Quality Assurance Project Plan Harbor Brook CSO 018 Constructed Wetlands Pilot Treatment System

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Prepared for

Onondaga County Department of
Water Environment Protection
Onondaga County, New York

Prepared jointly by

CH2MHILL

and

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Save the Rain

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SECTION 1

Project Background and Objectives

Combined sewer overflow (CSO) occurs when the amount of stormwater runoff entering combined municipal/stormwater sewers through roof drains and street inlets exceeds a sewer system's conveyance capacity. CSO discharge is a mix of stormwater, untreated sewage, and urban nonpoint source pollution. CSO outfalls are regulated under the National Pollutant Discharge Elimination System (NPDES), which is also subject to its state-level corollary (SPDES) (EPA 1993). CSO discharges contain a variety of constituents including excess nutrient loads, suspended solids, and organic waste that could have a negative environmental impact. While a wide spectrum of compounds may be found in this highly variable waste stream, the goal of CSO discharge treatment is twofold: (1) attenuate the CSO flow; (2) improve the water quality of CSO effluent by reducing the concentration of floatables, suspended solids, pathogenic bacteria, and excess nutrient loads.

Onondaga Lake (Syracuse, NY) has been the subject of intensive industrial and municipal pollution since the early 1800's. On January 20th, 1998, Onondaga County entered into an Amended Consent Judgment (ACJ) with the State of New York, New York State Department of Environmental Conservation (NYSDEC), and the Atlantic States Legal Foundation (ASLF). The primary goal of the ACJ is to reduce pollutant loads to Onondaga Lake from the Metropolitan Syracuse Wastewater Treatment Plant ("METRO") and the volume of municipal CSO discharges.

One green infrastructure alternative that has been the subject of extensive research for stormwater applications over the past 30 years is the "constructed treatment wetland" (Hammer 1989, Yu et al. 1996, Wong and Geiger 1997). A treatment wetland is an engineered ecosystem consisting of a substrate (soil or composite material), maintained hydrology, and vascular plant species constructed for the purpose of low-maintenance wastewater quality improvement (Kadlec and Wallace 2009).

Three types of treatment wetland systems for treatment of CSO effluent include: surface flow (SF), vertical down flow (VDF) and floating wetland islands (FWI) (Dittmer et al. 2005, Henrichs et al. 2007, Annelies et al. 2009, van Acker et al. 2005). SF systems typically resemble naturally occurring emergent marshes, whereas VDF systems are often operated as batch-loaded reactors in which wastewater seeps vertically through a vegetated sand or gravel substrate (Crites et al. 2006). FWI is a relatively new technology that employs the use of vegetated wetlands rafts in a surface water setting (Stewart et al. 2008).

CSO discharge to Harbor Brook, a tributary of Onondaga Lake, is a health concern and a representative point source of pollutant loading in the Lake's sewershed. Pursuant to the Fourth Stipulation and Order to the 1998 ACJ, Onondaga County has expressed interest in creating a pilot-scale treatment wetland system to assess the efficacy of green infrastructure technology in mitigating pollutant loads stemming from CSO 018, located near the intersection of Velasko Road and West Onondaga Street (Figure 1-1).

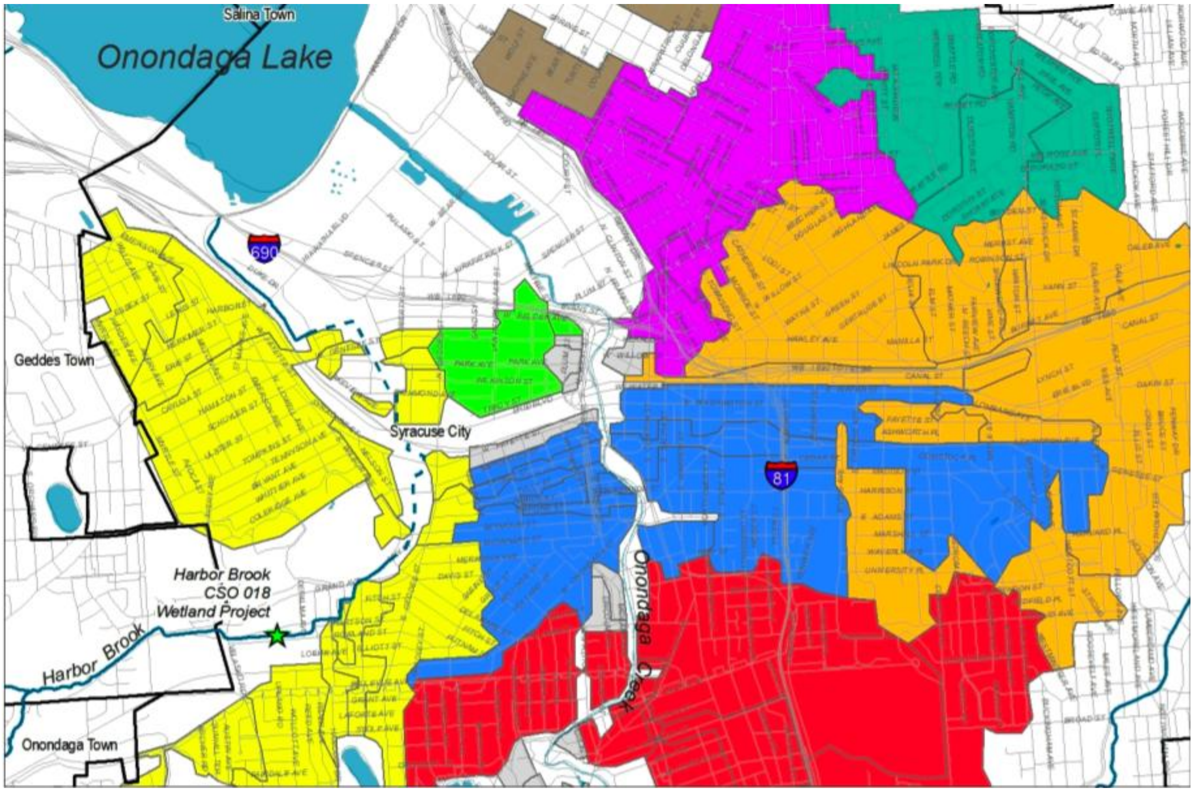

FIGURE 1-1 - Map Indicating Study Area/Shaded Areas Represent CSO Drainage Basins (CH2M HILL and CHA 2011)

To accomplish this goal, CH2M HILL and CHA have proposed a three-module, 2-acre, full-scale pilot constructed wetland treatment system to mitigate CSO events originating from CSO 018 (with the option of expansion to include the nearby CSO 078). The system will include a grit/floatable removal system and three discrete wetland cells, showcasing SF, VDF, and FWI-based designs and technologies. The three cells will be designed to treat pollutant inflows in series, parallel, and series-parallel flow configurations. The primary design objective for the system is to create the capacity for treatment of CSO discharge at loading rates modeled for a 1 year, 2 hour storm event, as indicated in the *Harbor Brook Pilot Project Basis of Design* (CH2M HILL and CHA 2011).

Monitoring is an essential component of treatment wetland maintenance and performance assessment (EPA 1993). CH2M HILL has retained the services of the State University of New York College of Environmental Science and Forestry (SUNY-ESF) to develop a monitoring plan for the Harbor Brook CSO 018 pilot project. SUNY-ESF will implement all monitoring related activities over the two-year pilot period following wetland construction. The primary objectives of this monitoring plan will be:

1. Provide a baseline, pre-construction water quality assessment for CSO 018 discharge and local groundwater resources
2. Assess performance of grit and floatable removal system

3. Assess target pollutant removal efficiencies for the pilot system with respect to the three different wetland types (FWI, VDF, SF) and three different flow sequences (series, parallel, series/parallel)
4. Assess the degree to which the pilot system interacts with surrounding groundwater resources
5. Assess the relationship of target pollutant mass removal efficiencies with secondary environmental parameters
6. Monitor structural parameters, operational issues, and cultural interactions with surrounding community
7. Include Quality Assurance/Quality Control (QA/QC) protocols consistent with the *2009 Onondaga County Ambient Water Quality Monitoring Program* (AMP) and pertinent State and Federal regulations

SUNY-ESF personnel will conduct monitoring activities over 2+ years of pre/post construction under the guidance of the CH2M HILL project team. Laboratory work will be conducted at the Onondaga County Department of Water Environment Protection (WEP) laboratories, by WEP staff.

SECTION 2

Project Organization

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SECTION 3

Monitoring Parameters

SUNY-ESF will monitor the constructed wetland site for the following parameters: target pollutants; wetland cell water levels and flow rates; *in-situ* environmental parameters; general maintenance concerns; and vegetation. Meteorological conditions will also be monitored. "Treatment system components" referred to in the following text signify the grit/floatables removal system and wetland Cells 1-3. The following sections codify the parameters of interest, indicating general sampling frequency and association with monitoring objectives.

3.1 Target Pollutants

The *Harbor Brook Pilot Project Basis of Design* highlights the following pollutants of concern at CSO 018: biological oxygen demand (BOD_5), total suspended solids (TSS), total Kjeldhal nitrogen (TKN), total phosphorous (TP), and fecal coliform (F. Coli) (CH2M HILL and CHA 2011). Additionally nitrate/nitrite (NO_3^-/NO_2^-) and NH_3-N will also be measured to assess the extent of nutrient transformations in the treatment wetland system.

Automated samplers will take composite water samples during storm events at all treatment system component inflow and outflow locations. Fecal coliform loads will be determined from discrete grab samples taken during storm events at those same locations. Additionally, grab samples will also be taken and analyzed for target pollutants at the grit and floatables removal system inlet. The primary metric of system performance will be the reduction of target pollutant mass loads between each treatment component's inflow and outflow points.

Grab samples will be taken for target pollutants at on-site monitoring wells before and after construction in order to determine the effect, if any, the treatment system has on local groundwater resources.

3.2 Water Levels and Flow

Water levels in wetland Cells 1 and 3 (FWI and SF, respectively) will be recorded during weekly site visits from *in-situ* staff gauges. Since Cell 2 (VDF) is expected to drain quickly and remain dry at the surface during non-storm event conditions, it will not be possible to record water levels there.

Flow (Q) will be measured using in-pipe ISCO flow-meters. A permanent installation of an ISCO 2150 Area Velocity Flow Module will record all outflows from the terminal point discharge from the treatment system into Harbor Brook ("outfall"). Event flow will also be recorded at treatment system component inflow/outflow points using portable ISCO 730 Bubbler Flow Modules. Measurements will be downloaded onto a portable field laptop during weekly site visits

3.3 In-Situ Environmental Parameters

In-situ measurements of diagnostic parameters provide insight into the biogeochemical processes at work within the treatment system and provide metrics of wetland health. Relating these variables to pollutant load reductions can help to indicate strategies for optimizing wetland performance and future system designs. *In-situ* environmental parameters will include: temperature (T), dissolved oxygen (DO), potential hydrogen (pH), specific conductance (SC), and turbidity. Measurements will be made on samples extracted from wetland cells using a peristaltic pump and YSI sonde (or equivalent field probe) on a weekly basis. Measurements will also be made on grab samples obtained during storm events.

3.4 Maintenance Concerns

Weekly site visits will afford the monitoring team the opportunity to address structural and practical concerns, including but not limited to: water levels, berm integrity, operation of the grit/floatable system, wildlife, vandalism, odors, vector control, and maintenance of automated sampling units. Community involvement will be a key factor in many of these issues. The project *Operations and Maintenance Plan* will detail protocols concerning the assessment and reporting of these issues. A field monitoring O&M checklist will also be included in the aforementioned manual.

3.5 Vegetation

Vegetation establishment and health determines wetland primary production, suitability of the habitat for aquatic life, sediment stabilization and nutrient cycling. Vegetation health will be monitored qualitatively, and density will be measured using simple quantitative field techniques. Monitoring personnel will make weekly field observations of wetland vegetation, noting locations, approximate numbers, and any significant die-off. Additionally, transects and 1 m^2 permanent vegetation plots will be established in accessible upland and wetland areas. Transects will be measured through the ecotopes of interest (e.g. upland berm, shallow emergent marsh). Three plots will be established along each transect using a random number generator. Plots will be monitored every monthly using a modification of the Daubenmire cover class system (Landis 2008). Plots will be classified as having covers of 0-1%, 1-5%, 5-25%, 25-50%, 50-75%, 75-90%, or 95-100%. Additionally, bird's eye view photographs of plots will be taken monthly and dominant species assessed and noted. Additional details on vegetation monitoring can be found in Elzinga et al. (2001).

Floating Wetland Islands (FWI) rafts will be generally inaccessible during the experimental period for detailed, non-visual monitoring. At the end of the experimental period root length and biomass will be assessed.

3.6 Meteorological Conditions

Local meteorological conditions will be monitored and recorded throughout the duration of the two-year pilot assessment phase. Records from the Urban Watershed Weather Station, located on-site at SUNY-ESF will be utilized to this end (http://weather.esf.edu/ESFweather.htm). Qualitative field observations of meteorological conditions will be noted during weekly site visits.

SECTION 4

Experimental Approach

SUNY-ESF will monitor the project site in both pre and post-construction phases. The focus of monitoring activities will be to develop comprehensive flow/water quality assessments of: CSO 018 discharges, individual treatment system component inflows/outflows, and local groundwater resources. The sampling program is designed to meet the monitoring plan objectives. Automated flow measurements will be coupled with automated and grab sample pollutant concentrations, such that a complete mass balance can be performed on each component of the treatment system.

4.1 Pre-Construction Monitoring

The objectives of the pre-construction monitoring phase will be to create a baseline assessment of target pollutant loads in: CSO 018 during storm events and local groundwater resources. The timeframe for this phase of monitoring will be roughly from late summer to fall, 2011.

4.1.1 CSO 018 Baseline Assessment

Grab samples and flow will be measured at the CSO 018 outfall during three storm events prior to construction. Storm event selection criteria is discussed in section 5.1. Samples will be analyzed for target pollutants and *in-situ* parameters using an YSI or equivalent field probe. CSO 018 will also be checked for flow under dry weather conditions during preliminary site visits. Flow will be measured with an ISCO 730 Bubbler Module. If sufficient flow occurs under dry conditions, grab samples will be taken and analyzed for target pollutants. If flow is present under dry conditions, but not in a measureable quantity, the time and date will be noted in the pre-construction monitoring report.

Expected Results

1. Determination of the primary pollutants in the CSO discharge

2. A pollutograph documenting the variability of target pollutant mass loadings during CSO discharge events

4.1.2 Groundwater Resource Evaluation

A synoptic survey of the 6 existing on-site groundwater monitoring wells will be made prior to construction. Groundwater monitoring wells/boreholes installed at the project site are detailed in 90% design drawing C-1000 (CHA 2011). All groundwater samples will be tested for target pollutants and *in-situ* environmental parameters.

Expected Results

1. A basic hydrogeochemical assessment of groundwater resources to determine the background concentrations of CSO related pollutants in the groundwater at the project site.

4.1.3 Summary

A summary of pre-construction monitoring regime can be found in Table 4-1. See section 5.3 for storm event sampling criteria and explanations of automated and grab sampling techniques.

TABLE 4-1
Pre-Construction Water Monitoring

Timing	Location	Frequency	Type	Parameters
Dry weather	Ground water monitoring wells (1-6)[1]	One synoptic survey	Grab	Target pollutants and *in-situ* parameters
Storm event	CSO 018 outfall	Three storm events	Grab	Target pollutants; *in-situ* parameters; Flow

[1] See 90% design drawing C-1000 (CHA 2011) for location of on-site monitoring wells

4.2 Post-Construction Monitoring

The objectives of the post-construction monitoring portion of this program are to determine treatment system mass removal rates for target pollutants, monitor secondary environmental parameters, maintain operational integrity of the system (see O&M program plan), and quantify potential impacts to groundwater resources. Post-construction monitoring will continue up to two years after pilot system construction. The flow chart shown in Figure 4-1A-C identifies where flow metering and sampling will occur during each of the three different flow configurations; series (S), parallel (P), and series/parallel (SP). In-pipe treatment system measurements will be made at manholes (MH) and flow diversion structures (FDS). Table 4-2 refers to specific sampling and flow metering sites for each of the treatment system components based on 90% design drawings developed by CHA (2011).

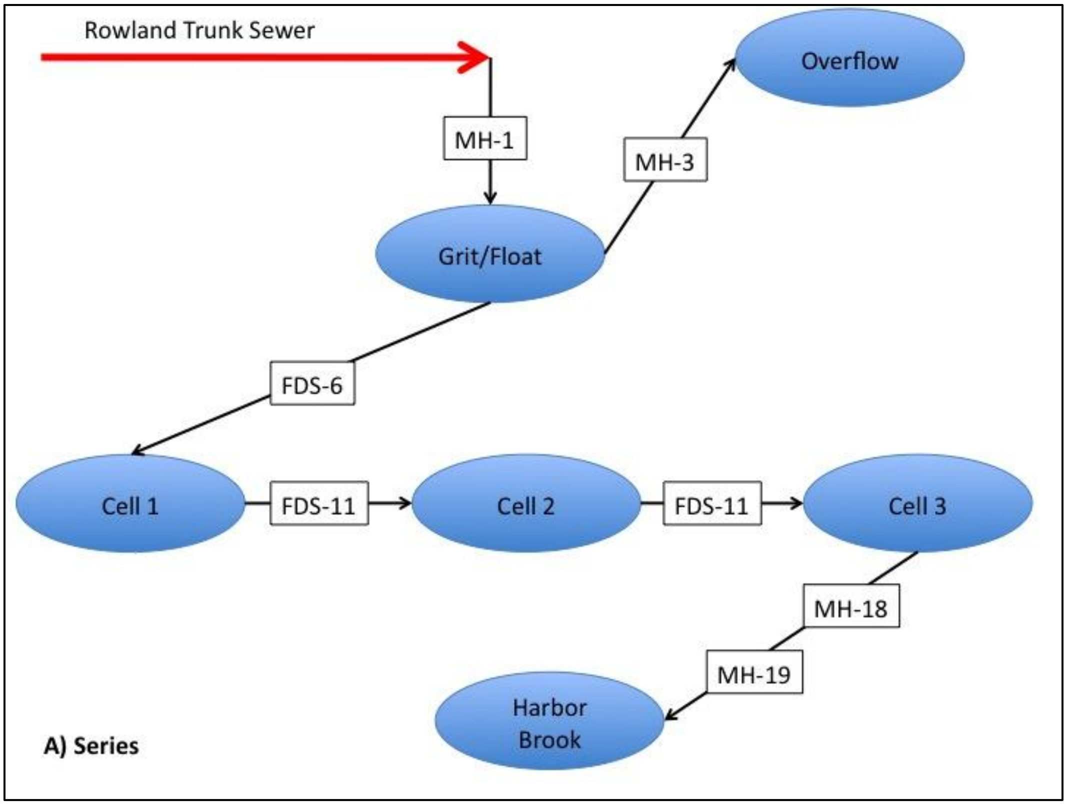

FIGURE 4-1A - Flow Chart Depicting All Potential Flow Paths Through Treatment System

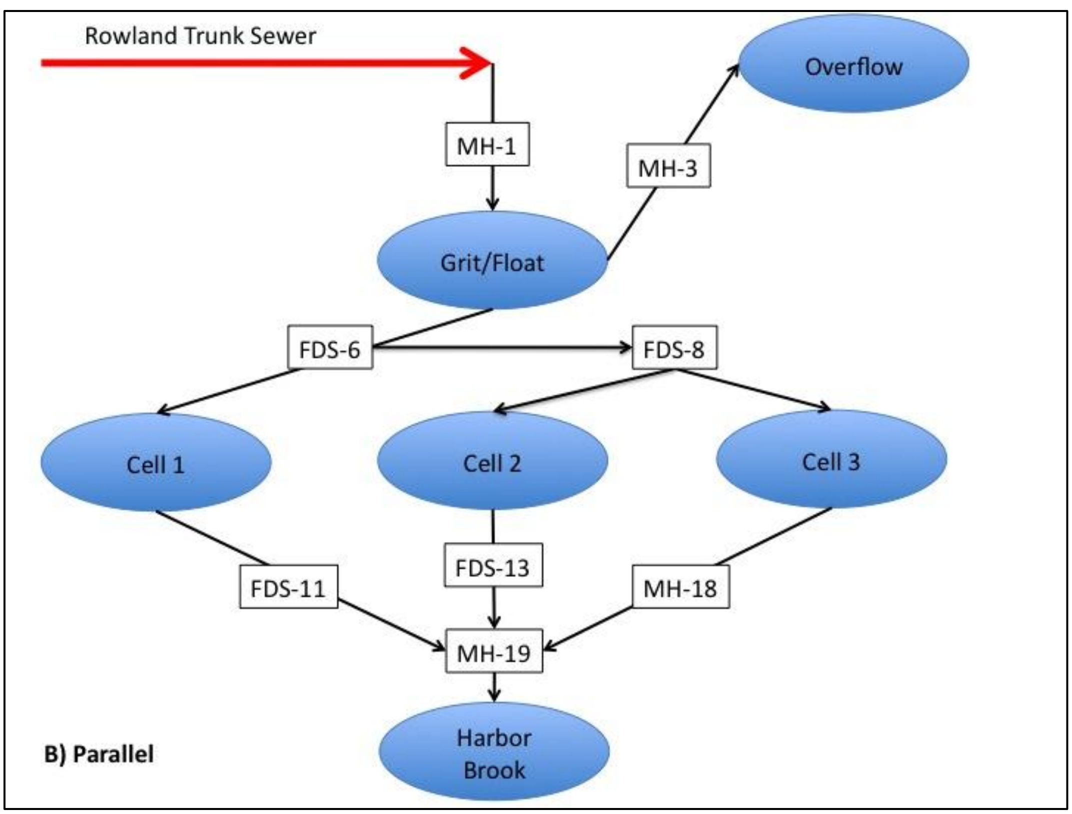

FIGURE 4-1B - Flow Chart Depicting All Potential Flow Paths Through Treatment System

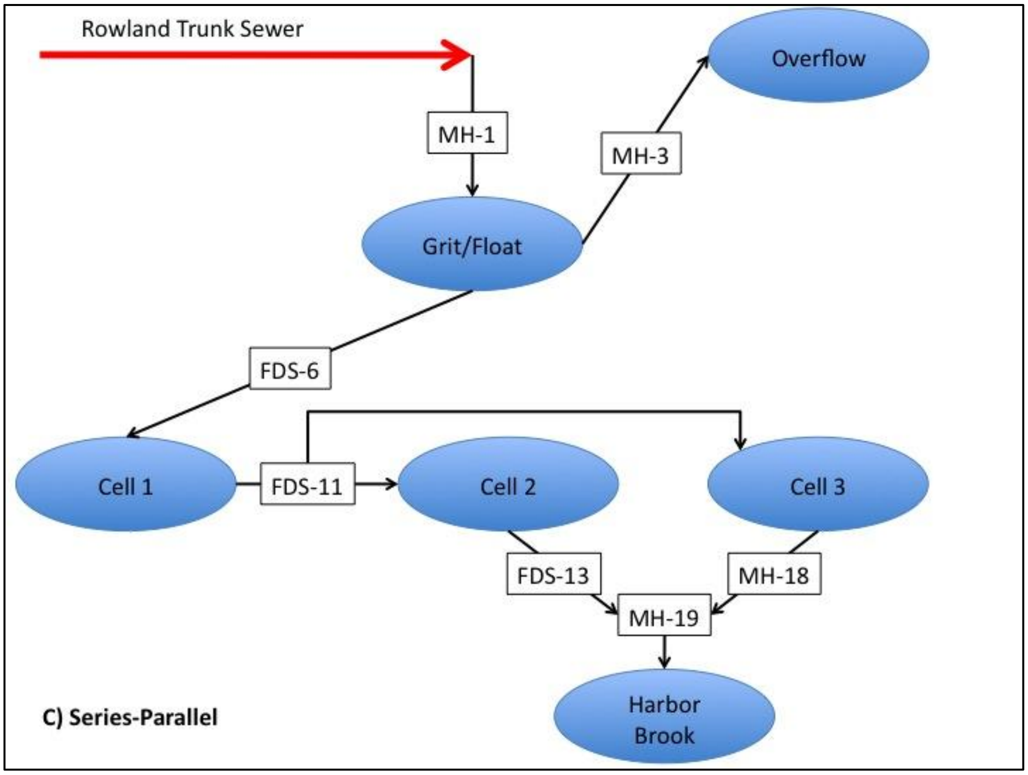

FIGURE 4-1C - Flow Chart Depicting All Potential Flow Paths through Treatment System

Notes:

The red arrow represents the normal flow path of CSO; black arrows represent flow paths for CSO after construction; black rectangles represent sampling/flow metering points in the treatment process; see 90% design drawings C-3001 and C-2002 for locations of MH's, FDS's, grit/floatable removal system and wetland cells

TABLE 4-2
Treatment System Sampling and Flow Metering Locations[1]

Flow Configuration	Series	Parallel	Series/Parallel
Sampling Locations	MH-1, FDS-6, FDS-11, FDS-13, MH-18	MH-1, FDS-6, FDS-11, FDS-13, MH-18	MH-1, FDS-6, FDS-11, FDS-13, MH-18
Flow Metering Locations	MH-1, MH-3, FDS-6, FDS-11, FDS-13, MH-18, MH-19	MH-1, MH-3, FDS-6, FDS-8, FDS-13, MH-18, MH-19	MH-1, MH-3, FDS-6, FDS-11, FDS-13, MH-18, MH-19

[1] See 90% design drawings C-3001 and C-2002 for locations of MH's and FDS's

4.2.1 Treatment System Water Quality/Flow Assessment

Automated flow-weighted composite samples will be taken for target pollutants (with the exception of fecal coliform) at all wetland cell inflow and outflow points during storm events to determine the mass removal efficiencies. Measurements will be taken using the ISCO 6712 Portable Automatic Sampler and associated 730 Bubbler Flow Module. Since large particulate matter and debris may compromise automated samplers, grab samples will be taken at grit and floatable (G&F) removal system inlet (MH-1 as shown in design drawing C-2002), tested for all target pollutants, and correlated to continuous flow measurements which will be taken at the G&F system inflow and outflow points. Discrete grab samples for fecal coliform will be taken at all treatment system component inflow and outflow points during storm events. Grab samples will be tested for *in-situ* environmental parameters during storm events using YSI or equivalent field probe. All flow in excess of system capacity will be diverted from the G&F system to the Harbor Brook Interceptor Sewer. All treatment system overflow will be flow metered using an ISCO 730 Bubbler Flow Module. See section 5.1 for storm event sampling criteria and definitions of automated and grab sampling techniques.

Dry weather grab samples will be taken from the center of wetland Cells 1 and 3 using a peristaltic pump or adjacent stilling well and tested for *in-situ* environmental parameters as a first-order approximation of general ecosystem health. Grab samples will not be obtainable from Cell 2 during dry weather due to the fact that it is expected to drain quickly and no open water will be present.

Expected Results

1. *Treatment System Component Pollutant Removal Efficiencies*

   Based on the data we obtain treatment system component inflow and outflow points (grit/floatables removal system, wetland cells), we will be able to calculate mass removal rates for different pollutants using the following equation (Kadlec and Wallace 2009).

   $$\% \text{ Mass Removal} = [(M_i) - (M_o)] * [100/(M_i)]$$

   Where:

   M_i/M_o = Mass inflow/outflow loads

   Using an Analysis of Variance (ANOVA) approach, primary comparisons will be made on mass removal rates between wetland cells and between different flow sequences. Interaction between the two will be assessed in a basic 2-way ANOVA with a 3x3 factorial design. Treatment of seasonal variation will be dependent on the distribution of flow configurations over the two-year monitoring period. Section 4.3 discusses an adaptive management approach to flow configuration and sampling coordination.

2. *Target Pollutant Removal Efficiencies vs. Secondary Environmental Parameters*

   Pollutant mass removal rates will be compared to environmental parameters (T, DO, pH etc.) using a linear regression approach. Correlating temperature with pollutant mass removal rates provides another metric of seasonal variation.

4.2.2 Ongoing Groundwater Resource Assessment

A quarterly survey of on-site groundwater monitoring wells will be made post-construction. During construction Monitoring Wells 1, 3, and 4 will be removed (as shown in design drawing C-1001). At this time, three new monitoring wells (MW's) will be installed at the study site (Wells A, B and C as shown in design drawing C-3002). Since the general groundwater gradient at the site is from southwest to northeast, MW A will be located upgradient from Cell 3 and MW's B and C will be located downgradient from Cells 3 and 2, respectively. These six remaining wells will be sampled for target pollutants and *in-situ* environmental parameters on a quarterly basis.

Expected Results

An ongoing hydrogeochemical assessment of site groundwater resources will determine the impacts, if any, that the treatment system has on ambient groundwater quality

4.2.3 Summary

A summary of post-construction monitoring regime can be found in Table 4-3. See section 5.1 for storm event sampling criteria and explanations of automated and grab sampling.

TABLE 4-3
Post-Construction Water Monitoring

Timing	Location	Frequency	Type	Parameters
Dry weather	Wetland cells (1 and 3)	Weekly	Grab	*In-situ* parameters, water level
	Groundwater monitoring wells (2, 5, 6, A, B, C)[1]	Quarterly	Grab	Target parameters, *in-situ* parameters
Storm events	Wetland Cell inflow/ outflow points[2]	Target 3 events/ month (March-Nov)	Automated	Target pollutants (except for fecal coliform), Flow
			Grab	Fecal coliform, *in-situ* parameters
	Grit and Floatable System Influent (MH-1)[3]	Target 3 events/ month (March-Nov)	Grab	Target Pollutants, *in-situ* parameters, Flow
	Emergency Bypass (overflow)[3]	As triggered	Automated	Flow

[1] As shown in 90% design drawings C-1000 and C-3002

[2] As shown in 90% design drawing C-3001

[3] As shown in 90% design drawing C-2002

4.3 Flow Configuration-Sampling Coordination

4.3.1 General Considerations

A crucial monitoring issue for the Harbor Brook treatment wetland system will be properly sampling each of the three different flow configurations. The three wetland cells (FWI, VDF, SF) will be set to receive CSO discharge in series, parallel, and series/parallel flow configurations (S, P, SP).[1] Coordinating operation of the different flow configurations with the sampling program during the 2-year monitoring phase will be a critical variable controlling the data generated to assess the performance of the system, and the associated experimental approach. The key word to describe the approach to flow configuration coordination during the monitoring phase of this project will be: *flexibility*. However, the following primary directives should be followed to ensure that objectives for smooth operation and adequate data collection are maintained:

- The priority of this monitoring program will be to obtain a balanced sample set of monitored storm events, in which each of the three flow configurations are equally represented
- Assessment of parallel flow will, however, be sacrificed if insufficient CSO discharge events occur within the experimental period in order to obtain a robust data set for the other two configurations
- The flow configuration will be set to series as soon as snowpack is anticipated, and will remain as such until spring thaw due to the fact that series flow offers the longest retention time with which to detain runoff associated with snowmelt
- An effort will be made to monitor each scenario under the full range of seasonal conditions so as to generate a sufficiently robust dataset which will lend itself to valuable statistical inferences

The schedule presented in Table 4-4 will be tentatively followed during the first year of post-construction monitoring. The estimated monitoring start date will be June. Modifications to this schedule will be made if that date changes such that sampling begins with the series flow configuration and the system cycles through all three configurations at least three times during the monitoring year. Re-assessments will be made during that time based on system performance. Recommendations for the second year of post construction monitoring will be documented in the first year annual monitoring report, which will be produced after the first calendar year of monitoring.

[1] For additional details on wetland cells and operational sequences, refer to the project *Basis of Design* (CH2M HILL and CHA 2011)

TABLE 4-4
Target 1st Year Storm Event Sampling Schedule

Sampling Season	Spring									Summer									Fall									Winter[2]
Month	March			April			May			June			July			Aug			Sept			Oct			Nov			Dec - Feb
Storm Event Sampling Configuration[1]	S	S	S	SP	SP	SP	P	P	P	S	S	S	SP	SP	SP	P	P	P	S	S	S	SP	SP	SP	P	P	P	S

[1] Where: S = Series; SP = Series/Parallel; P = Parallel

[2] Flow sequence will automatically be changed to Series before a snowpack develops, and will remain so until snowmelt

4.3.2 Triage

In order to ensure adequate monitoring under the range of seasonal conditions, different flow sequences will be prioritized based on event sampling goals. Based on modeling done by Brown and Caldwell, we estimate that an average of 4 CSO events/month will discharge into the constructed wetland system between March and November (CH2M HILL and CHA 2011). However, logistical and budget constraints will limit the number of events sampled to a *maximum* of 3 events/month. Additional storm event monitoring criteria is available in section 5.1 of this report.

The following guidelines are designed to create a process-based approach to flow configuration operations and allow for controlled alterations to the sampling schedule to account for the stochastic nature of event flows.

- Flow configuration will be changed at the end of the month to the next listed in the schedule if 1 or more events have been sampled under that configuration and the system has returned to steady state conditions

- Flow sequence will be changed to the next listed in the schedule after 3 events have been sampled under that configuration and the system has returned to steady state conditions, even if a month has not elapsed under that configuration

- If less than 2 events have been sampled under S or SP configurations during a given sampling season, the next available P slot(s) on the schedule will be replaced with either of the former two in a way that allows sampling targets to be met and minimizes flow configuration alterations

- If less than 2 events have been sampled under the P flow configuration, and 2 or more events have been monitored for S and SP in a given 3-month sampling season, P will be reverted to for the balance of the season

Modifications to this program will be made as needed throughout the pilot program. A final recommendation for the long-term treatment system flow configuration(s) will be made at the end of the 2-year pilot period.

4.3.3 Targets

Assuming that it is possible to sample 2-3 storm events per month during spring-fall, this schedule and associated triage estimates a total of 18-27 events to be sampled during the first year of the monitoring program. If mid-winter thaw events trigger CSO, grab samples will also be taken on a limited basis. The range of 18-27 sampling events is expected to provide a robust dataset. However, logistics and the unpredictable nature of storm events may cause this number to be lower. Therefore, the two-year target of events to be sampled during this study will be 36-54, over both years of post-construction monitoring. If less than 18 events are sampled in the first year, the second year flow configuration schedule will be modified to fill data gaps and reach the target two-year storm event monitoring goals.

SECTION 5

Field Data Collection

This section details field protocols for obtaining water samples and taking *in-situ* measurements of environmental parameters. All grab sample collection and preservation protocols described here are consistent with those described by the 2009 Draft *Onondaga County Ambient Monitoring Program* (AMP), *NYSDEC Quality Assurance Project Plan for Rotating Integrated Basin Studies: Rivers and Streams* (2011-2012), and the *NYSDEC Quality Assurance Project Plan to Evaluate the Ground Water Resources of NYS, Ver. 1.9* (2011).

Automated sampling techniques and strategies are consistent with guidelines set forth in the NPDES *Stormwater Sampling Guidance Document* (USEPA 1992) and the EPA approved manual, *Urban Stormwater BMP Performance Monitoring* (Geosyntec Consultants and Wright Water Engineers, Inc. 2009).

All field sampling and preservation techniques referenced herein are also consistent with standard EPA protocols (EPA 600/4-82-029 and 40 CFR 136).

Protocols applicable to the directives of this plan have been chosen from the aforementioned documents and major salient points are presented below.

5.1 Storm Event Sampling Guidelines

The most challenging aspect of monitoring a stormwater treatment system is the timing of water quality sampling. Peak pollutant concentrations/mass loads may not exactly line up with peak flows in the corresponding hydrograph (Figure 5-1). Additionally, rainfall is stochastic in nature, and it is difficult to manually capture "first flush" events, as well as a representative set of points along the wetland hydrograph for the duration of storm events. Therefore, this program will rely heavily on automated sampling to provide a realistic estimate of pollutant mass transfer rates into and out of the treatment system.

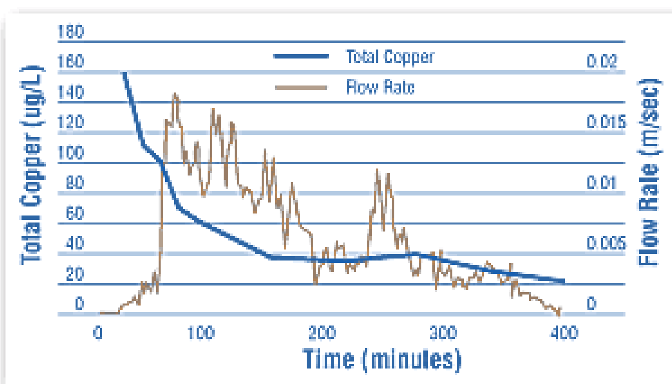

FIGURE 5-1 - Example Showing Incongruity Between Hydrograph (e.g. "Flow Rate") and Pollutograph (e.g. "Copper Concentration") (Caltrans 2011)

5.1.1 Planning For Events

As the pilot project monitoring program progresses, methodologies for CSO storm event tracking will be refined in quarterly reports. Close tracking of meteorological forecasts will be essential to this end. As a first order approximation, only events forecasted for average rainfall intensities exceeding 0.25" per hour will be considered, which is consistent with the criteria for CSO event monitoring discussed in the draft 2011 AMP. Storms occurring during the day will be prioritized for sample collection, due to health and safety concerns associated with field visits and equipment operation during the night.

Once a target rainfall date has been established, a field technician should visit the site in advance of anticipated rainfall to check equipment and program automatic sampling units.

5.1.2 Automated Sampling

ISCO 6712 portable automated sampling units can be programmed to take discrete or composite samples over the duration of a storm event based on increments of time or flow. All target pollutants can be measured using automated sampling, with the exception of fecal coliform. Associated advantages, disadvantages, and an adaptive experimental approach are discussed below.

Discrete vs. Composite Samples

Discrete samples are taken from a single source during a single moment in time. Composite samples contain aliquots extracted from the flow stream at pre-prescribed intervals, and combined into one sample (Figure 5-2). Composite sampling generally allows for sampling over a longer time-period/discharge volume, and will be the preferred method for automated sample collection during the first phase of pilot monitoring.

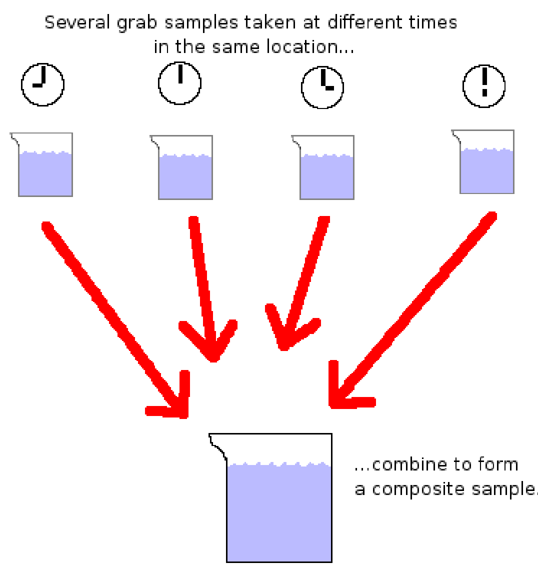

FIGURE 5-2 - Illustration Depicting Composite Sample Collection (MECC 2011)

Flow-weighted Sampling

Flow-weighted samples are obtained for pre-prescribed volume intervals. The measured sample concentration is assumed to represent the average concentration of the incremental water volume to which it corresponds (Gulliver et al. 2010). Composite sampling can also help to average concentrations over larger flow volumes. The National Research Council (2008) has recommended that continuous, flow-weighted sampling replace grab sampling as the preferred methodology for all stormwater monitoring programs.

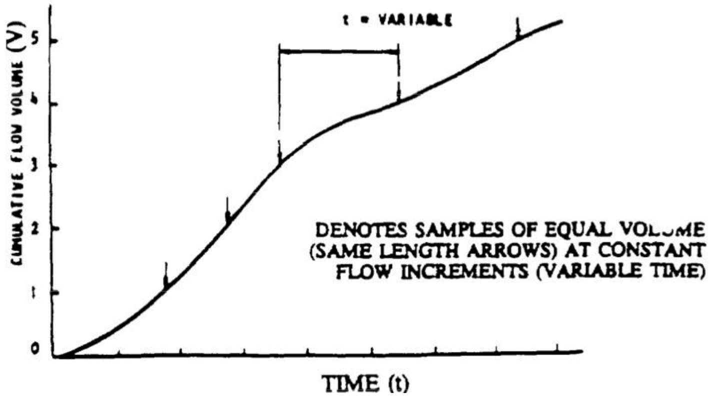

FIGURE 5-3 - Example of "Flow-Weighted" Sampling: Time (t) is Variable and Samples are Taken at Equal Increments of Flow Volume (V) (USEPA 1992)

Time-weighted Sampling

Time-weighted samples are obtained at pre-prescribed time intervals. The volume of discharge during each time interval can be obtained by integrating that time interval under the corresponding portion of the Q-time hydrograph. Time-weighted samples are generally considered to be less accurate at accounting for the variability of pollutants during event flow (Gulliver et al. 2010).

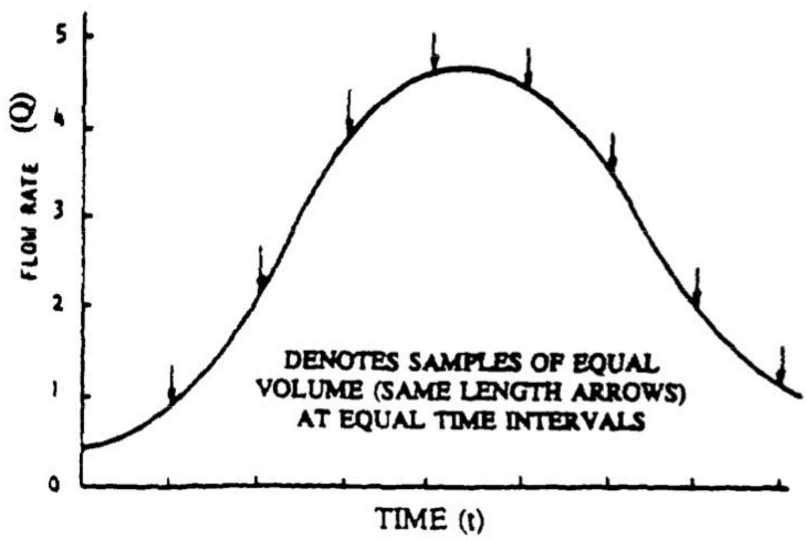

FIGURE 5-4 - Example of "Time-Weighted" Sampling: Flow Rate (Q) is Variable and Samples are Taken at Equal Increments of Time (t) (USEPA 1992)

Approach

Flow-weighted and time-weighted sampling techniques both have marked advantages and disadvantages. Flow-weighted sampling can be programmed to capture "first flush," the leading edge of CSO discharge, before subsequent interval-based sampling proceeds. However, it is harder to determine a proper volume increment for sampling. Volume increments can be determined for this pilot using event flows modeled by Brown and Caldwell (2011) for the design year 1991. Dividing modeled event flows by a prescribed volume increment results in the requisite number of sample aliquots needed to properly monitor a complete storm event. Flow increments should be chosen that result in between 1 and 12 (min and max capacity for the ISCO 6712 unit to collect all parameters of interest) composite samples for the largest number of modeled event flows.

While flow-weighted composite samples are preferred, time-weighted samples may be more appropriate for especially long or short storm events, where flow interval estimates may result in insufficient sample volume, or incomplete water quality characterization at the tail end of the event hydrograph. Additionally, time-weighted samples are easier to program, and provide a catch-all for the uncertainty associated with stochastic CSO discharges. Time-weighted samples may also be more appropriate for the parallel flow scenario, when event flows have a shorter residence time in the treatment system.

The approach of this monitoring plan will be to favor flow-weighted composite event samples under normal circumstances, but will also assess time-weighted composite sampling of shorter storm events during the first sampling season. After these approaches have been field-tested and reviewed using basic statistics, recommendations for further monitoring will be made in quarterly monitoring reports.

5.1.3 Storm Event Grab Samples

It will be necessary to take grab samples for fecal coliform bacteria during or directly after storm events. When possible, a grab sample should be taken during "first flush," directly after CSO discharge enters the treatment system, during peak discharge, and at the tail end of the event. Realistically, field personnel will not likely reach the project site in time to capture first flush.

Two sampling strategies are herein recommended for storm event grab sampling, which will be open to review and refinement during subsequent project stages.

1. Once a CSO event is confirmed, a field technician will visit the project site and take grab samples at all treatment system component inflow and outflow points. The field technician will then take spot measurements for water levels at staff gauges located in Cells 1 and 3, and make a first order approximation as to the amount of time it will take for the system to return to steady state based on hydrograph modeling presented in CH2M HILL and CHA (2011). The technician will then use best professional judgment regarding a potential follow-up grab sampling to characterize the tail end of event flows.

2. Within 24 hours of a CSO event, a field technician will take grab samples from Cells 1 and 3, and any inflow/outflow points if still active at that time.

All samples to be tested for fecal coliform must be preserved immediately and delivered to a laboratory for testing within 6 hours of sampling.

5.2 Sample Collection and Preservation

5.2.1 Treatment System Grab Samples

This protocol applies to all pilot treatment system component sampling points (MH's, FDS's). Protocol interpolated from the "Metro effluent sampling procedure," detailed in the AMP (2009).

Sampling Equipment

1. 1-Quart glass grab jar
2. Grab polyethylene sampling apparatus with rope or pole extension
3. Sample Compositing Churn
4. Coli Sampler
5. YSI 660/6600 or equivalent probe
6. Bucket (for sonde use)
7. LaMotte Test Kits for Cl2 and pH
8. Sulfuric Acid
9. Sodium Thiosulfate
10. Ice packs/cooler

Bottles

1. (1) 1-L white plastic pre-cleaned (TKN, NH3-N, TP)
2. (1) 1-L white plastic pre-cleaned (TSS, BOD5, NO_2/NO_3)
3. (2) 125-ml sterile plastic (F. Coli)

Sampling Procedure

1. Use a 1-Qt. glass jar in a grab polyethylene sampling apparatus on a rope or pole extension to collect water sample from CSO outlet or pilot system sampling point.

2. Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with 12 (1-qt.) grab samples.

3. When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

4. Collect a Coliform sample as per the Coliform Sampling Procedure (detailed in section 5.2 of this report).

5. Preserve samples as described in section 5.3 of this report (see summary in Table 5-1) and check samples for the appropriate pH.

6. Place samples on ice.

7. Collect field data with the YSI; place sonde in a sample bucket/sample compositing churn.

8. Record sample information on the Chain-of-Custody and record field observations on the field sheets.

5.2.2 Automated Sampling

Sampling Equipment

1. (1) ISCO 6712 Portable Automatic Sampler
2. (1) ISCO 730 Bubbler Flow Module
3. Sulfuric Acid
4. Ice pack(s) and cooler

Bottles

1. (12) 1-L plastic pre-cleaned, labeled bottles (TKN, NH_3-N, TP)
2. (12) 1-L plastic pre-cleaned, labeled bottles (TSS, BOD_5, NO_2/NO_3)

Sampling Procedure[2]

1. Arrive at site prior to anticipated storm event
2. Load base of ISCO automated sampler with ice packs
3. Load all 1-L bottles into sampler, alternating bottles intended for nutrients with those intended for conventional analysis
4. Make sure ISCO sample collection tubing is secure in bottom of sewer channel
5. Make sure ISCO bubbler flow module is secure in bottom of sewer channel
6. Program ISCO sampler using field manual and/or special instructions for extended programming
7. Return within 24-hours of initial programming
8. Preserve samples as described in section 5.3 of this report (see summary in Table 5-1) and check samples for the appropriate pH.
9. Place samples on ice
10. Record sample information on the Chain-of-Custody and record field observations on the field sheets

5.2.3 Groundwater Sampling

The following section is adapted from NYSDEC (2011).

Sampling Equipment

1. Pre-cleaned Teflon tubing
2. Peristaltic Pump
3. Coli Sampler
4. YSI 660/6600 or equivalent probe

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[2] See ISCO 6712 Operating Manual for more detailed instruction

5. Teflon bucket (for sonde use)
6. LaMotte Test Kits for Cl2 and pH
7. Sulfuric Acid
8. Sodium Thiosulfate
9. Ice packs/Cooler

Bottles

1. (1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
2. (1) 1-L white plastic pre-cleaned (TSS, BOD_5, NO_2/NO_3)
3. (2) 125-ml sterile plastic (F. Coli)

Sampling Procedure

1. Run tubing into piezometer or well in which water has equilibrated prior to sampling
2. Insert calibrated field probe into bucket, set to measure temperature, pH, SC, and DO
3. Pump water into bucket at slow enough rate for sensors to react (~100 to 250 ml/minute) but fast enough to maintain constant flow through the tubing
4. Once temperature, pH, SC, and DO have readings stabilized, record measurements and begin sampling
5. Rinse sample bottle with pump flow
6. Run tubing to bottom of sample bottle, so it fills from the bottom up
7. Preserve samples as described in section 5.3 of this report (see summary in Table 5-1) and check samples for the appropriate pH
8. Place samples on ice
9. Record sample information on the Chain-of-Custody and record field observations on the field sheets

5.2.4 Wetland Cell Direct Grab Samples

Grab samples can be acquired from the water column of wetland cells one and three either directly/from a stilling well, or by pumping water from the center of the cell using Teflon tubing (installed *in-situ*) and a peristaltic pump. Methods described for "groundwater samples" (using a pump approach) will be employed to this end.

5.3 Parameter-Specific Sample Preservation

5.3.1 Conventionals (TSS, BOD-5, NO3/NO2)

1. Sample from compositing churn is used to rinse out 1-gallon plastic bottle
2. Sample from composting churn is used to fill 1-gallon plastic bottle to shoulder
3. Bottle is cooled to $4^{O}C$

5.3.2 Nutrients (TKN, NH3-N, TP)

1. Sample from compositing churn is used to rinse out 1-L plastic bottle
2. Sample from composting churn is used to fill 1-L plastic bottle to shoulder
3. Determine Cl2 residual with a LaMotte Test Kit. If Cl2 residual is measured, add 30% Sodium Thiosulfate drop-wise; 1 drop/1 ppm Cl2, then add 1 drop excess
4. Adjust pH < 2 with H2SO4, cool to 4°C

Ex.: Cl2 measures 2.5 ppm - add 4 drops Sodium Thiosulfate - then H2SO4 to pH 1.5 - 2.0

TABLE 5-1
Sample Preservation and Collection Guidelines

<table>
<tr><th>Analyte</th><th>Total Volume Needed</th><th>Container</th><th>Preservation</th><th>Maximum holding time</th></tr>
<tr><td>Biological Oxygen Demand 5-day (BOD-5)</td><td rowspan="3">1 L (for all conventionals)</td><td rowspan="3">Plastic</td><td rowspan="3">Cool to 4°C</td><td>48 hours</td></tr>
<tr><td>Total Suspended Solids (TSS)</td><td rowspan="2">28 days</td></tr>
<tr><td>Nitrate/Nitrite (NO_3/NO_2)</td></tr>
<tr><td>Total Kjeldahl Nitrogen (TKN)</td><td rowspan="3">1 L (for all other nutrients)</td><td rowspan="3">Plastic</td><td rowspan="3">Cool to 4°C, H_2SO_4 to pH < 2</td><td rowspan="3">28 days</td></tr>
<tr><td>Ammonia Nitrogen (NH3-N)</td></tr>
<tr><td>Total Phosphorus (TP)</td></tr>
<tr><td>Fecal Coliform</td><td>125 ml</td><td>Plastic (pre-preserved with sodium thiosulfate crystals)</td><td>Cool to 4°C</td><td>6 hours</td></tr>
</table>

5.3.3 Fecal Coliform

1. Fecal Coliform sample is collected at water surface or directly from sampling stream using two sterile 125-ml plastic containers
2. The first container is filled from the source
3. The second container (disposable), pre-preserved with Sodium Thiosulfate crystals, is

filled from the first container leaving a small airspace to enable the sample to be shaken, and then cooled to 4°C

4. Samples are checked for residual chlorine using LaMotte Kit and treated with additional liquid sodium thiosulfate as described in the previous section.

Warning: Sample volumes for this parameter are crucial. Fill the bottle to just above the shoulder of the bottle leaving a small (approximately 2.5 cm) airspace to enable sample to be shaken. Do not allow the water to rise above the threads of the bottle.

SECTION 6

Field Data Collection QA/QC

All field data collection QA/QC protocols have been adapted for use in this monitoring program from the 2009 AMP.

6.1 Field Duplicates

One field duplicate will be collected during every sampling event for each parameter being tested. Therefore, if three parameters are being tested at three locations at the study site, a total of 12 samples should be taken. This provides a check on sampling equipment and precision techniques. It is impossible to take true field duplicates for automated samples (EPA 1992). Therefore, field duplicates will be used primarily to assess the accuracy of grab samples.

6.2 Equipment Rinseate Blanks

Equipment rinseate blanks will be obtained of the sample compositing churn before every field visit. The churn should be rinsed with de-ionized (DI) water and the water collected as a separate sample and analyzed for all parameters. This should be done prior to the collection of additional samples from the project site.

Automated ISCO samplers will be fed with 2 liters of DI water to be tested as a rinseate blank prior to programming for each storm event.

6.3 Sample Containers

Sample bottles will be acid washed and rinsed with DI water at WEP laboratory facilities after field use.

6.4 Sample Labeling

All sample bottles will be labeled with the time, date, analytes to be tested, pH if known, and any field preservation techniques employed.

6.5 Chain of Custody

Chain of Custody (COC) forms should be filled out for every sample taken during a field visit (see example COC form in Appendix A). Forms should include: sample type, container types, details on preservation techniques, and analysis to be performed, in addition to project personnel who had handled the bottle in the field. COC forms will be submitted to the WEP laboratory when samples are delivered for testing. WEP staff will be responsible for filing the original and scanning a digital copy. Care will be taken either print COC forms on waterproof "Rite in the Rain" paper or provide other adequate protections so that field notes can be taken during storm events.

6.6 Field Equipment Calibration

6.6.1 YSI Sonde

Detailed protocol for calibration and maintenance for the YSI Sonde can be found in the 2009 AMP. A summary field calibration checklist is as follows:

1. Calibration is typically performed the morning before use (and no more than 24-hours before use)
2. If DO membrane is replaced, the unit must be allowed to stabilize overnight
3. Temperature calibration is set by factory and does not require frequent calibration
4. DO membranes should be checked and replaced as needed after each use
5. The pH reference probe and temperature probes should be cleaned with 1:1 HCl and a cotton swab after each use
6. The pH probe calibration solution should be replaced daily
7. For long term storage, sondes are stored in a clean, dry space in a case
8. For short term storage sondes are stored in a calibration cup of tap water
9. Watertight connectors are lubricated when necessary in order to ensure a waterproof connection

6.7 Health, Safety, & Training

Considering the Harbor Brook treatment wetland will be capturing stormwater and municipal waste flows, health and safety for field staff will be an important concern. All field personnel will be supplied with pertinent Personal Protective Equipment (PPE), consistent with the requirements of the Onondaga County Department of Water Environment Protection (WEP) sample collection field staff. A list of the required equipment with winter modifications is supplied in Appendix B. All samples will be taken and handled with disposable latex gloves. Chemical splash goggles will be worn during sample preservation.

SUNY-ESF personnel will be responsible for all monitoring-related field work. To maintain consistency with the county, all field personnel associated with the Harbor Brook treatment wetland will receive field training from WEP staff apropos to “grey infrastructure” wastewater treatment facilities. Additionally, the NYS ELAP Certification Manual requires that all field staff that collect “analyze immediate” parameters in the field such as pH, temperature, or chlorine residual undergo training as specified under Item 249. To this end, The WEP hosts annual ELAP certified “pH Training,” which all field staff will be required to attend. Lighting installations will be maintained on site if night visits are necessary. A minimum of two staff members will accompany each other on field visits that occur at night or during inclement weather.

SECTION 7

Analytical Protocols

This section describes the lab protocols that will be used for water sample analysis. The WEP will conduct all water sample analyses for all analytes discussed in this monitoring program.[1] The WEP is a participating member of the New York State Health Environmental Laboratory Approval Program (ELAP). All methodologies used in the WEP are therefore approved by NYS. The following section details the QA/QC protocols used by the WEP to maintain NYS approved laboratory standards. As the WEP lab will be performing virtually all analyses associated with this monitoring plan, the following section is directly excerpted from the 2009 AMP. Omissions have only been made to remove discussion of analytes or equipment not relevant to this monitoring plan. Table 7-1 summarizes analytical methodologies for all analytes of interest.

TABLE 7-1
Analytical Procedures for Water Quality Analysis

Parameter	Code	Methods	Minimum reportable limit (mg/L)
Biological Oxygen Demand 5-day (BOD-5)	BOD5	1: (5210 B)	2.0
Total Suspended Solids (TSS)	TSS	1: (2540 D)	1.0
Total Kjeldahl Nitrogen (TKN)	TKN	2: (10-107-06-2-D)	0.15
Ammonia Nitrogen (NH3-N)	NH3-N	1: (4500 NH3-H)	0.01
Total Phosphorus (Manual) (TP)	TP	1: (4500 P-E)	0.003
Nitrate/Nitrite	NO_3/NO_2	1: (4500 NO3-E)	0.002
Fecal Coliform	FCOLI-MF	1: (9222 D)	1.0 (cells/100 ml)

1: Indicates Standard Methods (20th edition)

2: Indicates Lachat Instruments QuickChem Methods: Approved for use by USEPA- NYSDOH- ELAP

[1] Additional labs are being considered for fecal coliform testing. Only ELAP certified labs operating under protocols outlined by *Standard Methods* for the testing of fecal coliform bacteria will be considered, so as to maintain consistency with QA/QC requirements discussed in this plan

7.1 Chemicals and Reagents

7.1.1 Reagent Grade Water

Reagent grade water in the WEP environmental laboratory consists of DI water purified by means of mixed bed deionization. The processed water is required to attain a minimum resistivity of 10 mSiemen. A final pass through another mixed bed deionization filter at point of use maintains the highest quality possible (18 mS output). Actual Conductivity is determined daily. The date, conductivity @ 25°C, and analyst's initials are recorded in a tabular format in a bound notebook.

To monitor the quality of reagent grade water for bacteriological use, the tests as tabulated in the following Table 7-2 are performed.

TABLE 7-2
Reagent Grade Water Tests

Parameter	Frequency	Acceptable
Free Residual Chlorine	Monthly	None acceptable
Standard Plate Count	Monthly	<500 colonies/ml
Heavy Metals (Pb,Cd,Cu,Cr,Ni,Zn)	Yearly	<0.05 mg/l per metal <0.1 mg/l total
Suitability Test	Yearly	Ratio between 0.8-3.0

7.2 Reagents

Only American Chemical Society (ACS) grade or better chemicals are used. Chemicals are discarded within manufacturer's expiration date or 3 years, whichever comes first. Date of receipt is recorded on each container.

7.3 Standard Solutions/Titrants

Anhydrous reagent chemicals are oven dried at 100-105°C for at least 2 hours. Standard solutions or titrants not prepared from a primary standard are standardized against a primary standard at the frequency specified by the method or every 6 months if no frequency is specified. Standard solutions or titrants are not kept longer than 1 year. The date prepared and the expiration date appear on the container, along with title of standard or titrant, concentration, and preparer's initials. In a bound notebook, the preparation date, title of solution, concentration, manufacturer and lot number of reagent grade chemical(s) used, quantity prepared, expiration date, preparer's signature and, if appropriate, drying times & temperatures, tare and net weight, citation of preparation of primary standard, standardization titers and calculations are recorded.

7.4 Bench or Shelf Reagents

These are non-standardized solutions prepared by laboratory personnel. All of the pertinent information listed for standard solutions is recorded on both bottle label and in a bound notebook.

7.5 Calculations and Charts

A laboratory control chart will be constructed on the basis of at least 20 reference samples. Warning and control limits will be maintained based on standard WEP laboratory calculations. Calculations for control and warning limits, percent recovery, surrogate standards and duplicate analysis can be found in the QAPP of the 2009 AMP.

7.6 Laboratory Equipment

Analytical Balance

Analytical balances are serviced and calibrated internally by a qualified service organization 1/year and a dated certification sticker is provided.

Analytical balances are checked daily in two ranges with Class S weights. The ranges selected reflect the routine use of the balance. For example, the analytical balance used principally for evaporating dishes and aluminum dishes would need Class S weights having target values of bracketing the expected weights of the dishes. The date, target reading, actual reading, and analyst's initials are recorded in a bound notebook.

pH Meter

pH meters are calibrated daily using standard buffers and a two point calibration. This consists of creating a slope using standard pH buffers of pH 4.0 and 10.0. The slope is then checked using a standard buffer of pH 7.0, with an acceptable reading of + /- 0.05 pH units. The date, pH buffer target values, set points, actual readings, and analyst's initials are recorded in a tabular format in a bound notebook.

Conductivity Meter and Cell

The conductivity cell constant is determined annually using a 0.01-M potassium chloride solution. The date, resistance readings, average resistance, temperature, calculations, and analyst’s initials are recorded in a bound notebook.

The conductivity meter and cell is calibrated daily with a 0.001 M potassium chloride solution. An acceptable reading is +/- 20% of target value. The date, target value, actual reading, temperature, and analyst's initials are recorded in a tabular format in a bound notebook.

Thermometers

The WEP environmental laboratory possesses an NIST (National Institute of Standardized Temperature) traceable, factory-certified thermometer, which is checked at the various temperatures required by a variety of analytical requirements. Correction factors and adjustments to correction factors, new correction factors and analysts initials are recorded in a tabular format in a bound notebook.

Each working thermometer has a dedicated use, and is calibrated annually at the temperature of interest using the NBS thermometer. The date, thermometer designation, calibration temperature, correction factor, and the analyst's initials are recorded in a bound notebook.

Refrigerators

Laboratory refrigerators maintain a temperature of 1° to 5°C. These temperatures are checked once daily. An NIST certified thermometer with 1°C graduations is used. The date, times, temperature readings and analyst's initials are recorded in tabular format in a bound notebook.

BOD Incubators

The BOD Incubator maintains a temperature of 20°, +/- 1°C. Temperature readings are taken twice a day. This thermometer has graduations of 0.2°C. The same data is recorded as for refrigerators.

Ovens

Ovens are maintained at the target temperature of interest during use. Temperatures are checked at the beginning and end of each use. A dedicated thermometer with graduations of 1°C is used. The date, target temperature, time and temperature at the start and end of each cycle, oven use, and analysts' initials are recorded in a tabular format in a bound format.

Automated Ion Analyzer, Atomic Absorption Spectrophotometer, Inductively Coupled Plasma (ICP) Spectrophotometer

For instruments at this level of sophistication, the procedures for ensuring correct analytical results are too lengthy for this manual, and the USEPA/ELAP instructions should be followed for specific information. Good general laboratory procedures (GLP) are followed in the daily operation of this instrument; including, but not limited to:

1. Daily calibration for each analyte of interest.
2. Instrument blank for each analyte.
3. Method blank, duplicates, spikes, reference, and check standards are utilized daily for each analyte.

7.7 Laboratory Quality Control Documentation Requirements

A summary of analyte specific protocols can be found in Table 7-3.

TABLE 7-3
WEP Laboratory Quality Control by Parameter

Parameter	QC Measure required	Frequency
Biological Oxygen Demand 5-day (BOD-5)	Reference sample chart	Every 10th sample or monthly if less than 10 samples per month are analyzed
Nutrients (TKN, NH_3-N, NO_3/NO_2, TP)	Reference sample chart	Every 10th sample or monthly if less than 10 samples per month are analyzed
	Spiked sample chart	Every 20th sample or monthly if less than 20 samples per month are analyzed
	Duplicates tabulation	On positive samples only, a minimum of 10% of all samples

7.7.1 Standard Curves

Standard curves are prepared as specified in QA/QC manuals. All standard curves are dated and labeled with method, analyte, standard concentrations, and instrument responses.

A best-fit, straight line is drawn on graphed curves: the axis is labeled. The correlation coefficient is calculated. An acceptable correlation coefficient is 0.995 or greater.

Instrument response for samples is less than the highest standard. The lowest standard is near the detection limit.

If a specific method does not provide guidance in the preparation of a standard curve, the following guidelines are followed. For manual colorimetric methods, a blank and five standards that lie on the linear portion of the curve are used. A new curve is prepared each time an analysis is run. At each use, the curve is checked with a blank and a high standard. The high standard selected is greater than the expected sample concentrations. For automated colorimetric methods, a blank and a minimum of five standards are used. A new curve is prepared for each run. Instrument response is checked with a QC reference sample after each 10 samples. Low level standards are freshly prepared for each run.

7.7.2 Method Blank

A method blank consists of laboratory-pure water, which is processed and analyzed as if it were a sample. A method blank is run daily or with each batch of samples. Samples are related to the method blank by means of a date or batch identifier. Where applicable, the blank is calculated as a sample and a tabulation of blank results for each analyte with the date run and its appropriate acceptance criteria is maintained. Acceptance criteria for a method blank is a result less than the Minimum Reportable Limit (MRL) only.

7.7.3 Instrument Blank

An instrument blank consists of laboratory water, which is analyzed without adding reagents, filtering, etc. It is used for instrument set-up and no readings are recorded.

7.7.4 Trip Blank (special)

Trip blanks are required when analyzing volatile compounds in water. A trip blank is a sample of laboratory-pure water contained in a sample bottle appropriate to the analyte to be determined. Trip blanks are present but unopened at the sampling site and shipped to the laboratory with the environmental samples taken. A trip blank is included with samples collected at each sampling site. The trip blank is analyzed only when samples from a specific sampling site are positive for the analyte of interest. If reportable levels of the analyses of interest are demonstrated to have contaminated the field blank, re-sampling is required.

7.7.5 Reference Sample

A reference sample is prepared by spiking a known amount of analyte into an appropriate solvent. The concentrate or quality control sample is preferably obtained from an external source. When necessary, a sample prepared in-house is prepared independently of the calibration standard. A reference sample is analyzed with every tenth sample or monthly samples if fewer than ten samples per month are analyzed. Environmental samples are tied to the reference standard by means of a date or batch identifier.

Data generated by the analysis of reference standard are used to construct a control chart and control limits established. Instructions for constructing a control chart and computing limits are to be found later in this section.

Should a result fall outside the control limits, the analysis is out of control and immediate action is taken to determine the cause of the outlying result. Data generated on the same day as the outlying result are regarded as unreliable and the analyses repeated after corrective action has been taken and the procedure is back in control.

A new control chart with freshly computed control limits is generated annually. The last 20 reference standard data points for the previous year are used to compute the new control limits.

7.7.6 Spiked Recovery

Spiked recovery for an environmental sample is determined by dividing the sample into two aliquots. The first aliquot is analyzed as usual. The second aliquot is spiked with a known concentration of the analyte of interest. The spike should be approximately 10 times the method's standard deviation (at the level of interest). A spiked environmental sample is analyzed when appropriate at a frequency of 1 spiked sample for every 20 samples or 1 spiked sample per month if fewer than 20 samples per month are analyzed. Samples are related to the spiked recovery date by means of a date or batch identifier.

Data generated by the analysis of spiked samples are used to calculate the percent recovery. The percent recovery data is used to construct a control chart and tabulation and limits established.

A new control chart of tabulation, the analysis is regarded as out of control and immediate action is taken to determine the cause of the outlying result. Data generated on the same day as the outlying result are regarded as unreliable and the analysis repeated after corrective action has been taken and the procedure is back in control. A new control chart or tabulation with freshly computed limits is generated annually. The last 20 data points for the previous year are used to compute the new limits.

7.7.7 Duplicate Analysis

A duplicate analysis is required only when a sample yields a positive result. A minimum of 10 percent of all positive samples for a given analyte is analyzed in duplicate. The range between the duplicates is tabulated and acceptance limits established. Instructions for the tabulation and the computation of limits are to be found later in this section.

A new tabulation with a freshly computed acceptance limit is generated annually. The last 20 data points for the previous year are used to compute the acceptable control limits.

7.7.8 External QA/QC

In as much as the OCDWEP laboratory is a NYSDOH-ELAP certified laboratory, it is also National Environmental Laboratory Accreditation Conference (NELAC) certified, and is obligated to follow all of the criteria for maintaining this certification under the auspices of the ELAP program. Part of this program consists of a biannual inspection by a NYS Laboratory Inspector, who spends one or more days at each facility checking all aspects of the operation. In addition, performance evaluations are conducted twice per year. This consists of unknown samples sent to the laboratory to be analyzed and the results reported back to ELAP. The laboratory is required to submit results for each parameter that we are certified for, including bacteriology, metals, nutrients, etc.

The USEPA also uses the results from this program to satisfy the requirements of the SPDES permit program that regulates the various wastewater treatment plants in the OCDWEP system.

7.7.9 Internal QA/QC

In addition to the above, the WEP laboratory conducts an internal QA/QC program consisting of unknowns that are generated periodically by the WEP staff and given to technicians as “typical” samples, occurring without the analysts' knowledge. The object of this is to ensure that “typical” samples are analyzed using the same care as the “official” samples.

SECTION 8

Data Validation and Reporting

8.1 Data Review and Validation

Data will be reviewed for technical defensibility and usability. The former assesses the accuracy and precision of lab measurement. The latter assesses weather the dataset is robust enough to meet monitoring program objectives.

Technical defensibility review includes:

1. Internal laboratory quality control: blanks, spikes, replicates, and standard curves;
2. Review of COC forms;
3. Determination as to whether samples were processes within their maximum allowable holding timeframe (Table 4-4)

Usability review includes:

1. Charge balance of major cations and anions (if available from conventional samples)
2. Results of field duplicates
3. Statistical evaluation of dataset (outliers etc.)

8.1.1 Precision

Comparison of duplicate samples will provide a metric of reproducibility, following from the relative percent difference method between the two samples (NYSDEC 2011):

$$RPD = \frac{(c_1 - c_2) \times 100\%}{(c_1 + c_2)/2}$$

Where: *RPD* = relative percent difference
c1 = larger of the two observed values
c2 = smaller of the two observed values

8.1.2 Accuracy

Quantification of matrix spikes, laboratory blanks, and reference standards will provide metrics of accuracy. For matrix spikes, percent recovery will be calculated as follows (NYSDEC 2011):

$$\%R = 100\% \times \left(\frac{S - U}{C_{sa}} \right)$$

$\%R$ = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
Csa = actual concentration of spike added

When a standard reference material is used:

$$\%R = 100\% \ x \left(\frac{C_m}{C_{srm}} \right)$$

Where: $\%R$ = percent recovery
Cm = measured concentration of SRM
$Csrm$ = actual concentration of SRM

8.2 Reporting And Documentation

8.2.1 Field and Laboratory Data

Field monitoring forms will be tabulated into excel spreadsheets and uploaded to CH2M HILL Sharepoint online filing system by SUNY-ESF personnel.

Laboratory data is stored both on the Laboratory Information Management System (LIMS) and on paper copy to be filed at WEP. Data may be retrieved at any time from either of these sources.

8.2.2 Laboratory Reports

Samples are delivered to the laboratory along with chain of custody forms on the date of sampling. Laboratory reports are finalized and delivered to the project manager and field supervisor within 30 days of the sample date.

8.2.3 Reports

SUNY-ESF will deliver quarterly reports summarizing the results of field visits and data analyses. Annual monitoring reports will codify quarterly reports, interpret findings both quantitatively and qualitatively, and recommend further actions to be taken by the project team with reference to primary research objectives.

SECTION 9
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APPENDIX A
Example Chain of Custody Form

CHAIN OF CUSTODY RECORD

SAMPLE#

ONONDAGA COUNTY DEPARTMENT OF WATER ENVIRONMENT PROTECTION

Engineering and Laboratory Services Division

(Revision: JUNE 2006 – COC_62006Dbaseportraitmod.DOC)

Project Name	
IC/FC #	
Sewer#/WCode	
Invoice #	
DEC Permit	
Req by:	

Origin of Sample (i.e., Name of Industry, Treatment Plant, Hauler, etc.)

CATEGORY: AMP IND TP WHC SPECIAL QA/QC

CONTRACT LABORATORY List Name:

Start Date	End Date	P'UP Date	Start Time	End Time	SAMP TYPE	BOTTLE #	Container TYPE	Initial	Preserved? Yes	Preserved? No	SAMPLE NOTES (Lab) Receipt Temp

		Field pH		Meter #		Chlorine Residual	
Bottles/Comp		Aliquot/Bottle		Sample Interval		Refrigerated/ Iced	Yes / No

Preservation Checklist	Oxidizer Present? Yes	Oxidizer Present? No	Oxidizer Removed? Yes	Oxidizer Removed? No	PreKit# Initials
NH3-N					
TKN					
Color Interfer?			If yes, added [	"] Na Thio	

FLOW (Date/time) > 1.	2.
2^{nd} Reading	
1^{st} Reading	
TOTAL	
UNITS	

MATRIX: Solid WasWater SurWater PotWater Remarks (sample/collection details)

SPLIT WITH (Name/Title/Date):

PARAMETERS AS LISTED IN ANNUAL SCHEDULE? YES NO → If NO, List Sample Parameters below:

CHAIN OF CUSTODY (Print Name, Signature, Title, Date of Possession)

1.

2.

3.

APPENDIX B
County Personnel Protective Equipment Requirements

OCDWEP-ETS Wastewater Technician Field Staff Personal Protective Equipment Requirements

Job Activity	Electrical	Falls	Airborne Particles	Foot Injury	Hand Injury	Potentially Harmful Dust	Head Injury	Sun Exposure/Radiation	Chemical Exposure	Hearing/Noise	Harmful Gases	Drowning	Hypothermia	Apron	ANZI Z87 Safety Glasses	Chemical Splash Goggles	Dust Mask	Face Shield	Gloves	Hard Hat	Hearing Protection	Lanyards/Harness	Air Monitor	Floor Fall Protection	Safety Shoes	Safety Vest (Class II)	Safety Vest (Class III)	Class III Rain Suit	Ventilation	Life Jackets	First Aid Kit	Waders	Mustang Exposure Suit	Sunscreen	Tyvek Suit	Other
	Hazards													Personal Protective Equipment																						
General ETS Sample Collection		X	X	X	X	X	X		X	X	X				X	XP	A	A	X	P	P	S	P,S	S	X	S	S	S			X					
General ETS Sample Preservation			X		X	X			X		X				X	XP	A	A	X				A						X		X					
Lake/River/Tributary- Sampling																																				
By Boat		X		X	X			X	X	X		X	X		X	XP	S	A	X		S			X	X					X	X	S		Av		
Wading (Day)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X	X				X	X	X		Av		
Wading (Night - Dry Weather)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X		X			X	X					
Wading (Night - Wet Weather)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X			X		X	X					
Crane Use (Day)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X	X				X	X			Av		
Crane Use (Night - Dry Weather)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X		X				X					
Crane Use (Night - Wet Weather)		X		X	X		X	X	X			X	X		X	XP	S	A	X	S		S			X			X			X					
Wintertime- Lake/River																																				
Tributary		X		X	X		X	X	X			X	X		X	XP		A	X					X		X				X	X	X	X	Av		
Boat		X		X	X		X	X	X			X	X		X	XP		A	X		S	S		X						X	X	X	X	Av		
Ice		X		X	X		X	X	X			X	X		X	XP		A	X					X						X	X	X	X	Av		Refer to SOP.
Electrofishing																																				
Boat	X	X							X	X		X	X	X	X	XP		A	X		X	X			X					X	X					Linesman gloves
Tributary/Backpack	X	X						X	X			X	X	X	X	XP		A	X						X						X			Av		
Larval Trawls		X		X	X			X	X	X		X	X	X	X	XP		A	X		X			X	X					X	X	X		Av		
Macroinvertebrate																																				
Tributary		X						X	X			X		X	X	XP		A	X			X			X						X	X		Av		
Lake		X		X	X			X	X			X		X	X	XP		A	X						X					X	X			Av		
Juvenile Seines		X						X	X			X		X	X	XP		A	X			X			X						X	X		Av		
Nesting Survey		X						X				X										X		X	X					X	X	X		Av		Polarized glasses
Zebra Mussel (Lake and River)		X		X	X			X	X			X		X	X	XP		A	X			X									X	X		Av		
Macrophyte Collection		X						X	X			X		X	X	XP		A	X			X		X						X	X	X		Av		
YSI Sonde Replacement at USGS Sites		X		X	X		X	X				X			X				X			X		X						X	X	X		Av		
Mooring and YSI Buoy Deployment		X		X	X			X				X	X			XP		Av	X			X		X	X					X	X	X	X	Av		
Mooring and YSI Buoy Removal		X		X	X		X	X	X			X	X	X	X	XP		Av	X	X		X		X	X					X	X	X	X	Av	Av	

Key For PPE : **X** - Required, **XP** - Required during preservation, **P** - Required in Posted Areas/Operations (including Industries), **A** - As Recommended by Applicable MSDS, **S** - Refer to Supervisor and SOP, **Av** - Available for Use.

Please Take Notice: This is a summary of PPE equipment for various ETS Field Staff activities, and does not supersede any SOP requirements. If you have trouble locating a specific SOP, please contact your immediate supervisor.