CHAPTER 12. LAKE SAMPLING PROTOCOL

Overview of Lake Monitoring Program

In 2006, the Watershed Assessment Branch resumed sampling lake, reservoir, and pond waterbodies after an absence of activity since 1996. Using the rotating Watershed Basin Schedule much like TMDL sampling and the targeted Wadeable Stream Monitoring sampling occurs on targeted lakes (within the watershed group for that year) four times during the summer months (June - September or May - August). The number of stations per lake varies and is generally proportional to the size of the lake or the number of major branches or arms of the lake. The components of sampling include a vertical water chemistry profile (including the physiochemical properties, nutrients, and turbidity measurements), chlorophyll-*a* and fecal coliform sampling, Secchi depth, and some limited habitat and disturbance observations.

One of most unique aspects of Lake Sampling is the chlorophyll-*a* sampling, which is an indirect measure of phytoplankton.

Instructions for Assessing the Lake Site (Including Setting up the Site, Site Documentation, and Guidelines for Completing the Lake Assessment Forms)

The following is an instruction on how to establish lake sampling sites, document them, and use the Lake Assessment Form to evaluate various lake assessment parameters. Many of the procedures required to conduct this assessment have already been described above in the following:

CHAPTER 2 Section C. Guidelines for Completing the Stream Assessment Forms on page 2-28

CHAPTER 3. WATER COLLECTION PROTOCOLS starting on page 3-1

CHAPTER 14. Section A. Blanks and Duplicates starting on page 14-1

Section A. *Setting up the Site*

A field crew sampling lakes typically consists of at least two individuals (safety requires at least two people on a boat) charged with collecting habitat and biological/physicochemical data (*i.e.,* water quality). In some cases, smaller lakes and can be accessed with a one-man craft (*e.g.,* a canoe) and the second person can operate on the shoreline.

Throughout the following discussions, the term "Geomorph" will be used to describe the crewmember in charge of collecting habitat information and usually the water samples. "Biomorph" is the term used to describe the crewmember in charge of collecting Secchi

and physicochemical data. In the case of a solo sampler, these roles are both played out by the same individual.

USGS topographic maps with a 1:24,000 scale will be used to navigate to lakes and sampling sites on the lakes (GIS or Geographic Information System maps on laptop, county maps, or Gazetteer maps are supplemental). The map coordinator generally will not mark sites or sampling stations prior to begin of sampling since the index sites are established during the initial visit (unless a revisit of a previously established site is designated).

After the location of the lake has been navigated to and confirmed, the Geomorph is responsible for establishing the index site by traversing the lake from the access point to the dam (where the deepest point is usually located) taking note of lake depths, and pertinent disturbance information. The index site should be placed at the deepest point in the lake, provided this location poses no danger to the field crew. This deepest point is the most lake-like part of the reservoir. Larger lakes or lakes with multiple arms may require additional sampling stations. If a thorough reconnaissance is conducted during the initial visit, it is not necessary to travel throughout the entire lake during every visit as this may require more time than is available for secondary visits. An attempt to recon the lake via a motor vehicle during every visit should be done if there is a road that parallels the lake shore.

> ***IMPORTANT: There should be no deviation from the above protocol. The Geomorph must thoroughly cover the lake to accurately complete the activities/disturbances form.***

The Geomorph will perform other duties concurrent with the establishment of the index site ***(outlined in Section C. Guidelines for Completing the Lake Assessment Forms on page 12-7)***. Procedures specific to each sample type are discussed below.

Accessing the Lake

Since the WAB Lakes Sampling Program is limited to targeted lakes, the majority of the lakes should be easily accessible with fully operational boat ramps. However, in some cases, due to the remoteness of some sites or access points (usually on very small lakes or reference impoundments), traversing to the sample site may require strenuous hikes carrying the watercraft over difficult terrain; NOT DANGEROUS TERRAIN! If a difficult hike is necessary to get to a site, carefully consider the terrain and your personal ability and health to access the lake. If you feel it is too difficult (*e.g.,* too far to hike) or dangerous (*e.g.,* steep banks) to get to the lake or assess it, do not attempt it. Discuss it with other sampling teams who may be willing to try to get the site later**.**

> ***WARNING: DO NOT NAVIGATE TO ANY ASSESSMENT SITE THAT PRESENTS A DANGEROUS SITUATION TO YOU OR ANOTHER TEAM MEMBER!***

Target Lakes

Beginning in 2006, the Lakes Sampling Program has covered a representative portion of the lakes found in each hydrologic year's watersheds according to the rotating Watershed Basin Schedule. On the order of a 9-10 lakes will be sampled each year, with a greater or less number of lakes being sampled as data needs dictate and to avoid duplication of efforts, as some lakes are often sampled by other agencies.

Target sites are defined as natural and man-made lakes, ponds, and reservoirs greater than 5 acres. If there are a large number of waterbodies that meet this description in the given hydrologic year, the cutoff size may be elevated to 10 acres. To be considered a lake or reservoir for criterion purposes, summer residence times must be greater than 14 days. Limnologists usually agree that phytoplankton only accumulate in lake-like bodies of water with retention times greater than 7 days. Retention time is the most indicative factor making a body of water lake-like in behavior. Hence, only reservoirs with longer retention times are worth treating as lake-like for management purposes. Generally speaking, the number of sites per lake will follow this schedule:

Size (acres)	Number of Sites
Area ≤20	3
20 < Area ≤ 50	4
50 < Area ≤ 200	5
200 < Area ≤ 1000	6
1000 < Area	7

Sampling personnel will distribute points to sample a lake's largest arms or branches if there are any.

The target lakes and number of sites per lake are generally pre-determined and put on a site list (***See Table 12-1 on page 12-4 for an example of a lake site list***). Since you know you will be visiting all of the lakes on the list, they may be sampled in any order. This will allow you to work more efficiently, as some lakes may be adjacent on the list but not necessarily in geographical order. For example (***referring to Table 12-1 on page 12-4***): If you were working this lake list, you might sample Mountwood Park Lake, North Bend State Park Lake, Tracy Lake, and Pennsboro Water Supply Reservoir all on the same day or couple of days, since they are all close to each other, and along U.S. Route 50. The date and initials columns on the list should be filled in as the sites are completed. The bottom of the list may be used for any notes to the lab data coordinator, including but not limited to: the temporary site name and details used for the duplicate and field blank samples, accessibility notes, and landowner phone numbers.

Coordinates for the sampling sites are included in the lake list after being established during the initial visit. In addition, GIS data of the sites will be available for use on the field laptops after they are incorporated.

Table 12-1. An example of a typical lake site list.

Lake	An-Code	Site_ID	Latdeg	latmin	latsec	londeg	lonmin	lonsec	Date	Initials
Mountwood Park Lake	LK-10-L-1	MP-1	39	14	21.00	81	18	47.00		
Miletree Lake	LK-31-X-1-(L1)	ML-1	38	48	20.60	81	22	1.70		
Cedar Creek Lake	LK-72-(L1)	CC-1	38	53	0.50	80	51	12.80		
Saltlick Pond 9	LK-95-(L1)	SP-1	38	43	53.60	80	35	40.30		
Tracy Lake	LKH-10-R-(L1)	TL-1	39	19	1.40	80	58	57.50		
North Bend State Park Lake	LKH-10-R.3-(L1)	NB-1	39	13	14.30	81	5	50.70		
North Bend State Park Lake	LKH-10-R.3-(L1)	NB-2	39	13	34.2	81	6	5.8		
Pennsboro Wat. Sup. Resv.	LKH-10-FF.5-(L1)	PR-1	39	16	55.10	80	55	29.50		
Big Run Lake (Ubwc-22)	M-23-O-8-(L1)	BR-1	39	36	9.5	80	23	1.6		
Huey Run Lake (Ubcw-2)	M-23-V-(L1)	HR-1	39	31	2.62	80	24	36.03		

***IMPORTANT*: An attempt should be made to access all lake sites unless it appears dangerous or too difficult to do so. The map coordinator should be notified and consulted about all sites which were not accessed due to dangerous or difficult conditions as a visit to that site may be attempted by another sampling team that may be better able to reach the site.**

Locating the X-Site or Index Site on the Lake

Initial Visit

Unlike many other sampling programs, sampling stations for lake sites are not marked before the initial visit because index stations must be determined on-location. The sampling location is referred to as the **X-site** or **Index site** and is the deepest point in the particular section of the lake that is to be assessed. The **maximum** lake depth is observed via depth finder or other method to the nearest tenth of a foot. Traverse the lake thoroughly to locate this location. It is usually in the vicinity of the dam, or especially near drain structures, though not in all cases. While the index station should be located as closely as possible to this location, some drifting may occur during sampling. Do not set the index station near any potentially dangerous features. Some situations require creation of additional index sites when a large-sized or multi-lobed lake is involved.

Revisits

When returning to a lake site (either during the same sampling season or to an established site from years ago), GPS units should be used primarily to confirm the index latitude and longitude that is provided on the list for each index station. Using your GPS, if you can get one half of the coordinates to match almost exactly and the other half within a reasonable distance (no more than a couple of seconds), then you have adequately located the index site. If the GPS coordinates and the given index coordinates differ by more than a couple of seconds, re-check your position. **You should make an attempt to get an exact match if possible. Let the GPS run for several minutes (5-10) before matching the latitude and longitude.** Sampling teams should also consult other materials to ensure that they are at the correct location including: Laptop GIS programs, topographic, county, and/or gazetteer maps, or previous visit photocopies which include directions to the site, hand-drawn maps, and photos.

NOTE*:* Topographic maps are recycled and older sites may appear on the topographic maps. Take extra care to make sure that you are targeting the correct site.

***IMPORTANT*: Use the coordinates provided on the site list only as the coordinates on the previous visit photocopy may be in a different datum. Nevertheless, the hand-drawn map from the previous visit photocopy will be very useful in locating the exact same X-site that was established during the previous visit. You should make an attempt to get an exact match to the previous visit's X-site.**

There may be sites where the GPS unit will not track satellites and thus confirmation of the X-site coordinates may not be immediately possible. If you are certain from the other materials provided that you are in the correct location, you may begin sampling and try getting the GPS unit to lock onto satellites 10-15 minutes later. Team members should collaborate in these instances and utilize their best professional judgment (BPJ) to decide where the X-site is located. In such a case, finely tuned map reading skills are important.

After the X-site has been confirmed (or located via best professional judgment), the Geomorph will establish the index station.

***IMPORTANT*: With the exception of fecal coliform samples, collect all physicochemical, water samples, and GPS coordinates at the index site.**

Duplicate Sites

In order to fulfill quality assurance and quality control or QA/QC requirements (***see CHAPTER 14. Section A. Blanks and Duplicates on page 14-1***), one duplicate water chemistry sample should be taken during each round of sampling. The sampler in charge will determine where to conduct a duplicate sample. However, the site used to collect the duplicate sample should be selected at random. Do not wait until the end of a week or list to sample for a duplicate stream.

During a duplicate, only the top water chemistry sample needs to be duplicated, not the bottom sample. Sufficient sample containers should be filled, from the same depth in the water column, to have all nutrients analyzed. A second transfer bottle should also be filled so that a duplicate Chlorophyll-*a* sample can be filtered. A duplicate fecal coliform sample should also be collected from the shoreline at the same location and conditions as the primary sample. However, do not allow any disturbances caused in the process of collecting the primary sample (*e.g.* stirred up sediment) interfere with the duplicate sample. The habitat form does not need to be duplicated, just the water sampling activities. All duplicate samples and COCs should be labeled as Blind Duplicates for the lab (false Stream Names and AN-Codes) and no indication that it is a Duplicate.

Section B. *Site Documentation*

Part 1. Lake Coordinates and Global Positioning Systems (GPS)

Basic guidance on how to use a GPS to document a site can be found in ***CHAPTER 2. Section B. Part 1. Coordinates and Global Positioning Systems (GPS) on page 2-20***.

Because each lake is visited only 4 times in a season coordinates should be recorded at every lake visit. ***Table 2-2 on page 2-21*** outlines some typical frequency of GPS readings for various sample types.

Part 2. Lake Photographic Documentation

Basic guidance on how to use a camera to document a site can be found in ***CHAPTER 2. Section B. Part 2. Photographic Documentation on page 2-24***.

Specifically for lakes, we need a minimum of the following from each site to aid in relocating the site if necessary:

- View upstream from index site
- View downstream (usually of dam) from index site
- Typical lakeshore riparian cover

In addition, pictures of such items as the following may be useful:

- Lake alteration or management practices (boat ramps, campgrounds)
- Lake disturbances
- Waterfowl or other wildlife in or near lakes
- Silt laden streams flowing into clear lakes
- Scenic Views
- Field crews at work
- Distinctive views of lakes, buildings along lakes, industry along lakes, dams, boats or barges or other water related pictures
- Pollution sources and features (*e.g.,* point and non-point sources, metal hydroxides, poorly constructed roads, feedlots, *etc*.)

All pertinent information about a photo should be recorded on the field sheet under the photography log section (***see Section C. Part 1. PAGE 4-Photography Log on page 12-16).***

Section C. *Guidelines for Completing the Lake Assessment Forms*

This section is intended to provide information on interpreting each parameter as well as identifying the value(s) of resultant data. Most of the parameters and values on the Lake Assessment Form have already been addressed in ***CHAPTER 2. Section C. Guidelines for Completing the Stream Assessment Forms found on page 2-28***.

The parameters that have already been addressed above will not be described here unless they vary in some way on the Lake Assessment Form.

What is presented here explains what is found on the Lake Assessment Form that is unique to Lake Sampling and not found on other forms (*e.g.,* WAB, AWQN, TMDL-Initial Visit, TMDL-Secondary Visit, TMDL-Final Visit, TMDL-Source, and General WQ). The instructions on how to fill out the sections are the same unless otherwise stated.

Description of Lake Water Quality Assessment Form

The quality and quantity of habitat is a major determinant of aquatic community potential. Consequently, a thorough habitat characterization is essential for proper interpretation of biological (chlorophyll-*a* and fecal coliform) assessment results.

Front Side of All Pages

Like the other forms, the front sides of all pages have spaces to indicate the AN-Code of the site, Date of Collection, and Reviewer's Initials. ***See CHAPTER 2. Section C. Part 1. Front Side of All Pages on page 2-29 for an example***.

PAGE 1

IMPORTANT INSTRUCTIONS:

Always fill out the first page of the lake assessment form, get coordinates of the site, and take photographs, regardless of whether any type of sampling was conducted (even if lake is "non-target")! Also take photographs of the lake that display the reason why it was not considered target. This is important information and assists in database management. ***See Figure 12-1 on the next page for an example of PAGE 1 of the Lake Assessment Form*****.**

For a description of parameters and values not seen below ***see CHAPTER 2. Section C. Part 1. PAGE 1-Site Verification on page 2-30 for an example***.

Lake Site Verification

Visit Type: Check which type of visit that this sample event represents: **Initial Visit** (First visit of the sampling year), **Secondary Visit** (Return visit during sampling year), Final Visit (Last Visit during sampling year), or **Other**.

Lake Name and Location Description: Make sure the lake name on the map corresponds with the assigned AN-Code from your printed lake list. If they do not match, make a note of it on the habitat sheet and printed list. Include a detailed description of the location such as: Summersville Lake near dam, Woodrum Lake DS (abbreviation for Downstream) of boat ramp, Summersville Lake US (abbreviation for Upstream) of Muddlety Creek, *etc*.

Lake Water Quality Assessment Form

Visit Type:	☐ Initial ☐ Secondary ☐ Final ☐ Other:								
LOCATION VERIFICATION >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>							**Reviewers Initials**		
Lake Name (with Temporary Site Code & map location)							**Site ID**		
AN-Code		**Date**		**Start Time**		**Geo**		**Bio**	
Basin		**County**		**Quad**					
GPS Type		**EPE**		**XY's Proofed**		**By**			
Field Lat X-site	N	**Field Lon X-site**	W						
Corrected Lat	N	**Corrected Lon**	W						
Launch Site Lat	N	**Launch Site Lon**	W						
Sampled	☐ Yes ☐ No	**If not, why?**	☐ No Access-Physical Barrier (☐ *Permanent* / ☐ *Temporary*) ☐ No Access-Landowner Denial (☐ *Verbal Denial* / ☐ *Posted* / ☐ *Fenced* / ☐ *Private*) ☐ Dry ☐ Filled ☐ Other:						
Sample Type	☐ YSI ☐ Fecal ☐ Lake ☐ AMD ☐ Nutrients ☐ Acid Rain ☐ Orthophosphate ☐ Other:								
Duplicate type	☐ None ☐ Lab ☐ Fecal	**Duplicate WQ ID**		**Was site moved?**	☐ Yes ☐ No				
Explanation?									
Directions To Site									

Sketch of Lake Area and Comments: Indicate North with (↑), indicate flow direction from head of lake toward dam, indicate shore fecal sample (F), water sample (wq), indicate lat and long site with (X). Draw the sketch with a coarse resolution to give an overall idea of the lake layout relative to the WQ vs. Habtiat sample locations. If possible, include roads, structures, and landmarks on the shore.

Notes		**Single WQ Sample IDs**	**Top:**	
			Bottom:	

Page 1 WVDEP WAB Lake WQ Assessment Form (7/1/2014)

Figure 12-1. Example of the Site Verification section (PAGE 1) of the Lake Water Quality Assessment Form

Site ID: Temporary site codes that help distinguish multiple stations on any one lake. Usually pre-assigned by the sampling coordinator and found on the sampling list (see above). If you are going to add a sample locations add, just continue the numbering sequence given on the site list.

AN-Code: It is extremely important that the **correct** AN-Code (Alpha-Numeric Code) be recorded for each lake site. Mistakes in translation from the printed stream list to the habitat sheet must be avoided. Mistakes in this step create mass confusion and plenty of extra work during data entry. All lakes will have an AN-Code with the lake code designated between brackets (*e.g.,* - {L1}, - {L2}, *etc*.).

Date: Use mm/dd/yyyy format: *e.g.,* 04/29/1999.

Start Time: Use military time (*e.g.,* 1315). For lake sampling, this time represents the general start of sampling activities.

Geomorph: Initials of the team member completing the habitat form and usually the lab water samples.

Biomorph: Initials of the team member collecting Secchi depth and YSI readings.

Sampled?: Answer appropriately; **YES** or **NO.** This must be answered. In some instances you may be sampling some aspect (*e.g.,* WQ only) even if the site is declared to be inappropriate for a full season's assessment.

Sample Type: Indicate which of the data types were collected (1) **YSI** (represents any type of water quality sonde), (2) **Fecal**, (3) **Lake (includes nutrients and chlorophyll-a)**, (4) **AMD**, (5) **Nutrients**, (6) **Acid Rain**, (7) **Orthophosphate**, (8) **Other**. **Do not include Hydrolab/YSI sonde readings as part of the lab water data. This refers to laboratory-analyzed samples only.**

Was site moved?: If for any reason the lake site is moved, indicate here. This is most likely to be used during a Secondary Visit. Answer **YES** or **NO.**

Explanation?: Explain why the site was moved and where the site was moved to. **If the site is moved, it is important to identify and mark the location of the new assessment site on a topographic map with date and initials of team and fill out a form for both sites.**

Directions to Site: Give a detailed description on how the lake site was accessed. Include highway names & numbers, distances from prominent landmarks (manmade and/or natural), proximity to towns, *etc*. Indicate if contact with landowner/stakeholder/groundskeepers, *etc*. is necessary and note where, when, and why they should be contacted. Addresses of and other specifics about the landowner/stakeholder/groundskeepers can be written down on PAGE 4 of the form under the section called Landowner/Stakeholder Information.

Bird's-eye-view Sk*etc*h of Lake Assessment Area and General Comments: Provide a detailed sk*etc*h of the area and include reservoir flow direction, land use on left and right bank, upstream activities (if possible), proximity to permanent land marks, indicate direction by drawing a North arrow **(↑)**, and any observations which may provide pertinent information to the assessment and location of the lake area. Indicate where GPS coordinates are collected by marking the spot in the lake with an (**X**). Indicate direction of flow with an arrow (↑). Mark the lakeshore areas where fecal coliform samples are collected with an (**F**)**,** and mark water sample collection areas with a (**wq**), though these should be the same as where coordinates are taken at the index site.

> ***IMPORTANT: Keep in mind that a different field crew may be revisiting the site in 5 years and will rely heavily on your description/drawing to get back to the same location. In other instances, it may be necessary to determine the location using GIS programs.***

General comments can be very important when interpreting sample data. Therefore, any anomalies or outstanding attributes should be noted. On larger lakes, a printed aerial image or topographic map from GIS programs may be submitted in addition to the drawing since larger lakes may not all be viewable in an individual visit. When doing this, ensure the aerial image or topographic map is of the exact same location you visited (confirm by plotting the coordinates you acquired at the site in your GIS program over the image you will use). Print the image and attach it the lake assessment form BEFORE turning it in. Be sure to annotate the map with any features observed during your visit, especially the direction of north, the ramp or point used to access the lake, the index site, and the fecal coliform site. The location of dams or any other landmarks should also be marked whether the map is drawn or printed.

Single WQ Sample ID: Document the pre-assigned Water Quality Sample IDs used with this visit. This ID is unique and comes pre-printed on labels. It is used whenever a lab water sample is collected. Usually only one (Top) or two (Top & Bottom) water quality samples are taken with lake sampling. If more than two water quality samples are taken during the sampling event (*e.g.,* a waterbody profile), then this information will be documented on ***PAGES 5 & 6*** (***see page 12-16***) of the form with the specific collection information (*e.g.,* depth, distance, transect, *etc*.).

PAGE 2

Site Activities and Disturbances (Including Roads)

This section is generally the same as presented as above except it concentrates on what is seen near the index site. ***See CHAPTER 2. Section C. Part 1. PAGE 2-Site Activities and Disturbances (Including Roads) on page 2-37 for an example***.

See Figure 12-2 below for an example of the unique section of PAGE 2 on the Lake Assessment Form.

Human Activities: Look for signs of human activities specific to lakes around the immediate index site including fishing, swimming, *etc*. Answer **Yes** or **No**.

Boating Activities: Look for signs of boating activity around the immediate index site. Answer **Yes** or **No**.

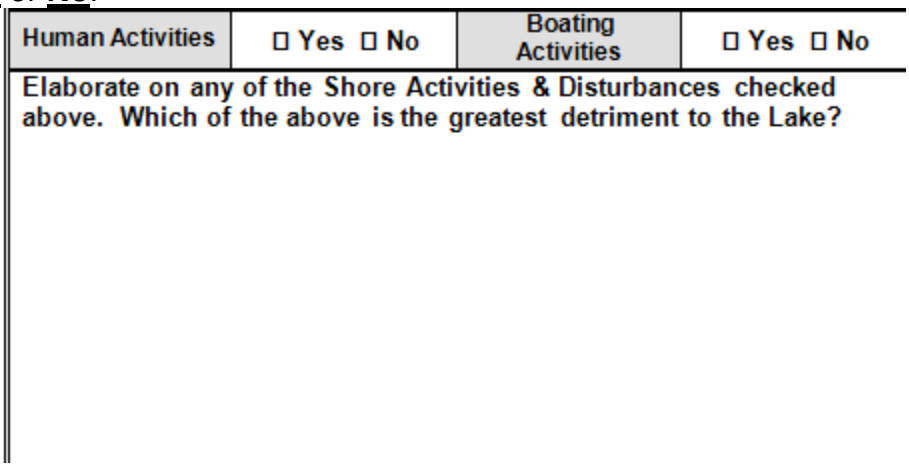

Figure 12-2. Example of the Human & Boating Activities (Center Left PAGE 2) of the Lake Assessment Form

Elaborate on any of the Shore Activities & Disturbances checked above. Which of the above is the greatest detriment to the lake?: This area is provided for notes about any of the Lake Assessment Area Activities & Disturbances checked above. If you checked boating activities, what type of boats are allowed, or feasible to use on this lake (electric only, 10 horsepower limit, any gas motors allowed, *etc*.). When known, record the type of drain controlling the discharge of the lake water to the downstream water body. At a minimum, you should note if the drain structure draws water from the top, bottom, or intermediate depth of the lake as this is important in assessing downstream impacts of the lake discharge.

This box should also be used to briefly describe the quality of the riparian zone around the lakeshore. What kind of trees dominates this zone? Are there any disturbances to the zone?

Comments Box: "If known, what is the predominant land use(s) in this lake's drainage? Is it mostly forested, agriculture, mining, logging, houses, urban? If mining present, is it active or abandoned, deep or strip, valley fills, *etc*. What is the predominant NPS pollution? Are there point sources above the assessment area? Indicate if you used maps (GIS) or field verified comments. **DO NOT LEAVE THIS BOX BLANK!"**

NOTE: This area is a good place to put comments about the land use observed from recon trips, conversations with local residents, or gleaned from the GIS land use or topographic maps. If comments are based on the map, note them as such. Landowner comments about the upstream activities should also go here. The source of each bit of information should also be noted (*e.g.,* GIS, Topo, Recon, or Local or Landowner).

PAGE 3

Field Water Quality Measures

For a description of parameters and values not seen in ***Figure 12-3 on the next page***, ***see CHAPTER 2. Section C. Part 1. PAGE 4 Sediment Characterization on page 2-53 for an example***.

WQ Sample Location: Indicate the cross-sectional location of the water quality sampling: 1) **Vertical** (*i.e.,* vertical profiles done on lakes where samples are taken at multiple depths – these are the most common), 2) **Other** (please describe).

WQ Type: Indicate type of water quality sampling: 1) **Profile** (*i.e.,* samples are taken at multiple locations, but kept separate as distinct samples) – most common on lakes, 2) **Other** if an integrated sampler is used to composite a sample over a range of depths, or another type of sample is taken (*i.e.,* a single sample is taken at the surface) -please describe here.

Sonde Method: Indicate the type of collection method used with the water quality sonde: 1) **Van-Dorn Bottle** (note – the Van-Dorn sampler is rarely used to collect water for the sonde. **2) Grab** (*i.e.,* direct stream or water column measurement, including using the long cable for vertical profiles – this is most common on lakes).

Lab Water Method: Indicate the type of collection method used to obtain the lab water: 1) **Van-Dorn Bottle** this is the most common method used in lakes, 2) **Grab** (*i.e.,* direct water column sample – if only a surface sample is necessary, this may be appropriate).

FIELD WATER»»»			Reviewers Initials	
ANCode		Date		

WQ Sample Location	☐ Vertical ☐ Other:	WQ Type	☐ Profile ☐ Other:
Sonde Method	☐ Van-Dorn Bottle ☐ Grab	Lab Water Method	☐ Van-Dorn Bottle ☐ Grab

Sonde I.D. #:________	Seasonal Water Level		Water Odors		Surface "Oils"		Turbidity	
If any problems occur with the Water Meter or any readings are suspect, record notes in the space below.		Below Normal		Normal		None		Clear
		Normal		Sewage (Not Septic)		Flecks		Slightly Turbid
		Above Normal		Petroleum		Sheen		Moderately Turbid
		Flooding		Chemical		Globs		Highly Turbid
Notes:				Anaerobic (septic)		Slick	Water color:	
				Other:				
			Foam/Suds (Rate 0-4 or NR)					

ABOVE: Record readings in box for corresponding physicochemical parameter. Insert a √ in the box for other categories.

Precipitation Status and History					
Current		Past 24 Hours (If Known)		Major Rain Event in past week?	☐ Yes ☐ No

Field Water Notes and Precipitation Comments:

Figure 12-3. Example of the Field Water Quality Measures (Top of PAGE 3) of the Lake Assessment Form

Lake Info

Lake Info							
Lake Depth	ft	Secchi Depth	ft	Depth of Top WQ Sample	ft	Depth of Bottom WQ Sample	ft
				Time of Top Sample		Time of Bottom Sample	
mL Filtered for Chlorophyll A Sample:				(Please transcribe the above depths and times to corresponding Lab Analysis Request forms)			
Lake Profile Notes:							

Figure 12-4. Example of Lake Info section (Bottom of PAGE 3) of the Lake Assessment Form

Lake Depth: The **maximum** lake depth observed via depth finder or other method should be recorded here to the nearest tenth of a foot.

Secchi depth: Record the single depth at which the Secchi disk disappears and reappears to the nearest tenth of a foot.

Depth and Time of Top and Bottom WQ samples: Record the time (military) of the Top and Bottom WQ samples. These times are to be transcribed to the Analysis Request Form later.

mL Filtered for Chlorophyll A Sample: Record the amount of water filtered to produce the chlorophyll-*a* filter sample.

Lake Profile Notes: Any other comments on lake dimensions and features can be recorded here, including wildlife observed.

PAGE 4

Landowner/Stakeholder Information

Photography Log

PAGE 4 includes information about landowner/stakeholders, site accessibility issues, and a photography log. This page is identical to that presented above in ***CHAPTER 2. Section C. Part 1. PAGE 12-Photography Log on page 2-103.***

PAGES 5 & 6

Sonde Lake Profile Readings

Record the parameters that are available, along with the depth and time of each reading on the rows of this page, beginning with the top sample. (Starting at the bottom increases the risk of contamination of the probes by bottom sediments, plants, or structures.) Allow the readings to equilibrate (sometimes requires up to 1 min) at each depth before recording the data. Any suspect readings (fluctuating greatly or apparently out of calibration) should be flagged and noted in the Lake Profile Notes on the previous page.

WQ Sample ID: This ID is unique and comes pre-printed on labels. It is used whenever a lab water sample is collected. If multiple water quality samples are taken during the sampling event (*i.e.,* a waterbody profile), then this information will be documented on another page with the specific collection information (*e.g.,* depth, distance, transect, *etc*.).

Depth Description: A one word description of the depth at which the water parameters were measured (*e.g.,* Top, Middle Bottom, Thermocline, *etc*.).

Depth (in feet): Depth in feet of the measurement.

IMPORTANT: This is mandatory for each reading.

Time: The time (military) at which the water parameters were measured at the given depth.

IMPORTANT: This is mandatory for each reading.

Physicochemical Parameters: Record any flags and the values for each of the physicochemical parameters indicated from the water probe:

1. Temp (^{O}C)
2. pH (Standard Units)
3. D.O. (mg/L)
4. Conductivity (μmhos/cm)

5. Chlorophyll-*a* (μg/L)
6. Turbidity (NTU).

Reviewers Initials		ANCode					Date				SONDE LAKE PROFILE READINGS PART 1>>>					
Measurement	WQ Sample ID	Depth Description (e.g., Top, Middle Bottom, Thermocline, etc.)	Depth (in feet) (Mandatory for each reading)	Time (Mandatory for each reading)	Temperature Flag	Temp (°C)	pH Flag	pH (S.U.)	Dissolved Oxygen Flag	Dis. Oxygen (mg/L)	Conductivity Flag	Specific Conduct (umhos/cm)	Chlorophyll A Flag	Chlorophyll A (ug/L)	Turbidity Flag	Turbidity (NTU)
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Page 5 WVDEP WAB Lake Assessment Form (4/12/2010)

Figure 12-5. Example of Sonde lake Profile Readings section (Pages 5 & 6) of the Lake Assessment Form

Section D. *WATER COLLECTION PROTOCOLS*

The water collection protocols listed below are to be conducted at every site established on a lake.

Part 1. Depth Classification

Lake Depth

The **maximum** lake depth is observed via depth finder or other method to the nearest tenth of a foot. Traverse the lake thoroughly to locate this location. It is usually in the vicinity of the dam, or especially near drain structures, though not in all cases. While the index station should be located as closely as possible to this location, some drifting may occur during sampling. Do not set the index station near any potentially dangerous features. This depth will be used later to help determine the intervals of sonde measurements in the lake profile.

Secchi Depth

A Secchi disk tethered to a rope or measuring tape demarcated by tenths of a foot is used to comparably measure the turbidity, or visibility through the upper fraction of the lake's water column. Readings should be taken using the naked (unimpeded/unaided) eye, without any hat or polarized glasses on, *etc*. Drop the disk down into the water and maintain visual contact with it by looking through a shaded surface of the water (*e.g.,* in the boat's shadow, or a hill's shadow) when possible. If the sun is directly overhead or otherwise creating extra glare, note this in the profile notes section. Lower the disk in the water column until its pattern is no longer visible and then note the depth. Then raise the disk again until it is visible and note the depth. This may take several back-and-forth attempts to finely determine the depth at which the disk disappears. If the depth at which the disk disappears is not the same as that at which it reappears, then the Secchi depth is the average of these two readings. Otherwise, record the single depth at which the depth disappears and reappears to the nearest tenth of a foot.

> ***IMPORTANT:*** ***Remember to account for the extra distance from the end of the measuring tape/rope and the attachment point to the Secchi disk if necessary.***

Part 2. Sonde Procedures

See CHAPTER 3. Section A. Water Quality Sondes & Sensors: Calibration, Routine Maintenance, & Use ***on page 3-1*** for information about how to calibrate and care for a sonde.

Before going to the field, make sure you know what the marks on your sonde cable mean, and check that they are accurate at least once at the beginning of the season. If your cable is not marked, a measuring tape can be attached to the sonde, but be sure to account for the additional distance between the end of the tape and the actual probes on the sonde (usually about 1.5 ft.).

Please note that functioning Chlorophyll-*a* probes are not available on every lakes sonde as they are very expensive probes and provide redundant data when lab samples are also collected and analyzed. Make sure you know if your sonde has a functioning, well calibrated probe, and if not, do not record Chlorophyll-*a* data.

After the water quality sampling location (index site) has been located, place the water quality sonde in the water and turn it on so that it can begin to equilibrate its readings. The sonde will be lowered from the subsurface sample to the bottom sample at the index site. Make sure the sonde will not encounter any entanglement hazards, or intakes that may suck the sonde in. If the sonde profile must be moved slightly from the deepest point because of these hazards, do so. In any case, be sure to document where and how you sampled on the habitat form.

***IMPORTANT*: If you are collecting water for analysis at a lab, directly from the lake, you must place the sonde in the same general location as the water sample collection.**

1. Remove the calibration cup from the end of the sonde, screw on the deployment guard, and deploy the sonde into the water column. **Be sure to not disturb the substrate at this point until all water data collection is completed.**

***IMPORTANT*: When deploying a sonde into the water, give it a little tap or shake once submerged. This will help dislodge any air bubbles inside the Conductivity Sensor that will bias a reading. Make sure that all probes are submerged adequately.**

2. Once fully submerged (*i.e.,* the very top of the sonde is submerged-a depth of approximately 1.5 feet for the probe end) in the water turn the unit on.

3. Let the readings stabilize for a few minutes. This time could be used to fill out parts of the habitat form, collect water samples, or check on the GPS coordinates.

4. Determining the reading intervals: Approximately 10 readings should be recorded as you progress vertically through the water column. The lake depth is determined by using a depth finder (***see Part 1. Depth Classification Lake Depth on page 12-17***).
   - For depths greater than 11 feet (determined by the depth finder), the interval is found by dividing the total depth by 10.
   - For depths of less than or equal to 11 feet, the minimum interval of 1 foot should be used, starting at 1.5 feet and ending at 10.5 feet. Use this same minimum interval for depths less than 11 ft., even though this will produce less than 10 total readings.
   - Finally, in deeper lakes where the sampling interval is greater, make an attempt to more precisely define the thermocline (the depth at which temperature, and often dissolved oxygen, makes a sharp change). For example, if the sampling interval on a deep lake is 13 feet, and you notice that the temperature or DO drop significantly between the current reading and the previous reading, go back and take samples every 1-3 feet until you locate the thermocline.

5. Record each of the parameters, along with the depth (based on the marks on the cable or an attached tape measure) and time, beginning with the top subsurface sample (1.5 feet deep). Do not start at the bottom as it increases the risk of contamination of the probes by bottom sediments, plants, or structures. Allow the readings to equilibrate (sometimes requires up to 1 min) at each depth before recording the data. Any suspect readings (fluctuating greatly or apparently out of calibration) should be flagged next to the parameter and noted in the Notes Box on the previous page. Do not attempt to go to the absolute bottom for the last reading as this will stir up bottom sediments, result in inaccurate readings, and leave you with a dirty sonde. Rather, the deepest reading should be taken somewhere

between 0.5 and 1.5 feet above the bottom, depending on how uneven the bottom appears when accessed via the depth finder (leave more room between the sonde and the bottom when it is very uneven to avoid collisions).

6. After recording all readings, turn the sonde off and retrieve from the lake. Take off the deployment guard and replace the calibration cup. Always make sure sand and other particles are kept clear of the threads on the sampling weight, cap, storage cup, and sonde itself. These threads are plastic and will strip if sand is caught in the treads while screwing these parts on and off.

7. Store the sonde securely for future use. When storing the sonde between sites or sampling events, only a small amount of 4.0 pH buffer inside the cup is necessary to keep the air (and membranes) moist. If the pH buffer is spilled at the site, you can get away with a few drops of water inside the cup until you can replace it back at a vehicle or the lab.

> ***IMPORTANT: Do not store the sonde with a full cup of water, as this will lessen the life of the pH Sensor.***

Part 3. Water Quality Sample Collection and Preservation

Lake Water Quality Parameters

- Alkalinity, Fecal coli., TSS, Tot. Phos., TKN, NO_2-NO_3-N, Mg (Tot.), Ca (Tot.) & Chlorophyll A

3 containers (wet iced, HNO_3, & H_2SO_4), 1 container for Chlorophyll Collection, 1 Chlorophyll filter, & fecal

Materials and Reagents

In addition to the Materials and Reagents described in ***CHAPTER 3. Section B. Materials and Reagents on page 3-33***, the following are required:

1. Chlorophyll-*a* transfer bottle – this can be the amber plastic 2L Nalgene bottle or simply a 1 L cubitainer surrounded by foil. In either case, the ***container should not be transparent*** as chlorophyll-*a* is light-sensitive. This transfer container may be reused from site to site, but should always be rinsed thoroughly with DI (deionized) or distilled water before sampling.
2. Van Dorn sampler – for retrieving top and bottom samples from lake (should be pre-rinsed before leaving the vehicle).
3. Fixatives (nitric acid, sulfuric acid, and sodium hydroxide) - for sample preservation.
4. Waterproof plastic bags or other suitable container - for holding bacteria sample bottles during transport.
5. Filtration Apparatus (Vacuum type) – for chlorophyll sample processing.
6. Glass fiber filters – these are GF/F filters (glass fiber – fine) from manufacturers such as Whatman.

7. Aluminum foil – for wrapping chlorophyll filter samples.

Safety Precautions

See ***Safety Precautions on page 3-34*** for information about how to handle water samples and fixatives.

Procedures for Collecting Water Quality Samples

See ***Labeling Sample Containers on page 3-34*** for information about how to label water sample containers.

Van Dorn Sampler Method for Depth Profiles

Make sure the Van Dorn sampling rope accurately reflects the distance to the middle of the sample tube at the beginning of each season.

At the selected water quality sampling location (index site), locate a good sampling location. Be sure to document where you sampled on the habitat form. **Be sure to not disturb the substrate around this point until all water sampling is completed.**

The top sample should be taken at a depth of approximately 1.5 ft., as this corresponds to the length of the lakes sondes (when the top of the sonde is at the water's surface, the probes are usually about 1.5 ft. underwater). Taking the sample just below the surface also prevents interference from surface films or scrums. The time of the top and bottom samples should be the same as the time noted on ***PAGE 3-Lake Info (starting on page 12-15)*** of the Lake Assessment Form.

Care should be taken when lowering Van Dorn sampler for bottom sample. Do not disturb lake sediments as mobilized (soluble) phosphorus will be analyzed in these samples and phosphorus-containing sediment should be considered contamination that will lead to inaccurately high results.

Collect the water samples as follows:

1. Set the Van Dorn sampler for collection by attaching the cable loops from each end cap to the trigger stub. The trigger is a sensitive mechanism and is easy to activate, so a demonstration by experienced personnel may be helpful. Also, make sure the valves at the spigot on each end are closed. (Note: the Van Dorn sampler should have been rinsed with DI or distilled water prior to each use.)

2. Lower the Van Dorn sampler to the desired depth as measured by the marked rope attached (make sure this rope accurately reflects the distance to the middle of the sample tube at the beginning of each season). Make sure to hold the messenger at the surface.

3. When the sampler is at the desired depth, pause for up to a minute to allow water at that depth to circulate through the sampler, and then release the messenger. A clicking sound will indicate that the sampler has been closed.

4. Retrieve sampler and set it on stand in boat.

5. The spigot on the pressure-relief end of the sampler should be rotated upward and opened to allow air to replace the water which will be drawn from the sampler.

6. The spigot on the opposite end is where the water will be drawn from. It should be pointed downward.

7. Water quality samples are collected in plastic containers (*e.g.*, cubitainers). At lake sites, typically 2 are needed for nutrient analysis: 1 unfixed, and 1 sulfuric-fixed.

8. Rinse the container **three times** at least **one-half full** with sample water from the Van Dorn sampler by opening the downward-pointing spigot. During the rinse, secure the lid on the cubitainer, shake for 5 seconds, and then empty.

9. Fill the container with sample water, making sure to limit the amount of organic matter in the sample, and expunge as much of the airspace as possible. The sulfuric-fixed nutrient sample should be preserved at the index station if there is a long travel time back to the vehicle.

> ***IMPORTANT:*** ***When collecting a sample to be analyzed for Alkalinity (unfixed sample) as much air as possible should be expunged from the sample container to avoid contamination*****.**

10. Finally, fill the Chlorophyll-*a* transfer bottle (***see Part 3. Water Quality Sample Collection and Preservation Materials and Reagents above for a definition***) with water from the top sample only (no bottom sample).

11. Repeat Steps 1-9 for the bottom sample.

Direct Dip/Grab Method (Fecal coliform Sample)

1. Use pre-sterilized bottle with Sodium thiosulfate tablet. Keep the bottle closed until you are ready to collect the sample.

2. Open bottle and handle carefully to avoid contamination. DO NOT TOUCH THE INSIDE OF THE LID OR BOTTLE.

3. The fecal sample site should be the closest shoreline to the index station. Shoreline stations are used because they are the most representative of the contact a wading or bathing human would have with the lake water. Take care not to disturb, or muddy, the water at the shoreline when approaching via boat.

4. Dunk the inverted bottle to approximately 1-1.5 feet below the surface and turn right-side-up to fill. DO NOT RINSE OR REFILL THE BOTTLE. If the bottle is too full, slowly pour a little out. Avoid areas with lots of scum or surface debris as any solid matter will contain disproportionately high amounts of bacteria, skewing results.

5. Place cap tightly on bottle and secure cap lock.

Sample Preservation (Fixation, Filtration, & Holding)

Filtration

Protocols for Sample Filtration with Peristaltic Pump/Drill Apparatus (Dissolved Metals and Nutrients)

See ***CHAPTER 3. Section B. Part 2. Sample Preservation (Filtration, Fixation, & Holding) Filtration on page 3-38*** for details on how to handle the filtration of any dissolved metals or nutrients.

Protocols for Sample Filtration with Hand Pump Apparatus (Chlorophyll-a and Water column algae)

The Chlorophyll-*a* is collected from the top sample (1.5 foot depth) because healthy phytoplankton are generally obtained from the photic zone (depth at which the illumination level is 1% of surface illumination). Filtering should be performed in subdued light as soon as possible after sampling since algal populations, thus chlorophyll *a* concentration, can change in a relatively short period of time. Aboard ship filtration is highly recommended.

The components of the Chlorophyll-*a* filtering are:
1. Nalgene filter cup apparatus
2. Hand pump and tubing to connect to filter cup
3. Whatman GF/F glass fiber filters
4. Forceps
5. Aluminum foil
6. Squirt bottle with DI or distilled water
7. Ziploc bags
8. Cooler with Ice (Dry Ice preferred)

Procedure:

1. Nalgene filtration apparatus should be rinsed with DI or distilled water before use at each site.

2. With hand pump attached to bottom of filter cup, place filter support screen on top, ensuring there is an O-ring between bottom half of filter cup and filter support. Lay glass fiber filter on top of support (With some filter types, there is an embossed grid-pattern on one side. Place this side facing down for consistency.)

Now attach the top half of filter cup by threading collar over filter. Again ensure there is an O-ring between the filter support and the top of the filter cup.

3. Use a separate, higher accuracy graduated cylinder (also rinsed with DI or distilled water) to measure the desired sample volume. Sample should be thoroughly mixed (via inversion) before pouring into cylinder so that solids are equally suspended.

4. Pour desired sample amount into cup (up to 500mL) and screw on top of filter cup apparatus to prevent contamination. Make sure at least one of the ports in the top of the filter cup apparatus is uncovered for pressure relief.

5. Pump the water from the top of the apparatus, through the filter, to the bottom collection cup.

> ***IMPORTANT:*** ***Do not exceed 7 psi when pumping; this will prevent breaking the filter and/or damage to the phytoplankton cells, causing a loss of chlorophyll. Excessive filtration time (>10 minutes) can also damage the cells. Do not increase the vacuum pressure once filtration has begun.***

6. If more than 500mL will be filtered, the bottom cup must be emptied by disassembling the apparatus. Otherwise, water will inundate the filter from underneath and ruin the process.

7. Repeat until steps 4-6 until a sufficient sample has been filtered to produce visible color on the filter. At least 500 mL should be filtered. If there is so much suspended solids in the sample that the filter becomes clogged before 500 mL is reached, filter as much as possible. There should be some color on the filter when complete. If the water is clear, larger volumes than 500 mL may be filtered, up to the maximum container size of 2 L.

8. Squirt a small amount of DI or distilled water from a squirt bottle into the top of the filter cup, washing all the sides down. This will transfer any residual solids to the filter itself. Pump the DI/distilled water through.

9. Disassemble the apparatus and, using clean forceps, fold the filter in half so that the side containing the chlorophyll is folded on itself.

10. Place the folded filter onto a clean sheet of aluminum foil and fold it gently so that filter is held securely in place.

11. Place foil containing filter into a plastic bag and label the bag just as you would label the containers for the other samples. The sample type is “Chl-a” and also record the volume filtered on the baggie.

12. Place the bagged filter sample onto ice (dry ice is preferable, but wet ice may be only available) immediately and transfer it to a freezer as soon as possible. Filter should be kept frozen until analysis, with the exception of storage on wet ice during transfer to the lab. Make sure to keep the bagged filter from being submerged in ice water if using wet ice as the bag may leak and ruin the sample.

Fixation

See ***CHAPTER 3. Section B. Part 2. Fixation on page 3-44*** for details on how to fix and preserve the other samples collected (*i.e.,* metals, nutrients, unfixed containers, fecal).

Holding

See ***CHAPTER 3. Section B. Part 2. Holding on page 3-45*** for details on parameter holding times (*i.e.,* metals, nutrients, unfixed containers, fecal).

Documentation

See ***CHAPTER 3. Section B. Part 2. Documentation on page 3-46*** for details on documentation of the sample using the Analysis Request Form with COC.

Lake Sampling Quality Assurance/Quality Control

Once a year, all field participants in the WAB attend mandatory training sessions in March-April prior to the initiation of the major sampling season. The purpose of these sessions is to ensure that all field personnel are familiar with sampling protocols and calibrated to sampling standards. Whilst a specific session on Lake Sampling is not covered, other sessions (*e.g.,* site documentation and completing the stream assessment forms, water collection protocols, field blanks and duplicates, *etc*.) are covered. In the field, individuals who are more experienced with Lake Sampling will be teamed up to give hands-on training to less experienced to assure reinforcement of training and accurate results before they are allowed to sample these stations solo. This document is also provided to all program personnel for review and use in the field.

Sample labels are to be accurate and complete and contain all the pertinent information. Sampling equipment will be checked for contaminants and excess dirt or moisture cleaned before and after each sampling event. Lot numbers of all preservatives are recorded on the Analysis Request Form for each sample submitted and entered into the database to allow for easy tracking. Sample transfer to the lab shall also be documented using the Chain-of-Custody (COC) portion of the Analysis Request Form.

Duplicate sampling and field blanks must be performed at a minimum of 2.5% of Lake Sample sites for each sampling round. The field blank and duplicate data are looked at by Watershed Assessment Branch staff and scrutinized to find any possible discrepancies, contamination, or faults in the sampling methods and techniques. Any problems are brought to the attention of the program management and steps are made to immediately correct the problem. Data that is related to the problem are flagged with

notes concerning the details of the situation so that decisions can be made whether or not to include the data in any further assessments or analysis. Procedures for performing duplicates and field blanks are presented in ***CHAPTER 14. Section A. Blanks and Duplicates on page 14-1.***