Quality Assurance Project Plan For Targeted Stormwater Management Program Effectiveness Monitoring

Conducted Under the Phase 1 Municipal Stormwater Permit

by

Port of Tacoma

FINAL

August 2009

Approved by:

Sue Mauermann, Director of Environmental Programs
Port of Tacoma

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Permittee Number WAR 04-4200

TITLE AND APPROVAL PAGES

Review and Approval

Name/Title/Organization	Signature	Date
Lisa Rozmyn, Port of Tacoma Stormwater Project Manager	[signature]	8/13/09
Cindy Lin, Port of Tacoma Compliance Manager	[signature]	8/14/09

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.

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DISTRIBUTION LIST

Title	Name/Affiliation	Telephone No.	version [1]
MS4 Permit Manager	Kurt Fremont/Washington Department of Ecology (Ecology)	(360) 407-6300	electronic, hard copy
MS4 Permit Planner	Julie Lowe/Ecology	(360) 407-6000	electronic

1. Specify if electronic copy or hardcopy

2.0 BACKGROUND

Quality assurance (QA) involves all planned and systematic actions necessary to ensure that activities are performed in accordance with accepted standards and that the resulting data are valid. Quality control (QC) is an integral part of the overall quality assurance function and includes all actions necessary to control and verify that sample collection activities and the resulting data meet established requirements. This section presents the purpose and overview of the Quality Assurance Project Plan (QAPP) developed for this project; an overview of the Phase I Municipal Stormwater Permit; Port of Tacoma (Port) properties under the control of the Phase I Permit; and the selection of a target environmental outcomes to be monitored by the Port.

2.1 PURPOSE AND OVERVIEW OF THIS QAPP

The purpose of this Quality Assurance Project Plan is to present the quality assurance and quality control (QA/QC) procedures for field activities and laboratory analyses associated with the Targeted Stormwater Management Program Effectiveness Monitoring. These activities will be conducted by the Port, as required by Section S8.E of the National Pollutant Discharge and Elimination System and State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems (MS4 permit).

Each permittee shall conduct monitoring designed to determine the effectiveness of the permittees' stormwater management program (SWMP) at controlling a stormwater related problem directly addressable by targeted actions in the SWMP. The stormwater management program effectiveness monitoring component shall be designed to answer one of each type of the following questions:

(1) The effectiveness of a targeted action (or narrow suite of actions), and

(2) The effectiveness of achieving a targeted environmental outcome.

At a minimum, the monitoring shall include stormwater, sediment or receiving water monitoring of physical, chemical and/or biological characteristics. The monitoring may also include data collection and analysis of other programmatic measures of effectiveness such as surveys and polls. Monitoring to identify sub-basin-specific water quality problems and characterize discharges for planning purposes may also be included.

For each of the two questions selected for monitoring, permittees shall develop a monitoring program containing the following elements:

- Description of the targeted action/targeted environmental outcome and a explanation of why it is significant to the permittee, and if the problem is significant to other stormwater managers;
- Specific hypotheses about the targeted action/targeted environmental outcome that will be tested by the monitoring problem;
- Specific parameters of attributes to be measured; and
- Modifications to management actions that are expected depending on the outcome of hypotheses testing.

Per Section S8.E of the MS4 permit, the Port will address the Targeted Stormwater Management Program Effectiveness Monitoring requirements by conducting monitoring to address:

- A Targeted Environmental Outcome – increase maintenance, enforce anti-idling policy to reduce diesel particulates from drayage trucks, and fitting catch basins with inserts thereby improving stormwater discharges from one of the Port's truck waiting yards and,
- A SWMP Targeted Action – Operations Employee training, Port drayage trucking customer education, and Port longshore breakbulk unloading procedural education.

This QAPP addresses the sediment monitoring program proposed for the Targeted Environmental Outcome (i.e., increased source reduction effort, consisting of more frequent inspection and maintenance). The approach and monitoring program associated with the selected SWMP Targeted Action (i.e., Operations Employee training and drayage trucking customer education) is being developed and is included as Appendix A to this QAPP.

2.2 PHASE 1 MUNICIPAL STORMWATER PERMIT

The Washington State Department of Ecology (Ecology) issued the final *National Pollutant Discharge and Elimination System (NPDES) and State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems* on January 17, 2007. The MS4 permit applies to all entities in Washington State required to have permit coverage under current (Phase I) U.S. Environmental Protection Agency (EPA) stormwater regulations. This includes cities and unincorporated portions of counties whose populations exceed 100,000. In accordance with the MS4 permit, permittees are required to develop and implement a comprehensive long-term monitoring program consistent with Special Condition S.8 of the permit. In general, the monitoring program shall include three components:

- Stormwater Monitoring (S8.D),
- Stormwater Management Program (SWMP) Effectiveness Monitoring (S8.E), the subject of this QAPP document, and
- Stormwater Treatment and Hydrologic Management Best Management Practices (BMP) Evaluation Monitoring (S8.F).

Ecology's objective in requiring a monitoring program is to provide a basis for the future reduction of stormwater pollutants. The information developed from monitoring establishes a baseline for evaluation of the effectiveness of stormwater management strategies. It may also assist in the identification of seasonal trends that may influence the interpretation of monitoring results.

2.3 Targeted Stormwater Management Program Effectiveness Monitoring

Per Section S8.E of the MS4 permit, the Port of Tacoma is required to conduct monitoring designed to determine the effectiveness of the Port's SWMP at controlling a stormwater problem that can be directly addressed by targeted actions outlined in the Port's SWMP. The Targeted SWMP Effectiveness Monitoring has been designed to answer the following questions:

- Question #1—The Effectiveness of Achieving a Targeted Environmental Outcome: To address Section S8.E.1.b of the Permit, the Port has selected to evaluate the effectiveness of a source control enhancement (i.e. increased maintenance frequency, anti-idling enforcement, and fitting catch basins with inserts at the trucks waiting/parking area) for its Targeted Environmental Outcome.
- Question #2—The Effectiveness of a SWMP Targeted Action: To address Section S8.E.1.a of the Permit, the Port has selected to evaluate the effectiveness of operations employee and drayage trucking customer training as its SWMP Targeted Action.

Question #1—Targeted Environmental Outcome:

The Port proposes to evaluate the effectiveness of source control enhancement as its Targeted Environmental Outcome. To evaluate the effectiveness of a combination of increased maintenance activities including sweeping and catch basin cleaning, enforcing anti-idling of drayage trucks and fitting catch basins with inserts thereby improving stormwater discharges from one of the Port's truck waiting yards, a baseline sediment quality monitoring program will be initially established. These source control activities will be conducted and then evaluated for their net benefits to water quality enhancement. The results of this monitoring may be used to improve the effectiveness of the Port's operations and maintenance.

Question #2—SWMP Targeted Action:

The Port proposes to evaluate the effectiveness of operations employee and drayage trucking customers training as its Targeted Action. The Port's existing employee training program will be reviewed and revised to improve annual training program and update Operations and Maintenance employees' understanding of stormwater practices and behaviors that are likely to reduce pollutants in stormwater runoff. The targeted outcome is an improved understanding among operations employees and the Port customers of beneficial stormwater practices and behaviors. Effectiveness monitoring will include data collection and analysis through surveys and/or polls (per Permit §S8.E.1.a) to be conducted prior to and after targeted operations employee training efforts and customer outreach. The required monitoring plan (per Permit §S8.E.3) for the Targeted Action component is being developed and will be included as Appendix A to this QAPP. This will be completed and submitted to Ecology for review prior to the monitoring implementation deadline of April 12, 2009.

The purpose of this QAPP is to describe the Targeted Environmental Outcome component of the Targeted Stormwater Management Program Effectiveness Monitoring, as described in Question #1 above.

2.4 Relevant SWMP Components and Relationship to Effective Monitoring

The Port currently performs a wide array of source control activities including: scheduled sweeping of parking lots and other areas associated with cargo terminals; catch basin and other system cleaning and preventative maintenance at terminals and rail yard facilities; and other related activities. Through the development of the Phase I Municipal Stormwater Management Program, the Port of Tacoma will identify and implement measures to prevent and control the contamination of stormwater discharges to local receiving waters. This includes both operational and structural source control BMPs. Stormwater Pollution Prevention Plans (SWPPPs) will also be developed for appropriate Port of Tacoma properties (per Permit §S6.E.7). Ecology's *2005 Western Washington Stormwater Manual* source control BMPs that currently apply to Port properties will also be included in the development of SWPPPs.

For this study, the Port will monitor the effectiveness of a set of source control and maintenance actions at reducing stormwater pollutants that enter receiving waters from Port properties. The management actions selected for the study are representative of the activities that occur on Port properties under the control of the MS4 permit, as discussed below.

2.5 Properties Under the Control of the NPDES Phase I Permit

The Port of Tacoma (Port) owns approximately 3,430 acres of land: 2,564 acres are located on the Tacoma Tideflats, 121 acres in the unincorporated Pierce County, and 745 acres in the unincorporated Thurston County as shown in Figure 1. At this time, the Port is actively pursuing divestment of the Thurston County property. For this reason, no analysis for this property is included in this document.

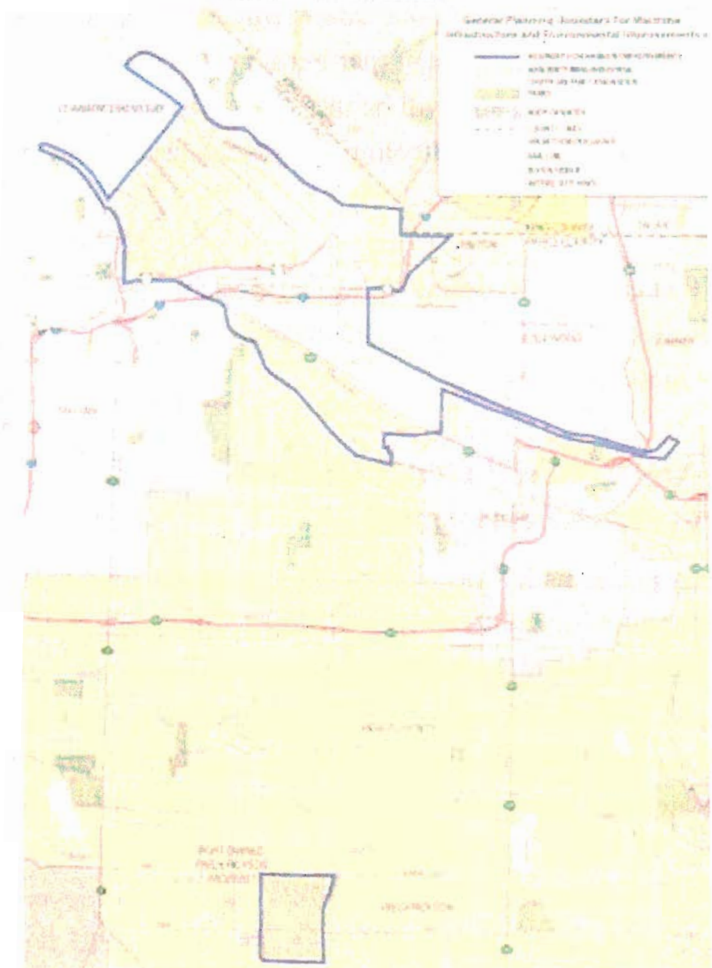

Figure 1. Vicinity map of Port properties

The 2,700 acres of Port property located on the Tacoma Tideflats and in unincorporated Pierce County borders the Puyallup River, the Hylebos, Blair and Sitcum Waterways, and Commencement Bay. These properties encompass a variety of industrial, commercial, shipping terminals, intermodal facilities, vacant land and mitigation/conservation areas that are utilized for shipping, manufacturing, warehousing, distribution and mitigation activities. A port parcel map for these properties is shown in Figure 2.

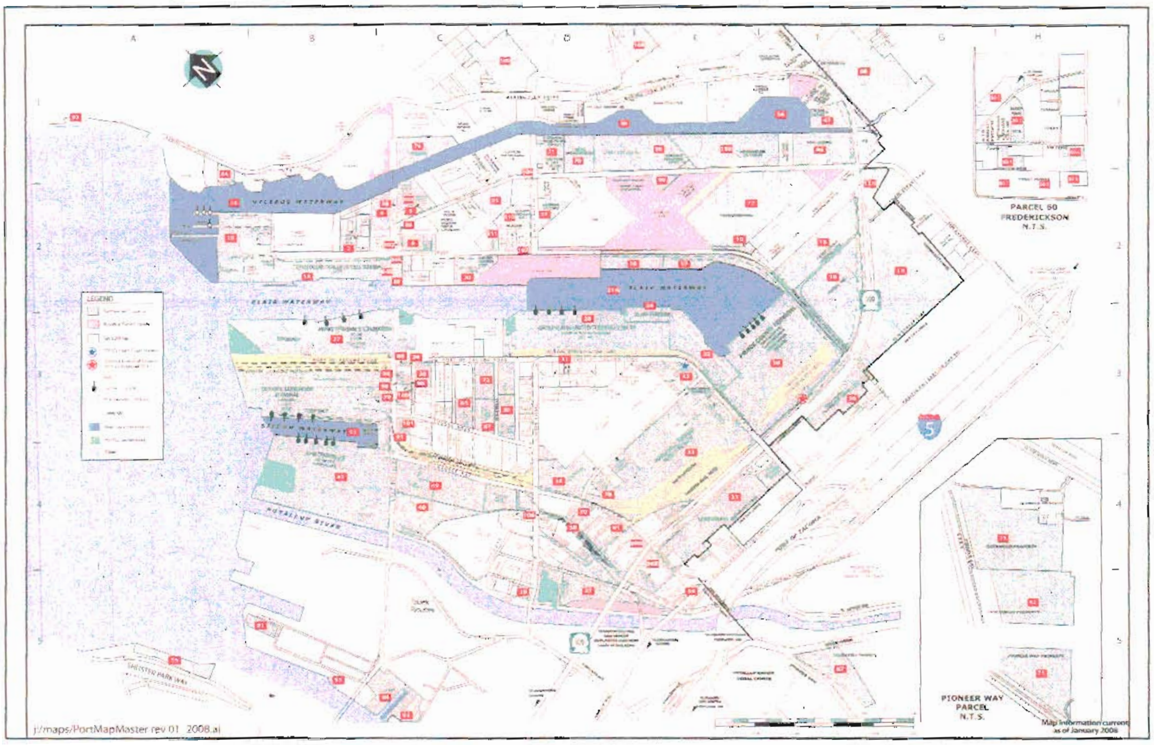

Figure 2. Port of Tacoma parcel map for properties located on the Tacoma Tideflats and unincorporated Pierce County.

Most of the industrial and municipal tenants on the Tacoma Tideflats are already under Industrial NPDES permits of their own, with on-site monitoring requirements specific to their business. These tenants must meet discharge standards independent of those required in the Port's NDPES I Stormwater Permit. Table 1 provides a breakdown of Port properties by NPDES permit type.

An analysis of Port properties shown in Table 1 reveals that approximately 746.8 acres (or 26.7%) of properties are covered under the Port's NPDES Phase I Municipal SWMP and areas where required stormwater monitoring could be performed. The remaining properties are either covered under other NPDES permits, have no discharge or are connected to the municipal sewer system, or are located within the Blair-Hylebos Peninsula redevelopment area. Properties located within the Blair-Hylebos Peninsula were not considered for monitoring since the peninsula is in the beginning stages of a major redevelopment project that is expected to continue through the year 2012. Figure 3 shows the current NPDES parcels by permit type.

Table 1. Port of Tacoma properties categorized by NPDES permit type

Permit Type	Acres	Percentage	Comments
General Permits	1041.6	37.3	Industrial and Boatyard properties included
No Discharge or Sewer Connected	318.7	11.4	
Blair-Hylebos Peninsula	688.5	24.6	Properties located within the Blair-Hylebos Peninsula redevelopment area.
Municipal Permit Area	746.8	26.7	Properties covered under NPDES Phase I Municipal SWMP. Includes Port and tenant operated and maintained properties.
Total:	2795.6		

Figure 3. Port parcel map by NPDES type

Properties falling under the Municipal Permit Areas were further reviewed and categorized by land use activity, as shown in Table 2. The land use evaluation reveals that the predominant use of Municipal Permit properties is vacant or natural areas, however, this land use category would not provide representative data comparable to other Municipal permittees. The next two dominant categories include new auto storage (10.3%) and general parking (7.2%). While new auto storage covers more acreage, general parking includes more than three times as many parcels and therefore is spread out around more of the Port properties. In addition, the higher turnover rate in general parking should generate more pollutants and be more representative of stormwater runoff from Port of Tacoma properties. For these reasons, the general parking land use sub type has been selected as the most appropriate land use for the Targeted Stormwater Management Program Effectiveness Monitoring. The process used to select a monitoring site from among these properties is described in Section 6.1.

Table 2. Dominant land uses in Port of Tacoma NPDES Phase I Municipal Permit area

Land Use	Acres	Percentage	Comments
Vacant/Natural Areas	493.3	66.1	Includes wetlands, vacant land, landscaped areas, and tidelands
New Auto Storage	77.0	10.3	
General Parking	53.9	7.2	Parking areas exposed to rainfall
Buildings	44.2	5.9	Includes warehouse, commercial, residential, and vacant buildings
Equipment Storage	37.3	5.0	
Container Parking	22.0	2.9	
Other	19.2	2.6	Includes roads, docks, and paved rail areas
Total:	746.8		

2.6 Selection Of Targeted Environmental Outcome To Be Monitored

Given the land use within the NPDES Phase I permitted area and the critical gate functions of the drayage trucks, the Port of Tacoma will focus on a targeted environmental outcome associated with implementing increased management activities at a representative Port property. The source control and maintenance activities that are being evaluated in this study are source control inserts in the catch basin servicing the truck waiting areas, increased routine maintenance activities including sweeping and catch basin cleaning, and enforcing anti-idling of drayage trucks. Specifically, the Port will conduct Targeted Stormwater Management Program Effectiveness Monitoring to evaluate the effectiveness of increased stormwater pollutant source control and maintenance activities at reducing the amount of certain stormwater constituents entering the Commencement Bay from a representative property. Storm drain sediment quality and relative quantity will be monitored prior to and after the implementation of the source control enhancements. The data collected will be used to assess if the increased stormwater management practices result in less sediment passing through the storm drains and at lower constituent concentrations.

3.0 PROJECT DESCRIPTION

This section presents the goals and objectives of the project; describes the boundaries, target populations and practical constraints of the study; and specifies the information and data required to meet the study objectives.

3.1 PROJECT GOALS

The goal of this project is to evaluate the effectiveness of increased stormwater pollutant source control and operational best management practices, specifically increasing routine maintenance activities including sweeping and catch basin cleaning, installing catch basin inserts and enforcing anti-idling of drayage trucks, for reducing the amount of certain stormwater constituents entering the Commencement Bay from a Port owned property (targeted environmental outcome).

3.2 PROJECT OBJECTIVES

The objectives of the project include:

(1) In a representative drainage basin, sample the quantity and quality of storm drain sediment during a "baseline" period when regular drayage truck operations are conducted and catch basin servicing are occurring in the drainage basin at a recommended frequency.

(2) In the same drainage basin, sample the quantity and quality of storm drain sediment during a "treatment" period after catch basin inserts are installed in catch basins within the drainage basin and anti-idling and increased maintenance activity policies are enforced.

(3) Determine from the data collected for objectives 1 and 2, if the source control enhancements result in less sediment passing through the storm drains and lower concentrations of certain constituents in these sediments.

3.3 INFORMATION REQUIREMENTS

Information required to meet the study objectives include:

- The volume and weight of material and concentrations of specific constituents in sediment samples that are continuously accumulated in selected storm drains during a "baseline" period (Objectives 1, 3), and

- The volume and weight of material and concentrations of specific constituents in sediment samples that are continuously accumulated in selected storm drains during a "treatment" period (Objectives 2, 3).

3.4 Data Collection

Sediments will be collected from selected storm drain monitoring sites using sediment traps during the "baseline" and "treatment" periods. At least annually, the collected sediments will be measured for volume, weighed, and analyzed for parameters that have been shown to be associated with stormwater discharges.

3.5 Target Population

For monitoring programs such as this, observations are made or samples are collected to describe "target populations". In this case, the target populations are characteristics of sediment coming from Port properties covered under the NPDES Phase I Municipal Stormwater Permit that are subject to specific management practices. Specific characteristics (or target populations) include:

- Sediment volume and weight, and
- Concentrations and loads of specific constituents in sediment carried by stormwater.

One representative sub-basin will be sampled to characterize these populations.

3.6 Study Boundary

The study area boundaries encompass Port-owned land covered under the jurisdiction of the NPDES Phase 1 Municipal Stormwater Permit as shown in Figure 3.

3.7 Practical Constraints

Practical constraints facing this monitoring project include limitations around site selection, physical characteristics of the monitoring site, operational activities at the monitoring site, equipment limitations and uncertainties inherent to this type of sampling.

- Limitation around site selection include:
    - It is the Port's intention to perform sampling on areas covered by the Municipal Stormwater permit and not those areas covered under a General Permit (i.e. Industrial Stormwater or Boatyard permit). The rationale for this is that these other permitted properties are already under a stormwater monitoring program approved by Ecology, as a condition of their permit.

- Candidate sites are limited to areas that are connected to the municipal storm sewer system and are not located within the Blair-Hylebos Peninsula redevelopment area.
- The group of candidate sites are smaller, isolated properties that have small drainage basins with short detention times and the drainage systems are often affected by backwater due to tidal influences.

- Characteristics of the selected site's storm drain system can constrain how sampling can be conducted. For instance, some of the storm drains junction structures (manholes and catch basins) may not have sumps where traditional sediment traps can be deployed. Also, small-diameter storm drain pipes are not ideal for deploying sediment traps.
- Sediment traps do not function in a manner that allows for the measurement of absolute sediment loading. Relative sediment loading can be determined over time at a site if the sediment traps are deployed consistently.
- It is difficult to predict how much sediment will be captured by a sediment trap during the expected deployment period. If sediment yields are higher than expected, a trap could fill faster than anticipated. If sediment yields are lower than expected, the trap might not capture enough sediment during the planned deployment period for performance of all desired physical and chemical analyses.

3.8 Decision Making

The results of this monitoring effort are not intended for use in making specific decisions nor compliance determination. In a broader context, results will allow regional agencies (e.g., Ecology) to gauge whether comprehensive stormwater management programs are making progress towards the goal of reducing the amount of pollutants discharged in stormwater and protecting water quality.

4.0 ORGANIZATION AND SCHEDULE

The following section identifies the project team, discusses the project schedule, identifies special training required for project implementation, and describes the process of revising this document.

4.1 ROLES AND RESPONSIBILITIES

The table below contains a list of the participants in the major aspects of the project and personnel responsible for updating the QAPP.

Table 3. Project participant roles and responsibilities

Position	Roles and Responsibilities
Department of Ecology Permit Coordinator/ Southwest Region	Responsible for reviewing and approving QAPP and project deliverables from Port of (Tacoma) to Department of Ecology
Project Manager/ Port of Tacoma	Responsible for overall management of the Port's NPDES compliance activities. Monitors and assesses the quality of work. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Ensures adequate training and supervision of all monitoring and data collection activities. Complies with corrective action requirements.
Technical Manager	Responsible for the development, approval, implementation and maintenance of the QAPP and technical coordination with other project team members.
Quality Assurance Manager	Responsible for validation and verification of data collected. Develops, facilitates and conducts monitoring system audits
Project Data Manager	Responsible for the acquisition, verification, and transfer of data
Consultant Project Manager	Responsible for Consultant project management and coordination with project team member and Consultant staff.
Consultant Technical Lead	Manages and oversees monitoring activities and data management conducted pursuant to the QAPP by the Consultant.
Analytical Laboratory Project Manager	Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for oversight of all operations, ensuring that all quality assurance/quality control (QA/QC) requirements are met, and documentation related to the analysis is complete and accurately reported. Enforces corrective action, as required.
Analytical Laboratory Quality Assurance Officer	Monitors the implementation of the Quality Assurance Manual (QAM) and the QAPP within the analytical laboratory to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Performs validation and verification of data before the report is sent to the Port.

4.2 SCHEDULE

The following table indicates the *approximate* implementation schedule for permit-related activities for stormwater monitoring. See Sections 3.2 and 3.3 for a description of the baseline and treatment periods. See Appendix A for a description of activities that will occur for the Targeted Action Monitoring.

Table 4. Anticipated project schedule

Calendar Years: 2008 to 2012				
Activity	**Anticipated Date of Initiation**	**Anticipated Date of Completion**	**Deliverable**	**Deliverable Due Date(1)**
Project Startup Activities	10/12/2008	4/12/2009	Project planning; monitoring equipment procurement; installation, and testing; staff training	Not reported to Ecology
Screening Period sediment sampling	4/12/2009	9/30/2009	Monitoring Report (1)	3/31/2010
1st baseline year sediment sampling	10/1/2009	9/30/2010	Monitoring Report	3/31/2011
2nd baseline year sediment sampling	10/1/2010	9/30/2011	Monitoring Report	3/31/2012
1st treatment year sediment sampling(2)	10/1/2011	9/30/2012	Monitoring Report	3/31/2013
2nd treatment year sediment sampling(3)	10/1/2012	9/30/2013	Monitoring Report	3/31/2014
Data Validation	11/1 for each annual sampling period	1/31 for each annual sampling period	Monitoring Report	(1)

(1) Submitted with Annual Report

(2) Activity ends in next permit cycle

(3) Activity occurs in next permit cycle

4.3 SPECIAL TRAINING NEEDS/ CERTIFICATION

Project staff will receive the following training/ certification as appropriate for their role in the project:

- Any field staff involved with monitoring equipment installation or equipment maintenance requiring confined space entry will have completed confined space entry training.
- Any field staff needing to access the monitoring sites will have TWIC badges.

- Field staff will receive training in sediment sampling equipment operation and maintenance procedures.
- Field staff will receive training in all necessary sample collection, sample handling and chain-of-custody for sediment sampling.

4.4 REVISIONS

Ecology must review this QAPP for Targeted Stormwater Management Program Effectiveness Monitoring under S8.E. of the MS4 permit (per Permit §S.8.C.2). Only substantial changes to the Effectiveness Monitoring Program will require that the QAPP be revised and re-submitted to Ecology for review. Changes requiring re-submittal of the QAPP to Ecology are considered external revisions.

Smaller changes to the Effectiveness Monitoring Program, not requiring Ecology review, are considered internal revisions. Justification, summaries, and details of internal revisions will be documented in a QAPP Addendum and will be distributed to all persons on the distribution list by the Port Project Manager. QAPP Addendums will be compiled and transmitted to Ecology no more frequent than quarterly.

5.0 QUALITY OBJECTIVES

This section presents the data quality objectives of the project and the measurement quality indicators that will be used to assess sediment data quality and usability. Data quality objectives will be achieved through careful attention to sampling, measurement, and quality assurance/quality control (QA/QC) procedures, as described in this plan.

5.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are both qualitative and quantitative statements that define the type, quality, and quantity of data necessary to support project decisions. The DQOs for the Port of Tacoma's Targeted Stormwater Management Effectiveness Monitoring are as follows:

- The data will be of known precision and accuracy;
- The data will be generated using controlled procedures for field sampling, sample handling, laboratory analysis, and record keeping;
- Reporting limits will be low enough for evaluation against Stormwater Management Program endpoints;
- Data of sufficient quality and quantity will be collected to calculate relative annual yields of target constituents used for assessing the effectiveness of enhanced programmatic activities; and
- Collected samples will meet the program-specific requirements for representativeness.

The measurement quality objectives for physical and chemical analyses of sediments are summarized in Table 5 The data quality parameters used to asses the acceptability of the data include precision, accuracy, representativeness, comparability, and completeness. These parameters are discussed in the following section.

Table 5. Measurement quality objectives for physical and chemical analyses in sediments

Parameter	Check Stnd/ Lab Control Sample	Lab Replicate	Matrix Spike	Matrix Spike Dup(1)	Surrogate Stnd	Lowest Conc. of Interest(2)
	Accuracy (% Rec)	Precision (RPD)	Accuracy (% Rec)	Precision (RPD)	Accuracy (% Rec)	(units)
Conventionals						
Total solids	80-120	20%	NA	NA	NA	NA
Total organic carbon	80-120	20%	75-125	NA	NA	0.10%
Grain Size	NA	5%	NA	NA	NA	NA
Metals						
Total recoverable (Cu, Zn, Pb, Cd)	80-120	20%	75-125	NA	NA	0.1–5.0 mg/Kg dry
Organics						
PAHs	50-140	NA	50-140	40%	50-140	70 µg/Kg dry
TPH						
NWTPH-Dx	50-150	NA	50-150	50%	50-150	25-100 mg/Kg

(1) Matrix spike duplicate percent recovery for organics targeted at 50-140%.

(2) Lowest concentration of interest corresponds to reporting limit targets listed in Appendix 9 of the Phase I Municipal Stormwater Permit expressed on a dry-weight basis.

5.2 Measurement Quality Indicators

Data quality and usability are evaluated in terms of performance criteria. Performance and acceptance are expressed in terms of measurement quality indicators (MQIs). The principal indicators of data quality are precision, accuracy, sensitivity, completeness, comparability, and representativeness. These measures are affected by factors in both the field and laboratory. Each term is explained below.

5.2.1 Precision

Precision is a measure of the agreement or repeatability of a set of replicated results obtained from duplicate analysis made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. Imprecise data are generally a problem because individual samples are not a reliable measure of the mean site conditions making it necessary to gather more data to characterize a given site. Often, poor precision is due to field variability, problems with sampling and sub-sampling procedures, contamination, or poor sensitivity of the laboratory methods.

Analytical precision is measured through matrix spike/matrix spike duplicates samples for organic analyses and through laboratory duplicates samples for inorganic analyses.

Laboratory duplicates are generally prepared by splitting one sample into two and performing a separate analysis on each split. Matrix spikes and matrix spike duplicates are prepared by adding a known concentration of analyte to a sample or to a laboratory duplicate and determining the concentration of the sample plus the spike. The two values (sample and duplicate, or spike and spike duplicate) are compared to provide an estimate of the precision of the laboratory method. The precision of a duplicate determination can be expressed as the relative percent difference (RPD), and is calculated as:

$$\%RPD = \left[\frac{|X_1 - X_2|}{\frac{(X_1 + X_2)}{2}} \right] \times 100$$

Where:

$\%RPD$ = relative percent difference

X_1 = native sample

X_2 = duplicate sample

Guidelines for project analytical and field precision measurements are discussed in Section 9.0. Analytical precision will be evaluated against quantitative RPD performance criteria presented in Table 5. Currently, no performance criteria have been established for field duplicates, thus data will not be qualified based solely on field duplicate precision.

5.2.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Analytical accuracy may be assessed by analyzing known reference materials or by analyzing "spiked" samples with known standards (laboratory control samples, matrix spike, and/or surrogates). Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of potential matrix effects on analytical accuracy. Factors that influence analytical accuracy include laboratory calibration procedures, sample preparation procedures, and laboratory equipment or deionized water contamination. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. Analytical accuracy, expressed as percent recovery (P), is calculated as

$$P = \left[\frac{(SSR - SR)}{SA}\right] \times 100$$

Where:

P = percent recovery

SSR = spiked sample result

SR = sample result (native)

SA = the spiked concentration added to the spiked sample

Guidelines for laboratory accuracy are discussed in Section 9.0. Analytical accuracy will be evaluated against quantitative laboratory control sample, matrix spike, and surrogate spike (organics) performance criteria presented in Table 5

5.2.3 Sensitivity

Sensitivity is the measure of the concentration at which an analytical method can positively identify and report analytical results. The sensitivity of a given method is commonly referred to as the detection limit. Although there is no single definition of this term, the following terms and definitions of detection will be used, as appropriate.

- **Instrument detection limit** (IDL) is the minimum concentration that can be measured from instrument background noise.
- **Practical quantification limit** (PQL) or **method reporting limit** is the concentration of the target analyte that the laboratory has demonstrated the ability to measure within specified limits of precision and accuracy during routine laboratory operating conditions. This value is variable and highly dependent on the sample matrix. It is the minimum concentration that will be reported as "unqualified" by the laboratory.
- **Method detection limit** (MDL) is a statistically determined concentration. It is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero as determined in the same or similar sample matrix. Due to the lack of information about analytical precision at this level, sample results greater than the MDL, but less than the PQL, will be laboratory qualified as "estimated".

A summary of method detection limits and method reporting limits (practical quantification limits) is included in Section 8.0 for the individual analytical methods required for sediments. The lowest concentrations of interest shown in Table 5 correspond to the reporting limit targets listed in Appendix 9 of the Phase I Municipal Stormwater Permit.

5.2.4 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition, or more specifically site conditions. Representativeness is a subjective parameter and is used to evaluate the efficacy of the sampling plan design. It can be assessed through the analysis of field duplicate samples and other measures.

Sediment samples will be collected so they are adequately representative of the volume and nature of the monitored parameters of interest. To meet this goal, samples will be collected according to appropriate procedures and should consider the following types of representativeness criteria:

- Continuous deployment of sediment traps
- All analyses must be conducted within method-required holding times.

Samples may be deemed "non-representative" and data rejected if any of these criteria are not met.

5.2.5 Completeness

Completeness is defined as the percentage of measurements judged valid compared to the total number of measurements made or planned for a specific sample matrix and analysis. It includes both targeted sample collection by the field team, and analytical work done by the laboratory. Essentially, it is used to assess how field situations and laboratory problems affected the overall success of the data collection effort. Completeness is calculated using the following formula:

$$Completeness = \frac{Valid\ \ Measurements}{Total\ \ Measurements} \times 100$$

All valid data will be used for this project. Data that has been qualified as estimated because the quality control criteria were not met will be considered valid for the purpose of assessing completeness, whereas data that have been qualified as rejected will not be considered. During the data validation process, an assessment will made of whether the valid data are sufficient to meet project requirements. If sufficient valid data are not obtained, corrective actions will be initiated by the project manager or his/her designee.

5.2.6 Comparability

Comparability is qualitative measure designed to express the confidence with which one data set may be compared to another. Sample collection and handling techniques, sample matrix type, and analytical method all affect comparability. Comparability is limited by other MQIs because data sets can be compared with confidence only when precision and accuracy are known. Data from one phase of an investigation or from a separate investigation can be compared to others when similar methods are used and similar data packages are obtained.

6.0 SAMPLING PROCESS DESIGN

This section summarizes the process used to select the monitoring site, describes the monitoring site, and describes the approach for collecting storm drain sediment samples.

6.1 MONITORING SITE SELECTION PROCESS

General parking was identified as the most representative land use for conducting monitoring required under Section S8.E of the Phase I Permit. All parcels containing general parking as a land use were identified and, from these, parcels with more than 25 percent of the area classified as general parking were selected for further review (Table 6).

Table 6. Parcel evaluation with general parking observed

Parcel ID	Total Area (Acres)	General Parking (% of parcel)	General Parking (Acres)
26	0.42	88	0.37
28	6.04	35	2.11
35	83.72	54	45.58
42	3.56	42	1.49
68	0.22	100	0.22

The heavy-duty drayage truck process parking area serving the Port-operated breakbulk terminal, a portion of parcel 42, was chosen as the most representative Port property to measure the implementation of the Port's SWMP. Approximately 42 percent (or 1.49 acres) of the 3.56 acre property is parking lot, making it the third largest parking area. The two parcels with larger parking areas are Parcel 28 and 35. Parcel 28 is an unused parking lot that is fenced off to any vehicle traffic and Parcel 35 is scheduled to be under construction into 2011, therefore Parcel 42 was selected as most representative of the Port's parking areas.

The selected representative site drains to three catch basins and subsequently to an outfall that discharges directly into the Sitcum Waterway. It has a relatively small, but uniform catchment area.

Although the Port is a major container Port in the Northwest, the Port also operates its breakbulk terminal that loads and unloads cargo and imported automobiles that cannot fit in the 20' or 40' containers. Portions of the unloaded cargo or cargo feed to the ships are transported to and from regions in and outside Puget Sound. The drayage truck processing area is operated by the Port staff, making it the most representative parking area on Port-controlled land. The drayage truck parking area and the three catchbasins being sampled for sediment as part of this project are located within the basin selected by the Port for the Stormwater Monitoring component of the Port's monitoring requirements under the Permit §S8.D. The activities conducted for the §S8.E study will not interfere with the §S8.D stormwater monitoring program. See Section 7.2 for further discussion regarding how the §S8.E sediment sampling methods will not impact §S8.D sediment monitoring.

6.2 MONITORING SITE DESCRIPTION

This section describes the Port-operated terminal property and storm drainage system and identifies sites for sediment sample collection. The drayage truck process area supporting the breakbulk terminal is located near the Sitcum Waterway, and adjacent to the Port Administrative Building. The 34,000 square foot upland property is predominately a mixture of the heavy- duty trucks and employee vehicle parking lot. A map of the drayage and break-bulk processing area is provided in Figure 4.

Figure 4. The Drayage Truck Parking Area for Port-operated Terminal

The on-site stormwater collection and conveyance system generally includes catch basins (flow-though type or with sump areas) with runoff conveyed through small-diameter pipes. The drainage basin contains five catch basins that drain to a single piped outfall (approx. 8-inch) that discharges to Sitcum Waterway. Three of the catch basins are located in the active drayage truck process area while the other two are located in the employee vehicle parking lot. Since this study focuses on source control and maintenance activities within the drayage truck process area, these three catch basins were selected for monitoring. A diagram of the storm drainage system and selected catch basins (CB 1, CB 2, and CB 3) is shown in Figure 5.

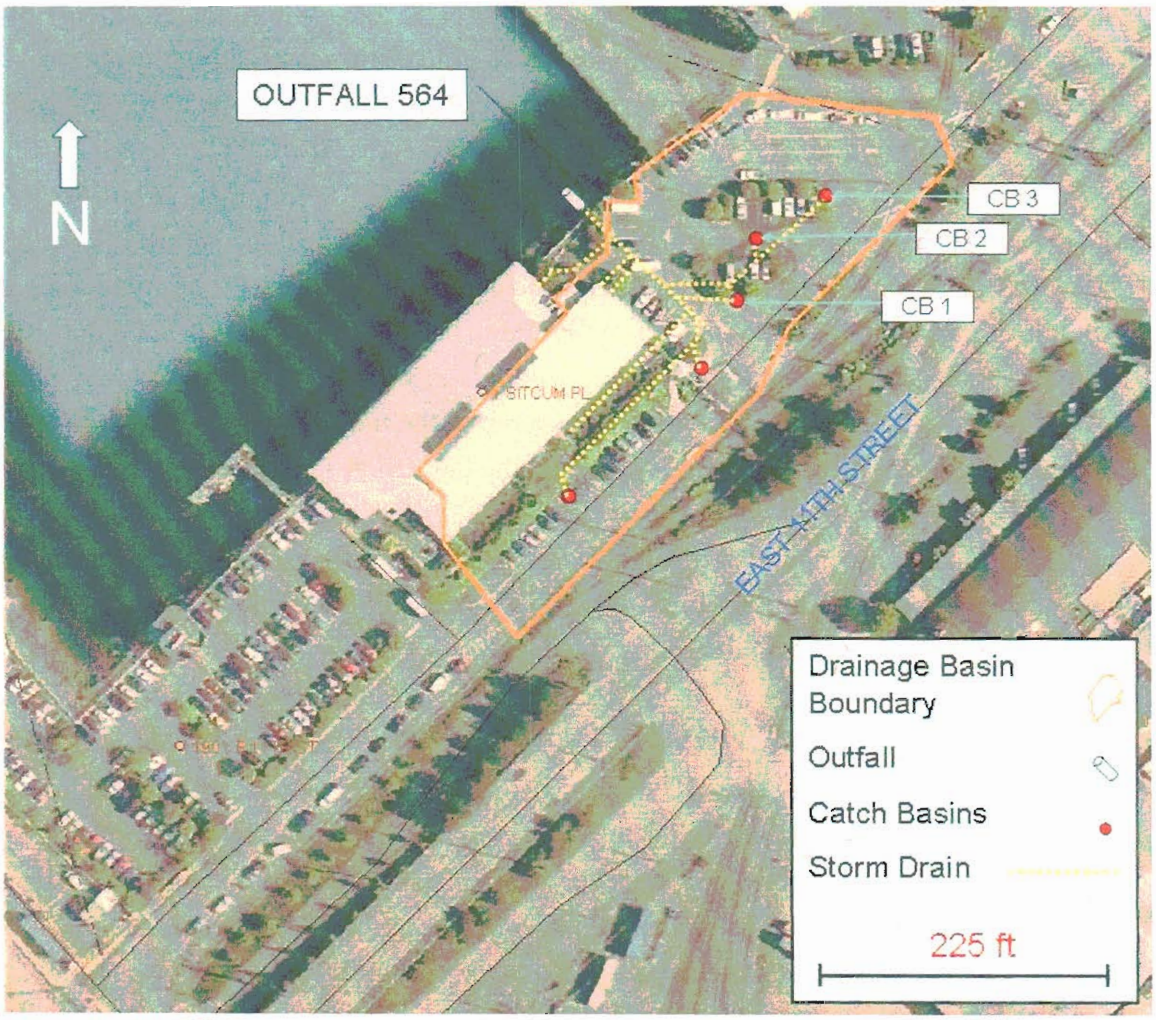

Figure 5. Drainage map showing sediment sampling locations.

6.3 IMPLEMENTATION PROCESS

The monitoring project will be implemented in three phases: (1) a screening period, (2) a baseline period, and (3) a treatment period. Each of these phases is described below, including the maintenance and monitoring activities that will occur during each phase.

6.3.1 Screening Period (April 2009 – October 2009)

During the first approximately six months of the implementation period, monitoring will be conducted to assess sediment yield for drainage basins or portions of drainage basins having different size catchments. The information obtained will be used to estimate how long sediment traps can be deployed before filling, or if alternate methods of sediment sampling need to be used. During this period, Port of Tacoma Environmental Department and Maintenance staff will continue routine sweeping of the heavy-duty drayage truck parking areas and annual cleaning of stormwater collection system infrastructure (catch basins, trench drains, etc.).

To assess the range of sediment yield, sediment traps will be deployed at three locations. Crews will periodically inspect bottles over the deployment period, primarily to track the volume of particulate material that has collected in traps. At the end of the deployment period (up to six months), the sediment collection bottles will be retrieved from the traps. Accumulated sediment volumes will be measured in the field. If sufficient sediment has been collected, samples may be transported to the laboratory for further processing and physical/chemical analysis as described in Section 8.0. Sediment weight will be measured in the laboratory and converted to a dry-weight basis. Average yields will be calculated for each of the catchments monitored, which will be used to determine how to deploy sediment traps for the remainder of the study.

6.3.2 Baseline Period, Years 2 and 3 (Oct. 2009 – Sept. 2011)

During the 2-year baseline period, Port of Tacoma Maintenance staff will continue: routine sweeping of the drayage truck parking areas; with the existing unenforced anti-idling policy; and annual cleaning of stormwater collection system infrastructure (catch basins, etc.). The purpose of sediment monitoring during the baseline period is to characterize storm drain sediment yield and quality when standard stormwater source control and maintenance activities are applied to the drainage basins.

Based on sediment yields observed during the screening period, a sufficient number of sediment traps will be deployed to collect a total of between three to six samples annually. This may include a combination of full-year deployments or by collecting two samples per year at sites that have higher observed yields. It is expected that this deployment strategy will provide between six and twelve sediment samples for the two-year baseline period.

At the end of each deployment period, sediment collection bottles will be retrieved from the traps. Accumulated sediment volumes will be measured in the field and the samples transported to the laboratory for further processing and analysis. Sediment weight will be measured in the laboratory and converted to a dry-weight basis.

Prior to initiating the third phase of the study, the baseline data will be evaluated to determine if a sufficient number of samples have been and likely will be collected to detect an effect of the increased maintenance practices on storm drain sediment quantity and quality (see Section 13.0 for further discussion). If this analysis suggests more data are needed, the Port may decide to extend the baseline and treatment periods.

6.3.3 Treatment Period, Years 4 and 5 (Oct. 2011 – Sept. 2013)

Sediment monitoring will be conducted for an additional two years to assess the effectiveness of increased source control and maintenance activities performed by Port Maintenance staff. At the beginning of the water year in 2011, catch basin insert sample bottles will be installed at the three catch basins in the study area. The Port will enforce its anti-idling policy in this truck waiting area and increase the routine maintenance activities. Enhanced maintenance activities will consist of increasing sweeping frequency and increasing catch basin cleaning from annually to bi-annually.

Sediment samples will be collected from the same deployment sites and ideally at the same frequency as for the baseline period. At the end of each deployment period, sediment collection bottles will be retrieved from the traps. Accumulated sediment volumes will be measured in the field and the samples transported to the laboratory for further processing and analysis. Sediment weight will be measured in the laboratory and converted to a dry-weight basis.

7.0 SAMPLING PROCEDURES

This section documents activities associated with the deployment, periodic inspection, and retrieval of the sediment traps. Further details on the field procedures that will be implemented to ensure quality control for sample collection and handling are provided in Section 9.1. Suspended particulate samples will be collected with the use of sediment traps. See Section 7.2 for further details.

Sediment traps will be deployed for up to six-months during the "screening period" and up to 12 months annually during each of the annual "baseline" and "treatment" periods. Glass bottles will comprise the sediment traps unless debris causes damage or breakage, at which time Teflon bottles will be deployed for the remainder of the study. Field personnel will deploy the sediment traps in catch basins at the locations described in Section 6.2. Field personnel will take care to deploy the traps consistently at each site to avoid introducing sampling bias due to the physical positioning of the sediment traps.

Crews will periodically inspect the bottles over the deployment period to: (1) ensure that container openings are free of litter and other debris that could limit sample collection; (2) ensure the glass collection bottle is not damaged or broken; and (3) note the volume of material that has collected in the trap. Inspection site visits will occur monthly at the beginning of the "screening period"; however, the frequency of subsequent inspections may be adjusted depending on how quickly the traps are filling.

At the end of the planned deployment period, or when a sediment trap is full or nearly full, the collection bottle will be removed from the housing or mounting bracket, capped with a screw closure, packaged, and placed in a cooler on ice for transport to the contract analytical laboratory for processing. Under no circumstance will samples be frozen prior to being processed, as this may change the particle size distribution prior to analysis. Processing will begin within 24 hours of retrieval.

See Section 8.2 for further information on sediment sample processing; sample amounts, containers, preservation, and analytical hold times; and sample labeling and chain- of-custody procedures. See Section 9.1.1 for further information on field QC procedures that will be implemented to ensure quality control for sediment sample collection and handling.

7.1 Sediment Sampling

Annual sediment monitoring and analysis will be conducted for the baseline and treatment periods of this study. Sediment samples will be collected in three catch basins located within the study area using in-line sediment traps. If the required sediment amount is unattainable from these devices, other collection methods may be employed with prior approval by Ecology.

The annual sediment sample collected will be analyzed for the following parameters:

- Total solids (% solids)
- Total organic carbon
- Grain size
- Metals including: total zinc, copper, cadmium, lead, and mercury
- Polycyclic aromatic hydrocarbons (PAHs)
- Total petroleum hydrocarbons (NWTPH-Dx)

See Section 8.3 Analytical Instruments for MDLs and analytical methods.

If the amount of sediment sample collected on an annual basis is insufficient to allow analysis for all parameters listed above, samples will be analyzed for as many parameter as possible in the following priority order (in descending order of priority):

(1) Total organic carbon
(2) Metals
(3) Grain size
(4) PAHs
(5) NWTPH-Dx

If insufficient sediment amounts exist to run the next highest priority pollutant, that analysis will be bypassed and analyses run on lower priority pollutants in accordance with the remaining priority order to the extent possible. Grain size analysis will be performed if enough sample is available for all parameters using the grain size method specified in Section 8.3, otherwise grain size will be characterized qualitatively.

Table 7 indicates the estimated sample amounts required for each parameter/analyte for the annual sediment. A total sample of at least 90 g of sediment is needed and up to 825 g is recommended to run the required chemical and physical analyses.

Table 7. Analytical parameters and required sample amounts for annual sediments

Parameter/Specific Analyte	Required Sample Volume (g) Min.	Recomm.
Conventionals Total solids	10	75
Total organic carbon	5	75
Grain size	25	300
Metals Total recoverable (Cu, Zn, Pb, Cd, Hg)	10	75
Organics PAHs	20	150
TPH (NWTPH-Dx)	20	150
Total Volume Needed for Annual Sediment Sample:	90 g	825 g

(1) Required sample volumes expressed on a wet-weight basis.

7.2 Sediment Sampling Apparatus

Suspended particulate samples will be collected with the use of in-line stormwater sediment traps, with a deployment period not to exceed one year. Construction details and performance of these traps is described in *Stormwater Sediment Trap Pilot Study* (Wilson and Norton, 1996). A diagram of the construction details of the traps is presented in Figure 6. In-line sediment traps constructed for this project will be provided by the contract sampling consultant or laboratory.

At least one sediment trap will be installed within each of the three catch basins to ensure the collection of sufficient sediments for the analysis of the required physical and chemical analyses. Multiple traps may be installed within each catch basin if screening period results indicate single traps may not provide sufficient sediment volume to conduct desired laboratory analyses.

Sediment will also be collected and analyzed at the basin outfall pipe for the §S8.D monitoring requirement. The sediment devices used for §S8.E monitoring utilize a bottle with an opening diameter of 1 ¾ inches. This represents a sediment catchment area that is 0.5%[1] of the total area of the catch basin (each catch basin is approximately 20 x 24

[1] Installation for a duplicate sample would include two sediment traps. Thus, the area would represent 1% of the total catch basin area.

inches). Therefore, the §S8.E devices cannot significantly reduce the amount of sediment available to be trapped by the §S8.D device. Additionally, Section 3.7 states,

> "Sediment traps do not function in a manner that allows for the measurement of absolute sediment loading. Relative sediment loading can be determined over time at a site if the sediment traps are deployed consistently."

Since the sediment trap devices for both §S8.D and §S8.E monitoring will be deployed consistently over several years of monitoring, trends in the relative quantity (loading) and quality (pollutant concentrations) will be ascertainable.

The three catch basins being sampled for sediment are approximately 20 x 24 inches and between 18 and 31 inches deep. Therefore, sediment trap installation, inspection, and removal will be conducted from the surface. In other words, staff will not enter the catchbasin to conduct work. S8E sampling activities will be coordinated with S8D sampling activities. To prevent disturbed sediment from being transported downstream to S8D monitoring instruments, S8E sediment trap installation, inspection, or removal will not be conducted during runoff events. Field staff will take care to minimize disturbance of sediment in the catch basins while conducting work.

7.3 Non-Direct Measurements

Maintenance logs for sweeping and catch basin cleaning and records of the enforcement of the anti-idling policy within the drayage truck parking areas will be obtained from the Port Maintenance staff. This information will be compared against the maintenance frequencies specified in Section 6.3 and will be included and discussed in the project annual reports.

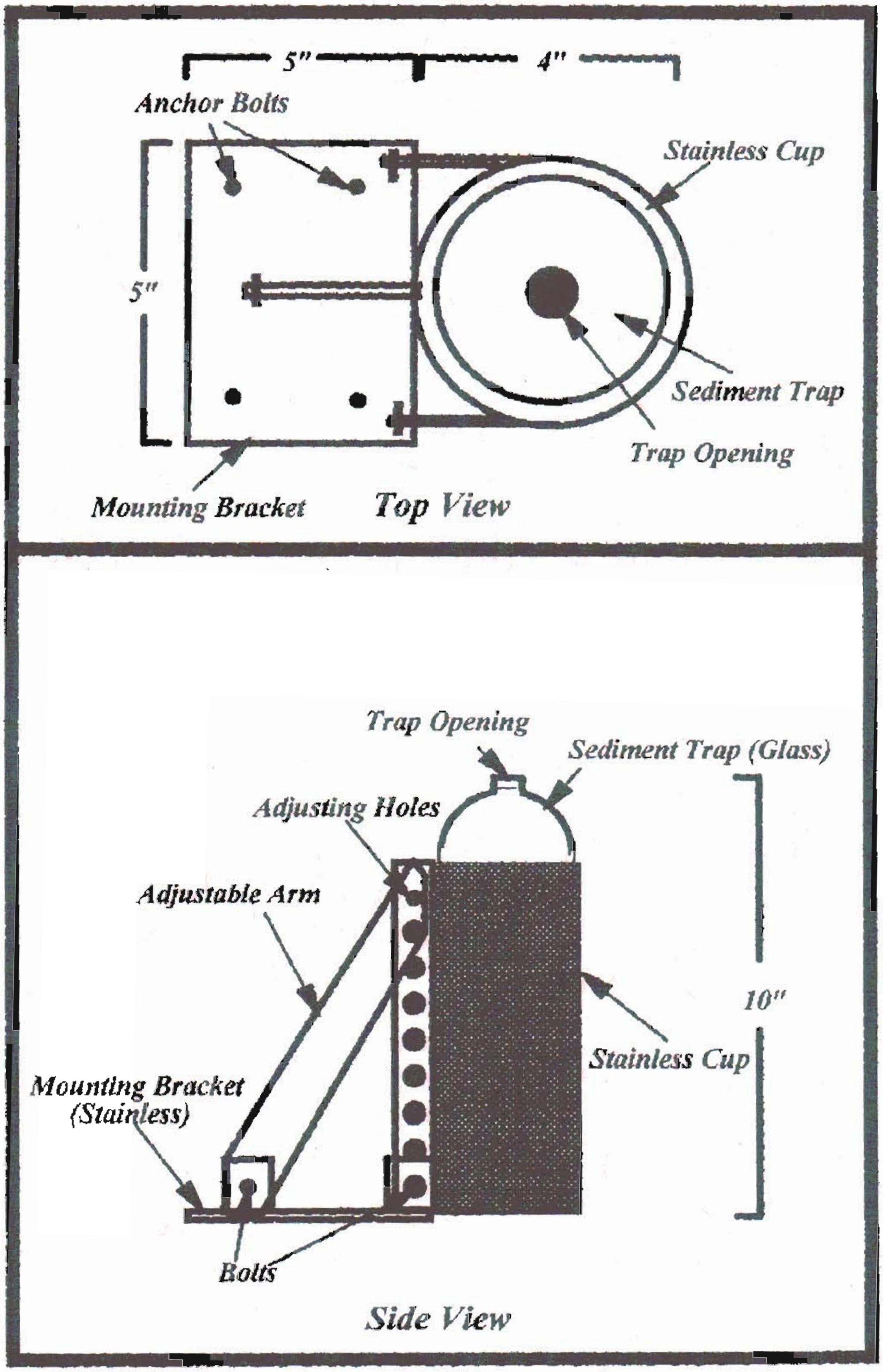

Figure 6. Construction details of typical stormwater sediment trap (Adapted from Norton, 1998)

8.0 MEASUREMENT PROCEDURES

This section presents the analytical laboratory(s) selected for this project; describes sample processing procedures that will be used for sediment samples; and describes chemical testing procedures used for the analysis of samples collected during this project.

8.1 LABORATORY SELECTION

The laboratory(s) selected for this program will have the demonstrated ability to achieve acceptable detection/reporting limits for the constituents of interest using standard analytical methods, meet project-specific criteria, and are accredited by the Washington State Department of Ecology. A laboratory currently certified to perform environmental analysis of soil by the Washington State Department of Ecology through the Environmental Laboratory Accreditation Program (ELAP) will be selected by the Port Project Manager for this monitoring work.

8.2 SAMPLE PROCESSING

This section presents the sample processing procedures for sediment; required sample amounts, containers, preservation, and holding times for physical and chemical analyses; and sample label and chain-of-custody procedures for processed samples.

8.2.1 Sediments

Sediment collection bottles retrieved at the end of deployment periods will be transported to the contract analytical laboratory following established sample handling procedures, as discussed in Section 7.0. Upon receipt at the contract analytical laboratory, the sediment samples will be moved to a designated clean room within the laboratory where the samples will be further processed. All processing will occur within 24 hours of retrieval. Processing will consist of first decanting off a portion of the overlying water, then centrifuging the remaining slurry to isolate the particulate fraction. After initial sample processing, the contents of each sample bottle will be weighed and the volume measured to estimate sediment amounts (wet-weight and volume basis) collected from each site. Next, all samples will be well mixed and transferred to pre-cleaned containers. After processing, samples will be chilled and maintained at 4 °C until analysis. Excess sample collected will be stored for potential repeat analyses.

Manipulations of the samples during processing will be accomplished using stainless steel utensils. All sample processing utensils will be decontaminated prior to use following established procedures. All sample containers will be glass jars with Teflon-lined closures, cleaned to EPA QA/QC specifications (US EPA, 1990). Required sample amounts, containers, preservatives, and analytical holding times for targeted parameters are included in Table 8. Analytical methods and method reporting limits for analysis of sediments are shown in Table 9.

8.2.2 Sample Amounts, Containers, Preservation, and Holding Times

Typical sample amounts, containers, preservation, and analytical holding times are summarized in

Table 8 for targeted sediment parameters. A brief discussion is provided below for each consideration.

The minimum sample amounts are the minimum sample sizes for a single analysis based on the contract analytical laboratory. In some cases, allowances have been made in the minimum sample amounts to account for potential repeat analyses or sample container damage.

Sub-samples obtained from composited sediment samples will be collected into contaminant-free containers according to analytical method specifications. The contract analytical laboratory will provide all appropriate sample containers required for this project.

Certain analytes require chemical preservation in order to minimize potential chemical changes or degradation that could occur in a sample prior to analysis. Samples prepared in the laboratory will be preserved and handled following method-specific requirements for both preservation and storage. No chemical preservatives are required for sediment samples collected for this project.

Technical holding times are the maximum length of time allowed between when a sample is collected to when the digestion, extraction, and/or analysis is initiated to ensure analytical accuracy and representativeness. All sediment samples retrieved from the field will be transported to the laboratory and processed as soon as practicable.

Table 8. Typical Sediment Sample Amount Containers, Preservatives, and Recommended Handling and Holding Time

Parameter	Minimum Amount	Container Type	Handling / Preservation	Holding Time
Conventional Parameters Total solids	10 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	14 days
Total organic carbon	5 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	14 days
Grain Size	25 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	6 months
Metals Total recoverable (copper, zinc, lead, cadmium, mercury)	10 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	6 months
Organics PAHs	20 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	14 days
TPH NWTPH-Dx	20 g, wet	Glass, WM	Cool to ≤ 6°C, no pres.	14 days

(1) Minimum sample listed for grain size assumes sample consists primarily of fine-grained sediments.

8.2.3 Sample Labels and Chain of Custody

Sediment samples prepared in the laboratory will be labeled for future identification. Sample labels will be prepared for each parameter-specific sample container. The laboratory will provide labels for all sample containers and labels will be filled out using waterproof ink, placed on the sample containers, and covered with clear plastic shipping tape.

At a minimum, each sample label will contain the following information:

- Project name and number,
- Station identification,
- Date and time of sample collection (24-hour clock using Pacific Standard Time),
- Total number of sample containers for each analysis and the number of each container (e.g., 1/4, 2/4, etc.),
- Sample/QC identification code,
- Analyses to be conducted, and
- Initials of field team member.

Chain-of-custody (COC) procedures will be strictly followed to provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. The laboratory(s) will provide sufficient copies of blank COC forms. All sample information (i.e., sample date/time, sample matrix, number of containers, etc.), including all required analyses, will be logged onto a COC form after sample processing in the laboratory, and prior to formal transfer of sample containers to the laboratory(s). Any time possession of the samples is transferred, the individual(s) relinquishing and receiving the samples will respectively sign, date, and note the time of transfer on the COC form. This record documents the transfer of custody of samples from the samplers to the laboratory(s).

The person responsible for transfer/transport of the samples to the laboratory(s) will complete and sign the COC. After the COC has been completed, the sampler(s) will retain a copy for future reference, and the COC will be placed in a clear zip loc bag and placed in the cooler. Coolers will be sealed with custody tape prior to transfer/transport and the custody seal will be signed and dated by the person transferring/transporting the samples, secured across the lid and body of the cooler, and covered with clear shipping tape.

Upon receipt of the samples, the laboratory(s) will assume responsibility for maintaining sample chain-of-custody, and will follow all applicable internal procedures for sample log-in, storage and holding times, tracking, and control.

8.3 Chemical Analysis Procedures

This section presents the chemical analysis procedures that will be used for the analysis of sediments collected during this project.

8.3.1 Analytical Instruments

Analytical instruments used by the laboratory will be maintained and calibrated according to the internal Laboratory Quality Assurance Plan (LQAP), all applicable standard operating procedures (SOPs), the instrument manufacturer's specifications, and any specific method requirements.

8.3.2 Analytical Methods and Reporting Limits

The target constituents for this project and corresponding analytical methods, method detection limits, method reporting limits, and reporting limit targets for sediments are presented in Table 9. All analyses will be conducted according to the project QAPP, the contract laboratory LQAP, and any specific analytical SOPs.

Table 9. Target constituents, analytical methods, laboratory method detection and reporting limits, and reporting limit targets for sediments.

Parameter	Laboratory Method (1)	Method Detection Limit (1)	Method Reporting Limit (1)	Reporting Limit Target (2)
Conventional Parameters				
Total solids	SM 2540B	NA	0.01%	NA
Total organic carbon	SM 5310B	0.02%	0.02%	0.10%
Grain Size**	ASTM D422	NA	NA	NA
Metals				
Total recoverable copper	EPA 6020	0.014 mg/Kg	0.1 mg/Kg	0.1 mg/Kg
Total recoverable zinc	EPA 6020	0.02 mg/Kg	0.1 mg/Kg	5.0 mg/Kg
Total recoverable lead	EPA 6020	0.016 mg/Kg	0.1 mg/Kg	0.1 mg/Kg
Total recoverable cadmium	EPA 6020	0.016 mg/Kg	0.1 mg/Kg	0.1 mg/Kg
Organics				
PAHs				70 µg/Kg dry
Naphthalene	EPA 8270D SIM*	0.056	3.3	
2-Methylnaphthalene		0.232	3.3	
Acenaphthylene		0.136	3.3	
Acenaphthene		0.188	3.3	
Dibenzofuran (MDL/MRL scan mode)		27	33	
Fluorene		0.12	3.3	
Phenanthrene		0.126	3.3	
Anthracene		0.133	3.3	
Fluoranthene		0.192	3.3	
Pyrene		0.578	3.3	
Benzo(a)anthracene		0.401	3.3	
Chrysene		0.169	3.3	
Benzo(b)fluoranthene		0.205	3.3	
Benzo(k)fluoranthene		0.45	3.3	
Benzo(a)pyrene		0.216	3.3	
Indeno(1,2,3-cd)pyrene		0.693	3.3	
Dibenz(a,h)anthracene		0.4	3.3	
Benzo(a,h,i)perylene		0.846	3.3	
1-Methylnaphthalene		0.23	3.3	
Pentachlorophenol (3)	EPA 8041-ECD or 8270D SIM	1.47	3.3	1.0 ug/Kg
NWTPH-Dx	NWTPH-Dx	NA	10.0 mg/Kg	25.0-100.0 mg/Kg

* Sample preparation procedures to follow 3550, 3640, 3660G, and 3620.

** Grain size analysis by Columbia Analytical.

(1) Laboratory methods, method detection limits, and method reporting limits (PQLs) based on information provided by Spectra Laboratories 7-15-09 and is subject to change.

(2) Reporting limit targets based on information listed in Appendix 9 of the Phase I Municipal Stormwater Permit and in the additional guidance Alternative Laboratory Methods Approved by Ecology for Use under the Phase I Municipal Stormwater Permit (Ecology, 2008).
(3) Alternative methods and/or MRLs are currently being assessed for approval by Ecology pending method detection limit studies from the lab. If methods are not approved by Ecology, samples will be subcontracted to a different laboratory that can meet required method and MDL.

9.0 QUALITY CONTROL

Quality control (QC) requirements and schedules for field and laboratory activities are presented in this section for this project. Project QC procedures will include the collection and analysis of field QC samples and the use of standard laboratory QC analyses. The overall quality of data generated for this project will be evaluated in terms of the MQIs specified in Section 5.2, in order to ensure that project data quality objectives are met.

9.1 FIELD QUALITY CONTROL

Field quality control requirements for this project will include recommended procedures for sampling and field measurement equipment, field documentation, sample collection, field QC samples, and corrective actions for field activities.

9.1.1 Field Quality Control Procedures

Original field records will be maintained in designated binders for all monitoring and field related activities using project-specific forms and established procedures. Field documentation will include maintenance inspection field sheets; sediment trap deployment, inspection, and retrieval field sheets; maintenance activity logs; work permits for confined spaces; chain of custody forms; and other required documentation. All entries in field notebooks will be written in waterproof ink. When errors are made on accountable documents, the person who made the error will make the correction by crossing a line through the error and entering the correct information. All corrections will be initialed and dated.

The sampling efforts for this program will employ the following field QC procedures to ensure consistency, reduce contamination, and ensure representative samples:

- Collect integrated sediment samples over multiple months using sediment traps.
- Collect samples in certified contaminant-free or properly decontaminated containers.
- Store sampling containers in clean, sealed boxes or bags prior to use.
- Use "clean hands/dirty hands" sampling techniques (that is, one team member performs "dirty tasks" such as lifting catch basin grates, and manipulating sediment trap brackets while the other member performs "clean tasks" such as handling sample bottles).

- Hold samples on ice in coolers during retrieval and delivery to laboratory.
- Deliver samples to laboratory with proper chain of custody, and within recommended holding times.

Field QC samples will be targeted for collection during planned deployments to be determined by the Consultant Project Manager or Consultant Technical Lead. QC samples require special labeling and tracking procedures. The various types of field control samples, field procedures for collecting these samples, and corrective measures are further discussed below.

Field corrective actions will be taken during this project to ensure the overall management of the project. The corrective action process will consist of identifying a problem, acting to eliminate the problem, monitoring the effectiveness of the corrective action, verifying that the problem has been eliminated, and documenting the corrective action. Examples of corrective actions are correcting chain-of-custody forms; correcting problems in sample collection, packing, shipping, field record keeping; or additional training in sampling. Additional activities may include re-sampling or evaluating and amending sampling procedures.

9.1.2 Field Control Samples

Field QC samples are used to assess sample collection procedures; environmental conditions during sample collection, storage, and transport to the laboratory(s); and the adequacy of equipment and sampling container decontamination. A rule-of-thumb of ten percent will be used for collection of field QC samples. This number is based on the total number of samples anticipated to be collected on an annual basis. Additional field QC samples may be needed to meet data quality objectives and quality control goals established within this QAPP. The types of field QC samples that will be collected for this project to meet QAPP objectives include the following:

- Field duplicate samples
- Temperature blanks

9.1.2.1 Field Duplicates

The purpose of collecting and analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. In general, a replicate or duplicate sample is defined as two (or more) samples collected at the same time and place and represent a way to estimate the total random variability (precision) of individual results. Field duplicate results are typically used as a qualitative evaluation of sampling precision and are not used as a basis for qualifying data or accepting/rejecting data.

The collection of field duplicate samples would require the installation and deployment of a second sediment trap in a catch basin. Provided a replicate device can be installed in the catch basin, a single field duplicate sample will be targeted for collection on an annual basis. Field duplicate samples, if collected, will be assigned a unique sample identifier added to the sample identification.

9.1.2.2 Temperature Blanks

Temperature blanks are prepared in the field using distilled or deionized water and placed in sampler cooler(s) and transported to the laboratory. The laboratory can use this blank to check the temperature of the samples upon receipt. Temperature blanks will be prepared in a designated laboratory container, assigned a sample identification code, labeled, and checked upon receipt. Temperature blanks will be submitted with all environmental samples delivered or shipped to the contract laboratory(s) during this project.

If the temperature measured by the laboratory exceeds the method-specific temperature requirement for a particular parameter, the field sampling crew should be notified so that corrective measures can be taken prior to retrieving the next batch of sediment samples (end of next deployment period).

Table 9 describes the guidelines for project field QC samples, including the type, frequency, acceptance limits, and corrective actions.

Table 9. Summary of project field quality control requirements

Field QC Sample	Frequency	Control Limit	Corrective Action(s)
Field duplicate	Once annually	Not applicable; qualitative evaluation only.	Review, modify sample collection procedures
Temperature blank	Each sample delivery or shipment	Temperature at or below method-specific limits	Review, modify sample collection, transport, and storage procedures

9.2 LABORATORY QUALITY CONTROL

The contract analytical laboratory will perform all chemical and physical analyses requested. In addition to performing the analysis, the laboratory will make every effort to meet holding times and target reporting limits for each analysis. Specific QA/QC policies and procedures followed by the contract analytical laboratory are detailed in the laboratory's Quality Assurance Plan (LQAP). The following section summarizes the laboratory QA/QC procedures that will be used to assess data quality throughout sample analysis.

9.2.1 Laboratory Control Samples

Routine analysis of laboratory quality control samples is necessary to validate the quality of the data produced. The type of QC analyses, frequency, and procedures depend on the analytical method and/or the QA/QC protocols required for a specific project. When all laboratory QC sample results are acceptable, the specific analysis is considered to be "in-control" and the data suitable for their intended use. Conversely, laboratory QC sample results that do not meet the specified acceptance criteria indicate that the procedure may not be generating acceptable data and corrective action may be necessary to bring the process back "in-control".

The specific procedures and frequencies for analytical quality control samples are detailed for each analytical method in the contract laboratory's Quality Assurance Plan (LQAP). Typical laboratory QC samples include (but are not limited to) the following:

- Method blanks,
- Laboratory control samples,
- Laboratory matrix replicates (inorganic/conventional parameters)
- Matrix spikes,
- Matrix spike duplicates (organic parameters),
- Standardized reference materials, and
- Other quality indicators

9.2.1.1 Method Blanks

A method blank is an aliquot of water or solid sample matrix that is free of target analyte and is processed as part of a sample batch. The purpose of analyzing method blanks is to demonstrate that contaminants or compounds of interest are not introduced into samples during laboratory processing. Method blanks will be prepared and analyzed by the contract analytical laboratory at a rate of at least one per twenty samples or one per analytical batch (whichever is more frequent). Method blanks will consist of laboratory-prepared blank water processed along with the batch of environmental samples, and will contain all reagents and undergo all procedural steps as a regular environmental sample for each analysis. An acceptable method blank is required prior to the analysis of field samples from a preparation batch.

For this project, an acceptable method blank result will be assumed as one that contains no target analyte at a concentration greater than one-half the contract analytical laboratory's reporting limit. An exception would include common laboratory contaminants, which may exceed the method detection limits (for select organic analytes) but may not be present at concentrations greater than five times the method reporting limit. If the results for a single method blank exceed the acceptance criteria, the source(s) of contamination should be corrected following established laboratory procedures. If necessary, the associated samples should be reprocessed and reanalyzed; however, this will not apply in situations where the analyte is detected in the samples at levels ≥ 20 times the method blank level. Remaining sample volume, analytical hold times, and relative sample concentrations will determine whether samples can be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified, as appropriate.

9.2.1.2 Laboratory Control Samples

A laboratory control sample is an aliquot of water or solid matrix free of target analytes to which selected (method specific) target analytes are added in known quantities. The purpose of analyzing laboratory control samples is to demonstrate the accuracy of the analytical method. Laboratory control samples will be prepared and analyzed by the contract analytical laboratory at a rate of at least one per twenty samples or one per analytical batch (whichever is more frequent). For this project, laboratory control samples will consist of laboratory fortified method blanks prepared at a concentration that falls within the analytical calibration range, but at a concentration different than the standards use to establish the analytical calibration curve.

Following analysis the percent recovery of each added analyte is calculated and compared to acceptance criteria (historic control limits established by contract laboratory). If the recovery of any analyte is outside the acceptable range for accuracy, the analytical process is not being preformed adequately for that analyte and corrective actions may be required. If necessary, the sample batch should be prepared again, and the laboratory control sample reanalyzed. If reanalysis is not possible, the associated sample results should be qualified, as appropriate.

9.2.1.3 Laboratory Matrix Replicates

The purpose of analyzing replicates is to demonstrate the precision of the analytical method. Replicates are two or more identical analyses performed on subsamples of the same environmental sample at the same time, and should be performed on samples that are expected to contain measurable concentrations of target analyte. For inorganic analyses, a minimum of one replicate set will be processed by the contract analytical laboratory for each analytical batch. Laboratory matrix replicates will also be analyzed for field duplicate samples collected as part of this program, at the targeted frequency specified above. Field sample collection procedures will be modified to ensure the collection of sufficient sample volumes to prepare replicate aliquots from field duplicate samples. Replicate samples are not routinely performed for organic parameters. Instead, analytical precision is evaluated through the analysis of duplicate matrix spike samples.

If the relative percent difference for any analyte is greater than the precision criteria, the analytical process is not being performed adequately for that analyte and corrective actions may be required (procedure evaluation), unless the excessive difference between the replicate samples is clearly matrix related. In cases where matrix problems are not suspect, the sample batch may be prepared again and laboratory replicates reanalyzed. If reanalysis is not possible, the associated sample results should be qualified, as appropriate.

9.2.1.4 Matrix Spikes

A matrix spike is an environmental sample to which known quantities of selected (method specific) target analyte have been added. The matrix spike is processed as part of an analytical batch and is used to measure the efficiency and accuracy of the analytical process for a particular sample matrix. Matrix spikes will be prepared and analyzed by the contract analytical laboratory at a rate of at least one per twenty samples or one per analytical batch (whichever is more frequent). Matrix spikes will also be analyzed for field duplicate samples collected as part of this program. Field sample collection procedures will be modified to ensure the collection of sufficient sample volumes to prepare matrix spike aliquots from field duplicate samples.

Following analysis the percent recovery of each spiked analyte is calculated and compared to specified acceptance criteria. If the recovery of any spiked analyte is outside the acceptable range for accuracy, the analytical process is not being performed adequately for that analyte and corrective actions may be required. If recovery of laboratory control samples for any organic analysis is acceptable, the analytical process is being performed adequately for that analyte, and the problem is most likely attributable to the sample matrix. Matrix spikes with unacceptable recovery values for inorganic analyses will be reprocessed and reanalyzed. If reanalysis results still fail to meet acceptance criteria, it will be assumed that that the sample matrix is affecting the recovery values. If matrix problems cannot be corrected, or reanalysis is not possible, the associated sample results should be qualified, as appropriate.

9.2.1.5 Matrix Spike Duplicates

A matrix spike duplicate is prepared in an identical manner to the matrix spike. Matrix spike duplicate analyses are often used to measure method precision and accuracy. In this case, the relative percent difference for recovery of a spiked analyte is calculated and compared to acceptance criteria. Matrix spike/matrix spike duplicate analyses will be performed only for required organic analyses, whereas matrix spike and laboratory replicate samples will be performed for required inorganic analyses. Matrix spike/matrix spike duplicates will be prepared and analyzed by the contract analytical laboratory for organic analysis at a rate of at least one pair per twenty samples or one pair per analytical batch (whichever is more frequent). Matrix spike duplicates will also be analyzed for field duplicate samples collected as part of this program.

If relative percent difference values between matrix spike duplicates do not meet acceptance criteria, but spike recovery values are acceptable, no re-extraction or analysis will be required. It will be assumed that the sample is not homogenous, causing poor analytical precision. If relative percent difference values between matrix spike duplicates do not meet acceptance criteria, and recovery values in one or both replicates in not acceptable, the sample and associated matrix spike replicates will be reprocessed and reanalyzed, provided sufficient sample volume is available and/or holding time remaining. If the reanalysis results are not within acceptance limits, it will be assumed that the sample is not homogenous, causing poor analytical precision.

9.2.1.6 Standardized Reference Material

A standard reference material is analyzed and certified by an outside organization to contain known quantities of select target analytes independent of analytical methods. These materials are normally purchased from suppliers outside of the contract analytical laboratory and are supplied with acceptance criteria. Analysis of standard reference materials is used to assess the overall accuracy of the laboratory's analytical process, and are routinely analyzed with each batch of sample for wet chemistry (conventionals analysis) samples. External reference samples are analyzed after instrument calibration and prior to sample analysis. Compound recovery values not within the specified limit indicate the need to evaluate either the calibration standards or instrumentation. These corrective actions will be conducted, as necessary, following procedures outlined in the contract laboratory's Quality Assurance Plan.

9.2.1.7 Other Quality Indicators

In addition to analyzing the quality control samples outlined previously, various indicators are added to environmental samples to measure the efficiency and accuracy of the contract analytical laboratory's analytical processes. Surrogate standards are added to extractable organic samples prior to extraction to monitor extraction efficiency. Internal standards are added to metals digestates for ICP-MS analyses and to organic samples or extracts prior to analysis to verify instrument operation.

The calculated recovery of surrogate analyses is compared to historic control limits maintained by the analytical laboratory to aid in assessing analytical efficiency for a given sample matrix. When these analyses fail to meet specific acceptance criteria, corrective actions are conducted consistent with the contract laboratory's Quality Assurance Plan.

Table 10 describes the guidelines for project analytical laboratory QC samples, including the type, frequency, acceptance limits, and corrective actions. Specific details on laboratory QC analyses, including corrective actions, are included in the contract analytical laboratory's Quality Assurance Plan.

Table 10. Summary of project laboratory quality control requirements

QC Procedure	Analysis	Frequency	Control Limit	Corrective Action(s)
Method Blank	Inorganics	5% or 1 per analysis batch	Analyte conc. ≤ PQL/MRL	Eval. procedure; identify contamination source; pot. batch/sample reanalysis; evaluate/qualify data <10x blank conc.
	Conventionals	Method specific; 5% or 1 per anal. batch, if req'd	Analyte conc. ≤ PQL/MRL	Eval. procedure; identify contamination source; pot. batch/sample reanalysis; evaluate/qualify data <10x blank conc.
	Organics/TPH	5% or 1 per anal. batch	Analyte conc. ≤ PQL/MRL (except common lab contaminants ≤ 5x PQL/MRL)	Eval. procedure; identify contamination source; pot. batch/sample reanalysis; evaluate/qualify data <5-10x blank conc.
LCS or SRM	Inorganics	5% or 1 per anal. batch	80-120% recovery, or CCL	Eval. procedure; recalibrate; pot. batch/sample reanalysis; evaluate/qualify affected data.
	Conventionals	Method specific;	Analyte-specific	Eval. procedure; recalibrate;

QC Procedure	Analysis	Frequency	Control Limit	Corrective Action(s)
		5% or 1 per anal. batch, if req'd	recoveries; usually 80-120% recovery	pot. batch/sample reanalysis; evaluate/qualify affected data.
	Organics/TPH	5% or 1 per anal. batch	Analyte-specific recoveries; usually 50-140 (organics) and 50-150 (TPH) for LCL or CCL	Eval. procedure; recalibrate; pot. batch/sample reanalysis; evaluate/qualify affected data.
Matrix Spike	Inorganics	5% or 1 per anal. batch; field duplicate (1/yr)	75-125% recovery	Eval. procedure and assess pot. matrix effects; pot. batch/sample reanalysis; evaluate/qualify affected data.
	Conventionals	Method specific; 5% or 1 per anal. batch, if req'd; field dup.	Analyte specific recoveries; usually 75-125% recovery	Eval. procedure and assess pot. matrix effects; pot. batch/sample reanalysis; evaluate/qualify affected data.
	Organics/TPH	5% or 1 per anal. batch; field dup.	Analyte-specific recoveries; usually 50-140 (organics) and 50-150 (TPH)	Eval. LCS or SRM recoveries to assess pot. matrix effects; evaluate/qualify affected data.
Sample / Spike Replicates	Inorganics	Duplicates @ 5% or 1 per anal. batch; field dup.	20% RPD	Eval. procedure and assess pot. matrix effects; pot. batch/sample reanalysis; evaluate/qualify affected data.
	Conventionals	Duplicate / triplicate @ 5% or 1 per anal. batch; field dup.	20% RPD/RSD	Eval. procedure and assess pot. matrix effects; pot. batch/sample reanalysis; evaluate/qualify affected data.
	Organics/TPH	Matrix spike duplicates @ 5% or 1 per anal. batch; field dup.	40% RPD (organics) 50% RPD (TPH)	Eval. procedure and assess pot. matrix effects; pot. batch/sample reanalysis; evaluate/qualify affected data.

(1) Definition of terms used: CCL – certified control limits; LCL – laboratory control limits; MRL – method reporting limit; PQL – practical quantitation limit; RPD – relative percent difference; RSD – relative standard deviation.

10.0 DATA MANAGEMENT PROCEDURES

There are two types of data that will be generated for this component of the Port's Targeted Stormwater Management Program Effectiveness Monitoring program: (1) field activity data, including sediment trap deployment, inspection, and retrieval; and (2) laboratory sediment quantity and quality data.

10.1 FIELD ACTIVITY DATA

Field activity data will be recorded in the field notebook. The field notebook will include the completed sediment trap deployment, inspection and retrieval field sheets, and chain of custody forms. Copies of these field data sheets are in Appendix B. The Consultant Project Manager is responsible for updating and storing the field notebook. The field notebook will be photocopied monthly, and the copy stored at the Port.

10.2 LABORATORY DATA

All laboratory reports will be transmitted electronically and via hard copy to the Port Project Manager and Consultant Technical Lead. Data reported electronically by the contract analytical laboratory(s) will be transferred to Excel spreadsheets comprising the project sediment quality database. The Port Project Manager and Consultant Technical Lead will compile and manage the database and back up the database each time new laboratory data is entered. The laboratory reports will be included as appendices in the annual reports.

11.0 ASSESSMENT/OVERSIGHT

Assessment and oversight activities will be performed to determine whether the QC measures identified in the QAPP are being implemented and documented as required. Audits and reviews are the tools to implement this process. For example, during a review, the auditor may check that a sediment trap has been correctly deployed or that information on a field data sheet matches information entered on a COC form. During an audit or review, the auditor may check for:

- Adherence to the site-specific plans
- Documentation of the process or system
- Proper identification, resolution, and documentation of nonconformance with the process or system
- Correction of identified deficiencies
- Assessments and Response Actions

11.1 Assessments and Response Actions

The need for an audit can be determined independently by the Project Manager, at the recommendation of the Port of Tacoma, or at the recommendation Ecology. Assessment activities may include surveillance, inspection, peer review, management system review, readiness review, technical systems audit, performance evaluation, and data quality assessment. The Project Manager, with assistance from the Quality Assurance Manager will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation. Audits of the analytical laboratories will be performed in accordance with the laboratory subcontract. The Project Manager, Quality Assurance Manager or designee, in compliance with the subcontract, will perform laboratory audits.
Field audits also may be conducted by the Quality Assurance Manager, Project Manager, or a designee.

11.1.1 Laboratory Performance and Systems Audits

Laboratory systems may be audited in accordance with project requirements. Contracted laboratories must submit a Laboratory Quality Assurance Plan (QAP). The QAP must include relevant standard operating procedures, a description of the laboratory's internal procurement policies, and its corrective action program. The laboratory audits will address at least the following questions:

- Is the laboratory operation being performed as required by the subcontract?

- Are internal laboratory operations being conducted in accordance with the laboratory QAP?
- Are the laboratory analyses being performed in accordance with method requirements?

Any nonconformance noted during an audit will result in a corrective action.

11.1.2 Field Team Performance and System Audits

The Quality Assurance Manager or a designated representative may conduct audits of the field activities in accordance with the project requirements. The audit will address at least the following questions:

- Are sampling operations being performed as stated in the QAPP and SOPs?
- Are the sample labels being filled out completely and accurately?
- Are the COC records complete and accurate?
- Are the field notebooks being filled out completely and accurately?
- Are the sampling activities being conducted in accordance with the QAPP and SOPs?
- Are the documents generated in association with the field effort being stored as described in the QAPP and SOPs?

The generation and documentation of field data also will be audited. The audits will focus on verifying that proper procedures are followed so that subsequent sample data will be valid. Any nonconformance noted during an audit will result in corrective action.
The results of the assessment and oversight activities will be reported to the Project Manager, who has ultimate responsibility for ensuring that the corrective action response is completed, verified, and documented.

12.0 REPORTING

Two types of reports will be generated in relation to the Targeted Stormwater Management Program Effectiveness Monitoring activities covered in this QAPP. These report types are:

(1) Status Reports to the Port Management, and
(2) Annual Stormwater Monitoring Reports

The Status Reports to the Port Management are not required by the MS4 permit, but will be used at the discretion of the Project Manager as internal means to track the progress of the monitoring program. Targeted Stormwater Management Program Effectiveness Monitoring Reporting is required by the MS4 permit to be included as a section in the overall Annual Report (per Permit §S8.H.1.b and §S9.G). The following sections describe the two types of reports.

12.1 STATUS REPORTS TO MANAGEMENT

Status reports to track Targeted Stormwater Management Program Effectiveness Monitoring progress may be prepared and submitted to the Project Manager as frequently as quarterly. A typical status report may include the following information and components:

- A summary of the number of sediment trap deployments and/or inspection site visits conducted and number of sediment samples retrieved, if any, during the current period.
- An appraisal of project progress relative to the overall proposed schedule,
- Summary of the quality control and validation review of analytical data reports, and
- Discussion of any project issues that may need to be addressed.

12.2 ANNUAL STORMWATER MONITORING REPORT

The Stormwater Monitoring Report (per Permit §S8.H) is a required component of the Annual Report (per Permit §S9.G). Targeted Stormwater Management Program Effectiveness Monitoring Reporting must be included in these Stormwater Monitoring Reports (per Permit §S8.H.1.b). The following items will be addressed in each Annual Stormwater Monitoring Report, as appropriate (per Permit §S8.H.1.b).

- A summary of the purpose, design, and methods of the monitoring program (per Permit §S8.H.1.b.i). The third Annual Report (submitted March 2010) will include this information initially, while subsequent reports will describe any changes instituted during the period addressed by the report.

- The status of implementing the monitoring program (per Permit §S8.H.1.b.ii)
- A comprehensive data and QA/QC report for the monitoring program, with an explanation and discussion of the data (per Permit §S8.H.1.b.iii). Each annual report will focus on the data collected and QA/QC activities conducted during the period addressed in the report in the context of information presented in prior reports.
- An analysis of the results of the monitoring program (per Permit §S8.H.1.b.iv). The project results will be presented in the annual report that follows the end of the treatment period (during the next permit cycle).
- Recommended future actions based on findings (per Permit §S8.H.1.b.v) will be resented in the annual report that follows the end of the treatment period (during the next permit cycle).

Each annual Stormwater Monitoring Report will compile sampling data from the previous water year[2]. Table 11 below summarizes the period of sampling data that will be included in each annual Stormwater Monitoring Report for the current MS4 permit. As is indicated in the Table, the Port is aware that a portion of this program will proceed into the next permit cycle and ensures that all reporting requirements will be met.

Table 11. Data Collection Period, Included in Each Annual Report

Report Date	Includes Sampling Data from
March 31, 2010	March 2009 through September 2009
March 31, 2011	October 2009 through September 2010
March 31, 2012	October 2010 through September 2011
Next permit cycle	October 2011 through March 2012 (end of permit)

12.2.1 Data Analysis

After completion of the baseline data collection period, the data collected during the baseline period will be analyzed to determine the differences in sediment quantity, constituent concentrations, and constituent loadings that could be detected with statistical significance at a statistical power of 0.80, based on the number of samples proposed for the study. If the magnitudes of the detectable differences are considered too large, then

[2] The first Annual Stormwater Monitoring Report submitted under this QAPP will include data from only a portion of the water year.

the Port may decide to extend the baseline and treatment periods in order to collect a larger sample size.

Following the conclusion of the data collection period, the sampling data will be analyzed to determine the following:

(1) Is the quantity (weight and volume) of sediment that accumulated in the sediment traps during the baseline period significantly different from the amount of sediment that accumulated in the traps during the treatment period?

(2) Are the concentrations and loads of chemical constituents in sediment samples collected during the baseline period significantly different from the concentrations and loads of chemical constituents in sediment samples collected during the treatment period? Constituent loads will be determined by multiplying the dry-weight of a sediment sample by the constituent concentrations in that sample.

Comparisons of sediment quantity, constituent concentrations, and constituent loadings during the baseline and treatment periods will be performed using a statistical test appropriate to the data distributions (e.g., Student's t-test, Wilcoxon rank-sum test, or Kruskal-Wallis procedure).

13.0 DATA REVIEW VERIFICATION AND VALIDATION

This section addresses data review, verification, and validations activities that occur after the data collection phases are complete. Implementation of these procedures determines whether the data conform to the specified criteria, thus satisfying the program objectives.

13.1 DATA REVIEW, VERIFICATION, AND VALIDATION SUMMARY

Data pertaining to the quantity and quality of storm drain sediment will be generated for this project. Data review involves examination of the data for errors or omissions. Data verification is the systematic process that involves examination of the QC results for compliance with acceptance criteria. Data validation involves the examination of the complete data package to determine whether the procedures in the QAPP were followed.

All data obtained from field observations and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives that are listed in Section 5.1. Only those data that are supported by appropriate quality control data and meet the measurement performance specification defined for this program will be considered acceptable and used in the project. The data review, verification, and validation procedures for each data type are discussed below.

Storm drainage system maintenance and sweeping logs will be reviewed and verified for completeness and to confirm that the maintenance was conducted in a manner and at a frequency as specified in this QAPP.

Verification and validation procedures will be based, as needed, on the guidance provided by the EPA (2002) in Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8. These procedures include, for example, how computer entries are compared to field data sheets, data gaps are identified, calculations are checked, and raw data are examined for outliers or nonsensical readings, and so forth.

The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation, and verification of the data each task generates or handles throughout each process. The Laboratory Quality Assurance Officer is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format for import to the project database. The Quality Assurance Manager is responsible for validating a minimum of 10 percent of the data produced in each task. Finally, the Project Manager, with the concurrence of the Quality Assurance Manager, is responsible for validating that all data to be reported meet the objectives of the project and are suitable for reporting.

13.2 Verification and Validation Methods

This section presents example methods that may be used for the data verification and validation process. The records needed for, general methods and process for completion of, and the reporting of verification and validation are discussed. Specific methods, as documented via SOPs or data reports, will be further developed.

13.2.1 Data Verification Inputs

Records that may be used as inputs for the data verification process a presented in Table 12.

Table 12. Example data verification inputs

Operation	Common Records	Sources for Record Specifications
Sediment trap deployment, inspection and sediment sample collection	Field logs, Chain of Custody forms (COC)	QAPP, Standard Operating Procedures for sample collection, pre-printed COC form instructions, project database.
Sample Receipt	COC forms from field personnel, receiver's copy of shipping bill, internal laboratory receipt forms, internal laboratory COC forms, laboratory documented temperature logs	QAPP, laboratory SOP for sample receipt, pre-printed COC instructions
Sample Preparation	Analytical services requests, internal laboratory receipt forms, internal laboratory COC forms, laboratory refrigerator or freezer logs, preparation logs or bench notes, manufacturer's certificates for standards or solutions	QAPP, reference method, laboratory SOP for analysis method, pre-printed instructions on internal forms and worksheets
Sample Analysis	Analytical services requests,	QAPP, reference method, laboratory

Operation	Common Records	Sources for Record Specifications
	internal laboratory receipt forms, internal laboratory COC forms, laboratory refrigerator or freezer logs, manufacturer's certifications for standards or solutions, instrument logs or bench notes, instrument readouts (raw data), calculation worksheets, quality control (QC) results, analytical reports from the lab to the client.	SOP for analysis method, pre-printed instructions on internal forms and worksheets
Records review	Internal laboratory checklists	QAPP, laboratory SOP for analysis method or laboratory QA Plan

Source: US EPA 2002

13.2.2 Data Verification Implementation Methods

Following are expected data verification methods to be used by the Quality Assurance Manager. Additional verification methods may be developed as the project progresses. A checklist of what verification was completed and when it was completed should be systematically documented throughout the project.

- Determine if maximum holding times were exceeded (for each parameter)
- Completeness and missing data: do the analytical results match what the field sheets and COCs have listed for samples collected?
- Correct analytical method used by laboratory?
- Correct detection limit achieved by laboratory?
- Matrix spike recovery within laboratory's limits?
- Laboratory duplicate within laboratory's limits?
- Expected trends: Is the result realistic for each individual parameter? Is the data point an outlier when compared to existing project data?

13.2.3 Data Verification Outputs

There are two general outputs from the data verification process:

(1) the verified data, and

(2) data verification records.

The verified data are the final data sets that will proceed on to the Data Usability Assessment (Section 14.0). These data sets will be in the format as described in Section 10.0. Data verification records will list the date when the Quality Assurance Manager has completed the verification process, indicate the methods used, and discuss relevant data issues. Data verification records could be included in, for example, the Status Reports to Management or the Data QA/QC report section of the Annual Stormwater Monitoring Report.

Any changes to the results as originally reported by the laboratory should either be accompanied by a note of explanation from the data verifier or the laboratory, indicated by an appropriate flag, or reflected in a revised laboratory data report. Data verification records can also include a narrative that identifies technical non-compliance issues or shortcomings of the data produced during the field or laboratory activities.

14.0 DATA QUALITY (USABILITY) ASSESSMENT

Data Quality Assessment (DQA) is completed after data verification and validation is done. If the Data Quality Objectives stated in this QAPP are met, then the data will be useable in meeting project objectives. If the Data Quality Objectives stated in this QAPP are not met, a determination must be made of whether the quantity and quality of the data are sufficient to meet project objectives. Anomalies in the data set will be identified and assessed, and their impact on meeting project objectives will be discussed in the pertinent Stormwater Annual Report.

The main goals of the DQA will be to determine if the resulting project data set:

(1) Indicates that maintenance activities were conducted in a manner and at a frequency indicated in the QAPP,

(2) Is representative of stormwater runoff conditions in the selected municipal drainage basin, and

(3) Is sufficient to determine whether the catch basin inserts, increased maintenance and truck idling enforcement activities conducted during the treatment period resulted in either a measurable reduction in the quantity of and/or a measureable improvement in the quality of storm drain sediment coming from the selected municipal drainage basin.

Table 13. Example DQA table

Study Period	Number of Sediment samples collected	Number of sediment samples that pass DQA	Percent of samples Targeted
Baseline Period			
Treatment Period			

15.0 REFERENCES

Ecology 2007a. Phase I Municipal Stormwater Permit, National Pollutant Discharge Elimination System and State Waste Discharge Permit for discharges from Large and Medium Separate Storm Sewer Systems. Washington State Department of Ecology. Olympia, Washington. Issuance Date January 17, 2007.

US EPA 1990. Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers, OSWER Directive #83240.0-05.

US EPA 2002. Guidance on Environmental Data Verification and Data Validation. EPA QA/G-8, 2002.

Wilson, C. and D. Norton 1996. Stormwater Sediment Trap Pilot Study. Washington State Department of Ecology. Publication No. 96-347, November 1996.

APPENDIX A: PORT OF TACOMA STORMWATER MANAGEMENT PROGRAM EFFECTIVENESS MONITORING—TARGETED ACTION

PORT OF TACOMA STORMWATER MANAGEMENT PROGRAM EFFECTIVENESS MONITORING—TARGETED ACTION

INTRODUCTION

Per Section S8.E of the NPDES Phase I Municipal Stormwater Permit (Permit), Targeted Stormwater Management Program (SWMP) Effectiveness Monitoring will be conducted by the Port of Tacoma (Port) to evaluate the effectiveness of providing training for Port employee, drayage trucking customers, and longshore breakbulk unloading procedures to improve their knowledge and level of understanding of beneficial stormwater practices and behaviors that they can change in order to reduce pollutants in stormwater runoff being discharged from Port properties. The following section discusses the required elements of the monitoring program (per Permit §S8.E.3).

SWMP EFFECTIVENESS MONITORING PLAN

Section S8.E.1 of the Permit states that the Permittee shall conduct monitoring designed to determine the effectiveness of the Permittee's SWMP at controlling a stormwater related problem that can be directly addressed by targeted action(s) within the SWMP. According to Section S8.E.2, monitoring may include data collection and analysis of other programmatic measures of effectiveness such as surveys and polls. Section S8.E.3 requires that the Permittee develop a monitoring plan for the collection of data needed to measure the effectiveness of the selected targeted SWMP action.

The following sections address the four required elements of the monitoring program, including:

- A description of the targeted action and why it is significant to the Port,
- Specific hypotheses to be tested by the monitoring program,
- Specific parameters/attributes to be monitored, and
- Expected modifications to management actions based on the outcome of hypotheses testing.

Each of these required elements is discussed below.

Description of Targeted Action

Section S8.E.3.a of the Permit requires a description of the targeted action, an explanation of why it is significant to the Permittee, and if the problem is significant to other stormwater managers.

• Description of the Targeted Action: The Port of Tacoma's targeted action is to educate staff, drayage truck customers, and longshore workers about the Port's NPDES Phase I Permit and required stormwater management program, current and planned future activities, and how their actions can impact stormwater discharges to adjacent water bodies. Educational materials will be developed and distributed to improve their understanding of stormwater practices, NPDES Permit requirements, and behaviors that they can undertake to reduce pollutants in stormwater runoff. The targeted outcome is an improved understanding of the requirements of the NPDES Permit, and beneficial stormwater practices and behaviors.

• Why it is Significant to the Permittee: Education of staff, customers and longshore workers on stormwater runoff and the effects of pollution in Puget Sound is an important factor in a successful Port Stormwater Program. Many other groups within the Port's jurisdiction already receive education and training on this subject through NPDES General Stormwater Permits, MS4 SWPPP requirements, City of Tacoma Municipal Code requirements and community outreach. Port staff, drayage customers and longshore workers could also benefit from stormwater education and could make a significant positive impact on the quality of runoff on Port property.

• Significance to other Stormwater Managers: Education is a required component for NPDES Municipal Stormwater Permittees. The outcome of the Targeted Action, surveys, and educational materials will be shared with other permittess and can be adapted to help their target audiences. For some entities, this will result in cost savings, by adapting materials that are successful.

Hypothesis

Section S8.E.3.b of the Permit requires a specific hypothesis about the targeted action outcome that will be tested by the monitoring program. The hypothesis is that targeted educational outreach materials distributed to tenants will improve tenant understanding and knowledge of the following:

• Permit requirements;

• Potential impacts that stormwater discharges can have to local receiving waters;

• Proper use and maintenance of Best Management Practices (BMPs);

• Methods that can be used to avoid, minimize, reduce, and/or eliminate adverse impacts from stormwater discharges;

• Impacts of illicit and other non-stormwater discharge, including what constitutes an illicit discharge;

• What behaviors that need to be changed in order to improve water quality in their stormwater runoff; and

• What programs or activities are conducted as part of the Port's SWMP.

Measurable Attributes

Section S8.E.3.c of the Permit requires information of the specific parameters, or attributes to be measured. For the targeted SWMP action, a survey will be developed and administered to before and after the receipt of educational materials. Attributes and measured changes will likely include the following:

- Knowledge of the Port's stormwater management program, applicable City codes, and practices on their own properties that are likely to improve water quality;
- Collected feedback on applicability and effectiveness of educational materials;
- Documentation of the status of on-site source control and best management Practices;
- Determination if educational materials have resulted in changes in behavior, revisions to current practices, and/or implementation of new practices aimed at improving stormwater runoff quality;
- Documentation of the type and frequency of use of the selected educational materials; and
- An assessment of the usefulness of this information, including suggested revision and enhancements to future educations materials.

Modifications to Management Actions

Section S8.E.3.d of the Permit requires and explanation about expected modifications to management actions resulting from the outcome of hypotheses testing. It is expected that the Port will learn a great deal about the targeted audience's level of stormwater knowledge in regard to SWMP, permits, City codes, and BMPs. From this collected information, the Port of Tacoma will:

- Determine if education has been an effective and useful SWMP action;
- Determine if additional targeted educational materials are needed;
- Evaluate, change, and refine educational materials for applicability to tenants and their effectiveness in changing practices and behaviors; and
- Discontinue use of materials tenants generally regarded as irrelevant or less useful for their particular operations.

APPENDIX B: FIELD DATA SHEETS

The following forms are subject to change based on monitoring program needs.

Port of Tacoma - Targeted Stormwater Management Program Effectiveness Monitoring

Sediment Trap Inspection and Retrieval

**** *coordinate all sediment field activities (S8E) with outfall monitoring (S8D)* ****

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Personnel:	Weather:	Date:

Sediment Trap Inspection

Station/ CB #	Arrival Time	Sediment trap house/bracket ok?	Trap bottle condition ok?	Sediment trap percent filled?	Sediment trap retrieved? (if yes fill in retrieval section below)	Sediment trap redeployed and secured?	Notes

Sediment Trap Retrieval

Station/ CB #	Time of retrieval	Sample ID	Sample placed in cooler on ice?	New trap deployed? (if yes complete deployment form)	Notes

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Sediment Trap Installation/Deployment

Personnel: ______________________ Weather: ______________
Station/Catch Basin #: ______________________ Date/Time: ______________

Sediment Trap	
Mounting type: pipe wall other	
Pipe: conrete brick metal other	
Pipe condition: cracked eroded smooth other	
Pipe diameter (in):	
Sediment trap housing/bracket ok?	
Sediment trap bottle deployed and secure?	
Installation/deployment complete?	
CB Plan View	CB Profile View

Photo #	Description
#	
#	
#	
#	
#	
General Notes	

***** coordinate all sediment field activities (S8E) with outfall monitoring (S8D). Do not conduct upstream sediment work while S8D stormwater or monitoring is being conducted. Prevent resuspension of sediment in upstream CB's as to not affect downstream sediment or water monitoring****