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## Sampling and Analysis Plan

# Silver Lake Water Quality Monitoring

# Halifax, Plympton, Pembroke and Kingston, Massachusetts

## PREPARED FOR

**Central Plymouth County Water District Commission**
c/o Frank Basler, County Administrator
44 Obery Street
Plymouth, MA 02360

January 18, 2022

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# INTRODUCTION AND PROJECT DESCRIPTION

ESS Group, Inc. (ESS) has developed this Sampling and Analysis Plan (SAP) to provide the Central Plymouth County Water District Commission (CPCWDC) with a detailed description of the technical approach and schedule for executing the Silver Lake Water Quality Monitoring Project (the Project).

Silver Lake is a designated Class A waterbody and Outstanding Resource Water (ORW) located in the towns of Halifax, Plympton, Pembroke, and Kingston, Massachusetts. In addition to serving as the primary source water reservoir for the City of Brockton and connected drinking distribution systems, Silver Lake constitutes the headwater source of the Jones River, a state designated cold water fishery (Figure 1).

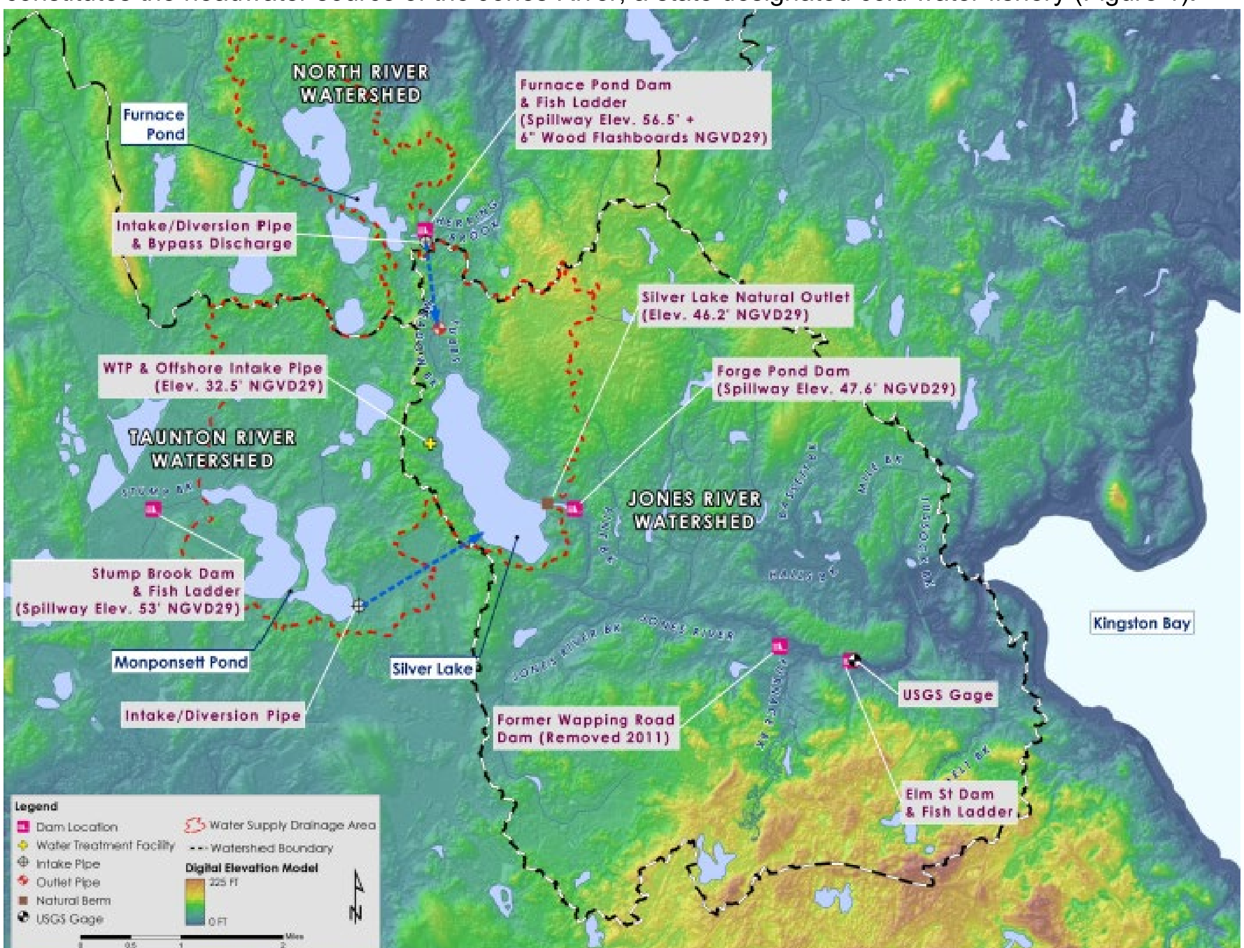



*Figure 1. Silver Lake, Diversions, and Watersheds*
Source: Princeton Hydro 2013

Concerns have arisen regarding potential water quality impacts to Silver Lake from watershed sources and water diversions. Silver Lake is now proposed for listing in the Draft 2018/2020 Integrated List of Waters by the Massachusetts Department of Environmental Protection (MassDEP). The proposed impairments include Fish Passage Barrier, Flow Regime Modification, and Dissolved Oxygen. The Dissolved Oxygen impairment would require a phosphorus TMDL to be developed for Silver Lake.

The overall goals of this Project are as follows:

1. Collect water quality data to help inform community management decisions to address water quality and quantity issues in Silver Lake and connected water bodies; and
2. Develop a baseline understanding of current water quality and continue to develop solutions-oriented relationships with the City of Brockton's Water Division and the public.

To support these goals, ESS will collect and analyze detailed water quality, physical, hydrologic, and biological data.

# PROJECT DESIGN

The Project is designed to improve the understanding of key water quality drivers in Silver Lake. This Project approach has been designed with the following questions, issues, and data gaps in mind.

- Publicly available water quality data for Silver Lake appears limited mainly to assessments completed in 2004 (ESS) and in 2008-2009 (JRWA; Chase et al. 2013). More recent data are needed to address the current condition of the lake.
- Diversion of water from East Monponsett Pond by the City of Brockton's public water supply system may increase the external loading of phosphorus to Silver Lake (Hanson, Murphy & Associates 2006). Over time, this could result in Silver Lake's water quality trending toward a state of more frequent and intense harmful algal blooms.
- In addition to the above, watershed loading to Silver Lake from stormwater runoff, septic systems (Hanson, Murphy & Associates 2006), agricultural runoff, and other sources may contribute to degradation of water quality.

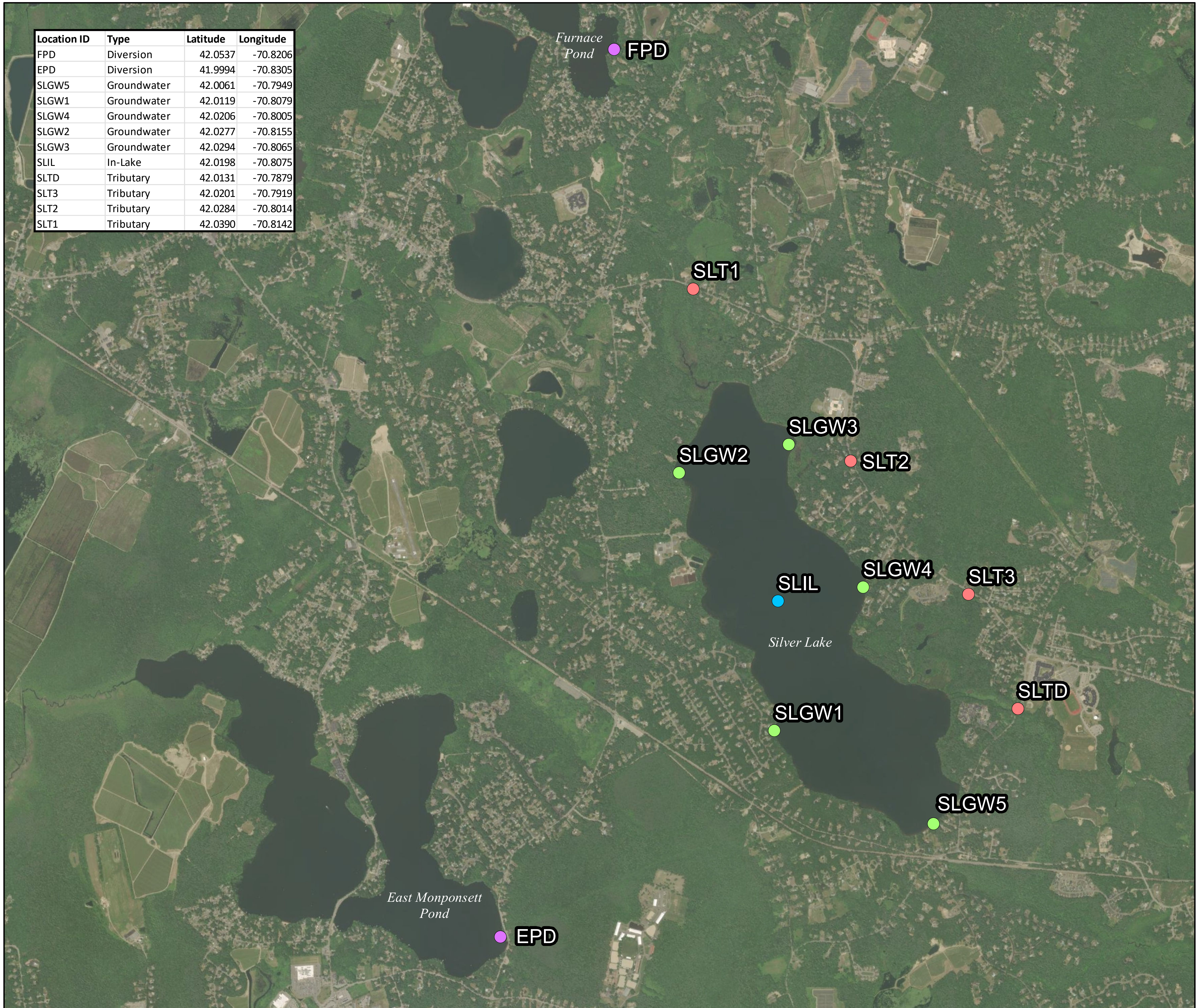
Components of the Project design are described in the following sections.

## Sampling Domain

The Project will include collection of data from Silver Lake, its natural tributaries, shallow groundwater, and water diversion sources. The anticipated primary sampling locations are shown in Figure 2 and described in Table A.

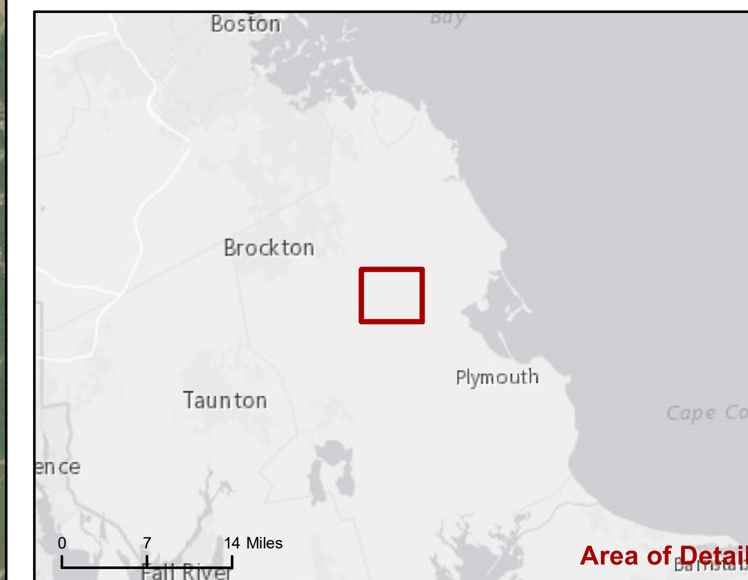
East Monponsett and Furnace Ponds are publicly accessible and do not require prior arrangement for sampling. Access to Silver Lake will be through the Silver Lake Water Treatment Plant, which is operated on behalf of the City of Brockton by Veolia North America. ESS will coordinate gate access directly with the plant operator prior to each visit to Silver Lake.

| Location ID | Type | Latitude | Longitude |
|---|---|---|---|
| FPD | Diversion | 42.0537 | -70.8206 |
| EPD | Diversion | 41.9994 | -70.8305 |
| SLGW5 | Groundwater | 42.0061 | -70.7949 |
| SLGW1 | Groundwater | 42.0119 | -70.8079 |
| SLGW4 | Groundwater | 42.0206 | -70.8005 |
| SLGW2 | Groundwater | 42.0277 | -70.8155 |
| SLGW3 | Groundwater | 42.0294 | -70.8065 |
| SLIL | In-Lake | 42.0198 | -70.8075 |
| SLTD | Tributary | 42.0131 | -70.7879 |
| SLT3 | Tributary | 42.0201 | -70.7919 |
| SLT2 | Tributary | 42.0284 | -70.8014 |
| SLT1 | Tributary | 42.0390 | -70.8142 |




**Legend**

- Sample Location with Diversion
- Groundwater Sample Location
- In-Lake Sample Location
- Tributary Sample Location




0 550 1,100 2,200 Feet

Source:
1) ESRI, World Imagery, 2019
2) ESS, Field Survey, September 2021

# Water Quality Sample Locations

**Silver Lake Water Quality Monitoring Program**
Central Plymouth County Water District Commission

ess group
environmental consulting & engineering services

**Figure 2**

Drawing Date: 1/17/2022 ...C663-000 Central Plymouth County Water District Commission- Silver Lake Water Quality Monitoring Program\04 GRAPHICS\GIS\MXD\C663_FigXX_WQSampleLocationsV05.mxd

**Table A. Sampling Locations**

| Water Body | Site ID | Description | Type |
|---|---|---|---|
| Silver Lake | SLIL | Deep hole | In-lake |
| Silver Lake | SLGW1 | Southwestern shoreline | Groundwater |
| Silver Lake | SLGW2 | Northwestern shoreline | Groundwater |
| Silver Lake | SLGW3 | Northeastern shoreline | Groundwater |
| Silver Lake | SLGW4 | Eastern shoreline | Groundwater |
| Silver Lake | SLGW5 | Southern shoreline | Groundwater |
| Tubbs Meadow Brook | SLT1 | Tubbs Meadow Brook between Route 27 and Silver Lake | Tributary |
| Little Brook | SLT2 | Little Brook between Route 27 and Silver Lake | Tributary |
| Mirage Brook | SLT3 | Mirage Brook between Route 27 and Silver Lake | Tributary |
| Jones River* | SLTD | Outlet from Silver Lake | Outlet |
| Furnace Pond/Diversion | FPD | Furnace Pond diversion to Tubbs Meadow Brook | In-lake/Diversion |
| East Monponsett Pond/Diversion | MPD | East Monponsett Pond diversion to Silver Lake | In-lake/Diversion |

**The Jones River is a cold water fishery (CWF) as designated by MassDEP, which adheres to more stringent dissolved oxygen criteria than non-CFW designated streams.*

## Sampling Design

The Project sampling design consists of the following principal elements:

1. Bathymetry, Aquatic Plant, and Benthic Surveys
2. In-Lake Water Column & Quality Sampling
3. Upstream and Downstream Monitoring
4. Groundwater Assessment
5. Sediment Coring and Phosphorus Fractionation

Each of these are described in the following sections.

## 1. Bathymetry, Aquatic Plant, and Benthic Surveys

Bathymetric, aquatic plant, and benthic surveys of Silver Lake will be completed and used to create detailed maps of water depth, plant growth, and area of the lake impacted by anoxia. Survey timing is September 2021.

***Bathymetry***. Bathymetry will be measured using an echosounder in deep, open waters and a calibrated sounding line in shallower waters where plant growth is dense. Given the wet antecedent conditions in June and July, Silver Lake will be near capacity in late summer. Therefore, the planned survey timing is likely to provide adequate water depth to complete the bathymetric mapping.

Lake bathymetry will be tied to the same vertical control as the prior survey completed by Coler and Colantonio (2003) and used to create an updated contour map of the lake. The aquatic plant mapping effort allows for opportunistic collection of bathymetric data and the subsequent update to the existing bathymetry map. This will allow for comparison with prior survey and the targeting of specific locations for additional survey effort, if needed.

The bathymetry survey will include at least 350 survey locations. The locations will be distributed using a gridded survey approach (Figure 3). This method is similar to point-intercept survey methods, in that it uses a pre-determined sampling interval to ensure adequate coverage of the entire water body. The primary difference is that, whereas point-intercept survey methods require navigation to a specific point (i.e., the intersection of each grid line), the gridded survey only requires navigation to each cell. This ensures adequate coverage of survey data throughout the lake while providing field crews with flexibility select the exact location and number of points within each cell based on observed field conditions.

The field data and geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

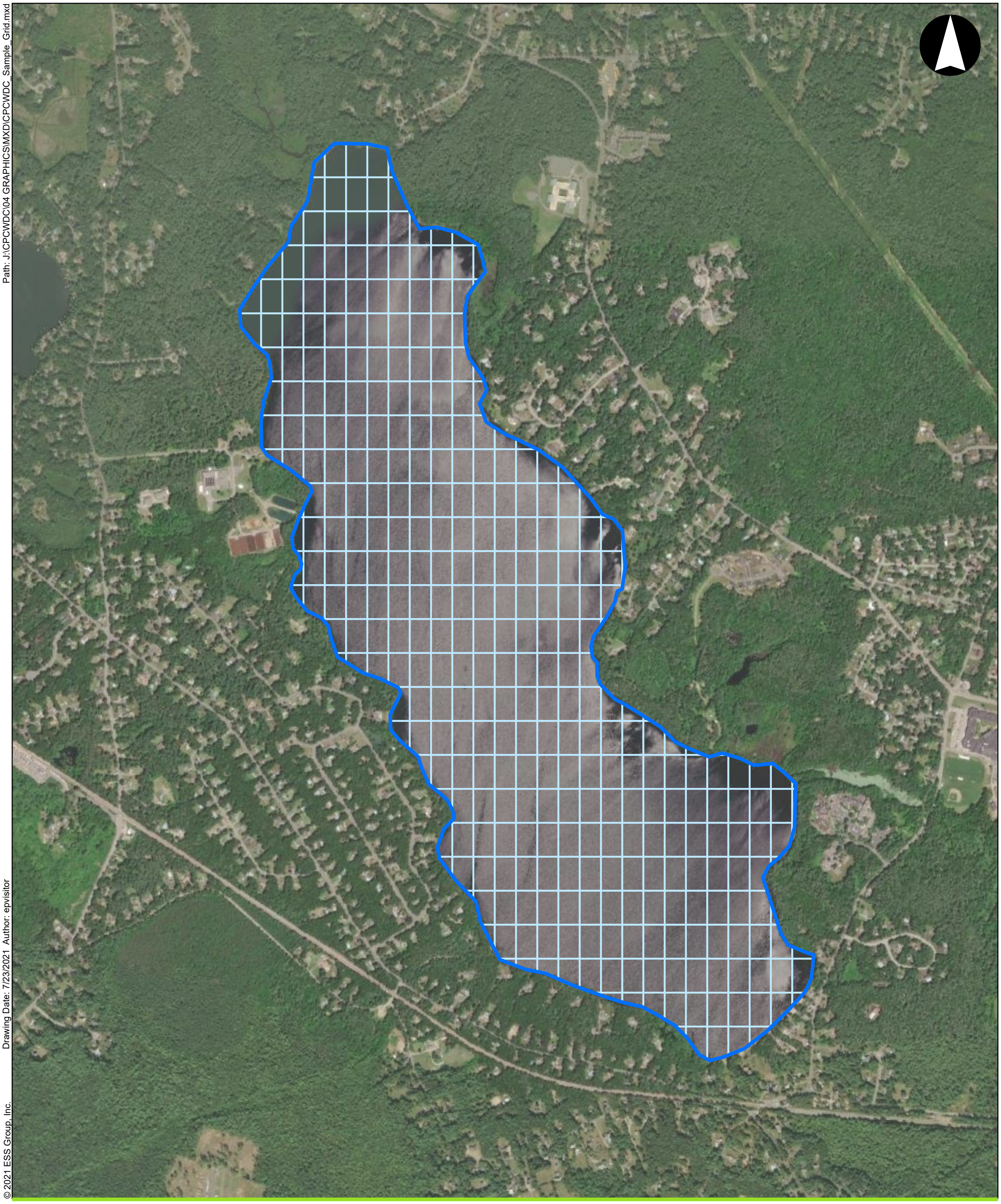
***Aquatic Plants***. Aquatic plant growth will be assessed at each survey location using one or more of the following tools: a color underwater video camera, macrophyte pole- and/or throw-rakes, and direct observation from the boat. Aquatic plants will be field identified to the lowest practicable taxonomic level (typically genus/species). Specimens that cannot be readily field-identified to genus/species level will be collected and identification under a high-powered dissecting microscope. Please refer to the attached SOP in Appendix A for additional details on aquatic plant identification in the field.

The planned timing provides ideal conditions for mapping rooted plants, which will be at their seasonal peak of growth. Aquatic plant data collected during the survey will include community composition, vegetative cover (percent of bottom) and biomass/volume (measure of vegetative growth in the water column). Supplemental data on substrate type (muck, sand, etc.) will also be collected.

As with the bathymetry survey, the plant survey locations will be distributed using a gridded survey approach. The field crew may elect to add more positions to capture variability in areas observed to be characterized by rapidly changing water depths and aquatic plant growth.

The field data and geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

Data collected from the aquatic plant survey will be used to generate maps of plant cover and biovolume for the lake, as well as the locations of any aquatic invasive species encountered.



Path: J:\CPCWDC\04 GRAPHICS\MXD\CPCWDC_Sample_Grid.mxd

Drawing Date: 7/23/2021 Author: epvisitor



ESS group
environmental consulting & engineering services

0 0.1 0.2 Miles

**Silver Lake Water Quality Monitoring Project**

Halifax, Plympton, Pembroke, and Kingston, MA

Source: 1) Esri, World Imagery, 2021

**Legend**

Silver Lake Boundary

Mapping Grid
Approximately 360 Nodes

**Silver Lake Mapping Grid**

**Figure 3**

Additionally, a field guide to the aquatic plants of Silver Lake will be produced as a resource for future monitoring efforts.

***Macroinvertebrates***. Due to their relatively long lifespan (months to years) and wide range of sensitivity to water quality conditions, benthic macroinvertebrates are one of the most useful organisms for inferring longer term water quality conditions in surface waters. It is anticipated that a benthic macroinvertebrate survey will serve as a supplemental measure of hypoxic or anoxic conditions at Silver Lake.

Benthic macroinvertebrate samples will be collected along a transect perpendicular to the long axis of the lake, allowing the collection of samples from both shallow and deep environments within the lake. A total of seven samples will be collected, each from a different depth (approximately 5 ft, 15 ft, 25 ft, 35 ft, 45 ft, 55 ft, and 65 ft, to be modified as needed if direct dissolved oxygen readings suggest depletion at shallower depths).

Depending on the conditions observed in the lake and depth of water at the sampling location, ESS will use a grab sampler (e.g., Ekman grab), clam rake, or dip net to collect macroinvertebrate samples. The total area sampled will be noted for each location so that the data can be used to quantify densities of each organism. Samples will be field-sieved using a 0.5-mm mesh bucket sieve and preserved in 75% ethanol.

Macroinvertebrates will be sorted from each sediment sample, then identified and enumerated by a Society for Freshwater Science (SFS) certified taxonomist under a high-power dissecting and/or compound microscope. The target level for macroinvertebrate identification will be genus/species for most organisms. This will allow for the mapping of the area of the lake affected by seasonal stressors, such as anoxia (i.e., areas lacking dissolved oxygen). Please refer to the Standard Operating Guidelines for Freshwater Macroinvertebrate Sorting for additional details regarding laboratory analysis of benthic macroinvertebrate samples.

The geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

### 2. In-Lake Water Column & Quality Sampling

In-lake sampling of water quality will be used to establish the current baseline conditions in Silver Lake. Survey timing is anticipated to begin in September 2021 and extend through October 2022, exclusive of months when ice cover is present (currently anticipated to be January and February).

To ensure acquisition of the most useful and complete dataset over a short period of time, the in-lake monitoring program will include both continuous data logging and collection of discrete water quality samples as part of the field program.

***Continuous Data Logging***. The continuous data logging portion of the field program will include deployment of two monitoring arrays at the deepest location in the lake (currently anticipated to be approximately 75 feet deep when water level is at normal pool elevation). The data logger array will be used to detect differences in key parameters (water level, temperature, and chlorophyll – a surrogate for algal growth) over time and through the vertical water column. One array will be located within 5 meters (16 feet) of the lake surface and the second array will be located within 16 feet of the sediment-water interface. The chlorophyll a datalogger will only be included in the shallow monitoring array. The surface datalogger array will be allowed to move up and down with changes in water level so that it remains at the same relative depth while the bottom datalogger will maintained at a fixed location to effectively track changes in water level.

Loggers will be programmed to collect readings at hourly intervals, which is anticipated to be sufficient to support the goals of the study. Data will be downloaded during each site visit. The logger arrays will be removed prior to the onset of ice cover and redeployed once Silver Lake is ice-free. See Appendix A for more information on logger installation and operation.

The geographic coordinates for the data logger array will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

***Discrete Water Quality Sampling***. To complement and supplement the continuous data logging program, multiple rounds of discrete in-lake water quality samples will be collected from September 2021 through October 2022, exclusive of January and February 2022, for a total of twelve sampling events.

During these events, samples will be collected from the same in-lake location as the datalogger array. Additionally, water quality profiles will be measured in situ within the water column. See Appendix A for more information on sampling methods and Table B for the distribution of in-lake sampling effort.

The geographic coordinates for each sampling location will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

Water quality samples will be sent to the laboratory for analysis of the following:

- Total Phosphorus
- Soluble Phosphorus
- Total Nitrogen (nitrite-N+nitrate-N and Total Kjeldahl N)
- Alkalinity
- Chlorophyll a – surface only
- E. coli – surface only
- Algae (Phytoplankton) Enumeration and ID – surface only

Additionally, the following parameters will be field measured:

- pH
- Secchi Disk Transparency
- Apparent Color
- Turbidity
- Water Temperature (full vertical profile at 1 m increments)
- Specific Conductance (full vertical profile at 1 m increments)
- Dissolved Oxygen (full vertical profile at 1 m increments)

**Table B. Surface Water Quality Analytes and Parameters to Be Monitored in Silver Lake**

| Analyte/Parameter | Sampling Position(s) at SLIL | Number of Visits | Number of Samples per Visit | Total Number of Samples |
|---|---|---|---|---|
| Total Phosphorus | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Soluble Phosphorus | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Total Nitrogen | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Alkalinity | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Chlorophyll a | Surface | 12 | 1 | 12 |
| Algal ID and Enumeration | Surface | 10 | 1 | 10 |
| *E. coli* | Surface | 10 | 1 | 10 |
| Cyanotoxins | Surface | 2 | 1 | 2 |
| pH | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Secchi Disk Transparency | Surface | 12 | 1 | 12 |
| Apparent Color | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Turbidity | Surface, Mid-depth, Bottom | 12 | 3 | 36 |
| Water Temperature* | Every meter | 12 | 22 | 264 |
| Specific Conductance* | Every meter | 12 | 22 | 264 |
| Dissolved Oxygen* | Every meter | 12 | 22 | 264 |

*Number of samples is estimated. Actual number will be determined by field conditions (i.e., water depth).

Since there is concern regarding documented impairments in East Monponsett Pond and Furnace Pond and the potential for these to impact Silver Lake through inter-basin water transfer, surface samples will also be collected from these diversions concurrent with a subset of the in-lake sampling events at Silver Lake. The timing of these sampling events will be targeted during periods of active diversion, as conditions allow. See table C for the distribution of sampling effort.

**Table C. Surface Water Quality Analytes and Parameters to Be Monitored from Diversions (East Monponsett and Furnace Ponds)**

| Analyte/Parameter | Sampling Locations | Number of Visits | Number of Samples per Location per Visit | Total Number of Samples |
|---|---|---|---|---|
| Total Phosphorus | 2 | 3 | 1 | 6 |
| Soluble Phosphorus | 2 | 3 | 1 | 6 |
| Total Nitrogen | 2 | 3 | 1 | 6 |
| Alkalinity | 2 | 3 | 1 | 6 |
| Chlorophyll a | 2 | 3 | 1 | 6 |
| Algal ID and Enumeration | 2 | 3 | 1 | 6 |
| *E. coli* | 2 | 3 | 1 | 6 |
| Cyanotoxins | 2 | 2 | 1 | 4 |
| pH | 2 | 3 | 1 | 6 |
| Secchi Disk | 2 | 3 | 1 | 6 |

| Analyte/Parameter | Sampling Locations | Number of Visits | Number of Samples per Location per Visit | Total Number of Samples |
|---|---|---|---|---|
| Apparent Color | 2 | 3 | 1 | 6 |
| Turbidity | 2 | 3 | 1 | 6 |
| Water Temperature | 2 | 3 | 1 | 6 |
| Specific Conductance | 2 | 3 | 1 | 6 |
| Dissolved Oxygen | 2 | 3 | 1 | 6 |

### 3. Upstream and Downstream Monitoring

Upstream and downstream monitoring will be used to improve understanding of the hydrologic and nutrient budgets for Silver Lake. Survey timing is anticipated to begin in September 2021 and extend through October 2022, inclusive of the winter months.

To ensure acquisition of the most useful and complete dataset over a short period of time, the upstream and downstream monitoring field program will include continuous data logging, direct measurement of discharge, and collection of discrete water quality samples.

***Continuous Data Logging***. The continuous data logging portion of the field program will include deployment of four water level loggers, including one each at Tubbs Meadow Brook, Little Brook and Mirage Brook (tributary inlets) and one downstream (outlet to Forge Pond). Additionally, since the water level loggers will be sealed (unvented), a fifth pressure logger will be deployed in a discreet location to allow for continuous atmospheric pressure correction. The deployed loggers will also continuously monitor temperature over the course of the study.

The geographic coordinates for each logger location will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

Water level loggers will be programmed to collect readings at hourly intervals. Data will be downloaded during each site visit. See Appendix A for more information on logger installation and operation.

***Discrete Water Quality and Discharge Sampling***. To complement and supplement the continuous data logging program, monthly rounds of discrete upstream and downstream water quality and discharge measurement will be completed from September 2021 through October 2022, for a total of 14 sampling events. At least two of the rounds will be collected during wet weather conditions to capture the impact of stormwater runoff.

The geographic coordinates for each upstream and downstream sampling location will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

See Appendix A for more information on sampling methods.

Water quality samples will be sent to the laboratory for analysis of the following:

- Total Phosphorus (low detect)
- Soluble Phosphorus (low detect)
- Total Nitrogen (includes nitrite-N+nitrate-N and TKN)

Additionally, the following parameters will be field measured:

- Stream Discharge
- pH
- Apparent Color
- Turbidity
- Specific Conductance
- Temperature
- Dissolved Oxygen

The discharge measurements collected in each stream monitoring location will be used to develop stage-discharge rating curves. These curves will, in turn, be used to convert logger water levels into a continuous discharge record for the period of study. This will also allow for the estimation of surface water contaminant loads from surface tributaries into Silver Lake and out of the lake into downstream waters.

## 4. Groundwater Assessment

Groundwater seepage sampling will be used to evaluate the influence of groundwater inflows on water quality in Silver Lake. The assessment will serve as a qualitative evaluation of the influence of groundwater inputs to Silver Lake but is not intended to be a comprehensive assessment of all groundwater sources. Survey timing for two sampling events is planned for April 2022 and October 2022.

Direct groundwater seepage has the potential to be a major source of pollutants to surface water bodies, particularly those with densely developed shorelines. Measuring the quantity and quality of these groundwater inputs can be important for understanding why an aquatic system is no longer meeting its water quality goals. A seepage survey measures the quantity and quality of groundwater entering the lake along the immediate shorelines where groundwater inseepage is highest and typically the most influenced by human behaviors and activities. This assessment is not intended to be an inventory of all groundwater sources, although the results may reveal potential pollutant sources and lead to opportunities for more detailed source identification and development of recommended remedies.

To measure the seepage rate, ten seepage meters will be deployed along five key shoreline segments of Silver Lake, including three at the upper end and two closer to the dam and outlet. Three of these shoreline segments will be located downgradient of nearby developed areas and two will be located adjacent to natural or less-developed areas. Two meters will be deployed along each shoreline segment to adequately capture the local variability in groundwater movement.

On the same day, shallow porewater samples will be collected from each of the five shoreline segments using a littoral interstitial porewater (LIP) sampler, which is essentially a mini-well that extracts groundwater from sediments for water quality testing. Samples will be measured in the field for temperature, pH, and specific conductance and compared to surface water quality measurements to ensure that groundwater is being obtained by the LIP sampler. A total of five composite groundwater quality samples will be collected in Silver Lake; one from each shoreline segment.

The geographic coordinates for each groundwater sampling location will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

See Appendix A for more information on sampling methods.

Laboratory analysis will be conducted for the following at each shoreline sampling segment:

- Soluble Phosphorus
- Ammonia
- Nitrate-Nitrogen

ESS anticipates completing the seepage sampling program in April 2022 and October 2022 to capture seasonal high and low water-table conditions.

### 5. Sediment Coring and Phosphorus Fractionation

Internal recycling is a potentially critical source of phosphorus loading in lakes that experience dissolved oxygen depletion from deep waters. The collection and analysis of sediment core samples will be used to determine the potential impact of internal nutrient recycling on water quality within Silver Lake. This will be accomplished through a sediment phosphorus fractionation analysis that quantifies the different forms of phosphorus present in the top sediment layers.

Field work is planned for April 2022 to avoid sampling during periods of strong thermal stratification, when phosphorus release into the water column would be expected to be at its maximum.

Under this approach, a gravity corer or similar device will be deployed from a boat to collect undisturbed and uncontaminated cores of 10 cm to 25 cm (depending on penetration and recovery depths achieved) for use in evaluating maximum phosphorus release rates. Collected cores will be extruded through the top of the upright corer and a sharp, clean blade will be used to section the material into 2-4 cm section.

Up to eight sediment cores will be collected and sliced into multiple 2-4 cm sections (for an anticipated total of up to 40 sections). Cores will be collected from locations distributed across a range of depths and geographic positions to be identified using the bathymetric, benthic, and water quality data collected under other tasks.

These core samples will be sent to a specialty phosphorus fractionation laboratory and analyzed for the following specialty parameters:

- Iron-bound phosphorus
- Aluminum-bound phosphorus
- Calcium-bound phosphorus
- Organically-bound phosphorus
- Percent water
- Loss on ignition-organic carbon content
- Density

These data will help to define the spatial variability of phosphorus across the lake bottom, as well as vertically within the bottom sediment. This will help to provide some indication of how deep into the sediment phosphorus release occurs, as well as provide critical information for dosing if nutrient inactivation is advanced as a desired future management approach.

### Quality Assurance

A Quality Assurance Project Plan (QAPP) will be prepared under separate cover and submitted to EPA Region 1 for review and comment. The purpose of the QAPP is to ensure that the data collected under this SAP meet the required data quality objectives.

## PROJECT SCHEDULE

The overall Project schedule is currently anticipated to extend from July 2021 to February 2023. A detailed Project schedule showing the timing of planned sampling events and deliverables is provided in Figure 4. Tasks 4 and 5 presents the specific schedule for sampling and analysis components included in this SAP.

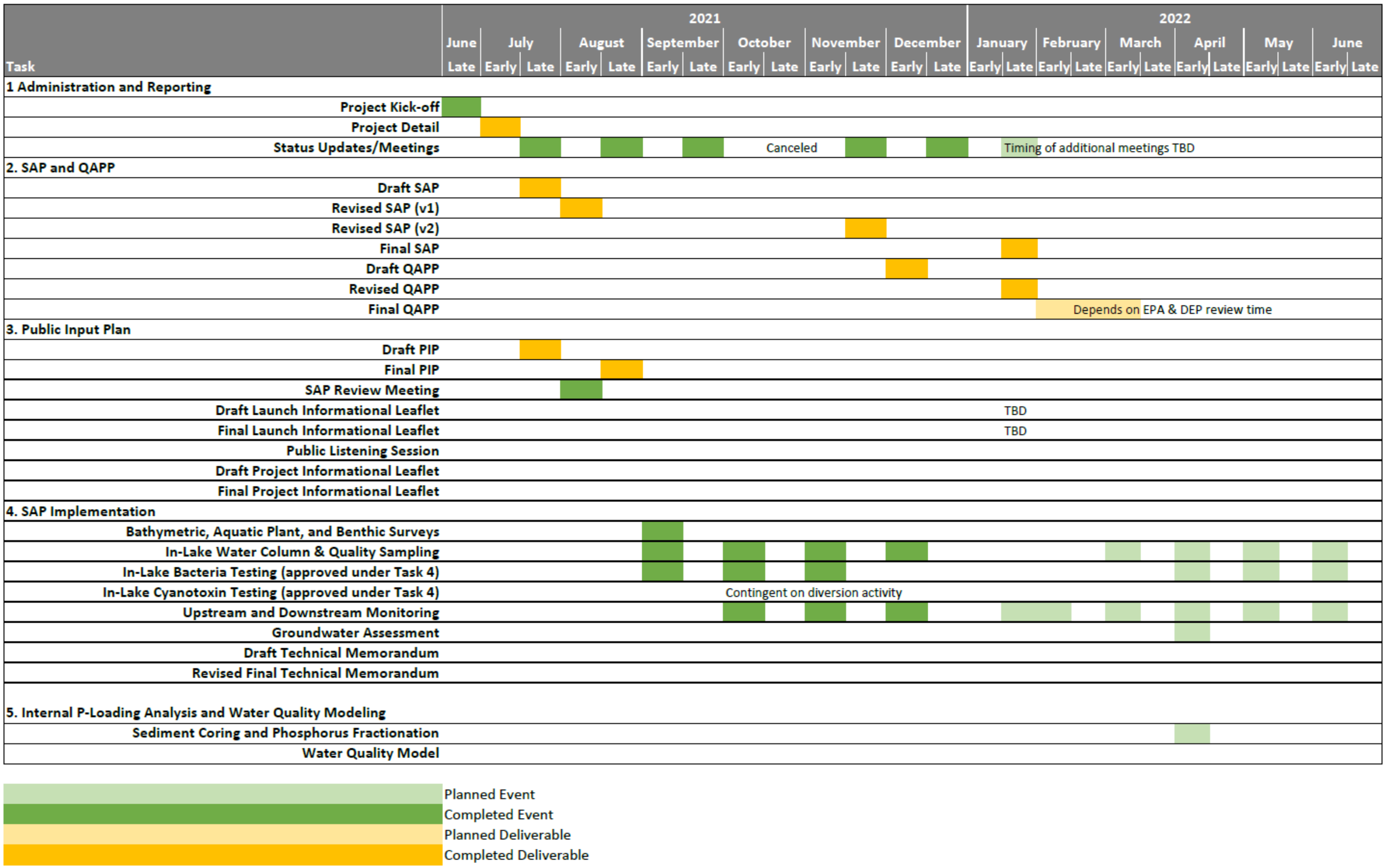



*Figure 4-1. Detailed Project Schedule for Silver Lake Water Quality Monitoring Project, June 2021 to June 2022*
Current through January 18, 2022

| | 2022 | | | | | | | | | | | | 2023 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | | August | | September | | October | | November | | December | | January | | February | | March | | April | | May | | June | |
| Task | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late |
| **1 Administration and Reporting** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Project Kick-off** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Project Detail** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Status Updates/Meetings** | Timing of additional meetings TBD | | | | | | | | | | | | | | | | | | | | | | | |
| **2. SAP and QAPP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft SAP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Revised SAP (v1)** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Revised SAP (v2)** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final SAP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft QAPP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Revised QAPP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final QAPP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **3. Public Input Plan** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft PIP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final PIP** | | | | | | | | | | | | | | | | | | | | | | | | |
| **SAP Review Meeting** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft Launch Informational Leaflet** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final Launch Informational Leaflet** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Public Listening Session** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft Project Informational Leaflet** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final Project Informational Leaflet** | | | | | | | | | | | | | | | | | | | | | | | | |
| **4. SAP Implementation** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Bathymetric, Aquatic Plant, and Benthic Surveys** | | | | | | | | | | | | | | | | | | | | | | | | |
| **In-Lake Water Column & Quality Sampling** | | | | | | | | | | | | | | | | | | | | | | | | |
| **In-Lake Bacteria Testing (approved under Task 4)** | | | | | | | | | | | | | | | | | | | | | | | | |
| **In-Lake Cyanotoxin Testing (approved under Task 4)** | | | | | | | Contingent on diversion activity | | | | | | | | | | | | | | | | | |
| **Upstream and Downstream Monitoring** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Groundwater Assessment** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Draft Technical Memorandum** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Revised Final Technical Memorandum** | | | | | | | | | | | | | | | | | | | | | | | | |
| **5. Internal P-Loading Analysis and Water Quality Modeling** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sediment Coring and Phosphorus Fractionation** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Water Quality Model** | | | | | | | | | | | | | | | | | | | | | | | | |

Planned Event
Completed Event
Planned Deliverable
Completed Deliverable

*Figure 4-2. Detailed Project Schedule for Silver Lake Water Quality Monitoring Project, July 2022 to June 2023*
Current through January 18, 2022

## PUBLIC COMMENTS

The CPCWDC hosted a public presentation of the Draft SAP on August 9, 2021 and made the Draft SAP document available for download and review from its website.

The CPCWDC originally provided the public with an opportunity to comment on the Draft SAP until August 20, 2021. On August 23, 2021, the Commission voted to extend the public comment period through September 30, 2021.

A summary of public comments received through September 30, 2021 is presented in Appendix B. This table includes both comments received verbally at the August 9, 2021 Draft SAP presentation as well as those received in written format. Full text of the written comments is also provided in Appendix B.

## Appendix A

## Field SOPs

STANDARD OPERATING GUIDELINES FOR THE CREATION OF AN AQUATIC PLANT MAP

## 1.0 INTRODUCTION

This Standard Operating Guideline (SOG) provides basic instructions for the mapping of aquatic plants present within standing waterbodies. The methods outlined below are intended to, (1) standardize plant mapping techniques used by ESS Group, Inc. (ESS) field personnel; and (2) standardize recording of field data to assure the creation of an accurate plant map.

## 2.0 REQUIRED MATERIALS

The following materials may be necessary for the creation of a plant map:

- Boat
- Long handled grappling rake (8-10 feet)
- Throw grappling rake (minimum of 75 ft of rope)
- Viewing scope
- Aquatic plant taxonomic keys and/or field guides
- Field map on water resistant paper
- Water resistant field notebook
- Small, sealable plastic bags (e.g., Whirl-pak or Ziploc) or jars
- Indelible marker
- GPS unit or tablet with GPS capability
- Underwater camera
- Echosounder (handheld or transom-mounted as appropriate to the vessel)
- Cooler
- Ice

## 3.0 METHODS

### 4.1 Aquatic Plant Survey and Sample Collection

Depending on the survey approach (point-intercept, point-transect, etc.) a project-specific survey plan will be developed prior to field collection of aquatic plant data. This plan will identify survey locations or areas to target based on size, shape, and bathymetry of the waterbody, as well as the project goals.

During the survey, the boat will be driven along each transect, to each point, or through each area identified in the survey plan. At the identified locations, a detailed survey of the aquatic plants will be carried out in the immediate area. The number of points surveyed will depend on the bathymetry and plant diversity in the survey area, with the aim of characterizing the composition, cover and biovolume of plant beds. Each point sampled will be numbered and recorded on the site map or using a GPS, in order to link plant survey data with location information.

At each survey point, a grappling rake will be used to sample aquatic plants from the waterbody for closer identification. Each plant present within each sample will be identified *in situ* (using keys if necessary) and recorded in the species list for the waterbody. Some surveys may require estimation of the level of growth (cover and/or biovolume) separately for one or more target species. In these instances, the code system specified in Section 4.2 should also be applied to the individual target species.

If identification of certain plants is not possible in the field, a generous sample of these plants will be stored with a little water in a plastic bag or jar clearly labeled in indelible ink. All such samples will be stored in a cooler to preserve the quality of the samples, and transported back to the lab for identification using a hand lens or dissecting microscope, if necessary. Unknown plants will be assigned a sequential code number (U1, U2, etc.) to use as a temporary species identification code. Tentatively identified plants should also be flagged with a note or comment that clearly indicates the need for lab confirmation. Once identified, these codes should be updated in the project database to reflect the final species determination.

### 4.2 Assessment of Percentage Plant Cover and Percentage Plant Biomass

At each survey point, ESS field personnel will estimate the percentage plant cover (i.e. the percentage of the bottom covered by plants, which is a factor of plant density). Estimates of plant cover may be made from the surface, if plants are adequately visible. Otherwise, a viewscope, underwater camera, or sampling rakes may be necessary to estimate plant cover. A simple code system will be used whereby percentage “ranges” are assigned an integer: i.e. 0 = 0%; 1 = 1%-25%; 2 = 26%-50%; 3 = 51%-75%; 4 = 76%-100%. At each survey point the estimation of plant cover will be recorded. Estimations of plant cover should be made by the same field staff member for the duration of the day’s survey work for consistency.

In addition to plant cover, biovolume will be estimated by ESS field personnel at each survey point. The percentage of biovolume represents that percentage of the water column that is occupied by plants; biovolume is a factor of water depth, plant height, and plant density. As noted above, a simple code system will be used to assign integers as estimations of percent biovolume. At each survey point the estimation of biovolume will be recorded with the associated transect and point number in the field notebook. Estimations of plant biovolume should be made by the same field staff member for consistency.

### 4.3 Creation of Plant Maps

- Download GPS data and apply differential correction, if real-time kinematic collection was not used and sub-meter horizontal accuracy is needed to meet project objectives.
- If vegetation survey data were recorded on a field map, associate the data with the measurement point locations recorded on the GPS.
- Using GIS, create maps that illustrate the distribution of target plants, percentage cover and percentage biomass of aquatic plants, as appropriate. Maps may be point-based or interpolated (polygon-based), depending on the objectives of the project.

## 5.0 QUALITY CONTROL

Unidentified plants (unknowns) or those whose taxonomic identification requires additional review for confirmation will be sampled *in situ* and transported back to the lab in plastic bags. Identification checks with other plant keys and consultations with ESS plant experts will be made to confirm species identification. In some cases, assistance from outside experts or genetic lab methods (cryptic species) may be required to confirm taxonomic identification. This will be determined on a case-by-case project basis.

Plant mapping figures should be checked by a second staff person before finalizing for inclusion in any project deliverables.

## 6.0 DOCUMENTATION

All observed and sampled plants will be recorded by ESS personnel in field notebooks, maps, and/or on a GPS unit. Any unanticipated site-specific information, which requires ESS personnel to deviate from the above SOG or project-specific requirements will be recorded. Documentation for recorded data must include a minimum of the following:

- Name or initials of person collecting the samples
- Sample identification/station location
- Date and time of sample collection
- Environmental conditions (e.g. wind, weather)
- Comments/observations
- Photographic documentation of unusual or unidentified species.

Photographic documentation of observed general conditions is also desirable.

GIS data may also require addition of metadata prior to finalizing the project geodatabase.

## GUIDELINES FOR MEASUREMENT OF SPECIFIC CONDUCTANCE

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine calibration and operation of a variety of specific conductance meters. This SOG document also addresses estimation of total dissolved solids (TDS) and salinity by direct measurement of specific conductance (specific methods and capabilities for these parameters are outlined in the manufacturer's individual instrument manuals). This SOG is designed to be consistent with EPA Method 120.1 and Standard Method 2510 B which address specific conductance measurements of drinking, surface, and saline waters, domestic and industrial wastes, and acid rain.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory analyses.

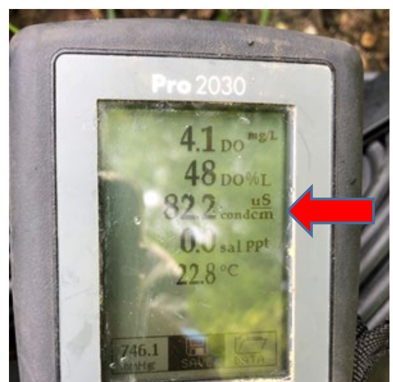
## 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.
- The analyst is responsible for verifying that the specific conductance meter is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Specific conductance meter
- Specific conductance meter manufacturer's instruction manual
- Deionized water
- Conductivity standard at concentration that approximates anticipated range of sample concentrations
- Lint-free tissues
- Calibration sheets or logbook
- Laboratory or field data sheets or logbooks




*Handheld YSI 2030 meter, red arrow showing where the specific conductance is measured*

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

- Specific conductance measurements should be taken in situ or soon after sample collection since temperature changes, precipitation reactions, and absorption of carbon from the air can affect the specific conductance. If specific conductance measurements cannot be taken immediately (within 24 hours), samples should be filtered through a 0.45 μm filter, stored at 4°C and analyzed within 28 days.
- Report results as specific conductance, μmhos/cm or μS/cm at 25°C.

- Secondary standards may be purchased as a solution from commercial vendors. These standards should not be used after their expiration dates as provided by the manufacturer. An expiration date of one year from date of purchase should be used if the expiration date is worn or missing.

## 4.2. Calibration and Measurement Procedures

- The specific conductance meter must be calibrated (or the calibration checked) before any analyses are performed.
- Set up the instrument according to the manufacturer's instructions.
- Rinse the probe with deionized water prior to use. If necessary, dry with a lint-free tissue or cloth.
- Follow the manufacturer's recommendations for appropriate calibration receptacle and depth of immersion.
- Record the stabilized specific conductance reading of the standard and the temperature. Enter the calibration mode (according to manufacturer's instructions) and change the value on the primary display to match the value of the calibration standard. The meter may be adjusted to ±20% from the default setting. If the measurement differs by more than ±20%, the probe should be cleaned, serviced, or replaced as needed.
- An additional check may be performed, if required by the project plan, by placing the probe into an additional standard. This standard should be from a different source than the standard used for the initial calibration. This standard should read within 5% of the true value.

*Use of YSI handheld device and probe*

- Verify the calibration at least once a month or whenever the instrument has been moved from freshwater to saltwater environments or vice versa. Recalibrate or service the instrument, as needed, if the check value is not within 15% of the true (calibration standard) value.

### 4.3. Troubleshooting Information

If there are any performance problems with any of the specific conductance meters which result in inability to achieve the acceptance criteria presented in Section 5.0 or the project-specific acceptance criteria, consult the appropriate section of the meter instruction manual for troubleshooting procedures. If the problem persists, consult the manufacturer's customer service department immediately for further guidance.

### 4.4. Maintenance

- Instrument maintenance should be performed according to the procedures and frequencies required by the manufacturer.
- The probe must be stored and maintained according to the manufacturer's instructions.

## 5.0 QUALITY CONTROL

- The meter must be calibrated (or the calibration checked) before sampling, and will not be used for sample determinations of specific conductance unless the initial check standard value is within 5% of the true value.

- Duplicate measurements of a single sample will be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within 10%.

## 6.0 DOCUMENTATION

- Meter calibration, temperature check, and maintenance information will be recorded in a calibration log. Specific conductance data may be recorded on the appropriate laboratory or field data sheets or logbooks.
- Calibration documentation should be maintained in a thorough and consistent manner. At a minimum, the following information should be recorded:
  - Date and time of calibration
  - Person performing the measurement
  - Instrument identification number/model
  - Expiration dates and batch numbers for all standards
  - Reading for standard before and after meter adjustment
  - Readings for all continuing calibration checks
  - Temperature of standards (corrected for any difference with reference thermometer)
  - Comments
- Documentation for recorded data must include a minimum of the following:
  - Date and time of analysis
  - Person performing the measurement
  - Sample identification/station location
  - Temperature (corrected for any difference with reference thermometer) and conductance of sample (including units and duplicate measurements).
  - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform specific conductance measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

Certain state certification programs require that specific conductance measurements be taken in the field by, or in the presence of, personnel that are qualified under the certification program.

GUIDELINES FOR MEASUREMENT OF DISSOLVED OXYGEN

# 1.0 INTRODUCTION

## 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine measurement of dissolved oxygen using a polarographic sensor-equipped dissolved oxygen meter with a digital read-out (e.g., YSI Pro2030 Dissolved Oxygen, Conductivity, Salinity Instrument). Measurements are made in accordance with methods that address dissolved oxygen measurement of drinking, surface, and saline waters, and domestic and industrial wastes.

## 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory measurements.

# 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.
- The analyst is responsible for verifying that the dissolved oxygen measuring device is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.


*Handheld YSI 2030 meter, Red arrow showing were the dissolved oxygen is measured*

# 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Dissolved oxygen meter with digital read-out device
- Manufacturer's instruction manual for the instrument
- Manufacturer's recommended operating solution and replacement membranes or caps
- Laboratory or field data sheets or logbooks

# 4.0 METHODS

## 4.1 Sample Handling, Preservation, and General Measurement Procedures

To achieve accurate dissolved oxygen measurements, samples should be analyzed in situ. Measurements in flowing waters should be made in relatively turbulent free areas. Measurements in standing waters may require gentle probe agitation to create water movement around the probe (check instrument manual to confirm).

## 4.2. Calibration and Measurement Procedures

To accurately calibrate some dissolved oxygen meters, it may be necessary to know the altitude of the region in which you are located and the approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has an approximate salinity of 35 practical salinity units (psu). If uncertain, measure salinity first with an appropriate device. The instructions below are applicable to the YSI Model 55; for other instruments, consult the instruction manual.

- Ensure that the sponge inside the instrument's calibration chamber is wet then insert the probe into the chamber. Turn the instrument on and wait for readings to stabilize (as long as 15 minutes, depending on the model).
- To calibrate, enter the calibration menu by pressing and releasing both the up and down arrow keys at the same time. Enter the altitude (in hundreds of feet) at the prompt by using the arrow keys to increase or decrease the altitude (example: 12 = 1,200 feet). Press enter when correct altitude is shown.
- The meter should display CAL in the lower left of the display with the calibration value in the lower right of the display and the current D.O. reading (before calibration) should be on the main display. Once the D.O. reading is stable, press ENTER. Enter the salinity at the prompt by using the arrow keys. Press ENTER when finished and the instrument will return to normal operation.
- Calibration should be performed at a temperature within ± 10°C of the sample temperature. Recalibrate every 15 samples and whenever the unit is turned on.
- If calibration is out of range, erratic readings occur, bubbles appear, or if the membrane becomes damaged, wrinkled, or fouled refill the membrane solution and/or replace the membrane, per the manufacturer's manual.

*Use of YSI handheld device and probe*

- Avoid contact with environments containing substances that may attack the probe materials (e.g. acids, caustics, and strong solvents).

### 4.3. Troubleshooting Information

If there are any performance problems with the dissolved oxygen-measuring device, consult the appropriate section of the instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

### 4.4. Maintenance

Instrument maintenance for meter-type dissolved oxygen measuring devices should be performed according to the procedures and frequencies required by the manufacturer. Rinsing the probe with distilled or deionized water and preventing exposure of the membrane to drying is typically all that is required on a day-to-day basis.

## 5.0 QUALITY CONTROL

Duplicate measurements of a single sample should be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within ± 0.2 mg/L.

## 6.0 DOCUMENTATION

All dissolved oxygen meter calibration, checks, and maintenance information will be recorded in a calibration logbook. Dissolved oxygen data may be recorded on the appropriate field data sheets or field books.

- Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:
  - Date and time of calibration
  - Person performing the measurement
  - Instrument identification number/model
  - Readings for all continuing calibration checks
  - Comments
- Documentation for recorded data must include a minimum of the following:
  - Date and time of analysis
  - Person performing the measurement
  - Sample identification/station location
  - Dissolved oxygen, both in mg/L and percent saturation and temperature of sample (including units and duplicate measurements)
  - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform dissolved oxygen measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

Certain state certification programs require that dissolved oxygen measurements in the field be taken by, or in the presence of, personnel that are qualified under the certification program.

# GUIDELINES FOR MEASUREMENT OF PH

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine calibration and operation of a variety of pH field pens. Although these meters may measure additional parameters (e.g., temperature, specific conductance, etc.), this SOG addresses pH measurement only (other capabilities are outlined in the appropriate SOG and manufacturer's individual instrument manuals). This SOG is designed specifically for the measurement of pH in accordance with EPA Method 150.1 and Standard Method 4500-H B which address electrometric pH measurements of drinking, surface, and saline waters, domestic and industrial wastes, and acid rain.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory analyses.

## 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.
- The analyst is responsible for verifying that the pH meter is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

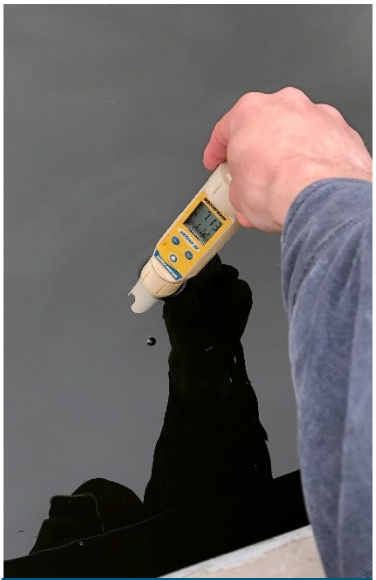
The following materials are necessary for this procedure:

- pH meter
- pH meter manufacturer's instruction manual
- Deionized or distilled water
- 4.0, 7.0, and 10.0 buffer solutions
- Lint-free tissues
- Mild detergent
- Manufacturer’s recommended storage solution
- Manufacturer’s recommended cleaning solution
- Field data sheet or logbook
- Calibration sheet or logbook

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

- To achieve accurate pH measurements, samples should be analyzed immediately in the field, or as soon as possible after collection. Sample should be measured *in situ* or collected in plastic or glass containers.
- As temperature can affect the pH measurements obtained, both the pH and the temperature of the sample must be recorded, unless the meter is capable of automatic temperature correction (ATC).
- Primary standard buffer salts available from NIST can be purchased and are necessary for situations where extreme accuracy is required. Secondary standard buffers may be purchased as a solution from commercial vendors and are recommended for routine use. Buffers should not be used after their expiration dates as provided by the manufacturer. An expiration date of one year should be used if the manufacturer does not supply an expiration date or if the buffers are prepared from pH powder pillows, etc.
- Keep the probe elevated off the bottom to avoid disturbing sediments. Allow readings to fully stabilize before recording the pH measurement. This may take several minutes, especially if the pH is drastically different from the last reading or the bulb has been allowed to dry out between readings.
- Rinse the electrode with deionized or distilled water between samples and wipe gently, if needed, with a lint-free tissue. If a more thorough cleaning is required, use a mild detergent (e.g., dish soap) or the manufacturer's recommended cleaning solution.



*Handheld pH meter*

- Store the probe in the manufacturer's recommended storage solution or, if this is not available, tap water. Do not use distilled or deionized water for storage purposes.

### 4.2. Calibration and Measurement Procedures

- The pH meter should be checked weekly before any analyses are performed. Otherwise, the meter should be checked or calibrated at the frequency specified in the project plan.
- Calibration should include a minimum of one point but ideally, a two point calibration that brackets the expected pH of the samples to be measured is desirable. Calibration measurements should be recorded in the calibration logbook.
- Choose either 7.0 and 10.0 (high range) or 4.0 and 7.0 (low range) buffers, whichever will bracket the expected sample range. Pour each buffer into a clean glass beaker. The volume should be sufficient to fully submerse the pH bulb and thermistor. If the pH is being measured in a laboratory, place the beaker on the magnetic stirrer and place the stirring bar in the beaker. Measure and record the temperatures of the buffers using a calibrated thermometer or automatic temperature compensation (ATC).
- Follow the manufacturer's calibration instructions.
- Once calibration is complete, discard the buffer and rinse the beaker (and stirring bar, if used) thoroughly with distilled or deionized water.

- An additional check may be performed, if required by the project plan, by placing the electrode into an additional buffer solution. This buffer should be from a different source than the buffers used for the initial calibration. This buffer should read within ±0.2 pH units of the buffer's true pH value.
- Recalibrate the instrument if any of the following apply:
  - the check value varies more than 0.2 pH units from the true value
  - the expected pH of the sampled water body is outside the current calibration range
  - readings are erratic or do not stabilize
  - the instrument has just been cleaned or otherwise disturbed for maintenance

### 4.3. Troubleshooting Information

If there are any instrument performance problems that result in the inability to achieve the acceptance criteria presented in Section 5.0, consult the appropriate section of the meter instruction manual for troubleshooting procedures. If the problem persists, consult the manufacturer's customer service department immediately for further guidance.

### 4.4. Maintenance

- Instrument maintenance should be performed according to the procedures and frequencies required by the manufacturer.
- The electrode should be stored and maintained according to the manufacturer's instructions.

## 5.0 QUALITY CONTROL

- Duplicate measurements of a single sample will be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within ±0.2 pH units.

## 6.0 DOCUMENTATION

- All pH meter calibration, temperature check, and maintenance information will be recorded in a calibration logbook.
- pH data may be recorded on the appropriate laboratory or field data sheets or logbooks.
- Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:
  - Date and time of calibration
  - Person performing the measurement
  - Instrument identification number/model
  - Expiration dates and batch numbers for all buffer solutions
  - Reading for pH 7.0 buffer before and after meter adjustment
  - Reading for pH 4.0 or 10.0 buffer before and after meter adjustment
  - Readings for all continuing calibration checks
  - Temperature of buffers (corrected for any difference with reference thermometer), including units
  - Comments

- Documentation for recorded data must include a minimum of the following:
    - Date and time of analysis
    - Person performing the measurement
    - Sample identification/station location
    - Temperature and pH of sample (including units and duplicate measurements)
    - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform pH measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

# GUIDELINES FOR MEASURING STREAMFLOW

## 1.0 INTRODUCTION

These guidelines provide instructions for the field measurement of flow rate in bodies of running water.

Descriptions of two field techniques are provided.

The first, called the time of travel method, is simple and does not require expensive or specialized equipment. This is most appropriate for rapid streamflow assessments where order of magnitude accuracy is acceptable or water depth is too low for the accurate measurement using a velocity meter.

The second method requires the use of a current meter, which is the preferred method where discharge measurements are being used to develop at-a-station rating curves and water depth is sufficient for measurement.

Additionally, these guidelines provide This method of calculating streamflow involves determining the cross-sectional area of the stream and measuring the average time it takes for a neutrally buoyant object to travel a known distance.

## 2.0 REQUIRED MATERIALS

The following materials are necessary for the measuring streamflow:

- Measuring stick to measure stream depth (folding stick is recommended)
- Flexible tape measure (longer than the width of the stream)
- Field data sheet, logbook, or tablet with electronic data sheet

If using a velocity meter, the following additional materials are also required:

- Swoffer Model 2100 current velocity meter (or similar)
- Calibrated wading rod

If using the time of travel method, the following additional materials are also required.

- A neutrally buoyant float
- Stopwatch (built-in app on most smartphones)
- Net (to catch the float)

## 3.0 METHODS

### 3.1 Choosing a Cross Section

*Measuring stream depth using a folding yard stick.*

- Select an appropriate stream cross section. The location selected should be straight (no bends), and free of obstructions. Unobstructed runs are ideal.

- Identify the left and right banks of the stream. When working in streams, left and right are relative to the mean flow direction. Therefore, the left bank will be to one's left when facing downstream but to one's right when facing upstream.

- To assure consistency of measurements and allow for easier comparison of data across time, flow should be measured at the same cross section of the stream during all visits. Include descriptions of site landmarks in field notes, and/or take photos of measurement locations. If site conditions allow, install permanent cross section markers, such as stakes or rebar.

- If a staff gauge is present near the stream measurement location, record the staff gauge depth during each visit.

### 3.2. Divide the Channel into Subsections

- Establish a transect by stretching the measuring tape across the stream, perpendicular to the channel axis. Secure each end of the tape to the stream banks so that the tape is taut.

- Take a minimum of four photographs, including one each facing upstream, the left bank, downstream, and the right bank.

- Starting with the left edge of water, measure width and stream depth at no less than three locations (stations) within the steam channel. This is the minimum number of stations and most streams will require more than three measurements to accurately calculate discharge.

- The area between each vertical station represents a channel subsection.

### 3.3. Measuring Velocity

#### 3.3.1 Time-of-Travel Method

- To measure travel time, time how long it takes for a neutrally buoyant object (a float) to travel a known distance. Suitable objects should float, but sit very low in the water to minimize influence from wind, and can be untethered or tethered (methods adapted from EPA, 2012a described below).

- Suitable floats include:
    - citrus fruits or pieces of citrus peel
    - cheese puffs
    - small sponge rubber balls
    - small sticks or bits of vegetation
- Always face upstream when taking velocity measurements. Stand far enough downstream that stream velocity is not affected in the location being measured.
- Surface velocity is generally greater than depth-averaged velocity, so a correction factor (0.8 for rocky-bottom streams, 0.9 for muddy-bottom streams) is applied to float travel times (see Section 3.3, EPA 2012b)
- Untethered floats should be biodegradable, or a second person equipped with a net should be stationed downstream of the sampling reach to retrieve the float(s).
- Hold the measuring stick above the water surface, perpendicular to the cross section. Release the untethered float somewhat upstream of the end of the measuring stick to allow the float to reach full flow velocity. Using a stopwatch, time how long it takes for the float to travel a known distance (3 ft is recommended for most streams but longer distances may be appropriate where velocity is high). Repeat this process three times to obtain an average time to travel at one station before proceeding to the next station.

### 3.3.2 Depth-Averaged Current Meter Method

- Set the current meter to average measurements over at least a three second period. Longer periods may be used if appropriate to conditions.
- Always face upstream when taking velocity measurements. Stand far enough downstream that stream velocity is not affected in the location being measured.
- Carefully place the wading rod in the flow until the base is firmly on the stream bottom.
- Orient the current meter perpendicular to the cross section transect.
- Ensure that the wading rod is straight up and down (not angled).
- Hold the wading rod steady while adjusting the calibrated height of current meter to match the measured depth. This will allow collection of measurements that are reflective of depth-averaged velocity.
- Once at least three seconds have passed, view the reading from the current meter. Allow at least three readings to occur before recording. This will prevent erroneous data due to averaging of measurements from the set up process.

## 3.4. Calculating Flow

- The following equation is used to calculate flow using the time-of-travel method):

$$Q = (ACL)/T$$

  - Q = stream discharge
  - A = cross sectional area
  - L = distance traveled by the float
  - C = correction factor (0.8 for rough streambeds, 0.9 for smooth streambeds)
  - T = average time of travel (seconds)

The following equation is used to calculate flow using the depth-averaged current meter method:

$$Q = AV$$

  - Q = stream discharge
  - A = cross sectional area
  - V = velocity at 60% depth

## 4.0 DOCUMENTATION

Record streamflow data on field sheets, field notebooks, or electronic tablets. Any unanticipated site-specific information, which requires deviation from the above guidelines should also be recorded. In addition to recording the required discharge data, field notes for streamflow measurement should include a minimum of the following:

- Name or initials of person conducting the measurement
- Discharge measurement method used
- Site ID or name
- Date and time of streamflow measurement
- Environmental conditions (wind, temperature, etc.)
- Other relevant observations about site conditions
- Photographic evidence of streamflow and site conditions is also useful for verification of relative stream stage and flow from different visits, as well as any environmental factors that may have influenced data collection.

## 5.0 REFERENCES

EPA, 2012a. Water: Monitoring and Assessment. 5.1 Stream Flow. United States Environmental Protection Agency. Office of Water. EPA 841-B-97-003. Accessed January 27, 2020 at https://archive.epa.gov/water/archive/web/html/vms51.html

EPA, 2012b. SESD Operating Procedure, Hydrologic Studies. Effective Date November 1, 2012. United States Environmental Protection Agency. Office of Water. SESDPROC-501-R3. Accessed January 27, 2020 at https://www.epa.gov/sites/production/files/2015-06/documents/Hydrological-Studies.pdf

## GUIDELINES FOR COLLECTION OF SURFACE WATER SAMPLES

### 1.0 INTRODUCTION

These guidelines provide basic instructions for the routine acquisition of surface water from lakes, ponds, and streams. The methods outlined below are intended to (1) standardize water sample collection methods; (2) ensure that samples delivered to the laboratory represent field conditions as accurately as possible; (3) assure proper documentation of sample collection; and (4) minimize cross contamination between sampling sites.

### 2.0 REQUIRED MATERIALS

The following materials are necessary for the acquisition of surface water samples:

- Nitrile gloves
- Labeled sample bottles provided by contracted laboratory (appropriately sanitized and containing the necessary preservative for desired analyses, see Table 1.0 for examples)
- Field data sheets or logbooks, including list of sites or locations to be sampled, and pencil
- Cooler with ice packs for sample storage
- Integrated depth sampler (if collecting algae sample)
- Secchi disk (if collecting algae samples)
- Laboratory Chain of Custody

**Table 1.0 Example Container Types, Preservative Requirements, and Hold Times for Water Quality Samples.**

| Analysis | Bottle Type | Preservative | Hold Time |
|---|---|---|---|
| Total Phosphorus | plastic | $H_2SO_4$ | 28 days |
| Dissolved Phosphorus | plastic | As Is | analyze immediately* |
| Total Suspended Solids (TSS) | plastic | As Is | 7 days |
| Nitrate/Nitrite | plastic | As Is | 48 hrs |
| Total Kjeldahl Nitrogen (TKN) | plastic | $H_2SO_4$ | 28 days |
| Metals - Total | plastic | $HNO_3$ | 6 months** |
| Metals - Dissolved | plastic | As Is | 6 months** |
| Algae | opaque plastic | Lugol's iodine | >1 year |
| Chlorophyll-a | opaque plastic | As Is | analyze immediately |
| Bacteria | sterile plastic | As Is | 6 hrs |

* = 24 hrs with field filtration, ** = 28 days for mercury

## 3.0 METHODS

### 3.1 General Sampling Instructions

Using a pre-cleaned (as is) bottle to fill a sample bottle containing preservative.

- Testing methods, sample containers, preservation techniques, and sample volumes should be selected in consultation with the laboratory to ensure that samples obtained will provide the desired results.

- Hold times vary considerably between different analytes and must be taken into consideration when planning field sampling efforts and lab courier pickups to assure the validity of analytical results.

- Field filtration of certain samples (dissolved phosphorus) is recommended. The laboratory can supply syringes and filters for use in the field.

- In general, surface water samples should be collected via direct grab methods.

- Sample collection should precede the measurement of physical field parameters (including pH, apparent color, turbidity, conductivity, and dissolved oxygen) in order to minimize the risk of sediment disturbance and/or sample contamination.

- Clean rubber gloves should be worn at each sampling location. When sampling multiple sites on the same day, gloves may be rinsed in the immediate area of the waterbody to be sampled (downstream at flowing sites).

- Approximately 1-inch of air space should be left when filling sample bottles (except for dissolved oxygen, alkalinity, and BOD samples), so that bottles may be shaken (if needed) before analyses (EPA, 1997; Simpson 1991).

- Sample containers with preservatives should not be used to collect water samples. If using containers with preservatives, a pre-cleaned container of similar type (an as is bottle) should be used to collect and subsequently transfer the sample to the preserved container.

- Ensure that all sample bottles are correctly and completely labeled before storage. Sample bottles should be stored in a cooler with ice packs (it is best to avoid ice, as meltwater could potentially contaminate samples) or in a refrigerator until they are submitted to a lab courier.

### 3.1.1. Lake and Pond Sampling

- Grab samples from lakes and ponds should be collected at approximately 8 to 12 inches beneath the water surface or mid-way between the surface and the bottom if the waterbody is shallow (EPA 1997). Samples should not be collected in close proximity to the lake shoreline or submerged obstacles.

- To collect water samples, hold an as is bottle near the base, remove the lid, and plunge it into the water with the opening facing downward. Invert the bottle and allow it to fill before bringing it to the surface. Decant sufficient water from the bottle to allow for the required headspace and replace the cover, or carefully pour the contents into a bottle containing preservative. Repeat the above process to refill the as is bottle as many times as necessary.

**Algae Samples**

*Integrated depth sampler for collection of algae samples.*

- Algae samples should be stored in opaque bottles with a small amount of Lugol's iodine for preservative (~1-2 drops in a 250 mL bottle). Algal taxonomy labs can provide opaque plastic bottles, but standard plastic as is bottles covered in aluminum foil can also be used.

- Algae samples should be collected using an integrated depth sampler. An integrated depth sampler consists of a length of tubing (~1in diameter, at least 2 m long) with a weight attached to one end. Sample collection procedures using the depth sampler should proceeds as follows (procedure adapted from EPA 2012):

  - Determine the euphotic zone:

    - Lower the secchi disk over the shaded side of the boat until it disappears. Lower the disk a bit further, then slowly raise the disk until it reappears. Record the reappearance depth. The euphotic zone is calculated by multiplying the reappearance depth by 2.

  - Holding onto the non-weighted end of the sampler, lower the tube into the water column. Rinse the sampler by submerging it three times.

  - Lower the sampler so that it is submerged to the depth of the euphotic zone, or fully submerged if the euphotic zone is deeper than the length of the sampler. Cover the opening at the non-weighted end with a gloved thumb.

- Lift the sampler completely out of the water and cover the opening at the weighted end with a gloved thumb (both ends should be covered). Repeatedly lift each end of the sampler to mix the water sample within the tube.
- Fill the algae sample bottle with the required volume of water from the sampler (the bottle will contain Lugol's solution as preservative so be careful not to over-fill).
- Unlike samples for most other analytes, preserved algae samples can be stored at room temperature before submission to a lab.

### 3.1.2. Stream Sampling

- Samples should be collected from the center of small streams (i.e., 10-20 feet wide with a maximum depth of less than 2 feet), and at a location where water depth is 2-3 feet in larger streams.
- Always approach a sampling location from downstream, traveling so as to minimize the disturbance of bottom sediments and upstream waters.
- Stand downstream of the desired sampling location, hold the sample bottle near its base and plunge it below the water surface with the opening (mouth) downward. The opening of sample bottles should always be directed away from the sampler in an upstream direction.
- To inform investigations about nutrient inputs, stream flow should be measured whenever water quality samples are collected (see Guidelines for Measuring Stream Flow)

## 4.0 DOCUMENTATION

Report surface water field data on sheets or in notebooks. Any unanticipated site-specific information, which requires deviation from the above guidelines, should be recorded. Field notes for surface water sampling should include a minimum of the following:

- Name or initials of person collecting the samples
- Sample identification/station location
- Date and time of sample collection
- Environmental conditions (e.g. wind, weather)
- Other comments or observations about water quality and site conditions (e.g. visible algae bloom, dead fish nearby, sample has noticeable odor or color, etc.)

Photographic evidence of any notable conditions is also desirable.

## 5.0 REFERENCES

EPA, 2012. 2012 National Lakes Assessment Field Operations Manual. Version 1.0, May 15, 2012. United States Environmental Protection Agency. Office of Water. EPA-841-B-11-003. Accessed January 22, 2020 at https://www.epa.gov/sites/production/files/2013-11/documents/nla2012_fieldoperationsmanual_120517_final_combinedqrg.pdf

# GUIDELINES FOR MEASURING GROUNDWATER SEEPAGE QUANTITY AND QUALITY

## 1.0 INTRODUCTION

These Standard Operating Guidelines (SOG) provide basic instructions for the routine measurement of groundwater seepage quality and quantity. These standard methods describe the proper installation of seepage meters and the operation of Littoral Interstitial Porewater (LIP) samplers.

## 2.0 REQUIRED MATERIALS

The following materials are necessary for the seepage meter installation procedure:

- Seepage meters of known diameter
- Plastic tubing with one hole stopper
- Seepage bags with one hole stoppers and plastic clamps
- 250 mL graduated cylinder
- Field book or data sheets

The following materials are necessary for the collection of groundwater samples for analysis:

- Hand pump
- 2-1 L filter flasks with stoppers and tubing
- Littoral Interstitial Porewater (LIP) sampler
- Sample bottles with labels

## 3.0 METHODS

### 3.1 Seepage Meter Installation

- Initially, representative segments of the shoreline, where seepage meters will be positioned, are selected based on topography and housing density. Such segments may also be assigned to shoreline locations based on specific project objectives.

- ESS personnel shall estimate seepage quantity by installing two seepage meters per defined shoreline segment and measuring the change in volume in the attached seepage bag over time. Change in volume multiplied by a conversion factor relating the allotted seepage time (i.e., fraction of the day for which the seepage meter was running) and then adjusting to unit area (square meter), yields the liters of inseepage (positive value) or outseepage (negative value) per square meter per day.

- Seepage meters shall be firmly embedded in the substrate to depth of greater than 4 inches. Inserting seepage meters to this preferred depth will ensure that volumetric changes observed in the attached seepage bags are truly representative of groundwater flows and will increase the likelihood that seepage meters will not be disrupted by strong currents or wave action.

- At each designated shoreline location (segments pre-determined by project plan), one seepage meter should be placed at a relatively shallow depth and one at a deeper depth in order to capture ground water flows that may be occurring in different strata.

- Seepage meters must be allowed to equilibrate for a minimum of 5 minutes before the system is “closed” by the attachment of the seepage bags.

- The seepage bag should be filled with an appropriate pre-measured volume of water. In most instances 250 mL will be appropriate. The pre-determined volume of water is necessary since this volume is compared to the volume obtained after sufficient time has elapsed to quantify the change in volume (either positive or negative).

- Seepage bags are to be secured in place with as little disturbance of the seepage meter as possible. The best approach is to slowly twist the seepage bag's rubber stopper into the hole of the seepage meter.

- Prior to use, seepage bags must be air dried in order to ensure that all residual water is removed from bags and therefore will not confound the change in volume measurements. Additionally, each bag and associated stopper must be visually inspected and air pressure tested prior to each use to ensure that no leakage can occur.

### 3.2. Groundwater Sampling Using Littoral Interstitial Porewater Sampler

- Groundwater seepage quality can be collected through sampling with a Littoral Interstitial Porewater (LIP) sampler. A hand pump, attached to a 250 ml HDPE plastic flask, creates a low-pressure vacuum causing water to flow from the LIP sampler into the attached plastic flask. To avoid accidental contact of the extracted water with the hand pump, a second plastic flask should be connected in-line using additional tubing.

- Porewater should be extracted from a minimum of three locations in each segment and composited using equal volumes from each location.

- Samples collected may be tested in the field for parameters such as, temperature, conductivity, and pH, and/or transferred into labeled bottles and sent to a laboratory for the other analyses.

## 4.0 DOCUMENTATION

Record data on field sheets, field notebooks, or electronic tablets. Any unanticipated site-specific information, which requires deviation from the above guidelines should also be recorded. Documentation should include a minimum of the following:

- Name or initials of person conducting the measurement
- Date
- Site ID or name
- Size of seepage meter (diameter)
- Time of seepage meter installation
- Time of seepage meter retrieval
- Volume of water added to seepage meter bag at installation
- Volume of water remaining in seepage meter bag at retrieval
- Results of in-lake and extracted groundwater field parameter measurements (temperature, pH, and specific conductance at a minimum)
- Environmental conditions (wind, temperature, etc.) and other relevant observations about site conditions
- Photographic evidence of conditions

## GUIDELINES FOR THE MEASUREMENT OF TURBIDITY

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine measurement of turbidity using a nephelometric turbidity meter with a digital read-out device (e.g., LaMotte 2020we Turbidimeter). Measurements are made in accordance with EPA Method 180.1 that addresses nephelometeric turbidity measurement of drinking, surface, and saline waters, and domestic and industrial wastes.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory measurements.

## 2.0 RESPONSIBILITIES

- The analyst is responsible for verifying that the turbidity measuring device is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.
- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Turbidity meter with digital read-out device
- Manufacturer's instruction manual for the instrument
- Turbidity tubes/cuvettes
- Mild detergent
- Lint-free cloth
- Distilled water
- Nephelometric Turbidity Unit (NTU) calibration standards
- Laboratory or field data sheets or logbooks


*Example of a sample cuvette*

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

To achieve accurate turbidity measurements, samples should be analyzed immediately upon collection (preferably within 15 minutes). Samples should be collected in glass or plastic containers.

### 4.2. Calibration and Measurement Procedures

- Select a turbidity standard in the range of the samples to be tested (typically 0.00 NTU, 1.00 NTU or 10.0 NTU) or as recommended by the manufacturer. Fill a turbidity tube or cuvette with the standard, cap, and wipe the tube with the clean lint-free cloth.

- Place the sample into the turbidity meter such that the indexing arrow or line on the turbidity tube is aligned with the indexing arrow or notch on the meter face. Close the lid and press the "READ" button. If the displayed value is not the same as the value of the standard (within 10%), continue with the calibration procedure.
- Follow the calibration procedures outlined by the manufacturer's manual.
- Verify the calibration every 15 samples and at the end of the day. Recalibrate the instrument if the check value varies more than 10% from the true value.
- Rinse cuvettes with deionized or distilled water and wiped gently with a lint-free tissue between sample analysis.
- Recalibrate the instrument with the appropriate NTU standard if the standard is not of the same order of magnitude as the samples being tested.
- The meter must be re-calibrated following any maintenance activities and prior to the next use.
- Record the turbidity reading to the nearest 0.01 NTU for measurements less than 11 NTU and to the nearest 0.1 for measurements greater than 11 NTU but less than 110 NTU. For values greater than 110 NTU record to the nearest 1 NTU.

*Turbidity meter*

### 4.3. Troubleshooting Information

If there are any performance problems with any of the meter-type turbidity measuring devices, consult the appropriate section of the meter instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

### 4.4. Maintenance

Instrument maintenance for meter-type turbidity measuring devices should be performed according to the procedures and frequencies required by the manufacturer.

## 5.0 QUALITY CONTROL

The turbidity measuring tubes will, at a minimum, be checked against NTU calibration standards at the frequency stated in Section 4.2. This verification procedure will be performed in accordance with the manufacturer's manual.

Duplicate measurements of a single sample will be performed at the frequency required in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within + 5% for readings below 10 NTU and + 10% for readings above 100 NTU.

## 6.0 DOCUMENTATION

All turbidity meter calibration, checks, and maintenance information will be recorded on the daily calibration sheet or logbook. Turbidity data may be recorded on the appropriate laboratory or field data sheets or logbooks.

Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:

- Date and time of calibration
- Person performing the measurement
- Instrument identification number/model
- Expiration dates and batch numbers for all standard solutions
- Reading for each standard before and after meter adjustment
- Readings for all continuing calibration checks
- Comments

Documentation for recorded data must include a minimum of the following:

- Date and time of analysis
- Person performing the measurement
- Sample identification/station location
- Turbidity of sample (including units and any duplicate measurements)
- Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform turbidity measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

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## GUIDELINES FOR USE OF WATER LEVEL DATALOGGERS IN SURFACE WATER

## 1.0 INTRODUCTION

These guidelines provide basic instructions for programming, deploying and downloading data from electronic dataloggers which are used for long-term water level monitoring and monitoring of other water quality parameters (e.g., temperature, conductivity). The methods outlined below are intended to (1) standardize datalogger monitoring of water levels; (2) ensure that data collected represent field conditions as accurately as possible; (3) provide guidance for the secure transfer and storage of data; and (4) assure proper field measurements and documentation.

## 2.0 REQUIRED MATERIALS

The following materials are necessary:

- Datalogger or Barologger
- Rebar, metal fence post or similar
- Sledgehammer or post driver
- Computer, laptop or tablet
- Communications device
- Datalogger software
- PVC housing and hose clamps
- Braided nylon twine or wire
- Water level monitoring device (electronic water level meter, plunker, etc.)
- Tools

## 3.0 PROGRAMMING THE DATALOGGER

The following general procedure is followed to edit the datalogger information and program the datalogger to collect readings. Always refer to the manufacturer's instructions for datalogger programming, deployment and data downloading and correction instructions.

If the datalogger is unvented, a second datalogger or Barologger will also need to be deployed to collect barometric pressure readings to support the barometric pressure correction of the data downloaded from the unvented datalogger.

- Connect the datalogger or Barologger to the computer, laptop or tablet using the supplied communications device.
- Select the appropriate COM or USB port for the communications device.
- Open the logger programming or launching page to allow for entering the logger details and programming the device for frequency of readings.
- Check the datalogger battery life and available memory to verify that it is acceptable for the intended use. This information can also be used to determine the frequency of data downloads that will be necessary.
- Rename the datalogger using the Site location.

- Program the datalogger to collect readings for the selected parameters at the specified interval.
    - The additional datalogger or Barologger should be programmed to collect readings at the same interval.
- Disconnect the datalogger from the communications device using the software program to disengage or remove from the communications device.

## 4.0 DEPLOYING THE DATALOGGER

The following general procedure should be used to deploy the datalogger for collection of readings.

- An appropriate location for the installation of the datalogger should be selected within a deep portion of the water body to allow for fluctuations in the water level.
    - An additional datalogger or Barologger should be mounted in the air in an inconspicuous location such as a tree or attached to a building.
- In surface water, the datalogger should be deployed within a PVC housing, if possible, to help to dampen any fluctuations (e.g., wave action or turbulence) in the surface water surface.
- The PVC housing should be secured using hose clamps to a mounting post (typically either rebar, metal fence post or similar) that can be driven into the substrate beneath the water body.
- Prior to deployment, collect a depth to water measurement from the top of the mounting post (rebar, metal fence post or similar) and an approximate depth to the bottom of the PVC housing.
- Deploy the datalogger by placing inside the PVC housing, attaching either braided nylon twine or wire to the datalogger, and threading through the top of the PVC cap to allow for retrieval of the datalogger without disturbing the position of the PVC housing.

## 5.0 DOWNLOADING DATA

The following general procedure should be followed when downloading the data.

- Soon after deployment (typically within two weeks, or as soon as possible given project constraints), a verification download should be performed to verify that the datalogger was programmed correctly and is collecting data at the appropriate interval.
- Subsequent downloads can be scheduled as necessary taking into consideration the frequency of readings and the available memory and battery life of the datalogger.
- Prior to removing the datalogger to download the data, collect a depth to water measurement from the top of the mounting post or other acceptable measuring point.
- Remove the datalogger and connect to the communications device.
- Connect the communications device to the computer, laptop or tablet and open the software.
- Navigate to the data download page and proceed with downloading the collected data.

    - Certain datalogger software packages will require that the datalogging process be stopped and the datalogger will have to be reprogrammed prior to redeployment.

- If the datalogger is unvented, correct the downloaded data using the program supplied by the Vendor using the data collected from the additional datalogger or Barologger.

## 6.0 STREAMFLOW MEASUREMENTS

In order to convert the hydraulic head (pressure) measurements from the datalogger to streamflow, a series of streamflow measurements needs to be collected at varying stream stages or flow stages to support the development of a rating curve.

*REFER TO THE GUIDELINES FOR MEASURING STREAMFLOW SOP FOR DETAILS ON THE COLLECTION OF STREAMFLOW MEASUREMENTS AND DEVELOPMENT OF A RATING CURVE.*

## 7.0 DOCUMENTATION

Maintain field notes for the datalogger deployment and data download events including the collected field measurements that will be used to QC the data collected by the datalogger and convert the collected measurements to elevation, if applicable.

Photodocumentation of the datalogger deployment and setup should also be maintained as well as any observations during the field visits.

## 8.0 REFERENCES

Select references to Vendors that supply dataloggers are provided below.

Solinst, Levelogger Series Software User Guide, https://www.solinst.com/products/dataloggers-and-telemetry/3001-levelogger-series/operating-instructions/user-guide/3001-user-guide.php

In-Situ, Rugged Troll 100 and 200 and Rugged Troll BaroTroll Instruments, https://in-situ.com/pub/media/support/documents/Rugged_TROLL_Manual.pdf

Onset, HOBO U20L Water Level Logger (U20L-0x) User’s Manual, https://www.onsetcomp.com/support/manuals/u20l_17153/

## GUIDELINES FOR USE OF CYCLOPS-7 DATA LOGGER

### 1.0 INTRODUCTION

These guidelines provide basic instructions for programming, deploying and downloading data from Cyclops-7 data logger which is used for long-term monitoring of Chlorophyll-a and temperature. The methods outlined below are intended to (1) standardize datalogger monitoring; (2) ensure that data collected represent field conditions as accurately as possible; (3) provide guidance for the secure transfer and storage of data; and (4) assure proper field measurements and documentation.

### 2.0 REQUIRED MATERIALS

The following materials are necessary:

- Cyclops-7 Data Logger
- Computer with java script installed
- USB to micro-USB adapter
- Stainless steel shackle and zip-tie
- Turner Designs Rhodamine Dye, 400 ppb, 1L (P/N: 6500-120)
- Distilled water
- 1L Beaker

### 3.0 PROGRAMMING AND CALIBRATING THE DATALOGGER

The following general procedure is followed to edit the Cyclops-7 information and program the datalogger to collect readings. Always refer to the manufacturer's instructions for datalogger programming, deployment and data downloading and correction instructions.

- Plug cyclops into computer that contains Java Script.
- Open Cyc7Control.jar located here Y:\EEP General\Cyclops and other Sensors
- Adjust collection rate to desired frequency (EX: 1reading/60 min)
- Click "Connect"
- Use distilled water for baseline reading
- Transfer sensor to Rhodamine Dye solution
- Enter 400 and ppb into their respective boxes.
- Click "Calibrate"
- Follow prompts until calibration is complete.
- Disconnect the logger

### 4.0 DEPLOYING THE DATALOGGER

The following general procedure should be used to deploy the Cyclops-7 for collection of readings.

- Unscrew the waterproof housing and flip control switch from "halt" to "record".
- The logger should be shackled to a vinyl coated steel cable using a stainless-steel shackle locked with a zip-tie to prevent the loss of the logger.

## 5.0 DOWNLOADING DATA

The following general procedure should be followed when downloading the data.

- Upon retrieval of the logger, unscrew the waterproof housing and flip the control switch from “record” to “halt”.
- Plug Cyclops into a computer and transfer data to an appropriate file.
- If redeploying the cyclops, flip control switch to “record” before reattaching the waterproof housing.

## 6.0 DOCUMENTATION

Maintain field notes for the Cyclops-7 deployment. Always note deployment time and download time.

Photo documentation of the cyclops deployment and setup should also be maintained as well as any observations during the field visits.

## 7.0 REFERENCES

Rhodamine dye for calibration: https://www.turnerdesigns.com/product-page/400-ppb-rhodamine-wt

# Appendix B

# Public Comments on Draft SAP

**Summary of Public Comments Received on Silver Lake Water Quality Monitoring Program SAP**

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
|---|---|---|---|
| August 9 (Verbal) | Bernadette Kolb CDM Smith | Recommend the use of continuous dissolved oxygen dataloggers as part of the in-lake logger array. This is needed to determine dates and extent of anoxia in bottom waters of the lake. It will also be critical for modeling the release of phosphorus from sediments. | Sampling has been expanded to more than 12 months and will now extend throughout the growing season of 2022 for improved measurement of seasonal anoxia in bottom waters of the lake. See revised SAP and QAPP. |
| | | What is the detection limit for phosphorus? Based on existing data from lake, would recommend 0.001 mg/L to minimize the occurrence of non-detect results. If 0.001 mg/L cannot be achieved, then suggest at least 0.005 mg/L. | Addressed in Table 3 of the QAPP. |
| | | What are the analytes that will be used to determine the total nitrogen concentration? | see Section A6 of the QAPP. |
| | | Will total nitrogen and total phosphorus be tested in the groundwater samples? Would recommend collecting these in at least one groundwater sample to make sure you are not missing a substantial component of the nutrient load. | This comment is addressed in the QAPP. Ammonia, nitrate-nitrogen, and total soluble phosphorus will be analyzed for in-groundwater samples. Particulate phosphorus and nitrogen are not targets of groundwater sampling and would likely be biased high in these samples due to limitations of LIP screening. Therefore, only soluble fractions have been retained in the groundwater analysis. |
| August 9 (Verbal) | Jamal Braithwaite Brockton Resident | What is the expected timeline for reporting results? | Please see updated timeline in the revised SAP and QAPP. |
| | | What thresholds will be used to compare findings of the study? | Water quality parameters will be compared to standards at 314 CMR 4.0 and the MassDEP Comprehensive Assessment and Listing Methodology (2018) in a weight of evidence approach as well as other appropriate DPH guidelines. Results may also be compared to other local or regional datasets to provide additional context, as applicable. |
| August 9 (Verbal) | Pine duBois Jones River Watershed Association | Identified four comments provided via email by Brad Chase (Massachusetts Division of Marine Fisheries). [These comments were later submitted in writing and are presented elsewhere in this table] | |
| | | Plant mapping should not be confined to shallow waters. We find plants with stems as long as 30 feet in Silver Lake. | Approximately 350 survey locations will be used for plant mapping including locations with >30 feet deep. Please see QAPP for more detailed explanation. |
| | | Recommend sampling closer to the Brockton dam. | Additional in situ water quality measurements may be collected |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
|---|---|---|---|
| | | | at other locations on an opportunistic basis to assist in characterizing variability of water quality within Silver Lake. |
| | | Silver Lake bathymetry was previously mapped by Coler and Colantonio. JRWA can provide this map to ESS, which may be help save time and effort. | Thank you for providing the Coler and Colantonio data. Since this data is 18 years old it was decided to conduct a more recent bathymetric survey. |
| | | JRWA established a solar-powered flow monitoring station at the outlet of Silver Lake as part of the RIFLS program. Data from that may be helpful to this study. | Thank you for the information. |
| August 10 | Brad Chase Division of Marine Fisheries | Sampling Locations, Figure 2 (page 3). SLIL is the only in-lake station for Silver Lake. It appears to be close to the SL4 station used for the DMF/JRWA River herring habitat assessment. I recommend more than one in-lake station. The project could adopt SL2 to gain information on the hypolimnion at a different location in the lake that may allow modeling of anoxia/hypoxia. Or add a shallow water station next to the Monponsett diversion or Tubbs Meadow Brook outlet. | The sampling program has been designed to enable an internal phosphorus load analysis and water quality model to be calibrated. These tools will be used to evaluate management options to address water quality. Additional in situ water quality measurements may be collected at other locations on an opportunistic basis to assist in characterizing variability of water quality within Silver Lake. |
| | | Continuous Data Logging (page 7). The continuous logging calls for "one array will be located within 5 meters (16 feet) of the lake surface and the second array will be located within 16 feet of the sediment-water interface." It is not clear to me if the logging will begin at 5 m below the surface and continue to 5 m off the bottom. If so, it will be missing important locations in the water column. I recommend starting the sampling at close the surface and the bottom. We often use 0.3 m from the surface and 0.5 m from the bottom. I've seen others use 0.5 m for both or 1.0 m off the bottom. | Comment Noted: The vertical positions of the loggers have been better defined. Please see QAPP (continuous loggers section). The collection of continuous logger information will be coupled with discrete water column sampling at several depths to characterize in lake profiles. |
| | | Table B. Surface Water Quality Analytes (page 8). The protocol has sampling every meter for temp., DO and specific conductivity. Conductivity is generally stable in the water column. Water pH varies with carbonic acid, ammonia, and photosynthesis dynamics and can reflect on the health of the water body. I recommend switching pH for conductivity for sampling every meter. | Although planned for at least three positions in the water column during each visit, additional pH readings may be opportunistically added to bracket large vertical changes in the water column, as warranted based on field conditions. |
| | | Table C. Surface Water Quality Analytes and Parameters to Be Monitored from Diversions (East Monponsett and Furnace Ponds) (page 9). The nutrient sampling is intended to "improve the understanding of hydrologic and nutrient budgets". It is not clear if the sample sizes at the diversions (3 visits) and SLIL (6 | Sampling has been expanded to more than 12 months and will now extend throughout the growing season of 2022. See revised SAP and QAPP. |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
|---|---|---|---|
| | | visits) are adequate to quantify a lake nutrient budget. Consideration should be given to designing the suitable sample structure at the inlets and outlet to prepare nutrient loading and budget estimates. | |
| August 17 | Steve Hurley Division of Fisheries and Wildlife | Suggest more water quality of sampling of Monponsett and Furnace outside of the diversion window, at last one sample in September. This would help to better show the impaired quality of these waters compared to Silver Lake. | Sampling has been expanded to more than 12 months and will now extend throughout the growing season of 2022. See revised SAP and QAPP. |
| | | Groundwater quality may have a big impact on Silver Lake and the proposed plan seems pretty limited on this potential impact. I would recommend increasing the amount of groundwater monitoring to help capture where the major inputs of nutrients from groundwater occur. | Sampling has been expanded to include two events and an additional shoreline location. See revised SAP and QAPP . |
| | | Cyanobacteria is a big issue now on the Cape and other areas: https://apcc.org/our-work/science/community-science/cyanobacteria/<br><br>https://www.mass.gov/info-details/guidelines-for-cyanobacteria-in-freshwater-recreational-water-bodies<br><br>Besides the cyanotoxins, information should be included on cell abundance and species composition of cyanobacteria. | Phytoplankton (including cyanobacteria) ID and enumeration has been included in the monitoring plan. See revised SAP and QAPP. |
| August 18 | Brian Reid Science Director, Center for Ecosystem Research in Patagonia | Need more detail on parameter uncertainty, laboratory methods, and detection limits. | Please see the QAPP. |
| | | Sampling season is incomplete (less than 1 year) without surface water sampling or flow readings from the summer months. | Sampling period has been expanded to more than 12 months and will now extend throughout the growing season of 2022. |
| | | Maintenance of the water level sensors should be transferred to some local responsibility. | The CPCWDC has interest in working with volunteers and local monitoring groups to promote ongoing monitoring. |
| | | Source diversions should be characterized instead of the diversion events. | Addressed in SAP and QAPP. |
| | | Regarding the proposed surface water sampling of the three tributaries SLT1,2,3, it is not clear why sampling will be conducted at road crossings. Access to the stream-lake confluences is relatively simple, and water quality at the confluence is a better indicator of load to the lake. | Sampling locations have been adjusted based on accessibility and suitability following field reconnaissance. Stream locations were selected to avoid backwater impacts from Silver Lake and for suitability to measure both discharge and water quality. See revised SAP and QAPP. |
| August 18 | Pine duBois | I am providing some files and links that I hope are useful for your study. | Thank you for sharing this information. |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
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| | Jones River Watershed Association | [In SAP pdf] Add new CFR determination to description of Jones River | Comment Addressed: Please see revised SAP. |
| | | [In SAP pdf] Add Hanson 2005 as a data source for publicly available water quality data. | Please see revised SAP. |
| | | [In SAP pdf] Add sampling locations per Chase and Hurley comments. | Additional sampling locations and events have been included in the revised SAP. |
| | | [In SAP pdf] The flow at Tubbs Meadow Brook location SLT1 may be affected by withdrawals from a groundwater well operated by Pembroke. | Comment Noted: No action required. |
| | | [In SAP pdf] Add another groundwater sampling site at specified location on northeastern shoreline. | A fifth groundwater sampling location has been added. |
| | | [In SAP pdf] Sample in-lake conditions below solar bees. | Assessment of solar bee performance is outside of the project scope. No action is required. |
| | | [In SAP pdf] Groundwater or surface discharge from this area (southwest side of pond)? SLGW1 is great but may not be sufficient to capture the subdivision development. Where is stormwater discharged from these streets? | A fifth groundwater sampling location has been added.<br>It is outside of the current sampling effort to characterize individual stormwater outfalls. No action required. |
| | | [In SAP pdf] Timing water leaving lake or backflowing from Forge Pond? | Comment noted. |
| | | [In SAP pdf] Add groundwater sampling from Wingate water treatment plant discharge or get info from plant operator? | A fifth groundwater sampling location has been added. If relevant and readily available, plant discharge data may be considered as supporting information. |
| | | [In SAP pdf] How will this compare to Coler and Colantonio bathymetric survey? | The same vertical control will be used as the Coler and Colantonio survey. Please see QAPP. |
| | | [In SAP pdf] Will plant growth interfere or affect [bathymetric] info? | Please see revised SAP and QAPP regarding measurement methods. |
| | | [In SAP pdf] See Brad Chase relative to doing this for pH, which can change where conductance stays constant. | Although planned for at least three positions in the water column during each visit, additional pH readings may be opportunistically added to bracket large vertical changes in the water column, as warranted based on field conditions. |
| | | [In SAP pdf] Note direction of flow when lake is low. Water backflows from Forge Pond. | Comment noted: No action required. |
| August 20 | Kate Bentsen Division of Ecological Restoration | For macroinvertebrate processing, unless density is a key metric, it would be more efficient to sort and identify a subsample rather than the entire sample. Subsampling to 300 organisms per sample is pretty standard. | See QAPP. No action required. |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
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| | | For water quality parameters that have a strong diel signal, like dissolved oxygen, be mindful of when in the day samples are taken to ensure consistency across sampling dates and locations. | Comment noted. No action required. |
| | | I recommend programming continuous loggers to collect data every 15-min, rather than every hour. Since loggers will be downloaded relatively frequently, there is not a concern about the loggers filling up too soon given the higher data resolution. | While 15 minute intervals are feasible, one hour intervals are anticipated to be sufficient for the purposes of this study and consistent with what has been collected to date. This interval allows for collection of round-the-clock data while reducing the data processing and management required for a 12-month-plus study duration. |
| | | Will staff gages be installed at each monitoring station? Staff gages are recommended in addition to the PVC housing/stilling well for the loggers to allow for consistent gages readings. These gage readings are useful for both making corrections to logger data (for offset and drift) as well as for rating curve development. The gage/PVC should also be surveyed with laser level and tripod to ensure gage/PVC have not moved during the period of record. | Installation and survey of staff gages are not anticipated for this project. To reduce the potential for movement, stream loggers will be removed from fixed housing for download during each visit. Loggers will be held at a consistent position within each housing using a fixed wire strung through the cap. Measurements of water depth at the logger housing will also be collected during each visit. |
| | | A downstream monitoring station is not needed, since a station already exists at the outlet of Forge Pond on the upstream side of the Lake St crossing. I can provide the water level and discharge data if you send a contact name/email for ESS. | Please see SAP and QAPP. A datalogger will be installed at this location for consistency with other discharge monitoring locations. However, the results can be compared to the existing station to help evaluate data quality. |
| | | Appendix A, guidelines for measuring streamflow: I would only measure using a velocity meter, and calculate discharge using the midpoint method. I would not recommend the time of travel method. Each velocity measurement should be averaged over 40 seconds (not 3 sec). Refer to EPA Best Practices Guide on further methods for flow measurements. | Addressed in the SAP and the Flow SOP. The time of travel method is not preferred but may be necessary to collect measurements where water depth is too shallow for the velocity meter. |
| | | A note on telemetry stations:<br>These stations are quite expensive for the initial setup and loggers plus the recurring cellular network costs. Most sites I gage I use HOBO loggers (unvented pressure transducers), which are much less expensive and easier to maintain. The trade-off, of course, is real-time data availability with telemetry, or only when the loggers are manually downloaded. | Comment noted: No action required |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
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| August 20 | William D. Chenard<br>Town of Pembroke | The Pembroke Select Board expressed approval of this effort and to evaluate the resulting data and develop potential alternatives for consideration for short- and long-term management of Silver Lake.<br><br>Additionally, the Town of Pembroke would like results of these samples of Silver Lake, its tributaries, and supporting water bodies sent to the Pembroke Town Manager's office once developed. | Pembroke's support for this project is noted. Data will be shared with Pembroke and all other interested entities. |
| August 20 | Jonathan Hobill<br>MassDEP | According to MassDEP records, Silver Lake has never experienced a significant cyanobacteria bloom. Therefore, enhanced testing for phycocyanin and increased frequency of algal toxins and enumerations would provide a better dataset for MassDEP to make aquatic life use determinations for 305(b) assessment. | Cyanotoxins have been added. Please see revised SAP and QAPP. |
| | | For related MassDEP assessments, the proposed in-lake sampling should:<br><br>a) Revise the Plan if needed to ensure QA/QC elements of the QAPP are addressed;<br>b) Include high frequency summer sampling for standard limnological parameters to enable lake assessment by MassDEP using methodologies in the Massachusetts CALM Guidance Manual;<br>c) Include detailed aquatic plant survey during the summer peak season;<br>d) Include data that enable estimation of limiting nutrients in the lake during summer. The plan should also clarify if soluble phosphorus is the reactive fraction or total;<br>e) Revisions to the SAP should be submitted to MassDEP for review and approval prior to monitoring. While not required, QAPP approval by MassDEP (or EPA) is a prerequisite for MassDEP use of project data for 305(b) assessments;<br>f) Final quality-controlled data should be submitted to MassDEP for potential use in 305(b) assessment. | Comment noted:<br><br>a) A QAPP has been created that will be submitted to MassDEP and EPA for review.<br>b) The SAP includes the collection of limnological parameters and will be evaluated in accordance with MassDEP guidelines in 314 CMR and the Comprehensive Assessment and Listing Methodology.<br>c) Aquatic plant surveys were completed in early September 2021, when most plants are at or near maximum development.<br>d) Total soluble phosphorus has been included in data collection activities.<br>e) The QAPP and revised SAP will be submitted to the DEP.<br>f) Comment noted. |

| Date Received | Commentor / Affiliation | Summary of Comment | Response |
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| | | The recently released EPA document, Ambient Water Quality Criteria to Address Nutrient Pollution in Lakes and Reservoirs, recognizes the role of zooplankton populations to determine the overall water quality of lakes, particularly as it relates to nutrients.<br>Inclusion of sampling and enumeration of zooplankton should be considered based on the content of the referenced EPA document. | Comment noted, however, the request is beyond the scope of this effort. The project team would welcome MassDEP as a partner if additional state resources can be provided. |
| August 23 | Pat Hill<br>City of Brockton Department of Public Works | The project goals cannot be met without including sampling through the growing season. The sampling design should be revised to allow project goals to be met. This is particularly important given that low dissolved oxygen conditions need to have their extent and duration document so that any internal load of phosphorus can be characterized to be examined against current programs focused on external loads. | The sampling program has been extended to include the 2022 growing season. Please see revised QAPP. |
| | | Sampling Domain<br>a) Location of SLT2 has a small contributing area and is upstream of most anthropogenic sources. If the sampling is limited to eight sampling locations, a better use of the SLT2 location would be to collect samples at an additional in-lake location. Having only one in-lake sampling site at the "deep hole" may not be representative of most in-lake areas and may not capture water quality issues that are typically best observed in shallower lake margins.<br>b) It is unclear where the samples from the diversions will be collected. Both diversions have sample taps and other structures that would permit a sample to be collected from the diversion itself. ESS would need to coordinate with the City for access to the locations, which can be arrange with advanced notice. The City feels strongly that samples should come from the diversions themselves rather than from the pond. | Comment noted:<br>a) Additional in situ water quality measurements may be collected at other locations on an opportunistic basis to assist in characterizing variability of water quality within Silver Lake.<br>b) See revised SAP and QAPP. |
| | | Bathymetry<br>The sampling plan should describe how near-shore bathymetry will be collected if the water depth is not sufficient. The vertical control datum should be specified in the plan and the bathymetry should be tied to an elevation standard. The accuracy of the proposed depth collection methods should also be included.<br><br>Given there is existing bathymetry and stage-volume curves for Silver Lake, the sampling | A calibrated sounding line will be used in shallow water. Please see QAPP for clarifying language. Given the 18 year gap between the bathymetric data collection in 2003, it was deemed appropriate to collect updated information. The bathymetry data collected as part of this study are not intended to replace the City's existing stage-volume curves. |

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| | | plan should explain why such detailed bathymetric data is needed and why the existing bathymetry has been found to be inadequate. The plan should also describe how the bathymetric data will be processes from the collected data points. | |
| | | Aquatic Plants<br>a) How will you determine which aquatic plant assessment tool to use? Each tool may require slightly different approaches. The general methodology for each should be described to ensure consistency.<br>b) August is appropriate timing for conducting aquatic plant surveys. Given that it is already mid-August, what is the contingency if the schedule slips? Atypical end date for SAV sampling is September 15 with an option to extend to end of September. Also as peak biomass is species-dependent, the sampling plan should provide a table of aquatic plant species expected to be present in Silver Lake and peak biomass/optimal survey windows.<br>c) Data collected from the aquatic plant survey will be used to generate maps and an aquatic plants field guide. How will this data be used in relation to water quality in the lake? Typically, the data being collected and maps being produced are used more for studies on SAV and habitat, not water quality.<br>d) A well-trained SAV survey crew can usually complete 50 survey locations per day. Collection of 350 locations would likely be a two-week effort. Aquatic plant surveys should focus on areas with suitable growing condition.<br>e) How will the supplemental data on substrate type be collected? Will grab samples be collected to validate? How will substrate be determined in areas of dense macrophyte stands? | Comment noted:<br>a) Plant rakes are used at all stations. Visual observations from the surface are used to supplement these, where plants are visible.<br>b) Plant surveys were completed in early September 2021. See QAPP for additional information on plant species and accounting for those that may be present earlier in the season.<br>c) See QAPP for additional information on use of data. Also, please see MassDEP Comprehensive Assessment Methodology (2018) page 21 (Primary productivity data; Rivers, Lakes, and Estuaries; https://www.mass.gov/doc/2018-consolidated-assessment-and-listing-methodology-guidance/download)<br>d) The aquatic plant survey was successfully completed.<br>e) Please see the QAPP for more information. The substrate data are qualitative and will only be used as a supporting measure. |
| | | Macroinvertebrates<br>It is incorrect that the relatively long lifespans of benthic macroinvertebrates make them useful for inferring water quality conditions. The primary reason benthic macroinvertebrates are used is that different taxonomic groups are more or less tolerant to water quality degradation. It is the presence or absence of these groups that make them valuable indicators of water quality. | Please see revised SAP and QAPP.<br><br>Macroinvertebrate data will be used only as a supporting measure to directly measured dissolved oxygen. |

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| | | The work plan should provide additional information on collection, processing, and identification of benthic macroinvertebrates (or an SOP).<br><br>The SAP indicates the use of macroinvertebrate data to determine where anoxia, a seasonal stressor, is present in Silver Lake. There are multiple concerns about this inferential approach when it is more straightforward to measure dissolved oxygen directly.<br><br>Macroinvertebrate sampling should be conducted in summer months. As winter nears, sampling is more likely to only capture a small subset of the taxa that inhabit Silver Lake. The survey season typically parallels the aquatic plant survey season, ending in late September. What is the planned sampling schedule and what are the contingencies in place if it cannot be conducted by September?<br><br>Open water and deep lake bottoms are generally species-poor compared to littoral habitats in a lake's shallower margins. The focus should be on shallower habitats. Typically, a 2:1 ratio of locations shallower than 10 feet to deeper locations is used. | The macroinvertebrate samples were collected in September 2021. |
| | | Continuous Data Logging<br>In-lake continuous data logging is planned for what will likely be September through December and March/April, when the lake is isothermal for the bulk of the period. What information is anticipated from this monitoring program and how will these data be used to enhance understanding of water quality in Silver Lake? Brockton records daily water temperature and elevation, rendering the proposed data loggers unnecessary to characterize isothermal conditions. Continuous chlorophyll data collection during the target months is not likely to provide any meaningful data on algal conditions.<br><br>If the continuous data logging program remains in the SAP, the location of the upper data logger should be specified with more accuracy. The chlorophyll data logger placement should reflect the likely depth of algae, the algal population that is being targeted, and the ability of the grab samples to provide verification that the data logger is properly representing the algal population in the lake. | The sampling period has been expanded to more than 12 months and will now extend throughout the growing season of 2022. Please see revised SAP and QAPP for information on schedule, location, and operation of data loggers. |

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| | | The depth of the data logger above the bottom should also be specified, along with the mooring design to ensure that the logger is not in contact with the sediment surface. One meter above the bottom is typical.<br><br>Additional SOPs should be added for the temperature and chlorophyll loggers. | |
| | | Discrete Water Quality Sampling<br>Detection limits for phosphorus should be included. Samples for ammonia should also be included.<br>A vertical profile of pH should be collected along with temperature, specific conductance, and DO.<br><br>Vertical profile measurements should be conducted every two week in the fall until turnover has occurred.<br><br>Unless there is a significant cyanobacteria bloom occurring at the time of sampling, cyanotoxin analyses are not needed.<br><br>Samples from the diversions themselves could result in damaged algae, if taken from sample taps. ESS should consider this when deciding whether to continue to analyze diversion samples for algal ID and enumeration. | Please see revised SAP and QAPP.<br><br>Although planned for at least three positions in the water column during each visit, additional pH readings may be opportunistically added to bracket large vertical changes in the water column, as warranted based on field conditions.<br>Cyanotoxins may be present even if cyanobacteria are not visible as a bloom.<br><br>Samples will be collected from the source waters for each diversion, as opposed to the sampling taps. |
| | | Groundwater Sampling<br>More definition of the groundwater sampling program is needed, including regional/local water table, to understand whether planned distribution of seepage meters will provide representative information.<br><br>To obtain representative data on groundwater-surface water interactions, sampling would need to occur in other seasons or a plan included to explain how the data from the period of greatest influence will be used. | Sampling has been expanded to include two events and an additional shoreline location. See revised SAP and QAPP |
| September 30 | Charlie Seelig<br>Town of Halifax | Recommend that West Monponsett Pond also be sampled. If there is diversion from East Monponsett Pond, then water from West Monponsett Pond will flow to East Monponsett Pond and also affect the water quality of Silver Lake. | Data from West Monponsett Pond would be helpful; this is beyond the scope of the current effort. However, samples will be collected from East Monponsett Pond. |

| | |
|---|---|
| **From:** | Joanne Zygmunt |
| **To:** | Matt Ladewig; Jeffrey Hershberger |
| **Cc:** | Frank Basler; Kimberly Groff; Pine duBois |
| **Subject:** | Fwd: ESS Silver Lake Monitoring |
| **Date:** | Tuesday, August 10, 2021 2:14:52 PM |

Brad Chase, DMF comments via Pine below

—
Joanne Zygmunt
Chair, Central Plymouth County Water District Commission
(508) 649-3479
www.centralplymouthcountywater.org

From: Pine duBois <pine@jonesriver.org>
Date: August 9, 2021 at 6:02:01 PM
To: Joanne Zygmunt <jzygmunt@plymouthcountyma.gov>
Subject: Fwd: ESS Silver Lake Monitoring

Pine duBois
pine@jonesriver.org
781-424-0353

http://www.jonesriver.org
*Save the River, Save the World!*

Begin forwarded message:

**From:** "Chase, Brad (FWE )" <brad.chase@state.ma.us>
**Subject: ESS Silver Lake Monitoring**
**Date:** August 9, 2021 at 4:47:38 PM EDT
**To:** Pine duBois <pine@jonesriver.org>

Hi Pine - I looked over the ESS Sampling and Analysis plan for the Silver Lake monitoring project. Fairly quick review. I've got the following comments at this point:

1.) Sampling Locations, Figure 2 (page 3). SLIL is the only in-lake station for Silver Lake. It appears to be close to the SL4 station used for the DMF/JRWA River herring habitat assessment. I recommend more than one in-lake station. The project could adopt SL2 to gain information on the hypolimnion at a different location in the lake that may allow modeling of anoxia/hypoxia. Or add a shallow water station next to the Monponsett diversion or Tubbs Meadow Brook outlet.

2.) Continuous Data Logging (page 7). The continuous logging calls for "one array will be located within 5 meters (16 feet) of the lake surface and the second array will be located within 16 feet of the sediment-water interface." It is not clear to me if the logging will begin at 5 m below the surface and continue to 5 m off the bottom. If so, it will be missing important locations in the water column. I recommend starting the sampling at close the surface and the bottom. We often use 0.3 m from the surface and 0.5 m from the bottom. I've seen others use 0.5 m for both or 1.0 m off the bottom.

3.) Table B. Surface Water Quality Analytes (page 8). The protocol has sampling every meter for temp., DO and specific conductivity. Conductivity is generally stable in the water column. Water pH varies with carbonic acid, ammonia, and photosynthesis dynamics and can reflect on the health of the water body. I recommend switching pH for conductivity for sampling every meter.

4.) Table C. Surface Water Quality Analytes and Parameters to Be Monitored from Diversions (East Monponsett and Furnace Ponds) (page 9). The nutrient sampling is intended to "improve the understanding of hydrologic and nutrient budgets". It is not clear if the sample sizes at the diversions (3 visits) and SLIL (6 visits) are adequate to quantify a lake nutrient budget. Consideration should be given to designing the suitable sample structure at the inlets and outlet to prepare nutrient loading and budget estimates.

Thanks, Brad

Brad Chase
Diadromous Fish Project Leader
Massachusetts Division of Marine Fisheries
brad.chase@mass.gov

www.mass.gov/marinefisheries

**From:** Pine duBois
**To:** Matt Ladewig; Joanne Zygmunt
**Cc:** Frank Basler
**Subject:** Fwd: Silver Lake SAP
**Date:** Tuesday, August 17, 2021 3:38:34 PM

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Hi Matt, Joanne and Frank—

I sent a late request to Steve Hurley at DFW to review the SAP as he is very familiar with Silver Lake, has done a fish inventory there (2013) https://www.jonesriver.org/getfile/tribasin/2013-08-27-SilverLake-FisheriesSamplingReport-PreliminaryDataSummary.pdf and has been actively surveying Jones River for as long as I can remember. His data led to the re-classification this year of Jones River as a Coldwater Fish Resource from the bay into Silver Lake. He has broad familiarity with the other resources as well. He could help address questions you may have, and has been a great resource for us.

If you don't already have the email I read from Brad Chase during the meeting last week, let me know and I can forward that as well.

Steve's suggestions are in his email below.

Thank you!

Pine duBois
pine@jonesriver.org
781-424-0353

http://www.jonesriver.org
*Save the River, Save the World!*

Begin forwarded message:

**From:** "Hurley, Steve (FWE )" <steve.hurley@state.ma.us>
**Subject: RE: Silver Lake SAP**
**Date:** August 12, 2021 at 8:36:56 AM EDT
**To:** Pine duBois <pine@jonesriver.org>

Hi Pine,

I have read through the SAP and I would suggest more water quality of sampling of Monponsett and Furnace outside of the diversion window, at last one sample in September. This would help to better show the impaired quality of these waters compared to Silver Lake. Groundwater quality may have a big impact on Silver Lake and the proposed plan seems pretty limited on this potential impact. I would recommend increasing the amount of groundwater monitoring to help capture where the major inputs of nutrients from groundwater occur.

Cyanobacteria is a big issue now on the Cape and other areas:
https://apcc.org/our-work/science/community-science/cyanobacteria/

https://www.mass.gov/info-details/guidelines-for-cyanobacteria-in-freshwater-recreational-water-bodies

besides the cyanotoxins, information should be included on cell abundance and species composition of cyanobacteria.

In addition to this water quality snapshot, a good summary of current and historical water use and diversions, as well as data on spillage to the Jones River and downstream resources from Monponsett and Furnace, is needed to really develop a good management plan for this system.

**Steve Hurley**
Southeast District Fisheries Manager
Massachusetts Division of Fisheries & Wildlife
195 Bournedale Road, Buzzards Bay, MA 02532
p: (508) 759-3406 | f: (508) 759-0381
mass.gov/masswildlife | facebook.com/masswildlife

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**From:** Pine duBois <pine@jonesriver.org>
**Sent:** Monday, August 9, 2021 5:22 PM
**To:** Hurley, Steve (FWE) <steve.hurley@mass.gov>
**Subject:** Silver Lake SAP



Hi Steve—
The Central Plymouth Co Water District Commission has retained ESS Group to do a WQ Assessment of Silver Lake to hopefully inform the management scheme.....We are on a call tonight (if yr not doing anything!!—like at 6PM—I am attaching the SAP below—if you have any time

to look at it in the near future and have suggestions—this is to review their plan—they have already been retained to do the work over the next year or two.

Please let me know if you have any input.
thanks
Keep well!!

Pine duBois
pine@jonesriver.org
781-424-0353

http://www.jonesriver.org
*Save the River, Save the World!*

## Matt Ladewig

**From:** funkmaestrob@gmail.com
**Sent:** Friday, August 20, 2021 12:51 PM
**To:** fbasler@plymouthcountyma.gov; Matt Ladewig
**Subject:** Observations on Silver Lake Water Quality Monitoring, Sampling and Analysis
**Attachments:** Silver LAke ESS Comments BLR.pdf

**Follow Up Flag:** Follow up
**Flag Status:** Flagged

Dear Frank and Matt,
Please consider the enclosed comments on the Silver Lake SAP.
Sincerely
Brian Reid

18 Aug 2021

Frank Bassler, County of Plymouth

Matt Ladewig, ESS Group

**RE: Observations on Silver Lake Water Quality Monitoring, Sampling and Analysis**

The proposed SAP represents a significant expansion of previous efforts to characterize the management and impacts to Silver and its outflows, the latter whose value lies in both municipal water supply and natural streamflow outputs to the Jones River. The combination of the simultaneous characterization of water sources, including natural surface inputs, artificial diversions and ground water, combined with high frequency sensor networks of streamflow inputs and lake water quality, is the principal merit of the proposed study design. Although not explicitly presented as such, the scope of work is effectively a partial mass balance (inputs of water and nutrients), which is necessary for evaluating nutrient load to the lake.

The following comments are provided, presented in the interest of clarifying or improving the existing study design, but also in anticipation of outcomes (for example, how the recommendations from this work sets the stage for continuation and long-term monitoring).

A general lack of references in support of the methodology makes it difficult to evaluate in detail the quality of the proposed work. Specifically, with regard to water quality analysis, it is important to define the detection limits, in turn affected by the specific analytical methods, and/or external laboratory where analyses will be conducted. The analysis of soluble reactive phosphorous could be chromatography, ICPMS, or a Lamotte test kit, none of which would be comparable to simple colorimetric methods IF they are applied to natural waters (certified laboratories with the best QA-QC may not meet this criteria, if their principal focus is on the analysis of waste water and not natural waters). For groundwater flux estimates, it is not clear whether the design considers the many recent advances in methodology (see below). Meanwhile, in terms of the overall estimate of phosphorous load, no information is provided on how this will be calculated (the basic mass balance equation: inputs – outputs = change in what is stored in the lake), what are the uncertainties, unmeasured components (unmeasured components of the mass balance, e.g. flux from sediments), and parameter assumptions. Parameter uncertainty and detection limits are significant elements of the study design that, based on the SAP, cannot be externally evaluated. Characterization of these uncertainties is important (even qualitatively) since the sampling season in incomplete (less than 1 year), no surface water sampling is proposed for critical summer months, and flow estimates from stage-discharge rating curve models may not reflect an adequate range of flow conditions (e.g. underestimating the dominant effect of storm events, pulses which may contribute most of the annual nutrient load). Also it is noted that there are no references to previous characterization of the site, including the Teal Inc. study of 1998, previous bathymetric mapping, or results of water quality monitoring (unpublished municipal monitoring or other sources).

In terms of the long-term need for monitoring, and given the low cost of standard off-the-shelf instrumentation proposed here (less than 1% of the overall project budegt), long lifespan (battery life approx. 10x the duration of the project), it is recommended that the water level sensors remain installed after the termination of this work, with maintenance transferred to some local responsibility. Maintenance costs of such sensors would be minimal, while the value of longer time series would be priceless.

The characterization of surface water diversions from Furnace and Monponsett Ponds may be problematic due to unpredictability of the timing and duration of diversions. Sampling of these artificial inputs will be dependent on prior notification, and will also contribute what would result in more or less unpredictable loads of surface water contaminants to Silver Lake. Characterization of the source of the diversions (the source ponds respectively), and not the diversion events, would much more adequately characterize the variability in the source water. Although this is beyond the scope of the monitoring proposed here, ultimately it would be advisable to implement a continuous monitoring program for Furnace and Monponsett Ponds, similar to the design proposed for Silver Lake, and based on combined water quality sampling of the lake water columns together with high frequency sensors. This would, eventually, provide water quality information from the sources of the diversions, as potential decision criteria for the timing of surface water diversions (hence water diversion during periods of poor source water quality could be avoided). Note that this is as an interim mitigation for Silver Lake, one that would improve the existing diversion operations, while informing local communities of potential management on the source ponds. However it is not considered a long term solution for Silver Lake water and water quality management.

Regarding the proposed surface water sampling of the three tributaries SLT1,2,3, it is not clear why sampling will be conducted at road crossings. Access to the stream-lake confluences is relatively simple, and water quality at the confluence is a better indicator of load to the lake. The intervening strea,m reaches may experience significant changes in water quality, either via assimilation or biogeochemical transformation, sedimentation of total constituents, noting also that there are some significant changes in land use in between.

The ground water sampling sites are representative in terms of "lake segmentation," however local variability in seepage rates may be high, and more replication of seepage measurements within sites may be necessary. Bag materials, tubing design, and other factors may lead to resistance and friction head that produce spurious results (Rosenberry and Menheer, SIR 2006-5053, USGS, also Rosenberry 2005 Limnology and Oceanography, among others, including a lot of unpublished guidance). The current proposal calls for 2 replicates per site, but in the case of replicates differing by an order of magnitude (which is common for seepage rates and other groundwater parametrization), how will this affect the overall estimate of nutrient load? Note that the seepage flux collected in bags could also be directly analyzed for nutrients (assuming prior equilibration of the seepage drum). As an external validation of seepage rates, it would be both useful and very easy to measure the vertical hydraulic gradient within the pore water samplers (water level in the piezometer higher than lake surface water level indicates positive pressure or net influx of ground water). This would provide validation of the direction of the groundwater flux. Even better would be to combine this with a falling head permeameter estimate of hydraulic conductivity (also simple to perform, but may take a few minutes to perhaps no more than an hour, depending on permeability). Combines, these produce an alternate estimate of groundwater flux via Darcy's Law.

Monitoring of oxygen concentration, potentially the most import direct indicator of stress upon organisms and ecosystem response of the lake, should be included for both the bottom and surface sensors. High frequency observation of oxygen concentration could provide an important baseline for long-term and real-time monitoring of changes in the lake (i.e. rates of metabolism calculated from oxygen data: see www.gleon.org for many examples). It is also recommended that optical sensors be used for oxygen measurements (instead of the proposed polarigraphic electrode), together with a wiper to avoid problems with fouling (for example MiniDOT dissolved oxygen logger - PME instruments, Zebratech, or other optical multiparameter sondes).

Fouling will also be a significant problem with the proposed ChlA sensor if a wiper is not used (elsewhere, the Aquatroll brand is mentioned, which has a wiper option). Note that the proposal provides very limited information on the methods of high frequency ChlA measurements, and does not consider calibration with in-situ measurements of Chlorophyll. The proposal makes no mention of laboratory analysis of ChlA, but this should be simultaneous to algal sampling. Phytoplankton sampling, to be consistent with the ChlA sensor, should be at a discrete depth corresponding with the datalogger, in addition to the proposed integrated sampling.

It is not clear why only total nitrogen will be analyzed for surface waters, but not nitrate, nitrite or ammonium. Inorganic N species may be significant in the deep water hypolimnion of the lake, and analysis of these surface water parameters would be consistent with the dissolved inorganic species analyzed from ground water.

Grab samples for macroinvertebrates may be problematic in areas of dense macrophyte beds, in which case diving may be necessary to collect samples. Grab samples also may not adequately represent larger, low-density, high biomass organisms such as freshwater mussels. This is problematic since mussels may be among the most significant indicators of water quality in coastal plain lakes of the region, simultaneously providing a natural control on water quality (via filtration), and meanwhile the known mussel fauna from Silver Lake includes several species of conservation concern. Significant freshwater mussel die-offs in Furnace pond in the 90s may have reduced or possibly eliminated the fauna from this lake – something that should be avoided at all costs in Silver Lake. Note that a possible regime shift from bare substrate and low density macrophytes (pers. obs. c. 2002) to macrophyte dominated substrate (current condition), may have already adversely affected the freshwater mussel community of Silver Lake.

I am available to discuss these comments and/or other ideas for improving the monitoring.

Sincerely,

Brian Reid

Board of Directors JRWA 1998-2001

Science Director, Center for Ecosystem Research in Patagonia (Centro CIEP: www.ciep.cl)

Brian.reid@ciep.cl

Local Address: 34 May Street, Boston MA 02130

**From:** Pine duBois
**To:** Matt Ladewig
**Cc:** Joanne Zygmunt; Frank Basler
**Subject:** SAP comments and info
**Date:** Wednesday, August 18, 2021 5:29:34 PM
**Attachments:** pdb comments ESS Silver Lake SAP DRAFT for Client Review-1.pdf
pdb 081821 ESS Draft Silver Lake PIP 072321.docx
2006-01-17 Silver Lake System Overview Report (HMA).pdf
Silver Lake JR Geology.pdf
GZA SLoutflowsTABLE5-2.pdf
JRWA nutrients 2009.xls

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Hi Matt—
I reviewed your ESS SAP again and inserted some comments to the docs that I hope are useful. I am attaching the public (PIP) review doc (with tracked changes) and the SAP (with comments) for your consideration. Perhaps some of it will be helpful.

I also reached out to DER and asked them to update the RIFLS (River and Instream Flow Stewrds) site, which right now only reflects info to June 2020, but they have more outflow data. Kate Benson there said she would update it as soon as she could. https://eeaonline.eea.state.ma.us/DFG/RIFLS/#/analytics/18

You will see in one of my comments relative to the sampling at the outflow of the lake to Forge Pond—that when the lake is low, water back flows from Forge Pond into Silver Lake — so this will have very different water quality should you run into that scenario.

I also asked that they provide input for your consideration and said that I needed it by Friday. So if I get anything I will forward that to you. If I can help clarify anything, please let me know

In addition, below here are some files that I hope are useful to you, that I'm not sure you have/ or have seen

the below link is a 4 min video of water entering the lake from the diversion pipe
https://jonesriver.org/media/silver-lake-water-quality/
we have other videos on our youtube channel, you may find interesting or helpful. https://www.youtube.com/user/JonesRiverEcology/videos

The below pdf is the Jeff Hanson study of 2006—Jeff initiated the desal plant in Dighton, lives in Brockton and recently consulted with CDM. It contains sampling lab sheets from 2005

you likely know this but I like the geologic perspective—glacial lake beginnings

In the FWIW department, the below chart from the 2003 GZA Jones river Watershed Study--https://jonesriver.org/ecology/gza-jones-river-watershed-study/
JRWA did some sampling when Brad Chase did his habitat Assessment for spawning river herring

Good Luck! If there is a way we can assist you with this project, please let me know. If you have travel issues—we have a residential house at the Landing for students that is currently empty—and also the Landing for staging or cleaning gear if that is helpful. About 5 miles from Silver Lake.

Pine duBois
pine@jonesriver.org
781-424-0353

http://www.jonesriver.org
*Save the River, Save the World!*

DRAFT for Client Review

404 Wyman Street, Suite 375, Waltham, Massachusetts 02451 • 781.419.9696
10 Hemingway Drive, 2nd Floor, East Providence, Rhode Island 02915 • 401.434.5560
780 Lynnhaven Parkway, Suite 400, Virginia Beach, Virginia 23452 • 757.821.3095

# Sampling and Analysis Plan

## Silver Lake Water Quality Monitoring

## Halifax, Plympton, Pembroke and Kingston, Massachusetts

## PREPARED FOR

**Central Plymouth County Water District Commission**
c/o Frank Basler, County Administrator
44 Obery Street
Plymouth, MA 02360

July 24, 2021

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## TABLES



## FIGURES



## APPENDICES

# INTRODUCTION AND PROJECT DESCRIPTION

ESS Group, Inc. (ESS) has developed this Sampling and Analysis Plan (SAP) to provide the Central Plymouth County Water District Commission (CPCWDC) with a detailed description of the technical approach and schedule for executing the Silver Lake Water Quality Monitoring Project (the Project).

Silver Lake is a designated Class A waterbody and Outstanding Resource Water (ORW) located in the towns of Halifax, Plympton, Pembroke, and Kingston, Massachusetts. In addition to serving as the primary source water reservoir for the City of Brockton and connected drinking distribution systems, Silver Lake constitutes the headwater source of the Jones River (Figure 1).

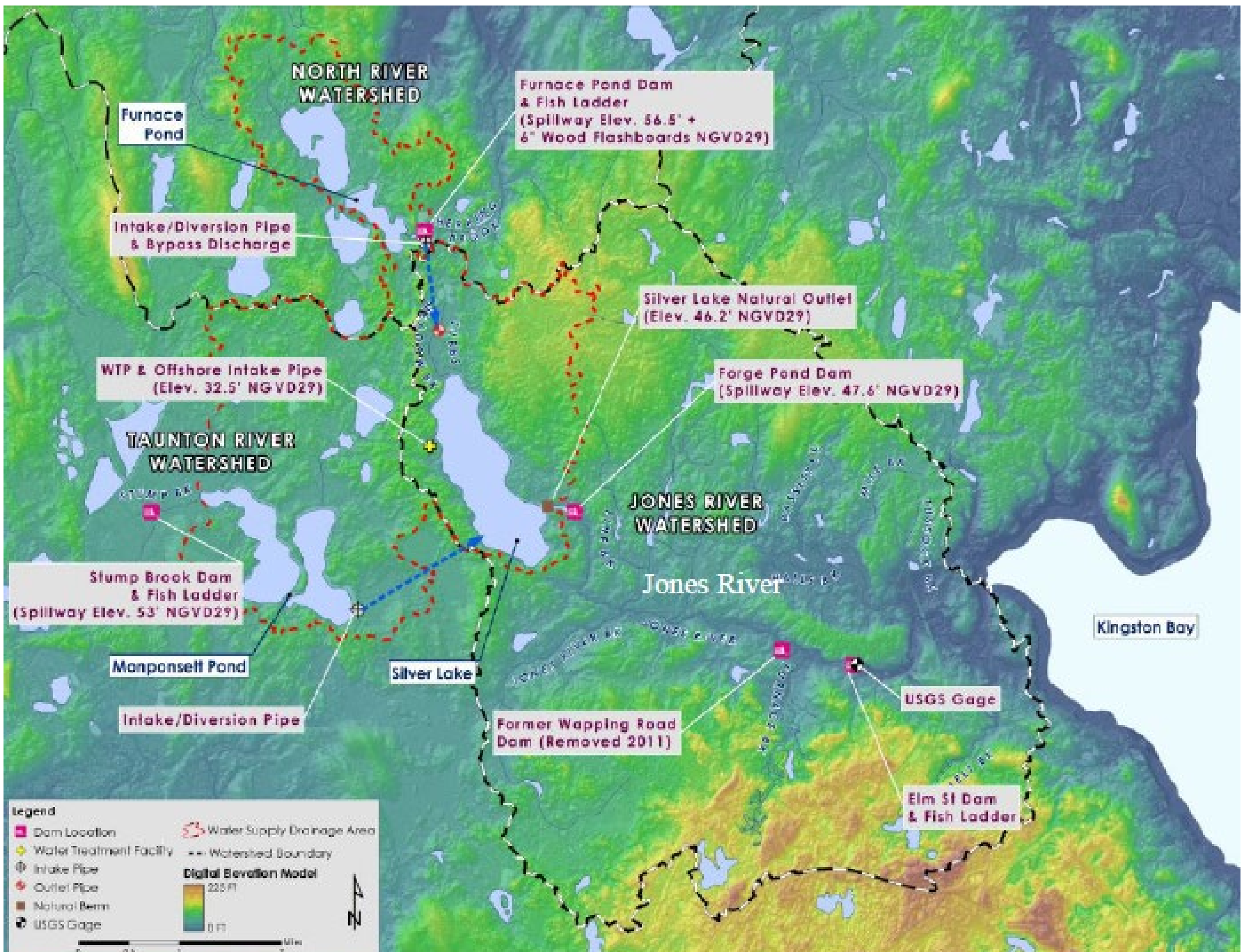



*Figure 1. Silver Lake, Diversions, and Watersheds*
Source: Princeton Hydro 2013

Concerns have arisen regarding potential water quality impacts to Silver Lake from watershed sources and water diversions. Silver Lake is now proposed for listing in the Draft 2018/2020 Integrated List of Waters by the Massachusetts Department of Environmental Protection (MassDEP). The proposed impairments include Fish Passage Barrier, Flow Regime Modification, and Dissolved Oxygen. The Dissolved Oxygen impairment, if finalized, would require a TMDL.

The overall goals of this Project are as follows:

1. Collect water quality data to help inform community management decisions to address water quality and quantity issues in Silver Lake and connected water bodies; and
2. Develop a baseline understanding of current water quality and continue to develop solutions-oriented relationships with the City of Brockton's Water Division and the public.

To support these goals, ESS will collect and analyze detailed water quality, physical, hydrologic, and biological data.

## PROJECT DESIGN

The Project is designed to improve the understanding of key water quality drivers in Silver Lake. This Project approach has been designed with the following questions, issues, and data gaps in mind.

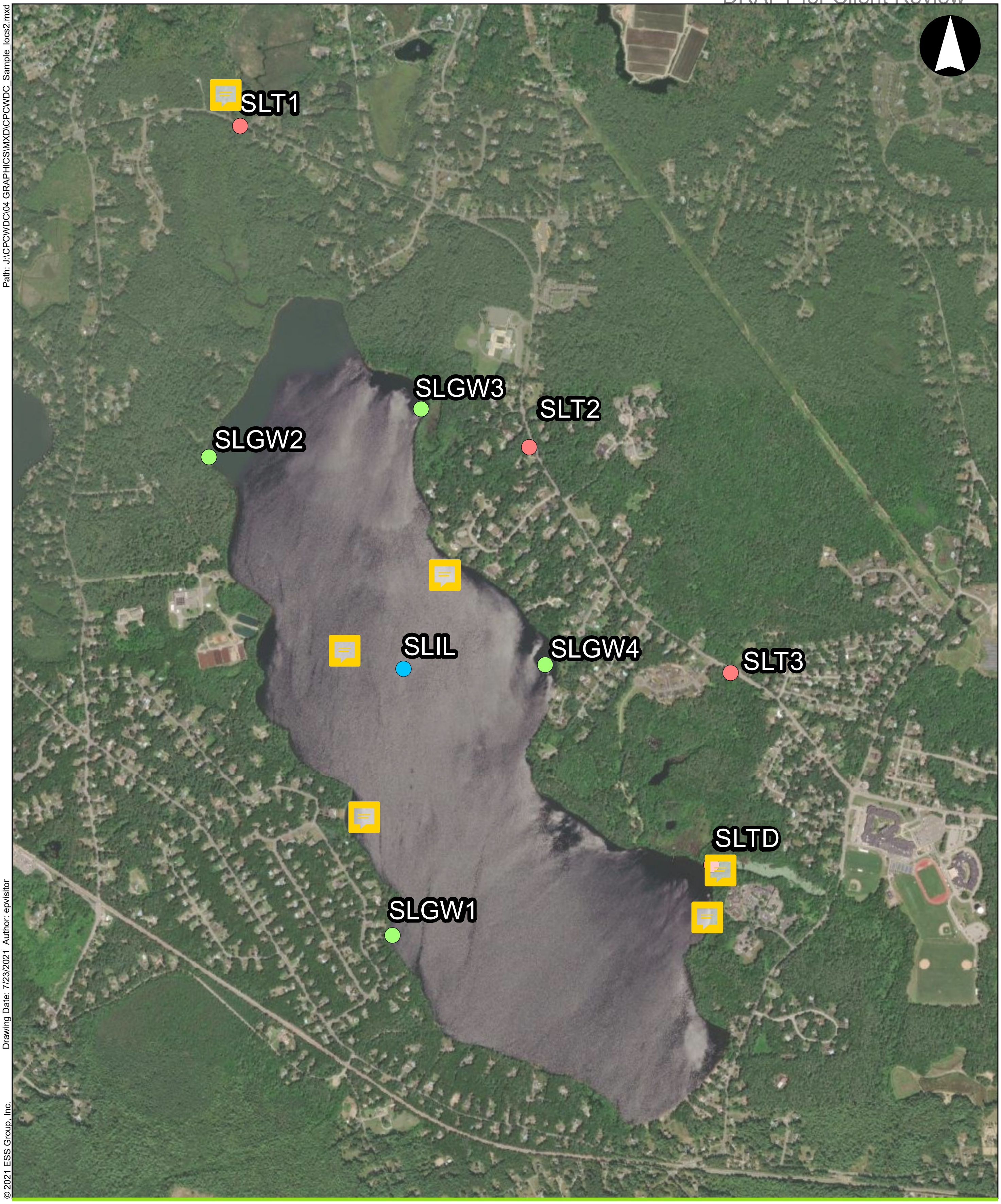
- Publicly available water quality data for Silver Lake appears limited mainly to assessments completed in 2004 (ESS) and in 2008-2009 (JRWA; Chase et al., 2013). More recent data are needed to address the current condition of the lake.
- Diversion of water from East Monponsett Pond by the City of Brockton's public water supply system may increase the external loading of phosphorus to Silver Lake. Over time, this could result in Silver Lake's water quality trending toward a state of more frequent and intense harmful algal blooms.
- In addition to the above, watershed loading to Silver Lake from stormwater runoff, septic systems, agricultural runoff, and other sources may contribute to degradation of water quality.

Components of the Project design are described in the following sections.

### Sampling Domain

The Project will include collection of data from Silver Lake, its natural tributaries, shallow groundwater, and water diversion sources. The anticipated primary sampling locations are shown in Figure 2 and described in Table A.

East Monponsett and Furnace Ponds are publicly accessible and do not require prior arrangement for sampling. Access to Silver Lake will be through the Silver Lake Water Treatment Plant, which is operated on behalf of the City of Brockton by Veolia North America. ESS will coordinate gate access directly with the plant operator prior to each visit to Silver Lake.






ESS group
environmental consulting & engineering services

0 0.15 0.3 Miles

**Silver Lake Water Quality Monitoring Project**

Halifax, Plympton, Pembroke, and Kingston, MA

Source: 1) Esri, World Imagery, 2021

Sample Locations are approximate and subject to change based on field observations

**Legend**

- Groundwater Sample Location
- In-Lake Sample Location
- Tributary/Outlet Sample Location

**Proposed Silver Lake Water Quality Sample Locations**

**Figure 2**

**Table A. Anticipated Sampling Locations**

| Water Body | Site ID | Description | Type |
|---|---|---|---|
| Silver Lake | SLIL | Deep hole | In-lake |
| Silver Lake | SLGW1 | Southwestern shoreline | Groundwater |
| Silver Lake | SLGW1 | Northwestern shoreline | Groundwater |
| Silver Lake | SLGW3 | Northeastern shoreline | Groundwater |
| Silver Lake | SLGW4 | Eastern shoreline | Groundwater |
| Tubbs Meadow Brook | SLT1 | Tubbs Meadow Brook between Route 27 and Silver Lake | Tributary |
| Little Brook | SLT2 | Little Brook between Route 27 and Silver Lake | Tributary |
| Mirage Brook | SLT3 | Mirage Brook between Route 27 and Silver Lake | Tributary |
| Jones River | SLTD | Outlet from Silver Lake | Outlet |
| Furnace Pond/Diversion | FPD | Furnace Pond diversion to Tubbs Meadow Brook | In-lake/Diversion |
| East Monponsett Pond/Diversion | MPD | East Monponsett Pond diversion to Silver Lake | In-lake/Diversion |

## Sampling Design

The Project sampling design consists of the following principal elements:

1. Bathymetry, Aquatic Plant, and Benthic Surveys
2. In-Lake Water Column & Quality Sampling
3. Upstream and Downstream Monitoring
4. Groundwater Assessment

Each of these are described in the following sections.

### Bathymetry, Aquatic Plant, and Benthic Surveys

Bathymetric, aquatic plant, and benthic surveys of Silver Lake will be completed and used to create detailed maps of water depth, plant growth, and area of the lake impacted by anoxia. Survey timing is anticipated for August 2021.

***Bathymetry***. Bathymetry will be measured using an echosounder in deep, open waters and a calibrated sounding line in shallower waters where plant growth is dense. Given the wet antecedent conditions in June and July, Silver Lake is currently near capacity. Therefore, the planned survey timing is likely to provide adequate water depth to complete the bathymetric mapping.

Lake bathymetry will be tied to a vertical control and used to create a contour map of the lake.

The bathymetry survey will include at least 350 survey locations. The locations will be distributed using a gridded survey approach (Figure 3). This method is similar to point-intercept survey methods, in that it uses a pre-determined sampling interval to ensure adequate coverage of the entire water body. The primary difference is that, whereas point-intercept survey methods require navigation to a specific point (i.e., the intersection of each grid line), the gridded survey only requires navigation to each cell. This ensures adequate coverage of survey data throughout the lake while providing field crews with flexibility select the exact location and number of points within each cell based on observed field conditions.

The field data and geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

***Aquatic Plants***. Aquatic plant growth will be assessed at each survey location using one or more of the following tools: a color underwater video camera, macrophyte pole- and/or throw-rakes, and direct observation from the boat. Aquatic plants will be field identified. Specimens that cannot be readily field-identified to genus/species level will be collected and identification under a high-powered dissecting microscope.

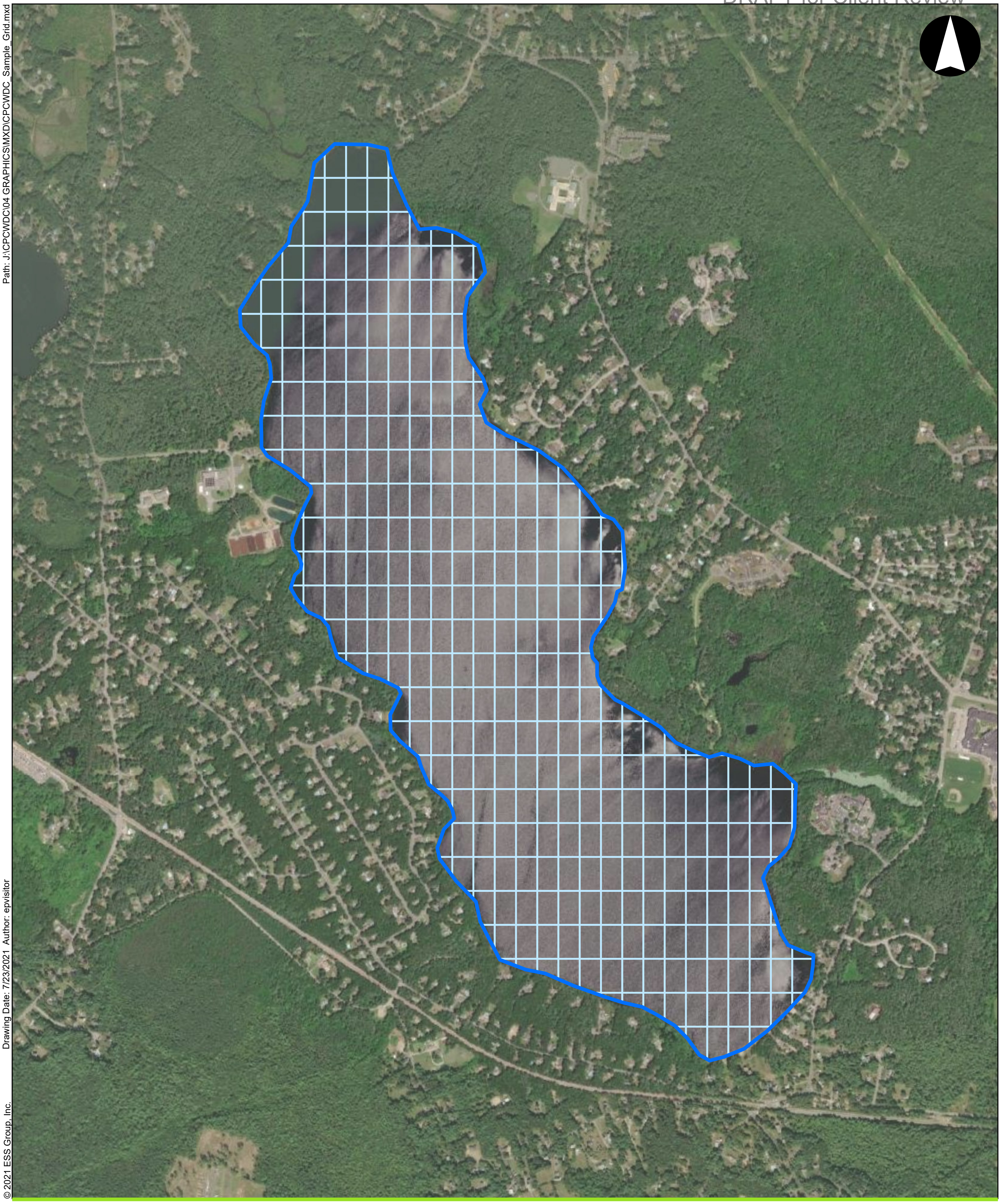
The planned timing provides ideal conditions for mapping rooted plants, which will be at their seasonal peak of growth.

Aquatic plant data collected will include community composition, vegetative cover (percent of bottom) and biomass/volume (measure of vegetative growth in the water column). Supplemental data on substrate type (muck, sand, etc.) will also be collected.

Data collected from the aquatic plant survey will be used to generate maps of plant cover and biovolume for the lake. Additionally, a field guide to the aquatic plants of Silver Lake as a resource for future monitoring efforts.

The aquatic plant surveys will include at least 350 survey locations. As with the bathymetry survey, the plant survey locations will be distributed using a gridded survey approach.

The field data and geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.



Path: J:\CPCWDC\04 GRAPHICS\MXD\CPCWDC\CPCWDC_Sample_Grid.mxd
Drawing Date: 7/23/2021 Author: epvisitor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0 0.1 0.2 Miles

**Silver Lake Water Quality Monitoring Project**

Halifax, Plympton, Pembroke, and Kingston, MA

Source: 1) Esri, World Imagery, 2021

**Legend**

Silver Lake Boundary

Mapping Grid
Approximately 360 Cells

**Proposed Silver Lake Mapping Grid**

**Figure 3**

***Macroinvertebrates***. Due to their relatively long lifespan (months to years), benthic macroinvertebrates are one of the most useful organisms for inferring longer term water quality conditions in surface waters.

Benthic macroinvertebrate samples will be collected along a transect perpendicular to the long axis of the lake, allowing the collection of samples from both shallow and deep environments within the lake. A total of seven samples will be collected, each from a different depth (approximately 5 ft, 15 ft, 25 ft, 35 ft, 45 ft, 55 ft, and 65 ft).

Depending on the conditions observed in the lake and depth of water at the sampling location, ESS will use a grab sampler (e.g., Ekman grab), clam rake, or dip net to collect macroinvertebrate samples. The total area sampled will be noted for each location so that the data can be used to quantify densities of each organism. Samples will be field-preserved in 75% ethanol.

Macroinvertebrates will be sorted from each sediment sample, then identified and enumerated by a Society for Freshwater Science (SFS) certified taxonomist under a high-power dissecting and/or compound microscope. The target level for macroinvertebrate identification will be genus/species for most organisms. This will allow for the mapping of the area of the lake affected by seasonal stressors, such as anoxia (i.e., areas lacking dissolved oxygen).

The geographic coordinates for each data point will be recorded using a Differential Global Positioning System (DGPS) capable of sub-meter horizontal accuracy in the NAD83 Massachusetts State Plane Coordinate system.

### In-Lake Water Column & Quality Sampling

In-lake sampling of water quality will be used to establish the current baseline conditions in Silver Lake. Survey timing is anticipated to begin in August 2021 and extend through April 2022, exclusive of months when ice cover is present (currently anticipated to be January and February).

To ensure acquisition of the most useful and complete dataset over a short period of time, the in-lake monitoring program will include both continuous data logging and collection of discrete water quality samples as part of the field program.

***Continuous Data Logging***. The continuous data logging portion of the field program will include deployment of two monitoring arrays at the deepest location in the lake (currently anticipated to be approximately 75 feet deep when water level is at normal pool elevation). The data logger array will be used to detect differences in key parameters (water level, temperature, and chlorophyll – a surrogate for algal growth) over time and through the vertical water column. One array will be located within 5 meters (16 feet) of the lake surface and the second array will be located within 16 feet of the sediment-water interface. The chlorophyll a datalogger will only be included in the shallow monitoring array. The surface datalogger array will be allowed to move up and down with changes in water level so that it remains at the same relative depth while the bottom datalogger will maintained at a fixed location to effectively track changes in water level.

Loggers will be programmed to collect readings at hourly intervals. Data will be downloaded during each site visit. See Appendix A for more information on logger installation and operation.

***Discrete Water Quality Sampling***. To complement and supplement the continuous data logging program, multiple rounds of discrete in-lake water quality samples will be collected from September 2021 through April 2022, exclusive of January and February 2022, for a total of six sampling events.

During these events, samples will be collected from the same in-lake location as the datalogger array. Additionally, water quality profiles will be measured in situ within the water column. See Appendix A for more information on sampling methods and Table B for the distribution of in-lake sampling effort.

Water quality samples will be sent to the laboratory for analysis of the following:

- Total Phosphorus
- Soluble Phosphorus
- Total Nitrogen (nitrite-N+nitrate-N and Total Kjeldahl N)
- Alkalinity
- Chlorophyll a
- Phytoplankton Enumeration and ID

Additionally, the following parameters will be field measured:

- pH
- Secchi Disk Transparency
- Apparent Color
- Turbidity
- Water Temperature (full vertical profile at 1 m increments)
- Specific Conductance (full vertical profile at 1 m increments
- Dissolved Oxygen (full vertical profile at 1 m increments)

**Table B. Surface Water Quality Analytes and Parameters to Be Monitored in Silver Lake**

| Analyte/Parameter | Sampling Position(s) at SLIL | Number of Visits | Number of Samples per Visit | Total Number of Samples |
|---|---|---|---|---|
| Total Phosphorus | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Soluble Phosphorus | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Total Nitrogen | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Alkalinity | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Chlorophyll a | Surface | 6 | 1 | 6 |
| Algal ID and Enumeration | Surface | 6 | 1 | 6 |
| *E. coli* | Surface | 4 | 1 | 4 |
| Cyanotoxins | Surface | 2 | 1 | 2 |
| pH | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Secchi Disk Transparency | Surface | 6 | 1 | 6 |
| Apparent Color | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Turbidity | Surface, Mid-depth, Bottom | 6 | 3 | 18 |
| Water Temperature* | Every meter | 6 | 22 | 132 |
| Specific Conductance* | Every meter | 6 | 22 | 132 |
| Dissolved Oxygen* | Every meter | 6 | 22 | 132 |

*Number of samples is estimated. Actual number will be determined by field conditions (i.e., water depth).

Since there is concern regarding documented impairments in East Monponsett Pond and Furnace Pond and the potential for these to impact Silver Lake through inter-basin water transfer, surface samples will also be collected from these diversions concurrent with a subset of the in-lake sampling events at Silver Lake. The timing of these sampling events will be targeted during periods of active diversion, as conditions allow. See Table C for the distribution of sampling effort.

**Table C. Surface Water Quality Analytes and Parameters to Be Monitored from Diversions (East Monponsett and Furnace Ponds)**

| Analyte/Parameter | Number of Visits | Number of Samples per Visit | Total Number of Samples |
|---|---|---|---|
| Total Phosphorus | 3 | 2 | 6 |
| Soluble Phosphorus | 3 | 2 | 6 |
| Total Nitrogen | 3 | 2 | 6 |
| Alkalinity | 3 | 2 | 6 |
| Chlorophyll a | 3 | 2 | 6 |
| Algal ID and Enumeration | 3 | 2 | 6 |
| *E. coli* | 3 | 2 | 6 |
| Cyanotoxins | 2 | 2 | 4 |
| pH | 3 | 2 | 6 |
| Secchi Disk Transparency | 3 | 2 | 6 |
| Apparent Color | 3 | 2 | 6 |
| Turbidity | 3 | 2 | 6 |
| Water Temperature | 3 | 2 | 6 |
| Specific Conductance | 3 | 2 | 6 |
| Dissolved Oxygen | 3 | 2 | 6 |

## Upstream and Downstream Monitoring

Upstream and downstream monitoring will be used to improve understanding of the hydrologic and nutrient budgets for Silver Lake. Survey timing is anticipated to begin in September 2021 and extend through April 2022, inclusive of the winter months.

To ensure acquisition of the most useful and complete dataset over a short period of time, the upstream and downstream monitoring field program will include continuous data logging, direct measurement of discharge, and collection of discrete water quality samples.

***Continuous Data Logging***. The continuous data logging portion of the field program will include deployment of four water level loggers, including one each at Tubbs Meadow Brook, Little Brook and Mirage Brook (tributary inlets) and one downstream (outlet to Forge Pond). Additionally, since the water level loggers will be sealed (unvented), a fifth pressure logger will be deployed in a discreet location to allow for continuous atmospheric pressure correction. The deployed loggers will also continuously monitor temperature over the course of the study.

Water level loggers will be programmed to collect readings at hourly intervals. Data will be downloaded during each site visit. See Appendix A for more information on logger installation and operation.

***Discrete Water Quality and Discharge Sampling***. To complement and supplement the continuous data logging program, monthly rounds of discrete upstream and downstream water quality and discharge measurement will be completed from September 2021 through April 2022, for a total of eight sampling events. At least one of the rounds will be collected during wet weather conditions to capture the impact of stormwater runoff.

See Appendix A for more information on sampling methods.

Water quality samples will be sent to the laboratory for analysis of the following:

- Total Phosphorus (low detect)
- Soluble Phosphorus (low detect)
- Total Nitrogen (includes nitrite-N+nitrate-N and TKN)

Additionally, the following parameters will be field measured:

- Stream Discharge
- pH
- Apparent Color
- Turbidity
- Specific Conductance
- Temperature
- Dissolved Oxygen

The discharge measurements collected in each stream monitoring location will be used to develop stage-discharge rating curves. These curves will, in turn, be used to convert logger water levels into a continuous discharge record for the period of study. This will also allow for the estimation of surface water contaminant loads from surface tributaries into Silver Lake and out of the lake into downstream waters.

### Groundwater Assessment

Groundwater seepage sampling will be used to assess the influence of groundwater inflows on water quality in Silver Lake. Survey timing is anticipated for April 2022.

Direct groundwater seepage can sometimes be a major source of pollutants to surface water bodies, including densely developed shorelines. Measuring the quantity and quality of these groundwater inputs can be important for understanding why the system is no longer meeting its water quality goals. A seepage survey measures the quantity and quality of groundwater entering the lake along the immediate shorelines where groundwater inseepage is highest and typically the most influenced by human behaviors and activities.

To measure the seepage rate, eight seepage meters will be deployed along four key shoreline segments of Silver Lake, including two at the upper end and two closer to the dam and outlet. Two of these shoreline segments will be located downgradient of nearby developed areas and two will be located adjacent to natural or less-developed areas. Two meters will be deployed along each shoreline segment to adequately capture the local variability in groundwater movement.

On the same day, shallow porewater samples will be collected from each of the four shoreline segments using a littoral interstitial porewater (LIP) sampler, which is essentially a mini-well that extracts groundwater from sediments for water quality testing. Samples will be measured in the field for temperature, pH, and specific conductance and compared to surface water quality measurements to ensure that groundwater is being obtained by the LIP sampler. A total of four composite groundwater quality samples will be collected in Silver Lake; one from each shoreline segment.

See Appendix A for more information on sampling methods.

Laboratory analysis will be conducted for the following at each shoreline sampling segment:

- Soluble Phosphorus
- Ammonia
- Nitrate-Nitrogen

ESS anticipates completing the seepage sampling program in spring of 2022 to capture seasonal high water-table conditions.

### Quality Assurance

A Quality Assurance Project Plan (QAPP) will be prepared under separate cover and submitted to EPA Region 1 for review and comment. The purpose of the QAPP is to ensure that the data collected under this SAP meet the required data quality objectives.

## PROJECT SCHEDULE

The overall Project schedule is currently anticipated to extend from July 2021 to June 2022. A detailed Project schedule showing the timing of planned sampling events and deliverables is provided in Figure 4. Task 4 presents the specific schedule for sampling and analysis components included in this SAP.

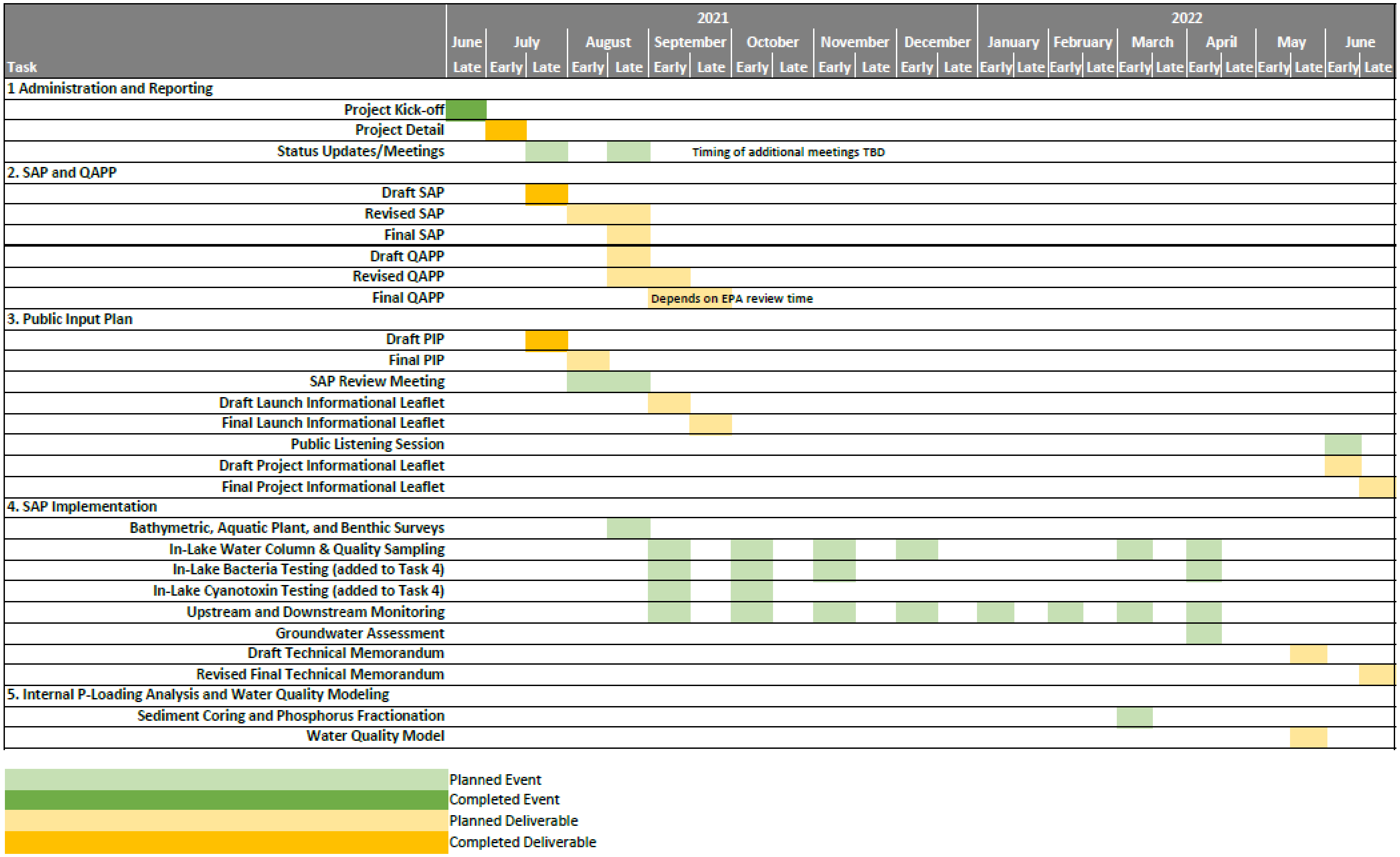



*Figure 4. Detailed Project Schedule for Silver Lake Water Quality Monitoring Project*
Current through July 24, 2021

# Appendix A

## Field SOPs

# GUIDELINES FOR MEASUREMENT OF SPECIFIC CONDUCTANCE

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine calibration and operation of a variety of specific conductance meters. This SOG document also addresses estimation of total dissolved solids (TDS) and salinity by direct measurement of specific conductance (specific methods and capabilities for these parameters are outlined in the manufacturer's individual instrument manuals). This SOG is designed to be consistent with EPA Method 120.1 and Standard Method 2510 B which address specific conductance measurements of drinking, surface, and saline waters, domestic and industrial wastes, and acid rain.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory analyses.

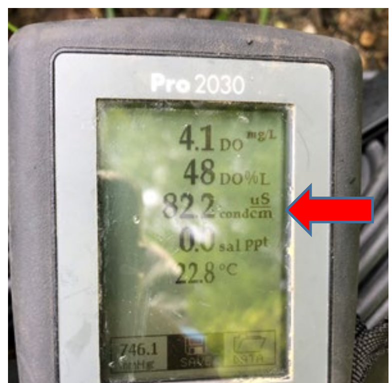
## 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.
- The analyst is responsible for verifying that the specific conductance meter is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Specific conductance meter
- Specific conductance meter manufacturer's instruction manual
- Deionized water
- Conductivity standard at concentration that approximates anticipated range of sample concentrations
- Lint-free tissues
- Calibration sheets or logbook
- Laboratory or field data sheets or logbooks




*Handheld YSI 2030 meter, red arrow showing where the specific conductance is measured*

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

- Specific conductance measurements should be taken in situ or soon after sample collection since temperature changes, precipitation reactions, and absorption of carbon from the air can affect the specific conductance. If specific conductance measurements cannot be taken immediately (within 24 hours), samples should be filtered through a 0.45 μm filter, stored at 4°C and analyzed within 28 days.
- Report results as specific conductance, μmhos/cm or μS/cm at 25°C.

- Secondary standards may be purchased as a solution from commercial vendors. These standards should not be used after their expiration dates as provided by the manufacturer. An expiration date of one year from date of purchase should be used if the expiration date is worn or missing.

## 4.2. Calibration and Measurement Procedures

- The specific conductance meter must be calibrated (or the calibration checked) before any analyses are performed.
- Set up the instrument according to the manufacturer's instructions.
- Rinse the probe with deionized water prior to use. If necessary, dry with a lint-free tissue or cloth.
- Follow the manufacturer's recommendations for appropriate calibration receptacle and depth of immersion.
- Record the stabilized specific conductance reading of the standard and the temperature. Enter the calibration mode (according to manufacturer's instructions) and change the value on the primary display to match the value of the calibration standard. The meter may be adjusted to ±20% from the default setting. If the measurement differs by more than ±20%, the probe should be cleaned, serviced, or replaced as needed.
- An additional check may be performed, if required by the project plan, by placing the probe into an additional standard. This standard should be from a different source than the standard used for the initial calibration. This standard should read within 5% of the true value.

*Use of YSI handheld device and probe*

- Verify the calibration at least once a month or whenever the instrument has been moved from freshwater to saltwater environments or vice versa. Recalibrate or service the instrument, as needed, if the check value is not within 15% of the true (calibration standard) value.

### 4.3. Troubleshooting Information

If there are any performance problems with any of the specific conductance meters which result in inability to achieve the acceptance criteria presented in Section 5.0 or the project-specific acceptance criteria, consult the appropriate section of the meter instruction manual for troubleshooting procedures. If the problem persists, consult the manufacturer's customer service department immediately for further guidance.

### 4.4. Maintenance

- Instrument maintenance should be performed according to the procedures and frequencies required by the manufacturer.
- The probe must be stored and maintained according to the manufacturer's instructions.

## 5.0 QUALITY CONTROL

- The meter must be calibrated (or the calibration checked) before sampling, and will not be used for sample determinations of specific conductance unless the initial check standard value is within 5% of the true value.

- Duplicate measurements of a single sample will be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within 10%.

## 6.0 DOCUMENTATION

- Meter calibration, temperature check, and maintenance information will be recorded in a calibration log. Specific conductance data may be recorded on the appropriate laboratory or field data sheets or logbooks.
- Calibration documentation should be maintained in a thorough and consistent manner. At a minimum, the following information should be recorded:
  - Date and time of calibration
  - Person performing the measurement
  - Instrument identification number/model
  - Expiration dates and batch numbers for all standards
  - Reading for standard before and after meter adjustment
  - Readings for all continuing calibration checks
  - Temperature of standards (corrected for any difference with reference thermometer)
  - Comments
- Documentation for recorded data must include a minimum of the following:
  - Date and time of analysis
  - Person performing the measurement
  - Sample identification/station location
  - Temperature (corrected for any difference with reference thermometer) and conductance of sample (including units and duplicate measurements).
  - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform specific conductance measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

Certain state certification programs require that specific conductance measurements be taken in the field by, or in the presence of, personnel that are qualified under the certification program.

# GUIDELINES FOR MEASUREMENT OF DISSOLVED OXYGEN

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine measurement of dissolved oxygen using a polarographic sensor-equipped dissolved oxygen meter with a digital read-out (e.g., YSI Pro2030 Dissolved Oxygen, Conductivity, Salinity Instrument). Measurements are made in accordance with methods that address dissolved oxygen measurement of drinking, surface, and saline waters, and domestic and industrial wastes.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory measurements.

## 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.

- The analyst is responsible for verifying that the dissolved oxygen measuring device is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.


*Handheld YSI 2030 meter, Red arrow showing were the dissolved oxygen is measured*

## 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Dissolved oxygen meter with digital read-out device

- Manufacturer's instruction manual for the instrument

- Manufacturer's recommended operating solution and replacement membranes or caps

- Laboratory or field data sheets or logbooks

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

To achieve accurate dissolved oxygen measurements, samples should be analyzed in situ. Measurements in flowing waters should be made in relatively turbulent free areas. Measurements in standing waters may require gentle probe agitation to create water movement around the probe (check instrument manual to confirm).

### 4.2. Calibration and Measurement Procedures

To accurately calibrate some dissolved oxygen meters, it may be necessary to know the altitude of the region in which you are located and the approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has an approximate salinity of 35 practical salinity units (psu). If uncertain, measure salinity first with an appropriate device. The instructions below are applicable to the YSI Model 55; for other instruments, consult the instruction manual.

- Ensure that the sponge inside the instrument's calibration chamber is wet then insert the probe into the chamber. Turn the instrument on and wait for readings to stabilize (as long as 15 minutes, depending on the model).
- To calibrate, enter the calibration menu by pressing and releasing both the up and down arrow keys at the same time. Enter the altitude (in hundreds of feet) at the prompt by using the arrow keys to increase or decrease the altitude (example: 12 = 1,200 feet). Press enter when correct altitude is shown.
- The meter should display CAL in the lower left of the display with the calibration value in the lower right of the display and the current D.O. reading (before calibration) should be on the main display. Once the D.O. reading is stable, press ENTER. Enter the salinity at the prompt by using the arrow keys. Press ENTER when finished and the instrument will return to normal operation.
- Calibration should be performed at a temperature within ± 10°C of the sample temperature. Recalibrate every 15 samples and whenever the unit is turned on.
- If calibration is out of range, erratic readings occur, bubbles appear, or if the membrane becomes damaged, wrinkled, or fouled refill the membrane solution and/or replace the membrane, per the manufacturer's manual.

*Use of YSI handheld device and probe*

- Avoid contact with environments containing substances that may attack the probe materials (e.g. acids, caustics, and strong solvents).

## 4.3. Troubleshooting Information

If there are any performance problems with the dissolved oxygen-measuring device, consult the appropriate section of the instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

## 4.4. Maintenance

Instrument maintenance for meter-type dissolved oxygen measuring devices should be performed according to the procedures and frequencies required by the manufacturer. Rinsing the probe with distilled or deionized water and preventing exposure of the membrane to drying is typically all that is required on a day-to-day basis.

## 5.0 QUALITY CONTROL

Duplicate measurements of a single sample should be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within ± 0.2 mg/L.

## 6.0 DOCUMENTATION

All dissolved oxygen meter calibration, checks, and maintenance information will be recorded in a calibration logbook. Dissolved oxygen data may be recorded on the appropriate field data sheets or field books.

- Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:
    - Date and time of calibration
    - Person performing the measurement
    - Instrument identification number/model
    - Readings for all continuing calibration checks
    - Comments
- Documentation for recorded data must include a minimum of the following:
    - Date and time of analysis
    - Person performing the measurement
    - Sample identification/station location
    - Dissolved oxygen, both in mg/L and percent saturation and temperature of sample (including units and duplicate measurements)
    - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform dissolved oxygen measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

Certain state certification programs require that dissolved oxygen measurements in the field be taken by, or in the presence of, personnel that are qualified under the certification program.

# GUIDELINES FOR MEASUREMENT OF PH

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine calibration and operation of a variety of pH field pens. Although these meters may measure additional parameters (e.g., temperature, specific conductance, etc.), this SOG addresses pH measurement only (other capabilities are outlined in the appropriate SOG and manufacturer's individual instrument manuals). This SOG is designed specifically for the measurement of pH in accordance with EPA Method 150.1 and Standard Method 4500-H B which address electrometric pH measurements of drinking, surface, and saline waters, domestic and industrial wastes, and acid rain.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory analyses.

## 2.0 RESPONSIBILITIES

- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.
- The analyst is responsible for verifying that the pH meter is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

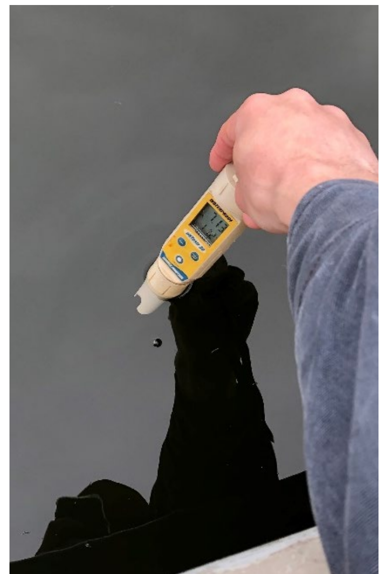
The following materials are necessary for this procedure:

- pH meter
- pH meter manufacturer's instruction manual
- Deionized or distilled water
- 4.0, 7.0, and 10.0 buffer solutions
- Lint-free tissues
- Mild detergent
- Manufacturer’s recommended storage solution
- Manufacturer’s recommended cleaning solution
- Field data sheet or logbook
- Calibration sheet or logbook

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

- To achieve accurate pH measurements, samples should be analyzed immediately in the field, or as soon as possible after collection. Sample should be measured *in situ* or collected in plastic or glass containers.
- As temperature can affect the pH measurements obtained, both the pH and the temperature of the sample must be recorded, unless the meter is capable of automatic temperature correction (ATC).
- Primary standard buffer salts available from NIST can be purchased and are necessary for situations where extreme accuracy is required. Secondary standard buffers may be purchased as a solution from commercial vendors and are recommended for routine use. Buffers should not be used after their expiration dates as provided by the manufacturer. An expiration date of one year should be used if the manufacturer does not supply an expiration date or if the buffers are prepared from pH powder pillows, etc.
- Keep the probe elevated off the bottom to avoid disturbing sediments. Allow readings to fully stabilize before recording the pH measurement. This may take several minutes, especially if the pH is drastically different from the last reading or the bulb has been allowed to dry out between readings.
- Rinse the electrode with deionized or distilled water between samples and wipe gently, if needed, with a lint-free tissue. If a more thorough cleaning is required, use a mild detergent (e.g., dish soap) or the manufacturer's recommended cleaning solution.



*Handheld pH meter*

- Store the probe in the manufacturer's recommended storage solution or, if this is not available, tap water. Do not use distilled or deionized water for storage purposes.

### 4.2. Calibration and Measurement Procedures

- The pH meter should be checked weekly before any analyses are performed. Otherwise, the meter should be checked or calibrated at the frequency specified in the project plan.
- Calibration should include a minimum of one point but ideally, a two point calibration that brackets the expected pH of the samples to be measured is desirable. Calibration measurements should be recorded in the calibration logbook.
- Choose either 7.0 and 10.0 (high range) or 4.0 and 7.0 (low range) buffers, whichever will bracket the expected sample range. Pour each buffer into a clean glass beaker. The volume should be sufficient to fully submerse the pH bulb and thermistor. If the pH is being measured in a laboratory, place the beaker on the magnetic stirrer and place the stirring bar in the beaker. Measure and record the temperatures of the buffers using a calibrated thermometer or automatic temperature compensation (ATC).
- Follow the manufacturer's calibration instructions.
- Once calibration is complete, discard the buffer and rinse the beaker (and stirring bar, if used) thoroughly with distilled or deionized water.

- An additional check may be performed, if required by the project plan, by placing the electrode into an additional buffer solution. This buffer should be from a different source than the buffers used for the initial calibration. This buffer should read within ±0.2 pH units of the buffer's true pH value.
- Recalibrate the instrument if any of the following apply:
  - the check value varies more than 0.2 pH units from the true value
  - the expected pH of the sampled water body is outside the current calibration range
  - readings are erratic or do not stabilize
  - the instrument has just been cleaned or otherwise disturbed for maintenance

### 4.3. Troubleshooting Information

If there are any instrument performance problems that result in the inability to achieve the acceptance criteria presented in Section 5.0, consult the appropriate section of the meter instruction manual for troubleshooting procedures. If the problem persists, consult the manufacturer's customer service department immediately for further guidance.

### 4.4. Maintenance

- Instrument maintenance should be performed according to the procedures and frequencies required by the manufacturer.
- The electrode should be stored and maintained according to the manufacturer's instructions.

## 5.0 QUALITY CONTROL

- Duplicate measurements of a single sample will be performed at the frequency specified in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within ±0.2 pH units.

## 6.0 DOCUMENTATION

- All pH meter calibration, temperature check, and maintenance information will be recorded in a calibration logbook.
- pH data may be recorded on the appropriate laboratory or field data sheets or logbooks.
- Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:
  - Date and time of calibration
  - Person performing the measurement
  - Instrument identification number/model
  - Expiration dates and batch numbers for all buffer solutions
  - Reading for pH 7.0 buffer before and after meter adjustment
  - Reading for pH 4.0 or 10.0 buffer before and after meter adjustment
  - Readings for all continuing calibration checks
  - Temperature of buffers (corrected for any difference with reference thermometer), including units
  - Comments

- Documentation for recorded data must include a minimum of the following:
    - Date and time of analysis
    - Person performing the measurement
    - Sample identification/station location
    - Temperature and pH of sample (including units and duplicate measurements)
    - Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform pH measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

# GUIDELINES FOR MEASURING STREAMFLOW

## 1.0 INTRODUCTION

These guidelines provide instructions for the field measurement of flow rate in bodies of running water.

Descriptions of two field techniques are provided.

The first, called the time of travel method, is simple and does not require expensive or specialized equipment. This is most appropriate for rapid streamflow assessments where order of magnitude accuracy is acceptable or water depth is too low for the accurate measurement using a velocity meter.

The second method requires the use of a current meter, which is the preferred method where discharge measurements are being used to develop at-a-station rating curves and water depth is sufficient for measurement.

Additionally, these guidelines provide This method of calculating streamflow involves determining the cross-sectional area of the stream and measuring the average time it takes for a neutrally buoyant object to travel a known distance.

## 2.0 REQUIRED MATERIALS

The following materials are necessary for the measuring streamflow:

- Measuring stick to measure stream depth (folding stick is recommended)
- Flexible tape measure (longer than the width of the stream)
- Field data sheet, logbook, or tablet with electronic data sheet

If using a velocity meter, the following additional materials are also required:

- Swoffer Model 2100 current velocity meter (or similar)
- Calibrated wading rod

If using the time of travel method, the following additional materials are also required.

- A neutrally buoyant float
- Stopwatch (built-in app on most smartphones)
- Net (to catch the float)

## 3.0 METHODS

### 3.1 Choosing a Cross Section

Measuring stream depth using a folding yard stick.

- Select an appropriate stream cross section. The location selected should be straight (no bends), and free of obstructions. Unobstructed runs are ideal.
- Identify the left and right banks of the stream. When working in streams, left and right are relative to the mean flow direction. Therefore, the left bank will be to one's left when facing downstream but to one's right when facing upstream.
- To assure consistency of measurements and allow for easier comparison of data across time, flow should be measured at the same cross section of the stream during all visits. Include descriptions of site landmarks in field notes, and/or take photos of measurement locations. If site conditions allow, install permanent cross section markers, such as stakes or rebar.
- If a staff gauge is present near the stream measurement location, record the staff gauge depth during each visit.

### 3.2. Divide the Channel into Subsections

- Establish a transect by stretching the measuring tape across the stream, perpendicular to the channel axis. Secure each end of the tape to the stream banks so that the tape is taut.
- Take a minimum of four photographs, including one each facing upstream, the left bank, downstream, and the right bank.
- Starting with the left edge of water, measure width and stream depth at no less than three locations (stations) within the steam channel. This is the minimum number of stations and most streams will require more than three measurements to accurately calculate discharge.
- The area between each vertical station represents a channel subsection.

### 3.3. Measuring Velocity

#### 3.3.1 Time-of-Travel Method

- To measure travel time, time how long it takes for a neutrally buoyant object (a float) to travel a known distance. Suitable objects should float, but sit very low in the water to minimize influence from wind, and can be untethered or tethered (methods adapted from EPA, 2012a described below).

- Suitable floats include:
  - citrus fruits or pieces of citrus peel
  - cheese puffs
  - small sponge rubber balls
  - small sticks or bits of vegetation
- Always face upstream when taking velocity measurements. Stand far enough downstream that stream velocity is not affected in the location being measured.
- Surface velocity is generally greater than depth-averaged velocity, so a correction factor (0.8 for rocky-bottom streams, 0.9 for muddy-bottom streams) is applied to float travel times (see Section 3.3, EPA 2012b)
- Untethered floats should be biodegradable, or a second person equipped with a net should be stationed downstream of the sampling reach to retrieve the float(s).
- Hold the measuring stick above the water surface, perpendicular to the cross section. Release the untethered float somewhat upstream of the end of the measuring stick to allow the float to reach full flow velocity. Using a stopwatch, time how long it takes for the float to travel a known distance (3 ft is recommended for most streams but longer distances may be appropriate where velocity is high). Repeat this process three times to obtain an average time to travel at one station before proceeding to the next station.

### 3.3.2 Depth-Averaged Current Meter Method

- Set the current meter to average measurements over at least a three second period. Longer periods may be used if appropriate to conditions.
- Always face upstream when taking velocity measurements. Stand far enough downstream that stream velocity is not affected in the location being measured.
- Carefully place the wading rod in the flow until the base is firmly on the stream bottom.
- Orient the current meter perpendicular to the cross section transect.
- Ensure that the wading rod is straight up and down (not angled).
- Hold the wading rod steady while adjusting the calibrated height of current meter to match the measured depth. This will allow collection of measurements that are reflective of depth-averaged velocity.
- Once at least three seconds have passed, view the reading from the current meter. Allow at least three readings to occur before recording. This will prevent erroneous data due to averaging of measurements from the set up process.

### 3.4. Calculating Flow

- The following equation is used to calculate flow using the time-of-travel method):

$$Q = (ACL)/T$$

  - Q = stream discharge
  - A = cross sectional area
  - L = distance traveled by the float
  - C = correction factor (0.8 for rough streambeds, 0.9 for smooth streambeds)
  - T = average time of travel (seconds)

The following equation is used to calculate flow using the depth-averaged current meter method:

$$Q = AV$$

  - Q = stream discharge
  - A = cross sectional area
  - V = velocity at 60% depth

## 4.0 DOCUMENTATION

Record streamflow data on field sheets, field notebooks, or electronic tablets. Any unanticipated site-specific information, which requires deviation from the above guidelines should also be recorded. In addition to recording the required discharge data, field notes for streamflow measurement should include a minimum of the following:

- Name or initials of person conducting the measurement
- Discharge measurement method used
- Site ID or name
- Date and time of streamflow measurement
- Environmental conditions (wind, temperature, etc.)
- Other relevant observations about site conditions
- Photographic evidence of streamflow and site conditions is also useful for verification of relative stream stage and flow from different visits, as well as any environmental factors that may have influenced data collection.

## 5.0 REFERENCES

EPA, 2012a. Water: Monitoring and Assessment. 5.1 Stream Flow. United States Environmental Protection Agency. Office of Water. EPA 841-B-97-003. Accessed January 27, 2020 at https://archive.epa.gov/water/archive/web/html/vms51.html

EPA, 2012b. SESD Operating Procedure, Hydrologic Studies. Effective Date November 1, 2012. United States Environmental Protection Agency. Office of Water. SESDPROC-501-R3. Accessed January 27, 2020 at https://www.epa.gov/sites/production/files/2015-06/documents/Hydrological-Studies.pdf

## GUIDELINES FOR COLLECTION OF SURFACE WATER SAMPLES

## 1.0 INTRODUCTION

These guidelines provide basic instructions for the routine acquisition of surface water from lakes, ponds, and streams. The methods outlined below are intended to (1) standardize water sample collection methods; (2) ensure that samples delivered to the laboratory represent field conditions as accurately as possible; (3) assure proper documentation of sample collection; and (4) minimize cross contamination between sampling sites.

## 2.0 REQUIRED MATERIALS

The following materials are necessary for the acquisition of surface water samples:

- Nitrile gloves
- Labeled sample bottles provided by contracted laboratory (appropriately sanitized and containing the necessary preservative for desired analyses, see Table 1.0 for examples)
- Field data sheets or logbooks, including list of sites or locations to be sampled, and pencil
- Cooler with ice packs for sample storage
- Integrated depth sampler (if collecting algae sample)
- Secchi disk (if collecting algae samples)
- Laboratory Chain of Custody

**Table 1.0 Example Container Types, Preservative Requirements, and Hold Times for Water Quality Samples.**

| Analysis | Bottle Type | Preservative | Hold Time |
|---|---|---|---|
| Total Phosphorus | plastic | $H_2SO_4$ | 28 days |
| Dissolved Phosphorus | plastic | As Is | analyze immediately* |
| Total Suspended Solids (TSS) | plastic | As Is | 7 days |
| Nitrate/Nitrite | plastic | As Is | 48 hrs |
| Total Kjeldahl Nitrogen (TKN) | plastic | $H_2SO_4$ | 28 days |
| Metals - Total | plastic | $HNO_3$ | 6 months** |
| Metals - Dissolved | plastic | As Is | 6 months** |
| Algae | opaque plastic | Lugol's iodine | >1 year |
| Chlorophyll-a | opaque plastic | As Is | analyze immediately |
| Bacteria | sterile plastic | As Is | 6 hrs |

* = 24 hrs with field filtration, ** = 28 days for mercury

## 3.0 METHODS

### 3.1 General Sampling Instructions

*Using a pre-cleaned (as is) bottle to fill a sample bottle containing preservative.*

- Testing methods, sample containers, preservation techniques, and sample volumes should be selected in consultation with the laboratory to ensure that samples obtained will provide the desired results.

- Hold times vary considerably between different analytes and must be taken into consideration when planning field sampling efforts and lab courier pickups to assure the validity of analytical results.

- Field filtration of certain samples (dissolved phosphorus) is recommended. The laboratory can supply syringes and filters for use in the field.

- In general, surface water samples should be collected via direct grab methods.

- Sample collection should precede the measurement of physical field parameters (including pH, apparent color, turbidity, conductivity, and dissolved oxygen) in order to minimize the risk of sediment disturbance and/or sample contamination.

- Clean rubber gloves should be worn at each sampling location. When sampling multiple sites on the same day, gloves may be rinsed in the immediate area of the waterbody to be sampled (downstream at flowing sites).

- Approximately 1-inch of air space should be left when filling sample bottles (except for dissolved oxygen, alkalinity, and BOD samples), so that bottles may be shaken (if needed) before analyses (EPA, 1997; Simpson 1991).

- Sample containers with preservatives should not be used to collect water samples. If using containers with preservatives, a pre-cleaned container of similar type (an as is bottle) should be used to collect and subsequently transfer the sample to the preserved container.

- Ensure that all sample bottles are correctly and completely labeled before storage. Sample bottles should be stored in a cooler with ice packs (it is best to avoid ice, as meltwater could potentially contaminate samples) or in a refrigerator until they are submitted to a lab courier.

### 3.1.1. Lake and Pond Sampling

- Grab samples from lakes and ponds should be collected at approximately 8 to 12 inches beneath the water surface or mid-way between the surface and the bottom if the waterbody is shallow (EPA 1997). Samples should not be collected in close proximity to the lake shoreline or submerged obstacles.

- To collect water samples, hold an as is bottle near the base, remove the lid, and plunge it into the water with the opening facing downward. Invert the bottle and allow it to fill before bringing it to the surface. Decant sufficient water from the bottle to allow for the required headspace and replace the cover, or carefully pour the contents into a bottle containing preservative. Repeat the above process to refill the as is bottle as many times as necessary.

**Algae Samples**

*Integrated depth sampler for collection of algae samples.*

- Algae samples should be stored in opaque bottles with a small amount of Lugol's iodine for preservative (~1-2 drops in a 250 mL bottle). Algal taxonomy labs can provide opaque plastic bottles, but standard plastic as is bottles covered in aluminum foil can also be used.

- Algae samples should be collected using an integrated depth sampler. An integrated depth sampler consists of a length of tubing (~1in diameter, at least 2 m long) with a weight attached to one end. Sample collection procedures using the depth sampler should proceeds as follows (procedure adapted from EPA 2012):
  - Determine the euphotic zone:
    - Lower the secchi disk over the shaded side of the boat until it disappears. Lower the disk a bit further, then slowly raise the disk until it reappears. Record the reappearance depth. The euphotic zone is calculated by multiplying the reappearance depth by 2.
  - Holding onto the non-weighted end of the sampler, lower the tube into the water column. Rinse the sampler by submerging it three times.
  - Lower the sampler so that it is submerged to the depth of the euphotic zone, or fully submerged if the euphotic zone is deeper than the length of the sampler. Cover the opening at the non-weighted end with a gloved thumb.

- Lift the sampler completely out of the water and cover the opening at the weighted end with a gloved thumb (both ends should be covered). Repeatedly lift each end of the sampler to mix the water sample within the tube.
- Fill the algae sample bottle with the required volume of water from the sampler (the bottle will contain Lugol's solution as preservative so be careful not to over-fill).
- Unlike samples for most other analytes, preserved algae samples can be stored at room temperature before submission to a lab.

### 3.1.2. Stream Sampling

- Samples should be collected from the center of small streams (i.e., 10-20 feet wide with a maximum depth of less than 2 feet), and at a location where water depth is 2-3 feet in larger streams.
- Always approach a sampling location from downstream, traveling so as to minimize the disturbance of bottom sediments and upstream waters.
- Stand downstream of the desired sampling location, hold the sample bottle near its base and plunge it below the water surface with the opening (mouth) downward. The opening of sample bottles should always be directed away from the sampler in an upstream direction.
- To inform investigations about nutrient inputs, stream flow should be measured whenever water quality samples are collected (see Guidelines for Measuring Stream Flow)

## 4.0 DOCUMENTATION

Report surface water field data on sheets or in notebooks. Any unanticipated site-specific information, which requires deviation from the above guidelines, should be recorded. Field notes for surface water sampling should include a minimum of the following:

- Name or initials of person collecting the samples
- Sample identification/station location
- Date and time of sample collection
- Environmental conditions (e.g. wind, weather)
- Other comments or observations about water quality and site conditions (e.g. visible algae bloom, dead fish nearby, sample has noticeable odor or color, etc.)

Photographic evidence of any notable conditions is also desirable.

## 5.0 REFERENCES

EPA, 2012. 2012 National Lakes Assessment Field Operations Manual. Version 1.0, May 15, 2012. United States Environmental Protection Agency. Office of Water. EPA-841-B-11-003. Accessed January 22, 2020 at https://www.epa.gov/sites/production/files/2013-11/documents/nla2012_fieldoperationsmanual_120517_final_combinedqrg.pdf

# GUIDELINES FOR MEASURING GROUNDWATER SEEPAGE QUANTITY AND QUALITY

## 1.0 INTRODUCTION

These Standard Operating Guidelines (SOG) provide basic instructions for the routine measurement of groundwater seepage quality and quantity. These standard methods describe the proper installation of seepage meters and the operation of Littoral Interstitial Porewater (LIP) samplers.

## 2.0 REQUIRED MATERIALS

The following materials are necessary for the seepage meter installation procedure:

- Seepage meters of known diameter
- Plastic tubing with one hole stopper
- Seepage bags with one hole stoppers and plastic clamps
- 250 mL graduated cylinder
- Field book or data sheets

The following materials are necessary for the collection of groundwater samples for analysis:

- Hand pump
- 2-1 L filter flasks with stoppers and tubing
- Littoral Interstitial Porewater (LIP) sampler
- Sample bottles with labels

## 3.0 METHODS

### 3.1 Seepage Meter Installation

- Initially, representative segments of the shoreline, where seepage meters will be positioned, are selected based on topography and housing density. Such segments may also be assigned to shoreline locations based on specific project objectives.

- ESS personnel shall estimate seepage quantity by installing two seepage meters per defined shoreline segment and measuring the change in volume in the attached seepage bag over time. Change in volume multiplied by a conversion factor relating the allotted seepage time (i.e., fraction of the day for which the seepage meter was running) and then adjusting to unit area (square meter), yields the liters of inseepage (positive value) or outseepage (negative value) per square meter per day.

- Seepage meters shall be firmly embedded in the substrate to depth of greater than 4 inches. Inserting seepage meters to this preferred depth will ensure that volumetric changes observed in the attached seepage bags are truly representative of groundwater flows and will increase the likelihood that seepage meters will not be disrupted by strong currents or wave action.

- At each designated shoreline location (segments pre-determined by project plan), one seepage meter should be placed at a relatively shallow depth and one at a deeper depth in order to capture ground water flows that may be occurring in different strata.

- Seepage meters must be allowed to equilibrate for a minimum of 5 minutes before the system is “closed” by the attachment of the seepage bags.

- The seepage bag should be filled with an appropriate pre-measured volume of water. In most instances 250 mL will be appropriate. The pre-determined volume of water is necessary since this volume is compared to the volume obtained after sufficient time has elapsed to quantify the change in volume (either positive or negative).

- Seepage bags are to be secured in place with as little disturbance of the seepage meter as possible. The best approach is to slowly twist the seepage bag's rubber stopper into the hole of the seepage meter.

- Prior to use, seepage bags must be air dried in order to ensure that all residual water is removed from bags and therefore will not confound the change in volume measurements. Additionally, each bag and associated stopper must be visually inspected and air pressure tested prior to each use to ensure that no leakage can occur.

### 3.2. Groundwater Sampling Using Littoral Interstitial Porewater Sampler

- Groundwater seepage quality can be collected through sampling with a Littoral Interstitial Porewater (LIP) sampler. A hand pump, attached to a 250 ml HDPE plastic flask, creates a low-pressure vacuum causing water to flow from the LIP sampler into the attached plastic flask. To avoid accidental contact of the extracted water with the hand pump, a second plastic flask should be connected in-line using additional tubing.

- Porewater should be extracted from a minimum of three locations in each segment and composited using equal volumes from each location.

- Samples collected may be tested in the field for parameters such as, temperature, conductivity, and pH, and/or transferred into labeled bottles and sent to a laboratory for the other analyses.

## 4.0 DOCUMENTATION

Record data on field sheets, field notebooks, or electronic tablets. Any unanticipated site-specific information, which requires deviation from the above guidelines should also be recorded. Documentation should include a minimum of the following:

- Name or initials of person conducting the measurement
- Date
- Site ID or name
- Size of seepage meter (diameter)
- Time of seepage meter installation
- Time of seepage meter retrieval
- Volume of water added to seepage meter bag at installation
- Volume of water remaining in seepage meter bag at retrieval
- Results of in-lake and extracted groundwater field parameter measurements (temperature, pH, and specific conductance at a minimum)
- Environmental conditions (wind, temperature, etc.) and other relevant observations about site conditions
- Photographic evidence of conditions

# GUIDELINES FOR THE MEASUREMENT OF TURBIDITY

## 1.0 INTRODUCTION

### 1.1 Purpose and Applicability

These Standard Operating Guidelines (SOG) provide basic instructions for routine measurement of turbidity using a nephelometric turbidity meter with a digital read-out device (e.g., LaMotte 2020we Turbidimeter). Measurements are made in accordance with EPA Method 180.1 that addresses nephelometeric turbidity measurement of drinking, surface, and saline waters, and domestic and industrial wastes.

### 1.2 Quality Assurance Planning Considerations

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Quality Assurance Project Plan (QAPP) (hereafter referred to as the project plan) or laboratory Quality Assurance Manual (QAM) and may include duplicate or replicate measurements or confirmatory measurements.

## 2.0 RESPONSIBILITIES

- The analyst is responsible for verifying that the turbidity measuring device is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOG and the project plan.
- The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOG and the project plan.

## 3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Turbidity meter with digital read-out device
- Manufacturer's instruction manual for the instrument
- Turbidity tubes/cuvettes
- Mild detergent
- Lint-free cloth
- Distilled water
- Nephelometric Turbidity Unit (NTU) calibration standards
- Laboratory or field data sheets or logbooks

*Example of a sample cuvette*

## 4.0 METHODS

### 4.1 Sample Handling, Preservation, and General Measurement Procedures

To achieve accurate turbidity measurements, samples should be analyzed immediately upon collection (preferably within 15 minutes). Samples should be collected in glass or plastic containers.

### 4.2. Calibration and Measurement Procedures

- Select a turbidity standard in the range of the samples to be tested (typically 0.00 NTU, 1.00 NTU or 10.0 NTU) or as recommended by the manufacturer. Fill a turbidity tube or cuvette with the standard, cap, and wipe the tube with the clean lint-free cloth.

- Place the sample into the turbidity meter such that the indexing arrow or line on the turbidity tube is aligned with the indexing arrow or notch on the meter face. Close the lid and press the “READ” button. If the displayed value is not the same as the value of the standard (within 10%), continue with the calibration procedure.
- Follow the calibration procedures outlined by the manufacturer’s manual.
- Verify the calibration every 15 samples and at the end of the day. Recalibrate the instrument if the check value varies more than 10% from the true value.
- Rinse cuvettes with deionized or distilled water and wiped gently with a lint-free tissue between sample analysis.
- Recalibrate the instrument with the appropriate NTU standard if the standard is not of the same order of magnitude as the samples being tested.
- The meter must be re-calibrated following any maintenance activities and prior to the next use.
- Record the turbidity reading to the nearest 0.01 NTU for measurements less than 11 NTU and to the nearest 0.1 for measurements greater than 11 NTU but less than 110 NTU. For values greater than 110 NTU record to the nearest 1 NTU.

*Turbidity meter*

### 4.3. Troubleshooting Information

If there are any performance problems with any of the meter-type turbidity measuring devices, consult the appropriate section of the meter instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

### 4.4. Maintenance

Instrument maintenance for meter-type turbidity measuring devices should be performed according to the procedures and frequencies required by the manufacturer.

## 5.0 QUALITY CONTROL

The turbidity measuring tubes will, at a minimum, be checked against NTU calibration standards at the frequency stated in Section 4.2. This verification procedure will be performed in accordance with the manufacturer’s manual.

Duplicate measurements of a single sample will be performed at the frequency required in the project plan. In the absence of project-specific criteria, duplicate measurements should agree within + 5% for readings below 10 NTU and + 10% for readings above 100 NTU.

## 6.0 DOCUMENTATION

All turbidity meter calibration, checks, and maintenance information will be recorded on the daily calibration sheet or logbook. Turbidity data may be recorded on the appropriate laboratory or field data sheets or logbooks.

Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:

- Date and time of calibration
- Person performing the measurement
- Instrument identification number/model
- Expiration dates and batch numbers for all standard solutions
- Reading for each standard before and after meter adjustment
- Readings for all continuing calibration checks
- Comments

Documentation for recorded data must include a minimum of the following:

- Date and time of analysis
- Person performing the measurement
- Sample identification/station location
- Turbidity of sample (including units and any duplicate measurements)
- Comments

## 7.0 TRAINING/QUALIFICATIONS

To properly perform turbidity measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOG. The analyst must also be experienced in the operation of the meter.

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## GUIDELINES FOR USE OF WATER LEVEL DATALOGGERS IN SURFACE WATER

### 1.0 INTRODUCTION

These guidelines provide basic instructions for programming, deploying and downloading data from electronic dataloggers which are used for long-term water level monitoring and monitoring of other water quality parameters (e.g., temperature, conductivity). The methods outlined below are intended to (1) standardize datalogger monitoring of water levels; (2) ensure that data collected represent field conditions as accurately as possible; (3) provide guidance for the secure transfer and storage of data; and (4) assure proper field measurements and documentation.

### 2.0 REQUIRED MATERIALS

The following materials are necessary:

- Datalogger or Barologger
- Rebar, metal fence post or similar
- Sledgehammer or post driver
- Computer, laptop or tablet
- Communications device
- Datalogger software
- PVC housing and hose clamps
- Braided nylon twine or wire
- Water level monitoring device (electronic water level meter, plunker, etc.)
- Tools

### 3.0 PROGRAMMING THE DATALOGGER

The following general procedure is followed to edit the datalogger information and program the datalogger to collect readings. Always refer to the manufacturer's instructions for datalogger programming, deployment and data downloading and correction instructions.

If the datalogger is unvented, a second datalogger or Barologger will also need to be deployed to collect barometric pressure readings to support the barometric pressure correction of the data downloaded from the unvented datalogger.

- Connect the datalogger or Barologger to the computer, laptop or tablet using the supplied communications device.
- Select the appropriate COM or USB port for the communications device.
- Open the logger programming or launching page to allow for entering the logger details and programming the device for frequency of readings.
- Check the datalogger battery life and available memory to verify that it is acceptable for the intended use. This information can also be used to determine the frequency of data downloads that will be necessary.
- Rename the datalogger using the Site location.

- Program the datalogger to collect readings for the selected parameters at the specified interval.
    - The additional datalogger or Barologger should be programmed to collect readings at the same interval.
- Disconnect the datalogger from the communications device using the software program to disengage or remove from the communications device.

## 4.0 DEPLOYING THE DATALOGGER

The following general procedure should be used to deploy the datalogger for collection of readings.

- An appropriate location for the installation of the datalogger should be selected within a deep portion of the water body to allow for fluctuations in the water level.
    - An additional datalogger or Barologger should be mounted in the air in an inconspicuous location such as a tree or attached to a building.
- In surface water, the datalogger should be deployed within a PVC housing, if possible, to help to dampen any fluctuations (e.g., wave action or turbulence) in the surface water surface.
- The PVC housing should be secured using hose clamps to a mounting post (typically either rebar, metal fence post or similar) that can be driven into the substrate beneath the water body.
- Prior to deployment, collect a depth to water measurement from the top of the mounting post (rebar, metal fence post or similar) and an approximate depth to the bottom of the PVC housing.
- Deploy the datalogger by placing inside the PVC housing, attaching either braided nylon twine or wire to the datalogger, and threading through the top of the PVC cap to allow for retrieval of the datalogger without disturbing the position of the PVC housing.

## 5.0 DOWNLOADING DATA

The following general procedure should be followed when downloading the data.

- Soon after deployment (typically within two weeks, or as soon as possible given project constraints), a verification download should be performed to verify that the datalogger was programmed correctly and is collecting data at the appropriate interval.
- Subsequent downloads can be scheduled as necessary taking into consideration the frequency of readings and the available memory and battery life of the datalogger.
- Prior to removing the datalogger to download the data, collect a depth to water measurement from the top of the mounting post or other acceptable measuring point.
- Remove the datalogger and connect to the communications device.
- Connect the communications device to the computer, laptop or tablet and open the software.
- Navigate to the data download page and proceed with downloading the collected data.

  - Certain datalogger software packages will require that the datalogging process be stopped and the datalogger will have to be reprogrammed prior to redeployment.

- If the datalogger is unvented, correct the downloaded data using the program supplied by the Vendor using the data collected from the additional datalogger or Barologger.

## 6.0 STREAMFLOW MEASUREMENTS

In order to convert the hydraulic head (pressure) measurements from the datalogger to streamflow, a series of streamflow measurements needs to be collected at varying stream stages or flow stages to support the development of a rating curve.

*REFER TO THE GUIDELINES FOR MEASURING STREAMFLOW SOP FOR DETAILS ON THE COLLECTION OF STREAMFLOW MEASUREMENTS AND DEVELOPMENT OF A RATING CURVE.*

## 7.0 DOCUMENTATION

Maintain field notes for the datalogger deployment and data download events including the collected field measurements that will be used to QC the data collected by the datalogger and convert the collected measurements to elevation, if applicable.

Photodocumentation of the datalogger deployment and setup should also be maintained as well as any observations during the field visits.

## 8.0 REFERENCES

Select references to Vendors that supply dataloggers are provided below.

Solinst, Levelogger Series Software User Guide, https://www.solinst.com/products/dataloggers-and-telemetry/3001-levelogger-series/operating-instructions/user-guide/3001-user-guide.php

In-Situ, Rugged Troll 100 and 200 and Rugged Troll BaroTroll Instruments, https://in-situ.com/pub/media/support/documents/Rugged_TROLL_Manual.pdf

Onset, HOBO U20L Water Level Logger (U20L-0x) User's Manual, https://www.onsetcomp.com/support/manuals/u20l_17153/

**From:** Pine duBois
**To:** Matt Ladewig
**Cc:** Joanne Zygmunt; Frank Basler
**Subject:** Fwd: Silver Lake
**Date:** Friday, August 20, 2021 10:54:38 AM

Good Morning Matt,

Kate Bentsen from DER got back to me with her comments on the SAP (see below email)—I sent her the link on the CPCWD site a few days ago. Kate took over for Michelle Craddock last year as our contact for the DER Priority Project—flow to Jones River, and manages the stream gage there at Lake Street. I will send her your email/contact info, so she can provide data to you directly, as she indicates below.

I hope this helps—I am not second guessing any of our partners comments as they have more experience then I do with these types of efforts.

I very much look forward to your work. Please let me know if there is anything we might help you with.

Thank you, and have a peaceful Henri!

Pine duBois
pine@jonesriver.org
781-424-0353

http://www.jonesriver.org
*Save the River, Save the World!*

Begin forwarded message:

**From:** "Bentsen, Kate (FWE)" <kate.bentsen@state.ma.us>
**Subject: RE: Silver Lake**
**Date:** August 19, 2021 at 10:12:24 PM EDT
**To:** Pine duBois <pine@jonesriver.org>

Hi Pine,

I reviewed the SAP and have a few comments:

- For macroinvertebrate processing, unless density is a key metric, it would be more efficient to sort and identify a subsample rather than the entire sample. Subsampling to 300 organisms per sample is pretty standard.
- For water quality parameters that have a strong diel signal, like dissolved oxygen, be mindful of when in the day samples are taken to ensure consistency across sampling dates and locations.
- I recommend programming continuous loggers to collect data every 15-min, rather than every hour. Since loggers will be downloaded relatively frequently, there is not a concern about the loggers filling up too soon given the higher data resolution.
- Will staff gages be installed at each monitoring station? Staff gages are recommended in addition to the PVC housing/stilling well for the loggers to allow for consistent gages readings. These gage readings are useful for both making corrections to logger data (for offset and drift) as well as for rating curve development. The gage/PVC should also be surveyed with laser level and tripod to ensure gage/PVC have not moved during the period of record.
- A downstream monitoring station is not needed, since a station already exists at the outlet of Forge Pond on the upstream side of the Lake St crossing. I can provide the water level and discharge data if you send a contact name/email for ESS.
- Appendix A, guidelines for measuring streamflow: I would only measure using a velocity meter, and calculate discharge using the midpoint method. I would not recommend the time of travel method. Each velocity measurement should be averaged over 40 seconds (not 3 sec). Refer to EPA Best Practices Guide on further methods for flow measurements.

A note on telemetry stations:
These stations are quite expensive for the initial setup and loggers plus the recurring cellular network costs. Most sites I gage I use HOBO loggers (unvented pressure transducers), which are much less expensive and easier to maintain. The trade-off, of course, is real-time data availability with telemetry, or only when the loggers are manually downloaded.

Let me know if you have any questions.

Kate

**From:** Pine duBois <pine@jonesriver.org>
**Sent:** Tuesday, August 17, 2021 7:02 PM
**To:** Bentsen, Kate (FWE) <kate.bentsen@mass.gov>
**Subject:** Re: Silver Lake

| | |
|---|---|
| **From:** | Sabrina Chilcott |
| **To:** | fbasler@plymouthcountyma.gov; Matt Ladewig |
| **Cc:** | William Chenard |
| **Subject:** | Pembroke Comments: Draft Sampling and Analysis Plan for the Silver Lake Quality Monitoring Project |
| **Date:** | Friday, August 20, 2021 11:05:00 AM |
| **Attachments:** | 20210820110014601.pdf |
| **Importance:** | High |

August 20, 2021

Central Plymouth County Water District Commission
Frank Basler, Plymouth County Administrator
fbasler@plymouthcountyma.gov

ESS Group, Inc.
Matthew Ladewig, CLM
mladewig@essgroup.com

Dear Mr. Basler and Mr. Ladewig:

The Town of Pembroke has reviewed the Draft Sampling and Analysis Plan for the Silver Lake Quality Monitoring Project and would like to submit comment on the Plan as invited.

At their meeting of August 18, 2021, the Pembroke Select Board expressed approval of this effort to sample surface water, groundwater and sediment within Silver Lake, its tributaries, and the supporting water bodies (Furnace Pond) and to evaluate the resulting data and develop potential alternatives for consideration for both short- and long-term management of Silver Lake.

Additionally, the Pembroke Select Board voted to authorize the Pembroke Town Manager to submit the following comment in regard to the Plan; **the Town of Pembroke would like the test results of these samples of Silver Lake, its tributaries and supporting water bodies sent to the Pembroke Town Managers office once developed.**

Please let us know if you require anything further to begin implementation of this program.

Sincerely yours,
William D. Chenard
Town Manager

Sabrina Chilcott
Assistant Town Manager
Office of the Pembroke Town Manager
Phone: 781-293-3844
Fax: 781-293-4650
schilcott@townofpembrokemass.org

**PEMBROKE SELECT BOARD**
**OFFICE OF THE TOWN MANAGER**
**100 Center Street, Pembroke, MA 02359**
781-293-3844 Fax: 781-293-4650

August 20, 2021

Central Plymouth County Water District Commission
Frank Basler, Plymouth County Administrator
fbasler@plymouthcountyma.gov

ESS Group, Inc.
Matthew Ladewig, CLM
mladewig@essgroup.com

Dear Mr. Basler and Mr. Ladewig:

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Additionally, the Pembroke Select Board voted to authorize the Pembroke Town Manager to submit the following comment in regard to the Plan; **the Town of Pembroke would like the test results of these samples of Silver Lake, its tributaries and supporting water bodies sent to the Pembroke Town Managers office once developed.**

Please let us know if you require anything further to begin implementation of this program.

Sincerely yours,

William D. Chenard
Town Manager

| | |
|---|---|
| **From:** | Martin, Gerard (DEP) |
| **To:** | fbasler@plymouthcountyma.gov; Matt Ladewig |
| **Cc:** | Garcia-Serrano, Millie (DEP); Langley, Lealdon (DEP); Hobill, Jonathan (DEP); Carey, Richard (DEP); Chase, Richard F (DEP); Hurley, Steve (FWE ); JZYGMUNT@PLYMOUTHCOUNTYMA.GOV |
| **Subject:** | MassDEP"s Comments on the Draft Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan |
| **Date:** | Friday, August 20, 2021 11:06:49 AM |
| **Attachments:** | Silver Lake SAP comments 8 20 2021.pdf |

Frank and Matt,

Please find attached comments on the Draft Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan prepared by the Massachusetts Department of Environmental Protection.

Let us know if you have any questions.

Sincerely,

Gerard Martin
Acting Deputy Regional Director
Bureau of Water Resources

Massachusetts Department of Environmental Protection
Southeast Regional Office
20 Riverside Drive
Lakeville, Massachusetts 02347

(508) 946-2799

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

# Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen A. Theoharides
Secretary

Martin Suuberg
Commissioner

August 20, 2021

Central Plymouth County Water District
Commission
Attn: Mr. Frank Basler, Administrator
Plymouth County Commissioners Office
44 Obery Street
Plymouth, MA 02360

RE: Comments on the Draft Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan

Dear Mr. Basler,

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the Draft Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan (the Plan) and provides the following comments:

1. According to MassDEP records, Silver Lake has never experienced a significant cyanobacteria bloom. Therefore, enhanced testing for phycocyanin pigments and increased frequency of algal toxins and enumerations would provide a better dataset to understand algal dynamics in the lake and it is recommended to allow MassDEP to make aquatic life use determinations for CWA 305(b) assessment.

2. One of the goals of the plan is to develop a “baseline understanding of current water quality” in Silver Lake. To this end and for related MassDEP assessments, at a minimum the proposed in-lake sampling should ensure that the following objectives are met:

   A. Revise the Plan if necessary to ensure that all standard Quality Assurance/Quality Control (QA/QC) elements of the Quality Assurance Project Plan (QAPP) are addressed;

   B. If possible, include high frequency summer sampling (e.g., weekly, two times per month) for standard limnological parameters (total phosphorus (P), total nitrogen (N), chlorophyll a, Secchi depth, dissolved oxygen/temperature depth profiles/deployed logger arrays, etc.) at one or more deep hole locations to enable lake assessment by MassDEP using methodologies outlined in the Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual at:

https://www.mass.gov/files/documents/2018/05/07/2018calm.pdf ;

C. Include a detailed aquatic plant survey during the summer peak season (including presence of non-natives, harmful algal bloom (HAB) occurrence, photo records);

D. If possible, include data that enable estimation of the limiting nutrients (N or P) in the lake during the summer. This can be done by sampling for dissolved inorganic N in addition to the planned sampling for soluble P. While P is most commonly the limiting factor to algal production in freshwater lakes, this should be checked with N:P ratios. On a technical note, the plan should clarify if "soluble phosphorus" is the dissolved reactive fraction or total dissolved fraction (note: a better measure of bioavailable P may be total reactive P via direct colorimetry of the unfiltered sample);

E. Revisions to the SAP should be submitted to MassDEP for review and approval prior to monitoring. While not required, QAPP approval by MassDEP (or the Environmental Protection Agency - EPA) is a prerequisite for MassDEP use of project data for 305(b) assessments. This review would allow MassDEP to make more detailed comments on the revised SAP; and

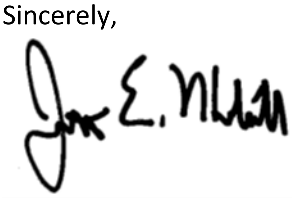
F. When available, final quality-controlled project data should be submitted to MassDEP for potential use in 305(b) assessment of Silver Lake. Guidance on data submittal can be found at: https://www.mass.gov/guides/external-data-submittals-to-the-watershed-planning-program.

3. The recently released EPA document, *Ambient Water Quality Criteria to Address Nutrient Pollution in Lakes and Reservoirs* (EPA-822-R-21-005; August 2021), recognizes the role of zooplankton populations to determine the overall water quality of lakes, particularly as it relates to nutrients. Language from the document includes the following (pg. 7): "[t]he rate of change of zooplankton biomass with respect to increasing phytoplankton biomass ($\Delta Z/\Delta P$) provides an informative measure of the effects of eutrophication on food web function for the purposes of informing the derivation of numeric nutrient criteria (Yuan and Pollard 2018)." The document can be found at: https://www.epa.gov/system/files/documents/2021-08/nutrient-lakes-reservoirs-report-final.pdf.

4. Inclusion of sampling and enumeration of zooplankton should be considered based upon the content of the EPA document.

MassDEP appreciates the opportunity to comment on the Plan. If you have any questions, please contact me at 508 946-2870.

Sincerely,



Jonathan Hobill
Regional Engineer
Bureau of Water Resources

ecc: Francis G. Basler Jr., County Administrator - fbasler@plymouthcountyma.gov

Matt Ladewig, ESS Group Project Manager - mladewig@essgroup.com

Joanne Zygmunt, CPCWDC Chair - JZYGMUNT@PLYMOUTHCOUNTYMA.GOV

Massachusetts Division of Fisheries and Wildlife
Attn: Steve Hurley, Southeast Fisheries Biologist

MassDEP - Boston
Attn: Lealdon Langley, Director, Division of Watershed Management (DWM)
Richard Carey, Acting Director, DWM, Watershed Planning Program
Richard F. Chase, Chief, DWM, Assessment and Data Management Section

MassDEP – Southeast Regional Office
Attn: Millie Garcia-Serrano, Regional Director
Gerard Martin, Acting deputy Regional Director BWR

## Matt Ladewig

**From:** Kershaw, Chad <KershawCJ@cdmsmith.com>
**Sent:** Monday, August 23, 2021 3:13 PM
**To:** fbasler@plymouthcountyma.gov; Matt Ladewig
**Cc:** dnorton@cobma.us; Patrick Hill; Kolb, Bernadette
**Subject:** Comments on Silver Lake Sampling and Analysis Plan
**Attachments:** Comments on Silver Lake Sampling and Analysis Plan.pdf

**Categories:** CPCWDC

Good Afternoon,

On the behalf of City of Brockton, please see attached for written comments on the Draft Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan, for you consideration. We understand these written comments are a business day late, and apologize in advance. We hope these comments can still be considered.

Thank you,

**Chad J. Kershaw, PE**
Project Manager
CDM Smith
260 West Exchange Street, Suite 300, Providence, RI 02903
direct: 401.457.0345   fax: 401.274.2173
cdmsmith.com

# City of Brockton
# Department of Public Works


Frank Basler
County of Plymouth
fbasler@plymouthcountyma.gov

Matt Ladewig
ESS Group, Inc.
mladewig@essgroup.com

Subject: Comments on Silver Lake Sampling and Analysis Plan

Dear Mr. Basler and Mr. Ladewig:

The City of Brockton has reviewed the Sampling and Analysis Plan for the Silver Lake Water Quality Monitoring study prepared by ESS group, dated July 24, 2021 and offers the following comments.

## 1. Project Goals and Objectives

The project goals include (1) to collect water quality data to inform management decisions to address water quantity and quality issues and (2) to develop a baseline understanding of current water quality.

These goals cannot be met without including sampling through the growing season (particularly given we are already approaching late August). The sampling design should be revised to allow the project goals to be met. This is particularly important given that the low oxygen conditions that have been found in the lake need to be to have their extent and duration documented so that any internal load of phosphorus can be characterized to be examined against the current programs design focused on external loads.

## 2. Sampling Domain

*a. Silver Lake Sampling Locations* - Figure 2 shows the water quality sampling locations: four for groundwater seepage, three tributaries and one in-lake location. After reviewing the Silver Lake watershed map, it appears that the contributing area to SLT2 is quite small such that it would not be a large part of the water budget for the lake, and that its location along Route 27 would be upstream of most of the anthropogenic sources so the water quality sample is unlikely to be representative of tributary input. If the sampling program is limited to 8 sampling locations, a better use of the SLT2 location would be to collect samples at an additional in-lake location.

Having only one in-lake sampling site introduces significant risk that you are not capturing representative data for all of Silver Lake. This risk is compounded by the single in-lake sample



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being in the "deep hole," which likely does not represent most in-lake areas and may not capture water quality issues that are typically best observed in shallower lake margins.

*b. Diversion Sampling Locations* - It is unclear where the samples from the East Monponsett Pond/Diversion and Furnace Pond/Diversion will be collected. It appears that the samples might be collected from the pond itself rather than the diversions. Both diversions have sample taps and other structures that would permit a sample to be collected from the diversion itself. To do this ESS would need to coordinate with the City for access to the locations; with advanced notice, the City/Veolia will accompany the samplers to the access points to allow for samples to be collected. The City feels strongly that samples should come from the diversions themselves rather than from the pond.

## 3. Bathymetry

The sampling plan has a stated assumption that the water level will be sufficient to complete bathymetry given that Silver Lake was near full in June-July. Given that it appears the work may not start until September (and possibly later), the sampling plan should describe how near-shore bathymetry will be collected if the water depth is not sufficient.

The vertical control datum should be specified in the plan. The bathymetry should be tied to a elevation standard. The accuracy of the proposed depth collection methods should also be included.

The plan for bathymetry data collection is very detailed. Given there is existing bathymetry and stage-volume curves for Silver Lake, the sampling plan should explain why such detailed bathymetric data is needed (i.e., what will the data be used for?) and why the existing bathymetry has been found to be inadequate. The plan should also describe how the bathymetric data will be processed from the collected data points.

## 4. Aquatic Plants

*a. Additional Detail needed for When and How Different Sampling Techniques will be Used:* "Aquatic plant growth will be assessed...using one or more of the following tools." How will you determine which tool to use? Use of underwater camera, rakes, and surface observations tend to require slightly different approaches. The plan needs to better explain when underwater cameras will be used versus rakes and/or surface observations. For each of these tools, the general methodology (e.g., transects for camera/rake, grids for surface observations, etc. and horizontal positioning control particularly given cable drift in deep locations) should be described to ensure consistency in collected in the targeted grid cells.

*b. Timing of Aquatic Plant Sampling:* "The planned timing provides ideal conditions for mapping rooted plants..." August is appropriate timing for conducting aquatic plant surveys. Given that it is already mid-August, what is the contingency if the schedule slips? Plant die-off for some species begins to happen as the days shorten and evenings cool in early fall. A typical end date for SAV sampling is September 15, with an option to extend to end of September (although not preferred if looking for cover/biomass).

Also as peak biomass is species-dependent, the sampling plan should provide a table of aquatic plant species expected to be present in Silver Lake and peak biomass/optimal survey windows.

*c. Use of Collected Data*: Data collected from the aquatic plant survey will be used to generate maps of plant cover, biovolume for the lake, and an aquatic plants field guide. How will this data be used in relation to water quality in the lake? Will plant cover/biovolume mapping be compared to water quality data (e.g., nutrient levels)? Typically, the data that is being collected and the maps being produced are used more for studies on SAV presence and habitat structure/quality, not necessarily water quality.

*d. Density of Sampling Locations*: The aquatic plant surveys will include at least 350 survey locations. With slightly adjustments depending on methodology, a well-trained SAV survey crew can usually complete 50 survey locations per day. Therefore, the aquatic plants surveys are likely a two-week effort. There are concerns about the scale of the effort and schedule relative to the value of the information (compared to other data being collected in the program), particularly as we approach the end of the growing season. It would likely make more sense to tailor the number and location of survey sites to the environmental conditions present. For example, the species likely present in Silver Lake are unlikely to be found at depths greater than 10 feet, depending on water clarity, and Silver Lake is up to 80 feet deep. Therefore, aquatic plant surveys should focus on areas with suitable growing conditions.

*e. Substrate Data:* How will the supplemental data on substrate type be collected? Will grab samples be collected to validate image processing if that is the planned method of substrate determination? How will substrate be determined in areas of dense macrophyte stands?

## 5. Macroinvertebrates

It is incorrectly stated that relatively long lifespans of benthic macroinvertebrates make them useful for inferring water quality conditions. While longevity (and there's a variable range of benthic macroinvertebrate lifespans) plays into it, the primary reason benthic macroinvertebrates are used to infer water quality conditions are that different groups (family/genus) are more or less tolerant to water quality degradation. It is the presence (or absence) of these groups that make them such valuable indicators of water quality.

*Additional information on sampling technique needed*: The work plan should provide additional information is provided on collection, processing, and identification of benthic macroinvertebrate samples (or a SOP in the appendix as is done for other sampling methods)., including information on

- How the organisms will be identified (e.g., ID the first 100 organisms?),
- How the community will be classified (e.g., using an established index?), and
- How the benthic community will be used to determine relative water quality condition in Silver Lake (e.g., compare to other benthic community data in similar MA lakes?).
- Target depths should be indicated relative to a reference datum. If the water level of Silver Lake is below full, will the target sampling depths be adjusted?
- When different sampling equipment will be used – the clam rake versus the Ekman dredge? Sampling becomes more inefficient with depth; organisms are often lost as the sample is retrieved, particularly when you have to pull a sample up from a depth of 65 feet. How this source of error in the samples be mitigated?

*Intended Use of Macroinvertebrate Data*: The sampling and analysis plan indicates the use of the macroinvertebrate data is to determine where anoxia, a seasonal stressor, is present in Silver Lake. There are multiple concerns about this approach to infer anoxia when it is more straight forward to measure dissolved oxygen in the lake directly, and the City recommends that direct DO measurements be made instead. Among the City's concerns with the proposed approach are:

- No information is provided to determine how that macroinvertebrate data will be evaluated to assess anoxia. How will anoxic effects on macroinvertebrates be distinguished from hypoxic conditions? If organisms are absent in the samples, how will other potential stressors and factors be distinguished from no oxygen conditions?
- The 10-ft depth spacing between the seven samples would provide much less accuracy than can be obtained with vertical profiling, which is typically conducted at 3-ft (or 1-m) intervals
- The presence (or absence) of certain benthic macroinvertebrates is not solely determined by water quality. Water quality parameters could be suitable, but it may be another environmental factor such as inappropriate substrate may be present that supports more intolerant taxa. Any macroinvertebrate sampling needs to be contemporaneously paired with data like water depth, substrate, aquatic vegetation, water clarity, and water quality parameters (T/DO/pH and nutrients) from the benthic sampling location to eliminate some of the "noise."

- Water quality effects from anoxia require knowledge of both the extent and the duration of the condition. The macroinvertebrate approach would only address the extent.
- Collecting a single round of macroinvertebrate sampling potentially misses the maximum extent of anoxia which in eutrophic lakes continues to expand until mixing occurs

*Sample Timing*: Macroinvertebrate sampling should be conducted in the summer months (June, July, and August) are typically preferred to capture a representative community. As winter nears, sampling is more likely to only capture a small subset of benthic macros that inhabit Silver Lake. The benthic macroinvertebrate survey season in MA typically parallels the aquatic plant survey season, ending in late September. What is the planned sampling schedule and are there contingencies in place if sampling cannot be conducted by September?

*Sample Locations*: Note that open water and deep lake bottoms are generally species-poor compared to littoral habitats in a lake's shallower margins. While the sampling design should consist of several sampling locations in open water, deep habitats, focus should be on shallower habitats. Typically, a 2:1 ratio of shallower sampling locations (< 10 feet) is used to deeper locations.

## 6. In-Lake Water Column and Quality Sampling

Sampling Period – As noted above, the stated goal of this sampling activity "establish baseline conditions in Silver Lake" cannot be adequately accomplished without sampling through the growing season. The sampling design should include a contiguous growing season so that the inputs of the previous winter/spring can be assessed for their roles in the interannual variability of the lake's water quality conditions.

## 6a. Continuous Data Logging

The continuous data logging is planned for what will likely be September through December and then March and April, with data being collected for at two depths for temperature and water depth and surface only for chlorophyll. Given that the bulk of this monitoring period is during the late fall and winter when the lake will be isothermal, what information is anticipated from this monitoring program and how will these data be used to enhance the understanding of water quality in Silver Lake? For example, daily water temperature is recorded by Brockton at the intake for the Silver Lake water treatment plant. This temperature is adequate to characterize isothermal conditions. Similarly, Brockton records the lake's daily water elevation rendering water depth recorders to be unnecessary. Continuous chlorophyll data collection during the target months likely to provide any meaningful data on algal conditions as nuisance and harmful algal conditions typically occur in the summer.

If the continuous data logging program remains in the sampling and analysis plan as envisioned in the draft plan then the following comments are germane:

- The location of the upper data logger should be specified with more accuracy, particularly since it includes a chlorophyll meter. Five meters will be near the thermocline in the lake and could be below the lake's photic zone. Algal conditions at the thermocline are often distinct from those in the epilimnion. The placement of the data logger should reflect (1) the likely depth of algae, (2) the algal population that is being targeted, (3) the ability of the grab samples to provide for verification that the data logger is properly representing the algal population in the lake.

- The depth of the data logger above the bottom should also be specified in the sampling plan, along with the mooring design to ensure that the data logger will not be able to be in contact with the sediment surface; 1 meter above the bottom is typical with the logger floated from a fixed mooring.

Lastly, the only SOP for the data logger is for water level determination. Additional SOPs should be added for the temperature and chlorophyll measurements.

## 6b. Discrete Water Quality Sampling

*Nutrient Analysis* – The detection limits for phosphorus parameters should be included in the sampling plan so their adequacy can be evaluated. In terms of nitrogen parameters, samples for ammonia should be included so that the total inorganic nitrogen can be defined.

*pH Data Collection* – pH measurements can be useful for interpreting algal data. If possible, a vertical profile of pH should be collected along with temperature, specific conductance and DO.

*Frequency of Vertical Profile Measurements* – These should be conducted every two weeks in the fall until fall turnover has occurred. This will allow an understanding of how uniform conditions occur in Silver Lake.

*Cyanotoxin Analysis* – Unless there is a significant cyanobacteria algal bloom occurring at the time of sampling, cyanotoxin analysis are not needed.

*Sample Parameters from the Diversions* – Because samples from the diversion themselves would be taken from sample taps, algae could be damaged. ESS should consider this when deciding whether to continue to analysis the diversion samples for algal ID and enumeration.

## 7. Groundwater Sampling

*More Information Needed* - More definition of the groundwater sampling program is needed. Background information on the regional/local groundwater water table would be useful to understand whether planned distribution of the seepage meters will provide representative information. Some potential concerns include what bottom types are being sought for placement of the seepage meters, and how representative those bottom types are of the lake in general.

*Timing of Groundwater Data Collection* – The sampling plan includes seepage and groundwater chemistry information in the spring because "this is when seepage is most influenced by human behaviors and activities." To obtain representative data on groundwater-surface water interactions, sampling would need to be collected in other seasons or a plan included to explain how the data from the period of greatest influence will be used.

Sincerely,

Patrick Hill
Interim Commissioner of Public Works
City of Brockton

cc: David Norton, City of Brockton
Bernadette Kolb, CDM Smith

**From:** Frank Basler
**To:** Seelig, Charlie
**Cc:** Matt Ladewig; Joanne Zygmunt; Kimberly Groff; Jeffrey Hershberger
**Subject:** RE: Deadline for comments on the Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan
**Date:** Friday, October 1, 2021 9:17:12 AM
**Attachments:** image001.png

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Hi Charlie;

Thank you for the note. I will forward your comment to ESS Group. I am sure we would love to do a bunch more sampling spots, but cost always plays a part in the selection process. If we are able to get some additional dollars, maybe we can add sites. We will keep you posted.

Thank you and stay well!

Sincerely,

*Frank*

Francis G. Basler Jr.
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**From:** Seelig, Charlie <Charlie.Seelig@halifax-ma.org>
**Sent:** September 30, 2021 5:07 PM
**To:** Frank Basler <fbasler@plymouthcountyma.gov>
**Subject:** Re: Deadline for comments on the Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan

Hi Frank,

After a very quick read, my only recommendation is that West Monponsett Pond also be sampled. If there is diversion from East Monponsett Pond to Silver Lake, there is then water flow from West Monponsett Pond to East Monponsett Pond which will affect the water quality of East Monponsett Pond and, subsequently, Silver Lake.

Charlie

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**From:** Frank Basler <fbasler@plymouthcountyma.gov>
**Sent:** Thursday, September 30, 2021 10:52 AM

**To:** Frank Basler <fbasler@plymouthcountyma.gov>
**Cc:** mladewig@essgroup.com <mladewig@essgroup.com>; Jeffrey Hershberger <jhershberger@essgroup.com>; Joanne Zygmunt <jzygmunt@plymouthcountyma.gov>; Mark Sotir <msotir@plymouthcountyma.gov>; Jack O'Leary <joleary@plymouthcountyma.gov>; Nancy O'Rourke <norourke@plymouthcountyma.gov>
**Subject:** Deadline for comments on the Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan

Final Reminder

Greetings;

The Sampling and Analysis Plan for the Silver Lake Water Quality Monitoring Project has been available for public comment. The SAP describes the proposed scope of the field sampling program, including locations, schedule, and methods to be used. This program involves the sampling of surface water, groundwater and sediment within Silver Lake, its tributaries, and the supporting water bodies (Monponsett ponds, Furnace Pond), evaluation of the resulting data, and development of potential alternatives for consideration for both short- and long-term management of Silver Lake.

Central Plymouth County Water District Commission held a public meeting on August 9th, 2021, to review the plan and provide an opportunity for questions and input. This meeting can be found at https://www.centralplymouthcountywater.org/water-quality-monitoring-at-silver-lake.html then click on the link for the meeting.

The Silver Lake Water Quality Monitoring Project Sampling and Analysis Plan, and support materials, are available for review at: https://www.centralplymouthcountywater.org/water-quality-monitoring-at-silver-lake.html

**The deadline for written comments on the plan was extended to September 30, 2021 and should be sent via email to fbasler@plymouthcountyma.gov and mladewig@essgroup.com. If you want to comment, please submit your thoughts or reach out to me.**

Thank you.

Sincerely,

*Frank*

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