Quality Assurance Project Plan for King County Program Effectiveness Monitoring Conducted Under the Phase 1 Municipal Stormwater Permit WAR04-4501 (Issued February 2007)

Revised October 2010

King County

King County Department of Transportation
Road Services Division, Roads Maintenance Section
Environmental Unit
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Quality Assurance Project Plan for King County Program Effectiveness Monitoring Conducted Under the Phase 1 Municipal Stormwater Permit WAR04-4501 (Issued February 2007)

Submitted by:

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Road Services Division

Citation:

King County, 2008. Quality Assurance Project Plan for Program Effectiveness Monitoring Conducted Under the Stormwater Management Implementation Grant Program. Grant Number SW08043

King County
Department of Transportation
Road Services Division

October 2010 S8.E QAPP Revision Summary:

New Study Sites:

- A water quality BMP study has been installed along SE Petrovitsky Roadabove Old Petrovitsky Road.
- A water quality BMP study has been installed along SE Petrovitsky Road just above SE 192nd Drive.
- A flow control BMP study has been installed along SE Petrovitsky Road below SE 192 Drive and just downstream from the water quality study. This flow control study includes placement of an additional BMP to the 2009 flow control study just completed, allows for evaluation of flow modifications between the upstream water quality BMP study or the flow controls downstream, and provides an additional year of monitoring of flow control BMPs placed in 2009.
- A flow control study proposed for installation at 276th Ave SE, downstream from 2009 study.

Parameter List

- Our data review to date suggests the ditch BMPs may reduce TSS and related compounds. We currently analyze dissolved metals, we propose the following additional analysis:
- total metals for arsenic, chromium, copper, nickel, lead, zinc
- total phosphorus
- Collection of grab samples for fecal coliform and total petroleum hydrocarbons (TPH) will be discontinued. The results from these parameters do not seem to be helping evaluate the effectiveness of the BMPs, and we feel that more useful information can be gained by the total metals and phosphorous analyses we propose substituting. TPH has not been detected; the fecals results vary significantly.
- Metals that have not been detected during 2009 monitoring: cadmium, selenium, and tin, will not be collected during the 2010 water year studies.

Staffing Changes: Section 4.0 Organization and Schedule (p. 11)

- Add Robert Dutton as Field Technical Support
- Change Jennifer Rilling (now Jennifer Keune) to Senior Review
- Add Kelli Sanders/Roads Data Quality Assurance Officer
- Drop Richard Sawyer (no longer works for King County)

- Drop Dana Walker (no longer works for King County)

Continuous Turbidity Monitoring (Section 7.4 p. 30)

- Water quality parameters (dissolved oxygen, pH, temperature, conductivity and turbidity) are currently monitored as grabs using multiparameter probes. The results from these parameters do not seem to be helping evaluate the effectiveness of the BMPs, and we believe we can obtain more useful information by substituting continuous monitoring equipment for turbidity. Our limited use of continuous recording sondes for monitoring turbidity to date has shown apparent decreases in turbidity when comparing upstream to downstream monitoring results. These continuous recording sondes will be used during storm events as an alternative monitoring technique to the extent that the sondes are available.

Revision Details:

3.3 (p. 9) Grab sampling details lined out.

4.0 (p. 11) Staffing updated as noted above.

5.5 Table 1 Reporting Limits (p. 15)

Reporting limit for nitrate-nitrite revised from 0.02 to 0.04 mg/L. Reporting limit for PAH-SIM revised from 0.1 to 1.0 ug/L. Dissolved metals for cadmium, selenium and tin, TPH, and fecal coliform removed.

6.1 Replaced site information with 2010 sites (p. 17)

Table 2 Water Quality BMP Monitoring Site Descriptions (p. 17)

2010 monitoring sites added. Descriptions and figures added to section.

6.2 Replaced site information with 2010 sites (p. 18)

Table 3 Flow Control BMP Monitoring Site Characteristics

2010 monitoring sites added. Descriptions and figures added to section.

6.4 Parameters for Analysis (p. 24)

Updated table with revised analytical list noted above.

7.2 Stormwater Monitoring Sampling Deployment (p. 27)

7.2.1 Updated with additional forecast references

7.2.2 Removed references to grab sampling for fecals and TPH

7.2.3 Revised paragraph on field filtering of metals. Discussed filtering of metals and preservation of samples in the laboratory when sample composite is split. Noted that the use of composite samplers eliminates

our ability to meet sample holding times for dissolved parameters and preservation of TKN.

7.4 Field Data Collection (p. 29)

Updated to reflect use of continuous recording sondes for turbidity.

8.0 Table 6 Stormwater Sample Volumes, Container Type, Holding Time and Preservatives (p. 33)

Updated table with revised analytical list noted above.

Table 7 Parameters, Methods, and Detection Limits (p. 34)

Updated table with revised analytical list noted above.

9.1 Conventionals

Table 8 Conventionals QC Limits (p. 36)

Updated table with analytical list and revised QC standards.

9.1 Conventionals

Table 9 Metals QC Limits (p. 36)

Updated table with analytical list and revised QC standards.

9.3 Organics QC

Table 10 Organics QC Limits (p. 37)

Deleted table for NWTPH-DX

Table 11 Laboratory QC Limits for PAH-SIM Recoveries (p. 37)

Revised table to reflect current laboratory QC limits and added Spike Blank recoveries. Replace dibenzofuran, incorrectly listed in Table 11, with 2-methylnaphthalene.

Table 9 Metals QC Limits (p. 36)

Dissolved Lead QC revised to current KCEL limits

Table 12 Microbiology QC Limits (p. 39)

Deleted table for fecal coliform limits

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APPROVALS

Jim Crawford King County Roads Division Date

King County Project Manager

Dean Wilson King County Water and Lands Division Date

King County Stormwater NPDES Monitoring Program Manager

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.

1.0. BACKGROUND

A portion of the stormwater draining to Puget Sound is runoff from rural, agricultural, and residential lands that is conveyed to receiving waters in roadside ditches. Runoff has been identified as a leading contributor of pollution discharging untreated water from roadside ditches into local surface water bodies. King County Department of Transportation (KCDOT) is responsible for maintaining over 1,800 miles of paved roadway throughout unincorporated King County. As the focus on stormwater regulatory programs for roadways increases, the King County Roads Maintenance Section (KCRMS) is responding by conducting research and developing affordable and effective Best Management Practice (BMP) designs to treat stormwater runoff within roadside ditches.

KCRMS is developing several in-line ditch stormwater treatment retrofit designs that are simple, low-cost, and low-maintenance BMPs, or cells, intended to attenuate and infiltrate flows and to reduce or remove water quality contaminants. The treatment cells can be installed within roadside ditches, requiring no additional land purchase or impacts to adjacent lands. The treatment cells are simple designs that can be easily modified to on-site conditions such as soil type, ditch gradient, flow regime, and pollutant type(s). The low costs of design, installation, and maintenance of the cells will allow other public and private entities to retrofit multiple areas, retaining stormwater locally and creating an aggregate regional decrease in quality and quantity impacts from roadside ditch discharges.

This approach focuses on capturing most small storm events and “first flush” conditions from larger events primarily through retention, infiltration and providing water treatment via filter media. The designs also decrease or attenuate stormwater flow peaks, using a combination of delay, filtration, and infiltration methods. The in-line ditch stormwater treatment BMP research will study the costs for development, implementation, and maintenance and will evaluate flow reduction and pollutant removal. Samples will include pre- and post-retrofit during multiple storm events.

2.0. GOALS AND OBJECTIVES

The goals and objectives for this study are to:

- Develop, install and test low-cost BMP designs intended to provide a measurable level of stormwater treatment to either reduce pollutant loads or attenuate storm peak hydrographs within existing road side ditches.

- Provide a set of stormwater monitoring data consisting of analytical results and storm flow data that have been subject to quality assurance reviews suitable for comparison of stormwater quality and storm hydrographs above and below each BMP. The criteria for collecting and reviewing this data are presented in the Quality Assurance Project Plan QAPP.

- Evaluate the level of effort and costs required in designing, installing and maintaining the BMPs.

- Making the results of this study available to the outside community through reports, journal articles and group presentations.

3.0. PROJECT DESCRIPTION

The purpose of this program is to study the effectiveness of several types of linear treatment BMP designs using low impact development principles for the retrofit of roadside ditches, and evaluate their effectiveness at suitable demonstration sites in King County. Stormwater runoff in the Puget Sound Basin is captured, transported and discharged by roadside ditches. This runoff often occurs in areas developed prior to enactment of storm water regulations and the issuance of municipal NPDES permits, and therefore there are no stormwater treatment facilities in the system. These systems have been identified by the municipal NPDES permits as needing retrofits.

Pollutants contained in stormwater runoff, and peak flows associated with storm events, can degrade receiving waters and their ecosystems. Evidence of these impacts is the many water bodies being listed as water quality impaired (303(d) list). Municipalities and other organizations in the region often lack funds available to purchase property, design, build and maintain large regional treatment facilities and so they need to develop low-cost treatment options. KCRMS has proposed roadside ditch retrofit designs to specifically target stormwater treatment within roadside ditches that can capture most or all small storm events and the first flush of larger storm events. These retrofits are intended to effectively treat stormwater runoff before pollutant loads and flow can impact downstream surface water bodies.

KCRMS will monitor both water quality and water quantity upstream and downstream of retrofitted ditches to determine the effectiveness of improving the water quality and modulating hydrology during storm events. An estimate of water retention times based on size and materials for each BMP will be calculated during the design of each BMP. However, since these BMPs do not have an engineered control structure that regulates discharge, the retention time may vary due to environmental conditions including season, storm frequency, rainfall intensity and infiltration rates, and the retention time may vary for every storm. The study design is based on the assumption that the upstream flow monitoring stations will be representative of the overall flow through the reach of ditch where the BMP will be placed. The study locations are selected to minimize stormwater inputs or outputs along the length of the BMP, allowing for direct comparisons of upstream and downstream hydrographs and laboratory results.

This QAPP describes the monitoring and testing requirements to evaluate the effectiveness of a total of eight in-line ditch BMPs. Four of the BMPs are intended to address water quality improvements; and four are intended as flow-control BMPs. BMP designs will be submitted and approved by Ecology before BMP monitoring is started. Two water quality and two flow-control BMP will be tested concurrently. Once the storm monitoring requirements for a BMP's location have been met, the monitoring equipment will be moved to a new location and the next BMP design will be monitored.

3.1 Water Quality BMPs

This study will test the hypothesis that retrofitting roadside ditches with Low Impact Development (LID) BMPs will improve storm water quality flowing to receiving waters. Flow-

weighted composite ~~and grab samples~~ will be collected at the four water quality BMP sites during twelve storms. Flow-weighted composite samples will be collected to characterize the average concentration of tested parameters during a sampled storm. This average concentration, or event mean concentration, will be used to compare water quality at different sampling locations. Flow-weighted composite samples will be collected for metals and conventional analysis ~~and grab samples will be collected for Total Petroleum Hydrocarbons (TPH) and Fecal Coliform analysis~~. Flow monitoring equipment will also be installed at each water quality monitoring station. Flow data will be used to calculate contaminant loadings.

Water quality sampling stations will be established both upstream and downstream of each ditch retrofit BMP. Event mean concentrations from the upstream sampling location will be compared to the event mean concentrations from the downstream sampling location using appropriate statistics (e.g. paired t-test). These comparisons will be used to evaluate what benefit this type of ditch retrofit BMP has on storm water quality. Additionally, sampling multiple ditch retrofit sites in this way will increase the confidence of conclusions drawn from this sampling program.

3.2 Flow Control BMPs

This study will also test the hypothesis that retrofitting roadside ditches with LID BMPs will reduce peak flows of stormwater to receiving waters during storms. Flow monitoring equipment will be installed both upstream and downstream at four flow control ditch retrofit BMP locations. At each BMP site, flow volumes from the upstream monitoring location will be compared to flow volumes from the downstream monitoring location using appropriate statistics. These comparisons will be used to evaluate what benefit this type of ditch retrofit BMP will have on storm water quantity.

3.3 Monitoring

60% to 80% of the stormwater samples will be collected during the wet season each year (October 1st through April 30th), and 20% to 40% will be collected during the dry season (May 1st through September 30th). However, these goals are dependant on the number of storms that produce measurable flows, particularly during the dry season, and the sampling rate may be affected by other logistical or stochastic constraints.

Automated sampling equipment will be deployed to collect flow-weight composite stormwater samples. Due to concern over safety, field staff will not be required to visit these sites, located along road right-of-ways during nighttime hours. ~~Grab samples for TPH and Fecal Coliform to be collected during storm events will be collected to the extent possible. The requirement to collect these samples by hand may limit the ability to collect them during every storm event.~~

Conceptual BMP designs have been prepared for this study. Prior to BMP construction, engineering designs will be finalized with drawings that comply with construction standards, codes and regulations. Final designs will address right-of-way hazards, flooding and private

property concerns, and degradation affecting traveled roadway integrity and limitations of standing water will be submitted to Ecology for approval.

4.0. ORGANIZATION AND SCHEDULE

Name/phone number	Responsibility	Organization
Rob Fritz 206-205-7107	Project Manager	King County Roads Maintenance Section
Jim Crawford 206-296-8276	Field Technical Coordinator, Autosamplers, Hydrology, QAPP, Data Analysis and Reporting	King County Roads Maintenance Section
Fritz Grothkopp 206-684-2327	Laboratory Project Manager	King County Environmental Laboratory
Colin Elliott 206-684-2343	Quality Assurance Officer	King County Environmental Laboratory
Dianne McElhany 206-684-2304	Metals Laboratory Supervisor	King County Environmental Laboratory
Brian Prosch 206-684-2331	Conventionals Laboratory Supervisor	King County Environmental Laboratory
Eric Thompson 206-684-2340	Microbiology Laboratory Supervisor	King County Environmental Laboratory
Ben Budka 206-684-2328	Environmental Services Supervisor	King County Environmental Laboratory
Jason Finlinson 206-205-3706	Roads Laboratory Technical Coordinator, BMP research and conceptual design, construction oversight, monitoring and data analysis.	King County Roads Maintenance Section
Jennifer ~~Rilling~~ Keune 206-205-3703	~~Data Quality Assurance Officer~~ Senior Review	King County Roads Maintenance Section

John Lyou P.E. 206-205-7123	Design Engineer	King County Roads Maintenance Section
Jon Cassidy	Maintenance Engineering Manager	King County Roads Maintenance Section
~~Richard Sawyer~~	~~Senior Review, Mapping and Drainage~~	~~King County Roads Maintenance Section~~
Dean Wilson	NPDES Stormwater Monitoring Program Manager	King County WLRD, Science Section
Stephen Conroy	Permit Review	King County Roads Maintenance Section
Kelli Sanders	Roads Data Quality Assurance Review	King County Roads Maintenance Section
Bob Dutton	Field Technical Support	King County Roads Maintenance Section

The project schedule is as follows:

September, 2008 QAPP due to Ecology

December 2008 Provide maps identifying four BMP study sites; two sites for water quality improvements and two for flow control improvements. Submit 90% BMP design plans 30 days prior to construction.

January 2009 Install first set of four BMPs.

December 2009 Provide maps identifying two additional sites for water quality improvement BMPs and two for flow control improvements. Submit 90% BMP design plans 30 days prior to construction.

January 2010 Install second set of BMPs.

January 2009 – March 2011

Submit quarterly progress reports within 30 days following the end of each quarter.

<u>Reporting Periods</u>.
January 1 through March 31
April 1 through June 30
July 1 through September 30
October 1 through December 31

May 31, 2011	Final monitoring report due
June 15th 2011	Make findings available for public review. Prepare a journal article to be ready for publication prior to grant expiration.

5.0. QUALITY OBJECTIVES

The King County Program Effectiveness study will address two questions:

1. The effectiveness of a targeted action:- the effectiveness of an in-line ditch BMP to influence either stormwater quality or flow.

2. The effectiveness of achieving a targeted environmental outcome:- the cost effectiveness of using tested BMP designs as an alternative to more traditional stormwater treatment.

To ensure that the project objectives are achieved, the quality of the data collected will be measured at each stage of data collection and analysis. Data quality will be assessed by determining the bias, precision, and accuracy of the data

5.1 Precision, Accuracy and Bias

Precision, accuracy and bias for analytical chemistry and microbiology will be measured by one or more of the following quality assurance/quality control (QA/QC) procedures:

- Collection of a field blank (results should be <MDL for all appropriate parameters)

- Collection filter blanks

- Analysis of various laboratories QC samples such as method blanks, matrix spikes, certified reference materials, and laboratory duplicates or triplicates.

5.2 Representativeness

Samples are to be collected in such a manner as to minimize potential contamination and other types of degradation in the chemical and physical composition of the water. Following guidelines for sampler decontamination, sample acceptability criteria and sample processing will help ensure that samples are representative. Proper preservation and storage of samples and preparation for analysis will achieve laboratory representativeness.

5.3 Completeness

Sampling according to project sampling criteria along with adherence to standardized sampling and testing protocols outlined in this QAPP, will aid in providing a complete set of data for this project. The goal for completeness is 100%. The samples from each event should produce greater than 90% acceptable chemical and biological data under the QC conditions described elsewhere in this QAPP.

Completeness may be affected by variables beyond the control of the sampling team. These variables include the variation in actual rainfall from the predicted rainfall for a given storm

event, the hold-time limitations on fecal coliform bacteria, and the stormflow response to rainfall at a specific monitoring site.

5.4 Comparability

Comparability is achieved through use of standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. Changes or updates to analytical methods and sampling techniques midway into the project must be validated and shown to be equivalent to existing methods before being implemented.

5.5 Reporting Limits

Table 1. Analytical Method Reporting Limits for Water Matrix Parameters

Parameter	Reporting Limit Criteria
Total suspended solids	1.0 mg/L
Hardness as CaCO3	0.33 (mg/ $CaCO_3$/L)
Total kjeldahl nitrogen	0.2 mg/L
Nitrate-nitrite (NO23)	~~0.02~~ 0.04 mg/L
Total Phosphorus	0.01 mg/L
Orthophosphate Phosphorus	0.005 mg/L
Total Recoverable Arsenic	0.5 ug/L
Dissolved Arsenic	0.5 ug/L
~~Dissolved cadmium~~	~~0.25 µg/L~~
Total Recoverable Chromium	1.0 µg/L
Dissolved Chromium	1.0 ug/L
Total Recoverable Copper	2.0 ug/L
Dissolved Copper	2.0 µg/L
Total Recoverable Lead	0.1 ug/L
Dissolved Lead	0.1 µg/L
Total Recoverable Nickel	0.5 ug/L
Dissolved nickel	0.5 ug/L

Parameter	**Reporting Limit Criteria**
~~Dissolved selenium~~	~~1.0 ug/L~~
~~Dissolved tin~~	~~1.5 ug/L~~
Total Recoverable zinc	2.5 ug/L
Dissolved zinc	2.5 µg/L
PAH-SIM	~~0.1~~ 1.0 µg/L
~~TPH (NWTPH-Dx)~~	~~0.2 mg/L~~
~~Fecal coliform~~	~~1 cfu/100 ml~~

6.0. SAMPLING DESIGN

Rainfall and flow monitoring will be conducted prior to sampling water quality parameters. Together, the rainfall and runoff data will be analyzed to determine the optimal sampling event criteria (e.g. rainfall, number of days to target sampling, flow volume pacing) to achieve project goals. By studying these site specific characteristics, more appropriate storm criteria can be developed which will lead to more accurate water quality characterization of the facilities.

6.1 Water Quality BMP Monitoring Site Descriptions

Table 2. Water Quality BMP Monitoring Site Characteristics

Monitoring Site Name				
	2009 Water Year Sites		**2010 Water Year Sites**	
	Site # RSW~~6~~ 1	**Site # RSW8**	**Site #RSW17**	**Site #RSW18**
Site Names:	148UP / 148DN	136UP / 136DN	192UP / 192M	OPUP / OPDN
Location	148thth Ave SE	SE 136th ST	SE Petrovitsky Road above SE 192nd DR	SE Petrovitsky Road above Old Petrovitsky Road
% Commercial	0	0	0	0
% Low Density Residential	80	0	100	0
% High Density Residential (4 DU/acre)	20	100	0	100 (R6-6 DU/acre)
% Industrial	0	0	0	0
Receiving Water	May Creek	~~Wetland drainage to May Creek Watershed~~ Cedar River Watershed	Shady Lake	Madsen Creek/Cedar River
Rain Gauge Location (~~latitude/longitude~~) (Easting/Northing)	KC gage #31UN located at : KC Roads Renton Maintenance Facility, E – 1308856 N-178651		KC gage #31Y2 Fairwood Raingage (located near the Fairwood shopping center) E – 1316219, N - 164445	

Monitoring Site Name				
	2009 Water Year Sites		**2010 Water Year Sites**	
	Site # RSW~~6~~-1	**Site # RSW8**	**Site #RSW17**	**Site #RSW18**
Yearly Precipitation (in)	42.03 inches (Average 2001-2007)		46.3 inches (Average 1996-2007 from gage 31Y. This gage was upgraded to a real-time gage in 2009 and named 31Y2 at the same location).	

6.1.1 SE Petrovitsky above SE 192nd Drive

The SE Petrovitsky Road water quality project above SE 192 Drive is shown as the red line in Figure 1. This project starts at a culvert discharging stormflow along SE Petrovitsky Road at an access point about two hundred feet above SE 192nd Drive. Six BMPs utilizing compost socks have been placed in the ditch from the culvert down to an existing flume located a short distance down and across from SE 192 Drive. The lower flume was the upstream monitoring point for a 2009 flow control BMP study and is now the upstream monitoring point for a 2010 flow control study. The site has a relatively high daily traffic (ADT) volume of approximately 8,200 vehicles per day. The ditch runs along Petrovitsky Road for about a half a mile above the BMP study site, receiving inputs from the roadway, private lots on the west side of the road and the Lake Young's watershed. The Lake Young's trail maintained by King County runs along the west side of the ditch. The ditch continues south east where a cross-tile directs flow under Petrovitsky Road to discharge into Shady Lake.

6.1.2 SE Petrovitsky at Old Petrovitsky Road

The water quality BMP project along Petrovitsky Road at Old Petrovitsky is shown as the red line in Figure 2. This project is located about a mile and a half north west from the 192nd project site, and flows to the east. The majority of the drainage basin is located on the north side of Petrovitsky Road. A school with a storm pond dominates the central portion of this drainage, but surface runnoff from streets and housing developments produce significant flows that are directed through culverts to the open section of ditch on the south shoulder of Petrovitsky Road. At Old Petrovitsky Road the ditch discharges to a catch-basin and cross-tile that direct it back under Petrovitsky Road to the north and into the headwaters of Madsen Creek in the Cedar River Watershed.

Figure 1. SE Petrovitsky above SE 192nd Drive

Figure 2. SE Petrovitsky at Old Petrovitsky.

6.2 Flow Control BMP Monitoring Site Descriptions

Table 3. Flow Control BMP Monitoring Site Characteristics

Flow Control BMP Monitoring Sites				
	2009 Water Year Sites		**2010 Water Year Sites**	
Site Characteristics[1]	~~**Site # RSW1**~~	~~**Site # RSW2**~~	**--**	**--**
Site Names:	276UP / 276DN	PETUP / PETDN	192M / 192DN	276UP / 276D / 276D2
Location	276th Ave SE	Petrovitsky Road	Petrovitsky Road below SE 192nd DR	276th Ave SE below SE 213th Drive
% Commercial	0	0	0	0
% Low Density Residential	100	100	100	100
% High Density Residential	0	0	0	0
% Industrial	0	0	0	0
Rain Gauge Location (latitude/longitude)	KC Hobart rain gauge (Recording) E-136575 N-154020	KC Layton Rain Gauge (Recording) E-1330895 N-158469	KC gage #31Y2 Fairwood Raingage (located near the Fairwood shopping center) E – 1316219 N - 164445	KC Hobart rain gauge (Recording) E-136575 N-154020
Yearly Precipitation (in)	46.92 (Average 1996-2007)	43.96 (Average 1988 – 2007)	46.3 inches (Average 1996-2007 from gage 31Y. This gage was upgraded to a real-time gage in 2009 and named 31Y2 at the same location).	46.92 (Average 1996-2007)
[1]Note: "RSW" site numbers are used as identifiers for water quality samples only. Flow control sites are referenced by their site name.				

6.2.1 276th Ave SE

The location of the 276th Ave SE site is shown in Figure 3. An open roadside ditch crossed by several driveways with 12-inch and 15-inch culverts is located on the west shoulder of 276th Ave SE between SE 208th Street and SE 216th Street. This ditch drains to a stream that crosses 276th Ave SE just north of SE 208th Street, flowing west towards Issaquah Creek. The watershed for this section of ditch is dominated by rural residential properties on the west side 276th Ave SE and collects runoff from this busy paved roadway. A flow control BMP will be placed in the ditch north of SE 213th Street. Monitoring stations will be established within King County road right-of-way on the west side of the ditch just upstream and downstream from the BMP. Flow will be measured either by weirs into existing culverts or placing trapezoidal flumes in the ditch at each end of the BMP. A rain gage will be located at the BMP site.

This street has a relatively high average daily traffic (ADT) volume of approximately 7,105. Good parking areas are located on the east side of the road, on SE 208th and SE 213th Streets. Right –of-way space between the east side of the ditch and private property line will allow for site access away from the road shoulder. Utility power poles are located along the east side (opposite) of the road for potential power supply if needed or solar panels may be used to maintain charge of battery supply. Lack of sidewalks may limit opportunities for vandalism at this site.

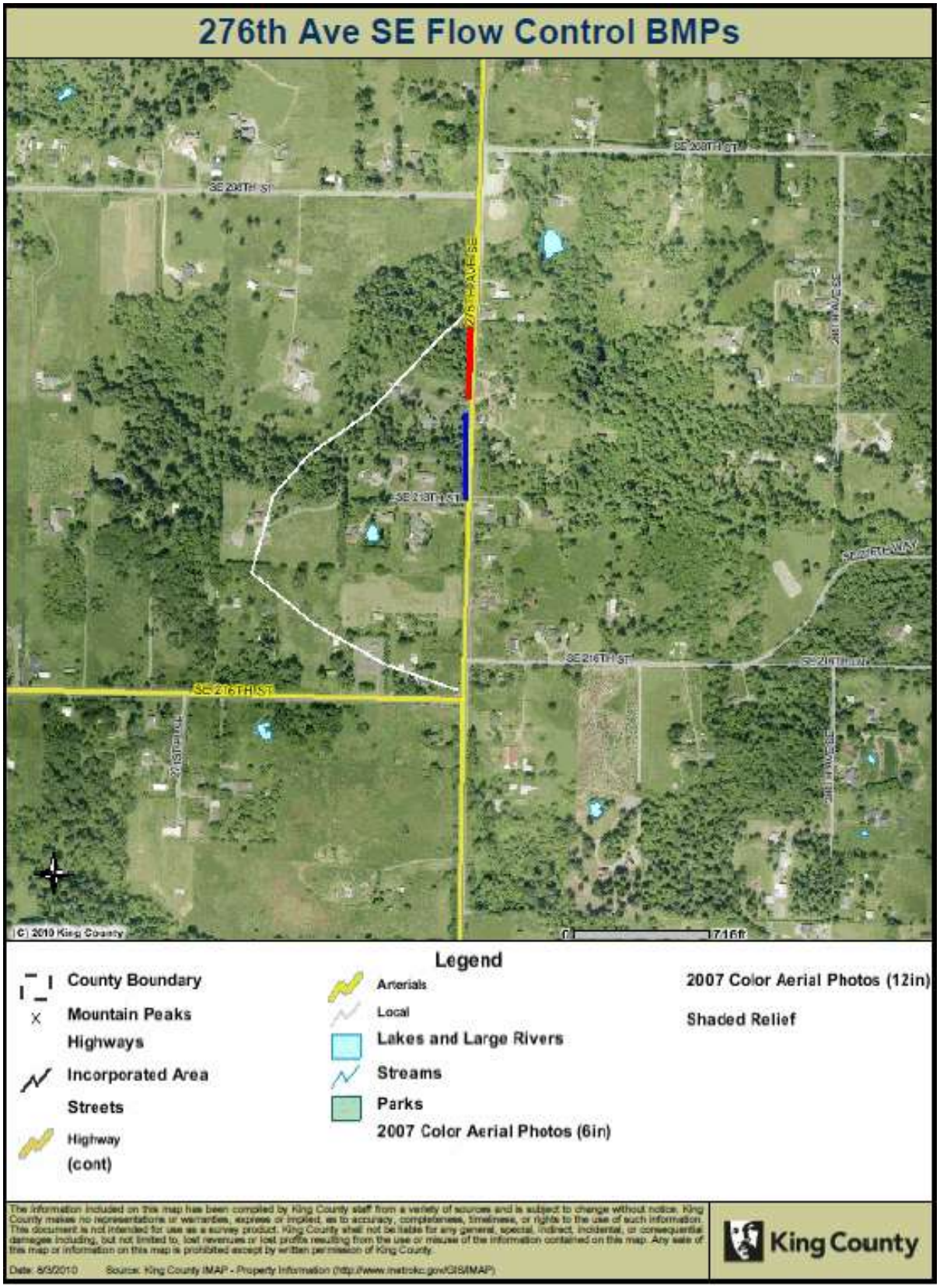
6.2.2 Petrovitsky Road

The location of the 2010 Petrovitsky Road below SE 192 Drive flow control BMP project is shown as the blue line in Figure 1. This study is a modification of the 2009 flow control BMP project, where an additional BMP has been added to last years installations. It is also directly downstream from a series of water quality BMPs placed upstream for a 2010 water quality study. The upstream monitoring station for this flow control study is also the downstream monitoring station for the water quality study. This allows for three monitoring stations to cover the two BMP projects with the intent of comparing flows between the upstream water quality station and the downstream flow control station in addition to a comparison between the upstream flow control station (the “mid-point” monitoring station) and the downstream flow control station. Flow will be measured at each station using the same type of primary measurement device: extra-large 60° V trapezoidal flumes.

6.2.3 276th Ave SE

The location of the proposed 2010 276th Ave SE flow control BMP project is shown as the red line in Figure 3 (the blue line is the location of the 2009 study). This study extends the 2009 flow control BMP project downstream by about 250 feet with the addition compost-sock based BMPs. The upstream and downstream flow monitoring stations will be left in place and a third flow monitoring station will be installed below the new BMPs. This allows for three monitoring stations to cover the extent of with the intent of comparing flows between the upstream, mid-point and downstream flow control stations. Flow will be measured at each station using the same type of primary measurement device: extra-large 60° V trapezoidal flumes.

Figure 3. 276th Ave. SE



6.3 Qualifying Storm Event Criteria for Stormwater Quality Sampling

Table 4. Qualifying storm criteria for Water Quality BMPs:

	Wet Season	Dry Season
Seasonal Period	October 1 through April 30	May 1 through September 30
Minimum Amount of Rainfall	Produces measureable flow in ditch sufficient for composite sample collection	Produces measureable flow in ditch sufficient for composite sample collection
Rainfall Duration	No fixed min. or max.	No fixed min. or max.
Antecedent Dry Period	< or equal to 0.02 rain in previous 24-hours	< or equal to 0.02 rain in previous 72-hours
Inter-event Dry Period	6 hours	6 hours

6.4 Parameters for Analysis

Parameters for stormwater composite sample collection include:

- TSS (Total Suspended Solids)
- Hardness
- TKN
- Orthophosphate
- Total Metals (arsenic, chromium, copper, lead, nickel, zinc)
- Dissolved Metals (arsenic, chromium, copper, lead, nickel, zinc)
- PAH-SIM (Poly Aromatic Hydrocarbons)

~~Parameters for stormwater grab sample collection include~~:

- ~~TPH-Dx~~
- ~~Fecal Coliform~~

(No grab samples are proposed under this QAPP revision)

The goal of qualifying composite samples is:

- Sample collection for up to 24 hours for each storm (No minimum time requirement)
- Have a minimum of 7 to 10 aliquots
- Represent greater than 50% of the storm based on the hydrograph after the storm.

7.0. SAMPLING PROCEDURES

7.1 Stormwater Monitoring Equipment Installation

Autosamplers, equipped with 15-liter glass or polytetrafluoroethylene (PTFE) treated sample carboys, and flow meters will be installed upstream and downstream from each BMP at each monitoring site in locked housings or utility boxes. The flow meters will be connected to a Primary Flow Measurement Device (Primary Device - weirs or flumes) to measure stormflow. The composite sampler will receive signals from the flow meter to initialize and "pace" the timing of sample aliquots. Prior to sample collection, flow data will be collected at each monitoring site to establish a relationship between rainfall and stormflow for each site; this information will be used to set the timing of aliquot collection (sample pacing) in the composite sampler. The goal of composite sampling is to set a pacing interval that will collect representative aliquots from the majority of the stormflow hydrograph without over filling the composite sample container. Rainfall will be monitored within a reasonable distance from each BMP (for further information on flow metering see SOP NPDES-CM-1000, Regional Stormwater Standardization Project 2008).

7.1.1 Autosampler

Composite water quality samples will be collected using ISCO autosamplers equipped with 2.5 to 5 gallon glass or PTFE sample carboys. Autosamplers will be automatically triggered by flow monitoring equipment. A target amount of 6 to ~~10~~ 18 liters of stormwater will be collected over the course of each sampled storm. The total time of collection will not exceed 24 hours.

Guidelines for selecting primary control structures include:

- Compound Thel-Mar weir – discharges from 0.4 to 251 gpm
- V-notch (triangular) weir for discharges <1 cfs, can measure flows up to 10 cfs, maximum head of 2 feet
- Parshall flume, free flow or submerged flow, well-distributed flow free of turbulence
- H-type flumes:
    - HS flumes (0.085-0.821 cfs maximum flow),
    - H flumes (0.347-84.5 cfs maximum flow),
    - HL flumes (20.7-117 cfs maximum flow),
- Preferred approach is rectangular, but can be used in conjunction with an outlet pipe
- Trapezoidal flume, ideal shape for ditches, critical flow preferred, can measure range of flow rates from 0.010-26,000 cfs depending on flume design

(Guidelines derived from ISCO 2006).

Any site visits during a storm event will include verifying that the level and flow recorded by the data logger agrees with direct observations of the primary device (for further information on flow metering see SOP NPDES-CM-1000).

7.2 Stormwater Monitoring Sampling Deployment

7.2.1 Monitor Forecast

Sampling staff will monitor the weather forecast for each event. This documentation will show due diligence for the decisions to deploy, not to deploy or to set sampler program based on the predicted rainfall amount. The call to target a storm for sampling will include a review of the percent chance of the minimum rainfall occurring, allowing for sufficient time for storm preparation. Storm targeting includes calculating the sampler pacing and trigger levels to be used for each autosampler during the storm.

- **NOAA, National Weather Service:** http://www.wrh.noaa.gov/index.php
- University of Washington Dept. of Atmospheric Sciences (several sites):
    - Latest Available MM5 Summary http://www.atmos.washington.edu/mm5rt/rt/load.cgi?latest+YYYYMMDDHH/images_d2/ksew.mg.gif+text+12%20km%20Seattle,WA%2047.69N,122.24W
    - GFS-Initialized Pacific Northwest WRF Weather Forecasts (UW MM5 Model Runs) http://www.atmos.washington.edu/mm5rt/gfsinit.html
    - UW Probability Forecast http://www.probcast.washington.edu/
- **Weather Underground:** http://www.wunderground.com/
    - **Real Time Rainfall radar and local rain gage reports:**
    - http://www.wunderground.com/wundermap/?lat=47.67833&lon=-122.26959&zoom=9&type=map&rad=1&rad.num=6&rad.spd=25&rad.opa=70&rad.stm=0&wxsn=1&wxsn.mode=r&svr=0&cams=0&sat=0&riv=0&mm=0&hur=0&fire=0
- **Northwest Weathernet Inc.:** http://www.nw-weathernet.com/kingco.htm (1-800-937-8676)
- **COLA Meteograms:** http://wxmaps.org/pix/forecasts.html or http://wxmaps.org/pix/meteograms.html
- **East Pacific IR Loop:** http://www.wrh.noaa.gov/sew/ir4kmP.php
- **King 5 Doppler:** http://www.king5.com/weather/doppler/indexrad.html?http://www.king5.com/live/weather_images/K5-340mileAnim-640x480.gif&Title=340%20Mile%20Range

7.2.2 Composite Sampler Deployment

Storm preparation is a specific pre-storm protocol that requires a series of equipment checks and documentation to verify proper operation of field equipment. (Tele-metered stations may allow some of these checks to be completed remotely).

- Verify operation of the autosampler and review the programming
- Verify operation and calibration of the sample pump
- Rinse and back-flush the inlet tubing and screen with laboratory-grade distilled deionized water.
- Check that the pump inlet screen is clear of debris and well secured to obtain sample
- Verify the power supply (replace 12 volt batteries or verify operation of alternate power sources)

- Check the sample container(s) (lids off)
- Add ice or verify refrigeration
- Check primary flow devices, clear any debris
- Verify operation of the flow meter
- Zero or record the flow totalizer readings
- Set and re-check the autosampler flow pacing and trigger levels.

When storm preparation checks have been completed, the station is ready for unattended sampling.

Stormwater will be collected for a maximum of 24 hours (samples can be retrieved earlier if the hydrograph returns to pre-storm levels). Review of the hydrograph will determine if the storm and sample meet the qualifying conditions. Telemetered flow devices, if available, may help with this decision.

Field staff will wear powder-free gloves for safe handling to prevent contamination of samples. Sampling staff should continue to monitor the targeted storm event throughout the event.

~~Samples for TPH and Fecal Coliform will be collected as grabs during first - flush stormflow conditions to the extent possible. Composite samples are not appropriate for these parameters due to their tendency to adhere to sampling equipment, change in concentration, and are not sterile for the collection of bacteria samples. (For further information on grab sampling, see SOP NPDES-DS-2000)~~

Any discrete measurements of dissolved oxygen, pH temperature, turbidity and conductivity will be made during the storm.

7.2.3 Post Storm Sample Handling Procedures

As soon as possible after the conclusion of the event, sampling staff will retrieve the samples. Sampling staff will download and verify data from the autosampler and flowmeter:

- Rainfall hydrograph
- Flow hydrograph
- Event runoff volume
- Timing and number of aliquots collected
- Runoff volume sampled

The collected sample volume will be checked by sampling staff to verify minimum sample volume requirements.

The condition of the primary flow device will be checked for debris, changes to placement, and wear that may have affected flow readings.

~~Samples for dissolved metals will be filtered in the field at the time the composited sample is removed from the autosampler using pre-cleaned, disposable 0.45 micron filter units.~~ Due to the need to properly split the sample, any individual sample processing such as filtering or preservation will be done at the laboratory at the time of composite splitting. The ~~remaining~~

composited sample will be placed in an iced cooler and transported to the laboratory for splitting into ~~the remaining~~ sample containers provided by the laboratory.

Filtering and/or preservation requirements for dissolved metals, total kjeldahl nitrogen, and orthophosphate have holding times prescribed as within 15 minutes of sample collection. Since the sample collection time for flow-composited samples is the time the final aliquot is collected by the autosampler and not the time the composite sample is split into its individual sample containers, these holding times are not attainable for this (or any) flow composite sample project. This will require holding time data flags for these parameters.

All samples collected will be placed on ice with proper chain of custody and shipped or delivered to the laboratory. During sample preparation, all field QA/QC samples (equipment blanks, trip blanks) that require analysis will be recorded in field notebooks, on chain-of-custody forms and placed on ice in the same cooler with stormwater samples for laboratory delivery. The flow-weight composite sample will be transported back to the field laboratory (or KCEL) where it will be split in to appropriate sample containers provided by the laboratory.

7.3 Sample Labeling and Identification

Samples collected at water quality BMP project sites will have labels that ~~will~~ include:

- Sample ID
- Laboratory ID (a unique sample number assigned by KCEL)
- Sample Date and Time (the sample date and time for composite samples is the time of the last sample aliquot).
- Sample Start Time (time of the first sample aliquot)
- Analysis

The sample ID will be:

“RSW” for Roads Stormwater

“Site #” according to the Ditch BMP Site notebook

“UP” or “DN” – for the location upstream or downstream from the BMP at that site.

Sample ID RSW1UP would be assigned to a sample collected upstream of the BMP at site number 1.

QC samples:

Equipment blanks will be labeled “RSWBlank”; the location where the blank was collected will be documented in the field notes.

Filter Blanks will be labeled “RSW-FFBlank” (Field Filter Blank); the location where the blank was collected will be documented in the field notes.

7.4 Field Data Collection

This use of continuous recording sondes for turbidity only will replace discrete measurements using multi-probe instruments, as long a these continuous recording meters are available. The sondes (YSI 6920 or equivalent) using optical turbidity probes will be calibrated according to the same protocol as originally described in the QAPP. These sondes are limited in number, and not dedicated to this project. They are exposed when placed in the roadside ditch monitoring locations and cannot be well protected from theft or damage. Therefore they will be used "as available" to accompany as many targeted storm sampling events as possible with the intent of collecting continuous turbidity measurements upstream and downstream from the BMPs during these storm events. It may not be possible used during every sampled storm event at every site.

If single point monitoring for water quality parameters is done the following will apply:

> A multi-probe instrument (YSI 6920 or equivalent) will be used to make discrete measurements of field parameters for: dissolved oxygen, pH temperature, turbidity and conductivity. Discrete measurements will be made when field staff can safely make mid-storm site visits. See "Procedures for field measurement" Standard Operating Procedures (SOP) #NPDES FM – 1000 - 5000.

Continuous temperature readings will be monitored using logging temperature probes (OnSet or equivalent) placed at the upstream and downstream BMP monitoring locations.

Field notes will be maintained for all field activities, including the collection of samples and the gathering of environmental data. Field notes will be kept on water-resistant paper. Field notes will be recorded on pre-printed field sheets, prepared specifically for this project. Field documentation will include routine station maintenance and storm preparation, sampling and post storm information. Information recorded on field notes will include, but not be limited to:

- Name of recorder
- Sampling personnel
- Sample or station and replicate number
- Sample station locator information
- Depth of sediment sampled
- Sample depth (water depth above the surface of the sediment)
- Date and time of sample collection (all times will be recorded for multiple sampler deployments)
- Physical characteristics of sediment such as color, gross grain size distribution, debris, and odor

During sample collection, field data forms and/or field notebooks will be used to document data collection procedures. Field data forms will include the following information:

- Field staff present (on-site)
- Weather conditions
- Date and time of site arrival
- Time of sample collection/sample distribution into bottles w/preservative
- Equipment calibration performed and results of calibrations
- Bottle configuration
- Time of download of data
- Number of samples collected
- Any problems that occur in the field
- Number of days of preceding dry conditions
- Rainfall amount in inches of the storm event from when sampling begins
- Observational field notes

7.5 Chain of Custody

During sample collection, all sample containers will be either installed in the autosamplers at the sampling site or in the custody of the sampling personnel. After collecting the samples, field personnel will deliver all samples to laboratory's Sample Receiving area and enter them into the Sample Receiving Logbook, as described in ESS SOP # 01-01-003-001 (Sample Management). The possession of the samples by the laboratory is effective at the time the Logbook is signed by sampling personnel and the laboratory sample manager.

Chain-of-custody (COC) forms should be used to accompany samples being transported from the site. Attach a copy of your COC form to your QAPP. These forms are typically provided by the laboratory and can include the following information:

- Sample time and date
- Preservatives used
- Name of sampler
- Analytical test method requested
- Parameter to be analyzed
- Field QA/QC samples collect such as duplicates, trip blanks, temperature blanks, etc.

7.6 Decontamination Procedures

Once samples are collected, all re-usable equipment should be decontaminated with wash and rinse water. EPA approved detergents and de-ionized water (ASTM I or II) should be used to provide efficient decontamination of equipment. Equipment blanks will be analyzed to check for possible cross contamination between sampling events. The amount of equipment blanks collected is optional, based on data quality objectives established earlier in this document. Proper personal protective equipment (new powder-free gloves) should be worn during sampling activities and during decontamination processes. (For more information on decontamination procedures see KCEL SOPs 06-05-002-001_*Trace Metals Section Labware and Equipment Cleaning Procedures* and 07-04-001-002 *Glassware Cleaning Procedure*).

7.7 Collection of Field QA/QC Samples

The number of Field QA/QC samples required is based on the total number of samples collected. Additional blanks may be needed to meet data quality objectives and quality control goals established within this QAPP. For preparation of equipment blanks, trip blanks and field blanks, ASTM Type I or II de-ionized water is recommended. The table below provides a list of blanks that will be collected in the field to meet QAPP objectives:

Table 5. QA/QC Samples for BMP monitoring.

QC Type	Frequency of Collection	Collection Procedure
Equipment Blank	Twice per year (12 storms) at each site	Run laboratory grade-metals and organic free water through equipment after decontamination and collect samples in the appropriate container with preservative for a full analysis of all parameters collected during a sampled storm event. Place immediately on ice.
Field Filtration Blank	Once per year (12 storms) at each site	Same as above
Temperature Blank	During every sample shipment or delivery	Fill a polyethylene bottle with ASTM Type I or II de-ionized water and place directly on ice in same cooler where samples are present.

7.7.1 Corrective Action

Results from equipment and filtration blanks will be used to evaluate the effectiveness of decontamination procedures for the autosamplers and metals filters. Results above MDL will trigger a review of field methods and these cleaning procedures.

7.8 Periodic Preventative Maintenance

Periodic preventative maintenance of equipment can be done by sampling staff between storm events to ensure equipment is operating properly. Signs of vandalism, rusting equipment, equipment failure or other maintenance issues will be documented in field notebooks or on field data forms. Any significant changes in site conditions that will affect sampling should be revised in the QAPP. Ecology recommends including preventative maintenance in your project schedule provided in Section 5, *Organization and Schedule*.

8.0. MEASUREMENT PROCEDURES

The table below includes stormwater sample volume, container type, holding time and preservative needed for each required parameter.

Table 6. Stormwater Sample Volume, Container Type, Holding Time, and Preservatives

Parameter	Recommended Quantity	Container	Holding Time	Preservation
Stormwater Monitoring Samples – All Water Matrices				
Total suspended solids (TSS)	1000 mL	1000 mL CWM HDPE	7 days	Refrigerate at <6°C
Total Kjeldahl Nitrogen (TKN)	250 mL	250mL CWM HDPE	Preserve w acid within 15 minutes of collection, then 28 days at <6°C	H_2SO_4 to pH<2, store at <6°C
Nitrate-nitrite (NO23)	60 mL	60 mL CWM HDPE (Collect together with ORTHOP)	Filter within one day, then 14 days frozen	Freeze at -18°C
Orthophosphate Phosphorus (ORTHOP)	60 mL	60 mL CWM HDPE (Collect together with NO23)	Field filter within 15 minutes of collection, then 14 days frozen	Freeze at -18°C
Total Phosphorus (TOTP)	250 mL	250 mL CWM HDPE	28 days[1]	Freeze within 2 days at -20°C
Dissolved Metals (Arsenic, ~~Cadmium~~, Chromium, Copper, Lead, Nickel, ~~Selenium~~, ~~Tin~~, Zinc).	250 mL	500 mL Acid washed HDPE bottle	6 months	Field filter within 15 minutes; HNO_3 to pH<2 at laboratory
Total Recoverable Metals (Arsenic, Chromium, Copper, Lead, Nickel Zinc).	250 ml	500 mL Acid washed HDPE bottle	6 months	pH<2 at laboratory
Hardness	250 ml	500 mL Acid washed HDPE bottle	6 months	HNO_3 to pH<2 at lab
PAHs	4 X 1 liters	1 liter amber glass jar	7 days	pH tested, adjusted 6 to 9 within 15 min. of sampling. Store at 4 degrees C

Parameter	Recommended Quantity	Container	Holding Time	Preservation
~~Semi-Volatile Petroleum Products (NWTPH-Dx)~~	~~1000 mL~~	~~1000 mL amber glass bottle with Teflon-lined cap (volume affects reporting limit)~~	~~7 days (14 days if pH adjusted to 2 with 1:1 HCl)~~	~~Refrigerate all samples at 4ºC (for 14 day hold time adjust pH to 2 with 1:1 HCl)~~
~~Fecal coliform~~	~~500 mL~~	~~500 mL polypropylene autoclaved bottle~~	~~6+2 hours~~	~~If chlorine is expected in the sample, then request thiosulfate preservative~~

Table 7. Parameters, Methods, and Detection Limits

Water Quality Parameters	Method	Reporting Detection Limit (KCEL Method Detection Limit)	Practical Quantitation Limit (KCEL Reporting Limit)
Total suspended solids	SM2540D	0.5 mg/L	1.0 mg/L
Hardness as CaCO3	EPA 200.8/SM2340B.ED19	0.066 (mg $CaCO_3$/L)	0.33 (mg $CaCO_3$/L)
TKN (Total Kjeldahl Nitrogen)	EPA 351.2	0.1 mg/L	0.2 mg/L
Nitrate-Nitrite (NO23)	SM4500-NO3-F	0.01 mg/L	~~0.02~~ 0.04 mg/L
Orthophosphate Phosphorus	SM4500-P-F	0.002 mg/L	0.005 mg/L
Total Phosphorus	SM4500-P-B,F	0.005 mg/L	0.01 mg/L
Dissolved arsenic	EPA 200.8	0.1 µg/L	0.5 ug/L
~~Dissolved cadmium~~	~~EPA 200.8~~	~~0.05 µg/L~~	~~0.25 ug/L~~
Dissolved chromium	EPA 200.8	0.2 µg/L	1.0 ug/L
Dissolved copper *	EPA 200.8	0.4 µg/L	2.0 ug/L
Dissolved Lead	EPA 200.8	~~0.075~~ 0.1 µg/L[1]	~~0.1~~ 0.5 ug/L[2]
Dissolved Nickel	EPA 200.8	0.1 µg/L	0.5 ug/L
~~Dissolved Selenium~~	~~EPA 200.8~~	~~1.0 µg/L~~	~~1.0 ug/L~~

Water Quality Parameters	Method	Reporting Detection Limit (KCEL Method Detection Limit)	Practical Quantitation Limit (KCEL Reporting Limit)
~~Dissolved Tin~~	~~EPA 200.8~~	~~0.3 µg/L~~	~~1.5 ug/L~~
Dissolved zinc	EPA 200.8	0.5 µg/L	2.5 ug/L
Total Recoverable Arsenic	EPA 200.8	0.1 µg/L	0.5 ug/L
Total Recoverable Chromium	EPA 200.8	0.2 µg/L	1.0 ug/L
Total Recoverable Copper	EPA 200.8	0.4 µg/L[3]	2.0 ug/L
Total Recoverable Nickel	EPA 200.8	0.1 µg/L	0.5 ug/L
Total Recoverable Lead	EPA 200.8	0.1 µg/L	0.5 ug/L
Total Recoverable Zinc	EPA 200.8	0.5	2.5
PAH-SIM	EPA-8270D	0.05 ug/L	0.1 µg/L
~~Semi-Volatile Petroleum Products (NWTPH-Dx)~~	~~NWTPH-Dx (GC/FID) - Ecology, 1997 (Publication No. ECY-97-602)~~	~~0.2 mg/L~~	~~0.2 mg/L~~
~~Fecal coliform (Turbidity <25 NTUs~~	~~SM9222D~~	~~1 cfu/100ml~~	~~1 cfu/100ml~~
~~Fecal coliform (Turbidity >25 NTUs~~	~~SM9222E~~	~~1 cfu/100ml~~	~~1 cfu/100ml~~

* King County Environmental Laboratory detection limit for dissolved copper is 0.4 ug/L using EPA method 200.8 without using EPA 1669 sample collection for ultra low trace metals ("clean hands/dirty hands" sampling). Automated sampler methodology is not suitable for ultra-low level analyses. Therefore, this slightly higher detection limit will be used for this project.

9.0. QUALITY CONTROL

9.1 Conventionals

Laboratory QC samples for conventional analyses and associated control limits are summarized below. These QC samples will be analyzed at a frequency of one per analytical batch of 20 or fewer samples.

Table 8. Conventionals QC Limits

Parameter	*Method Blank*	*Laboratory Duplicate %RPD*	*Spike Blank %Recovery*	*Matrix Spike %Recovery*	*Laboratory Control Sample %Recovery*
TKN	<MDL	20%	80-120%	70- ~~125~~ 130%	80-~~115~~ 120%
Nitrate + Nitrite	<MDL	20%	80-120%	75-125%	85-115%
Orthophosphate Phosphorus	<MDL	20%	80-120%	75-125%	85-115%
Total Phosphorus	<MDL	20%	80-120%	75-125%	85-115%
Total Suspended Solids	<MDL	25%	N/A	N/A	80-120%

9.2 Metals

Laboratory QC samples for trace metals analyses and associated control limits are summarized below. These QC samples will be analyzed at a frequency of one per analytical batch of 20 or fewer samples.

Table 9. Metals QC Limits

	QC Sample			
Parameters	*Method Blank*	*Laboratory Duplicate %RPD*	*Matrix Spike %Recovery*	*Spike Blank %Recovery*
Total Recoverable Metals	<MDL	20%	75-125	85-115
Dissolved Metals	<MDL	20%	75- ~~130~~ 125	85-115
Hardness	<MDL	20%	75- ~~130~~ 125	85-115

9.3 Organics QC

Laboratory QC samples for organic compound analyses associated control limits are summarized below. Unless otherwise noted below, these QC samples will be analyzed at a frequency of one per analy7tical batch of 20 or fewer samples.

Table 10. Organics QC Limits

Analysis	Method Blank	Spike Blank (% Recovery)	Matrix Spike % Recovery	MS/MSD RPD	Laboratory Duplicate (RPD)	Surrogate % Recovery
~~Semi-Volatile Petroleum Products (NWTPH-Dx)~~	~~<MDL~~	~~50-150~~	~~NA~~	~~NA~~	~~100~~ [a]	~~50-150~~

Table 11. Laboratory QC Limits for PAH-SIM Recoveries

	Matrix Spike		Spike Blank	
Parameter	**Lower Limit (%)**	**Upper Limit (%)**	**Lower Limit (%)**	**Upper Limit (%)**
Acenaphthene	~~47~~ 44	~~145~~ 94	37	99
Acenaphthylene	~~33~~ 51	~~145~~ 103	43	111

	Matrix Spike		Spike Blank	
Parameter	**Lower Limit (%)**	**Upper Limit (%)**	**Lower Limit (%)**	**Upper Limit (%)**
Anthracene	~~27~~ 50	~~133~~ 119	54	121
Benzo(a)anthracene	~~33~~ 62	~~143~~ 117	65	117
Benzo(a)pyrene	~~17~~ 38	~~163~~ 134	45	133
Benzo(b)fluoranthene	~~24~~ 62	~~159~~ 113	62	117
Benzo(g,h,i)perylene	~~10~~ 25	~~219~~ 122	29	134
Benzo(k)fluoranthene	~~11~~ 45	~~162~~ 120	50	121
Chrysene	~~17~~ 39	~~168~~ 115	44	114
Dibenzo(a,h)anthracene	~~10~~ 25	~~227~~ 138	34	140
~~Dibenzofuran~~ 2-Methylnaphthalene	40	160	40	160
Fluoranthene	~~26~~ 58	~~137~~ 115	63	115
Fluorene	~~59~~ 54	~~122~~ 113	54	104
Indeno(1,2,3-Cd)Pyrene	~~10~~ 38	~~171~~ 130	33	152
Naphthalene	~~21~~ 24	~~133~~ 85	15	93
Phenanthrene	~~54~~ 57	~~120~~ 108	54	107
Pyrene	~~52~~ 51	~~115~~ 142	54	136
2-fluorobiphenyl surrogate	33	96	same	
d14-terphenyl surrogate	63	125	same	

[a] ~~For NWTPH-Dx, the Laboratory Duplicate will be analyzed at a frequency of one per 10 samples or fewer.~~

* Extraction batch = 20 samples or less prepared within a 12 hour shift

**QC batch = 20 samples or less prepared over a 14-day period. Samples must be of the same matrix.

< MDL = Method Blank result should be less than the *method detection limit*.

RPD = Relative Percent Difference

NA = Not Applicable

Table 12. Microbiology QC Limits

Parameter	QC	Laboratory Duplicate	Before Filtration	After Filtration
~~Fecal Coliform~~	~~One set per 20 samples*~~	~~One per 20 samples*~~	~~One per 20 samples*~~	~~One per 20 samples*~~
	~~Positive and Negative Controls~~		~~One MF filter run before samples are processed through filtration system~~	~~One MF filter run after samples are processed though filtration system~~

~~*= If batches are less then 20 in size and received throughout the working day, then QC, LD, BF and AF are run on samples received over a 4 hour period of time.~~

~~Note: To meet NPDES requirements for fecal coliform analysis, samples must be delivered to the laboratory no later then 6 hours after collection.~~

9.4 QC Practices for Field Measurements

Procedures for collection of field parameters are documented in SOP NPDES FM 1000 - 5000 – *Standard Operating Procedures for Field Measurements (general): pH, Specific Conductance, Temperature, Dissolved Oxygen and Turbidity* (Regional Stormwater Standardization Project 2008) (Appendix C). Meter operation is verified through routine calibrations and daily calibration check standards. Dissolved oxygen readings are subject to a daily post-field calibration check.

Table 13. YSI 6920 Sonde Calibration And Daily Meter Check Criteria

Parameter	Schedule	Calibration Standard	Meter Check Standard[1]	Meter Check Standard Acceptance Criteria
DO	Daily	%Saturation in Air	%Saturation in Value	+/- 5% of % Saturation Value[2]
Specific Conductivity	Twice Monthly	1.000 mS/cm	0.5 mS/cm	+/- 3% (0.485 – 0.515 mS/cm)
Turbidity	Twice Monthly	0 NTUs 40 NTUs	20 NTUs	+/- 5% (18.0 – 22.0)
pH	Twice Monthly	7.0 10.0	~~7.42~~ 6.86	+/- 0.1 pH unit <u>Calibration Slope Values</u>: 7.0 mV = 0 +/- 50 10.0 mV = 177 +/- 50 Slope = 162 to 180 <u>Check Standards</u> ~~7.32 – 7.52~~ 6.79 – 6.93
Temperature	Twice Monthly	VWR Model 100A Digital Temperature Meter	Ambient Probe Comparison	1.0 °C
			Ice Bath	1.0 °C
Logger Date & Time	Daily	Clock In KCRMS Laboratory		+/- 1 minute

[1]Meter Check Standards and Criteria used for Daily Meter Calibration Checks and Twice Monthly Calibrations

[2] YSI % DO air saturation values can be verified by referencing Table 6 - Solubility of Oxygen in Water at Various Temperatures and Pressures R.F. Weiss (1970) U.S. Geological Survey, variously dated, *National Field Manual for the Collection of Water-Quality Data*: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.

9.5 Corrective Actions

Individual SOPs describe specific corrective actions for each analytical procedure and QC measure. If QC samples exceed their control limits, the analysis is repeated, if possible, or documented and affected samples qualified. If samples are lost or compromised, the project manager must determine whether to re-sample or to disregard the station for the specific parameter or event.

KCEL documentation and record keeping will follow standard protocols, as described in Kruger (2002). Within the analytical laboratory, each section and analytical procedure has its own documentation protocol. The minimum documentation required in the laboratory includes an instrument logbook, analysis log, calibration and analysis documentation, and Laboratory Information Management System (LIMS) hardcopy sheets.

For all analytical results generated by laboratory activities, sufficient hardcopy data must be stored such that a review could verify that the requirements of the reference method and SOP were met. The format of stored data may include logbook entries, field notes, bench-sheets, and printouts of instrument or data files. Storage of only the electronic version of these documents is not sufficient to meet current data storage requirements. Subcontracted tests are to document in a similar manner.

9.5.1 Logbooks

Hand written information used as supporting documentation, which is not stored directly with the analysis results, such as standards preparation records and equipment calibration checks, must be maintained in logbooks. All logbooks must be paginated. Logbooks prepared from instrument printout or other loose pages should be bound prior to storage. Logbook entries should be made using indelible black ink (no pencils) and dated and initialed. Logbooks and individual logbook entries must be uniquely identified if they are to be referenced in other documents. All deletions and corrections must be a single line cross-out, accompanied with the date and initials of the person making the correction.

10.0. DATA QUALITY ASSESSMENT, QUALIFICATION, AND REPORTING

10.1 Data Quality

Analytical data will be reviewed for compliance with the QC criteria presented in earlier sections of this QAPP. Data from the automated samplers will be uploaded after each storm event in the field. The automated field data will be downloaded to a computer network in the office that is backed up daily where it will be stored and managed using the ISCO Flowlink software program. As necessary, these data will also be exported to other software programs (e.g., Excel and Access) to facilitate analyses and reporting.

Data reported by the laboratory, including field measurements, must pass a review process before final results are available to the client. A "Peer Review" process is used where a second analyst or individual proficient at the method reviews the data set. The reviewer will complete a data review checklist which will document the completeness of the data package and if any QC failures exist.

Once data review is complete and all data quality issues have been resolved or corrected, the status of the data in LIMS will be changed to "approved". Once a data set has been approved, it is "posted" or transferred to the portion of the LIMS database known as the Environmental Data System (EDS) where all historical LIMS data are maintained. Signatures or initials of the laboratory lead and reviewer(s) indicate formal approval of hardcopy data or reports (non-LIMS), typically on the review checklist. A copy of this approved checklist should be stored with the final hardcopy data package.

10.2 Data Storage

Data will not be distributed outside each laboratory unit or to clients until it has met the full definition of final data. "Final Data" is defined as approved data posted to the historical database (EDS) or is otherwise in its final reportable and stored format (if not a LIMS parameter). This implies the data has been appropriately peer reviewed, properly qualified and is in its final format in terms of units and significant figures. Not only is final data assured of a higher level of quality through peer reviewing and qualification, but it will also match any future reports since it has come from the final storage location.

Procedures for the storage and disposal of hardcopy laboratory data are summarized in King County Environmental Laboratory's SOP #1105v1 (Records Storage) which is based on King County and Washington State governmental records storage requirements. It is the policy of the laboratory to store all data packages, supporting documentation, and project records for a minimum of ten years, based on the data of sample collection or field data measurement. The subcontract laboratory is responsible for its own records storage which should be at least ten years.

In LIMS, the final sample and QC data are maintained indefinitely in the EDS database, which is backed up daily. Additional LIMS information specific to sample management is maintained a minimum of one year past the data the final results were posted. Other types of electronic data such as instrument files may be stored but no laboratory-wide policy is currently available.

10.2.1 Data Packages

For each run or analysis sequence, a data package will be produced which will include all appropriate raw data for standards, samples, and QC analyses. Data packages must include the inclusive dates and times of the analyses and the identity of the analyst(s). If corrective actions were taken or a compromised sample was analyzed, the data package will contain a copy of the Data Anomaly for and/or a Compromised Sample Form (or their equivalent). Specific requirements for the contents of data packages are described in each method SOP. The analyst(s) who generated the data is responsible for compiling the data package and transferring it to the data reviewer. Prior to data review, the data packages are organized according to method SOPs. Data packages may reference other data sets or documents rather than requiring each data package to contain copies of all necessary information. All deletions and corrections to handwritten or printed documentation must be a single line cross-out, accompanied with the data and initials of the person making the correction.

10.3 Data Reduction, Review, and Reporting

All laboratory and field measurements will follow the procedures outlined in the KCEL's SOPs and QA Manual. Laboratory staff will be responsible for internal quality control verification, proper data transfer, and reporting data to the Project Manager via the Laboratory Information Management System (LIMS).

Information regarding the physical characteristics of each monitoring site (e.g., watershed area, watershed land use, number of inflow points) will be compiled prior to final site selection from various sources including field reconnaissance, geographic information system (GIS) analysis, as-builts, hydraulic reports, and other records. These physical characteristics will be incorporated into the quarterly and final monitoring reports.

Analytical and hydrologic data (i.e. flow and precipitation data) collected in association with this monitoring program will be reviewed for quality assurance purposes. These data will be examined for gaps, anomalies, or inconsistencies between the discharge, water level, and/or precipitation data from the various monitoring stations. In the event that quality assurance issues are identified on the basis of these reviews, a site visit will be performed immediately to troubleshoot the problem and to implement corrective actions if possible. Any quality assurance issues that are detected through these reviews will be documented in the electronic data record and in separate tracking forms. This review will be performed to ensure that all data are consistent, correct, and complete, and that all required quality control information has been provided. Quality control elements identified in the Quality Objectives section will also be examined to determine whether the data quality objectives for the project have been met. Results

from these reviews will be documented in quality assurance worksheets that will be prepared for each batch of samples. In the event that a potential quality assurance issue is identified through these reviews, the quality assurance technical lead will review the data to determine whether any response actions are required. Response actions in this case might include the collection of additional samples or the reanalysis of existing samples.

Qualifiers will be applied to water quality data during the data quality review process.

Table 14. Laboratory Qualifiers

Qualifier	Description
General	
H	Indicates that a sample handling criterion was not met in some manner prior to analysis. The sample may have been compromised during the sampling procedure or may not comply with holding times, storage conditions, or preservation requirements.
R	Indicates that the data are judged unusable by the data reviewer. The qualifier is applied based on the professional judgment of the data reviewer rather than any specific set of QC parameters and is applied when the reviewer feels that the data may not or will not provide any useful information to the data user.
<MDL	Applied when a target analyte is not detected or detected at a concentration less than the associated method detection limit (MDL). The MDL is the lowest concentration at which a sample result will be reported.
<RDL	Applied when a target analyte is detected at a concentration greater than or equal to the associated MDL but less than the associated reporting detection limit (RDL). RDL is defined as the lowest concentration at which an analyte can reliably be quantified.
RDL	Applied when a target analyte is detected at a concentration that, in the raw data is equal to the RDL.
TA	Applied to a sample result when additional narrative information is available in the text field. The additional information may help to qualify the sample result but is not necessarily covered by any other qualifier.
Chemistry	

Qualifier	Description
B	Applied to a sample result when an analyte was detected at a concentration greater than the MDL in the associated method blank. The qualifier is applied when the sample concentration is less than ten times the blank concentration (5 times the blank concentration for Trace Organics). The qualifier indicates that the analyte concentration in the sample may be significantly influenced by laboratory contamination.
E	Applied to a sample result that was measured at a concentration greater than the calibration range of the method. It is applied when the detected analyte concentration exceeds the upper instrument calibration limit and further dilution is not feasible. The reported value is an estimated analyte concentration.
J	Applied to a sample result that is considered an estimated value.
JG	Applied to a sample result that is considered an estimated value with a low bias. This will typically be applied when QC results indicate the recovery of the analyte is below the expected limits of the method.
JK	Applied to a sample result that is considered an estimated value with an unknown bias. This will typically be applied when QC results indicate the method precision did not meet the expected limits of the method.
KL	Applied to a sample result that is considered an estimated value with a high bias. This will typically be applied when QC results indicate the recovery of the analyte is above the expected limits of the method.
Microbiology	
FAIL	The result of the positive or negative control failed (applied to QC results only)
PASS	The result of the positive or negative control passed (applied to QC results only)
C	Value is an estimate, based on presence of confluent growth

10.4 Audits

10.4.1 Laboratory Audits

Audits will be performed by the laboratory project manager (Fritz Gothkopp) after analysis of each sample batch has been completed and submitted for review by the analyst. The results of this audit are presented as a cover letter attached to the hard-copy laboratory report sent to KCRMS. This audit reviews laboratory QC criteria (including the condition of samples upon receipt and laboratory QC addressed in this QAPP). The audit calls out any qualifiers that have been applied to the data contained in the report. KCRMS technical lead (Jim Crawford) will review each laboratory audit report as well as the attached QC data set (method blanks, spike blanks, laboratory duplicates, matrix spikes and laboratory control samples) to confirm the reported QC criteria have been addressed in the audit report. Reviewed data sets will be entered into internal KCRMS databases; once entered a second staff member (Jake Finlinson) will conduct spot checks on the database to confirm accurate transfer of data.

Corrective action will include contacting the laboratory project manager to address any QC discrepancies, and the resolution will be documented. Corrective action for any qualifiers that relate to the integrity or condition of samples received by the laboratory will be addressed by reviewing procedures with the field staff, and the review will be documented.

10.4.2 Field Audits

Field data are collected by data loggers connected to primary flow devices and an autosampler. During routine site visits and visits to setup sampling equipment, field staff document readings from the equipment, document adjustments to the equipment, and note the equipment condition and maintenance needs. Field notes will be stored in project files and data will be transferred to appropriate electronic files.

Field audits will include review of field forms and notes collected by field staff for each monitored storm event by the technical lead (Jim Crawford). Forms will be reviewed for completeness, and any recommended maintenance issues noted will be addressed and scheduled. Entry of data from field forms into KCRMS databases will be reviewed by Jake Finlinson.

Audits will include review of each storm sampling data set by the technical lead, including aliquots and storm hydrographs to verify sampling events that successfully meet storm criteria presented in this QAPP. Corrective action will address sampling attempts that do not result in composite samples that meet the specified criteria. This will include review of storm predictions, rainfall and sample pacing predictions, autosampler calibration and programming procedures, and integrity of the flow monitoring device.

Field audits at the BMP monitoring locations will be made on a quarterly basis by the technical lead to verify the integrity of the primary flow measuring device and to review the operation of field monitoring equipment. Corrective action may include repairs to the flow device, additional equipment maintenance and training for field staff.

10.4.3 MDLs

If concentrations are below MDLs for dissolved metals sampled during storms, a determination will be used to equate the non-detects to a typical 0.5 MDL.

10.5 Monitoring Reports

The final monitoring report will include:

- OVERVIEW DESCRIPTION OF PROJECT: Review of the water quality problem being addressed and generally how this project was going to accomplish problem resolution.
- OUTCOME: a description of what the project accomplished, how it was accomplished, and a summary of what was not done and why. This review will address important challenges/obstacles that were faced and addressed.
- EVALUATION: Why was the project successful or unsuccessful? What is the significance of the project's outcome(s). WHAT ARE THE WATER QUALITY BENEFITS.
- QUALITY ASSURANCE: What was done to analyze the credibility of the data collected. What are the results of the analysis?
- FOLLOW-UP: What remains to be done and how will it be accomplished. Will the project be continued with or without grant funding? Maintenance activities will be addressed
- GENERAL COMMENTS to address issues that do not fit easily into the above categories.
- Appendix to include any additional important documents.
- Include Recipient's name and Agreement Number at the top of each page following the cover page.

- Number pages at bottom
- Include photo documentation of site conditions, equipment setup, vandalisim or other anomalies.

Sampling results from individual BMPs will be summarized in individual storm reports.

Summaries will be produced for each sampled storm event and will include the following specific information: precipitation amount and duration of the event; number of sample aliquots collected at each station; coverage of composite sampling at each station over the storm hydrograph; summary statistics for flow data collected at each station; pollutant values measured in samples collected at each station; and apparent pollutant removal efficiencies for each parameter based on analytical values and total stormflow. Finally, the reports will summarize all quality assurance issues associated with the data based on the results of the audits and the data validation and verification review.

10.6 Data Verification and Validation

Data verification will be conducted using data collected on field sheets and results of laboratory analysis. Narrative summaries will be created by a laboratory project manager to accompany each laboratory report highlighting any anomalies that may need addressing and possible corrective actions to take. Narrative summaries of the field sampling process will be prepared by the monitoring project manager to address anomalies and corrective actions that may be required in the field.

The monitoring project manager will be responsible for ensuring that field data have been reviewed for quality assurance information including:

- Accuracy in transcribing field and electronic data
- Changes in, and deviations from, the QAPP
- Results of performance and/or system audits
- Significant quality assurance problems and recommended solutions
- Data quality assessment results in terms of precision, bias, representativeness, completeness, comparability, and reporting limits
- Discussion of whether the quality assurance objectives were met, and the resulting impact on decision-making

Validation of data will be conducted through laboratory QC processes previously described and during the QC process for in-situ field measurements and field data transfer.

10.7 Data Usability

Data collected during storm and base flow events will be used to calculate event-mean concentrations of pollutants, and produce storm-flow hydrographs to demonstrate differences in water quality and storm flow regimes above and below various BMP designs. These data will be used to asses the effectiveness of the BMPs in removing pollutants and/or in moderating stormflow peaks.

11.0.REFERENCES

Ecology, 2007. Washing State Department of Ecology. Phase 1 Municipal Stormwater Permit. Olympia WA. January 17, 2007

ISCO 2006 *Isco Open Channel Flow Measurement Handbook* Sixth Edition. Edited by D. Walkowiak, M.A. Teledyne Isco, Lincoln, Nebraska

Appendix A

Ecology Quarterly Reporting and Final Report Formats

WA DEPARTMENT OF ECOLOGY

WATER QUALITY PROGRAM

PROGRESS REPORT FORM

Funding Source: ☐ 319 ☐ Centennial ☐ DIF ☐ Revolving Fund

☐ Reclaimed Water ☐ Stormwater

Grant/Contract/Loan Number:

Project Title:

Project Period:

Recipient Organization:

Recipient Project Manager:

Reporting Period:

Date This Form Was Prepared:

Ecology Contacts:

Regional Project Manager:

Financial Manager:

Funding: Total Eligible Cost: $

Total Ecology Award: $

Total Expenditures to Date: $

Task and Milestone Achievements (for current reporting period only)

Task 1 – Project Administration/Management

Activities

Task 2 – (title)

Activities

Task 3 – (title)

Activities

Task 4 – (title)

Activities

Tasks/Milestones not achieved and why

Potential Future Challenges to Performance (time delays, staff changes, etc.)

General Comments

List the cumulative totals for all numerically measurable accomplishments for this calendar year

(Example: amount of riparian area planted, length of fencing installed, technical assistance, conservation plans, etc)

SUGGESTED FORMAT FOR FINAL PROJECT REPORTS

for

STORMWATER MANAGEMENT IMPLEMENTATION GRANT PROJECTS

- COVER PAGE: Sample attached

I. OVERVIEW DESCRIPTION OF PROJECT: What was the water quality problem being addressed and generally how was this project going to do it.

II. OUTCOME: Using the project tasks as your guide, describe what the project accomplished and how. Also what was not done and why. Use numbers and/or specific examples if possible. Describe any important challenges/obstacles you faced and how you addressed them.

III. EVALUATION: Why was the project successful or unsuccessful? What is the significance of the project's outcome(s). WHAT ARE THE WATER QUALITY BENEFITS.

IV. QUALITY ASSURANCE: What was done to analyze the credibility of the data collected. What are the results of the analysis?

V. FOLLOW-UP: What remains to be done and how will it be accomplished. Will the project be continued with or without grant funding? (Be sure to mention maintenance activities)

VI. GENERAL COMMENTS: Optional, if you have comments that do not fit easily into the above categories.

- Include any additional important documents required under your agreement.
- Include Recipient's name and Agreement Number at the top of each page following the cover page.
- Number pages at bottom
- Include photo documentation

Appendix B

Project Documentation Forms

KCRMS In-Line Ditch BMP Stormwater Sampling Field Form

Date: _____ Field Staff: _____
Site: Sample ID:

Storm Setup:
Watch Time[1]: Flow Meter Time: Sampler Time:

Flume/weir[2]		Auto Sampler: Isco 6712	
Water Depth (feet)	_____	Measure Grab Sample Volume	_____
Flow Meter: 4230 bubbler		Check All tubing	_____
Level (feet)	_____	Check/set inlet screen	_____
Flow (gpm)	_____	Pump 2 gall. RO water	_____
Zero Totalizer:	_____	Put Clean Bottles In Cooler	_____
Sampler Control Tab:		Attach Tubing	_____
Set Enable Criteria	_____	Add Ice	_____
Select Trigger	_____	Review Program:	_____
Reset Latch	_____	Set Pacing/Pulse Value	_____
Verify Pacing (10 gpm)	_____	Set sample volume	_____
Click Apply button	_____	Run Program	_____
Battery: Volts > 12.5?			

Temperature Probes Lanched and placed?

Mid-Storm Check Date: _____ Watch Time[1]: _____ Flow Meter Time: _____ Staff: _____

Flume/weir[2]		Auto Sampler Isco 6712	
Remove Debris?	_____	Enable OK?	_____
Water Level (feet)	_____	No. of Grabs Collected:	_____
Meter: 4230 bubbler		Errors Listed?	_____
Level (feet)	_____		
Flow (gpm)		Battery: Volts > 12.5?	

Grab Samples Collected?
TPH Fecals (6 hr hold time for Fecals) Date: Watch Time[1]:

Water Quality Sonde Reading:			
Sonde No. _____	DO	_____	mg/L
	pH	_____	
Cal. Date: _____	Temperature	_____	°C
Daily Check? _____	Conductivity	_____	mS/cm
	Turbidity		NTUs

Post-Storm Check Date: _____ Watch Time[1]: _____ Flow Meter Time: _____ Staff: _____

Flume/weir		Auto Sampler Isco 6712	
Water Depth (feet)	_____	Date/Time of First Successful Aliquot[3]:	_____
Flow Meter 4230 bubbler		Date/Time of Last Successful Aliquot[3]:	_____
Level (feet)	_____	Number of Aliquots collected	_____
Flow (gpm)	_____	Download Sampler	_____
Totalizer Reading:	_____	Save Report File	_____
Download Meter	_____	Review Hydrograph & Aliquots	_____
Save History File (Device Tab)		Sample Volume Collected	

Flow & Composite Sample Review:
Flow Meter: % of storm hydrograph recorded: _____
Total Storm Volume (gals) _____
Percent of Storm Sampled? _____
Antecedent Dry Period (hours) _____
Inter-storm dry period (hours)

Specific Maintenance Needs/Comments:

[1]Watch (cell phone or laptop) Time: Meters kept in PST, one hour earlier than Daylight Time
[2]Water Level: for Thel-Mar Weirs subtract 0.017 ft from water level reading measured at bubble tube.
[3] Date Time of first and last successful aliquots are sample times for COC.

H:\Programs\Ditch Stormwater BMP Grant\DG Field Operations\Field Documents\Ditch SW Monitoring Forms_REV 11-20-09.xls\Storm_Sampling

Site_____

KCRMS In-Line Ditch Flow Monitoring Site Visit Station Check Sheet

192 Mid-Point

Site: **PETROVITSKY** Station: **192M** **Petrovitsky at SE 192nd Mid-point Station**

Date: Field Staff:

1) Pre-Maintenance Water Level Measurements (feet):

Time (PST)[1]	**Flume Water Depth**[2]	Logger Level	Logger Offset
			NA (Isco bubble Meter)

2) Meter Check:

Flume:	Structure OK?	Yes	No		
	Removed Debris?	None	Yes:		
	Flushed Stilling Well?	Yes	No		
Flow Meter	Meter Time[1]:			Watch Time[1]	Adjusted? Yes/No
	Offset Adjusted?	Yes	No	Adjustment:	
	Desiccant Ok?	Yes	No	Replaced? Yes	No
	Downloaded?	Yes	No		
Battery	Volts			(Replace at 12.2 Volts)	
	Replaced?	Yes	No		

3) Post-Maintenance Water Level (feet):

Time (PST)[1]	**Flume Water Depth**[2]	Logger Level	Logger Offset
			NA (Isco bubble Meter)

Maintenance Needs/Comments

192 DOWNSTREAM

Site: **PETROVITSKY** Station: **192DN** **Petrovitsky at SE 192nd Downstream Station**

Date: Field Staff:

1) Pre-Maintenance Water Level Measurements (feet):

Time (PST)[1]	**Flume Water Depth**[2]	Logger Level	Logger Offset

2) Meter Check:

Flume:	Structure OK?	Yes	No		
	Removed Debris?	None	Yes:		
	Flushed Stilling Well?	Yes	No		
Flow Meter	Meter Time[1]:			Watch Time[1]	Adjusted? Yes/No
	Offset Adjusted?	Yes	No	Adjustment:	
	Desiccant Ok?	Yes	No	Replaced? Yes	No
	Downloaded?	Yes	No		
Battery	Volts			(Replace at 12.2 Volts)	
	Replaced?	Yes	No		

3) Post-Maintenance Water Level (feet):

Time (PST)[1]	**Flume Water Depth**[2]	Logger Level	Logger Offset

Maintenance Needs/Comments

[1] Note if time is recorded in Pacific Daylight Time (PDT) or Pacific Standard Time (PST - 1 hour earlier than daylight time)

[2] Verify water depth with steel tape.

H:\Programs\Ditch Stormwater BMP Grant\DG Field Operations\Field Documents\Ditch SW Monitoring Forms_REV11-20-09.xls Ditch SW Monitoring Forms_REV11-20-09.xls 192 Flow Check

KCRMS Autosampler Pacing

				Upstream						Downstream				
Site	**Location**	**Station**	**Storm Date**	**Rainfall (inches)**	**Flow (gallons)**	**Pacing Used**	**Aliquots Obtained**	**Target Pacing**	**Station**	**Rainfall (inches)**	**Flow (gallons)**	**Pacing Used**	**Aliquots Obtained**	**Target Pacing**
Old Pet	**1**	**OPUP**							**OPDN**					
192	**2**	**192UP**							**192M**					

Appendix C

SOPs

SOP NPDES FM 1000 - 5000 – Standard Operating Procedures for Field Measurements (general): pH, Specific Conductance, Temperature, Dissolved Oxygen and Turbidity

SOP NPDES DS 2000 - Standard Operating Procedures for the Grab Sampling of Surface Storm Water

SOP # 06-05-002-001 Trace Metals Section Labware and Equipment Cleaning Procedures

SOP # 07-04-001-002 Glassware Cleaning Procedure

DRAFT