

STANDARD OPERATING PROCEDURES FOR FIELD SAMPLERS

VOLUME I

Revision 6.2

TRIBUTARY AND IN-LAKE SAMPLING TECHNIQUES



**STATE OF SOUTH DAKOTA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
WATERSHED PROTECTION PROGRAM**

STEVEN M. PIRNER, SECRETARY

May, 2018

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FOR FIELD SAMPLERS**

VOLUME I

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**STATE OF SOUTH DAKOTA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
WATER RESOURCES ASSISTANCE PROGRAM**

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1.0 INTRODUCTION AND BACKGROUND

The lakes and rivers of South Dakota provide a basic natural resource, recreational in nature, of utmost importance to the economy of the state and quality of life for its 814,180 residents (2010 census). Approximately 800 lakes, ranging in size from prairie potholes to the Missouri River mainstem reservoirs, are readily available for public use. Five hundred seventy-three state lakes have been recognized as significant waterbodies, specifically categorized by the South Dakota Department of Environment and Natural Resources (SD DENR) as to their assigned beneficial uses.

The great majority of state lakes are relatively small and naturally shallow, often situated on sizeable watersheds comprised of nutrient-rich glacial soils. Consequently, both natural and cultural eutrophication are likely to proceed at much higher rates than in larger, deep lakes located in less-fertile surroundings in other parts of the country. Physical and biological changes, made manifest only after decades in larger bodies of water, are often visible in many South Dakota lakes within a few years.

Agricultural practices in South Dakota, as elsewhere, have intensified over past decades and are major contributors to cultural eutrophication via nutrient loss and sedimentation. Much of this process can be prevented or impeded by proper land and watershed management procedures that are incorporated into the SD DENR Watershed Protection Program (SD DENR-WPP).

One of the main objectives of the SD DENR WPP is to assess the water quality of lakes and streams and their watersheds. Assessments are accomplished by describing the current conditions in impacted watersheds, tracking trends in water quality, determining sources of lake and stream degradation, targeting these sources, and setting reachable, obtainable goals for water quality improvement. Chemical, physical, and biological characteristics of the lakes and their tributaries in South Dakota are assessed and if impaired Total Maximum Daily Loads (TMDLs) will be developed and written to improve water quality of lakes and streams in South Dakota. Obtaining high quality data is essential to achieving these goals.

Of vital importance in the early stages of a watershed assessment project are the compilation of baseline data and the establishment of baseline conditions that can later be compared with data collected after lake and stream protection restoration measures have been installed and implemented. Only in this way can changes in lake or stream water quality be reliably ascribed either to natural variation, mitigation or watershed restoration efforts.

It is imperative that proper field procedures be followed during sample collection and that samples are collected in a consistent manner. Standard Operating Procedures (SOPs) activities will ensure accurate, precise, and representative lake and tributary data as well as continuity in methodology between projects. This document describes the standard operating procedures to be used by SD DENR-WPP staff, local coordinators, stakeholders, and field personnel.

2.0 WATERSHED PROTECTION PROGRAM DESCRIPTION

The SD DENR WPP is designed as a two-phased effort to 1) identify sources of pollution and determine alternative restoration methods, and 2) control the sources of pollution and restore the quality of state lakes and streams. The program is typically a state and local endeavor, with financial and technical assistance from federal agencies used whenever possible.

The watershed assessment stage of the program encompasses a series of procedures to assess current conditions of selected water bodies. Included in this phase are water quality, water quantity and watershed data collection. Generally, the local project sponsors are responsible for collecting the data using existing local resources or in combination with Section 319(h) (supplemental grant) funding. SD DENR WPP provides equipment, training and technical assistance to the project sponsor. Following the collection of sufficient data, SD DENR WPP conducts an evaluation of the data and prepares a report. This assessment summarizes baseline information, identifies sources of pollution, describes alternative pollution control and restoration methodologies, outlines implementation costs and details SD DENR WPP recommendations. The state provides these services using Section 319(h) federal funds, state natural resource fee funds, and local matching funds.

Prior to implementation of specific pollution control and restoration alternatives, the local project sponsor develops a work plan for in-lake and watershed restoration based on recommendations from the assessment and local stakeholder concerns. Technical assistance for this process is provided by SD DENR WPP. This plan is then submitted to the State Water Plan administrators for consideration. If the plan is approved, the project sponsors are eligible to apply for appropriate state funding. The primary funding sources used by the sponsors are the State Consolidated Water Facilities Construction Fund, Conservation Commission fund, USDA EQIP funds, EPA Section 319 (h) Implementation fund and local funding.

Nonpoint source pollution from agricultural activities is the primary pollution source affecting lakes and streams in South Dakota. The methods used to control this source are selected on a case-by-case basis. Selection is based on evaluation of individual watersheds using the Annualized Agricultural Nonpoint Source Model, AnnAGNPS (USDA-ARS, 2015) or EPA BASINS and HSPF. These models delineate critical areas within each watershed and are then used to predict which control methods Best Management Practices (BMPs) would be most effective.

Following modeling evaluation, coordination with state and federal agricultural agencies is solicited to verify the nature of the identified critical cells and the selected control methods. For those areas targeted as critical, the owners/operators are contacted to request their voluntary participation in the control program. There are no provisions for forcing compliance to correct identified problem areas.

BMPs used in a watershed restoration plan maybe mechanical and/or managerial, and include but are not limited to large and small sediment control structures, streambank erosion control, and the installation of Animal Waste Management Systems (AWMS). In those few instances where point source pollution may be a problem, the best available technology is applied to correct the problem.

In-lake recommendations may include, but are not limited to, natural flushing (after reducing or eliminating sources of pollution), sediment removal, in-lake phosphorus control, weed harvesting, chemical weed control and some preliminary attempts at biomanipulation. The recommendations for in-lake BMPs are implemented after or in conjunction with watershed BMPs.

In conjunction with the development of watershed pollution control alternatives, the assessment data evaluation may also provide recommendations for stream and lake restoration alternatives. Again, the recommendations are made on a case-by-case basis with input from all concerned organizations. Funding for implementation is made available primarily through the State Consolidated Water Facilities Construction Fund, the EPA 319, USDA EQIP, Nonpoint Source Program, and local funding.

3.0 STUDY AREA DESCRIPTION

A. Regional Characteristics

South Dakota is a rural, agricultural state with a surface area of 77,047 square miles. Rolling plains are the main topographic feature of this northern prairie state. The most visible geographic forms in the state are the Missouri River, which divides the state into 'East River' and 'West River' areas, and the Black Hills - an isolated area of granitic uplift in the far west. The maximum elevation of the state is 2,210 meters (7,242 feet) at Harney Peak in the Black Hills. The lowest elevation, 294 meters (965 feet) is near Big Stone City in the bed of Big Stone Lake.

The unglaciated West River mixed-and short-grass prairie of South Dakota has few natural lakes, but a number of man-made lakes and numerous small farm ponds are found here. Three large Missouri River mainstem reservoirs form the eastern boundary of the West River prairie. The majority of lakes within the Black Hills are also impoundments.

The particular geology of an area exerts considerable influence on both the surface and ground water quality. Rothrock (1943) and Flint (1955) recognized 12 major physical regions within state boundaries. As a result of this geologic diversity, the water quality of the state is highly variable. The water quality of eastern South Dakota (Prairie Coteau) is indicative of the types of glacial drift deposited at various localities, and of the Dakota Sandstone aquifer (Nickum, 1969).

South Dakota has a sub-humid to semiarid climate subject to periods of drought at roughly 20-year intervals. Due to the shallow nature of the lake basins formed by glaciers in the region, average water depth of eastern state lakes is less than eight feet. During a prolonged drought, many lakes may dry up completely, while others are reduced to very low water levels with attendant high saline concentration.

For this reason, most of the prairie lakes of eastern South Dakota can be classified as warmwater semi-permanent. These lakes respond quickly to changes in annual rainfall and the underlying water table with fluctuations in lake water levels and water quality. The majority of state lakes tend to be turbid and well-supplied with dissolved salts, nutrients, and organic matter mostly by runoff from agricultural and domestic sources. The shallowness of the lakes, together with the mixing action exerted by strong summer winds, prevents continuous thermal stratification in all but a few cases.

Intensive agricultural practices have contributed greatly to the cultural process of lake eutrophication via soil loss and sedimentation. Fortunately, much of the cultural process can be prevented or impeded by the planned and timely application of watershed and lake preservation and restoration measures adopted by SD DENR WPP.

The sample population consisted of 572 lakes and reservoirs representing 192,219 acres in South Dakota that have been identified in the Surface Water Quality Standards as supporting warm or coldwater fisheries. The survey design utilized three strata; targeted lakes, managed fisheries and unmanaged fisheries. Unassessed water bodies were not replaced with alternate waterbodies and the final weightings were adjusted based on the lakes that were sampled (SD DENR, 2016).

The present goals of this sampling effort, TMDL assessments and SD DENR WPP are as follows:

1. Establish baseline water quality information, particularly for sediment and nutrients.
2. Enter lake and tributary water quality data into the USEPA STORET/WQX computer system and the SD WPP NR92 Water Quality Database.
3. Assess the trophic status of lakes.
4. Determine whether the assessed lakes are meeting assigned water quality beneficial use criteria.
5. Document long-term trends in water quality.
6. Determine attainable goals and targets for impaired waterbodies.
7. Design and support implementation projects to reduce watershed loading and improve overall water quality of lakes and streams in South Dakota.

South Dakota has a total of 10,298 miles of rivers and major streams. Major or significant streams in this context are waters that have been assigned aquatic life use support in addition to the beneficial uses of fish and wildlife propagation, recreation, stock-watering and irrigation. This definition includes primary tributaries and, less frequently, sub-tributaries of most state rivers and larger perennial streams. In a few cases, lower order tributaries may be included, for example the Black Hills area, which has a relatively large number of permanent streams. If all existing and mostly waterless stream channels and gullies, the great majority of which serve only to carry snowmelt or stormwater runoff for a week or two during an average year, are to be included as state waters, total stream mileage within South Dakota would exceed the above quoted figure by at least ten times.

B. Ecoregions

Due to differences in geography, there are marked variations among the eight Level III ecoregions in South Dakota (Figure 3.0.1). The Black Hills are located in the *Middle Rockies* ecoregion. The *Northwestern Great Plains* ecoregion includes most of the South Dakota prairie west of the Missouri River. Also situated in southwestern South Dakota, along the Pine Ridge Indian Reservation is the *Western High Plains* ecoregion. There is a small area of the *Nebraska Sandhills* ecoregion, which encroaches on the southern border of South Dakota in Oglala Lakota, Bennett, and Todd counties. The *Northwestern Glaciated Plain* ecoregion covers the Missouri River plateau east of the Missouri River. There is a small area of this ecoregion reaching into the West River area near the Nebraska border. The *Northern Glaciated Plains* ecoregion covers the majority of eastern South Dakota from the James River valley to the eastern border. Only two smaller Level III ecoregion areas are found in the rest of the state. The extreme northeastern corner of the state is touched by the *Lake Agassiz Plain*, which extends north into the Red River Valley. Also, patches of the *Western Corn Belt Plains* ecoregion encroach into South Dakota from the borders of southwest Minnesota and northwest Iowa.

Level III ecoregions are further refined and delineated into Level IV ecoregions and are shown in Figure 3.0. 2. By definition, these ecoregions support different compositions of biota. Sampling biota within each ecoregion (Level III and IV) should detect differences in biological communities.

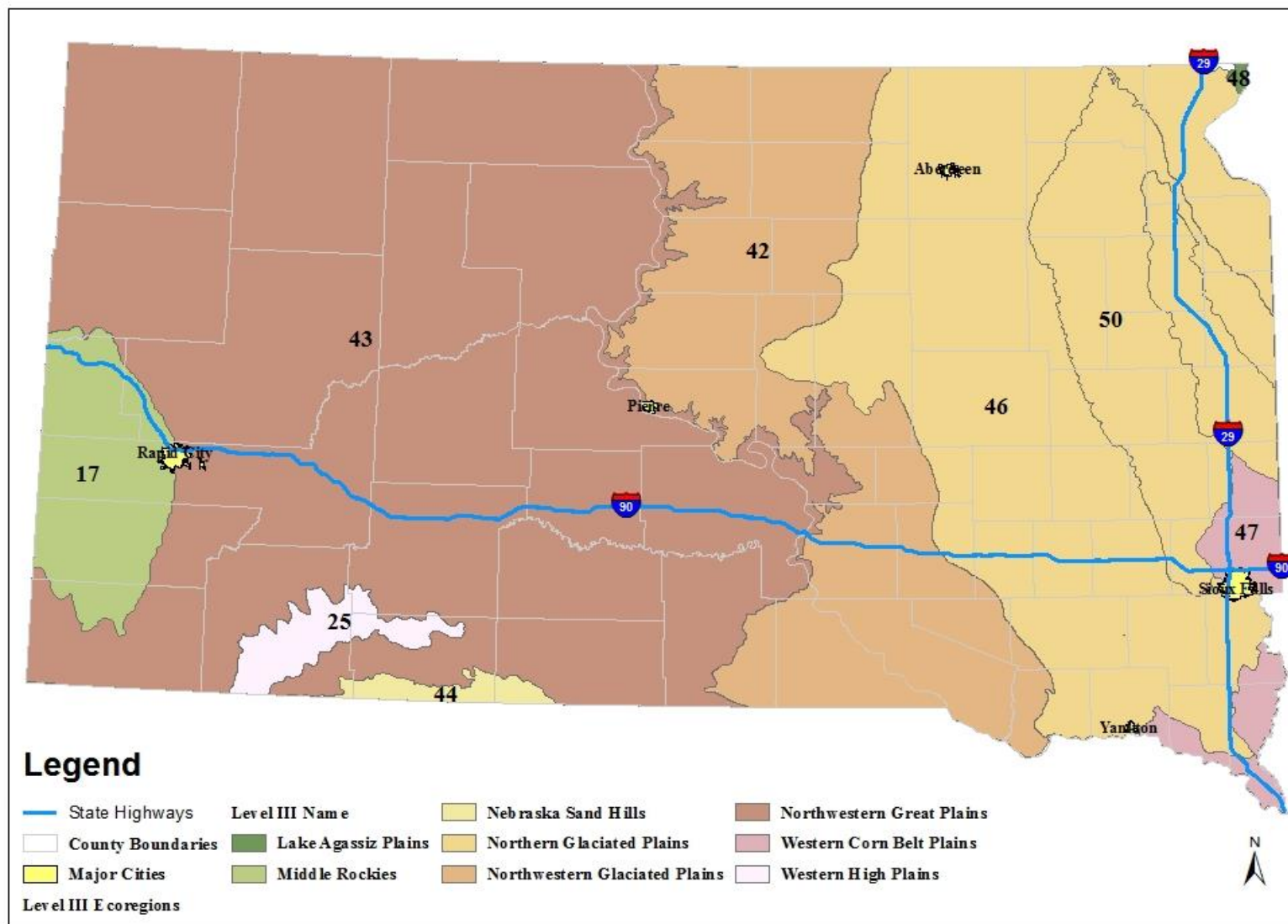


Figure 3.0. 1. South Dakota Level III Ecoregions.

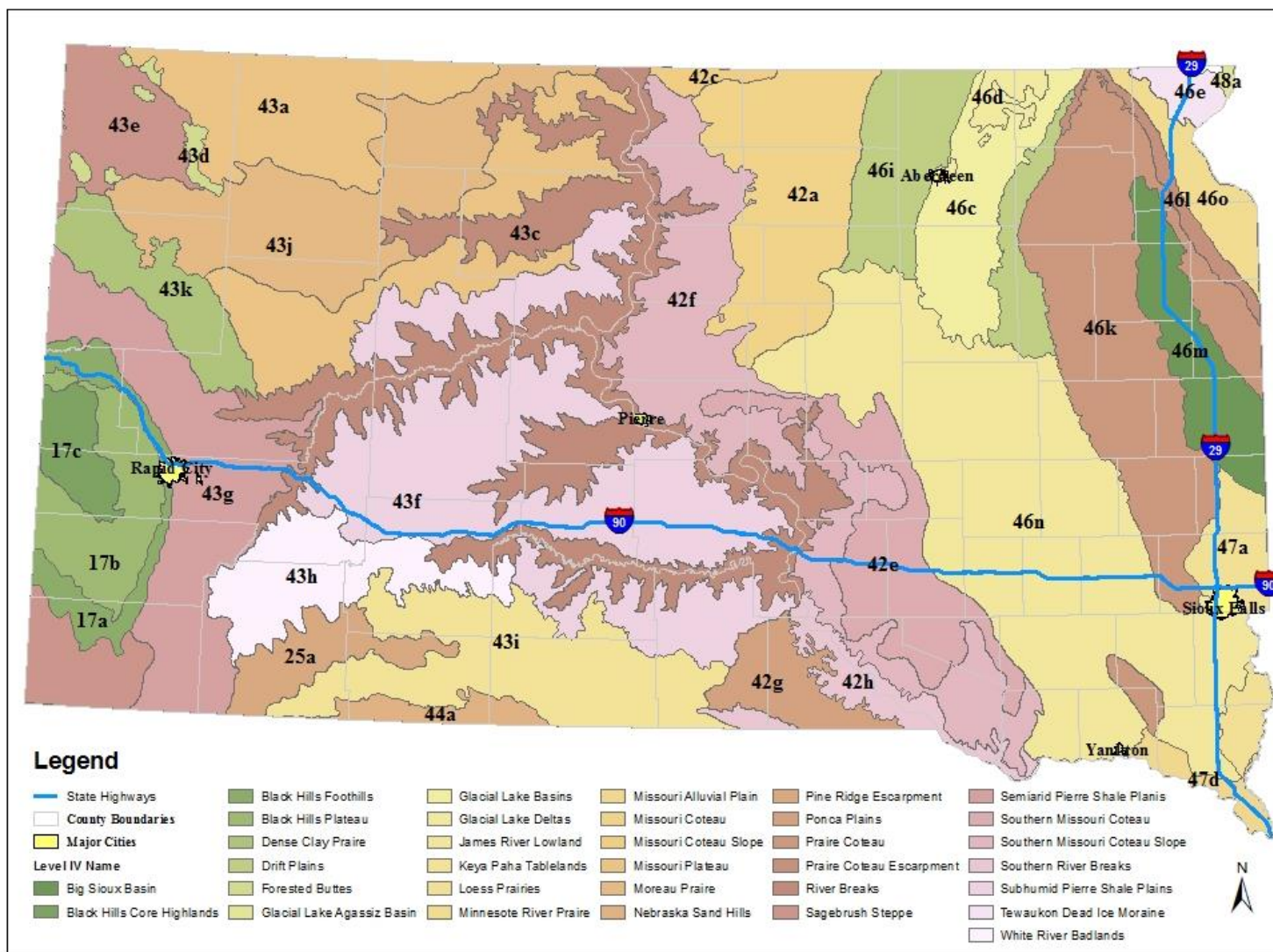


Figure 3.0. 2. South Dakota Level IV Ecoregions.

4.0 PRE-SAMPLING PROCEDURES

Each field investigation must be evaluated and designed on an individual basis. Common procedures addressed in developing an assessment work plan include the following:

- A. Determine the objectives for sampling.
- B. Review existing information and all data on the waterbody (ies) under investigation.
- C. Contact Federal Agencies: Forest Service, United States Geological Survey, Natural Resource Conservation Service, Army Corp of Engineers, Bureau of Reclamation; State Agencies: South Dakota Game Fish & Parks, Department of Agriculture and other programs within SD DENR: Water Rights, Surface Water Quality, Minerals and Mining, Geological Survey, and Feedlot Program; and local organizations: Water Development Districts, Watershed Partnerships, and Conservation Districts can provide watershed information, long-term data, land owner contacts, and historical information for developing viable watershed projects and Project Implementation Projects (PIP).
- D. Obtain adequate maps and diagrams to define the study area.
- E. Conduct field reconnaissance of the proposed study area.
- F. Develop a list of proposed sampling sites, sampling frequency, and sample analysis.
- G. Contact local land owners for permission to place monitoring sites and access to their land for chemical, biological, and habitat sampling, if required.
- H. Review entire project and ensure QA/QC sampling is adequate.
- I. Arrange schedules, responsibilities, funding, and contracts with all appropriate agencies, sponsors, and laboratories involved with the study. Coordinate and manage all activities.
- J. Develop a list of necessary equipment and supplies.
- K. Check the operation of all equipment prior to field use.
- L. Review and apply all safety procedures to field sampling.
- M. Train, monitor, and audit all local coordinators and sampling personnel throughout the project to ensure data quality and continuity.
- N. Record and document each QA/QC audit on audit forms provided in Appendix A of this document or can be found in the 2016 South Dakota NonPoint Source Program, Quality Assurance Project Plan (SD NPS QAPP, 2016).

5.0 DOCUMENTATION AND REPORTING

A. Documentation

A field notebook is **REQUIRED** to keep track of the sample date, time and the calibration of equipment. Use a write-in-the-rain notebook with bound and numbered pages. Use the same notebook for all project observations and samples. A standard format is not required; however, entries in the field logbook must be legible and include, but are not limited to, the following:

1. Logbook

- a. Record the types of meters being used, meter serial numbers, and the state ID number, if available, in the front of the logbook.
- b. Record the site or location where the calibration and inspection took place.
- c. Record the date and time when the calibration and inspection took place.
- d. Record the barometric pressure from the YSI 650 MDS meter or other meter that was used to calibrate the optical dissolved oxygen probe on the YSI Sonde.
- e. Record the pH meter reading for a known buffer solution during calibration.
- f. Record the conductivity meter reading for a known calibration solution (specific conductance is in $\mu\text{S}/\text{cm}$).
- g. Recheck the calibration at each site.
 - i. If the meter drifts between locations, report the drift in the logbook and the site where it occurred.
 - ii. If a meter drifts, recalibrate and record the re-calibration data in the logbook.
 - iii. Make notes of any damage to the instrument or difficulty in operation or calibration.
- h. Record all field observations, information, tributary stage data, and sample information in the logbook at each site.
- i. Record air and water temperature.
- j. Record cloud cover and precipitation.
- k. Record the number and type of data sheets filled out at each site (i.e. sample and/or flow data sheet).
- l. **REMEMBER!! You cannot put too much information in the logbook!**
- m. **NOTE: Initial or sign and date each day's entry in the logbook!!!!!!**
- n. Report any sampling difficulties or equipment malfunctions to the Project Officer as soon as possible.

B. Reporting

Monthly reporting is REQUIRED for all project coordinators and will encompass but is not limited to:

1. **Stage and Discharge Data**

Monthly stage and flow measurements will be provided to the Project Officer for data analysis and validation in an Excel spreadsheet format. After stage and discharge data from each site and date has been entered in the computer, indicate date entered and sign the data sheet. Keep all field discharge sheets used to calculate discharge in separate folders by monitoring site and provide them to the Project Officer as needed.

2. **Field Measurement, Chemical, and Biological Water Quality Data**

Monthly updates of chemical, biological, and field measurement data entered into NR92 spreadsheet format, directly into Access® STORET program, or in Excel® spreadsheet format depending will be provided upon Project Officers discretion. Similar to stage and discharge data, after field measurement, chemical, biological, and habitat data from each site and date has been entered into the computer indicate date entered and sign the data sheet. Keep all field measurement, chemical, and biological sheets in separate folders by monitoring site and provide them to the Project Officer as needed.

3. **Landuse Data**

Monthly updates on AnnAGNPS, HSPF Basins, BIT or project specific landuse data collection as per outlined schedule are required. Data requirements will be in either Excel® or ArcMap® format, depending on Project Officer discretion.

4. **Updated Equipment List**

An initial equipment list including model and serial numbers and site location will be required at the beginning of each project after site installation (Appendix A, Table A-6). Any alterations, problems, maintenance, and/or other deficiencies throughout the project will be noted and an updated list will be required as equipment needs and or locations change. The completed and/or modified equipment list will be sent to the project and equipment officer in Pierre or the appropriate regional office depending upon project.

6.0 INSTRUMENT CALIBRATION AND SETUP

Each field instrument must be calibrated and inspected prior to use, and operated according to manufacturer specifications. If problems with any field instrument are encountered, the user should consult the manufacturer's manual, the Project Officer, and/or call the manufacturer (last resort) for help. Daily calibrations and instrument observations must be on recorded on the SD DENR WPP YSI CALIBRATION WORKSHEET (Appendix A, Table 1) and at least noted in the project logbook (Section 5.0 - Logbook Procedures) prior to field use. General calibration procedures and necessary instrument inspections are presented below for equipment routinely used by project coordinators, seasonal personnel, and SD DENR WPP staff.

A. Flow Meters

1. Marsh-McBirney Flo-mate Model 2000 Portable Flowmeter

Calibrate the instruments in accordance with specific manufacturer's instructions (Marsh-McBirney, 1995). The only calibration (adjustment) for the Flo-mate Model 2000 Portable Flowmeter is to zero-adjust the meter. This should be checked daily. If meter reads outside a stability of ± 0.05 ft/sec. then perform zero adjustment procedures outlined below, adapted from Marsh-McBirney instruction manual, Rev. C, 01/95. The master key function summary figure is provided in Figure 6.0. 1.

Comment:

Each key in the zero adjust sequence must be pressed within 5 seconds of the previous key. If the time between key entries is longer than 5 seconds or if a wrong key is pressed, the unit will display an ERR 3. Turn the unit OFF then back ON and try again.

- a. Clean the sensor with soap and water to remove any buildup on the probe and dry, as it may cause noisy readings.
- b. Attach sensor to the wading rod.
- c. Fill a five gallon bucket with water and place wading rod with sensor attached into the bucket. Set the height of the sensor to three (7.6 cm) to four inches (10.2 cm) above the bottom of the bucket. Position the wading rod to place the sensor approximately near the center of the bucket (equal-distant and a minimum of three inches away from all sides of the bucket).
- d. Secure or brace wading rod to eliminate movement during zero adjustment procedures.
- e. After securing wading rod wait 10 to 15 minutes to ensure the water is not moving before taking any zero readings.

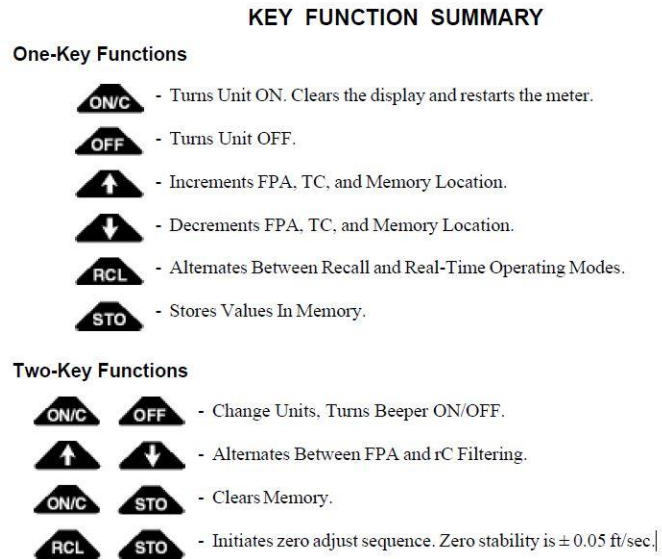
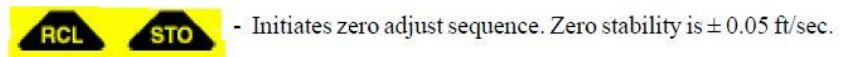
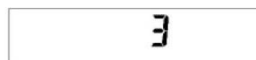


Figure 6.0. 1. Key function summary for the Marsh-McBirney Model 2000 flowmeter.

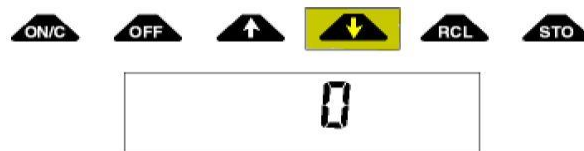
- f. Before starting the zero adjust procedure, turn the meter on and reduce the fixed point averaging (FPA) period from 40 seconds, where it should be set for everyday use, to 5 seconds using the down arrow.
- g. To initiate the zero adjust procedure press the RCL and STO buttons simultaneously, see below.



- h. The number “3” will be displayed, see below.



- i. Within 5 seconds reduce number from “3” to zero using the down arrow, see below.



- j. After zero is reached the screen will show “32” and then automatically start a countdown to zero.
- k. Once the countdown reaches one the count will hold for a second or two then the meter will turn off.
- l. Restart the meter and note the reading on the screen which should be at or near zero (± 0.05 ft/sec).
- m. **Be sure to record the before zero adjust meter reading, the after zero adjust reading, date, time, and technician performing procedure in the project logbook.**

- n. When using the meter in the field, be sure to fill out the section of the SD DENR WPP Discharge Datasheet indicating that a Zero Adjust was performed in the lab or at the sampling site.

2. SonTek FlowTracker Handheld ADV, adapted from FlowTracker Technical Manual.

Follow FlowTracker Technical Manual to setup and calibrate meter (SonTek, 2009). Pre-Deployment Diagnostics - Ideally test prior to first deployment of the season to check that the meter is working properly, weekly in the lab/office, and in the field if sensor is dropped or hit to ensure accuracy and data quality. This procedure is also outlined in Appendix B.

- a. Hold the FlowTracker in a small tank or bucket of water (or in a natural environment) such that the probe is submerged and there is a boundary (surface, side, or bottom) within view.
- b. Ideally, the boundary should be placed 20-30 cm (8 to 12 inches) from the probe. You may need to add a small amount of fine dirt or other seeding material and stir the bucket well for good test conditions. Regular tap water usually does not have enough scatterers (seeding) for a valid test.
- c. Connect the FlowTracker to the computer and turn the system on.
- d. Run the FlowTracker software (click Start | Programs | SonTek Software | FlowTracker).
- e. Click Connect to a FlowTracker. Select the correct COM port and click Connect.
- f. Click BeamCheck.

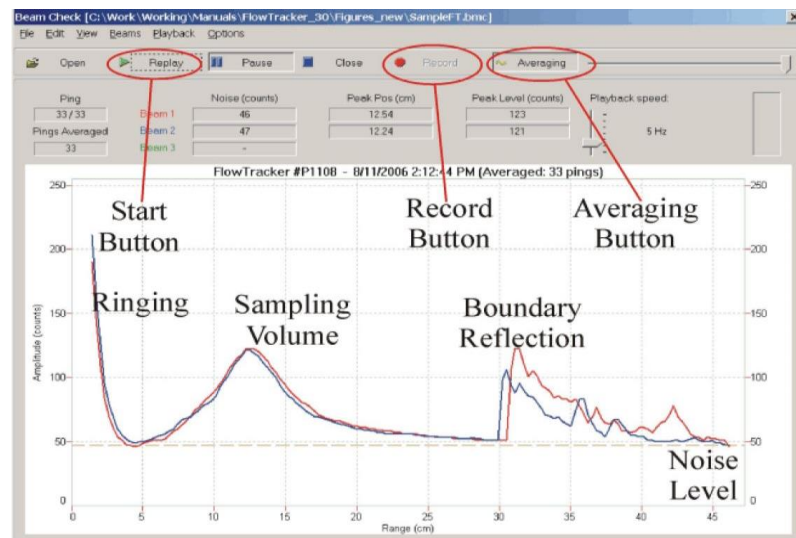


Figure 6.0. 2. Beam Check screen shot with the program screen and amplitude forms.

- g. To view real-time beam check data:
 - i. Click “**Start**”. This establishes communication with the instrument and starts data display.
 - ii. Use the menu and control items (Appendix B, Table B 2) to alter the display of data as desired.
 - iii. Figure 6.0. 2 and Appendix B (Table B-2 and Table B-3) review beam check display features and sample program output.
 - iv. See Appendix B (Table B-4 through Table B-5) for examples of how to interpret the data.
 - v. Click Stop to end the display of data.
 - vi. Use “**File|Exit**” to close the Beam Check window.
- h. To record real-time beam check data for later playback:
 - i. Start the display of real-time data as described above.
 - ii. Click Record to save all data to a file. The user will be prompted for a file name and storage location. Typically, a minimum of 20 pings is required for proper data analysis.
 - iii. Use the menu and control items (Appendix B, Table B-2) to alter the display of data as desired. The recorded data is not affected; only the display of data is affected.
 - iv. Click Pause or Stop to interrupt or end data collection.
- i. To play back previously recorded beam check data (using a .bmc data file):
 - i. Click “**Open**” to select a previously recorded beam check file (.bmc).
 - ii. Click “**Replay**” (or Pause) to start the playback of data.
 - iii. Use the menu and control items (Appendix B, Table B 2) to alter the display of data as desired. The recorded data is not affected; only the display of data is affected.

3. **StreamPro ADCP and iPAQ Pocket PC Setup**

The following procedures describe setup procedures for the StreamPro ADCP and the iPAQ Pocket PC to collect discharge measurements (Teledyne, 2008).

3.1 **StreamPro Setup**

- a. Install eight (8) AA batteries into the StreamPro by turning off the power, removing the Solar Shield (four thumb screws) and then the battery compartment door by loosening the three thumb screws (See Figure 6.0. 3 below).

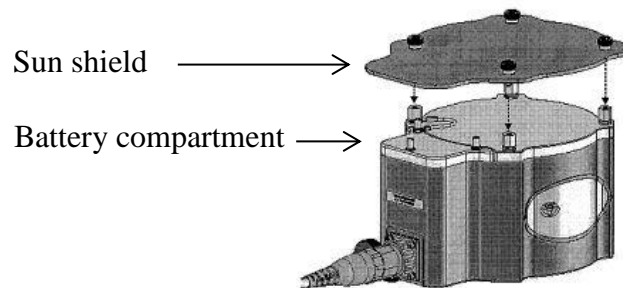


Figure 6.0. 3. Sun shield and battery compartment locations.

- b. Remove the battery holder from the compartment and remove all old batteries. Replace with eight new alkaline batteries matching battery polarity as shown on the battery holder (See Figure 6.0. 4 below).



Figure 6.0. 4. Stream Pro battery holder.

- c. Before reinserting the battery holder observe that the inside of the battery housing area is dry and clean
- d. Place battery holder in the battery compartment making sure the battery contacts on the holder match the two springs inside the housing.
- e. If the battery compartment O-ring seal fails or appears dry or hard; replace it. When reinserting or replacing the seal, thoroughly clean both the cover plate and the blue surface area around the O-ring.
- f. Then apply a minimal amount of silicone lubricant to the O-ring seal because lubricant attracts dirt; therefore, apply it sparingly and use a lint free cloth to remove any excess lubricant.
- g. Close the battery compartment door and tighten the thumbscrews. As you tighten all three thumbscrews, tilt the housing to see that the O-ring has not moved out of the O-ring slot (see Figure 6.0. 5 below).
- h. Tighten all three thumbscrews in rotation a couple of turns at a time so that the cover comes down evenly and squarely on the housing. Only tighten the battery cover thumb screws **finger tight**.

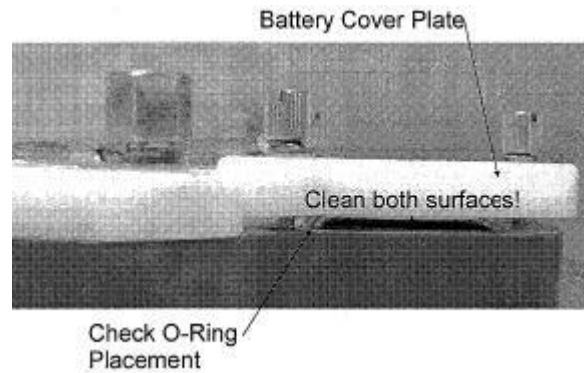


Figure 6.0. 5. Battery compartment O-ring placement.

- i. CAUTION: It is important to only gently finger tighten the sun shield screws when placing the sun shield back on the electronic housing M6 bolts. Should any movement occur on the M6 bolts due to over tightening the sun shield screws, the Loctite seal will be broken allowing the M6 bolts to subsequently become loose. **It is imperative to check the M6 bolts visually for tightness by observing the spring washers.** The spring washers should be fully compressed. The figure below shows the spring washers under compression and the washers not under compression (see Figure 6.0. 6 below).

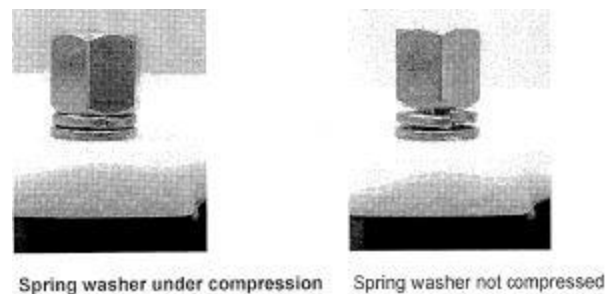
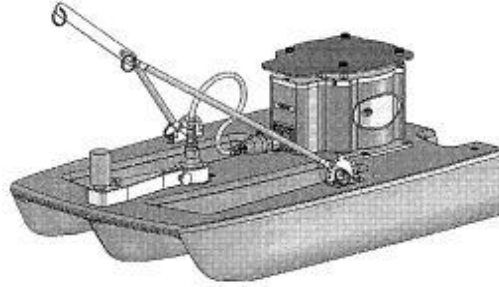


Figure 6.0. 6. Battery compartment spring washer compression differences.

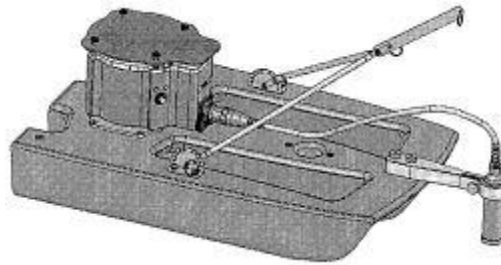
- j. The float is designed to attach the boom in an in-hull or extended position depending upon stream conditions. Generally the in-hull position is used for most deployments.
- k. Use the boom in the in-hull position for fast moving water or where the transducer may be struck by floating objects (see Figure 6.0. 7 below).



In-hull Position

Figure 6.0. 7. Boom setup in the in-hull position.

- l. Use the boom in the extended position for slow moving shallow waters. In this configuration the transducer mounting depth can be adjusted up or down in the water as needed (see Figure 6.0. 8 below).



Extended Position

Figure 6.0. 8. Boom setup in the in-hull position.

- m. After best deployment position has been determined based on stream characteristics, mount the boom in desired position with two thumb screws.
- n. Loosen the thumbscrew on the transducer clamp. Feed the transducer cable up through the bottom of the clamp. Attach the transducer cable to the electronics housing and attach the boom to the float using the supplied thumbscrews. If mounting the boom in the in-hull position, attach the counterweight to the front thumbscrew to help balance the float.
- o. Locate the embossed number three on the edge of the transducer. This identifies Beam3. **Rotate the transducer so that Beam 3 is forward and at a 45degree angle to the float** (see Figure 6.0. 9 below).

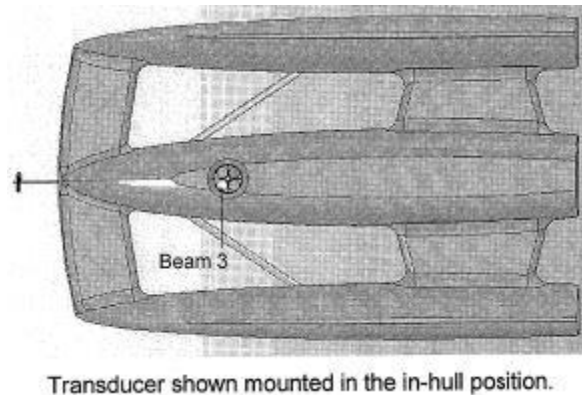


Figure 6.0. 9. Correct transducer mounting position (beam 3 in correct position).

- p. **NOTE** Beam 3 should remain forward and at a 45 degree angle for both the in-hull and extended positions.
- q. For the in-hull position, the transducer needs to be pushed into the arm until the line on the transducer is aligned with the top of the boom (see Figure 6.0. 10 below). This helps protect the transducer from damage even if the float is dragged along the ground.

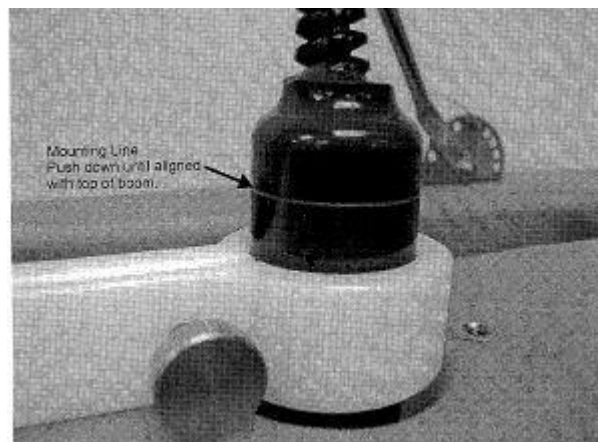


Figure 6.0. 10. Mounting line alignment location of the transducer (align with top of the boom).

- r. For the extended position, adjust the transducer depth so that it is three to six centimeters below the surface of the water (see Figure 6.0. 11 below).

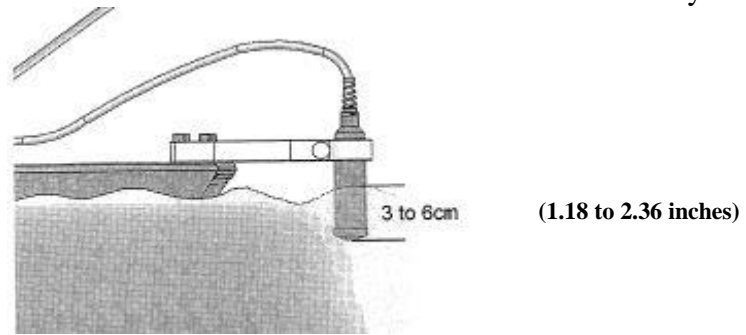
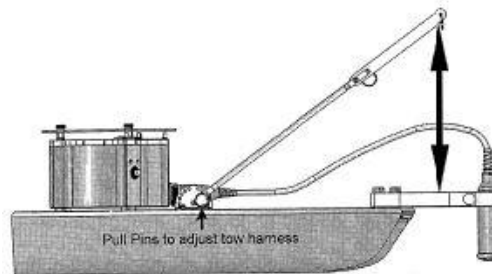


Figure 6.0. 11. Correct transducer depth for the extended mounting position.

- s. After final configuration adjustments to the transducer are complete, tighten the thumbscrew on the clamp to hold the transducer in place.
- t. Adjust the angle of the towing harness as needed by pulling both pins and raising or lowering the arm. Make sure that both pins are engaged and equally positioned (see Figure 6.0. 12 below).



Towing harness pin locations and angle

Figure 6.0. 12. Pull pin locations to adjust the towing harness.

- 3.2. Setting up the iPAQ Pocket PC
 - a. Keep the iPAQ Pocket PC connected to the cradle or AC adapter when it is not in use. Trickle charging does not hurt Poly Lithium Ion batteries. When you place the iPAQ Pocket PC in the charger the charge light will not flash until the battery reaches a minimum charge. Continue to fully charge the battery for at least four hours.
 - b. **If the iPAQ Pocket PC battery charge goes to low the iPAQ will not turn on, even if it is placed in the cradle.** This can give you the impression that the iPAQ is broken, but this indicates the battery is totally discharged.
 - c. Remove the iPAQ Pocket PC from the cradle. Disconnect the AC adapter power line from the cradle and use the

power adapter plug to connect the AC adapter directly to the iPAQ Pocket PC, see Figure 6.0. 13 below.

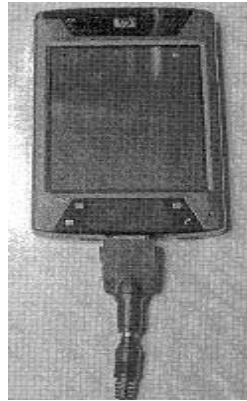


Figure 6.0. 13. Use the power adapter plug to connect the AC adapter directly to the iPAQ Pocket PC.

- d. Let the iPAQ Pocket PC charge for at least 30 minutes. Do a soft reset as needed to restore the iPAQ Pocket PC (see **Soft Reset** below). Continue to fully charge the battery for at least four hours.

Soft Reset

Perform a normal or “soft” reset when you want to stop all running programs or your iPAQ Pocket PC is acting strange.

- Remove the Pocket PC from its cradle and locate the reset button on the iPAQ Pocket PC (see Figure 6.0. 14 below).



Figure 6.0. 14. Location of the reset button.

- Using the stylus, lightly press the reset button for two seconds. The iPAQ Pocket PC will restart in approximately five seconds and display the Today screen.
 - **Note: A soft reset will not erase any programs or data stored in RAM or ROM.**
 - **!!!!CAUTION: A soft reset will erase all unsaved data!!!!**

Power settings

- e. After the iPAQ Pocket PC is powered up, check and set the power settings as follows (Figure 6.0. 15).
- f. Tap “**Start**” menu, tap “**Settings**”, Tap “**System**” tab, then “**Power**” and “**Advance**” tab.
- g. Uncheck the On battery power: Turn off device if not used to 3 minutes box.

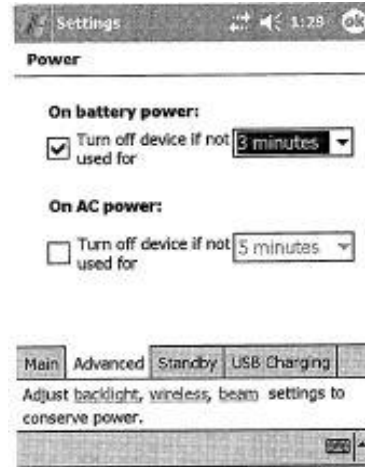


Figure 6.0. 15. Power settings screen on iPAQ.

- h. **CAUTION:** After collecting data, set (check) the **On battery power: Turn off device if not used to 3 minutes**. Leaving the iPAQ Pocket PC on will result in a dead battery. **Data files could be lost if the battery completely discharges!** Always copy data files to your desktop computer for permanent storage.
- i. Tap the Standby tab. Adjust (slide) the Standby Period to 24 hours to give you the maximum “Approximate hours left”.

USB Charging Using Field Laptop

- j. The iPAQ Pocket PC can be charged in the field using a laptop computer with a USB port. To activate USB Charging do the following.
- k. From the **power settings screen**, tap the **USB Charging** tab.
- l. Tap the USB Charging box and select “**Slow**” or “**Fast**” Charge radio button. It takes approximately two hours to fully charge the iPAQ Pocket PC using the “**Fast**” setting.
- m. Tap **ok** to exit the power settings screen.
- n. **NOTE: If the iPAQ Pocket PC battery voltage is low, Bluetooth may not turn on. If you turn Bluetooth on, but do not see the blue LED, charge the battery.**

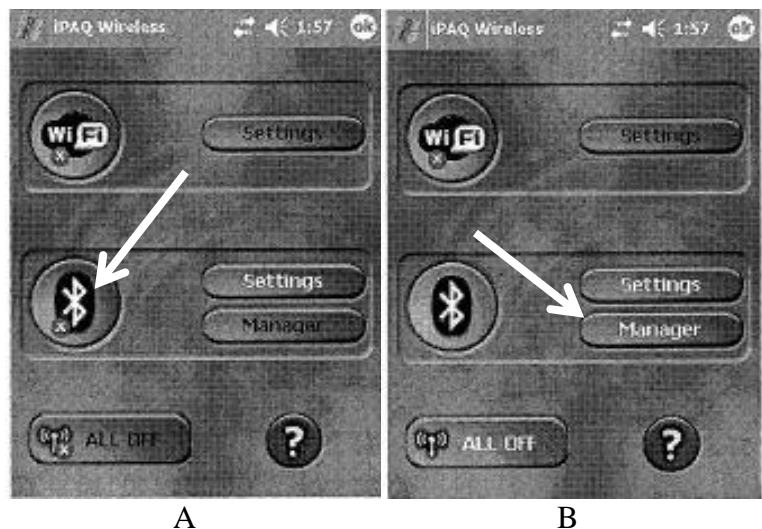
3.3. Bluetooth Basic Operation

- a. To turn on Bluetooth tap the Wireless icon located in the lower right corner of the iPAQ Pocket PC start screen above “Contacts” see black arrow in Figure 6.0. 16 below.



Figure 6.0. 16. Bluetooth wireless icon location on iPAQ

- b. Tap the **Bluetooth icon** to start Bluetooth (see below “A”). The icon will turn gray and the red/white x will disappear and the manager button will light up. When Bluetooth is on the blue LED light at the top left corner of the iPAQ Pocket PC will flash. **Note: using Bluetooth increases battery usage so turn off when not needed!!**



- c. If the iPAQ Pocket PC Bluetooth connection has been previously set up for the StreamPro, **turn on the StreamPro ADCP**. The Amber LED light indicates the

power is on and the battery level is normal (Figure 6.0. 17). If the Amber light is blinking, replace the StreamPro ADCP batteries before connecting (see section 6.1, steps “a” through “h”).

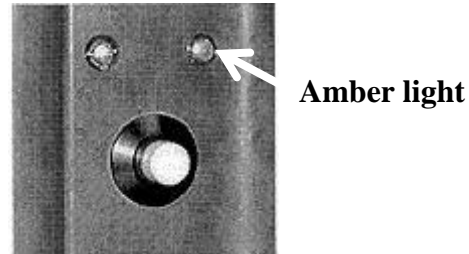


Figure 6.0. 17. StreamPro amber power and battery level light location.

- d. After the StreamPro ADCP is turned on, tap the “**Manager Button**” (see step “b”, picture “B”) then the **My Shortcuts** tab and double tap the RDI SPRO icon (Figure 6.0. 18). This connects the StreamPro with the iPAQ Pocket PC.

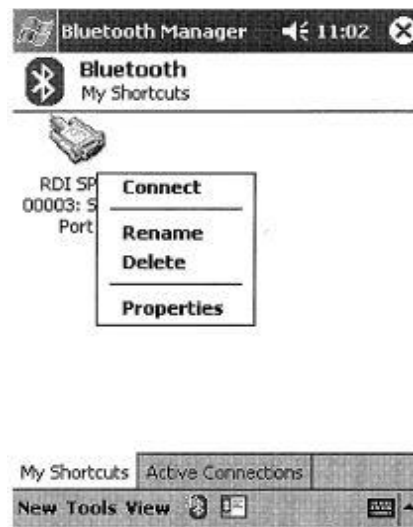


Figure 6.0. 18. RDI SPRO icon location.

- e. If successful, the StreamPro blue light indicator comes on (Figure 6.0. 19). To verify tap the **Active Connection** tab on the iPAQ Pocket PC to view connection.

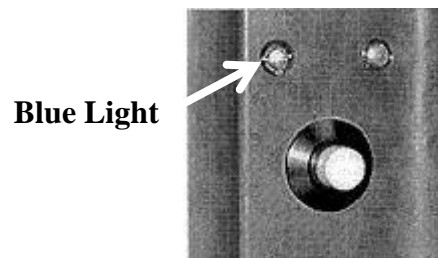


Figure 6.0. 19. Location of the Bluetooth connection light.

3.4. Start StreamPro on the iPAQ PC

- a. Tap Start on the iPAQ Pocket PC and then tap the StreamPro program, see white arrow below (Figure 6.0. 20).

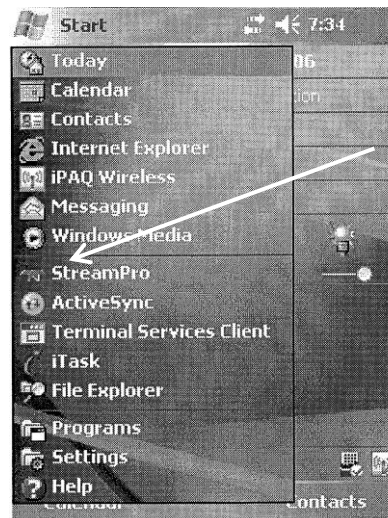


Figure 6.0. 20. Location of the StreamPro program on the start menu.

- b. Select the **StreamPro Application** button to start program (see black arrow Figure 6.0. 21 below).

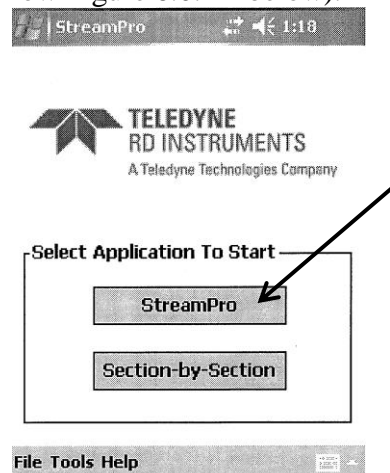


Figure 6.0. 21. StreamPro application button location.

- c. StreamPro will start and show the setup tab (Figure 6.0. 22).

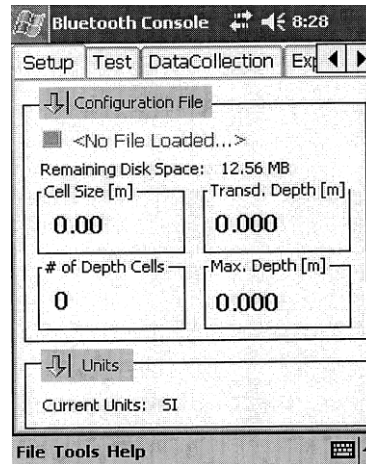


Figure 6.0. 22. StreamPro setup tab screen.


To continue, load a configuration file:

- Tap on “**Configuration File**” on in StreamPro program and select “**Load**”.
 - Select “**SD Card**” and then select “**Project Files**” and then “**FACTORY-DEFAULT.xml**” and tap OK.
 - Make changes in this file unique to your site, **rename and save changes**.
- d. Now the unit is ready to measure flows and calculate discharge. Procedures for collecting streamflow data and discharge are outlined in Section 12.0, “B”, “2”.

3.5 TELEDYNE StreamPro ADCP, adapted from the StreamPro ADCP Operations Manual, 2008.

The StreamPro does not need calibration however the unit should be tested before trip deployment. The following procedure outlines the Self-Test procedure for the StreamPro ADCP (Teledyne, 2008a).

- a. Install fresh batteries (AA) in the StreamPro ADCP battery compartment and press the Red power button to power up the unit.
- b. Turn on the iPAQ Pocket PC and check battery charge percentage (if the battery charge percentage is below 50 percent, recharge the iPAQ battery by plugging it into a USB connector on a laptop or plugging the iPAQ into the docking unit.
- c. Establish a Bluetooth connection from the StreamPro and the iPAQ Pocket PC (see section 6.0 of this manual).
- d. Start the StreamPro program on the iPAQ Pocket PC.
- e. Load the factory default configuration file as follows.

- i. Tap the “**Setup**” tab.
- ii. Tap the “**Configuration File**”.
- iii. Select “**Factory Default**” to set the StreamPro to the default settings. The message should indicate:
 “*Factory Defaults Loaded*”.
- iv. Tap the “**Test**” tab.
- f. Tap “**Instrument**”.
- g. Tap “**Instrument**”.
- h. Tap “**Self-Test**”. Once the test is complete, use the scroll bar on the right side of the screen to view all the test results (See Figure 6.0. 23 below).

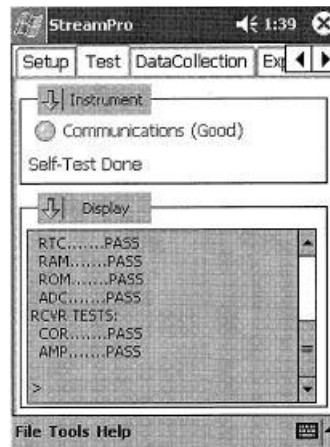


Figure 6.0. 23. Testing and reviewing results the StreamPro iPAQ Pocket PC screen.

- i. If any test fails **DO NOT USE!!** Contact the Project Officer and/or Teledyne RD Instruments.
- j. If all the Self-Test parameters pass the unit is ready for deployment. Disconnect by turning off the Bluetooth connection, powering down the StreamPro ADCP, closing out of the StreamPro application (tap “File” on the lower left of the screen and tap “Exit StreamPro”). Place the StreamPro ADCP, tow ropes, and manuals back in the protective case for deployment.

B. Multi-Parameter Meters

1. YSI Multiprobe Meters (6 series sondes)

The following calibration procedures are for the most commonly used sensors. **While calibrating the instrument, the operator must complete in detail the South Dakota WPP YSI Calibration Worksheet for all applicable probes and Sondes (Appendix A, Table A-1).** For detailed information on all calibration procedures, refer to **Section 2.9.2 of the Instruction Manual, Calibrate** (YSI, 2011).

To ensure more accurate results, the technician can rinse the calibration cup with water, and then rinse the sensor that you are going to calibrate with a small amount of the calibration solution. Discard the rinse solution and add fresh calibration solution. The correct amount of calibration solution will depend on the size of the sensor calibration cup.

- Carefully immerse the probes into the solution and rotate the calibration cup to engage several threads. YSI recommends supporting the sonde with a ring stand and clamp to prevent the sonde from falling over.
- With a field cable connecting the sonde to the 650-MDS access the calibration menu.
- The exact appearance of this menu will vary depending upon the sensors that are available and enabled on your sonde. To select any of the parameters from the “**Calibrate**” menu, highlight the parameter and press “**Enter**”. The following menu will vary depending on the parameter chosen, so refer to the following sections for details on calibrating each probe.

Note: Calibration of the Depth and Level sensor should be completed first at every site, followed by calibration of the Dissolved Oxygen sensor. The remaining sensors only need to be checked at the start of each sampling session.

- After entering the calibration value, or accepting the default value, press “**Enter**”. A real-time display will appear on the screen. Carefully observe the stabilization of the reading of the parameter that is being calibrated. When the readings have been stable for approximately 30 seconds, press “**Enter**” to accept the calibration. When calibrating each parameter **NEVER accept an Out of range warning message “PRESS NO”!** Instead investigate problem such as expired or wrong calibration solution, improperly entered calibration constant, or probe and/or sonde needs cleaning, adjustment and/or replacement.
- Press “**Enter**” to continue and return to the Calibrate menu, and proceed to the next calibration.
- If an **Error message** appears, begin the calibration procedure again. Be certain calibration standard is correct for the calibration parameter and that the value you entered for the calibration standard is correct. Also see Section 6 of the Instruction Manual, Troubleshooting for more information on error messages. If you continue to observe error messages during calibration use the “**Uncal**” procedure outlined in **Section 6.0, B, 2 - YSI Calibration Reset Procedure**; and if that does not remedy the problem contact your Project Officer and/or YSI Customer Service. See **Section 9 of the Instruction Manual, Warranty and Service Information** (YSI, 2011).

In the following sections, specific start-up calibration procedures are compiled for all sensors that commonly require calibration. If a sensor listed is not installed in your sonde, skip that section and proceed to the next sensor until the calibration protocol is complete. Before you use the sonde in the laboratory or field, read and study the detailed calibration information compiled in **Section 2.9.2 of the Instruction Manual, Calibrate** (YSI, 2011).

a. **Temperature**

Temperature does not require calibration*, and is therefore not included in the **Sonde menu / Calibrate** menu.

* Once per year the temperature probe will be tested against a NIST thermometer to monitor temperature probe accuracy and measurement variation. If you think that the temperature probe reading is not correct or it is more than $\pm 0.5^{\circ}\text{C}$ ($\pm 0.9^{\circ}\text{F}$) off, remove the temperature probe, completely dry temperature port, and turn on the 650 MDS and select Sonde run. The temperature of the sonde should display -9.99°C (14.02°F) without its sensor. A sonde with a number other than -9.99°C is most likely dealing with a contaminated port or circuit malfunction. Proceed to the port and probe cleaning procedure described below.

Port and probe cleaning procedure

To remove contamination which can include grease, saltwater electrolyte, and calibration reagents, the probes and sonde can be submerged in hot tap water which has dishwashing soap with degreaser. The water temperature should be around 35° to 40°C . The soapy water mix must be pumped into the open sonde ports and probe connectors to be effective. Using a lab rinse bottle will help flush out the ports. Soak the probe and affected sonde connectors for one hour. Rinse thoroughly with deionized water after the soak. Follow this with a thorough rinse of 90% isopropyl alcohol. Shake or blow dry the port with an air source or allow air-drying overnight.

After the sonde is dry reconnect the cable to the 650 MDS and the sonde without the temperature probe installed and power up. Select Sonde run and observe the temperature reading. The temperature should read -9.99°C . If the sonde reads correctly install the cleaned and dried temperature probe and measure temperature against a NIST thermometer to ensure it is less than $\pm 0.5^{\circ}\text{C}$ ($\pm 0.9^{\circ}\text{F}$). If the temperature reading is still outside the accuracy range order a new temperature/conductivity probe and install.

b. **Depth and Level**

For the Depth and Level calibration, you can leave the sonde set up the same way as for dissolved oxygen, in water-saturated air.

- i. Select “Pressure – Abs (non-vented)”. The depth sensor is factory calibrated, but it is **always necessary to zero the absolute sensor relative to the local barometric pressure.** The zeroing procedure should be carried out with the sonde in air for this initial calibration. Alternatively, you may set zero or an offset while the sonde is submersed for “relative depth” applications. After the depth option is selected, enter 0.00 or other appropriate value in meters or feet (0.47 m or 1.54 ft. for the 600 XL sondes, .35 m or 1.17 ft. for 6820 sondes and 0.30 m or 1.00 ft. for the 6600 sondes depending on your Report Setup) at the prompt, press “**Enter**” and monitor the stabilization of the depth readings. After no changes occur for at least 30 seconds, press “**Enter**” to confirm the calibration. This zeroes the sensor with regard to current barometric pressure. As instructed, press “**Enter**” again to return to the **Calibrate** menu.
- ii. Zeroing the depth sensor by the above protocol (entering 0.00 at the screen prompt) will result in a measurement of the distance between the water surface and the ports of the depth module. In order for the observed depth readings to reflect the distance between the water surface and the actual probe array, measure the length between the upper hole and the bottom of the sonde guard. Then, if you are concerned about this small difference, enter the measured difference (0.47 m or 1.54 ft. for the 600 series sondes, .35 m or 1.17 ft. for 6820 sondes and 0.30 m or 1.00 ft. for the 6600 sondes depending on your Report Setup) at the screen prompt instead of 0.00.

For best performance of depth measurements, users should ensure that the sondes orientation remains constant while taking readings. This is especially important for vented level measurements and for sondes with side mounted pressure sensors.

c. **ROX Optical Dissolved Oxygen (ODO)**

Unlike all other sensors for YSI 6-series sondes, the response of the ROX Optical DO sensor is not linear relative to the species being measured. This non-linearity requires that the sensor be factory-calibrated at a number of oxygen values and the data fit to a third-order regression. The three constants and the sensor value at zero dissolved oxygen which define this regression analysis are automatically stored in the sensor at the time of factory-calibration. **It is important to note that these constants are a function of the sensor membrane installed on the 6150 probe and NOT a function of the probe; i.e., the constants reflect the characteristics of the sensor membrane and NOT the probe.**

When a 6150 probe is purchased from YSI, it already has a sensor membrane installed and the constants of that membrane are transferred automatically to the sonde PCB when the sensor is run for the first time. After transfer, the regression constants ODO K2-ODO K4 and the value at zero oxygen, K1, can be viewed by accessing the **Advanced|Cal Constants** menu.

It should also be noted that the ROX sensor is characterized by two additional parameters – ODO Gain and Tzero. The ODO gain reflects the small change in the calibration which is carried out by the user in a 1-point calibration as described below. The Tzero value will always be the same as K1 until the user elects to perform a 2-point calibration as described below, at which time it will change slightly to reflect the adjustment of the zero oxygen value. You will also note that a different set of constants for your specific sensor membrane are supplied on the instruction sheet which came with your 6150 probe. These five constants (K1-K4 and C) have a different appearance than those shown in **Advanced|Cal Constants** because they are in coded form to allow error free reentry by the user in the unlikely event that the regression constants in the probe are lost. The C constant is a check sum value associated with the values of K1-K4 and will prevent acceptance of the constants if typographical errors are made in their entry by the user. The coded constants must be entered in the **Calibrate|Optic X – Dissolved Oxy|Enter Cal Sheet** as shown below. The constants can also be viewed at any time by selecting **Calibrate|Optic X – Dissolved Oxy|View Cal Sheet**.

YSI recommends that you replace your sensor membrane after 1 year of use by purchasing the 6155 Optical DO Membrane Replacement Kit. This kit will be supplied with a new set of coded constants which characterize the new membrane and they **MUST** be entered via the **Calibrate|Optic X – Dissolved Oxy|Enter Cal Sheet** selection as show above. Once the new constants have been entered in coded form they will be transferred to the probe and will be visible in un-coded form in **Advanced|Cal Constants**.

NOTE CAREFULLY: As opposed to the 6562 Rapid Pulse Polarographic DO sensor described above, there is no difference between the calibration routine for sensors which will be used for sampling or monitoring applications. Usually the **Autosleep RS-232** feature in the **Advanced|Setup** menu will be activated for ROX calibrations, but there is no problem if it is not active.

Select the **Optic X-Dissolved Oxy** option from the Calibrate menu to calibrate the oxygen probe. The submenu will offer the technician the option of calibrating in percent air-saturation

(ODOsat %), or concentration (mg/L). Calibrating either of the choices will automatically calibrate the other. Select the ODOsat % in air-saturated water, you will be prompted for the next step where you must elect to do either a 1-point or a 2-point calibration. Except under unusual circumstances (conditions near zero dissolved oxygen), **the user should select the 1-point calibration.**

i. 1-Point Dissolved Oxygen Calibration Using Percent Air Saturation

Use this method for calibration of your 6150 Dissolved Oxygen Sensor to obtain the maximum accuracy under normal operating conditions.

- (a) Place the sensor into a calibration cup containing about 1/8 inch of water which is vented by loosening the threads. Wait approximately 10 minutes before proceeding to allow the temperature and oxygen pressure to equilibrate.
- (b) Select **ODOsat %** and then **1-Point** to access the **DO calibration procedure**. Calibration of your Optical dissolved oxygen sensor in the DO % procedure also results in calibration of the DO mg/L mode and vice versa.
- (c) Enter the current barometric pressure in mm of Hg. (Inches of Hg x 25.4 = mm Hg).
- (d) **Note:** Laboratory barometer readings are usually “true” (uncorrected) values of air pressure and can be used “as is” for oxygen calibration. Weather Service readings are usually not “true”, i.e., they are corrected to sea level (CBP), and therefore cannot be used until they are “uncorrected” (UBP). The procedure and formula for this “un-correction” (where the BP readings MUST be in mm Hg) are as follows:
 - Obtain barometric pressure reading (BP) from nearest location (airport or town).
 - Convert current barometric pressure inches to mm of Hg. (Inches of Hg x 25.4 = mm Hg).
 - Calculate the correction factor (CF):
$$CF = \frac{760 - (Altitude \times 0.026)}{760}$$
 - To calculate the un-corrected barometric pressure (UBP) multiply the corrected

barometric pressure (CBP) by the previously calculated correction factor CF:

- **$CBP \times CF = UBP$.**

- (e) Press “**Enter**” and the current values of all enabled sensors will appear on the screen and change with time as they stabilize. Observe the readings under **ODOsat %**. When they show no significant change for a minimum of 30 seconds, press “**Enter**”. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to return to the Calibrate menu.

- (f) **NOTE:** the sonde will only read 100% saturation if the barometric pressure is 760 mmHg. To determine the actual DO in %, divide the barometer reading by 7.6.

Example: $695 \text{ mmHg} \div 7.6 = 91.45\%$

- (g) Check the ODO Gain in the **Advanced Menu**. An acceptable range is 0.85 to 1.15, NOTE: Maximum range before getting error message is $1 \pm .25$.

d. **Conductivity**

This procedure calibrates specific conductance, conductivity, and salinity.

- i. Place the correct amount of conductivity standard into a clean, dry, or pre-rinsed calibration cup.
- ii. For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the water you are preparing to sample. However, we do not recommend using standards less than 1 mS/cm. For example:

- For fresh water, use a 1 mS/cm conductivity standard.
- For brackish water use a 10 mS/cm conductivity standard.
- For seawater use a 50 mS/cm conductivity standard.

SD DENR WPP uses conductivity standard produced by the South Dakota Public Health Laboratory in Pierre, SD and is 1,410 $\mu\text{S/cm}$ (1.410 mS/cm) @ 25 °C or as indicated on the bottle label

- iii. Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of used standard solution that can be discarded. Be

certain that you avoid cross-contamination of standard solutions with other solutions. Make certain that there are no salt deposits around the oxygen and pH probes, particularly if you are employing standards of low conductivity.

- iv. Carefully immerse the probe end of the sonde into the solution. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell. The probe must be completely immersed in calibration solution past its vent hole. Use a volume that ensures that the vent hole (the 1 cm opening in the conductivity probe) is covered with solution.
- v. Allow at least one minute for temperature equilibration before proceeding.
- vi. From the **Calibrate** menu, select **Conductivity** to access the conductivity calibration procedure and press “**Enter**”. Then select **SpCond** to access the specific conductance calibration procedure and press “**Enter**”. Enter the calibration value (**be sure to enter the standard value as mS/cm at 25° C (1.410) not 1,410 µS/cm**) based on the standard you are using and press “**Enter**”. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- vii. Observe the readings under **Specific Conductance µS/cm^c**. When temperature and specific conductance show no significant change for a minimum of 30 seconds, press “**Enter**”. The screen will indicate that the calibration has been accepted (successful) and prompt you to press “**Enter**” again to return to the **Calibrate** menu.
- viii. Rinse the probe and calibration cup in de-ionized water and carefully dry afterward to begin pH calibration.

e. **pH 2-Point**

Using the correct amount of pH 7 buffer standard in a clean, dry or pre-rinsed calibration cup, carefully immerse the probe end of the sonde into the solution. Allow at least 1 minute for temperature equilibration before proceeding.

- i. From the Calibrate menu, select **ISE1 pH** to access the pH calibration choices and then select **2-Point**. Press “**Enter**” and input the value of the buffer at the prompt.
- ii. **NOTE: The actual pH value of all buffers is somewhat variable with temperature and that the correct value from the bottle label for your calibration temperature should be entered for maximum accuracy. For example, the pH of YSI “pH 7 Buffer” is 7.00 at 25 °C, but 7.02 at**

- 20 °C.** Table 6.0. 1 shows temperature compensation values for three commonly used pH buffers.
- iii. After entering the correct pH value of the buffer, press Enter and the current values of all enabled sensors will appear on the screen and change with time as they stabilize in the solution. Observe the readings under pH and when they show no significant change for a minimum of 1 minute, press Enter. The display will indicate that the calibration is accepted. On the SD DENR WPP YSI CALIBRATION WORKSHEET write down the calibration solution temperature, standard, pre-calibration after stabilizing, and post calibration values and the post calibration pH millivolts for span calculation.
 - iv. After the pH 7 calibration is complete, press Enter again, as instructed on the screen, to continue. Rinse the sonde in water and dry the sonde before proceeding to the next step.
 - v. Using the correct amount of pH 10 buffer standard into a clean, dry or pre-rinsed calibration cup, carefully immerse the probe end of the sonde into the solution. Allow at least 1-minute for temperature equilibration before proceeding.
 - vi. Press Enter and input the correct value of the second buffer for your calibration temperature (Table 6.0. 1) at the prompt. Press Enter and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize in the solution. Observe the readings under pH and when they show no significant change for a minimum of 30 seconds, press Enter. After the second calibration point is complete, press Enter again, as instructed on the screen, to return to the Calibrate menu. On the SD DENR WPP YSI CALIBRATION WORKSHEET write down the calibration solution temperature, standard, pre-calibration after stabilizing, and post calibration values and the post calibration pH millivolts for span calculation.
 - vii. Rinse the sonde in water and dry. Thoroughly rinse and dry the calibration containers for future use.

NOTE: The majority of environmental water of all types has a pH between 7 and 10. Therefore, unless you anticipate a pH of less than 7 for your application, YSI recommends a two point calibration using pH 7 and pH 10 buffers.

Table 6.0. 1. Temperature compensation values for three commonly used pH buffers.

Temperature		pH		
°F	°C	4.00	7.00	10.00
32.0	0	4.01	7.13	10.34
33.8	1	4.01	7.12	10.32
35.6	2	4.01	7.12	10.30
37.4	3	4.01	7.11	10.32
39.2	4	4.00	7.11	10.29
41.0	5	4.00	7.10	10.25
42.8	6	4.00	7.09	10.24
44.6	7	4.00	7.09	10.23
46.4	8	4.00	7.09	10.23
48.2	9	4.00	7.08	10.21
50.0	10	4.00	7.07	10.19
51.8	11	4.00	7.07	10.18
53.6	12	4.00	7.06	10.16
55.4	13	4.00	7.06	10.15
57.2	14	4.00	7.05	10.13
59.0	15	4.00	7.05	10.12
60.8	16	4.00	7.04	10.11
62.6	17	4.00	7.04	10.10
64.4	18	4.00	7.03	10.08
66.2	19	4.00	7.03	10.07
68.0	20	4.00	7.02	10.06
69.8	21	4.00	7.02	10.07
71.6	22	4.00	7.03	10.09
73.4	23	4.00	7.02	10.06
75.2	24	4.01	7.01	10.03
77.0	25	4.01	7.00	10.00
78.8	26	4.01	7.00	9.99
80.6	27	4.01	7.00	9.98
82.4	28	4.01	6.99	9.96
84.2	29	4.01	6.99	9.95
86.0	30	4.01	6.99	9.94
87.8	31	4.01	6.99	9.95
89.6	32	4.01	6.99	9.96
91.4	33	4.02	6.98	9.96
93.2	34	4.02	6.98	9.97
95.0	35	4.02	6.98	9.98
96.8	36	4.02	6.98	9.95
98.6	37	4.02	6.98	9.93
100.4	38	4.03	6.97	9.90
102.2	39	4.03	6.97	9.88
104.0	40	4.03	6.97	9.85

2. YSI Calibration Reset Procedure (6 series sondes)

The reset procedure should be used only if errors are encountered during calibration (indicates that the meter is set out of the solution range).

- a. Turn the YSI 650 MDS handheld to **On**.
- b. Select **Sonde menu** and press “**Enter**”.
- c. From this menu select the **Advanced** option and press “**Enter**”.
- d. Next select the **Cal constants** and press “**Enter**”.
- e. After selecting, make sure all values on the YSI are within their operating ranges as those found in Table 6.0. 2. If operating ranges are outside of the ranges listed in Table 6.0. 2, they were mainly from accepting calibration when an “Out of range” warning message appeared. **This forces (sets) values outside of their normal operating range and measured values for each specific**

parameter will not be accurate. When calibrating each parameter **NEVER** accept an Out of range warning message “PRESS NO”! (If accepted by the operator **FINGERS WILL BE BROKEN!!!!!!!!!!!!**) Instead investigate problem such as expired or using the wrong calibration solution, improperly entered calibration constant, or probe and/or sonde needs cleaning, adjustment and/or replacement. Make note of those incorrectly set and press the Escape key two times to return to the main menu. **Contact your Project Officer for help with this problem and write problems and repairs in the PROJECT LOGBOOK and in comments section of the SD DENR WPP YSI CALIBRATION SHEET.**

Table 6.0. 2. YSI calibration constants.

<i>Parameter</i>	<i>Default</i>	<i>Operating range</i>	<i>Comments</i>
Cond:	5	4 to 6	Traditional cell constant
DO gain:	1	0.5 to 2.0	
ODO gain	1	0.75 to 1.40	
ODO Tzero	Same as K1	+/- 0.45 from K1	ODO value at zero oxygen after 2-point cal
ODO K1	N/A	N/A	ODO value at zero oxygen
ODO K2	N/A	N/A	ODO regression coefficient
ODO K3	N/A	N/A	ODO regression coefficient
ODO K4	N/A	N/A	ODO regression coefficient
Pres offset:			
if not vented	-14.7	-20.7 to -8.7	
if vented	0.0	-6 to 6	
mV offset:	0.0	-100 to 100	
pH offset:	0.0	-400 to 400	
pH gain:	-5.0583	-6.07 to -4.22	

- f. From the main menu, select Calibrate and press Enter.
- g. Select one parameter that was out of adjustment and enter through options until required to enter the calibration constant value.
- h. Instead of entering the calibration constant value, hold down the Enter key and press Esc key to enter the “Uncal?” prompt select Yes and press Enter. This resets the range to the **default value** listed in Table 6.0. 2.
- i. Repeat steps “g” through “h” for each of the values that are out of adjustment.

3. YSI Data Download Procedure (6 series sondes)

- a. Install download cable to 650 MDS and connect to the serial port (Com 1 or other appropriate Com Port) on the computer.
- b. Turn on computer and **open EcoWatch software.**
- c. Select **Comm, settings** and **Port Setup.**
- d. Select **Com Port (Com 1)** used by computer under **Settings for Port.**
- e. For “Port Parameters” select **Baud - 9600, Data – 8-bits and Parity – None.**
- f. For “Protocol” select **Kermit.**
- g. For “Handshaking” select **XonXoff.**

- h. Select **"OK"** to accept these settings.
- i. Select **Comm, Terminal** and **Com 1**; a dialog box will appear that the program is ready to accept data.
- j. Power up 650 MDS.
- k. Select **Communications** and press **"Enter"**.
- l. Select **Kermit 650** **PC →** and press **"Enter"**.
- m. Select desired file(s) to transfer or **All Files** and press **"Enter"**.
- n. Each transferred file is transferred as a ****.dat** file into the EcoWatch program under ECOWIN/Data.

4. **Creating Site List on YSI 650 MDS**

- a. Turn on YSI 650 MDS.
- b. Select **"Logging Setup"**.
- c. **Check** the **"Use Site List"** box and the display will increase.
- d. Select **"Edit Site List"** at the bottom of the list.
- e. Enter Filename, site name, and site number as needed.
- f. When finished press **"Escape"**

5. **Setting up YSI Unattended Data Logging (6600 Sondes Only)**

- a. Connect a 650 MDS to a calibrated 6600 Sonde.
- b. Turn on 650 MDS.
- c. Select **"Sonde menu"** and press **"Enter"**.
- d. Select **"Run"** and press **"Enter"**.
- e. Select **"Unattended sample"** and press **"Enter"**.
- f. Set **"Interval"** to 15 minutes and press **"Enter"**.
- g. Start date and time should be defaulted as long as the date and time on the Sonde is correct, if different check Sonde date and time and adjust as necessary. Go back into **Run, Unattended sample** and check the **Start date and Start time** the **Start time** should be 15 minutes from the time the operator selected the **Unattended sample** section. If needed, the Start date and time still be adjusted, just select either and change as needed.
- h. Enter unique **"File"** name and press **"Enter"**.
- i. Enter unique **"Site"** name and press **"Enter"**.
- j. Check the Free memory to make sure there is enough logging memory for the file. If not, download data to clear memory.
- k. Highlight the **"1st sample in x.xx minutes"** and press **"Enter"** to update the time until first sample. If the operator needs more time for setup and deployment, go back up to **"Start time"** and adjust time for more minutes until 1st sample.
- l. Highlight **"View parameters to log"** and adjust as needed.
- m. When satisfied, highlight **"Start logging"** and press **"Enter"**.
- n. The operator can view current data only after the first sample is logged by re-connecting the 650 MDS to the Sonde in the field and selecting **"Sonde menu"**, **"Run"**, **"Unattended sample"**, and highlighting the **"View last sample"** and press **"Enter"**. After reviewing data, disconnect 650 MDS, cable, cap the Sonde with a

water proof cap, install weighted sonde guard, and re-deploy the Sonde.

6. YSI EXO Handheld Calibration and Operation Instructions

a. Powering up and connecting to the YSI EXO:

1. Press green power button on EXO handheld.
2. **Connect to the sonde:** Connect the field cable ends to the handheld (black end of the cable) and sonde (white end of cable). Be sure that connections are tight. If the handheld is powered up when connected to the sonde using a field cable, it will automatically connect.

b. Setting up the YSI EXO for Sampling:

To collect data at a point

Example: using the YSI from a bridge or in a stream to collect one water quality measurement.

- a. Press the “**Deploy**” button and then select “**Sonde Settings.**” In this menu, select “**Averaging**” and then select “**Accelerated**”. This makes the data readout from the probe stabilize at an appropriate rate for collecting data at a point.

c. Creating Sites in the Site List and Logging Data

Example: Adding monitoring site(s) names to the YSI EXO handheld to log sonde water quality measurement data from a bridge or stream monitoring site.

Creating Sites in the Site List

1. Press the “Handheld” button on the top left of the EXO handheld.
2. Scroll down to “Logging” and press the enter button.
3. Make sure that the “**Use Site List**” box is checked. Scroll down to “Site” and press the enter button.
4. Select “**Add new...**” Select “**Site Name**” and enter the site name. Enter latitude, longitude, and altitude if desired.
5. Select “**Save**”. The site is now included in the Site List.
6. Repeat as needed to add additional monitoring sites.

Log a Single Sample

1. On the EXO Handheld dashboard, select “**Log One Sample**”.

2. To log the sample to an existing site in the site list, select **“Site”** and select the appropriate site from the site list.
3. Select **“Log Now!”** A sample will be logged to the site that was selected. This site is now displayed in the menu next to **“Site”**.
4. When returning to monitor the same site at a later date the operator can select the initial site file and log the current data (**Log Now**) from the site and the more recent data will be logged using the current date.

d. **To View Saved Measurements**

1. Press the **“Data”** button. Choose the site from the site list for the data you wish to view. Apply any desired begin and end dates and times. If viewing data saved to the handheld, ensure that **“Handheld”** is displayed next to **“Source.”** If viewing data saved to the sonde, ensure that **“Sonde”** is displayed next to **“Source”**.
2. Select **“Show data”** to view numerical data, or select **“Graph data”** to see the data presented as a graph.

1. **To Log Data Continuously**

1. Press the **“Handheld”** button in the top row of orange buttons on the EXO handheld. Press the **“Handheld”** button on the top left of the EXO V2 handheld.
2. Ensure that the **“Continuous Mode”** box is checked. If logging to a site in the site list, ensure that the **“Use Site List”** box is also checked.
3. Set the logging interval by selecting **“Log Interval”** and using the keypad to enter the desired amount of time that passes until another sample is saved.
4. Press the **“Deploy”** button to bring up the Dashboard. Select **“Start Logging...”** and ensure that the log interval and site are correct. Select **“Start Now.”**
5. To stop logging data continuously, select **“Stop Logging.”**

C. **Stage Recorders and Data Loggers**

A variety of stage recorders and data loggers are used by SD DENR WPP, each with different setup, download and calibrating methods. Specific device methods are given in the following sections. Calibrate each instrument in accordance with the manufacturer instructions. If problems occur, contact the Project Officer or the equipment manufacturer.

1. Configuring OTT Thalimedes using Hydras 3 software.

This procedure initializes the OTT Thalimedes and sets the unit up for stage recording and data collection.

1.1. Initial Setup OTT Thalimedes

- a. Start the Hydras 3 software and select **New Workspace** under the **File** menu.
- b. Use the name of your project to name the workspace.
- c. Double click Hydras 3 to create path
- d. Once the workspace is created, click the (+) sign next to the **Workspace**.
- e. Highlight All Stations.
- f. Select **Communication** and **Read / Operate** from the Hydras 3 menu.
- g. Select **OTT Thalimedes** from the sensor type menu. Make sure the Protocol type is set at **OTT Protocol 2 (selective)** and Communication path **IrDA OTT IrDALink (USB) COMx.19200Bd** for use on any USB port on the computer or **IrDA LinkIt Adapter, COM1 (or other computer specific COM port), 19200Bd, and 8N1** to use the infrared reader. To use direct connect with a serial port installed on the logger under **Communication** select **RS232C/ V24, Com 1 (or other computer specific COM port), 19200Bd, and 8N**.
- h. Then Select **Configuration Hydrosens (Matrix) or Orphim/Thalim/Nimbus** radio button to program the unit.
- i. Connect the IrDA LinkIt Adapter to a serial cable and attach it to the serial port (**COM1**) or on the computer or if direct connecting attach the serial cable to the serial port tail connector installed on the Thalimedes and to the serial port on the computer.
- j. If using a newer computer without a serial port, connect a **USB to RS232 adapter to a USB port** on the laptop and connect a **RS232 serial cable to the RS232 serial connector on the adapter. Then connect the serial cable to the serial port tail connector installed on the Thalimedes.**
- k. Wake the Thalimedes by placing your hand over the infrared motion sensor (two red sensors at the lower left corner of the display) until the display is visible (approximately 2-4 seconds).
- l. While pointing the reader at the IrDA interface sensor or attaching the sensor to the Thalimedes using a rubber band, select **“Start”**.
- m. After the computer uploads the sensor data, make sure that:
 - i. Input new **Station Name** and **Number**.
 - ii. Select **Units** in feet or meters.
 - iii. Set the sensor to **sample every 5 minutes** (Sample interval) and **record every 15 minutes** (Storage interval).
 - iv. Measure the Stage and **check box next to Meas. Value** – set new and enter new stage.

- v. During initial setup check Erase Data Storage Box.
- vi. **Check the computer and make sure the time and date on the computer is correct.**
- vii. Check **Set date / time (PC time) Box.**
- viii. Select **Set Clock to PC time (**
- ix. Make sure that the **Baud rate RS232C is set at 19,200Bd.**
- n. Wake the Thalimedes unit and place IrDA LinkIt or USB IrDA Link adapter over the IrDA interface sensor on the Thalimedes.
- o. Select **Program.**
- p. After programing is complete, review the screen to ensure that all entries have been updated and are correct. If not make changes and select Program again.
- q. Select **Exit.**
- r. Select **Standard (selective)** under Read data.
- s. Make sure the All sensors and the All box under dates are checked.
- t. Select **Start** (information will show up in the bottom left corner of the Hydras 3 Communication screen).
- u. When complete, click **End.**
- v. Select **Communication** and **Raw data management** from the Hydras 3 menu. The unit (file) that was just downloaded is highlighted.
- w. Click the **Selected** button that will transfer the sensor and station information from the download file to the workspace file.
- x. A Confirm screen will come up stating that the station (for this workspace) has not been entered! Create new entry? Select **Yes.**
- y. Another confirm screen will come up stating that the sensor (for this station) has not been entered! Create new entry? Select **Yes.**
- z. Close raw data management window.
- aa. Once window closes, click the (+) sign next to the All Station and make sure the new station shows up on the 'all station' list for the project workspace.
- bb. Click the (+) sign next to the New Station and make sure the sensor is listed.
- cc. Double click on the sensor to bring up the Evaluation screen.
- dd. The unit is now programmed and ready for use at that site.

1.2. Downloading Data (OTT Thalimedes)

- a. Start the Hydras 3 software.
- b. Select (highlight) the desired project (workspace).
- c. Connect the **IrDA LinkIt Adapter** to a serial cable or a **USB IrDA Link adapter** and attach it to the serial port (**COM1, or other computer specific COM port**) or a USB port on the computer.
- d. Click the (+) sign next to the highlighted project.
- e. Click the (+) sign next to the All Stations.
- f. Highlight specific station for downloading.

- g. Select **Communication** and **Read / Operate** from the Hydras 3 menu.
- h. Select **Thalimedes** from the sensor type menu. Make sure the Protocol type is set at **OTT Protocol 2 (selective)** and select **IrDA LinkIt Adapter or USB IrDA Link adapter** on the USB port under Communication path.
- i. Check the box in front of **Standard (selective)**.
- j. Make sure the **All sensors** and **All** box under dates are checked.
- k. Wake the Thalimedes unit and place IrDA LinkIt Adapter or the USB IrDA LinkIt Adapter over the IrDA interface sensor on the Thalimedes.
- l. Select **Start** (information will show up in the bottom left corner of the Hydras 3 Communication screen).
- m. When complete, click **End**.
- n. Select **Communication** and **Raw data management** from the Hydras 3 menu. The unit (file) that was just downloaded is highlighted.
- o. Click the **Selected** button transfer the data to the station and sensor.
- p. Click the (+) sign next to the station just transferred.
- q. Double click on the sensor to bring up the Evaluation screen to view and analyze data.
- r. Repeat above procedure at all remaining stations.
- s. **If unable to connect or download data with the IrDA LinkIt Adapter, follow the instructions below to direct connect the OTT Thalimedes.**

1.3 Direct Connection to OTT Thalimedes RS-232 serial cable

- a. Obtain one short (female-female) RS-232 serial cable (**non-modem cable**).
- b. Cut the serial cable approximately **9 inches** from each end to create two useable connection/download cables (one cable for each OTT Thalimedes unit that has difficulty connecting/downloading).
- c. Unscrew the battery cap and remove the battery and cap.
- d. Grasp the clear cover over the Thalimedes unit and press firmly down to remove the cover exposing the circuit board.
- e. Remove the protective cap next to the permanently wired cap at the end of the unit.
- f. Break out the end of the cap and thread the cut end of the serial cable created in step “b” through the non-threaded end of cap until **one** inch of the cable is through the cap.
- g. Strip off $\frac{3}{4}$ of an inch of the outside protective cover to reveal the wires inside.
- h. Separate the Red, Brown and Yellow wires.
- i. Cut the remaining wires off flush with the end of the protective cover ($\frac{3}{4}$ of an inch) serial cable.

- j. Strip off 3/8 of an inch of the outside protective cover of the Red, Brown and Yellow wires.
- k. Using a small flat tip screwdriver, attach wires to bus connector locations (terminal strip, Figure 6.0. 24) described below (Table 6.0. 3):

Table 6.0. 3. Serial cable wire color connections to OTT Thalimedes bus connector locations.

Wire Color	Bus Location
Red	RxD
Brown	TxD
Yellow	GND

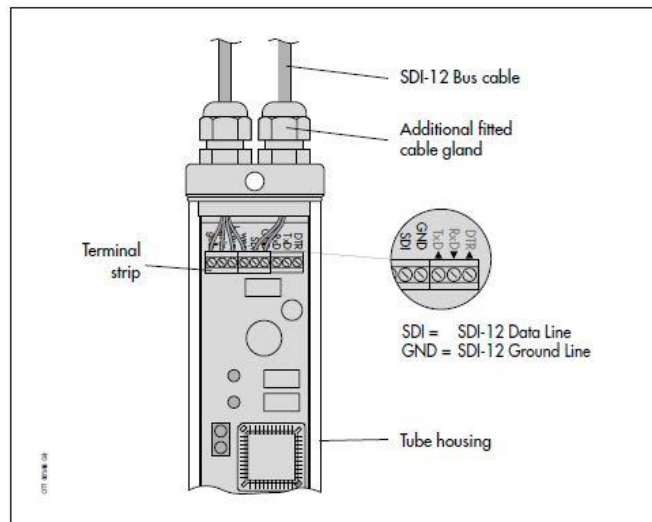


Figure 6.0. 24. Terminal strip and buss location for OTT Thalimedes encoders.

- l. Once wires are locked in their proper locations apply silicone around where the cable goes through the bulkhead (Top and Bottom). Grasp the clear cover over the Thalimedes unit and press firmly upward and twist to replace the protective cover over the circuit board.
 - m. Replace the battery and screw on the battery cap.
 - n. The unit is now ready to directly download.
2. **Configuring OTT Orpheus Mini (Using Orpheus Mini software).**
 - a. Connect the **USB “Linkit” adapter** to the laptop and turn the computer on.
 - b. Start the OTT Orpheus Mini operating program.
 - c. **Place the magnetic infrared end of the USB “Linkit” adapter on the infrared communication interface port** on the top of the Orpheus mini.

- d. To initially program the Orpheus Mini select **File** in the upper left hand corner of the startup screen.
- e. Under the **General** box click the **Advanced Operations** box and make sure **no boxes are selected** in the **Observer** box and select **OK**. (This ensures the **Setup Device** button appears on the startup screen).
- f. Select the **Setup Device** button on the main screen which **opens the Basic Operations screen (Figure 6.0. 25)**.

Figure 6.0. 25. OTT Orpheus Mini programming screen for the Orpheus Mini (adapted from the Operating Instructions for the OTT Orpheus Mini (QTT OM, 2016).

- g. Select **File** tab in the upper left portion of the screen and select **New configuration OTT Orpheus mini**.
- h. Under **Number Type** in the **site name and number** (i.e. WWCBact02a).
- i. Type in measurement station name.
- j. **Pressure Sensor**
 - i. Use number provided (0001), or generate unique one (up to four digits).
 - ii. **Keep** the name **Water level**.
 - iii. **Measurement type / Measurement Range**, select **Water Level and Depth**.
 - iv. **Unit**, select **(ft (0.01))**, check the **Set Water level – set newly** Box, and **type in the water level from the staff gauge**.
 - v. **Sample interval**, select **5 minutes (00:05:00)**.
 - vi. **Storage interval**, select **15 minutes (00:15:00)**.

- k. **Temperature**
 - i. Use number provided (0002), or generate unique one (four digits).
 - ii. Keep the **name Temperature**.
 - iii. **Unit, select (°C (0.01))**,
 - iv. **Sample interval, select 5 minutes (00:05:00)**.
 - v. **Storage interval, select 15 minutes (00:15:00)**.
- l. Place the infrared end of the **USB “Linkit” adapter on the infrared communication interface port** on the top of the Orpheus mini.”
- m. Press the **Set date/time button** to use the computer **date/time** or to manually make adjustments to the date or time (the operating program automatically corrects for daylight saving and leap year).
- n. At this point **review entries** and when satisfied press **Program**. This will generate a warning message, **“Warning: Reset Orpheus Mini and delete data memory additionally?”**, press **“Yes”** (recommended for initial and new installations). **CAUTION: All measurements collected up to this point will be irretrievably lost!!!!**
- o. When satisfied click **OK**.
- p. **Re-check entries** one more time to verify that values and entries correct, **if satisfied click the back button (bottom right corner)**. This will return you to the main page
- q. Then **check the water level using a staff gauge or other measuring device to determine the stage**.
- r. Check the level of the measure value setting by clicking the word **“File”** in the upper left hand corner of the screen and select **“Option”**, under the **Observer section** select **“Only observer mode”** box and click **“OK”**.
- s. Then select the **“Setup Device”** button on the main menu. The **main screen will disappear** and the **Basic operation screen will flash up and then disappear** and the **Observer screen will show up**. After a few seconds the Observer screen will indicate the **instantaneous values of water level, water temperature, and battery voltage**. ***Note if the battery voltage is less than 3.5 to 3.6 volts REPLACE BATTERIES!**
- t. If the water level (stage) **does not correspond to the measured value collected earlier, enter the correct value** in the water level box and then select the **“Refresh”** button. This resets (reprograms) the water level in the data logger and the value will disappear from the water level box and display to the right of the box on the screen.
- u. **To check for variation in the water level measurements** click the **“Automatic refresh”** box below the refresh button. This takes a water level reading from the probe every 5 seconds and displays it on the screen. **When satisfied de-select the “Automatic refresh” box**.

- v. Then select the **“Exit”** button to return to the main screen. ****Note** when the main screen appears the setup device button has changed to **“View Instantaneous Values”**. If you need to program more Orpheus Mini units, clicking the word **“File”** in the upper left hand corner of the screen and select **“Option”**, under the Observer section and **DE-SELECT** the **“Only observer mode”** box and click **“OK”**. The Setup Device button will be displayed again on the main screen.

2.1. Downloading OTT Orpheus Mini (using Orpheus Mini software).

Downloading protocols for use OTT Orpheus Mini data loggers via laptop computers and Orpheus Mini software.

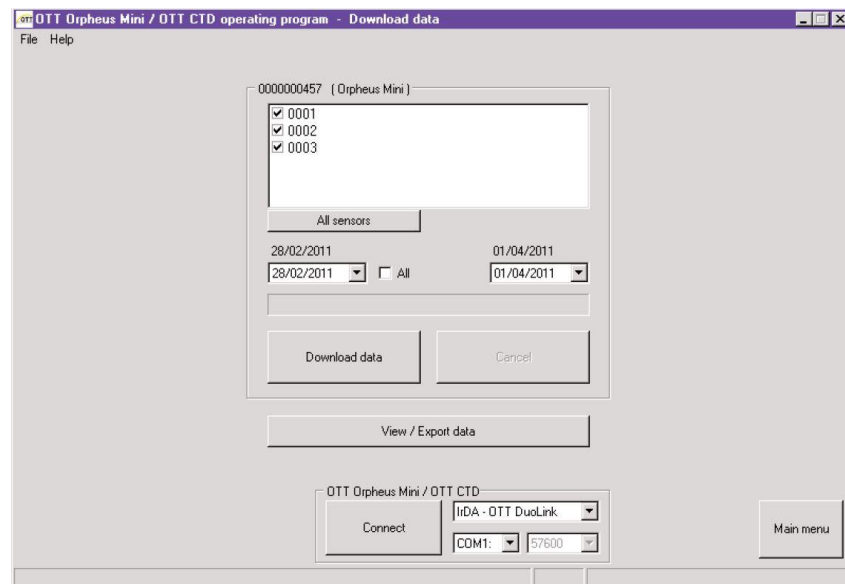


Figure 6.0. 26. OTT Orpheus Mini Downloading Data screen (adapted from the Operating Instructions for the OTT Orpheus Mini (QTT OM, 2016).

- a. Connect the USB **“Linkit”** adapter to the laptop and turn the computer on.
- b. **Start the OTT Orpheus Mini** operating program.
- c. Place the magnetic infrared end of the USB **“Linkit”** adapter on the infrared communication interface port on the top of the Orpheus mini housing.
- d. From the **OTT Orpheus Mini opening screen** click on the **“Download Data”** bar.
- e. The download screen appears with the site name or sensor number above the available sensors check marked (Figure 6.0. 26).
- f. Enter a **desired date range** or select the **“all” data box** for downloading the all recorded data in the data logger.

- g. When satisfied click the Download data button to begin downloading (Figure 6.0. 26).
- h. Once clicked, a progress bar is displayed while the data is being downloaded. When downloading is complete for all sensors (may take up to 20 minutes), the progress bar disappears.
- i. When complete click on the “**View / Export data**” button (Figure 6.0. 26) to open the View / Export Data screen (Figure 6.0. 27).

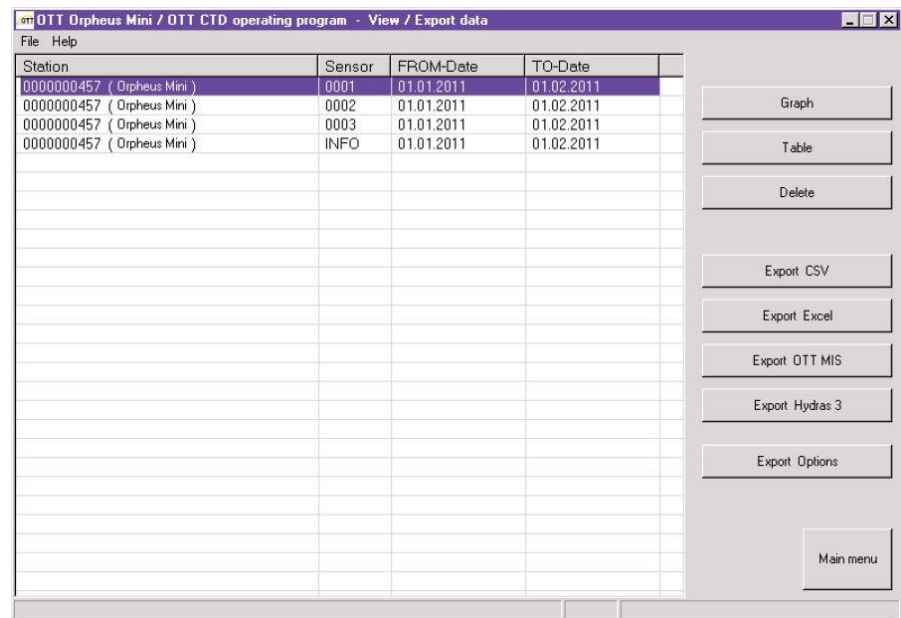


Figure 6.0. 27. OTT Orpheus Mini View / Export data screen (adapted from the Operating Instructions for the OTT Orpheus Mini (QTT OM, 2016).

- j. Highlight the stage and temperature files that were just downloaded ending in today’s date (Figure 6.0. 27).
- k. Then click on the “**Graph**” button to view these files graphically. Do this to look for obvious gaps or wild shifts in the data.
- l. When satisfied close all open graphs.
- m. Then select the INFO file and click the “**Table**” button to look at a log of all the settings and the times the observer logged into the Orpheus Mini by date and if there were any data errors, number of times the reading limits were exceeded or each time the stage was adjusted.
- n. When satisfied close the window.

2.2 Transferring OTT Orpheus Mini files to Excel

Follow the protocols below to export, convert, and transfer stage and/or temperature files in OTT Orpheus Mini to Excel.

- a. To export data files in Excel® (**.xls) or CSV (**.csv) formats, click the “**Export Excel**” or “**Export CSV**” buttons.*

***NOTE: If your computer has older versions of Excel® with limited rows available, large datasets will not be transferred completely.**

- b. Once either button is selected the data transfer begins and depending upon the laptop, data transfer may take quite a while to covert and transfer (eight to ten minutes or more). As the OTT Orpheus Mini software transfers the data, click and hold the left mouse button on the vertical scroll button and pull it down to the bottom of the screen and release the mouse button. The scroll button will move towards the top of the screen as more and more data is being transferred the scroll bar may appear not to be moving and you may want to close the file; do not let this fool you as the data is still being transferred. At this point move the cursor up to the top of the excel screen and click the reduce button (-) until excel shows up on the task bar.
 - c. Look at the **OTT Orpheus Mini View / Export** data screen until an information screen appears saying “**1 File(s) exported to MS Excel**”. This means the file transfer is successfully completed.
 - d. Click “**OK**” and reduce (-) the OTT Orpheus Mini screen to the task bar.
 - e. Expand the Excel program by clicking the Excel icon on the task bar.
 - f. Click and hold the left mouse button on the vertical scroll button and pull it down to the bottom of the screen and release the mouse button. This should be the bottom row of the data that was just transferred; scroll down a couple of more rows to verify all the data was transferred and that data did not stop on the last available row meaning an incomplete dataset.
 - g. When satisfied, save the Excel file in the appropriate format and location.
3. **Setting up and transferring Data the OTT RLS (Radar) unit with Campbell Scientific CR200 Series Dataloggers using PC200W software.**

These units are typically set up on long term WQM bridge sites to measure and record stage.

3.1 Setting up a CR200 Datalogger on computer

- a. Connect Computer to the CR200 Datalogger using RS232 cable.
- b. Open PC200W software.
- c. Select the “**add new datalogger**” icon (Figure 6.0. 28).

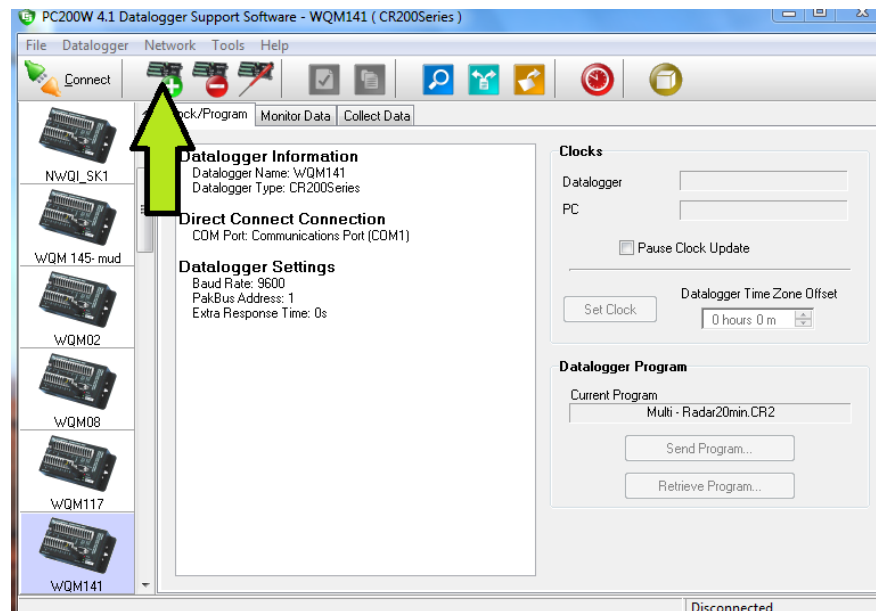


Figure 6.0. 28. PC200W software screen shot, add datalogger.

- d. An EZSetup wizard will open up with a list of options (Figure 6.0. 29).

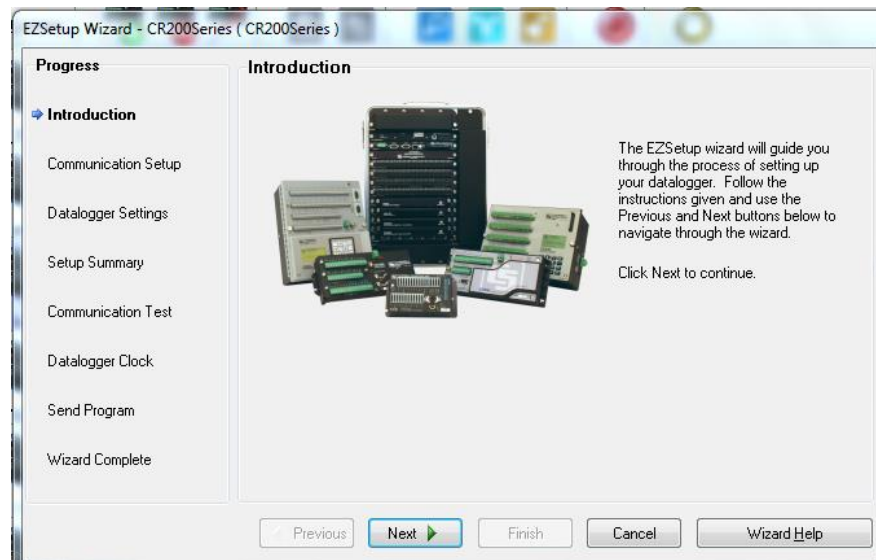


Figure 6.0. 29. PC200W software screen shot, EZSetup Wizard.

- e. Select “**Next**” to prompt the Communication Setup screen (Figure 6.0. 30). Highlight the “**CR200Series**” for datalogger type and Name your datalogger. This name is what will appear on the left hand side of the screen when you open up PC200W.

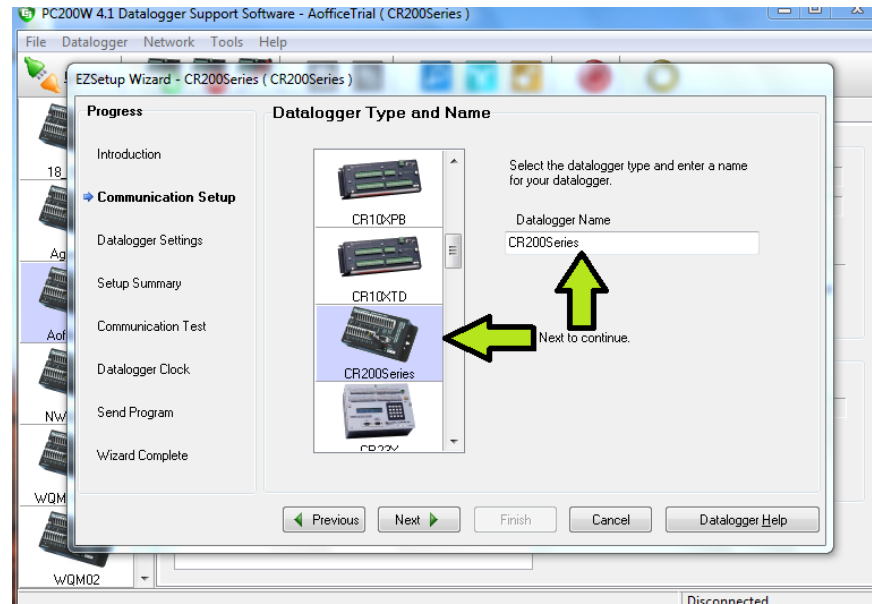


Figure 6.0. 30. PC200W software screen shot with Datalogger Type and Name, and Communication Setup.

- f. After naming your datalogger (Figure 6.0. 30), select “Next” which will prompt the Datalogger Settings screen (Figure 6.0. 31).

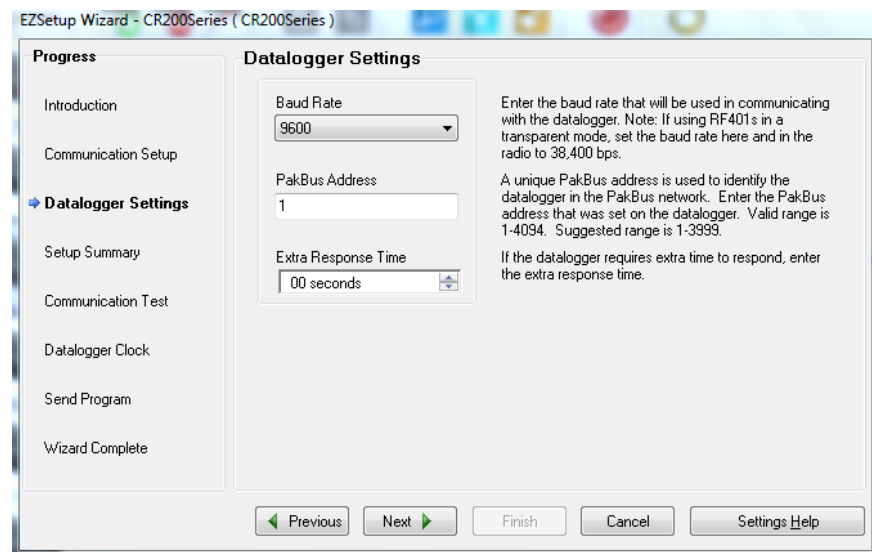


Figure 6.0. 31. PC200W software screen shot of Communication Setup Datalogger Settings.

- g. Select “Next” and a warning/message will pop up talking about using the same PakBus Address and Select “Yes” (Figure 6.0. 32).

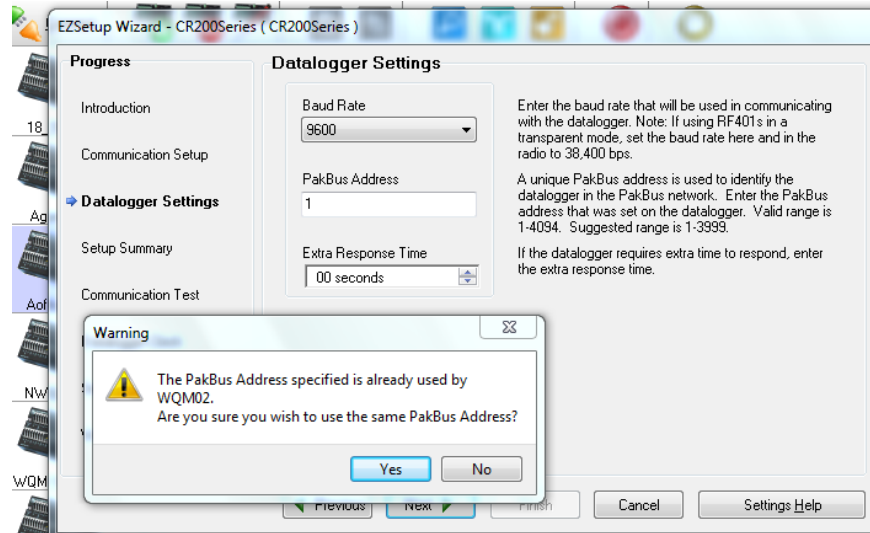


Figure 6.0. 32. PC200W software screen shot of Communication Setup Datalogger Settings, Warning.

- h. After selecting “Yes”, select “Next” or “Finish” until the wizard is over.

3.2 Downloading data from CR200 Dataloggers

- a. Connect Computer to the CR200 Datalogger using a RS232 cable.
- b. Open the PC200W software.

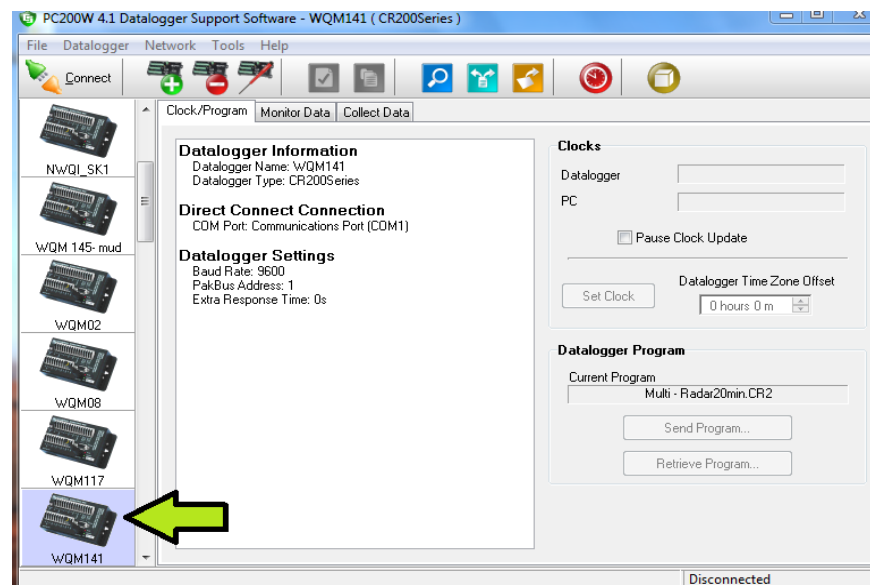


Figure 6.0. 33. PC200W software screen shot, Highlighted site location.

- c. Highlight site location on the left hand side of the screen, WQM141 is highlighted in the example (Figure 6.0. 33).

- d. Click the **“Connect”** icon on the upper left hand side of the screen (Figure 6.0. 34). The software should now be connected and communicating with the datalogger.

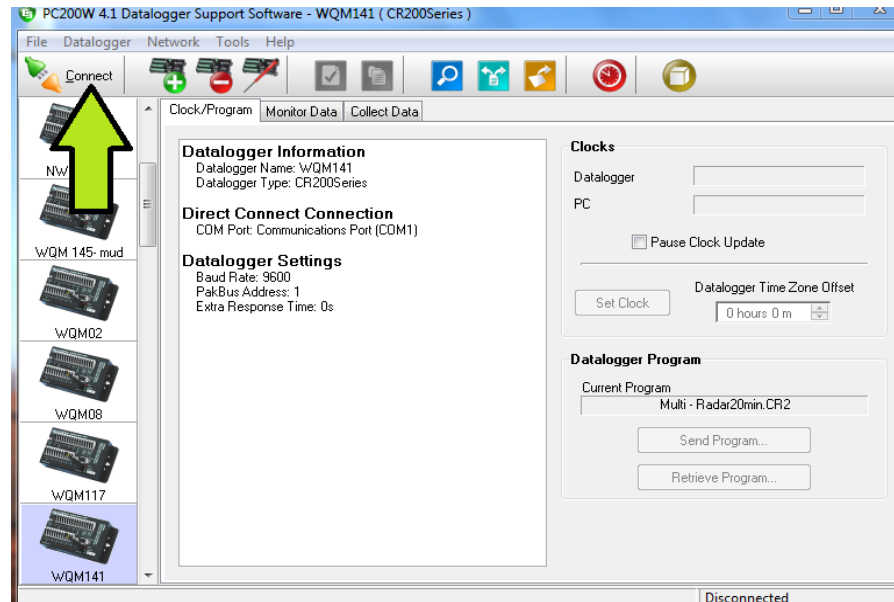


Figure 6.0. 34. PC200W software screen shot, Connect button location.

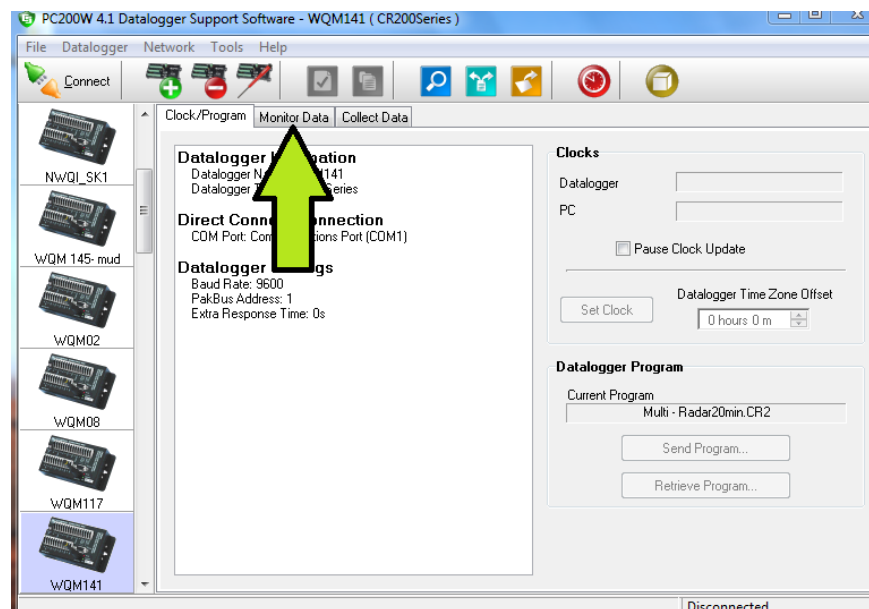


Figure 6.0. 35. PC200W software screen shot, Monitoring tab location.

- e. Click the **“Monitor Data”** tab (Figure 6.0. 35) and record the measurement values and battery voltage in the project logbook and on the datasheet (Figure 6.0. 36). These represent the most recent instantaneous values. Notice in this example that **“AofficeTrial”** is highlighted on the left. In the bottom right corner, a timer shows the connection time.

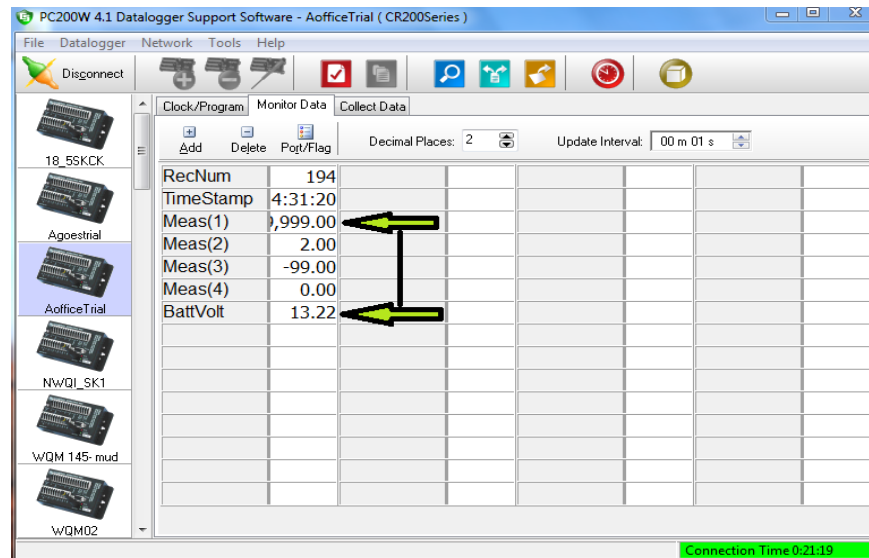


Figure 6.0. 36. PC200W software screen shot, Monitoring tab data locations.

- f. After recording measurement and battery voltage values, click the “Collect Data” tab (Figure 6.0. 37), select Remote1 from the table list (1), select “All data from datalogger” (2), and then click “Collect” (3). This will start the downloading process.

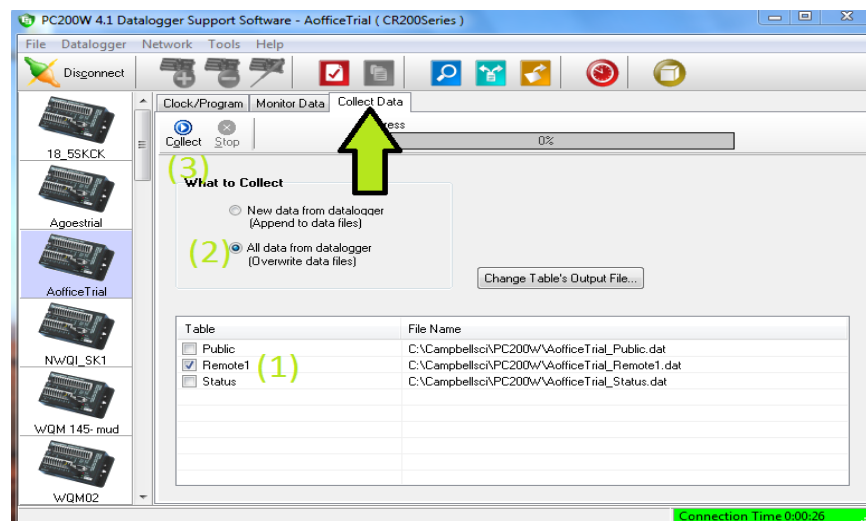


Figure 6.0. 37. PC200W software screen shot, Collect Data tab locations.

3.3 Changing Logging Programs for CR200 Dataloggers

- a. Connect Computer to the CR200 Datalogger using RS232 cable.
- b. Open PC200W software.
- c. Highlight site location on the left hand side, WQM141 is highlighted in the example (Figure 6.0. 38).

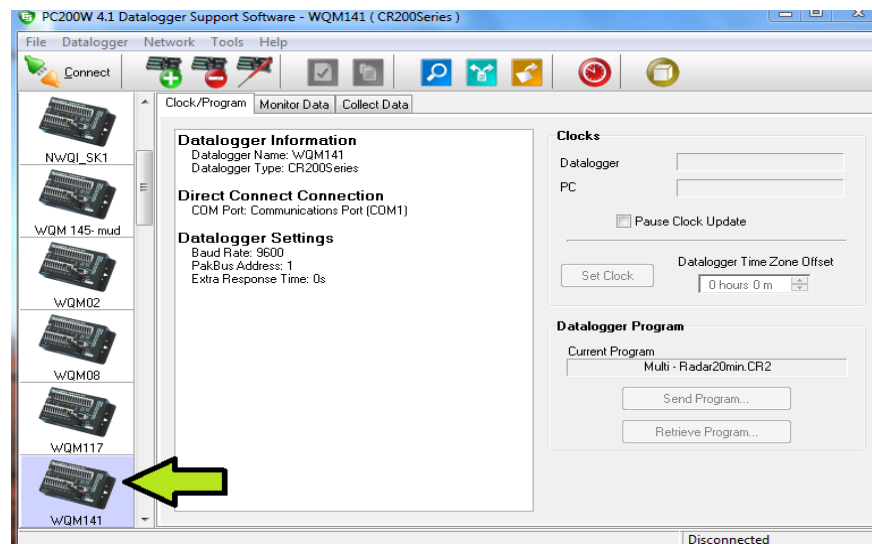


Figure 6.0. 38. PC200W software screen shot, Highlighted site location example.

- d. Click the “**Connect**” icon on the upper left hand side of the screen (Figure 6.0. 39). The software should now be connected and communicating with the datalogger (Figure 6.0. 39).

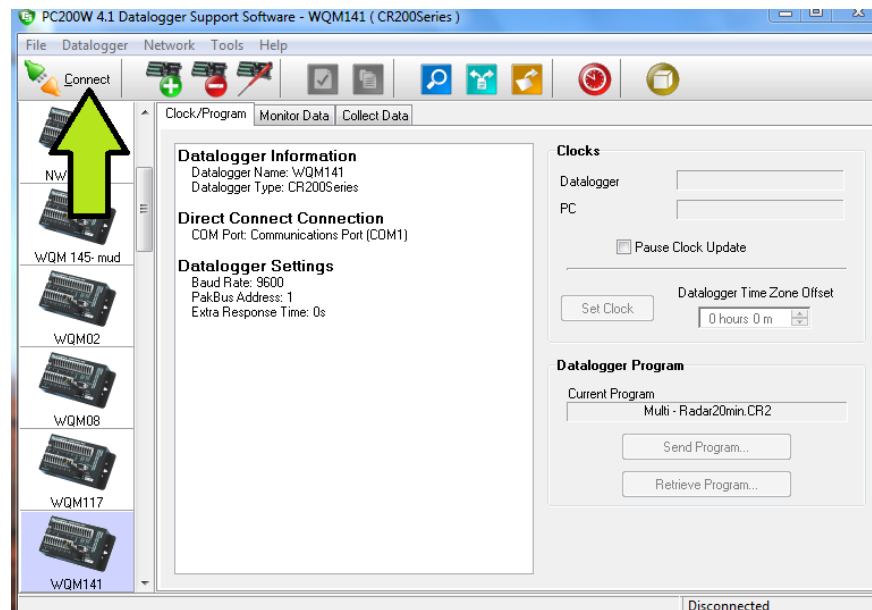


Figure 6.0. 39. PC200W software screen shot, Connect button location.

- e. Click on “**Send Program**” (Figure 6.0. 40).

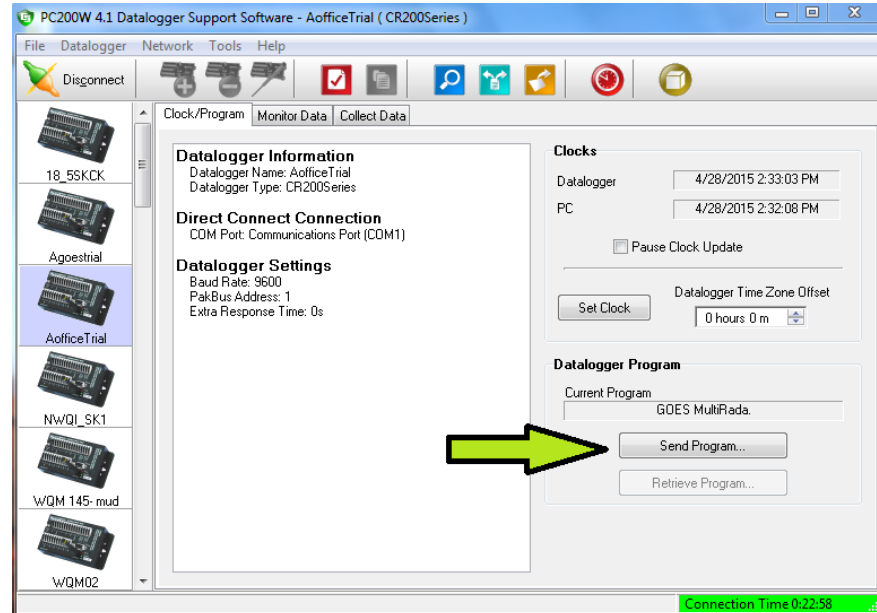


Figure 6.0. 40. PC200W software screen shot, Location of the send Program.

- f. This will prompt the following warning. **Make sure and download data before sending a new program otherwise all of the data will be deleted** (Figure 6.0. 41).

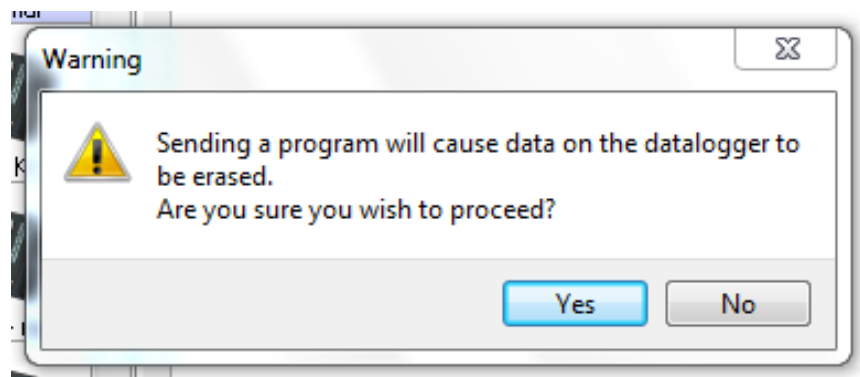


Figure 6.0. 41. PC200W software screen shot, Warning message.

- g. After selecting “Yes”, navigate to where the programs are stored on your computer and select the appropriate program (usually “**Multi – Radar20min.CR2**”), click on “**Open**” and the program will be loaded on the datalogger (Figure 6.0. 42).

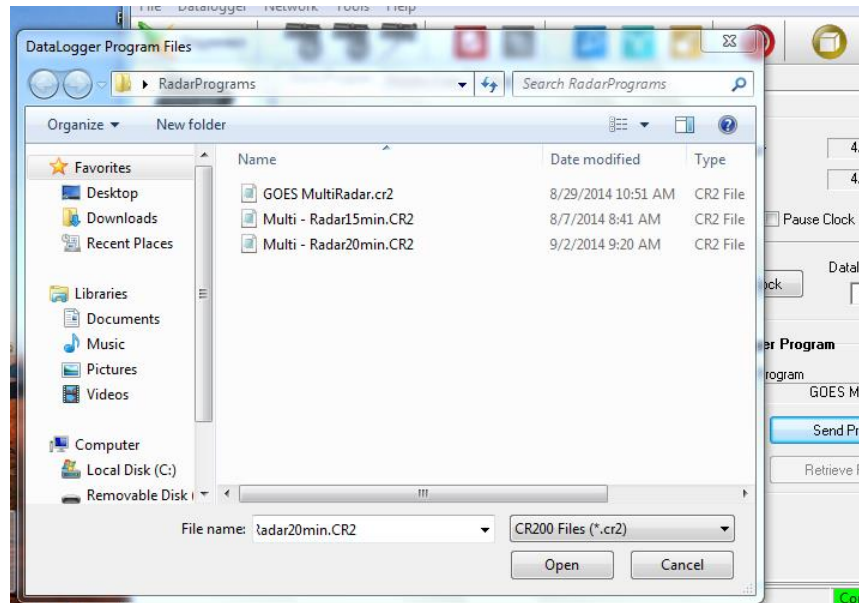


Figure 6.0. 42. PC200W software screen shot, Example of file locations with different naming nomenclature.

3.4 Transferring Stage Data to SD DENR WPP Discharge Database

- a. Open PC200W-Shortcut file on the desktop.
- b. Copy and transfer files that were collected.
- c. Use a flash drive/jump drive to transfer files.
- d. Insert flash drive/jump drive into PC.
- e. Open a selected site location using Excel from the flash drive.
- f. Highlight Column A.
- g. Under the “Data” tab, select “Text to Columns”.
Step 1 of 3, leave as “Delimited” and just select “Next”.
 - 1) Step 2 of 3, select “Tab” and “Comma” as delimiters and then select “Next”.
 - 2) Step 3 of 3, nothing needs changed so just select “Finish”.
- h. Now you should have five separate columns in the Excel worksheet.
 - 1) Timestamp, Record, Meas(1), Meas(2), and BattVolt.
- i. We are now going to separate the “Timestamp” column.
 - 1) Highlight Column A.
 - 2) Under the “Data” tab, select “Text to Columns”.
 - 3) Step 1 of 3, select “Fixed width”, and select “Next”.
 - 4) Step 2 of 3, nothing changes so select “Next”.
 - 5) Step 3 of 3, nothing changes so select “Finish”.
 - 6) A message will appear asking if you want to replace contents, select “OK”.
 1. This will replace the “Record” column with times, which is alright.

- j. Now we have to change the formats of both Column A (Dates) and Column B (Times).
 - 1) Highlight Column A.
 - 2) Right click your mouse to bring up the “Format Cells” option.
 - 3) Under the “Number” tab, select “Date”.
 - 4) We want the first option highlighted (03/14/2001), so select “OK”.
 - 5) Doing this should have trimmed off the time stamp that was attached to the date.
 - 6) Now highlight Column B.
 - 7) Right click your mouse to bring up the “Format Cells” option.
 - 8) Under the “Number” tab, select “Time”.
 - 9) We want the second option to put the time into military time (13:30), so select that option and then select “OK”.
- k. Open Discharge Measurement Database from the following directory:
 - 1) N:\WATRSBED\Discharge and Stage Data\DischargeMeasurements.mdb.
- l. Using the drop down menu, select the site location that is being updated.
- m. Following the loading of the site data, scroll down the “Date, Time, GaugeStage” table to the bottom of the table to figure out when the last date the data was collected.
 - 1) Note the date, time, and gauge stage because from this time and date is when the data will be amended.
- n. We will copy the new data from our Excel sheet from the Date, Time, and Gauge Stage that was previously noted.
- o. Paste the updated “Date, Time, Gauge Stage” into the table.

D. Temperature Probes

- 1. **HOBO Temperature Probe setup using HOBOWare® Lite software.**

1.1 Initializing and setup.

- a. Start HOBOWare Lite software on laptop or desk top computer.
- b. Connect the Optic USB Base Station to the laptop or desk top computer.
- c. Insert the temperature probe into the Optic USB Base Station and line up arrows for activation.
- d. Select the Launch button or Launch from the Device tab drop down which opens up the Launch Logger window.

- e. Make sure that the Battery State of the logger is in the “GOOD” range. If battery state is “FAIR, POOR, or BAD” obtain a new HOBO Water Temp Pro v2 probe and send the old probe back to Onset Computer Corporation to retrieve the data and have a new battery installed, continue with step “f”.
- f. Enter the station and or sampling site to name logger under the Description entry window.
- g. Select (check) box 1 to log Temperature only or Select (check) boxes 1 and 2 to log Temperature and Battery Voltage.
- h. Next select the Logging Interval, normally only one logging interval is needed for most temperature studies.
- i. The Logging Interval should be set to log every 30 minutes unless the project specific PIP require an increase or decrease in the logging interval.
- j. If desired multiple intervals can be setup to target different time periods during the day or night by increasing or decreasing the logging intervals throughout a 24 hour period. The Project Officer will inform the project coordinator when and if the need arises to change initial logging interval settings.
- k. Select the Now radio button under the Launch Options window to deploy the probe at this time.
- l. If deployment the probe will be delayed select the Delayed radio button under the Launch Options window and set the desired date and time for probe launch.
- m. Select the “Launch” button and the screen will show a Launching Logger window with a progress bar. When the download (launch) is complete the launching logger window will disappear.
- n. Disconnect the temperature probe from the Optical USB Base Station, close out of the HOBOWare program, turn off computer, and deploy probe.

1.2 Downloading HOBO Temperature Probe

- a. Retrieve the HOBO probe from the stream, river, or lake.
- b. Start HOBOWare Lite software on laptop or desk top computer.
- c. Connect the Optic USB Base Station to the laptop or desk top computer.
- d. Insert the temperature probe into the Optic USB Base Station and line up arrows for activation.
- e. Select the Readout Device button or Readout from the Device tab drop down which opens up the Stop Logger window.

- f. If only downloading the probe to collect data redeploying it again select the “**Don’t Stop**” button to continue logging while downloading the probe.
- g. The Save window comes up to save the site, HOBO file.
- h. Move the cursor to just after the site name and before the .HOBO and click, enter the date downloaded in the file name and select “**Save**”. Then the Plot setup window opens to select what attributes to plot and when complete select “**Plot**”.
- i. When graphing is complete select the “**Export data table**” button and the Export Options window opens.
- j. Select the export to a single file radio button and select “**Export**”.
- k. Then the Save window opens with the same site and date file name but it is saving as a .csv file.
- l. Verify site, date and file location of the file to be saved and select “**Save**”.
- m. If deployment or project is complete select the “**Stop**” button to end logging before downloading data. Then follow steps “f” through “k” to download and save temperature data.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

A. General Information and Handling Procedures

Quality assurance of the sample starts when the sample is initially collected. This requires some basic handling procedures. These procedures are as follows:

1. If several locations are to be sampled during one sample run, which includes both clean and impacted (polluted) sites, sampling should progress from the clean areas to the polluted areas. This lessens the chance of unintentional contamination of cleaner samples through the use of contaminated sampling equipment.
2. Sampling equipment (graduated cylinders, Integrated Depth Sampler, Van Dorn samplers, etc.) should be rinsed with stream or lake water to be sampled before samples are collected. Automated equipment should be properly cleaned and new intake hose used if and when appropriate.
3. Sample containers must be appropriate to the sampled parameter and use special cleaning procedures if necessary.
4. A regular schedule of calibration of field instrumentation must be followed as described previously. The calibration process is necessary to ensure that the instrument(s) is working properly and within the range of acceptability as determined by manufacturer specifications. All instrumentation used in field activities must be calibrated prior to field use and periodically thereafter, according to manufacturer instructions. Where required, field instrumentation must be calibrated at the beginning and end of each sampling day. All calibrations must be recorded on a SD DENR WWP Calibration Sheet and in the project logbook.
5. Continuous sampling devices must be calibrated according to manufacturer specifications and checked as often as necessary. Sample lines for continuous devices must be cleaned or new lines installed prior to each installation. All maintenance and calibration will be recorded in the project logbook.
6. In those instances where field equipment cannot be calibrated, the local coordinator (sampler) will call the Project Officer and attempt field repairs on affected equipment. The Pierre office is responsible for providing information on ordering new parts if equipment is in need of repair.
7. All instrumentation will be examined for maintenance/repair recommendations and checked for proper operation by the Project Officer prior to return to the Program office in Rapid City, Vermillion, Watertown or Pierre. Any necessary maintenance will be performed immediately to assure instrumentation is in good operating condition prior to the next use.

B. QA/QC Sampling

The following QA/QC samples will be included in field sampling programs as described below:

- For tributary sites, **one set** of QA/QC samples will be collected for every 10 tributary sampling sets collected (10%). **One set of QA/QC samples consists of one field replicate and one blank sample.**
- For in-lake sites, **one set** of QA/QC samples will be collected for every 10 in-lake sample sets collected (10%). **One set of QA/QC samples consists of one field replicate and one blank sample.**

1. Replicates

- a. Field replicate samples are independent samples collected in such a manner that they are equally representative of the parameter(s) of interest at a given point in space and time. In short, a second sample is collected in the same way with the same equipment as close in time and space to the previous sample as practicable.
- b. The field replicate sample will be taken at an existing monitoring station. No marks will be used which would indicate that the sample is anything other than a regular sample from the station identified on the label. The sampler will record the location and date of the replicate sample along with the regular or routine sample.
- c. Secure a sufficiently well-mixed (homogeneous) water sample representative of the sample source to prepare samples and replicates.
- d. Upon receipt of the laboratory results, the Project Officer will notify the Quality Assurance Officer (QAO) if the results from the replicate samples are not within plus or minus two standard deviations. The quality assurance coordinator will discuss corrective actions with the laboratory director and Project Officer. The Project Officer shall keep results on file and report annually all QA/QC results to the quality assurance coordinator.

2. Field Blanks

- a. Field Blanks are defined as samples which are obtained by running analyte-free deionized water through sample collection equipment (pump, filter, etc.) after decontamination, and placing it in appropriate sample containers for analysis. These samples will be used to determine if decontamination procedures have been sufficient. To ensure the integrity of field blanks, they should be collected, stored, and shipped with all other samples.

- b. Upon receipt of the laboratory results, the Project Officer will notify the QAO if the results from the blanks are above detection limits for any parameter. The quality assurance coordinator will discuss corrective actions with the laboratory director and the Project Officer. The Project Officer shall all keep results (datasheets) on file.
- c. Equipment blanks will be used to verify that the equipment used during sampling does not contaminate the sample; DI water is filtered through the filtration equipment, transferred to a sample bottle, preserved, and analyzed by the laboratory. The equipment blank is collected at 10 percent of sampling locations. Data acceptability of equipment blanks is determined by evaluating a group of equipment blanks collected throughout the project. Acceptable results are determined by the following:

Equation 7.0. 1. $SD < \bar{\mu}$

Where SD = standard deviation and
 $\bar{\mu}$ = sample population mean.

The SD of each parameter must be less than the mean of all values in each parameter during the project.

If acceptability criteria for equipment blanks are exceeded in any parameter the Local Coordinator will report exceedence to the Project Officer. The Project Officer will review data and discuss results with the QAO, Team Leader and Laboratory Manager to identify and develop corrective action plan(s). Generally, just one elevated sample parameter will cause exceedence in that parameter. Most exceedences that occur were tracked to using different brands of DI water (Distilled Water) purchased from different stores and using different brands during the project.

C. Precision and Accuracy

1. Precision

Precision may be expressed as Relative Percent Difference. RPD is used to determine precision when only a small amount of data is available. SD DENR Water Protection Program (SD DENR WPP) will use a control limit of 80–120 percent RPD for normally distributed sample parameters with original and replicate sample values greater than or equal to five times the analyte detection limit; or a control limit of plus or minus the analyte detection limit if either the sample or replicate value is less than five times the analyte detection limit. The results for two samples should be compared using the relative percent difference between them (20 percent RPD).

- a. At least ten percent of all water quality samples will be replicated for determination of precision.
- b. Data will be obtained for each water quality parameter sampled during the project using the Relative Percent Difference (RPD).

Equation 7.0. 2.
$$RPD = \left[\frac{|S - R|}{S + R/2} \right] * 100$$

Relative Percent Difference (RPD) where S = Sample and R = Replicate.

Sample parameters TSS, VTSS, *E. coli*, and fecal coliform bacteria typically do not display normal distribution. The following technique is used to determine control limits for these parameters. TSS, VTSS, fecal coliform, and *E. coli* bacteria replicate and original results are assessed by calculating precision criteria and determining whether the log ranges are acceptable using the following procedure:

- a. The data are arranged in pairs where D1 is the original sample and D2 is the duplicate.
- b. The log of each measurement is determined (L1, L2).
- c. The difference (range) of the log values is calculated: $R = (L1 - L2)$.
- d. Using the absolute value of each range, a mean range (Mean-R) is calculated: $\text{Mean-R} = (R1 + R2 + R3 + \dots + R_n) / N$.
- e. The precision criterion is calculated by multiplying the Mean-R by 3.27 and rounding to the tenths place.
- f. The precision criterion is compared to the range of each pair.
- g. Acceptable – the log range value is less than the precision criterion calculated previously; Unacceptable – the log range value is greater than the precision criterion.

Accuracy and precision statements for each measured chemical parameter for the SD DENR WPP are derived from those reported by the South Dakota State Health Laboratory or MIDCONTINENT Testing Laboratory, respectively.

2. Accuracy

- a. Data for each water quality parameter will be tested and reported for accuracy according to the QA/QC Manual. Quality control checks used in the laboratory are addressed in each laboratory quality assurance manual. Current accuracy ranges for specific parameters at the SD State Health Laboratory and Mid-Continent Laboratory. Accuracy for the laboratory will be reported as a percent recovery from a spike.

- b. At a minimum, one or more the following quality control checks will be utilized for all SD DENR WPP projects, studies, and TMDLs:

Spiked Samples	Field Blanks	Duplicate Samples
Control Charts	Reagent Checks	

- c. Field blank samples will be reported as normal samples with a goal of “Below Detection Limits.”

D. Preventive Maintenance

1. All equipment used in the field will be maintained according to manufacturer recommendations. Manufacturers commonly provide instructions for the care and cleaning of equipment and recommend a schedule of maintenance.
2. Each of the field instruments is to be checked and examined the day before the sampling activity is to begin to ensure that the equipment will work properly when needed.
3. Spare parts, such as batteries, probes, O-rings, standard solutions, logbooks, glassware, etc., will be kept on hand and taken into the field as space permits.
4. Preventive maintenance, activities and repairs on major field instruments or measuring devices will be recorded in project specific logbook(s) kept for each project.

E. Project and Sampler QA/QC Audits

1. In addition to in-field training and certification/documentation of such training, field samplers are evaluated on their field performance during field QA audits conducted by the SD DENR WPP Quality Assurance Officer (QAO) or Project Officers. The SD DENR WPP Field Samplers Audit Forms are provided in Appendix A, Table 9 and must be filled out when the QAO or the Project Officer audits the project and/or field personnel. If any deficiencies are noted during the audits, they will be documented on SD DENR WPP Field Samplers Audit Forms. Corrective actions will be developed documented and implemented prior to further data collection and field sampling. Verification of correction of any deficiencies must be documented in writing on the SD DENR WPP Field Samplers Audit Forms prior to the continuation of further sample collection activities. Documentation will be kept in the project file and copies will be scanned and sent to the SD DENR WPP QAO for submittal with the annual QA/QC report and will also be made available upon request to the QAO during announced or unannounced project audits.

8.0 LABORATORY ANALYTICAL METHODS

Per Surface Water Quality Standards, tests or analytical procedures to determine conformity with surface water quality standards will be made in accordance with methods approved in 40 CFR Part 136. It is the responsibility of the Project Officer to specify and ensure that the laboratory uses approved analytical methods listed in 40 CFR Part 136 for all SD DENR WPP water quality samples.

Analytical Procedures

Laboratories routinely analyze parameters outlined in Table 9.0. 1 and Appendix A, Table A-5. Non-routine analyses may also be performed by the laboratory using methodology outlined in the Twenty Second Edition of Standard Methods, within the limitations of laboratory equipment, media, reagents, etc. (APHA, 2012).

The methods noted above (APHA, 2012) are to be used exclusively, and an analyst, without prior approval from their manager or section supervisor, may use no other methods.

9.0 SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Routinely, only a few parameters will be analyzed in the field, including pH, dissolved oxygen, temperature, specific conductivity and Secchi depth. The State Health Laboratory or Mid-Continent Laboratory will analyze the majority of other chemical constituents, therefore, samples will have to be preserved, cooled to 6 °C, and transported to the contracting laboratory. All samples will be packed in loose ice and shipped to the laboratory within 24 hours of collection (if possible) in non-breakable coolers. The concentrations of the following parameters will be determined by using a series of equations based on other chemical parameters that were analyzed at the South Dakota State Health Laboratory and/or Mid-Continent Laboratory:

Total Nitrogen

Organic Nitrogen

Unionized Ammonia as N

The analytical methods used for all parameters mentioned in this manual are presented in 40 CFR Part 136. Appropriate containers, preservatives and holding times are presented in Table 9.0. 1.

- A. Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When the use of an automatic sampler makes it impossible to preserve each aliquot, then samples are preserved by maintaining them at 6°C until compositing and sample splitting is completed.
- B. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time.
- C. Some samples may not be stable for the maximum time period given in table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
- D. Samples should be filtered immediately on-site before adding preservative for dissolved metals.
- E. Guidance applies to samples to be analyzed by GC (Gas Chromatography), LC (Liquid Chromatography) or GC/MS (Gas Chromatography/Mass Spectrometer) for specific organic compounds.

Table 9.0. 1. Sample Containers, Preservatives, Parameters, and Holding times for most samples collected by SD DENR WPP and SWQ Programs.

Bottle	Size & Material		Preservative	Parameters	Holding Time ⁴
A	DOH	1000 mL HDPE	Cool to 6°C	Alkalinity, total solids, TSS, volatile solids, TDS, BOD, CBOD, CO ₃ , Hardness, K, lab pH, lab conductivity, nitrate, chloride, fluoride, HCO ₃ , SO ₄	48 hours
	MID CONTINENT	1000 mL polypropylene			
B	DOH	1000 mL HDPE	2 mL H ₂ SO ₄ pH <2 Cool to 6°C	Ammonia, Nitrite+Nitrate, TKN, Total P, COD	28 days
	MID CONTINENT	1000 mL polypropylene			
C	DOH	250 mL sterilized HDPE	Na ₂ SO ₃ if chlorinated Cool to 6°C	Fecal coliform, <i>E coli</i> , total coliform, enterococci, fecal PFG	6/24 hours ¹
	MID CONTINENT	2 - 100 mL sterilized polystyrene			
D	DOH	100 mL polystyrene	Field filter 0.25 mL H ₂ SO ₄ pH <2 Cool to 6°C	Dissolved P, dissolved inorganic nitrogen	28 days
	MID CONTINENT	150 mL fluoropolymer			
Metals - Dissolved	DOH	100 mL polystyrene	Field filter 0.25 mL HNO ₃ pH <2 Cool to 6°C	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Cu, Hg, Pb, Mg, Mn, Ni, Se, Ag, Na, Ti, U, Vn, Zn, Fe, Mo, fluoride, K, Cl, and silica	28 days
	MID CONTINENT	500 mL polypropylene			
Metals - Total Recovery	DOH	100 mL polystyrene	0.25 mL HNO ₃ pH <2 Cool to 6°C	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Cu, Hg, Pb, Mg, Mn, Ni, Se, Ag, Na, Ti, U, Vn, Zn, Fe, Mo	28 days
	MID CONTINENT	500 mL polypropylene			
Oil & Grease	all	1000 mL amber glass	2 mL HCl pH <2 Cool to 6°C	Oil & Grease	28 days
R	all	1 gal cubitainer polypropylene	Cool to 6°C	Radium-226, radium-228	6 months
CN	DOH	250 mL polypropylene	NaOH pH>10 Cool to 6°C	Total cyanide, WAD cyanide *Mitigate interferences as described in 40 CFR136	48 hours ²
	MID CONTINENT	500 mL polypropylene			
H	all	1000 mL glass amber	Cool to 6°C	TPH - diesel, caffeine	14 days ³
V	all	40 mL amber glass vial	Cool to 6°C	VOC, TOC, DOC, TPH -gasoline	14 days ³

Shaded = Normal Sampling Suite for SD DENR Watershed Protection Program

¹ Holding time for bottle C parameters is 6 hours for compliance samples. Noncompliance samples must be analyzed within 24 hours of collection.

² The maximum holding time for total and WAD cyanide is 14 days as long as all interferences have been mitigated as described in 40 CFR 136. If interferences are unknown the maximum holding time is 6 hours. 40 CFR 136 may be viewed at <http://www.ecfr.gov>.

³ The holding time for bottles H and V is 14 days from the time of collection to laboratory extraction.

⁴ Maximum holding time is based on the analyte with the shortest shaded hold time.

10.0 LABORATORY SHEETS AND CHAIN-OF-CUSTODY

The majority of samples collected for assessment, implementation, water quality project monitoring, or most other sampling projects do not need complete custody documentation. However, under certain conditions, such as possible compliance investigations, SD DENR WPP must be able to prove that any analytical data offered into evidence accurately represent environmental conditions existing at the time of sample collection. Due to the evidentiary nature of such samples, possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. It must be clearly demonstrated that none of the involved samples could have been tampered with during collection, transfer, storage, or analysis. SD DENR WPP chain-of-custody protocols and procedures are described below.

The separate SD DENR Chain of Custody form is not additionally required (Appendix A, Table A-10). The SD DENR Chain of Custody form will only be used in special circumstances or in times when the other forms are not appropriate for specific samples.

A. Documentation

To maintain and document sample possession, the following chain-of-custody procedures are followed:

1. Sample Custody - A sample is under custody under one of the following conditions:

- a. It is in your direct possession (you are holding it).
- b. It is in your direct line-of-sight after being in your possession (you can see it).
- c. It was in your possession; you locked it up or placed it in a sealed container to prevent tampering (no one can access the sample without leaving evidence of access, e.g. seal broken, tape removed, etc.).
- d. It is in a designated, secure area (typical evidence holding area).

B. Field Custody

1. The Project Officer will advise laboratory personnel that a sample requiring chain-of-custody will be collected and will specify the approximate date and time that it will arrive at the laboratory. In instances where date and time are not known in advance of a field trip, the laboratory should be notified as soon as possible about the arrival of such samples.
2. Samples must be collected in accordance with required and established methods set forth in this SOP, the SD DENR WPP Quality Assurance Project Plan (QAPP), and 40 CFR Part 136 (or other applicable section).

C. Chain-of-Custody Samples

1. To establish the documentation necessary to trace sample possession, a Chain-of-Custody Record (refer to SD DENR WPP QAPP) must be filled out and accompany each set of samples. The record should accompany the water quality data form and the samples to the laboratory. This record tracks sample custody transfers between the sampler and laboratory analysts. At a minimum, the record should contain:
 - a. The StationID or sample identification;
 - b. The signature of the collector and witnesses when present;
 - c. The date and time of collection; place and address of collection;
 - d. Substances sampled;
 - e. Signatures of persons involved in the chain of possession; and, inclusive dates of possession.

All chemical water samples collected using this SOP utilize the SD DENR WPP Water Quality Data Sheet (Appendix A, Table A-4) or SD DENR WPP Contaminate (Elutriate) Sample Data Sheet (Appendix A, Table A-5) as laboratory data sheets (commonly referred to as lab sheets) and Chain-of-Custody documents. When properly signed by all affected personnel, these forms comply with chain of custody requirements. The separate SDDENR Chain-of-Custody form is not additionally required. The SD DENR Chain-of-Custody form (Appendix A, Table A-10) will only be used in special circumstances or in times when the other forms are not appropriate for specific samples.

2. Samples will be packaged properly for shipment and taken or shipped to the appropriate (contracted) laboratory for analysis (See addresses and locations below). The samples for each shipping container shall be placed in the large plastic bags provided by the laboratory.
3. If samples are split with a source or government agency, it will be noted in the remarks section of the Chain-of-Custody Record. The note should indicate with whom the samples are being split and be signed by both the sampler and recipient.
4. Each transfer of sample custody must be documented on the Chain-of-Custody Record.
5. The Chain-of-Custody Record identifying its contents will accompany all shipments. The original record will accompany the shipment, and the Project Officer will retain a copy and place it in the project file.
6. The laboratory should have assigned laboratory personnel who are responsible for overseeing the reception of all controlled custody samples.
7. When the samples are not in the immediate possession of the individual having official custody, they must be kept in a locked enclosure.
8. After the laboratory has completed the sample analysis, the Water Quality Data form and the Chain-of-Custody record will be returned to the appropriate program. These items will be kept on file for at least five years. Access to the Chain-of-Custody file is limited to program personnel only.

D. Delivery or Shipment of Samples

Samples must be packed in coolers on loose ice for shipment or delivery to the laboratory. You must include appropriate paperwork. Make sure the container does not leak and all shipping or delivery labels are legible. Generally, samples need to be chilled to less than 6° C. Make sure there is adequate ice in the cooler to keep samples chilled during transit.

1. Completely fill out and sign a SD DENR WPP Water Quality Data Sheet or (Appendix A, Table A-4) or SD DENR WPP Contaminate (Elutriate) Sample Data Sheet (Appendix A, Table A-5) for each sample station.
2. If the samples are being shipped or sent with the courier, place all sample containers in a large plastic bag. Add loose ice to the bag and tie closed. Place the bag inside the shipping cooler.
3. Ensure that all SD DENR WPP Water Quality Data Sheets are filled out and the on sheet SD DENR WPP chain-of-custody section is signed and dated before protecting the documents from getting wet by placing them in a plastic bag and putting them in the shipping cooler.
4. Securely seal the cooler with packing tape.
5. Shipping coolers are shipped via mail (USPS, FedEx, etc.), delivered by the courier, or delivered by the sampler to the appropriate laboratory.

11.0 DECONTAMINATION OF SAMPLE CONTAINERS AND SAMPLING EQUIPMENT

The State Health Lab and/or MIDCONTINENT Labs will decontaminate sample containers prior to use in the field. Decontamination involves detergent washing, rinsing with dilute chromic acid and final rinsing with laboratory-grade distilled water. Decontamination of sampling equipment (probes and instruments) will be accomplished through the use of distilled water. However, if sampling in waters documented with Aquatic Invasive Species (AIS), sampling equipment, waders, and boats will follow decontamination protocols outlined below.

Aquatic Invasive Species (AIS) decontamination of field sampling equipment and clothing based on SD GF&P and SD DENR WPP procedures are as follows:

- A. AIS (Aquatic Invasive Species) Decontamination Protocols for Field Workers (Adapted from SD GF&P protocols and amended with boat wash stations and known listed impaired waters in South Dakota, and SD DENR protocols, April 2016).

The following decontamination protocols were designed to prevent field workers from spreading Aquatic Invasive Species (AIS) while performing their duties on waterbodies in South Dakota. A two-tiered approach was developed to ensure that adequate preventative measures are taken while minimizing impacts to time-sensitive field work.

1. Level 1 Decontamination (Undetected/Negative Waters)

The Level 1 Decontamination protocol is to be utilized when watercraft, equipment or clothing have been used in a waters designated as undetected or negative for AIS. This is the minimum decontamination standard and, where time permits, Level 2 Decontamination protocol should be followed to ensure the highest level of AIS prevention.

- a. **Perform a watercraft inspection.**
- i. Upon removing the watercraft from the water, begin inspecting the boat from bow to stern on one side. Pay special attention to through-hull fittings and trailer cross members, bunks, and rollers. Repeat the process on the opposite side of the watercraft as well as the interior of the vessel.
 - ii. Collect all plant fragments and other debris found during the inspection, seal them in a plastic bag (trash bag or Ziplocs[®]), and dispose of the bag in a trash receptacle.
 - iii. Rinse dirt, mud, and debris from the watercraft. Rinsing can be done by power washing the watercraft at a GFP office or B.A.S.S./ SD GFP boat wash location (Table 11.0. 1). If the watercraft is to be used in multiple water bodies in

the same day or if a power wash location is unavailable, the debris may be removed by rinsing the watercraft with water from the water body (i.e. a 5 gallon bucket filled prior to trailering the watercraft).

- iv. Remove all drain plugs prior to leaving the boat launch area.
- v. Trim the motor down to allow the water to drain prior to leaving the boat launch area. Remember to secure the motor in the correct position prior to travel.
- vi. If time permits, allow the watercraft to completely dry prior to subsequent use. If the vessel will be used on multiple waters in the same day, towel-dry all standing water prior to subsequent use

b. **Equipment & Clothing**

- i. Inspect all equipment (nets, tools, waders, boots etc.) for plants, mud or other attached debris.
- ii. Rinse dirt, mud and debris from the equipment or clothing to the extent possible. Nets and equipment that have substantial algal growth or mud should be power washed.
Felt or porous soled boots and waders may not be used at any time in the field.
- iii. If time permits allow the equipment or clothing to completely dry or freeze prior to subsequent use.

2. **Level 2 Decontamination (Inconclusive, Suspect, Positive, or Infested Waters)**

The Level 2 Decontamination protocol must be followed when watercraft, equipment or clothing have been used in a waters designated as inconclusive, suspect, positive or infested for AIS (See Table 11.0. 2). This protocol is the minimum requirement and may be supplemented with additional measures when applicable.

a. **Perform a watercraft inspection.**

- i. Upon removing the watercraft from the water, begin inspecting the boat from bow to stern on one side. Pay special attention to through-hull fittings and trailer cross members, bunks, and rollers. Repeat the process on the opposite side of the watercraft as well as the interior of the vessel.
- ii. Collect all plant fragments and other debris found during the inspection, seal them in a plastic bag (trash bag or Ziploc[®]), and dispose of the bag in a trash receptacle.
- iii. Remove all dirt, mud, and debris from the watercraft.
- iv. Waters containing AIS plants or fish - The watercraft and trailer must be power washed to remove any plant

fragments or mud on the vessel. No plant fragments or mud may remain on the vessel after decontamination.

- v. Waters containing AIS invertebrates - The watercraft and trailer must be power washed with water heated to no less than 140°F. Furthermore, all interior compartments with standing water must be flushed with 140°F water for no less than three minutes. No plant fragments or mud may remain on the vessel after the decontamination
- vi. Remove all drain plugs prior to leaving the boat launch area.
- vii. Trim the motor down to allow the water to drain prior to leaving the boat launch area.
- viii. Waters containing AIS invertebrates - Engine “muffs” must be used in conjunction with a hot water pressure washer until water exiting the motor is 140°F.
- ix. Remember to secure the motor in the correct position prior to travel.
- x. Allow the watercraft to completely dry prior to subsequent use. If the vessel will be used on multiple waters in the same day, towel-dry all standing water prior to subsequent use

b. **Equipment & Clothing**

- i. Inspect all equipment (nets, tools, waders, boots etc.) for plants, mud or other attached debris.
- ii. Remove dirt, mud and debris from the equipment or clothing.
- iii. **Waters containing AIS plants or fish** - Nets and equipment that have algal growth or any mud or debris attached must be power washed and, if possible, be allowed to completely dry prior to subsequent use.
- iv. **Waters containing AIS invertebrates** - Nets and equipment that became wet or that have algal growth, mud or debris attached must be power washed with water heated to no less than 140°F and must be allowed to completely dry prior to subsequent use. Items that cannot be power washed must decontaminated with hot water (140°F for no less than three minutes), soaked in hot water (>113° for no less than 40 minutes), or frozen.
- v. **Didymo infested waters** — All clothing and equipment must be soaked in a 5% dish detergent solution for no less than 30 minutes, hot water (>113°F) for no less than 40 minutes, or put in a freezer until frozen solid.
- vi. **Boots/Waders** - Any mud or debris on boots and waders must be removed. If possible boots and waders should be soaked in 140°F water for no less than three minutes or in

hot water (>113°F) for no less than 40 minutes. **Felt or porous soled boots and waders may not be used at any time in the field.**

c. **Considerations**

For items or situations not specifically addressed in this document there are general protocols that should be applied. Anything used in/on negative or undetected water must be free of mud and plants and should be cleaned with water (from the water body or a power washer). Anything used in/on an inconclusive, suspect, positive or infested waters must be free of mud and plants and decontaminated with hot water (140°F for no less than three minutes), soaked in hot water (>113°F for no less than 40 minutes), or frozen.

Reusable sample containers (carboys where lake, stream or river water is composited) will not be rinsed in the lake, 2 rinses of ~200 mL of DI water at the completion of sampling efforts at a given waterbody is sufficient to provide clean blank samples from sample containers.

B. **Boat and Trailer Wash Locations**

B.A.S.S./SD GFP Cooperative Boat and Trailer Wash Program

To help stop the spread of AIS species and fish diseases, wash your boat, disinfect your live well and remove all mud and aquatic plants and animals from all gear!

The South Dakota Department of Game, Fish and Parks and the South Dakota B.A.S.S. Federation in an effort to prevent the further spread of aquatic nuisance species such as zebra mussels, quagga mussels and Eurasian watermilfoil. The program encourages boaters (including those with personal watercraft) to wash their boats (including livewells and any place that may hold water) and trailers at participating facilities (Table 11.0. 1) before launching them into South Dakota waters.

1. **Boat and trailer**

Boaters who have had their boat or personal watercraft in waters outside the State of South Dakota or in South Dakota waters known to contain aquatic nuisance species (Table 11.0. 2) should wash their boat and trailer. The following list of B.A.S.S./GFP cooperating boat wash stations (Table 11.0. 1) all provide the necessary space and high pressure hot wash necessary for you to rid your boat and trailer of any unwanted "hitchhikers."

2. **Disinfecting live wells**

Anyone who has had their boat in waters that are known to contain VHS (Viral Hemorrhagic Septicemia) in the Great Lakes region should clean and disinfect all livewells on the boat. Clean and disinfect live wells with a

10% household bleach solution (i.e., 1 1/2 cup household bleach to one-gallon of water). Since chlorine is toxic to fish, rinse live well to remove residual chlorine and drain it away from fish-bearing waters

Table 11.0. 1. B.A.S.S./SD GFP Cooperative Boat and Trailer Wash Facilities throughout South Dakota.

City	Business	Address
DeSmet	Mr. Bill's Car Wash	109 4th St SW
Estelline	Dale's Sinclair	402 State Ave
Ft. Pierre	Shur Shine Car Wash	Deadwood Ave
Hartford	Sunnyside Carwash	201 E Hwy 38
Madison	Super Wash	304 NE 2nd Street
Milbank	Eastside Carwash	E Hwy 12
	Westside Truck and Car Wash	504 24th Ave
Mitchell	Mega Wash	1905 N Main St
	Mega Wash	800 E Kay Ave
	Sportsman's Car Wash	601 E Spruce St
Pierre	Super Car Wash	1100 N Garfield Ave
	Truck-n-Car Wash	1513 E Wells Ave
Rapid City	Arnie's Pressure Wash	3100 S Hwy 79
	Parkway Car Wash	206 E Blvd N
	Zaug Wash	612 Timmons Blvd
Redfield	Appel Oil Company	833 W 3rd St
Sioux Falls	Clean Finish Car Wash	515 S Sycamore Ave
	Shop'n Cart Car Wash	4309 E 12th St
	Superwash - 12th St	2000 W 12th St
	Superwash - Marion Rd	801 S Marion Road
	Wash World Car Wash	321 N Cliff Ave NE
Vermillion	Henderson's Ultimate	821 Princeton St
	Royal Car Wash	801 Stanford St
Watertown	Cenex - C Store	E Hwy 212
	Super Wash	501 14th Ave NE
	Westside Car Wash	715 3rd Ave NW
White River	Gillen's Station	Hwy 83 N 1st St
Yankton	Classic Car Wash	600 W 23rd St

Table 11.0. 2. Known AIS Fish, Plants, and Invertebrate locations in South Dakota through the end of 2015

	FISH							PLANTS						INVERTEBRATES					
	Bighead Carp	Silver Carp	Grass Carp	Black Carp	European Rudd	Snakehead	Western Mosquitofish	Brittle Naiaid	Curly Pondweed	Didymo	Eurasian Water-milfoil	Purple Loosetriffe	Flowering Rush	New Zealand Mudsnail	Rusty Crayfish	Zebra Mussel	Quagga Mussel	Asian Clam	Red Rimmed Melania
Missouri River																			
Lake Oahe					X				X		X								
Lake Sharpe					X				X		X	X							
Lake Francis Case					X				X		X								
Lewis & Clark Lake					X				X		X							X	
Below GPD	X	X	X		X													X	
James River	X	X	X																
Big Sioux River																			
Below Falls Park	X	X	X																
Vermillion River					X														
Below E. Vermillion SRA	X	X	X																
Fall River																			
Hot Springs City Limits																			X
Cascade Creek																			
Cascade Springs																			X
Castle Creek																			
Below Deerfield Reservoir										X									
Rapid Creek									X	X		X							

Table 11.0. 2.(continued) Known AIS Fish, Plants, and Invertebrate locations in South Dakota through the end of 2015.

	FISH							PLANTS						INVERTEBRATES					
	Bighead Carp	Silver Carp	Grass Carp	Black Carp	European Rudd	Snakehead	Western Mosquitofish	Brittle Naiad	Curly Pondweed	Didymo	Eurasian Water-milfoil	Purple Loosetriffe	Flowerin g Rush	New Zealand Mudsnail	Rusty Crayfish	Zebra Mussel	Quagga Mussel	Asian Clam	Red Rimmed Melania
Angostura Reservoir									X								?		
Big Stone Lake									X										
Canyon Lake									X										
Interstate Lakes (Brookings)					X														
Lake Alice					X				X										
Lake Byron	X	X																	
Lake Faulkton													X						
Lake Louise													X						
Lake Madison					X														
Lake Mitchell									X										
Lake Vermillion					X														
McCook Lake								X	X										
Mina Lake					X														
Newell Reservoir					X														
Pactola Reservoir					X														
Roy Lake									X										
Sheridan Lake					X				X										
Stockade Lake									X										

C. **AIS (ANS) Decontamination using commercially available quaternary ammonia compound (QAC) disinfectant products.**

Protocols were adapted from Colorado Parks and Wildlife, Department of Natural Resources (2015) and are used by US Forest Service, Region 2 for disinfection protocols (CPWDNR, 2015).

1. **Bath Disinfection Recommendations**

a. **Submersion of small gear and waters:**

- i. Prior to disinfection, clean debris, mud, and vegetation off of equipment and waders.
 - Muddy disinfectant solution can lose its effectiveness and capacity to kill invasive organisms.
- ii. Visually inspect waders and equipment for New Zealand mud snails and other invasive aquatic organisms prior to cleaning.
- iii. The recommended minimum active QAC concentration for effective disinfection is 0.4% or 4.0 ml of QAC per L of water; amount of disinfectant per gallon varies, and is dependent upon the percent active QAC in the disinfectant being used (Table 11.0. 3).
- iv. Equipment and waders should be submerged in disinfectant solution for a minimum of **10 minutes**.
- v. Follow all handling instructions on disinfectant label or Material Safety Data Sheet (MSDS).

Table 11.0. 3. Commercially available QAC disinfectants, percent (%) active QAC, percent QAC concentration in solution, amount of disinfectant needed (mL and ounces) per gallon of water to obtain a minimum active QAC concentration of 0.4%, and ratio of disinfectant to water. *Italics* indicate that product has been discontinued.

Disinfectant Name	% Active QAC (MSDS)	% QAC Conc. In Solution	mL per gal	Ounces per gal	QAC: H ₂ O
<i>Sparquat 256</i>	<i>12.5</i>	<i>0.4</i>	<i>121.2</i>	<i>4.1</i>	<i>1:31</i>
Quat 4	10.0	0.4	153.8	5.2	1:25
Super HDQ Neutral	16.9	0.4	91.7	3.1	1:41
Green Solutions (GS) High Dilution Disinfectant 256	21.7	0.4	71	2.4	1:53
Vedco 128	8.45	0.4	180.4	6.1	1:21
Quat 128	8.45	0.4	180.4	6.1	1:21

Shaded = Used by SD DENR WPP

2. **Spray Disinfection Recommendations (used by SD DENR WPP in Black Hills streams for wader disinfection)**

a. **Cleaning off small gear and waders using disinfectant spray:**

- i. Prior to disinfection, clean debris, mud, and vegetation off of equipment and waders.
- ii. Visually inspect waders and equipment for New Zealand mud snails and other invasive aquatic organisms prior to cleaning.
- iii. The recommended minimum active QAC concentration for effective spray-application disinfection is twice that for submersion disinfection, 0.8% or 8.0 ml of QAC per L of water (Table 11.0. 4).
- iv. Equipment and waders should be fully covered in disinfectant solution for a **minimum of 10 minutes**. Reapplication may be necessary if hot (evaporative) or wet conditions dilute spray solution on equipment.
- v. Follow all handling instructions on disinfectant label or MSDS.
- vi. Power washing with hot water (140° F) is an option, if available.

Table 11.0. 4 Commercially available QAC disinfectants, percent (%) active QAC, percent QAC concentration in solution, amount of disinfectant needed (ml and ounces) per gallon of water to obtain a minimum active QAC concentration of 0.8%, and ratio of disinfectant to water. Italics indicate that product has been discontinued.

Disinfectant Name	% Active QAC (MSDS)	% QAC Conc. In Solution	mL per gal	Ounces per gal	QAC: H₂O
<i>Sparquat 256</i>	12.5	0.8	242.4	8.2	1:16
Quat 4	10.0	0.8	307.6	10.4	1:12
Super HDQ Neutral	16.9	0.8	183.4	6.2	1:21
Green Solutions (GS) High Dilution Disinfectant 256	21.7	0.8	142	4.8	1:27
Vedco 128	8.45	0.8	360.8	12.2	1:11
Quat 128	8.45	0.8	360.8	12.2	1:11

Shaded = Used by SD DENR WPP

3. **Checking Disinfectant Solution Efficacy**

Muddy or diluted disinfectant can lead to a loss of effectiveness and capacity to kill invasive organisms. It is important to change the solution once it becomes muddy and/or diluted due to repeated use. If you are uncertain about the concentration, “Quat Check 1000” Test Papers can be purchased from Grainger. The solution is diluted to a ratio of 1:5 (one cup of solution to five cups of water) prior to testing. If the diluted solution is between 600 and 800 ppm (or higher), as indicated by the color of the test strip, the solution can continue to be used. If the solution is less than 600 ppm, the solution is no longer effective at killing invasive organisms. Dispose of per the manufacturer’s label and make a new disinfection bath using the guidelines provided above.

4. **General Public Recommendations**

Due to the disparate QAC concentrations in the various products available for purchase by the public, it is possible that confusion could be created by having different dilution recommendations for these various products. Therefore, a standard rate of dilution should be set for the general public when using QAC’s for disinfection, which will be of adequate active QAC concentration to produce complete disinfection when using even the lowest active ingredient products. The recommendation for *any* QAC used by the general public to disinfect waders is 6 ounces per gallon (see Table 11.0. 5 for QAC concentration in solution); this ensures a full kill of invasive aquatic organisms if they are using lower concentration products (such as Vedco 128 or Quat 128). All steps in the disinfection process otherwise remain the same.

Table 11.0. 5 Commercially available QAC disinfectants, percent (%) active QAC, percent QAC concentration in solution, and amount of disinfectant recommended to the public (ml and ounces) per gallon of water to obtain a full kill of invasive aquatic organisms. Italics indicate that product has been discontinued. NOTE: 6 ounces disinfectant per gallon equates to a ratio of QAC to water of 1:21.

Disinfectant Name	% Active QAC (MSDS)	% QAC Conc. In Solution	ml per gal	Ounces per gal
<i>Sparquat 256</i>	12.5	0.59	177.5	6.0
<i>Quat 4</i>	10.0	0.47	177.5	6.0
Super HDQ Neutral	16.9	0.79	177.5	6.0
Green Solutions (GS)				
High Dilution Disinfectant 256	21.7	1.0	177.5	6.0
Vedco 128	8.45	0.40	177.5	6.0
Quat 128	8.45	0.40	177.5	6.0

Shaded = Used by SD DENR WPP

3. **Efficacy Against Other AIS (ANS) of Concern**

The recommendations made in this document for disinfecting gear that has come in contact with New Zealand mudsnail infested waters are higher than those for *Myxobolus cerebralis*, Whirling Disease (Hedrick et al. 2008), chytrid fungus (Johnson et al. 2003), quagga mussels (Britton and Dingman 2011), and zebra mussels (Wong 2012). Therefore, these recommendations should be effective for preventing the spread of these species as well. Consult the literature for disinfection concentrations for other ANS of concern that are not included in this list.

4. **Disposal**

Wastewater treatment plants are capable of processing water containing small amounts of QACs in solution. Therefore, rinsing used solutions of QACs down a sanitary sewer is a safe method of disposal. However, QACs should be kept out of storm sewers and other waterways. Always dilute old product before rinsing down sanitary sewers directly from the container, and follow MSDS and label recommendations regarding rinsing and disposal of empty containers. QACs become tightly bound to organic matter in soils and sediments (Owens et al. 2000) and are degraded by aerobic bacteria (Tezel 2009). Therefore, small amounts of QAC from spray or bath disinfection may come in contact with the environment with few negative effects. However, it is not recommended to dump large amounts of QAC solutions directly on the ground.

TRIBUTARY SAMPLING TECHNIQUES

12.0 SAMPLING PROCEDURES FOR TRIBUTARY SAMPLING

A. Field Observations

Prior to other activities, comments and observations regarding the weather and sampling site must be recorded. It is important to record all field observations of conditions at the sampling sites that could influence the water quality of the collected sample. These observations are recorded on SD DENR Water Quality Data collection sheets (Appendix A, Table A4). Examples of observations recorded under COMMENTS include but are not restricted to: “cloudy, heavy rainfall two days ago, cattle grazing near sampling site, dense submergent or emergent aquatic vegetation present at sampling site, etc.”

Header information

<u>Agency Code</u>	# assigned by the South Dakota Public Health Laboratory only. If analyzed by another laboratory, contact Kris Dozark (773-5682) for code Number.
<u>Sample Date</u>	Date sample is collected.
<u>Time</u>	Time sample is collected.
<u>Sampler(s)</u>	Initial or print sampler(s) name(s).
<u>Source Water</u>	Waterbody name and description.
<u>Station ID</u>	Project specific sampling site identification number.
<u>Site Location</u>	Site location description unique to site.
<u>Project</u>	Print project name.
<u>Project ID</u>	Project specific project identification code (STORET/WQX) if unknown contact your Project Officer.
<u>Type of Sample</u>	Check/mark appropriate box.
<u>Medium</u>	Check/mark water or circle Other and describe.
<u>Relative Depth</u>	Check/mark appropriate box.

In addition to comments, specific observations **must** be recorded on the field data sheet (UNITS DESIGNATED ON SHEET) and are as follows:

<u>Specific Conductivity</u>	Record in ($\mu\text{S}/\text{cm}^{-1}$ same as $\mu\text{mho}/\text{cm}^{-1}$).
<u>Dissolved Oxygen</u>	Record in (milligrams per Liter (mg/L)).
<u>Discharge</u>	Record in (Cubic Feet per Second (CFS)).
<u>Total Depth</u>	Record in (feet).
<u>Sample Depth</u>	Record in (feet).
<u>Width</u>	Record in (feet).
<u>Gage Stage</u>	Record in (feet).
<u>Field pH</u>	Record in scientific units (su).
<u>Air Temperature</u>	Record in degrees (Celsius).
<u>Water Temperature</u>	Record degrees (Celsius).
<u>Turbidity</u>	Record in (Nephelometric Turbidity Units (NTU)).
<u>Secchi</u>	Record in (meters).
<u>Wind</u>	Record as (≥ 30 MPH), (20-30 MPH), (10-20 MPH), (5-10 MPH) or (0-5 MPH)).
<u>Elevation</u>	Record in (feet).

B. Field Analyses

Calibrate all instruments prior to field use as described in Section 6.0. Record all field analysis data on field data collection sheets and in the project logbook.

1. YSI Multi Parameter Meter (650 MDS with Sonde) Method

Most projects/studies will use YSI multi parameter meter and must be operated in accordance with manufacturer specifications (Section 6.0).

- a. Calibrate instrument following Section 6.0, B, 1.
- b. Make sure weighted probe guard is attached to the sonde.
- c. Select **“Sonde Run”**.
- d. Place the probe into the stream.
- e. If water is static, provide stirring by gently and continuously agitating the probe.
- f. Allow sufficient time for the sonde and probe to stabilize.
- g. Record data in logbook and on the data sheet (Appendix A, Table A-4) and/or save in memory.
- h. **Saving data to the YSI 650 MDS handheld.**
 - i. Navigate to the upper left portion of the screen and highlight **“Log one sample”** under the 650 column.
 - ii. Press **“Enter”** and a site list will appear with files that were previously created.
 - iii. Highlight the desired monitoring site and hit **“Enter”** to store data to that file. The highlighted **“Log one sample”** will change to **“Sample Logged”** and will flash approximately three times verifying completion.
 - iv. If the current site has not been sampled or data has not been saved in the file memory; Select **“Edit Site List”** press **“Enter”**.
 - v. Enter site name, stationID, and site number as needed. When finished, press **“Enter”** and under the 650 column the **“Sample Logged”** and will flash approximately three times verifying that the data has been saved.
- i. When sampling is complete, remove weighted probe guard and install the calibration cup with a small amount water in the bottom to protect probes from drying out and store unit in carrying case.

2. Temperature

- a. **Air Temperature**
 - i. Always collect air temperature readings out of direct sunlight and indicate in °C.
 - ii. Record the reading on the SD DENR Water Quality Data collection sheet (Appendix A, Table A4) and in the project logbook.

b. Water Temperature

- i. Water temperature should be collected directly from flowing water in the stream.
- ii. If a bottle of water needs to be collected to obtain a temperature, measure the water temperature as soon as possible after collection.
- iii. Place the thermometer into the stream and provide stirring or gentle agitation.
- iv. Allow sufficient time for the thermometer or thermistor to stabilize to sample temperature.
- v. Read the temperature and indicate in °C.
- vi. Record the reading on the SD DENR Water Quality Data collection sheets (Appendix A, Table A4) and in the project logbook.

3. Total Depth

- a. Record total depth on the SD DENR WPP Water Quality Data collection sheet (Appendix A, Table A4) and the logbook using the maximum cross sectional depth (indicated in feet) at tributary sites.

4. Flow - Marsh-McBirney

- a. Calibrate (zero adjust) the meter using methods found in Section 6.0, A, 1 of this manual.
- b. Use/setup a 40 second averaging period for the Marsh/McBirney.
- c. Stake a measuring tape across the stream at the selected site.
- d. Attach sensor to the bottom of the wading rod (Figure 12.0. 1) and point sensor into the oncoming flow when recording.
- e. To collect a reading, adjust the wading rod so that the sensor is pointing upstream and the sensor depth adjusted to 0.6 of the total water depth (Figure 12.0. 1) at each interval and record flow in ft/sec. Rotate the sensor slightly from side to side during the 40 second averaging period and record the flow reading (after 40 seconds the display will hold the average reading for a short time to make it easier to record on the datasheet).
- f. Record all tape, location, width, depth, area, mean in vertical (velocity), and discharge data on the SD DENR WPP Discharge Datasheet (Appendix A, Table A-2). Width, area, and discharge are calculations can be calculated after all readings at the site have been collected.

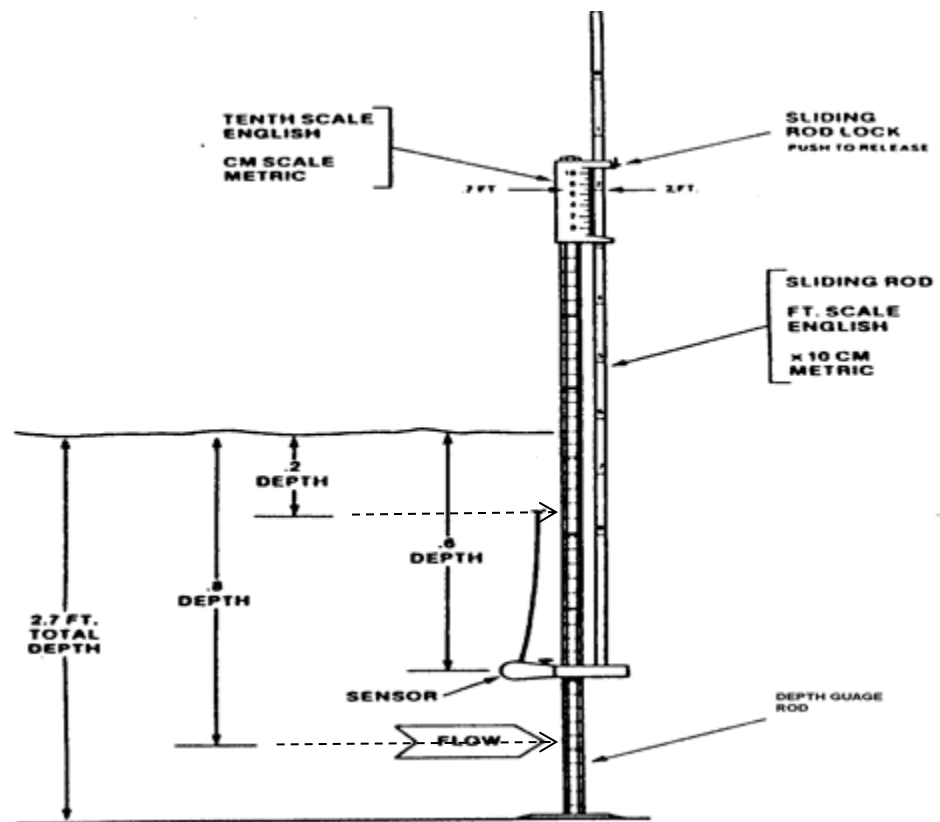


Figure 12.0. 1. Wading rod for the Marsh-McBirney flowmeter. Adapted from the Marsh-McBirney, Inc. Model 2000 portable water flow meter instruction manual.

- g. If total depth in any interval is greater than 0.61 meters (2.0 feet), the flow will have to be recorded from depths of 0.2, 0.6 and 0.8 from the surface of the water.
 - i. To set the sensor at 20 percent (0.2) of the total depth, **multiply** the total depth of the interval by **eight-tenths (0.8)** and set the sliding rod to that calculated value (for Figure 12.0. 1, 0.54 feet).
 - ii. To set the sensor at 60 percent of the total depth, set the sliding rod in the setting scale at the total depth or the technician can **multiply** the total depth by **four-tenths (0.4)** and set the sliding rod to that calculated value (for Figure 12.0. 1, 1.08 feet).
 - iii. To set the sensor at 80 percent of the total depth, **multiply** the total depth of the interval by **two-tenths (0.2)** and set the sensor on the sliding rod to that calculated value (for Figure 12.0. 1, 2.16 feet).

- h. When completed, average the 0.2 and 0.8 velocity readings and average that value with the 0.6 velocity to calculate flow for that interval. These calculations may be calculated after all velocities have been collected for each transect.
- i. After total discharge has been calculated, record it on the SD DENR WPP Discharge Datasheet (Appendix A, Table A-2), the SD DENR Water Quality Data collection sheet (Appendix A, Table A4) and in the project notebook.

5. **Flow - FlowTracker Handheld ADV, adapted from FlowTracker Quick Start Guide and user's manual, 2009.**

Pre-Deployment Diagnostics (test weekly in the lab or office)

- Use laptop with FlowTracker software installed.
- Connect FlowTracker to laptop using Communication/Power Cable.
- Start software and open BeamCheck.
- Follow instructions found in Appendix B.

Field Diagnostics

- a. Insert the mounting pin (probe) into the wading rod and secure with screw.
- b. Attach mounting bracket on top of the wading rod and attach keypad to the mounting bracket.
- c. Field diagnostics
 - Recorder Status: (2 in System functions menu)
 - Check available space; download data and format the recorder as needed.
 - Battery Data: (5 in System functions menu)
 - Expected life from new batteries (Alkaline 25 hrs.), and remember cold weather reduces capacity.
 - Temperature Data: (4 in System functions menu)
 - Place probe in stream and give it time to equilibrate.
 - Check temperature data to be sure it is reasonable for the environment.
 - Raw Velocity Data: (6 in System functions menu)
 - Place the probe in the area to be measured.
 - Orient the probe upstream perpendicular to the tag line (tape).
 - SNR data should ideally be above 10 dB but will read at 4 dB and above.
 - Velocity data should appear reasonable for the environment.
 - System Clock: (9 in System functions menu)
 - Verify the date and clock is set correctly.

- Auto QC Test: (7 in the System functions menu)
 - Place the probe in the water area to be measured
 - Orient the probe upstream perpendicular to the tag line (tape) and away from bottom obstructions.
 - Press 1 and then Enter to begin QC Test (Beam Check).
 - After 20-pings and pass/fail message press Enter
 - When complete the Flowtracker will display QC Check OK no errors found or an error message.
- If error is found do not use the Flowtracker!**

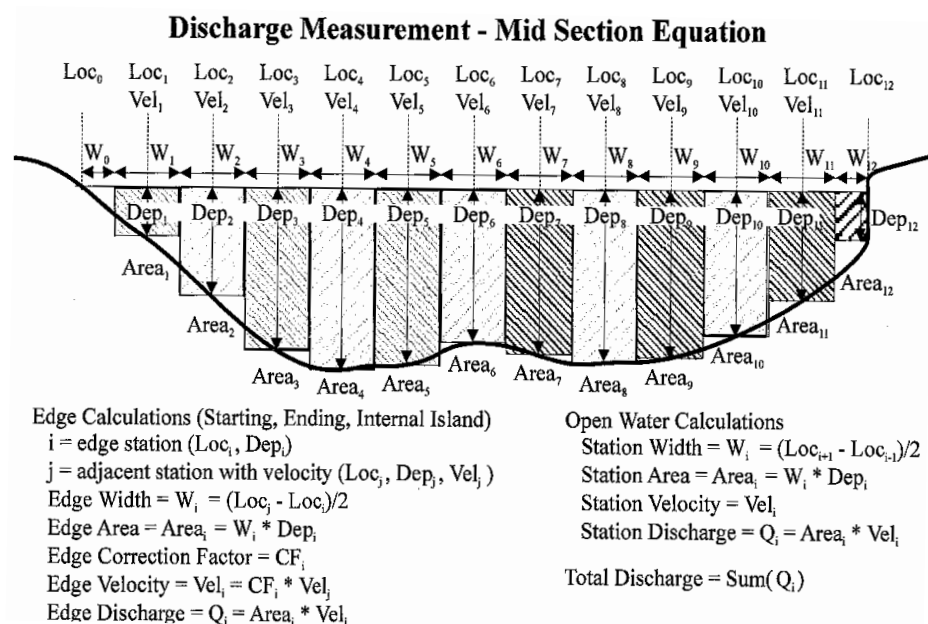


Figure 12.0. 2. Mid-Section Diagram and Equations.

- d. **Starting discharge measurement**
- i. Turn on FlowTracker, Press “Enter” and then press “1” (Setup Parameters Menu).
 - ii. Press “2” and check to see if the averaging period is set to 40 seconds, if not type in 40.
 - iii. Make sure the mode is discharge if not press “3”.
 - (a) Press “1” for discharge.
 - iv. Press “5” Discharge settings mode to select the appropriate discharge equation based on the flow distribution in the stream.
 - (a) **If the main flow in the stream appears to be uniform across the stream select “MID” “1” (See Figure 12.0. 2).**
 - (b) **If the main flow is restricted to the middle or one side of the stream select “MEAN” “2” (See Figure 12.0. 3).**
 - v. When finished press “0”.

- e. Select a site with reasonably uniform bottom conditions that can be waded <1.2 m (4 ft.).
 - f. String a measuring tape (0.1 ft) across the river or stream perpendicular to the stream streambank/stream flow.
 - g. Using the measuring tape determine stream width (wetted width) and divide the total width by 10 to ideally 20 intervals to determine equal distant stream locations. There must be enough intervals so that no more than 10% of stream discharge is represented at any one stream location. This may not be possible on very narrow streams. At a minimum, measurements may be made every 0.25 feet (3 inches).
1. For example, the tape line measures 1.5 feet at the left bank shore and 17 feet at the right bank shore. Subtracting 1.5 from 17 results in a stream width of 15.5 feet. In order to prevent greater than 10% stream discharge in any one stream location, at least 20 stations should be the measured. 15.5 feet divided by 20 stations would result in increments of 0.775 (0.77) feet.

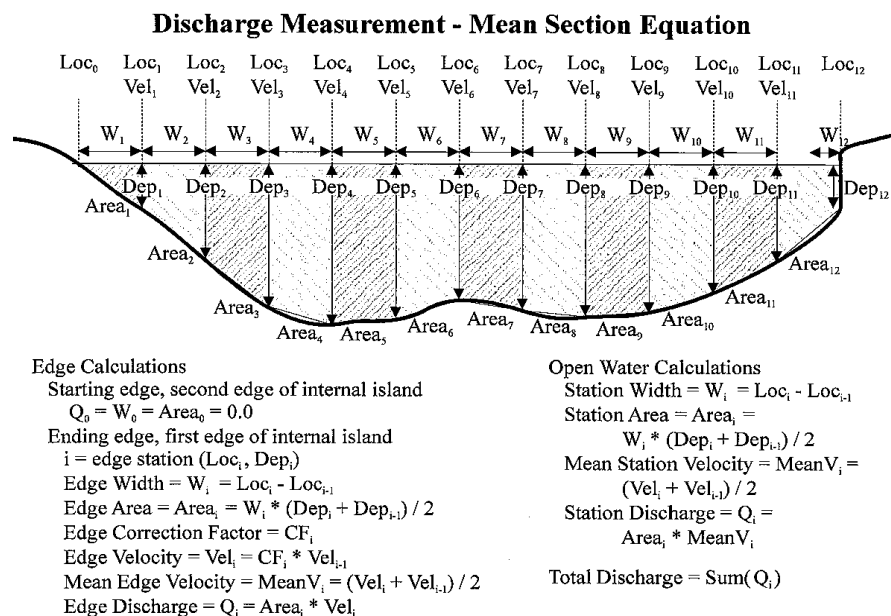


Figure 12.0. 3. Mean Section Diagram and Equations.

- g. Press “3” Start data run on the handheld.
- h. Press “1” Name data file “Project Specific” up to eight characters then press Enter on the handheld.
- i. Press “2” File extension “user discretion” three characters (author uses numbers, 001 and if I have to repeat I use the same name and the 002 extension, etc.) then press “Enter” on the handheld.
- j. Press “9” to accept name and extension.
- k. Press “1” to enter Site name if desired.

- l. Press “2” to enter operator name.
- m. Press “9” to start transect.
- n. Press “Enter”.
- o. Press QC Menu to enter gauge data.
- p. Press “1” to enter staff gauge height.
- q. When satisfied Press “Enter” to accept, then press “0” (zero) to continue.
- r. Press “1” and run Automatic QC Test at first site each day only. The only other time the operator would run another QC Test is if the Doppler head is dropped or arms are hit knocking them out of alignment.
- s. Press “2” to skip test only if test has already been run that day.
- j. Press “Enter”.
- k. Press “1” to end test.
- l. Begin at the first station Loc0 Press “Set Location” blue button enter tag line (tape) measurement in feet to 0.01 (Figure 12.0. 4).
- m. Press “Enter”.
- n. Enter LEW or REW (**Determined When Facing Downstream**) by toggling key “4”.
- o. Press “Set Depth” blue button, enter depth in feet if other than zero “0” (Figure 12.0. 4).



Photo by Mike Teitz

Figure 12.0. 4. The FlowTracker handheld keypad.

- p. Press “Enter”.
- q. Press “Next Station”.

- r. Move to next station listed on the screen or move to the pre-determined interval calculated in step “g”, press “**Set Location**” and enter the distance.
- s. Press “**Set Depth**” and enter the total depth the station.
- t. At this point if water depth is greater than zero press “**Measure**” and take velocity measurement at one (using 0.6 tenths method) or more depths when total depth is greater than 2.0 ft. (0.61 m) or greater.
- u. This process is repeated at each station across the transect until the “**End Section**” (grey button) button is pressed Loc_i (Figure 12.0. 4).
 - i. When “**End Section**” key is pressed the ending-edge information is displayed. Enter the information for this edge. At this time the “**Previous Station**” and “**Next Station**” buttons can also be pressed to review completed stations. Press “**Calculate Discharge**” to compute the total cross-sectional discharge for all completed stations
 - ii. Write down all appropriate data on flow datasheets SD DENR WPP Discharge Measurement Sheet or SD DENR WPP Discharge Datasheet (Appendix A, Table A-3 or Table A-2, respectively).
- v. Press “0” to return to the main menu before shutting down. **THE TECHNICIAN MUST ALWAYS RETURN TO THE MAIN MENU TO MAKE SURE THAT ALL DATA IS SAVED!**

6. **StreamPro Discharge Measurement, adapted from StreamPro Quick Start Guide (Teledyne, 2008)**

- a. Turn on HP iPAQ and start StreamPro software by tapping the start button and a drop down box will appear, and then select StreamPro.
- b. **Configure the StreamPro for deployment.**
 - i. Make sure that the power is turned on for the StreamPro ADCP.
 - ii. Establish a Bluetooth connection with the StreamPro ADCP. Touch the iPAQ wireless icon at the bottom right corner of the screen to turn on Bluetooth. If connection cannot be made to the StreamPro RESET the iPAQ by inserting a pen or paper clip in the reset access hole on the bottom of the iPAQ and try again.
 - iii. Use the **Setup tab** to load and/or modify a configuration file. “.xml”
 - (a) To change settings click on “Configuration File” and change settings and click the Accept button.
 - (b) To save modified file click on “Configuration File” and “Save as” change file name and hit return.

- c. Perform a **Moving Bed Test (MBT)** at each site and every time the site is visited! Some Rivers and sites carry such a heavy sediment load that they do not have a clearly definable bottom. The MBT is done to prove that the bed of the section is **NOT** in motion. If the test shows biased bottom tract data at the site, try moving to a different nearby location to see if the problem changes. Run the test as follows:
 - i. Start StreamPro and load the default configuration file.
 - ii. Set the **Transducer Depth** and an estimated **Maximum Stream Depth** (See Change Default Settings, Section 6.0, C, 6, 6.4, c).
 - iii. Save the configuration file with a unique name [example MBed.xml] (Figure 12.0. 5).

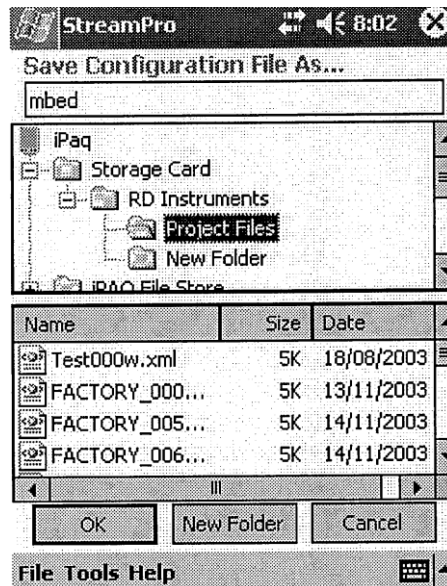


Figure 12.0. 5. StreamPro save configuration file screen.

- iv. Place the StreamPro in the center of the stream/river or the point at which the highest velocities can be seen.
- v. In the StreamPro tap the **Data Collection** tab (Figure 12.0. 6).
- vi. Tap **Display, Graph**. Select **Ship Track** (Figure 12.0. 6).
- vii. Tap the **Transect Start** button to initiate data recording.
- viii. Tap **OK** to enter an **Edge Distance of 0 feet** (the distance is not important).
- ix. Hold the StreamPro ADCP in position for five minutes and try and minimize any movement (good luck!). **Any movement indicated on the ship Tract Plot above actual movement would indicate a Moving Bed.**

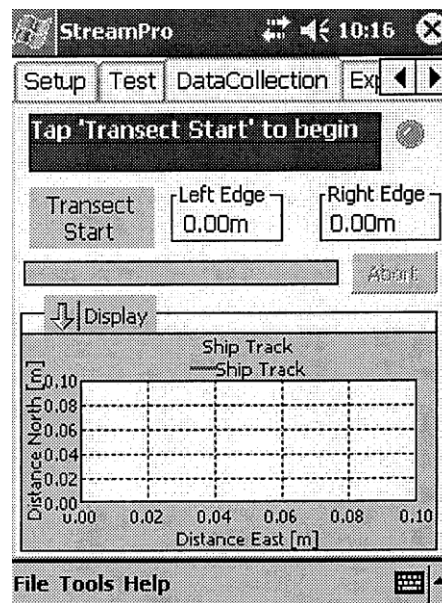


Figure 12.0. 6. StreamPro data collection tab and ship track display screen.

- x. Tap the Transect Stop button to stop data recording.
- xi. Tap OK to enter an Edge Distance of 0 feet (the distance is not important).
- xii. Tap the Playback tab, tap Display, Graph, and Ship Tract to view the ship tract plot (Figure 12.0. 7).

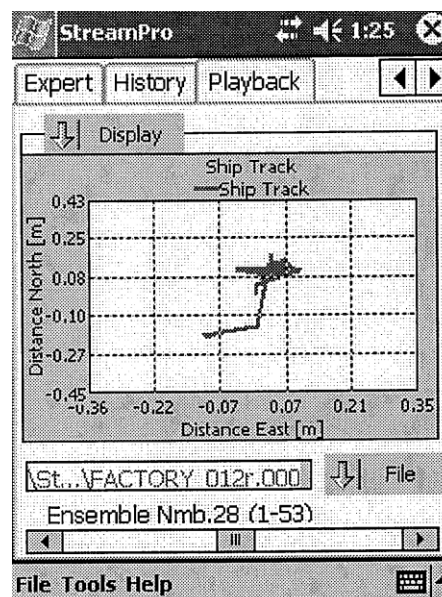


Figure 12.0. 7. StreamPro playback tab display of ship track screen.

If the test indicates bed movement move to a more suitable section. The example above indicates minimal ADCP movement.

- xiii. Tap **Display, Digits** to switch the display back to digits. Use the scroll bar at the bottom of the screen to view the Bottom Depth. Use the data to set a better estimate of the **Maximum Stream Depth** for future transects.
- d. **Measure Start and Stop Points for stream edges.**
Edges locations must be determined prior to beginning data collection. Typically, edge measurements are taken as close to the streambank as can be measured and still read valid data. Ensembles that contain a minimum of two good depth cells are considered valid data.
 - i. Wade into the stream/river, or otherwise locate the StreamPro float in the water at a point far enough from the edge to be certain good measurements may be taken.
 - ii. Start the StreamPro application and select the Test tab.
 - iii. Tap **Instrument, Start Pinging** to begin measuring without recording data (Figure 12.0. 8). On the **Test** tab screen, in the bottom-right corner is displayed the number of good depth bins (see arrow). This value is updated on every ensemble.

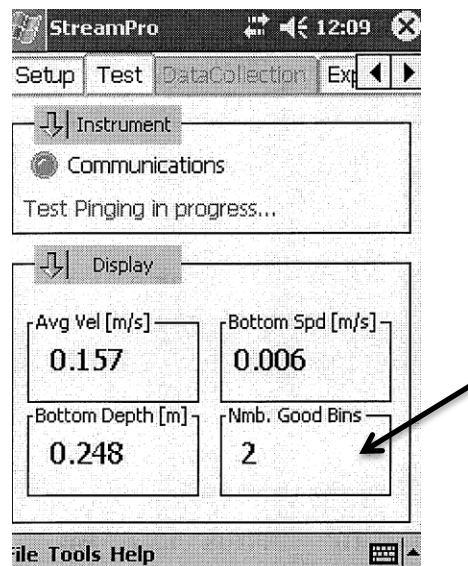


Figure 12.0. 8. StreamPro test tab with the number of good bins identified.

- iv. Slowly move the StreamPro closer to the bank. As the stream/river becomes shallower the number of good depth cells reading should gradually decrease. When the boundary between one and two good depth cells is located, move just far enough from the bank as to produce a solid two-depth cell measurement.
- v. Stake, flag, or mark this location. This represents the starting point for the transect.

- vi. Measure the distance between the staked (marked) location and the physical edge of the stream or river.
- vii. Repeat the process at the far bank to locate the stopping point of the transect.

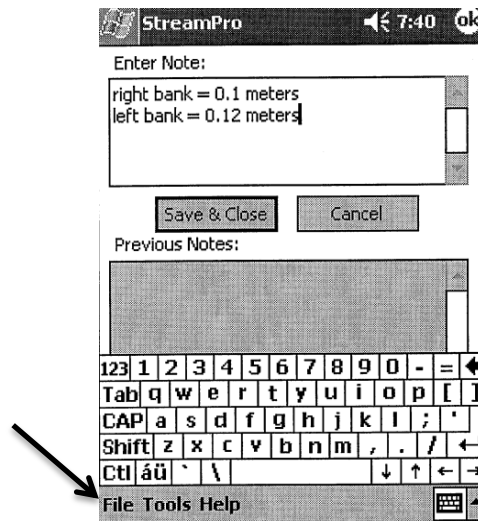


Figure 12.0. 9. StreamPro file notes location.

- viii. Tap **File, Edit Notes** [lower left corner of the screen (black arrow)] (Figure 12.0. 9).
- ix. Tap the **Enter Note** area and enter the right and left bank distances.
- x. Tap **Save & Close** (Figure 12.0. 10).
- xi. These values will be used later during data collection. When returning to this page the previous entries will show up in the previous notes screen (Figure 11.0. 10, white arrow).

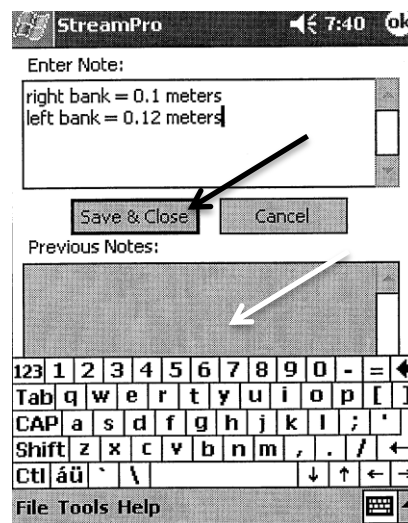


Figure 12.0. 10. StreamPro save and close button location.

e. **Collecting data**

Collect a minimum of four high quality transects that agree with each other within 5 percent of the mean of all the samples. The following sequence must be repeated for every transect taken at each sampling location.

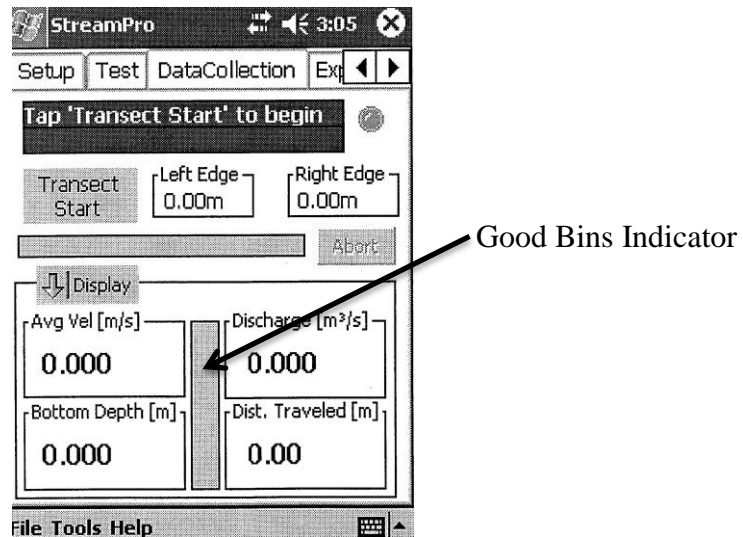


Figure 12.0. 11. StreamPro data collection tab and the location of the good bins bar.

- i. Move the StreamPro ADCP to the previously determined starting point.
- ii. In StreamPro, select the **Data Collection** tab (Figure 12.0. 11).
- iii. Tap **Transect Start** button to initiate data recording (Figure 12.0. 11). (Note: the small vertical bar graph on the Data Collection tab digits display area is a **Good Bins Indicator**).

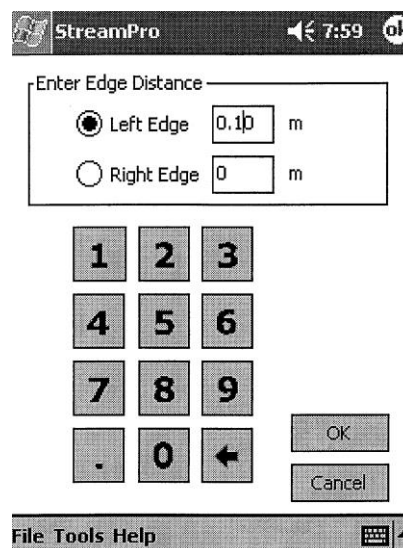


Figure 12.0. 12. StreamPro edge entry screen, Left Edge.

- iv. Check the Left or Right Edge button and enter the Edge distance when prompted. This value was recorded as a note when the edge measurement was determined (Figure 12.0. 12).
- v. Select OK to accept the distance. (Note: The **Left Edge** is the left bank of the stream or river **when looking downstream.** StreamPro will automatically toggle between the left and right edges during transects).
- vi. Hold position while the StreamPro records good edge measurements.
- vii. StreamPro will prompt the technician with the message **“Taking edge measurements. Hold position”** while this process is taking place.
- viii. When good measurements have been read, StreamPro will prompt the technician to move across the river or stream by displaying **“Transect in progress. Please proceed to the opposite bank”**.
- ix. By appropriate means, move the StreamPro in the water towards the opposite shore at a slow steady pace.

Towing the boat tips:

When departing from the edge, pull the cable in such a way as to slowly accelerate the boat away from the edge and when approaching the other edge slowly reduce the speed you apply to the cable such that the boat decelerates and does not overshoot the predetermined edge. The goal is to go from edge to edge and not over shoot at either edge. Doing so will allow you to obtain the most accurate measurements, in particular the area measurement.

Good Bins Indicator Information

The small vertical bar graph on the Data Collection tab digits display area is a Good Bins Indicator. This indicates the percentage of the number of bins used to compute the velocity displayed out of the total number of bins possible in an ensemble (number of bins above the sidelobe interference line). The graph displays good cells from the top down (Figure 12.0. 11 and Figure 12.0. 13).

If a cell is bad the color of the cell is black. Bad cells in the middle of a profile will be indicated by the position of the bad cell.

For good cells the cell colors change as follows:

- If only one cell is good, displays it as Red
- If only two cells are good, displays them in Yellow
- If three or more cells are good, displays then in Green.

- x. When the StreamPro arrives at the opposite shore, tap **Transect Stop** button.

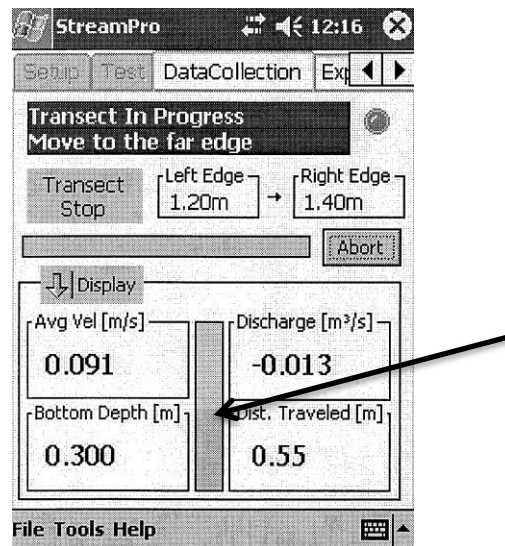


Figure 12.0. 13. StreamPro good bins indicator (percentage of bins used to calculate velocity displayed out of total bins possible in an ensemble).

- xi. Check the Left or Right Edge button and enter the Edge distance when prompted. This value was recorded as a note when the edge measurement was determined. Use this measure and enter Edge distance for the new shore (Figure 12.0. 14).

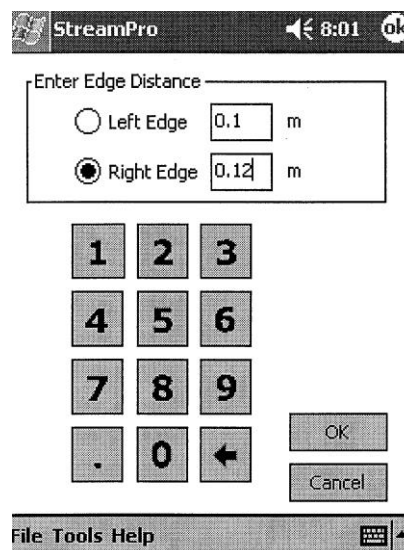


Figure 12.0. 14. StreamPro edge entry screen, Right Edge.

- xii. Select **OK** to accept the distance and wait for the instrument to complete the edge measurements.
- xiii. Once the edge is computed, the data recording stops and the data file is closed.

- xiv. Tap the **Transect Start** button again to repeat the process in the opposite direction (the StreamPro automatically switches direction when the data file is closed (Left to Right or Right to Left bank).
- xv. Tap **Transect Stop** once reaching the opposite shore
- xvi. Repeat these steps to capture at least four good transects.

f. **Viewing History**

The History section is used to compare transect files (Figure 12.0. 15). After collecting at least four transects for each station on the waterbody, **each file must be verified to be within 5% of the mean discharge calculated for the set.** If any transects are outside of this tolerance, additional transects need to be measured.

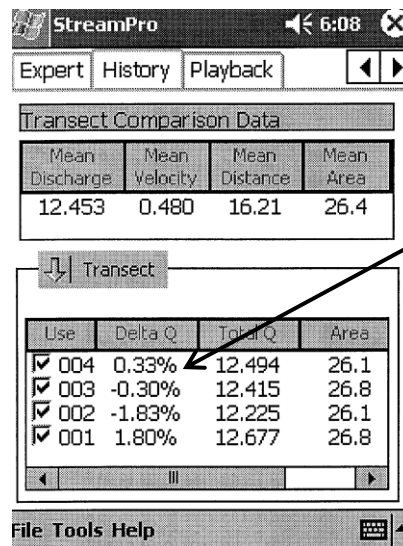


Figure 12.0. 15. StreamPro history tab screen

- i. To view the history of each transect collected, tap the **History** tab.
- ii. All transects will appear in the bottom half of the display in order of the most recent transect at the top of the scrolling list.
- iii. Individual transects may be added or removed from the mean calculation by selecting or clearing the check mark beside each on the far left side of the screen.
- iv. On the upper portion of the display, the mean values for total discharge, river/stream velocity, total distance and total area are displayed and recomputed whenever an individual transect is added or removed from the solution (Figure 12.0. 16).

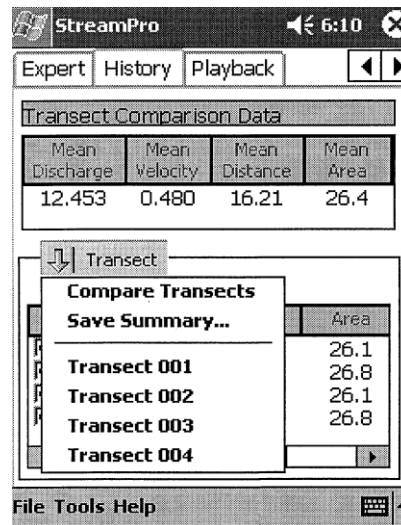


Figure 12.0. 16. StreamPro history screen to view each transect summary.

- v. To review the discharge summary tap **Transect** (Figure 12.0. 16), then tap the data file to view the transect summary for each data file opened.
- vi. Tap **Transect**, and then tap **Compare Transects** to return to the Compare Transects screen.
- vii. Selecting a specific transect will display a transect summary that includes: (Table 12.0. 1)

Table 12.0. 1. Transect summary items and units.

Item	Units
Total Q	ft ² /s
Measured Q	ft ² /s
Left Q	ft ² /s
Right Q	ft ² /s
Top Q	ft ² /s
Bottom Q	ft ² /s
Total Length	ft
Avg. Velocity	ft/s
Total Area	ft ²

- viii. When satisfied with the results and all transect selected (checked) percentages are less than five percent of the mean discharge calculated for the set, fill out the required information on the SD DENR WPP Discharge Measurement Datasheet (Appendix A, Table A-3).

g. **Moving and Copying Data Files**

This section shows how to move or copy data files from the iPAQ Pocket PC to the desktop computer.

Saved file locations

Using the factory default configuration file, data files are saved to the *\Storage Card\RD Instruments\Project Files* folder if the storage card is installed or to the *\iPAQ File Store\RD Instruments\Project Files* folder if the storage card is not installed.

If the technician saves a configuration file (Save As), then data files collected with that configuration file will be saved to the same location. If the technician does not select a folder and location, by default the configuration files are saved to the My Documents folder on the iPAQ Pocket PC. For safer storage, select **Storage Card** for the **Location**.

- i. Place the iPAQ Pocket PC in the cradle.
- ii. When Microsoft ActiveSync starts, click the Explore icon.
- iii. Navigate to the folder where the files were saved.
- iv. Highlight the files you want to move.
- v. On the “**Edit**” menu, select “**Copy To Folder**” and select the folder where the files will be copied.
- vi. If you want to move the data files from the iPAQ Pocket PC, select “**Move To Folder**” and select the folder where the data files will be moved

7. **Stage Recording/Data Logging**

- a. Program stage recorders, data loggers, and temperature loggers as per Section 6.0.
- b. Be sure to check, adjust and download stage recorders and data loggers **every two weeks or as conditions change**.
- c. **BE SURE TO WRITE DOWN ALL STAGE CHANGES AND DOWNLOAD INFORMATION IN THE PROJECT LOGBOOK!!!!!!!!!!!!!!**
- d. Keep all stage recorders and data loggers in dry protected housings.

C. **Sample Collection**

There are basically two sample collection methods for tributary sampling:

1. Grab sampling
2. Composite sampling (tributary sampling with a suspended sediment sampler)

A typical sample set for a sampling a site consists of the following bottles and preservative:

- Two (2) one-liter polypropylene bottles (“A” bottle, preserve sample by cooling to 6° C; and “B” bottle, preserve samples using 2-mL of concentrated H₂SO₄).
- One (1) 100 mL bottle for total dissolved phosphorus (TDP) sample, preserve sample using five to seven drops of concentrated H₂SO₄ (filtered from extra one-liter sample bottle).
- One (1) 250 mL poly-plastic bacteriological bottle (“C” South Dakota Public Health Laboratory) or two (2) 100 mL sterile bottles depending upon laboratory used and preserve by cooling sample to 6° C.
- Collect one (1) OR two (2) extra one-liter sample in a brown polypropylene bottle(s) for use in filtering total dissolved phosphorus (TDP), chlorophyll-*a* samples, and **(if required)** algae.

Labeling

Using a water proof pen or marker fill out Water Quality Bottle label containing the project, source water location, laboratory code, station ID, sampler initials, date, and time (Figure 12.0. 17). Check appropriate sample depth and select bottle type "A" or "B" bottles one (1) liter bottle each, "C" one (1) 250 mL bacteriological bottle or two (2) 100 mL bottles), "D" one (1) 100 mL bottle for total dissolved phosphorus, and affix to the appropriate bottle(s) (Figure 12.0. 17).

Project:		Initials:	
Source:			
Code:			
Station:			
Date		Time	
<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater	
<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
<input type="checkbox"/> E	<input type="checkbox"/> R	<input type="checkbox"/> V	<input type="checkbox"/> H
		<input type="checkbox"/> CN	<input type="checkbox"/> Oil
		<input type="checkbox"/> Dis	<input type="checkbox"/> Recov

Figure 12.0. 17. SD DENR WPP Water Bottle Label

Project:		Date
Source:		Time
Station:		Initials
Program:		Comp mL
<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater
<input type="checkbox"/> Algae	<input type="checkbox"/> Composite	<input type="checkbox"/> Periphyton
<input type="checkbox"/> MacroInv	<input type="checkbox"/> Grab	<input type="checkbox"/> Phyto
<input type="checkbox"/> AFD	<input type="checkbox"/> Replicate	<input type="checkbox"/> Art Sub
<input type="checkbox"/> Chl A	<input type="checkbox"/> Blank	<input type="checkbox"/> Nat Sub
		Filtered mL
		Surface Area

Figure 12.0. 18. SD DENR WPP Quality Biological Bottle Label

1. Grab Sampling

Collecting a Sample

a. The 250 mL/100 mL bacteriological sample (“C” Bottle).

The "C" bottle (bacteriological sample) should be collected first. The 250 mL bottle is used when the sample requires more than one bacteriological analysis and will be analyzed at the State Public Health Laboratory. If the sample only requires one bacteriological analysis, the 100 mL bottle may be used. Be careful not to contaminate the inside of the lid or mouth of the bottle with your fingers or introduce other sources of contamination. At no time

should composite samples be collected for microbiological examination.

- i. The "C" bottle(s) are sterile bottles and **should never be rinsed** with distilled or sampling site water.
- ii. Remove lid and position the open end of the bottle towards the current flow and away from the hand of the collector.
- iii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.
- iv. The sampling depth should be between 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the water surface if possible. If the water depth is shallower, the sampler should avoid contaminating the sample by inadvertently introducing surface debris and bottom sediments via shallow conditions.
- v. During sampling, tip the bottle slightly upward to allow air to escape and the bottle to fill. On the initial plunge, the "C" sample bottle should be filled completely or at least above the 250 mL/100 mL mark (Figure 12.0. 19). Immediately after obtaining the sample, pour off the excess sample water from the container until the sample volume is 250 mL or 100 mL depending upon bottle and screw on cap securely.
- vi. **If the sample bottle is not filled at least to the 250 mL/100 mL mark on the sampling bottle, discard the sample and sample bottle and repeat the process with a new "C" bottle. DO NOT re-immers**
e the original bottle to add more sample volume.
- vii. Place sample bottle in a cooler on loose ice (6° C); **no other preservative is required for "C" bottles.**
- viii. Bacteriological samples need to arrive at the laboratory within 24 hours.

b. **The "A" bottle (one-liter bottle).**

Because of the small diameter of the neck of the bottle, no sweeping motion is required while filling the bottle "A." Fill the "A" bottle following the procedure below.

- i. The "A" bottle and cap **should be rinsed** with sampling site water prior to collection of the sample to ensure no cross contamination.
- ii. Position the open end of the bottle towards the current flow and away from the hand of the collector.
- iii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum. The sampling depth should be between 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the water surface, if possible.

- iv. Tip the bottle slightly upward to allow air to escape and the bottle to fill.
- v. The "A" sample bottle should be filled completely or filled at least above the volume indicated in Figure 12.0. 19. Immediately after obtaining the sample, pour off the excess sample water from the container until the sample volume similar to Figure 12.0. 19 and cap immediately.
- vi. Place the sample container in a cooler on loose ice (6° C); no other preservative is required for bottle "A."

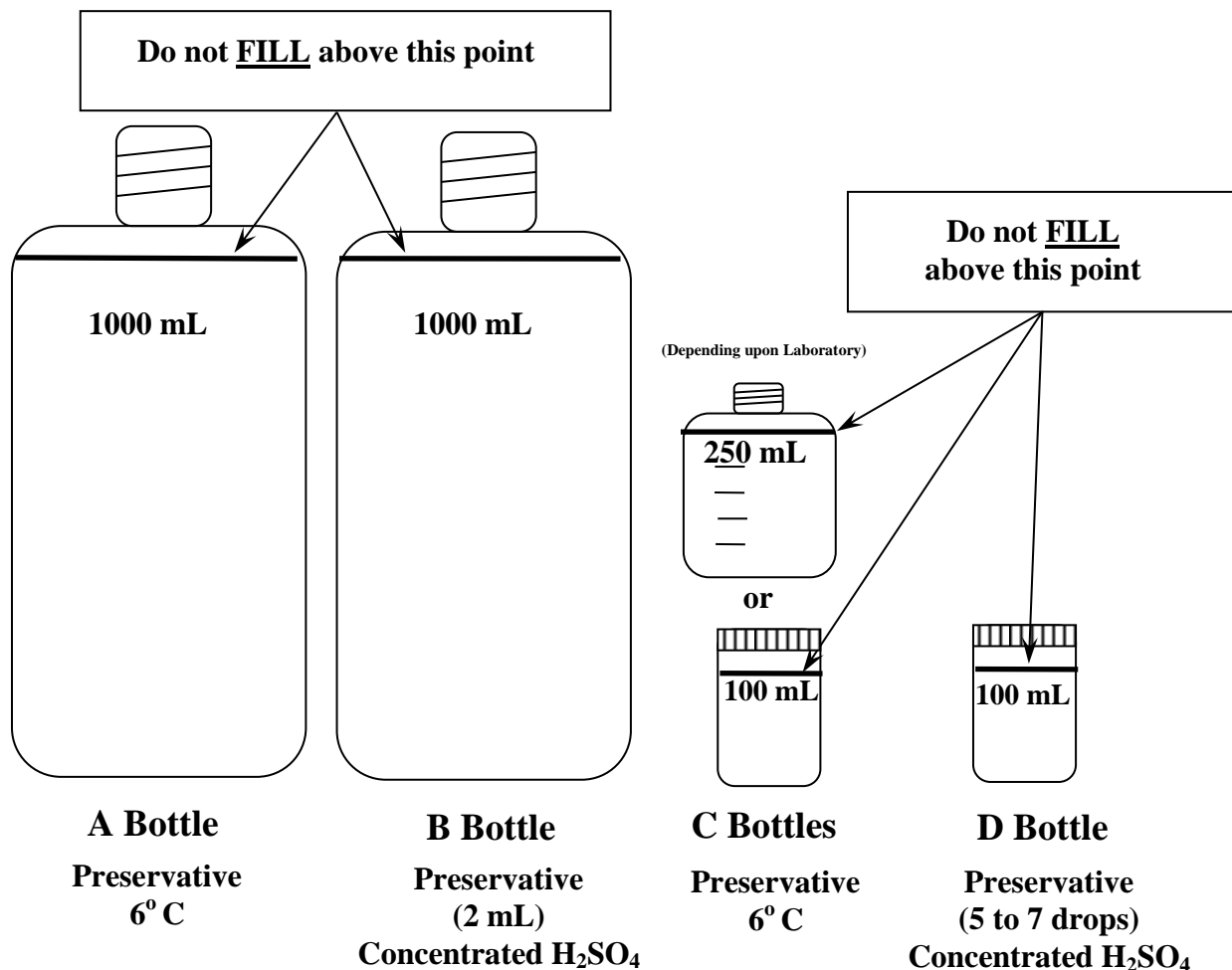


Figure 12.0. 19. Fill diagram and preservative for typical SD DENR WPP tributary sampling suite.

c. **The “B” bottle (one-liter bottle).**

Follow collection procedures for filling bottle “A” to fill bottle “B.” bottle. However, preserve the sample using the following procedure below.

- i. After the sample has been collected, preserve this sample with 2 mL of concentrated sulfuric acid (H_2SO_4) to lower the pH of the sample below 2 standard units. If the laboratory provides ampoules of preservative (H_2SO_4), pore the contents of the ampoule into the filled sample bottle to lower the pH of the sample below 2 standard units
- ii. **Periodically** use pH test strips (paper) to verify the pH has been lowered to < 2 standard units.
- iii. After H_2SO_4 has been added and the bottle capped, the sample bottle is inverted several times to ensure mixing of the preservative throughout the sample.
- iv. Place sample containers in a cooler on loose ice (6°C) for shipment to the laboratory.

d. **Collection of extra one liter bottle(s).**

If collecting only water to be filtered for total dissolved phosphorus, the sample can be collected in a one-liter polypropylene bottle following collection procedures for filling bottle “A”. If, however, chlorophyll *a* and/or algae samples are also required, collect sample(s) in **one-liter brown polypropylene bottle(s)** and fill following collection procedures for filling bottle “A”. If chlorophyll *a* and/or algae samples are not required, discard the rest of the sample(s) after filtering the total dissolved phosphorus sample.

e. **The “D” bottle (100 mL plastic bottle (“X” top)).**

Water to be filtered for this sample comes from the extra one-liter bottle(s) collected in Section 12.0 (C.) (1.) (d.). Procedure for field filtration and preservation of the total dissolved phosphorus sample are described below.

- i. **DO NOT PRE-RINSE the “D” bottle and cap with de-ionized (distilled) water.**
- ii. Thoroughly **rinse** the field filtration device with de-ionized (distilled) water prior to assembly, once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 0.45 micron pore size filter**) and vacuum (filter/rinse) approximately **250 ml** of distilled water through the filter (Figure 12.0. 20).

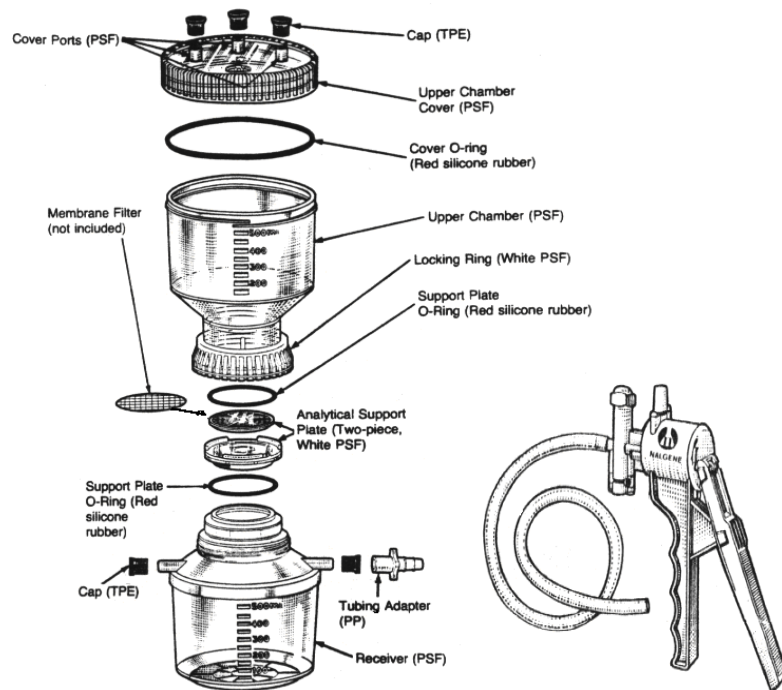


Figure 12.0. 20. Nalgene filter holder with receiver and vacuum pump. Adapted from “Instruction Manual for Nalgene Filter Holders with Receiver and Filter Holders with Funnel,” Nalgene Company, Rochester, New York.

- iii. After vacuum filtration, empty the distilled water from the bottom reservoir, by removing both the cap and the hose from the bottom reservoir and pouring the filtered water out of one of the holes. **DO NOT remove the upper chamber** during the rinsing operation. After the distilled rinse water has been poured out of the receiver, tilt the filtration unit and gently shake the unit to remove any water remaining in either drain ports of the receiver.
- iv. Pour approximately 120 mL of sample water (from the extra one-liter bottle) into the upper chamber and filter. If the filter clogs the filter due to excessive amounts of suspended sediment or algae, see step v. below.
- v. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, carefully pour the a very small portion of the filtered sample water out the receiver (a few drops) onto the ground to rinse any distilled water that may be in either drain port in the bottom reservoir. Place the uncapped “D” bottle under the drain port and pour the remaining filtered sample water into the

- sample bottle ensuring that no unfiltered water from the upper chamber gets into the “D” sample bottle; and cap. Set the partially filled and capped “D” bottle aside and remove the clogged filter, and repeat steps the process above (ii, iii, and iv).
- vi. When complete, transfer the filtered water in the reservoir (100 mL) into the partially filled “D” sample bottle as described in step “v”. Add 5 to 7 drops (0.25 mL) of concentrated sulfuric acid (H_2SO_4) to lower the pH of the sample below 2 standard units.
 - vii. Place the acidified “D” bottle into a storage cooler on loose ice.
 - viii. Rinse the entire filtration apparatus with de-ionized water between sample site locations.
 - ix. After collection, all sample bottles must be immediately placed on loose ice or into a refrigerator and kept cool (6°C) prior to and during shipping to a laboratory.

After all samples have been collected and preserved at each sampling site, completely fill out the project logbook and a separate SD DENR WPP Water Quality Datasheet for each site (Appendix A, Table A-4).

2. Composite Sampling

2.1. Suspended Sediment Sampler

General Overview

A suspended sediment sampler collects water quality data more accurately with less sampling bias than a simple grab sample. The suspended sediment sampler should be used to collect water samples from tributaries whenever possible. SD DENR WPP uses a US DH-81A adapter, US DH-77 plastic cap, US DH-77 plastic nozzle, US DH-77 three (3) liter plastic bottle and a three (3) foot wading rod with handle.

The “transit rate” of the suspended sediment sampler is the rate of movement of the suspended sediment sampler from the surface of the stream to the bottom of the stream and back again to the surface (Figure 12.0. 21). This rate must be constant at all sampling verticals at every sampling station, i.e. the rate of movement must be the same at each sampling interval. The transit rate also needs to be fast enough so that it does not allow the collection bottle to over-fill.

- The sampling bottle on the suspended sediment sampler should not be filled to more than 80% capacity.

- A separate bottle or container should be on hand to hold the sample until a sufficient amount of water is collected to fill the needed sample bottles.
- A 0.91-meter (3-foot) wading rod is provided with the suspended sediment sampler bottle. If the stream depth is too deep for this wading rod then it will be necessary to attach an extension pole to the wading rod.

When to use the Suspended Sediment Sampler

The sampler is best used at depths greater than 0.30 meter (1 foot). If the field technician should encounter low flow (< 0.06 cms (2.0 cfs)) or shallow depth (< 0.30 m (1 foot)) situation at the tributary sampling location, then the Grab Sampling methods described previously ((B), (1) of this section) should be employed.

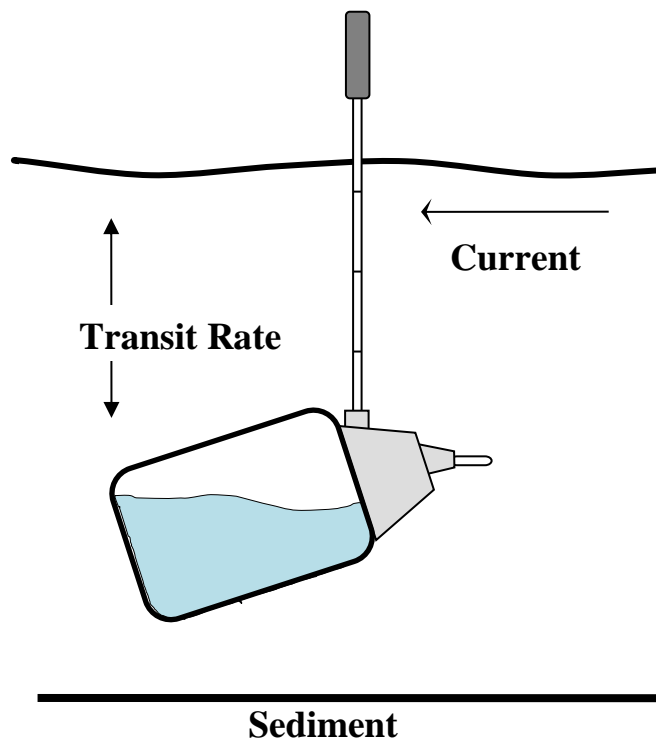


Figure 12.0. 21 General use of the suspended sediment sampler used by SD DENR WPP.

- Suspended Sediment Sampling Procedure**
 - The sediment sampler and a bottle for compositing the water sample should be rinsed with sample water prior to use at each site and rinsed with de-ionized water after use at each site. The pre-rinse should be with sampling water from the tributary

- site to be sampled. Distilled water should be used to rinse the sampler and bottle after the sample is collected at the site.
- ii. Stake a tape measure across the stream/river to be sampled (transect).
 - iii. Attach the suspended sediment sampler to the bottom of the wading rod. Facing upstream, point the nozzle into the oncoming flow when collecting the sample (Figure 12.0. 21).
 - iv. **The suspended sediment sampler should be used at the same intervals from which the flow data was collected.** If flow data was collected every 0.15 meter (0.5 foot) then the sediment sampler should be used at every 0.15 meter (0.5 foot) interval.
 - v. The sampler nozzle should be lowered to just above the water's surface, allowing the back end of the sampler to rest on the surface of the water. This will allow proper orientation of the sampling bottle with respect to flow.
 - vi. The suspended sediment sampler is gently moved downward until the tail end of the bottle all most touches the streambed. Once the sampler reaches this point, the direction is immediately reversed, returning the bottle to the surface. The sampler must be moved at a constant transit rate throughout this entire sequence (mentally count up as the sampler travels down (i.e., 1,2,3,4,5,...n) and mentally count back down (i.e., n,...,5,4,3,2,1) to zero back at the surface.
 - vii. Once the sampler has returned to the surface, move to the next interval in the stream, or empty the sample into the composite container if you cannot complete one more up-and-down cycle without exceeding the sample bottle's 80% full mark.
 - viii. Move to the next interval and use the exact same transit rate (upward and downward movement of the sample bottle) explained above.
 - ix. Note: The movement, either upward or downward, must be conducted at a constant rate at each interval. Also, the transit rate should be such that it does not allow the water bottle to overflow.
 - x. Once the last vertical sample has been collected, the field sampler must determine if the volume of water in the composite sample bottle is enough to fill all the sample bottles (bottles A, B, D, and extra one-liter sampling bottle) including any special samples such as metals, pesticides, or any quality

assurance/quality control samples. If the volume of water in the composite bottle is sufficient after the first series of verticals, the collection period ends. **If there is not enough water to fill all the necessary sampling bottles, another round of vertical sampling must be completed.**

- xi. **Note:** If the volume of water collected is not enough to fill all the bottles, **all** vertical sampling points must be sampled again. Samples must be collected across the entire stream cross-section so that a representative (integrated/composite) sample has been collected.
- xii. After a sufficient composite sample has been collected, bottles must then be filled (“A”, “B”, and an extra one liter bottle for filtering the “D” bottle). The “C” bottle (*E. coli* and/or fecal coliform bacteria) is filled by dipping the bottle in the stream as described in (Section 12.0 (1.) (a.)).
- xiii. Prior to filling each sample bottle, it is necessary to stir, invert or mix the composite bottle so that the chemistry and sediment particles are somewhat uniform throughout the composite bottle.
- xiv. After stirring, fill bottle “A”, stir, fill bottle “B”, then fill bottle D by, removing the necessary amount of sample into the pre-rinsed and pre-filtered Nalgene Vacuum Pump container. Filter this and put it into bottle D using the bottle “D” filtration method described in Section 12.0 (1.) (e.).
- xv. Preserve the sample with 5 drops to 7 drops (0.25 ml) of concentrated H₂SO₄ to lower the pH of the sample below 2 standard units, label, fill out SD DENR WPP Water Quality Data Sheets, package (sample cooler on ice (6° C)), and ship to the contracting laboratory.

D. Chlorophyll *a* Sampling

Procedure for Tributary Chlorophyll *a* Sampling

Generally, tributary chlorophyll *a* sampling consists of three discrete sub-samples that are composited into one along one transect in a stream or river. Individual/discrete samples will consist of one grab sample each.

Select a wadeable area upstream of the sampling site (chemical or bioassessment) and set up a transect.

Composite samples will be collected in three (3) pre-rinsed 500 ml brown (opaque) sampling bottles and composited into one 1,500 mL sample. The samples should be

kept out of the sun and on ice. **Rinse these bottles thoroughly with de-ionized (distilled) water prior to use.**

For **individual/discrete samples** use a separate pre-rinsed 500 ml brown (opaque) sampling bottle for each monitoring site.

1. For **composite samples**, (collect samples only from areas with noticeable flow) collect three 500 ml grab samples, one from the right third of the stream bank, one from the center third of the stream, and one from the left third of the stream bank.
2. For **individual/discrete samples** collect the sample from mid-transect. Fill the sample bottle(s) using the method described below.
 - a. Position the open end of the bottle (500 ml brown bottle) towards the current flow and away from the hand of the collector.
 - b. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.
 - c. The sampling depth should be 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the water surface, if possible. If the waterbody is static, make a sweeping motion horizontally away from the sampler.
 - d. Tip the bottle slightly upward to allow air to escape and the bottle to fill. The sample bottle should be filled to within approximately one inch of the top to allow mixing of the sample before analysis.

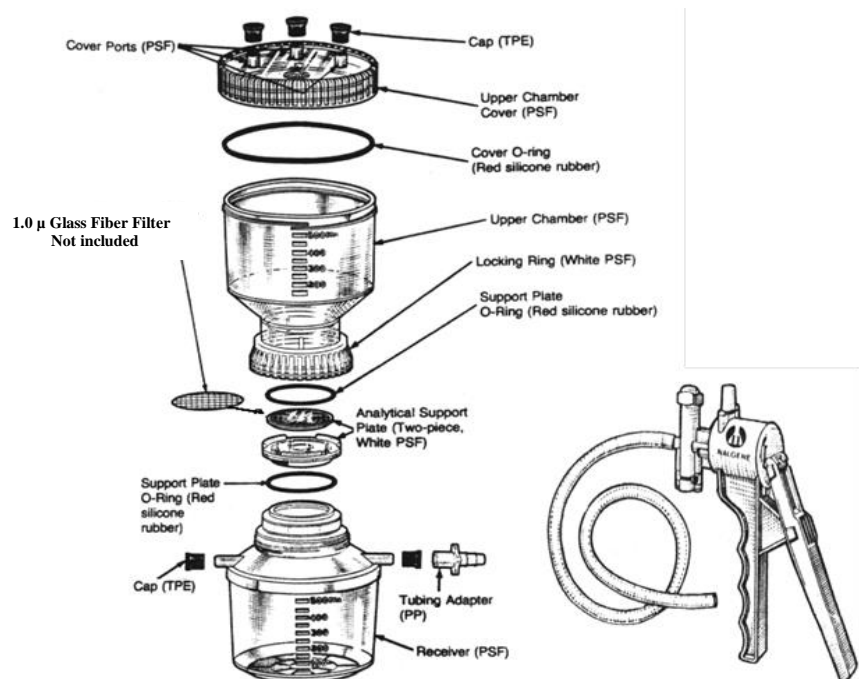


Figure 12.0. 22. Nalgene filter holder with receiver and vacuum pump. Adapted from “Instruction Manual for Nalgene Filter Holders with Receiver and Filter Holders with Funnel,” Nalgene Company, Rochester, New York.

3. Sample Filtration Methods

- a. Take the sample(s) back to shore to conduct sub-sample compositing and/or filtration. **All compositing and filtration will take place in a shaded area out of direct sunlight** using the same filter apparatus in Figure 12.0. 22.
- b. For individual and/or discrete samples, follow filtration procedures described in “6” and following.
- c. For composite samples, gently shake the each sample bottle to thoroughly mix the sample and pour 166 mL of water from each 500 mL sub-sample bottle into a graduated cylinder and pour each 166 mL into one 500 mL brown composite bottle until full. A minimum of **400 mL** of sample water will be required to complete chlorophyll *a* filtering (composite sample or discrete). **Note:** the Project Officer will determine the minimum amount of sample water to be filtered for all projects and is dependent upon project specific objectives. Gently mix, invert or shake the sample bottle prior to pouring the sample into the filter apparatus.
- d. Thoroughly rinse the field filtration device with de-ionized (distilled) water prior to assembly, once rinsed assemble the field filtration device with a new filter (**47 mm diameter, 1.0 micron glass fiber filter**) (*Note: these filters are different than the 0.45 micron membrane filters used for total dissolved phosphorus filtration*) (Figure 12.0. 22).
- e. Vacuum filter/rinse approximately **250 mL** of distilled water through the filter.
- f. Using a graduated cylinder, pour a minimum of exactly 400 mL of sample water into the upper chamber. Pump the vacuum pump gently as not to break algal cells (**approximately 7 inches of Hg (178 mm Hg or 3.4 lbs. /in²)**).
- g. If the upper and lower chambers of the filter apparatus have a maximum capacity of 250 mL, filter 200 mL of the sample, then pour the filtered water out the vacuum port of the lower chamber on to the ground. Once the lower reservoir is empty, carefully add the final 200 mL to the upper chamber and finish the filtering process.
- h. If the sample is very turbid or contains excessive amounts of algae or suspended solids, add the appropriate (known volume) amount of water to the upper chamber (400 mL or 200 mL) and filter as much of the sample as possible (until no water will go through the filter). Carefully pour the remaining contents of the upper chamber into a graduated cylinder and record the volume. Subtract the remaining volume from the initial volume to determine total volume filtered. Record this on the sample/bottle label (step “1.”).
- i. After filtering (total volume or 400 mL), gently remove the upper chamber and, with tweezers, fold the side of the filter with the deposited algae over onto itself **once**.

- j. With tweezers, place the folded filter on a piece of aluminum foil.
- k. Securely wrap the filter paper in aluminum foil, making sure no sunlight can reach the filter.
- l. Fill out a water proof SD DENR WPP biological label with an indelible marker (Figure 12.0. 23). Include project name, source water name, station ID, if there are multiple sample bottles per station ID mark number of sample bottles (i.e. 1 of 3, 2 of 3, or 3 of 3), and program acronym (i.e., WPP, SWQ, GF&P, SDSU, SDSM&T,..., etc.). Then fill in the date, time, sampler initials, and **the volume of water filtered VERY IMPORTANT**. Secure the label to the aluminum foil and wrap with clear packing tape.

Project		Date
Source		Time
Station		Initials
Program:		Comp mL
<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater
<input type="checkbox"/> Algae	<input type="checkbox"/> Composite	<input type="checkbox"/> Periphyton
<input type="checkbox"/> MacroInvt	<input type="checkbox"/> Grab	<input type="checkbox"/> Phyto
<input type="checkbox"/> AFD	<input type="checkbox"/> Replicate	<input type="checkbox"/> Art Sub
<input type="checkbox"/> L.Chl A	<input type="checkbox"/> Blank	<input type="checkbox"/> Nat Sub
		Filtered mL
		Surface Area

Figure 12.0. 23. SD DENR WPP Biological Label

- m. Place the aluminum foil with the chlorophyll *a* sample into a zip-lock freezer bag. Keep the filter as close to freezing temperature as possible during transport. As soon as possible, freeze the sample (foil and filter) and keep it frozen through sample shipping and laboratory storage and analysis.
- n. **Frozen chlorophyll *a* samples** should be packed in a separate cooler with a generous portion of **DRY ICE** and shipped as soon as possible to the South Dakota Public Health Laboratory (see below).

South Dakota Public Health Laboratory
615 East 4th Street
Pierre, SD 57501-1700

- o. **Sample holding time for filtered and frozen chlorophyll *a* samples is (3 (THREE) WEEKS);** send in all frozen chlorophyll *a* samples as soon as possible using **DRY ICE** to the address below. Call your Project Officer immediately after sample collection to coordinate shipping and sample analysis.

Frozen chlorophyll *a* samples delivered to SD DENR at the address below:

South Dakota Department of Environment and Natural Resources
Joe Foss Building
523 E Capitol Avenue
Pierre, SD 57501-3182

- p. **DO NOT SHIP FILTERED CHLOROPHYLL *a* SAMPLES IN THE SAME COOLER WITH THE CHEMICAL SAMPLES ON REGULAR ICE. THESE SAMPLES ARE SHIPPED TO THE SOUTH DAKOTA PUBLIC HEALTH LABORATORY.** This cooler is not cold enough to keep chlorophyll *a* samples frozen. When the samples unthaw, samples will start to degrade causing the algal cells to lyse and chlorophyll *a* to deteriorate reducing the actual chlorophyll *a* concentration that was originally in the sample.

4. **Non-Filtered Chlorophyll *a* Sampling Methods**

- a. For **composite samples**, (collect samples only from areas with noticeable flow) collect three 500 ml grab samples, one from the right third of the stream bank, one from the center third of the stream, and one from the left third of the stream bank.
- b. Fill out a water proof SD DENR WPP Biological Label with an indelible marker (Figure 12.0. 23). Include project name, source water name, station ID, if there are multiple sample bottles per station ID mark number of sample bottles (i.e. 1 of 3, 2 of 3, or 3 of 3, etc.), and program acronym (i.e., WPP, SWQ, GF&P, SDSU, SDSM&T,..., etc.) and check the Chl A and Composite box if appropriate. Then fill in the date, time, and sampler initials. Secure the label to the brown bottle(s) and wrap with clear packing tape.
- c. Place the sample bottles in the sample cooler on loose ice and keep the cooler out of direct sunlight.
- d. For **individual/discrete samples** collect the sample from mid-transect. Fill the sample bottle(s) using the method described below.
 - i. Position the open end of the bottle (500 ml brown bottle) towards the current flow and away from the hand of the collector.
 - ii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.
 - iii. The sampling depth should be 15.2 (0.5 foot) to 30.5 cm (1 foot) below the water surface, if possible. If the waterbody is static, make a sweeping motion horizontally away from the sampler.
 - iv. Tip the bottle slightly upward to allow air to escape and the bottle to fill. The sample bottle should be filled to within approximately one inch of the top to allow mixing of the sample before analysis.
- c. Fill out a water proof SD DENR WPP Biological Label with an indelible marker (Figure 12.0. 23). Include project name, source water name, station ID, if there are multiple sample bottles per station ID (sample protocols require more than 500 mL of sample water per site) mark number of sample bottles (i.e. 1 of 3, 2 of 3, or 3

- of 3, etc.), and program acronym (i.e., WPP, SWQ, GF&P, SDSU, SDSM&T,..., etc.) and check the Chl A and Composite box if appropriate. Then fill in the date, time, and sampler initials. Secure the label to the brown bottle(s) and wrap with clear packing tape.
- d. Place the sample bottles in the sample cooler on loose ice and keep the cooler out of direct sunlight.
- e. **Sample holding time for non-filtered chlorophyll *a* samples is (7 (SEVEN) DAYS); send in all non-filtered chlorophyll *a* samples as soon as possible to the address below. Call your Project Officer immediately after sample collection to coordinate sample analysis.** If the Project Officer cannot be contacted, please call Kris Dozark at the phone number below to coordinate sample analysis.

South Dakota Department of Environment and Natural Resources
Joe Foss Building
523 E Capitol Avenue
Pierre, SD 57501-3182

ATTN: Kris Dozark

Office phone: 1-605-773-4254

13.0. WATERSHED MODELING

The SD DENR WPP uses a variety of watershed models depending upon project objectives to evaluate watershed conditions and estimate current hydrology and loading and estimate BMP load reductions. This section is not an exhaustive list of models used by SD DENR WPP but represents the majority of modeling options.

A. Annualized Agricultural Non-Point Source Model (AnnAGNPS)

South Dakota will use the AnnAGNPS for sheet and rill runoff simulations. The model was developed and is supported by the Natural Resources Conservation Services Agricultural Research Services (NRCS ARS, 2015). It was selected for the following reasons:

- Public familiarity with the model, its predecessor (AGNPS single event version)
- Staff familiarity with the model
- The model is highly suited to common SD landscapes

The model will typically be applied as follows, however, in the event that data of better quality is available, DENR will use the best data available:

1. The model will be applied to USGS 12 digit Hydrologic Unit Codes (HUC). HUC boundaries will be reinforced with the 100,000 scale National Hydrography Dataset (NHD) flowlines to insure the model simulation is limited to within the HUC. The 12 digit HUCs are typically around 20,000 acres in size which make them excellent candidates for this model. The data used for the model will be as follows:
 - a. Elevation will be from USGS 30 meter National Elevation Dataset (NED) or can use higher resolution (IFSAR and LIDAR) datasets.
 - b. Soils will be NRCS SSURGO shapefiles supported by data from the National Soil Information System (NASIS) database.
 - c. Landuse will be the most current available 3 consecutive years of digital National Ag Statistics Service (NASS) data.
 - d. Weather data will consist of synthesized data from the Generation of weather Elements for Multiple applications (GEM) program.
 - e. Impoundment data will be obtained from the National Wetland Inventory (NWI).
 - f. Feedlot information will be obtained from the state feeding area inventory.
2. The following scenario simulations will be 25 years in length and used for risk analysis and BMP prioritization by comparing current conditions to mitigated conditions.
 - a. The watershed will be modeled in its “current” condition according to the data at hand. The current condition simulation will be

compared with water quality data to assess the accuracy of the model. Primary comparison will be conducted by selecting a simulated year(s) that exhibited similar rainfall, storm frequency, and event magnitude totals to the year(s) in which water quality loadings are available. The model will be considered calibrated when simulated water and sediment yields are within 10% to 20% of measured loads. This will also provide the base file which will be used during the implementation phase to calculate the downstream impacts resulting from BMP installation.

- b. All landuses will be changed to a pre-settlement condition, typically CRP condition grass. This simulation provides a basis to determine the feasibility of a TMDL. If, when calibrated, the model suggests that pre-settlement conditions do not provide the necessary reductions to meet a TMDL, then the need for a site specific target should be examined.
- c. All current grazing conditions will be modeled in both good and poor condition. By modeling both conditions of grass, it is possible to calculate what would be expected by improving a “typical” acre of grass from poor to good condition in this watershed. Including all grass will give a mean value which will be exceeded if implemented on high risk areas. The result is an implicit margin of safety.
- d. All crops will be modeled as both minimum and no till systems. By modeling both conditions, it is possible to calculate what would be expected by improving a “typical” acre of cropland from minimum till to no-till in this watershed. Including all cropland will give a mean value which will be exceeded if implemented on high risk areas. The result is an implicit margin of safety.
- e. The current condition will be run with and without feeding areas. Modeling the feeding areas will provide an idea of their overall contribution of sediment and nutrients.
- f. The watershed will be simulated entirely with a monoculture of grass in good and poor condition as well as with a monoculture of corn in both tilled and untilled condition. These simulations will be used to identify portions of the watershed that are most susceptible to erosion.

3. **Incorporation of the implicit margin of safety.**

The changes in pounds (poor to good) from the individual cells are averaged to develop a mean value for the entire watershed. This mean value is less than the value found in the high priority areas. Any implementation on a high priority area would result in more pounds being reduced than the mean of the watershed used in the model loading calculations.

For Example, assuming all cells are equal size:

*Cell #1 = 60 lbs.

*Cell #2 = 35 lbs.

Cell #3 = 3 lbs.
Cell #4 = 1 lbs.
Cell #5 = 1 lbs.
100 lbs. Average = 20 lbs.

*High Priority Cells

Actual implementation in Cell #1 would result in 40 lbs. greater reduction than used in the model. Likewise a reduction in Cell #2 would result in 15 lbs. greater reduction than used in the model. This is the primary way in which SD has incorporated an implicit margin of safety in this model.

4. **BMP prioritization and critical areas.**

- a. The AnnAGNPS model, when run with the datasets listed above, should be expected to produce a relatively accurate downstream load, but when examined on a cell by cell basis, errors may be expected. For this reason, using the current condition to generate critical cells is not advised; however the following process may be used to prioritize areas.
- b. Animal feeding operations will utilize the states AFO map and the associated rankings. Operations are prioritized for further investigation based on size and proximity to waterways. This list is to be used in a “protect here first” manner.
- c. Portions of the watershed that are high risk for erosion will be determined by comparing the monoculture simulations (both grass and corn). By using a monoculture, it eliminate any bias or error that may be found in land use layers by identifying those portions of the watershed that are most vulnerable to erosion. These high risk areas will be addressed in the implementation in a “protect here first” manner.

5. **Calculating reductions from BMPs during the implementation phase.**

- a. BMP installation will be simulated using the EPA STEPL program.
- b. The loads generated by STEPL will be used for reductions reporting to the GRTS program.
- c. When feasible, TMDL attainment and progress will be determined through water quality sampling.
- d. When water quality sampling is not feasible, progress towards TMDL attainment may be calculated by using the loads from STEPL in conjunction with the delivery rates from AnnAGNPS. A delivery ratio for nutrients and sediment to the outlet of the watershed is calculated for each cell in AnnAGNPS.
- e. In the event that the TMDL receives water from multiple 12 digit HUCS, they will be routed together using reach routing calculations in the NHDplus toolbox from ArcGIS.

B. AQUARIUS

AQUARIUS Time-Series™ is a comprehensive software package that significantly reduces the time required to organize, validate, correct, and plot hydrometric and water quality data. AQUARIUS Time-Series™ provides the user with a suite of intuitive toolboxes for higher quality statistical analysis, reporting, data grading, and modeling (AQUARIS, 2015).

AQUARIUS is maintained and supported by Aquatic Informatics based out of Vancouver, British Columbia.

South Dakota DENR will utilize the AQUARIUS program according to the methods described in both the user manuals and available through the online training available for this program.

The use of the program will be primarily focused on water quantity, the data for which will be supplied by USGS and DENR gauges and field measurements. With the functionalities of the program, the DENR expects to use in TMDL development include:

- Obtaining USGS data through the built in internet portal
- Using the modeling portion of the program to simulate runoff in streams with limited gauge data
- Developing rating discharge curves for DENR gauges
- Analyze stage/discharge data outlier analysis to improve

C. FLUX Model

The FLUX model is a US Army Corp of Engineers model based upon a series of technical reports written by Dr. William W. Walker and published by the U.S. Army Engineer Waterways Experiment Station. Use of the models will strictly follow the guidelines established within the user manual titled “Simplified Procedures for Eutrophication Assessment and Prediction.” Any deviations from the manual should be explained in detail.

1. FLUX Model

FLUX is an interactive program designed for use in estimating the loadings of nutrients or other water quality components passing a tributary sampling station over a given period of time. These estimates can be used in formulating reservoir nutrient balances over annual or seasonal averaging periods appropriate for application of empirical eutrophication models.

- a. Data requirements include
 - i. Grab-sample nutrient concentrations, typically measured a weekly to monthly frequency for a period of at least one year. Source will typically be field collected data.
 - ii. Corresponding flow measurements (instantaneous or daily mean values). The source will typically be field collected data.
 - iii. A complete flow record (mean daily flows) for the period of interest. Source may be USGS gauge data, DENR gauge data, or a synthesized and or combined data set developed from AQUARIUS.

D. Elevation Derivatives for National Applications (*EDNA*)

EDNA is a multi-layered database derived from a version of the National Elevation Dataset (NED), which has been hydrologically conditioned for improved hydrologic flow representation. It was developed and is supported by the USGS (EDNA, 2007). The seamless EDNA database provides 30 meters resolution raster and vector data layers including:

- Aspect
- Contours
- Filled DEM
- Flow Accumulation
- Flow Direction
- Reach Catchment Seedpoints
- Reach Catchments
- Shaded Relief
- Sinks
- Slope
- Synthetic Streamlines

Hydrologically conditioned elevation data, systematically and consistently processed to create hydrologic derivatives, can be useful in many topologically based visualization and investigative applications. Drainage areas upstream or downstream from any location can be accurately traced facilitating flood analysis investigations, pollution studies, and hydroelectric power generation projects.

The use of this model is primarily to obtain an idea of average annual discharge at un-gauged stream sites.

Additional information on this model may be found at the following website:
<http://edna.usgs.gov/Edna/edna.asp>

E. **Hydrologic Simulation Program – FORTRAN (HSPF) through the EPA BASINS Platform**

As described in its user's manual, "HSPF is a set of computer codes that can simulate the hydrologic and associated water quality, processes on pervious and impervious land surfaces and in streams and well-mixed impoundments." HSPF is capable of simulating hundreds of processes involved with overland and subsurface flow in a watershed. It has an extensive user manual with large user groups and is used through EPA's BASINS platform Website: <http://www.epa.gov/waterscience/basins>

Although HSPF has a wide variety of water quality modules and is able to model many parameters it will primarily be used by the SD Dept. of Environment and Natural Resources to model bacterial (fecal coliform/ E. coli) impairments. As the department's expertise in the model grows other modules may be added depending on the TMDL project and outcome for the pollutants of concern.

HSPF will be used through the BASINS interface as outlined on the EPA website. As SDDENR's expertise with HSPF grows BASINS may be replaced by a more streamlined system using ARCGIS and other methods to develop the preliminary datasets required for the user control input (UCI) file. At present, BASINS will be used as the platform for delineating the watershed, producing stream reach and sub-watershed information, and downloading the meteorological information for the watershed data management (WDM) file.

The outline below, which was taken from EPA's website, shows the logical progression taken for developing a HSPF model run. The information and data available for each watershed will dictate how these steps may be modified.

F. **StreamStats Basin Characteristics**

StreamStats is a Web application that incorporates a Geographic Information System (GIS) to provide users with access to an assortment of analytical tools that are useful for a variety of water-resources planning and management purposes, and for engineering and design purposes. StreamStats users can select USGS data-collection station locations shown on a map and obtain previously published information for the stations. Users also can select any location along a stream and obtain the drainage-basin boundary, basin characteristics, and estimates of streamflow statistics for the location. The streamflow statistics that StreamStats can provide for data-collection stations and for user-selected ungaged sites vary among the states that are implemented in StreamStats and among data-collection stations within states. Estimates obtained for ungaged sites assume natural flow conditions at the site.

StreamStats also includes several tools that rely on searching along the stream network upstream or downstream from user-selected sites to identify stream reaches and water-related activities along the streams, such as dams and point discharges, and obtain information about those activities. In addition, users can

obtain elevation profiles along stream channels and between points on the land surface.

Separate applications have been established for each state that has implemented StreamStats. The State Applications link at the left provides access to a web page that shows where StreamStats is available and where it is being implemented. Users can select an individual state application from the map or the pull-down list on the State Applications page to view an introductory page for the state, which contains a link to the StreamStats user interface. The introductory pages explain any unique functionality that is available for the state and provides citations to reports that document the methods implemented for the state.

G. Bacterial Source Loading Calculator

One additional program used by DENR is the Bacterial Source Loading Calculator which is based off the old Bacterial Indicator Tool (<http://www.epa.gov/waterscience/basins/bs3tbit.htm>). The BIT is a spreadsheet program used to estimate bacterial contribution from multiple pervious and impervious sources. The Bacterial Source Loading Calculator or BSLC (<http://www.tmdl.bse.vt.edu/outreach/C85/>) was developed using Visual Basic for Applications (VBA) in Microsoft EXCEL and designed to organize and process the bacterial inputs needed to develop a TMDL to address a bacterial impairment. The program provides an accounting platform for all possible bacterial sources in the watershed.

Estimates of livestock, wildlife, septic and other sources of bacteria are used on a project specific basis depending on the data sources. In general: Livestock estimates will come from field reconnaissance, National Agricultural Statistics Service (NASS) data, Natural Resource Conservation Service (NRCS), or other sources as they become available. Wildlife estimates will be derived through SD Game, Fish, and Parks publications, SD State University Research, US Fish and Wildlife Service or other sources as they become available. Onsite Wastewater Systems (septic tanks) estimates will come from existing studies on the specific watershed (if available), SD Dept. of Transportation countywide GIS databases for occupied residences, or other sources as they become available.

Once the sources have been quantified the bacterial loadings from the various land uses are exported out of EXCEL and copied into the HSPF UCI file. After the calibration and validation steps of the HSPF model run are completed with the bacterial data, source allocation can be completed for the TMDL. Estimates in the reductions needed to meet the TMDL goal will then be completed. This is project specific and is dependent on the sources found within each watershed.

For more information about the Bacteria Source Load Calculator, contact:

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IN-LAKE SAMPLING TECHNIQUES

14.0 IN-LAKE SAMPLING PROCEDURES

A. Field Observations

Prior to other activities, comments and observations regarding the weather and sampling site must be recorded. It is important to record all field observations of conditions at the lake that could influence the water quality of the collected sample. These observations are recorded on SD DENR Water Quality Data collection sheets (Appendix A, Table A4). Examples of observations recorded under COMMENTS include but are not restricted to: “cloudy, heavy rainfall two days ago, cattle grazing near sampling site, dense submergent or emergent aquatic vegetation present at sampling site, etc.”

Header information

<u>Agency Code</u>	# assigned by the South Dakota Public Health Laboratory only. If analyzed by another laboratory, contact Kris Dozark (773-5682) for code Number.
<u>Sample Date</u>	Date sample is collected.
<u>Time</u>	Time sample is collected.
<u>Sampler(s)</u>	Initial or print sampler(s) name(s).
<u>Source Water</u>	Waterbody name and description.
<u>Station ID</u>	Project specific sampling site identification number.
<u>Site Location</u>	Site location description unique to site.
<u>Project</u>	Print project name.
<u>Project ID</u>	Project specific project identification code (STORET/WQX) if unknown contact your Project Officer or Kris Dozark (773-5682).
<u>Type of Sample</u>	Check/mark appropriate box.
<u>Medium</u>	Check/mark water or circle Other and describe.
<u>Relative Depth</u>	Check/mark appropriate box.

In addition to comments, specific observations **must** be recorded on the field data sheet (**UNITS DESIGNATED ON SHEET**) and are as follows:

<u>Specific Conductivity</u>	Record in ($\mu\text{S}/\text{cm}^{-1}$ same as $\mu\text{mho}/\text{cm}^{-1}$).
<u>Dissolved Oxygen</u>	Record in (milligrams per Liter (mg/L)).
<u>Total Depth</u>	Record in (feet).
<u>Sample Depth</u>	Record in (feet).
<u>Gage Stage</u>	Record in (feet).
<u>Field pH</u>	Record in scientific units (su).
<u>Air Temperature</u>	Record in degrees (Celsius).
<u>Water Temperature</u>	Record degrees (Celsius).
<u>Turbidity</u>	Record in (Nephelometric Turbidity Units (NTU)).
<u>Secchi</u>	Record in (meters).
<u>Wind</u>	Record as (> 30 MPH), (20-30 MPH), (10-20 MPH), (5-10 MPH), or (0-5 MPH)).
<u>Elevation</u>	Record in (feet).

B. Field Analyses

Calibrate all instruments (prior to field use as described in the Section 6.0. Record all field analysis data on field data collection sheets and in the project logbook.

1. YSI Multi Parameter Meter (650 MDS with 6 Series Sonde) Method

Most projects/studies will use YSI 650 MDS units with a 6 Series multi-parameter Sonde and must be operated in accordance with manufacturer specifications (Section 6.0).

- a. Calibrate instrument following Section 6.0 or use the abbreviated calibration sheet located in Appendix A, Table A-8. Record all calibration values on the SD DENR WPP YSI Calibration Worksheet (Appendix A, Table A-1).
- b. Make sure weighted probe guard is attached to the sonde.
- c. Select **“Run”**.
- d. Place the probe into the lake.
- e. If water is static, provide stirring by gently and continuously agitating the probe.
- f. Allow sufficient time for the sonde and probe to stabilize.
- g. Record data in logbook and on a datasheet and/or save in memory.
- h. A procedure for saving data in memory storage using the 650 MDS is given below.

2. Parameter profiles

YSI readings should be collected (logged) from the surface and every one (1) meter of depth or less depending upon total depth of the lake at each monitoring site until the bottom is reached. The step-by step instructions are as follows.

- a. Power up the YSI 650 MDS and connect the sonde.
- b. Calibrate the sonde following steps in Section 6.0.
- c. Move out to sampling site and deploy sonde (surface sample).
- d. Select **“Logging Setup”**.
- e. Make sure the **Use Site List** is not checked. If checked, highlight use site list and select **“Enter”** to deactivate the selection.
- f. Press Esc to return to main menu.
- g. Select **“Sonde Run”**.
- h. When the parameters have stabilized, highlight the **“log one sample”** in the box above the parameter list and press **“Enter”**.
- i. The user will be prompted to enter a file name and site description.
- j. Enter file name (i.e., BobSmith1).
- k. Enter site description (i.e., Bob Smith Lake).
- l. Press **“OK”**.
- m. Press **“Enter”** to log sample information in 650 MDS memory (“sample logged” will show and flash approximately three times in the display box).

- n. Record the Depth, Temperature, Specific Conductance, pH, and Dissolved Oxygen under the appropriate site location on the SD DENR WPP In-Lake Sampling Field Datasheet (Appendix A, Table A-7).
- o. Lower sonde down to one meter or next predetermined depth and let the parameters stabilize, highlight log one sample and press “**Enter**”.
- p. Continue this procedure until the profile is completed (every meter or at other predetermined depths) until the bottom is reached (just above the bottom (e.g. 0.3 meters above the bottom)).
- q. When the profile is complete press “**Esc**” to return to main menu.
- r. View the file just created to ensure data was collected and logged correctly.
- s. Select “**File**”.
- t. Select “**View File**”.
- u. When sampling is complete, remove weighted probe guard and install the calibration cup to protect probes and store unit in carrying case.

3. **YSI EXO Multi Parameter Meter (EXO handheld with EXO1 or EXO2 Series Sondes) Method to collect one sample or sample profile.**

SD DENR WPP is transitioning from YSI MDS 650 handhelds with 6 Series Sondes to YSI EXO Handheld with EXO1 or EXO2 Series Sondes in accordance with manufacturer specifications (Section 6.0).

a. **Setting up YSI EXO handheld and sondes or vertical profiles Sampling:**

To collect in- lake vertical profiles in a lake.

Example: when collecting measurement data from lakes and logging multiple samples at a range of depths.

- 1. Press the “**Deploy**” button and then select “**Sonde Settings**.” In this menu, select “**Averaging**” and then select “**Rapid**.” This makes the data readout from the probe stabilize faster, so less time is spent waiting between logging samples.
- 2. Press the “**Calibration**” button, and then select “**Depth**.” Select “**Setup**” and ensure that the “**Mounting**” option is set to “**Moving**.”
- 3. Attach the weighted sensor guard sonde to the bottom of the sonde to ensure proper alignment in the water and to increase the rate at which the sonde sinks.

- b. **Creating Sites in the Site List**
 - 1. Press the Handheld button in the top row of orange buttons on the EXO handheld.
 - 2. Scroll to **Use Site List** and use the Enter key to check the box next to it. If the box is already checked, move to step 3.
 - 3. Scroll down to **Site** and select it using the Enter button.
 - 4. Select the site from the list, or enter a new site using the keypad. Once the site you wish to log data to is selected, use the left arrow or Esc key to return to the home screen.
 - 5. On the home screen, select “**Log One Sample**” and press “**Enter**”. Select the site from the site list, or select “**Log Now**” to log data without assigning it to a site.

- c. **To Log a Single Sample or a vertical profile**
 - 1. On the EXO Handheld dashboard, select “**Log One Sample**”.
 - 2. To log the sample to an existing site in the site list, select “**Site**” and select the appropriate site from the site list.
 - 3. Select “**Log Now!**” A sample will be logged to the site that was selected. This site is now displayed in the menu next to “**Site**”.
 - 4. To log a profile lower the sonde down to the next predetermined depth and wait for sensors to stabilize and select “**Log one Sample**”.
 - 5. Continue this procedure until the probe is approximately 0.3 meters above the bottom of the lake or pond.

- d. **To Log Data Continuously**
 - 1. Press the “**Handheld**” button in the top row of orange buttons on the EXO handheld.
 - 2. Ensure that the “**Continuous Mode**” box is checked. If logging to a site in the site list, ensure that the “**Use Site List**” box is also checked.
 - 3. Set the logging interval by selecting “**Log Interval**” and using the keypad to enter the desired amount of time that passes until another sample is saved.
 - 4. Press the “**Deploy**” button to bring up the Dashboard. Select “**Start Logging...**” and ensure that the log interval and site are correct. Select “**Start Now.**”
 - 5. To stop logging data continuously, select “**Stop Logging**”.

- e. **To View Saved Measurements**
 - 1. Press the “**Data**” button. Choose the site from the site list for the data you wish to view. Apply any desired begin and end dates and times. If viewing data saved to the handheld,

ensure that “Handheld” is displayed next to “**Source.**” If viewing data saved to the sonde, ensure that “**Sonde**” is displayed next to “**Source.**”

2. Select “Show data” to view numerical data, or select “Graph data” so see data presented as a graph.

4. **Secchi Depth**

- a. Confirm that the lowering line is firmly attached to the Secchi disk.
- b. Remove sunglasses and hat. Also, do not use view scopes or other visual aids. If wearing prescription sunglasses, temporarily replace them with regular clear lens prescription glasses.
- c. Lower the Secchi disk over the shaded side of the boat until it disappears.
- d. Read the depth indicated on the lowering line. If the disappearance depth is <1.0 meter, determine the depth to the nearest 0.05 meter by marking the line at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 meter. Record the disappearance depth on the SD DENR In-lake Field Data Collection Sheet (Appendix A, Table A-7).
- e. Lower the disk a bit farther and then slowly raise the disk until it reappears and record the reappearance depth, using the same level of precision as before.
- f. Calculate the euphotic zone depth by multiplying the depth where the disk reappeared by 2. Use this calculation to determine the depth at which water samples will be taken with the integrated sampler.
 - i. If euphotic zone is less than 2 meters, water samples will be collected only within the euphotic zone.
 - ii. If euphotic zone is greater than 2 meters, water samples will be taken from the top 2 meters of the water column.
- g. Record the depth of integrated water samples.
- h. Note any conditions that might affect the accuracy of the measurement in the comments field.

5. **Total Depth**

- a. Record total depth at all in-lake sampling sites (A, B, and C) in meters on the SD DENR WPP In-lake Field Data Collection Sheet (Appendix A, Table A-7).

C. **In-lake Water Sampling Methods**

Most in-lake water samples collected for the SD DENR WPP will entail the use of an Integrated Depth Sampler which composites multiple samples from multiple sites within in a lake (Figure 14.0. 1). However, some lake projects require collection of separate surface, mid-level, and bottom samples from the same in-

lake sampling location. These samples will be collected using a Van Dorn type sampler (Figure 14.0. 3 and Figure 14.0. 4).

1. Integrated Depth Sampler



Figure 14.0. 1 Modified integrated depth sampler based on MPCA Sampler

Integrated Depth Sampler Setup Procedure and Summary of Methods

Collect water samples using an “integrated sampler”- SD DENR modified design (ball valve on both ends) which was based on the Minnesota Pollution Control Agency (MPCA), see Figure 14.0. 1. The device is a PVC tube 6.6 feet (2.01 meters) long with an inside diameter of 1.25 inches (3.18 centimeters) fitted with a stopper plug on one end and a ball valve on the other, old design (Figure 14.0. 2). The device allows collection of water from the upper two meters of the water column (within the euphotic zone). If the euphotic zone is < 2.0 m deep (as calculated from the Secchi Disk Transparency section of the SD DENR WPP In-lake Sampling Field Data Collection Sheet (Appendix A, Table A-7)), lower the integrated sampler only to the depth of the euphotic zone, and take additional grab samples as necessary to collect the total volume needed for filling all the sample bottles (4 m).

Remove the rubber stopper (old design) or open both the upper ball valves (newer design) and rinse the sampler by submerging it in the lake three (3) times. With the lower valve open and the stopper off, slowly lower the sampler into the water as vertically as possible until the upper end is just below the surface (or you have reached the depth of the euphotic zone if it is < 2.0 m). Cap or close the top ball valve and slowly raise the sampler as

vertically as possible. Close the lower ball valve when the bottom of the sampler is near the surface. Dispense the contents of the sampler into an appropriate storage container.

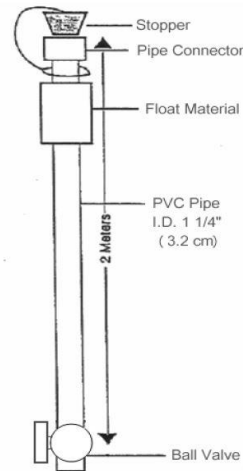


Figure 14.0. 2. Integrated depth water sampling device (MPCA), SD DENR modified version has a ball valve at both ends and seems to work better.

In-lake Sample Collection

- a. Rinse each water sample collection container and/or composite sample collection container with surface water 3-times.
- b. Collect a Secchi depth reading at each in-lake sampling site to calculate the depth of the euphotic zone. **Method follows:**
 - i. Confirm that the lowering line is firmly attached to the Secchi disk.
 - ii. Remove sunglasses and hat. Also, do not use view scopes or other visual aids. If wearing prescription sunglasses, temporarily replace them with regular clear prescription glasses.
 - iii. Lower the Secchi disk over the shaded side of the boat until it disappears.
 - iv. Read the depth indicated on the lowering line. If the disappearance depth is <1.0 meter, determine the depth to the nearest 0.05 meter by marking the line at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 meter. Record the disappearance depth (DAD) on the appropriate datasheet (Appendix A, Table A-7).
 - v. Lower the disk a bit farther and then slowly raise the disk until it reappears and record the Re-

- Appearance Depth (RAD) using the same level of precision as before (Appendix A, Table A-7).
- vi. Calculate the euphotic zone depth by multiplying the depth where the disk reappears (RAD) by 2. Use this calculation to determine the depth at which water samples will be taken with a depth integrated sampler and record it on the datasheet (Appendix A, Table A-7).
 - (a) If euphotic zone is less than 2 meters, water samples will be collected only within the euphotic zone.
 - (b) If euphotic zone is greater than or equal to 2 meters, water samples will be taken from the top 2 meters of the water column.
 - vii. Record the depth of integrated water samples at each site (Sites A, B, and C) for all measurements on the In-lake Field Datasheet (Appendix A, Table A-7).
 - viii. Note any conditions that might affect the accuracy of the measurement (waves, sun, excessive algal bloom, etc.) in the notes field at the bottom of the datasheet.
- c. Remove the rubber stopper cap (older version) or open the ball valve at the top of the sampler (newer version) and open the ball valve on the bottom end of the sampler. Rinse the sampler by submerging the sampler in the lake three times and draining. **Do this on the opposite side of the boat you plan to sample from. DO NOT TAKE ANY SAMPLES NEAR THE MOTOR!**
 - d. Slowly lower the sampler into the lake as vertically as possible. Stop when the upper end is just below the surface if the euphotic zone is ≥ 2 m deep. SD DENR WPP protocols are to collect two full (2 m) integrated samplers of surface water at each in-lake sampling site (a total of 4 m of euphotic surface water per sampling site). If the euphotic zone is < 2.0 m deep, the integrated sampler will be vertically lowered into the lake to a depth of the previously calculated euphotic zone for that site and sample; additional samples will be taken to collect the total volume needed to equal a total of 4 m of euphotic only surface water.
 - e. Cap the upper end with the rubber stopper firmly (older version) or close the ball valve on top of the sampler (newer version) and slowly raise the sampler as vertical as possible.

- f. When the bottom of the sampler is near the surface, reach underneath the surface of the water and close the ball valve on the bottom end of the sampler.
- g. Lift the sampler into the boat, keeping it as vertical as possible.
- h. Dispense the contents of the sampler into the previously rinsed sample collection container or composite sample container by removing the rubber stopper (older version) or opening the upper ball valve (newer version) and then the lower ball valve and drain contents of the sampler into an appropriate pre-rinsed composite storage container. **When the last sample is transferred to the composite container at each site, seal (cap) the sample container, and move it to a shaded area of the boat or cover it to avoid exposing the sample to direct sunlight and/or higher temperatures.**
- i. When all samples have been collected at the lake, rinse the sampler with tap water or distilled water prior to using it at the next lake.

2. Van Dorn-type samplers.

Sampler Setup Procedure

Rinse the sampling apparatus thoroughly with water from the sampling site prior to collection of samples. *Surface samples* should be collected approximately 1 meter (3.28 feet) below the surface of the water. *Bottom samples* should be collected from approximately 0.5 meter (1.64 feet) above the lake bottom. Care must be taken not to come in contact with the lake bottom, as this may result in sampling suspended bottom sediment in the sampler.

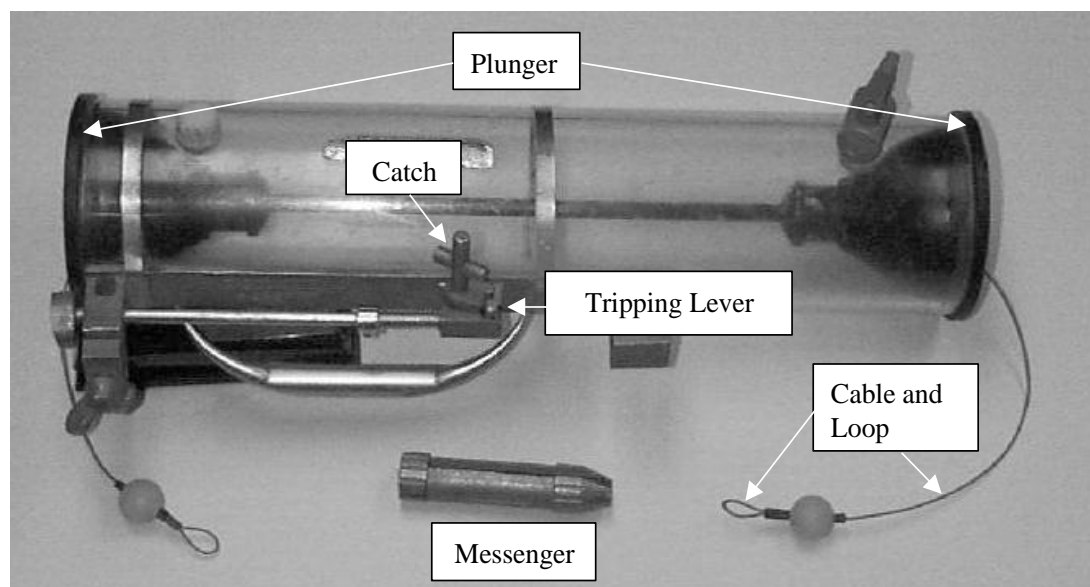


Figure 14.0. 3. Trip lever style “Van Dorn” sampler (older style)

- a. **Collecting a Sample using a Van Dorn Sampler (Trip Lever Style (older style, Figure 14.0. 3)).**
 - i. Place the sampler catch behind the tripping lever.
 - ii. Pull one of the plungers from one end of the sampler and clip the cable loop of the plunger to the appropriate sampler catch. If placed properly, the plunger and cable will put pressure (torque) on the sampler catch and tripping lever.
 - iii. Pull the plunger and cable from the opposite end and hook the loop appropriately to the opposite sampler catch. The Van Dorn sampler is now ready to be used to collect a water sample.
 - iv. Lower the sampler into the water and stop the sampler at the appropriate depth. Send the messenger down the line to trip the sampler (Figure 14.0. 3.).
 - v. Pull the filled sampler up from the lake and dispense the sample water using petcocks into sample bottles, a composite sample container, or graduated cylinder depending upon PIP sampling protocols. If flow from the petcock is slow, open the upper petcock or vent to release pressure, or if there is no upper vent or petcock on the sampler, grasp one side of the upper plunger and gently pull upwards to break the seal to release vacuum to increase flow.
 - vi. When bottom sample is collected, check for an excessive amount of bottom sediment or turbidity in the Van Dorn sampler. If the sample appears turbid, discard the sample and repeat steps “ii” through “v”.
 - vii. Before lengthy storage, rinse the Van Dorn sampler with distilled water.

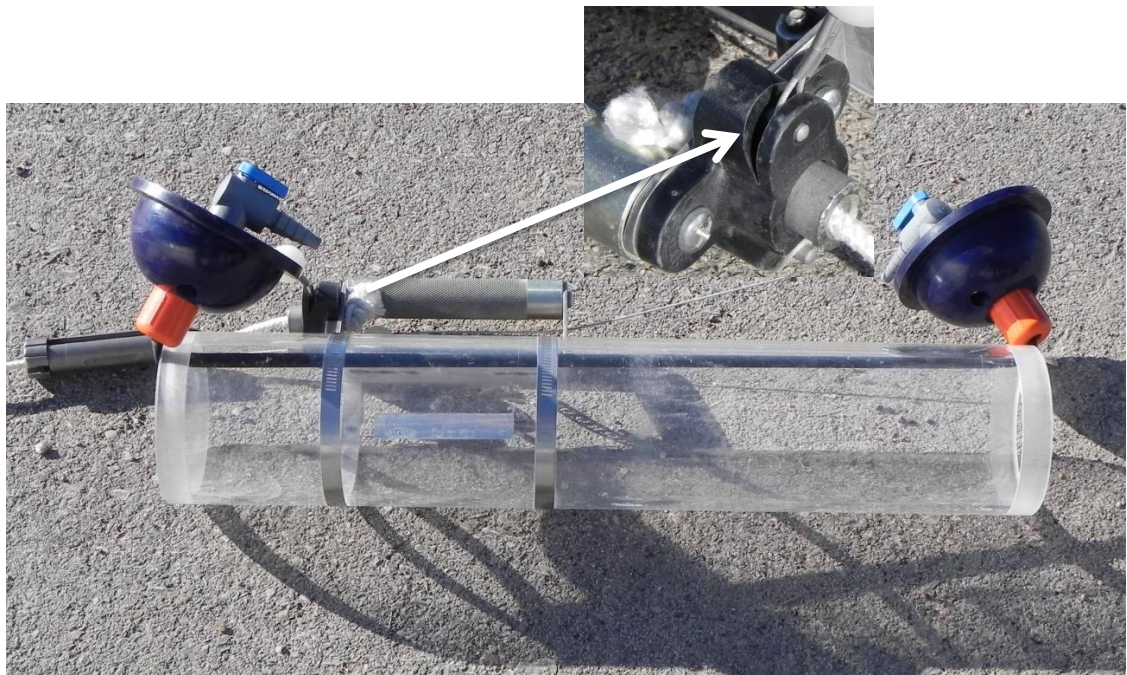


Figure 14.0. 4. Pin release style “Van Dorn” sampler.

- b. **Pin Release Style (newer style, Figure 14.0. 4).**
 - i. Make sure the pin mechanism is in good working order.
 - ii. Press down the pin release and pull plunger from the end nearest the trip release and hook the cable loop of the plunger into the appropriate slot in the pin release mechanism (Figure 14.0. 4.).
 - iii. Release the pin release and ensure the cable loop is completely around the pin (not pinched by the pin).
 - iv. Pull the plunger and cable from the opposite end and hook the cable loop to the opposite pin on the pin release. The Van Dorn sampler is now ready to be used to collect a water samples.
 - v. Lower the sampler into the water and stop the sampler at the appropriate depth. Send the messenger down the line to trip the sampler.
 - vi. Pull the filled sampler up from the lake and dispense the sample water using petcocks into sample bottles, a composite sample container, or graduated cylinder depending upon PIP sampling protocols. If flow from the petcock is slow, open the upper petcock or vent to release pressure, or if there is no upper vent or petcock on the sampler, grasp one side of the upper plunger and gently pull upwards to break the seal to release vacuum and increase flow.
 - vii. When the bottom sample is collected, check for an excessive amount of bottom sediment or turbidity. If the sample

- appears turbid even slightly, discard the sample and repeat steps “ii” through “v”.
- viii. Before lengthy storage, rinse the Van Dorn sampler with distilled water.

3. In-lake Sample Collection

There are basically two sample collection methods for in lake sampling:

- **Grab sampling** (both without (1.1) and with (1.2) the use of a Van Dorn-type sampler).
- **Composite sampling** (in-lake sampling with an Integrated Depth Sampler or a Van Dorn-type sampler).

A typical sample bottle set for an in-lake sampling site (Figure 14.0. 7) consists of the following:

- a. Two (2) one-liter polypropylene bottles.
- b. One (1) 100 mL bottle for total dissolved phosphorus samples.
- c. One 250 mL poly-plastic bacteriological bottle (Health Lab) or Two (2) 100 mL plastic bottles (MIDCONTINENT Testing Laboratory).
- d. Collect one (1) or (2) extra one-liter brown polypropylene bottle(s) (depending on project specific goals outlined in the PIP or under the direction of the Project Officer) for use in filtering total dissolved phosphorus, chlorophyll-*a* samples (filtered or unfiltered), and if required, algae samples. **Be sure to collect enough sample water from each location to fill all containers.**

If project requires the collection of midwater and or bottom samples extra sample bottle sets will be required at each in-lake monitoring site. These samples can only be collected using Van Dorn samplers, and if bottom samples are required no chlorophyll *a* or alga samples will be collected. Also bottom samples will not be collected if the total water depth of the site is less than 2.74 meters (9 feet), outlined by the PIP, or as directed by the Project Officer.

Note: If any other non- typical or special sampling is required refer to the Special Sampling Techniques section for specific sampling techniques and sample bottle requirements.

Bottle Labeling

Using a water proof pen fill out Water Quality Bottle labels containing the project, source water location, laboratory code, station ID, sampler initials, date, and time (Figure 14.0. 5.). Check appropriate sample depth and select bottle type "A" or "B" bottles one (1) liter bottle for each sample, "C" one (1) 250 mL bacteriological bottle or two (2) 100 mL plastic bottles), "D" one (1) 100 mL bottle for total dissolved phosphorus, and affix one bottle label to each the appropriate bottle (Figure 14.0. 5). See the example below.

Project:	
Source:	
Code:	Initials
Station:	
Date	Time
<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom
<input type="checkbox"/> Midwater	
<input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D	<input type="checkbox"/> CN <input type="checkbox"/> Oil
<input type="checkbox"/> E <input type="checkbox"/> R <input type="checkbox"/> V <input type="checkbox"/> H	<input type="checkbox"/> Metals <input type="checkbox"/> Dis <input type="checkbox"/> Recov

Figure 14.0. 5. Water quality sample bottle label used by the SD DENR WPP.

If extra brown sampling bottle(s) are collected for unfiltered chlorophyll *a*, algae analysis, or other biologically based sample collection media by filling out SD DENR WPP Biological Bottle labels. Based on the type of sample, complete all applicable fields including project, source water location, station ID, program initials (WPP, SWQ, SDSM&T, etc.), date, time, sampler initials, composite volume, filtered volume, or surface area (Figure 14.0. 6).

Project:	Date
Source:	Time
Station:	Initials
Program:	Comp mL
<input type="checkbox"/> Surface <input type="checkbox"/> Bottom <input type="checkbox"/> Midwater	Filtered mL
<input type="checkbox"/> Algae <input type="checkbox"/> Composite <input type="checkbox"/> Periphyton	Surface Area
<input type="checkbox"/> Macroinv <input type="checkbox"/> Grab <input type="checkbox"/> Phyto	
<input type="checkbox"/> AFD <input type="checkbox"/> Replicate <input type="checkbox"/> Art Sub	
<input type="checkbox"/> Chl A <input type="checkbox"/> Blank <input type="checkbox"/> Nat Sub	

Figure 14.0. 6. Biological bottle label used by the SD DENR WPP.

4. Grab Sampling

Collecting a Grab Sample using Sample Bottles.

The following section describes the procedures for collecting in-lake grab samples (surface only) using sample bottles only.

The "C" bottle (bacteriological sample) should be taken **first**. Be careful not to contaminate the inside of the lid or mouth of the bottle with your fingers or introduce other sources of contamination.

- a. **Collecting the 250 mL or 100 mL bacteriological sample ("C" Bottle).**

COMPOSITE SAMPLES WILL NOT BE COLLECTED for microbiological examination, "C" bottle.

- i. The "C" bottle **WILL NOT BE RINSED** with sampling site water or distilled water.
- ii. Position the open end of the bottle away from the hand of the collector, the shore, the sampling platform, or boat.
- iii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.
- iv. If collecting in-lake QA/QC samples, plunge two (2) sample bottles at the same time (one bottle in each hand) to collect one routine and one replicate sample.
- v. Ideally, the sampling depth should be 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the water surface. Make a sweeping motion horizontally away from the sampler if the sample bottle has a wide diameter (neck); if the sampling bottle has a small diameter (neck) no sweeping action is required.

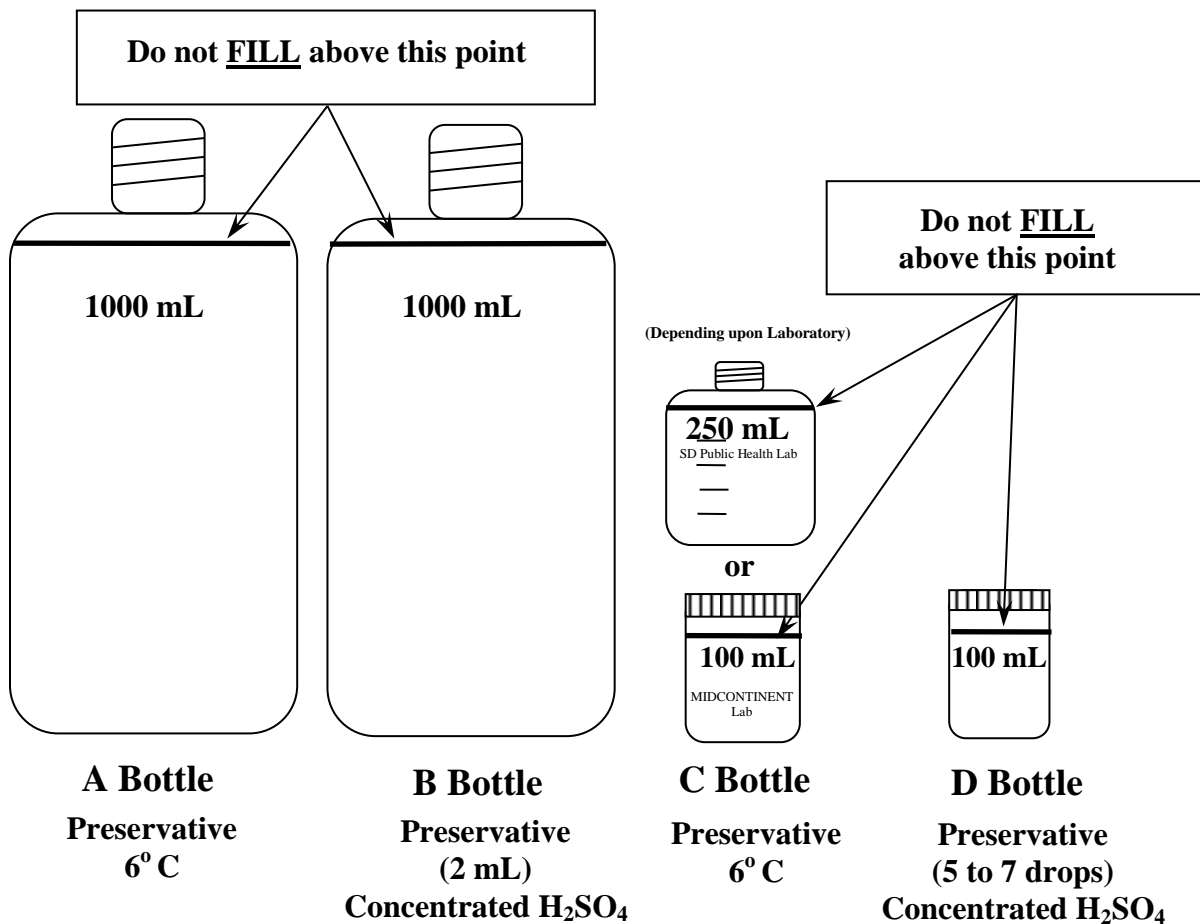


Figure 14.0. 7. Fill diagram and preservative for typical SD DENR WPP in-lake sampling suite.

- vi. While sample bottle(s) are underwater, tip the bottle slightly upward to allow air to escape and the bottle to fill. On the initial plunge, the "C" sample bottle should be filled completely or at least above the 250 mL or the 100 mL mark depending upon laboratory sampling bottle (Figure 13.0. 7). Immediately after obtaining the sample, pour off the excess sample water from the container until the sample volume is 250 mL or 100 mL, respectively and cap. **If the sample bottle is not filled at least to the 250 mL or 100 mL mark on the sampling bottle, discard the sample and sample bottle and repeat the process with a new "C" bottle. DO NOT re-immense the original bottle to add more sample volume.**
- vii. Place a completed bottle label on the bottle(s) and place the sample container(s) in a cooler on loose ice (6° C); no other preservative is required for "C" bottle. **Bacteriological samples need to arrive at the laboratory within 24 hours of sample collection.**

b. **Collecting the "A" bottle (one-liter bottle).**

- i. The "A" bottle and cap **SHOULD BE RINSED** three times with sampling site water prior to collection of the sample to ensure no cross contamination.
- ii. Grasp the 1,000 mL bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum. The sampling depth should be 15.2 cm (1 foot) to 30.5 cm (1 foot) below the water surface, if possible. Make a sweeping motion horizontally away from the sampler if the sample bottle has a wide diameter (neck); if the sampling bottle has a small diameter (neck) no sweeping action is required.
- iii. If collecting in-lake QA/QC samples, plunge two (2) pre-rinsed sample bottles at the same time (one bottle in each hand) to collect one routine and one replicate sample.
- iv. Tip the bottle slightly upward to allow air to escape and the bottle to fill.
- v. The "A" sample bottle should be filled completely or at least above the volume indicated in Figure 13.0. 7. Immediately after obtaining the sample, pour off the excess sample water from the container until the sample volume complies with Figure 13.0. 7 and cap immediately.
- vi. Place the completed bottle label on the bottle and place the sample container in a cooler on loose ice (6° C), **no other preservative is required for the "A" bottle.**

c. **Collecting the "B" bottle (one-liter nutrient bottle)**

Follow grab sample collection procedures for filling bottle "A" to fill bottle "B". Preserve the "B" sample bottle using the following procedure below.

- i. After the sample has been collected, **preserve this sample with 2 mL of concentrated sulfuric acid (H₂SO₄) to lower the pH of the sample below 2 standard units.** If using the MIDCONTINENT Laboratory bottles add acid from one ampoule provided by the laboratory to the water to stabilize the sample. Randomly test the acidity level of the water with pH paper. The technician needs to ensure that the water has a pH < 2. If not, add another ampoule of acid until the test of the water indicates that the sample has the appropriate acidity. In most cases one ampoule will be sufficient.
- ii. After H₂SO₄ has been added, the capped sample bottle is inverted several times to ensure mixing of the preservative throughout the sample.
- iii. Place a completed bottle label on the bottle and place the sample container in a cooler on loose ice (6° C) for shipment or delivery to the laboratory.

Table 14.0. 1. Required Chlorophyll *a* filter volume requirements based on Secchi disk depth.

Secchi Depth		Filter Volume
(meters)	(feet)	(mL)
> 0 - < 0.15	> 0 - < 0.5	100
> 0.15 - < 0.30	> 0.5 - < 1.0	200
> 0.30 - < 2.0	> 1.0 - < 6.6	400
> 2.0 - < 3.0	> 6.6 - < 9.8	1,000
> 3.0	> 9.8	2,000

d. **Collection of extra one-liter bottle(s)**

When collecting grab samples without a Van Dorn-type sampler, extra sample bottle(s) need to be collected (surface samples only). These sample(s) are for total dissolved phosphorus filter water (120 ml), chlorophyll *a* filter water (100 mL to 2,000 mL), based on sampling site Secchi depth (Table 14.0. 1), or raw water (nonfiltered water) sample bottles to be filtered at the SD DENR WPP laboratory prior to analysis, and algae sample analysis (500 ml). Collect the sample(s) in one-liter brown polypropylene bottles following the procedures below.

- i. All extra one-liter brown polypropylene bottle(s) and caps **SHOULD BE RINSED** three times with sampling site water prior to collection of the sample to ensure no cross contamination.
 - ii. Grasp the 1,000 mL brown bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum. The sampling depth should be 15.2 cm (1 foot) to 30.5 cm (1 foot) below the water surface, if possible. Make a sweeping motion horizontally away from the sampler if the sample bottle has a wide diameter (neck); if the sampling bottle has a small diameter (neck) no sweeping action is required.
 - iii. If collecting in-lake QA/QC samples, plunge two (2) pre-rinsed sample bottles at the same time (one bottle in each hand) to collect one routine and one replicate sample.
 - iv. Tip the bottle slightly upward to allow air to escape and the bottle to fill.
 - v. Extra sample bottles should be filled completely or at least to the neck of the bottle. Immediately after obtaining the sample, pour off excess sample water from the container until the sample volume complies with Figure 14.0. 7 (“A” or “B” bottles) and cap immediately.
- e. **Collecting the "D" bottle (100 mL plastic bottle (State Public Health Lab “X” top bottle))**

Water to be filtered for this sample comes from extra one-liter grab sample brown polypropylene bottle(s) collected in Section 14.0 (C.) (1.) (1.1) (d.). Procedure for field filtration and preservation of the total dissolved phosphorus sample is described below.

- i. **DO NOT PRE-RINSE** the “D” bottle or cap with de-ionized (distilled) water or in-lake sample water.
- ii. Thoroughly **rinse** the field filtration device with de-ionized (distilled) water prior to assembly, once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 0.45 micron pore-size filter**) and vacuum filter/rinse approximately **250 mL** of distilled water through the filter (Figure 14.0. 8).
- iii. After vacuum filtration, empty distilled water from the bottom reservoir, by removing both the cap and the hose from the bottom reservoir spouts and pouring the water out of one of the spouts down the drain or on to the ground. **DO NOT remove the upper chamber during the rinsing operation.**
- iv. Gently shake the extra one-liter bottle to homogenize the sample and pour approximately 120 mL of sample water (from the extra one-liter bottle) into the upper chamber and

- filter. If the filter clogs due to excessive amounts of suspended sediment or algal material, see step “v” below.
- v. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, pour the portion of filtered water in the bottom reservoir into the “D” bottle, cap, and put on ice in a sample cooler, then remove the clogged filter, and repeat the process above (“ii”, “iii”, and “iv”).
 - vi. Transfer the filtered water in the bottom reservoir (100 mL) into the “D” bottle as described in step “v”. **Preserve the sample by adding five to seven drops of concentrated H_2SO_4 to the sample and tighten cap securely.** After preserving the sample, periodically check the pH of the sample using pH test strips to ensure the samples are less than 2 standard units.
 - vii. Place the completed bottle label on the bottle and place the acidified “D” bottle into a storage cooler with loose ice (6°C).

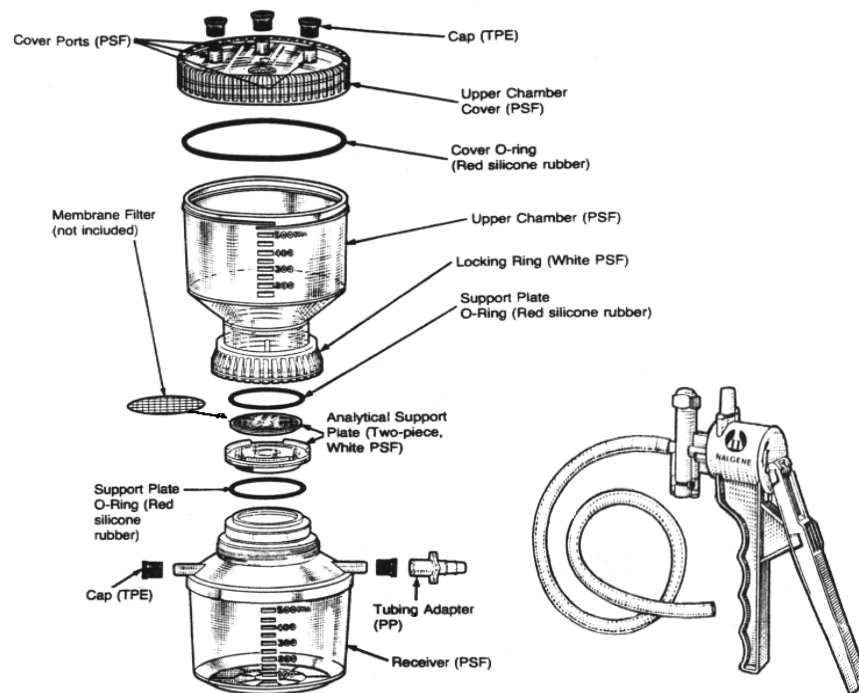


Figure 14.0. 8. Nalgene filter holder with receiver and vacuum pump.
This figure was taken from the “Instruction Manual for Nalgene Filter Holders with Receiver and Filter Holders with Funnel,” Nalgene Company, Rochester, New York.

- viii. Rinse the entire filtration apparatus with de-ionized (distilled) water between samples and sampling site locations.

- ix. **After collection, all sample bottles must be immediately placed on ice or into a refrigerator and kept cool prior to and during shipping to the appropriate laboratory for analysis.**

Place completed SD DENR WPP bottle labels on the bottle(s) and place the sample containers in a cooler on loose ice (6° C), **no other preservative is required for any extra one-liter brown bottles.**

Remember, if collecting QA/QC samples (replicates) be sure to collect twice the volume of water needed. If chlorophyll *a* and/or algae samples are not required for the project, filter the total dissolved phosphorus sample and discard the rest of the sample.

After all samples have been collected and preserved at each sampling site, completely fill out a SD DENR WPP Water Quality Datasheet and a SD DENR WPP In-lake Sampling Field Data Collection Sheet (Appendix A, Table A-4 and Table A-7).

1.2. Collecting a Grab Sample with a Van Dorn-type sampler

The following section describes the procedure for collecting an in-lake grab sample using a Van Dorn type sampler.

The “C” bottle (bacteriological sample) is taken directly out of the lake without the use of the Van Dorn-type sampler and should be taken first. Be careful not to contaminate the inside of the lid or mouth of the bottle with your fingers or introduce other sources of contamination.

- a. **Collecting the 250 mL or 100 mL bacteriological sample “C” bottle(s) (surface sample only). Composite samples WILL NOT BE collected for microbiological examination.**
- i. The "C" bottle **SHOULD NOT BE RINSED** with distilled or sampling site water.
 - ii. Position the open end of the bottle away from the hand of the collector, the shore, the sampling platform, or boat.
 - iii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.
 - iv. If collecting in-lake QA/QC samples, plunge two (2) sample bottles or two sets of sample bottles at the same time (one 250 mL bottle or two 100 mL bottles, depending upon laboratory, in each hand) to collect routine and replicate QA/QC samples.
 - v. The sampling depth should be 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the water surface. Make a sweeping motion

- horizontally away from the sampler; if the sampling bottle has a small diameter neck no sweeping action is required.
- vi. Tip the bottle slightly upward to allow air to escape and the bottle to fill. On the initial plunge, the "C" sample bottle should be filled completely or at least above the 250 mL or 100 mL mark depending upon laboratory (Figure 14.0.7.). Immediately after obtaining the sample, pour off the excess sample water from the container until the sample volume is approximately 250 mL or 100 mL and cap each bottle securely.
 - vii. **If the sample bottle is not filled at least to the 250 mL or 100 mL mark on the sampling bottle, discard the sample and sample bottle and repeat the process with new "C" bottles. DO NOT re-immers**
e the original bottle to add more sample volume.
 - viii. Place a completed SD DENR WPP bottle label on the bottle and place the sample container in a cooler on loose ice (6° C) for shipment to the appropriate laboratory, **no preservative is required for the "C" bottle(s).**
 - ix. **Bacteriological samples need to arrive at the laboratory within 24 hours.**

b. **Collecting the "A" bottle (one-liter bottle)**

Fill the "A" bottle following the grab sample procedure below. The same procedure should be used whether collecting surface or bottom samples.

- i. The "A" bottle and cap **should be rinsed** with sampling site water prior to collection of the sample to ensure no cross contamination.
- ii. **The "A" bottle should be filled directly from the Van Dorn sampler** by opening and closing petcock valves on the Van Dorn-type sampler.
- iii. The "A" sample bottle should be filled to the volume indicated in Figure 14.0. 7 and capped immediately.
- iv. Place a completed SD DENR WPP water quality bottle label on the bottle and put the sample container in a cooler on loose ice (6° C) for shipment to the laboratory, **no other preservative is required for the "A" bottle.**

c. **Collecting the "B" bottle (one-liter nutrient bottle)**

Follow collection procedures for filling the "A" bottle to fill the "B" bottle. The same procedure should be used for collecting surface and/or bottom samples. Preserve the "B" bottle sample following the procedures below.

- i. After the sample has been collected using the Van Dorn sampler, **fill the “B” bottle with water directly from the Van Dorn sampler and preserve this sample with 2 mL of concentrated sulfuric acid (H_2SO_4) to lower the pH of the sample below 2 standard units.** If using MIDCONTINENT Laboratory bottles, add acid from one ampoule to the water bottle to stabilize the sample. Test the acidity level of the water with pH paper. You need to ensure that the water has a $pH < 2$ standard units. If not, add another ampoule of acid until the test of the water indicates that the sample has the appropriate acidity. In most cases one ampoule will be sufficient.
- ii. After H_2SO_4 has been added, the sample bottle is inverted several times to ensure mixing of the preservative throughout the sample.
- iii. Place a completed SD DENR WPP water quality bottle label on the bottle and place the sample container in a cooler on loose ice ($6^\circ C$) for shipment to the appropriate laboratory.

d. **Collection of extra one liter bottle(s)**

When collecting grab samples using Van Dorn-type sampler, extra brown polypropylene sample bottles need to be collected for surface and/or bottom samples. Surface sample bottles are for total dissolved phosphorus filter water (120 ml), chlorophyll *a* filter water (100 mL to 2,000 mL) depending upon sample site Secchi depth (Table 14.0. 1) or raw water (nonfiltered water) sample bottles to be filtered at the SD DENR WPP laboratory prior to analysis, and algae sample analysis (500 ml). If collecting bottom samples using a Van Dorn type sampler, fill only one brown polypropylene bottle directly from the sampler for filtering total dissolved phosphorus filter water (120 ml). When filtering the total dissolved phosphorus sample is finished, discard the remaining sample.

- i. All extra one-liter brown polypropylene bottles and caps **SHOULD BE RINSED** three times with sampling site water prior to collection of the sample to ensure no cross contamination.
- ii. To collect surface samples, lower the top of the Van Dorn type sampler down below the surface of the water approximately 15.2 cm (0.5 foot) to 30.5 cm (1 foot) below the surface.
- iii. Send the messenger down the rope to trip the trip lever and collect the sample.
- iv. Pull the sampler into the boat and set the sampler vertically on the bench seat or shelf.

- v. Fill all extra brown polypropylene bottles directly from the Van Dorn sampler.
- vi. If collecting in-lake QA/QC samples, fill two or more pre-rinsed brown polypropylene sample bottles to collect routine and replicate samples.
- vii. Extra sample bottles should be filled completely or at least to the neck of the bottle. Immediately after obtaining the sample, pour off any excess sample water from the container until the sample volume complies with Figure 14.0. 7 (“A” or “B” bottles) and cap immediately.
- viii. Place a completed SD DENR WPP Biological bottle label on each the bottle and place the sample containers in a cooler on loose ice (6° C), **no other preservative is required for any extra one-liter brown bottles to be sampled for total dissolved phosphorus or chlorophyll *a* analysis.**
- ix. If a 500 mL brown polypropylene bottle was collected for algae analysis, preserve the sample with 2 mL to 4 mL of Lugol’s solution (depending upon laboratory requirements). Be careful when using or handling Lugol’s solution as it has iodine in it which can stain your fingers and clothes.
- x. Place a completed SD DENR WPP Biological bottle label on each preserved algae sample and store in a cooler on loose ice (6° C) for shipment to the appropriate laboratory.

e. **Collecting the “D” bottle (100 mL plastic bottle (“X” top))**

Water to be filtered for these samples comes from extra one-liter brown polypropylene sample bottle(s) filled directly from water collected with the Van Dorn type sampler (surface and/or bottom sample); see Section 14.0 (C.) (1.) (1.2) (e.) for sample collection procedures. Procedure for field filtration and preservation of the total dissolved phosphorus sample is described below.

- i. **DO NOT PRE-RINSE** the “D” bottle or cap with de-ionized (distilled) water or in-lake sample water.
- ii. Thoroughly rinse the field filtration device with de-ionized (distilled) water prior to assembly; once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 0.45 micron pore-size filter**) and vacuum filter/rinse approximately **250 mL** of distilled water through the filter (Figure 14.0. 8).
- iii. After vacuum filtration, empty the distilled water from the bottom reservoir, by removing both the cap and the hose from the vacuum pump from the bottom reservoir spouts and pour the water out of one of the spouts down the drain or onto the ground. **DO NOT remove the upper chamber during the rinsing operation.**

- iv. Pour approximately 120 mL of sample water from one of the extra one-liter bottles into the upper chamber and filter Section 14.0 (C.) (1.) (1.2) (d.). If the filter clogs due to excessive amounts of suspended sediment or algal material, see step “v” below.
- v. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, pour the portion of filtered water in the bottom reservoir into the “D” bottle, cap, and put on ice in a sample cooler, then remove the clogged filter, and repeat the process above (“ii”, “iii”, and “iv”).
- vi. When filtering is complete, transfer the filtered water in the bottom reservoir (100 mL) into the “D” bottle as described in step “v”. Preserve the sample by adding five to seven drops of concentrated H_2SO_4 to the sample and tighten cap securely. If using MIDCONTINENT Laboratory bottles, add acid from one ampoule to the water bottle to stabilize the sample. Test the acidity level of the water with pH paper. You need to ensure that the water has a $\text{pH} < 2$ standard units. If not, add another ampoule of acid until the test of the water indicates that the sample has the appropriate acidity. In most cases one ampoule will be sufficient.
- vii. Place a completed SD DENR WPP bottle label on the bottle and place the acidified “D” bottle into a storage cooler with loose ice (6°C).
- viii. Rinse the entire filtration apparatus with de-ionized (distilled) water between samples and sampling site locations.
- ix. After collection, all sample bottles must be immediately placed on ice or into a refrigerator and kept cool prior to and during shipping to the appropriate laboratory.

Remember, if collecting QA/QC samples (replicates) be sure to collect twice the volume of water needed. If chlorophyll *a* and/or algae samples are not required for the project, filter total dissolved phosphorus sample(s) and discard the rest of the sample.

After all samples have been collected and preserved at each sampling site, completely fill out a SD DENR WPP Water Quality Datasheet and a SD DENR WPP In-lake Sampling Field Data Collection Sheet (Appendix A, Table A-4 and Table A-7).

2. Composite Sampling

Composite samples are samples that contain water from more than one location or site in a lake. As discussed previously, no (bacteriological) “C” bottle samples are collected while doing composite sampling. Sample

collection is the only thing that differs from grab sampling using an Integrated Depth Sampler or a Van Dorn type sampler. All other aspects of sample handling can be found in the Grab Sampling section (14.0 (C) (1) (1.2)).

2.1 In-lake Composite Sampling using a Van Dorn type Sampler

- a. The sampling plan (PIP) or Project Officer will determine which samples are to be composite samples.
- b. Pre-rinse a plastic graduated cylinder twice with sampling site water.
- c. Collect a sample in a rinsed Van Dorn-type sampler or other in-lake sampling device (Section 14.0 (C) (1) or (2).
- d. Rinse the sample containers (“A”, “B” and extra one-liter bottle(s)) with a portion of the sample water collected.
- e. SD DENR in-lake sampling protocols are to collect three samples from each lake or waterbody and composite these samples into one composite sample set per lake.
- f. Calculate the amount of water needed from each sub-sampling site. Divide the size of your sample container (milliliters), by the number of sampling sites to be composited.

Example: Compositing three sites and placing them in the “A”, “B”, and extra one-liter brown bottles (1,000 mL).

$$1,000 \text{ mL bottles} / 3 \text{ (sites)} = 333 \text{ mL/bottle/site}$$

- g. Pour the previously calculated amount of water from the Van Dorn type sampler (i.e. 333 mL) at each sub-sample location into the graduated cylinder.
- h. Pour the water from the graduated cylinder into each pre-rinsed sample bottle (“A”, “B” and extra one-liter brown bottle(s)).
- i. Repeat procedures “g.” and “h.” on the remaining in-lake sub-sampling sites.
- j. Preserve and filter bottles following procedures in the grab sampling section previously documented.
- k. Place completed SD DENR WPP water quality (Figure 14.0. 5) and/or biological bottle labels (Figure 14.0. 6) on each sample bottle and store in a cooler on loose ice (6° C) for shipment to the appropriate laboratory.

After all samples have been collected and preserved at each lake, completely fill out a SD DENR WPP Water Quality Datasheet and a SD DENR WPP In-lake Sampling Field Data Collection Sheet (Appendix A, Table A-4 and Table A-7).

2.2 In-lake Sample Collection using an Integrated Depth Sampler

- a. Calculate the euphotic zone depth at each in-lake monitoring site by multiplying the depth where the disk reappears (RAD) by 2. Use this calculation to determine the depth at which water samples will be taken with a depth integrated sampler and record it on the datasheet (Appendix A, Table A-7).
 - i. If euphotic zone is less than 2 meters, water samples will be collected only within the euphotic zone.
 - ii. If euphotic zone is greater than or equal to 2 meters, water samples will be taken from the top 2 meters of the water column.
- b. Record the depth of integrated water samples at each site (Sites A, B, and C) for all measurements on the SD DENR WPP In-lake Field Datasheet (Appendix A, Table A-7).
- c. Note any conditions that might affect the accuracy of the measurement (waves, sun, etc.) in the notes field at the bottom of the datasheet.
- d. Rinse the composite sample collection container with surface water 3-times.
- e. Remove the rubber stopper cap (older version) or open the ball valve at the top of the sampler (newer version) and open the ball valve on the bottom end of the sampler. Rinse the sampler by submerging the sampler in the lake three times and draining. **Do this on the opposite side of the boat you plan to sample from. DO NOT TAKE ANY SAMPLES NEAR THE MOTOR!**
- f. Slowly lower the sampler into the lake as vertically as possible. Stop when the upper end is just below the surface if the euphotic zone is ≥ 2 m deep. SD DENR WPP protocols are to collect two full (2 m) integrated samplers of surface water at each in-lake sampling site (a total of 4-meters of surface water in the euphotic zone). If the euphotic zone is < 2.0 m deep, the integrated sampler will be vertically lowered into the lake to a depth of the previously calculated euphotic zone for that site and sample; additional samples will be taken to collect the total volume needed to equal a total of 4 meters of surface water in the euphotic zone.
- g. Cap the upper end with the rubber stopper firmly (older version) or close the ball valve on top of the sampler (newer version) and slowly raise the sampler as vertical as possible.

- h. When the bottom of the sampler is near the surface, reach underneath the surface of the water and close the ball valve on the bottom end of the sampler.
- i. Lift the sampler into the boat, keeping it as vertical as possible.
- j. Dispense the contents of the sampler into the previously rinsed composite sample collection container by removing the rubber stopper (older version) or opening the upper ball valve (newer version) and then the lower ball valve and drain contents of the sampler into an appropriate pre-rinsed composite storage container. **When the last sample is transferred to the composite container at each site, seal (cap) the sample container, and move it to a shaded area of the boat or cover it to avoid exposing the sample to direct sunlight and higher temperatures.**
- k. Repeat the above procedures at each in-lake sampling site recording all data on the SD DENR WPP In-lake Sampling Field Data Collection Sheet (Appendix A, Table A-7).
- l. When all samples have been collected at the lake, return to the shore and load the boat on the trailer, and drive the vehicle under trees or into the shade to process the samples out of direct sunlight.
- m. Place the composite sample container on the tailgate of the truck or back of the vehicle for easy dispensing of sample water into sample bottles.
- n. Obtain “A”, “B”, “D”, and extra brown polypropylene sample bottles and SD DENR WPP water quality and biological labels. Fill out all required labels and place them on the appropriate sample bottles.
- o. Rinse the “A”, “B”, and extra brown polypropylene sample bottles three times with water from the composite sample container prior to filling the samples.
- p. Prior to filling the bottles, shake the composite sample container vigorously to mix the sample.
- q. Then fill all the in-lake sample bottles “A”, “B”, and two (2) extra brown polypropylene bottles.
- r. Immediately cap the “A” bottle and place in a cooler on loose ice (6° C). Add 2 mL of concentrated H₂SO₄ to the “B” bottle and test the pH level of the water of the “B” bottle with pH paper. You need to ensure that the water has a pH < 2 standard units. If the pH is greater than 2 standard units add 2 more drops of concentrated H₂SO₄ and recheck the pH to ensure the pH is < 2 standard units. If using MIDCONTINENT Laboratory bottles add acid from one ampoule to the “B” bottle to stabilize the sample. Test the acidity level of the water of the “B” bottle with pH paper. You need to ensure that the water has a pH < 2 standard units. If not, add another ampoule of acid until the test of

the water indicates that the sample has the appropriate acidity. In most cases one ampoule will be sufficient. When complete, put the “B” bottle in the sample cooler on loose ice (6° C).

- s. Obtain a sterilized 100 mL plastic bottle “D” bottle for Total Dissolved Phosphorus samples, complete a SD DENR WPP water quality bottle label, and place it on the sample bottle.
- t. **DO NOT PRE-RINSE the “D” bottle or cap with de-ionized (distilled) water or in-lake sample water.**
- u. Thoroughly rinse the field filtration device with de-ionized (distilled) water prior to assembly; once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 0.45 micron pore-size filter**) and vacuum filter/rinse approximately 250 mL of distilled water through the filter (Figure 14.0. 8).
- v. After vacuum filtration, empty distilled water from the bottom reservoir, by removing both the cap and the hose from the vacuum pump from the bottom reservoir spouts and pour the water out of one of the spouts down the drain or onto the ground. **DO NOT remove the upper chamber during the rinsing operation.**
- w. Pour approximately 120 mL of sample water from one of the extra one-liter bottles or directly from the composite sample container into the upper chamber and filter (Section 14.0 (C.) (1.) (1.2) (e.)). If the filter clogs due to excessive amounts of suspended sediment or algal material, see step “x” below.
- x. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, pour the portion of filtered water in the bottom reservoir into the “D” bottle, cap, and put on ice in a sample cooler, then remove the clogged filter, and repeat the process above (“u”, “v”, and “w”).
- y. When sample filtering is complete, transfer the filtered water in the bottom reservoir (100 mL) into the “D” bottle as described in step “v”. Preserve the sample by adding five to seven drops of concentrated H₂SO₄ to lower the pH of the sample below 2 standard units. You need to ensure that the water has a pH < 2 standard units. If the pH is greater than 2 standard units add 2 more drops of concentrated H₂SO₄ and recheck the pH to ensure the pH is < 2 standard units. If using MIDCONTINENT Laboratory bottles add acid from one ampoule to the “B” bottle to stabilize the sample. Test the acidity level of the water of the “B” bottle with pH paper. You need to ensure that the water has a pH < 2 standard units. If not, add another ampoule of acid until the test of the water indicates that the

sample has the appropriate pH (< 2 standard units). In most cases one ampoule will be sufficient and tighten cap securely.

- z. Place a completed SD DENR WPP bottle label on the bottle and place the acidified “D” bottle into a storage cooler with loose ice (6° C).
- aa. Rinse the entire filtration apparatus with de-ionized (distilled) water between samples and sampling site locations.
- bb. After collection, all sample bottles must be immediately placed on ice or into a refrigerator and kept cool prior to and during shipping to the appropriate laboratory.
- cc. Rinse the sampler with tap water or distilled water prior to using it at the next study lake or when not in use.

D. Chlorophyll *a* Sampling

1. Procedure for Field Filtering In-lake Chlorophyll *a* samples

Both composite and individual/discrete chlorophyll-*a* samples are collected following grab and/or composite sample collection protocols and stored in extra one-liter brown polypropylene bottles on ice as outlined in Section 14.0 (C) (1.2) (e).

All chlorophyll *a* sample processing and filtration will be done in a shaded area out of direct sunlight!!

- a. Take the in-lake sample(s) back to shore to conduct sample processing. All filtration will take place in a shaded area out of direct sunlight using the same filter apparatus in Figure 14.0. 8.
- b. Thoroughly **rinse** the field filtration device with de-ionized (distilled) water prior to assembly, once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 1.0 micron glass fiber filter**) (*Note that these filters are different than the 0.45 micron membrane filters used for total dissolved phosphorus filtration*) (Figure 14.0. 8.).
- c. Vacuum filter/rinse approximately **250 mL** of distilled water through the filter and discard water in the bottom reservoir.
- d. Determine the total amount of sample volume to be filtered based on Secchi depth (Table 14.0. 2) to complete the chlorophyll *a* filtering (discrete or composite samples).

Table 14.0. 2. Required Chlorophyll a filter volume requirements based on Secchi disk depth.

Secchi Depth		Filter Volume
(meters)	(feet)	(mL)
> 0 - < 0.15	> 0 - < 0.5	100
> 0.15 - < 0.30	> 0.5 - < 1.0	200
> 0.30 - < 2.0	> 1.0 - < 6.6	400
> 2.0 - < 3.0	> 6.6 - < 9.8	1,000
> 3.0	> 9.8	2,000

- e. **Gently** mix, invert the brown polypropylene sample bottle before pouring the sample into a graduated cylinder and then pour the measured water into the upper chamber of the filter apparatus. Pump the sample gently as not to break algal cells (approximately 7 inches of Hg (178 mm Hg or 3.4 lbs/in²)) through the filter.
- f. If the upper and lower chambers of the filter apparatus have a maximum capacity of 250 mL, filter 200 mL of the sample, then pour the filtered water out on to the ground. Once the lower reservoir is empty replace the spout cap and the vacuum tube, add the final 200 mL to the upper chamber and finish the filtering process. Repeat this procedure as needed to filter greater filter volumes as required based on Table 14.0. 2.
- g. If the sample is very turbid or contains excessive amounts of algae or suspended solids add the appropriate amount of water from to chart into the upper chamber (known volume) and filter as much of the sample as possible (until no water will go through the filter). Carefully pour the remaining contents of the upper chamber into a graduated cylinder and record the volume. Subtract the remaining volume from the initial volume to determine total volume filtered. Record the volume filtered on the SD DENR WPP Water Quality Datasheet (Appendix A, Table A-4) and on the SD DENR WPP Biological label chlorophyll *a* (Figure 14.0. 9).
- h. After filtering the total volume required, gently remove the upper chamber and, with tweezers, fold the side of the filter with the deposited algae over onto itself once.
- i. With tweezers, place the folded filter on a piece of aluminum foil and securely wrap the filter paper in aluminum foil, making sure no sunlight can reach the filter.

Project:			Date:
Source:			Time:
Station:			Initials:
Program:			Comp mL:
<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater	Filtered mL:
<input type="checkbox"/> Algae	<input type="checkbox"/> Composite	<input type="checkbox"/> Periphyton	
<input type="checkbox"/> MacroInv	<input type="checkbox"/> Grab	<input type="checkbox"/> Phyto	Surface Area:
<input type="checkbox"/> AFD	<input type="checkbox"/> Replicate	<input type="checkbox"/> Art Sub	
<input type="checkbox"/> Chl A	<input type="checkbox"/> Blank	<input type="checkbox"/> Nat Sub	

Figure 14.0. 9. SD DENR WPP Biological Label.

- j. Fill out a water proof SD DENR WPP biological label with an indelible marker (Figure 14.0. 9). Include project name, source water name, station ID, if there are multiple sample bottles per station ID mark number of sample bottles (i.e. 1 of 3, 2 of 3, or 3 of 3), and program acronym (i.e., WPP, SWQ, GF&P, SDSU, SDSM&T,..., etc.). Then fill in the date, time, sampler initials, and the volume of water filtered **VERY IMPORTANT**. Attach the completed SD DENR WPP biological bottle label on the aluminum foil with the sample in it. Place the aluminum foil with chlorophyll *a* sample into a zip-lock freezer bag. Keep the filter on dry ice at all times during transportation.

South Dakota Department of Environment and Natural Resources
Joe Foss Building
523 E Capitol Avenue
Pierre, SD 57501-3182

ATTN: Kris Dozark

Office phone: 1-605-773-5682

- k. While out in the field, keep all chlorophyll *a* samples on ice at all times and when arriving back at the lab or office place chlorophyll *a* samples in a freezer. When shipping filtered samples back to SD DENR in Pierre for analysis (address above), **ship samples on DRY ICE to ensure samples stay frozen during transport and remember sample holding time for filtered chlorophyll *a* is only 3 WEEKS**. Call Project Officer immediately after sample collection to coordinate shipping and sample analysis.

2 Non-Filtered Chlorophyll *a* Methods

Instead of processing (filtering) the samples in the field, the sample bottles can be labeled, placed in cooler on loose ice and shipped to South Dakota Public Health Laboratory in Pierre and picked up by SD DENR WPP staff for filtering and analysis. These samples only have a **7-DAY HOLDING TIME** and need to be shipped to the or dropped off to the SD DENR office in Pierre as soon as feasible.

- a. Collect individual/discrete or composite chlorophyll *a* samples in brown polypropylene samples bottles as per outlined previously (above). Fill out a water proof SD DENR WPP biological label with an indelible marker (Figure 14.0. 9). Include project name, source water name, station ID, if there are multiple sample bottles per station ID mark number of sample bottles (i.e. 1 of 3, 2 of 3, or 3 of 3, etc.), and program acronym (i.e., WPP, SWQ, GF&P, SDSU, SDSM&T,..., etc.) and check the Chl A box. Then fill in the date, time, and sampler initials. Secure the label(s) to the brown bottle(s) and wrap with clear packing tape.
- b. Instead of filtering the samples in the field, field personnel can fill out SD DENR WPP Water Quality Datasheets, one for each sampling site and place the samples and completed field datasheets on loose ice in an appropriate cooler for shipping to the lab in Pierre.
- c. **Sample holding time for non-filtered chlorophyll *a* samples is only (7 (SEVEN) DAYS);** send in all non-filtered chlorophyll *a* samples as soon as possible to the address below. Call your Project Officer immediately after sample collection to coordinate sample analysis. If the Project Officer cannot be contacted, please call Kris Dozark at the phone number below to coordinate sample analysis.

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Joe Foss Building
523 E Capitol Avenue
Pierre, SD 57501-3182

ATTN: Kris Dozark

Office phone: 1-605-773-5682

15.0. IN-LAKE MODELING

A. BATHTUB Model

Overview

BATHTUB is designed to facilitate application of empirical eutrophication models to morphometrically complex reservoirs. The program performs water and nutrient balance calculations in a steady-state, spatially segmented hydraulic network that accounts for advective transport, diffusive transport, and nutrient sedimentation. Eutrophication-related water quality conditions (expressed in terms of total phosphorus, total nitrogen, chlorophyll a, transparency, organic nitrogen, non-orthophosphorus, and hypolimnetic oxygen depletion rate) are predicted using empirical relationships previously developed and tested for reservoir applications (Walker, 1985). To provide regional perspectives on reservoir water quality, controlling factors, and model performance, BATHTUB can also be configured for simultaneous application to collections of networks of reservoirs.

1. Data requirements include:
 - Water quality data collected from field measurements.
 - Loading data typically generated from the FLUX program.

B. PROFILE Model

Overview

PROFILE is an interactive program designed to assist in the analysis and reduction of pool water quality measurements. The user supplies a data file containing basic information on the morphometry of the reservoir, monitoring station locations, surface elevation record and water quality monitoring data referenced by station, date and depth. The program's functions are in three general areas: (a) Display of concentrations as a function of elevation, location and/or date, (b) Calculation of mixed-layer summary statistics and standard error, and calculation of hypolimnetic and metalimnetic oxygen depletion rates from temperature and oxygen profiles.

SPECIAL SAMPLING TECHNIQUES

16.0. METAL SAMPLING

South Dakota Department of Environment and Natural Resources Watershed Protection Program (SD DENR WPP) will provide the preservative for metal sampling. Most metals are preserved with nitric acid (HNO₃); however, refer to Table 9.0. 1. for specific preservative requirements. On rare circumstances and sampling situations, samples will be collected, cooled to 6° C and shipped on loose ice to the contracting laboratory within 24 hours and preserved at the laboratory.

A. Sample Collection

1. Tributary sample collection techniques (see section 12.0).
2. In-lake sample collection techniques (see section 14.0).

B. Sampling Procedures

1. Tributary sampling

Secure one (1) 100 mL High-Density Polyethylene (HDPE) bottle (Public Health Laboratory) or a 500 mL HDPE bottle (MIDCONTINENT Laboratory) or use bottle(s) supplied by other laboratories for sampling **Total Recoverable Metals** analyses. For **Dissolved Metals** analyses collect sample in a 1,000 mL bottle to be filtered after collection and placed filtered sample into a 100 mL HDPE bottle.

- a. Label sample bottle using waterproof pen with project name, waterbody source, laboratory code, station ID, metals ((dissolved (sample must be filtered) or total recovery), samplers' initials, date, surface or bottom and time collected (Figure 16.0. 1).

Project:											
Source:											
Code:										Initials	
Station:											
Date						Time					
<input type="checkbox"/> Surface				<input type="checkbox"/> Bottom				<input type="checkbox"/> Midwater			
<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D					Metals			
<input type="checkbox"/> E	<input type="checkbox"/> R	<input type="checkbox"/> V	<input type="checkbox"/> H	<input type="checkbox"/> CN	<input type="checkbox"/> Oil			<input type="checkbox"/> Dis	<input type="checkbox"/> Recov		

Figure 16.0. 1. SD DENR WPP Water Quality bottle label.

- b. Pre-rinse sample bottle(s) with sample water three times prior to sample collection.
- c. Position the open end of the sample bottle towards the current flow and away from the hand of the collector.
- d. Grasp bottle securely at the base and plunge the entire bottle below the water surface.
- e. Sampling depth should be 15.2 cm (0.5 foot) to 30.5 cm (1.0 foot) below the water surface.

- f. Tip the sample bottle slightly upward to allow air to escape and the bottle to fill.
- g. Fill metals bottle(s) to volume similar to the “A” and “B” bottles in Figure 14.0. 7.
- h. **Preserve total recoverable** sample bottle(s) by adding 0.25 mL to 1-mL of concentrated HNO₃ (Nitric Acid), depending upon bottle size; or add one ampoule of HNO₃ to the sample bottle(s) (provided by the laboratory) to bring the sample(s) below a pH of 2 standard units. You need to ensure that the water has a pH < 2 standard units. If the pH is greater than 2 standard units add two more drops of concentrated HNO₃ and recheck the pH to ensure the pH is < 2 standard units. If using MIDCONTINENT Laboratory bottles add the ampoule provided by the laboratory to the total recoverable bottle to stabilize the sample. Test the pH value of the total recoverable bottle sample with pH paper. You need to ensure that the water has a pH < 2 standard units. If not, add another ampoule of HNO₃ acid until the test of the water indicates that the sample has the appropriate pH < 2 standard units).
- i. Completely fill out a SD DENR WPP Water Quality Data Sheet (Appendix A, Table A-4).
- j. **Dissolved metals samples** require field filtration using a 0.45 micron disposable filter. Field filtering must be done on site within 15 minutes of sample collection. Construct and thoroughly rinse the field filtration device with de-ionized (distilled) water prior to assembly; once rinsed, assemble the field filtration device with a new filter (**47 mm diameter, 0.45 micron pore-size filter**) and vacuum filter/rinse approximately 250 mL of distilled water through the filter (Figure 14.0. 8).
- k. After vacuum filtration, empty the distilled water from the bottom reservoir, by removing both the cap and the hose from the vacuum pump from the bottom reservoir spouts and pour the water out of one of the spouts down the drain or onto the ground. **DO NOT remove the upper chamber during the rinsing operation.**
- l. Pour enough sample water (minimum of 120 mL) from one of the extra one-liter bottle(s) into the upper chamber of the filtration device and filter. If the filter clogs due to excessive amounts of suspended sediment or algal material, see step “m” below.
- m. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, pour the portion of filtered water in the bottom reservoir into the metals bottle, cap, and put on ice in a sample cooler, then remove the clogged filter, and repeat the process above (“j”, “k”, and “l”).
- n. After filtering is complete pour the filtered water in the lower receiver into the pre-labeled 100 mL HDPE plastic bottle.
- o. Preserve the sample by adding 1-mL concentrated HNO₃ (nitric acid) to the sample.

- p. If you are unfamiliar with the buffer capacity of the water being sampled (feedlot waste, point source discharges, mining wastewater, etc., may be highly buffered), make sure you verify the pH with pH test paper (pH < 2 standard units) to make sure enough preservative has been added when finished tighten the cap securely.
- q. Re-check the SD DENR WPP bottle label on the bottle to ensure that all data is correct and place the acidified bottle into the storage cooler with loose ice (6° C).
- r. **If no preservative was provided, package the samples in a cooler on ice (6° C) and ship or deliver samples to the contracting laboratory within 24 hours to be preserved (not recommended).**
- s. Ship or deliver samples to the contracting laboratory following Section 16.0 (C).

2. In-Lake sampling

Secure one (1) 100 mL HDPE bottle (Public Health Laboratory) or (1) 500 mL HDPE bottle (MID-CONTINENT Laboratory) or use bottle(s) supplied by other laboratories.

- a. Label in-lake sample bottle using waterproof pen with project name, waterbody source, laboratory code, station ID, metals (dissolved or total recovery), samplers' initials, date, surface or bottom and time the sample was collected (Figure 16.0. 1).
- b. Pre-rinse sample bottle with sample water three times prior to sample collection.
- c. Collect water sample following collection procedures outlined in Section 14.0 (C) (1) (Integrated Depth Sampler) or Section 14.0 (C) (2) (In-lake Water Sampling Method (Van Dorn-type sampler)).
- d. If using an Integrated Depth Sampler, collect two full samplers (4 meters) of sample water and empty each sample into a pre-rinsed composite sample container. When sampling is complete fill the metals bottle(s) directly from the composite sample container.
- e. If using a Van Dorn type sampler, the metals bottle should be filled directly from water collected with the Van Dorn sampler by opening and closing the petcock valve(s).
- f. Fill metals bottle(s) to volumes similar to sample bottles in Figure 14.0. 7.
- g. **For total recoverable metals samples** Preserve the Public Health Laboratory sample (100 mL) by adding 0.25 mL of concentrated HNO₃ (Nitric Acid) to bring the sample pH < 2 standard units. Preserve the MID-CONTINENT Laboratory sample (500 mL) by adding one ampoule of HNO₃ (Nitric Acid) to the sample bottle or 1-mL of concentrated HNO₃ to bring the sample pH below 2 standard units. Check the pH of each sample after adding the acid using pH test paper to verify the pH is < 2 standard units.

- h. **Dissolved metals samples** require field filtering using 0.45 micron disposable filters. Field filtering must be done on site within 15 minutes of sample collection. Construct and thoroughly rinse the field filtration device with de-ionized (distilled) water prior to assembly; once rinsed, assemble the field filtration device with a new filter (47 mm diameter, 0.45 micron pore-size filter) and vacuum filter/rinse approximately **250 mL** of distilled water through the filter (Figure 14.0. 8).
- i. After vacuum filtration, empty the distilled water from the bottom reservoir, by removing both the cap and the hose from the vacuum pump from the bottom reservoir spouts and pour the water out of one of the spouts down the drain or onto the ground. **DO NOT remove the upper chamber during the rinsing operation.**
- j. Pour enough sample water (minimum of 120 mL) from the composite sample container into the upper chamber of the filtration device and filter. If the filter clogs due to excessive amounts of suspended sediment or algal material, see step “k” below.
- k. If 100 mL cannot be filtered at one time because of excessive suspended solids or algae, pour the portion of filtered water in the bottom reservoir into the pre-labeled Dissolved Metals bottle, cap, and put on ice in a sample cooler, then remove the clogged filter, and repeat the process above (“h”, “i”, and “j”).
- l. After filtering is complete pour the filtered water from the lower receiver into the pre-labeled 100 mL HDPE plastic bottle.
- m. Fill out and complete a SD DENR WPP Water Quality Data Sheet for each in-lake sampling site.
- n. Re-check the SD DENR WPP bottle labels on the bottle to ensure that all data is correct and place the acidified bottle into the shipping cooler with loose ice (6° C).
- o. **If no preservative was provided, package the samples in a cooler on ice (6° C) and ship or deliver samples to the contracting laboratory within 24 hours to be preserved (not recommended).**
- p. Ship or deliver samples to the contracting laboratory following Section 16.0 (C).

C. Shipping the Sample

- 1. Place all sample containers (bottles) in appropriate shipping cooler(s). Pour enough ice into the sample cooler to completely cover all sample bottles in the cooler.
- 2. Make sure that all SD DENR Water Quality Data Sheets (Appendix A, Table A-4) are filled out completely (one sample sheet for each sampling site in the cooler). These documents are placed in a one-gallon Ziploc[®] water proof freezer bag that is taped inside the upper lid of the shipping cooler or is placed in the cooler between the insulation and cardboard lid depending upon cooler.
- 3. Securely seal the cooler(s) with clear packing tape.

4. Coolers are shipped or taken by the sampler to the South Dakota State Public Health Laboratory at the address below or other contracted laboratory (MIDCONTINENT Testing Laboratories) where analyses are to be performed.

South Dakota Public Health Laboratory
615 East Fourth Street
Pierre, South Dakota 57501-1700

or

MIDCONTINENT Testing Laboratories, Inc.
2381 South Plaza Drive, P.O. Box 3388
Rapid City, SD 57709

D. QA/QC Samples

Quality assurance/quality control procedures are to collect one QA/QC sample set (1-replicate and 1-blank) for every 10 routine samples collected and are presented in Section 7.0., of this document.

17.0. ELUTRIATE SAMPLING (In-Lake Sediment Sampling)

A. Purpose

This method is generally aimed to test sediment for contaminants for future dredge projects and eventual land application and to produce information about contaminants that may affect the benthic community. This method is used as a screening process by the field technician or may be designated in the work plan. The choice of specific sampling sites is based primarily on field reconnaissance, known flow patterns through the lake, locations of tributary inputs, and any other known point sources which may affect the outcome and distribution of the sediment contaminants. This sampling method will be used to collect sediment samples used as general screening for specific pollutants identified in the Project Implementation Plan (PIP).

B. Materials

Sampling Equipment

1. Boat or Ice Auger and Chipping Bar.
 - a. Life jackets (use in boat or on ice).
 - b. Other required safety equipment.
2. Sediment Samplers
 - a. Corer (Benthos Gravity, Alpine Gravity, Phleger, Multiple).
 - b. Grab (Franklin Anderson, Dietz-LaFond, Peterson, Shipek, or Ponar).
 - c. Dredge (Birge-Ekman).
3. Five one-gallon glass jars (with Teflon-lined lids) per sampling site.
4. Shipping cooler(s).
5. One (1) clean 18.9 liter (5 gallon) bucket or rectangular tub for each grab sampling site. Two (2) 18.9 liter (5 gallon) buckets or rectangular tub will be needed if composite samples are required.
6. Print 5 SD DENR WPP blank bottle labels per sample set and one contaminates data sheet for each sampling site (Appendix A, Table A-5).

C. Procedure

1. SD DENR WPP has a standard suite of parameters that are outlined in the Project Implementation Plan (PIP) or will be modified by the Project Officer prior to sample collection.
2. Coordinate with the Project Officer and the laboratory to select a sampling date and time to minimize storage time prior to analysis.
3. Select a work day early in the week to sample and ship coolers, preferably Mondays or Tuesdays.

4. Sample early in the day to complete labels, time to pack samples, fill out SD DENR WPP Contaminates Sample Data Sheets (Appendix A, Table A-5) or if needed fill out a separate SD DENR chain-of-custody datasheet (Appendix A, Table A-10). Ship or deliver sample coolers the same day as collection, to the contracting laboratory.

D. Sampling Site Procedures

1. Grab Sampling

- a. Measure in-lake depth with a depth finder, Secchi disk, or weight, and record the measurement on the elutriate sample data sheet.
- b. Label three (3) 3.79-liter (1-gallon) narrow-mouth glass jars with Teflon lined lids (receiving water samples) with the Project Name, Source Lake Name, LaboratoryID (code), Station (site), samplers' Initials, Date, Time, Depth, check Bottom, circle Grab, circle Receiving Water, and fill in numbers of bottles (Figure 17.0. 1.).

Project:		
Source:		
Code:	Initials	
Station:		
Date		Time
Depth:	<input checked="" type="checkbox"/> Bottom	Type (circle) Grab Composite
Bottle Circle	Receiving Water	Sediment Bottle __ of 3__

Figure 17.0. 1. Receiving water contaminates bottle label.

- c. Label two (2) 3.79-liter (1-gallon) wide-mouth glass jars with Teflon lined-lids (sediment samples) with the Project Name, Source Lake Name, LaboratoryID (code), Station (site), samplers' Initials, Date, Time, Depth, check Bottom, circle Grab, circle Sediment, and fill in numbers of bottles (Figure 17.0. 2.).

Project:		
Source:		
Code:	Initials	
Station:		
Date		Time
Depth:	<input checked="" type="checkbox"/> Bottom	Type (circle) Grab Composite
Bottle Circle	Receiving Water	Sediment Bottle __ of 2__

Figure 17.0. 2. Sediment contaminates bottle label.

- d. Being careful not to disturb the lake bottom, obtain samples of water from near the bottom of the lake using a pre-rinsed Van Dorn,

- Kemmerer bottle, or other non-contaminating sampler. Collect multiple grab samples of overlying water compositing them into a pre-cleaned and rinsed 18.9 liter (5-gallon) bucket.
- e. Completely fill (to the lid) three (3) 3.79-liter (1-gallon) narrow-mouth glass jars with Teflon lined-lids with water obtained from step “d” (receiving water) and securely cap the jars with Teflon-lined lids.
 - f. Place receiving water sample bottles into large heavy plastic bags and seal them with plastic tape and write (sealed) on the tape and place sealed plastic bags into the sampling/shipping cooler. Ideally, the cooler came with Styrofoam or bubble-rap to place between the bagged sample bottles to reduce the chance of breakage during shipment. Temporarily, place a bag of ice in the cooler to keep the samples cool during sediment sample collection.
 - g. After receiving water samples are completed, collect sediment samples with a Ponar sampler or other appropriate sediment sampling device. Place the sediment collected from each sampler grab into a pre-cleaned 18.9-liter (5-gallon) bucket or suitable sized large tub. Sample enough sediment to fill the 18.9 liter bucket/tub at least halfway to have enough sediment to fill both sample bottles.
 - h. Mix the sediment in the pre-cleaned bucket with latex gloves or a wooden or heavy stirring spoon or stick to homogenize the sample.
 - i. Completely fill (to the lid) two 3.79 liter (1-gallon) wide-mouth glass jars with sediment per sampling site. **Make sure that container is completely filled with sediment and that air bubbles are not trapped in the container.** Carefully rinse the glass jar threads and the cap with sample water to clean the threads for a better seal. **Securely cap with Teflon-lined lid.**
 - j. Place sediment sample bottles into separate large heavy plastic bags and seal it with plastic tape and write (sealed) on the tape, then place sealed plastic bag into the sampling/shipping cooler on loose ice (6° C).

7. Composite Sampling

Composite sediment sampling is similar to grab sampling except separate receiving water and sediment samples are collected throughout the lake and composited.

- a. Composite sampling sites will be defined in the Project Implementation Plan (PIP) or will be chosen by the Project Officer before sampling begins.
- b. Two (2) pre-rinsed buckets will be needed for compositing (homogenizing) receiving water and sediment samples. One (1) 18.9-liter (5-gallon) bucket will be used to composite (homogenize) three 11.4 liters (3-gallons) of receiving water and one (1) 18.9-liter (5-gallon) bucket to composite (homogenize) 7.6 liters (2-gallons) of sediment.

- c. Determine the appropriate amount of receiving water and sediment to collect from each sub-sampling site. See procedure below:
 - i. To calculate the amount receiving water and sediment needed from each sub-sample. Divide the minimum amount of sample needed in liters, by the number of sampling sites to be composited. See below:

Receiving Water Example

When compositing 3 sampling sites for receiving water (11.4 liters (3-gallons) required).

$$11.4 \text{ liters (3-gallons)} / 3 \text{ sites} = 3.8 \text{ liters (1-gallon)}$$

At a minimum pour the previously calculated amount of receiving water (rounded 4 liters (1.06 gallons)) into the pre-rinsed 18.9-liter (5-gallon) bucket. Collect this volume at all remaining sub-sampling sites.

Sediment Example

When compositing 3 sites for sediment samples (7.6 liters (2-gallons) required).

$$\begin{aligned} &\text{To collect 7.6 liters (2-gallons) of sediment} / 3 \text{ sites} = \\ &2.5 \text{ liters (0.67-gallon) of sediment from each sampling} \\ &\text{site in the lake} \end{aligned}$$

At a minimum deposit the previously calculated amount of sediment (rounded to 2.7 liters (0.71 gallon) from each sub-sampling site into the pre-rinsed 18.9-liter (5-gallon) bucket. Collect this volume at all remaining sub-sampling sites.

- d. Label three (3) 3.79-liter (1-gallon) narrow-mouth glass jars (receiving water samples) with the lake name, date, time, receiving water, site, depth, composite and samplers' initials (see Figure 17.0. 1).
- e. Label two (2) 3.79-liter (1-gallon) wide-mouth glass jars (sediment samples) with the lake name, date, time, sediment, site, depth, composite and samplers' initials (see Figure 17.0. 2).
- f. At each sub-sampling site, measure in-lake depth with a depth finder, Secchi disk, or weight, and record each depth measurement on the contaminate sample data sheet under the field comments section of the datasheet. When the last sub-sample is complete, sum all sub-sample depths and divide that number by the total number of sub-sampling sites on the lake. Write the average composite sample depth for the lake in the Total Depth box on the datasheet and write in Average before Total Depth.

- g. At the first sub-sampling site, being careful not to disturb the lake bottom, obtain the previously calculated volume of water from near the bottom of the lake using a pre-rinsed Van Dorn, Kemmerer bottle, or other non-contaminating sampler and pour it into a pre-rinsed 18.9 liter (5-gallon) bucket.
- h. After collecting the receiving water sample at the sub-sampling site, collect a sediment sub-sample with a Ponar sampler (most used) or other appropriate sediment sampling device. Place the sediment collected from sampler grab into a separate pre-cleaned 18.9 liter (5-gallon) bucket.
- i. Repeat procedure 'g' and 'h' at the remaining sub-sampling sites.
- j. Swirl receiving water sampling bucket to homogenize the sample and pour contents into three pre-rinsed and labeled receiving water (narrow mouth) glass sample bottles. Make sure all sample bottles are filled completely to the top of the lid and cap each bottle with a Teflon-lined lid.
- k. Place full receiving water sample bottles into a large heavy plastic bag and seal it with plastic tape and write (sealed) on the tape and the place sealed plastic bag into a sampling/shipping cooler on loose ice (6° C).
- l. To prepare the sediment composite sample, mix the sediment composite sample in the 18.9 liter (5-gallon) bucket by hand with latex gloves or a wooden or heavy stirring spoon or stick to homogenize the sample. homogenize the sample.
- m. Carefully fill two (2) pre-rinsed and labeled 1-gallon wide-mouth glass jars with sediment. Make sure that container is completely filled with sediment and that air bubbles are not trapped in the container. Carefully rinse the glass jar threads and the cap with sample water to clean the threads for a better seal. Securely cap with Teflon-lined lid.
- n. Place full sediment sample bottles into a large heavy plastic bag and seal it with plastic tape and write (sealed) on the tape. Remove the temporary ice bag from the shipping cooler and the place sealed plastic sediment sampling bags into the shipping cooler(s) with the Receiving Water sample bottles. Place the remaining Styrofoam or bubble-rap to in between the bagged sample bottles the cooler to reduce the chance of breakage during shipment.
- o. Completely fill the shipping cooler with loose ice to chill and cool samples down to 6° C.

E. Shipping the Sample

- 1. Completely fill out an SD DENR WPP Contaminate Sample Data Sheet(s) (write in "**Elutriate Sample**" in the Field Comments section of the data sheet) and ensure all sheets and the Project Logbook are filled out (one sample sheet for each sampling site in the cooler).
- 2. Ensure all sample containers (sample bottles) are placed in large plastic bags, all plastic bags are taped and sealed, and all bags are covered with loose ice (6° C).

3. Sign, date, and time the chain-of-custody section of each SD DENR WPP Contaminate Sample Data Sheet(s) in the cooler or fill out a separate SD DENR chain-of-custody datasheet (Appendix A, Table A-10).
4. Place all SD DENR WPP Contaminate Sample Data Sheet(s) into a large Ziploc[®] bag, seal the freezer bag, and tape it to the inside lid of the cooler or place it on top of the ice.
5. Close the cooler, address, and securely seal the cooler with clear packing tape.
6. **Care should be taken when handling/lifting shipping cooler(s) due to excess weight (ice, sediment and water samples can exceed 75 to 100 lbs. or more); GET HELP when lifting contaminate coolers!**
7. Coolers are shipped or taken by the sampler to the State Health Laboratory at the address below or MIDCONTINENT Testing Laboratories or other contracted laboratories where analyses are performed, (see addresses below).

South Dakota Public Health Laboratory
615 East Fourth Street
Pierre, South Dakota 57501-1700

or

MIDCONTINENT Testing Laboratories, Inc.
2381 South Plaza Drive, P.O. Box 3388
Rapid City, SD 57709

8. **SHIP OR TRANSPORT THE SAMPLES TO THE LAB THE SAME DAY AS COLLECTION, IF AT ALL POSSIBLE!**

F. **Quality Control (Field)**

1. Provide representative samples for analysis.
2. Rinse all containers properly prior to use.
3. Initiate appropriate storage procedures immediately after collection.
4. Properly label and record dates and locations of sample collections, as well as other pertinent information, on the contaminate sample data sheet.
5. Fill out and complete the logbook for each day of sampling
6. Sign the SD DENR WPP contaminate sample data sheet and be sure to sign, date and time in the chain-of-custody section of the datasheet.
7. If the samples are hand delivered to the laboratory open the coolers and have laboratory personnel sign the samples received section chain-of-custody section of the datasheet.
8. Have laboratory personnel make a copy of each data sheet and give the copies to you for the project file.

18.0 DISCRETE GRAB SAMPLES FOR UPSTREAM AND DOWNSTREAM SAMPLING

A. Site Location

Generally, discrete upstream and downstream sampling is used especially when there is a unique situation, spill or complaint. Sampling site locations are different than those sites specified in the Project Implementation Plans (PIPs) and/or by the Project Officer. Downstream samples are always collected first to lessen potential contamination and impact.

1. Locate the downstream site between one hundred meters to one kilometer downstream from the potential pollution source or area of interest.
 - a. Do not sample in any ponded or pooled areas because of backwater impacts. If the closest access point is on private land, be sure to have permission before sampling. If at all possible, sample in public right-of-ways which require no permission.
 - b. If the source being sampled has no direct discharge, make sure you have sampled downstream of the suspected impact area.
 - c. Be sure there are no unknown pollution sources in the area you are trying to sample; if there are, document on the SD DENR WPP water quality data sheet.
2. Locate the upstream site between one hundred meters to one kilometer upstream from the potential pollution source depending upon access.
 - a. Do not sample in any ponded or pooled areas because of backwater impacts. If the closest access point is on private land, be sure to have permission before sampling. If at all possible, sample in public right-of-ways which require no permission.
 - b. Ensure upstream sampling site is far enough upstream of the potential impacted area as to not influence the upstream sample.
 - c. If there are potential impacts (point sources or other pollution concerns) above the upstream sampling site, document this on the water quality data sheet.
3. At times the water in the tributary will travel for long distances before mixing with the contaminated water due to temperature or differing solute concentrations. If distinct zones of water are observed, move the sampling site further downstream to where the waters have mixed.

B. Sample Collection

1. Follow the equipment calibration procedures presented in Section 6.0 of this manual.
2. Follow the tributary sampling procedures presented in Section 12.0 of this manual.

C. Shipping Samples

1. Completely fill out a SD DENR Water Quality Data Sheet (Appendix A, Table A-4) for each site/station/sample in the cooler.
2. Place all sample containers (bottles) in appropriate sample cooler(s). Pour enough ice into the sample cooler to completely cover all sample bottles in the cooler.
3. Make sure that all SD DENR Water Quality Data Sheets (Appendix A, Table A-4) are filled out completely (one sample sheet for each sampling site in the cooler). These documents are placed in a one-gallon Ziploc[®] water proof freezer bag and taped inside the upper lid of the shipping cooler or is placed in the cooler between the insulation and cardboard lid depending upon cooler.
4. Securely seal the cooler(s) with clear packing tape.
5. Coolers are shipped or taken by the sampler to the State Health Laboratory at the address below or other contracted laboratory (MIDCONTINENT Testing Laboratories) where analyses are to be performed.

South Dakota Public Health Laboratory
615 East Fourth Street
Pierre, South Dakota 57501-1700

or,

MIDCONTINENT Testing Laboratories, Inc.
2381 South Plaza Drive, P.O. Box 3388
Rapid City, SD 57709

19.0. PROCEDURE TO ESTABLISH AND USE PHOTO POINTS

The photo point is a method of monitoring that provides a way to assess changes to a point of reference or a landscape view over time. Photographs or digital images taken from the same vantage point at a planned frequency provide a visual record that may be more easily understood by the non-scientific community than detailed quantitative analysis. These photographs or digital images also provide valuable supplementary information for detailed scientific studies.

A. Photo Point Location

The photo point needs to be located in a manner that assures that the point can be relocated in the field at a later date. A permanent marker such as a piece of rebar, an old disk blade, an embedded set of bricks or a concrete block should be placed at the photo point and used as a reference for taking photos. The marker needs to be further identified by painting with fluorescent paint, use of a flag, reference stake or steel post to help in relocating. Locating with a Global Positioning System (GPS) is also advised. Care should be taken when setting the point to account for livestock or other potential disturbances to the marker and use common sense in choosing the type of marker to be placed. The marker should be undisturbed throughout the project duration and it may be advantageous to leave a marker permanently in anticipation of future use in monitoring follow-up.

The photo point should be located on a map preferably an aerial photo. The map can be taken to the field and used as a guide in finding the marker. Using the GPS is also useful in relocating the point. GPS location data (latitude and longitude) should be a part of the map description as well as Township, Range and Section. It is also recommended to provide a written description of the photo point with reference to any obvious identifying characteristics such as a lone tree, fence posts, a particular-looking rock, etc.

B. Equipment

The only equipment needed for this procedure is a camera, a pencil and a notepad. The camera may be conventional or digital with sufficient quality to take clear photographs or images of the item of interest. The same camera or one with similar attributes should be used throughout the project.

C. Photo Point Procedure

The photographer should initially note the date, general weather conditions, and time of day. A brief written description of the item to be photographed should be included on the notepad and developed for each photograph taken. Note the photo or image number with each description so one can identify the images or prints after they are developed. One should try to take the photographs at the same time of day, in similar light, similar weather conditions and at the same season of the year.

Stand adjacent to the photo point in the same manner each time and note the direction you are facing. When taking the photograph, you should be aware of and account for your shadow or other disturbances that may detract or obscure the interpretation of the picture or image. Look through the camera at the item of interest and see if there is anything within the camera field that can be used as a reference point for future photographers. Is there a tree or skyline feature in the viewfinder that will help locate the photo point? These features should be described in sufficient detail to enable a photographer to view these references with relative ease during photograph sessions. If no obvious reference points are within the field of view, you either can use compass bearings, or, an artificial reference point can be placed within the field of view. Remember to take into account potential disturbances to the marker from livestock or other potential problems.

A minimum of two photographs per item should be taken and their descriptions logged onto the notepad. Additional photographs may be taken at different angles or views at the discretion of the photographer to further document the point.

Photo sessions should be conducted at time intervals that allow for anticipated changes to the items of interest and should coincide with other assessments of the item of interest. Project progress, time of season, budgetary constraints, etc. should be considered when choosing photo session frequency.

D. Photo Point Data Management

Once the photographs or images are developed, the photos or images with written descriptions should be placed in a binder or other record book or file. The negatives should be accompanied by written descriptions and placed in appropriate storage. Working copies of the photographs should be made available to facilitate future photo sessions at the site and provide information and education for the project.

E. Photo Point Interpretation

A picture can be worth a thousand words and the photo point procedure can provide just that if it is done properly. The procedure is meant to provide a visual record of the changes (or lack of changes) of an item of interest. It may be necessary sometimes to provide the viewer with a description of what they are seeing and why the photographs are different. This is when the writer supports the photograph with written descriptions that direct the viewer to particular items in the photographs. Once this is accomplished, the viewer can then make interpretations of what he/she sees in the pictures.

20.0. REFERENCES CITED

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Appendix A

SD DENR Watershed Protection Program Data Sheets

Table A-1.

SD DENR WPP YSI CALIBRATION WORKSHEET

Date of Calibration: _____ Time: _____ Location _____

Sonde ID: _____ 650 MDS ID: _____ Technician(s): _____

ROX DO wiper changed? Y / N _____

Note: If parking problems occur with optical probes having a serial number 07L (Dec 07) or older, be sure the firmware is 3.06 or later. Parking issues with optical probes having a serial number prior to 07L may be related to a dirty wiper body or pad.

Check MDS 650 battery status; if below half replace batteries before calibration: Batteries Changed Y \ N _____

Record sonde battery voltage: _____ (if applicable)Record the following diagnostic numbers after calibration.

Record Calibration Values

	Standard	Pre Cal / Post Cal / Accepted	
6560 Conductivity cell constant _____ Range $5.0 \pm .45$	Temperature _____	_____	Sonde <input type="checkbox"/>

Conductivity _____ / _____ ☐

pH mv Buffer 7 _____ Range 0 ± 50 mv	pH 7 STD Temp _____	pH 7*** _____	_____ / _____ <input type="checkbox"/>
--	---------------------	---------------	--

pH mv Buffer 10 _____ Range -180 ± 50 mv *	pH 10 STD Temp _____	pH 10*** _____	_____ / _____ <input type="checkbox"/>
--	----------------------	----------------	--

If applicable:

pH mv Buffer 4 _____ Range $+180 \pm 50$ mv*	pH 4 STD Temp _____	pH 4*** _____	_____ / _____ <input type="checkbox"/>
--	---------------------	---------------	--

*Note: Millivolt span between pH 4 and 7 should be ≈ 165 to 180 mvMillivolt span between pH 7 and 10 should be ≈ 165 to 180 mv

Buffer 10 mv _____

- Buffer 7 mv _____

= span mv _____ ☐ check if within rangeDO ROX NA _____ / _____ ☐DO ROX % **** _____ / _____ ☐

ODO gain _____

*** = Look up pH standard correction values in Table 1 on back of sheet

DO % Calculated – (BP mmHg divided by 7.6) = DO % saturation,

Example: $760 \div 7.6 = 100.0\%$

Barometric Pressure: _____ mmHg / 7.6 = _____ DO % **** (Enter percentage into DO ROX standard column)

Depth Calibration - If zero was entered, record barometric pressure at time of calibration _____ mmHg, or

If collecting profiles, depth calibration should be redone at each lake or monitoring site

Depth Calibration - If offset depth was entered, record value _____ meters/feet and barometric pressure _____ mmHg

Calibration Accepted: Yes ☐ No ☐ **

** explain below

Notes: If Sondes have other probes please write probe specific calibration values and if calibration was successful.

Table A1.1. pH Standard Correction Values based on Temperature

Temp [°C]	pH 4	pH 7	pH 10
0	4.01	7.13	10.34
1	4.01	7.12	10.32
2	4.01	7.12	10.30
3	4.01	7.11	10.32
4	4.00	7.11	10.29
5	4.00	7.10	10.25
6	4.00	7.09	10.24
7	4.00	7.09	10.23
8	4.00	7.09	10.23
9	4.00	7.08	10.21
10	4.00	7.07	10.19
11	4.00	7.07	10.18
12	4.00	7.06	10.16
13	4.00	7.06	10.15
14	4.00	7.05	10.13
15	4.00	7.05	10.12
16	4.00	7.04	10.11
17	4.00	7.04	10.10
18	4.00	7.03	10.08
19	4.00	7.03	10.07
20	4.00	7.02	10.06
21	4.00	7.02	10.07
22	4.00	7.03	10.09
23	4.00	7.02	10.06
24	4.01	7.01	10.03
25	4.01	7.00	10.00
26	4.01	7.00	9.99
27	4.01	7.00	9.98
28	4.01	6.99	9.96
29	4.01	6.99	9.95
30	4.01	6.99	9.94
31	4.01	6.99	9.95
32	4.01	6.99	9.96
33	4.02	6.98	9.96
34	4.02	6.98	9.97
35	4.02	6.98	9.98
36	4.02	6.98	9.95
37	4.02	6.98	9.93
38	4.03	6.97	9.90
39	4.03	6.97	9.88
40	4.03	6.97	9.85

Table A-2. SD DENR WPP Discharge Datasheet (Marsh-McBirney and/or Flowtracker flowmeters)

(Record units under the heading for each column)

Site: _____

Page ____ of ____

Date: _____ Time: _____ Sampler(s): _____

Meter: _____, Stage Before: _____, Stage After: _____

If meter is Marsh-McBirney Flo-mate Model 2000 was Zero Adjust Test performed at lab or site: Y / N ?

If meter is FlowTracker was Automatic QC Test Run at site: Y / N ?

If Yes, did it pass Y / N, If No do not use meter. Comments _____

Row	Tape	Location	Width	Depth	Area (W*D)	Mean in Vertical	Discharge (W*D*MV)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
Total Discharge							

Number of Stations _____

Width _____ (ft), Area _____ (ft²), Temperature _____ (°F or °C), Method _____. Uncertainty _____ (%),

Mean Velocity _____ (ft/s), Max Velocity _____ (ft/s), Average Depth _____ (ft), Max Depth _____ (ft).

Table A-2.1. SD DENR WPP Discharge Datasheet (for Marsh-McBirney and/or Flowtracker flowmeters)
(Record units under the heading for each column)

Site: _____

Page 2 of 2

Date: _____

Time: _____

Sampler(s): _____

Row	Tape	Location	Width	Depth	Area (W*D)	Mean in Vertical	Discharge (W*D*MV)
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
Total Discharge							

Number of Stations _____

Width _____ (ft), Area _____ (ft²), ^{Water}Temperature _____ (°F or °C), Method _____. ^{circle one}Uncertainty _____ (%),

Mean Velocity _____ (ft/s), Max Velocity _____ (ft/s), Average Depth _____ (ft), Max Depth _____ (ft).

Table A-3.[illegible]

Table A-4. SD DENR WPP Water Quality Datasheet

SD DENR Water Quality Data										Rev 11/12
Agency Code										
Sample Date	Time	Sampler								
Source Water					Station ID					
Site Location										
Project							Project ID			
Type of Sample	<input type="checkbox"/> Replicate	<input type="checkbox"/> Grab	<input type="checkbox"/> Integrated Vertical	Medium			<input type="checkbox"/> Water / Other			
	<input type="checkbox"/> Blank	<input type="checkbox"/> Composite	<input type="checkbox"/> Integrated Flow	Relative Depth			<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater	

SPC/Cond @ 25c		µmho/cm	pH		SU	Field Comments
Dissolved Oxygen		mg/L	Air Temp		C	
Discharge		CFS	Water Temp		C	
Total Depth		Ft	Turbidity		NTU	
Sample Depth		Ft	Secchi Disk		Meters	
Width		Ft	Wind		mph	
Gage Stage		Ft	Elevation		Ft	

All Samples must be packed in ice and chilled to 6 C

Liter A	Liter B	Bottle C	Bottle D	Metals	
<input type="checkbox"/> Alkalinity <input type="checkbox"/> TSOL <input type="checkbox"/> TSSOL <input type="checkbox"/> VTSS <input type="checkbox"/> TDSOL <input type="checkbox"/> BOD <input type="checkbox"/> CBOD <input type="checkbox"/> CO3 <input type="checkbox"/> Hardness <input type="checkbox"/> K <input type="checkbox"/> Lab pH <input type="checkbox"/> Lab Cond <input type="checkbox"/> Nitrate <input type="checkbox"/> Cl <input type="checkbox"/> Fluoride <input type="checkbox"/> HCO3 <input type="checkbox"/> SO4	2 mL H2SO4 pH<2 <input type="checkbox"/> Ammonia <input type="checkbox"/> NO3-NO2-N <input type="checkbox"/> TKN <input type="checkbox"/> Total P <input type="checkbox"/> COD Lab Comments	<i>Na2S2O3 solution Chlorinated</i> <i>Note: 250 mL presample requires refrigerating more than one or two bottles</i> <input type="checkbox"/> * count/100 mL <input type="checkbox"/> Total Coliform <input type="checkbox"/> Fecal Coliform <input type="checkbox"/> Enterococci* <input type="checkbox"/> E Coli* <input type="checkbox"/> Fecal PFG Oil Grease 2 mL HCL <input type="checkbox"/>	100 mL L. Field Filtered 0.25 mL H2SO4 <input type="checkbox"/> TDP <input type="checkbox"/> DIN Bottle R <input type="checkbox"/> Ra 226 <input type="checkbox"/> Ra 228 Bottle CN 500 mL NaOH pH >10 <input type="checkbox"/> CN <input type="checkbox"/> WADCN Bottle H Liter Glass Amber <input type="checkbox"/> TPH Amber Bottle V <input type="checkbox"/> VOC <input type="checkbox"/> TOC <input type="checkbox"/> TPH Vial <input type="checkbox"/> DOC Bottle E Field Filtered <input type="checkbox"/> SO4 <input type="checkbox"/> Fluoride <input type="checkbox"/> Cl <input type="checkbox"/> HCO3	100mL each Add 0.25 mL HNO3 Dissolved Field Filtered Total Recoverable <div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Al <input type="checkbox"/> Sb <input type="checkbox"/> As <input type="checkbox"/> Ba <input type="checkbox"/> Be <input type="checkbox"/> B <input type="checkbox"/> Cd <input type="checkbox"/> Ca <input type="checkbox"/> Cr <input type="checkbox"/> Cu <input type="checkbox"/> Hg <input type="checkbox"/> Pb <input type="checkbox"/> Mg <input type="checkbox"/> Mn <input type="checkbox"/> Ni <input type="checkbox"/> Se <input type="checkbox"/> Ag <input type="checkbox"/> Na <input type="checkbox"/> Ti <input type="checkbox"/> U <input type="checkbox"/> Vn <input type="checkbox"/> Zn <input type="checkbox"/> Fe <input type="checkbox"/> Mo <input type="checkbox"/> Fluoride <input type="checkbox"/> K <input type="checkbox"/> Cl <input type="checkbox"/> Silica </div> <div> <input type="checkbox"/> Al <input type="checkbox"/> Sb <input type="checkbox"/> As <input type="checkbox"/> Ba <input type="checkbox"/> Be <input type="checkbox"/> B <input type="checkbox"/> Cd <input type="checkbox"/> Ca <input type="checkbox"/> Cr <input type="checkbox"/> Cu <input type="checkbox"/> Hg <input type="checkbox"/> Pb <input type="checkbox"/> Mg <input type="checkbox"/> Mn <input type="checkbox"/> Ni <input type="checkbox"/> Se <input type="checkbox"/> Ag <input type="checkbox"/> Na <input type="checkbox"/> Ti <input type="checkbox"/> U <input type="checkbox"/> Vn <input type="checkbox"/> Zn <input type="checkbox"/> Fe <input type="checkbox"/> Mo </div> </div>	
Lab Filtered A Bottle <input type="checkbox"/> Ca <input type="checkbox"/> Mg <input type="checkbox"/> Na	Relinquished By: _____ Date/Time: _____ Received By: _____ Date/Time: _____ Relinquished By: _____ Date/Time: _____ Received By: _____ Date/Time: _____ Relinquished By: _____ Date/Time: _____ Received By: _____ Date/Time: _____				
Sample Temp (C)	Date / Time Received			Lab #	

Table A-5. SD DENR WPP Contaminats (Elutriate) Datasheet

SD DENR Water Quality Data										Rev 11/12																																																	
Agency Code																																																											
Sample Date		Time	Sampler Print/Sign																																																								
Source Water					Station ID																																																						
Site Location																																																											
Project							Project ID																																																				
Type of Sample	<input type="checkbox"/> Replicate	<input type="checkbox"/> Grab	<input type="checkbox"/> Integrated Vertical			Medium		<input type="checkbox"/> Water / Other																																																			
	<input type="checkbox"/> Blank	<input type="checkbox"/> Composite	<input type="checkbox"/> Integrated Flow			Relative Depth		<input type="checkbox"/> Surface	<input type="checkbox"/> Bottom	<input type="checkbox"/> Midwater																																																	
SPC/Cond @ 25c		<input type="text"/>	µmho/cm	pH	<input type="text"/>	SU	Field Comments																																																				
Dissolved Oxygen		<input type="text"/>	mg/L	Air Temp	<input type="text"/>	C																																																					
Discharge		<input type="text"/>	CFS	Water Temp	<input type="text"/>	C																																																					
Total Depth		<input type="text"/>	Ft	Turbidity	<input type="text"/>	NTU																																																					
Sample Depth		<input type="text"/>	Ft	Secchi Disk	<input type="text"/>	Meters																																																					
Width		<input type="text"/>	Ft	Wind	<input type="text"/>	mph																																																					
Gage Stage		<input type="text"/>	Ft	Elevation	<input type="text"/>	Ft																																																					
<i>All Samples must be packed in ice and chilled to 6 C</i>																																																											
<i>Check All for Standard Elutriate Sample</i>																																																											
<input type="checkbox"/> Alachlor <input type="checkbox"/> Endosulfan_2 <input type="checkbox"/> PCB_1254 <input type="checkbox"/> Aldrin <input type="checkbox"/> Endrin <input type="checkbox"/> PCB_1260 <input type="checkbox"/> Alpha_BHC <input type="checkbox"/> Gamma_BHC <input type="checkbox"/> Toxaphene <input type="checkbox"/> Atrazine <input type="checkbox"/> Heptachlor <input type="checkbox"/> COD <input type="checkbox"/> Beta_BHC <input type="checkbox"/> Heptachlor_EpoX <input type="checkbox"/> Total Phosphorus <input type="checkbox"/> Chlordane <input type="checkbox"/> Methoxychlor <input type="checkbox"/> TKN <input type="checkbox"/> DDD <input type="checkbox"/> PCB_1016 <input type="checkbox"/> Ammonia <input type="checkbox"/> DDE <input type="checkbox"/> PCB_1221 <input type="checkbox"/> Hardness <input type="checkbox"/> DDT <input type="checkbox"/> PCB_1232 <input type="checkbox"/> Nitrate <input type="checkbox"/> Diazinon <input type="checkbox"/> PCB_1242 <input type="checkbox"/> Nitrite <input type="checkbox"/> Dieldrin <input type="checkbox"/> PCB_1248 <input type="checkbox"/> Arsenic			<input type="checkbox"/> PCB Screen <input type="checkbox"/> 2,4D <input type="checkbox"/> Dicamba <input type="checkbox"/> Hexachlorobenzene <input type="checkbox"/> Oil and Grease <input type="checkbox"/> BHC-delta <input type="checkbox"/> Mirex			Metals 100mL each X bottle 4 Deg C <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">Total Dissolved Field Filtered</td> <td style="width: 50%;">Total Recoverable with Acid Digestion</td> </tr> <tr><td><input type="checkbox"/> Al</td><td><input type="checkbox"/> Al</td></tr> <tr><td><input type="checkbox"/> Sb</td><td><input type="checkbox"/> Sb</td></tr> <tr><td><input type="checkbox"/> As</td><td><input type="checkbox"/> As</td></tr> <tr><td><input type="checkbox"/> Ba</td><td><input type="checkbox"/> Ba</td></tr> <tr><td><input type="checkbox"/> Be</td><td><input type="checkbox"/> Be</td></tr> <tr><td><input type="checkbox"/> B</td><td><input type="checkbox"/> B</td></tr> <tr><td><input type="checkbox"/> Cd</td><td><input type="checkbox"/> Cd</td></tr> <tr><td><input type="checkbox"/> Ca</td><td><input type="checkbox"/> Ca</td></tr> <tr><td><input type="checkbox"/> Cr</td><td><input type="checkbox"/> Cr</td></tr> <tr><td><input type="checkbox"/> Cu</td><td><input type="checkbox"/> Cu</td></tr> <tr><td><input type="checkbox"/> Hg</td><td><input type="checkbox"/> Hg</td></tr> <tr><td><input type="checkbox"/> Pb</td><td><input type="checkbox"/> Pb</td></tr> <tr><td><input type="checkbox"/> Mg</td><td><input type="checkbox"/> Mg</td></tr> <tr><td><input type="checkbox"/> Mn</td><td><input type="checkbox"/> Mn</td></tr> <tr><td><input type="checkbox"/> Ni</td><td><input type="checkbox"/> Ni</td></tr> <tr><td><input type="checkbox"/> Se</td><td><input type="checkbox"/> Se</td></tr> <tr><td><input type="checkbox"/> Ag</td><td><input type="checkbox"/> Ag</td></tr> <tr><td><input type="checkbox"/> Na</td><td><input type="checkbox"/> Na</td></tr> <tr><td><input type="checkbox"/> Ti</td><td><input type="checkbox"/> Ti</td></tr> <tr><td><input type="checkbox"/> U</td><td><input type="checkbox"/> U</td></tr> <tr><td><input type="checkbox"/> Vn</td><td><input type="checkbox"/> Vn</td></tr> <tr><td><input type="checkbox"/> Zn</td><td><input type="checkbox"/> Zn</td></tr> <tr><td><input type="checkbox"/> Fe</td><td><input type="checkbox"/> Fe</td></tr> <tr><td><input type="checkbox"/> Mo</td><td><input type="checkbox"/> Mo</td></tr> </table>				Total Dissolved Field Filtered	Total Recoverable with Acid Digestion	<input type="checkbox"/> Al	<input type="checkbox"/> Al	<input type="checkbox"/> Sb	<input type="checkbox"/> Sb	<input type="checkbox"/> As	<input type="checkbox"/> As	<input type="checkbox"/> Ba	<input type="checkbox"/> Ba	<input type="checkbox"/> Be	<input type="checkbox"/> Be	<input type="checkbox"/> B	<input type="checkbox"/> B	<input type="checkbox"/> Cd	<input type="checkbox"/> Cd	<input type="checkbox"/> Ca	<input type="checkbox"/> Ca	<input type="checkbox"/> Cr	<input type="checkbox"/> Cr	<input type="checkbox"/> Cu	<input type="checkbox"/> Cu	<input type="checkbox"/> Hg	<input type="checkbox"/> Hg	<input type="checkbox"/> Pb	<input type="checkbox"/> Pb	<input type="checkbox"/> Mg	<input type="checkbox"/> Mg	<input type="checkbox"/> Mn	<input type="checkbox"/> Mn	<input type="checkbox"/> Ni	<input type="checkbox"/> Ni	<input type="checkbox"/> Se	<input type="checkbox"/> Se	<input type="checkbox"/> Ag	<input type="checkbox"/> Ag	<input type="checkbox"/> Na	<input type="checkbox"/> Na	<input type="checkbox"/> Ti	<input type="checkbox"/> Ti	<input type="checkbox"/> U	<input type="checkbox"/> U	<input type="checkbox"/> Vn	<input type="checkbox"/> Vn	<input type="checkbox"/> Zn	<input type="checkbox"/> Zn	<input type="checkbox"/> Fe	<input type="checkbox"/> Fe	<input type="checkbox"/> Mo	<input type="checkbox"/> Mo
Total Dissolved Field Filtered	Total Recoverable with Acid Digestion																																																										
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Lab Comments <div style="display: flex; justify-content: space-between;"> <div>Relinquished By: _____</div> <div>Date/Time: _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Received By: _____</div> <div>Date/Time: _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Relinquished By: _____</div> <div>Date/Time: _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Received By: _____</div> <div>Date/Time: _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Relinquished By: _____</div> <div>Date/Time: _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Received By: _____</div> <div>Date/Time: _____</div> </div>																																																											
Sample Temp (C)		Date / Time Received				Lab #																																																					

Table A-6. SD DENR WPP Equipment Data Sheet

Date: _____

Project: _____

Coordinator: _____

Project Officer: _____, **Phone:** _____

[illegible]

Signature: _____, Date: _____

SD DENR WPP In-lake Sampling Field Data Collection Sheet

Sampler(s) _____ Date _____ Time _____

Total Depth Site A: _____(m)
 _____(ft)

Total Depth Site B: _____(m)
 _____(ft)

Total Depth Site C: _____(m)
 _____(ft)

[illegible]

Surface Temp. _____	Surface Temp. _____	Surface Temp. _____
Bottom Temp. _____	Bottom Temp. _____	Bottom Temp. _____
Surface DO _____	Surface DO _____	Surface DO _____
Bottom DO _____	Bottom DO _____	Bottom DO _____
Surface pH _____	Surface pH _____	Surface pH _____
Bottom pH _____	Bottom pH _____	Bottom pH _____
Surface Sp. Cond _____	Surface Sp. Cond _____	Surface Sp. Cond _____
Bottom Sp. Cond _____	Bottom Sp. Cond _____	Bottom Sp. Cond _____

Average Depth _____ (m)	Average Secchi Depth _____ (m)
Average Surface Temp. _____ (°C)	Average Bottom Temp. _____ (°C)
Average Surface DO _____ (mg/L)	Average Bottom DO _____ (mg/L)
Average Surface pH _____ (s.u.)	Average Bottom pH _____ (s.u.)
Average Surface Sp. Conductivity _____ (µS/cm)	Average Bottom Sp. Conductivity _____ (µS/cm)

A-13

Table A-7.1. South Dakota DENR WPP In-lake Sampling Field Data Collection Sheet

Lake Name _____ **Lake ID** _____

Sampler(s) _____ **Date** _____ **Time** _____

Lake Profile (continued)

[illegible]

Notes:

Table A-8. SD DENR WPP YSI Calibration Instructions

****Always calibrate specific conductivity first, pH second, dissolved oxygen third, and Depth last****

Specific Conductivity

1. Pre-rinse the calibration cup and sensors with a small amount of the calibration standard or rinse standard and discard.
2. Insure that the conductivity sensor is completely submerged in standard. It is important not to have trapped bubbles in the cells. Gently shake the sonde to help dislodge any air bubbles that may be trapped in the conductivity sensor.
3. Select “Specific Conductivity” from the calibration menu, then enter the specific conductivity value of the calibration standard (i.e., 1.412 mS/cm not ~~1412~~ μ S/cm).
4. Wait for probe to stabilize, then select “calibrate”. Record before and after calibration values on the WPP Calibration Datasheet.
5. If the sonde reports “Out of Range” after the calibration, investigate the cause! Never override a calibration error message without knowing the reason. Typical causes for this error message are incorrect entries (entering 1000 μ S/cm instead of 1.0 mS/cm), dirty probe (Clean probe with small stiff-bristle brush), low solution level, air bubbles in the probes cell, calibrating in conductivity instead of specific conductivity, and/or bad standard.
6. After calibrating probe, highlight “continue” and press Enter. NEVER press the back button after calibrating, always select “continue”.

pH

1. Select “2-point” calibration method from the pH calibration menu.
2. Enter first pH value (usually pH 7) and press Enter. Wait for pH meter to stabilize, then select “calibrate”.
3. Record before and after pH values and pH MV value on calibration sheet, then select “continue”. NEVER press the back button after calibrating, always select “continue”.
4. Enter second pH value (usually pH 10) and press Enter. Wait for pH meter to stabilize, then select “calibrate”.
5. Record before and after pH values and PH MV value on calibration sheet, then select “continue”. NEVER press the back button after calibrating, always select “continue”.

Optical Dissolved Oxygen (ROX)

1. Dry the temperature sensor and the ROX membrane to remove any water droplets.
2. Put 1 inch of water in the calibration cup and thread onto the end cap $\frac{1}{2}$ thread. Do not fully thread the calibration cup onto the end cap!
3. Allow the sonde to sit in the calibration cup for 15 minutes to ensure that the air is 100% saturated and that the temperature is stable.
4. Select ODO% and enter the barometric pressure in mmHg (inches x 25.4) and press Enter. The sonde will do a 4 second count down and then say “Press Enter when the readings are stable”. Wait at least 30 seconds before you press the Enter button.

Depth

1. Select Pressure – Abs (non-vented). The depth sensor is factory calibrated, **but it is always necessary to zero the absolute sensor relative to the local barometric pressure**. The zeroing procedure should be carried out with the sonde in air for this initial calibration.

Alternatively, you may set zero or an offset while the sonde is submersed for “relative depth” applications. After the depth option is selected, enter 0.00 or other appropriate value in meters or feet (0.47 m or 1.54 ft for 600 series sondes, 0.35 m or 1.17 ft. for 6820 sondes, and 0.30 m or 1.00 ft. for the 6600 sondes depending on your Report Setup) at the prompt, press Enter and monitor the stabilization of the depth readings. After no changes occur for at least 30 seconds, press Enter to confirm the calibration. This zeroes the sensor with regard to current barometric pressure. As instructed, press Enter again to return to the Calibrate menu.

2. Zeroing the depth sensor by the above protocol (entering 0.00 at the screen prompt) will result in a measurement of the distance between the water surface and the ports of the depth module. In order for the observed depth readings to reflect the distance between the water surface and the actual probe array, measure the length between the upper hole and the bottom of the sonde guard. Then, if you are concerned about this small difference, enter the measured difference (0.30 m or 1.54 ft for 600 series sondes, 0.35 m or 1.17 ft. for 6820 sonde and 0.30 m or 1.00 ft. for the 6600 sonde depending on your Report Setup) at the screen prompt instead of 0.00.
3. For best performance of depth measurements, users should ensure that the sonde orientation remains constant while taking readings. This is especially important for vented level measurements and for sondes with side mounted pressure sensors.

Table A-9.

SD DENR WPP Field Samplers Audit Form

Sampler(s): _____; **Date:** _____; **Time:** _____

Task	Description	Compliance (Y, N, or NA)	Comment
1	Updated SOP on-hand and available		
2	Calibration Standards expired		
3	Laboratory or office calibration		
4	Calibration sheet completed properly		
5	Barometric pressure recorded on calibration sheet		
6	Re-calibration of DO at each site		
7	Random re-check of calibration throughout the day		
8	Flow meter calibrated if necessary		
9	Life vest (in water) or safety vest (on bridge) worn		
10	Flow measurements collected and recorded properly		
11	Flow data sheet filled out and flow calculated properly		
12	Sampling equipment available and in working order		
13	Appropriate project sample data sheets available		
14	Recorded YSI parameters properly and in correct units		
15	Sample parameters appropriate based on project PIP		
16	Bottles proper type (per SOPs)		
17	Bottle labels filled out correctly		
18	Bottles rinsed before sample collection (except bacteria and TDP)		
19	Water samples collected using proper technique/equipment		
20	QA/QC replicate/blank samples collected properly (if collected)		
21	Bottles preserved correctly		
22	Samples preserved in loose ice and in appropriate cooler(s)		
23	Made copies of sample data sheets and retained one in file		
24	Sample data sheets stored with samples and delivered to lab		
25	Filled out Project Logbook for the site or for the day		

Comments and overall review:

Corrective Actions:

Signatures:


Auditor: _____; **Sampler(s):** _____

Table A-9 (continued)

SD DENR WPP QA/QC Summary Table

Project						
Audits		# Corrective Actions				
Type	Date(s)					
Field						
Desk						
Sample Collection						
Sampling Site	Sample Parameters	Sample Design	Samples Collected	Completeness (%)		
Total						

Table A-10. SD DENR WPP Chain of Custody Record.



Department of Environment and Natural Resources
523 E Capitol, Pierre, SD 57501 • 605-773-3151

Chain of Custody Record

5/1/2011

DENR Program						Preservative Filtered (Y/N) Analyses Requested	For Lab Use Only					
Project ID							Sample Condition					
Agency Code							Sample Temperature					
Contact Name/Phone							Lab Comments					
Sampled by							Turnaround Requested Standard _____ Rush _____					
	Station ID	Sample Date	Sample Time	Medium	No. of bottles						Comments	Lab #
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Relinquished by (signature)	Company Name	Date/Time	Received by (signature)	Company Name	Date/Time

APPENDIX B

FlowTracker Beam Check Procedures

Table B-1. Diagnostic Software Procedure (BeamCheck).

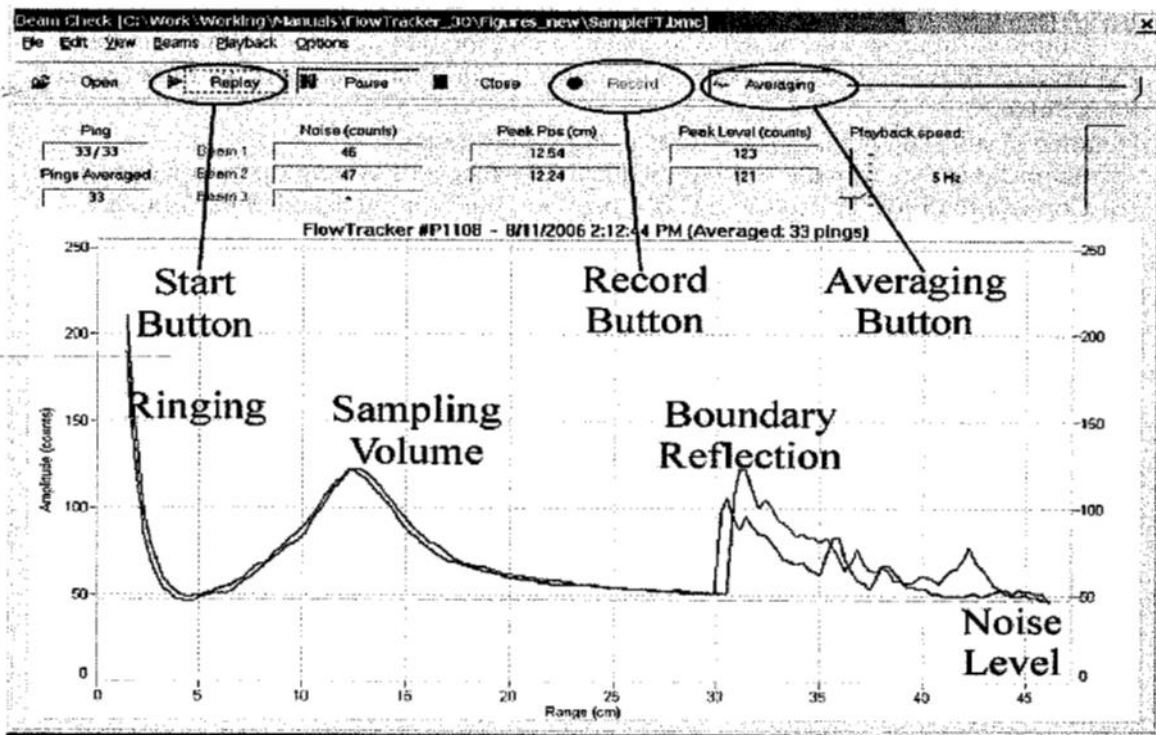
SonTek/YSI

4.1. Diagnostic Software (BeamCheck)

BeamCheck (Figure 1) is a diagnostic program that is used to verify FlowTracker performance. This is the same diagnostic program used at SonTek; it provides you with a powerful tool for understanding and verifying system performance. We recommend you become familiar with this software and use it on a regular basis.

To run *BeamCheck*:

- Hold the FlowTracker in a bucket of water (or a natural environment) such that the probe is submerged and there is a boundary (surface, side, or bottom) within view.
 - Ideally, the boundary should be placed 20-30 cm (8-12 in) from the probe.
 - You may need to add a small amount of fine dirt or other seeding material and stir the bucket well for good test conditions. Regular tap water usually does not have enough scatterers (seeding) for a valid test.
 - Connect the FlowTracker to the PC and turn the system on.
 - Run the *FlowTracker* software (click **Start | Programs | SonTek Software | FlowTracker**).
 - Click **Connect**.
 - Select **BeamCheck** on the left side of the screen; now:
 - Click **Start**.
 - Click **Record** to save all data to a file. Typically, a minimum of 20 pings is required for proper data analysis.
 - Click **Averaging** to average multiple pings together.
- (Figure 1) shows a sample output screen.



B-
Figure 1. BeamCheck Sample Output Screen.

In *BeamCheck*, the FlowTracker sends a pulse of sound and outputs the return signal strength for each receiver as a function of time. Features in the signal strength profile verify different aspects of system performance (Figure 1).

- The horizontal axis indicates the range from the FlowTracker probe (in cm).
- The vertical axis is in internal signal strength units called counts (1 count = 0.43 dB).
- *Ringing* from the transmit pulse appears on the left side of the graph.
- The location of the *sampling volume* is indicated by increased signal strength in a bell-shaped curve.
 - The sampling volume curve corresponds to the transmit pulse passing through the focal point of the receivers.
 - The peak of this curve corresponds to the center of the sampling volume.
 - The location of the sampling volume varies, but is typically 10-12 cm.
 - All receivers (2 or 3) should see the peak in the same location, although there will be variation in the height and shape of the curve.
- A sharp spike indicates a *boundary reflection* (if a boundary is within range).
 - If the probe is close to a boundary, a sharp reflection should be seen.
 - The size and shape of this reflection will vary depending on the nature of the boundary and its distance from the FlowTracker.
- Signal strength decreases to the electronic *noise level* past the boundary.

When using *BeamCheck*, it is important to understand that the output plot will vary considerably because of the nature of acoustic scattering.

- Each of the above items should be visible (Figure 1).
- If no sampling volume peak can be seen, try adding some fine dirt or other seeding material and stirring the water to increase the signal strength.
- If the *BeamCheck* output differs significantly from the sample shown here, refer to the *FlowTracker Technical Manual* for more details about interpreting this data.

Table B-2. Beam Check Menu and Control Items

<ul style="list-style-type: none"> • File Menu <ul style="list-style-type: none"> o Open – Opens a previously recorded beam check file (.bmc) for playback and review. o Record – Starts the data recording process if you wish to store the real-time information being displayed to a data file. You will be prompted for a file name and location. o Print – Sends the currently displayed graph to a selected printer. o Close – Closes the currently selected beam check file (.bmc), but not the main window. o Exit – Stops the beam check process and closes the Beam Check window. • Edit Menu <ul style="list-style-type: none"> o Copy – Sends the currently displayed graph to the Windows clipboard. You can then “paste” the graph in another program such as Microsoft Word. • View Menu <ul style="list-style-type: none"> o Amplitude – Sets the graph to display a representation of signal strength versus time. o Sine/Cosine – Not used. o Show range as X-Axis – Sets the X-axis of the graph to display signal strength data in meters rather than number of samples. o Show decay curve – Not used. • Beams Menu <ul style="list-style-type: none"> o Beam 1/2/3 – Lets you select which combination of beams to display. Beam 3 is disabled on 2-beam systems. o All beams – Displays data for all the beams. • Playback Menu <ul style="list-style-type: none"> o Start/Replay – Begins the process of displaying either real-time (Start) or previously recorded (Replay) data to the graph and tabular displays. o Pause – Toggles between either pausing or continuing the display of data. o Stop/Close – Ends the process of displaying real-time data or closes a file being replayed. • Options Menu <ul style="list-style-type: none"> o Averaging – Smooths the display of data by continually averaging successive pings. The number of pings that have been averaged is shown in the Pings Averaged box. By averaging the pings, a more representative display of the data is shown. o Force high-speed connection – Sets the computer-to-instrument interface to a higher baud rate so that data updates occur more quickly. The default for this feature is ON. You should only turn this feature OFF if you experience communication problems. • Controls (e.g., buttons, slide switches) <ul style="list-style-type: none"> o Open – Opens a previously recorded beam check file (.bmc) for playback and review. o Start / Replay – Begins the process of displaying either real-time (Start) or previously recorded data (Replay) to the graph and tabular displays. If no previously recorded data file has been opened, the button says Start; if a file has been opened, the button says Replay. o Pause – Toggles between either pausing or continuing the display of data. o Stop / Close – Ends the process of displaying data. If no previously recorded data file has been opened, the button says Stop. If a file has been opened, the button says Close, and will now function to both stop the display of data and to close the data file. o Record – Starts the data recording process if you wish to store the real-time information being displayed to a data file. You will be prompted for a file name and location. From that point on, the data that is being displayed will be recorded until you click Stop. o Averaging – Smooths the display of data by continually averaging successive pings. The number of pings that have been averaged is shown in the Pings Averaged box. By averaging the pings, a more representative display of the data is shown. o Ping Selector (slide control next to Averaging button) – Lets you select an individual “ping” to display. Click and drag the slider to select the desired ping number (shown in the Ping box). When used, the Averaging feature is disabled. o Playback Speed (slide control) – Lets you change the rate at which playback data is displayed. Click and drag the slider to the desired playback speed. Values in Hz display data faster than values in seconds. For example: a setting of 50 Hz will replay data at a rate of 50 pings per second, while a setting of 10 s will display a ping every 10 seconds. The default for this setting is 5 Hz (i.e., data replayed at a speed of 5 pings per second). o Zoom In/Out (mouse control) – To zoom-in on a particular area of the graphic display, use your mouse to click-and-drag a box around the desired area (see Figure B-1). You can also zoom-in just by clicking on a particular feature within the graph. To zoom-out, right click your mouse anywhere on the graph to step through the zoom-out levels. The click point will coincide with the center of the zoom.

Table B-3. Beam Check Display Features

- **BeamCheck Display Features**
This section describes BeamCheck display features (Figure 17).
 - O Ping – Indicates the number of the transmitted pulse (i.e., “ping”) that is currently being displayed on the graph and in the tabular data boxes. If real-time data is being displayed, only the current ping number is displayed. If previously recorded data is being displayed, both the current ping and the total number of recorded pings are displayed. For example, 3 / 27 means ping number 3 from a data set containing 27 pings is being displayed.
 - O Pings Averaged – When Averaging has been selected, this box indicates the number of pings that have been averaged together for the currently displayed graph and tabular data.
 - O Noise – Shows the electronics noise level for the receiver of each beam. This value is determined by the signal strength when the instrument is not receiving any return reflections from the water. This value should match the signal strength for the flat portion of the graph. The noise value is displayed in “counts”.
 - O Peak Pos – This is the location of the center of the peak for the sampling volume for each of the receivers. The displayed value can be in either centimeters (cm) or counts, depending on the setting of the Show range as X-Axis option. The position of the peak should be about the same for each receiver.
 - O Peak Level – This is the height of the peak for the sampling volume for each of the receivers. This will vary depending on the amount of scattering material in the water.
 - O Graph Title – A title bar appears within the graph itself (Figure B-1). This title bar shows the type of instrument (e.g., ADV, FlowTracker), its serial number, and the date/time that data collection began. Time is displayed in the format set within the Windows Control Panel (Start|Settings|Control Panel|Regional Options|Time).
 - O Graph Range/Samples (X-axis) – The graph itself shows a plot of the return signal strength for each beam as a function of time following the transmit pulse. The “time” portion is shown along the graph’s X-axis. This value can be shown as a function of range (in meters) or as a function of samples depending on the setting of the Show range as X-Axis option.
 - O Graph Amplitude (Y-axis) – The graph itself shows a plot of the return signal strength for each beam as a function of time following the transmit pulse. The “signal strength” portion is shown along the graph’s Y-axis. This value is shown in “counts”.

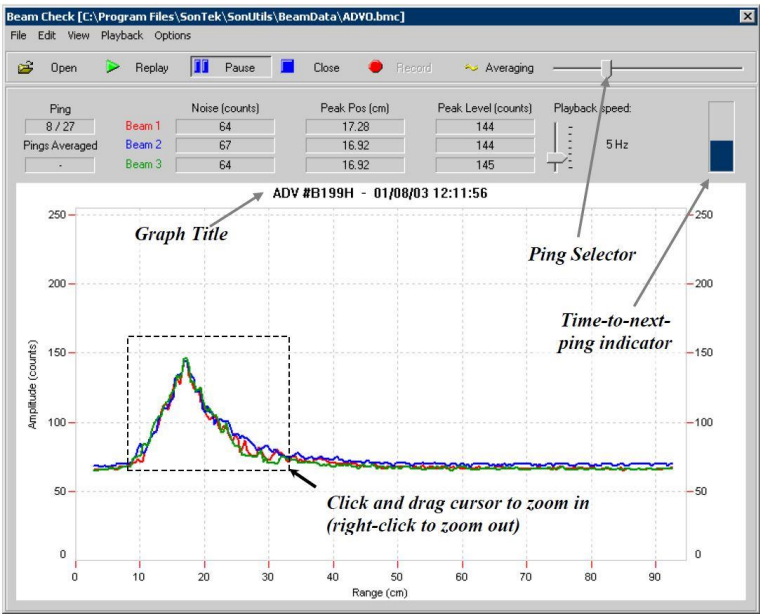


Figure B-1 Beam Check Display Features

Table B-4. Sample Program Output

- Sample Program Output
BeamCheck operates in the following manner.
 - The FlowTracker transmits a pulse of sound. It then receives the return signal strength for each of the 2 (or 3) receivers as a function of time following the transmit pulse.
 - Features in the return signal strength profile are used to verify different aspects of system performance.
 - The software also plots sine and cosine channel versus time for each receiver. These are used for internal diagnostics at SonTek and are not needed for user diagnostics. The sine and cosine outputs are not discussed in this manual. The plot of signal strength versus time shows several features (Figure B-2):
 - Ringing from the transmit pulse.
 - Increased signal strength in a bell-shaped curve corresponding to the sampling volume.
 - A sharp spike from the boundary reflection, if within range.
 - Signal strength leveling to the electronic noise level past the boundary.
 - The display is updated every ≈ 5 seconds (each plot is the average of a number of samples).
 - The horizontal axis is in FlowTracker timing units; time corresponds to the distance from the transmitter. One count axis equals 0.06 cm (0.15 in).
 - The vertical axis is in internal signal strength units called counts (1 count = 0.43 dB). Each feature of the BeamCheck signal strength plot is described in detail below.

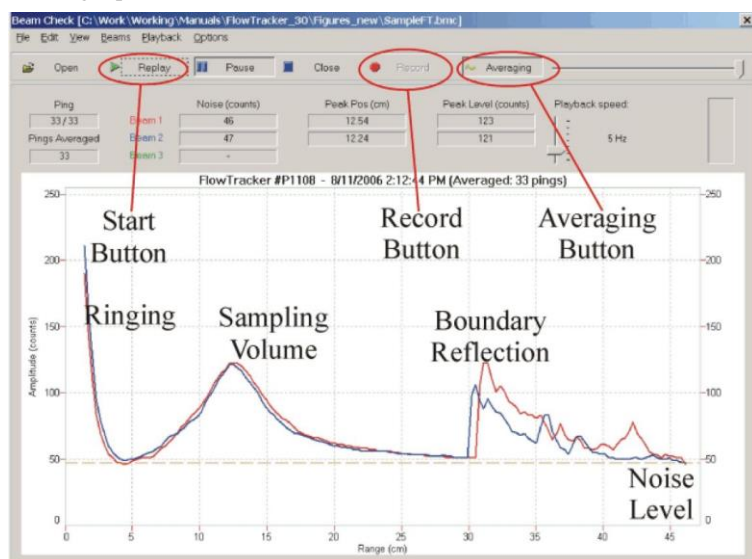


Figure B-2 BeamCheck Sample Output Screen

- The first ≈ 5 cm of the horizontal axis is electronic “ringing” following the transmit pulse. The transmit pulse is generated by a strong electrical signal, and requires some time for the electronics and transducers to recover.
- If there is sufficient scattering material in the water, there will be an increase in signal strength in a bell-shaped curve that corresponds to the transmit pulse passing through the focal point of the receivers. The peak of this curve corresponds to the center of the sampling volume. The location of the center of the sampling volume varies from probe to probe but typically is in the range of 10-12 cm. All receivers (2 or 3) should see the peak in the same location, although there will be variation in the height and shape of the curve.
- If the probe is close to a boundary (bottom, surface, or side), a sharp reflection should be seen. The size and shape of this reflection will vary depending on the nature of the boundary, its distance from the FlowTracker, and the acoustic conditions of the water. We can estimate the distance from the probe to the boundary by the location of the boundary reflection. In Figure B-2, this occurs at about 30 cm from the probe.
- After the boundary reflection, the signal strength flattens out in the region where there is no reflected signal from the water. The value at which it flattens out is the electronics noise level. This noise level is typically about 30-70 counts; it is also shown in the tabular display at the top of the screen. An easy way to measure the instrument noise level is to run BeamCheck when the probe is not in the water. In this case, the entire plot should show a constant return at the instrument’s noise level.
- When using BeamCheck, it is important to understand that the output plot will vary considerably because of the nature of acoustic scattering. The shape and height of the return signal, particularly the bell curve for the sampling volume, will show considerable variation between updates. When using the program for diagnostics, look at the general shape of the curve and for features that are consistently present.

Table B-5. Diagnosing Hardware with Beam Check

- Diagnosing Hardware Programs with Beam Check
Beam Check can be used to detect most problems that can occur with a FlowTracker. This section describes the program output for some possible situations.

Low Scattering Strength (Figure B-3)

If there is insufficient scattering material (e.g., very clear water), the sampling volume peak will be small or non-existent. This situation can be confused with a malfunctioning transmitter (see Figure B-4) unless the boundary is in view. Note that in Figure B-3 we clearly see the boundary reflection at ≈ 23 cm, but do not see a sampling volume peak around 10 cm. In this situation, place a small amount of seeding material in the water to act as scattering material (fine dirt or clay will work quite well).

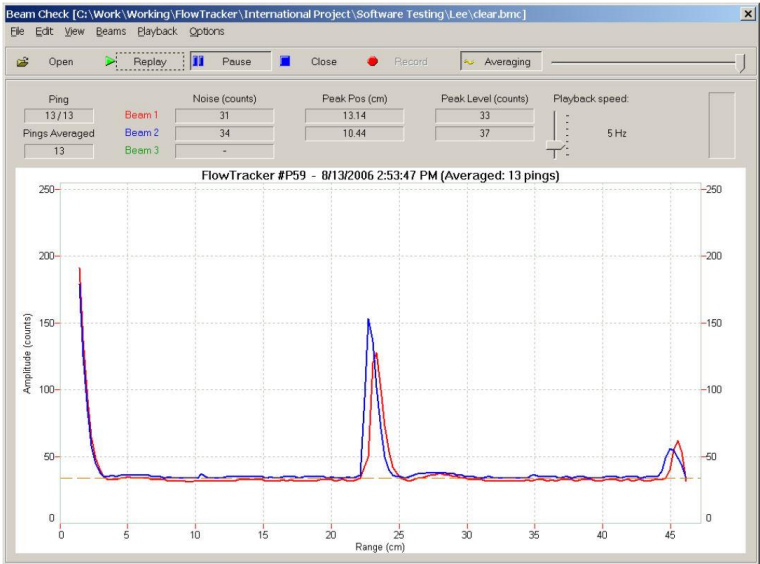


Figure B-3 BeamCheck Output with Low Scattering Strength

Malfunctioning transmitter (Figure B-4)

This appears as a flat response with signal strength at the normal noise level. This can be confused with a disconnected probe or low scattering levels (see Figure B-3). Note the absence of a boundary reflection to distinguish this from low scattering levels.

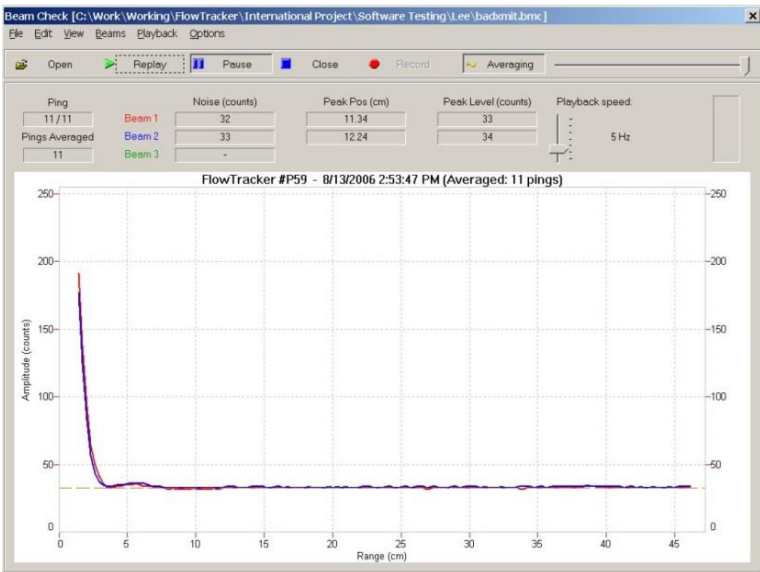


Figure B-4 BeamCheck Output with Malfunctioning Transmitter

Table B-5. (continued) Diagnosing Hardware with Beam Check

Malfunctioning receiver(s) (Figure B-5)

The signal from each receiver should have approximately the same strength as the sampling volume. If the differences exceed 10-20 counts, clean off the each transducer and make sure the beams are not physically blocked before calling SonTek. Damaged receiver arm (no Figure provided) If the sampling volume in one receiver is offset along the horizontal axis, it means the receiver arm has been physically bent. A bent arm will change the FlowTracker calibration and will affect the accuracy of velocity data. Contact SonTek if you have a damaged probe for details about repair options.

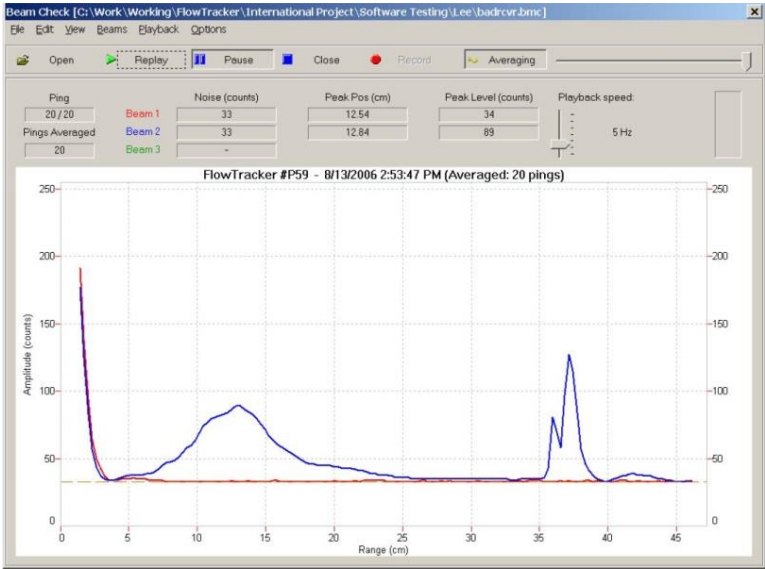


Figure B-5 BeamCheck Output with Malfunctioning Receiver

Excessive noise (Figure B-6)

If the electronics noise level is more than 10 counts above its normal level, it may be a sign that something is wrong. Likewise, if the noise level between beams is significantly different (as in Figure B-6), this may indicate a system problem. The noise level may also be higher than normal because of external electromagnetic interference, or because water has condensed on the receiver electronics.

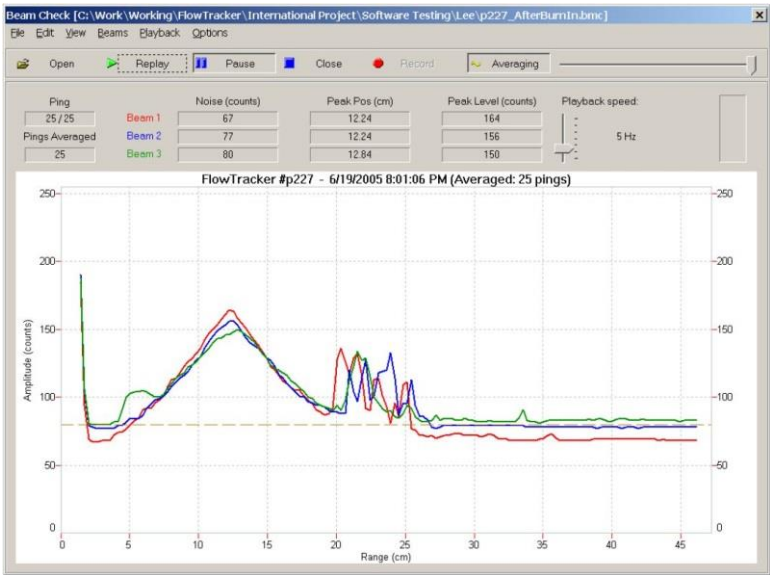


Figure B-6 BeamCheck Output with Excessive Noise

Table B-5. (continued) Diagnosing Hardware with Beam Check

High signal strength past the boundary (Figure B-7)
If the signal strength does not fall off rapidly past the boundary, the additional acoustic noise can potentially increase the noise in velocity measurements. This additional acoustic noise is most commonly seen in small tanks, particularly when built from acrylic or glass. While it may occur during testing in the office or laboratory, it is rarely a factor during field operations with the FlowTracker.

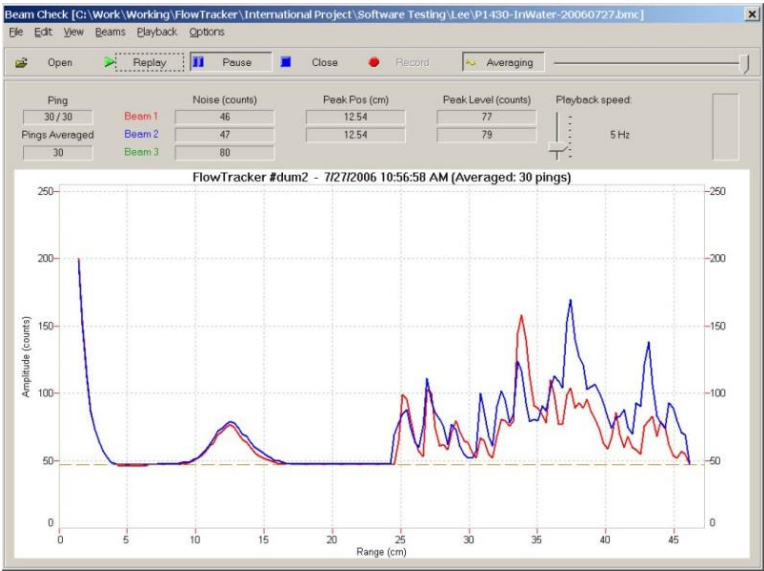


Figure B-7 – BeamCheck Output with Noise Past Boundary



