Environment and Climate Change Canada
Environnement et Changement climatique Canada

Standard Operating Procedures for Auto-Monitoring (PISCES Platform & Internally Logging Unattended Samplers)

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Acronyms

ECCC	Environment and Climate Change Canada
FWQMSD	Freshwater Quality Monitoring and Surveillance Division
PISCES	Pontoon for In-Situ Characterization of Environmental Systems
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
SOP	Standard operating procedure

Table of Contents

List of Figures

1.0 Introduction

The Freshwater Quality Monitoring and Surveillance Division (FWQMSD) of Environment and Climate Change Canada (ECCC) operates automated, unattended sampling at select locations. This document is intended to standardize the protocols to prepare the equipment prior to and during deployment, as well as during maintenance and retrieval, to maintain consistency in the data record. The protocols outlined here are derived from equipment-maintenance manuals provided by the manufacturers and protocols developed by the United States Geological Survey's (USGS) *Guidelines and Standard Procedures for Continuous Water Quality Monitors: Station Operation, Record Computation, and Data Reporting (2006)* (USGS 2006). These procedures are limited to field applications. These procedures do not address study design, health and safety, or analytical requirements. Consistent use of these procedures will ensure that the generated data are accurate, scientifically robust, and comparable between samplers, sampling events, and sampling sites.

2.0 General Considerations

Unattended monitoring is intended to provide a continuous data record of conditions over an extended period. The instruments being deployed are technologically advanced; however, the datasets produced are only as good as the maintenance, calibration practices, and quality assurance (QA)/quality control (QC) protocols that are strictly adhered to. The following are key considerations in the use of automated monitoring equipment:

- water quality measuring sondes must be carefully prepared for storage to avoid damaging the sensors;
- units must be calibrated within 24 hours before long-term deployment to avoid pre-deployment instrument drift;
- care must be taken during programming for sampling and data logging, and testing must occur before deployment to ensure that sampling and logging activities are active and accurate;
- QA/QC measurements must be recorded during deployment and retrieval;
- calibration and cleaning must occur within 24 hours of retrieval to ensure accurate fouling and instrument drift calculations; and
- detailed documentation is essential to support sample QA/QC, as well as to ensure data integrity and interpretation of the results.

3.0 Equipment

3.1 YSI Water quality-Monitoring Systems

The 6-Series Environmental Monitoring Systems from YSI are multi-parameter, water quality measurement and data collection systems. They are intended for use in research, assessment, and regulatory compliance applications. The system is comprised of two parts: a handheld display and a sonde, which are connected by a waterproof cable. A sonde is a torpedo-shaped, water quality monitoring device that is placed in the water to gather water quality data. Sondes may have multiple probes; the sondes used by FWQMSD include probes that measure the following:

- water temperature;
- dissolved oxygen;
- turbidity;
- pH levels; and
- specific conductance.

Figure 1. YSI 6600 sonde.

Automated monitoring is completed using two different types of YSI sondes: those that allow for internal logging and those that are used for QA/QC purposes that do not have internal logging capabilities. Both are set up using a handheld 650 display.

The YSI 6600 sonde is capable of either discrete or unattended sampling. It contains a power source and permits internal data logging for a specified duration. The size of the dataset and the available battery life will depend on a series of factors, including sampling frequency and length of deployment. FWQMSD primarily uses the 6600 V2 or 6600 EDS for automated, unattended sampling.

Figure 2. YSI 6820 sonde and 650 handheld display.

The YSI 6820 V2 is a smaller version of the 6600 and is used solely for discrete, in-situ sampling. The 6820-series sonde does not have an internal power source or logging capabilities, and it relies on the handheld 650 for power and communication. This device is used to provide QA/QC readings that can calculate the drift of a deployed 6600 and it also collects in-situ physical water quality data during surface-water sampling and semi-permeable membrane device deployment.

Please see Appendices 7.1 and 7.2 for the complete user's manuals for the YSI 6-Series sondes and the 650 MDS handheld display.

3.2 Pontoon for In-Situ Characterization of Environmental Systems (PISCES)

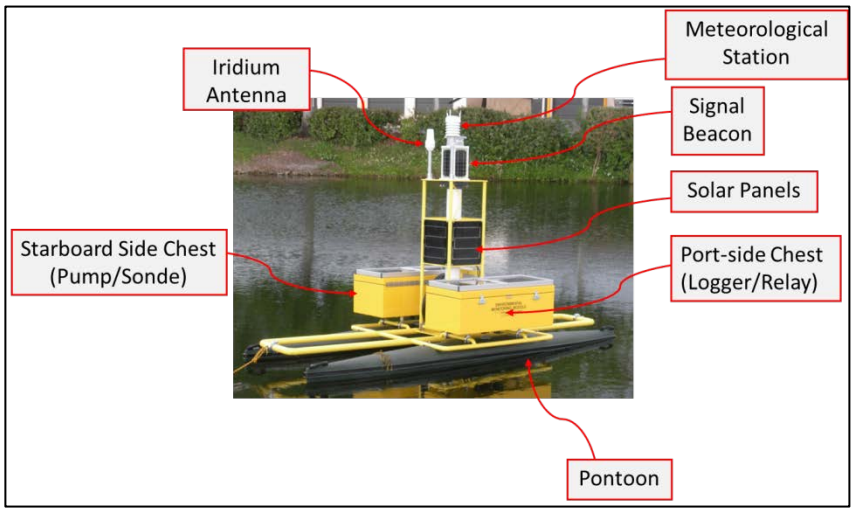

Figure 3. PISCES platform.

The EMM 350 PISCES, manufactured by YSI-Xylem, is a lightweight, pontoon-based water-monitoring platform designed for use in coastal-, estuary-, river-, and lake-monitoring applications. Within two topside aluminum chests, the PISCES holds a data acquisition system, batteries, a data logger, a peristaltic pump, and multi-parameter, water quality-monitoring sondes. The PISCES tower is equipped

with a meteorological station that measures wind speed and direction, relative humidity, precipitation, and air temperature. In addition, the station is capable of real-time data reporting over the Iridium satellite network. Finally, the station complies with all Transport Canada regulations regarding visibility and signaling in Navigable Waters.

Please see Appendix 7.3 for the PISCES user's manual.

4.0 Methods

4.1 YSI Sonde in Non-Real-Time Deployment

This section will describe the preparation for and deployment of YSI sondes in unattended, non-real-time monitoring. Section 4.2 will describe the use of a PISCES platform for real-time monitoring with a YSI.

4.1.1 Calibration and Maintenance

The YSI sondes are stored over the winter. They need to be brought out of winter storage and calibrated per the manufacturer's protocols (YSI Inc. 6-Series Manual). The calibration procedure, including common troubleshooting and critical information for users, has been summarized from the manufacturer's literature and from professional training initiatives. The calibration procedures used by the FWQMSD for automated monitoring can be found in Appendix 7.6. While the manufacturer has not specified a timeframe for calibration prior to extended deployment, FWQMSD has – through extensive consultation with other experienced users – developed a policy whereby the calibration of all sondes that will be deployed for automated monitoring must take place within 24 hours of deployment. This ensures that any pre-deployment drift will be negligible. Similarly, FWQMSD has an internal standard where all YSI sondes used for spot sampling or for QA/QC during automated deployments or retrievals must have been calibrated within 5 days of use.

4.1.2 Setup for Internal Logging (Non-Real-Time)

After calibration is complete, the sondes must be programmed to take and log measurements on a specific time schedule. This information, which is specific to the setup of an internal logging file, should be recorded in a personal field book. It is best practice to set the sonde to begin sampling prior to deployment; this will confirm that all wipers complete the correct rotation sequence and that the samples are being correctly logged internally. To configure the sonde for logging, connect to the sonde using the 650 display and set it up according to the objectives of your study. Detailed instructions on how to program the sondes for unattended sampling can be found in the manufacturer's user guide.

It is best practice to install new, fresh batteries with every deployment. Battery life is dependent on the type of battery used, measurement frequency, and environmental conditions (i.e., cold temperatures will reduce battery life). In

addition, it is best practice to set the logging duration to be longer than the expected duration to allow for unforeseen delays in retrieval.

4.1.3 Deployment

This section describes the casing and mooring, as well as the activation of the sonde for unattended, non-real-time monitoring. See Section 4.2 for real-time monitoring using the PISCES platform.

4.1.3.1 Mooring

The mooring design to deploy a YSI sonde accounts for the substrate of the river, and it provides maximum security against movement of the array by debris. Figure 5 illustrates the components of the mooring system. For more information on the specific cable lengths and materials used in developing a sound mooring system, please refer to the ECCC FWQMS-AA Standard Operating Procedure (SOP) *Deployment Arrays*, which details the procedure for correctly creating an array system for a given site, depending on the depth and discharge characteristics of the river.

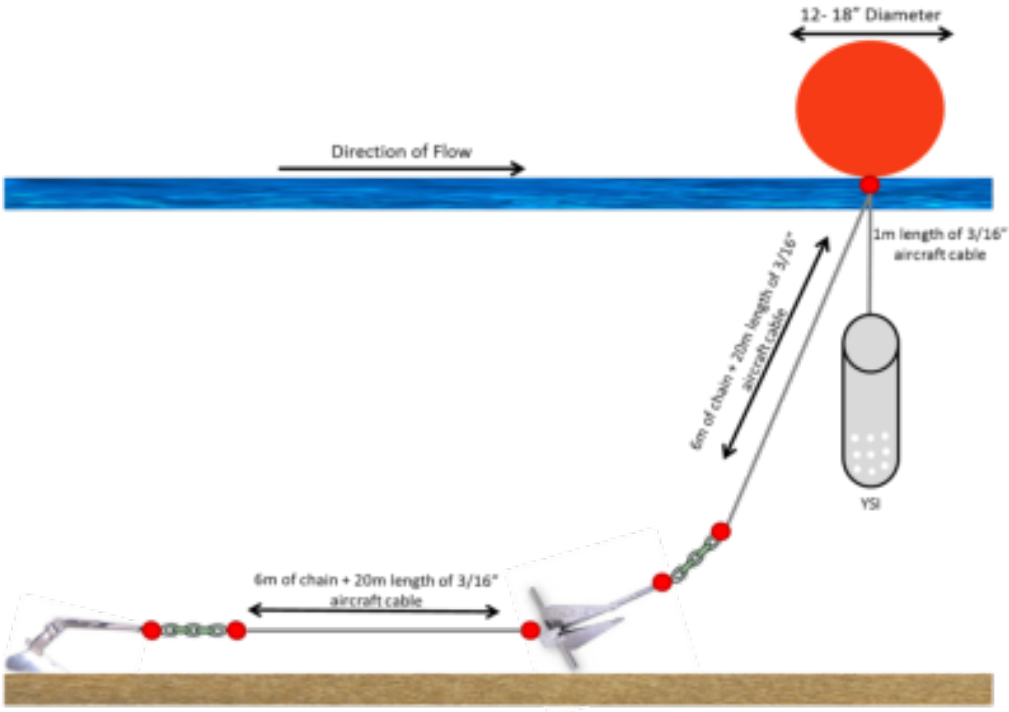

Figure 4. Mooring design.

4.1.3.2 Housing Apparatus

While the YSI 6600 is a robust sonde, high-quality, protective casing is required to protect this asset when left unattended in large rivers. Debris that is carried down large rivers can range from small branches to large trees. A heavy-duty polyvinyl

chloride (PVC) pipe (otherwise known as plumbers' pipe) 15 cm in diameter with holes drilled for water flow is used as protective casing. The components of the casing are outlined in Figure 6:

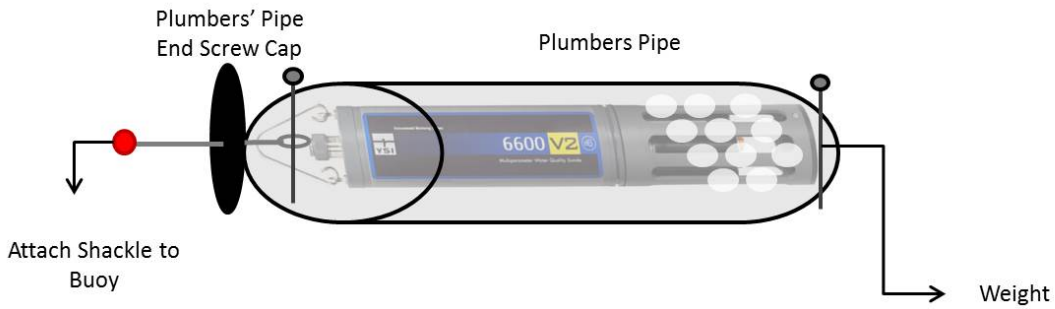

Figure 5. Housing apparatus components.

A white PVC pipe is used instead of a black PVC pipe, as the latter can cause invalid temperature readings when it heats up in the sun; it can also interfere with the optical readings for some sensors. To ensure good water flow over the sensors, the drilled holes should be a minimum of 2 cm in diameter and 5 cm apart, and they should cover from the bottom of the pipe to 15 cm above the sensor guard on the sonde (USGS 2006). Additional holes should be drilled every 15 cm above the sensors. All pipes should have an open bottom to allow any debris to fall out, and a bolt through the bottom should serve as a safety measure against losing the sonde (Figure 7). Another bolt at the top of the casing through the metal handle of the sonde allows an airline cable from the buoy (which is passed through a hole drilled in the screw cap) to connect to the sonde's metal handle. This allows the sonde to be suspended in the PVC pipe (Figure 8).

Figure 6. Bottom of the deployment tube.

4.1.3.3 Activating Monitoring

If the set-up procedure in Section 4.1.2, “Setup for Internal Logging (Non-Real-Time)”, has been followed, the sonde should begin monitoring at 8:00 a.m. on the day of deployment. Before placing the sonde in the housing apparatus, observe the probes at predetermined intervals to ensure that the wipers are engaging as programmed, and that the wipers are parking appropriately. If all appears accurate, proceed with deployment.

Replace the calibration/storage cup on the YSI with a protective non-weighted cage (provided by the manufacturer with the purchase of a sonde). Place the YSI in the PVC tubing, ensuring that the support bolt is threaded through the bracket attached to the top of the YSI. Insert the cable that will lead to the buoy through a hole drilled in the screw cap and secure a thimble at the end (Figure 8). Thread the support bolt through this thimble and secure the bolt in the pipe with a nut. Screw on the top of the PVC tubing and attach the shackle to the buoy. Prior to deployment, complete a QA/QC comparison with another recently calibrated YSI sonde (as outlined in Section 4.1.4.2, “Infield QA/QC Readings”). Once completed, gently lower the PVC tube into the water.

Figure 7. Top of the deployment tube.

4.1.4 Retrieval

This section describes the infield equipment retrieval and fouling/drift measurements, as well as the process for data retrieval from a YSI 6-series sonde.

4.1.4.1 Physical Retrieval

After the desired sampling period, return to the location of the deployed sonde. Once safely connected to the anchor/buoy system (see ECCC FWQMS-AA SOP *Occupational Health and Safety: Working with Anchored Equipment*), lift the PVC pipe containing the YSI gently out of the water. Record the retrieval time and, if necessary, deactivate the automated logging using the 650MD handheld device (Sonde Menu ⇨ Run ⇨ Unattended Sample ⇨ *Stop Logging*). If the logging does not stop, the YSI will continue to clean its optic sensors after it has been removed from the water, which may disturb the fouling on the sensors. Take pictures of any fouling on the sensors (Figure 8) and be sure to record useful observations related to the condition of, or any abnormalities with, the sonde. Complete a QA/QC comparison with another recently calibrated YSI sonde (as outlined in Section 4.1.4.2, “Infield QA/QC Readings”). Once these tasks have been completed, place the probes in a clean and dry calibration cup for transport. The calibration cup should not contain a sponge (often used to maintain a high relative humidity in the cup for the dissolved oxygen sensor) or anything else that could potentially disturb the fouling on the probes. The fouling on the probes and sensors must be left undisturbed to collect accurate fouling measurements. These fouling measurements, as well as an instrument-drift calibration for the retrieved sonde, should be completed within 24 hours of the sonde’s retrieval. If the retrieved PVC tube is to be reused immediately for a new sonde deployment, it must be cleaned thoroughly with river water, scrubbing off any biofouling or grime before redeployment.

Figure 8. Sonde fouling.

4.1.4.2 Infield QA/QC Readings

An infield QA/QC check should be completed immediately before deployment and after the retrieval of a YSI sonde. During deployment, this check ensures that the sonde to be deployed is properly measuring various parameters and within an acceptable range. Upon retrieval, it provides information about how the sonde was functioning during deployment and whether any drift has occurred. A detailed

fieldwork sheet used to record these QA/QC readings is in Appendix 7.5. This worksheet highlights the allowable range of difference between the automated deployment sonde and the QA/QC sonde for each parameter, as described as acceptable by the USGS (2006). These QA/QC measurements should be documented and kept for deployment records.

To perform the QA/QC comparison, two sondes are required: the sonde being retrieved/deployed, and a recently calibrated QA/QC sonde (usually the smaller 6820). Before starting this process, ensure that the boat is safely connected to the YSI anchor/buoy system. To complete the comparison, both sondes are placed in the water simultaneously on the same side of the boat. If the sonde is about to be deployed, it should be placed in the water inside the clean PVC deployment tube. If the sonde was recently retrieved, it should be connected to a handheld monitor and replaced in the water, inside the PVC in which it was deployed. This retrieved PVC tube should not be cleaned before taking the QA/QC comparison measurements. Once in the water, both sondes can be set to take a discrete spot measurement (see *6-Series Multi-Parameter Water Quality Sondes User Manual (2006)).* When both sondes stabilize, the readings for each parameter should be concurrently recorded. For sondes that are to be deployed, these readings should be compared against USGS standards (USGS 2006); if they are outside the acceptable range noted by USGS, a note should be made, particularly since a correction may need to be applied during data processing. After the QA/QC measurements have been taken, proceed with the deployment or retrieval process, as outlined in Sections 4.2.2.4 “Activating Monitoring” or 4.1.4.1 “Physical Retrieval” in this chapter.

4.1.4.3 Data Retrieval

Internally logged data can be retrieved from an YSI 6-series sonde using the YSI developed software, EcoWatch Lite. Procedures for installation, configuration, and data export are outlined in the EcoWatch Lite Software User Manual (Appendix 7.4). A 6067B adapter cable (YSI 6-series sonde to the RS-232 adapter) is required to connect the sonde to a serial-port PC interface. Data may be uploaded from the sonde in a variety of formats. FWQMSD uploads data in .csv format for use in Microsoft Excel.

4.1.4.4 Fouling Measurements and Instrument Drift Calibration

Fouling and instrument drift measurements provide essential information for drift calculations and data correction. Once the YSI sonde was retrieved from the water, fouling measurements and instrument drift calibration should be completed within 24 hours (see Appendix 7.5 for an example of a Post-Retrieval Fouling Measurements and Instrument Drift Calibration worksheet).

4.1.4.4.1 Fouling Measurements

Fouling on the probes may be biological (e.g., algae) or physical (e.g., fine sediment). This can progressively affect the measurements taken by the probes

(fouling drift). The combination of both types of fouling is assessed after retrieval and is used to correct for fouling drift in the measurement record. To produce the most accurate fouling measurements, effort must be made to not disturb any of the fouling on the probes and sensors. The optic sensors should only be cleaned once by the wipers prior to taking these readings (rather than twice, as set for long-term deployment).

The readings can be taken in the Sonde Menu ⇨ Run mode. The procedure to take fouling measurements for each probe is as follows:

- **Dissolved oxygen:**
    - Add a small amount of tap water to the calibration cup (only up to 2.5 cm in depth) and engage only the first couple of threads of the cup to the sonde, while ensuring that neither the dissolved oxygen sensor nor the temperature probe are in contact with the water's surface. Wait about 10 minutes for high relative humidity to develop within the cup. After that time, and once both the temperature and dissolved oxygen have stabilized, record the percentage and mg/L of dissolved oxygen, as well as the atmospheric pressure (mmHg).
- **Turbidity:**
    - Using tap water, rinse the calibration cup with tap water for a total of three times; then, rinse the calibration cup once with a small amount of 126 NTU standard turbidity solution. Practicing the "beer pour" technique described in Appendix 7.4, fill the calibration cup with 126 NTU standard solution to a level that will submerge the end of the turbidity sensor, but that will preferably not touch the rest of the probes (this depends on the configuration of the sonde). Carefully place the turbidity probe in the solution and fully thread the cup onto the sonde. Wrap the calibration cup in thick paper (a large brown envelope, for example) or a garbage bag to block light from entering the solution, as this is an optical measurement. Once the turbidity has stabilized, record the measurement.
- **Specific conductivity and temperature:**
    - Using tap water, rinse the calibration cup three times; then, rinse it once with a small amount of 1413 µS/cm standard conductivity solution. Fill the calibration cup to a level that will submerge the conductivity/temperature probe. The YSI may need to be leaned to one side to fully submerge the sensor. When doing so, make sure to minimize the disturbance of any fouling on all other sensors. Once the temperature and specific conductivity have stabilized, record both measurements. Remove the probes from the calibration cup and place a

traceable thermometer into the standard solution; record this second temperature reading.

- **pH:**
    - Using tap water, rinse the calibration cup three times; then, rinse it once with a small amount of pH 7 standard solution. Fill the calibration cup to a level that will submerge the pH and conductivity/temperature probes. The YSI may need to be leaned to one side to fully submerge the sensor. When doing so, make sure to minimize the disturbance of any fouling on all other sensors. Once the temperature and pH have stabilized, record the pH measurement.
- **Depth:**
    - While the probes are not in any solution (i.e., “in air”), record the depth measurement once it has stabilized.

4.1.4.4.2 Cleaning

Once the fouling measurements are collected, the sonde and the probes must be thoroughly cleaned prior to an instrument drift calibration. Gently clean and remove all fouling from the probes and sensors using tap water and KimWipes or Q-tips. On the conductivity/temperature probe, each opening should be cleaned with a wire brush (provided by YSI) by pushing the brush in and out of both openings for a total of 10–20 times on each side. The depth sensor can be cleaned out using a syringe filled with tap water to flush grime out of the depth sensor opening (located on the body of the sonde) until the water runs clear. For turbidity and dissolved-oxygen optical probes, do not rub the optical sensors too aggressively; dabbing them with a moist KimWipe is sufficient. Be especially careful when cleaning the pH bulb, as it is very fragile. Never stick a Q-tip between the glass bulb and the cage at the tip of the pH probe, as this will fracture the glass bulb.

4.1.4.4.3 Instrument Drift Measurements (and Optional Calibration)

Instrument drift is the slight progressive drifting of measurements, when compared to standard, that occurs after the calibration of an instrument; this may be especially noticeable after more time has elapsed since calibration. To assess whether instrument drift has occurred, the probes should be placed in standard solutions after cleaning and measurements should be recorded. Calibration is typically performed at the same time as the instrument drift measurement. However, instrument drift measurements can be collected without calibrating the instrument if done through the Sonde Menu ⇨ Run mode. The method for conducting an instrument drift calibration is identical to a regular YSI sonde calibration (see Section 4.1.1, “Calibration”); however, in this case, the “pre-

calibration" reading that is given during calibration also represents the instrument drift reading. If the instrument drift readings are collected through the Sonde Menu ⇨ Run mode without calibrating the instrument, the procedure for rinsing between readings and solutions should be the same as the calibration procedure outlined in Section 4.1.1, "Calibration". For more information on data processing, please see the ECCC FWQMS-AA SOP *Data Procedures*.

4.2 PISCES

In this section, the preparation and deployment of the PISCES platform system for automated, near-real-time monitoring is described. PISCES is capable of real-time satellite data acquisition; if your program calls for this technology, your YSI representative should assist you with enabling this feature.

4.2.1 Pre-Deployment Setup and Configuration

IMPORTANT NOTE: Any time you are working inside the chests of the PISCES, **ALWAYS SECURE THE LIDS OPEN**. There is a chain attached to the met tower for this purpose. The lids are very heavy; if one falls on your hand or arm, it *WILL* break bones.

Prior to deployment the following tasks must be completed:

4.2.1.1 Power Systems

The 12VDC lead acid batteries should be placed on a charger for 24 hours to ensure they are fully charged. Signal beacons must be charged via solar energy. Place the beacons outdoors in an area that features maximum exposure to sunlight for 72 hours. Alternatively, the beacons can be placed under a charging light.

4.2.1.2 System Inspection

Inspect the beacon lantern for cracks in the lens or solar panels. Check the mounting hardware for corrosion. Check for moisture buildup inside the housing. Replace if necessary.

Inspect the battery terminals for corrosion. To remove terminal corrosion buildup, first remove the battery from the compartment, sprinkle baking soda on the affected posts, let stand 5 minutes, then wipe with a damp cloth.

Carefully inspect all wiring connections for corrosion or vulnerable-looking connections. Also inspect the cabling that runs between the chests and to the junction box for drying or cracking.

Wash all solar panels with a mixture of warm water and mild soap. Rinse thoroughly. There are six solar panels in total – four on the tower and one on each

chest. Check all the panels for cracks or damage and check the cables from the solar panels to the power relay.

Check the junction box integrity (the grey box on the met tower). Check the O-ring and ensure the seals are tight; ensure there is no moisture accumulation inside.

4.2.1.3 System Setup

Once all the system inspections are complete and the various components have been charged, the PISCES can be set up for deployment.

Install the batteries. One battery goes into each chest. The cables are identified as positive and negative; be sure to connect them properly. Place the ring connector over the hole in the battery and attach with the provided bolt.

Raise the met tower. Secure using the U-bolts connected to the tower.

To test the signal beacon before installing, bring it into an area with very little light (e.g., the bathroom). If the signal beacon begins flashing automatically, it is ready to install; if not, use the remote programmer (provided with the unit) to reset the lantern as follows: point the programmer at the lantern and press the Start button. If the lantern responds with a flash, it is ready for programming. If not, wait 10 seconds and try again. When the lantern flashes, you may reset the factory default by entering the security code **753** and then the factory default code **911**. The lantern will flash once between each button you press, then there will be three quick flashes at the end of the sequence to confirm. Therefore, you must wait for these three flashes to confirm that programming has occurred. The sequence is as follows: START {flash} 7 {flash} 5 {flash} 3 {flash} 9 {flash} 1 {flash} 1 {flash} ENTER {flash} {flash flash flash}. If the lantern only flashes twice at the end, something went wrong, and the entire sequence must be repeated. Install the signal beacon using the four mounting bolts provided.

The intake tubing, which allows water to be pumped from two depths (1 m and 4 m) into the auto-monitoring sondes that are stored in the chests for measurements, must be attached to the underside of the starboard-side chest to prepare for testing. The nozzles that accept these tubes are marked with the same colour tape as the tubing. If PISCES must be transported to the deployment site after testing, these tubes must be removed during transportation.

Figure 9. Intake tubing.

4.2.1.4 Sonde Installation

The sondes go into the starboard-side chest with the pump. FWQMSD installs one Turner and one YSI sonde in the PISCES. The probes must be put in flow cells (provided with PISCES) rather than probe guards or calibration cups.

Remove the bolts holding the clamps together; the lip of the lid is a good place to hold the bolts while working. Connect the YSI data/power cable to the sonde. Connect the YSI flow cell to tubing that will carry water in/out of the cell: RED marked tubing to the BOTTOM of the flow cell and GREEN marked tubing to the TOP of the flow cell. Connect the Turner data/power cable to the sonde. Connect the Turner flow cell to the water tubing: BROWN marked tubing to the BOTTOM of the flow cell and YELLOW marked tubing to the TOP of the flow cell. Pop the sondes through the clamps and slide them all the way forward, keeping the proper coloured tubing on the top. Make sure the intake tubes underneath the sondes are not crimped. Replace the bolts and hand tighten them to secure the sondes. Ensure that the lever on the peristaltic pump is in the closed position (all the way over to the right, as in Figure 10).

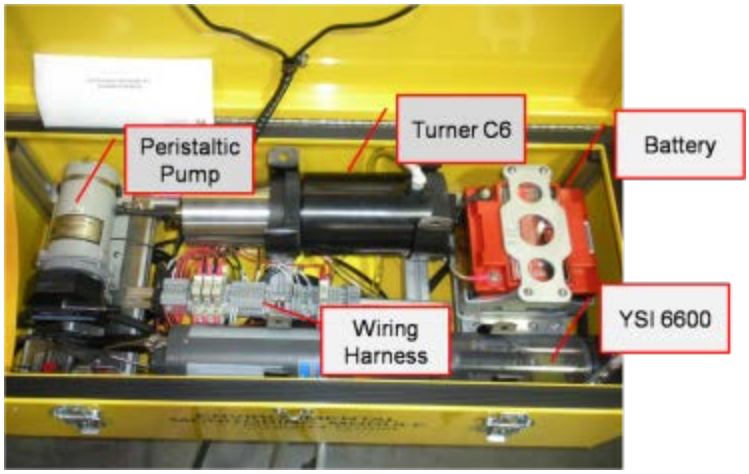

Figure 10. Sonde installation.

4.2.1.5 Testing

Once the sondes are properly connected, fill a large container of water and completely immerse both intake tubes. Place the black overflow tube in such a position that it will flow back into the container as well.

In the FWQMSDs PISCES program, the automatic pump cycle begins at the top of every even hour (12:00, 14:00, 16:00, and so on) and it lasts for approximately 20 minutes. To avoid complications, do not start testing in the middle of a cycle; wait until after this time to turn on the PISCES for testing.

Turn on the power to PISCES using the large switch in the RELAY box (port-side chest):

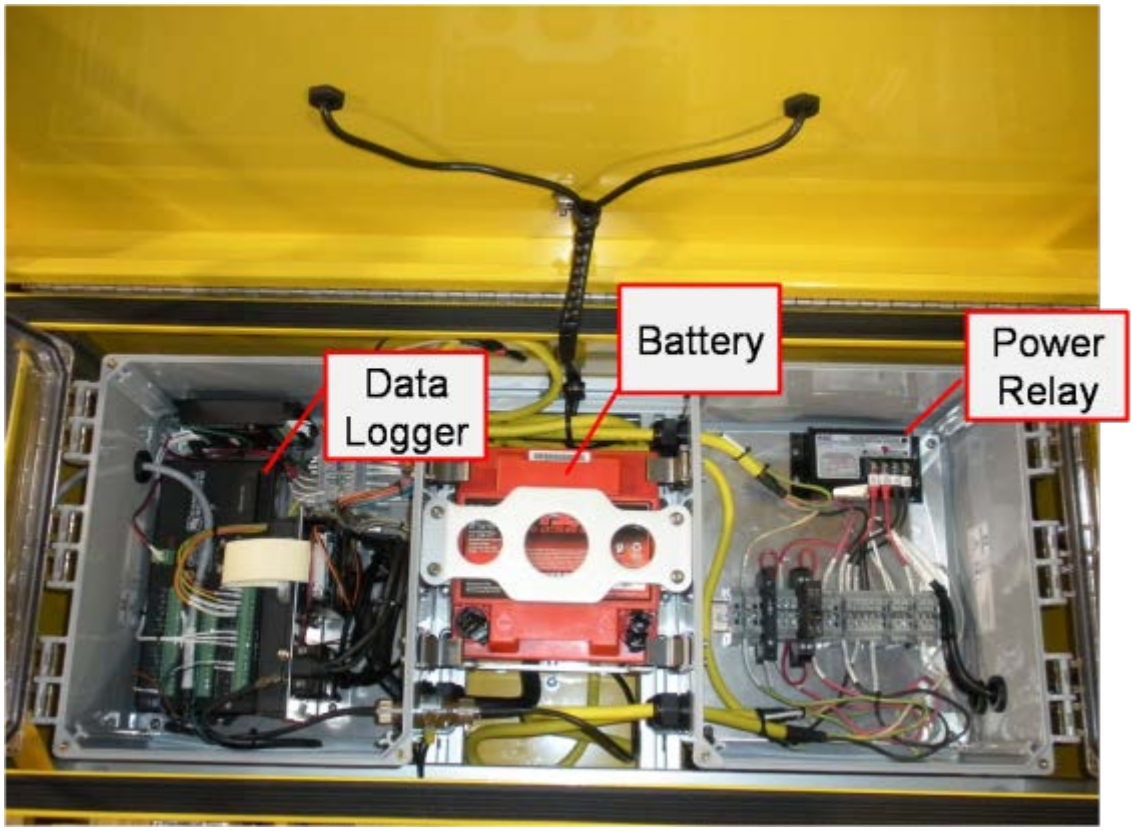

Figure 11. Main power switch location.

Using a small screwdriver, toggle the very bottom switch on the datalogger switchboard to “Manual”.

In the manual control box, only switches one to four are active. Their functions are as follows:

1. ON position – Pump forward; OFF position – Pump off.

2. ON position – Pump reverse; OFF position – Pump off.

3. ON position – 4 m depth intake; OFF position – 1 m depth intake.

The ON position powers the instruments in the pump chest (YSI and TURNER).

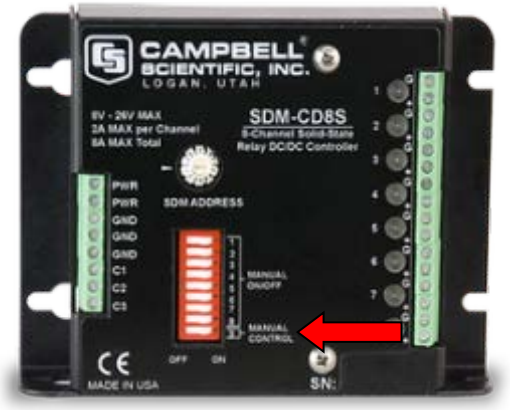

Figure 12. Manual control box.

Test all components of a sampling cycle in this order:

1. Leave switch 3 in the OFF position, enabling the 1 m depth intake.

2. Move switch 1 pump to the ON position; this is the forward pump switch. The pump should start. Watch the water intake hoses in your bucket to ensure that the water is drawing up from the 1 m intake point. Let the pump run until the flow cell is completely full and the water runs freely from the black overflow tube. Move switch 1 to the OFF position, disabling the pump.

3. Move switch 4 to the ON position, giving power to the instruments. Watch the wipers in the YSI to see if they turn.

4. If all looks good, move switch 2 to the ON position, turning the pump to the reverse position. The pump should start working and the water should run in reverse, out of the flow cell through the intake tube and back into your bucket. Once the tubes are clear of water and air bubbles are seen, switch the pump off by moving switch 2 to the OFF position.

5. Move switch 3 to the ON position, enabling the 4 m depth intake. Repeat steps 2–4 above, making sure to watch that the intake is now occurring from the 4 m intake hose.

6. Once all manual tests have been completed, move all switches to the OFF position, including the manual control switch. Leave the power to the PISCES on and keep the intake tubes in the water.

7. At the next scheduled pump cycle (the top of the next even hour – 12:00, 14:00, 16:00, and so on), watch the full cycle from beginning to end to make sure that each step occurs (pump in from 1 m, pump stop, wipers on sonde activate, pump reverses, stop, pump in from 4 m, stop, wipers active, pump reverses, stop). The whole cycle takes about 20 minutes to complete.

Once all these tests have been completed and everything is running smoothly, PISCES is ready for deployment. Turn off the power (or it will continue to pump every 2 hours) and coil up the intake hoses inside the tower. If deployment is to occur within the next 24 hours, the YSI may be left installed in the chest. If not, remove it and recalibrate on the day of deployment before reinstalling it in the chest.

4.2.2 Deployment

4.2.2.1 Transportation to the Deployment Sites

Lower the met tower by unscrewing the U-bolts. With at least four people at each corner of the main frame, as indicated in the photo, lift the PISCES and place it onto a flatbed snowmobile trailer. Alternatively, the PISCES will fit into the back of a full-sized pickup truck with the tailgate left down.

Make sure the PISCES is tightly secured using appropriate strapping.

If driving on gravel roads, consider protecting the solar panels by taping cardboard around the tower. Upon arrival at the site, gently clean any dust that arose from transport from the tower components, especially the solar panels and beacon.

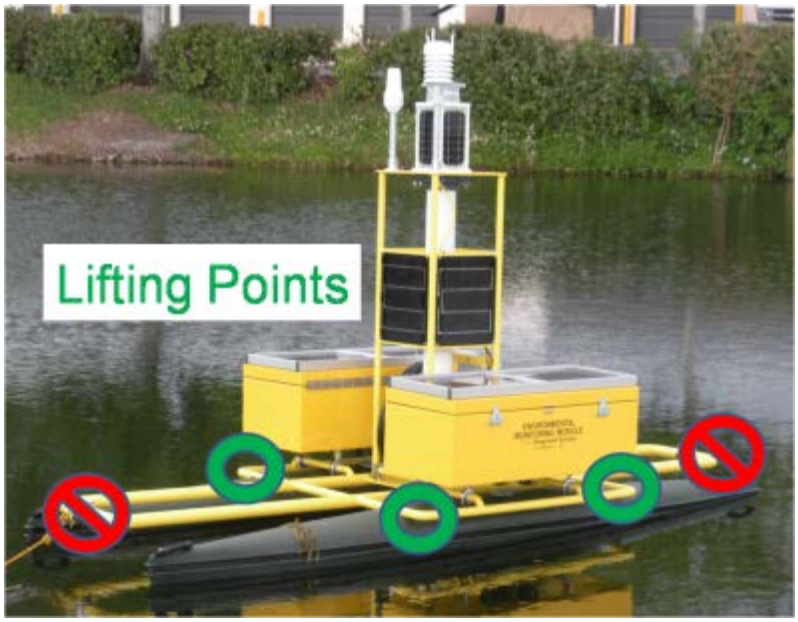

Figure 13. Lifting points.

4.2.2.2 Mooring

The PISCES anchoring system should be a minimum of about 227 kg (500 lbs). The anchor line length should be a 4:1 ratio of length:depth (see ECCC FWQMS-AA SOP *Arrays*). The mooring system is made up of three components: i) the anchors; ii) 1 m of 5 cm stainless-steel chain attached to the anchors; and iii) a nylon rope with a tensile strength of approximately 454 kg (1,000 lbs) attached to the chain (this rope attaches to the PISCES).

4.2.2.3 Deploying the PISCES

If the sondes were removed after testing, re-install them in the starboard-side chest while the PISCES is on dry land.

On the river, the PISCES can either be towed behind a vessel, or it can be held alongside the vessel and transported slowly to the deployment location. The latter requires several hands to hold the PISCES, as well as very slow travelling. Make sure that there is a tether line attached to the PISCES in case it is inadvertently released.

Figure 14. Towing the PISCES.

Secure the mooring line to the anchor point on the bow of the PISCES using a large shackle. Ensure that the shackles are secured with Loc-Tight and mousing wire.

Figure 15. Mooring point.

4.2.2.4 Activating Monitoring

1. **Activating monitoring:**

    a) Ensure the intake tubing is securely attached to the intake nozzles on the starboard-side chest. There is a clip on the tubing and a ring at the base of the met tower; ensure that these are securely connected. Carefully lower the intake tubing through the hole at the base of the tower. Ensure that the pressure valve on the peristaltic pump is engaged.

Figure 16. Pump valve.

b) Open the port-side chest, plug a laptop computer into the data logger using an SDI12 connector or adapter, and open the Loggernet software.

c) Click “Connect”.

Figure 17. Loggernet start-up screen.

d) Choose which station you wish to connect to.

e) Click “Connect”.

** **Note:** Click “Disconnect” before moving to another site and/or disconnecting your serial or USB serial from the datalogger serial connector (RS-232). **

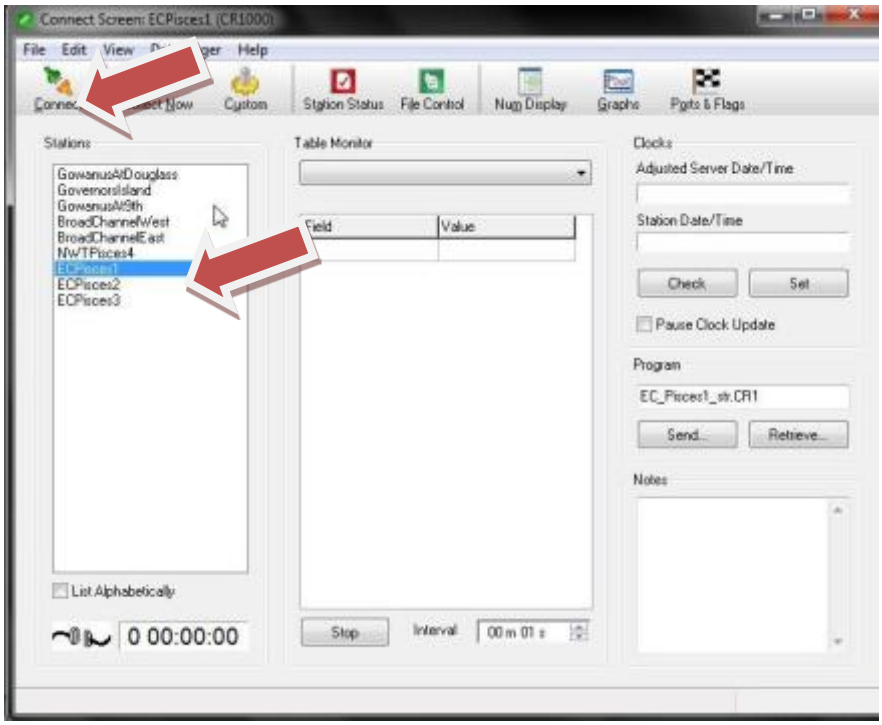

Figure 18. Loggernet connection screen.

f) Click “Num Display”. Click “Display 1”.

Figure 19. Loggernet connect screen.

g) Select the first row of the first column.

h) Click “Add” and choose “Public”; then, choose the data to view. You can also collect data, send data to the program, or collect data from the program while connected.

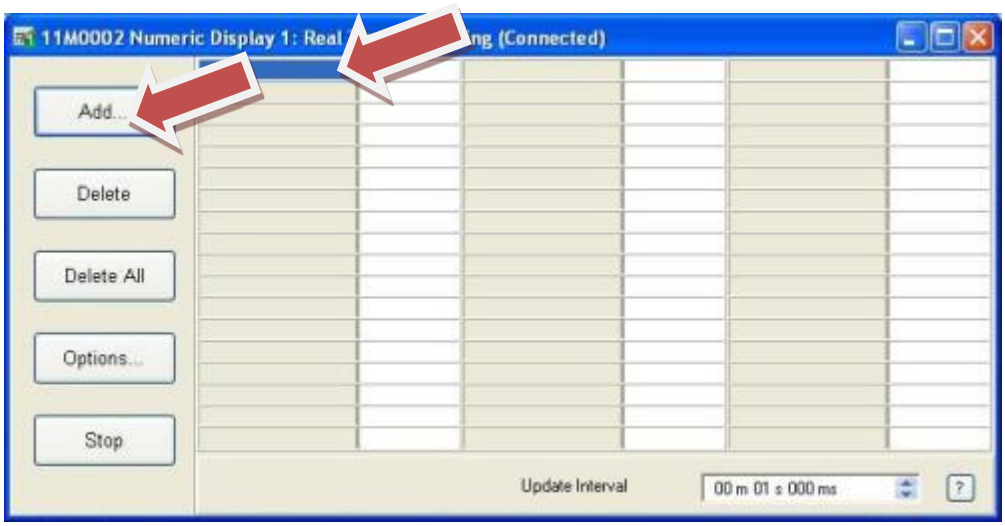

Figure 20. Loggernet real-time connect screen.

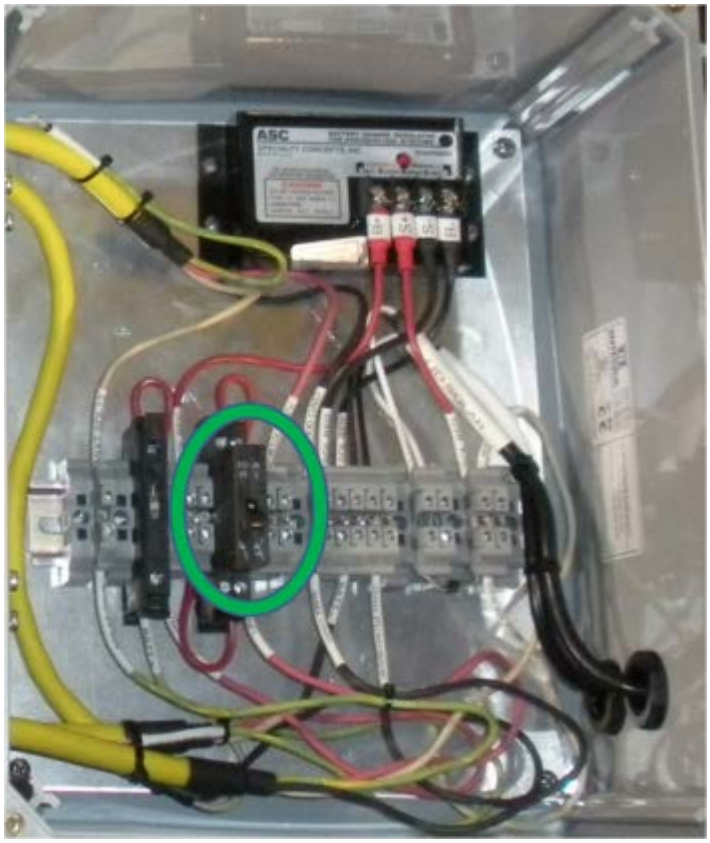

Figure 21. Main power switch.

i) Turn on the large power switch, which is in the port-side chest on the right-hand side. Wait until the next scheduled pump cycle to ensure that everything is functioning as it should be. Watch the entire pump cycle.

j) If you are confident that everything is running as it should be, disconnect the computer, and close and padlock all the boxes.

4.2.3 Monthly Maintenance

4.2.3.1 Checking Individual Components

- **Beacon:**
  - Check the lens for cracks;
  - Check the mounting hardware;
  - Check for moisture buildup inside the housing; and
  - Check for optic eye operation by covering the sensor to see if the beacon lights up.

Figure 22. Signal beacon.

- **Solar panels:**
  - Check the cables; and
  - Check the panels for any damage or excessive dirt. If the panels are very dusty, it will compromise their ability to charge the batteries. Use river water and a rag to wipe them down.

Figure 23. Solar panel.

- **Junction box:**
  - Check the integrity of the box;
  - Ensure the packing glands are tight;
  - Check the O-ring; and
  - Ensure that there is no moisture accumulation inside.

Figure 24. Junction box.

- **Power cable:**
  - Check the cable and connectors for damage or ultraviolet degradation;
  - Ensure the connectors are clean; and
  - Ensure the connectors are lubricated at each visit.

4.2.3.2 Swapping Sondes

Prepare the new sondes that will be installed with the procedure detailed in Appendix 7.4 and calibrate the QA/QC YSI sonde.

Make every effort to swap the sondes during the window between pump cycles to avoid an interruption in data. If you must swap the sondes while there is a risk that the pump cycle will start, turn off the main power to the PISCES first (see

Figure 11). Failure to do so could cause the pump to activate while the flow cell is disconnected, flooding the chest and damaging the wiring.

When you arrive at the PISCES, take note of the various site conditions, such as the air temperature, wind conditions, cloud cover, flow conditions, colour of the water, unusual odours, and debris on or around the PISCES. Take photos of any debris and then clear away any that has collected on the bow and mooring line. To anchor the boat to the mooring while working, clip a tether line to the PISCES frame.

Before opening the chest with the sondes, take a reading with the QA/QC YSI sonde at both 1 m and 4 m (or the chosen depths of the water-intake tubes). Record the readings.

Hold the QA/QC sonde and the new sonde to be deployed side by side in the river, if possible, and take readings from each. Conversely, take readings one at a time at approximately the same place. Record the readings on the field sheet and calculate whether the readings are within the acceptable ranges from USGS (USGS 2006) listed on the field sheet.

Pull up the intake tubes and clear them of any debris. Put them back into the water through the met tower. Open the chest and **secure the lid** (this is always important, but especially so when working in wind or waves).

The YSI 6600-series sonde is the closest to the front of the chest and has a clear flow cell; the Turner is the large sonde at the back of the chest with a black-flow cell. The procedure to swap these sondes is the same for both.

Remove the wingnuts (the lip of the lid makes a good shelf to hold these while working). If you drop a wingnut into the chest, use the magnet in your toolkit to retrieve it. Gently pull the sonde out of the bracket and remove the tubing from the flow cell by depressing the silver clip. Disconnect the data cable. Remove the flow cell and replace it with a clean and dry calibration cup (avoid touching the probes and **DO NOT** fill the calibration cup with water to avoid disturbing any fouling before drift measurements are completed). Rinse and brush out the flow cell, removing as much fouling and debris as possible. Place the flow cell on the new to-be-deployed sonde, reconnect all intake tubes and cables, and place in the brackets. Inspect the intake tubes, as well as the tubing, through the pump; ensure all are in good condition with no cracks or wear. Ensure that the intake tubes are not kinked or pinched. Replace and tighten the wingnuts.

Monitor the PISCES until the next scheduled pump cycle is complete. If there is a lot of time available, complete the water sampling while waiting. Connect a laptop computer to the data logger and watch the entire pump cycle to ensure that everything is functioning as it should be, and that the sonde is communicating with the data logger. Seal and padlock all the chests.

In a controlled environment, and within 24 hours, perform drift measurements and calibrations, as discussed in Section 4.1.4.3, “Data Retrieval”.

4.2.4 Seasonal Decommissioning and Storage

4.2.4.1 PISCES Removal

Tether a secure line from your vessel to the PISCES and secure a float to the mooring line. If it is almost time for a pump cycle, allow it to complete before turning off the main power. Take a reading from both depths of the intake tubing with the QA/QC sonde. Turn off the power to the PISCES. Disconnect the PISCES from the mooring line and tow it to shore in the same manner as deployment. Secure the PISCES on a trailer or in the box of a truck for transport.

4.2.4.2 Sinking the Mooring Line

The moorings for the PISCES are too heavy to remove without a crane. To use the same mooring line next season, sink the line in a manner that will enable you to find it again in the spring. Remove the nylon mooring line. Pull the mooring cable in as much of a vertical direction as you can, so that your vessel is directly on top of the anchors. Take a GPS reading. Attach a floating line to the end of your stainless-steel mooring cable and allow your boat to drift downstream. Attach a small (23-kg or 50-lb) anchor to the end of your floating line, take a GPS reading, and drop your anchor. In the spring, using a weighted hook, trawl back and forth between these two GPS points until you hook onto your submerged, floating line.

4.2.4.3 Preparing PISCES for Storage

Using warm water and a mild detergent, thoroughly clean all solar panels, the outside of the chests, and the PISCES pontoons.

Remove all intake tubing from the exterior and interior of the pump chest. Open the valve on the pump.

Remove the beacon signal by unscrewing the four corner bolts.

Remove the batteries from both chests.

Remove the silver U-bolts from the tower on one side and fold the tower down so it is resting on the frame.

PISCES can be stored in a cold storage shed for the winter. Leave the chests open for several days (or the full month between trips) to ensure they are completely dry.

5.0 Field QA/QC

The QA/QC requirement for automated sampling is two-fold: i) it provides confirmation of calibration of newly deployed instruments; and ii) it provides a

reference point from which to calculate instrument drift over the duration of the deployment.

QA/QC for any automated water quality sampling begins with proper maintenance and calibration in a controlled environment. Please see Appendix 7.4 for maintenance and calibration procedures for the automated instrumentation used by FWQMSD.

5.1 Methods

Whether YSIs are deployed on their own or as part of a platform, their calibration should occur within 24 hours of deployment to ensure limited pre-deployment instrument drift. Similarly, drift measurements should be completed within 24 hours of retrieval.

Upon arrival at an automated deployment, take note of the various site conditions, such as the air temperature, wind conditions, cloud cover, flow conditions, the colour of the water, unusual odours, and debris on or around the area of deployment. Take photos of any debris and then clear away any that has collected on the mooring line(s).

5.1.1 YSI

QA/QC measurements for auto-monitoring with the YSI are taken using a YSI 6820 multi-parameter sonde.

Before disturbing the deployment, take a reading with the 6820 sonde at the same depth as your deployment or intake tubing (for PISCES deployments, this should be done at both 1 m and 4 m). Record the readings on the field sheet (See Appendix 7.4 for the field sheet).

Hold the 6820 sonde and the new 6600 sonde to be deployed side by side in the river, if possible, and take readings from each (or take readings one at a time at approximately the same place). Record their readings and calculate whether they are within the acceptable ranges listed on the sheet. Record the measurements from both sondes on the field sheet.

5.1.1.1 Final Reading for Standalone Deployment

Pull the YSI deployment tube out of the water, remove the top cap of the tubing, and connect the YSI using a data/power cable to a 650 handheld display. With the YSI still in the deployment tubing, take a reading from your deployment depth. Record the measurements on the field sheet.

5.1.1.2 Final Reading for PISCES Deployment

Use the most recent data received from the PISCES as your final deployment reading. Use this data in the calculation for instrument drift (see Section 4.1.4.3, “Data Retrieval”).

5.1.2 Turner C6

The C6 probes are not known to drift over time, and calibrations are more stable and secure than those of the YSIs; therefore, the QA/QC requirements are less stringent. Simply record the initial deployment and final readings of the sonde, as transmitted by the PISCES, on the field sheet.

5.2 Turner C6

Detailed documentation is essential in support of QA/QC. Standard, comprehensive, and secure record keeping is essential to sample tracking, data integrity, and the interpretation of results.

All data records shall include:

- site name;
- site code;
- a list of crew members;
- sampling date and time (deployment and retrieval);
- period of deployment;
- identification of retrieved and deployed sondes;
- deployment depth;
- GPS coordinates (latitude and longitude);
- water depth (if possible, at deployment and retrieval);
- information regarding log file setup;
- confirmation of operations (witnessed wipers turning, etc.);
- all readings from the QA/QC, deployed, and retrieved sonde;
- times of retrieval and deployment; and
- comments – handling/debris/biofouling (degree/class/observations) of anomalous conditions.

This information will be used in data QA/QC and interpretation, and it will also include the identification of any samples that have been compromised.

The data records shall be backed up on a regular basis as a best practice.

6.0 References

Environment and Climate Change Canada. 2014. *Data Validation Procedures for Automated Water Quality Data*. DRAFT.

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YSI Environmental. 2006. *YSI 650 MDS User Manual*.

YSI Incorporated. 2006. *6-Series Multi-Parameter Water Quality Sondes User Manual*.

YSI Incorporated. 2011. *EcoWatch Lite Software User Manual*.

YSI Incorporated-Integrated System and Services. 2011. *EMM 350 PISCES User Manual*.

Additional information can be obtained at:

Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Email: ec.enviroinfo.ec@canada.ca