APPENDIX 9 – Stormwater Discharge Monitoring

This Appendix applies to Permittees with stormwater discharge monitoring requirements pursuant to Special Condition S8 Monitoring and Assessment, particularly ~~section~~sections S8.B.2, for Clark County, and S8.C.2, if a Permittee chooses not to participate in the Regional Stormwater Monitoring Program (RSMP) by paying into a collective fund to implement RSMP effectiveness studies.

Stormwater discharge monitoring is intended to characterize stormwater runoff quantity and quality at a limited number of locations in a manner that allows analysis of loadings and changes in conditions over time and generalization across the Permittee's jurisdiction.

QAPP Preparation

Permittees shall prepare a Quality Assurance Project Plan (QAPP) in accordance with *Quality Assurance Project Plan Guidance, Special Condition S8.D, Phase I Municipal Stormwater Permit,* December 2010 (Ecology Publication no. 10-10-075 http://www.ecy.wa.gov/pubs/1010075.pdf). The QAPP shall be developed by qualified staff or contractors with experience in applying Ecology or Environmental Protection Agency (EPA) QAPP Guidelines.

A stormwater discharge monitoring QAPP shall be submitted to Ecology in accordance with the deadlines in S8. The QAPP shall describe field collection methods and sample preparation methods appropriate to each group of analytes, reporting limits, and field conditions.

Permittees are responsible for maintaining an up-to-date approved QAPP for stormwater discharge monitoring. Significant changes shall be reviewed by Ecology and reflected in a revised QAPP. Significant changes include, but are not limited to:

- Land disturbing activities over 10 acres in size within the sampled drainage area.
- Relocating a monitoring station.
- Introducing new sampling equipment.
- Unanticipated back water conditions, base flow, or tidal influences.
- Changes in laboratories, analytical methods, or reporting limits.

Discharge Monitoring Location Selection

Stormwater monitoring discharge monitoring locations shall have mapped tributary conveyance systems and drainage areas, and be suitable for permanent installation and operation of flow-weighted composite sampling equipment. Additional monitoring location selection guidance and information about how to estimate a rainfall to runoff relationship is available in *Standard Operating Procedure for Automatic Sampling for Stormwater Monitoring, ECY002* from the Ecology Quality Assurance Page (http://www.ecy.wa.gov/programs/eap/quality.html~~(~~; specific guidance for automatic sampling is available at http://www.ecy.wa.gov/programs/eap/qa/Agency/ECY_WQ_SOP_AutomatedSampling_v1_0ECY002.pdf).

Permittees may identify a discharge monitoring location upstream in the conveyance system (*i.e.*, upgradient of the outfall) in order to achieve the desired land use, to accommodate the installation of sampling equipment, and/or to avoid or minimize back water or tidal interference.

The QAPP shall describe each stormwater discharge monitoring location and associated drainage basin in detail. The QAPP must describe how each discharge monitoring location was selected, the size of the drainage basin, and the percentage of area in the drainage basin representing the following land uses: high density residential, low density residential, commercial, industrial, agriculture, and transportation right-of-way. ~~The table~~Table A9-1 below provides characteristics to consider for some of these land uses. However, density definitions can vary from jurisdiction to jurisdiction and may be defined locally in codes and comprehensive plans. Report the residential density definitions used if they differ from these.

Table A9-1 Land Use Selection Characteristics

Land use category	Characteristics
High density residential	4 dwelling units per acre or greater
Medium to high density residential	2 to 4 dwelling units per acre
Low density residential	1 to 2 dwelling units per acre
Commercial	Includes multi-family residential
Industrial	Not predominated by one facility with a few operators

Flow Monitoring

Discharge monitoring locations must be evaluated for a rainfall to runoff relationship in order to ensure that the discharge monitoring location will receive enough runoff for sufficient sample volume. This rainfall to runoff relationship will also assist in programming the automatic sampling equipment. In order to establish the rainfall to runoff relationship, one year of continuous flow recording (including base flow and all storm events) is necessary.

Monitoring Frequency

Permittees shall sample each stormwater discharge monitoring location according to the frequency described below. Documented good faith efforts with good professional practice by the Permittee which do not result in collecting a successful sample for the full number of required storms may be considered as contributing toward compliance with this requirement.

For each location, the Permittee shall sample and analyze a minimum of eleven (11) qualifying storm events per water year. Qualifying storm event sampling must be distributed throughout the year, approximately reflecting the distribution of rainfall between the wet and dry seasons (with a goal of 60-80% of the samples collected during the wet season and a goal of 20-40% of the samples collected in the dry season).

Ecology may approve a reduced sampling frequency if the Permittee provides a statistical analysis demonstrating that monitoring goals can be met with fewer samples.

Qualifying Storm Event Criteria

The wet season is from October 1 through April 30. A qualifying wet season storm event is defined as follows:

- Rainfall volume: 0.20" minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: Less than or equal to 0.05" rain in the previous 24 hours
- Inter-event dry period: 6 hours

The dry season is from May 1 through September 30. A qualifying dry season storm event is defined as follows:

- Rainfall volume: 0.20" minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: less than or equal to 0.02" rain in the previous 48 hours
- Inter-event dry period: 6 hours

Types of Sampling

Storm events shall be sampled using flow-weighted composite sampling techniques. Automatic samplers shall be programmed to begin sampling as early in the runoff event as practical and to continue sampling past the longest estimated time of concentration for the tributary area. Refer to *Standard Operating Procedure for Automatic Sampling for Stormwater Monitoring, ECY002* (http://www.ecy.wa.gov/programs/eap/quality.html) for guidance on how to conduct flow weighted composite sampling.

For storm events lasting less than 24 hours, samples shall be collected for at least seventy-five percent (75%) of the storm event hydrograph. For storm events lasting longer than 24 hours, samples shall be collected for at least seventy-five percent 75% of the hydrograph of the first 24 hours of the storm.

Each composite sample ~~should~~shall be targeted to contain at least 10 aliquots. Composite samples with 7 to 9 aliquots are acceptable if they meet the other sampling criteria and help achieve a representative balance of wet season/dry season events and storm sizes.

Continuous flow recording of all storm events (not just sampled storm events) is necessary for at least one complete water year to establish a baseline rainfall/runoff relationship. Ongoing continuous flow monitoring is required for each of the sampled storm events as necessary to properly conduct the flow-weighted composite sampling. Precipitation data shall be collected from the nearest rain gauge reporting at least hourly rainfall amounts.

Grab samples are necessary for some parameters (see below) and shall be collected early in the storm event. Refer to *Standard Operating Procedure for Grab Sampling for Stormwater Monitoring, ECY001* (http://www.ecy.wa.gov/programs/~~wq/stormwater/municipal/SOPGrabSampling.pdf~~eap/quality.html).

Field Code Changed

Use of in-line sediment traps or similar collection system is preferred for sediment samples; refer to *Standard Operating Procedure for Collection of Stormwater Sediments using In-Line Sediment Traps, ECY003* (http://www.ecy.wa.gov/programs/eap/quality.html).

Sediment samples shall be collected once per water year at each stormwater discharge monitoring location, or in the vicinity of each stormwater monitoring location, during the month of May or June.

Sampling of receiving water sediment deposits is an alternative where approved by Ecology.

Parameters

Flow-weighted composite samples shall be analyzed for the following parameters utilizing an Ecology- or EPA-accredited laboratory and the methods and reporting limits as provided in table A9-~~1~~2 at the end of this appendix or otherwise approved by Ecology.

- Conventional parameters: total suspended solids (TSS), turbidity, conductivity, chloride, biochemical oxygen demand (BOD5), hardness, pH, and methylene blue activating substances (MBAS).
- Nutrients: total phosphorus, orthophosphate, total kjeldahl nitrogen, and nitrate plus nitrite
- Metals, total and dissolved: copper, zinc, cadmium, lead, and mercury
- Organics:
    - Polycyclic aromatic hydrocarbon (PAH) compounds: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h~~),~~)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene
    - Herbicides: 2,4-D and ~~dichlobenyl~~dichlobenil
    - Insecticides: carbaryl and chlorpyrifos
    - Phthalates: bis(2-Ethylhexyl)phthalate

If the volume of the stormwater sample collected from a qualifying storm is insufficient to allow analysis for all of the parameters listed above, the sample shall be analyzed for as many parameters as possible in the following priority order: (1) metals and hardness; (2) TSS; (3) organics: PAHs, herbicides, insecticides, phthalates; (4) nutrients; (5) conductivity; (6) BOD_5; and (7) remaining conventional parameters. If insufficient sample exists to run the next highest priority pollutant, that analysis ~~should~~may be bypassed and analyses run on lower priority pollutants in accordance with the remaining priority order to the extent possible. Parameters that are below reporting limits after two years of data may be dropped from the analysis.

Grab samples shall be analyzed for the following parameters utilizing an Ecology- or EPA-accredited laboratory and the methods and reporting limits listed in ~~table~~Table A9-~~1~~2 at the end of this Appendix.

- Fecal coliform bacteria
- Total petroleum hydrocarbons (TPH): NWTPH-Gx and NWTPH-Dx and BTEX (benzene, toluene, ethyl-~~benxene~~benzene, and xylenes). ~~The lube oil fraction, not the diesel fraction, is targeted for NWTPH-Dx~~

Sediment samples shall be analyzed for the following parameters utilizing an Ecology- or EPA-accredited laboratory and the methods and reporting limits listed in table A9-~~2~~3 at the end of this Appendix or otherwise approved by Ecology. If the volume of sediment sample is insufficient to analyze for all of the parameters listed below, the sample shall be analyzed for as many parameters as possible in the following priority order:

- Total organic carbon
- Metals: copper, zinc, lead, cadmium, and mercury
- Organics:
  - PAH compounds: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, 2,6-~~dimethylnapthalene~~dimethylnaphthalene, 2-~~ethylnapthalene~~methylnaphthalene, fluoranthene, naphthalene, benzo(ghi)perylene, phenanthrene, and pyrene
  - Petroleum hydrocarbons: NWTPH-Dx
  - Pyrethroids: bifenthrin
  - PCBs: aroclors
- Total volatile solids
- Total phosphorus
- Percent solids, grain size

A minimum of one sediment sample per year shall be collected. Additional samples shall be collected if insufficient sample exists from a single sample to run all of the organic pollutants listed above. A visual, qualitative determination of grain size shall be reported for all samples (in addition to the quantitative analysis for all samples with sufficient volume). Parameters that are below reporting limits after two years of data may be dropped from the analysis.

Recordkeeping and Reporting

For each stormwater monitoring location, calculate the following:

- Event Mean Concentrations (EMCs)
- Total annual pollutant load by parameter
- Seasonal pollutant loads by parameter for the wet and dry seasons

The annual pollutant load calculations must be based on a water year and include wet and dry season loads and total annual load (wet plus dry season load). The loadings shall be expressed as total pounds and as pounds per acre, and must take into account potential pollutant load from base flow. Loadings shall be calculated following *Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, ECY004* (http://www.ecy.wa.gov/programs/eap/quality.html). Pollutant loading information is required for water quality parameters only.

Annual Monitoring Reports shall be submitted with each Annual Report beginning with the first Annual Report following the first full water year of monitoring. Annual Monitoring Reports shall provide all monitoring data collected during the preceding water year (October 1 – September 30). Concentration data shall be provided in the same units that are specified for Reporting Limits in Tables A9-~~1~~2 and A9-~~2~~3. Flow data shall be provided in gallons per minute. Loading

data for each water year shall be provided in total pounds and in pounds per acre. Annual Monitoring Reports shall consist of a narrative report, an Excel spreadsheet with all data and pollutant loading calculations, and a submittal to Ecology's Environmental Information Management (EIM) database. ~~Guidance for EIM data submittals is provided in *Stormwater Monitoring Report Guidance, Phase I Municipal Stormwater Permit,* **Reporting** *Requirements for Special Condition S8,* November 2010 (Ecology Publication No. 10-10-028).~~ For the Annual Monitoring Report to be considered on time, the EIM data submission process must be initiated before April 1 of each relevant year, and completed by June 15 of each relevant year.

Annual Monitoring Reports shall include:

- A brief summary of each monitored drainage basin (full details of the monitoring drainage basin ~~should~~shall be in the QAPP), including any changes within the contributing drainage area or changes to the monitoring station that could affect hydrology and/or pollutant loading.
- A description of each flow-weighted composite and grab sampled storm event, including:
  - General summary about storm event criteria, including:
    - Precipitation data (in inches) including antecedent dry period and rainfall distribution throughout the event.
    - Flow and hydrograph data including sampled and total runoff time periods and volumes.
    - Total number of qualifying storm events captured and analyzed at each monitoring location.
    - Distribution of storms collected between wet and dry seasons (permit goals include 60-80% of storms during the wet season and 20-40% of storms during the dry season).
    - Logistical problems associated with any storm event criterion.
  - A hyetograph and a hydrograph for each sampled storm event. Include properly labeled graphs that display the following:
    - Date of the storm event~~,~~.
    - Time of day versus precipitation information~~,~~.
    - Time versus flow rate (in gallons per minute~~), and,~~).
    - Time versus aliquot collection.
    - Display the total duration of the storm event, not just the duration when samples were collected (remember your pollutant load calculation must include flow for the entire storm event, not just the water quality sampled portion~~)~~).
  - A summary of (or in the graph) the total runoff volume in gallons.
  - A rainfall/runoff relationship table used to estimate the un-sampled storm events (~~where~~when water quality samples were not collected). This is used for future estimations of annual and seasonal loads.
  - Whether or not any chemicals were removed from the list of analysis due to two years of non-detect data.
  - A brief summary with storm event dates where insufficient volumes were collected. Include the parameters analyzed.

- A description of the sediment sampling event, including:
  - Whether or not any chemicals were removed from the list of analysis due to two years of non-detect data.
  - A summary of sediment sampling (including dates) where insufficient volumes were collected. Include the parameters analyzed.
- Event Mean Concentrations (EMCs)
- The wet and dry season pollutant loads and annual pollutant load based on water year for each discharge monitoring location expressed in total pounds, and pounds per acre. Include the following:
  - For storm events where water quality samples were collected, the load in pounds per day for each parameter for each sampled storm event, include date of storm events.
  - An estimated seasonal pollutant load for each parameter at each discharge monitoring location. This is calculated using all storm events (~~where~~when water quality samples were collected and when samples were not collected).
  - A total annual pollutant load (wet season load + dry season load) for each parameter (include estimated events).
  - The rainfall/runoff relationship including your pollutant load estimates for un-sampled events.
  - Note that if any data is unavailable to effectively estimate your rainfall to runoff relationship due to an incomplete water year, submit this information in the next year's stormwater monitoring report.
- Quality Assurance/Quality Control information for each *successfully sampled qualifying storm event* at each discharge monitoring location and *sediments* sampled at each discharge monitoring location, including:
  - A narrative summary of your field and laboratory verification, validation results and quality control checks performed.
  - A narrative analysis of your field and laboratory quality control sample results and how they compare with your data quality objectives/indicators in your QAPP.
  - Corrective actions reported/taken.
- An explanation and discussion of results from each *successfully sampled qualifying storm event* at each discharge monitoring location and *sediments* collected at each discharge monitoring location, including:
  - A statistical analysis of the event mean concentrations for each parameter and a narrative description of significant findings from this analysis.
  - Any conclusions based on data from this study including analyses of previously collected data from these discharge monitoring locations.
- A description of Stormwater Management Program activities currently taking place or planned within the monitoring station's drainage area that may have affected or may potentially affect future monitoring results.

If the Permittee monitors any pollutant more frequently at the stormwater discharge monitoring locations, then the results of this monitoring shall be included in the annual monitoring report reflecting the water year in which the monitoring occurred.

After three (3) water years of data, the Annual Monitoring Report shall include:

- Trend analyses,
- An evaluation of the data as it applies to the SWMP, and
- Any stormwater management activities the Permittee has identified that can be adjusted to respond to this data.

Laboratory Methods

The Permittee's stormwater discharge monitoring program shall use the following analytical methods or other methods approved by the U.S. Environmental Protection Agency or Ecology with similar reporting limits, unless alternative methods are approved by Ecology. Any alternative method proposed by a Permittee must have a similar reporting limit, or must be justified as adequate for the likely, expected range of concentrations. Permittees are not guaranteed approval of alternative methods or reporting limits.

In cases where smaller volumes of water are expected to be collected, or to save analytical costs, Permittees may propose that some of the analyses be optimized for specific parameters or groups. The Permittee must, in consultation with a qualified chemist, define the exact volumes and optimization steps and include them in the QAPP.

Table A9-~~1~~2 Analytical Procedures in Stormwater

Analyte	Method in Water	Reporting Limit[a]
Conventional Parameters		
Total suspended solids	SM 2540B[b] or SM 2540D	1.0 mg/L
Turbidity	EPA Method 180.1 or SM2130B	± 0.2 NTU
Conductivity	SM 2510 or EPA Method 120.1	± 1 umhos/cm
Chloride	EPA Method 300.0, EPA Method 325.2, or SM4110B or SM4500 Cl-E	0.2 mg/L
BOD_5	SM5210B	2.0 mg/L
Particle size distribution[1]	Coulter Counter, Laser diffraction, or comparable method - *see attached method*	NA
~~Grain Size~~	~~Sieve and pipette (ASTM 1997), PSEP 1986/2003, or comparable method~~	~~NA~~
pH	EPA Method 150.2 or SM $4500H^+$	0.2 units
Hardness as $CaCO_3$	EPA Method 200.7, SM2340B(ICP), SM2340C (titration) or SM 3120B	1.0 mg/L
Methylene blue activated substances (MBAS)	CHEMetrics Colorimetric or SM5540C	0.025 mg/L
Bacteria		
Fecal Coliform	SM 9221E	2 min., 2E6 max.
Nutrients		
Orthophosphate and total phosphorus	EPA Method 365.3, EPA Method 365.4, SM 4500-P E or SM4500-P F	0.01 mg P/L
Total Kjeldahl nitrogen	EPA Method 351.2, EPA Method 351.1, SM 4500 Norg-B, SM 4500 Norg-C, SM 4500 NH3-D, SM 4500 NH3-G, SM 4500 NH3-E or	0.5 mg/L

[1] Particle size distribution is required only for monitoring sites that measure discharge from best management practices.

	SM4500 NH3-F	
Nitrate-Nitrite	EPA Method 353.2 or SM 4500 -$NO3^-$ E	0.01 mg/L
Metals		
Total recoverable zinc	EPA Method 200.8 (ICP/MS), EPA Method 200.7 (ICP) or SM 3125 (ICP/MS)	5.0 µg/L
Dissolved zinc	EPA Method 200.8 (ICP/MS), or SM 3125 (ICP/MS)	1.0 µg/L
Total recoverable lead	EPA Method 200.8 (ICP/MS), or SM 3125 (ICP/MS)	0.1 µg/L
Dissolved lead, copper, and cadmium	EPA Method 200.8 (ICP/MS), or SM 3125 (ICP/MS)	0.1 µg/L
Total recoverable copper	EPA Method 200.8 (ICP/MS), or SM 3125 (ICP/MS)	0.5 µg/L
Total recoverable cadmium	EPA Method 200.8 (ICP/MS), or SM 3125 (ICP/MS)	0.2 µg/L
Total and dissolved mercury	EPA Method 7470 (CVAA), EPA Method 245.7, or EPA Method 1631E	0.1 µg/L
Organics		
PAH compounds	EPA Method 8310 or 8270 D SIM	0.1 µg/L
Herbicides (2,4-D, dichlobenil)	EPA Method 8270 D SIM or 8151 A	0.1 µg/L, 1 µg/L
Carbamate insecticides (carbaryl)	EPA Method 632	0.5 µg/L
Organophosphate insecticides (chlorpyrifos)	EPA Method 625 or EPA Method 614, 8270 D, EPA Method 622, EPA Method 1657	0.5 µg/L
Phthalates (bis(2-ethylhexyl)phthalate)	EPA Method 8270 D	1 µg/L
Petroleum Hydrocarbons		
NWTPH-Dx	Ecology, 1997, (Publication No. 97-602) ~~or EPA SW-846 method 8015B; lube oil fraction~~	0.25-0.5 mg/L
NWTPH-Gx	Ecology, 1997, (Publication No. 97-602)	0.25 mg/L
BTEX	EPA Method 8260 or 602	1 µg/L or 5 µg/L

a. The QAPP shall identify Ecology- or EPA-approved methods with appropriate reporting limits. An individual sample that could not be run at a reporting limit because of matrix interference or other such reasons would not be called into question for compliance purposes. All results ~~should~~shall be reported. For non-detect values below the reporting limit, report results at the method detection limit from the lab and the qualifier of "U" for undetected at that concentration.

b. To ensure accurate results, Ecology recommends modifying these methods to analyze (filter) the entire field sample. Research results indicate that errors may be introduced by decanting a subsample, although using a funnel splitter may help. The analyst may also consider analyzing several premixed subsamples from the same sample container to determine if significant variability occurred due to stratification. Reports shall indicate whether the entire field sample or a subsample was used.

NA – Not applicable

SM – Standard Methods

Table A9-23 Analytical Procedures in Sediments

Analyte	Method in Sediment	Reporting Limit[a]
Conventional Parameters		
Percent solids	SM 2540G	NA
Total organic carbon	Puget Sound Estuary Protocols (PSEP 1997), SM 5310B, SM 5310C, SM 5310D or EPA Method 9060	0.1%
Grain size	Sieve and Pipette (ASTM 1997), ASTM F312-97, ASTMD422 or PSEP 1986/2003	NA
Total phosphorus	EPA Method 365.3, EPA Method 365.4, SM 4500 P E or SM 4500 P F	0.01 mg/kg
Total volatile solids	EPA Method 160.4 or SM 2540G	0.1%
Metals		
Total recoverable zinc	EPA Method 200.8 (ICP/MS), EPA Method 6010, EPA Method 6020 or SM 3125 (ICP/MS), or EPA Method 200.7 (ICP)	5.0 mg/kg
Total recoverable lead	EPA Method 200.8 (ICP/MS), EPA Method 6010, EPA Method 6020 or SM 3125 (ICP/MS)	0.1 mg/kg
Total recoverable copper	EPA Method 200.8 (ICP/MS), EPA Method 6010, EPA Method 6020 or SM 3125 (ICP/MS)	0.1 mg/kg
Total recoverable cadmium	EPA Method 200.8 (ICP/MS), EPA Method 6010, EPA Method 6020 or SM 3125 (ICP/MS)	0.1 mg/kg
Total recoverable mercury	EPA Method 245.5 or EPA Method 7471B	0.005 mg/kg
Organics		
PAH compounds	EPA Method 8270 D	70 µg/kg dry
Pyrethroids (bifenthrin)	EPA Method 8270 D, EPA Method 1660	1.0 µg/kg dry
PCBs (aroclors)	EPA Method 8082	80 µg/kg dry
Petroleum Hydrocarbons		
NWTPH-Dx	Ecology, 1997 (Publication No. 97-602) or EPA SW-846 method 8015B	25.0-100.0 mg/kg

a. The QAPP shall identify Ecology- or EPA-approved methods with appropriate reporting limits. An individual sample that could not be run at a reporting limit because of matrix interference or other such reasons would not be called into question for compliance purposes. All results ~~should~~shall be reported. For non-detected values below the reporting limit, report results at the method detection limit from the lab and the qualifier of "U" for undetected at that concentration.

NA – Not applicable

SM – Standard Methods

WET SIEVING AND MASS MEASUREMENT

FOR LASER DIFFRACTION ANALYSIS

WET SIEVING

Sample Collection/Handling

Samples should be collected in HDPE or Teflon containers and held at 4 degrees C during the collection process. If organic compounds are being collected, the sample containers should be glass or Teflon.

Preservation/Holding Time

Samples should be stored at 4o C and must be analyzed within 7 days (EPA, 1998). Samples may not be frozen or dried prior to analysis, as either process may change the particle size distribution.

Sonication

Do not sonicate samples prior to analysis to preserve particle integrity and representativeness. Laboratories using laser diffraction will have to be notified not to sonicate these samples at any time during the analysis. It is recommended that this request also be written on the chain-of-custody form that the analytical laboratory receives in order to assure that sonication is omitted.

LABORATORY PROCEDURES

Equipment

2 Liters of stormwater sample water (total sample required for analysis (ASTM D 3977))
Drying oven (90 degrees C +2 degrees)
Analytical balance (0.01 mg accuracy)
Desiccator (large enough diameter to accommodate sieve)
Standard sieves - larger than 2" diameter may be desirable
500 um (Tyler 32, US Standard 35)
250 um (Tyler 60, US Standard 60)
Beakers - plastic (HDPE)
Funnel (HDPE - Large enough diameter to accommodate sieve)
Wash bottle
Pre-measured reagent-grade water

Sample Processing

- Dry 250 um and 500 um mesh sieves in a drying oven to a constant weight at 90 ± 2° C.
- Cool the sieves to room temperature in a desiccator.
- Weigh each sieve to the nearest 0.01 mg.
- Record the initial weight of each dry sieve.
- Measure the volume of sample water and record.
- Pour the sample through a nested sieve stack (the 500 um sieve should be on the top and the sieve stack should be stabilized in a funnel and the funnel should be resting above/inside a collection beaker).
- Use some of the pre-measured reagent-grade water in wash bottle to thoroughly rinse all soil particles from sample container so that all soil particles are rinsed through the sieve.

- Thoroughly rinse the soil particles in the sieve using a pre-measured volume of reagent-grade water.
- The particles that pass through the sieve stack will be analyzed by laser diffraction Particle Size Distribution (PSD) analysis using the manufacturers recommended protocols (with the exception of no sonication).
- Particles retained on the sieve (>250 um) will not be analyzed with the laser diffraction PSD.
- Dry each sieve (500 um and 250 um) with the material it retained in a drying oven to a constant weight at 90 ± 2° C. The drying temperature should be less than 100° C to prevent boiling and potential loss of sample (PSEP, 1986).
- Cool the samples to room temperature in a desiccator.
- Weigh the cooled sample with each sieve to the nearest 0.01 mg.
- Subtract initial dry weight of each sieve from final dry weight of the sample and sieve together.
- Record weight of particles/debris separately for each size fraction (> 500 um and 499 - 250 um).
- Document the dominant types of particles/debris found in this each size fraction.

Laser Diffraction (PSD)

PSD results are reported in ml/L for each particle size range. Particle size gradations should match the Wentworth grade scale (Wentworth, 1922).

Mass Measurement

Equipment

Glass filter - 0.45 um (pore size) glass fiber filter disk (Standard Method D 3977) (larger diameter sized filter is preferable)
Drying oven (90 degrees C +2 degrees)
Analytical balance (0.01 mg accuracy)
Wash bottle
Reagent-grade water

Procedure

- Dry glass filter in drying oven at 90 ± 2° C to a constant weight.
- Cool the glass filter to room temperature in a desiccator.
- Weigh the 0.45 um glass filter to the nearest 0.01mg.
- Record the initial weight of the glass filter.
- Slowly pour the laser diffraction sample water (after analysis) through the previously weighed 0.45 um glass filter and discard the water.
- Use reagent-grade water in wash bottle to rinse particles adhering to the analysis container onto glass filter
- Dry glass filter with particles in a drying oven at 90 ± 2° C to a constant weight.
- Cool the glass filter and dried particles to room temperature in a desiccator.
- Weigh the glass filter and particles to the nearest 0.01mg.
- Subtract the initial glass filter weight from the final glass filter and particle sample weight.
- Record the final sample weight for particles <250 um in size.

Quality Assurance

Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the particles will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically, and, if necessary, the ground glass rims should be greased or the "O" rings should be replaced.

Handle sieves with clean gloves to avoid adding oils or other products that could increase the weight. The weighing room should not have fluctuating temperatures or changing humidity. Any conditions that could affect results such as doors opening and closing should be minimized as much as possible.

After the initial weight of the sieve is measured, the sieve should be kept covered and dust free. Duplicate samples should be analyzed on 10% of the samples for both wet sieving and mass measurements.

Reporting

Visual observations should be made on all wet sieved fractions and recorded. For example if the very coarse sand fraction (2,000-1,000 um) is composed primarily of beauty bark, or cigarette butts, or other organic debris this should be noted. An option might also be for a professional geologist to record the geological composition of the sediment as well.

REFERENCES

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PSEP. 1986. Recommended Protocols for measuring conventional sediment variables in Puget Sound. Prepared by Tetra Tech, Inc. for U.S. Environmental Protection Agency and Puget Sound Water Quality Authority. Tetra Tech Inc., Bellevue, WA.

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