characterization projects. The ortho-phosphate method in the Catch Basin Storm Filter QAPP, however, was incorrectly listed as SM4110-B. The method incorrectly listed in the QAPP was not listed in Appendix 9 of the permit, so the samples were analyzed by the colorimetric method which is consistent with the method used for Stormwater Characterization sediment samples and Appendix 9 of the permit.

Table 5.4b – Comparison Table of Sediment Sample Parameters, Methods and Reporting Limits Used for this Project

Catch Basin Storm Filter – Sediment								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report-ing Limit**	**Comments**
Conventional	Bulk Density	lb/ft^3	ASTM 2937	ASTM 2937			0.01	
	Grain size	%	ASTM D422	ASTM D422	ASTM D422	ASTM D422	0.1	
	Total solids	%	SM2540B	EPA160.3	EPA160.3 or SM2540B	SM2540B	0.01	Method reported is an old EPA number for Equivalent method
	Total Volatile Solids	%	EPA160.4	EPA160.4	EPA160.4	EPA160.4	0.01	
Metals	Cadmium	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	0.3	ICP was inadvertently analyzed by the lab instead of ICP-MS. Detection limits were met.
	Copper	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	0.5	
	Lead	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	5	
	Zinc	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	2	
Nutrients	Phosphorous	as P mg/Kg	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	3	Method reported is an old EPA number for Equivalent method
Total Petroleum Hydrocarbon (TPH)	Diesel Range Organics - Diesel	mg/L	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	25	
	Diesel Range Organics - Oil						10	

For the metals analysis, ARI inadvertently used method SW6010B rather than SW6020. The laboratory has corrected this error and will use the QAPP method for all future analysis.

5.5 Sampling Event Summary

This section presents a summary of events sampled during WY2009. This was a partial sampling year that began on February 16, 2009 (per the permit) and ended on September 30, 2009 (with the end of the water year).

Flow monitoring and water quality sampling stations at each CBSF were constructed and fully operational by February 2009, with stormwater sampling beginning with the first qualifying events after February 16. Sediment samples were collected at the end of the water year.

5.5.1 Stormwater Samples

Two storm events, designated SE-01 and SE-02, were successfully sampled at both CBSF1 and 2 locations on March 1-2 and March 2-3, 2009, respectively. The events qualified for all rainfall and sampling parameters.

The storm hydrologic data for each CBSF event, including precipitation, flow and sample information, is presented in Table 5.5.1. Event specific flow, rainfall and aliquot information are graphically presented in site- and event-specific hydrograph - Figures 5.5.1a-d.

Table 5.5.1. CBSF Event Hydrologic Data Table

Analyte Name	Units	Goal	SE-01 CBSF1 02-MAR-09	SE-02 CBSF1 02-MAR-09	SE-01 CBSF2 02-MAR-09	SE-02 CBSF2 03-MAR-09
Storm Event Start	date/time	NA	3/1/09 1400	3/2/09 1805	3/1/09 1400	3/2/09 1805
Storm Event End	date/time	NA	3/2/09 0940	3/3/09 0920	3/2/09 0720	3/3/09 1025
Storm Event Duration	hours	>1	19:40	15:15	17:20	16:20
Antecedent Dry Period	hours	>6	7.3	13.7	7.3	13.7
Precipitation Total	inches	=0.15	0.37	0.23	0.37	0.23
Max. Precip. Intensity	in/hour	NA	0.09	0.11	0.09	0.11
Mean Precip. Intensity	in/hour	NA	0.02	0.02	0.02	0.02
Max. Total Flow Rate	cfs	NA	0.04	0.03	0.10	0.13
Total Flow Volume	cf	NA	143.6	86.7	631.3	448.2
Max. Total Bypass Rate	cfs	NA	0.00	0.00	0.00	0.00
Total Bypass Volume	cf	NA	0.0	0.0	0.0	0.0
Number of Aliquots	no.	=10	26	14	42	22
Percent Storm Sampled	%	=75	100.0%	99.9%	100.0%	98.3%

Notes:

NA - not applicable

Figure 5.5.1a. CBSF1 Hydrograph – Storm Event 01

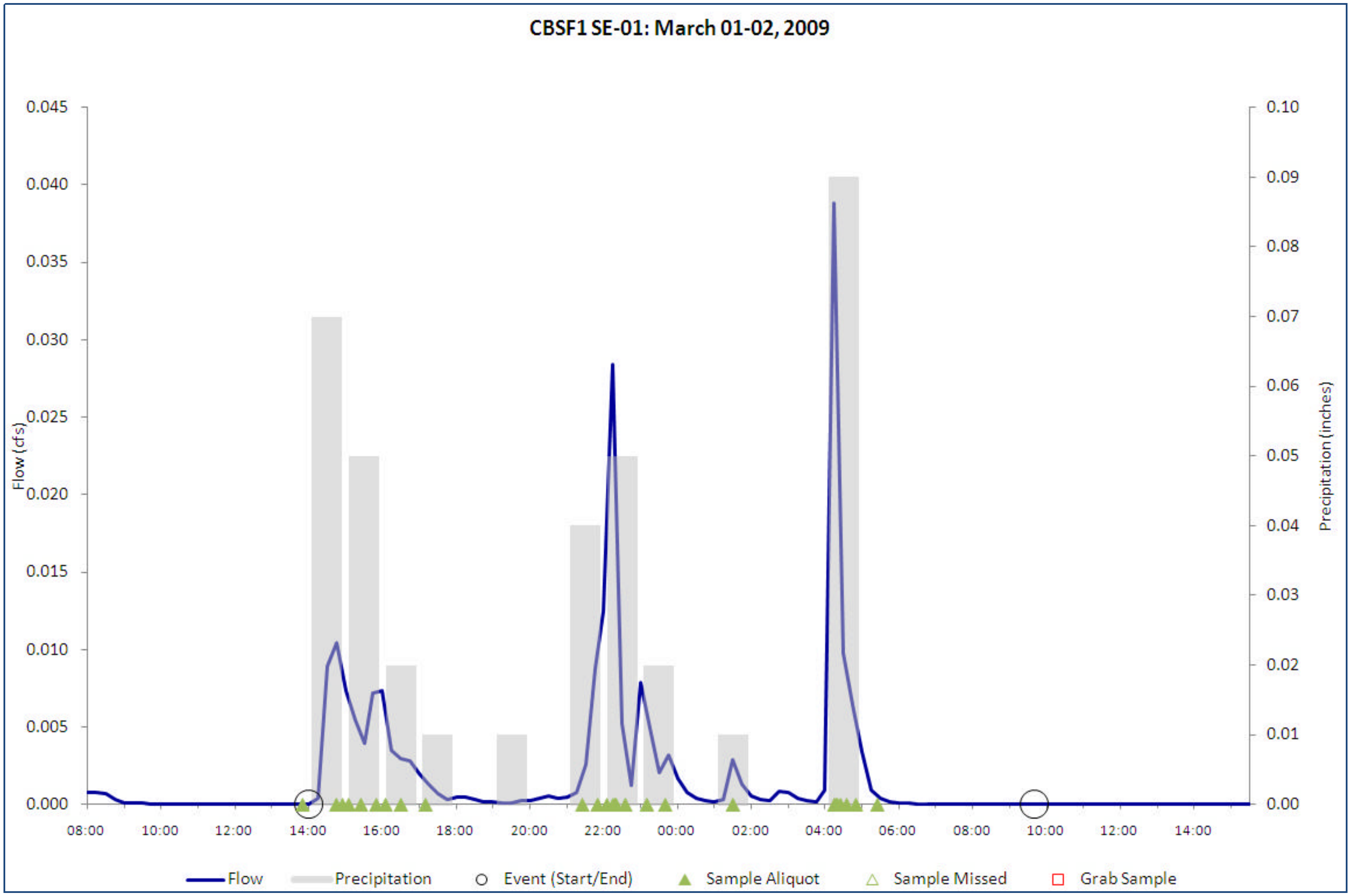


Figure 5.5.1b. CBSF2 Hydrograph – Storm Event 01

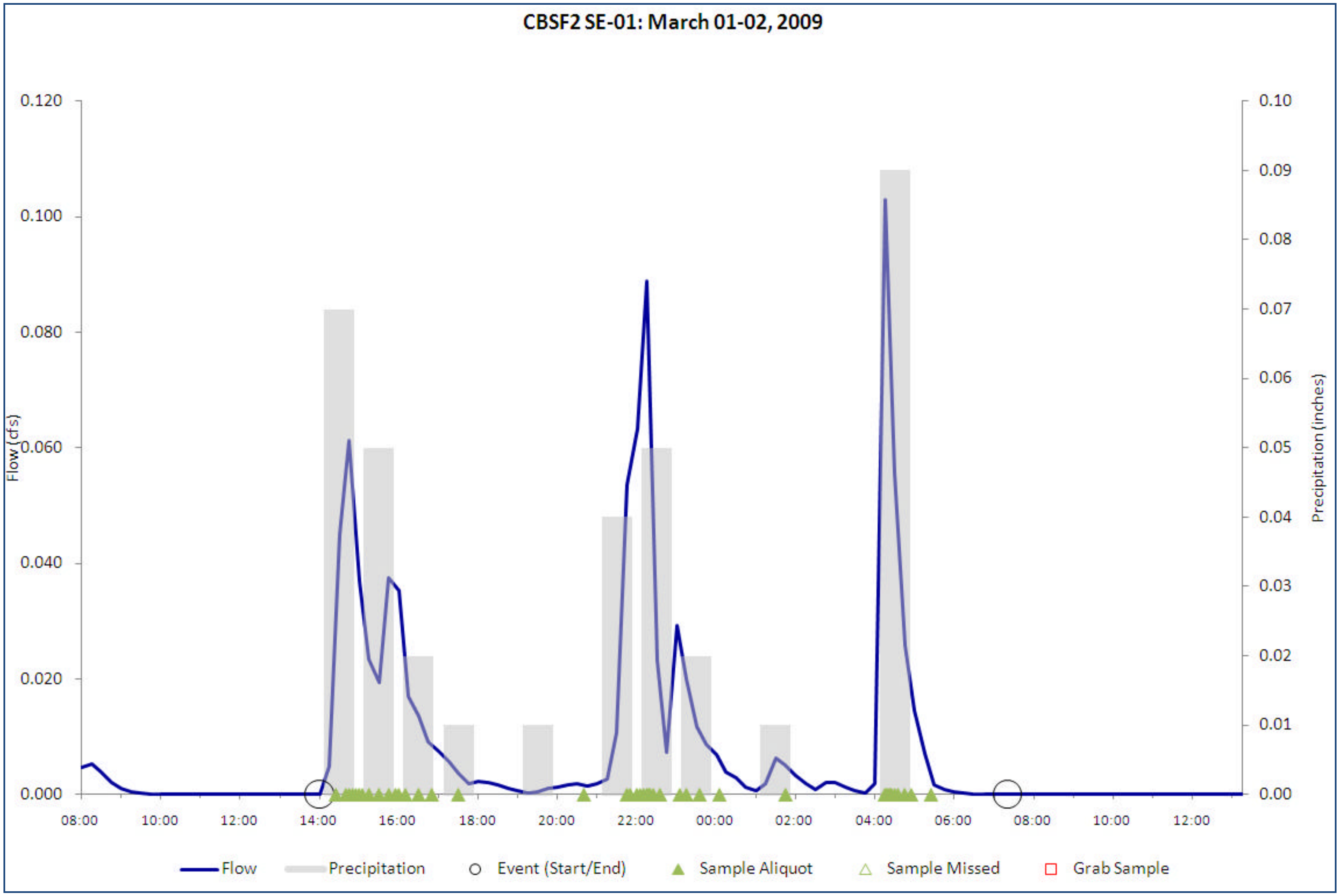


Figure 5.5.1c. CBSF1 Hydrograph – Storm Event 02

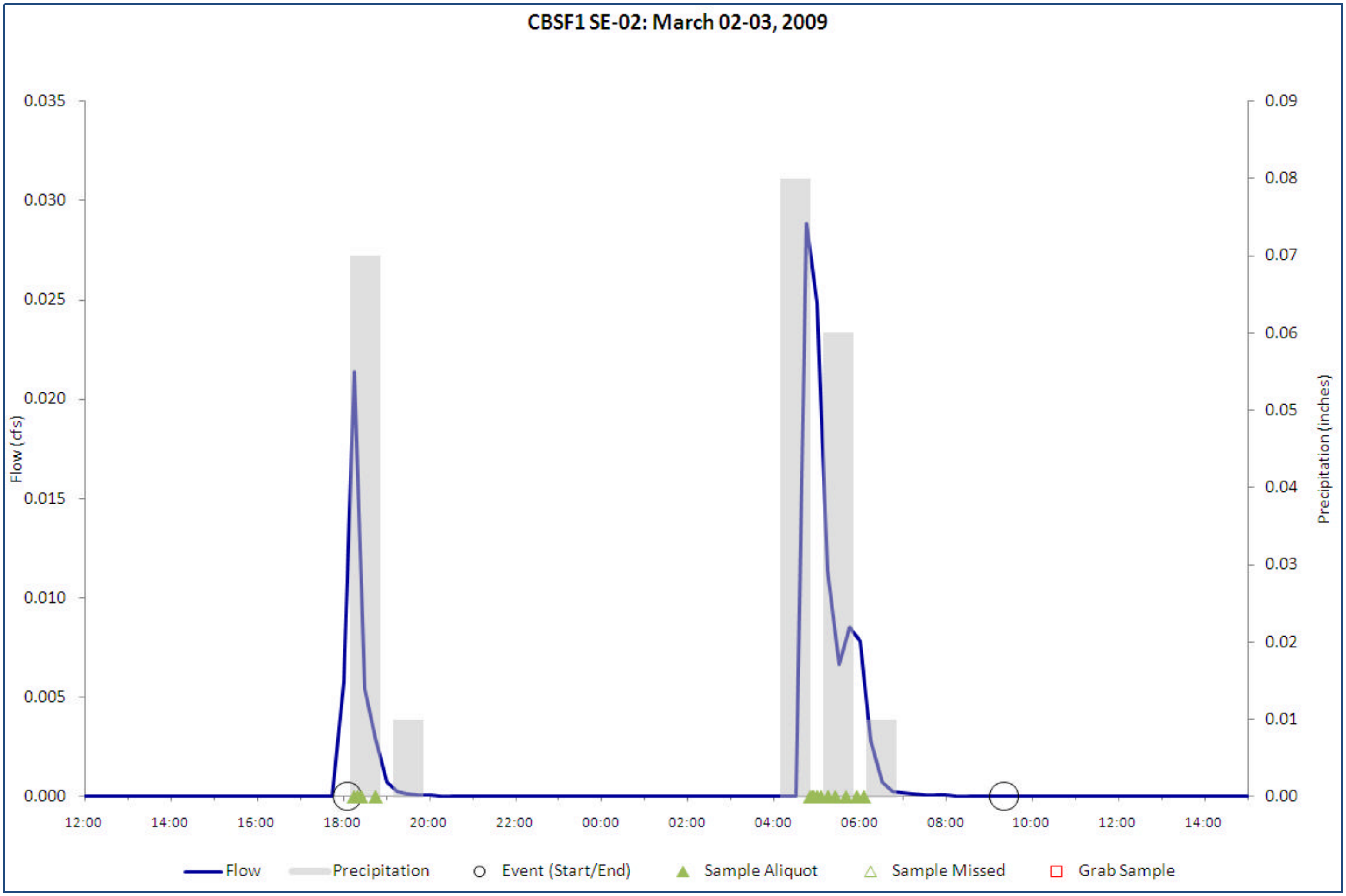


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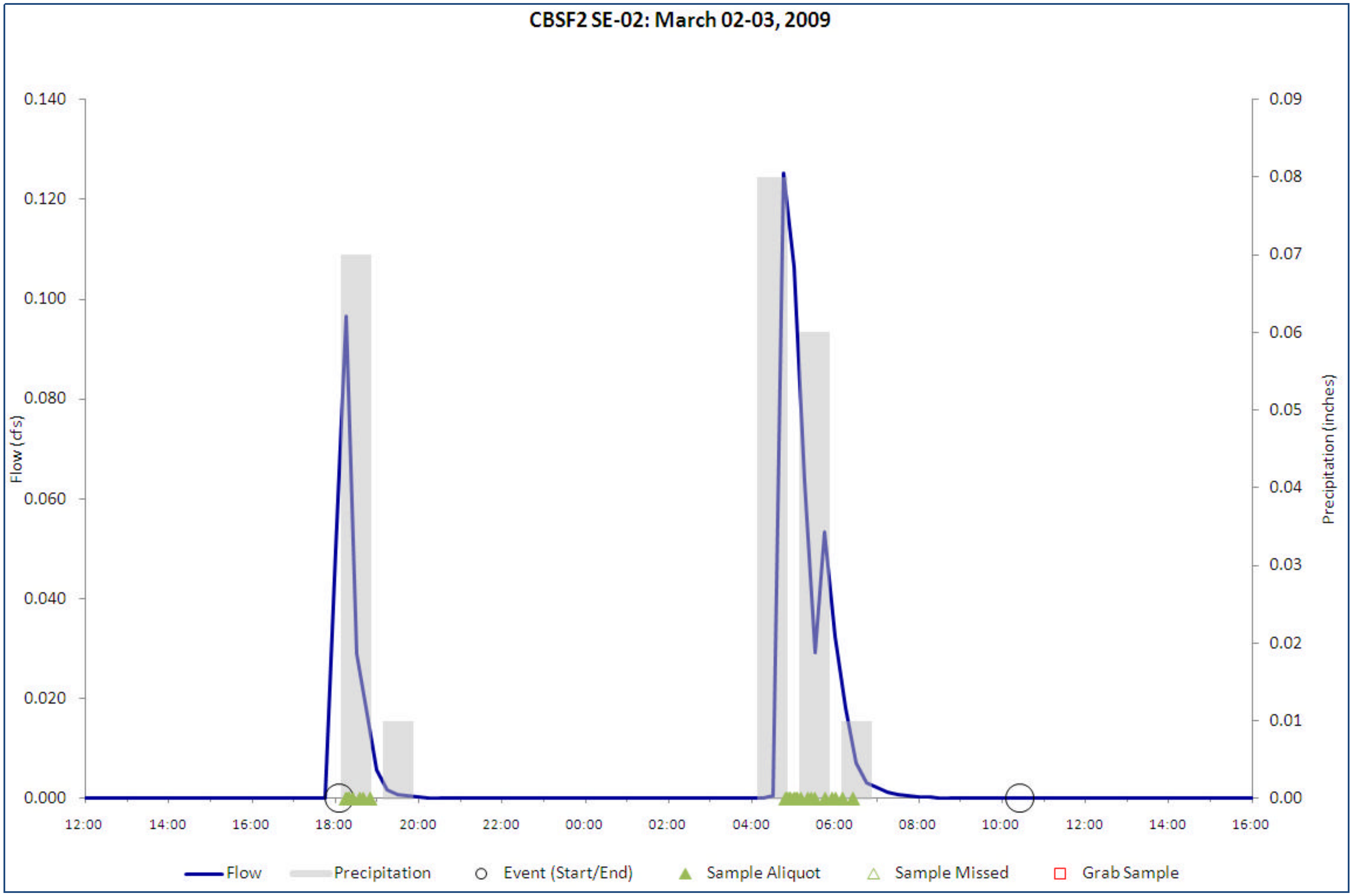
Figure 5.5.1d. CBSF2 Hydrograph – Storm Event 02



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5.5.2 Sediment Sampling

Annual sediment accumulation monitoring and sampling was performed on September 23, 2009. To prepare for the partial water year's sampling activities; both CBSFs were maintained on February 10, 2009, which included cleaning all sediment and replacing the filter cartridges. During quarterly CBSF inspection of all the CBSFs installed along California Ave. SW on June 19, 2009, the City's contractor cleaned sediment from CBSF1 despite being instructed to perform no maintenance on the two CBSFs being monitored. They realized their error before cleaning CBSF2. Due to the lack of significant rainfall between June 19 and September 23, there was not enough sediment to sample in CBSF1.

Sediment depth was measured in all chambers. Sampleable amounts of sediment were present in CBSF2 in the influent chamber (CBSF2-Sed1) and the two filtration chambers (CBSF2-Sed2).

5.6 Sampling Results

The following section briefly discusses the results of the Catch Basin Stormfilter BMP samples collected during WY2009. The permit requirement for this monitoring is to meet a statistical goal to determine mean effluent concentrations and mean percent removals with 90 -95% confidence and 75 – 80% power. As this was the first year, and only a partial water year, of this sampling, a limited amount of samples were collected and no statistical evaluation of the data was performed. The City will be collecting additional data during WY2010 and an evaluation of progress towards meeting the statistical goal will be included in the WY2010 report. All analytical work was performed by ARI.

5.6.1 Stormwater Samples

The results of the two events sampled are summarized in Tables 5.6.1a and b.

Table 5.6.1a. Analytical Summary – CBSF1 Stormwater Samples

Analyte	Units	SE-01 CBSF1-IN 01-MAR-09		SE-01 CBSF1-OUT 01-MAR-09	Percent Change	SE-02 CBSF1-IN 02-MAR-09	SE-02 CBSF1-OUT 02-MAR-09		Percent Change
pH	std units	**7.76**		**6.65**	NA	**6.49**	**6.53**		NA
Solids, Total Suspended	mg/L	**144**		**64.5**	55.2	**168**	**91.5**		45.5
Phosphorus, Total	mg-P/L	**0.412**		**0.222**	46.1	**0.52**	**0.274**		47.3
Ortho-phosphate	mg-P/L	**0.008**		**0.008**	0.0	**0.014**	**0.013**		7.1
Copper, Total	ug/L	**30.4**		**17.9**	41.1	**30.2**	**19.8**		34.4
Copper, Dissolved	ug/L	**4.6**	J	**5.2**	-13.0	**3.7**	**4.4**		-18.9
Zinc, Total	ug/L	**146**		**125**	14.4	**158**	**100**		36.7
Zinc, Dissolved	ug/L	**16**		**29**	-81.3	**15**	**20**		-33.3
Hardness	mg/L CaCO3	**28**		**24**	NA	**26**	**15**		NA
Sediment Conc. > 500 um	mg/L	**16.43**		**4.28**	NA	**50.73**	0.01	U	NA
Sediment Conc. 500 to 250 um	mg/L	**10.55**		**4.89**	NA	**15.15**	**5.41**		NA
Sediment Conc. 250 to 125 um	mg/L	0.01	U	**0.03**	NA	**8.6**	0.01	U	NA
Sediment Conc. 125 to 62.5 um	mg/L	**0.1**		**43.15**	NA	**21.76**	0.01	U	NA
Sediment Conc. 62.5 to 3.9 um	mg/L	**157.2**		**148.5**	NA	**175.6**	**135.5**		NA
Sediment Conc. 3.9 to 1 um	mg/L	**26.69**		**28.3**	NA	**38.4**	**30.98**		NA
Sediment Conc. < 1 um	mg/L	**8.12**		**12.06**	NA	**11.75**	**9.33**		NA

Notes

U - Analyte was not detected at or above the reported result.

J- Analyte was positively identified. The reported result is an estimate.

Table 5.6.1b. Analytical Summary – CBSF2 Stormwater Samples

Analyte	Units	SE-01 CBSF2-IN 01-MAR-09	SE-01 CBSF2-OUT 01-MAR-09	Percent Change	SE-02 CBSF2-IN 02-MAR-09	SE-02 CBSF2-OUT 02-MAR-09	Percent Change
pH	std units	**6.57**	**6.57**	NA	**6.67**	**6.66**	NA
Solids, Total Suspended	mg/L	**179**	**72**	59.8	**116**	**79.6**	31.4
Phosphorus, Total	mg-P/L	**1.34**	**0.236**	82.4	**0.28**	**0.236**	15.7
Ortho-phosphate	mg-P/L	**0.014**	**0.011**	21.4	**0.016**	**0.014**	12.5
Copper, Total	ug/L	**26.8**	**16**	40.3	**17.8**	**14.8**	16.9
Copper, Dissolved	ug/L	**2.9**	**3.8**	-31.0	**2.7**	**3.2**	-18.5
Zinc, Total	ug/L	**190**	**79**	58.4	**107**	**80**	25.2
Zinc, Dissolved	ug/L	**11**	**15**	-36.4	**13**	**15**	-15.4
Hardness	mg/L CaCO3	**51**	**21**	NA	**20**	**18**	NA
Sediment Conc. > 500 um	mg/L	**4390**	**2.37**	NA	**25.62**	0.01 U	NA
Sediment Conc. 500 to 250 um	mg/L	**655**	**7.3**	NA	**12.92**	**2.02**	NA
Sediment Conc. 250 to 125 um	mg/L	**3.76**	0.01 U	NA	**19.11**	0.01 U	NA
Sediment Conc. 125 to 62.5 um	mg/L	**27.86**	0.01 U	NA	**35.11**	**3.26**	NA
Sediment Conc. 62.5 to 3.9 um	mg/L	**158.1**	0.01 U	NA	**185.5**	**112.2**	NA
Sediment Conc. 3.9 to 1 um	mg/L	**19.94**	**68**	NA	**21.39**	**14.14**	NA
Sediment Conc. < 1 um	mg/L	**6.35**	**68**	NA	**6.94**	**6.31**	NA

Notes

U - Analyte was not detected at or above the reported result.

J- Analyte was positively identified. The reported result is an estimate.

5.6.2 Sediment Monitoring and Sampling

Sediment depth was monitored to determine average depth in each chamber of the CBSFs. The average depth was converted to volume and mass using the unit dimensions and density data calculated by ARI. Where sampleable quantities of sediment were present, samples were collected and sent to ARI for analysis.

5.6.2.1 Sediment Accumulation Monitoring

The results of the sediment accumulation monitoring are presented in Table 5.6.2.1. The sediment accumulation period for CBSF1 was June 19 to September 23 (100 days) and for CBSF2 was February 10 to September 23 (225 days). The shorter accumulation period for CBSF1 was due to accidental cleaning by the City's contractor.

Table 5.6.2.1. – CBSF Sediment Accumulation Data

Location (chamber)	ID	Sediment Depth (ft)	Sediment Volume (CF)	Wet Sediment Mass (kg)[3]	Dry Sediment Mass (kg)[4]	Total Wet Sed Mass per Unit (kg)	Total Dry Sed Mass per Unit (kg)
CBSF1-Influent	CBSF1-Sed1	0.27	1.08	40.5	15.2	54.6	23.9
CBSF1-Filter	CBSF1-Sed2	0.04	0.31	14.0	8.7		
CBSF1-Effluent	CBSF1-Sed3	0	0	0	0		
CBSF2-Influent	CBSF2-Sed1	1.22	4.92	184.7	69.3	259.3	115.6
CBSF2-Filter	CBSF2-Sed2	0.11	1.65	74.6	46.3		
CBSF2-Effluent	CBSF2-Sed3	0	0	0	0		

The sediment accumulation monitoring measured most, but not all, all of the sediment captured by the units over the accumulation period. The unmeasured portion was captured by the filter cartridges. Due to difficulties quantifying the mass or volume retained in the cartridges, which is considered negligible compared to solids settled in the chambers, the sediment retained in the cartridges was not quantified.

5.6.2.2 Sediment Sampling

The results of sediment samples collected from the two locations are summarized in Table 5.6.2.2. Although there was a measurable amount of "sediment" in CBSF1, it consisted entirely of recently-deposited organic matter from the nearby trees and was estimated to contain less than

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[3] Calculated from wet density of 82.6 and 99.4 lbs/CF from CBSF2 influent and chamber samples, respectively.

[4] Calculated from dry density of 31.0 and 61.7 lbs/CF from CBSF2 influent and chamber samples, respectively

1 percent non-organic matter, so no samples were collected from CBSF1. The lack of sediment in CBSF1 is attributed to the accidental sediment removal on June 19.

Samples were submitted from the influent and filtration chambers of CBSF2. The fines portion (clay to coarse silt) of the grain size analysis was not performed on the influent chamber sample because the sample did not contain the required 5 grams of fines in the pipette portion of the analysis.

Table 5.6.2.2. Analytical Summary - CBSF Sediment Data Summary

Analyte	Units	CBSF2-SED1 23-SEP-09		CBSF2-SED2 23-SEP-09	
Phosphorus, Total	mg/kg	394		162	
Cadmium, Total	mg/kg	0.6		0.4	
Copper, Total	mg/kg	45.6		35.9	
Lead, Total	mg/kg	86		42	
Zinc, Total	mg/kg	287		177	
Diesel Range Hydrocarbons	mg/kg	1200		680	
Motor Oil	mg/kg	2900		3600	
Solids, Total	%	39.8		53.6	
Solids, Total Volatile	%	19.7		8.44	
Gravel	%	18.8		6.7	
Very Coarse Sand	%	17.5		15.8	
Coarse Sand	%	19.4		25.8	
Fine Sand	%	12.8		11.1	
Medium Sand	%	20.3		24.3	
Very Fine Sand	%	4.9		4.9	
Coarse Silt	%	NM		0.4	
Medium Silt	%	NM		5.8	
Fine Silt	%	NM		1.9	
Very Fine Silt	%	NM		1.4	
9-10 Phi Clay	%	NM		0.3	
8-9 Phi Clay	%	NM		0.9	
>10 Phi Clay	%	NM		0.5	
Total Fines	%	6.3	J	11.3	J

Notes:
J- Analyte was positively identified. The reported result is an estimate.
NM - Not measured. Insufficient fines to perform analysis

5.7 Performance Evaluation

Data analysis will be performed in the next annual report when a more robust sample set is obtained.

5.8 Quality Assurance/Quality Control Report

5.8.1 Analytical QA/QC Results

Refer to *Appendix C2 - Analytical QA/QC Report* for a discussion of the QA/QC results.

5.8.2 Field QA/QC Results

5.8.2.1 Flow Monitoring QA/QC Results

Flow data from both the CBSF sites, related to the successful sample events, were reviewed for gaps, sensor drift and outliers. The level sensors were calibrated immediately prior to both sampled storm events and no corrections were necessary for the recorded flow data.

5.8.2.2 Tubing Blanks

Results of the four tubing blank samples are summarized in Table 5.8.2.2. One sample was collected from the sampler tubing at each monitoring station on February 18, 2009 and the samples were analyzed for all of the composite parameters except for particle size distribution, pH and hardness. No parameters were detected with the exception of low levels of total and dissolved copper in the CBSF1-In blank and total phosphorus in the CBSF2-Out blank. The total copper concentration in the CBSF1-In blank was 1.6 µg/L compared to the reporting level of 0.5 ug/L. The total copper concentrations in the CBSF1-In stormwater samples were 30.4 and 30.2 ug/L which are well over 10 times the blank concentration so no action is necessary per USEPA guidelines.

Dissolved copper was detected in the one blank at a concentration of 1.0 µg/L compared to the reporting level of 0.5 ug/L. The dissolved copper concentrations in the CBSF1-In stormwater samples were 4.6 and 3.7 ug/L which are less than five times the blank concentration so dissolved copper data for CBSF1-In are flagged “J”.

The total phosphorus concentration in the CBSF2-Out blank was 0.01 mg-P/L compared to the reporting level of 0.008 mg-P/L. The total phosphorus concentrations in the CBSF2-Out stormwater samples were 0.236 and 0.236 mg-P/L which are well over 10 times the blank concentration so no action is necessary per USEPA guidelines.

Table 5.8.2.2. CBSF Sampler Tubing Blank Data

Analyte	Units	Reporting Limit	CBSF1-IN		CBSF1-OUT		CBSF2-IN		CBSF2-OUT	
Copper, Dissolved	ug/L	0.5	1		0.5	U	0.5	U	0.5	U
Copper, Total	ug/L	0.5	1.6		0.5	U	0.5	U	0.5	U
Ortho-Phosphorus	mg-P/L	0.004	0.004	U	0.004	U	0.004	U	0.004	U
Total Phosphorus	mg-P/L	0.008	0.008	U	0.008	U	0.008	U	0.01	
Zinc, Dissolved	ug/L	4	4	U	4	U	4	U	4	U
Zinc, Total	ug/L	4	4	U	4	U	4	U	4	U

Notes
U – Analyte was not detected at or above the reported result.

5.8.2.3 Sediment Duplicate Samples

Table 5.8.2.3 presents a comparison of the sediment sample collected at CBSF2-Sed1 with the corresponding duplicate sample results and the RPDs. Only the total fines results, of 6.3 and 9.9 percent with an RPD of 44 percent, RPDs exceeds the MQO of 35 percent so the total fines data are flagged ‘J’. It is notable that, of the two samples submitted, only one contained enough material to analyze the total fines fraction so the high RPD is partially due to the low total fines concentration in the sample.

Table 5.8.2.3. CBSF Sampler Tubing Blank Data

Analyte	Units	CBSF2-SED1 Sample 23-SEP-09	CBSF2-SED2 Duplicate 23-SEP-09	Relative Percent Difference %
Gravel	%	18.8	15.3	20.5
Very Coarse Sand	%	17.5	18.1	-3.4
Coarse Sand	%	19.4	18.4	5.3
Medium Sand	%	20.3	20.1	1.0
Fine Sand	%	12.8	13	-1.6
Very Fine Sand	%	4.9	5.2	-5.9
Total Fines	%	6.3	9.9	-44.4
Solids, Total	%	39.8	38	4.6
Solids, Total Volatile	%	19.7	19.45	1.3
Cadmium	mg/kg	0.6	0.6	0.0
Copper	mg/kg	45.6	54	-16.9
Diesel Range Hydrocarbons	mg/kg	1200	1100	8.7
Dry Density	lb/ft3	31	28.7	7.7
Lead	mg/kg	86	78	9.8
Phosphorus, Total	mg/kg	394	409	-3.7
TPH- Motor Oil	mg/kg	2900	2800	3.5
Wet Density	lb/ft3	82.6	77.8	6.0
Zinc	mg/kg	287	264	8.3

5.9 Explanation and Discussion of Results

Data analysis will be performed in the next annual report when a more robust sample set is obtained.

5.10 Hydrologic Management BMP Monitoring Strategy

SPU is implementing a large scale Natural Drainage System (NDS) project in conjunction with the redevelopment project for the High Point neighborhood in West Seattle. Stormwater swales, which are a prominent component of this NDS project, are part of what is termed a "Low Impact Development" (LID) approach to managing stormwater runoff. The goal of the LID approach is to minimize the effect that changes in land use associated with urbanization can have on the natural hydrology within a given catchment. As opposed to conventional stormwater systems that route runoff directly to storm drains, the NDS swales first route runoff through a vegetated/compost amended swale (termed a bioretention swale), slowing runoff and allowing for infiltration into the underlying soils. Excess runoff is then routed to a conventional stormwater conveyance system. The end result is improved stormwater quality and decreased flooding and erosion in downstream receiving waters. The High Point NDS swales, unlike previous NDS swales constructed by SPU, have been constructed to provide shallow surface ponding (3 to 10 inches), with 3 to 4 feet of biorention soil and an underdrain collection system.

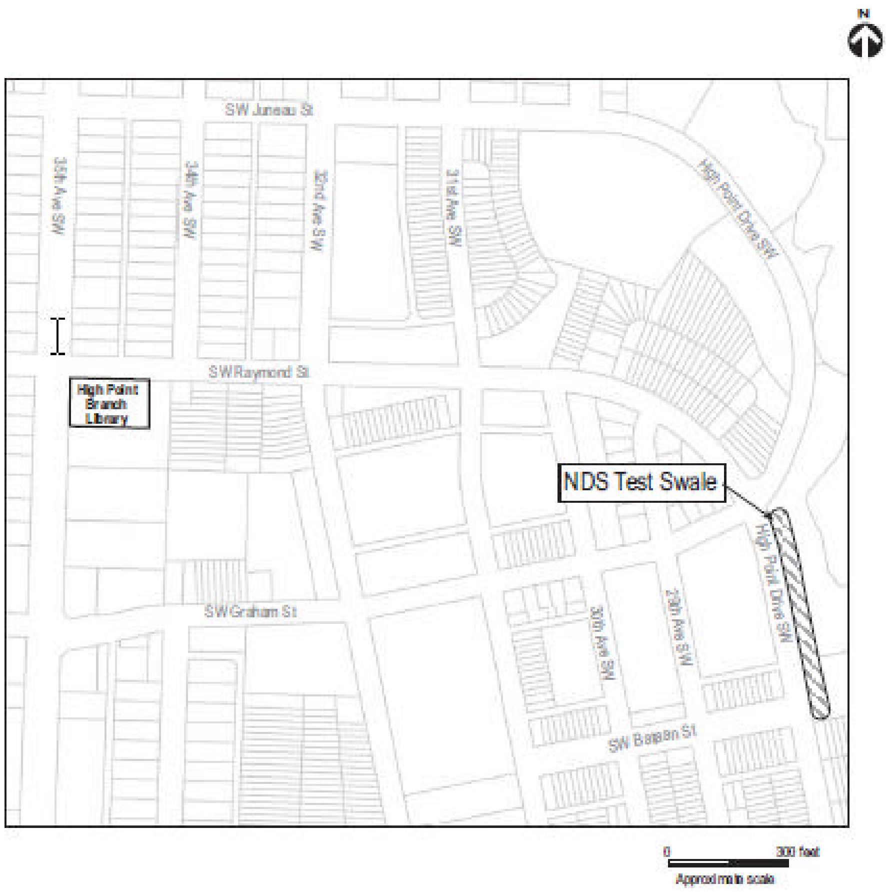
The goal of the High Point NDS flow monitoring was to increase the understanding of the performance effectiveness and potential limitations of NDS swales in reducing storm flows. The performance effectiveness data will provide a basis for NDS design refinements that might be considered to improve performance, and/or reduce installation costs.

SPU hired Herrera Environmental Consultants to conduct hydrologic monitoring of one NDS swale (refered to as the "test swale" - see Figure 5.10a). This monitoring consisted of:

- Implementation of controlled infiltration tests on the swale's surface
- Continuous measurements of ponding depth on the swale's surface
- Continuous measurements of discharge within the swale's underdrain system
- Continuous measurements of precipitation in the immediate vicinity of the swale.

The specific monitoring procedures were implemented in accordance with the Quality Assurance Project Plan (QAPP) for the monitoring program that was submitted to Ecology and approved in December 2007. As described in the QAPP, the monitoring for this project was to be conducted over a three year period beginning in December 2006 and ending in September 2009. However, starting on December 1, 2007, 8-inches of rain fell on the study area over a 74-hour period. The NDS test swale was severely damaged by runoff from a nearby construction site during this storm. The hydrologic monitoring was conducted for the remainder of the 2008 water year but was not continued into the 2009 water year because of the damage. Results of the monitoring were documented in two data reports, *High Point Block-Scale Monitoring Water Year 2007 and 2008 Data Reports*, and summarized below.

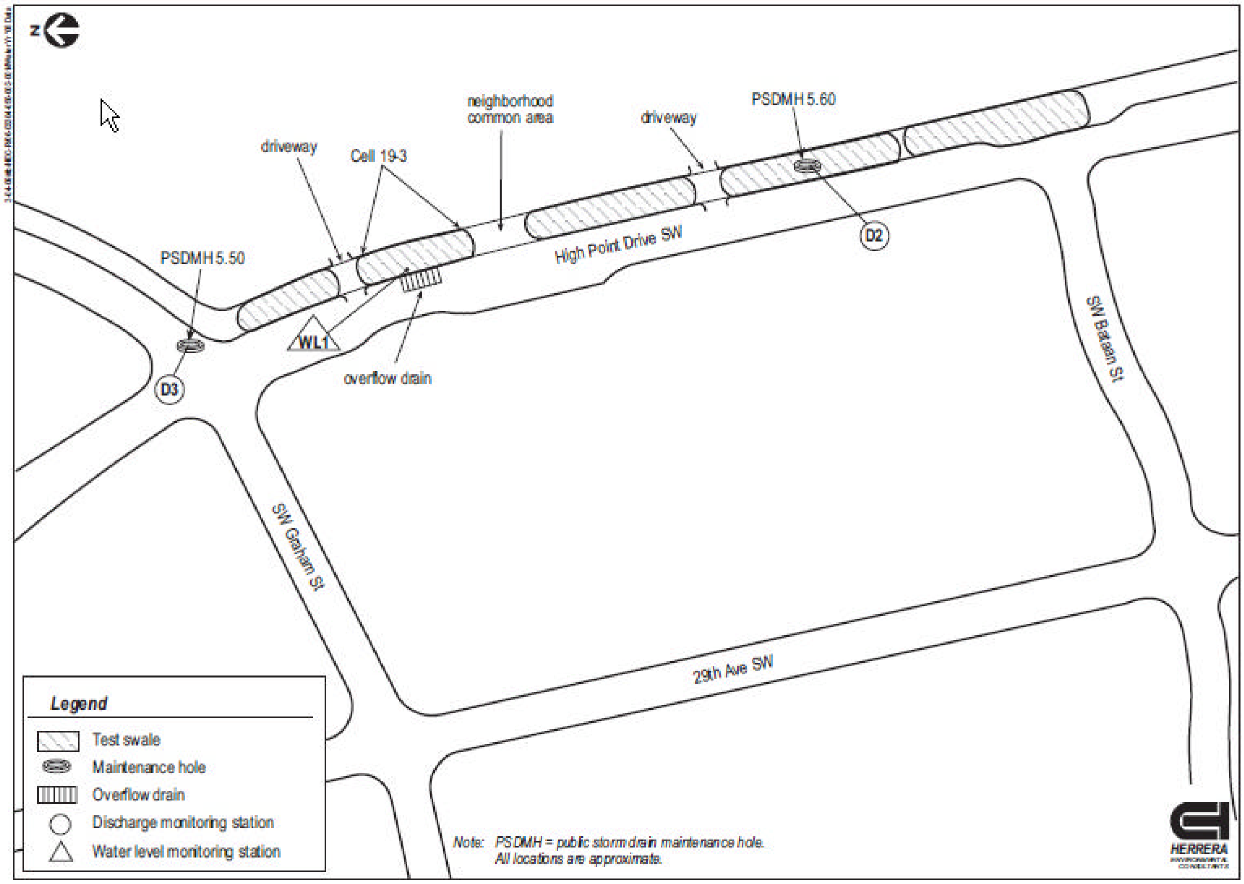
Figure 5.10a. Site Map – High Point NDS Test Swale



Continuous water level data, collected on the surface of the swale using a CSI pressure transducer and data logger, was used to measure the ponding depth. Ponding depth data was collected at one station – WL1. Discharge to the swale's underdrain was collected at two stations – D2 and D3 – using DataGator flow monitors installed in the underdrain. These monitoring stations are shown on Figure 5.10b.

Precipitation was measured by a Hydrologic Services tipping bucket rain gauge on the roof of the Seattle Public Library, High Point Branch located about ¼-mile west of the test swale (Figure 5.10a).

Figure 5.10b. Plan View – High Point Test Swale



5.11 Hydrologic Management BMP Performance

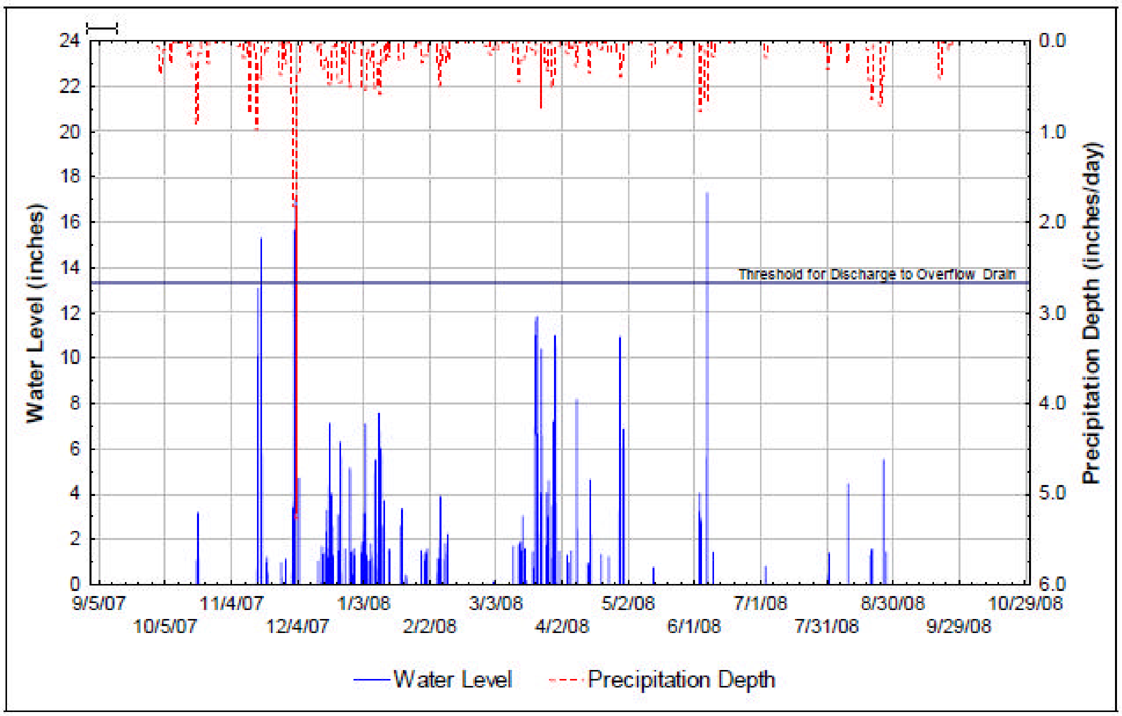
5.11.1 Infiltration Test Results

Measured infiltration rates for the NDS test swale were 4.22 and 6.11 inches/hour from the two controlled infiltration tests performed during the study. These infiltration rates were substantially higher than the rate that was assumed for the design phase of the High Point NDS swales, which was an infiltration rate of 2 inches/hour.

5.11.2 Ponding Depth Monitoring Results

The frequency of ponding within the NDS test swale increased markedly in water year 2008 relative to water year 2007 due to a combination of factors. In 2007, ponding within the NDS test swale was rarely observed. At no time did water levels within the NDS test swale exceed the depth threshold that would result in a discharge to the overflow drain. However, field observations indicated that the NDS test swale was severely damaged by construction-related runoff during the December 1, 2007 storm event. Sediment deposited with this runoff likely decreased surface infiltration rates and contributed to the increased ponding in the NDS test swale during water year 2008. Additionally, the drainage basin contributing to the NDS test swale expanded due to new roadway and housing construction that occurred over the spring and summer of 2007. Because of this increase in contributing basin area, the rainfall/runoff relationship for the NDS test swale changed between water years 2008 and 2007. This change likely also contributed to the increased ponding observed in the NDS test swale during water year 2008. Despite the increased frequency of ponding during water year 2008, water levels within the NDS test swale exceeded the depth threshold (13.32 inches) that results in a discharge to the overflow drain on only three occasions. Ponding data for WY2008 is presented in Figure 5.11.2.

Figure 5.11.2. Ponding Depth Measures WY2008– High Point Test Swale

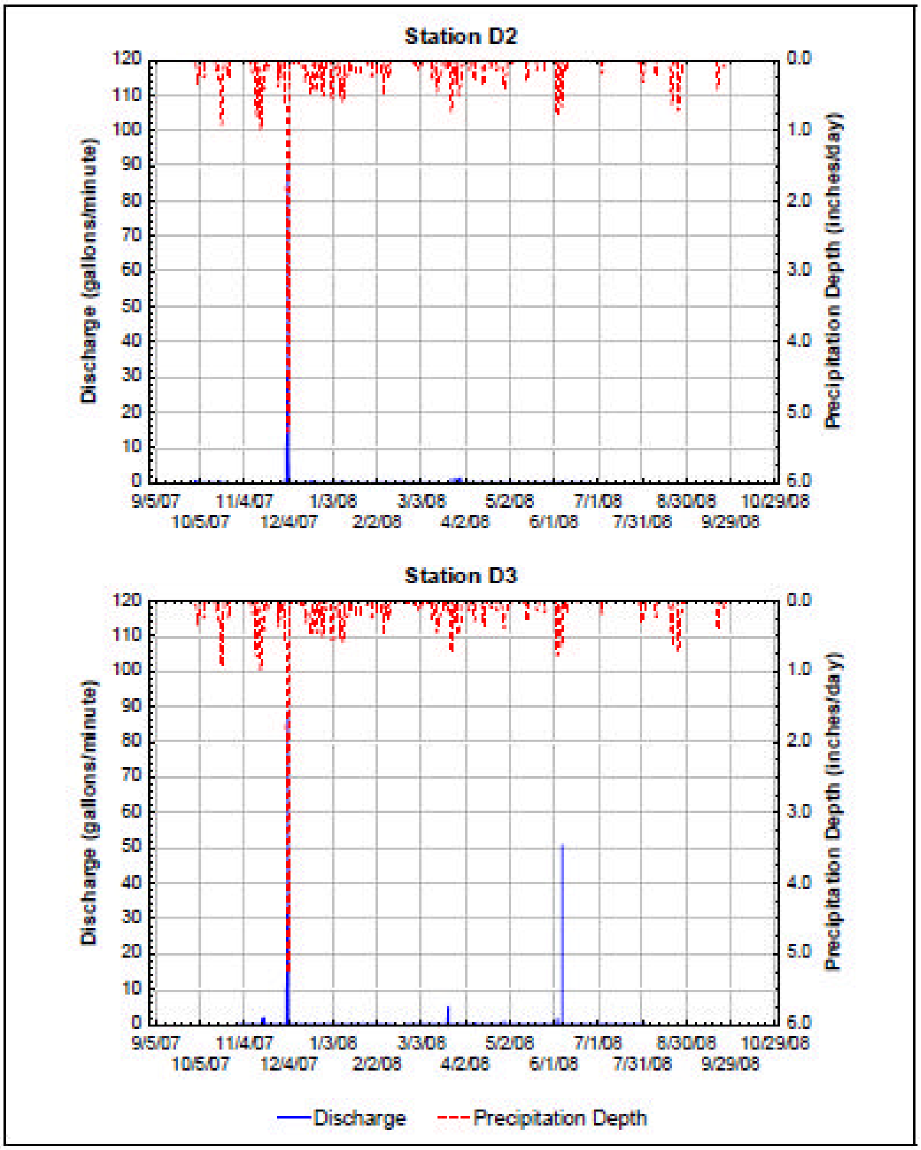


5.11.3 Discharge Monitoring Results

Discharge monitoring was performed at two stations, identified as D2 and D3, within the test swale's underdrain (Figure 5.10b).

In general, the NDS test swale at High Point effectively infiltrated all runoff from storm events with precipitation totals less than the 6-month, 24-hour, and 2-year, 24-hour design storms for water quality and flow control, respectively. Except for the December 1, 2007, storm event, flow volumes and peak discharge rates measured in the underdrain system also remained fairly low even when measured precipitation totals exceeded the corresponding thresholds for these design storms. The low discharge rates observed from the underdrain system of the test swale are likely influenced by underlying native soils that are relatively permeable (i.e., gravelly sand/sandy gravel and slightly fine to medium sand). Discharge data for WY2008 is presented graphically on Figure 5.11.3b.

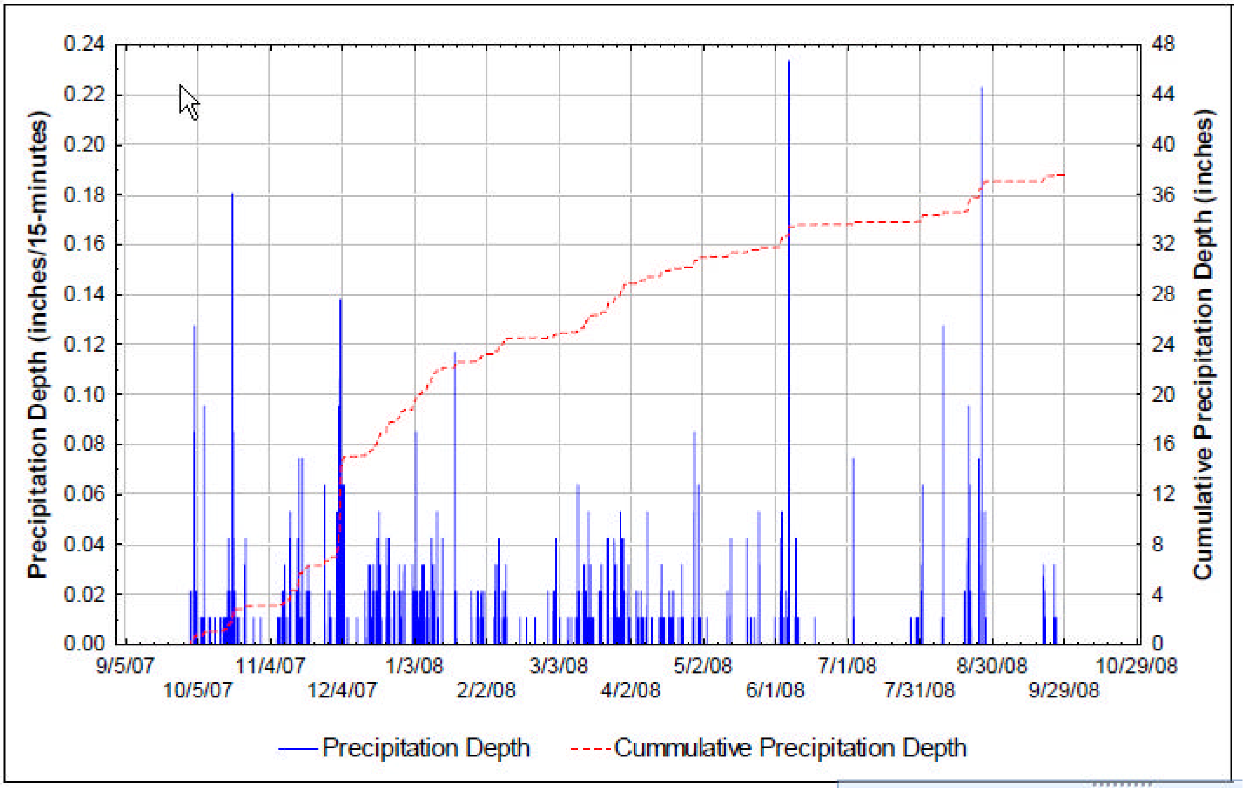
Figure 5.11.3b. Discharge Data – Stations D2 and D3 – WY2008



5.11.4 Precipitation Monitoring Results

Continuous hydrologic data collected during water year 2008 indicated that precipitation totals for four storm events exceeded the threshold corresponding to the 6-month, 24-hour design storm. The precipitation total for one storm also exceeded the threshold corresponding to the 2-year, 24-hour design storm. However, the total duration of all of these storms was longer than 24 hours. Precipitation data for WY2008 is displayed on Figure 5.11.4.

Figure 5.11.4. High Point Precipitation Data – WY2008



5.12 Future Modeling Work

The original intention was to use data obtained from the test swale flow monitoring to develop an algorithm for bioretention swales with an underdrain that can be used by the Western Washington Hydrology Models (WWHM) and MSG Flood models. These two models are suggested in the City's Directors' Rules as appropriate for calculation of volumes for estimating the hydrology of surface water runoff. However, EPA is in the process of revising their Stormwater Management Model (SWMM) to incorporate LID techniques. One of revisions is a new algorithm for bioretention swales with an underdrain. SPU staff are working with EPA to validate the new algorithm in a beta version of SWMM using the flow data collected from High Point. Because of this revision to SWMM, SPU is considering the need to develop a stand-alone algorithm for the WWHM and MSG Flood if the SWMM model, which is free to the public, contains this tool. The results of the SWMM model validations and the algorithm for WWHM and MSG Flood, if produced, will be included in a future report.

Appendix C.1: MEMORANDUM OF AGREEMENT BETWEEN THE CITY OF SEATTLE, SEATTLE PUBLIC UTILITIES AND WASHINGTON STATE UNIVERSITY FOR BMP EFFECTIVENESS MONITORING S8.F.

13F-3743-5328(0327)
0182463

MEMORANDUM OF AGREEMENT NO. DA2009-39
BETWEEN
THE CITY OF SEATTLE
AND
WASHINGTON STATE UNIVERSITY
FOR
BIORETENTION SOIL TESTING AND BIORETENTION FACILITY STORMWATER MONITORING

THIS MEMORANDUM OF AGREEMENT ("Agreement") is made by and between the City of Seattle ("City"), a municipal corporation of the State of Washington, acting through its Seattle Public Utilities Department ("SPU"), and Washington State University (WSU) ("Provider").

1. **EFFECTIVE DATE** This Agreement shall be effective on the date it is signed by both parties ("Effective Date").

2. **TERM OF AGREEMENT** The Provider is retroactively authorized to have begun work on the Scope of Work of this Agreement as of September 1, 2009. This retroactive authorization includes with it the Provider's obligation and agreement to the terms and conditions of this Agreement as they may apply to any work performed by the Provider prior to the execution of this Agreement and expire ("Completion Date") as stated in ATTACHMENT B – TERMS AND CONDITIONS, attached hereto and made a part of this Agreement.

3. **SCOPE OF SERVICES** Provider shall perform the services described in ATTACHMENT A – SCOPE OF SERVICES AND SCHEDULE, (the "Project") attached hereto and made a part of this Agreement. Digital Materials: Provider shall provide digital materials, including reports, data, maps, graphs and photos that are compatible with current Seattle Public Utilities file and data formats.

   Copyright in all material created by Provider and paid for by City as part of this agreement shall be the property of the State of Washington. Both City and Provider may use these materials, and permit others to use them, for any purpose consistent with their respective missions as agencies of the State of Washington. This material includes, but is not limited to: books, computer programs, documents, films, pamphlets, reports, sound reproductions, studies, surveys, tapes, and/or training materials. Material which Provider provides and uses to perform this agreement but which is not created for or paid for by City shall be owned by Provider or such other party as determined by Copyright Law and/or Provider's internal policies; however, for any such materials, Provider hereby grants (or, if necessary and to the extent reasonably possible, shall obtain and grant) a perpetual, unrestricted, royalty free, non-exclusive license to City to use the material for City internal purposes.

4. **BILLING AND PAYMENT** Provider shall submit invoices to SPU and SPU shall pay Provider up to the Total Dollar Amount, all in accordance with ATTACHMENT B – TERMS AND CONDITIONS, attached hereto and made a part of this Agreement.

5. **NO JOINT UNDERTAKING** Nothing in this Agreement shall be construed to make or render the parties hereto partners, joint ventures or participants in any joint undertaking whatsoever.

6. **SCHEDULE** The parties shall comply with the schedule appearing in ATTACHMENT A – SCOPE OF SERVICES AND SCHEDULE. Compliance with the schedule is important to successful completion of the Project. The parties shall promptly and regularly notify each other of any occurrences affecting the schedule and shall attempt to agree upon an amended schedule if necessary or appropriate, to be effective upon execution of an Amendment to this Agreement in accordance with Section 19. Notwithstanding, failure to comply with the schedule shall constitute a Default and be grounds for termination unless or until any Amendment is executed.

7. **NO THIRD PARTY BENEFICIARIES** This Agreement is entered into solely for the mutual benefit of the parties hereto. This Agreement is not entered into with the intent that it shall benefit either party's agents, assigns, consultants or contractors, and no such other person or entity shall be a third party beneficiary of this Agreement.

8. **PUBLICATION** Each party may publish the results of the Project, and may acknowledge its respective role in and support of the Project.

9. **INDEMNIFICATION** To the extent permitted by Washington law, the Provider does hereby defend, indemnify and hold the City and its employees and agents harmless from all losses, liabilities, claims, actions or damages arising out of the Provider's performance of the services contemplated by this Agreement to the extent attributable to the negligent acts or omissions by the Provider, its agents or employees.

10. **INSURANCE** No insurance certification is required. However, Agency agrees that it will maintain premises and vehicle liability insurance in force with coverages and limits of liability that would generally be maintained by similarly situated Agencies and workers

City of Seattle

compensation insurance as may be required by Washington State statutes.

11. **ASSIGNMENT** This Agreement shall not be assigned in whole or in part by either party without the prior written approval of the other party.

12. **COMPLIANCE WITH LAW** The parties to this Agreement shall comply with all Federal, State, and local laws and ordinances.

13. **DEFAULT AND TERMINATION** This Agreement may be terminated by either party hereto upon written notice delivered to the other party at least thirty (30) days prior to the intended date of termination. By such termination, neither party may nullify obligations already incurred prior to the date of termination. In the event of Termination for Convenience of this Agreement by City, City shall pay all reasonable costs and non-cancelable obligations incurred by Provider as of the date of termination.

14. **CITY ABILITY TO TERMINATE DUE TO LACK OF APPROPRIATIONS** It is understood that funds for the payment of the services to be provided hereunder are allocated out of monies received by the City from tax sources and/or other governmental entities and that funding for the services to be provided hereunder may be decreased or eliminated by executive or legislative action. Therefore, the parties agree that notwithstanding any other provision of this Agreement, if said funding is decreased or eliminated, or if in the judgment of the executive or legislative authority of the City, continuation of this Agreement would be an unnecessary expenditure of public funds, then the City may terminate this Agreement without further obligation to Provider after the City has given Provider written notice of such termination at least thirty (30) days prior to the effective date of termination and documentation of such executive or legislative action. City shall pay all reasonable costs and non-cancelable obligations incurred by Provider as of the date of termination.

15. **SEVERABILITY** If any provision of this Agreement or any provision of any law, rule or document incorporated by reference into this Agreement shall be held invalid, such invalidity shall not affect the other provisions of this Agreement which legally can be given effect without the invalid provision. To this end, the provisions of this Agreement are declared to be severable.

16. **APPLICABLE LAW** This Agreement shall be governed by and construed in accordance with the laws of the State of Washington. The jurisdiction and venue of any action brought hereunder shall be in the Superior Court of King County.

17. **AUDIT** During the progress of the Project and for a period of no less than three years from the Completion Date, each party will keep and make available for each other's inspection and audit all records pertaining to the Project, including accounting records. The parties shall furnish to each other copies of these records upon request and shall maintain the records in accordance with work order accounting procedures prescribed by the Division of Municipal Corporations of the State Auditor's Office.

18. **NOTICES** All notices to the parties to this Agreement shall be in writing and addressed to those persons identified on ATTACHMENT B – TERMS AND CONDITIONS.

19. **AMENDMENT** This MOA shall not be amended or modified except in writing and signed by both parties hereto.

20. **ENTIRE AGREEMENT** This Agreement and any written attachments or Amendments thereto, constitutes the complete contractual agreement of the parties and any oral representations or understandings not incorporated herein are excluded.

WASHINGTON STATE UNIVERSITY
PO Box 643140, Pullman, WA 99164-3140

By: Bruce R. Myers 11/5/09
Signature Date

Dan Nordquist
Director, Authorized Inst. Official
[Type or Print Name]
Office of Grant and Research Development
[Type or Print Title]

SEATTLE PUBLIC UTILITIES
The City of Seattle

By: [signature] Acting Director 11/12/09
Signature Date

NANCY AHERN, DEPUTY DIRECTOR

By: Ray Hoffman 11/19/09
Signature Date

RAY HOFFMAN, ACTING DIRECTOR

ATTACHMENTS:
A – SCOPE OF SERVICES AND SCHEDULE
B – TERMS AND CONDITIONS
C – BUDGET DETAILS

Appendix C.2: ANALYTICAL DATA – QUALITY ASSURANCE / QUALITY CONTROL REPORT

This Analytical Data Quality Assurance/Quality Control (QA/QC) Report addresses analytical data collected for both the Stormwater Characterization (S8.D) and Catch Basin Stormwater BMP (S8.F) projects.

All laboratory data packages received included a hardcopy report and an electronic data deliverable (EDD). The laboratory case narratives were reviewed for quality control issues and corrective action taken for each sample delivery group. The data were evaluated for required methods, holding times, reporting limits, accuracy, precision, and blank contamination.

Each EDD was imported into a review template where deviations from the MQOs were identified and associated samples were qualified accordingly. The following tables describe the details of this review.

Stormwater Characterization – Water & Sediment
Analytical Methods & Reporting Limits

The following tables describes the method the laboratory performed, the method nomenclature the laboratory used on the data reports, the method described in SPU's QAPP and the method Ecology has accredited the lab to perform. The comment section addresses any areas of non-conformance. Reporting limits represent the minimum value the laboratory is able to report. Reporting limits can vary by individual samples, particularly for sediments where the quantity and dilution analyzed affect the minimum detectable value.

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
Bacteria	Fecal coliform bacteria	CFU/100 mL	SM9222D	SM9222D	SM 9221E	SM9222D	4	Membrane Filtration was alternatively performed.
Total Petroleum Hydrocarbons (TPH)	Diesel Range Organics - Diesel	mg/L	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	0.25	

Stormwater Characterization – Water

Analyte Group	Parameter	Units	Analytical Method Performed	Analytical Method Reported	Analytical Method in QAPP	Lab's Ecology Accreditation	Lab Report Limit	Comments
	Diesel Range Organics - Oil						0.5	
	Gas Range Organics	mg/L	NWTPH-Gx	NWTPH-Gx	NWTPH-Gx	NWTPH-Gx	0.25	
Conventional	Biological Oxygen Demand (BOD5)	mg/L	SM5210-B	EPA405.1	SM5210-B	SM5210-B	3	Method reported is an old EPA number for Equivalent method
	Chloride	mg/L	EPA325.2 SM4110-B	EPA 325.2	SM4110-B	SM4110-B	1	EPA325.2 was run in error by the Lab. Corrective action was taken.
	Conductivity (Specific conductance)	umho/cm @ 25°C	SM2510-B	EPA120.1	SM2510-B	EPA2120.1 & SM2510-B	1	methods are equivalent per 40 CFR 136 & both are Listed in Appendix 9
	Hardness (total)	mg/L $CaCO^3$	SM2340-B	SW6010B	SM2340-B or C	SM2340-B	0.33	Method reported is the analytical procedure for the SM2340-B
	pH	S.U.	EPA 150.2	EPA 150.2	EPA 150.2	EPA9045	0.01	Equivalent Electrometric method
	Surfactants	mg/L	SM 5540-C	SM 5540-C	SM 5540-C	SM 5540-C	0.025	
	Total Suspended Solids (TSS)	mg/L	SM2540-D	EPA160.2	SM2540-D	SM2540-D	1	Method reported is an old EPA number for Equivalent method

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
	Turbidity	NTU	SM2130-B	EPA180.1	SM2130-B	EPA180.1 & SM2130-B	0.025	methods are equivalent per 40 CFR 136 & both are Listed in Appendix 9
Metals (dissolved & total)	Cadmium	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.2	
	Copper	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.5	
	Lead	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	1	
	Mercury[1]	ug/L	NA	NA	EPA 1631E	EPA245.1	0.1	Mercury was not analyzed for water in WY2009
	Zinc	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	4	
Nutrients	Nitrate-nitrite	mg/L	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2	0.01	
	Nitrogen, Total Kjeldahl (TKN)	mg/L	EPA351.4	EPA351.4	EPA 351.2		0.6	.
	Orthophosphate	as P mg/L	SM4500-P E	EPA365.2	SM4500-P E	SM4500-P E	0.004	Method reported is an old EPA number for Equivalent method
	Phosphorus, Total	as P mg/L	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	0.008	Method reported is an old EPA number for Equivalent method
Semi Volatile Organic Compounds (SVOCs)	Pentachlorophenol (fungicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.5	
	Polycyclic aromatic hydrocarbons (PAHs)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.1	

Stormwater Characterization – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
	Phthalates	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	1	
Pesticides, Chlorinated	2,4-D (herbicide)	ug/L	SW-846 8151	SW-846 8151	SW-846 8151	SW-846 8151	1	
	MCPP (herbicide)	ug/L	SW-846 8151	SW-846 8151	SW-846 8151	SW-846 8151	250	
	Triclopyr (herbicide)	ug/L	EPA8321B	EPA8321B	SW-846 8151	EPA8321B	0.08	
Pesticides, Organo-chlorine	Dichlobenil (herbicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.1	
Pesticides, Organo-nitrogen	Prometon (herbicide)	ug/L	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	SW-846 8270D SIM	0.3	
Pesticides, Organo-phosphorus	Chloropyrifos (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.08	
	Diazinon (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.08	
	Malathion (insecticide)	ug/L	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	0.4	

During the QA/QC review, it was determined that the contract lab (ARI) analyzed samples using a current analytical method but reported the method as an identical, but older method name/number. The deviations between the methods performed and the methods reported are displayed in the above table. In discussions with Stewart M. Lombard, Lab Accreditation Unit Supervisor, Department of Ecology, it was confirmed that the chemistries and analytical techniques used are identical between the analytical methods performed and the analytical methods reported for the parameters listed in the following table.

Comparison of Methods Performed to Methods Reported

Parameter	Analytical Method Performed	Analytical Method Reported	Analytical Technique
BOD	SM5210-B	EPA405.1	Potentiometric
Hardness	SM2340-B	SW6010B	ICP-calculation
TSS	SM2540-D	EPA160.2	Gravimetric
Orthophosphate	SM4500-P E	EPA365.2	Colorimetric
Phosphorous, Total	SM4500-P E	EPA365.2	Colorimetric

As a result of the QA/QC review, ARI has been directed by Ecology to discontinuing reporting data using the old method numbers.

For the chloride analysis, the EPA Method 325.2 (colorimetric) was erroneously performed on some samples. This error was corrected and subsequent analyses were performed by Ion Chromatography (Method 300.0). Method 300.0 is equivalent to SM4110-B.

During the QA/QC review, it was discovered that ARI performed the fecal coliform analysis using the membrane filtration technique (SM9222D). The method listed in the QAPP was multiple tube fermentation (SM9221E). While these two methods utilize different analytical techniques, we currently feel that method performed (SM9222D) is preferable because membrane filtration provides direct enumeration of bacteria concentrations.

During the review, it was discovered that ARI performed the TKN analysis using the potentiometric method (EPA351.4). The method listed in the QAPP is the colorimetric method (EPA351.2). ARI discovered this error and have since started to use the correct method.

For trichlopyr, Pacific Agricultural Labs (subcontracted by ARI) could only achieved the required, lower reporting limit using method EPA8321B, which they are accredited for by Ecology. We elected to use this method, which was not originally listed in our QAPP, to achieve the lower reporting limit.

Stormwater Characterization – Sediment								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
Conventional	Total solids	%	SM2540B	EPA160.3	EPA160.3 or SM2540 B	SM2540B	0.01%	Method reported is an old EPA number for Equivalent method
	Grain size		NA	(PSEP 1997) or ASTM F312-97 or ASTM D422	(PSEP 1997) or ASTM F312-97 or ASTM D422	PSEP & ASTMD422		Qualitative analysis was performed due to insufficient volume.
	Total organic carbon	%	SM5310 B	Pumb81TC	EPA 9060 or SM5310 B,C, or D	EPA 9060 & SM5310 B,C, or D	0.2	Plumb81TC is identical to 5310B (Combustion-IR)
Metals	Cadmium	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	0.5	
	Copper	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	1	
	Lead	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	2	
	Mercury	mg/kg	SW-846 7471A	SW-846 7471A	SW-846 7471A	SW-846 7471A	0.05	
	Zinc	mg/kg	EPA 200.8	EPA 200.8	EPA 200.8 or 6020	EPA 200.8	10	
Persistent Organic Compounds	Polychlorinated biphenyls (PCBs)	ug/kg	SW-846 8082	SW-846 8082	SW-846 8082	SW-846 8082	100	
Semivolatile Organic Compounds	Pentachlorophenol (herbicide)	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	100	
	Phenols	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	20-200	
	phthalates	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	70	
	Polycyclic aromatic hydrocarbons (PAHs)	ug/kg	SW-846 8270	SW-846 8270	SW-846 8270	SW-846 8270	20-100	

Stormwater Characterization – Sediment								
Analyte Group	Parameter	Units	Analytical Method Performed	Analytical Method Reported	Analytic al Method	Lab's Ecology Accreditation	Lab Report	Comments
Pesticides, Organophosphorus	Diazinon	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	50	
	Malathion	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	25	
	Chloropyrifos	ug/kg	SW-846 8270D	SW-846 8270D	SW-846 8270D	SW-846 8270D	25	

Holding Times:

The following samples were analyzed past the prescribed holding times.

Sample ID	Date/Time	Method Code	Validation Qualification Reason
R1	9/21/2009 10:20	EPA160.3	Analyzed Past holding Time (8 days)
C1	9/21/2009 11:40	EPA160.3	Analyzed Past holding Time (8 days)
I1	9/21/2009 14:10	EPA160.3	Analyzed Past holding Time (8 days)
TUBING_PTFE	2/20/2009 11:35	SW8270DSIM	Samples extracted Past 7 days
TUBING_PTFE	2/23/2009 14:20	SW8270DSIM	Samples extracted Past 7 days

The Total Solids analysis for the 9/21/2010 sediment samples was performed one day past the holding time due to some questions the laboratory had in prioritizing the analyte list due to insufficient quantity. This has been resolved and no future delays are anticipated. All results for samples that were analyzed past holding time but within two times the holding time were qualified as estimated.

The tubing blank samples were re-extracted and re-analyzed due to a failed laboratory control sample during the first analysis. This re-analysis caused the re-extraction to take place after the required holding time. Results for these samples were qualified as estimated.

Method Blank Report

Parameter	Reported Result	Lab Qualifier	Units	Reporting Limit (RL)	Qualification Action
Diethylphthalate	23		ug/kg	20	No action - Assoc. samples <RL
bis(2-Ethylhexyl)phthalate	9		ug/L	1	No action - Assoc. samples <RL

No sample results were qualified, as all associated sample were less than the method reporting limit.

Accuracy Checks

Parameter	Sample ID	Matrix	Analysis Type	Units	Recovery check
2,4,5-Trichlorophenol	R1	SED	MS	ug/kg	LOW
2,4,6-Trichlorophenol	R1	SED	MS	ug/kg	LOW
			MSD	ug/kg	LOW
2,4-Dichlorophenol	R1	SED	MS	ug/kg	LOW
2-Chlorophenol	R1	SED	MS	ug/kg	LOW
			MSD	ug/kg	LOW
2-Nitrophenol	R1	SED	MS	ug/kg	LOW
Acenaphthene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Anthracene	R1	SED	MSD	ug/kg	HIGH
Benzo(a)anthracene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Benzo(a)pyrene	NPDES-LAB-QC	DI	BS	ug/L	HIGH
	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Benzo(b)fluoranthene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Benzo(g,h,i)perylene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Benzo(k)fluoranthene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Butylbenzylphthalate	R1	SED	MS	ug/kg	LOW
			MSD	ug/kg	LOW
Chlorpyrifos	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Chrysene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Copper	C1	SED	MS	mg/kg	LOW
d10-2-Methylnaphthalene	R1	STORMW	N	ug/L	LOW
d4-2-Chlorophenol	R1	SED	MS	ug/kg	LOW
	C1	SED	MS	ug/kg	LOW
	I1	SED	MS	ug/kg	LOW
Dibenz(a,h)anthracene	NPDES-LAB-QC	DI	BS	ug/L	HIGH
	R1	SED	MSD	ug/kg	HIGH

Parameter	Sample ID	Matrix	Analysis Type	Units	Recovery check
Diethylphthalate	R1	SED	MS	ug/kg	LOW
			MSD	ug/kg	LOW
Dimethylphthalate	R1	SED	MS	ug/kg	LOW
Di-n-Butylphthalate	R1	SED	MS	ug/kg	LOW
Fluoranthene	R1	SED	MS	ug/kg	HIGH
Fluorene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Indeno(1,2,3-cd)pyrene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Lead	C1	SED	MS	mg/kg	LOW
Phenanthrene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Pyrene	R1	SED	MS	ug/kg	HIGH
			MSD	ug/kg	HIGH
Triclopyr	NPDES-LAB-QC	DI	BS	ug/L	HIGH
			BD	ug/L	HIGH
Zinc	C1	SED	MS	mg/kg	LOW

Table of Qualified Data

The following table lists data that was qualified and the reason for the qualification.

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
1-Methylnaphthalene	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
2,4,5-Trichlorophenol	C1	9/21/2009 11:40	SED	920	UJ	MS/MSD Rec < LCL
	I1	9/21/2009 14:10	SED	900	UJ	MS/MSD Rec < LCL
	R1	9/21/2009 10:20	SED	600	UJ	MS/MSD Rec < LCL
2,4,6-Tribromophenol	TUBING_PTFE	2/20/2009 11:35	DI	12.6	J	Samples extracted Past 7 days
		2/23/2009 14:20	DI	12.3	J	Samples extracted Past 7 days
2,4,6-Trichlorophenol	C1	9/21/2009 11:40	SED	920	UJ	MS/MSD Rec < LCL
	I1	9/21/2009 14:10	SED	900	UJ	MS/MSD Rec < LCL
	R1	9/21/2009 10:20	SED	600	UJ	MS/MSD Rec < LCL

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
2,4-Dichlorophenol	C1	9/21/2009 11:40	SED	920	UJ	MS Recovery < LCL
	I1	9/21/2009 14:10	SED	900	UJ	MS Recovery < LCL
	R1	9/21/2009 10:20	SED	600	UJ	MS Recovery < LCL
2-Chlorophenol	C1	9/21/2009 11:40	SED	180	UJ	MS/MSD Rec < LCL
	I1	9/21/2009 14:10	SED	180	UJ	MS/MSD Rec < LCL
	R1	9/21/2009 10:20	SED	120	UJ	MS/MSD Rec < LCL
2-Methylnaphthalene	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
2-Nitrophenol	C1	9/21/2009 11:40	SED	920	UJ	MS Rec. < LCL
	I1	9/21/2009 14:10	SED	900	UJ	MS Rec. < LCL
	R1	9/21/2009 10:20	SED	600	UJ	MS Rec. < LCL
4-Nitrophenol	C1	9/21/2009 11:40	SED	920	UJ	MS/MSD RPD Exceeded
	I1	9/21/2009 14:10	SED	900	UJ	MS/MSD RPD Exceeded
	R1	9/21/2009 10:20	SED	600	UJ	MS/MSD RPD Exceeded
Acenaphthene	C1	9/21/2009 11:40	SED	62	J	MS Recovery > UCL
	I1	9/21/2009 14:10	SED	62	J	MS Recovery > UCL
	NPDES-LAB-QC	1/1/1899 00:00	SED	5	UJ	MS Recovery > UCL
				83.5	J	MS Recovery > UCL
	R1	9/21/2009 10:20	SED	90	J	MS Recovery > UCL
				439	J	MS Recovery > UCL
				465	J	MS Recovery > UCL
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Acenaphthylene	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Anthracene	C1	9/21/2009 11:40	SED	200	J	MSD Rec. > UCL
	I1	9/21/2009 14:10	SED	130	J	MSD Rec. > UCL
	R1	9/21/2009 10:20	SED	94	J	MSD Rec. > UCL
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Benzo(a)anthracene	C1	9/21/2009 11:40	SED	810	J	MS/MSD Rec. >UCL
	I1	9/21/2009 14:10	SED	580	J	MS/MSD Rec. >UCL

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
	R1	9/21/2009 10:20	SED	430	J	MS/MSD Rec. >UCL
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Benzo(a)pyrene	C1	9/21/2009 11:40	SED	930	J	MS/MSD Rec. >UCL
	I1	9/21/2009 14:10	SED	760	J	MS/MSD Rec. >UCL
	R1	9/21/2009 10:20	SED	480	J	MS/MSD Rec. >UCL
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Benzo(b)fluoranthene	C1	9/21/2009 11:40	SED	1300	J	MS/MSD Rec. >UCL & RPD exceeded
	I1	9/21/2009 14:10	SED	730	J	MS/MSD Rec. >UCL & RPD exceeded
	R1	9/21/2009 10:20	SED	750	J	MS/MSD Rec. >UCL & RPD exceeded
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Benzo(g,h,i)perylene	C1	9/21/2009 11:40	SED	1000	J	MS/MSD Rec. >UCL & RPD exceeded
	I1	9/21/2009 14:10	SED	900	J	MS/MSD Rec. >UCL & RPD exceeded
	R1	9/21/2009 10:20	SED	480	J	MS/MSD Rec. >UCL & RPD exceeded
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Benzo(k)fluoranthene	C1	9/21/2009 11:40	SED	1100	J	MS/MSD >UCL & RPD exceeded
	I1	9/21/2009 14:10	SED	880	J	MS/MSD >UCL & RPD exceeded
	R1	9/21/2009 10:20	SED	490	J	MS/MSD >UCL & RPD exceeded
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Butylbenzylphthalate	C1	9/21/2009 11:40	SED	400	UJ	MS/MSD Rec. <LCL
	I1	9/21/2009 14:10	SED	890	UJ	MS/MSD Rec. <LCL
	R1	9/21/2009 10:20	SED	120	UJ	MS/MSD Rec. <LCL
Chlorpyrifos	I1	9/21/2009 14:10	SED	710	UJ	MS/MSD Rec > UCL

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
	R1	9/21/2009 10:20	SED	330	UJ	MS/MSD Rec > UCL
Chrysene	C1	9/21/2009 11:40	SED	1300	J	MS/MSD Rec >UCL & RPD Exceed
	I1	9/21/2009 14:10	SED	1100	J	MS/MSD Rec >UCL & RPD Exceed
	R1	9/21/2009 10:20	SED	750	J	MS/MSD Rec >UCL & RPD Exceed
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Copper	C1	9/21/2009 11:40	SED	239	J	RPD & Rec for batch QC (C1) failed
				260	J	RPD & Rec for batch QC (C1) failed
				361	J	RPD & Rec for batch QC (C1) failed
	I1	9/21/2009 14:10	SED	131	J	RPD & Rec for batch QC (C1) failed
	R1	2/25/2009 15:54	STORM W	5	J	Tubing Blank contamination
		3/5/2009 12:11	STORM W	3	J	Tubing Blank contamination
		9/21/2009 10:20	SED	81	J	RPD & Rec for ba tch QC (C1) failed
d10-2-Methylnaphthalene	R1	2/25/2009 15:54	STORM W	0.99	J	Surrogate recovery < LCL
	TUBING_PTFE	2/20/2009 11:35	DI	2.47	J	Samples extracted Past 7 days
		2/23/2009 14:20	DI	2.66	J	Samples extracted Past 7 days
d14-Dibenzo(a,h)anthracene	TUBING_PTFE	2/20/2009 11:35	DI	2.87	J	Samples extracted Past 7 days
		2/23/2009 14:20	DI	3.09	J	Samples extracted Past 7 days
Dibenz(a,h)anthracene	C1	9/21/2009 11:40	SED	340	J	MSD Rec. > UCL
	I1	9/21/2009 14:10	SED	280	J	MSD Rec. > UCL
	R1	2/25/2009 15:54	STORM W	0.1	UJ	MSD Rec. > UCL
		3/5/2009 12:11	STORM W	0.1	UJ	MSD Rec. > UCL
		9/21/2009 10:20	SED	160	J	MSD Rec. > UCL
	TUBING_PTFE	2/20/2009 11:35	DI	0.1	UJ	MSD Rec. > UCL
						Samples extracted Past 7 days, MSD Rec. > UCL
		2/23/2009 14:20	DI	0.1	UJ	MSD Rec. > UCL

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
						Samples extracted Past 7 days, MSD Rec. > UCL
Dibenzofuran	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Diethylphthalate	C1	9/21/2009 11:40	SED	180	UJ	MS/MSD Rec<LCL
	I1	9/21/2009 14:10	SED	180	UJ	MS/MSD Rec<LCL
	R1	9/21/2009 10:20	SED	120	UJ	MS/MSD Rec<LCL
Dimethylphthalate	C1	9/21/2009 11:40	SED	180	UJ	MS Recovery below LCL
	I1	9/21/2009 14:10	SED	180	UJ	MS Recovery below LCL
	R1	9/21/2009 10:20	SED	120	UJ	MS Recovery below LCL
Di-n-Butylphthalate	C1	9/21/2009 11:40	SED	210	J	MS Rec. < LCL
	I1	9/21/2009 14:10	SED	180	UJ	MS Rec. < LCL
	R1	9/21/2009 10:20	SED	120	UJ	MS Rec. < LCL
Fluoranthene	C1	9/21/2009 11:40	SED	2700	J	MS/MSD Rec. > UCL
	I1	9/21/2009 14:10	SED	1900	J	MS/MSD Rec. > UCL
	R1	9/21/2009 10:20	SED	1500	J	MS/MSD Rec. > UCL
				2950	J	MS/MSD Rec. > UCL
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Fluorene	C1	9/21/2009 11:40	SED	100	J	MS/MSD Rec. > UCL
	I1	9/21/2009 14:10	SED	88	J	MS/MSD Rec. > UCL
	R1	9/21/2009 10:20	SED	83	J	MS/MSD Rec. > UCL
				480	J	MS/MSD Rec. > UCL
				502	J	MS/MSD Rec. > UCL
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Indeno(1,2,3-cd)pyrene	C1	9/21/2009 11:40	SED	720	J	MS/MSD Rec. >UCL & RPD exceeded
	I1	9/21/2009 14:10	SED	600	J	MS/MSD Rec. >UCL & RPD exceeded
	R1	9/21/2009 10:20	SED	360	J	MS/MSD Rec. >UCL & RPD exceeded
				821	J	MS/MSD Rec. >UCL & RPD exceeded
				1120	J	MS/MSD Rec. >UCL & RPD exceeded

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Lead	C1	9/21/2009 11:40	SED	149	J	MS Recovery below LCL
				155	J	MS Recovery below LCL
				210	J	MS Recovery below LCL
	I1	9/21/2009 14:10	SED	94	J	MS Recovery below LCL
	R1	9/21/2009 10:20	SED	158	J	MS Recovery below LCL
Naphthalene	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Pentachlorophenol	TUBING_ PTFE	2/20/2009 11:35	DI	0.5	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.5	UJ	Samples extracted Past 7 days
Phenanthrene	C1	9/21/2009 11:40	SED	1200	J	MS/MSD Rec.>UCL & RPD Exceeded
	R1	9/21/2009 10:20	SED	750	J	MS/MSD Rec.>UCL & RPD Exceeded
				2720	J	MS/MSD Rec.>UCL & RPD Exceeded
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Samples extracted Past 7 days
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Phosphorus, Total	R1	2/25/2009 15:54	STORM W	0.352	J	Tubing Blank contamination
		3/5/2009 12:11	STORM W	0.326	J	Tubing Blank contamination
				0.338	J	Tubing Blank contamination
				0.732	J	Tubing Blank contamination
Pyrene	C1	9/21/2009 11:40	SED	2000	J	MS/MSD Rec.>UCL & RPD Exceeded
	I1	9/21/2009 14:10	SED	1600	J	MS/MSD Rec.>UCL & RPD Exceeded
	R1	9/21/2009 10:20	SED	1200	J	MS/MSD Rec.>UCL & RPD Exceeded
	TUBING_ PTFE	2/20/2009 11:35	DI	0.1	UJ	Associated samples non-detects
		2/23/2009 14:20	DI	0.1	UJ	Samples extracted Past 7 days
Solids, Total	C1	9/21/2009 11:40	SED	29.8	J	Analyzed Past holding Time (8 days)

Parameter	Sample ID	Sample Date and Time	Matix	Result	Validation Qualifier	Reason for Qualification
	I1	9/21/2009 14:10	SED	39.5	J	Analyzed Past holding Time (8 days)
	R1	9/21/2009 10:20	SED	35.8	J	Analyzed Past holding Time (8 days)
				36.2	J	Analyzed Past holding Time (8 days)
				40.5	J	Analyzed Past holding Time (8 days)
Zinc	C1	9/21/2009 11:40	SED	960	J	MS Recovery below LCL
				980	J	MS Recovery below LCL
				1100	J	MS Recovery below LCL
	I1	9/21/2009 14:10	SED	860	J	MS Recovery below LCL
	R1	2/25/2009 15:54	STORM W	13	J	Tubing Blank contamination
		3/5/2009 12:11	STORM W	13	J	Tubing Blank contamination
		9/21/2009 10:20	SED	370	J	MS Recovery below LCL

Catch Basin Storm Filter – Water & Sediment Analytical Methods & Reporting Limits

The following table describes the method the laboratory performed, the method nomenclature the laboratory used on the data reports, the method described in SPU's QAPP and the method Ecology has accredited the lab to perform. The comment section addresses any areas of non-conformance. Reporting limits represent the minimum value the laboratory is able to report. Reporting limits can vary by individual samples, particularly for sediments where the quantity and dilution analyzed affect the minimum detectable value.

Catch Basin Storm Filter – Water								
Analyte Group	Parameter	Units	Analytical Method Performed	Analytical Method Reported	Analytical Method in QAPP	Lab's Ecology Accreditation	Lab Report Limit	Comments
Conventional	Hardness (total)	mg/L CaCO3	SM2340-B	SW6010B	SM2340-B or C	SM2340-B	0.33	Method reported is the analytical procedure for the SM2340-B

Catch Basin Storm Filter – Water								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
	Particle Size Distribution	mg/L	TAPE/ASTMD 3977C	TAPE/ASTMD 3977C	TAPE	PSEP	0.01	
	pH	s.u.	SM 4500 - H^+ B	EPA 150.2	SM 4500 - H^+ B	EPA9045	0.01	Equivalent Electrometric method
	Total Suspended Solids (TSS)	mg/L	SM2540-D	EPA160.2	SM2540-D	SM2540-D	1	Method reported is an old EPA number for Equivalent method
Metals (dissolved & total)	Copper	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	0.5	
	Zinc	ug/L	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	4	
Nutrients	Ortho-phosphate	as P mg/L	SM4500-P E	EPA365.2	SM4110-B	SM4500-P E	0.01	
	Phosphorus, Total	as P mg/L	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	0.02	Method reported is an old EPA number for Equivalent method

Ortho-phosphate was analyzed by SM4500-P, a colorimetric method for both the Catch Basin Storm Filter and the Stormwater Characterization projects. The ortho-phosphate method in the Catch Basin Storm Filter QAPP, however, was incorrectly listed as SM4110-B. The method incorrectly listed in the QAPP was not listed in the permit's Appendix 9. So the samples were analyzed by the colorimetric method which is consistent with the method used with Stormwater Characterization.

Catch Basin Storm Filter – Sediment								
Analyte Group	**Parameter**	**Units**	**Analytical Method Performed**	**Analytical Method Reported**	**Analytical Method in QAPP**	**Lab's Ecology Accreditation**	**Lab Report Limit**	**Comments**
Conventional	Bulk Density	lb/ft^3	ASTM 2937	ASTM 2937			0.01	
	Grain size	%	ASTM D422	ASTM D422	ASTM D422	ASTM D422	0.1	
	Total solids	%	SM2540B	EPA160.3	EPA160.3 or SM2540B	SM2540B	0.01	Method reported is an old EPA number for Equivalent method
	Total Volatile Solids	%	EPA160.4	EPA160.4	EPA160.4	EPA160.4	0.01	
Metals	Cadmium	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	0.3	ICP was inadvertently analyzed by the lab instead of ICP-MS. Detection limits were met.
	Copper	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	0.5	
	Lead	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	5	
	Zinc	mg/kg	SW846 6010B	SW846 6010B	EPA 200.8 or 6020	SW846 6010B	2	
Nutrients	Phosphorous	as P mg/Kg	SM4500-P E	EPA365.2	Manual (SM 4500-P E) or Automatic (SM 4500-P F)	SM4500-P E	3	Method reported is an old EPA number for Equivalent method
Total Petroleum Hydrocarbon (TPH)	Diesel Range Organics - Diesel	mg/L	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx	25	
	Diesel Range Organics - Oil						10	

For the metals analysis, ARI inadvertently used method SW6010B rather than SW6020. The laboratory has corrected this error and will use the QAPP method for all future analysis.

Holding Times:

No samples were analyzed past the prescribed holding times.

Method Blank Report

Parameter	Reported Result	Units	Prep Batch ID	MB Hits
Zinc	**2**	mg/kg	**3050B-20090924**	Above RL

No sample results were qualified; all sample results were greater than ten times the blank contamination.

Accuracy checks

All laboratory control samples, surrogates, matrix spike recoveries and standard reference materials that were associated with reported sample results were within acceptance criteria.

Precision Checks

All laboratory replicate samples and matrix spike/matrix spike duplicate precision checks that were associated with reported sample results were within acceptance criteria.

Table of qualified data

The following table lists data that was qualified and the reason for the qualification.

Parameter	Sample ID	Sample Date	Matrix	Reported Result	Validation Qualifier	Units	Reason for Qualification
Copper	CBSF1-IN	3/2/2009 5:22	STORMW	4.6	J	ug/L	Tubing Blank result 1 ug/L
Total Fines	CBSF2-SED1	9/23/2009 10:00	SED	6.3	J	%	Field Dup. RPD >35%
		9/23/2009 10:01	SED	9.9	J	%	Field Dup. RPD >35%
	CBSF2-SED2	9/23/2009 10:50	SED	11.3	J	%	Field Dup. RPD >35%