STANDARD OPERATING PROCEDURE FOR CALIBRATION, MAINTENANCE, AND USE OF HYDROLAB MULTIPROBES

GSL IMPOUNDED WETLANDS 2012 MONITORING ACTIVITIES

State of Utah
Department of Environmental Quality
Division of Water Quality

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Utah Division of Water Quality (DWQ) Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical experts. The primary purpose of this document is for internal DWQ use. This SOP should not replace any official published methods.

Any reference within this document to specific equipment, manufacturers, or supplies is only for descriptive purposes and does not constitute an endorsement of a particular product or service by the author or by DWQ. Additionally, any distribution of this SOP does not constitute an endorsement of a particular procedure or method.

Although DWQ will follow this SOP in most instances, there may be instances in which DWQ will use an alternative methodology, procedure, or process.

REVISION PAGE

Date	Revision #	Summary of Changes	Sections	Other Comments
9/9/2011	1	not applicable	not applicable	Put into new standardized format, began document control/revision tracking

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1.0 SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the calibration, use, and maintenance of Hydrolab MiniSonde® water quality multiprobes (Hydrolabs or multiprobes) during water sample collection. Reliable water quality field readings are an essential part of any water quality monitoring program. Field readings are typically measurements of current water quality conditions at the time of water sample collection. If deployed for longer periods, Hydrolabs can be used to record temporal changes in water quality. In addition, the Hydrolab Surveyor allows other field information (such as weather and flow conditions at the time of sampling) to be recorded electronically.

This SOP applies to any DWQ personnel, non-DWQ cooperator, or volunteer using a Hydrolab multiprobe for water quality sampling. Hydrolab multiprobe use during lake sampling is included in a separate SOP (see DWQ's SOP for Lake Hydrolab Data Collection) and describes how DWQ uses Hydrolabs for depth profiling and to determine sample locations within the lake water column. Procedures for the use of other types of multiprobes such as YSI's or In Situ Trolls are discussed in separate DWQ SOPs.

The information discussed in this SOP is not a substitute for Hydrolab user manuals or other technical documentation. Consult the appropriate manual for a complete guide to the proper use, calibration, maintenance, storage, deployment, and troubleshooting of Hydrolab instruments. This SOP is to be used as a reference but the complete user manual should always accompany the multiprobe operator.

Additional helpful references for multiprobe instrument use:

- *General multiprobe use* - United States Geological Survey's Field Manual (Gibs et al. 2007)

- *Long-term deployment of multiprobes* – USGS technical guidance (Wagner et al. 2006)

DWQ utilizes the following Hydrolab equipment models:

Sondes: MiniSonde 4a ,MS5 and Hydrotech

Surveyors: Surveyor 4

2.0 SUMMARY OF METHOD

Hydrolab multiprobes are calibrated at least once daily during use, unless being used for longer-term deployment applications. Hydrolabs are maintained according to a regular maintenance schedule. Hydrolabs are used by DWQ to simultaneously measure pH (standard units), dissolved oxygen (D.O.) concentration (mg/L), dissolved

oxygen (D.O.) percent saturation (% sat), specific conductance (µs/cm), and temperature. Readings are recorded on "Trip Sheets" or other field data sheets and also stored electronically on the instrument, downloaded to DWQ's server and then uploaded to DWQ's database after a monitoring trip is completed.

3.0 DEFINITIONS

Annotation: A series of numbers stored on the Hydrolab surveyor that identifies the Storet number of the site, project code, type of water being sampled, sampling organization, weather conditions, site conditions, etc.

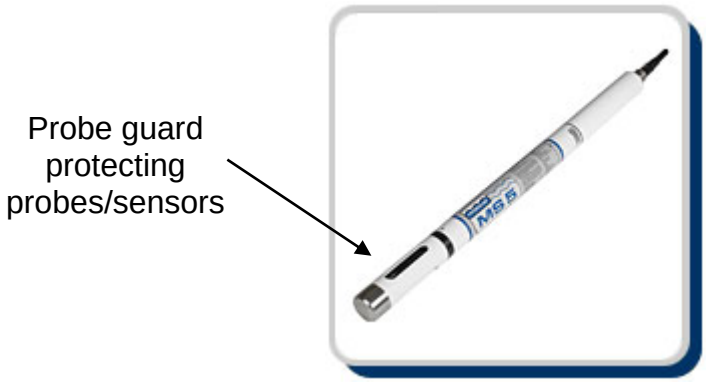
Calibration: Checking or adjusting (by comparison with a standard of known value) the accuracy of a measuring instrument; calibration errors lead to inaccurate results and measurement bias

Deployment: Refers to long-term unattended monitoring of water quality parameters using the multiprobe to log data at programmed intervals

Hydrolab: A type of multiprobe instrument that measures in-situ water quality parameters such as dissolved oxygen, pH, specific conductance, depth, and temperature.

Multiprobe: A multiparameter instrument combing several sensors on one piece of equipment, enabling simultaneous collection of several water quality parameters in the field. Measurements may be instantaneous or logged over time.

Sonde: The portion of the Hydrolab housing the sensors and placed into the water.



Surveyor: The electronic data storage portion of the Hydrolab equipped with a screen and arrow buttons. It is attached to the sonde by a cord and is fully detachable. All annotations entered and data collected are

stored within the surveyor. DWQ's Hydrolabs are equipped with the Surveyor 4 model.

4.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware that hazardous conditions potentially exist at every waterbody. If unfavorable conditions are present at the time of sampling, it is recommended that the sampling be rescheduled. If hazardous conditions arise during sampling, such as lightning, high winds, rising water, or flash flood warning, personnel should cease sampling and move to a safe location.

Always use caution when operating a multiprobe from a bridge or boat and take appropriate actions to make the situation as safe as possible; suspend the sampling if conditions are unsafe.

Wear gloves or be sure to wash hands after sampling, especially when sampling wastewater discharges or ponds, lagoons, or other potentially contaminated sampling points at regulated facilities.

An electrical shock hazard exists if the Hydrolab is used in a wet or outdoor environment while powered via the external 115 VAC power supply. During field use, operate using battery power only. If it is necessary to power the Hydrolab with the 115 VAC power supply in wet/outdoor conditions, a Ground Fault Interrupt (GFI) circuit is required (installation must be performed by a licensed electrician).

Use caution if a sensor is broken during use – exposed parts may include sharp and broken glass and wires.

When loosening removable parts from a multiprobe, point the instrument away from your body and other people. Pressure may build up under the removable parts, causing them to disengage with force, potentially causing bodily harm.

Take care during battery replacement to not mix depleted and fresh batteries, make sure batteries are installed in the correct orientation, and remove the thumbscrew to

access the battery compartment slowly and carefully – failure to do so may result in bodily harm and/or damage to the instrument.

Avoid skin contact and inhalation of potentially hazardous solutions used for equipment cleaning such as isopropyl alcohol.

5.0 CAUTIONS

The instructions in this SOP and in the applicable Hydrolab user manual must be followed by all field personnel to avoid damage or loss of expensive equipment.

Use the supplied sensor guard to protect the sensors on the sonde during use. Failure to cover the sensors with the sensor guard could result in irreparable damage to the sensors.

Always store the sonde properly: Between sampling sites, fill the plastic cap covering the sensors with a very small amount of tap water or pH 4 buffer (no more than ½ inch) to keep the sensors moist. If stored improperly for short periods of time (between sampling sites), the Hydrolab may give inaccurate readings. If stored improperly for long periods of time (the sensors are allowed to dry out completely), the sensors may be irreparably damaged. See **Section 9.4.2** for detailed storage instructions.

Use caution when suspending the Hydrolab from a bridge; be observant of debris coming from upstream that may damage the sonde or become entangled in the cable.

Take care when storing the Hydrolab in the field vehicle to ensure it is safe from breakage during transport.

Water can get trapped between the multiprobe battery cap contact surface and the top of the multiprobe battery compartment o-rings. To avoid water leaks into the multiprobe battery compartment during maintenance or replacement, place the multiprobe horizontally on the work surface when removing the battery cap. To avoid water contact with multiprobe internal components during battery replacement, avoid replacing the batteries close to a water source. If water leaks into the multiprobe battery compartment, remove the batteries, pour the water out, and thoroughly dry the compartment with a hair dryer (on low heat) or a towel. Once dry, install new batteries.

It is recommended that the Hydrolab not be exposed to extreme temperatures below 1°C or above 50°C.

6.0 INTERFERENCES

The Hydrolab must be properly calibrated to ensure accurate results.

Inaccurate readings may result if the Hydrolab is lowered into bottom sediments versus the water column/open water. Also, collect readings after any disturbed sediments have

been cleared by the current. When sampling wetlands or other slow-flowing or non-flowing water bodies, it is essential to avoid sediment stirred up from wading to the sampling point to ensure an accurate reading of field parameters. Alternatively, lower the sonde from a boat in these situations.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Field personnel are required to read this SOP annually and acknowledge they have done so via a signature page (see **Appendix 1**) that will be kept on-file at DWQ along with the official hard copy of this SOP.

Personnel collecting field readings must be familiar with Hydrolab calibration and use, safety procedures, proper handling, and record keeping. Monitors are responsible for attending refresher meetings held each spring to review calibration procedures and use. New staff will be trained in the field by experienced personnel.

The procedures discussed in this SOP can change over time as a result of the technological changes being implemented; such information generally is available from the manufacturer, either online or in an updated user manual or other technical guidance document. Monitors operating Hydrolabs must stay current as to how their instrument operates and is maintained.

8.0 EQUIPMENT AND SUPPLIES

____Copy of this SOP
____Site portfolio
____Copy of project-specific SAP
____Hydrolab Sonde Calibration sheet (see **Appendix 2**)
____Field sheets/field notebook
____Water-proof pens/markers
____Maps
____GPS unit
____Camera
____Hydrolab case
____Hydrolab MiniSonde and Surveyor with cable of appropriate length
____Surveyor power charger
____Extra batteries for sonde
____Another Hydrolab Minisonde to be used as a back-up
____Maintenance tool kit
____Hydrolab MiniSonde calibration cup and cap
____Hydrolab MiniSonde sensor guard
____Tap water
____DI (deionized) water (carboys, half-gallon jugs, and squeeze bottles)
____pH calibration standard solution (also called buffer) at pH 7 and 10, temperature correction chart and expiration date for buffers, if not printed on the bottle

____pH SRM (Standard Reference Material) or other certified pH standard to check calibration
____Conductivity calibration standard solution (2 values) near or bracketing expected value of water to be sampled
____Aquarium air pump with a bubbler stone
____Container of tap water at room temperature
____Lint-free cloth (such as Kimwipes)
____Cooler
____Ice
____Safety gear
____Chest waders with belt or hip boots

9.0 PROCEDURE

9.1 Pre-Sampling Trip Preparation

1) Review the project-specific SAP to confirm the sampling locations and the targeted sampling conditions.

2) Coordinate with other monitors to make sure equipment is available for use.

3) Charge the Surveyor for at least overnight or over the weekend before the day/week it is to be used. On longer sampling trips, the Surveyor should be charged each night before use the next day.

4) Check the battery life of the sonde to be used and replace batteries if needed.

5) Obtain any necessary permission for site access.

9.2 Calibration

In order to ensure reliability of readings, the instruments are calibrated each morning prior to sampling and at any time during the day following a reading that may be unusual or exceeding physical standards set forth in R317-2 Standards of Quality for Waters of the State (Table 2.14.2).

Ideally, choose calibration standards that are close to or bracket values expected in the field. To ensure accuracy, discard used calibration standard after use; do not reuse calibration standards.

The MiniSonde 4a and MS5 multiprobes used by DWQ have a variety of sensor configurations for the parameters being measured; however the same calibration principles apply to all like sensors. In addition, the sondes can be used interchangeably with different Surveyor models and other handheld devices.

Buffers should be protected against wide temperature variations, whether in transit, during use, or in storage. The values of buffers that experience extreme heat or freezing temperatures can no longer be assumed to be valid. Discard compromised buffer solutions appropriately and notify the DWQ monitor responsible for purchasing new buffer solutions. Store buffer solutions in coolers while in the field to protect them from extreme heat or cold, if necessary.

If possible, calibrate with buffer solutions similar to the temperature of the water to be sampled. This ensures the most accurate results. For specific conductance, do not equilibrate the temperature of the conductivity standards to that of the water to be sampled if that water temperature is < 6°C or > 40°C. At these temperatures, specific conductance changes significantly as a function of temperature.

Never insert a sensor into a buffer stock solution bottle during calibration; pour the buffer solution off into a separate container before calibration.

Before calibration, inspect the sensors and perform any necessary cleaning.

Because pH buffer solutions typically have conductivities higher than conductivity standards or environmental waters, the following calibration order is recommended:

9.2.1 Temperature

The temperature sensor is factory-calibrated and no adjustment is necessary but accuracy can be checked with a NIST (National Institute of Standards and Technology) certified thermometer, if inaccurate readings are suspected.

9.2.2 Specific Conductance

For specific conductance, the conductivity sensor requires a 2-point calibration. These points may be “0” and another standard value (as described below and recommended by the manufacturer). Alternatively, use 2 standard values for calibration and perform the “0” as a check that the sensor is functioning properly. Ideally choose calibration standard values that are near to or bracket the expected environmental values.

1) Turn on the Surveyor and allow it to warm up.

2) First prepare the conductivity cell for “zeroing” by rinsing the probe thoroughly with DI water and using lint-free paper towel (such as a Kimwipe) to gently dry both the inside and outside of the conductivity cell.

3) On the Surveyor main screen press the “Setup/Cal” key.

4) Press the “Calibrate” key.

5) Press the “Sonde” key (you are now in the calibration submenu).

6) Move the cursor to “SpSond : µS/cm” and press “Select”.

7) Use the cursor to enter 0 in the units box.

8) Press “done”.

9) You should get the “Calibration Successful” message, if not see **Section 9.5**.

10) Next screw the calibration cup on.

11) Rinse the sensors 3 times with a small amount of the conductivity standard.

12) Hold the sonde vertical (or secure with a ring-stand) with the sensors pointing up; keep the calibration cup on but remove the cap.

13) Fill the calibration cup with the conductivity standard solution – at least enough to fill the conductivity cell and cover the temperature sensor. Tap the calibration cup gently to dislodge any bubbles trapped in the conductivity cell.

14) Allow the reading to stabilize and record the current value on the display into the appropriate space on the calibration sheet.

15) Follow steps 3 through 6.

16) Use the cursor to enter the value of the conductivity standard from the bottle into the units box.

17) Press “done”.

18) You should receive a “Calibration Successful” message, if not see **Section 9.6**.

19) Press the “Go Back” key 2 times to see the results of the calibration.

20) Record the current value on the display into the appropriate space on the calibration sheet.

21) Empty the calibration cup.

22) Use a different conductivity standard solution as a check and record the value the sonde reads into the appropriate space on the calibration sheet. The “check” conductivity solution should measure within 5% of the expected value. If sampling involves compliance or potential legal issues, use a certified SRM for this check and record the results appropriately on the calibration sheet. If the “check” buffer or SRM does not fall within the 5% criteria limits, recalibrate for specific conductance. If after testing or replacing the buffers, acceptable calibration cannot be achieved, maintenance or repair of the instrument may be required.

9.2.3 pH

In most cases, pH 7 and pH 10 buffers will be acceptable. If a low pH is expected in the field, calibrate with pH 4 and pH 7. Always start calibration with the pH 7 buffer. During calibration, fill out the Hydrolab Sonde Calibration sheet completely and accurately.

1) Turn on the Surveyor.

2) Remove the sensor guard and screw the calibration cup on.

3) Rinse the sensors 3 times with DI water.

4) Rinse the sensors 3 times with a small amount of the pH 7 buffer solution.

5) Hold the sonde vertical (or secure with a ring-stand) with the sensors pointing up; keep the calibration cup on but remove the cap.

6) Fill the calibration cup with the pH 7 buffer solution – at least enough to cover the pH sensor and the temperature sensor.

7) Allow the reading to stabilize and record the current value on the display into the appropriate space on the calibration sheet.

8) On the main Surveyor screen, press the “Setup/Cal” key.

9) Press the “Calibrate” key.

10) Press the “Sonde” key (you are now in the calibration submenu).

11) Move the cursor to “pH : Units” and press select.

12) Use the cursor to enter the value of the pH buffer from the bottle into the units box.

13) Press “done”.

14) You should receive a “Calibration Successful” message, if not see **Section 9.5**.

15) Press the “Go Back” key 2 times to see the results of the calibration.

16) Record the current value on the display into the appropriate space on the calibration sheet.

17) Empty the calibration cup.

18) Rinse the sensors 3 times with DI water and then follow steps 4 through 16 for the next pH buffer.

19) Empty the calibration cup.

20) Use a third pH buffer as a check and record the value the sonde reads into the appropriate space on the calibration sheet. The third "check" pH buffer should measure within 5% of the expected value. If sampling involves compliance or potential legal issues, use a certified SRM for this check and record the results appropriately on the calibration sheet. If the "check" buffer or SRM does not fall within the 5% criteria limits, recalibrate for pH. If after testing or replacing the buffers, acceptable calibration cannot be achieved, maintenance or repair of the instrument may be required.

9.2.4 Dissolved Oxygen

Clark Cell (pictured below, illustration from user manual)

This sensor can be calibrated using water-saturated air or a solution of known dissolved oxygen concentration (e.g. by Winkler titration). DWQ utilizes the water-saturated air method. Dissolved Oxygen (DO) calibration with the Clark Cell is accomplished by filling the calibration cup to the o-ring with water and calibrating to the local corrected Barometric Pressure (BP).

1) Turn on the Surveyor.

21) Remove the sensor guard and screw the calibration cup on.

2) Rinse the sensors 3 times with DI water.

3) Hold the sonde vertical (or secure with a ring-stand) with the sensors pointing up; keep the calibration cup on but remove the cap.

4) Fill the calibration cup with tap water until it is just level with the o-ring used to secure the DO membrane.

5) Carefully remove any water droplets from the DO membrane with the corner of a lint-free cloth (such as a Kimwipe).

6) Cover the calibration cup with the cap inverted. Allow the readings to stabilize. Do not screw the cap on as this will increase the pressure across the membrane yielding an inaccurate calibration result.

7) The sensor is ready for calibration when the readings on the display have stabilized.

8) Record the current value on the display into the appropriate space on the calibration sheet.

9) On the main screen press the “Setup/Cal” key.

10) Press the “Calibrate” key.

11) Press the “Sonde” key (you are now in the calibration submenu).

12) Move the cursor to “DO : %Sat” and press “Select”.

13) Use the cursor to type the BP reading from the Surveyor display. If the Surveyor you are using does not have BP the reading can be taken form another Surveyor with BP or from a local weather station or airport. True BP must be used for calibration. Record the BP on the calibration sheet as well. **Appendix 4** gives instructions for estimating Local BP if it is not available on a Surveyor.

14) Press “Done”.

15) You should get the “Calibration Successful” message, if not see **Section 9.6**.

16) Press the “Go Back” key 2 times to see the results of the calibration.

17) Record the current value on the display into the appropriate space on the calibration sheet.

LDO (pictured below, illustration from user manual)

This sensor is calibrated by immersing the probe into a container of tap water which has been saturated with air by an air pump with a bubbler stone and then calibrating to the local corrected BP.

1) Plug in the air pump upon arriving to the shop. Let the pump run while calibrating for specific conductance and pH. If the water container is low on water, refill it with water stored in the quart container sitting next to it on the counter. Be sure to refill the container used to store water with tap water. Water used for calibration needs to sit for at least 12 hours to allow the water temperature to stabilize to room temperature. *Changes in water temperature while calibrating will cause errors in the calibration results. If water temperature changes more than 0.5C during calibration, it is recommended to recalibrate the sensor.*

2) After the water is sufficiently aerated unplug the pump and submerse the probe into the container. If the pump is left on oversaturation will occur and cause errors in the calibration results.

3) In the field tap water can be air-saturated by filling a $^1/_2$ gallon container with tap water stabilized to the outside temperature and vigorously shaking it for 40 seconds.

Calibrate the probe in a shaded area so heating of the water from the sun does not affect the calibration results.

4) Immerse the probe in the container of water. Watch the LDO display on the Surveyor and proceed with calibration after the "% Sat" reading has stabilized.

5) On the main screen press the "Setup/Cal" key.

6) Press the "Calibrate" key.

7) Press the "Sonde" key (you are now in the calibration submenu).

8) Move the cursor to "DO : %Sat" and press "Select".

9) Use the cursor to type the BP reading from the Surveyor display. If the Surveyor you are using does not have BP the reading can be taken form another Surveyor with BP. Record the BP on the calibration sheet as well. **Appendix 4** gives instructions for estimating Local BP if it is not available on a Surveyor.

10) Press "Done".

11) You should get the "Calibration Successful" message, if not see **Section 9.6**.

12) Press the "Go Back" key 2 times to see the results of the calibration.

13) Record the current value on the display into the appropriate space on the calibration sheet.

9.3 Routine Field Use

- At the sampling site, remove the calibration cup, attach the sensor guard, and turn on the Surveyor to allow it to warm up.

- Set up the run file on the Surveyor: From the Series4Sonde>Files>Surveyor4 screen, move the cursor to Create and press the SELECT key. Enter the file name as the Trip ID.

- Annotate the site location and field conditions on the Surveyor: Refer to **Appendix 3** for detailed guidance.

- Position the sonde in the waterbody. The Hydrolab sonde may be positioned in the waterbody to be sampled using the following methods:

    - Wading into a flowing waterbody and positioning the sonde in the thalweg

    - Positioning the sonde in water along a bank/edge (preferably a location with good flow) if waterbody cannot be waded

- Lowering the sonde into a waterbody from a bridge or a boat

- Whatever method is chosen, be sure to use a cable of appropriate length, place the sonde in water that is well-mixed whenever possible, avoid laying the sonde in bottom sediments or between large rocks on stream bottoms, and allow the sonde to orient itself to the flow (sensors will face downstream in a flowing waterbody).

- While the readings stabilize, look over the water quality readings displayed on the Hydrolab to make sure they fall within acceptable limits. Recalibration of the Hydrolab may be needed if any parameters are exceeding. The following are a list of parameter exceedances:

    - Dissolved oxygen: Greater than 100% saturation

    - pH: Values less than 6.5 or greater than 9.0

    - Specific conductance: Values greater than 10 times or less than 1/10 the standard used for calibration

- Once the readings have been verified by the operator and all parameters have stabilized, select “Store” and choose the appropriate file to record the readings on the Surveyor.

- For notes on the field sheet (see Appendix 5) go to “Files”, “Surv 4”, select the files/ Trip ID, scroll to “Review”, select beginning, click the up arrow for the most recent stored data, and transcribe it on the field form.

- Be sure to safely store the Hydrolab in the field vehicle for transport between sites. Also, replace with sensor guard with a calibration cup containing a small amount (~10 milliliters is sufficient) field water, tap water, or pH 4 buffer to ensure sensors do not dry out between sites. Do not store the sensors in DI water between sites and do not allow any storage medium to freeze around the sensors.

9.4 Post-Sampling Trip Activities

9.4.1 Hydrolab Data Download

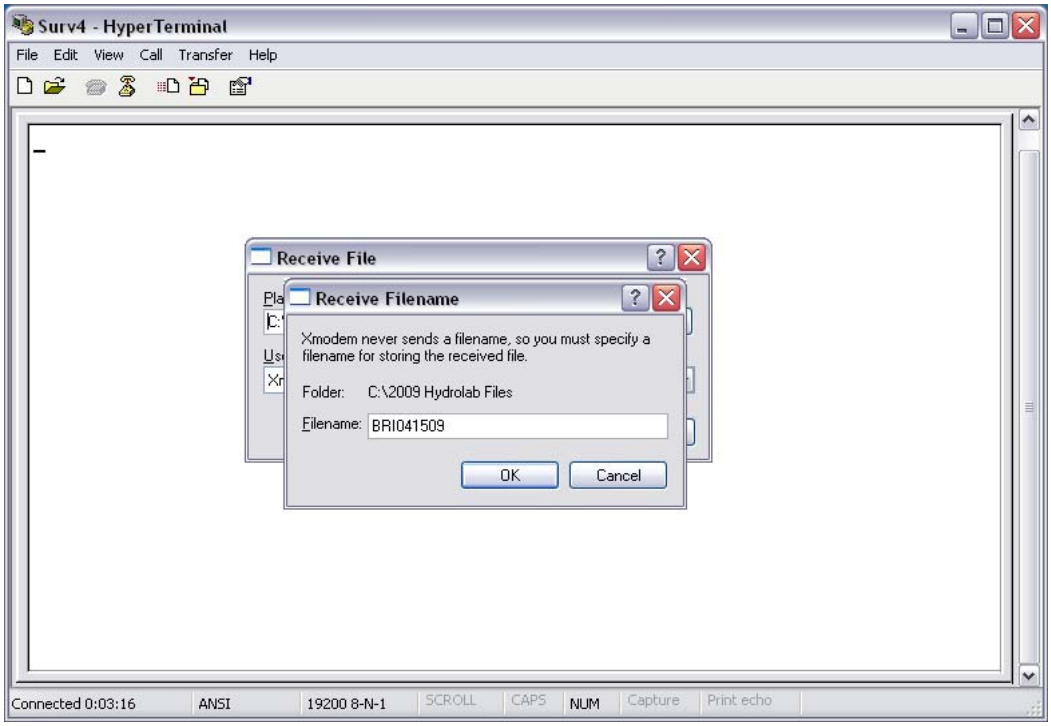
1) Connect the Surveyor to a computer with the serial cable.

2) Turn on both the computer and Surveyor.

3) On the Surveyor push the “File” button. On the “File” screen scroll down the list and select “Transmit”. On the “Transmit” screen highlight the run name used for the run and press “Select”. On the next screen scroll down and select “SS-

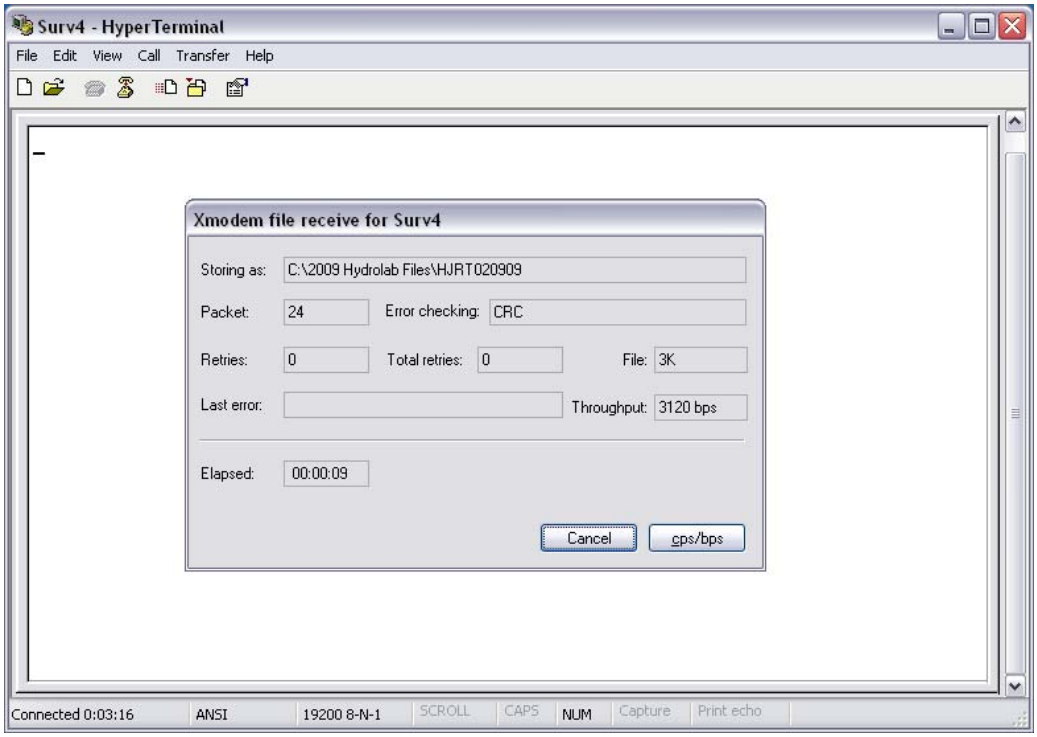
Importable" and press "Done". A screen will appear with a message that says "Press Any Key to Start". **Do not press a key yet until step 4 is completed and you are ready for step 5.**

4) On the Computer double click the "Shortcut to Surv4.ht" icon. This will open the Hyper Terminal program. Click on the "Transfer" menu and select "Receive" the "Receive File" window will open. Do not change any information and press "Receive". The "Receive Filename" window will open. Enter the run name you assigned to the run in the "Filename" box i.e. BRI041509 (see **figure below**). **Do not press OK yet; go to step 5 first.**



5) **This step is important.** When both of the above tasks 3 and 4 are done you must first push any button (except power button) on the Surveyor to start the transfer and immediately click OK on the "Filename" window to start the transfer. The "Xmodem file receive for Surv4" window will appear and the file will start the download.

6) Watch the "Xmodem file receive for Surv4" window and you should see the file being transferred by watching the "File" box and seeing the number of kilobytes downloaded increase (see **figure below**).

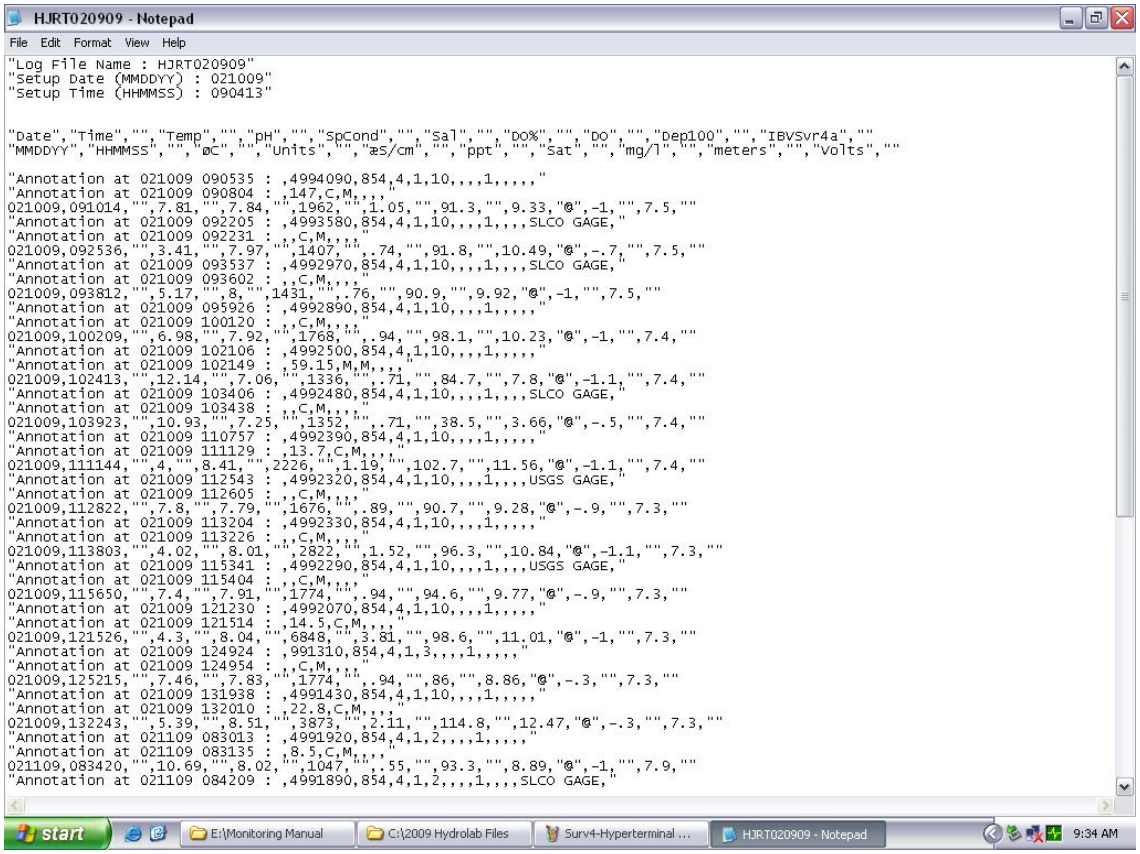


7) When the download is complete the windows will close. When this is done close the “Svur4 Hyper Terminal” program. On the bottom of the display the Surveyor will show “Transfer completed”, “Press any key…”.

8) Open the “Shortcut to 2009 Hydrolab Files” program and find the run you just downloaded. Right click on the file name and select “Note Pad’ to open the file. Check the file to make sure it downloaded correctly (see **figure below**). If yes, close out the “2009 Hydrolab Files” program.

9) When you are sure the file downloaded correctly delete the file from the Surveyor. Press any key on the Surveyor and then the “Back” button until you get to the “File” menu. Scroll and select “Delete” from the menu. Enter “1” on the menu and push done.

10) Turn off the Surveyor and shut down the computer. Plug the Surveyor into a charger to make sure it is fully charged for the next run.



9.4.2 Hydrolab Storage

Short Term Storage

- Short term storage is storage lasting only **one to three weeks**.

- Store the probes in a solution of 50% deionized water and 50% Storage Solution (4 molar KCl buffered to pH 4, purchased from HydroTech). Fill the storage cup with enough solution so that pH probe is covered with the solution when sitting on the shelf (at least one inch). Alternatively, use pH 4 buffer (recommended by the manufacturer) or tap water as storage solution. If the sonde has a low ionic strength pH reference sensor, fill the rubber cap with pH reference solution and slide it snugly over the sensor.

- Do not allow the storage solution to freeze around the sensors. Do not store the sensors in DI water or environmental water.

- When sonde is taken out of storage soak the probes the probes in tap water for approximately one half hour.

- After soaking in tap water the probes must be serviced again as per the maintenance schedule.

Long Term Storage

- Long term storage is storage lasting **one month or longer**.

- If the sonde has batteries in it used for long term deployment, remove the batteries during long term storage. Leave the lithium clock battery inside the sonde.

- Store the probes in 100% Storage Solution (4 molar KCl buffered to pH 4, purchased from HydroTech). Fill the storage cup with enough solution so that pH probe is covered with the solution when sitting on the shelf (at least one inch). Alternatively, pH 4 buffer (recommended by the manufacturer) or tap water as storage solution. If the sonde has a low ionic strength pH reference sensor, fill the rubber cap with pH reference solution and slide it snugly over the sensor.

- Do not allow the storage solution to freeze around the sensors. Do not store the sensors in DI water or environmental water.

- When sonde is taken out of storage soak the probes in tap water for approximately one half hour.

- After soaking in tap water the probes must be serviced again as per the maintenance schedule.

Cable Storage

- Store the cables in coils of at least 6" or larger. Never knot cables.

- Use the protective plugs when the cables are stored making sure the ends are well lubricated with silicone grease. **Do not use any other kind of grease.**

9.5 Troubleshooting

- If a Hydrolab needs repair or a replacement part contact appropriate DWQ staff to arrange the service.

- If the "Calibration Failed" message is displayed during sensor calibration, check that calibration standards are within expiration dates and have been stored properly. If problems with calibration standards are not suspected, attempt to recalibrate. If the calibration fails a second time, clean the sensor (see **Section 9.7**) and repeat the calibration. If calibration fails again, the sensor likely needs maintenance or repair. Refer to **Section 9.7**.

- If the Surveyor display shows a warning message, do not use the sensor until the error has been identified and corrected.

- Consult the Hydrolab user manual Appendix 6 for Troubleshooting assistance or contact the Hydrolab Technical Support and Service department at:

  Hach Hydromet *Technical Support & Service*
  P.O. Box 389
  Loveland, CO 80539

  Tel: 800-949-3766 opt. 2
  970-669-3050 opt. 2
  Fax: 970-461-3921
  E-Mail: techsupport@hachhydromet.com

See **Appendix 6** for a list of troubleshooting tips.

9.5.1 Schedule of Maintenance Activities

Maintenance schedules for DWQ's Hydrolabs are recorded on the Monitoring Section's GroupWise email-based calendar. More detailed cleaning and maintenance instructions for each sensor can be found in **Appendix 7**.

Weekly Maintenance Activities

Cleaning: Sondes should be cleaned off with soap and water. Clean the casting (white body) with a sponge and clean the sensors with an extra soft toothbrush and cotton swabs. Remove iron from circulator, if applicable. Clean calibration cups and sensor guards with soap and water.

Probe Maintenance:

- **DO** – Replace the DO membrane on Clark Cells. While the membrane is removed, carefully clean the interior copper by rubbing it with a pink eraser in a **clockwise** direction. Clean the outside of the probe with isopropyl alcohol and cotton swaps. For LDO, clean with soapy water and cotton swab; DO NOT USE ALCOHOL. For detailed instruction regarding membrane replacement, consult the user manual.

- **pH** – On Friday, after returning from a monitoring run, gently clean outside of sensor with isopropyl alcohol, and replace electrode solution with 4 molar KCL solution.

- **Other sensors** – Clean with soap, water, and cotton swab. Fill the calibration cup with a small amount of pH 4 buffer solution for storage.

NOTE: Wait 24 hours before calibrating sensors after changing DO membrane and pH solution.

Monthly Maintenance Activities (also perform the "Weekly" maintenance tasks)

- **DO** – Change DO solution.
- **pH** – Change the Teflon Reference Junction bi-monthly, on even months. Detailed instructions are included in the user manual.
- **Conductivity** – Use cotton swabs to clean between cells.
- **Circulators** – Remove pin from circulator and clean.

Miscellaneous – Soak sensors and sensor guards in vinegar for 20 minutes if hard water stains are present. Clean the outside of all sensors with isopropyl alcohol, except the LDO sensor which should be cleaned with soap only.

9.5.2 Repair

If a sonde, Surveyor, or sensor needs repair, report the issue to the DWQ monitor responsible for Hydrolab maintenance and repair.

10.0 DATA AND RECORDS MANAGEMENT

On the Hydrolab Sonde Calibration sheet note any problems that arose during calibration or in the field and whether it was resolved or not. If the problem cannot be resolved, the person responsible for Hydrolab maintenance is to be notified and the Hydrolab Sonde Calibration sheet with the problem noted on it given to them so they can conduct the repairs or have the unit sent off for repair if necessary.

Also note any equipment issues or purchasing needs in the field notes.

Downloaded Hydrolab files are to be saved into the "Monitors" folder in the DWQ shared drive (which is backed up routinely onto DEQ servers). Hydrolab files should be reviewed every 2 weeks by the monitor performing the file download. Once formatted and determined to be complete and accurate, the monitor will upload the Hydrolab data to water quality database staging area. The Database Manager performs and additional review prior to pushing the data into the database for permanent storage.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Hydrolabs must be calibrated before use and calibration must be documented as described in this SOP and other project-specific documentation.

Project-specific quality assurance and quality control requirements are described in project-specific Sampling and Analysis Plans (SAPs) and should be communicated to the field team by the Project Manager.

Representative water-quality data is to be collected, according to the sampling conditions required under the project-specific SAP. Multiprobe operators should not alter designated sampling locations or times unless otherwise directed by a project manager. If hydrologic conditions are significantly different from those targeted in the SAP, operators should contact the project manager for further instructions. Operators should record in field notes any site conditions that may lead to an unrepresentative field reading and should take site photographs to record these observations.

12.0 REFERENCES

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13.0 APPENDICES

Appendix 1 - SOP Acknowledgment and Training Form (front and back)

SOP Acknowledgement and Training Form

This SOP must be read and this form signed annually. This form must be kept with the current version of the SOP.

Document Title:	
Document Revision Number:	
Document Revision Date:	

Please sign below in accordance with the following statement: "I have read and understood the above referenced document. I agree to perform the procedures described in this SOP in accordance with the document until such time that it is superseded by a more recent approved revision."

Printed Name	Signature	Date

SOP Acknowledgement and Training Form (continued)

Trainee: Sign below to acknowledge that training on this SOP was received, understood, and all questions/concerns were addressed by the trainer.

Trainer: Sign below to acknowledge that training on this SOP was completed for the individual listed and that trainee is competent to perform the procedures described within.

Date of Training	Trainee Printed Name	Trainee Signature	Trainer Printed Name	Trainer Signature

Appendix 2 – Hydrolab Calibration Sheet

Utah Division of Water Quality
Monitoring Section

Hydrolab Sonde Calibration Report

Date/Time:_____ Analyst:_____ Location _____
Run:_____ Sonde Name:_____ Type:

pH

Calibration Point	Buffer Value	Pre-Cal. Reading	Post Cal. Reading	SRM	
4.00				Certified Value	Measured Value
7.00					
10.00					

pH Buffer Exp.Date: 7.00 _____ 10.00 _____

Specific Conductance

Calibration Point	Buffer Value	Pre-Cal. Reading	Post Cal. Reading	SRM	
! Calibration Standard Should Reflect Sample Values Range !				Certified Value	Measured Value
0-Point					
Std.					

SpCond. Standard. Exp. Date: _____

Dissolved Oxygen

Barometric Pressure (mm/Hg)	Pre-Cal. % Saturation	Post Cal. % Saturation

! Remember To Turn Circulator Off For Clark Cell D.O. Calibration !

Date / Time

Today's Date	Watch Time (24 Hour)	Surveyor Date	Surveyor Time	Adjusted ?	
				Yes	No
				☐	☐

Battery Voltage

Surveyor 4 Internal Battery Volts	Surveyor 3 Internal Battery Volts	Surveyor 3 External Battery Volts

Problems or Remarks

Person Contacted for Repairs if Needed: _____ Date: _____
Date Sent for Repairs: _____ Repairs Made By: _____
Date Completed: _____

ver. 1.2-4/17/2008

Appendix 3 – Annotation Quick Reference

In The Field (Annotation)

On (files, Surv4, select file, annotate) – Annotate, select appropriate file
1st Annotation (14 dashes total):
— [storet #] — [cost code] — [flow code] — [org- 01 is DWQ] — [weather code #1] — [weather code #2] — [weather code #3] — [weather code#4] — [field condition code] — — — — [field comment] — (ENTER)
Example:
— 4996690 — 359 — 4 — 1 — 1 — — — — — 1 — — — — — USGS —

** flow code examples: 04- flowing 10- no flow - 11- inaccessible
weather code: 1 is clear etc. weather codes 2-4 are optional
field condition code examples:
field comment examples: USGS, too swift, too deep

2nd Annotation (7 dashes total) – Be sure to let readings stabilize before storing.
— [flow] — [units] — [M or E] — [Avg. velocity] — [M or Ew] — Residual chlorine — (ENTER)

Example:
— 9.8 — C — M — — —0.8 —

** units = c (cfs- cubic feet/second), m (mgd – million gallons/day), g (gpm – gallons/minute)
M or E = Measured or Estimated
Type (of avg velocity in ft/sec) = M or E (should be M)

Go to main screen (when sonde is in the water), allow to stabilize, and select "Store". Choose the appropriate file.
For notes on the field sheet. Go to Files, Surv4, select the file, scroll to Review, select beginning, click the 'up' arrow for the last (most recent) stored data. Transcribe it.

HYDROLAB CODES

Field Conditions

1 Normal	6 Solid Ice
2 Evidence of Recent High Water	11Clear water
3 Flood	12 Milky water
4 Shore Ice	13 Cloudy water
5 Anchor Ice	14 Opaque water

Weather Conditions

1 Clear	7 Light rain
2 Overcast	8 Heavy rain
3 Partly Cloudy	9 Hail
4 Windy	10 Light snow
5 Fog	11 Heavy snow
6 Dust	

Sample Type Codes (stream and misc)

04 Grab Sample
05 1st Trimester Composite
06 2nd Trimester Composite
07 3rd Trimester Composite
08 8 Hour Composite
09 Total Composite – 24 hr
10 No flow/discharge
11 No Access
15 1st Quarter Composite
16 2nd Quarter Composite
17 3rd Quarter Composite
18 4th Quarter Composite
19 Raceway Cleaning
20 Field Data Only
30 Sludge
40 Sediment
50 Soil
60 Air
70 Tissue

Org/Agency Codes

1 Utah DWQ
2 BLM
3 Forest Service (NFS)
4 National Park Service (NPS)
5 Mountainlands Association of Governments
6 Central Utah Water Conservancy District
7 Bureau of Reclamation (BOR)
8 Wasatch County
9 Salt Lake City/County Health Dept.
10 Salt Lake County Water Conservancy Dist.
11 Salt Lake County Water Reclamation
12 Utah State University (USU)
13 Division of Wildlife Resources (DWR)
14 Other
15 Division of Air Quality
16 Division of Drinking Water
17 Division of Oil, Gas, and Mining (OGM)
18 Utah City/County Health Dept
19 Bear River Dist. Health - Logan
20 Div. Emergency Response and Remediation
21 Div. Solid and Hazardous Waste - RCRA
22 Drinking Water Systems
23 Div. Radiation Control
24 Davis County

Appendix 4 – Estimating Local Barometric Pressure (taken directly from Hach LDO Sensor Instruction Sheet)

Determine the barometric pressure for entry as the calibration standard. The barometric pressure needs to be in mmHg. 1mmHg = 0.00133322 bar = 133.322 pascal = 0.019336778 pounds/square inch [absolute].

Local Barometric Pressure, BP, in mmHG can be estimated using:

$$BP' = 780 - 2.5(A_{ft}/100) \text{ or } BP' = 780 - 2.5(A_m/30.5)$$

where:
BP' = Barometric pressure at altitude
BP=Barometric pressure at sea level
A_{ft} = Altitude in feet
A_m = ALtitude in meters

If using the local weather bureau BP, remember these numbers are corrected to sea level. To calculate the uncorrected atmospheric pressure BP', use the following equations:

$$BP' = BP - 2.5(A_{ft}/100) \text{ or } BP' = BP - 2.5(A_m/30.5)$$

where:
BP' = Barometric pressure at altitude

BP=Barometric pressure at sea level
A_{ft} = Altitude in feet
A_m = ALtitude in meters

Local barometric pressure in mbar (*BPmbar*) can be converted to local barometric pressure in mmMG (*BPmmHG*) using:

$$BPmmHG = 0.75 \times BPmbar$$

Appendix 5 – Trip Sheet Example

Date:
Trip ID: **WS**
Description: **2011 Willard Spur**

Samplers: [Flemer] [Tahir] [Seese] [Harris] [ ]

BOD	=	10	Chem	=	11	Fil. Nuts	=	12
Dry Weight (WC)	=	12	Fil. Metals	=	12			
NF Nutrient	=	11	Chl-a (WC)	=	12			

Seq. #	Project	STORET	Station Desc.	Date	Time	W. Temp	pH	DO (%)	DO	Conductivity	Flow	E/M
1	375	4985651	Willard Spur WMA 0	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
2	375	4984610	Harold Crane WMA 1	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
3	375	4984620	Harold Crane WMA 2	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4	375	4984630	Harold Crane WMA 3	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5	375	4984640	Harold Crane WMA 4	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
6	375	4984650	Harold Crane WMA 5	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
7	375	4984655	Harold Crane WMA Bypass	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
8	375	4984656	Harold Crane WMA Bypass 2	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
9	375	4984697	Harold Crane WMA Pond 13z	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
10	375	4984760	Irrigation Return Flow1	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
11	375	4984762	Willard Perry Outfall	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
12	375	4920420	Willard Bay Res. N. Outlet	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Appendix 6 – Hydrolab troubleshooting tips (Table 6.8-7 from USGS Field Manual)

[DO, dissolved oxygen; NIST, National Institute of Standards and Technology; SC, specific electrical conductance; ORP, oxidation-reduction (redox) potential; Cl, chloride; NH_4, ammonium; NO_3, nitrate; NTU, nephelometric turbidity unit]

Symptom	Possible cause(s), corrective actions, and tips
Erratic or jumpy readings	• May be caused by loose connections or sensitivity to the electrical capacitance of your body and to static electricity: avoid touching the sonde housing and try to keep a distance of about 1 meter from the sonde.
Display does not turn on	• Check that the batteries are installed properly and are fully charged. • Battery performance decreases with deceasing temperature. Batteries that charge at room temperature may not perform well when the temperature approaches freezing. Carry spare batteries.
The display does not show readings; the readings seem to be wrong	• Check that the readings are displayed in the appropriate units. Inspect all connectors for moisture, dirt, damage, or a loose connection. Clean as recommended by the manufacturer. • Disconnect and reconnect and recalibrate the sensors. When replacing sensors, the waterproof and dustproof properties of the instrument must be maintained or instrument performance will degrade.
Data on the display appear scrambled	• Check for computer speed and software and hardware compatibility. • Check for a damaged cable. • Check that the correct units are displayed. • If data remain scrambled, consult the manufacturer or authorized service center.
Initial drifting of the readings	• Increase the time for sensors to equilibrate to the water temperature. • Check that the sensors are appropriately submerged and (if necessary for the instrument) that they are at the appropriate inclination from the horizontal.
Dissolved-oxygen reading is unstable or inaccurate	• Check that the sensor has been calibrated to the true onsite barometric pressure or altitude; recalibrate the sensor at the proper barometric pressure and, to the extent possible, with calibrants brought to sample temperature. • Amperometric DO method: Inspect the membrane for a puncture, bubbles, or improper installation. Verify the integrity of the membrane, electrolyte solution, and O-ring by checking the reading against a zero-DO solution. Rinse the sonde thoroughly.
Temperature reading is unstable or inaccurate	• Check for water in the connector; dry the connector and reinstall the sensor. • Check the accuracy of the reading with an NIST-traceable thermometer and have it replaced if necessary. Usually, only the manufacturer can replace a faulty thermistor.
Reading is unstable or inaccurate for SC, pH, ORP, turbidity, Cl, NH_4, or NO_3	• Examine the sensor for dirt or damage. Clean dirty sensors according to the manufacturer's instructions. Replace damaged sensors and recalibrate. • Ensure that the temperature reading is accurate by allowing sufficient time for the temperature sensor to equilibrate to the water temperature. • Check that the calibration solutions used for SC, pH, and ORP were not expired or subject to contamination. • Recalibrate the sensor(s), first bringing the calibration solutions as close to the ambient temperature of the sample as is practical, given ambient field conditions. • Check pH reference junction: if dry, follow manufacturer's instructions for soaking the sensor in tap water or buffer solution until readings stabilize. Alternatively, replace the junction. • Check the sensor connector for water; dry the connector and reinstall the sensor. • If the ZoBell check fails, was temperature dependence of the ZoBell solution accounted for? • The SC sensor must be fully immersed for proper calibration and sample measurement. There must be no bubbles in the cell. • The turbidity sensor wiper must be clean, activated, and rotating properly. Check that expired turbidity calibrants were not used, including any diluted 4000-NTU formazin standard (which must be used within 24 hours of preparation).

Appendix 7 – Detailed Cleaning and Maintenance Instructions for Hydrolab Sensors

pH Glass Electrode Maintenance – As Needed

1. If the glass pH sensor is coated with oil, sediment, or biological growth use a very soft cotton swab or soft non-scratching cloth with Isopropyl alcohol or mild soap to clean the bulb. Isopropyl alcohol is recommended because it will not leave a film on the bulb where soap possibly can. Rinse thoroughly with tap water.
2. If the pH electrode **fails** to calibrate, or there is drift in the readings use the following cleaning instructions. This cleaning procedure should be followed **only** if the above problems exist.
   a. Clean bulb with Isopropyl alcohol.
   b. Soak bulb inn 0.1 N HCl for five minutes.
   c. Rinse with tap water.
   d. Soak over night in clear pH 4 buffer solution.
   e. Rinse with tap water and dry.
3. If this does not solve the problem the glass electrode should be replaced. Contact the monitor responsible for Hydrolabs to replace the bulb or send to a certified Hydrolab service center.

Standard Reference Electrode – Small Junction

1. Replace pH electrolyte in reference electrode weekly.
2. Unscrew the Teflon junction and pour out the old electrolyte.
3. Use a dropper bottle or syringe and rinse the housing once with 4 molar KCl saturated with AgCl electrolyte solution (purchased from HydroTech).
4. Refill the housing and make sure there are no bubbles trapped inside.
5. Use a screwdriver to screw the Teflon junction back on to place. As the junction is screwed on electrolyte should emerge through the top of the junction. If not, replace the junction. (Make sure there is an o-ring on the junction when replacing it.)
6. The pH junction should be replaced every two weeks when used on a regular basis.
7. If sonde has been idle for several weeks replace the electrolyte and check the junction before calibration.

Standard Reference Electrode – Large Junction

1. Replace pH electrolyte in reference electrode weekly.
2. Gently pull the entire sleeve away from the sonde and discard old electrolyte.
3. Rinse the sleeve once with 4 molar KCl saturated with AgCl electrolyte solution (purchased from HydroTech).

4. Turn the sleeve upside down and fill with electrolyte
5. Slightly push the sleeve onto the base of the pH probe.
6. Turn the sonde upside down and push the sleeve on the rest of the way. Electrolyte and air bubbles should emerge from the Teflon Junction as you push the sleeve down. There is considerable resistance when pushing the sleeve on so it is helpful to have the cable connection plastic protector on so you can place the sonde on the ground to help push the sleeve on. If electrolyte does not emerge from the junction after two attempts a new junction is needed.
7. The pH junction should be replaced every two weeks when used on a regular basis.
8. If sonde has been idle for several weeks replace the electrolyte and check the junction before calibration.

DO Maintenance – Clark Cell

1. The electrolyte and DO membrane should be replace weekly.
2. Remove the old membrane and discard electrolyte.
3. Rinse the probe once with 2 molar KCl with Triton (purchased from HydroTech).
4. Fill the DO probe with new electrolyte making a reverse meniscus taking care not to have any bubbles present.
5. Bend the new DO membrane into a U shape curving upwards.
6. Gently place the membrane on the probe letting the ends drop down.
7. Center the o-ring on the probe and roll it into place to secure the membrane.
8. If the membrane is wrinkled or bubbles are present under the membrane repeat the process with a new membrane.
9. Soak the membrane over night in tap water to relax the membrane.
10. **If the DO probe does not calibrate or won't stabilize when reading perform the following procedure.**
11. If the gold ring on the sensor is discolored or tarnished take a pink erasure and rub the ring in a clockwise direction. The ring should be a bright gold color when finished.
12. Rinse the probe a few times with de-ionized water then replace the electrolyte and membrane.

DO Maintenance – LDO

1. If the LDO cap becomes fouled by oil or biological growth use an optical tissue or soft cotton swab with soapy water to clean the sensor cap.
2. **Never** use organic solvents like acetone or Isopropyl alcohol to clean the cap. These solvents will damage the plastic sensor cap.
3. If more than half of the black covering on the cap is removed, the cap should be replaced.

4. If the probe becomes difficult to calibrate or readings drift there may be water under the cap.
5. Carefully remove the cap and check for water droplets. If water is present use a soft tissue to remove the water from the cap.
6. Carefully replace the cap by gently screwing it back on making sure it seals with the o-rings. **Do Not** over-tighten the cap as it will not seal properly.

Conductivity Maintenance – 5 Nickel Electrodes

1. The five nickel electrodes should be cleaned monthly at a minimum.
2. Remove the screws securing the conductivity cell block. Pull the cell block off.
3. Remove the five small o-rings that are slipped over the electrodes. Polish the entire surface of the electrodes with fine grit emery cloth strips or 400 grit, or finer, wet/dry sandpaper. Be careful not to scratch the nearby glass pH electrode.
4. Replace the o-rings if they are rigid, cut, or flattened.
5. Clean the electrodes and cell block with a brush and Isopropyl alcohol.
6. Rinse the electrodes and cell block with de-ionized water.
7. Wet the five o-rings with water to allow a better seal. Do not use any grease to install the o-rings. Install the new o-rings. Re-install the conductivity cell block. Insert and tighten the screws just enough to make sure the cell block is seated flat against the conductivity sensor body.
8. Rinse the sensor twice with de-ionized water. Let the sensor soak in tap water overnight to allow the freshly-polished electrodes to re-equilibrate with an aqueous environment.

Conductivity Maintenance – Ceramic Cells

1. The cells should be cleaned weekly.
2. Clean the oval measurement with a soft non-abrasive brush or cotton swab.
3. Use Isopropyl alcohol or soap to remove oils or biological growth.
4. Rinse with tap water.