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State of Washington

Automatic Sampling for Stormwater Monitoring

**Standard Operating Procedure
Version 1.2**

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Washington State Department of Ecology

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Version 1.2

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Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
6/29/2018	1.1	General updates to dates, references and website throughout. Safety section update.	All	Brandi Lubliner
1/11/2024	1.2	Recertification. Only version number and date changes	All	Brandi Lubliner

1.0 Purpose and Scope

- 1.1** This document is the Department of Ecology’s Standard Operating Procedure (SOP) for collection of stormwater samples using automated equipment. External users that reference this SOP are expected to describe or reference their own agency or jurisdiction safety protocols in their Quality Assurance Project Plan (QAPP), as this document describes Ecology protocols. This SOP is designed to be used for in-pipe stormwater discharge sampling and covers a variety of technologies. Most but not all steps may also be used for open channel installations.
- 1.2** This SOP applies to those activities that involve the programmable automated collection of composite water quality samples. The purpose of this SOP is to provide general guidelines and procedures on how automatic samplers work, how to install and program the instruments, and sample collection and processing procedures.
- 1.3** This SOP describes programming and collection procedures when using automated samplers, (in common terms) for both flow-weighted and time-weighted sampling and base flow compositing.

2.0 Applicability

- 2.1** Storm runoff and base flow are collected and transported through natural channels, ditches, culverts and engineered pipe and treatment systems. Each monitoring site will have individual characteristics that require a specific configuration of equipment and installation that best enables the collection of representative water quality samples. A successful location for automatic samplers features stable hydraulics and the ability to install sampling equipment. Other important factors include selection of a water quality monitoring site representative of a specific land use or activity, and if calculating pollutant loadings, selecting a location that provides accurate (as defined in the project QAPP) determination of flow (water quantity) in addition to water quality.
- 2.2** When sampling runoff or BMP influent/effluent, care must be taken to obtain samples from points that are not affected by pre-water quality treatment.
- 2.3** Additionally, groundwater, back water conditions or tidal influences and interactions should be avoided in the stormwater sample and may require further modification of these procedures.
- 2.4** Automatic samplers can be configured to collect composite samples to reflect a mean water quality concentration. Composite sampler configurations can include:
- 2.4.1** Constant Time/Volume Proportional to Flow Rate or Flow Increment
 - 2.4.2** Constant Time/Volume Proportional to Flow Volume Increment
 - 2.4.3** Constant Time/Constant Volume (EPA, 1992).
- 2.5** Automatic samplers may not represent the complete range of particle sizes in water. Automatic samplers are not capable of sampling bed load material and are less effective in sampling larger particles. They can be effective in representing particles up to about 250

µm if the sampler intake is suitably located to collect subsamples from a well-mixed sample, such as from a cascading stream (SSFL, 2008).

- 2.6 Bed load samples and special floatable capture nets may be needed to supplement automatic samplers if information for the complete range of solids is needed (SSFL, 2008).

3.0 Definitions

- 3.1 **Automated Sampler:** A portable unit that can be programmed to collect discrete sequential samples, time-composite samples or flow-composite samples (WCD, 2007).

- 3.2 **Base flow:** Flows occurring in the drainage after 48 hours with no measurable rainfall are defined as base flows. This flow may be consistent or intermittent within a stormwater conveyance system.

- 3.3 **Best Management Practice (BMP):** Physical, structural, and/or managerial practices that, when used singly or in combination, reduce the downstream quality and quantity impacts of stormwater (National Research Council, 2008).

- 3.4 **Composite Sample:** Used to determine "average" loadings or concentrations of pollutants, such samples are collected at specified intervals, and pooled into one large sample, can be developed on time, flow volume or flow rate. Four types of composite samples can include:

- 3.4.1 **Constant Time/Volume Proportional to Flow Rate:** Samples are taken at equal increments of time and are composited proportional to the flow rate at the time each sample was taken (Appendix A, Figure 1). This type of composite sample would typically require manual compositing of sub-samples taken from each time-series aliquot (collected manually or by auto sampler) based on a flow meter record, and require using only the instantaneous flow rate at the time each aliquot was collected (a spreadsheet is needed to do this). A fully-automatic flow weighted composite sample of this type is not typically used or even possible with an auto-sampler/flowmeter. This is also commonly referred to as a flow weighted composite sample.

- 3.4.2 **Constant Volume/Constant Flow Volume Increment:** Samples of equal volume are taken at equal increments of flow volume and composited (Appendix A, Figure 2). This type of composite sample is most often used and can be completely automated using conventional auto sampler and flow meter pairs, and does not require manual compositing of sub-sample aliquots unless for other special purposes, such as a paired set of time-series samples to complement the composite sample. This is also commonly referred to as a flow proportional composite sample.

- 3.4.3 **Constant Time/Volume Proportional to Flow Volume Increment:** Samples are taken at equal increments of time and are composited proportional to the volume of flow since the last sample was taken (Appendix A, Figure 1). This type of composite sample would typically require manual compositing of sub samples from time-series aliquots (collected manually or by auto sampler) based on a flow meter record, and require totaling the flow volume increments between sampling (a spreadsheet is needed to do this). A fully-automatic flow weighted composite sample of this type is not typically used or even

possible with an auto-sampler/flow meter. This is also commonly referred to as manual flow proportional compositing.

- 3.4.4 **Constant Time/Constant Volume:** Samples of equal volume are taken at equal increments of time and composited to make time-composite an average sample. This method is the simplest and does not require flow measurement, but it does not yield a flow-weighted composite. This type of method may be well suited for certain special studies including toxicity assessments. However, this method is not consistent with the current stormwater permit application regulations (EPA, 1992) (Appendix A, Figure 4). This is also known as a time composite sample.
- 3.5 **Confined Space Entry Site:** A space that is large enough and so configured that an employee can bodily enter and perform assigned work, has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry) and is not designed for continuous employee occupancy (OSHA, 2009).
- 3.6 **Conveyance System:** A single pipe or series of pipes that convey stormwater as part of a municipal separate storm sewer drainage system (EPA, 2008).
- 3.7 **Drainage Area:** The area contributing runoff to a single point measured in a horizontal plane, which is enclosed by a ridge line (National Research Council, 2008).
- 3.8 **Event Mean Concentration (EMC):** Pollutant concentration of a composite of multiple samples (aliquots) collected during the course of a storm. The EMC accurately depicts pollutant levels from a site and is most representative of average pollutant concentrations over an entire runoff event (SSFL, 2008).
- 3.9 **Event Mass Load (EML):** calculated by multiplying event mean concentration (EMC) by event runoff volume.
- 3.10 **Hydrograph:** A graph of runoff rate, inflow rate or discharge rate past a specific point as a function of time (National Research Council, 2008).
- 3.11 **Hyetograph:** A graph of measured precipitation depth (or intensity) at a precipitation gauge as a function of time (National Research Council, 2008).
- 3.12 **Mean Concentration (MC):** either the arithmetic mean or the flow-weighted mean of instantaneous concentrations for a pollutant parameter. Flow-weighted mean is the flow-rate weighted average of instantaneous concentrations corresponding to the measured runoff flow rates (Stormwater, 1995).
- 3.13 **Outfall:** Point source where an effluent or municipal separated storm sewer system discharges into receiving waters (EPA, 1992, Ecology, 2009).
- 3.14 **Pollutant Load:** A mass concentration multiplied by the total volume of water passing by a certain point in time.
- 3.15 **Stormwater:** That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel or a constructed infiltration facility. According to 40 CFR, part 122.26(b)(13), this includes stormwater runoff, snow melt runoff and surface runoff and drainage (National Research Council, 2008).

3.16 **Time of Concentration:** The time of travel for rain runoff from the farthest point in the tributary area to the sampling location.

4.0 Personnel Qualifications/Responsibilities

4.1 All field staff will be familiar with other standard operating procedures for water quality sampling and/or trained to collect representative environmental samples. This practice will ensure that the sampling event is completed efficiently and cross-training on all aspects of sampling will have been completed. Staff must demonstrate a competency for sample collection using appropriate sampling equipment and techniques.

4.2 The field lead directing sample collection must be knowledgeable of all aspects of the project's Quality Assurance Project Plan (QAPP) and/or project goals and objectives to ensure that credible and useable data are collected.

4.3 All field staff will have OSHA's 8-Hour Confined Space Entry certification if confined space entry is required to access the sampling location, perform maintenance and/or sample collection.

4.4 Other training requirements may be necessary depending on situations encountered at each site.

5.0 Equipment, Reagents, and Supplies

5.1 Automated sampler

5.2 Flow rate recording equipment is highly recommended to be installed with flow monitoring equipment

5.3 Portable computer or data transfer unit

5.4 Automatic sampler unit's bottle configuration section

5.5 Pre-cleaned Suction intake tubing (Teflon® or Teflon®-lined) and hose clamps

5.5.1 For the suction intake tubing, Teflon® or Teflon®-lined tubing is required if organic analysis because of its inert properties. Polyethylene is acceptable for non-organic analysis, however silicone-rubber tubing is used through a peristaltic pump. To determine the length of tubing needed, see Section 6.3.1

5.6 Mounting ring for holding tubing within a piped system

5.7 Anchors or anchoring system (stainless steel plate or bands) to secure tubing in place

5.8 Stainless steel inlet strainer

5.9 Power source (deep cycle RV/Marine battery, rechargeable battery, AC power source or solar-powered batteries) and connector cables

5.10 Water quality instrument and probe (pH/conductivity/temperature meter and probe)

- 5.11 Triggering equipment (liquid level actuators are sometimes used for flow-proportional composite sampling as a trigger for sample collection)
- 5.12 Miscellaneous tools (knife, scissors, flat-head and Phillips screwdrivers, portable battery-powered drill and drill bits, a measuring tape, rope, duct tape, ty-raps and diagonal cutter, survey tape, fluorescent spray paint, and extra batteries for instruments)
- 5.13 Safety and personal protective equipment (flashlights and head lamps, dry chemical hand-warmer heat packs, hand sanitizer, hart hats, safety glasses/goggles, disposable gloves, earplugs, first aid kit, traffic safety cones, and high visibility safety clothing). Refer to Safety Section 9.
- 5.14 Site access tools (shovel and brush removal tools, manhole hook and sledge hammer, waterproof boots and waders)
- 5.15 Documentation/field recording equipment (writing instruments, clip board, *Rite-in Rain*TM field sheets/notebook, laboratory Chain-of-Custody (COC) forms)
- 5.16 Decontamination and sample processing equipment (de-ionized water, large plastic bags, ice and plastic barrier, clean, non-metallic ice chest, corn or churn splitters, decontaminated sample bottles either Teflon®, glass or polyethylene but based on parameters to be sampled)
- 5.17 Confined Space Entry Equipment, if applicable, portable multi-gas meter, full body harness, ventilating blower and power source, 3-way rescue and recovery tripod and winch system. Other materials needed for confined space entry as specified in OSHA Occupational Safety and Health Standards 1910.146 and Washington Administrative Code 296-809.

6.0 Summary of Procedure

6.1 *Monitoring Site Selection*

- 6.1.1 Select a representative site to ensure data is collected which best represents the storm runoff condition through the stormwater conveyance.
- 6.1.2 A representative sampling location should include a stormwater outfall location where stormwater is relatively well mixed and relatively “stable” or “uniform”. For selecting sites with uniform flows, avoid steep slopes, junctions, confluences, grade changes, and areas of irregular channel shape due to breaks, repairs, roots, debris, etc. Sites with pipe slopes less than 2% typically have uniform flows.
- 6.1.3 Select sites where the channel and storm drains are soundly constructed and have free-flowing (gravity flow) conditions.
- 6.1.4 Avoid selecting sites affected by backwater and/or tidal conditions since these areas can complicate measurement of flow and the interpretation of data.
- 6.1.5 For selecting BMP sites, determine the total number of inlets and outlets. If more than one, additional samplers may be needed to characterize multiple inlets/outlets.
- 6.1.6. Ensure the influent sampling station will not include any prior treatment of stormwater up-gradient from the station.

- 6.1.7 Obtain permission (if applicable) for site access (Ecology, 2007) and conduct a follow-up site inspection during dry and wet weather.
- 6.1.8 Note the following information for each selected monitoring site in field notebooks:
 - 6.1.8.1 The contributing drainage area flowing to the site
 - 6.1.8.2 The discharge tributary system (discharge to receiving water or other area)
 - 6.1.8.3 Site constraints or safety concerns
- 6.1.9 Dry and Wet Weather Inspections
 - 6.1.9.1 During dry weather, inspect the site for base flows (dry weather flows, presence of debris, signs of staining, odors, discoloration in water, unusual flows and/or excessive sediment/solids deposits. Note observations in field notebooks.
 - 6.1.9.2 During wet weather, inspect the discharge flow condition to get a sense for sampling conditions during storm runoff events. Note observations in field notebooks.

6.2 *Delineating the Drainage Area to the Monitoring Site*

- 6.2.1 Delineate the drainage area by determining which areas drain to the monitoring location. The delineation will help identify potential sources from land uses/contributing area, estimate the time of concentration and establish jurisdictional authority. This will likely be an important part of identifying stakeholders in the watershed or sub-basin (Ecology, 2007).
- 6.2.2 Obtain drainage system information from the local jurisdiction (piping and/or stormwater conveyance system, source maps, GIS files and Auto Cad files).
- 6.2.3 For delineating your drainage area, surface water drainage from the landscape typically follows topography in most areas, with a common exception being urban areas (Ecology 2007). However, in some instances, stormwater conveyance systems are designed to pump uphill to tie into drain pipes.

6.3 *Equipment Installation*

- 6.3.1 For installation of the suction tubing intake, meter probes and triggering equipment, locate the appropriate place at the monitoring station for representative placement. The selected area should be an area where the runoff stream is adequately well mixed to ensure representative sampling from the entire cross section of the conveyance system (typically mid-stream in the pipe/channel). The suction tubing intake, other parameter probes and sampler triggering devices must be placed downstream of flow monitoring devices in such a manner as to not create turbulence which can influence flow measurements.
- 6.3.2 Prior to installation and equipment handling, wear clean, powder free gloves and practice clean handling techniques.
- 6.3.3 Cover the end of the suction intake tubing with new aluminum foil, tape or laboratory grade cellophane to prevent contamination during installation.
- 6.3.4 If confined space entry is required to install the suction intake, ensure field staff is properly trained and certified.

- 6.3.5 Place the intake tubing in the stormwater conveyance system where it will best represent runoff through the system providing at least 2” of depth or greater for the intake. The suction intake must be covered during sampling to avoid improper aliquot collection.
- 6.3.6 For placement of the suction intake in less than 2 inches of water, a depth can be created by constructing a deeper pool, for example with weirs or flumes.
- 6.3.7 Take caution when placing any constriction in the pipe since it can also cause sedimentation which can cover the intake and affect the aliquot volume collected.
- 6.3.8 If constricting items are used, provide regular maintenance and checks to keep the sampler intake free of debris and sedimentation.
- 6.3.9 If necessary, mount the suction intake slightly above mid-stream on one side of the pipe/channel if high solids loadings (bed load, trash, debris) are present. However, with the suction intake offset of the mid channel, low flows may not completely submerge the strainer.
- 6.3.10 Place the suction tubing mid-stream, facing upstream, parallel to the water flow and downstream of the flow measuring device. The line should not be placed in an eddy or area of flow disturbance (WCD, 2007).
- 6.3.11 Place the line to avoid disturbance or turbulence in the flow pattern (this could interfere with flow measurements).
- 6.3.12 Prevent clogging by adjusting the tubing at an angle.
- 6.3.13 Use an anchor system or anchors to secure the tubing. Some manufacturers have a mounting plate available to mount the tubing and other probes in the channel or pipe.
- 6.3.14 Anchor the line to prevent bending/crimping during high velocity storm flows within the pipe/channel. Place an anchor every 20 inches for higher-velocity flows.
- 6.3.15 Ensure there are not kinks or dips in the tubing which can hold residual amounts of liquid or deposited stormwater solids/sediments that could cross-contaminate sample volumes (WCD, 2007).
- 6.3.16 Attach a strainer to the end of the pre-clean suction intake tubing. Slide the end of the strainer into the tubing and secure it with a stainless steel hose clamp.
- 6.3.17 Cut the tubing to the desired length in 1 foot increments and cap the end with new aluminum foil, tape or laboratory grade cellophane to prevent contamination.
 - 6.3.17.1 The minimum length of the pump tubing must be used to minimize the contact of the sample water and tubing as the sample water is carried from the intake tubing into the sample containers. See the manufacturer documentation on the technical limits for the automatic sampler pump and the recommended maximum length of tubing, and for limitations in elevation difference between pickup point and sampler.
 - 6.3.17.2 If the sampling program is long-term, the suction intake tubing can remain in-place for extended periods, however, provisions must be made for flushing the tubing thoroughly with de-ionized water before each sampling event and with site water (de-ionized or ambient water) before each aliquot is drawn. It is recommended to replace the tubing periodically, semiannually or annually, depending on site conditions, project QAPP, and

experience with specific tubing. Frequency of replacement and methods used for cleaning of the tubing should be support with collection of quality assurance/quality control (QA/QC) samples.

- 6.3.18 Measure the entire length of tubing since this information is needed when programming the automated sampler. Record measurements in field notebooks (WCD, 2007).
- 6.3.19 Install all other appropriate probes and/or sampler triggering device near the suction intake tubing placement.
- 6.3.20 All equipment installed within the stormwater conveyance systems should be secured in a way to not create turbulence and not to dislodge from the sampling location. Turbulence can create cavitation (air pockets) around the suction intake which varies the volume of water sampled for each aliquot.
- 6.3.21 For installation of the automated sampler, place the sampler on a level surface as close to the sample intake as possible. See the manufacturer documentation on the technical limits for the automatic sampler pump including vertical pump height and the recommended maximum length of tubing. It is recommended that the vertical distance be a maximum between 26-28 feet depending on equipment used. The sampler should never be placed at a height below the sampler intake. This situation would create a siphon
- 6.3.22 When sampling for metals, only stainless steel fittings or clamps should be used in all areas of sample contact. Other metallic hardware (plates, fittings, conduit and clamps) should not be used in areas of sample contact. Take care to ensure that the ends of all tubing do not touch any object that is not known to be clean during installation. Metallic hardware can be used only in areas where contact with the sample doesn't occur e.g., anchors used on the outside of the tubing.
- 6.3.23 For above-ground enclosures, install housing/enclosure for the equipment well above the highest water level expected.
 - 6.3.23.1 Secure enclosure in such a manner to prevent tipping, vandalism, or theft.
 - 6.3.23.2 Use electrical metal conduit, plastic conduit or a water pipe to protect the length of sample intake tubing from sampling point into the enclosure. Make sure the conduit is large enough to accommodate all connection cables (flow meter, parameter probes, and rain gauge), and that any rough or sharp edges resulting from cutting the conduit are removed by reaming or scraping.
 - 6.3.23.3 Place the sampler on a level surface within the enclosure and lock to prevent equipment theft/vandalism.
- 6.3.24 For placement within a manhole or junction box, place the automated sampler either on a shelf in the manhole/catch basin junction box or hang sampler inside the manhole/catch basin. Some manufactures have suspension harnesses and other anchors commercially available.
 - 6.3.24.1 Make sure that the sampler is above any high water level within the pipe. High water, such as surcharging or tidal water, can float the sampler damaging the sampler unit and/or its electronics and can contaminate the enclosed sample container(s) once the sampler is submerged.

- 6.3.24.2 Secure the sampler in place.
- 6.3.24.3 Install a secondary “safety line” for all equipment to prevent equipment from being lost if platform or hanger fails.

6.4 *Preparing the Sampler*

- 6.4.1 Remove the cover or top of sampler and carefully place it to the side making sure not to kink the sample intake line.
- 6.4.2 Prepare the base section for the desired configuration (composite bottle or sequential multi-bottle setup).
- 6.4.3 Place the cover back on and feed the pre-cleaned flexible pump tubing through the peristaltic pump and into the area of the sampler where the sample bottle(s) are housed.
- 6.4.4 Take care to ensure that the ends of the tubing do not touch any object that is not known to be clean during installation.
- 6.4.5 Slide the end of the sample intake tubing (at least ½ inch) into the pump tubing and secure it with a hose clamp, if necessary.
- 6.4.6 Connect other equipment to sampler such as flow meters, rain gauges, level actuator, and/or parameter probes.
- 6.4.7 Attach power source to sampler (solar, AC, battery).
- 6.4.8 Turn on sampler and any other equipment.
- 6.4.9 To check sampler function, purge the sample tubing with site water or de-ionized water to make sure the sampler is operating properly. See manufacturer’s manual.

6.5 *Flow-Proportional-Sampling*

- 6.5.1 Examples of collecting a flow-proportional composite samples include sampling of the same sample aliquot volume at a predetermined runoff volume interval (e.g., one sample aliquot collected every thousand cubic feet) (i.e., volume proportioned), or collected on an even-time basis with sample aliquot volume proportional to the instantaneous flow rate (i.e., flow proportioned). This method is typically not used automatically since most equipment does not support this function.
- 6.5.2 Flow-proportional composite samples collect more frequently at higher flow rates and less frequently at lower flow rates (as flow rate increases, the time between aliquots decrease). This method is a direct measure of the storm’s hydrograph or the relationship between the pollutant concentration and flow rate. This allows a direct estimation of event mean concentration (EMC) and Event Mass Load (EML).
- 6.5.3 Key parameters for flow-proportional sampling include:
 - 6.5.3.1 Forecasted precipitation volume/amount
 - 6.5.3.2 Expected amount of runoff volume
 - 6.5.3.3 Expected storm duration

- 6.5.3.4 Expected peak flow rate
- 6.5.3.5 Minimum composite volume required for desired analyses,
- 6.5.3.6 Minimum accepted number of aliquots, sample aliquot size, and maximum bottle volume
- 6.5.4 Sequential (multi-bottle) Sampling:
 - 6.5.4.1 Sequential sampling allows for isolation of specific samples or groups of samples from specific periods of the runoff hydrograph and provides more visual indication of sampler malfunction if it occurs.
 - 6.5.4.2 For sequential sampling, program the sampler on either flow-proportioned or time composite sampling scheme.
 - 6.5.4.3 If each sample is collected on the flow-proportioned or time basis and if each aliquot volume sampled is uniform, the samples can be combined to represent a flow-proportioned or time composite, respectively, of the specific period of interest.
 - 6.5.4.4 If discrete samples are collected on a time or non-uniform flow basis, a flow-proportioned composite sample could be created by splitting each discrete sample in proportion to the discrete sample's runoff volume or instantaneous flow rate at the time of sample collection.
 - 6.5.4.5 Key parameters for sequential sampling include, but are not limited to:
 - 6.5.4.5.1 Minimum composite volume required for desired analyses
 - 6.5.4.5.2 Minimum accepted number of aliquots and sample aliquot size

6.6 *Time Composite Sampling*

- 6.6.1 Time composite samples are collected by sampling the flow at a set time intervals (e.g., one sample aliquot collected every ten minutes). The sample aliquot volume is the same for each sample collected.
- 6.6.2 Key parameters for time composite sampling include:
 - 6.6.2.1 Desired time interval
 - 6.6.2.2 Minimum composite volume required for desired analyses.
 - 6.6.2.3 Minimum accepted number of aliquots and sample aliquot size
 - 6.6.2.4 Maximum bottle volume

6.7 *Sampler Programming*

- 6.7.1 Automatic samplers alone or with flow measurement devices can be programmed to collect various types of samples including: time composite, flow composite, and sequential (multi-bottle) sampling schemes. Each type of equipment system has unique programming elements, however, these three elements are common to all systems: flow quantity interval, total number of aliquot samples and the volume of each aliquot sample.
- 6.7.2 In general, the automated sampler is programmed to collect a sample aliquot each time it receives a pulse. The pulse can be either time-based or flow-based.

- 6.7.3 For specific, step-by-step procedures for programming the automated sampler, refer to the Manufacturer's User Manual.
- 6.7.4 Programs can vary between automated equipment but some elements are similar and include: start sampling (enable) and end sampling (disable) options. These options are dependent upon flow depth, flow velocity, precipitation amount, or time.
- 6.7.5 If tidal influences are present at the monitoring site, program the sampler to pause/disable in the middle of a storm event to avoid sampling marine water.
- 6.7.6 To ensure collection of representative samples, automatic samplers should be programmed to perform a back-flow purge cycle in between each aliquot collected. Purging the sample intake tube prior to collection of each aliquot also helps keep the line clear.
- 6.7.7 Programming for Flow-Proportional Composite Sampling
- 6.7.7.1 Estimate a storm runoff volume for a specifically targeted storm event.
- 6.7.7.2 Calculate initial programming elements to produce representative samples for a range of storm events.
- 6.7.7.3 Pace the sampler to fill the composite bottle(s) at an appropriate level based on the forecasted rainfall depth of the storm.
- 6.7.7.4 Take caution when using storm forecasts. Inaccuracies may contribute to difficulty planning for the actual size of an incoming storm. As a result, a larger than predicted storm event may fill sample bottles too fast or if smaller than forecasted, the sample bottles may only fill partially resulting in insufficient sample volume for analysis.
- 6.7.7.5 For estimating storm runoff volumes, develop a rainfall to runoff relationship. If this is not possible and/or data are not available, storm runoff volumes can be estimated using computer models or mathematical equations. See Appendix B for two example methods to estimate rainfall/runoff relationship.
- 6.7.7.6 Refine initial estimates as actual rainfall and runoff data are collected.
- 6.7.7.7 For estimating the total sample volume needed from the storm event, refer to each chemical and/or biological test which has a volume requirement. Once the analytical tests are selected, the required volumes for each test plus any required QA/QC analyses are summed to calculate the total volume needed for analyses.
- 6.7.7.8 Bottle schematics and their volumes vary. Typically, 9.5 L (2.5 Gal) composite jars and 12 (1 L), 8 (2 L), 4 (3.7) bottle kits for sequential sampling are available. These volumes are usually sufficient for general characterization sampling.
- 6.7.7.9 If a greater sample volume is required, modification to the sampler may be necessary, two samplers can be used at the one location or field staff may have to be present on site to replace filled bottles. This set-up may require special equipment programming and it is recommended to contact the equipment manufacturer.

6.7.7.10 Determine your programming parameters (flow quantity interval, total number of aliquot samples and the volume of each aliquot sample) by using your estimated storm runoff volume and the total sample volume. These elements are as follows:

$$V_r/V_{fi} \approx N \approx V_s/V_a$$

V_r = total runoff volume

V_{fi} = flow quantity interval

N = number of sample aliquots

V_s = total sample volume

V_a = volume of sample aliquot

(WEF, 1993 and California DOT, 2000) (See example in Section 6.7.7.16)

6.7.7.11 First, define the number of sample aliquots needed to produce a sufficient composite sample volume that represents the runoff for the entire sampling event.

6.7.7.12 For representative sampling, it is recommended that the sample aliquot volume be a minimum of 200 milliliters, at least 10 aliquots are collected, and at least 75 percent of the total event volume is sampled.

6.7.7.13 Equipment constraints must also be considered when programming samplers. For example, if battery power is used, the battery capacity and its drain from pumping up the vertical pump distance, purging, and the volume of each aliquot pumped, limits the number of aliquots that can be pumped during a storm event. Please refer to the manufacturer's literature for pumping limitations based on the battery capacity.

6.7.7.14 Additionally, many samplers need 1-2 minutes to complete a pumping cycle (purge and sample pump). It is important to regulate the flow quantity interval such that the sampler does not have to run continuously (make sure pacing rate exceeds the expected peak flow rate). At least 5 minute intervals between aliquots is recommended to allow for a full pumping cycle and to limit drain on the sampler battery.

6.7.7.15 Most storm events will be smaller or larger than predicted, so it is impossible to always fill the sample bottle(s) each time. It is recommended to use an automatic sampler that can stop sampling when the sample bottle is full to prevent overfilling.

6.7.7.16 Example Equation: $V_r/V_{fi} \approx N \approx V_s/V_a$

Where,

V_r = total runoff volume

V_{fi} = flow quantity interval

N = number of sample aliquots

V_s = total sample volume

V_a = volume of sample aliquot

(WEF, 1993 and California DOT, 2000)

6.7.7.16.1 Example Scenario 1:

V_s = 10 liters (10,000 milliliters)

V_a = 200 milliliters

$$N \approx V_s / V_a = 10,000/200 \text{ milliliters} = 50 \text{ sample aliquots}$$

Flow Quantity Interval

$$V_{fi} \approx V_r/N$$

If $N = 50$ sample aliquots and V_r , the total runoff volume is 120,000 cubic feet

$$V_{fi} = 120,000 \text{ cubic feet} / 50 = 2,400 \text{ cubic feet is the desired flow quantity interval}$$

6.7.7.17 Because of the variability of storm events, a margin of safety can be provided by setting the sample pacing that will work for a wide range of storm events. For example, program elements can be set to collect the minimum number of aliquots for the minimum desired rainfall event and the minimum composite volume required for analyses. If the storm event is greater than the minimum storm targeted, there will be sufficient volume available in the composite bottle(s) to collect aliquots for the larger event.

6.7.7.17.1 Example Scenario 2:

The minimum amount of rainfall to be sampled is 0.20 inches with the runoff volume of 120,000 cubic feet (cf). The minimum number of sample aliquots, $N = 10$, and V_s , total sample volume, required for all the desired analyses is 2.5 liters (2,500 milliliters):

V_a = volume of sample aliquot

$$V_a \approx V_s/N = 2,500 \text{ milliliters} / 10 \text{ sample aliquots} = 250 \text{ milliliters}$$

Flow Quantity Interval

$$V_{fi} \approx V_r/N$$

$$V_{fi} = 120,000 \text{ cubic feet} / 10 = 12,000 \text{ cubic feet is the desired flow quantity interval}$$

If the composite bottle is 9.5 liters, 38 sample aliquots can be collected with the volume of sample aliquot, V_a , set at 250 milliliters.

6.8 *Refining program parameters*

6.8.1 Refine program parameters when actual and estimated runoff differs by a factor of 2 or more.

6.8.2 Seasonal and annual program refinements may be necessary to account for seasonal and annual variation in rainfall that affect resulting runoff from precipitation events. These variations can include rainfall intensity, soil saturation, infiltration rate, and changes in impervious areas.

6.8.3 Modify calculations by revising the runoff coefficient. However, keep in mind that there will be some variability based on the storm and basin conditions. Program refinements include optimizing flow quantity interval.

6.8.4 If the composite sample volume collected was less the minimum required, decrease the sample interval.

6.8.5 If the composite bottle(s) fills before the end of the storm, increase the sample interval.

6.8.6 Divide the actual storm runoff volume by the total number of sample aliquots to determine a new flow quantity interval.

6.9 ***Programming for Time-Proportional-Sampling***

- 6.9.1 Time composite sampling is done by sampling runoff at a set time intervals (e.g., one sample aliquot collected every ten minutes). The sample aliquot volume is the same for each sample collected.
- 6.9.2 Key parameters for time composite sampling are as follows:
 - 6.9.2.1 Minimum composite volume required for desired analyses
 - 6.9.2.2 Maximum bottle volume
 - 6.9.2.3 Duration of storm or event to be sampled
 - 6.9.2.4 Desired time interval
 - 6.9.2.5 Minimum accepted number of aliquots
 - 6.9.2.6 Sample aliquot size.
- 6.9.3 To program for time-proportional composites, estimate the duration of the targeted storm event.
- 6.9.4 Program the sampler to fill the composite bottle(s) at an appropriate rate for the predicted precipitation duration. Take caution that it is very hard to predict storm duration. If the actual duration is larger than predicted, the sample bottle(s) will fill too fast, missing the tail-end of the storm, and the samples will not represent the entire storm event. If the duration results in a smaller than predicted storm, your minimum aliquot collection criteria may not be met which could result in insufficient volumes collected for analysis.
- 6.9.5 Calculate total sample volume (refer to Section 6.7.7.7)
- 6.9.6 Estimate the forecasted storm and runoff duration
- 6.9.7 Program the sampler to begin sampling as early in runoff event as practical and to continue past the end of the storm event and/or set maximum limit (e.g., 24 hours)
- 6.9.8 Estimate the site's rainfall to runoff relationship (refer to Section 6.7.7.5, Appendix B). If available, site specific data or a computer model can be used. Appendix B contains two examples for estimating rainfall to runoff relationship.
- 6.9.9 If rainfall to runoff information is unavailable, estimate the runoff duration from the forecasted storm duration, amount of rainfall, and the longest estimated time of concentration for the tributary area. The National Weather Service and/or the National Oceanic Atmospheric Administration forecasts can provide estimates of storm duration along with the amount of rainfall, usually in three hours and six hours increments.
- 6.9.10 Typically, the runoff duration at the site is longer than the forecasted rainfall duration. The time of concentration (T_c), for the tributary area provides a measure to ensure the pacing is set to obtain a representative sample and to ascertain if sampling of contributions from the entire basin are represented, (i.e. sampling at or near the T_c may not be representative of the entire basin). See Appendix C for examples for estimating time of concentration.

- 6.9.11 The minimum time to program the auto sampler is 2 times the time of concentration beyond the forecasted end time of the rain event. Refine your estimated as rainfall and runoff data are collected
- 6.9.12 Determine the program parameters
- 6.9.12.1 The equipment program elements, time interval, total number of aliquot samples and the volume of each aliquot sample, can be determined from the storm runoff volume and the total sample volume. These elements are as follows:
- 6.9.12.2 $T_r/T_i \approx N \approx V_s/V_a$
 Where,
 T_r = runoff duration
 T_i = time interval
 N = number of sample aliquots
 V_s = total sample volume
 V_a = volume of sample aliquot
 (WEF, 1993)
- 6.9.12.3 First, it is important to define a representative sample. A representative sample is defined as an adequate number of sample aliquots collected to produce a sufficient composite sample volume that represents the runoff for the entire sampling event. It is recommended that the sample aliquot volume be a minimum of 200 milliliters, that at least 10 aliquots are collected, for a minimum duration of at least two times the time of concentration for the drainage area.
- 6.9.12.4 Equipment constraints must also be considered in setting program elements. If battery power is used, the battery capacity drains from pumping, purging, and when filling aliquots which can limit the number of aliquots taken during a storm event. Refer to the manufacturer's literature for pumping limitations based on the battery capacity.
- 6.9.12.5 In addition, many samplers need 1-2 minutes to complete a pumping cycle (purge and sample pump). It is important to regulate the flow quantity interval such that the sampler does not have to run continuously (make sure pacing rate exceeds the expected peak flow rate). It is recommended to program the sampler at 5-minute intervals between aliquot collections to conserve battery power.
- 6.9.12.6 Program the sampler to stop sampling when the sample bottle is full to prevent overfilling.
 Example Scenario 1: $T_r/T_i \approx N \approx V_s/V_a$
 $V_s = 10$ liters (10,000 milliliters).
 $V_a = 200$ milliliters
 $N \approx V_s/V_a = 10,000/200$ milliliters = 50 sample aliquots
 $T_i \approx T_r/N$
 $N = 50$ sample aliquots and,
 $T_r = 4$ hours (240 minutes)
 $T_i = 240$ minutes / 50 = approximately 5 minutes is the desired time interval
- 6.9.12.7 Pace the sampler to include a margin of safety that works for a wide range of storm events. For example, pace the sampler to collect a minimum number of aliquots for the minimum desired rainfall duration and the minimum composite volume required for analyses. If the

storm event is longer than the forecasted storm duration, there will be sufficient volume available in the composite bottle(s) to collect aliquots during the longer duration.

6.10 ***Sampler Enables***

- 6.10.1 Most samplers include an “enable/disable” or “start/stop” function. Enable/disable functions can include, but are not limited to:
- 6.10.2 Rain gauge: The sampler enables when the first rainfall measurement is taken
- 6.10.3 Water level or velocity speed: Enable the sampler when base flows or a set water level occurs. For example, the base flow at a site increases from 0 to 0.3 ft in summer due to commercial irrigation but most storms easily exceed 0.5 ft. Thus, the enable is set to 0.32 ft to prevent false enables and ensures that a true storm is sampled and not the irrigation water. Liquid level actuators are sometimes used to enable for sample collection.
- 6.10.4 Water quality parameters: A conductivity threshold option that exists either alone or in combination with velocity, this can be used in tidal influenced areas (disable functions such as high conductivity readings and zero or negative velocities).

6.11 ***Measuring Rainfall***

- 6.11.1 It is recommended to measure rainfall at the study site using a simple tipping bucket rain gauge (Ecology, 2008). Set rainfall measurements at intervals that correlate to the flow measurements such as 5 minute, 15 minute or hourly readings.
- 6.11.2 As an alternative to having a rain gauge on site, use a rain gauge located within the drainage area, or websites (the National Weather Service and National Oceanic Atmospheric Administration) that contain real time precipitation forecasts. These forecasts can help provide estimates of storm duration along with the amount of rainfall to aid in staff deployment.

6.12 ***Storm Event Staff Deployment***

- 6.12.1 Field crews should be fully prepared to deploy when a qualifying storm event has been forecasted. Once deployed and on site powder free gloves should be worn and clean techniques practiced.
- 6.12.2 Upon site arrival, field staff should perform field checks. Check battery levels/power sources, tubing and all other connections to the equipment. Additionally, pump the suction tubing with de-ionized water (use at least 3x the total line volume).
- 6.12.3 Remove the sampler base and carefully place it to the side. Be careful not to kink the sample intake line and do not allow the exposed pump tubing end to contact hands or any other surfaces.
- 6.12.4 Place clean bottle(s) in the base, keeping lids on the bottles. Label each bottle with station ID and the sequential bottle number.
- 6.12.5 Add ice to the sampler either in the base or around the bottle(s) making sure that the ice and ice water won't come in contact with sample water, contaminating the sample.
- 6.12.6 Remove lid(s) and place in a clean plastic, sealable bags. Label the bag with the site location name.

- 6.12.7 Check sample distributor, place sampler top back on the base ensuring the pump tubing end is secure and in place.
- 6.12.8 Program the sampler and verify that the sampler is in “sampling mode”.
- 6.12.9 Document all activities in the field notebook.
- 6.12.10 If for any reason the composite sample bottle(s) need replacement during a sampling event, the field crew should:
 - 6.12.10.1 Pause the automatic sampler program.
 - 6.12.10.2 Wear clean powder free gloves and practice clean sampling techniques
 - 6.12.10.3 Remove the sampler base. Do not allow the exposed pump tubing end to contact hands or any other surfaces.
 - 6.12.10.4 Place lids on filled or partially filled bottle(s), and remove from sampler base. Replace with clean bottle(s).
 - 6.12.10.5 Continue sampler program and verify that the automatic sampler is in sampling mode.
 - 6.12.10.6 Secure sampler at site.
 - 6.12.10.7 Document bottle(s) replacement activities in the field notebook.

6.13 *Sample Retrieval*

- 6.13.1 At the end of the storm event, deploy field staff to retrieve sample bottles.
- 6.13.2 Upon arrival, inspect all components of the automatic sampling system to make sure samples were properly collected. If any unwarranted conditions are found, note conditions in field notebook.
- 6.13.3 Check battery levels and/or power source.
- 6.13.4 Visually inspect the components and tubing for damage and/or clogging.
- 6.13.5 Download field data from the automatic sampling system, rain gauge and other appropriate equipment.
- 6.13.6 Wear clean powder free gloves and practice clean sampling techniques.
- 6.13.7 Remove the sampler base. Do not allow the exposed pump tubing end to contact hands or any other surfaces.
- 6.13.8 Remove sample bottle(s) or entire sampler base. It is recommended to transport sample bottle(s) to lab in the sampler base/tray or cooler for transport.
- 6.13.9 Handling the samples carefully, as little as possible, and by as few people as possible in order to minimize the risk of contamination.
- 6.13.10 Place lids on the samples.
- 6.13.11 Inspect bottle(s) for any problems and make note in the field notebook. Note any empty bottle(s), low sample volumes [one bottle not as full as other bottle(s) or all are low],

cracked or broken bottle(s) and/or if any spillage occurred during sample collection or during bottle(s) removal.

- 6.13.12 Note physical characteristics of each bottle including sample turbidity and approximate liquid volume.
- 6.13.13 Add ice around the bottle(s) to keep them cool during transport.
- 6.13.14 Keep samples in dark and cool during transport.
- 6.13.15 Place sampler top on the base or a new base.
- 6.13.16 Purge the sample tubing with de-ionized water or decontaminate the sampler tubing using a phosphate-free detergent and rinse with de-ionized water (remove wastewater properly from the site).
- 6.13.17 Cover the exposed pump tubing with aluminum foil, tape or laboratory grade cellophane.
- 6.13.18 Place the cover back on the sampler and secure the sampler in place.
- 6.13.19 Perform any other necessary decontamination processes, program the sampler (if applicable), and finish maintenance checks etc. prior to leaving the site.
- 6.13.20 Secure the sampler at site.
- 6.13.21 Immediately transport bottle(s) to sample preparation area and/or laboratory.

6.14 *Sample Representativeness Evaluation*

- 6.14.1 Create a checklist including the project-specific criteria to evaluate whether or not samples meet appropriate storm event criteria.
- 6.14.2 As suggested in Ecology Publication No. 07-03-006, *Characterizing Stormwater for Total Maximum Daily Load Studies: A Review of Current Approaches*, February 2007, “representative” storm criteria can include:
 - 6.14.2.1 Rainfall: No fixed maximum, typical minimum range is 0.1 to 1.0 inch
 - 6.14.2.3 Duration: Typical range is 6 to 24 hours
 - 6.14.2.4 Antecedent Dry Period: Typical range is 6 to 24 hours
 - 6.14.2.5 Inter-event Dry Period: Typically 6 hours. In parts of the state where overlapping storms are common, the inter-event defines when to one storm is over and another event would begin for sampling.
 - 6.14.2.6 Percent of the storm captured (it is recommended that at least 75% of the storm event hydrograph is captured to best represent the storm)
- 6.14.3 Additional criteria is also needed including: total precipitation of storm, entire storm event duration
- 6.14.4 For sequential sample composting (taking multiple bottles and combining into one representative sample, the following two items must be determined:
 - 6.14.4.1 Percent of the sampling event flow represented by each individual bottle.

- 6.14.4.2 Which of the sample bottle(s), if any, will limit the compositing of samples. For the most part, aliquots which represent a specified volume collected at a specified flow volume, are collected uniformly throughout the sampling event.
- 6.14.4.3 From the downloaded rainfall and sampler data, review rainfall hyetograph, runoff hydrograph, time aliquot was collected, and sampler program report.
- 6.14.4.4 Compare data to acceptable storm capture parameters, such as number of aliquots, percent storm captured, total precipitation of storm.
- 6.14.5 Make decision whether or not to analyze the sample based on qualification.
- 6.14.6 In cases where sample bottles have unequal sample volumes, the individual sample(s) should be composited in relative proportion. In such cases, multiple composite samples should be combined using the following equation:

$$\frac{V_n}{V_t} = P_n \quad \text{and} \quad S_t \cdot P_n = S_n \quad \text{or} \quad S_n = S_t \cdot \frac{V_n}{V_t}$$

V_n – volume of flow that passed during the collection of bottle n

V_t – total volume of flow passed during the sample collection event

P_n – percent of the total sampled flow represented by bottles n

S_t – the total volume of sample collected in all bottles combined

S_n – volume of sample contributed from bottle n toward the composite sample

- 6.14.7 Use appropriate sample handling techniques to minimize exposure of the samples to human, atmospheric and other potential source of contamination.
- 6.14.8 Use a mechanical splitter or vigorously agitate to ensure that all liquid and solid will be transferred from the sample bottle to the composite bottle.

6.15 Sample Processing

- 6.15.1 If the samplers are using sequential (multi-bottle) sampling, they will most often need to be composited to produce a single composite sample. In addition, the composite sample may need to be split into multiple containers for each analysis.
- 6.15.2 For processing samples, mix samples thoroughly before splitting.
- 6.15.3 Composite samples may be split into separate bottles by manual vigorous agitation, using a mechanical splitter such as Teflon cone Dekaport splitter or Teflon churn splitter. Consider the following limitations for these methods:
- 6.15.4 Splitting the composite sample with an additional step using another equipment exposes the sample to another surface which may increase the possibility of contamination.
- 6.15.5 If you are handling a large volume (5+ gallons), you need to properly agitate it and split into analytical bottles. It is recommended to use a mechanical splitter (Teflon cone Dekaport splitter) to ensure that the samples are split evenly into the composite bottles. This should minimize any bias that could occur when trying to agitate and pour off a certain amount of each subsample into a composite. However, this process can be time consuming, is not straightforward, and may require expensive equipment (e.g. \$5000 Teflon churn splitter).

- 6.15.6 It is often difficult to pour from a wide mouth composite bottle into a small analyte bottle without allowing setting, pouring happens so slowly. Instead, a mechanical splitter (Teflon churn splitter) may be used to continuously agitate a sample and split off the individual analyte bottles.
- 6.15.7 The preferred method of splitting should balance minimizing bias from splitting the sample and minimizing contamination from sample handling when using a mechanical splitter. The preferred method should be identified in the project specific QAPP.

6.16 *Field Calibration and Maintenance*

- 6.16.1 The success of any sampling program is dependent on proper maintenance of the equipment. Maintenance on the automated sampler and other complimentary equipment is required especially when the equipment is in place for extended periods of time or when sampling multiple events.
- 6.16.2 Because of the adverse operating conditions associated with sampling (exposure to extreme conditions and events), the equipment should be maintained frequently and after each sampling event.
- 6.16.3 Perform regular maintenance every time the sampler is set to collect a storm event. Regular maintenance includes, but is not limited to:
 - 6.16.4 Check to make sure all connections are tight.
 - 6.16.5 Inspect the strainer and clear it of debris and sedimentation if necessary.
 - 6.16.6 Make sure tubing is secure.
 - 6.16.7 Inspect sample intake tubing for kinks, cracks, biological buildup, and unusual discoloration and replace if necessary.
 - 6.16.8 If the site to be monitored for extended period, it is recommended to replace the tubing on an annual basis. Other replacement schedules may be required, depending on the specific installation and project requirements.
 - 6.16.9 Inspect pump tubing for wear, cracks, biological buildup, and unusual discoloration. Replace with de-contaminated pump tubing periodically.
 - 6.16.10 Note maintenance activities in field notebook.
 - 6.16.11 Calibrate the auto sampler every time the sampler is set to collect a storm event. Use procedures in accordance with manufacturer specifications.
 - 6.16.12 Rinse tubing with de-ionized water, or site water (i.e., stormwater or ambient water such as base flow).
 - 6.16.13 Check the sampler by collecting a manual sample at the desired setting using the sampler and measure its volume.
 - 6.16.14 Check the sample bottle(s) to verify the desired sample volume was delivered to the sample bottle(s). If not, recalibrate desired sample volume.
 - 6.16.15 Adjust the sample volume to the desired sample aliquot volume according to manufacturer specifications.

6.16.16 Note calibration in field notebook.

6.17 *Sampler housing*

6.17.1 If the sampler unit is removed or a new unit is placed at the site, the unit should be thoroughly cleaned/decontaminated before placement to prevent cross contamination from previous events or sites.

6.17.2 Inspect desiccant and replace if necessary. This reduces the moisture buildup in the equipment and protects the system electronics.

6.17.3 For sequential sampling, inspect the sample distribution arm and its proper operation.

6.17.4 Check all equipment batteries and replace with freshly charged batteries as necessary.

6.17.5 Note maintenance activities in field notebook.

6.17.6 Decontamination and Cleaning of Equipment (Ecology, 2014, California, 2000 and FL DEP 2004). Specific procedures for decontamination are dependent on analytical parameters to be measured and should be identified in the Project QAPP. The following procedures may need to be modified with a Project QAPP:

6.17.6.1 Before the onset of a new study, thoroughly clean the auto sampler unit(s) using warm soapy water.

6.17.6.2 Rinse the equipment with de-ionized water and let air dry.

6.17.6.3 Replace the tubing (if not new) and rinse with de-ionized water.

6.17.6.4 Clean the strainer with a brush and soapy water and rinse thoroughly.

6.17.6.5 Clean the pump tube and discharge tube by attaching the suction line and placing the end in soapy water.

6.17.6.6 Manually pump the cleaning solution through the system.

6.17.6.7 Rinse three times with de-ionized water and let dry.

6.17.6.8 Clean the suction tubing using the same procedure, rinse with methanol and let dry.

6.17.6.9 Cap ends of tubing with new aluminum foil, tape or laboratory grade cellophane and place in a large sealable plastic bag.

7.0 Records Management

7.1 *Field sheet data for each sample should include:*

7.1.1 Monitoring station location

7.1.2 Personnel - Initials of Sampling Personnel

7.1.3 Time of sample collection

7.1.4 Sample Method (i.e. intermediate equipment used or individual sample containers)

7.1.5 Field observations that could affect the quality of the samples

8.0 Quality Control and Quality Assurance Section

8.1 Blanks (types)

8.1.1 Field rinsate blank

8.1.2 Equipment rinsate blank

8.1.3 Bottle blanks

8.1.4 Trip blanks

8.1.5 Initial installation blank

8.2 Duplicates (what type/how many/options)

8.2.1 Separate sampler and flowmeter

8.2.2 Separate sampler, same flowmeter

8.2.3 Internal duplicate

8.2.4 Composite sample split

9.0 Safety

9.1 There are many hazards associated with sampling stormwater. Some of these hazards include fast moving water, deep water, and steep slopes to sampling sites and hostile dogs or people. Use extreme caution when exiting vehicles, walking along busy roads and approaching your sampling site.

9.2 Safety is top priority for field staff and supervisors. Sample sites may be located on or near roads and bridges. Roadside hazards, weather conditions, accidents, and construction should be evaluated before departure (especially in winter). If the hazard is a permanent condition, relocation of the station may be necessary. Review periodically to assist with these safety determinations.

9.3 Develop a site specific safety plan based on the Environmental Assessment Program Safety Manual (Ecology, 2016) and the Chemical Hygiene Plan (Ecology, 2018b).

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