

**Massachusetts**  
**Targeted Assessment Monitoring Program**  
**Field Operations Manual**  
**Lakes**

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## ACRONYMS

Acronyms	Definition
AED	Automated Electronic Defibrillation
CALM	Consolidated Assessment and Listing Methodology
CN	Control Number
COC	Chain of Custody
CPR	Cardiopulmonary Resuscitation
DDT	Dichloro-diphenyl-trichloroethane
MassDEP	Massachusetts Department of Environmental Protection
DI	Deionized
DO	Dissolved oxygen
DOC	Dissolved organic carbon
GIS	Geographic Information Systems
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified
HAZMAT	Hazardous material
H <sub>3</sub> PO <sub>4</sub>	Phosphoric acid
HDPE	High-density polyethylene
HS	Hydrogen sulfide
ID	Identification
LIMS	Laboratory Information Management System
TAM	Massachusetts Probabilistic Monitoring and Assessment Program
MDFW	Massachusetts Division of Fisheries and Wildlife
NHD	National Hydrographic Dataset
NLA	National Lake Assessment
NPDES	National Pollutant Discharge Elimination System
OWMID	Office of Water Management Identification
PC	Personal Computer
PCB	Polychlorinated biphenyl
PFD	Personal floatation device
PPE	Personal protection equipment
PSI	Pressure per square inch
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
SOP	Standard operating procedures
SWQS	Surface water quality standards
UPS	United Parcel Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Service
WES	Senator William X. Wall Experiment Station
WM	Wide mouth
WPP	Watershed Planning Program

**Note:** This Field Operations Manual is adapted from the field operating procedures developed and followed in the 2012 National Lakes Assessment conducted by USEPA (USEPA, 2011). The formatting of this manual is modeled on USEPA manual and some sections (e.g., Benthic Macroinvertebrate Assemblage) where technical details (e.g., operational procedures) are relevant are taken nearly verbatim from the USEPA manual.

## 1. BACKGROUND

This manual describes field protocols and daily operations for crews to use when monitoring lakes as part of the Massachusetts Targeted Assessment Monitoring Program (TAM). TAM is a component of the Massachusetts Department of Environmental Protections (MassDEP), Watershed Planning Programs (WPP) water monitoring strategy that uses deterministic sampling designs to assess designated uses in priority assessment units (AU) or waterbodies. TAM is implemented on a seven-year rotating basin schedule and includes both a lake and river component. This manual is specific to the lake component and the river component is discussed in other documents. Additional information regarding the seven-year rotating basin schedule is provided in Appendix A. The primary objectives of the TAM include:

- Prioritize AUs or waterbodies for monitoring.
- Assess designated uses (*Aquatic Life Use*, *Recreational Use*, and *Fish Consumption Use*) in priority lakes.
- Assess potential stressors impairing aquatic life, recreation, and fish consumption uses in priority lakes.

TAM is designed to be completed during the summer (May through September). Field crews will collect a variety of measurements and indicators from an index site located at the maximum depth point of the lake, a shoreline site located at a point of public access (e.g., beach or boat access), multiple sites in the littoral zone and the entire lake for certain indicators. All of the indicators and measurements as well as their sampling and analysis methodologies were selected to achieve to the primary assessment objectives of the TAM.

### 1.1. Prioritization of Waterbodies

Lakes within each basin rotation cohort are evaluated to determine the appropriate prioritization category as described in Table 1.1 for each lake. The evaluation is based on information from several sources including historical monitoring data, landscape data (e.g., land use, impervious cover), assessment methodology, and pollution control strategies. Based on the assigned priority categories and other factors (e.g., access, resources), approximately 8 – 10 lakes will be selected each year from the prioritization list for monitoring. Additional information regarding the prioritization scheme is provided Appendix A.

**Table 1.1** Prioritization categories for Targeted Assessment Monitoring

Priority	Priority Order	General Category	Category Descriptions <sup>1</sup>
High	1	Delisting	Assessment units currently listed in Categories 4c or 5 where there are indications it <u>should not</u> be listed for at least one impairment cause (indications can be environmental improvement or listing/assessment methodology changes or errors).
High	2	Listing	Assessment units NOT listed in Categories 4c or 5 where there are indications it <u>should be</u> listed for at least one impairment cause (indications can be environmental degradation or listing/assessment methodology changes or errors).
Medium	3	Unassessed (suspect impairment)	Assessment units listed in Category 3 or waters without an assessment unit where there are indications it could listed in Categories 4c or 5 for at least one impairment cause (i.e. unassessed waters suspected to be impaired).
Medium	4	Stressor Identification	Assessment units listed in Category 5 for a non-pollutant (i.e. Fishes Bioassessment, Aquatic Macroinvertebrate Bioassessment) with no stressor impairment causes.
Medium	5	CWF Determination	Assessment units or waters without an assessment unit thought to be an undesignated or under documented coldwater fishery (CWF).
Low	6	Unassessed (suspect support)	Assessment units listed in Category 3 or waters without an assessment where there are indications it could listed in Category 1 or 2 (i.e. unassessed waters likely to support uses).
Low	7	Priority NPDES	Assessment units or most sensitive receiving waters with a prioritized NPDES permit development (i.e. situations where a <u>reassessment</u> of the targeted assessment unit would be of value).
Low	8	TMDL Effectiveness	Assessment units currently listed in Category 4a where the TMDL was potentially successful in removing the use impairment or the original listing of the impairment cause was potentially <u>in error</u> .
Low	9	Priority TMDL	Assessment units in Category 5 prioritized for TMDL development (i.e. situations where a <u>reassessment</u> of the listed assessment unit would be of value).

1 – Assessment units placed in prioritization categories based on available information (indications) from multiple sources (monitoring data, landscape data, assessment methodology, pollution control, assessment methodologies, etc.). Annual basin selection will be consistent with rotating basin schedule.

Monitoring parameters will generally include all typical default analytes (e.g., bacteria, nutrients, chloride, probes) unless an indicator specific project is identified.

## **1.2. Selection and Description of Survey Indicators**

As part of the indicator selection process, WPP evaluated indicators used in the 2018 Massachusetts Consolidated Assessment and Listing Methodology (CALM), historic WPP lake monitoring, the National Lake Assessments (NLA) conducted by USEPA in 2007 and 2012, Regional Monitoring Networks (RMN) coordinated by EPA and lake monitoring conducted by other states (MassDEP 2018; USEPA 2011; USEPA 2020). Key indicator screening and evaluation criteria included applicability to the target population, utility in achieving the monitoring objectives, cost/resource effectiveness, available assessment methodologies, and ability to reflect various aspects of ecological condition.

The remainder of this section briefly describes the indicators that the TAM will use to assess designated uses, identify key stressors impairing uses and describe various physiochemical or habitat characteristics of each lake. Some indicators provide a basis for evaluating more than one category. For example, an assessment of phytoplankton is useful for assessing both aquatic life and recreation uses as well as identifying stressors (e.g., nutrients). A summary of the indicators is presented in Table 1.2.

### **1.2.1. Aquatic Life Use**

Waters supporting the *Aquatic Life Use* should be suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. This use includes reproduction, migration, growth, and other critical functions. Results from all the indicators (biological, habitat, and physiochemical) are considered in assessing the *Aquatic Life Use*. However, the biological community data, in many cases, outweigh all other types in the decision-making process since they are considered an integration of the effects of pollutants and other conditions over time (MassDEP 2018).

#### *1.2.1.1. Phytoplankton Assemblage*

Phytoplankton are organisms that can produce its own food using light, water, carbon dioxide, or other chemicals (i.e., autotrophs) and represent the plant portion of suspended material in a lake. They primarily drift and move passively in the water column based on water currents and temperature differences. Phytoplankton communities provide oxygen to the water through photosynthesis and are an important component of the food web for fish and zooplankton. Overabundance of algae can lead to oxygen deficits via respiration and subsequent decomposition. The phytoplankton assemblage and abundance will change over the summer months with changing environmental conditions, both natural and human induced. Analyzing these changes will contribute to our understanding of the trophic status and ecological health of the lake.

#### *1.2.1.2. Macroinvertebrate Assemblage*

Benthic macroinvertebrates are relatively large (>200 – 500 um) organisms that lack a backbone and inhabit the bottom areas and substrates of water bodies. Since many macroinvertebrates are sensitive

to pollution, somewhat immobile, and have relatively long-life cycles within an aquatic system, the composition, structure, and function of the macroinvertebrate populations are responsive to both acute and chronic stressors and integrates multiple stressors. The TAM lake assessment will focus on the benthic macroinvertebrate assemblage occupying the littoral habitat of the lake (USEPA 2011).

#### *1.2.1.3. Vertical Profile Measurements*

Vertical or depth profiles are measurements of temperature, dissolved oxygen (DO), pH and conductivity from different depths at the index site (i.e., location of max depth) in each lake. Vertical profiles are collected using both discrete and continuous probe measurements. These measurements are used to determine the presence or absence of temperature stratification, the extent of the epilimnion, metalimnion and hypolimnion if stratification does exist, stratification patterns through the summer, and the compliance with DO and temperature criteria and guidance for the support of aquatic life.

#### *1.2.1.4. Chlorophyll a*

Chlorophyll is a pigment found in plants that allows the organism to use radiant energy for converting carbon dioxide into organic compounds in a process called photosynthesis. Several types of chlorophyll exist and these and other pigments are used to characterize algae. One type, chlorophyll a, is most widely used for biomass estimates since it is found in all algae. Knowledge of chlorophyll a concentration provides qualitative and quantitative estimations of biomasses and trophic status (MassDEP 2018).

#### *1.2.1.5. Non-native Species*

A non-native (or exotic) species is a species occupying an area outside of its natural range or distribution due to introduction by human activity. Non-native species, unlike the natural biota, have few or no controls, are often extremely invasive (dominating and/or eliminating native biota), and can displace a healthy and desirable aquatic community and produce economically and recreationally severe impacts even though no other change has occurred in the watershed (MassDEP 2018).

#### *1.2.1.6. Water Chemistry (including nutrients)*

Water chemistry measurements (total phosphorus, total nitrogen, chloride, dissolved organic carbon, total alkalinity, total hardness, color, turbidity) are used to analyze buffering capacity, nutrient availability, trophic status and nutrient enrichment, and water chemistry classification (e.g., alkaline lake, soft water lake, etc.). These measurements, excluding chloride, will not be used directly or definitively to indicate the condition of aquatic life but will be used with or provide context to the other indicators in the TAM lake assessments (MassDEP 2018).

### **1.2.2. Recreational Uses**

*Recreational Use* is divided into two separate contact scenarios for analysis. Waters supporting the *Primary Contact Recreational Use* are suitable for any recreation or other water use during the recreation season (1 April to 15 October) in which there is prolonged and intimate contact with the

water with a significant risk of ingestion of water. Waters supporting the *Secondary Contact Recreational Use* are suitable for any recreation or other water use during any time of year in which contact with the water is either incidental or accidental. The assessment of the *Recreational Use* is based on sanitary (i.e., bacteria), safety (e.g., Secchi depth) considerations, and/or aesthetic condition of the lake (MassDEP 2018).

#### *1.2.2.1. Macrophyte Cover and Biovolume*

Aquatic macrophytes provide important functions to a healthy ecosystem (e.g., nutrient cycling, habitat for fish and macroinvertebrates, food source). However, overabundant growth of aquatic macrophytes can physically impair swimming, boating, and fishing recreational activities. The percent of the lake surface area covered by macrophytes (surface cover), the percent of lake volume filled with macrophytes (biovolume), the growth habit and type of species, and the dominance of the species within the plant community are measurements used to evaluate aquatic macrophyte growth (MassDEP 2018).

#### *1.2.2.2. Secchi Disk Transparency*

A Secchi disk is an opaque disk with alternating black and white quadrants used to estimate the transparency of the water in the lake by measuring the depth where the disk is no longer seen when lowered into the water column. Low transparency can obscure hazardous objects and impair swimming as a recreational use. Secchi disk transparency can also be used to estimate the euphotic zone (generally 3 x the Secchi disk) and trophic conditions in the lake (MassDEP 2018).

#### *1.2.2.3. Pathogens*

Most pathogens (bacteria, viruses, protozoan, fungi, or parasites) originate from the gastrointestinal tract of warm-blooded animals and transported to water bodies through feces can contaminate the water and result in gastrointestinal disorders and infections for those who ingest or come in contact with the water. *Escherichia coli* are used as an indicator of fecal contamination thus high concentrations would indicate an impairment of recreational uses (MassDEP 2018).

#### *1.2.2.4. Cyanobacteria*

Cyanobacteria are microscopic organisms found naturally at low concentrations in freshwater systems but can form blooms (dense aggregation of cells) under optimal conditions. These cyanobacteria blooms can potentially impair recreational uses through decreased transparency, poor aesthetic conditions, and the production of algal toxins (e.g., microcystin, anatoxin-a) by the cyanobacteria. Microcystin is a hepatotoxin that can damage the liver and cause gastroenteritis, vomiting, convulsion/seizures depending upon the dose and length of exposure. Microcystin is considered to be the most commonly found cyanobacterial toxin in water and is the toxin most responsible for human and animal poisonings. Anatoxin-a is a potent neurotoxin (toxins that affect the nervous system) and ingestion of cells containing anatoxin-a can lead to memory impairment, seizures, respiratory or cardiac

arrest. Cyanobacteria counts will be used to evaluate the potential impairments due to cyanobacteria (MassDEP 2018).

#### *1.2.2.5. Aesthetic Condition*

Aesthetic condition is a subjective measure of how pleasing the water body is to the senses for both active and passive recreational activities (fishing, boating, wading, walking, or resting near the water, etc.). The narrative aesthetics criterion in the Massachusetts Surface Water Quality Standards (SWQS) states that surface waters should be “free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life” (MassDEP 2013). Qualitative evaluations of aesthetic conditions (e.g., objectionable deposits) are used to assess their impact on recreational uses (MassDEP 2018).

### **1.2.3. Fish Consumption Use**

Human consumption of fish (*Fish Consumption Use*) is included in the definition of *Secondary Contact Recreation Use* in the Massachusetts Surface Water Quality Standards (SWQS) (MassDEP 2013). However, the status of the *Fish Consumption Use* will be evaluated for this assessment as an individual use rather than part of the *Secondary Contact Recreational Use*. Chemical contaminants enter the food chain and biologically accumulate in tissues of aquatic organisms with each successive level of the food chain potentially having higher contaminant levels (much higher than surrounding water). The contaminant levels in fish tissue are compared to available criteria to determine if the levels potentially pose a risk to human health (MassDEP 2018).

#### *1.2.3.1. Metals*

Mercury is the most common cause of impairment to fish consumption and the primary concern of this assessment. Mercury is a natural highly toxic element and can be present at low levels in most places. While naturally occurring, human activities (e.g., coal burning, trash incineration) have significantly increased mercury levels in the environment. In lakes, mercury can be transformed by natural processes into methylmercury, an organic form of mercury that is the most dangerous to human health, and biologically accumulated through the food chain. Humans are most commonly exposed to methylmercury through the consumption of fish and the concentrations within edible portions of the fish (filets) can indicate how safe the fish are to consume (MassDEP 2016). The levels of other metals (arsenic, selenium, cadmium, and lead) metals will also be used to evaluate the safety of fish consumption.

### **1.2.4. Lake and Habitat Characterizations**

General characterization of the lake morphology, physical littoral habitat and human disturbance (watershed and lake scale) serves two primary purposes. It can help identify potential stressors that may be impairing uses and provide context for the interpretation of the other indicators.

#### 1.2.4.1. Physical Littoral Habitat

Physical littoral habitat for the purpose of this assessment includes the substrate bottom, aquatic macrophyte, and fish cover habitat categories. Semi-quantitative evaluations of the available habitat types (e.g., cobble, emergent macrophytes) and densities within each of the habitat categories will be used to characterize the overall physical littoral habitat. In addition, map variables derived from GIS such as shoreline land use, length, and complexity will be used to supplement the semi-quantitative field measurements of physical littoral habitat.

#### 1.2.4.2. Human Disturbance

The list of potential human disturbances is extensive and in the case of lakes can include hydraulic alteration, shoreline alteration, urbanization, residential, stormwater, etc. Qualitative field evaluations of the types and severity of human disturbances and/or pollution sources will be recorded at multiple scales (e.g., whole lake, littoral). In addition, multi-scale map derived variables from GIS such as land use (e.g., residential, agriculture), impervious cover, NDPDES discharges, etc. will be used to supplement the qualitative field observations of disturbance.

#### 1.2.4.3. Bathymetry

Bathymetry is the measurement of the lake depth in relation to the lake surface and if a sufficient number of measurements are taken a bathymetric or contour map of the lake can be created. Measurements will be taken at a sufficient resolution using transects or other methods (e.g., shoreline tracing) to create a bathymetric map for each lake. The bathymetric maps will be used to provide context and interpretation to the other indicators (e.g., the lake volume with DO < 5 mg/L, lake volume filled by macrophytes).

**Table 1.2** Summary of indicators

Indicator Type	Indicator	Location
Aquatic Life Use	Discrete vertical profile measurements (DO, temperature, pH and Conductivity) Continuous vertical profile measurements (DO and temperature)	Index site
	Water Chemistry (total alkalinity, total hardness, color, turbidity, chloride, DOC)	Index site
	Nutrients (total phosphorus and total nitrogen)	Index site
	Phytoplankton assemblage	Index site
	Chlorophyll-a	Index site
	Macroinvertebrate assemblage	Littoral zone
	Non-native species	Whole lake

Indicator Type	Indicator	Location
Recreation Use	Pathogens ( <i>E. coli</i> )	Shoreline site
	Macrophyte cover and biovolume	Whole lake
	Secchi Disk transparency	Index site
	Cyanobacteria	Index site
	Aesthetic conditions	Index site Shoreline site Littoral zone
Fish Consumption Use	Fish tissue contaminants (mercury and other metals)	Whole lake
Lake and Habitat Characterization	Physical littoral habitat	Littoral zone
	Human disturbance	Whole lake
	Bathymetry	Whole lake

## 2. LOGISTICS

### 2.1. Roles and Contact Information

Effective communication between TAM field crews, TAM coordinators, and laboratory staff at Wall Experiment Station (WES) or contracted laboratories is essential for the survey to proceed with maximum efficiency and to ensure collection of high-quality data. This section provides:

1. A general description of the roles and responsibilities of key WPP personnel in providing logistical and technical support for the collection and processing of samples by the TAM field crews
2. Flow of communication between TAM field crews, TAM coordinators and laboratory staff (i.e., who to call for specific types of questions or support needs)
3. Contact information

The **TAM Management Team** consists of the WPP Monitoring Coordinator, WPP QA/QC Coordinator, Field and Lab Coordinator, and TAM Coordinator. This overall team is responsible for overseeing all aspects of TAM and ensuring technical and quality assurance requirements are properly carried out. The team is the final authority on all decisions regarding lake selection, field sampling, and laboratory analysis.

The **WPP Monitoring Coordinator** is responsible for the planning and coordination of all environmental monitoring by WPP including TAM. This includes technical oversight, staff assignments and scheduling. The **QA/QC Coordinator** is responsible for the overall quality assurance and quality control of environmental monitoring and data handling at WPP including TAM. This includes standard operating procedures (SOP) development, training, data review and validation, QAPP development, QC reporting,

coordination, and communication with labs. The **Field and Lab Coordinator** is responsible for coordination of activities in WPP labs (Instrument Calibration, Chlorophyll-a, Color/Turbidity) used for the TAM project as well as some aspects of employee safety and training. The **TAM Coordinator** is responsible for the lake selection and the general day to day coordination of field activities including the preparation of all bottles and field sheets and the development of the TAM survey schedule.

The **TAM Indicator Coordinators** are responsible for assisting with the development and correct implementation (i.e., training) of standard operating procedures (SOP) associated with their indicator or area of responsibility. They are a primary contact for the field crews regarding questions or other issues involving the collection, transportation or processing of samples associated with their indicators of responsibility.

The **TAM Crew Leads** with the assistance of WPP seasonal staff are responsible for all aspects of survey preparation, sample and data collection, and post survey activities on assigned surveys using techniques and procedures detailed in this field operations manual. A summary of roles and contacts is provided in Table 1.3.

**Table 1.3** Contact information

Role		Name	Contact Information
<b>TAM Management Team</b>	WPP Monitoring Coordinator	Arthur Johnson	<a href="mailto:Arthur.Johnson@mass.gov">Arthur.Johnson@mass.gov</a> 508-767-2873
	QA\QC Coordinator	Sue Flint	<a href="mailto:Suzanne.Flint@mass.gov">Suzanne.Flint@mass.gov</a> 508-767-2789
	TAM Coordinators	James Meek Dan Davis	<a href="mailto:James.Meek@mass.gov">James.Meek@mass.gov</a> 508-767-2863 <a href="mailto:Daniel.Davis@mass.gov">Daniel.Davis@mass.gov</a> 508-767-2853
	Field and Lab Coordinator	Shervon DeLeon	<a href="mailto:Shervon.DeLeon@mass.gov">Shervon.DeLeon@mass.gov</a> 508-767-2853
<b>Indicator Coordinators</b>	<i>E. coli</i> bacteria	Shervon DeLeon	<a href="mailto:Shervon.DeLeon@mass.gov">Shervon.DeLeon@mass.gov</a> 508-767-2853
	Color/turbidity	Shervon DeLeon	<a href="mailto:Shervon.DeLeon@mass.gov">Shervon.DeLeon@mass.gov</a> 508-767-2853
	Chlorophyll a/Algae	Joan Beskenis	<a href="mailto:Joan.Beskenis@mass.gov">Joan.Beskenis@mass.gov</a> 508-767-2794
	Fish	Dan Davis Pete Mitchell	<a href="mailto:Daniel.Davis@mass.gov">Daniel.Davis@mass.gov</a> 508-767-2853 <a href="mailto:Peter.Mitchell@mass.gov">Peter.Mitchell@mass.gov</a> 508-849-4029
	Macroinvertebrate	Steve Bittner	<a href="mailto:Steven.M.Bittner@mass.gov">Steven.M.Bittner@mass.gov</a> 508-767-2857
	Macrophyte Mapping	Dan Davis	<a href="mailto:Daniel.Davis@mass.gov">Daniel.Davis@mass.gov</a> 508-767-2853

Role		Name	Contact Information
TAM Crew Leads	All Indicators	James Meek	<a href="mailto:James.Meek@mass.gov">James.Meek@mass.gov</a> 508-767-2863
	All Indicators	Dahlia Tympanick	<a href="mailto:Dahlia.Tympanick@mass.gov">Dahlia.Tympanick@mass.gov</a> 508-767-2858
	All Indicators	Pete Mitchell	<a href="mailto:Peter.Mitchell@mass.gov">Peter.Mitchell@mass.gov</a> 508-849-4029
	All Indicators	Dan Davis	<a href="mailto:Daniel.Davis@mass.gov">Daniel.Davis@mass.gov</a> 508-767-2853
	All Indicators	Steve Bittner	<a href="mailto:Steven.M.Bittner@mass.gov">Steven.M.Bittner@mass.gov</a> 508-767-2857
	Fish	Dan Davis Pete Mitchell	<a href="mailto:Daniel.Davis@mass.gov">Daniel.Davis@mass.gov</a> 508-767-2853 <a href="mailto:Peter.Mitchell@mass.gov">Peter.Mitchell@mass.gov</a> 508-849-4029

## 2.2. Key Information and Supplies

### 2.2.1. Lake Dossiers

Dossiers will be created for each lake in TAM by the **TAM Coordinator**. The dossiers will contain information regarding access permissions, equipment requirements (e.g., engine, boat), waterbody impairments (e.g., non-natives), relevant lake characteristics, sampling locations and management histories (e.g., herbicide treatments). In addition, the dossiers will contain maps indicating the surrounding environment (USGS topographic and aerial maps), sampling locations (index site, shoreline site and littoral habitat stations) and access points. An example of a lake dossier is provided in Appendix B. All lake dossiers will be organized in a binder and multiple copies will be available.

### 2.2.2. Survey Schedule

A survey schedule containing all planned TAM surveys occurring during the defined field season will be created by the **TAM Coordinator** prior to the initiation of any sampling activities. The survey schedule will include details regarding the lakes and indicators to be sampled by the field crews and the TAM Crew Leads assigned to each survey. The schedule will be reviewed and approved by the **WPP Monitoring Coordinator** and **TAM Crew Leads**. On a weekly basis during the field season, the **WPP Monitoring Coordinator** will assign additional staff, typically WPP seasonal staff, as necessary to complete the field crews (typically 2 individuals) for each survey and provide the weekly field assignments to the staff. An example weekly schedule is provided in Appendix C.

### 2.2.3. Forms

Forms are the key to data collection and tracking for lakes in TAM. The forms used for lakes in TAM fall into two general categories: field sheets and chain-of-custody (COC) forms. Currently, all forms are paper but electronic forms are in development and expected to be implemented prior to the conclusion of the field season.

### *2.2.3.1. Field Sheets*

Field sheets are the primary documents where we record measurements, observations, and sample collection information during the course of a survey or sampling event. For most surveys, an individual field sheet is used for each station per sampling event. Field sheets for lakes in TAM include:

- Lake Field Sheet (Index Site & Shoreline Site)
- Lake Vertical Profile Deployment
- Macroinvertebrate/Littoral Habitat
- Macrophyte/Whole Lake Assessment
- Macrophyte Identification/Voucher

**Waterproof (e.g., Rite-in-the-Rain) paper is used exclusively for the field sheets.** These forms will be reviewed annually and updated as appropriate. Samples of TAM field sheets can be found in Appendix D. While each field sheet type is unique, common information recorded on field sheet forms can include, but is not limited to:

- Site name and watershed location
- Station Description (including GPS coordinates)
- Station Access Information
- Sample Name and ID #
- Personnel on-site performing the sampling
- Dates and times of sample collection
- Pertinent observations regarding uses (aquatic life, recreation, etc.)
- Summary of weather conditions
- Site observations and any aberrant sample handling comments
- Sample collection information (sample collection methods and devices, sample collection depth /heights, sample preservation information, matrix sampled, etc.).

Certain information (e.g., site ID, sample IDs) that will not change can be pre-filled out prior to the survey to save time in the field. The **TAM Coordinator** prepares all field sheets with any pre-filled information and provides them to the **TAM Crew Leads**. Other information that is time-, location- and/or condition-specific is filled out at the station ONLY. Upon completion of the survey, each completed field sheet is submitted to the **QA/QC Coordinator** or designated representative for scanning and hard copy filing.

### *2.2.3.2. Chain of Custody*

Standard chain-of-custody (COC) forms are used to track and transfer sample custody for all samples from WPP staff to the appropriate laboratories (i.e., WES, WPP lab, and contractor). The proper procedure for filling out a COC form and transferring sample custody is documented in the respective laboratory Quality Assurance Plans. COC forms for the TAM include:

- Contractor (phytoplankton, chloride)
- EPA Lab (chlorophyll a)
- WPP laboratory (color, turbidity, *E. coli*)
- WES (nutrients, total alkalinity, total hardness)

**Waterproof (e.g., Rite-in-the-Rain) paper is used exclusively for the COC forms.** These forms will be reviewed annually and updated as appropriate. Samples of TAM COC forms can be found in Appendix E. While COC forms from different labs vary to some degree, common information recorded on COC forms can include, but is not limited to:

- Site identification
- Sample identification
- Collection date/time/samplers
- Analyses requested
- Sample matrix
- Sample preservation
- Delivery persons/ date/time

The **TAM Coordinator** prepares all the COC forms automatically using the WES LIMS pre-login procedures (for WES samples) and/or via PC/manual (for all other labs) and provides the forms to the TAM Crew Leads. Once prepared, the COC forms are checked for errors prior to use. Upon completion of the survey and sample delivery, a copy each completed and signed field COC form is submitted to the QA/QC Coordinator or designated representative for scanning and hard copy filing.

#### *2.2.3.3. Field Operations Manual*

This Field Operations Manual for field activities shall be available in the field for use if needed, and to ensure consistency between field crews. The **TAM Coordinator** will review the Field Operations Manual annually and with assistance from the **TAM Crew Leads** and **QA/QC Coordinator** make necessary revisions to standard operating procedures.

#### **2.2.4. Electronic Field Data**

Relevant electronic field data (e.g., latitude longitude for sites) will be uploaded to the appropriate electronic field device (e.g., field GPS units, auto GPS units) by the **TAM Coordinator** prior to the initiation of any sampling activities. Table 2.1 summarizes the type of electronic data to be uploaded to each type of field device.

**Table 2.1** Electronic field data uploads and devices

Electronic Device	Electronic Data Uploads
Field GPS Units	Index Site location ( <i>if known</i> ) Shoreline Site locations Boat Access locations Littoral Plot locations
Sonar Unit (Macrophyte Mapping)	Sampling Transects Rake Throw locations Littoral Plot locations
Auto GPS Unit	Shoreline Site locations Boat Access locations Parking locations ( <i>if required</i> )
<b>Note:</b> Locations are uploaded as latitudes and longitudes in decimal degrees and sampling transects are loaded in a .gpx format.	

### 3. SAFETY AND HEALTH

#### 3.1. Safety and Health

##### 3.1.1. General Considerations

It is the responsibility of the survey crew leader to ensure that the safety precautions outlined in this manual are taken by survey field personnel and that all safety policies and procedures are followed.

##### 3.1.1.1. Recommended Training

Prior to engaging in field work, all survey crew members should take the following recommended training:

- First aid, Cardiopulmonary Resuscitation (CPR) and Automated Electronic Defibrillation (AED)
- Boating and water safety [NOTE: This course is required for all crew leads and boat operators]
- Lake field sampling, including safety issues and protocols related to sampling activities for WPP surveys
- 8-hour HAZMAT review training (PACE) regarding handling of chemicals and other hazardous materials

##### 3.1.1.2. Communications

Effective communication is a key ingredient to safe fieldwork. To ensure smooth communications, each field survey will follow the following guidelines:

- Adherence to all safety guidelines contained in this manual, which collectively comprise the standard “Safety Plan” for TAM lake surveys
- Adherence to sampling itinerary (vehicle used & description, time of departure & return, travel route)
- Readily available contacts for police, ambulance, hospitals, and fire departments
- Guidebook locations for emergency services available near each sampling site

- Weather watch by crew lead, who is the final arbiter for go/no-go decisions

#### *3.1.1.3. Personal Safety*

Personal safety will be ensured by practicing the following prior to and during each survey (as applicable):

- Use of proper field clothing and PPE (e.g., hats, sunglasses, sunscreen, extra glasses, proper footwear (no flip-flops), etc.) for all team members at all times
- Use of PFD/lifejackets for all team members, and in accordance with safety procedures (e.g., one extra throwable life preserver)
- Knowledge of medical and personal information (e.g., allergies, personal health conditions and abilities (i.e., to swim))
- Keep list of personal contacts (family, telephone numbers, etc.)
- Consider updating immunizations against tetanus, hepatitis, typhoid fever, and polio.

#### **3.1.2. Safety Equipment**

Minimum equipment and materials for ensuring safety during each lake survey and to be readily available IN THE BOAT is as follows:

- PPE as required (inc. raingear if it might rain)
- Use of PFD/lifejackets for all team members, and in accordance with safety procedures (e.g., one extra throwable life preserver)
- First Aid kit
- Oars and oar locks
- Extra boat plugs
- Fire extinguisher (for boats w/ motors)
- Cell phone and important contacts (e.g., fish kill or spill notification)
- Chemical reagent/waste container(s)
- Bailer (for small leaks)
- Flare gun, boat horn and/or safety whistle (singly or any combination based on need; e.g., for isolated lakes, a flare gun may be more appropriate to signal for help)

Additional safety equipment and materials to be available ON SHORE/IN VEHICLE includes:

- Waders
- Field kit
- Rope
- Boating toolbox
- Assorted gloves
- Food & drink
- Extra clothes

#### **3.1.3. Safety Guidelines for Field Operations**

The following safety guidelines shall be adhered to for all lake surveys:

- Two persons must be present during all sample collection activities, and no one should be left alone while in the field.
- Personnel participating in field activities on a regular or infrequent basis should be in sound physical condition.
- Field personnel should have a daily check-in procedure for safety, including a departure safety checklist to ensure secure fastenings for trailer, motor(s), boats, etc.
- Persons using sampling equipment should become familiar with the hazards involved and establish appropriate safety practices prior to using them. Make sure all equipment is in safe working condition. If boats are used to access sampling sites, personnel must consider and prepare for hazards associated with the operation of motor vehicles, boats, winches, tools, and other incidental equipment.
- Boat operators should be familiar with U.S. Coast Guard rules and regulations for safe boating contained in a pamphlet, "Federal Requirements for Recreational Boats, " available from a local U.S. Coast Guard Director or Auxiliary or State Boating Official (U.S. Coast Guard, 1987).
- All boats with motors must have fire extinguishers, boat horns, life jackets or flotation cushions, and flares or communication devices.
- Field personnel should be able to swim, and personal flotation devices must be used.
- If needed, chest waders made of rubberized, neoprene, or breathable material and suitable footwear must always be worn with a belt to prevent them from filling with water in case of a fall.
- Proper footwear must be worn at all times. Many hazards lie out of sight in the bottoms of lakes, rivers and streams. Broken glass or sharp pieces of metal embedded in the substrate can cause serious injury if care is not exercised when walking or working with the hands in such environments.
- When appropriate, wear gloves to protect from harmful materials, including Infectious agents and toxic substances that can be absorbed through the skin or inhaled may also be present in the water or sediment. All surface waters and sediments should be considered potential health hazards due to potential toxic substances or pathogens. Use gloves if necessary, and clean exposed body parts as soon as possible after contact.
- All electrical equipment must bear the approval seal of Underwriters Laboratories and must be properly grounded to protect against electric shock.
- Use appropriate protective equipment (e.g., gloves, safety glasses) when handling and using hazardous chemicals
- Handle and dispose of chemical wastes properly. Persons must become familiar with the health hazards associated with using chemical fixing and/or preserving agents Chemical wastes can be hazardous due to flammability, explosiveness, toxicity, causticity, or chemical reactivity. All chemical wastes must be discarded according to standardized health and hazards procedures (e.g., National Institute for Occupational Safety and Health [1981]; USEPA [1986]). Do not dispose any chemicals in the field.

- Persons working in areas where poisonous snakes may be encountered must check with the local Drug and Poison Control Center for recommendations on what should be done in case of a bite from a poisonous snake.
- Any person allergic to bee stings, other insect bites, or plants (i.e., poison ivy, oak, sumac, etc.) must take proper precautions and have any needed medications (e.g., benedryl) handy.
- Field personnel should also protect themselves against the bite of deer or wood ticks because of the potential risk of acquiring pathogens that cause Rocky Mountain spotted fever and Lyme disease.
- All field personnel should be familiar with the symptoms of hypothermia and know what to do in case symptoms occur. Hypothermia can kill a person at temperatures much above freezing (up to 10oC or 50oF) if he or she is exposed to wind or becomes wet.
- Field personnel should be familiar with the symptoms of heat/sun stroke and be prepared to move a suffering individual into cooler surroundings and hydrate immediately.
- Protect against the sun using sunglasses, hats, sunscreen, etc.
- Benthic macroinvertebrate sampling (only): When appropriate, use heavy gloves when hands are used to agitate the substrate during collection of benthic macroinvertebrate samples.
- Electrofishing (only): Follow directions of survey crew lead exactly; wear insulated gloves.
- Keep a low center of gravity while in the boat. Standing and other questionable movements can cause the boat to capsize.

## 4. BASE SITE ACTIVITIES

Field crews will need to conduct a number of activities at the WPP office and laboratory (base station) in preparation for a survey and after returning from a survey. The specifics of these activities will vary depending on the type of survey. There will be multiple types of surveys for the lakes in TAM: **Index Site**, **Lake Vertical Profile Deployment**, **Shoreline Site**, **Littoral** (macroinvertebrates, littoral habitat) and **Whole-Lake** (fish tissue, macrophytes, and non-natives). Close attention to these activities is required to ensure that the field crews know:

- locations and nature of activities
- access situation for each lake (e.g., is early access notification required?)
- equipment and supplies needed for each survey and lake
- how samples are to be stored at the base station and/or transported to the lab

### 4.1. Pre-survey Preparation

Survey preparation for the assigned field crews typically occurs a day prior to the survey and/or the morning of the survey. The weekly monitoring schedule (Section 2.2.2) will indicate the survey type and possibly which lakes are assigned to the survey thus dictate the necessary preparation activities. In general, the preparation for each survey by the field crews involves:

- Identifying the lakes that are part of the survey.
- Notifying landowners of our sampling where required.

- Checking out a vehicle (vehicle should be reserved in advance)
- Preparing and loading
  - Boats and motors as required.
  - Equipment used in all surveys (e.g., GPS)
  - Equipment specific to the lakes (e.g., bottles, field sheets, guidebooks)
  - Equipment specific to the survey type (e.g., Van Dorn).
  - Decontamination equipment as needed.
  - Personal equipment (e.g., rain gear, sunscreen)

#### 4.1.1. Equipment

##### 4.1.1.1. Check Lists

Checklists are very useful when preparing for a survey and help ensure that required activities are completed and all needed equipment for a particular survey is prepared and loaded into the vehicle or boat. The following tables provide checklists for each survey type. **Quantities should be revised as necessary to implement the decontamination objectives (see Section 9), which may require the use of duplicate equipment (to avoid using items on >1 lake per trip), depending on the item.**

**Table 4.1** Equipment checklist – All surveys

Type	Item	Quantity
<b>Lake Information</b>	Survey guidebook ( <i>Shoreline site surveys only</i> )	1
	Lake dossiers binder	1
<b>General Equipment</b>	Vehicle book (w/gas card and information)	1
	Boats and motors ( <i>not needed for Shoreline site surveys</i> )	1
	Auto GPS unit	1
	Field GPS unit	1
	Clipboard and pens	2
	Safety kit	1
	Digital camera	1
	WPP cell phone	1
	First aid kit	1
	Traffic cone	1
	Personal protective equipment (e.g., sunglasses, hat)	As needed
	Personal tools and supplies (e.g., food, water, Leatherman)	As needed

**Table 4.2** Equipment checklist – Index site surveys – Water Sample Collection

Type	Item	Quantity
<b>Field sheets</b>	Lakes Field Sheet (Index Site)	1 per lake
	Vertical Profile Deployment	1 per lake
	Macrophyte Identification/Voucher	1 per lake
<b>Collection:</b>	Sonar unit	1 per lake

Type	Item	Quantity
<b>Water column depth Profile Measurements Secchi Disk transparency Water Sample Depth Integrated Sample Visual Observations</b>	Multiprobe kit (temperature, DO, pH and conductivity) <i>YSI EXO Sonde and Logger</i>	1
	Weighted sonde guard ( <i>Hydrolab only</i> )	1
	Storage\Calibration cup	1
	Deionized water (500mL)	1
	Secchi Disk (20 cm)	1 per lake
	Viewscope	1 per lake
	Van Dorn sampler 2.2 L (Beta)	1 per lake
	Poly syringe (60 mL)	1 per lake
	Syringe filter (0.45 um)	1 per lake
	Depth integrated sampler (10 – 30 m)	1 per lake
	Sample composite container (2L)	1 per lake
	Funnel	1
	Deionized water (3L)	1
	Macrophyte key (non-natives)	1
	Compass (GPS unit)	1
<b>Storing &amp; Preservation</b>	HDPE bottle (250 mL, amber, rectangle) Phytoplankton	1 per lake
	HDPE bottles (250 mL, amber, round) Chlorophyll a	1 per lake
	HDPE bottle (500 mL, natural, NM) Total alkalinity	1 per lake
	HDPE bottle (500 mL, natural, NM) Total hardness	1 per lake
	HDPE bottles (120 mL, natural, WM) Color/turbidity	1 per lake
	HDPE bottles (250 mL, natural, WM) Nutrients (surface), nutrients (near bottom)	2 per lake
	HDPE bottles (60 mL, natural, WM) Chloride	1 per lake
	HDPE bottles (40 mL, glass vial pre-preserved with H <sub>3</sub> PO <sub>4</sub> ) Dissolved organic carbon	2 per lake
	1 mL 9N H <sub>2</sub> SO <sub>4</sub> vials – nutrients	2 per lake
	2 mL 1:1 HNO <sub>3</sub> vial – total hardness ( <i>Added post-survey in WPP lab</i> )	1 per lake
	Lugol's solution (6 mL) ( <i>Added post-survey in WPP lab</i> )	1 per lake
	Disposable graduated pipettes	1 per lake
	Wet ice	As need
	Cooler	1

**Table 4.3** Equipment and supplies – continuous temperature and DO vertical profiles – Index Site

Type	Item	Quantity
<b>Field Sheet</b>	Vertical Profile Deployment	1
<b>Collection: Temperature Dissolved Oxygen</b>	Sonar unit	1
	Onset HOBO DO and temperature data logger (DO/T)	2
	Onset HOBO Tidbits MX data logger (Temp)	As needed
	Instrument rope line – length based on lake depth (e.g., ¼" solid braided polyester rope, ½"braided poly rope, 3/8" Potwarp)	1
	Floating line (grab line)	As needed
	Primary buoy (sub-surface)	1
	Secondary buoy (surface)	1
	Primary anchor (instrument line)	1
	Secondary anchor (grab line)	1
	Supplemental floats for grab line	2
	YSI EXO multi-probe sonde and logger	1
	Underwater camera (AquaView)	1
	Sounding Line w/weight	1

**Table 4.4** Equipment checklist – Shoreline site surveys

Type	Item	Quantity
<b>Field sheet</b>	Lakes Field Sheet (Shoreline Site)	1 per lake
	Macrophyte Identification/Voucher	1 per lake
<b>Collection: Water Samples Visual Observations</b>	Gloves (latex/nitrile, non-powdered)	As needed
	Sampling pole	2
	Macrophyte key (non-natives)	1
<b>Storing and preserving</b>	IDEXX bottle (120 mL, clear, round, sterile) <i>E. coli</i>	1 per lake
	Wet ice	As need
	Cooler	2
	Hip boots or chest waders	1 per person

**Table 4.5** Equipment checklist – Littoral surveys (macroinvertebrate, littoral habitat) surveys

Type	Item	Quantity
<b>Field sheet</b>	Macroinvertebrate Littoral Habitat	1 per lake
	Macrophyte Identification/Voucher	1 per lake
	Site Map	1 per lake
<b>Collection: Visual Observations Benthic macroinvertebrate</b>	Macrophyte key	1
	Viewscope	1
	Sonar Unit	1
	Medium zip lock plastic bags	As needed
	Large zip lock plastic bags	As needed
	Standard Kick net (500 µm) with 4 foot handle	1
	Bucket (5-gallon capacity, plastic)	1

Type	Item	Quantity
Storing and preserving	Tote (14-gallon, plastic, white)	1
	Sieve bucket (500 µm)	1
	Forceps	1
	Squirt bottle (1 L Nalgene) – lake water	1
	Spoon (stainless steel)	1
	Chest waders/hip boots	1 per person
	HDPE bottle (2 L, white, wide-mouth)	1-5 per lake
	Reagent alcohol (100%)	As needed
	Labels: Benthic macroinvertebrate samples	As needed
	Scissors	1
	Grease pen	1
	Wet ice	As needed
	Cooler	1

**Table 4.6** Equipment checklist – Whole Lake (Macrophyte) surveys

Type	Item	Quantity
Field sheet	Site Maps (included in field sheets)	1
	Macrophyte Survey	1
	Macrophyte Identification/Voucher	1
Collection: Bathymetry/Biovolume	Sonar unit (with microSD loaded with transects/sites)	1
	Underwater camera (AquaView)	1
Collection: Aquatic plants	Aquatic plant rake	1
	Macrophyte key	1
	Field GPS unit ( <i>if rake throw sites are not in sonar unit</i> )	1
	Sonar Unit	1
Storing	Medium zip lock plastic bags	As needed
	Large zip lock plastic bags	As needed
	Wet ice	As needed
	Cooler	1

**Table 4.7** Equipment checklist – Whole Lake (Fish tissue) surveys

Type	Item	Quantity
Field sheet	Macrophyte Identification/Voucher	1 per lake
Collection: Electrofishing Boat	Coffelt 18-foot electrofishing boat	1
	40-inch Wisconsin ring and droppers	1
	Honda EG 5000™ Generator	1
	Dip nets	3
	Rubber gloves	3
	Novelty bat	1
	Depth sounder	1
Collection: Gillnets	Gillnets (various size and configurations)	As needed
	Floats	As needed

Type	Item	Quantity
	Novelty bat	1
	Depth sounder	1
Storing and preserving	Cooler	1
	Wet ice	As needed

#### 4.1.1.2. Multiprobes

Multiprobes are primarily used during the index site surveys to measure the vertical profiles of DO, temperature, pH and conductivity and conduct QA/QC checks on the vertical profile deployment. If a calibrated multiprobe is needed for a survey, the **TAM Coordinator** submits a probe request (Deployment and/or Multiprobe Request Form) to the calibration laboratory supervisor and QA Analyst at least one week prior to each survey. The multiprobes will be calibrated by the calibration laboratory supervisor or designate the day before or morning of the survey and can be picked up by the field crew from the instrumentation lab on the morning of the survey.

#### 4.1.1.3. Deployment Sondes

Deployment sondes are used to continuously measure DO and temperature at multiple depths on a vertical instrument line. If calibrated deployment sondes are needed for a survey, the **TAM Coordinator** submits a probe request (Deployment Sonde Request Form) to the calibration laboratory supervisor and QA Analyst at least one week prior to the survey. The deployment sondes will be calibrated and set to launch by the calibration laboratory supervisor or designate before the survey date and can be picked up by the field crew from the instrumentation lab on the morning of the survey.

#### 4.1.1.4. Survey Kits

Survey kits for the index site and shoreline surveys will be prepared on a monthly basis by the **TAM Coordinator**. The shoreline site survey kits will be organized by site groups (i.e., a group of sites scheduled to be sampled on the same day by the same crew) and the index site survey kits will be organized by lake. **The survey kits will contain field sheets with known information pre-filled (e.g., site ID, town), COC forms for the analysis laboratories and labeled sample bottles.** The kits will be located in the equipment storage room.

#### 4.1.1.5. Boats and Motors

A boat and motor will be needed for all surveys excluding the shoreline site surveys. The WPP currently have three boat types (an electroshocking boat, a whaler and Jon boats) and two engine types (gas, electric) and oars available for use on the surveys. The lake dossiers will indicate a suggested boat and motor combination based on the lake. Selecting the appropriate boat and motor for the survey will be made by the survey crew lead and will be based on the following factors.

- Survey type – the electroshocking boat is used primarily on the fish tissue surveys.
- Boat access – the absence of a boat ramp on the lake will require the use of a Jon boat.
- Size of the lake – the whaler will be advantageous on larger lakes to save time.

- Distance to the index site – when the boat launch point is close to the index site electric motors or oars may be more advantageous considering decontamination procedures.
- Non-natives and decontamination – a different boat and motor/oars combination will be used on each lake in a multi-lake survey (e.g., index site surveys) to avoid in the field decontamination of the boat and motor. See Section 9.0 for more information decontamination. Example 1 – the survey includes two lakes both with boat ramps but at one lake the index site is very close to the launch point. In this situation, the best option may be to bring two Jon boats and just one motor, use a different boat at each lake, use the motor at one lake and use just oars at the lake with close index site. This will decrease the potential transmission of non-natives, eliminate the need for in field decontamination of the boat and motor and simplify decontamination on return to base station (one less motor to decontaminate).
- Time since last used – drying of the equipment is often a component to decontamination so when faced with a choice between two equally viable boats or motors, select the one that has been drying the longest.

#### *4.1.1.6. Quality Assurance and Quality Control Sampling for Field Activities*

Only a portion of the surveys will be selected for the collection of quality control samples (ambient field blanks and field duplicates). These surveys will be indicated in the field sheets, COC forms and the sampling schedule.

**Ambient Field Blanks:** In preparation for the blank samples, the field crew will need to acquire an appropriate volume of DI water from the Barnstead filter system in the instrumentation laboratory. The DI water can be prepared the day before or the morning of the survey. Follow the instructions posted on the wall adjacent to the Barnstead.

**Field Duplicates:** The collection of field duplicates for water quality surveys will be based on an approximate rate of 10% of the total and will be distributed among the various crews at a rate of one set of QC samples per week by the program coordinator. Crews will be required to collect QC samples if the QC sample containers are included in the prepared sampling kits for the specific survey.

Other QA/QC precautions to help ensure data validity are:

- Pre-rinsing sample containers (except for DOC and E. coli)
- Pre-rinsing samplers
- Duplicate Secchi readings

## **4.2. Post-survey Activities**

Post-survey activities are critical to maintain a functioning and efficient monitoring and should not be overlooked by the field crew. The primary post-survey activities involve the handling of samples, field sheets and COC forms and the decontamination, cleaning and putting away field equipment.

Completing these activities appropriately will support sample transportation to contract labs, sample analysis in the WPP laboratory and future field crews.

#### 4.2.1. Sample Handling

Samples have two potential destinations following the completion of a survey: direct transportation to a laboratory or storage at the base station for future delivery to a laboratory or analysis at the WPP laboratory. Color, turbidity and chlorophyll-a samples will be analyzed or processed at the WPP laboratory. Chlorophyll a samples will be filtered and frozen at the WPP laboratory and delivered to the EPA laboratory in Chelmsford, MA for analysis. Other samples will be stored at the base station for varying time lengths prior to delivery. Fish tissue samples require processing at the base station prior to storage, see Section 8.3.4 Sample Processing for details. Table 4.7 summarizes the handling of each sample type.

**Table 4.7** Post-survey sample handling

Survey	Sample	Storage	Delivery Location
Index Site	Total alkalinity HDPE bottle (500 mL, natural, narrow mouth)	Refrigerator Survey Prep Area	WES Contract Lab Weekly
	Total hardness HDPE bottle (500 mL, natural, narrow mouth)		
	Nutrients (surface) HDPE bottles (250 mL, natural, wide mouth)		
	Nutrients (near bottom) HDPE bottles (250 mL, natural, wide mouth)		
	Chloride HDPE bottles (60 mL, natural, wide mouth)		
	Dissolved organic carbon Amber glass bottles (40 mL x 2)		
	Color/turbidity HDPE bottles (120 mL, natural, wide mouth)		WPP Lab
	Chlorophyll a (filtered at WPP Lab) HDPE bottles (250 mL, amber, round)	Refrigerator Survey Prep Area (water sample) Freezer (filter) Biological Lab	EPA Lab Weekly
	Phytoplankton HDPE bottles (250 mL, amber, rectangle)	Refrigerator Biological Lab	Contract Lab Weekly
Shoreline Site	<i>E. coli</i> IDEXX bottle (120 mL, clear, round)	None	WPP Lab
Fish Tissue	Mercury/metals HDPE bottles	Freezer Biological Lab	WES Weekly
Macroinvertebrate Macrophyte	Macroinvertebrate HDPE bottle (2L, natural, round)	Flame Cabinet Biological Lab	Contract Lab Season End
	Macrophyte Voucher Medium Ziploc bag	Refrigerator Survey Prep Area	WPP Lab

#### 4.2.2. Field sheets and COC Forms

The appropriate COC forms must be completed immediately following the survey for all water quality samples (i.e., day of the survey). The proper procedure for filling out a COC form is documented in the respective laboratory Quality Assurance Plans. Upon returning to the base station and completing any needed sample processing (e.g., Fish tissue), check the samples against the COC forms and transfer them to storage. Any missing samples should be crossed off the COC form. The complete and signed COC forms will be placed in the COC In-transit manila envelope attached to the storage refrigerators.

The macroinvertebrates and macrophyte do not technically have COC forms associated with their samples or vouchers and are tracked differently than the other samples. The **Macrophyte Identification/Voucher** field sheet will be used as a sample tracking form for macrophyte vouchers and placed with other COC forms in the COC In-transit manila envelope attached to the storage refrigerators. The macroinvertebrate samples upon arrival at the biological laboratory will be recorded in the Laboratory Sample Log-in notebook. Each sample is assigned a sample identification number (BenSampleID#) and habitat data identification number (HabSampleID#).

The TAM Crew Lead reviews all field sheets for completion following the survey and submits them to TAM Coordinator for final review. It is not required that crew lead field sheet review occurs immediately and could occur in the days following the survey.

#### 4.2.3. Cleaning & Decontamination

##### 4.2.3.1. Post-Survey Equipment Cleaning/Drying (non-pressure washing)

The following equipment, at a minimum, will require “gentle” (non-pressure washed) cleaning with soap, tap water and DI water:

- Van Dorn bottles
- Multiprobes (to be done in Instrumentation Lab)
- Secchi disk
- Integrated tube sampler
- Viewscope
- Sonar transducer

##### 4.2.3.2. Post-Survey Equipment Decontamination (using pressure washing)

Prior to next use, most equipment will need to be decontaminated upon returning to the base station. Refer to Section 9 Decontamination for Non-native Species for the appropriate decontamination procedures using pressurized water.

##### 4.2.3.3. Shipping Samples

Samples for algae and cyanobacteria analysis (not chlorophyll a) will need to be mailed via UPS to the designated contract lab on a weekly basis.

## 5. INDEX SITE SURVEYS

Several different measurements and indicators are collected at the index site (as described in Table 1.2): a temperature, DO, conductivity and pH depth profile, Secchi transparency, chlorophyll-a, phytoplankton, water chemistry, nutrients. In addition, several semi-quantitative visual observations of weather, aesthetics, pollution sources and macrophytes composition and density are recorded to provide a general description of the conditions on the lake at the time samples were collected by the field crews. A detailed description of the individual elements is provided below, in the general order they should be collected (although it is recognized that there will be, by necessity, concurrent tasks).

### 5.1. Locating the Index Site

The index site is located at the point of the maximum depth within a lake. There are three potential scenarios in locating the index site:

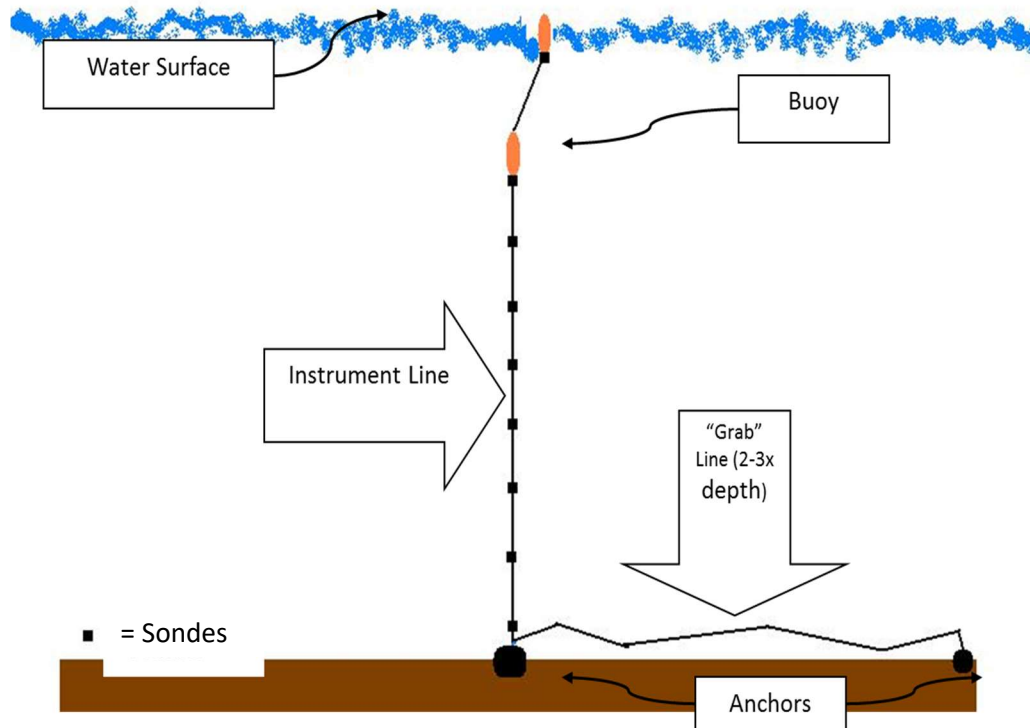
- 1) If the location of the index site was previously identified, use a field or sonar GPS unit to navigate to the site. Use the depth readings of the sonar or the location of the vertical probe deployment to confirm that you are located at the index site.
- 2) If the general location of the index site is known due to an existing bathymetric map, search that area of the lake for the maximum depth. When the point of maximum depth is identified, record the latitude and longitude on the **Lakes Field Sheet (Index Site)** and conduct sampling. Spend no more than 30 minutes searching for the point of maximum depth.
- 3) In situations where the location of the maximum depth is completely unknown, begin the search in areas expected to be the deepest (e.g., near an impoundment). When the point of maximum depth is identified, record the latitude and longitude on the **Lakes Field Sheet (Index Site)** and conduct sampling. Spend no more than 30 minutes searching for the point of maximum depth.

It may not be possible to sample at the exact point of maximum depth (e.g., very small area) but the depth should be within 0.5 m of the known maximum depth.

### 5.2. Continuous Temperature and DO Vertical Profiles

#### 5.2.1. Summary of Method

Deploy water quality sondes on a vertical instrument line to continuously measure temperature and DO at predefined fixed depths. The instrument or sonde line is vertically suspended below a buoy and attached to the lake bottom using an anchor system. On the vertical instrument line, Onset DO/T sondes are deployed near the surface (approximately 0.5 – 1 meter down from the water surface) and near the bottom (approximately 0.5 – 1 meter up from the lake bottom). Temperature sondes are deployed at equal depth intervals on the vertical instrument line between the two Onset DO/T sondes. The depth intervals for the temperature probes are based on the site depth and availability of probes. Figure 5.1 provides a basic diagram of an example vertical profile deployment.



**Figure 5.1** Diagram of a vertical profile deployment (Stamp 2020)

## 5.2.2. Equipment and Supplies

Table 5.1 provides the equipment and supplies needed for a continuous temperature and DO vertical profile deployment.

**Table 5.1** Equipment and supplies – continuous temperature and DO vertical profiles

Type	Item	Quantity
<b>Field Sheet</b>	Vertical Profile Deployment	1
<b>Collection: Temperature Dissolved Oxygen</b>	Sonar unit	1
	Onset HOBO DO and temperature data logger (DO/T)	2
	Onset HOBO Tidbits MX data logger (Temp)	As needed
	Instrument rope line – length based on lake depth (e.g., ¼" solid braided polyester rope, ½"braided poly rope, 3/8" Potwarp)	1
	Meter stick	1
	Floating line (grab line)	As needed
	Primary buoy (sub-surface)	1
	Secondary buoy (surface)	1
	Primary anchor (instrument line)	1
	Secondary anchor (grab line)	1
	Supplemental floats for grab line	2
	YSI EXO multi-probe sonde and logger	1
	Underwater camera (AquaView)	1
	Sounding Line w/weight	1

#### 5.2.2.1. Deployment Sondes

The sondes used for the continuous temperature and DO vertical profiles are the Onset HOBO dissolved oxygen and temperature data logger and HOBO Tidbit MX temperature data logger. The TAM Coordinator is responsible for requesting calibrated deployment sondes from the WPP instrument calibration laboratory for all surveys that require them. The request must be made no later than one week before the survey. The WPP instrument calibration laboratory calibrates the deployment sondes the day before or the morning of the survey. A YSI EXO multi-probe sonde and logger is included in the deployment sonde calibration request to collect discrete vertical profile measurements for QA/QC purposes (Note: if a YSI is unavailable, a Hydrolab MS4/5 sonde paired with a Surveyor 4a/5 logger is used).

### 5.2.3. Vertical Profile Deployment Procedure

1. Deployment Preparations (*Completed at the base station*)
  - a. Determine the depth of the lake at the **Index Site** (point of maximum depth) using existing bathymetric maps or previous sampling visits to the lake.
  - b. Construct the vertical instrument or sonde line (primary subsurface buoy – instrument line – primary anchor). The bottom of the primary subsurface buoy should be approximately 0.5 to 1.0 meters below the water surface (shallow lakes will need to be closer to 0.5 meters). Include attachment points (e.g., rope loops, stainless steel links) for the secondary surface buoy line at the top and the grab line at the bottom. The purpose of the primary subsurface buoy is to keep the vertical instrument line taut.
  - c. Construct the grab line (approximately 2-3x the depth) with float line (place supplemental floats on the float line if necessary), and the secondary anchor. The grab line is attached to the vertical instrument line at the primary anchor using stainless steel links. The grab line can be attached just before deployment.
  - d. Construct the secondary surface buoy line with regular line and the surface buoy. Leave approximately 1.5 – 2.0 meters of slack between the subsurface buoy and surface buoy. The secondary surface buoy line can be attached just before deployment. Attach deployment details and contact information to the surface buoy so individuals know the purpose of deployment and who to contact if discovered.
  - e. Attach the calibrated deployment sondes (Onset DO/T and Onset Tidbits) to the vertical instrument line. The Onset DO/T sondes are attached just below the bottom of the subsurface buoy (approx. 0.5 – 1.0 meters below the water surface) and 0.5 - 1.0 meters from the bottom of the primary anchor on the vertical instrument line. The Onset Tidbit temperature sondes are attached on the vertical instrument line between the Onset DO/T sondes.
    - i. If there is less than 5 meters between the Onset DO/T sondes, Onset Tidbit temperature sondes are attached approximately every 0.5 meters on the vertical instrument line.

- ii. If there is more than 5 meters between the Onset DO/T sondes, Onset Tidbit temperature sondes are attached approximately every 1.0 meters on the vertical instrument line.
  - f. Use the **Vertical Profile Deployment** field sheet to record the sonde identification number in the Sonde ID# column and sonde type in the Sonde Type column. Record the sonde information in the order (top to bottom OR shallow to deep) attached on the instrument or sonde line. Measure the distance from the top of the primary subsurface buoy to each attached sonde and record in the Measured Sensor Line Depth column on **Vertical Profile Deployment** field sheet. Record the basic site information (Unique ID, Station Name, Project, crew) if not already completed.
2. Sonde Deployment
- a. Navigate to the **Index Site** and anchor the boat. (**NOTE: IF WATER QUALITY SAMPLE COLLECTION IS OCCURRING ON THE SAME SITE VISIT, COLLECT WATER SAMPLES FIRST**)
  - b. Measure the lake depth at the **Index Site** using a weighted sounding line. This method provides better accuracy than sonar depth finders or bathymetric maps. Record the depth on the **Vertical Profile Deployment** field sheet. If this depth measurement is significant different ( $> \pm 0.5$  meters) from depth used to construct the vertical instrument line adjust the instrument line and/or the location of the sondes on the line as appropriate.
  - c. Deploy the vertical instrument line.
    - i. Attach the grab line with the secondary anchor and secondary surface buoy line to the vertical instrument line.
    - ii. Lower the primary anchor and vertical instrument line slowly and in a controlled manner into the water while keeping the secondary surface buoy and secondary anchor in the boat. The grab line can be used in combination with the vertical instrument line to lower the primary anchor to the bottom. **Use caution and avoid hitting the sondes on the side of the boat when lowering the instrument line.**
    - iii. Use the AquaView camera to assess the success of the deployment (e.g., is the instrument tangle? did the primary hit something on the bottom and rollover?). If the deployment is satisfactory, the secondary buoy and line can be placed in the water.
    - iv. Pull up the boat anchor and row due north from the deployment while running out the grab line. Once all the grab line is out, drop the secondary anchor attached to the grab line into the water. Using a field GPS unit, record the coordinates of the grab line anchor in the General Notes on the **Vertical Profile Deployment** field sheet.
  - d. Record the Start Date and Immersion Time on the Lake Vertical Profile Deployment field sheet. Record the observed Water Level on the **Vertical Profile Deployment** field sheet.
  - e. Return with the boat to the deployed vertical instrument line.

- i. Measure the distance from the surface of the water to the top of the sub-surface buoy using a meter stick and record it on the **Vertical Profile Deployment** field sheet in the Sub-Surface Buoy Depth field.
  - ii. Add the Sub-Surface Buoy Depth to each of the Measured Sonde Line Depth and record the results in the Calculated Sonde Water Depth column on the **Vertical Profile Deployment** field sheet.
  - iii. Using a field GPS unit, record the coordinates of the sub-surface buoy in the Field Latitude **and Field Longitude** fields on the **Vertical Profile Deployment** field sheet.
3. QA/QC Checks using a multiprobe and logger.
    - a. See Section 5.3 generally and 5.3.4 specifically for guidance.

### 5.3. Discrete Temperature, DO, pH and Conductivity Vertical Profiles

#### 5.3.1. Summary of Method

Use a multi-parameter water quality meter (multi-probe) to measure temperature, DO, conductivity and pH at predefined depth intervals. The predefined intervals are based on the site depth and the location of any sondes deployed on a vertical instrument line. Lower the multi-probe sonde into the water and record the vertical profile of temperature, DO, conductivity and pH at the predetermined depth intervals. Avoid putting the sonde into contact with the bottom sediments as this will likely result in inaccurate measurements. An accurate measure of the site depth using sonar will help prevent this from occurring.

#### 5.3.2. Equipment and Supplies

Table 5.2 provides the equipment and supplies needed to measure the temperature, DO, pH and conductivity profiles.

**Table 5.2** Equipment and supplies – discrete temperature, DO, pH and conductivity vertical profiles

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site) Vertical Profile Deployment ( <i>if needed</i> )	1
Collection: Water column depth	Sonar unit	1
Collection: Profile Measurements	Multiprobe (temperature, DO, pH and conductivity) <i>YSI EXO sonde and logger</i>	1
	Weighted sonde guard ( <i>Hydrolab only</i> )	
	Storage\Calibration cup	1
	Deionized water (500 mL)	1
	AquaView ( <i>if sondes are deployed</i> )	1

#### 5.3.2.1. Multi-probe Sonde

The multi-probes used for vertical profiles will be a YSI EXO sonde and logger. If a YSI is unavailable, a Hydrolab MS4/5 sonde paired with a Surveyor 4a/5 logger is used. The TAM Coordinator is responsible for requesting calibrated multi-probes from the WPP instrument calibration laboratory for all surveys that require them. The request must be made no later than one week before the survey. If sondes are deployed on a vertical instrument line at the site, the request for the calibrated multi-probes is done in conjunction with the deployed sondes. The WPP instrument calibration laboratory will calibrate the multi-probe the day before or the morning of the survey. More detailed information regarding the operation of the multiprobe sondes and logger can be found in Appendix F.

### 5.3.3. Discrete Vertical Profile *(No Sondes Deployed)*

#### 5.3.3.1. Index Site and Index Site Profile Field Sheets

If sondes are **not** deployed in the lake, use the Multiprobe Information section in the **Lakes Field Sheet (Index Site)** to record the discrete vertical profile data and not the **Vertical Profile Deployment** field sheet and the QC Multiprobe – Vertical Profile Deployment section.

Use the Observation section of the **Lakes Field Sheet (Index Site)** to record the following:

- The depth at the index site and the method used to measure the depth in the Sample Data section on page 2.

Use the Multiprobe Information section of the **Lakes Field Sheet (Index Site)** to record the following:

- The sonde and logger identification numbers and calibration information on the top of the page.
- The OWMID used to identify all the vertical profile measurements is located in the Multi-Probe Information section. OWMIDs to be used are assigned by the TAM Coordinator prior to the surveys.
- The profile table is located in the Multi-Probe Data section. It includes columns to record time, depth, temperature, DO, percent saturation, conductivity, and pH (as well as optional total dissolved solids). If the number of rows in the profile table is insufficient to record the entire profile use an additional page to complete the profile.

#### 5.3.3.2. Depth Profile Procedure

These are the step-by-step procedures for measuring temperature, pH, and DO profiles at the index site.

1. Multiprobe Preparation:

- a. Remove storage cup and attach the weighted sonde guard (YSI EXO – storage cup is over the sonde guard). **CHECK TO ENSURE THE SONDE IS SECURELY ATTACHED TO THE DATA CABLE.**
- b. Record the sonde and logger number on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section.
- c. Calibrate the depth. Record the calibration time on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section.

- d. Annotate the OWMID identified on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section into the logger (**YSI EXO – select the correct OWMID from pre-loaded list**).
2. Determine Site Depth:
  - a. Accurately measure the depth using a sonar or other means and record on the **Lakes Field Sheet (Index Site)**.
  - b. Record the method used to determine the depth on the **Lakes Field Sheet (Index Site)**.
3. Determine Measurement Intervals:
  - a. The number of readings and the depth intervals taken depends on the site depth. Below is a list of rules for determining the intervals:
    - i. The profile will always begin with a measurement just below the surface (0.5 m).
    - ii. If the site is less than 5.0 m deep, record measurements beginning just below the surface and at 0.5 m intervals, until approximately 0.5 m above the bottom.
    - iii. If the depth is greater than 5.0 m, record beginning just below the surface (0.5 m) and then at 1.0 m intervals until reaching approximately 0.5 m above the bottom.
    - iv. In general, the depth of the last measurement should be determined conservatively and take in account max depth and bottom substrate uncertainty to avoid lowering the sonde into the bottom sediment or sediment/water interface.  
**Example:** the sonar indicates the maximum depth is 4.1 m; the depth of the last measurement should be 3.5 m.
4. Measure Temperature, DO, pH and conductivity:
  - a. Lower the sonde in the water and measure the vertical profile of temperature, DO, pH and conductivity at the predetermined depth intervals (top to bottom direction). Use caution to avoid lowering the sonde into the bottom sediment or sediment/water interface.
  - b. Let readings stabilize at each measurement depth before starting to store readings.
  - c. Store a measurement in the logger every 30 seconds for 3 minutes at each predetermined depth. Record the final stored measurement on the **Lakes Field Sheet (Index Site)** in the Multiprobe Data section.
  - d. Note any measurements that the crew feels needs further comment (e.g. instability, last measurement may have been in the sediment/water interface) or when a measurement cannot be made in the Probe Notes section.

#### 5.3.4. Discrete Vertical Profile (*Sondes Deployed QA/QC Check*)

Discrete vertical profiles when sondes are deployed on a vertical instrument line at the lake serve two purposes. The discrete vertical profile serves both as a QA/QC check on the deployed sondes and as additional information regarding physicochemical (e.g., pH and conductivity) conditions in the lake. It can also serve as backup DO and temperature data if the deployed sondes fail QA/QC.

#### *5.3.4.1. Lake Vertical Deployment Field Sheet*

If sondes are deployed in the lake, use the **Vertical Profile Deployment** field sheet and the QC Multiprobe – Vertical Profile Deployment section to record the discrete vertical profile data and not the Multiprobe Information section in the **Lakes Field Sheet (Index Site)**.

Use the **Vertical Profile Deployment** field sheet to record the following:

- The multiprobe sonde and logger identification numbers and calibration information near the top of the QC Probe – Vertical Profile Deployment section. Three QC Probe – Vertical Profile Deployment pages are provided in the field sheet for three different QA/QC events. If there are additional QA/QC events add additional QC Probe – Vertical Profile Deployment pages.
- The OWMID used to identify all the discrete vertical profile measurements is located in the QC Probe – Vertical Profile Deployment section. OWMIDs to be used are assigned by the TAM Coordinator prior to the surveys.
- The profile table is located in the QC Probe – Vertical Profile Deployment section. It includes columns to record time, depth, temperature, DO, percent saturation, conductivity, and pH (as well as optional total dissolved solids), and which deployed sonde is located at that depth. If the number of rows in the profile table is insufficient to record the entire profile use an additional page to complete the profile.

#### *5.3.4.2. Depth Profile Procedure*

These are the step-by-step procedures for measuring temperature, pH, and DO profiles at the index site.

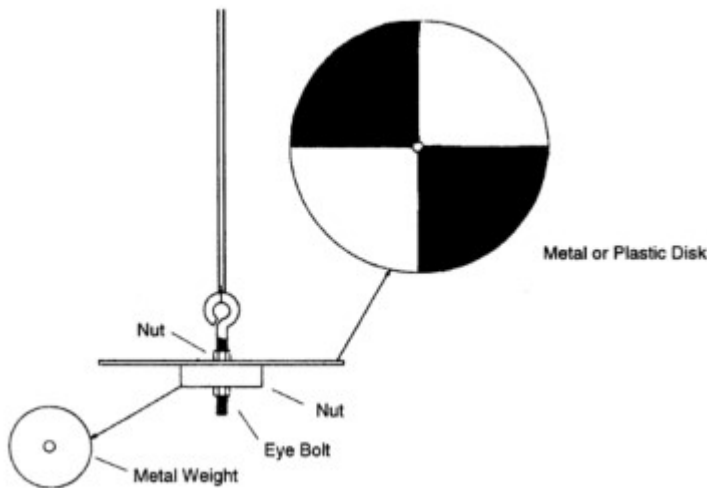
1. Using the AquaView camera, examine the vertical line deployment (buoys, line, sondes, anchor) and note any issues in the Vertical Profile Deployment Notes section of the **Vertical Profile Deployment** field sheet. Examples of problems that could be noted: instrument line is not taut, excessive growth on the sondes, etc.
2. Determine the depths of the deployed sondes:
  - a. Measure the distance from the surface of the water to the top of the sub-surface buoy and record it on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
  - b. Add the Sub-Surface Buoy Depth measured on the QC date to each of the Measured Sonde Line Depth in the Vertical Profile Deployment information section and note the current water depth of each sonde deployed on the vertical instrument line.  
**Measurements should be collected at all depths with deployed sondes.**
3. Multiprobe Preparation:
  - a. Remove storage cup and attach the weighted sonde guard (YSI EXO – storage cup is over the sonde guard). **CHECK TO ENSURE THE SONDE IS SECURELY ATTACHED TO THE DATA CABLE.**
  - a. Record the sonde and logger number on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
  - b. Calibrate the depth. Record the calibration time on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.

- c. Annotate the OWMID identified on the **Vertical Profile Deployment** field sheet in the Multiprobe – Vertical Profile Deployment section into the logger (**YSI EXO – select the correct OWMID from pre-loaded list**).
4. Determine Site Depth:
  - a. Accurately measure the depth using a sonar or other means and record on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
5. Determine Measurement Intervals:
  - a. The number of readings and the depth intervals taken depends on the site depth and deployed sonde depths. Below is a list of rules for determining the intervals:
    - i. The profile will always begin with a measurement just below the surface (0.5 m).
    - ii. Record measurements at each depth corresponding to a deployed sonde (See Step 1). Record the sonde number from Vertical Profile Deployment Information section that is deployed at the measurement depth.
    - iii. In general, the depth of the last measurement should be determined conservatively and take in account max depth and bottom substrate uncertainty to avoid lowering the sonde into the bottom sediment or sediment/water interface.
    - iv. Add additional measurements at depths without deployed sondes as needed to complete the profile.
      1. It may be necessary to add a surface (0.5 meters from surface) and/or near bottom reading (0.5 meters from bottom) since the deployed Onset DO/T might be deeper or shallower than the typical surface and near bottom measurements.
      2. It may be necessary to add measurements at depths between deployed sondes to complete the profile (i.e., insufficient probes to deploy at planned depths). Use the general convention described in section 5.3.3 (3a) for guidance.
6. Measure Temperature, DO, pH and conductivity:
  - a. Lower the sonde in the water and measure the vertical profile of temperature, DO, pH and conductivity at the predetermined depth intervals (top to bottom direction). Use caution to avoid lowering the sonde into the bottom sediment or sediment/water interface.
  - b. Let readings stabilize at each measurement depth before starting to store readings.
  - c. Store a measurement in the logger every 30 seconds for 3 minutes at each predetermined depth. Record the final stored measurement on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
  - d. Note any measurements that the crew feels needs further comment (e.g., instability, last measurement may have been in the sediment/water interface) or when a measurement cannot be made in the Multiprobe QC Notes section.

## 5.4. Secchi Disk Transparency

### 5.4.1. Summary of Method

A Secchi disk is a round opaque 20 cm disk with alternating black and white quadrants that is lowered into the water column to measure the lake's transparency or clarity (see Figure 5.2). Take the reading on the sunny side of the boat using a Viewscope without sunglasses or a hat. Record the depths where the disk disappears when descending and reappears when retrieving.



**Figure 5.2** Secchi disk diagram (USEPA, 1991).

### 5.4.2. Equipment and Supplies

Table 5.3 provides the equipment and supplies needed to measure the Secchi Disk transparency.

**Table 5.3** Equipment and supplies – Secchi disk transparency

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
Collection: Secchi Disk transparency	Secchi Disk (20 cm)	1
	Sounding line (20 m, calibrated, marked in 0.1 m intervals)	1
	Viewscope	1

### 5.4.3. Procedure for Determining Secchi Disk Transparency

Note that because the optimal time to record Secchi disk depths is within 3 hours of solar noon, take readings approximately between the hours of 10 am and 4 pm. Solar noon is approximately 1 PM Daylight Saving Time, which applies during the normal sampling period in the summer.

Measure Secchi disk transparency:

1. Verify that Secchi line has been calibrated and is accurately measuring depth at 0.1 m increments.

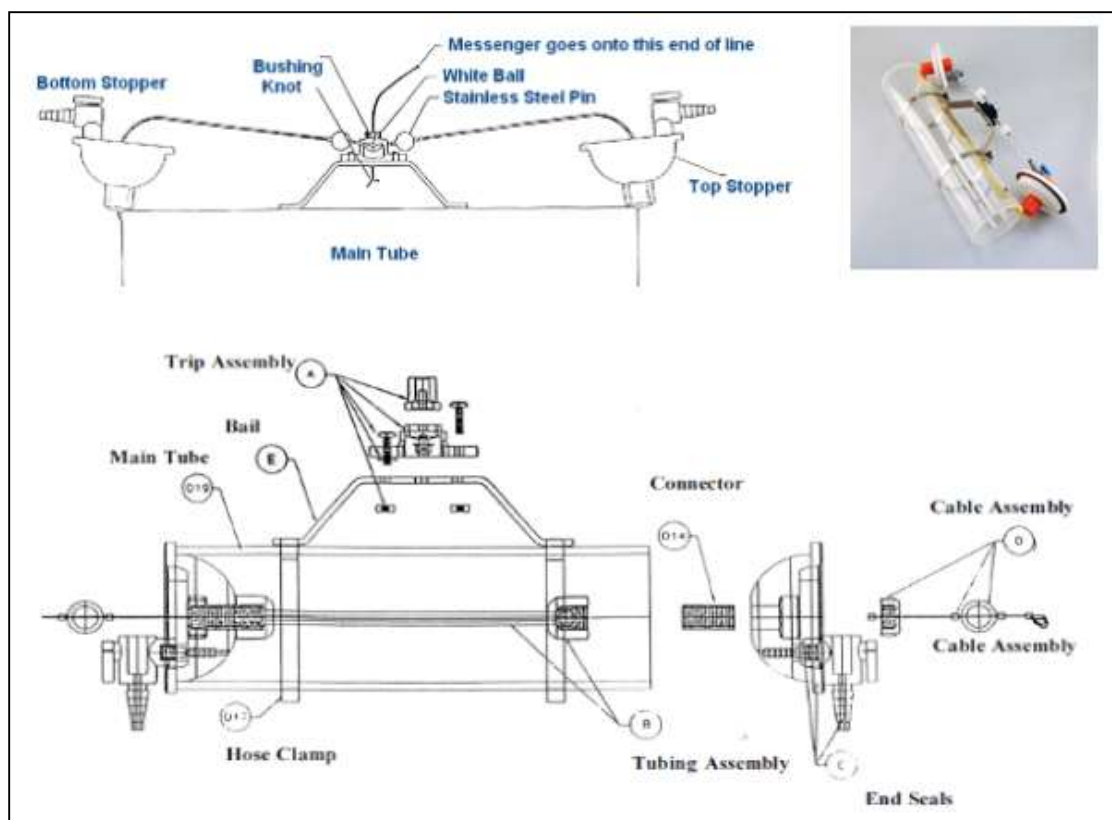
2. Without the use of sunglasses, vertically insert one end of viewscope a few inches into the water to eliminate ripples and glare.
3. Lower Secchi disk so it is not in the boat's shadow. If no viewscope is available, lower the Secchi from the shaded side of the boat and note on the **Lakes Field Sheet (Index Site)** that no viewscope was used.
4. While observing through the viewscope tube, record Secchi disk depth as the average of depth to complete disappearance and slightest hint of reappearance. Record to nearest 0.1 meter and record time of observations on the **Lakes Field Sheet (Index Site)**.
5. If Secchi disk is visible on bottom (or disappears in weeds) write depth and "bottom" or "in weeds" on datasheet next to the Secchi depth at that point.
6. For complete surface cover (e.g., algal scum, complete duckweed or macrophyte cover at the surface), clear an area at the surface temporarily in order to get a good reading (if possible; noting conditions). Where it is not possible to create a temporary clear vertical column to take a reading, do not take a reading (and note conditions).
7. Repeat the procedure with a different crew member and record the measurement (Dup) on the **Lakes Field Sheet (Index Site)** next to the first measurement.

## 5.5. Water Sample Collection and Preservation

### 5.5.1. Summary of Method

Collect ALL water samples using a Van Dorn sampler. This sampler allows collection of water from the water column at discrete depths. The Van Dorn sampler is an open tube with spring loaded seals and valves on both ends of the tube (Figure 5.3). The sampler is lowered to the desired depth in the water column and a weight or messenger is sent down the line holding the sampler to trigger the spring mechanism that shuts the end seals. The sampler is retrieved, and its contents are dispensed to the appropriate sample containers.

Pre-rinse the Van Dorn sampler with lake water from collection depth prior to collecting samples. Set the spring-loaded end seals on the Van Dorn sampler and lower it to 0.5 m (surface), trigger the end seals, and retrieve the sampler. Dispense the contents into the appropriate sample containers for storage. Take additional samples as necessary to achieve the needed volume of water. Repeat this process to collect samples at 0.5 – 1.0 m up from the bottom of the lake (near bottom). Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and cause inaccurate results. Preserve the samples using the appropriate method for each sample container.



**Figure 5.3** Van Dorn samplers (Wildco 2016)

### 5.5.2. Equipment and Supplies

Table 5.4 provides the equipment and supplies needed to collect water samples at the index site.

**Table 5.4** Equipment and supplies – water sample collection

Type	Item	Quantity
<b>Field sheet</b>	Lakes Field Sheet (Index Site)	1
<b>Collection: Water Sample</b>	Van Dorn sampler 2.2 L (Beta)	1
	Poly syringe (60 mL)	1
	Syringe filter (0.45 µm)	1-2
	Deionized water (3L – QC lakes)	1
<b>Storing &amp; Preservation</b>	HDPE bottle (500 mL, natural, narrow mouth) Total Alkalinity	1
	HDPE bottle (500 mL, natural, narrow mouth) Total Hardness	1
	HDPE bottles (120 mL, natural, wide mouth) Color/turbidity	1
	HDPE bottles (40 mL, glass vial pre-preserved with H <sub>3</sub> PO <sub>4</sub> ) Dissolved organic carbon	2
	HDPE bottles (250 mL, natural, wide mouth) Nutrients (surface), nutrients (near bottom)	2

Type	Item	Quantity
	HDPE bottles (60 mL, natural, wide mouth) Chloride	1
	1 mL 9N H <sub>2</sub> SO <sub>4</sub> vials	2
	2 mL 1:1 HNO <sub>3</sub> vial – total hardness (Added post-survey in WPP lab)	1
	Wet ice	As need
	Cooler	1

### 5.5.3. Sampling Procedure

Collect and preserve water samples:

1. Check OWMIDs to confirm the bottles are correct and to organize the bottles for sampling.  
(e.g., filtered samples, near bottom)
2. Rinse the Van Dorn sampler with lake water from 0.5 m (surface) by collecting an initial sample.
  - a. Set the spring-loaded end seals on the sampler and lower it to the surface depth using the metered line.
  - b. Wait a few seconds, send the messenger to trigger the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
  - c. Open both stopper valves to rinse the stoppers on the end seals. Dispose of rinse water (i.e., initial sample) on opposite side of the boat from the sample collection side.
3. Collect samples at 0.5 m (surface) using the Van Dorn sampler.
  - a. Set the spring-loaded end seals on the sampler and lower it to the surface depth using the metered line.
  - b. Wait a few seconds, send the messenger to trigger the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
  - c. Rinse the listed sample bottles two times (cap/shake/discard) each using the water from the sampler. Use the stoppers on the end seals to dispense the water.
    - i. 500 mL total alkalinity bottle
    - ii. 500 mL total hardness bottle
    - iii. 250 mL nutrients (surface) bottle
    - iv. 60 mL chloride bottle
    - v. 120 ml color/turbidity bottle
  - d. Fill each of the rinsed sample bottles (excluding the total alkalinity bottle) to the shoulder (approx. ½" head space) with the water from the sampler. **Fill the total alkalinity sample bottle completely with the water from the sampler leaving NO head space.**
  - e. Rinse the 60 mL syringe two times with water from the sampler and attach the 0.45 um filter to the syringe.

- f. Fill the syringe with water from the sampler and flush the 0.45  $\mu\text{m}$  filter with approximately 20 - 30 mL of sample water.
    - g. Repetitively fill the syringe and filter the water from the sampler. Fill the two 40 mL DOC vials (**w/ no rinse**). The DOC bottle is pre-preserved with  $\text{H}_3\text{PO}_4$ , so use caution to avoid losing the preservative when collecting the sample.
  4. Rinse the Van Dorn sampler with lake water from approximately 0.5 – 1.0 m up from the lake bottom (near bottom) by collecting an initial sample.
    - a. Set the spring-loaded end seals on the sampler and lower it to the near bottom depth using the metered line. **Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and lead to inaccurate results.**
    - b. Wait a few seconds, send the messenger to trigger the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
    - c. Open both stopper valves to rinse the stoppers on the end seals. Dispose of rinse water (i.e., initial sample) on opposite side of the boat from the sample collection side.
  5. Collect samples at approximately 0.5 – 1.0 m up from the lake bottom (near bottom) using the Van Dorn sampler.
    - a. Set the spring-loaded end seals on the sampler and lower it to the near bottom depth using the metered line. **Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and lead to inaccurate results.**
    - b. Wait a few seconds, send the messenger to trigger the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
    - c. Rinse the 250 mL nutrient (near bottom) bottle two times each using the water from the sampler.
    - d. Fill the rinsed sample bottle to the shoulder (approx.  $\frac{1}{2}$ " head space) with the water from the sampler.
  6. Preserve the samples bottles as indicated on the COC forms.
    - a. 500 mL total alkalinity bottle - Cool to 4°C
    - b. 500 mL total hardness bottle - Cool to 4°C, 2 ml 1:1  $\text{HNO}_3$  (**added at WPP lab**)
    - c. 250 mL nutrients (surface) bottle - Cool to 4°C, 1 mL 9N  $\text{H}_2\text{SO}_4$   
(Larger sample volumes will require more  $\text{H}_2\text{SO}_4$ .)
    - d. 250 mL nutrients (near bottom) bottle - Cool to 4°C, 1 mL 9N  $\text{H}_2\text{SO}_4$   
(Larger sample volumes will require more  $\text{H}_2\text{SO}_4$ .)
    - e. 60 mL chloride bottle - Cool to 4°C
    - f. 120 mL color/turbidity bottle - Cool to 4°C
    - g. 250 mL DOC bottle - Cool to 4°C, pre-preserved with  $\text{H}_3\text{PO}_4$
  7. Place all samples in the cooler with ice.
  8. Record the sample times, depths, analyses, and types on the **Lakes Field Sheet (Index Site)**.

## 5.6. Chlorophyll-a and Phytoplankton Assemblage

### 5.6.1. Summary of Method

Collect the chlorophyll-a and phytoplankton samples using a depth integrated sampler. The depth of the integrated sample for chlorophyll-a and phytoplankton is the depth of the euphotic zone and estimated as three times the Secchi disk transparency depth. If the lake depth is less than three times the Secchi disk transparency depth, adjust the depth of the integrated sample to 0.5 m from the lake bottom. The depth integrated sampler is flexible metered PVC tubing with an inner diameter of 1.27 cm (1/2 in) and a weight attached to the end. Multiple lengths (10 – 30 m) are available to accommodate usage in different situations (e.g., very shallow, or deep lakes).

Lower the depth integrated sampler down to the calculated integration depth, crimp the tube above the water surface and pull the depth integrated sampler up and out of the water. Hold the weighted end of the depth integrated sampler near the mouth of a sample compositing container and release the crimp in the tube to allow the water to drain out into the sample compositing container. Repeat the sampling procedure until a minimum of 750 mL is collected in the sample compositing container. Mix the sample in the compositing container and dispense to the appropriate sample containers. Preserve the samples as needed using the appropriate methods.

### 5.6.2. Equipment and Supplies

Table 5.5 provides the equipment and supplies needed to collect chlorophyll a and phytoplankton samples at the index site.

**Table 5.5** Equipment and supplies – chlorophyll a and phytoplankton sample collection

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
Collection: Depth Integrated Sample	Depth integrated sampler (10 – 30 m)	1
	Sample composite container (1L, 2L lakes > 10 m deep )	1
	Secchi disk	1
	Funnel	1
	Deionized water (1L – QC lakes)	1
Storing & Preservation	HDPE bottle (250 mL, amber, rectangle) Phytoplankton	1
	HDPE bottles (250 mL, amber, round) Chlorophyll a	1
	Graduated pipettes	2
	Lugol's solution (6 mL) <i>(Added post-survey in WPP lab)</i>	6 mL
	Wet ice	As need
	Cooler	1

### 5.6.3. Sampling Procedures

Collect and preserve water samples:

1. Check OWMIDs to confirm the bottles are correct and to organize the bottles for sampling.
2. Measure Secchi disk transparency depth (Section 5.2) and multiply the measurements by three to determine the integration depth.
3. Pre-rinse the depth integrated sampler with lake water by collecting an initial sample.
  - a. Lower the depth integrated sampler down to the calculated integration depth, crimp the tube above the water surface and pull the depth integrated sampler up and out of the water. Place your thumb over the end of the tube when it breaks the water surface to prevent the sample from leaking out of the tube.
  - b. Hold the weighted end of the depth integrated sampler on opposite side of the boat from the sample collection side and release the crimp in the tube to allow the water to drain into the lake.
4. Collect samples using the depth integrated sampler.
  - a. Lower the depth integrated sampler down to the calculated integration depth, crimp the tube above the water surface and pull the depth integrated sampler up and out of the water. Place your thumb over the end of the tube when it breaks the water surface to prevent the sample from leaking out of the tube.
  - b. Hold the weighted end of the depth integrated sampler near the mouth of a sample compositing container and release the crimp in the tube to allow the water to drain out into the sample compositing container.
  - c. Repeat this process until a minimum of 750 mL is collected in the sample compositing container. Approximately 125 mL is collected for every meter that the depth integrated sampler is lowered into the water column.
  - d. Rinse the 250 mL phytoplankton bottle and 250 mL chlorophyll a bottle two times and with water from the sample compositing container. Fill the sample bottles to the shoulder with water from the sample compositing container. DO NOT fill the phytoplankton bottle beyond the shoulder to allow appropriate preservation. **Mix the sample in the compositing container prior to filling each bottle.**
5. Preserve the samples bottles as indicated on the COC forms.
  - a. 250 mL phytoplankton bottle - Cool to 4°C, 5 mL Lugol's solution. **On single day surveys, the Lugol's solution is added to the phytoplankton samples at the base station (WPP lab).**
  - b. 250 mL chlorophyll a bottle - Cool to 4°C
6. Place all samples in the cooler with ice.
7. Record the sample times, integration depths, analyses, and types on the **Lakes Field Sheet (Index Site)**.

## 5.7. Condition Observations

### 5.7.1. Summary of Method

Collect semi-quantitative data on weather conditions, aesthetic conditions, potential pollution sources and macrophyte composition and density. This data will provide a general description of the lake conditions at the time of sample collection. Visually observe conditions on the lake while in transit to the index site and following the collection of samples at the index site. Record the semi-quantitative observations in the appropriate sections on the **Lakes Field Sheet (Index Site)**.

### 5.7.2. Equipment and Supplies

Table 5.6 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the lake.

**Table 5.6** Equipment and supplies – visual semi-quantitative observations (Index site)

Type	Item	Quantity
<b>Field sheet</b>	Lakes Field Sheet (Index Site)	1
	Macrophyte Identification/Voucher	1
<b>Collection: Visual Observations</b>	Macrophyte key (non-natives)	1
	Viewscope	1
	Compass (GPS unit)	1

### 5.7.3. Sampling Procedures

Observe and record lake conditions at the Index Site:

1. Observe the weather conditions including air temperature and wind conditions, wave conditions and lake level. Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the conditions.
  - a. If available, use a current air temperature from a smartphone weather application or a display in a vehicle versus estimating.
  - b. If uncertain about the wind direction, use a compass to determine the direction.
  - c. If the lake level is not normal, estimate the level difference from normal (ft) and record on the field sheet.
2. Observe the aesthetic conditions (odor, turbidity, color, objectionable deposits, and floating scum) of the lake. Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the conditions.
  - a. If other is selected for any condition description, make notes describing the other.
  - b. Describe the details, extent and severity of any significant objectionable deposits or floating scum in the space provided or General Notes. Especially note if the deposits or scum are minor or natural.
3. Based on the observations of aesthetic conditions, indicate on the **Lakes Field Sheet (Index Site)** whether the field crew judges the lake aesthetics to be impaired by those conditions.

- a. Aesthetics are by nature subjective so there should be robust discussion between field crew members on the question of impairment.
4. Examine the lake and shoreline for any existing beneficial uses or pollution sources. Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the conditions.
  - a. Describe the details, extent and severity of any observed beneficial uses or pollution sources in the space provided or the General Notes.
5. Observe the macrophyte densities at the Index Site. Check the appropriate density description (none, sparse, moderate, dense, or very dense) for each macrophyte category in the Station Specific Plant Density section and record the species if known on the **Lakes Field Sheet (Index Site)**.
6. Observe algal density and water column characteristics (e.g., color, transparency, pH, DO saturation) to determine if a bloom is occurring. If a bloom is occurring, check the categories on the **Lakes Field Sheet (Index Site)** that best describes the evidence, type, and extent/severity of the bloom.
  - a. Physical water characteristics (e.g., DO saturation and pH) could provide evidence of a bloom so complete this section after the vertical profile measurements.
7. If any non-natives macrophyte species are observed while in transit to or at the Index Site, note them on a **Macrophyte Identification/Voucher** field sheet. Record the observed species, observation location (e.g., near access point) and the purpose for the observation (i.e., “non-native”).
  - a. If a **Macrophyte Identification/Voucher** field sheet is required, be sure to complete site information section of the field sheet including the field sheet log ID from the corresponding **Lakes Field Sheet (Index Site)** or the survey.
  - b. If there is a macrophyte suspected to be non-native, collect a voucher in a zip lock plastic bag, label the bag with site ID, voucher ID, and the date. Record the voucher ID, observation location and the observation purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.
  - c. If more than one macrophyte voucher is collected, place all the vouchers in a larger zip lock plastic bag and label it with site ID and the date.

## 6. LITTORAL SURVEYS

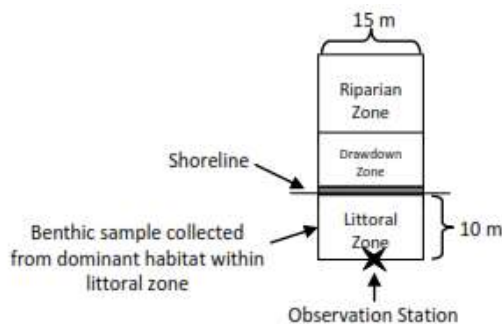
To better understand the character of littoral habitats and conditions, travel to 10 evenly spaced physical littoral habitat stations around the lake and document conditions and characteristics observed within a defined plot area. The full array of measurements and sampling described in this chapter include:

- measures or observations of littoral habitat cover and structure at the 10 littoral stations;
- observations of aesthetic conditions within and adjacent to the littoral station;
- observations of non-native macrophytes;
- collection of benthic macroinvertebrates at each of the 10 littoral stations and composited as a single sample.

## 6.1. Locating and Establishing the Littoral Zone Plots

The approximate locations (latitude, longitude) of the 10 evenly spaced littoral zone stations are determined prior to the sampling visit, uploaded to a field GPS unit and marked on a site map by the TAM Coordinator. GIS is used to select the 10 evenly littoral zone stations on the lake outline. While the first littoral zone station which determines the location of the other stations was not randomly selected, it was selected by GIS based on the numbering and positioning of the digitizing vertices which will not create a systematic bias in the data and is essentially random.

Using the site maps and GPS, proceed by boat around the lake, locate, and stop at each of the pre-determined 10 littoral stations. At each littoral zone station, visually establish a plot that measures 15m wide and extends 10m out from the shoreline. **The shoreline is defined as the interface between “lake-like” conditions and riparian or wetland conditions.** Note any significant changes to the original littoral station location on the site map. The littoral habitat, human disturbance and aesthetic condition characterizations and benthic macroinvertebrate sample collection will occur in and around this littoral plot.



**Figure 6.1** Location of the littoral plot in relation to the shoreline, drawdown zone and riparian zone

### 6.1.1. Ambiguous Shorelines

In most cases, the shoreline will be easily identified as the current waterline. In some instances, however, the shoreline might not be obvious. Listed below are some general situations and rules that should be applied to them. Make field notations for all circumstances.

- If there has been a significant drop in lake level due to drought, dam repair, or other reasons, shallow areas may be exposed that are usually covered with water. In this case, consider the current waterline as shoreline for the purposes of this survey, not the normal waterline.
- If there are extensive very shallow areas or shoals, consider the shoreline to be the boundary between the shallow area and deeper open water, as defined by ease of access by a small sampling boat.
- If access to the true shoreline is prevented by an area of dense aquatic or terrestrial vegetation, consider the shoreline to be the boundary between the vegetation and deeper open water. Again, define the operational shoreline by ease of access by small sampling boat.
- If a river or stream enters a lake, the shoreline begins where no flow is visible.

### **6.1.2. Altered Shoreline**

The goals of the littoral surveys are to characterize the littoral zone conditions based on observations at 10 evenly spaced littoral plots around the lake. Adjustments to the littoral habitat station locations might be needed if the field crew runs into unusual conditions or problems (i.e., differences between the site map and current on the ground conditions). Below are some rules concerning modifications to the station location(s).

- If only a small portion of the shoreline differs and it does not affect, or only slightly affects, a littoral site location, sketch the lake shoreline on the site map and reposition the station (if needed).
- If the difference causes a contraction of the shoreline and a littoral station location is lost, sketch the lake shoreline on the site map and decide to (a) keep the station, relocate it on the revised shoreline map and adjust some or all other stations in order to keep stations evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations).
- If the difference causes an expansion of the shoreline, the crew should sketch the lake shoreline on the site map and make a decision to (a) add one or more stations, mark them on the revised shoreline map and adjust some or all other stations if needed so they are evenly spaced around the lake (i.e., designate more than 10 stations), or (b) adjust the stations so that they are evenly spaced around the lake (i.e., keep 10 stations).
- If the Site Map does not in any way match the lake shoreline, draw a new sketch map approximating the shoreline, and re-establish the 10 littoral stations. A quick way to locate 10 evenly-spaced littoral stations is to: (a) lay a piece of string on the lake perimeter, (b) pick up the string, measure it, and mark out 10 equal parts, and (c) lay the string back on the perimeter and use the marks to locate the 10 sites on the map.

### **6.1.3. Littoral Station Inaccessible**

- If a littoral station is inaccessible, you must decide to (a) relocate the station and adjust some or all other stations so that they are evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations). The size of the lake will help drive this decision.
- Draw and explain all adjustments to the shoreline based on field observations directly on the site map.

## **6.2. Physical Littoral Habitat Characterization**

### **6.2.1. Summary of Method**

The littoral habitat, human disturbances and aesthetic conditions are characterized using semi-quantitative visual observations at 10 evenly spaced littoral plots. Locate and establish the littoral plots described in 6.1. Position the boat on the lake side of the littoral plot (i.e., 10 m from the shoreline) and complete the semi quantitative observations to characterize the habitat (substrate, aquatic macrophyte,

fish) and aesthetics condition within each littoral plot and human disturbances present within and around each littoral plot on the **Macroinvertebrate Littoral Habitat** field sheet.

### 6.2.2. Equipment and Supplies

Table 6.1 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the lake.

**Table 6.1** Equipment and supplies – visual semi-quantitative observations

Type	Item	Quantity
<b>Field sheet</b>	Macroinvertebrate Littoral Habitat	1
	Macrophyte Identification/Voucher	1
	Site Map	1
<b>Collection: Visual Observations</b>	Macrophyte key	1
	Viewscope	1
	Field GPS unit	1
	Sonar Unit	1
	Medium zip lock plastic bags	As needed
	Large zip lock plastic bags	As needed

### 6.2.3. General Observations

Begin the littoral habitat characterization with general observations.

1. Visually establish the littoral plot.
2. Measure and record the lake depth 10 m from the shore at each littoral station (observation point). Note the new location on the site map if the point has to be significantly relocated for some reason.
3. Note on the **Macroinvertebrate Littoral Habitat** field sheet whether there is shoreline flooding. If so, visually estimate the depth and the horizontal distance of flooding. A lake at normal high-water level at the time of sampling will have zero values for both flooding height and horizontal distance.
4. Note on the **Macroinvertebrate Littoral Habitat** field sheet whether there is drawdown. If so, visually estimate and record the vertical (height) and the horizontal (distance) distances between the present lake level and the normal high-water line. A lake at normal high-water level at the time of sampling will have zero values for both drawdown height and horizontal distance.
5. Record the presence or absence of water surface scums, algal mats, or oil slicks within the littoral zone on the **Macroinvertebrate Littoral Habitat** field sheet.

#### 6.2.4. Substrate Characteristics

Semi-quantitative categories are used to estimate the cover for substrate types (e.g., cobble and leaf pack), fish habitat cover (e.g., woody debris and overhanging vegetation) and aquatic macrophytes (e.g., floating, emergent) visible within the littoral zone plot. The categories are as follows:

- 0 = absent (0% cover)
- 1 = sparse (<10% cover)
- 2 = moderate (10 – 40% cover)
- 3 = heavy (40 – 75% cover)
- 4 = very heavy (>75% cover)

When estimating the cover mixtures of more than one class visible in the littoral zone plot, all present classes might be given a moderate (2) or heavy (3) ratings. One dominant class present with no clear subdominant class might be ranked very heavy (4) with all the remaining classes either sparse (1) or absent (0). Two dominant classes visible in the littoral plot with more than 40 percent cover can both be ranked heavy (3).

6. Estimate the areal cover of bottom substrate types and particle size classes visible within littoral zone plot. Cover categories range from absent to very heavy, as described in above. Record all observations by filling in the appropriate number on the **Macroinvertebrate Littoral Habitat** field sheet. The estimates of bottom substrate cover (i.e., first substrate encountered on the surface of the littoral bottom) are based on observations made from the boat, while wading or while sampling the macroinvertebrates. If the bottom is covered with materials other than mineral substrates, choose "Organic (leaf pack, detritus, wood)". Note: The purpose of this measure is to characterize the littoral substrate bottom generally and qualitatively.
7. Record sediment color within the littoral zone. Select "None" or "Other" if the sediment does not match one of the color categories options on the Physical Habitat form.
8. Record sediment odor within the littoral zone. For sediment odor, the choices are "HS" (sulfurous, rotten egg), "Anoxic" (sewage odor), "Chemical" (strong odor like turpentine, paint, etc.), "Oil", or "Other" (including musty, organic, and fishy odors). If "Other" is indicated, explain the observation in the comment section of the form.

#### 6.2.5. Macrophyte Cover

9. Estimate the areal cover of submerged, emergent (has erect portions above the water surface), floating (either rooted or non-rooted vegetation), and total macrophytes within the littoral zone plot. Cover categories range from absent to very heavy, as described in 6.2.4. Record all observations by filling in the appropriate numbers on the **Macroinvertebrate Littoral Habitat** field sheet. These estimates can be made from the boat or while wading.
10. Record if any non-native macrophytes are observed within any of the littoral plots on the **Macrophyte Identification/Voucher** field sheet. Record the observed species, observation location (e.g., Plot D) and the purpose for the observation (i.e., "non-native").
  - If there is a macrophyte suspected to be non-native, collect a voucher in a zip lock plastic bag, label the bag with site ID, voucher ID, and the date. Record the voucher ID,

observation location and the observation purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.

- If more than one macrophyte voucher is collected, place all the vouchers in a larger zip lock plastic bag and label it with site ID and the date.

#### 6.2.6. Fish Cover

Estimate the areal cover of potential fish habitat observed within the littoral zone. These features are within or partially within the water and conceal fish from aquatic and terrestrial predators such as large fish, otters, kingfishers, and osprey. Cover categories range from absent to very heavy, as described in 6.2.4. Record all observations by filling in the appropriate numbers on the **Macroinvertebrate Littoral Habitat** field sheet. In most cases these estimates can be made from the boat.

11. Estimate and record cover for the following fish habitat types:

- Aquatic and Inundated Herbaceous Vegetation: Submerged, floating, or emergent live aquatic or non-woody herbaceous plants
- Woody Debris/Snags: Inundated or partially inundated dead trees, branches, or root wads with diameter >0.3 m (1 ft)
- Woody brush/woody debris: Inundated dead or living woody vegetation <0.3 m diameter.
- Inundated Live Trees: Inundated portions of trees >0.3 m in diameter
- Overhanging Vegetation: <1 m from the water surface (do not include higher overhanging vegetation, which might provide perches for birds such as kingfishers)
- Ledges or Sharp Drop-offs: Overhanging banks, submerged rock shelves, and steep sloping rock walls Boulders: Larger than basketball size
- Human Structures: Docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts)

#### 6.2.7. Human Influences

Record any observations of human influences within or adjacent to the littoral zone. Adjacent is defined as found within a hypothetical plot of equal size (10 m deep by 15 m wide) on each side of the littoral plot. Observations are recorded as not present (0), present outside and/ or adjacent to littoral zone (A), or present within (W) the littoral zone. Record all observations by filling in the appropriate observation on the **Macroinvertebrate Littoral Habitat** field sheet. Do not mark "A" if it is already marked "W" in the littoral zone (only mark the more influential).

12. Note the present or absence of the following human influences:

- Buildings
- Commercial
- Park Facilities/Man-made Beach
- Docks/Boats
- Walks, dikes, or revetments
- Trash/Landfill

- Roads or Railroads
- Power Lines
- Row Crops
- Pasture/Hay fields
- Orchard
- Lawns
- Other (if present)

### 6.3. Benthic Macroinvertebrate Assemblage

#### 6.3.1. Summary of Methods

Benthic macroinvertebrates are collected using a semi-quantitative sampling of multiple habitats in the littoral zone of lake using a 500 µm mesh kick net (Figure 6.2). Sample collection is stratified on the following specific habitat types: rocky/cobble/large woody debris; macrophyte beds; fines (including mud, sand, or silt); and leaf packs.



**Figure 6.2 Standard** kick net (500µm) used for collecting benthic macroinvertebrates.

#### 6.3.2. Equipment and Supplies

Table 6.2 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the lake.

**Table 6.2** Equipment and supplies – benthic macroinvertebrate collection

Type	Item	Quantity
<b>Field sheet</b>	Macroinvertebrate Littoral Habitat	1
	Macrophyte Identification/Voucher	1
<b>Documentation</b>	Labels: Benthic macroinvertebrate samples	1
	Scissors	1
<b>Collection: Benthic macroinvertebrate</b>	Standard Kick net (500 µm) with 4 foot handle	1
	Spare net(s)	As needed
	Bucket (5-gallon capacity, plastic)	1
	Tote (14-gallon, plastic, white)	1
	Sieve bucket (500 µm)	1

	Forceps	1
	Squirt bottle (1 L Nalgene) – lake water	1
	Spoon (stainless steel)	1
	Chest waders	1 per person
<b>Storing and preserving</b>	HDPE bottle (2 L, white, wide mouth)	1-5
	Reagent alcohol (100%)	2 gal
	Grease pen	1
	Cooler	1

### 6.3.3. Sampling Procedure

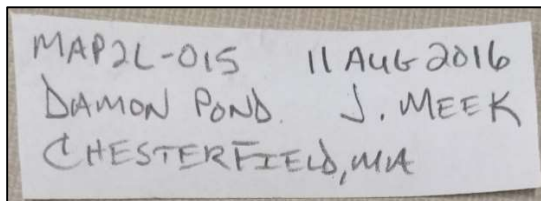
#### 6.3.3.1. Site Selection and Sample Collection

The process for selecting the littoral plots is described in Section 6.1 Locating and Establishing the Littoral Zone Plots. All macroinvertebrate samples should be collected from the **dominant habitat type** within the 10 m x 15 m littoral plot. The sampling process is described below.

#### 6.3.3.2. Sample Processing in the Field

Use a tote/bucket while sampling to transport the composite sample to each littoral plot for sample collection. Once the composite sample from the collections at all of the 10 littoral plots is sieved and reduced in volume, store in a 2 L bottle and preserve with 100% reagent alcohol. Multiple bottles may be required if detritus is heavy. Sample bottles should not be filled more than about halfway with collected materials before starting a new bottle.

Place paper labels (Figure 6.3) indicating the TAM site identification (e.g., TAM-015), date, name of the lake, town, sample bottle count (e.g., 3 of 4) and the collector inside each sample bottle. Use a lead pencil (No. 2) to write the labels. The date, site identification, sample bottle count (e.g., 3 of 4) and preservation solution (100% reagent alcohol) if used, are marked on the sample bottles side and lid using a grease pen.



**Figure 6.3** Example of label to be placed in containers with benthos samples

#### 6.3.3.3. Benthic Macroinvertebrate Sampling

1. After locating and establishing the littoral zone plots according to procedures described in 6.1, identify the dominant habitat type within the plot from the classifiers below:
  - Rocky/cobble/large woody debris

- Macrophyte beds - Record the macrophyte species sampled on the Macrophyte Identification/Voucher field sheet.
  - Fines (including mud, sand, or silt)
  - Leaf pack
2. After identifying the dominant habitat type, use the rectangular-frame kick-net (equipped with 500- $\mu$ m mesh) to sweep through 1 linear meter of the dominant habitat type at a single location within the 10 m x 15 m littoral plot, making sure to disturb the substrate enough to dislodge organisms.
    - If the dominant habitat is rocky/cobble/large woody debris it may be necessary to carefully exit the boat and disturb the substrate (e.g., overturn rocks, logs) using your feet or scrub the substrate (i.e., rocks and logs are too big to move) using a brush while sweeping the net above and around the disturbed area to capture dislodged organisms.
    - If the dominant habitat is very dense macrophyte beds it may be necessary to carefully exit the boat to obtain sufficient leverage to disturb the macrophytes and sweeping the net through the disturbed area.
    - Because a rectangular-frame kick-net is being used for sampling, the **maximum** depth for sampling will be approximately 1m (the length of the dip-net handle); therefore, in cases in which the depth of the lake quickly drops off, it may be necessary to sample in the nearest few meters to the shore.
  3. After completing the 1m sweep, remove all organisms and debris from the net and place them in a tote/bucket following sample processing procedures described in the following section.
  4. Record the dominant habitat type sampled and the collection method on the **Macroinvertebrate Littoral Habitat** field sheet. Note: Sometimes multiple habitat types will be sampled when targeting the dominant habitat type (e.g. getting fines or muck when targeting macrophytes or leaf packs). If this is significant, note both habitat types on the field sheet.
  5. Proceed to the next littoral plot and repeat steps 1-4. The organisms and detritus collected at each littoral plot on the lake should be combined in a single tote/bucket to create a single composite sample for the lake. After sampling at all 10 littoral plots is complete, process the composite sample in the tote/bucket according to procedures described in the following section. One to five bottles should be sufficient to hold the composited sample from each lake.
    - If there is a large amount of debris (e.g., sticks, plants, leaves) accumulating in the composite sample, remove debris between sampling stations, after the debris is inspected, picked, and/or washed to ensure no organisms are lost.
    - If your first collection results in too much debris, discard it, move location within the same littoral plot and dominant habitat type, and take another sample.

#### 6.3.3.4. Preparing Composite Samples

1. Pour the entire contents of the tote/bucket into a sieve bucket with 500  $\mu$ m mesh size. Remove any large objects and wash off any clinging organisms back into the sieve before discarding. Using a wash bottle filled with clean lake water, rinse all the organisms from the tote/bucket into the sieve bucket. This is the composite sample for the lake.

2. Estimate the total volume of the sample in the sieve bucket and determine how many sample bottles will be required. Using your hands, place any remaining sample smaller debris (e.g. leaves, woody debris, pine needles etc.) evenly into the selected sample jars. Rinse your hands in the sieve bucket following transfer to the sample bottles.
3. Wash the remaining contents of the sieve bucket to one side by gently agitating the sieve in the water. Wash the sample into a sample bottle using as little water from the wash bottle as possible. If the sample bottle is too full, pour off some water through the sieve until the sample bottle is not more than half full, or use a second bottle or more if necessary. Carefully examine the sieve for any remaining organisms and use forceps to place them into the sample jar.
4. Place a paper label (Figure 6.2) inside each sample bottle with the following information written with a number 2 lead pencil:
  - TAM site identification (e.g., TAM-015)
  - Date of collection
  - Name of lake
  - Town
  - Sample bottle count (e.g., 3 of 4)
  - Collector
5. Using a grease pen, write the date, site identification, sample bottle count (e.g., 3 of 4) and preservation solution (100% reagent alcohol) on each sample bottles side and lid.
6. Fill each sample bottle up to the neck with 100% reagent alcohol. NOTE: Prepared composite samples can be transported back to the vehicle before adding alcohol if necessary. In this case, fill the jar with lake water, which is then drained using the net (or sieve) across the opening to prevent loss of organisms, and replaced with ethanol at the vehicle.
7. Clean the cap and sample bottle threads with a toothbrush and place the cap securely on each sample bottle. Slowly tip the sample bottle to a horizontal position, and then gently rotate the sample bottle to mix the preservative. Do not invert or shake the jar.

## **7. SHORELINE SITE SURVEYS**

The shoreline site represents areas of the lake with known public recreation (e.g., a beach, canoe launch) or easy public access (e.g., abutting road) where recreation is mostly to occur on the lake. The following indicators are collected at the shoreline site (as described in Table 1.1): *E. coli* (pathogen surrogate). In addition, several semi-quantitative visual observations of weather, aesthetics, pollution sources and algal bloom characteristics (if one exists) are recorded to provide a general description of the conditions at the shoreline site at the time samples were collected by the field crews. This data will assist in the evaluation of the recreation use condition or status. A detailed description of the individual elements is provided below.

### **7.1. Selecting and Locating the Shoreline Site**

The approximate locations (latitude, longitude) of the shoreline sites are determined prior to the sampling visit, uploaded to an auto GPS unit, and marked on a site map by the TAM Coordinator. The

shoreline site locations are determined by evaluating locations of public access on each lake and determining which of the available options would best reflect an area of known or potential public recreation and contact with the water. In cases where access is restricted to the lake (e.g., restricted water supplies), a shoreline site will be selected based on the locations that would likely be available to the public if access was not restricted. This site selection process could involve site reconnaissance to determine the best location for the site. Generally, the order of preference for the location of the shoreline site is as follows:

- Beach or other swimming area
- Canoe launch
- Boat ramp area
- Fishing area
- Abutting road

Using the site maps and an auto GPS unit, locate and stop at each of the shoreline sites within the survey group. At the shoreline site use a field GPS to identify the exact location if it is unclear from the auto GPS and site maps. In general, do not alter the pre-determined stations, unless necessary.

## 7.2. Water Sample Collection and Preservation

### 7.2.1. Summary of Method

Collect the *E. coli* samples using a pole sampler (Figure 7.1). Wade approximately knee to waist deep into the lake at a location that reflects the water quality within the recreational zone (e.g., designated swimming area) and use the sampling pole to collect the *E. coli* samples. Preserve the samples as needed using the appropriate methods.



**Figure 7.1** Sampling pole

### 7.2.2. Equipment and Supplies

Table 7.1 provides the equipment and supplies needed to collect *E. coli* samples.

**Table 7.1** Equipment and supplies – *E. coli* samples

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Shoreline Site)	1

Type	Item	Quantity
<b>Collection:</b> <i>E. coli</i>	Gloves (latex/nitrile, non-powdered)	As needed
	Sampling pole	1
<b>Storing and preserving</b>	IDEXX bottle (120 mL, clear, round, sterile) <i>E. coli</i>	1
	Wet ice	As need
	Cooler	2
	Hip boots or chest waders	1 per person

### 7.2.3. Sampling Procedures

Collect and preserve *E. coli* samples:

1. Check OWMIDs to confirm the bottles are correct and to organize the bottles for sampling.
2. Wade approximately knee to waist deep into the lake at a location that reflects the water quality within the recreational zone (e.g., designated swimming area). Minimize the suspension of bottom sediments to the extent possible when wading into the lake.
3. Rinse the cable cuffs and the end of the sampling pole in the lake.
4. Collect *E. coli* samples using a sampling pole.
  - a. Place the listed sample bottles in the appropriate cable cuff and squeeze close.
    - i. 120 mL IDEXX bottle – *E. coli*
  - b. Remove the cap from the bottle and extend the pole to the desired, undisturbed sampling location.
  - c. Rotate the pole until the bottle is upside down just prior to breaking the water surface. Immerse the bottle to the desired depth (**approx. 6 - 9 inches below the surface**) and then rotate the pole to fill the bottle. **DO NOT RINSE SAMPLE BOTTLE.**
  - d. Remove the sample bottle from the water, cap it and then remove it from the cable cuff.
  - e. Shake sample bottle gently to mix the contents, uncap the sample bottle, pour off water until the water level is approximately at the shoulder of the bottle and recap the sample bottle.
5. Preserve the samples bottles as indicated on the COC forms.
  - a. 120 mL IDEXX bottle - Cool to 4°C, bottle contains preservative
6. Place all samples in the cooler with ice.
7. Record the sample times, integration depths, analyses and types on the **Lakes Field Sheet (Shoreline Site)**.

## 7.3. Condition Observations

### 7.3.1. Summary of Method

Collect semi-quantitative data on weather conditions, aesthetic conditions, potential pollution sources and algal bloom characteristic, if one exists. This data will provide a general description of the shoreline site conditions at the time of sample collection. Visually observe conditions at the shoreline site before

and following the collection of samples. Record the semi-quantitative observations in the appropriate sections on the **Lakes Field Sheet (Shoreline Site)**.

### 7.3.2. Equipment and Supplies

Table 7.2 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the shoreline site.

**Table 7.2** Equipment and supplies – visual semi-quantitative observations (shoreline site)

Type	Item	Quantity
<b>Field sheet</b>	Lakes Field Sheet (Shoreline Site)	1
	Macrophyte Identification/Voucher	1
<b>Collection: Visual Observations</b>	Macrophyte key (non-natives)	1

### 7.3.3. Sampling Procedures

Observe and record conditions at the shoreline site:

1. Observe the weather conditions including water surface characteristics at the shoreline site. Check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the conditions.
  - a. If available, use a current air temperature from a smartphone weather application or a display in a vehicle versus estimating.
  - b. If uncertain about the wind direction, use a compass to determine the direction.
  - c. If the lake level is not normal, estimate the level difference from normal (ft) and record on the field sheet.
2. Observe the aesthetic conditions (odor, turbidity, color, objectionable deposits, and floating scum) at the shoreline site. Check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the conditions.
  - a. If other is selected for any condition description, make notes describing the other.
  - b. Describe the details, extent and severity of any objectionable deposits or floating scum in the space provided or the General Notes. Especially note if the deposits or scum are minor or natural.
3. Based on the observations of aesthetic conditions, indicate on the **Lakes Field Sheet (Shoreline Site)** whether the field crew judges the aesthetics at the shoreline to be impaired by those conditions.
  - a. Aesthetics are by nature subjective so there should be robust discussion between field crew members on the question of impairment.
4. Examine the lake and shoreline for any existing beneficial uses or pollution sources. Check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the conditions.
  - a. Describe the details, extent and severity of any observed beneficial uses or pollution sources in the space provided or the General Notes.

5. Observe the macrophyte densities at the Shoreline Site. Check the appropriate density description (none, sparse, moderate, dense, or very dense) for each macrophyte category in the Station Specific Plant Density section and record the species if known on the **Lakes Field Sheet (Index Site)**.
6. Observe algal density and water column characteristics (e.g., color, transparency, pH, DO saturation) to determine if a bloom is occurring. If a bloom is occurring, check the categories on the **Lakes Field Sheet (Index Site)** that best describes the evidence, type, and extent/severity of the bloom.
  - a. Physical water characteristics (e.g., DO saturation and pH) could provide evidence of a bloom so complete this section after the vertical profile measurements.
7. If any non-native macrophyte species are observed during sampling at the shoreline site, note them on a **Macrophyte Identification/Voucher** field sheet. Record the observed species, observation location (e.g., near access point) and the purpose for the observation (i.e. “non-native”).
  - a. If a **Macrophyte Identification/Voucher** field sheet is required, be sure to complete site information section of the field sheet including the field sheet log ID from the corresponding **Lakes Field Sheet (Shoreline Site)** or the survey.
  - b. If there is a macrophyte suspected to be non-native, collect a voucher in a zip lock plastic bag, label the bag with site ID, voucher ID, and the date. Record the voucher ID, observation location and the observation purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.
  - c. If more than one macrophyte voucher is collected, place all the vouchers in a larger zip lock plastic bag and label it with site ID and the date.

## 8. WHOLE LAKE SURVEYS

Some indicators require that measurements and data are collected throughout the lake (as described in Table 1.1): fish tissue, macrophyte (cover, biovolume and non-native) and lake wide activity/disturbance data are collected throughout the lake to provide a comprehensive assessment of those indicators at the time data were collected by the field crews. Detailed descriptions of the individual indicators are provided in the following sections.

### 8.1. Macrophyte Survey

#### 8.1.1. Summary of Method

Quantitative measurements of lake depth and submerged aquatic macrophyte cover and biovolume are collected along a series parallel transects in the lake using both down scanning and side scanning transducers (sonar unit). The data collected by the sonar unit is uploaded to BioBase, a cloud-based platform that automates the processing of sonar data to produce maps and reports regarding bathymetry and submerged aquatic macrophyte cover and biovolume. Macrophyte species identifications will be conducted via rake throws (manual extraction) at 10 grid locations with the goal to identify the dominant macrophyte species in the lake and the presence of non-native macrophyte

species. In addition, a paper map indicating semi-quantitative estimates of biovolume throughout the lake will be completed as a backup to the BioBase produced maps.

### 8.1.2. Equipment and Supplies

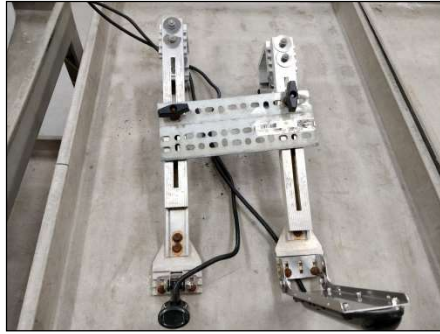
**Table 8.1 Equipment and supplies - aquatic macrophyte survey**

Type	Item	Quantity
<b>Field sheet</b>	Macrophyte Survey	1
	Macrophyte Identification/Voucher	1
	Site Maps ( <i>included in field sheets</i> )	1
<b>Collection: Aquatic macrophyte survey</b>	Sonar unit (with microSD loaded with transects/sites)	1
	Underwater camera (AquaView)	1
	Viewscope	1
	Macrophyte rake	1
	Macrophyte key	1
	Field GPS unit	1
<b>Storage and Preservation</b>	Medium zip lock plastic bags	As needed
	Large zip lock plastic bags	As needed
	Small cooler	1
	Wet ice	As needed

### 8.1.3. Depth, Biovolume and Percent Cover Measurement Procedure

These are the step-by-step procedures for measuring depth, biovolume and percent cover within the lake using a sonar unit.

1. Set relevant sonar settings (e.g., ping rate, frequency) to the recommended values from BioBase. Refer to the BioBase Quick Reference in Appendix G for guidance on the settings.
2. Mount the sonar transducers (down scanning and side scanning) to the boat transom using the clamps (Figure 8.1).
  - Mount transducer and side scan sonar to starboard (right side facing the front of the boat) of propeller. Avoid mounting transducers within 3" of the propeller.
  - Ensure transducer and side scan sonar are 12 inches apart.
  - Ensure transducer is level and at least 1/8 inch below hull.
  - If there is interference, adjusting the transducer angle may help.
  - See Appendix H for other general mounting and adjustment guidance (Navico 2014).



**Figure 8.1** Sonar transducer mounting clamps

3. Load the general sampling transects (created in GIS and pre-loaded from a gpx file) onto the sonar from the SD card in the sonar.
  - On sonar viewer → Go to Files → Load desired transect (.gpx) file. The lake site ID and transect type will be indicated in the file name.
  - Designed transect spacing for each lake will vary due to resource constraints. Transect space should be set so that mapping can be completed in 1 day.
  - Pre-loaded transect have a minimum spacing of 40 m. Transect spacing was increased on larger lakes to achieve the resource usage goals. Two types of transect will be preloaded: straight line transects parallel to the longest shoreline and concentric circle transect following the shoreline. Selection of the type of transects to use will be based on lake characteristic and at the discretion of the TAM crew lead. Generally, concentric circles are more appropriate for smaller ponds and coves in larger lakes.
  - Pre-loaded transects are for general guidance and set at a minimum spacing. If time allows, reduce the transect spacing or consider adding additional transects based on field conditions or in directions perpendicular to their original transects.
4. Record the offset of transducer to surface of water on **Macrophyte Survey** field sheet when boat is filled with passengers and gear.
5. Complete the general information sections (e.g., date, time, field crew, sampling activity) in the **Macrophyte Survey** field sheet.
6. Start logging sonar measurements.
  - On sonar viewer → Go to Advance Menu → Select “Log Sonar” dialog
  - Name the sonar logging file. Record the file name on **Macrophyte Survey** field sheet.
  - Make sure you select sl2 file type to capture both transducer and side scan sonar.
  - In the case of low battery, stop sonar logging prior to changing the battery and restart sonar logging with a different file name when battery change is complete.
7. Travel the designed transect with the boat while logging measurements with the sonar unit.
  - Maintain a speed between 3-5 mph which will minimize the disturbance from the motor and increase the transducers’ ability to obtain an adequate signal.
  - Adjusts the designed transect as necessary based on field conditions. Considerable individual judgment may be required to successfully complete the mapping.

8. Complete the Macrophyte Survey Details and Data File Tracking sections in the **Macrophyte Survey** field sheet. Indicate areas of the lake not surveyed both in the Macrophyte Survey Details section and on the Macrophyte Percent Biovolume map.
9. Record the visual semi-quantitative biovolume estimates for the backup biovolume map on the **Macrophyte Survey** field sheet.
  - Estimate biovolume visually while traveling the designed transects and record the locations and extent of each biovolume percentage category on the lake outline map using the provided shading key.
  - Priority should be given to recording areas on the lake outline map where biovolume is estimated to be dense (50% - 75%) or very dense (75% - 100%). Estimates of lower biovolume percentages will be difficult to visually estimate, especially the specific extent or boundaries.

#### 8.1.4. Dominant Macrophyte Species Identification Procedures

The goal of this procedure is to identify the dominant macrophyte species (>10% cover) in the lake and the presence of any non-native macrophytes. A full quantitative assessment of all aquatic macrophytes present is not possible due to resource constraints and not required to achieve the TAM lake assessment objectives.

These are the step-by-step procedures for using rake throws to identify the dominant macrophyte species and the presence of non-native species.

1. Load the rake throw locations (created in GIS and pre-loaded from a gpx file) onto the sonar from the SD card in the sonar.
  - On sonar viewer→Go to Files→Load desired rake throw location (.gpx) file. The file should contain 10 rake throw locations identified with numbers 1 -10. The lake site ID will be indicated in the file name.
  - Completing the 10 rake throws is the minimum effort. Additional sites necessary to achieve the monitoring objectives based on the field conditions are encouraged if resources allow.
  - The location of the 10 rake throws will also be uploaded to all field GPS units which may be easier to use than the sonar unit under certain circumstances.
2. Complete the General Information sections (e.g., date, time, field crew, sampling activity) in the **Macrophyte Identification/Voucher** field sheet.
3. At each lake throw location complete the following activities. The rake throws can be conducted either concurrently or consecutively with the macrophyte mapping depending on field conditions and general efficiency determinations.
  - a. Visually estimate the biovolume and percent cover in an approximately 10 m x 10 m area around the lake throw location. If necessary, use the AquaView underwater camera or view scope to make the visual estimate. Record the estimate on the Macrophyte Species Map next to the corresponding rake throw in the **Macrophyte Survey** field sheet. Sparse (S) = 5%-25%, Moderate (M) = 25%-50%, Dense (D) = 50% - 75%, Very Dense (VD) = 75% - 100%, No Plants (NP) = 0%

- b. Confirm throwing line is securely attached to weighted rake at one end. Throw the rake approximately 5 – 10 m in the direction of the rake throw location and the highest density of macrophytes. Allow the rake to settle to the lake bottom, slowly pull the rake back to the boat and remove representative macrophytes from the rake for identification.
        - c. Record all macrophyte species identified from the rake throw on the **Macrophyte Identification/Voucher** field sheet and the observed location (e.g. rake throw #4). If any species appears at multiple locations, add the additional locations to the first record of the species on the field sheet (e.g., rake throw #4, 7, 10). See Appendix D for an example
        - d. Retain a voucher sample for any macrophyte species that are unable to be positively identified and any non-native species (requires confirmation from additional staff). Write a voucher ID (Site ID – Voucher#) and the date on a medium zip lock bag and place the voucher sample into the bag with some lake water to prevent the plant from drying out. Record the voucher ID and observed location on the **Macrophyte Identification/Voucher** field sheet.
        - e. If there is insufficient time, it is permissible to retain a single voucher sample containing multiple species from a single rake throw versus retaining a voucher sample for each individual species. Indicate on the zip lock bag and **Macrophyte Identification/Voucher** field sheet how many species are suspected in each bag. See Appendix D for an example.
        - f. If an area of significant macrophyte densities is excluded from the 10 rake throws and time allows, conduct additional rack throws in those areas following the above procedures. Indicate the location of any additional rake throws on the Macrophyte Species Map in the **Macrophyte Identification/Voucher** field sheet.
4. Complete post-survey base station activities.
  - a. Identify macrophyte species in all retained voucher samples and record the identifications on the **Macrophyte Identification/Voucher** field sheet. If it is necessary or advantageous to print out a new **Macrophyte Identification/Voucher** field sheet to complete this activity due to the number of voucher samples, write “Draft” in the header of the original field sheet and “Final” in the header of new field sheet. Discard the “Draft” version once the “Final” version is complete.
  - b. Record on the **Macrophyte Identification/Voucher** field sheet the overall percent cover for each species in the lake. This is qualitative estimate based on the number of observed locations for each species and a general estimate of the percent cover at each location for the given species.

## 8.2. General Lake Assessment

### 8.2.1. Lake/Catchment Site Activities and Disturbances

Record any of the sources of potential stressors listed in Table 8.2 on the **Macrophyte Survey** field sheet, that were observed while on the lake conducting the macrophyte survey, or while driving or

walking through the lake catchment. For activities and stressors that you observe, rate their abundance, or influence as low (L), moderate (M), or heavy (H) on the line next to the listed disturbance. Leave the line blank for any disturbance not observed. The distinction between low, moderate, and heavy will be subjective. For example, if there are two to three houses on a lake, circle "L" for low next to "Houses." If the lake is ringed with houses, rate it as heavy (H). Similarly, a small patch of clear-cut logging on a hill overlooking the lake would rate a low ranking. Logging activity right on the lake shore, however, would get a heavy disturbance ranking. The section for "Lake Site Activities and Disturbances Observed" includes residential, recreational, agricultural, industrial, and lake management categories.

**Table 8.2** Site activities and disturbances observed during macrophyte survey

<b>Observe lake activities or disturbances listed and record as L (low), M (moderate), or H (heavy) intensity on the Assessment form (except as noted below):</b>	
<b>Residences</b>	Presence of any houses and residential buildings around the lake.
<b>Maintained Lawns</b>	Presence of any maintained lawns around the lake.
<b>Construction</b>	Presence of any recent construction in the immediate area around the lake or signs of recent sedimentation events (depositional fans).
<b>Pipes/Drain</b>	Presence of any pipes or drains feeding into or out of the lake.
<b>Dumping</b>	Any evidence of landfill or dumping around the lake, including garbage pits and informal dumping of large amounts of trash or cars and appliances along roads or lakeshore. This does not include small amounts of litter.
<b>Roads</b>	Presence of any maintained roads in the immediate area around the lake.
<b>Bridges/Causeways</b>	Presence of any bridges or causeways across or in the immediate vicinity of the lake.
<b>Sewage Treatment</b>	Presence of sewage treatment facility.
<b>Hiking Trails</b>	Presence of formal hiking trails around the lake.
<b>Parks, Campgrounds</b>	Presence of organized public or private parks, campgrounds, beaches or other recreational areas around the lake.
<b>Primitive Parks, Camping</b>	Presence of informal or primitive parks, camping areas, beaches or other recreational areas (e.g., swimming holes) around the lake.
<b>Resorts</b>	Level of resort activity; this could include motels, resorts, golf courses, and stores.
<b>Marinas/Docks</b>	Presence of any marinas or boat docks.
<b>Trash/Litter</b>	Relative abundance of trash or litter around the lake.
<b>Surface Films, Scum or Slicks</b>	Relative abundance of surface films, scum, or slicks on the lake.
<b>Cropland</b>	Presence of cropland.
<b>Pasture</b>	Presence of pastures.
<b>Livestock Use</b>	Presence of livestock use.
<b>Orchards</b>	Presence of orchards.
<b>Poultry</b>	Presence of poultry operations.
<b>Feedlot</b>	Presence of feedlot or concentrated animal feeding operations.
<b>Water Withdrawal</b>	Any evidence of water withdrawal from the lake.

<b>Observe lake activities or disturbances listed and record as L (low), M (moderate), or H (heavy) intensity on the Assessment form (except as noted below):</b>	
<b>Industrial Plants</b>	Any industrial activity (e.g., canning, chemical, pulp) around the lake or in the catchment.
<b>Mines/Quarries</b>	Any evidence of mining or quarrying activity in the catchment or around the lake.
<b>Oil/Gas Wells</b>	Any evidence of oil or gas wells in the catchment or around the lake.
<b>Power Plants</b>	Presence of any power plants.
<b>Logging</b>	Any evidence of logging or fire removal of trees in the lake area.
<b>Evidence of Fire</b>	Any evidence of forest fires in the lake area.
<b>Odors</b>	Presence of any strong odors.
<b>Commercial</b>	Any commercial activity (e.g., convenient stores, shopping centers, restaurants) around the lake or in the catchment.
<b>Liming</b>	Any evidence of liming activities.
<b>Chemical Treatment</b>	Presence of any chemical treatment facilities.
<b>Angling Pressure</b>	Estimate of the intensity of fishing activity in the lake.
<b>Drinking Water Treatment</b>	Presence of any drinking water treatment facilities.
<b>Macrophyte Control</b>	Any evidence of dredging or other activities to control macrophyte growth; describe these in the "Comments" section on Side 2.
<b>Water Level Fluctuations</b>	Any evidence of water level fluctuations due to lake management.

### 8.2.2. Overall Waterbody Character

Rate the waterbody character which is the physical habitat integrity of the waterbody and is largely a function of riparian and littoral habitat structure, volume change, trash, turbidity, slicks, scums, color, and odor. TAM attempts to define water body character through two attributes: degree of human disturbance and aesthetics. Rate each of these attributes on a scale of 1 to 5.

In the human disturbance evaluation, a "1" would indicate that a lake is highly disturbed (e.g. ringed with houses, seawalls, docks, etc.) and a "5" would indicate the lake is pristine with no signs of any human disturbance. On the **Macrophyte Survey** field sheet, circle the number that best describes your opinion about human disturbance.

In the aesthetics (whether the lake is appealing or not) evaluation the decision is based on any factors about the lake that may disturb you (trash, algal growth, weed abundance, overcrowding) and impact your enjoyment of the lake. On the **Macrophyte Survey** field sheet, circle the number using the descriptions in Table 8.3 that best describes how suitable the lake is for recreation and aesthetic enjoyment today (i.e. Aesthetic Appeal). If the aesthetic appeal score is less than 3, indicate the cause(s) in the Aesthetics Impairment Cause section and describe the extent and severity.

**Table 8.3** Aesthetic score descriptions

Score	Description
1	Enjoyment is nearly impossible.
2	Level of enjoyment is substantially reduced.
3	Enjoyment is slightly impaired.
4	There are very minor aesthetic problems; it is otherwise excellent for swimming, boating, and enjoyment.
5	It is beautiful and could not be any nicer.

### 8.3. Fish Tissue

#### 8.3.1. Summary of Method

Fish (live or freshly killed) are collected using a number of different sampling methods or fish collection gears including electroshocking, gill netting, trotline, traps, and angling. Three individuals of edible and legal size are collected for each target species with a goal of collecting fish in five different species. These numbers are the goal but can vary depending on the sampling efficiency and species present in the lake. The samples are iced immediately and transported back to the WPP fish laboratory for preparation. Preparation consists of dissecting a skinless fillet from one side of the whole fish. The tissue samples are wrapped, tagged, bagged, and frozen until such time as they can be delivered to the lab for analysis. The tissue samples from the individuals in each species will be composited into one sample at WES before analysis.

#### 8.3.2. Equipment and Supplies

Table 8.4 provides the equipment and supplies to collect and process fish tissue samples. The equipment and supplies table contains only information for the two most commonly used collection methods, electroshocking boat, and gillnets.

**Table 8.4** Equipment and supplies – fish tissue collection and processing

Type	Item	Quantity
<b>Collection: Electrofishing Boat</b>	Coffelt 18-foot electrofishing boat	1
	40-inch Wisconsin ring and droppers	1
	Honda EG 5000™ Generator	1
	Dip nets	3
	Rubber gloves	3
	Novelty bat	1
	Depth sounder	1
<b>Collection: Gillnets</b>	Gillnets (various size and configurations)	As needed
	Floats	As needed
	Novelty bat	1
	Depth sounder	1
<b>Storing and preserving</b>	Cooler	1

Type	Item	Quantity
	Wet ice	As needed

### 8.3.3. Sampling Procedures

All collections are made in accordance with a Scientific Collection Permit issued by the Massachusetts Department of Fisheries and Wildlife (MDFW). The goal at each lake is to collect three individuals of edible and legal size in five of the target species. In order to assess the level of contamination present in fish of different trophic guilds and habitat types, fish species targeted should include at a minimum; largemouth bass, *Micropterus salmoides*, and/or chain pickerel, *Esox niger*, (predators); yellow perch, *Perca flavescens*, and/or white perch, *Morone americana*, (water column invertivores/omnivores); and bullhead, *Ameiurus sp.* and/or common carp, *Cyprinus carpio*, (benthic feeding omnivores). Other potential target species are listed in Table 8.5.

**Table 8.5** Target species list

Common Name	Scientific Name	Trophic Guild Habitat
largemouth bass	<i>Micropterus salmoides</i>	predator
smallmouth bass	<i>Micropterus dolomieu</i>	predator
chain pickerel	<i>Esox niger</i>	predator
black crappie	<i>Pomoxis nigromaculatus</i>	predator/piscivore
white perch	<i>Morone americana</i>	water column invertivore
yellow perch	<i>Perca flavescens</i>	water column invertivore
Bluegill	<i>Lepomis macrochirus</i>	littoral invertivore
Pumpkinseed	<i>Lepomis gibbosus</i>	littoral invertivore/omnivore
white sucker	<i>Catostomus commersoni</i>	bottom feeding omnivore
brown bullhead	<i>Ameiurus nebulosus</i>	bottom feeding omnivore
yellow bullhead	<i>Ameiurus natalis</i>	bottom feeding omnivore
carp	<i>Cyprinus carpio</i>	bottom feeding omnivore

The preferred method of fish collection is boat electroshocking and will be use wherever possible but depending on the situation, lakes can be sampled using one or more of the following collection methods:

#### 8.3.3.1. Electroshocking Boat

Boat electrofishing is performed by maneuvering an electrofishing boat along: shorelines and littoral habitat; submerged, floating, and emergent macrophyte beds; rockpiles, logs, and stumps; and other “structure”. Stunned fish are collected by one or two netters stationed on the platform located in the bow of the boat. Fish are held in a live well filled with site water until collection is completed. The sample is chosen from the collected fishes. Fish, which are selected as part of the sample, are dispatched by a blow to the head (using a small novelty baseball bat or piece of hardwood). They are then immediately placed on ice in coolers. All remaining fish are released alive.

#### *8.3.3.2. Gill Net*

Gill netting entails the deployment of gill nets (vertical panels of monofilament netting). The nets are anchored by weights at each end attached to the bottom weighted edge of the net (lead line). The upper edge of the net is composed of a polyethylene line, which floats and thereby keeps the net “open” or spread. Surface floats are attached with rope to both ends of this “float line”. Nets are usually 50-100 m in length and 2 m in height. Size of fish caught is dependent on the size of mesh that is incorporated in the construction of a particular mesh. Mesh sizes usually range from 1.5 – 7.5 cm. Most gill net sets are made on the bottom. Orientation is usually perpendicular to shore or along weed beds or other structure. Sets are between 2 to 24 hours in length. Fish that are caught in gill nets frequently die. Fish chosen for inclusion as part of a sample are those which are still alive or appear fresh. Live fish are dispatched by a blow to the head. They are immediately placed on ice in coolers. All remaining live fish are released. Dead fish are disposed of either on or offsite.

#### *8.3.3.3. Trotlines*

Trot lines are essentially long lines of baited hooks. They either rest on the bottom or in the case of polyethylene lines float slightly above the bottom. They are anchored by a weight at one or both ends and are buoyed by a float at the other. Trotlines are usually baited with worms or small fishes, set late in the afternoon and left overnight. Lines are retrieved on the following morning and fish are removed. Fish that are chosen for inclusion as part of a sample, are either alive, or appear fresh. If alive they are dispatched with a blow to the head and immediately placed in ice filled coolers following collection. All remaining fish are either released alive or if dead are disposed of either on or offsite.

#### *8.3.3.4. Traps*

Fish traps are wooden or metal/plastic gear similar to lobster traps employed on rare occasions in an attempt to catch bullhead or catfish. Wooden traps require soaking in water for few days prior to deployment. Traps are baited with dog food, fish food pellets, or other bait and allowed to set overnight. Traps are checked the following day and fish are removed. Fish chosen for inclusion as part of a sample are dispatched by a blow to the head then immediately placed in coolers on ice. All remaining fish are released alive.

#### *8.3.3.5. Angling*

Angling usually pertains to rod and reel fishing. Rod and reel angling is performed by casting or placing lures or bait into areas which likely to be holding fish. Fish which take the bait or lure are hooked and reeled in. Fish meeting species and size requirements are dispatched by a blow to the head and then immediately placed on ice. All remaining fish are released alive.

### **8.3.4. Sample Processing**

#### *8.3.4.1. Sample Login*

Fish packed in ice are brought to the WPP fish laboratory in Worcester. Each fish is assigned a Sample Lab ID that is comprised of the WES Sample Log In Batch Number (the calendar year followed by a three integer identifier determined by the laboratory WES) followed by a three place integer identifier and in the case of composites followed by a small letter. For example, the first fish from a survey conducted in the Year 2015 would be assigned a code of 2015233-001. If it is part of a composite the letter “a” is added (2015233-001a). The next fish in that composite would be numbered 2015233-001b. If the next fish was to be analyzed individually or as part of a different composite sample the number would change to 2015233-002 or 2015233-002a. Each fish is measured and weighed, and notes are made, when appropriate, as to an individual fish's general condition (i.e. the occurrence of lesions, tumors, or other anomalies). All information is recorded on a Fish Collection and Inventory form and a WES Sample Batch Number Form (see Attachment G).

#### *8.3.4.2. Fish Ageing*

Scales, fin rays, or spines are removed for use in age determination. Scales are removed from most fishes. Pectoral spines are removed from bullheads (*Ameiurus* sp.) and catfish (*Ictalurus* sp.), fin rays are removed from carp (*Cyprinus carpio*).

- Scale removal - An individual fish that has been measured, weighed, and assigned an individual sample code is placed on its side on a clean cutting board. Mucous (slime) dirt or other foreign matter is removed by passing the blade of a knife gently over the area (towards the tail) from which scales is to be removed (see Attachment H). A stout sharp knife is then used to loosen 10 to 20 scales by pushing on the scales firmly with the point and pushing towards the tail. The loosened scales are then picked up, by passing a knife gently under the scales and lifting. The knife blade is then inserted into an open # 1 coin/scale (2.25 in. x 3.5 in.) envelope (see Attachment 6). The sides of the scale envelope are pressed onto the knife gently with the thumb and forefinger and the knife blade is slowly removed. The scales are left inside the envelope. The year, individual sample lab ID, and species code are noted on the outside of the scale envelope. Flaps are left unglued.
- Spine and fin ray removal - An individual fish that has been measured, weighed, and assigned an individual sample code is placed on its side on a clean cutting board. A knife is inserted along the pectoral spine or fin ray and the spine or ray is loosened by cutting the adjacent tissue. The spine or ray is then grasped with pliers, twisted gently and removed. The spine or fin ray is then dropped into a scale envelope. The year, individual sample lab ID, and species code are noted on the outside of the scale envelope. Flaps are left unglued

#### *8.3.4.3. Filleting*

An individual fish is placed on its side on a pre-cleaned glass cutting board (washed and rinsed in hot tap water and rinsed twice more in de-ionized water). The fish is filleted, and the fillet is laid skin side down on the cutting board. All fish to be included in a composite sample are processed in the same manner providing there is room on the glass cutting board. Each fillet is then skinned, by running a fillet knife between the skin and the flesh. An appropriate amount of the dorsal muscle tissue is excised from the full fillet. All equipment used in the filleting process is then rinsed in hot tap water to remove slime, scales, and blood, then rinsed twice in de-ionized water and the next sample is prepared. This procedure is followed until all samples have been prepared.

#### *8.3.4.4. Partitioning, Packaging, and Labeling*

The boneless fish flesh sample is then picked up with the knife and placed in a HDPE container. The cover and the container itself are marked in permanent ink with the sample lab ID. Pre-numbered paper labels are also used when provided by the laboratory. Composite samples range from two to five fish (depending on the success of the catch) from like-sized individuals (within approx. 25% for each total length) of the same species. Any deviations from this definition are noted. Samples from a specific waterbody are put into one- or two-gallon Ziplock™ freezer bags with the Sample Tracking Chain of Custody Record (COC) and the WES Sample Batch Number Form. The freezer bags are then placed in the freezer. Fish are delivered to the WES within 14 days.

## **9. DECONTAMINATION FOR INVASIVE SPECIES**

### **9.1.1. Overview**

The primary mechanisms to be employed to prevent the spread of invasive plant and animal species (non-native and native) are as follows:

- Sampling one lake per day and cleaning/drying in-between uses
- Using duplicate equipment when sampling > 1 lake per day to avoid using the same equipment on multiple lakes
- Decontaminating equipment back at the office using high pressure washing or freezing
- Managing sampling schedule to allow for sufficient drying time for equipment
- Cleaning and inspection as standard protocol
- Using portable sprayers with salt solution or other approved decontamination solution (e.g., white vinegar) in the field when visiting multiple lakes during shoreline surveys
- Using self-serve car washes, if necessary
- Generally limiting the number of lakes sampled in one day to two (to minimize logistical complications)

All lakes shall be treated using the same procedures, regardless of the presence/absence of invasive organisms. The primary cleaning fluids shall be pressurized water (i.e., no chemical additives for normal cleaning) and 5% salt (NaCl) solution. As necessary, procedures shall also comply with statewide 2023 decontamination protocols (CN 59.93).

### **9.1.2. Watercraft (boats, motors, and trailers)**

#### *9.1.2.1. Summary of Method*

Boats, motors, and trailers will be used at only one lake per crew trip. If sampling two or more lakes in one day, multiple boats, motors and trailers will be used in combinations to prevent introduction of trailer/boat/motor that was used on the first lake into the second lake. Clean all boats and trailers using high pressure washing upon returning to the office. Clean outside and inside of motors (i.e., remove propeller to clean drive shaft if appropriate) thoroughly with wash water using earmuff device. Clean, inspect, let dry for 48 hours prior to next use.

#### *9.1.2.2. Equipment and Supplies*

- Min. 1000 PSI pressure washer
- Earmuff
- NaCl

#### *9.1.2.3. Decontamination Procedures*

##### One lake/day surveys:

Check the boat, trailer, and motor and do a thorough inspection and clean off any visible plants (or segments), animals and mud by hand after exiting the water body. Use small dip net to trap remnants in live well, and then pour salt granules in live well. Pressure wash the boats, trailers, and motors upon return to the office (use a minimal of 1000 PSI and use fabric cloth for the catch basin opening at 8 New Bond St. loading dock drain). Let equipment dry for 48 hours prior to next use.

##### >One Lake/day Surveys:

If sampling two lakes or more in one day, multiple boats, motors and trailers will be used in combinations to prevent introduction of trailer/boat/motor that was used on the first lake into the second lake. Before leaving each waterbody, check the boat and do a thorough inspection and clean off any visible plants (or segments), animals and mud by hand. Clean the boats, trailers, and motors using high pressure washing upon return to the office (as described above). Let dry for 48 hours prior to next use.

### **9.1.3. Other Equipment**

#### *9.1.3.1. Summary of Method*

Where possible, use the same concept as for watercraft, (i.e., used at only one lake per crew trip). If sampling two or more lakes in one day, use multiple duplicate sets of equipment to prevent introduction from first lake into the second lake. If this is not possible, use a 5% salt solution or other approved decontamination solution (e.g., white vinegar) sprayer to wash/soak equipment in-between lakes (e.g., waders, sampling pole, etc. for shoreline sampling of multiple lakes). For larger equipment items (e.g., fish nets), pressure wash thoroughly upon return to the office (as described above) and let dry for 48

hours prior to next use. For smaller more sensitive items (e.g., Van Dorn samplers), wash with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. For smaller non-sensitive items (e.g., anchor ropes, Secchi disk), freeze equipment for a minimum of 12 hours prior to next use.

#### *9.1.3.2. Equipment and Supplies*

- Min. 1000 PSI pressure washer
- NaCl salt solution
- Sprayer

#### *9.1.3.3. Decontamination Procedures*

##### One lake/day surveys:

Check the equipment and do a thorough inspection and clean off any visible plants (or segments), animals and mud by hand after exiting the water body. Pressure wash the large equipment upon return to the office (use a minimal of 1000 PSI and use fabric cloth for the catch basin opening at 8 New Bond St. loading dock drain). Let equipment dry for 48 hours prior to next use. Wash other smaller sensitive equipment with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. Freeze smaller non-sensitive equipment for a minimum of 12 hours prior to next use.

##### >One Lake/day Surveys:

If sampling two or more lakes in one day, use multiple duplicate sets of equipment where possible. Before leaving each waterbody, check all equipment and do a thorough inspection and clean off any visible plants (or segments), animals and mud by hand. On shoreline surveys, it is necessary to use some equipment at multiple lakes. Use salt sprayer to decontaminate waders, sampling pole, etc. between sites. Clean large equipment using high pressure washing upon return to the office (as described above). Let dry for 48 hours prior to next use. Wash other sensitive equipment with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. Freeze smaller non-sensitive equipment for a minimum of 12 hours prior to next use.

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## **APPENDIX A: SEVEN-YEAR FLEXIBLE WATERSHED MONITORING SCHEDULE**

# Seven-year Flexible Watershed Monitoring Schedule

## Introduction

Most elements of the MassDEP's existing surface water monitoring programs are administered by personnel of the Division of Watershed Management's Watershed Planning Program (DWM-WPP). Current and proposed surface water monitoring program elements are presented in A Strategy for Monitoring and Assessing the Quality of Massachusetts' Waters to Support Multiple Water Resource Management Objectives 2016 - 2025 (the Monitoring Strategy). The ultimate goal embodied in the Monitoring Strategy is to implement a comprehensive monitoring program that serves all water quality management needs and addresses all water body types. As such, the monitoring program is designed to provide data and information from streams, rivers, lakes, reservoirs, estuaries, coastal areas and wetlands to support the five major objectives listed below.

- 1) Assess the status or condition of Massachusetts' waters
- 2) Develop, implement and evaluate pollution control strategies
- 3) Develop policies and standards and identify emerging issues
- 4) Measure the effectiveness of water quality management programs
- 5) Maintain reserve monitoring capacity to respond to unforeseen data needs

Major themes inherent in both the MassDEP's water management programs and the monitoring elements that support them are 1) the focus on the watershed as the fundamental planning unit for water quality management, 2) the assessment of biological communities, such as aquatic macroinvertebrates and fish, as the most reliable indicators of water quality conditions and ecosystem health, 3) the application of new technology and streamlined systems for data processing and analysis to support monitoring and assessment activities, and 4) the formation and reliance on partnerships and collaboration to meet water quality goals. Massachusetts' existing and proposed water monitoring programs include both deterministic (targeted) and probabilistic (random) sampling networks and encompass both rotating watershed monitoring cycles as well as non-rotating, priority-driven schedules.

Probabilistic sampling designs provide statistically valid estimates of the use support status of 100% of the waters in a target population (e.g., shallow streams, deep rivers, lakes, etc.) with data and information collected from a random sample of those waters. Beginning in 2011 MassDEP carried out a five-year probabilistic survey of shallow streams and applied a similar sampling design to lakes and ponds from 2016 – 2018. A random sampling design for Massachusetts' coastal waters is currently in development.

While probabilistically derived sampling networks determine, at larger scales (e.g., statewide), the percentage of stream miles or lake acres that are meeting water quality standards, they are not as useful for assessing the use-support status of individual water bodies or assessment units (AU) or for identifying individual impaired waters for listing pursuant to § 303(d) of the Clean Water Act (CWA). The Monitoring Strategy calls for the use of targeted monitoring designs to confirm causes and identify sources of impairment or to demonstrate that previously impaired waters are now supporting their beneficial uses and can be removed from the 303(d) list of impaired waters. Furthermore, monitoring data from targeted waters are needed to develop, implement and measure the effectiveness of control strategies, such as TMDLs, watershed-based plans, National Pollutant Discharge Elimination System (NPDES) wastewater

discharge permits and best management practices (BMP). These program elements and the monitoring networks needed to support them are depicted in Figure 1.

### **Rotating Watershed Water Quality Management**

Watershed protection is the dominant theme of many state water quality management programs, and the EPA has endorsed this approach by providing financial and technical support for watershed-based water quality management activities. In 1993 the MassDEP placed the 27 major watersheds and coastal drainage areas (loosely termed “basins”) in Massachusetts on a rotating five-year schedule to synchronize monitoring, assessment and other components of its watershed management program. The goal was to allocate one year to each of five water management steps or phases (i.e., Year 1 – planning; Year 2 – monitoring; Year 3 – assessment; Year 4 – implementation of control strategies; and Year 5 – effectiveness evaluation), after which the process would begin again.

The completion of all of the steps in the watershed management process within a five-year time-frame proved to be impracticable. The practice of watershed management is inherently complex, resource-intensive and time-consuming and project demand often outpaces available funding and other resources. Therefore, while MassDEP’s water management program continues to progress in a step-wise fashion to restore impaired waters and protect waters that meet water quality standards, in practice these steps are typically not completed within a five-year timeframe as originally conceived. Furthermore, the watersheds were originally grouped to balance workloads associated with permitting and other related administrative tasks rather than equalizing the number of river miles or lake acres among the five groups for monitoring and assessment purposes. To facilitate monitoring, the “basins” were regrouped in 2010 on a regional basis to take advantage of potential benefits to monitoring survey logistics of more closely aligned watersheds, and to more equitably distribute Massachusetts’ total river miles among the five groups. To date, despite this new arrangement, targeted assessment monitoring in these watershed groups has been precluded by priority-driven monitoring schedules and a general lack of resources.

### **Flexible Seven-Year Basin Rotation for Monitoring**

The use of the watershed, or river basin, as a fundamental planning unit for water quality management was a guiding principle in the development of the Monitoring Strategy, and it remains a goal of the DWM-WPP to resume monitoring and assessment activities on a rotating watershed schedule. However, the need exists to maintain enough flexibility within that schedule to perform additional monitoring to meet other water management program needs. To that end, the DWM-WPP is establishing a sequential schedule that provides the opportunity for monitoring to be carried out in each watershed at least once every seven years, yet allows for monitoring resources to be disproportionately applied in each watershed to fulfill specific water resource management objectives. Massachusetts’ 27 major watersheds and coastal drainage areas have been arranged by geography (and hydrology) into four major groups, or cohorts (A-D), each consisting of three to ten “basins”. In turn, each major cohort is subdivided into one or two minor cohorts, each of which represents one year of the seven-year monitoring schedule (Figures 2 and 3).

Basic assessment monitoring will be performed in each minor cohort for one year and will be consecutive within major cohorts (e.g. A2 will always follow A1). However, the extended time allotted to the major cohorts (two years for all but three basins) allows for the basic schedule to be adapted to fulfill specific data needs. As such, the level of effort applied to monitoring within each major cohort, will not necessarily be evenly distributed through the minor cohorts or among individual basins, but will vary depending on priorities and objectives. Therefore, targeted monitoring may be focused anywhere within the major

cohort and, if necessary, extend through all or a portion of the time allotted to that cohort. A few examples are presented below to illustrate how the above design provides the flexibility to meet a number of monitoring objectives while maintaining an overall rotating watershed structure.

Absent the need for site- or project-specific data, the overall monitoring goal will default to basic assessment and monitoring each year will be designed in accordance with the prioritization scheme presented in the following section. In Cohort A, the Concord, Merrimack, Nashua and Shawsheen watersheds (A1) would be monitored in Year 1 followed by the Ipswich, Parker, and Charles watersheds, and North Coastal and Boston Harbor coastal drainage systems (A2) in Year 2. WPP monitoring resources could be applied disproportionately, if, for example, the Merrimack and Charles watersheds received higher priority for whatever reason, in which case they might be monitored for both years in Cohort A.

Alternatively, sampling at selected locations could be performed for up to two years in larger-order rivers if pollutant loading information is needed to support TMDL development or NPDES permit development, while rotating through smaller-order rivers in the corresponding minor cohorts. If intensive surveys were needed to support model development in a particular watershed, they could also be carried out in multiple years within the major cohort. Finally, depending upon circumstances, monitoring resources might be more efficiently applied by performing stream sampling in both minor cohorts (A1 and A2) in the first year followed by lake sampling in the second year.

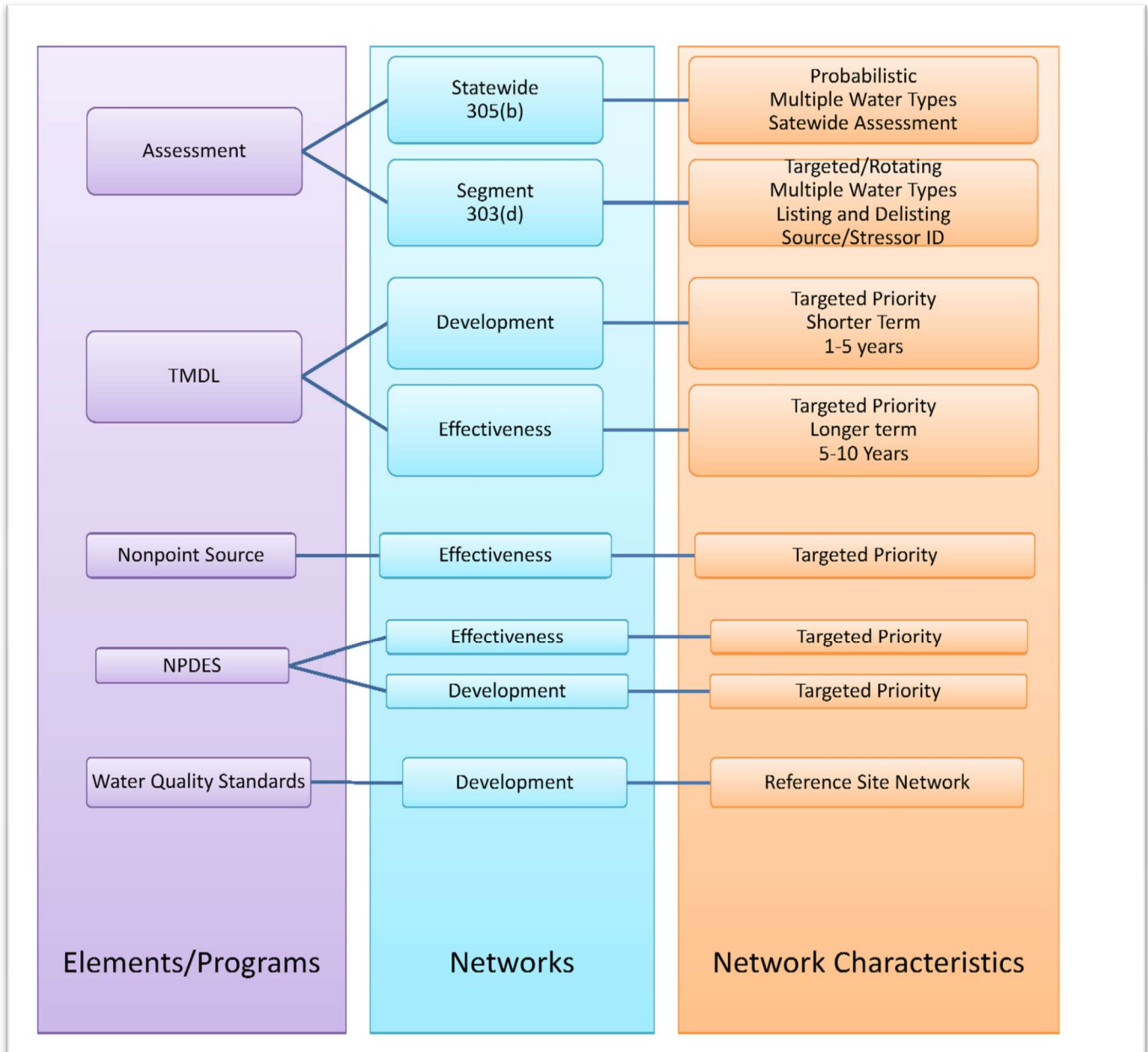
The proposed rotating basin structure not only provides flexibility to prioritize and apportion monitoring resources, but also presents multiple options for managing various monitoring program elements. For example, the delegation of monitoring projects to WPP monitoring personnel can be place-based (e.g., monitoring coordinator is assigned a basin for managing any monitoring activities in that basin), expertise-driven (e.g., one coordinator manages all fish sampling to be carried out in a given year, or resource-driven (e.g., one coordinator manages lake monitoring, while others coordinate stream sampling, etc.). In any case, projects will be assigned in accordance with the monitoring priorities established for the major cohort and may extend up to two years in most cohorts.

### Prioritizing Waters for Targeted Assessment Monitoring

Priority	Priority Order	General Category	Category Descriptions <sup>1</sup>
High	1	Delisting	Assessment units currently listed in Categories 4c or 5 where there are indications it <u>should not</u> be listed for at least one impairment cause (indications can be environmental improvement or listing/assessment methodology changes or errors).
High	2	Listing	Assessment units NOT listed in Categories 4c or 5 where there are indications it <u>should be</u> listed for at least one impairment cause (indications can be environmental degradation or listing/assessment methodology changes or errors).
Medium	3	Unassessed (suspect impairment)	Assessment units listed in Category 3 or waters without an assessment unit where there are indications it could listed in Categories 4c or 5 for at least one impairment cause (i.e. unassessed waters suspected to be impaired).
Medium	4	Stressor Identification	Assessment units listed in Category 5 for a non-pollutant (i.e. Fishes Bioassessment, Aquatic Macroinvertebrate Bioassessment) with no stressor impairment causes.
Medium	5	CWF Determination	Assessment units or waters without an assessment unit thought to be an undesignated or under documented coldwater fishery (CWF).
Low	6	Unassessed (suspect support)	Assessment units listed in Category 3 or waters without an assessment where there are indications it could listed in Category 1 or 2 (i.e. unassessed waters likely to support uses).
Low	7	Priority NPDES	Assessment units or most sensitive receiving waters with a prioritized NPDES permit development (i.e. situations where a <u>reassessment</u> of the targeted assessment unit would be of value).
Low	8	TMDL Effectiveness	Assessment units currently listed in Category 4a where the TMDL was potentially successful in removing the use impairment or the original listing of the impairment cause was potentially <u>in error</u> .
Low	9	Priority TMDL	Assessment units in Category 5 prioritized for TMDL development (i.e. situations where a <u>reassessment</u> of the listed assessment unit would be of value).

1 – Assessment units placed in prioritization categories based on available information (indications) from multiple sources (monitoring data, landscape data, assessment methodology, pollution control, assessment methodologies, etc.). Annual basin selection will be consistent with rotating basin schedule.

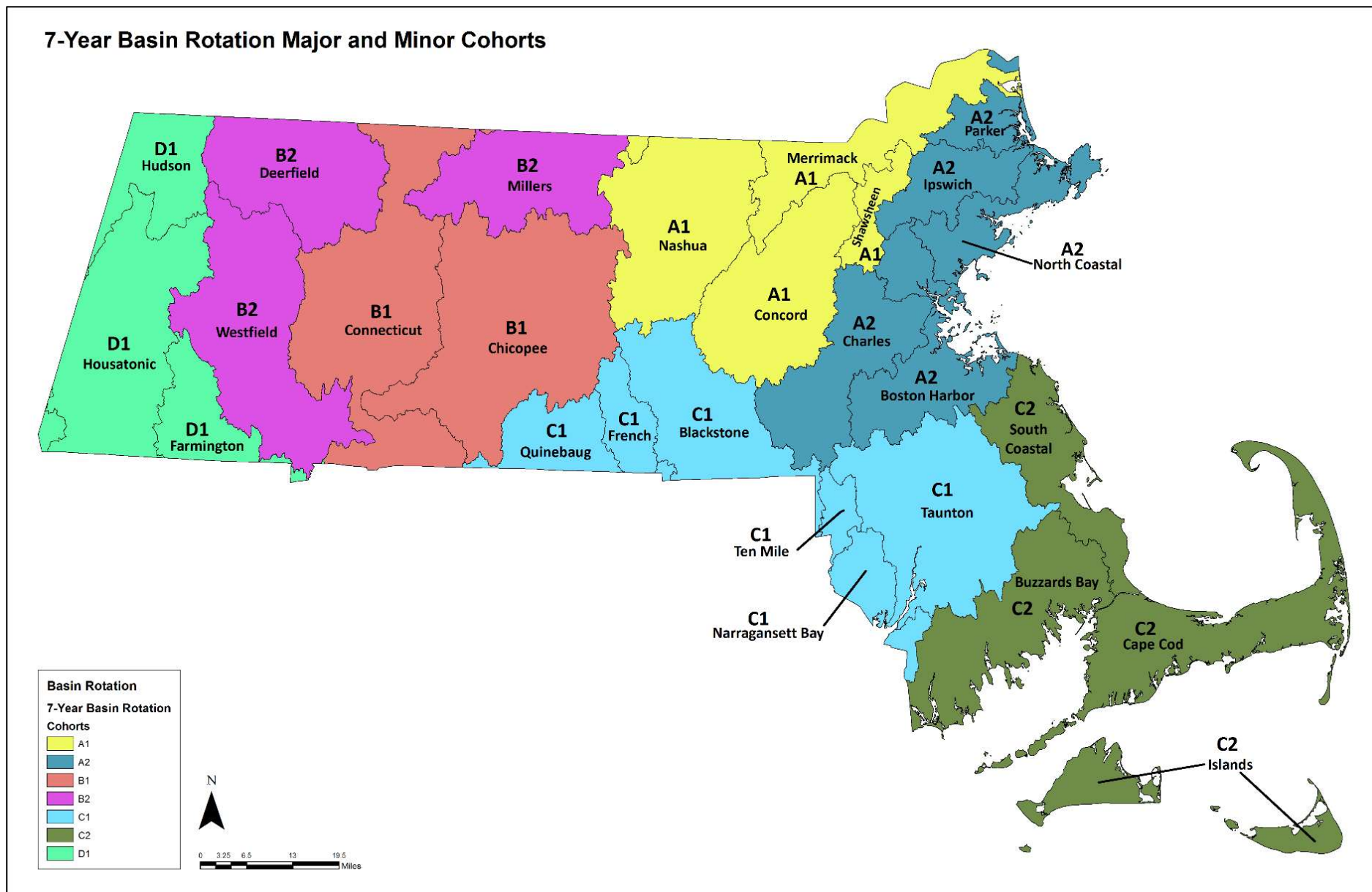
Monitoring parameters will generally include all typical default analytes (e.g., bacteria, nutrients, chloride, probes) unless an indicator specific project is identified.



**Figure 1.** Monitoring Networks for Multiple Water Management Objectives

**Table 2.** DWM-WPP Seven-Year Basin Rotation for Water Resource Monitoring

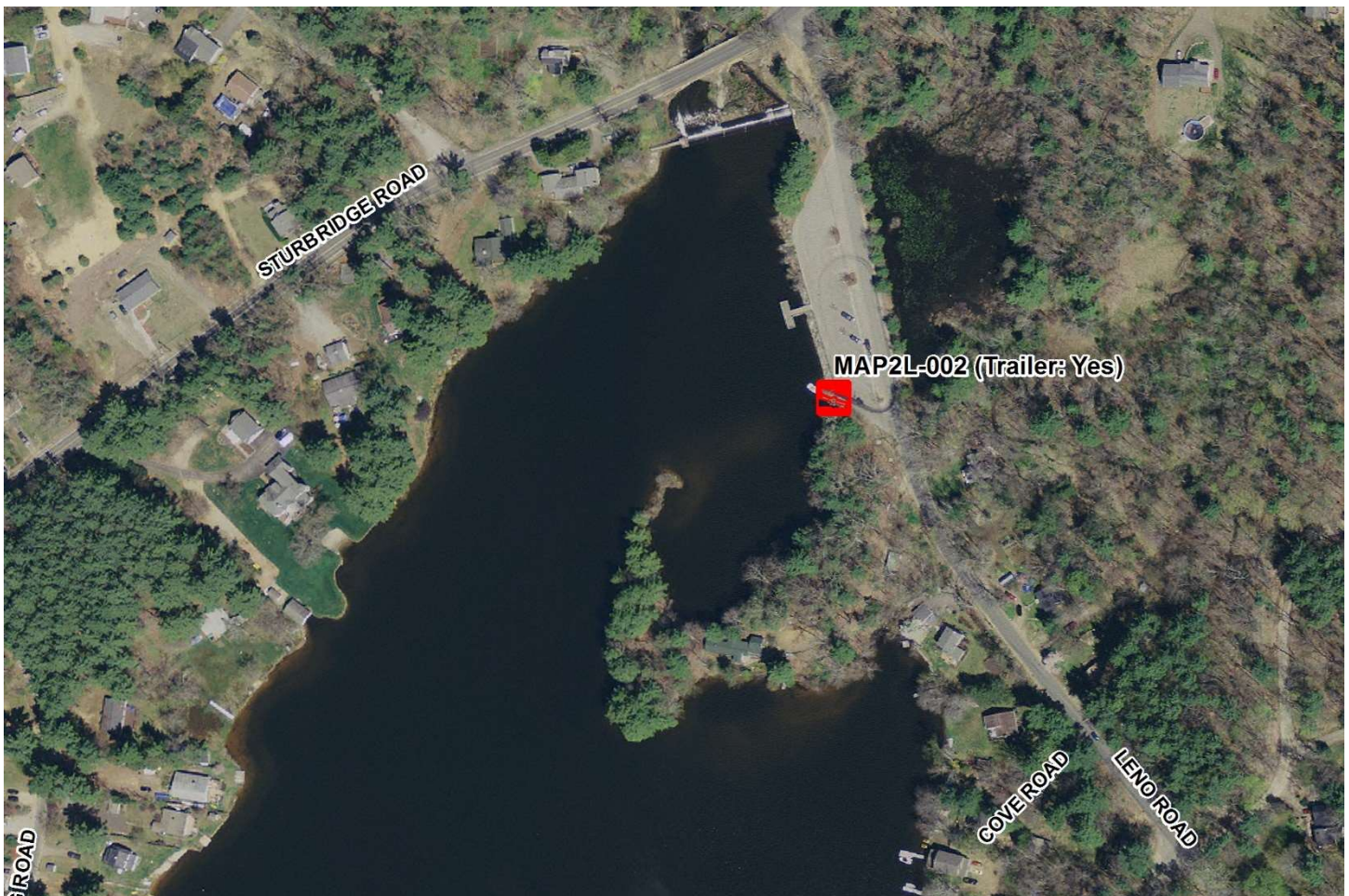
				NHD Water Resource Estimations					Assessment Units	
NAME	Major Cohort	Total Years in Cohort	Minor Cohort	Perennial River Miles	River Miles per Year	Lakes > 5 Acres	Lake Acreage	Lakes per Year	River Segments (Total Length Miles)	Lake Segments (Total Area Acres)
Concord (SuAsCo)	A	2 (2021-2022)	A1	529	1324	134	7186	367	53 (187)	61 (6572)
Merrimack			A1	344		93	5071		39 (140)	29 (3515)
Nashua			A1	664		126	10344		79 (273)	69 (9524)
Shawsheen			A1	98		12	408		21 (65)	14 (406)
Ipswich			A2	157		68	2992		22 (97)	39 (1922)
North Coastal			A2	116		64	2698		22 (41)	42 (2006)
Parker			A2	81		24	588		7 (28)	12 (290)
Charles			A2	384		113	3726		45 (178)	50 (2824)
Boston Harbor			A2	274		100	4352		60 (166)	50 (2982)
Connecticut	B	2 (2023-2024)	B1	999	1722	96	3358	233	63 (345)	46 (2460)
Chicopee			B1	907		168	31113		51 (259)	74 (29797)
Millers			B2	435		97	4762		30 (134)	64 (3846)
Westfield			B2	630		85	4295		63 (320)	33 (3648)
Deerfield			B2	474		21	788		130 (366)	22 (561)
Ten Mile	C	2 (2025-2026)	C1	92	1322	21	937	611	10 (35)	12 (595)
Taunton			C1	746		223	13697		49 (222)	87 (10901)
Narragansett Bay			C1	178		29	4552		20 (65)	6 (3769)
Blackstone			C1	334		148	6509		48 (168)	100 (5177)
Quinebaug			C1	210		56	2451		28 (86)	25 (1980)
French			C1	97		56	3603		18 (39)	43 (3420)
Buzzards Bay			C2	479		210	6546		25 (79)	72 (4983)
South Coastal			C2	244		131	4925		22 (58)	75 (4214)
Cape Cod			C2	177		280	11567		16 (33)	68 (5706)
Islands			C2	86		69	5738		6 (12)	5 (106)
Housatonic	D	1 (2027)	D1	547	952	117	5982	194	35 (219)	33 (4284)
Hudson			D1	229		13	759		26 (109)	8 (716)
Farmington			D1	175		64	3907		40 (108)	18 (2135)
			Totals	9687		2618	152852		1028 (3830)	1157 (118338)

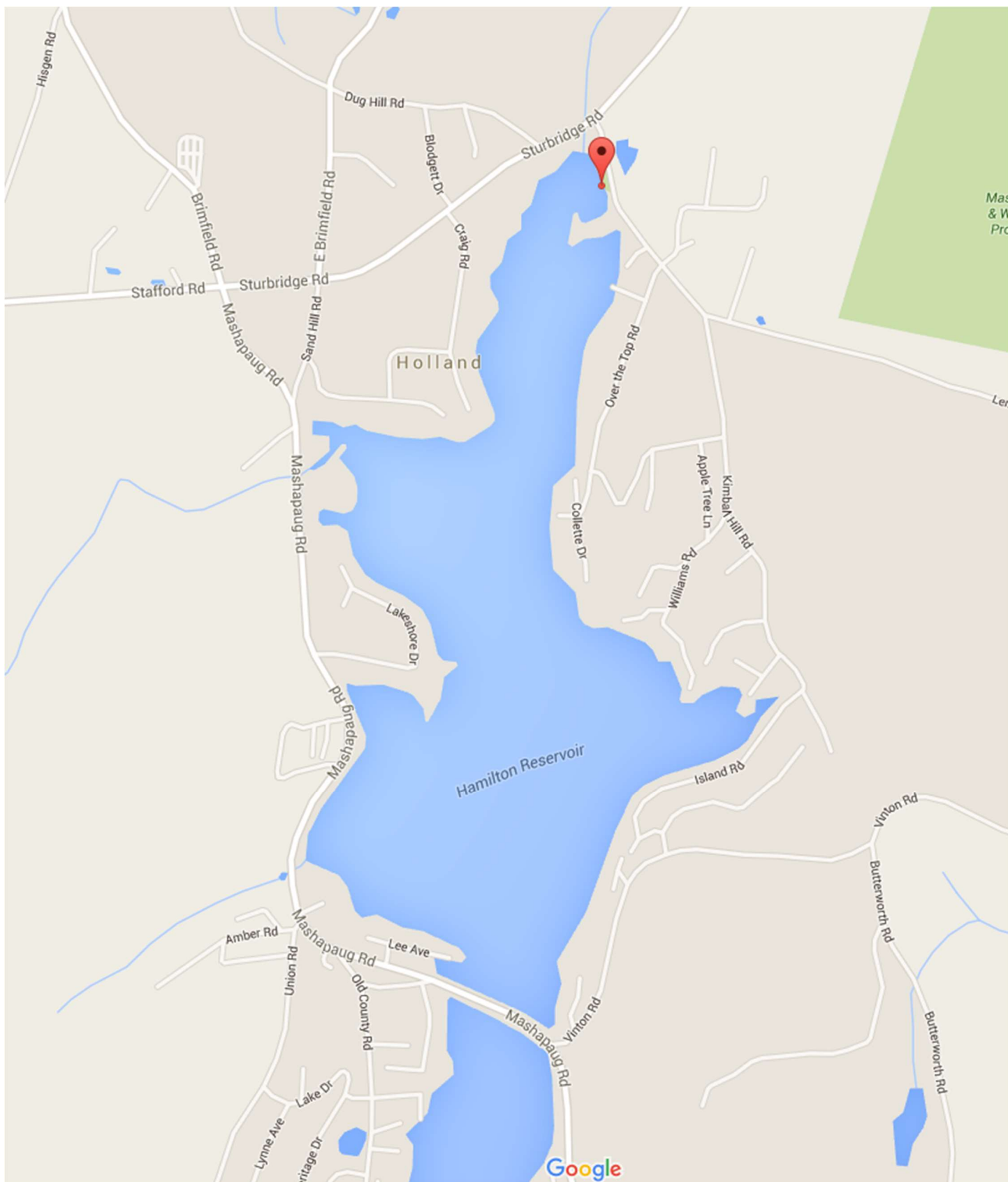


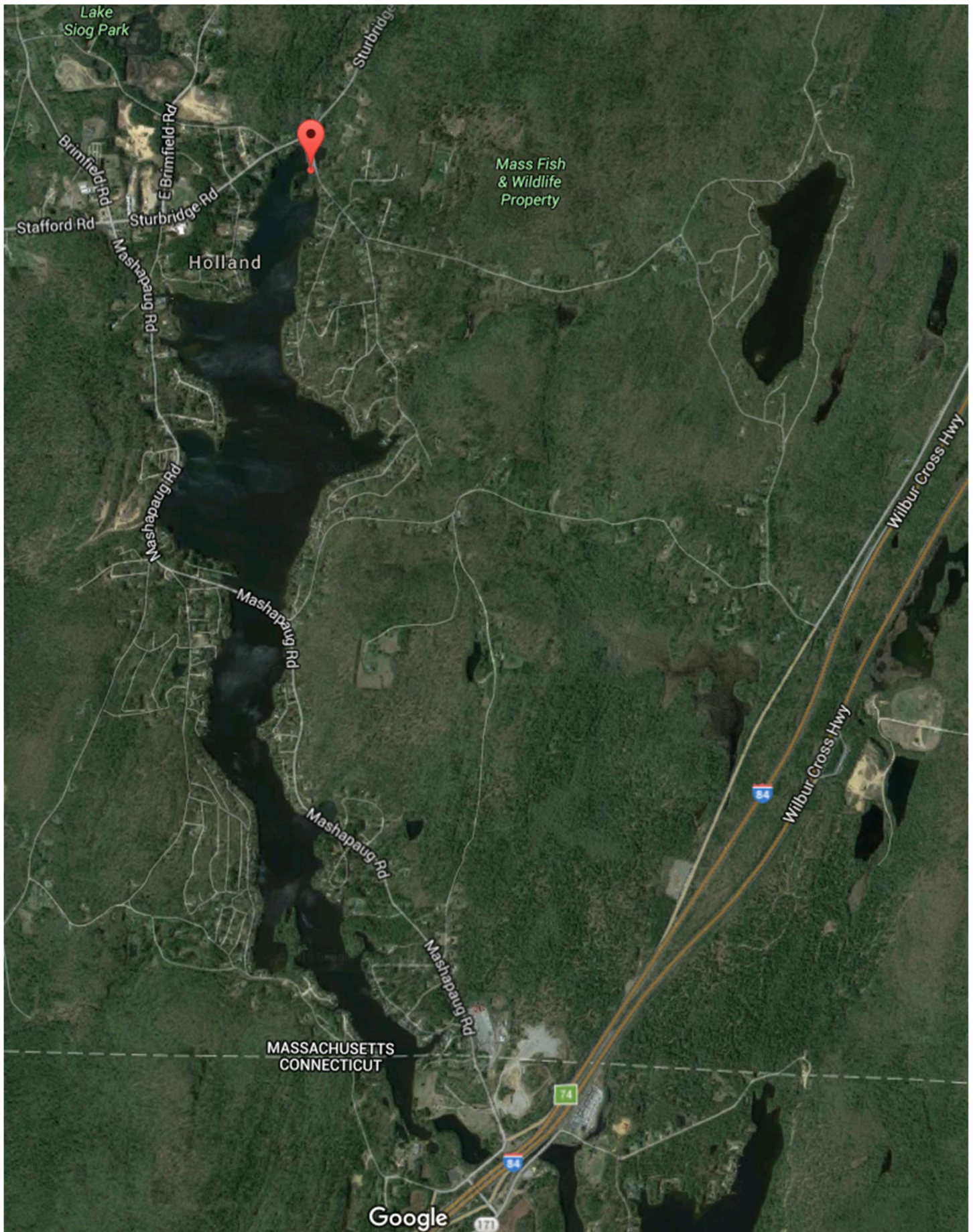
**Figure 3.** DWM-WPP Seven-Year Basin Rotation for Water Resource Monitoring

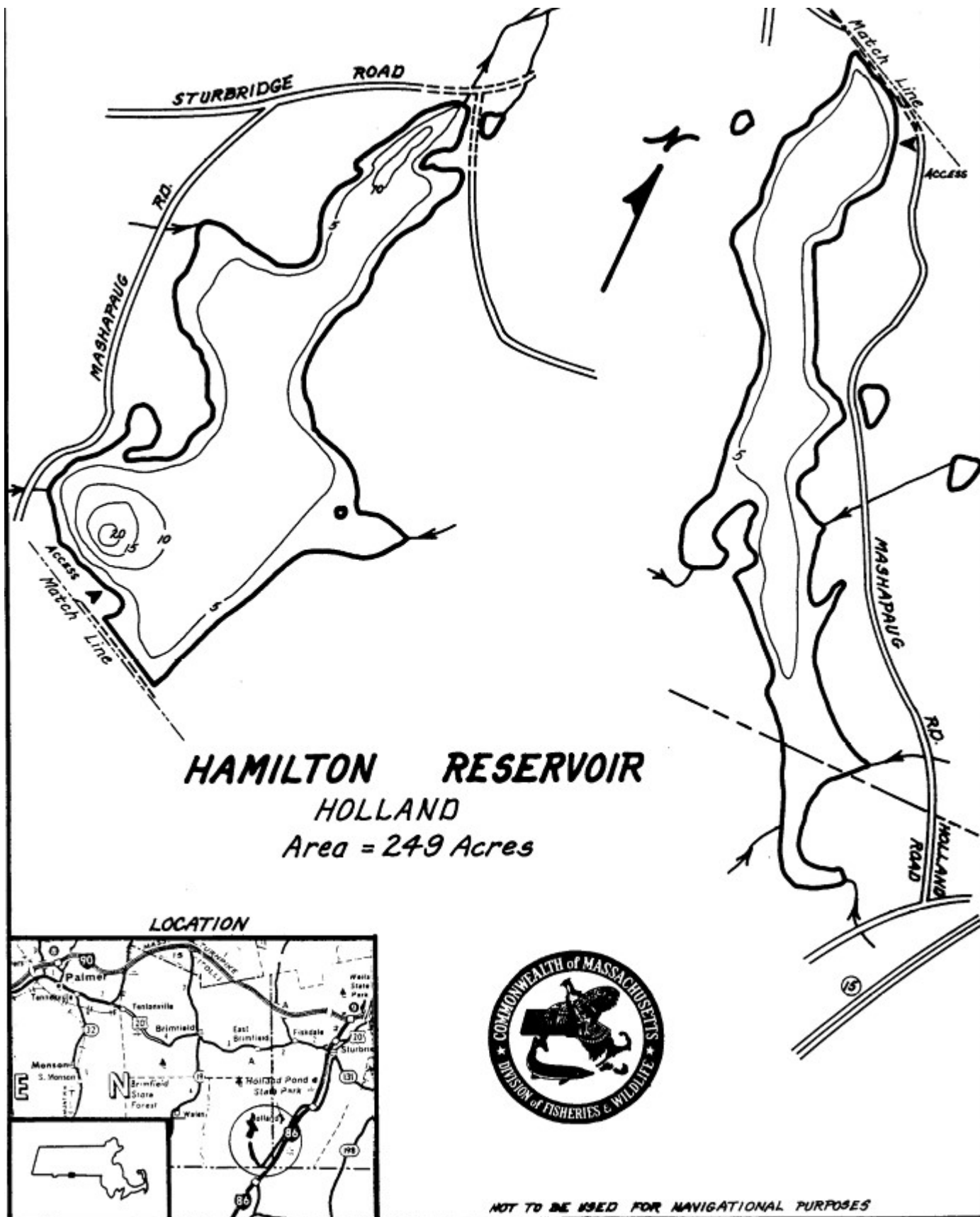
## **APPENDIX B: EXAMPLE LAKE DOSSIER**

TAML-002		Hamilton Reservoir			
Town	Holland	Watershed	Quinebaug	Impoundment	Yes
Size (ha)	97.0	Max Depth (m)	6.4	Herbicide 2015	Yes
Known Non-natives	Variable Milfoil				
303(d) List Causes	(Non-Native Aquatic Plants*)				
Access Type	Public Boat Ramp	Ownership	Town of Holland		
Access (Lat, Long)	42.06784, -72.15245	Access Contact Info	None		
Trailer Accessible	Yes	WQ Motor Minimum Distance to Index (m)	Gas (2600)		
Index Site ID	W2619	Index Site (Lat, Long)	42.05275, -72.15819 (Estimate)		
Confirmed Index Site (Lat, Long)					
Notes					









## **APPENDIX C: EXAMPLE WEEKLY SCHEDULE**

**WPP 2016 Environmental Monitoring Program – Weekly Monitoring Assignments**  
**Week 3: May 16 – 20, 2016**

<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>May-16</b>	<b>May-17</b>	<b>May-18</b>	<b>May-19</b>	<b>May-20</b>
<b>MAPL - Fish TT</b>	<b>MAPL - Fish TT</b>	<b>RSN 2 - DO\WQ</b>	<b>MAPL - Fish TT</b>	<b>MAPL - Fish TT</b>
Davis	Maietta	Meek	Mitchell	Maietta
Reardon	Rousseau	Bangoret	Davis	Rousseau
Diebboll	Dewani		Bangoret	Dieboll
		<b>MAPL 3 - Shoreline (BacT Only)</b>		
	<b>Instr Lab - RSN QC Probe Cal</b>	Mitchell	<b>Color/Turbidity Lab</b>	<b>Delivery (WES)</b>
	Nuzzo	Dewani	Diebboll	Bangoret
			Rousseau	Dewani
		<b>Colilert Lab Process</b>	<b>Colilert Lab Read</b>	
		Diebboll	Diebboll	
		Rousseau	Rousseau	

**Key (Format: Project-Site Group or Lakes Task1\Task2\etc.)**

T = Temperature Probe Deploy	QC = QC check on long-term deploy
DO = Multiprobe Deploy (Onset or Hydrolab)	PU = Long-term probe pickup
Index = Index Site (deep hole) Sampling	RSN = Reference Site Network
Shoreline = Shoreline Site Sampling	MAPL = Probabilistic Lake Monitoring
LT = Long-term probe	Profile = Lake DO/T Profile
M&M = Macrophytes and macroinvertebrate	WQ = Water Quality Sampling
Fish TT = Fish Toxics Tissue	Delivery = Sample delivery

## **APPENDIX D: FIELD SHEET**

MassDEP/Division of Watershed Management/Watershed Planning Program  
**LAKES FIELD SHEET (2022)**

Crew Lead (initial) \_\_\_\_\_

<b>STATION INFORMATION (fill out prior to departure)</b>	
Field Sheet Login #: 22-M017-01	Unique ID: W3159
Project: TAM A2-4 (2022)	Site Name (STAID): TAM-008
Waterbody Name: Keyes Pond (93009)	Town: Westford
<b>GENERAL SITE INFORMATION</b>	
Alternate Station Description (Does site match description?) <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If not, describe below:	
Field Lat/Long	Lat/Long Method <input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Handheld GPS <input type="checkbox"/> Other
Survey Crew Lead: Meek	Other Crew: <u>Galligan</u>
Date: 9/27/2022	Time: <u>845</u> <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT
Weather Conditions <input type="checkbox"/> Clear <input type="checkbox"/> Mostly sun <input type="checkbox"/> Mostly cloud <input checked="" type="checkbox"/> Overcast <input type="checkbox"/> Fog <input type="checkbox"/> Drizzle <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Snow	
Air Temperature <input type="checkbox"/> < 20 °F <input type="checkbox"/> 21-30 °F <input type="checkbox"/> 31-40 °F <input type="checkbox"/> 41-50 °F <input type="checkbox"/> 51-60 °F <input checked="" type="checkbox"/> 61-70 °F <input type="checkbox"/> 71-80 °F <input type="checkbox"/> 81-90 °F <input type="checkbox"/> 91-100 °F	
Water Odor <input checked="" type="checkbox"/> None <input type="checkbox"/> Musty <input type="checkbox"/> Petrol <input type="checkbox"/> Sewage <input type="checkbox"/> Effluent <input type="checkbox"/> Sulfide <input type="checkbox"/> Fishy <input type="checkbox"/> Chlorine <input type="checkbox"/> Rotten Veg. <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Turbidity <input type="checkbox"/> None <input checked="" type="checkbox"/> Slightly Turbid <input checked="" type="checkbox"/> Moderately Turbid <input type="checkbox"/> Highly Turbid <input type="checkbox"/> Unobservable	
Water Color <input type="checkbox"/> None <input type="checkbox"/> Brownish <input type="checkbox"/> Blackish <input checked="" type="checkbox"/> Greenish <input type="checkbox"/> Greyish <input type="checkbox"/> Reddish <input type="checkbox"/> Yellowish <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Floating Scum <input checked="" type="checkbox"/> None <input type="checkbox"/> Algal mat <input type="checkbox"/> Foam <input type="checkbox"/> Oily sheens <input type="checkbox"/> Pollen blankets <input type="checkbox"/> Sewage <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
General Notes:	
<b>OBSERVATIONS (RIVER AND LAKE)</b>	
Objectionable Deposits <input checked="" type="checkbox"/> None <input type="checkbox"/> Trash <input type="checkbox"/> Flocculent mass <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
Shoreline Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Unobservable Description:	
Wildlife <input type="checkbox"/> None <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input checked="" type="checkbox"/> Birds <input type="checkbox"/> Amphibians <input type="checkbox"/> Other Description:	
Beneficial Uses <input type="checkbox"/> None <input type="checkbox"/> Swimming <input checked="" type="checkbox"/> Boating <input type="checkbox"/> Water intake <input checked="" type="checkbox"/> Fishing <input type="checkbox"/> Other Description:	
Pollution Sources <input type="checkbox"/> None <input type="checkbox"/> Outfalls <input type="checkbox"/> Garbage <input checked="" type="checkbox"/> Road runoff <input type="checkbox"/> Waterfowl <input type="checkbox"/> Land clearing <input checked="" type="checkbox"/> Lawns	
Aesthetics Impaired? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO Based on water odor, clarity, unnatural color, growths, scum and/or deposits, is the site impaired?	
Water Level (relative to annual high-water level) <input type="checkbox"/> Low <input type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below _____ ft	
<b>STATION SPECIFIC PLANT DENSITY</b> None 0% Sparse 1-25% Moderate 25-50% Dense 50-75% Very Dense 75-100% Unobservable	
Overall Aquatic Plants <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Floating Aquatic Plants	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Emergent Aquatic Plants	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Submerged Aquatic Plants	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Duckweed	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U
Free-floating algae	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U
<b>ALGAL BLOOM</b>	
Algal Bloom Present <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	
Bloom Type <input type="checkbox"/> Cyanobacteria <input type="checkbox"/> Green Algae <input type="checkbox"/> Other <input type="checkbox"/> Unknown	
Evidence of Bloom (check all that apply) <input type="checkbox"/> Scum <input type="checkbox"/> Color <input type="checkbox"/> Turbidity <input type="checkbox"/> Odor <input type="checkbox"/> Other	
Lakeward Width (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Shoreline Length (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Bloom specific notes:	

SITE SPECIFIC PERIPHYTON		None: 0%	Sparse: 1-25%	Moderate: 25-50%	Dense: 50-75%	Very Dense: 75-100%	Unobservable
Filamentous	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Film	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Loose Floe	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Orange <input type="checkbox"/> White <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
<b>OBSERVATIONS (LAKE)</b>							
Wind Conditions <input checked="" type="checkbox"/> Calm <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Gusty <input type="checkbox"/> Strong							
Wind Direction <input checked="" type="checkbox"/> Calm <input type="checkbox"/> North <input type="checkbox"/> Northeast <input type="checkbox"/> East <input type="checkbox"/> Southeast <input type="checkbox"/> South <input type="checkbox"/> Southwest <input type="checkbox"/> West <input type="checkbox"/> Northwest							
Water Surface <input checked="" type="checkbox"/> Calm <input type="checkbox"/> Ripples <input type="checkbox"/> Choppy <input type="checkbox"/> White caps							
Dom. Habitat <input type="checkbox"/> Bedrock <input type="checkbox"/> Boulder <input type="checkbox"/> Cobble <input type="checkbox"/> Gravel <input type="checkbox"/> Sand <input type="checkbox"/> Silt <input type="checkbox"/> Woody debris <input type="checkbox"/> Organic <input type="checkbox"/> Vegetation <input type="checkbox"/> Other <input checked="" type="checkbox"/> Unobservable							
Max Depth Site <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Station Max. Depth <u>5.5</u> meters		Depth Method <input type="checkbox"/> Secchi <input type="checkbox"/> Lead line <input checked="" type="checkbox"/> Sonar <input type="checkbox"/> Survey Rod <input type="checkbox"/> Other			
<b>WHOLE LAKE PLANTS</b> None 0% Sparse 1-25% Moderate 25-50% Dense 50-75% Very Dense 75-100% Unobservable							
Overall Aquatic Plants <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U							
Dominant Aquatic Plants (in order of dominance, include any NON-NATIVE)							
(E/S/F)							
(E/S/F)							
(E/S/F)							
Duckweed specific <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U							
Duckweed Band Width (m) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m							
Duckweed % Cover <u>    </u>							
<b>SECCHI MEASUREMENT</b>							
Secchi Measured <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Time: <u>9:15</u> <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT		Secchi Method <input checked="" type="checkbox"/> Secchi disk <input type="checkbox"/> Secchi tube <input type="checkbox"/> Other			
Secchi depth <u>1.70</u> meters		Dup. Secchi depth <u>1.64</u> m		On bottom <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Secchi reading condition <input checked="" type="checkbox"/> Viewfinder used <input type="checkbox"/> In weeds <input type="checkbox"/> In sunlight		Secchi Comments:					
<b>SAMPLE - GENERAL</b>							
Samples taken from <input type="checkbox"/> From shore/left bank <input type="checkbox"/> From shore/center stream <input type="checkbox"/> From shore/right bank <input type="checkbox"/> Wade in/left bank <input type="checkbox"/> Wade in/center stream <input type="checkbox"/> Wade in/right bank <input type="checkbox"/> Bridge upstream <input type="checkbox"/> Bridge downstream <input checked="" type="checkbox"/> Boat <input type="checkbox"/> Shore (Lake) <input type="checkbox"/> Wading (Lake) <input type="checkbox"/> Dock <input type="checkbox"/> Pipe <input type="checkbox"/> Other (describe): <u>    </u>							
Samples taken from description:							

Sample-Lab	25-0653				25-0654				25-0655			
Sample Type	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input checked="" type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:			
OWMID Parent												
Medium	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other			
Medium (Subdivision)	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown			
Relative Depth	<input checked="" type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input checked="" type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom			
Start/End Depth (m)	0.5 / 1				4.7 / 1				0 / 4.5			
Start Time (Date/Time)	09/27/22 1845 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST				09/27/22 1900 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST				09/27/22 1915 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST			
End Time (Date/Time)	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST			
Gear Type	<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input checked="" type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input checked="" type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input checked="" type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A			
Gear Serial #	1317111A				1317111A							
Composite (Type)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input checked="" type="checkbox"/> Depth			
Field Lat/Long	/				/				/			
Field Lat/Long Method	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS			
Sample Notes	SURFACE				NEAR BOTTOM				INTEGRATED			
Bottle Group	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field
Bacteria (B)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Metals (M)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
OrgCarb (OC)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N3)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Solids (S)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Chl a (I)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/> Y <input checked="" type="checkbox"/> N
Color/Turb (R)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Alkalinity (C)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Hardness (H)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> HNO <sub>3</sub>	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Phytoplank (A)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Lugols	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N

LAKES Field Sheet Log# 22-M017-01 Unique ID: W3159 Page 4 of 4 (rev. 1/24/22)

MassDEP/Division of Watershed Management/Watershed Planning Program  
LAKES FIELD SHEET (2022)

Crew Lead (initial) *DS*

<b>STATION INFORMATION (fill out prior to departure)</b>	
Field Sheet Login #: 22-M002-01	Unique ID: W3154
Project: TAM A2-4 (2022)	Site Name (STAD): TAM-005S
Waterbody Name: Learned Pond (82069)	Town: Framingham
<b>GENERAL SITE INFORMATION</b>	
Alternate Station Description (Does site match description?) <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If not, describe below:	
Field Lat/Long /	Lat/Long Method <input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Handheld GPS <input type="checkbox"/> Other
Survey Crew Lead: Davis	Other Crew: Malmquist
Date: 6/27/2022	Time: 8:00 <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT
Weather Conditions <input type="checkbox"/> Clear <input type="checkbox"/> Mostly sun <input type="checkbox"/> Mostly cloud <input checked="" type="checkbox"/> Overcast <input type="checkbox"/> Fog <input type="checkbox"/> Drizzle <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Snow	
Air Temperature <input type="checkbox"/> <20 °F <input type="checkbox"/> 21-30 °F <input type="checkbox"/> 31-40 °F <input type="checkbox"/> 41-50 °F <input type="checkbox"/> 51-60 °F <input type="checkbox"/> 61-70 °F <input checked="" type="checkbox"/> 71-80 °F <input type="checkbox"/> 81-90 °F <input type="checkbox"/> 91-100 °F	
Water Odor <input checked="" type="checkbox"/> None <input type="checkbox"/> Musty <input type="checkbox"/> Petrol <input type="checkbox"/> Sewage <input type="checkbox"/> Effluent <input type="checkbox"/> Sulfide <input type="checkbox"/> Fishy <input type="checkbox"/> Chlorine <input type="checkbox"/> Rotten Veg. <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Turbidity <input checked="" type="checkbox"/> None <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Moderately Turbid <input type="checkbox"/> Highly Turbid <input type="checkbox"/> Unobservable	
Water Color <input checked="" type="checkbox"/> None <input type="checkbox"/> Brownish <input type="checkbox"/> Blackish <input type="checkbox"/> Greenish <input type="checkbox"/> Greyish <input type="checkbox"/> Reddish <input type="checkbox"/> Yellowish <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Floating Scum <input checked="" type="checkbox"/> None <input type="checkbox"/> Algal mat <input type="checkbox"/> Foam <input type="checkbox"/> Oily sheens <input type="checkbox"/> Pollen blankets <input type="checkbox"/> Sewage <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
General Notes:	
<b>OBSERVATIONS (RIVER AND LAKE)</b>	
Objectionable Deposits <input checked="" type="checkbox"/> None <input type="checkbox"/> Trash <input type="checkbox"/> Flocculent mass <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
Shoreline Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Unobservable Description:	
Wildlife <input type="checkbox"/> None <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input checked="" type="checkbox"/> Birds <input type="checkbox"/> Amphibians <input type="checkbox"/> Other Description:	
Beneficial Uses <input type="checkbox"/> None <input checked="" type="checkbox"/> Swimming <input type="checkbox"/> Boating <input type="checkbox"/> Water intake <input type="checkbox"/> Fishing <input type="checkbox"/> Other Description:	
Pollution Sources <input type="checkbox"/> None <input type="checkbox"/> Outfalls <input type="checkbox"/> Garbage <input checked="" type="checkbox"/> Road runoff <input type="checkbox"/> Waterfowl <input type="checkbox"/> Land clearing <input checked="" type="checkbox"/> Lawns	
Aesthetics Impaired? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO Based on water odor, clarity, unnatural color, growths, scum and/or deposits, is the site impaired?	
Water Level (relative to annual high-water level) <input type="checkbox"/> Low <input checked="" type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below _____ ft	
<b>STATION SPECIFIC PLANT DENSITY</b> None 0% <input type="checkbox"/> Sparse 1-25% <input type="checkbox"/> Moderate 25-50% <input type="checkbox"/> Dense 50-75% <input type="checkbox"/> Very Dense 75-100% <input type="checkbox"/> Unobservable	
Overall Aquatic Plants <input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Floating Aquatic Plants	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Emergent Aquatic Plants	<input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Submerged Aquatic Plants	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:
Duckweed	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U
Free-floating algae	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U
<b>ALGAL BLOOM</b>	
Algal Bloom Present <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	
Bloom Type <input type="checkbox"/> Cyanobacteria <input type="checkbox"/> Green Algae <input type="checkbox"/> Other <input type="checkbox"/> Unknown	
Evidence of Bloom (check all that apply) <input type="checkbox"/> Scum <input type="checkbox"/> Color <input type="checkbox"/> Turbidity <input type="checkbox"/> Odor <input type="checkbox"/> Other	
Lakeward Width (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Shoreline Length (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Bloom specific notes:	

SITE SPECIFIC PERIPHYTON		None: 0%	Sparse: 1-25%	Moderate: 25-50%	Dense: 50-75%	Very Dense: 75-100%	Unobservable
Filamentous	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Film	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Loose Floc	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Orange <input type="checkbox"/> White <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
<b>OBSERVATIONS (LAKE)</b>							
Wind Conditions <input type="checkbox"/> Calm <input type="checkbox"/> Slight <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Gusty <input type="checkbox"/> Strong							
Wind Direction <input type="checkbox"/> Calm <input type="checkbox"/> North <input type="checkbox"/> Northeast <input type="checkbox"/> East <input type="checkbox"/> Southeast <input checked="" type="checkbox"/> South <input type="checkbox"/> Southwest <input type="checkbox"/> West <input type="checkbox"/> Northwest							
Water Surface <input checked="" type="checkbox"/> Calm <input checked="" type="checkbox"/> Ripples <input type="checkbox"/> Choppy <input type="checkbox"/> White caps							
Dom. Habitat: <input type="checkbox"/> Bedrock <input type="checkbox"/> Boulder <input type="checkbox"/> Cobble <input type="checkbox"/> Gravel <input checked="" type="checkbox"/> Sand <input type="checkbox"/> Silt <input type="checkbox"/> Woody debris <input type="checkbox"/> Organic <input type="checkbox"/> Vegetation <input type="checkbox"/> Other <input type="checkbox"/> Unobservable							
Max Depth Site <input type="checkbox"/> Yes <input type="checkbox"/> No		Station Max. Depth _____ meters		Depth Method <input type="checkbox"/> Secchi <input type="checkbox"/> Lead line <input type="checkbox"/> Sonar <input type="checkbox"/> Survey Rod <input type="checkbox"/> Other			
<b>WHOLE LAKE PLANTS</b> None: 0% Sparse: 1-25% Moderate: 25-50% Dense: 50-75% Very Dense: 75-100% Unobservable							
Overall Aquatic Plants <input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U							
Dominant Aquatic Plants (in order of dominance, include any NON-NATIVE)							
Cattails						(E/S/F)	
						(E/S/F)	
						(E/S/F)	
Duckweed specific <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U							
Duckweed Band Width (m) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m							
Duckweed % Cover _____							
<b>SECCHI MEASUREMENT</b>							
Secchi Measured <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Time: _____ <input type="checkbox"/> EST <input type="checkbox"/> EDT		Secchi Method <input type="checkbox"/> Secchi disk <input type="checkbox"/> Secchi tube <input type="checkbox"/> Other			
Secchi depth _____ meters		Dup. Secchi depth _____ m		On bottom <input type="checkbox"/> Yes <input type="checkbox"/> No			
Secchi reading condition <input type="checkbox"/> Viewfinder used <input type="checkbox"/> In weeds <input type="checkbox"/> In sunlight				Secchi Comments:			
<b>SAMPLE - GENERAL</b>							
Samples taken from <input type="checkbox"/> From shore/left bank <input type="checkbox"/> From shore/center stream <input type="checkbox"/> From shore/right bank <input type="checkbox"/> Wade in/left bank <input type="checkbox"/> Wade in/center stream <input type="checkbox"/> Wade in/right bank <input type="checkbox"/> Bridge upstream <input type="checkbox"/> Bridge downstream <input type="checkbox"/> Boat <input type="checkbox"/> Shore (Lake) <input checked="" type="checkbox"/> Wading (Lake) <input type="checkbox"/> Dock <input type="checkbox"/> Pipe <input type="checkbox"/> Other (describe): _____							
Samples taken from description:							

Sample-Lab	25-0505				<Place OWMID Label here>				<Place OWMID Label here>			
Sample Type	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:			
OWMID Parent												
Medium	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other			
Medium (Subdivision)	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown			
Relative Depth	<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom			
Start/End Depth (m)	/				/				/			
Start Time (Date/Time)	06/27/22 18:00 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST			
End Time (Date/Time)	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST			
Gear Type	<input checked="" type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A			
Gear Serial #												
Composite (Type)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input checked="" type="checkbox"/> Depth			
Field Lat/Long	/				/				/			
Field Lat/Long Method	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS			
Sample Notes												
Bottle Group	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field
Bacteria (B)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Metals (M)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
OrgCarb (OC)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H <sub>3</sub> PO <sub>4</sub>	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N3)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Solids (S)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Chl a (I)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Color/Turb (R)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Alkalinity (C)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Hardness (H)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Phytoplank (A)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N

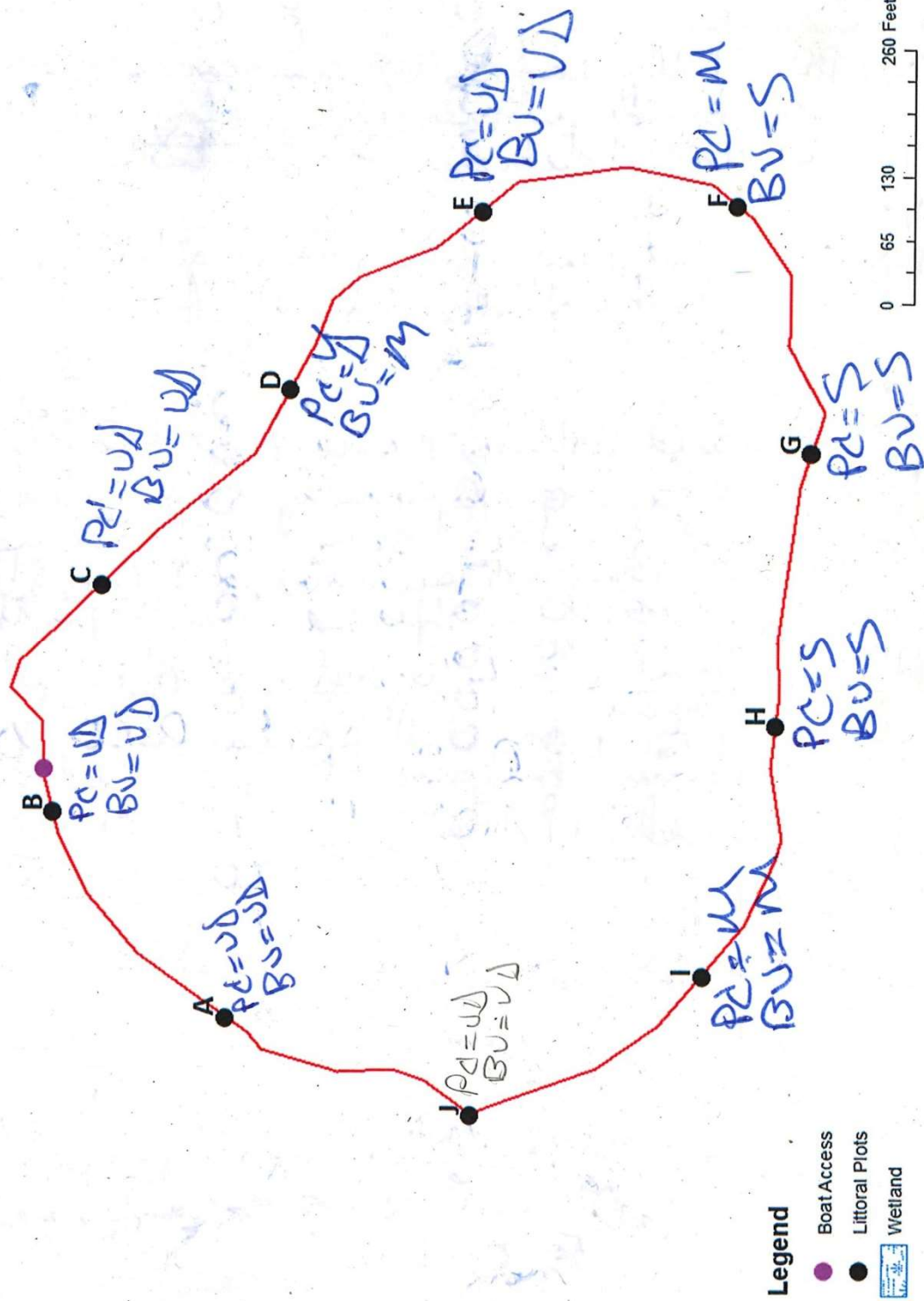
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Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macroinvertebrate Littoral Habitat Field Sheet (2017)

General Information										
Project: MAP2 Lakes (2017)					Survey Crew Lead: <i>Muck</i>					
Lake (PALIS): Robbins Pond (81111)					Survey Crew Assist: <i>Tow</i>					
Site Name: MAP2L-145					Station Description (If new, describe below and record latitude and longitude) Composite sample – 10 littoral plots					
Date: <i>8/15/17</i>										
Time (24 hr): <i>830</i>					Plot A Lat: 42.53823			Plot A Long: -71.60602		
Littoral Plot	A	B	C	D	E	F	G	H	I	J
Plot Characteristics										
All estimates should be in metric.										
Depth (10 m offshore)	<i>0.5</i>	<i>0.5</i>	<i>0.9</i>	<i>1.0</i>	<i>2.0</i>	<i>1.5</i>	<i>2.0</i>	<i>1.0</i>	<i>0.7</i>	<i>0.5</i>
Shoreline Flooding (Depth/Distance)	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
Drawdown (Height/Distance)	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
Surface Film	N = None S = Scum A = Algal Mat O = Oily F# = Other									
	<i>N</i>	<i>N</i>	<i>N</i>	<i>O</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>
Substrate Odor	N = None S = H <sub>2</sub> S A = Anoxic O = Oil F# = Other									
	<i>A</i>	<i>A</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>
Substrate Color	Bl = Black G = Gray Br = Brown R = Red F# = Other									
	<i>Bl</i>	<i>Bl</i>	<i>Bl</i>	<i>Br</i>	<i>Br</i>	<i>Bl</i>	<i>Br</i>	<i>Br</i>	<i>Br</i>	<i>Bl</i>
Macroinvertebrate Sample	R = Rocky/Cobble/Woody M = Macrophyte F = Fines (mud, silt, sand) L = Leaf Pack, Detritus F# = Other									
Habitat Sampled	<i>M, L</i>	<i>M, L</i>	<i>M, L</i>	<i>M, F</i>	<i>M, F</i>	<i>F, L</i>	<i>F, L</i>	<i>F</i>	<i>F, M</i>	<i>M, L</i>
Collection Method	B = Boat W = Wading									
	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>
Human Influences	O = Not Present P = Present adjacent to littoral plot C = Present within littoral plot									
Buildings	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>	<i>O</i>
Commercial			<i>P</i>	<i>P</i>						
Park Facilities/Man-made Beach			<i>O</i>	<i>O</i>						
Docks/Boats										
Walks, dikes or revetments										
Trash/Landfill										
Roads or Railroads										
Power Lines										
Row Crops										
Pasture/Hay fields										
Orchard		<i>↓</i>								
Lawn		<i>P</i>								
Other( )	<i>↓</i>	<i>O</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>

Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macroinvertebrate Littoral Habitat Field Sheet (2017)

MAP2L-145



Revision Date 10/2015

UniqueID#

Field Sheet Login#

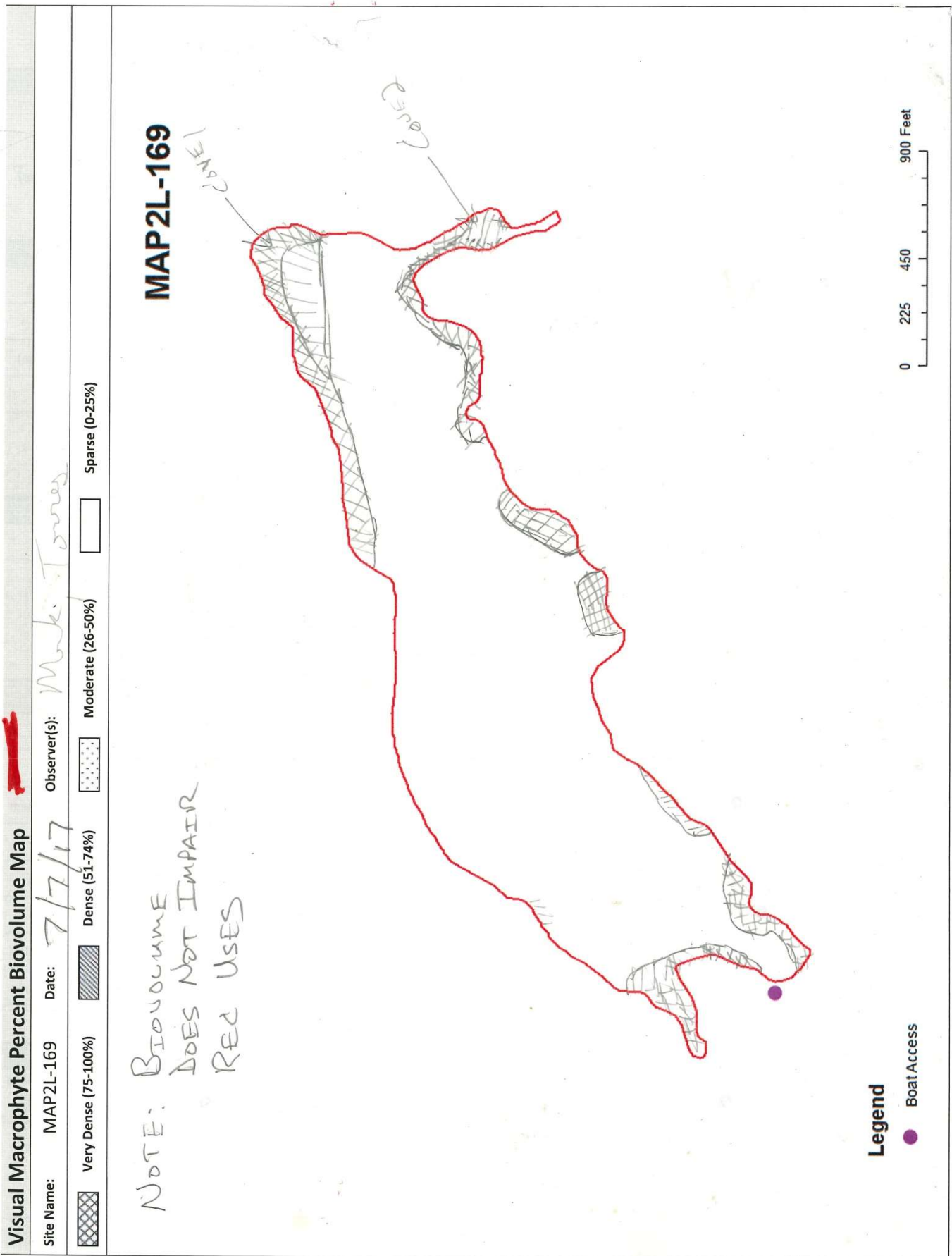
For Office Use Only

**Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)**

<b>General Information</b>				
<b>Project:</b> MAP2 Lakes (2017)		<b>Survey Crew Lead:</b> <i>Mark</i>		
<b>Lake (PALIS):</b> Robbins Pond (81111)		<b>Survey Crew Assist:</b> <i>Torres</i>		
<b>Site Name:</b> MAP2L-145		<b>Station Description</b> (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)		
<b>Date:</b> <i>8/15/17</i>				
<b>Time (24 hr):</b> <i>830</i>				
<b>Sampling Activity</b> <input type="checkbox"/> Macroinvertebrate <input type="checkbox"/> Macrophyte Mapping <input type="checkbox"/> Deep Site WQ <input type="checkbox"/> Shoreline WQ <input type="checkbox"/> Fish Tissue <input type="checkbox"/> Other				
<b>Macrophyte Identification</b>		VD = Very Dense (75 – 100%)            D = Dense (50 – 75%)            M = Moderate (25-50%)            S = Sparse (1-25%)		
Species ID <small>(If uncertain, leave blank and collect voucher)</small>	Overall Percent Cover	Voucher ID <small>(Site ID – Species ID) (Example: 002-01)</small>	Observation Location - Purpose <small>(Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID</small>	ID Analyst
01 <i>Nymphaea odorata</i>	<i>D</i>		<i>RTA, B, C, D, E, J</i>	<i>JM</i>
02 <i>Nuphar variagata</i>	<i>S</i>		<i>Mixed in but at lower densities</i>	<i>JM</i>
03 <i>Cabomba caroliniana</i>	<i>S</i>		<i>RT J, 1/2 mixed in</i>	<i>JM</i>
04				
05				
06				
07				
08				
09				
10				
11				
12				
13				
14				
15				
<b>Voucher Labeling</b> Place each plant voucher in a separate plastic bag labeled with the <b>Voucher ID</b> and <b>Date</b> . Place all individually bagged plant vouchers into a large bag labeled with the <b>Site ID</b> and <b>Date</b> . <b>Voucher Plant Identification</b> After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.				

Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macrophyte Survey Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Muk</i>		
Lake (PALIS): Stiles Pond (92063)		Survey Crew Assist: <i>Tones</i>		
Site Name: MAP2L-169		Station Description (If new, describe below and record latitude and longitude)		
Lake Area (ha): 23.9				
Macrophyte Survey Details				
Start Date: <i>7/7/17</i>		End Date: <i>7/7/17</i>		Cover and Biovolume Method <input type="checkbox"/> Visual Estimates <input checked="" type="checkbox"/> Sonar Estimates
Start Time: <i>9:30</i>		End Time: <i>1:30</i>		Sonar ID (if applicable):
Approximate Transect Spacing: <i>~25m</i> Indicate the approximate orientation and location of the transects on the blank lake figure (reverse side).				
Entire Lake Surveyed? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If no, reason(s)? <input type="checkbox"/> Equipment Failure <input type="checkbox"/> Macrophyte Density <input type="checkbox"/> Resources <input type="checkbox"/> Other				
Survey Notes:				
Data File Tracking				
Saved File Name: <i>169 20170707A &amp; B</i>			Saved Location:	
Data Upload Date:		Uploader:		Upload Destination:
Data File Notes:				
Lake/Catchment Site Activities and Disturbances Observed in Field (Intensity: Blank = Not Observed, L = Low, M = Moderate, H = High)				
Residential	Recreational	Agricultural	Industrial	Lake Management
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Residences	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Hiking Trails	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Cropland	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Industrial Plants	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Liming
<input checked="" type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Maintained Lawns	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Parks, Campgrounds	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Pasture	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Mines/Quarries	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Chemical Treatment
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Construction	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Other Parks/Camping	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Livestock Use	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Oil/Gas Wells	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Angling Pressure
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Pipes, Drains	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Resorts	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Orchards	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Power Plants	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Drinking Water
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Dumping	<input checked="" type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Marinas <i>(Docks)</i>	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Poultry	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Logging	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Treatment
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Roads	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Trash/Liter	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Feedlot	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Evidence of Fire	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Macrophyte Control
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Bridges/Causeways	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Surface Films/Scum	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Water Withdrawal	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Odors	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Water Level Altered
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Sewage Treatment	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Macrophytes	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Cranberry Bog	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Commercial	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Fish Stocking
Overall Waterbody Character				
Human Disturbance		Aesthetic Appeal		
Pristine ⑤ ④ ③ ② ①		Highly Disturbed ② ①		
Human Disturbance		Aesthetic Appeal (Aesthetic Appeal < 3 = Impairment)		
⑤ ④ ③ ② ①		Appealing ⑤ ④ ③ ② ① Unappealing		
<input type="checkbox"/> Debris/Floatables/Trash <input type="checkbox"/> Excessive Algal Growth <input type="checkbox"/> Taste and Odor <input type="checkbox"/> Oil and Grease <input type="checkbox"/> Other <input type="checkbox"/> Foam/Flocs/Scum/Oil Slicks <input type="checkbox"/> Aquatic Plants (Macrophytes) <input type="checkbox"/> Turbidity <input type="checkbox"/> Sedimentation/Siltation Aesthetic Impairment Cause (Check all that apply) Description (details, extent and severity): <i>AESTHETICS SUPPORT</i>				



**Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)**

General Information	
<b>Project:</b> MAP2 Lakes (2017)	<b>Survey Crew Lead:</b> <i>Muh</i>
<b>Lake (PALIS):</b> Stiles Pond (92063)	<b>Survey Crew Assist:</b> <i>Tones</i>
<b>Site Name:</b> MAP2L-169	<b>Station Description</b> (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)
<b>Date:</b> <i>7/2/17</i>	
<b>Time (24 hr):</b> <i>9/30</i>	

**Sampling Activity** ☐ Macroinvertebrate ☒ Macrophyte Mapping ☐ Deep Site WQ ☐ Shoreline WQ ☐ Fish Tissue ☐ Other

**Macrophyte Identification** VD = Very Dense (75 – 100%) D = Dense (50 – 75%) M = Moderate (25-50%) S = Sparse (1-25%)

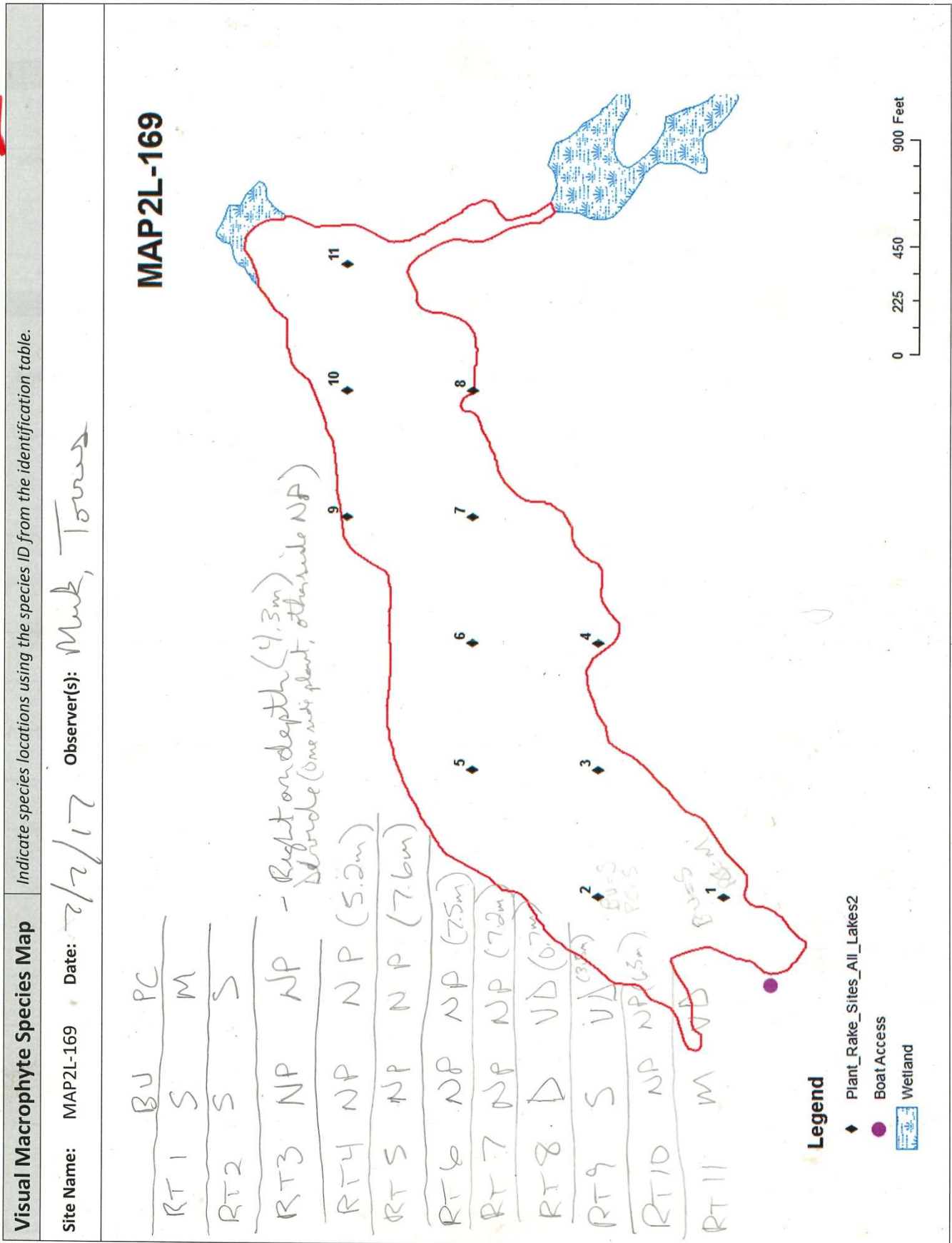
Species ID (If uncertain, leave blank and collect voucher)	Overall Percent Cover	Voucher ID (Site ID – Species ID) (Example: 002-01)	Observation Location - Purpose (Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID	ID Analyst
01		169-01	RT 1 (1sp)	
02		169-02	RT 2 (1sp)	
03		169-03	RT 8 (4sp)	
04		169-04	RT 9 (1sp)	
05		169-05	RT 11 (2sp)	
06		169-06	COVE 1 (4sp)	
07		169-07	COVE 2 (1sp-UNIQUE)	
08				
09				
10				
11				
12				
13				
14				
15				

**Voucher Labeling**

Place each plant voucher in a separate plastic bag labeled with the **Voucher ID** and **Date**. Place all individually bagged plant vouchers into a large bag labeled with the **Site ID** and **Date**.

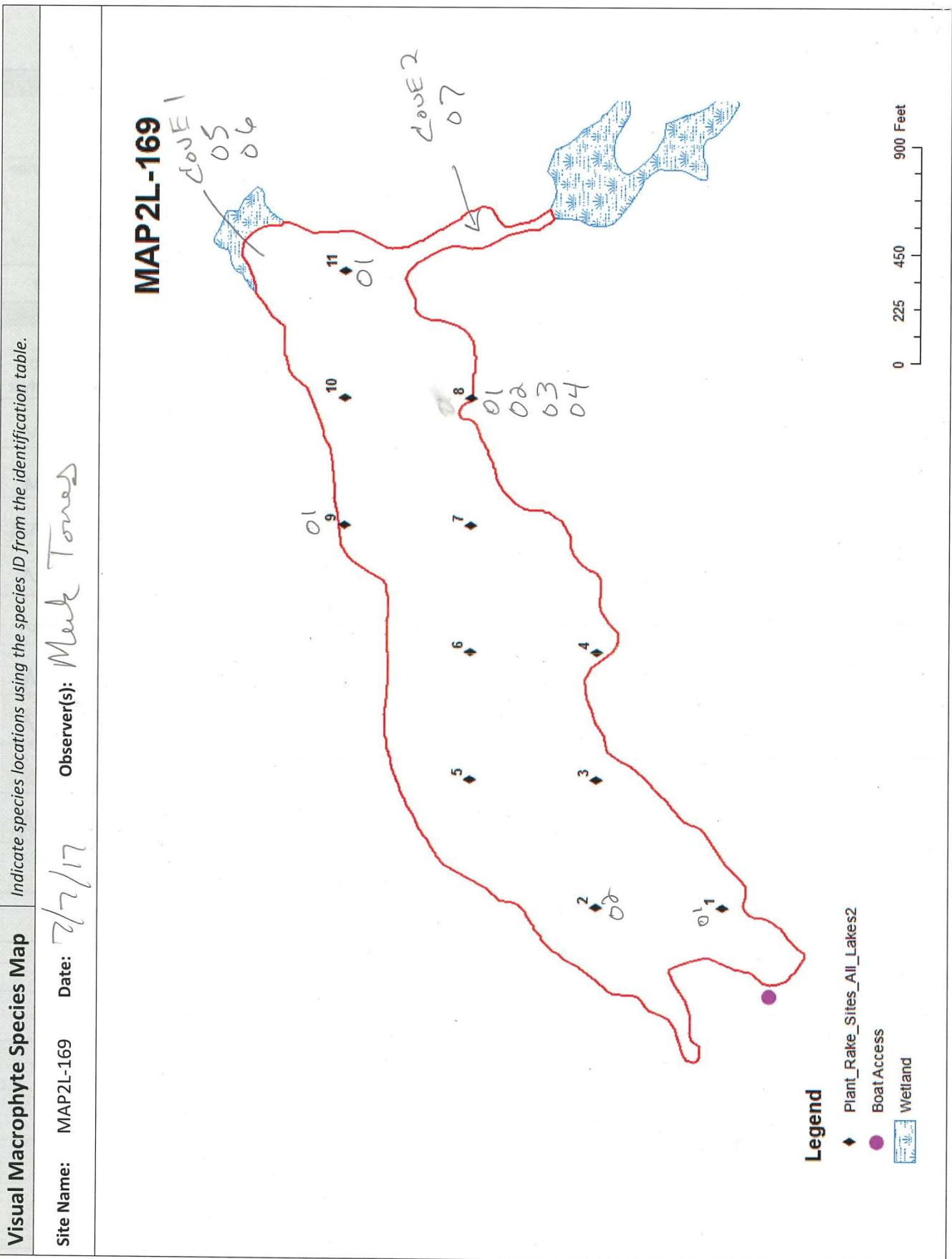
**Voucher Plant Identification**

After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.



Massachusetts Department of Environmental Protection/Watershed Planning Program  
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Munk</i>		
Lake (PALIS): Stiles Pond (92063)		Survey Crew Assist: <i>Tones</i>		
Site Name: MAP2L-169		Station Description (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)		
Date: <i>7/2/17</i>				
Time (24 hr): <i>930</i>				
Sampling Activity <input type="checkbox"/> Macroinvertebrate <input checked="" type="checkbox"/> Macrophyte Mapping <input type="checkbox"/> Deep Site WQ <input type="checkbox"/> Shoreline WQ <input type="checkbox"/> Fish Tissue <input type="checkbox"/> Other				
Macrophyte Identification		VD = Very Dense (75 – 100%) D = Dense (50 – 75%) M = Moderate (25-50%) S = Sparse (1-25%)		
Species ID (If uncertain, leave blank and collect voucher)	Overall Percent Cover	Voucher ID (Site ID – Species ID) (Example: 002-01)	Observation Location - Purpose (Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID	ID Analyst
01 <i>Potamogeton robbinsii</i>	<i>M</i>		<i>COVE 1</i> <i>RT1, RT8, RT9, RT11</i>	<i>JM</i>
02 <i>Aquatic moss</i>	<i>S</i>		<i>RT2, RT8</i>	<i>JM</i>
03 <i>Brasenia schreberi</i>	<i>S</i>		<i>RT8</i>	<i>JM</i>
04 <i>Nuphar variegata</i>	<i>S</i>		<i>RT8</i>	<i>JM</i>
05 <i>Nymphaea odorata</i>	<i>S</i>		<i>COVE 1</i>	<i>JM</i>
06 <i>Pontederia cordata</i>	<i>S</i>		<i>COVE 1</i>	<i>JM</i>
07 <i>Utricularia vulgaris</i>	<i>S</i>		<i>COVE 2</i>	<i>JM</i>
08				<i>JM</i>
09				<i>JM</i>
10				
11				
12				
13				
14				
15				
<b>Voucher Labeling</b> Place each plant voucher in a separate plastic bag labeled with the <b>Voucher ID</b> and <b>Date</b> . Place all individually bagged plant vouchers into a large bag labeled with the <b>Site ID</b> and <b>Date</b> . <b>Voucher Plant Identification</b> After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.				



Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) LM

Lake Vertical Profile Probe Deployment (2022)

Site and Survey Information					
Field Sheet Login#: 22-M502-01		Unique ID: W3149		Site Name (STAID): TAM-003	
Project: TAM A2-4 (2022)			Lake (PALIS): Morses Pond (72079)		
Crew Lead: Meek			Other Crew: <u>Davis</u>		
Field Latitude (DD): <u>42.29716</u>			Field Longitude (DD): <u>-71.319743</u>		
General Comments:					
Water Level (relative to annual high-water level): <input type="checkbox"/> Low <input checked="" type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below:					
Start Date: 6/28/2022			Immersion Time (24hr): <u>910</u>		
End Date: <u>10/4/22</u>			Taken-out-of-water Time (24hr): <u>1220</u>		
Weighted Line Max Depth (m) @ Deploy: <u>6.9</u>			Sub-Surface Buoy Depth <sup>1</sup> (m): <u>0.35</u>		
Vertical Profile Deployment Information					
Sonde No.	Measured Sonde Line Depth <sup>2</sup> (m)	Calculated Sonde Water Depth <sup>3</sup> (m)	OWMID	Sonde ID#	Sonde Type
1	<u>0.7</u>	<u>1.05</u>	25-0423	<u>20781156</u>	<input checked="" type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
2	<u>1.5</u>	<u>1.85</u>	25-0424	<u>20583767</u>	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
3	<u>2.5</u>	<u>2.85</u>	25-0425	<u>20583768</u>	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
4	<u>3.5</u>	<u>3.85</u>	25-0426	<u>20583769</u>	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
5	<u>4.5</u>	<u>4.85</u>	25-0427	<u>20583770</u>	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
6	<u>5.5</u>	<u>5.85</u>	25-0428	<u>20781151</u>	<input checked="" type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
7			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:

If deploying more than 7 sondes, continue on the back

- 1 – Sub-surface buoy depth is distance from the water surface to the top of the sub-surface buoy.
- 2 – Sonde line depth is distance from the top of the sub-surface buoy to the sonde.
- 3 – Sonde water depth is distance from water surface to the top of the sub-surface buoy (1) PLUS distance from top of the sub-surface buoy to the sonde (2). Enter 3 into WQD for deploy sonde depth.

Vertical Profile Deployment Information (Continued)					
Sonde No.	Measured Sonde Line Depth <sup>2</sup> (m)	Calculated Sonde Water Depth <sup>3</sup> (m)	OWMID	Sonde ID#	Sonde Type
8			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
9			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
10			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
11			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
12			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
13			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
14			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
15			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
16			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
17			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
18			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
19			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
20			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:

1 – Sub-surface buoy depth is distance from the water surface to the top of the sub-surface buoy.

2 – Sonde line depth is distance from the top of the sub-surface buoy to the sonde.

3 – Sonde water depth is distance from water surface to the top of the sub-surface buoy (1) PLUS distance from top of the sub-surface buoy to the sonde (2). Enter 3 into WQD for deploy sonde depth.

Crew Lead (Initial) JM

Marses

Page 3 of 8 (rev 3/24/2022)

Crew Lead (initial) \_\_\_\_\_ Lake Vertical Profile Probe Deployment (2022)

Fieldsheet Login #: 22-M502-01      Unique ID: W3149      Page 4 of 8 (rev 3/24/2022)

Crew Lead (initial) *DM* Lake Vertical Profile Probe Deployment (2022) *Morse*

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Crew Lead (initial) \_\_\_\_\_ Lake Vertical Profile Probe Deployment (2022)

Fieldsheet Login #: 22-M502-01 Unique ID: W3149 Page 6 of 8 (rev 3/24/2022)

## Crew Lead (initial)

240525

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Crew Lead (initial) \_\_\_\_\_ Lake Vertical Profile Probe Deployment (2022)

Fieldsheet Login #: 22-M502-01 Unique ID: W3149 Page 8 of 8 (rev 3/24/2022)



## **APPENDIX E: CHAIN OF CUSTODY FORMS**



Commonwealth of Massachusetts  
Executive Office of Environmental Affairs  
Department of Environmental Protection  
Senator William X. Wall Experiment Station

## Sample Tracking & Chain-of-Custody Record

Cooler Temperature at Receipt \_\_\_\_\_ °C  
WES Sample Log-In Batch # \_\_\_\_\_

Agency-Bureau-Division-Region	
Bureau: BWR	
Division/Unit: DWM - WPP	
<input type="checkbox"/> DEP WES	<input type="checkbox"/> DEP Boston
<input type="checkbox"/> DEP NERO	<input type="checkbox"/> DEP SERO
<input type="checkbox"/> DEP CERO	<input type="checkbox"/> DEP WERO
<input type="checkbox"/> Other Agency: _____	

Project Description	
Name: MAP2 Lakes (2017)	
Coordinator: James Meek	
Phone #: 508-767-2863	
Fax #: _____	
RTN: _____	
Case #: _____	

Analytical Laboratory (for samples sent to a laboratory other than WES)	
Name: Worcester	
Address: 8 New Bond Street Worcester, MA 01606	
Contact: R. Chase	
MA Cert#: _____	
Phone #: 508.767.2859	

Sample Lab ID (Batch # above plus # below)	Sample Field ID	Site Name	Field Locator (Within Site)	Sample Matrix Code*	Collector (last name, first initial)	Collection		Sample Preserv. Code #**	G/C***	Chlorine Residual (yes/no)	Analysis Requested
	10-5315	MAP2L-128		SRW	Reardon M	9/28/2017	1108		G	Y	Color/Turbidity
	10-5316	MAP2L-128		SRW		9/28/2017	1112		G		Color/Turbidity
	10-5317	MAP2L-128		SRW		9/28/2017	1040		G		Color/Turbidity
	10-5321	MAP2L-128		SRW		9/28/2017	1140		C		Chlorophyll a
	10-5322	MAP2L-128		SRW		9/28/2017	1145		C		Chlorophyll a
	10-5323	MAP2L-128		SRW		9/28/2017	1055		C		Chlorophyll a
	10-5324	MAP2L-161		SRW		9/28/2017	1320		G		Color/Turbidity
	10-5326	MAP2L-161		SRW		9/28/2017	1345		C	Y	Chlorophyll a

Remarks: Week 39

Chain of Custody: (Required, including signatures, for all samples submitted to WES Laboratories)					
Relinquished by:			Received by:		
Printed name	Signature	Date	Printed name	Signature	Date
Matthew Reardon	<i>Matthew Reardon</i>	9/28/17	James Meek	<i>James Meek</i>	9/29/17
FC:dg		9/29/17	DEP WPP	<i>DEP WPP</i>	9/29/17

**\* Matrix Codes**

AC = Air Canister  
ACT = Air Cartridge Tube  
AF = Air Filter  
CPL = Commercial Product Liquid

CPS = Commercial Product Solid  
DW = Drinking Water  
(Treatment and Distrib)  
FBT = Fish/Biological Tissue  
FEC = Feces/Fecal Matter

GRRW = Gray Water  
GW = Ground Water  
IWW = Industrial Wastewater  
LL = Landfill Leachate  
SOIL = Soil

LW = Liquid Waste  
ME = Marine/Estuarine Water  
SED = Sediment  
SRW = Surface Water  
STW = Storm water/CSO  
SW = Solid Waste  
TB = Trip Blank (Type I Reagent Water)

UN = Unspecified Water/Wastewater  
WO = Waste Oil  
WW = Domestic Wastewater  
WWS = Wastewater Sludge

**\*\* Sample Preserv Codes**

1 = Cool ≤ 4° C  
2 = pH < 2 with H<sub>2</sub>SO<sub>4</sub>  
3 = pH < 2 with HNO<sub>3</sub>  
4 = pH < 2 with HCl  
5 = pH > 12 with NaOH  
6 = Ascorbic acid  
7 = Filtered (0.45-µm pore size)  
8 = Sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>)  
9 = Mercuric chloride (HgCl<sub>2</sub>)  
10 = Sodium sulfite (Na<sub>2</sub>S)  
11 = Ammonium chloride (NH<sub>4</sub>Cl)  
12 = Ethylenediamine  
13 = EDTA  
14 = Methanol  
15 = Reagent Water (Type I)

**\*\*\* G/C = Grab/Composite**

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## **APPENDIX F: QUICKGUIDE FOR FIELD USE OF MULTI-PROBE SONDES AND LOGGERS**

## YSI EXO User Quick Guide

### Initial

- Hold blue storage cup and loosen (not separate) black tension ring by turning COUNTERCLOCKWISE to remove storage cup from probe.
- Press power button to turn on Exo

### Calibrate Depth

- Calibrate depth BEFORE placing in water
- Press **"Calibrate"** button, select depth and press **Enter**
- Select calibrate and press **Enter**
- Check to make sure calibration value is 0.000 wait to make sure reading is stable (green checkmark appears at the right-hand corner of the graph)
- Press **Enter** to accept calibration.
- Press **"Handheld"** icon to return to **Setup** Screen

### Select User ID

- Place probe in water at sampling location (for probe equilibration)
- Scroll down to **"User ID"** (selected user will be in brackets, E.G.: "UserID [Medeiros]")
- Select **"User ID [last name]"** and press **Enter**
- Select desired ID and press **Enter**
- Select **"Select [last name]"** and press **Enter**

### Turn on Auto Stable

- On **Setup** Screen scroll to "Auto Stable" (should read "Auto Stable [On]), press **Enter**
- Screen should read **"Auto Stable"** at top
- Scroll down to **"Start Auto Stable"**, press **Enter**

### Blinking "AS" should be displayed next to parameters.

- Blinking red parameters are not yet stable. Blinking green parameters are stable. (Parameters must be consistent with auto stable settings for five consecutive samples ten seconds apart before they will be considered stable.)
- Once ALL parameters are stable the "AS" will be solid green for auto stable parameters. Wait at least 5 minutes before logging samples EVEN if "AS" has turned solid green. If it has been greater than 5 minutes and "AS" has not turned green indicating stability, use your best professional judgement and begin logging when you feel the parameters are stable.

### Begin Logging

- To begin logging select **"Start Logging"** and press **Enter**
- Do **NOT** hit **"Start Now!"** yet!
- Scroll down to **"Site"** (current selected site will be in brackets E.G.: "Site ID [52-0756]")
- Select **Site[site ID]** and press **Enter**
- Select desired Site and press **Enter**
- Select **"Start Now!"** and press enter to start logging
  - If a site needs to be added that is not in the list, select **"add new"** and press **Enter**
  - Enter new site ID using virtual keyboard, scroll down to "enter" bar on keyboard and press **Enter**
  - **IMPORTANT** Scroll down and select **"Save"**, press **Enter**
  - You can now select this as the site ID and press **Enter**
  - Scroll back up and select **"Start Now!"**, press **Enter**
- The logger will start logging at 30 second intervals (note the start time and log for 2 minutes)

### Stop Logging

- To stop logging select “**Stop logging**” and press **Enter**

### Review Data

- To review data Hit “**Data**” button
- Select “**View Data**” and press **Enter**
- Scroll to “**Site [site]**” and press **Enter**
- Select desired site ID, press **Enter**
- Scroll to “**Begin Date**”, press **Enter**
- Enter desired date, press **Enter**
- Scroll to “**Show Data**”, press **Enter**
- Data will be displayed on screen
- Write last line of data to appropriate spaces on field sheet

### Move to Next Site

- Turn off handheld unit
- Place blue cup back on sonde and tighten ring to secure to bulkhead

## QuickGuide for Field Use of HYDROLAB MS4/5 and SVR4a/5

(last updated 4/30/14)

- At first site, take storage cup off sonde unit and put on weighted strainer.
- Connect Cable to sonde (if needed).
- Turn on Surveyor (blue box)
- Avoid common mistakes: Forgetting the probe guards!; Forgetting the QC probe!; Annotating the wrong OWMID #; Forgetting to annotate OWMID #

### USER INTERFACE INFORMATION

The user interface for the Hydrolab Survey 4 is dated and non-intuitive. Users often struggle navigating the menus. Once the byzantine navigation patterns are memorized you will master the process.

After starting up the Surveyor 4 you will see the screen below. The four blue buttons on the touchpad correspond with the four menu items on the lower portion of the screen. The blue touchpad button about to be pressed in the screen below corresponds to the "Setup/Cal" onscreen menu option. See Figures 1, 2 below.

#### 1) TO CALIBRATE DEPTH

- Make sure the sonde is IN AIR near the surface of the water.
- Press blue touch pad key that corresponds to "**Setup/cal**" (see Figure 1)
- Press blue touch pad key that corresponds to "**Calibrate**"
- Press "**Sonde**".
- After a short wait you'll get a screen with options, Figure 3-"**Calibrate**"
- Scroll to "**Dep 100: Meters**" using arrow keys on touchpad (Figure 4).
- Press "**Select**" you'll get another screen: Dep 100: meters. Old: ? New: ? -0123456789. If necessary Use arrow keys and select for each character.
- Enter 0.00 or use default 0.00 values. Press 'done'.
- Go back to the main menu using 'Go Back'.

#### 2) ANNOTATE OWMID

It is very important to both remember to annotate the OWMID as well as use the proper OWMID. If you taking side-by-side quality control readings using the attended probe, use the appropriate attended QC OWMID# (located towards the bottom of page 1 or on the rear of your field sheet).

**Annotate OWMID# ONLY (no other notes) for the station (e.g., SM-0389).**

- To annotate press "**Files**"
- Press "**Svr4a**"
- Next choose file (usually 2: Surveyor 4a) and press "**Select**".

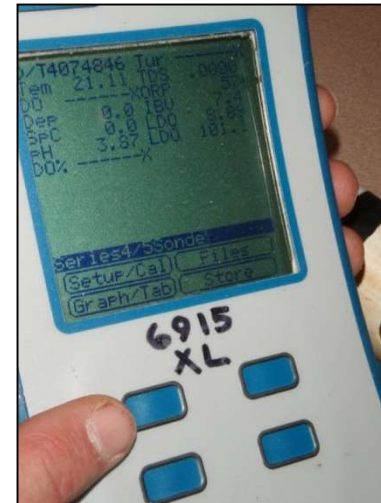


Figure 1: Overview of Surveyor 4 User Interface

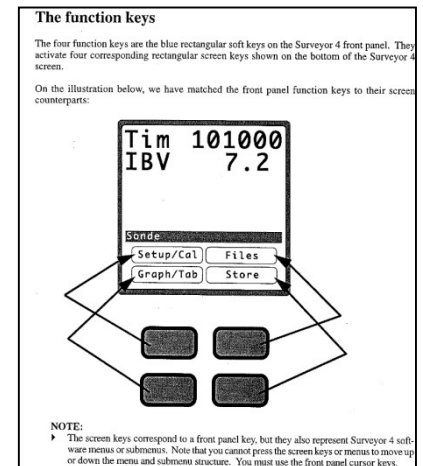


Figure 2: Overview of Screen Layout

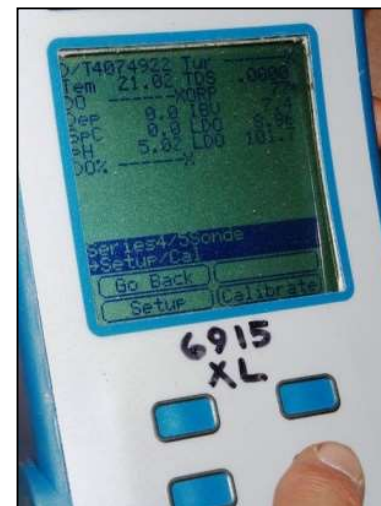


Figure 3: "Calibrate"

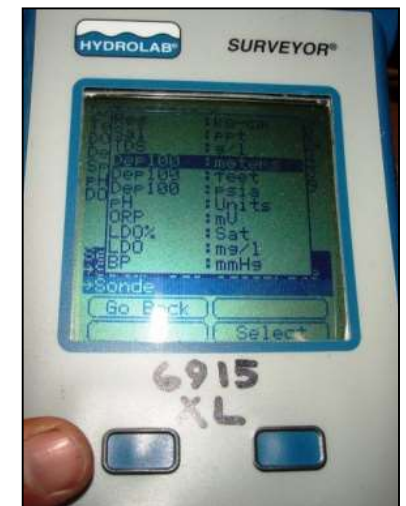


Figure 4: Depth

- The cursor should now be on **"Annotate"**, if not, move it there with arrow key's, press **"Select"**. (Figure 5)
- Using the arrow keys on touchpad and **"Select"** for each character, type the OWMID # on the field sheet (remember 2 characters a dash and 4 numbers)
- Use the 'Backspace Key' to correct errors (Figure 6).
- When typed correctly press **"Done"** to store the annotation to the file.
- Go back to the main menu using the 'Go Back' key.

### 3) TO SAMPLE

The item that often takes long to stabilize is pH, especially in colder (<10 deg. C) water. Make sure to check that both dissolved oxygen and pH have stabilized before taking measurements.

- Place sonde in the water.
- **Wait** for probes to equilibrate and stabilize. When readings are stable press **"Store"** and note start time.
- Select again to use the **"manual"** file. It will store one set of readings automatically to the logger.
- Continue to store readings manually @ 30 second intervals for a minimum of 3 minutes.
- If readings are moving around, continue to take readings as appropriate.

### 4) TO REVIEW DATA

- To review files, press **"Files"**
- Press **'Svr4a'**
- Screen arrow down to **"Review"**, and press **"Select"** (Figure 7)
- Arrow to correct file if necessary. Press **"Select"**.
- It will ask Beginning or Date/ Time. Move to **"Beginning"**, Press **"Select"**. (Figure 8).
- Press the **Up Arrow** on touchpad to go from the next screen to get the *last readings*. If last readings are not valid for some reason, continue scrolling up to the last valid reading.
- Manually record the LAST valid reading on fieldsheet. Make sure date and time, located across bottom after <<Review>>, make sense. (Figure 9).
- Go back to the main menu using **"Go Back"**.
- Press **on/off** key.
- Return to case and make sure to put probe in moistened temporary storage cup.

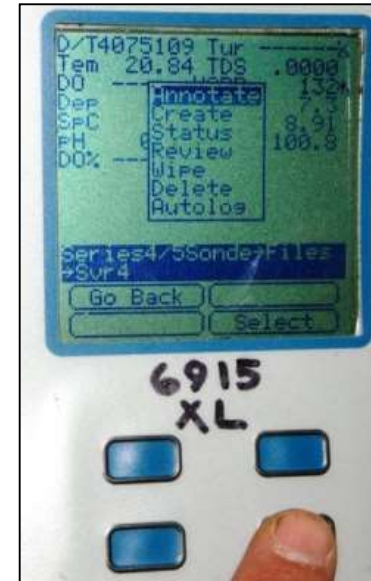


Figure 5: Annotate - Start

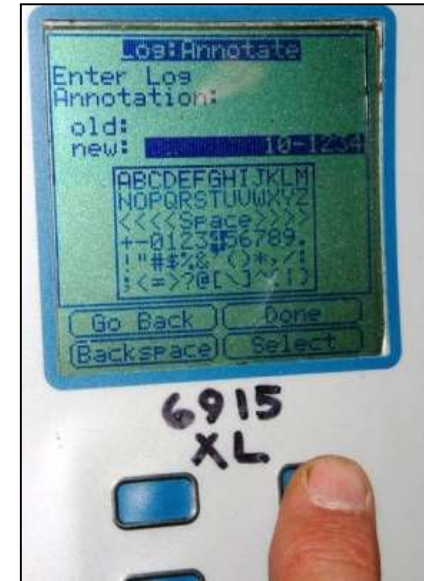


Figure 6: Annotate - OWMID



Figure 7: Review

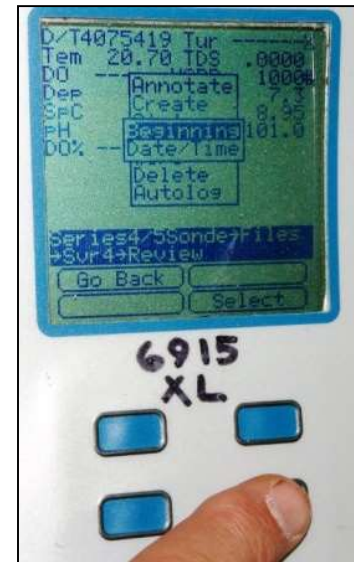


Figure 8: Beginning

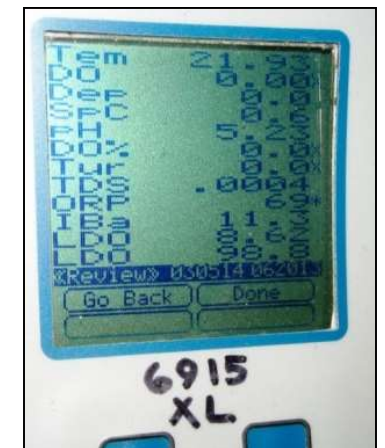


Figure 9: Review readout

## **APPENDIX G: BIOBASE QUICK REFERENCE**



Quick Reference – Standard Operating Procedure (Updated 10/07/2015)

**Installation**

- We recommend following the Lowrance HDS unit installation instructions that accompany the unit. Failing to install the transducer correctly may interfere with the sonar signal, and prevent the gathering of accurate data.
- Please ensure your unit has the latest firmware – see <http://www.lowrance.com/en-US/Software-Updates/>
- **Always ensure a clear signal (both Sonar and GPS) prior and during logging.** Periodic disruptions due to various causes are ok; sustained disruptions of signal will result in inaccurate or no data. Always monitor the 200 kHz page

**Lowrance™ HDS Unit Settings (Recommended)\***

- Transducer "Installation"
  - HDS Gen1&2: Press Page, toggle to and select SONAR, press MENU twice, select SONAR Select INSTALLATION; Select your Transducer (check the silver tag on your transducer cable for the model)
  - HDS Gen2&3 Touch: Press Pages button, select SETTINGS, select SONAR; Select INSTALLATION; Select Transducer (check the silver tag on your transducer cable for the model)
- Fishing Mode = Shallow Water (for vegetation detection or depths < 60ft, if deeper, use Fresh Water setting)
  - HDS Gen1&2: Press Page, toggle to and select SONAR, press MENU twice, select SONAR
  - HDS Gen2&3 Touch: Press Pages button, select SETTINGS, select SONAR
- Ping Rate = 10-15 pps
  - HDS Gen1&2: Press Page, toggle to and select SONAR, press MENU
  - HDS Gen2&3 Touch: Press Pages button, select SONAR, select ADVANCED
- Sonar Range = Auto (Default); critical for optimal bottom and vegetation detection
  - HDS Gen1&2: Press Page, toggle to and select SONAR, press MENU
  - HDS Gen2&3 Touch: Press Pages button, select SONAR
- Frequency of Broadband Sonar = 200KHz Mandatory for all three layers – other freqs. will create depth maps only
  - HDS Gen1&2: Press Page, toggle to and select SONAR, press MENU
  - HDS Gen2&3 Touch: Press Pages button, select SONAR
- WAAS Differential Correction Enabled on GPS
  - HDS Gen1&2: Press MENU twice, select SYSTEM, select SATELLITES, select CONFIGURE, enable WAAS
  - HDS Gen2&3 Touch: Press the Pages button, select SETTINGS, select SYSTEM, select SATELLITES, select CONFIGURE, enable WAAS
- Recommended Speed =  $\leq 5.5$  mph. Faster is ok for slowly changing bottom, go slower during rapid depth changes
- **Monitor your SONAR page; if signal becomes interrupted at faster speeds, slow down.**
- Maximum Speed = 20 mph (Bathymetry), 12 mph (Vegetation), 10 mph (Bottom Composition).
- Bytes per sounding = Default 3200

**Recording Sonar**

- We recommend carrying two 8-32 (not 64) gb SD cards. We recommend logging no longer than one hour per file. **Ensure SD card compatibility/function prior to recording sonar by ensuring the card is recognized in the Log Sonar menu dialog**
- Logging sonar:
  - HDS Gen1&2: press MENU. Near the bottom of the menu options, select LOG SONAR.
  - HDS Gen2&3 Touch: press the Pages button, select SONAR, select ADVANCED, select LOG SONAR.
- File Format = .sl2, .sl3, .or .slg. Review/select other logging options. Select RECORD.
- Stop recording:
  - HDS Gen1&2: press MENU again, select LOG SONAR and select STOP LOGGING.
  - HDS Gen2&3 Touch: select LOG SONAR, select STOP LOGGING
  - **DO NOT select STOP/START SONAR during recording** – this will only stop/start pinging, not recording and may corrupt your file resulting in lost data
- Do not split both 83 & 200 kHz frequencies or adjust SONAR file/frequency/logging settings. If adjustments need to be made, stop the file, make the adjustment, and then resume logging a new file. Changing displays and zoom levels is ok

**Transects**

- Transects can be any spacing and depends on the user coverage needs. Users can adjust the buffer in BioBase. 40-m spacing is sufficient for most needs
- Use a design (perpendicular to shore, parallel, concentric) that results in the most efficient coverage of water and maps features to your acceptable level of detail
- Monitor your Lowrance Chart and record a trail to monitor coverage. For pre-planning purposes, transects can be created in GIS, saved to a .gpx file, and then imported into your HDS unit.

**Data Upload**

- Once recorded, files can be saved to the user's local computer or uploaded directly from the SD card.
- Files are uploaded using the BioBase Client Tool that is downloaded from the user's BioBase homepage.
- Time required to upload and process the files will depend on a number of factors including the size of the file, size of the area surveyed, and internet connection speed. An email will be sent to you once processing is complete.

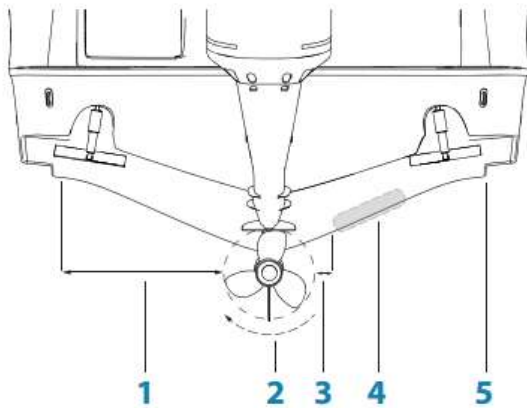
\*Refer to the Lowrance™ HDS manual or full ciBioBase Operator's Guide for additional details on depth finder options. © Navico, Inc.



## **APPENDIX H: SONAR TRANSDUCER MOUNTING GUIDANCE**

## Select a transducer location

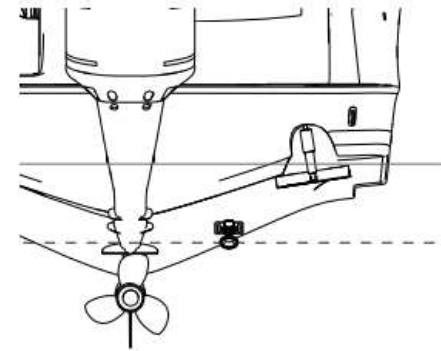
The primary aim is to stay clear of propeller and hull generated turbulence, while mounting the transducer as close to the center of the vessel as possible.



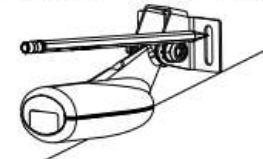
- 1 Avoid mounting within 1 m (3.3') to port (left) of propeller**
- 2 Conventional clockwise propeller rotation**
- 3 Avoid mounting within 7.5 cm (3") to starboard of propeller**
- 4 Best mounting location - undisturbed water flow**
- 5 Planing strake - avoid mounting behind here**

## Attaching the transducer

The transducer should be installed parallel with the transom's waterline, not the bottom of the boat (deadrise).



- **Note:** Ensure the entire bottom surface of the transducer hangs at least 3 mm (1/8th of an inch) lower than the bottom of the hull.



Hold the transducer with bracket up to the transom of the boat and trace the slotted screw hole locations (two on the 83/200 KHz transducer, and four on the 50/200 KHz transducer). Mark drilling points in the middle of each outline, to allow for transducer height adjustment. Drill pilot holes to suit fasteners.

- **Note:** Check that there is nothing on the other side of the mounting surface that may be damaged by drilling.

Attach transducer to transom, using supplied stainless steel fasteners. Drill a 25 mm (1") hole above the waterline, large enough to pass the plug through.