Standard Operating Procedure for:

The Measurement of Dissolved Oxygen, Temperature, Specific Conductance, pH, and Chloride using the YSI Professional Plus Handheld Multiparameter Meter

Missouri State University

and

Ozarks Environmental and Water Resources Institute (OEWRI)

Prepared by: _____ Date: _____
OEWRI Assistant Director

Approved by: _____ Date: _____
OEWRI Director

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1. Scope and Applicability

The YSI Professional Plus (YPP) multiparameter meter is used to collect water temperature, specific conductance, pH, dissolved oxygen, and chloride in streams and impoundments. The purpose of this document is to provide a protocol for collecting field-based water chemistry parameters, laboratory calibration procedures, instrument troubleshooting, and maintenance.

Manufactures Contact Information
YSI Incorporated
1725 Brannum Lane
Yellow Springs, Ohio 45387
Telephone: 800-765-4974
http://www.ysi.com

2. Summary of Method

This instrument is used to collect field-based water temperature, SC, DO, pH, and Cl. The instrument must be calibrated prior to going into the field using appropriate procedures to verify accuracy. At least one field duplicate shall be collected to verify precision during each sampling trip. Data and calibration notes are downloaded from the instrument using the communications saddle and Data Manager software provided and exported into a database format. Finally, the instrument shall be cleaned and stored properly according to the manufactures recommendations.

3. Definitions

Field Duplicate (FD): Two samples taken at the same time and placed under identical circumstances and that are treated identically throughout field and laboratory procedures. Analysis of field duplicates indicates the precision associated with sample collection, preservation, and storage as well as laboratory procedures.

Method Detection Limit (MDL): The lowest level at which an analyte can be detected with 99 percent confidence that the analyte concentration is greater than zero. The MDL is defined by the instrument manufacturer and is the lowest value of the instrument's detection range (see Table 1 in section 18).

4. Health and safety

When wading in streams where water depths ≥1 m, wear a life jacket and/or remove hip boots or chest waders. Be sure to wash your hands with bacteria disinfectant soap after wading in streams. This is particularly important for streams that drain livestock areas, sewage treatment plant effluents, and other obvious pollution sources. Wear protective gloves if necessary to avoid water borne illness.

5. Interferences

An improperly calibrated instrument can lead to erroneous results. See the manufacturer's instruction manual for proper calibration procedures and in section 8.

6. Personnel qualifications

Water chemistry parameters will be collected by OEWRI field personnel who have received appropriate training from experienced personnel, prior coursework, and field experience regarding the collection of water parameter data**.**

7. Equipment and supplies

1. Hard-sided carrying case
2. YSI Professional Plus Instrument (Serial Numbers: Sonde 1 – 14H100274; Sonde 2 – 14H100273)
3. 4-m quarto cable w/
    a. pH probe
    b. DO probe
    c. Chloride probe
    d. Temperature and conductivity probe
4. Probe storage cap
5. Probe protective cap
6. Cable management kit
7. Cable weight
8. 2-extra C batteries

8. Instrument Calibration

8.1 Calibration of the instrument should be carried out prior to using it in the field, ideally just before leaving or the day before. During periods of infrequent use, the probe should be calibrated once per month. The calibration order is as follows, DO, Specific Conductance, pH, and then Chloride. The chloride probe should be removed during the calibration of specific conductance and pH because of the interactions of high ionic liquids with the probe sensor stability.

8.2 Reagents and standards

1. 1,000 µS/cm conductivity calibration solution
2. pH 4.0 standard buffer solution
3. pH 7.0 standard buffer solution
4. pH 10.0 standard buffer solution
5. 500 ppm Chloride Standard
6. 10 ppm Chloride Standard

8.2.1 Preparing Standards

DO Deionized water is used to calibrate the probe to 100% dissolved oxygen.

pH and Conductivity pH buffer solutions and conductivity standards are purchased from a laboratory supply company and used without modification.

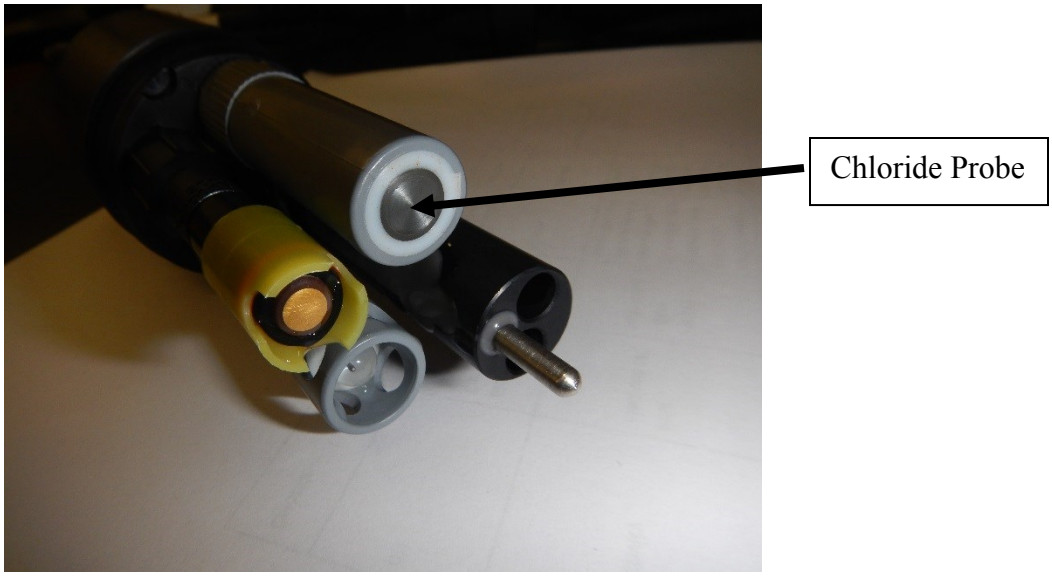
Chloride Certified 500 ppm chloride standard is purchased from a laboratory supply company. Add 0.5 grams of anhydrous magnesium sulfate to the 1 liter container. Invert and mix thoroughly to dissolve the solid reagent. The 10 ppm

chloride standard is made from the 500 ppm chloride standard. Carefully measure 20 mL of the 500 ppm chloride standard and add to a 1,000 mL volumetric flask. Add 0.5 grams of anhydrous magnesium sulfate to the flask. Add 500 mL of DI water, swirl to dissolve the solid reagents, and then dilute to the volumetric mark with DI water. Mix well by repeated inversion and transfer the 10 ppm standard to a labeled storage bottle. The shelf life of these standard solutions is 6 months.

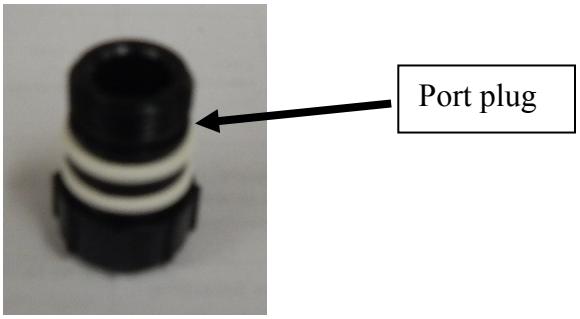
8.3 Calibration and standardization

Fill out the appropriate calibration bench sheet as the calibration is performed. Remove the Chloride probe before calibrating the instrument. This can be done during the 15 minute instrument warmup time.

1. Press the **Probe** button, highlight **Setup**, and press enter.
2. Highlight **ISE2 (Cl)** and press enter. Uncheck the enabled box.
3. Unscrew the Chloride probe.



4. Screw a port plug into the sensor port.



1. DO

Dissolved Oxygen is calibrated using a 1-point calibration method with water saturated air. The dissolved oxygen probe requires a 15 minute warmup time to provide accurate readings. Make sure the probe has been powered on for at least 15 minutes before beginning the calibration. While the instrument is warming up, check the DO membrane for any tears or wrinkles. If necessary, replace the DO membrane.

Rinse the sensor using DI water. Put a small amount of DI water into the plastic storage cup and attach it to the probe. Make sure there are no water droplets on the DO membrane or temperature sensor. Wipe off any excess water with Kimwipes. Leave several threads disengaged to ensure atmospheric venting. Let the probe rest for 10-15 minutes for the storage container to become completely saturated with oxygen. When the DO% and temperature values under “Actual Readings” have stabilized highlight **Accept Calibration** and press enter and then the **Cal** button.

Table 6.2 from the USGS National Field Manual lists oxygen solubility values for specific temperature and barometric pressure combinations. Find the DO value for the temperature and barometric readings taken at the time of calibration and record this on the calibration log sheet. The measured reading with the probe still in the storage cup should be within 5% of this published value.

2. Conductivity

Specific conductance is calibrated using a one-point calibration method using a 1,000 µS/cm conductivity calibration solution. Press **Cal**, highlight **Sp. Conductance**, and press enter. Highlight **SPC-uS/cm**, and press enter. Highlight **Calibration Value** and press enter to input the value of the calibration standard (1,000).

Rinse the probe and plastic storage cup, first with tap water and then with the calibration solution. Fill the plastic storage cup with the 1,000 µS/cm conductivity calibration solution, ensuring the entire conductivity sensor is submerged in the solution (or else the instrument will read approximately half of the expected value). Once the temperature and conductivity readings stabilize record the pre-calibration value, highlight **Accept Calibration** and press enter. Leave the probe in the calibration solution and record the post-calibration reading.

3. pH

pH is calibrated using a three-point calibration method using pH 4, 7 and 10 buffer solutions. Ensure the chloride probe has been removed from the instrument before calibrating pH. Press **Cal,** highlight **ISE1 (pH)** and press enter. The message line will show the instrument is “Ready for point 1”. Rinse the sensor and plastic storage cup with pH 7 buffer solution, and then fill the storage cup 2/3 with pH 7 buffer solution. The instrument should automatically recognize the buffer value and display it at the top of the calibration screen. If the calibration value is incorrect, the auto buffer recognition setting in the Sensor Setup menu may be

incorrect. If the calibration value is incorrect, highlight the **Calibration Value** and press enter to input the correct value.

Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the first calibration point. The message line will then display "Ready for point 2". Retain buffer solution for an after calibration reading.

Rinse the probe and storage cup with pH 4 buffer solution and fill the storage cup 2/3 with the buffer solution. Double check the **Calibration Value**, and adjust if necessary. Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the second calibration point. Retain buffer solution for an after calibration reading.

Rinse the probe and storage cup twice with pH 10 buffer solution and fill the storage cup 2/3 with the buffer solution. Double check the **Calibration Value,** and adjust if necessary. Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the third calibration point. Finalize the calibration by pressing the **Cal** button. Record the after calibration reading of the pH buffer solutions.

4. Chloride

Chloride is calibrated using a two-point calibration method using 500 ppm and 10 ppm standard solutions. Reinstall the chloride probe by unscrewing the port plug and replacing the chloride sensor. Be careful when screwing the sensor in, do not cross thread it. Enable the chloride sensor by pressing the **Probe** button, highlighting **Setup,** pressing enter, highlighting **ISE2 (Cl),** pressing enter, and checking the enable box.

Begin by thoroughly rinsing the probes and the storage cup with DI water. Press the **Cal** button, highlight **ISE2 (Cl),** and press enter. Rinse the probe and storage cup with the 10 mg/L Chloride standard and then fill the storage cup 2/3. Adjust the **Calibration Value** if necessary. When the reading stabilizes note the pre-calibration values on the bench sheet, highlight **Accept Calibration** and press enter. Reserve the standard for the post-calibration reading. Rinse and fill the storage cup 2/3 with the 500 mg/L Chloride standard. Adjust the **Calibration Value** if necessary. When the reading stabilizes note the pre-calibration values on the bench sheet, highlight **Accept Calibration** and press enter. Press the **Cal** button to finalize the calibration. Record the post calibration values on the bench sheet.

9. Collecting Data

A. Turn meter on 15 minutes before sampling, meter will be in "Run" mode. The DO parameter requires 15 minutes to acclimate before sampling.

B. Place probe in sampling location; gently stir with probe until readings stabilize. Movement releases air bubbles and allows accurate DO readings.

C. Press **Log One Sample** (highlighted) to open submenu.

D. Select the appropriate site name and folder (project), Highlight **Sites** or **Folders** and press enter to select other sites or folders to save your sample to. (Example: Site: Fort; Folder: Urban 319).

1) To create a new site or folder, scroll to the end of the current options and press **Add new…** Use the meter controls to label and select the **Enter** option to save.

E. Press **Log Now!** to capture results. Instrument will confirm successful data capture.

F. If logging samples at specific time intervals (rather than a single data point), press the **System** key (top left), scroll down to **Logging**, press enter, enable **Continuous Mode** and adjust to appropriate time **Interval**. Run screen will now show **Start Logging** rather than **Log One Sample**. Once a continuous log has started, the **Start Logging** option is replaced with **Stop Logging**.

10. Data acquisition, calculations, and reporting

A. Install Data Manager to computer; appropriate USB drivers will automatically be installed also.

B. Connect the Pro Plus instrument to the Communications Saddle and the saddle to the USB port on the computer.

C. During the first connection, Windows may prompt through the 'New Hardware Found' wizard to complete the USB driver installation.

D. Open Data Manager and turn on the Pro Plus instrument.

E. In Data Manager, select the correct instrument under the **Select Instrument** heading, click the **Retrieve Instrument Data** tab, and check **Data, GLP, Site List, Configuration,** or **Select All** to retrieve data. Click **Start**.

F. Once the file transfer is finished, that data can be viewed, printed, and exported from Data Manager and if desired, the data can be deleted from the Pro Plus instrument.

G. On the Pro Plus instrument, press the **File** key (top right) and select **Delete Data** if you do not want to keep the data on the instrument.

11. Computer hardware and software

The Data Manager software, communication saddle, and USB cable are provided for the instrument by YSI.

12. Method performance

See system specification table in Section 18.

13. Pollution prevention

All wastes from these procedures shall be collected and disposed of according to existing waste policies within the MSU College of Natural and Applied Sciences. Volumes of reagents made should mirror the number of samples being analyzed. These adjustments should be made to reduce waste.

14. Data assessment and acceptable criteria for quality control measures

A. The analyst should review all data for correctness.

B. Relative percent difference (RPD) should be calculated for pairs of duplicate analyses to determine precision.

C. The desired precision is ± 20%.

D. The completed report is reviewed by the analyst's supervisor or the OEWRI QA officer.

15. Corrective actions for out-of-control or unacceptable data

A. The results for precision and blank data are compared to the acceptable values for this analysis; ± 20% and 0, respectively, for all analytes

B. If data are unacceptable for any reason, the analyst should review their analytical technique prior to conducting this analysis again.

C. The instrument may require trouble shooting techniques if the data are unacceptable

1) Clean the probes
2) Perform maintenance procedures as outlined in manual
3) Replace defective sensors
4) Send the instrument to the manufacturer for repair.

16. Waste management

The wastes generated in this method are not hazardous. The quantities are very small and can be discarded in the laboratory sink.

17. References

A. Professional Plus Calibration Tips. 2009. YSI, Yellow Springs, Ohio.

B. Professional Plus Quick-Start Guide. 2009. YSI, Yellow Springs, Ohio.

C. Professional Plus User Manual. 2009. YSI, Yellow Springs, Ohio.

D. Professional Plus Water Quality Instrument – Specifications. 2011. YSI, Yellow Springs, Ohio.

E. Rounds, S.A., Wilde, F.D., and Ritz, G.F., 2013. United States Geological Survey National Field Manual for the Collection of Water-Quality Data. Chapter A6, Section 6.2

18 Tables, diagrams, flowcharts and validation data

A. YSI Professional Plus System Specifications (Cables and Sensors)

YSI Professional Plus System Specifications (Cables and Sensors)						
Parameter	**Sensor Type**	**Range**	**Accuracy**	**Resolution**	**Units**	**Calibration**
Dissolved Oxygen (%)	Polarographic	0 to 50 mg/L	0 to 20 mg/L	0.1 or 0.01 mg/L	mg/L, ppm	1 point

(temp comp range -5 to 45°C)	or Galvanic		(± 2% of reading or 0.2 mg/L, whichever is greater) 20 – 50 mg/L (± 6% of reading)	(user selectable); 0.1% air saturation		
Temperature (Field rugged cables)		-5 to 70°C	±0.2°C	0.1°C	°C, °F, K	
Conductivity	Four electrode cell	0 to 200 mS/cm (auto range)	±0.5% of reading or 0.001 mS/cm, whichever is greater (1-, 4-m cable) ±1% of reading or 0.001 mS/cm, whichever is greater (20-m cable)	0 to 0.500 mS/cm = 0.001 0.501 to 50.00 mS/cm = 0.01 50.01 to 200 mS/cm = 0.1 (range dependent)	µS, mS	1 point
pH	Glass Combination Electrode	0 to 14 units	±0.2 units	0.01 units	mV, pH units	1, 2, 3, 4, 5, or 6 point (user selectable); US, NIST or Custom Buffers
Chloride	Ion Selective Electrode	0 to 1000 mg/L, 0 to 40°C	±15% of reading or 5 mg/L, whichever is greater	0.01 mg/L	mg/L-Cl-, mV	1, 2, or 3 point (user selectable)

B. YSI Calibration Log

Date of Calibration: _____ Analyst: _____

Instrument Number: _____

DO membrane Checked? Y N DO membrane Changed? Y N

Record the following calibration values:

DO

Barometric Pressure at time of calibration (mmHg) _____

Air Temperature at time of calibration (°C)_____

DO of oxygen saturated air Post Calibration (mg/L) _____

Solubility of oxygen in freshwater at time of calibration (USGS Table) (mg/L) _____

Conductivity (µS/cm) – Pre_____ Post _____ Lot #_____

pH

pH 7 Pre_____ pH mV value_____ Post_____ Lot #_____

pH 4 Pre_____ pH mV value_____ Post_____ Lot #_____

pH 10 Pre_____ pH mV value_____ Post_____ Lot #_____

NOTE: Span between pH 4 and 7, and 7 and 10 mV values should be ≈ 165 to 180 mV. 177 is the ideal distance or 59 mV per pH unit.

Chloride

1st point (10 mg/L) Pre_____ Cl mV value _____ Post_____

2nd point (500mg/L) Pre_____ Cl mV value _____ Post_____

10 mg/L Cl mV range: 225 mV +/- 20 mV
500 mg/L Cl mV Range: ideally, 40 to 70 < 10 mg/L mV value

Record the following diagnostic numbers <u>after</u> calibration, by viewing the .glp file and reading the values for the day's calibration

Conductivity Cal Cell Constant _____ Range 5.0 +/- 1.0 acceptable

DO Sensor Value (uA) _____ (Membrane dependent, see DO Cal Tips)

pH Slope _____ (≈ 55 to 60 mV/pH, 59 ideal)

pH Slope % of ideal _____