Water chemistry assessment protocol for wetland monitoring sites

Biological Monitoring Program

I. Purpose

To describe and document the standard operating procedure (SOP) used by the Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to collect wetland water chemistry data from wetlands which have a suitable water column for the purpose of evaluating water quality, relating to biological condition criteria, watershed restoration and/or standards development.

II. Scope/limitations

The following SOP applies to all wetland monitoring sites having a suitable water column at the time of sampling and for which an integrated evaluation of water quality is to be conducted. A suitable water column is defined as a minimum of 15 centimeters (cm) of standing water in or adjacent to the wetland assessment area. An integrated wetland assessment involves the collection of biological (macroinvertebrate and/or plant) and chemical data to assess wetland condition. These protocols are suitable for use in all wetland classes which have a suitable water column during the sampling visit.

The protocols included here only describe those used by MPCA biologists to collect wetland water samples and measure water chemistry parameters in the field. This document does not include any of the analytical procedures utilized by the Minnesota Department of Health (MDH) or other environmental laboratory to perform analytical analysis. In most instances, the MDH laboratory analyzes MPCA wetland water samples. For more information about their analytical procedures, see the MDH Environmental Laboratory Sampling and Analysis Guide available at: http://www.health.state.mn.us/divs/phl/environmental/handbook.pdf

III. General information

Wetland sampling sites may be selected for a number of reasons including:

1. randomly selected for ambient condition monitoring
2. selected for the development and calibration of biological or other criteria,
3. selected to evaluate a suspected source of pollution
4. sites selected for wetland trend assessment
5. sites selected as part of watershed evaluation or assessment
6. sites selected for special studies which may or may not relate to other reasons provided here for site selection

IV. Personnel requirements

A. Field crew leader: The field crew leader must be a professional aquatic biologist with a good knowledge of wetland ecology. He or she must have a minimum of a Bachelor of Science degree in aquatic biology or a closely related field; and have a minimum of six months field experience in environmental monitoring. Field crew leaders should be proficient using Global Positioning System (GPS) and conventional maps.

B. Field assistant/intern: The field assistant/intern must have at least one year of college education and at a minimum an interest in aquatic biology. Coursework in environmental, natural resource, and/or biological science is preferred.

C. General qualifications: All personnel conducting this procedure must have the ability to perform rigorous physical activity in an outdoor setting and be capable of carrying up to 50 pounds of sampling equipment.

V. Responsibilities

A. Field crew leader: The field crew leader is responsible for implementing the action steps of the procedure and ensuring that the data generated meets the standards and objectives of the Biological Monitoring Program and the MPCA. In addition, the field crew leader is responsible for planning sampling activities and ensuring that all MPCA policies and protocols are followed during all sampling activities.

B. Field assistant/intern: The field assistant/intern is responsible for implementing the action steps of the procedure; including the maintenance, stocking, and storage of sampling equipment, data collection, and data recording.

VI. Training

All inexperienced personnel will receive instruction from a trainer designated by the program manager. Major revisions in this protocol require that all personnel that apply this procedure on behalf of the MPCA be re-trained in the revised protocol by experienced personnel. The field crew leader will provide additional instruction to the field assistant/intern as needed and will be responsible for monitoring the performance of the field assistant/intern throughout the field season.

VII. Action steps

- **Equipment check:** Before heading into the field, confirm that all equipment necessary to complete this procedure is present, in proper working condition (Table 1), and fresh batteries or battery packs are available for battery operated equipment.
- **Aquatic invasive species (AIS)**: Prior to going to the field to collect samples:
  - Check the Minnesota Department of Natural Resources (MDNR) most current version of Designated Invested Waters (DIW) to determine if you will be sampling within any known AIS infested waters. The latest version of the DIW is available at: http://files.dnr.state.mn.us/eco/invasives/infested_waters.pdf. All water bottles containing water from DIW must have a safety green AIS label affixed to them to alert MDH staff to autoclave all unused water and the bottle prior to disposal.
- **Field sampling:** Wetland water sampling techniques discussed here are intended to measure the basic chemical and physical properties of the water column within the assessment area. Where to collect water samples within a wetland is important for insuring valid comparisons across sampled wetland sites. Both chemical (e.g. dissolved oxygen) and physical (e.g. temperature) properties of the water column can vary greatly within a wetland depending on factors such as sampling date and time, vegetative structure and water depth. Analysis of water chemistry results from survey studies

(e.g. Minnesota Wetland Condition Assessment (MWCA), Depressional Wetland Assessment, or National Wetland Condition Assessment (NWCA)) will be stratified by associated wetland plant community type as needed.

Table 1. Equipment needed to complete the MPCA wetland water chemistry SOP.

Equipment	Purpose	Operation Check
Sample bottles:		
MDH 1000 ml general (plastic)	Collect water for chloride, alkalinity, TSS, and sulfate measurement	- Sufficient quantity for sampling all sites (1/site) - Clean labels attached - Expiration date
MDH 250 mL nutrient (plastic)	Collect water for Kjeldahl nitrogen, nitrate + nitrite, total phosphorus, and total organic carbon (TOC) measurement	- Sufficient quantity for sampling all sites (1/site) - Clean labels attached - Expiration date
5 mL 10% H_2SO_4 preservative vial for nutrient samples	Preserve nutrient samples	- Sufficient quantity for sampling all sites (1/site) - Verify adequate volume (e.g., no empty containers)
Other equipment:		
Hach - multi-probe meter	Measure pH, specific conductivity, water temperature, and dissolved oxygen in the field	- Proper calibration - Calibration standards present - Associated charger, batteries, and operating manual present
Color wheel	Measure water color in the field	- Deionized water for reference standard - Associated instructions present
Secchi tubes (100 cm "mini Secchi)	Measure water transparency in the field	- View depth of mini secchi disk
Water dipper with cup	Apparatus to collect a clean water sample	- Make sure the beaker cup is included with dipper handle
Nitrile gloves **(optional)**	Prevent sample contamination from skin oils and applications	- Assure an adequate supply prior to leaving FOC
Cooler with ice	Short term preservation of water chemistry samples	- Adequate supply of ice
Cellphone	Communication	- Associated chargers present
Site files and maps	Site location information	
GPS unit	Record sampling location coordinates	- Associated charger, batteries, and operating manual present
Paper data sheets & clipboard	Record water chemistry field parameters	
Handheld data recorder	Record water chemistry field parameters	
Pencils	Record data	
Fine point permanent marker	Label water sample bottles	

Digital MDH Chain of Custody – lab sample transmittal form	Request analyses for grab samples	
Digital camera	Capture site field photos	- Associated cables and battery charged
Chest waders	Keep sampling crew dry	- Waders and wading boots - Materials to repair waders
Raingear	Keep sampling crew dry	
AIS labels	Label bottles from water with known aquatic invasive species	

Table 2. Wetland water chemistry sample parameters with sample container type, preservation, holding times, and MDH analysis codes.

Parameter	Units	Sample Collection	Sample Bottle	Preservation	Holding Time	MDH Analysis Code
Dissolved O_2	mg/L	Measured in the field w/ multi-probe meter	na	None	na	na
Temperature	ºC	Measured in the field w/ multi-probe meter	na	None	na	na
Specific Conductivity	µS/cm	Measured in the field w/ multi-probe meter	na	None	na	na
pH		Measured in the field w/ multi-probe meter	na	None	na	na
Transparency	cm	Measured in the field w/ Secchi tube	na	None	na	na
Color	PCU	Measured in the field w/ color wheel	na	None	na	na
Total Phosphorus	mg/L	Composite grab sample at just below the surface	250 mL nutrient	10% H_2SO_4 4 ºC	28-days	59
Total Kjeldahl Nitrogen	mg/L	Composite grab sample at just below the surface	250 mL nutrient	10% H_2SO_4 4 ºC	28-days	68
Total Nitrate + Nitrite-N	mg/L	Composite grab sample at just below the surface	250 mL nutrient	10% H_2SO_4 4 ºC	28-days	69
TOC	mg/L	Composite grab sample at just below the surface	250 mL nutrient	10% H_2SO_4 4 ºC	28-days	98
Total Chloride	mg/L	Composite grab sample at just below the surface	1000 mL general	4 ºC	28-days	297
Sulfate	mg/L	Composite grab sample at just below the surface	1000 mL general	4 ºC	28-days	293
Alkalinity	mg/L	Composite grab sample at just below the surface	1000 mL general	4 ºC	14-days	22
Total Suspended Solids	mg/L	Composite grab sample at just below the surface	1000 mL general	4 ºC	7-days	3

The MPCA wetland biological monitoring program collects water samples and measures water column characteristics within the target biological assessment area (AA). Assessment areas can occur in a number of different wetland plant community classes many of which may not have an adequate water column for collecting a suitable water sample. Use the following criteria to locate sampling locations for water chemistry:

For the MWCA or NWCA, the water sample is to be collected within the AA, preferably as close as possible to **the point** considering:

- Adequate depth ~ 15 cm.
- As close as possible to the middle of water body – w/o comprising safety.
- Avoid inlets and outlets as they can create atypical water sampling results.
- For the depressional wetland survey, water samples should be collected near the biological sampling location. For all other sampling applications, collect the sample from within a representative area of the shallow near-shore area in or just beyond the emergent fringe. Sometimes the water sample will need to be collected from a pocket of open water or water containing/floating or submerged vegetation.

Sufficient water sample volume should be collected to analyze all parameters included in Table 2. The 1000 milliliter (mL) general chemistry sample bottle has enough volume to analyze for the following: chloride, sulfate, total suspended solids (TSS) and alkalinity. The 250 mL nutrient bottle has enough volume for the following analyses: Kjeldahl nitrogen, nitrate + nitrite, total phosphorus, and total organic carbon (TOC).

A. Label bottles: Sample bottles are difficult to label after being immersed in water, therefore, bottles should be labeled prior to sample collection. Using a fine point permanent marker clearly print the site (e.g.'12Redw164'), sample ID# (e.g., 164). ***The revised MDH bottle protocol specifies that the site ID is the only thing to be written on the bottle label.*** Note, that the bottle type is bar-coded, so a 250 mL nutrient bottle must be the bottle that is acidified preserved and a1000 mL or 250 mL general bottle must not be acidified. No special instructions are allowed on the label. If anything other than the ID is on the label the sample will not be certified or might even be refused for analysis. If errors are made in the field, use another bottle. Do not use an 'unpreserved' 250 mL bottle for nutrients even if it is field preserved with 5 mL H_2SO_4. When multiple samples are collected from a wetland, the site and sample IDs must be modified in order to distinguish field replicate samples. A single letter code will be added to the site name (e.g. '03Redw064A') and sample ID# (e.g., 064A). The letter 'A' represents field replicate number one 'B' would represent replicate number two, and so on. These replicate identifiers are important because they link the water chemistry data to the biological data collected from the same location within the wetland.

B. Collect water samples: For NWCA samples, when possible, plan daily site routing to sample wetlands with known water columns by or before 11:00. Use of nitrile gloves to avoid contamination from hand creams or other potential body contaminants is recommended, but not a requirement of this sampling protocol.

Once the location for sample collection has been established and the bottles have been properly labeled, water samples are to be collected after biological sampling has been completed. This will avoid delays in returning the samples to the 4 ºC iced cooler. If they are collected after the biological sampling is completed, then the sampling area must not have been disturbed by the biological sampling activities. Ultimately it is up to the crew leader whether to collect water samples prior to the biological sample collection. If water samples are collected prior to the biological samples after collection they should be placed in a foldable field cooler pack if available, otherwise samples should be floated in the shade in site water to help maintain ambient temperature conditions. (*Note: MDH advises against pre-rinsing their bottles with sample water before collection of the sample since the bottles are lab certified to be clean*).

With sample bottle caps in place, carefully wade to the location where water sampling is to occur. Use the long-handled dipper to carefully collect dipped water sample from just below the water surface. Hold the dipper inverted with mouth downward and downwind. Immerse the dipper in clear water outside of any area with disturbed wetland bottom sediments (roil). Collect water in the dipper from approximately 5- 10 cm below the water surface by turning the dipper cup to allow trapped air to escape then steadily sweep the dipper cup horizontally in a short arc. In the same motion, raise the dipper from the water and carefully pour the contents into the sample bottle, holding the bottle and dipper in a downwind direction. Replace the cap and repeat the process in a new location a few feet from the initial location to collect additional water as needed until adequate sample volume is reached. Both sample bottles should be filled to the shoulder. They do not need to be filled to the bottle rim. In wetlands with dense duckweed or filamentous algae on the water surface, use the underside of the dipper cup to gently make a clearing prior to immersing the dipper to collect the sample.

C. Preserve water samples: When both sample bottles are filled, add preservative to the nutrient bottle and mix thoroughly by inverting several times. Though not required it is recommended that sample bottles be placed in re-sealable plastic bags (e.g., ziplock©) in order to keep sample bottles collected from one site together and also to help maintain label integrity in the cooler. Assure that bottle lids are firmly tightened prior to placing them in the cooler. Place all sample bottles in a cooler packed with ice as soon as possible. Preferably, bottles should be kept under the ice to assure they are kept cool. Keep samples on ice until delivery to MPCA Field Operations Center at the end of the sample mission where they are then stored in a refrigerator prior to their delivery to the MDH Environmental Laboratory (601 Robert Street North, St. Paul, MN).

MDH Chain of Custody sheets must accompany samples sent to the Environmental Laboratory for analysis.

D. Laboratory tracking sheet: Each wetland crew leader will be provided access to a digital example of a completed MDH Chain of Custody lab sheet. The following fields should already be filled out for each Chain of Custody Form: **Facility Code: MNPCA; Program Code: RA; Project Name: Wetland Biological Monitoring; Project Task Code:**

"Wetland Biological Assessment" or "Wetland Water Level" or "Wetland Watershed Assessment", **Project Manager:** [*John Genet (651) 757-2386*].

The following fields must be uniquely completed for each set of samples submitted to MDH. Location Identifier [12Redw164] (= 'site' on sample bottle) (*Note: MDH has a 10 character limit on Location Identifier)*; Sample Type: use only sample type codes provided on the form; **Date**, **Time**, Start Depth in meters; enter "0.2"; End depth is left blank; Grab (G) or Composite (C) Sample: usually G; Lab Matrix Code: use "NW"; Field Matrix Code; Use "Wtr-Surf"; Sampler Comments: complete as needed; #of Count: "2"; MDH Analysis Group Code: "10"; Additionally add "Alkalinity" (LIMS 22) and "TSS" (LIMS 3). Assure only boxes are selected for each submitted sample.

E. Measure field parameters: In addition to the water samples that are field collected and analyzed in the laboratory, the MPCA measures a number of parameters in the field using a HACH multi-probe meter. With this instrument the following parameters are measured:

- pH
- specific conductivity
- dissolved oxygen
- and water temperature

Place the sensors at an approximate depth of 10 cm below the water surface in an area where bottom sediments have not been disturbed. Allow adequate time for the readings to stabilize before recording or logging the data. Once stabilized, either immediately record measurements onto a datasheet (e.g., Appendix A) or log data and transcribe onto a datasheet once back in the truck. Also record the time when the measurements were made.

Recharge or replace batteries in multi-probe as necessary. Download and/or transcribe any data from the probe that was not previously done so in the field. Probes should be calibrated prior to each sampling mission, typically on Monday before heading out. Periodically, calibration may be required during a sampling excursion if the probe is having problems stabilizing or if readings are suspect. Each time a probe is calibrated, an entry should be made in the calibration log book that includes the date, time, personnel, probe type, reference standard, and pre-calibration values.

Use the secchi tube to measure the water column transparency according to protocols adapted from their use in streams (see Appendix B). Be sure to measure water color using the color test kit according to the manufacturer's instruction manual. (*Note: Reduction of the sample volume from 10 mL to 5 mL will be necessary if the initial reading is out of range; see 'High Range' method*). After determining the color value, immediately record this value on the field datasheet.

F. Decontamination: Prior to leaving the wetland, rinse waders and all field equipment to prevent spread of exotic and invasive species. For more detailed information on this procedure see the *Decontamination* SOP. Clean water dipper and rinse with deionized water between survey sites.

G. Data and equipment maintenance: Immediately after each day of field sampling, the following actions must be taken to insure sample integrity and maintain sampling equipment for further use:

H. Miscellaneous: Dry and repair waders as necessary. Acquire fresh ice for cooler when the equivalent of one 5 pound bag of ice remains. Charge batteries in cell phone and camera as needed.

VIII. Quality assurance and quality control

Compliance with this procedure will be maintained through annual internal reviews. Technical personnel will conduct periodic self-checks by comparing their results with other trained personnel. Calibration and maintenance of equipment will be conducted according to the guidelines in the manufacturer's manuals.

In addition to adhering to the specific requirements of this sampling protocol and any supplementary site specific procedures, the minimum quality assurance/quality control (QA/QC) requirements for this activity are as follows:

A. Control of deviations: Deviation shall be sufficiently documented to understand reasons for the deviations allow reconstruction of the activity as performed, if necessary.

B. QC samples: Replicate samples or resampling efforts will be collected from at least 10% of sites sampled in any given year as a means of determining sampling error and temporal variability.

C. Verification: The field crew leader will conduct periodic reviews of field personnel to ensure that the procedures detailed in this SOP are being followed.

IX. Literature referenced

Minnesota Department of Health Environmental Laboratory Handbook. Environmental Laboratory Section, Public Health Laboratory Division, Minnesota Department of Health, St. Paul, Minnesota. http://www.health.state.mn.us/divs/phl/environmental/handbook.pdf

APPENDIX A

FORM WQ-1: MWCA ASSESSMENT AREA WATER QUALITY (Front)

Reviewed by (Initials): _____

Site ID: _____ | Date (mm/dd/yyyy): _____ | Crew initials: _____

Presence of Surface Water in the AA: ◯ yes ◯ **no** | Confirm Sampleable Water (>15 cm): ◯ yes ◯ **no**

Choose one:	Choose one:	Hydrogeomorphology - Choose One:
◯ Freshwater ◯ Saline	◯ Estuarine ◯ Palustrine	◯ Pond ◯ Channel ◯ Other ◯ Lake ◯ Backwater _____

Characteristics of AA Surface Water Body (where sampled) – Mark all that apply | Flag: ____

Substrate Color:	Water Clarity:	Substrate:	Water Smell:	Water Surface:
◯ Black ◯ Brown ◯ Gray ◯ Other _____	◯ Clear ◯ Turbid ◯ Stained ◯ Milky ◯ Other _____	Vegetation Present? ◯ Yes ◯ no ◯ Sand ◯ Cobble ◯ Muck ◯ Organic ◯ Gravel ◯ Mineral ◯ Other _____	◯ None ◯ Algae Odor ◯ Chem. ◯ Rotten veg. ◯ Sulphur ◯ Fishy ◯ Other _____	◯ Film ◯ Algae Bloom ◯ Floc ◯ Vegetation ◯ Sheen ◯ Other _____

Water Chemistry Sampling | No Water Sample Collected ◯

Sample ID:	Chilled:	Time Collected (military time)	Comments
	◯ Yes ◯ No	:	

Duplicate Water Chemistry Sampling
Collect duplicate sample at team's 1st, 10th, 20th (etc.) site with Sampleable water

Cumulative number of sites with Sampleable water = _____

Duplicate Sample ID:	Chilled:	Time Collected (military time)	Comments
	◯ Yes ◯ No	:	

Optional - Surface Water Field Readings

Instrument: ◯ Boba ◯ Bossek ◯ Jango ◯ Other

Parameter	Reading	Flag	Parameter	Reading	Flag
Dissolved Oxygen (xx.xx):	mg/L		Temperature (xx.xx):	ºC	
pH (xx.xx)			Conductivity (xxx)	µS/cm	
Color (xx)	PCU		Transparency	cm	

Duplicate: Water Field Readings

Parameter	Reading	Flag	Parameter	Reading	Flag
Dissolved Oxygen (xx.xx):	mg/L		Temperature (xx.xx):	ºC	
pH (xx.xx)			Conductivity (xxx)	µS/cm	
Color (xx)	PCU		Transparency	cm	

Surface Water Measurements

Surface Water > 100 cm: ◯ yes ◯ no

Maximum Depth of Surface Water (cm) _____ % AA covered with surface water _____

Flag codes: K = No measurement made, U = Suspect measurement, F1, F2, etc. = misc. flags assigned by each field crew.
Explain all flags in comments on the back of this form.

Form WQ-1: MWCA Assessment Area Water Quality (Back)	Reviewed by (initials): _____
Site ID: _____ Date (mm/dd/yyyy): _____	

Flag	Comments:

Physical Condition	1 Crystal Clear	2 Some algae	3 Definite Algae	4 High Algae	5 Severe Bloom
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Aesthetic and Use Suitability	1 Beautiful	2 Minor Aesthetic Problems	3 Slight concern about body contact	4 High concern about body contact	5 Avoid entry – severely degraded aesthetics
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

MPCA Wetland Monitoring Program

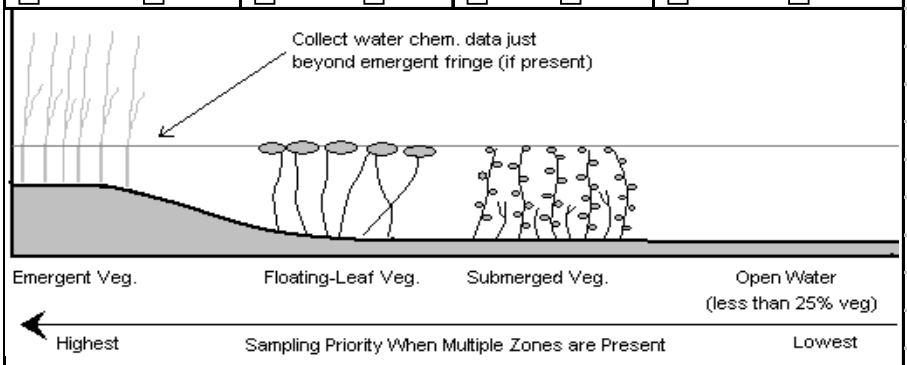
WETLAND INVERTEBRATE VISIT FORM

Wetland Name:		**Date:**	☐ **Reportable (A)** ☐ **Replicate**
Field Number:	**County:**	**Crew:**	**Replicate Identifier:** **B C D E**

COORDINATES	**LATITUDE**	**LONGITUDE**
Field GPS:	____ ° ____ ' ____ . ____ "	____ ° ____ ' ____ . ____ "

Indicate Relative Sampling Locations (using zones in diagram)

Emergent	**Floating**	**Submergent**	**Open Water**
☐ DN ☐ Chem	☐ DN ☐ Chem	☐ DN ☐ Chem	☐ DN ☐ Chem



NOTES/COMMENTS

OTHER BIOLOGICAL OBSERVATIONS

Taxa	**Present?**	**Abundance**		
Fish	☐	One	Few	Many
Fathead Minnow	☐	One	Few	Many
Stickleback	☐	One	Few	Many
Central Mudminnow	☐	One	Few	Many
Carp	☐	One	Few	Many
Bullhead	☐	One	Few	Many
Redbelly Dace	☐	One	Few	Many
Other _____	☐	One	Few	Many
Frog (seen or heard in wetland)	☐	One	Few	Many
Tadpoles	☐	One	Few	Many
Adults: _____	☐	One	Few	Many
Northern Leopard	☐	One	Few	Many
Green	☐	One	Few	Many
Other _____	☐	One	Few	Many
Salamander	☐	One	Few	Many
Juvenile: _____	☐	One	Few	Many
Adults: _____	☐	One	Few	Many
Birds (seen or heard in wetland)	☐	One	Few	Many
Red-Winged Blackbird	☐	One	Few	Many
Yellow Headed Blackbird	☐	One	Few	Many
Mallard	☐	One	Few	Many
Wood Duck	☐	One	Few	Many
Canada Goose	☐	One	Few	Many
Sora	☐	One	Few	Many
Great Blue Heron	☐	One	Few	Many
Others _____	☐	One	Few	Many

DIPNET SAMPLE

☐ **D-net Sample Taken** **TIME:**

D-net taken by: **DATE:** ___/___/___

TEMP:

Number of D-nets Taken: _____

D-net Sample #	**~ Depth (m)**	**#Jars**
1	_____	_____
2	_____	_____

SAMPLE SITE INFORMATION

Wetland Bottom: Firm Soft Mucky Help!!

Comments:

Aquatic Vegetation:

Submergent: None Sparse Moderate Dense

Emergent: None Sparse Moderate Dense

Floating: None Sparse Moderate Dense

Filament. Algae: None Sparse Moderate Dense

Shoreline Vegetation:

Grassy Shrubs Wooded Other

Comments:

Weather: Sunny Partly-Cloudy Overcast Windy Calm Rainy

PHOTOGRAPHIC DOCUMENTATION

Looking left from sampling location: #

Looking opposite shore from sampling location: #

Looking right from sampling location: #

Best Overall View of Wetland: #

WATER CHEMISTRY

DEPARTMENT OF HEALTH SAMPLES	FIELD MEASUREMENTS
☐ **125 ml General**	☐ **pH ------**
☐ **250 ml Nutrient**	☐ **Specific Conductivity ---**
☐ **Preserved with H_2SO_4**	☐ **Water Temp ---** **^{o}C**
WATER CHEM. SAMPLING NOTES	☐ **Dissolved Oxygen ---** **mg/L** % Saturation --- time of measurement____ : ____ : ____
	☐ **T-tube reading ---** **60-cm tube** **100-cm tube** **symbol:** **cm** **symbol:** **cm** **screw:** **cm** **screw:** **cm**
	☐ **Color Wheel ----** **PCU**

SKETCH OF WETLAND

Include roads/trails used to access site, most convenient parking, location of sampling, any other relevant info.

Appendix B

Measuring wetland water clarity with Secchi tubes

Note: Do not wear sunglasses while taking measurements, as this affects the accuracy of your reading.

Action steps

1. Collect water sample in tube or if needed use dipper cup to fill tube. To collect a water sample, extend the Secchi tube horizontally away from you in an area of clear water. Once full, use other hand to cover over the open end to keep entire volume of water within the tube while raising the tube above the water surface. Use of dipper cup may be required when shallow depths preclude the collection of a clean sample with the tube.
    - Collect sample where sediments have not been stirred up.
    - Avoid collecting algae, duckweed, or any other material in the tube. As necessary, use the tube to clear a small area prior to immersing the open end of the Secchi tube.

2. Take tube readings in open conditions. Avoid direct sunlight by turning your back to the sun if necessary. [*Make sure you do not wear sunglasses while taking a transparency measurement, as this affects the accuracy of the readings*.]
    - Take reading on shore or in shallow water so that bottom of 100-cm tube is not submerged.
    - Pull the inside string to remove the black and white Secchi disk from the tube. While looking into the tube from the top, slowly lower the Secchi disk down into the tube until it just disappears from sight. When it disappears, stop lowering.

3. While continuing to look down the top of the tube, slowly pull the string to raise the disk until it reappears. Lower and raise the disk until you find the midpoint disappearance and reappearance of the disk.

4. Pinch the string against the side of the tube to hold the disk at the midpoint depth. Look at the side of the tube, across the top of the disk, to see the closest centimeter mark on the tape.

5. Record the Secchi depth, to the nearest cm, on the field data sheet. If the disk does not disappear, and you see it clearly resting on the bottom of the tube, record “greater than 100 (>).