Operation and Maintenance of YSI ProDSS Hand-held Water Quality Meter

Wet Tropics Major Integrated Project Standard Operating Procedure WTMIP SOP 005

Version 1.0

Wet Tropics Major Integrated Project

11 March 2020

Table of Contents

WTMIP SOP 005 – Operation and Maintenance of YSI ProDSS Hand-held Water Quality Meter

1. Purpose and scope

This document provides guidance on the operation and maintenance of an YSI ProDSS Water Quality Meter as part of the Wet Tropics Major Integrated Project (WTMIP).

The method outlined in this document applies when undertaking ProDSS maintenance and field use.

2. Training, competency and responsibilities

Program staff, contract staff, landholders and external stakeholders participating in the maintenance or collection of field readings using a ProDSS are provided with training in the use of the equipment. Records of participant competency are maintained within the Terrain Natural Resource Management (NRM) file management system (SharePoint). All program staff, contract staff, landholders and external stakeholders should familiarize themselves with the relevant industry standard operating procedures for sampling (DES 2018 & DSITI 2017) and review equipment manual/specifications before undertaking sample or data collection.

Table 1 Roles and responsibilities of WTMIP program participants

Position	Responsibilities
WTMIP Project Leader	Provide resources for the implementation and continued development of this method.
WTMIP Water Quality Project Officers (Leader/Technicians)	Ensure methods described in this method document are followed. Train new staff members in the methods. Continually review and develop the methods where appropriate.
WTMIP program staff, contract staff, landholders and external stakeholders	Follow the methods described in this document. Provide feedback to WTMIP Water Quality Project Officers for continued development of this method document.

3. Workplace health and safety

Field based and office work activities must adhere to Terrain NRM work health and safety (WHS) requirements. The following procedures and available equipment must be considered prior to undertaking maintenance or fieldwork:

- Joint Corporate Nature, Terrain NRM, Cape York NRM and Northern Gulf Resource Management Group Health and Safety Policy and Procedures Manual.
- Terrain NRM Water Quality Monitoring Risk Assessment.
- Personal Protective Equipment, such as safety boots, pants, long sleeved shirt, hat.
- Relevant material safety data sheets

4. Record keeping

For each instrument the following procedures and documents should be established and kept up to date:

- List of spare parts and suppliers/sources for repair
- Maintenance and calibration schedules
- Electronic record of inspection, maintenance and repair activities detailing dates and people involved
- Electronic record of calibration activities detailing dates, times, results, standard(s) used, and people involved. Keeping records allows it to be determined whether the equipment has been maintained in a sound operating condition and the recorded data is credible. This information is vital when undertaking investigations or if an audit is taking place.

5. Calibration equipment

Equipment required for this procedure includes:

- YSI ProDSS and calibration cup
- Toughbook with downloaded calibration record sheet and KorDSS program
- YSI ProDSS port to USB cable
- Calibration solution for conductivity, turbidity, pH, oxidation-reduction potential (ORP), dissolved oxygen
- Personal Protective Equipment (PPE) – Protective glasses, gloves, long sleeve shirt, closed-in shoes.
- YSI ProDSS replacement probes and tools
- YSI ProDSS maintenance schedule

Table 2 Calibration solutions

Manufacturer	Parameter/Reagent	Calibration point
Australian Chemical Reagents (ACR)	pH	pH 4, 7 and 10
ACR	Conductivity	50 µS/cm, 1000 µS/cm both at @ 25°C
YSI	Turbidity	124 FNU
Cairns Regional Council Water Laboratory	RO Water (zero turbidity)	0 FNU
ACR	Redox/ORP (A & B Solutions)	240 mv @ 25°C
ACR	Nitrate as nitrogen (NO_3_N)	1 and 10 mg/L
Tap water or environmental water sample	DO	DO %

Figure 1 YSI ProDSS and calibration cup (photo source ysi.com)

Figure 2 ACR & YSI Calibrations Solutions

Figure 3 Gloves and safety glasses (photo source Safetyequip.com.au)

Figure 4 Sensor installation

1 Sensor	4 Sensor retaining nut
2 Port plug	5 Sensor installation/removal tool
3 Bulkhead (4 port pictured)	

Figure 4 Sensors & tools (photo source ProDSS user manual, 2016)

Figure 5 Toughbook & KorDSS software icon

Calibration Worksheet

	UTC Time	Coordinated Universal Time
Start Date/Time	26/06/2019 9:56	
End Date/Time		
Previous Calibration Date	4/06/2019 09:46	
Technician	Emma-Lee Harper	

Sensor Type	Dissolved Oxygen	Sonde Type	ProDSS
Sensor SN	18F102197	Sonde SN	18G101321
Sensor Firmware Version		Sonde Firmware Version	
Calibration Parameter	DO %	Sonde ID	ProDSS 1 Tully

QC score: Pass

	Cal Point 1	Cal Point 2	Cal Point 3
Standard	Sat %		
Pre Calibration Value	103.2		
Post Calibration Value	100.5		
Raw Value			
Temperature	21.2		
Additional Input 1			
Additional Input 2			
Additional Input 3			
Type	Deionised Water		
Manufacturer			
Lot Number			
Calibration Point Accepted	Yes		
Stability Achieved	Yes		

Completed: Yes

Additional Post Calibration Info:

Figure 6 Calibration Worksheet (page 1 used as example)

6. Calibration method

The methods outlined below have been formed on guidance provided in the following documents:

- YSI 2016. ProDSS user manual Rev D.
- YSI 2016. ProDSS Instrument QSG Rev B.
- YSI 2017. EXO user manual web Rev D

6.1 Pre-calibration preparation

6.1.1 General clean and sensor QC check

1. Familiarise yourself with the safety data sheets for each of the calibration reagents.
2. Clean unit, wash sonde with fresh water and soft cloth to remove any foreign matter. Remove calibration cup from sonde bulkhead. Hold calibration cup and twist the black ring (**Figure 1**) at the top of the calibration cup in an anticlockwise direction. The calibration cup should now slide off. Clean the calibration cup as this holds the reagent during the calibration process.
3. Remove black protective housing from the sonde bulkhead (**Figures 1**) holding the top and bottom, twist your lower hand anticlockwise. The protective sonde housing will unscrew and slide off.
4. When cleaning, check for build-up of foreign material on sensors and bulkhead, remove if present using a soft cloth. Be careful not to touch the sensitive areas of the sensors (**Figure 7**), as this can cause damage to probe components.
5. Once probes, housing and calibration cup are clean, re-attach the black protective housing outlined in step 2 by screwing on in a clockwise direction.
6. Using the YSI ProDSS port to USB cable, attach the cable to the YSI and into the USB port on the Toughbook. Open the program KorDSS on the Toughbook desktop (**Figure 5**) and select “Connect to Sonde” on the far right-hand side of the home screen.
7. At the bottom of the screen a green, yellow or red bar will show up showing the combined QC score of the sonde and sensors. Green is good, Yellow is a warning (sensor either require calibration, maintenance or are nearing the end of their life, requiring) and Red is a failed QC score. Note the QC score for the unit in the calibration worksheet (**Figure 6**).
8. If the QC score is yellow or red, at the top of the screen select “sensors” and it will display individual sensors. Record in the calibration worksheet any sensors that are coloured yellow or red. These will need to be re-checked after calibration to ensure they are working correctly and do not require replacing

Figure 7 Sensors – Areas of sensitivity (photo source ysi.com)

6.1.2 pH and pH/ORP clean

pH and pH/ORP sensors require periodic cleaning to ensure the sensor is free from contamination or build up on the sensing elements (reference junction). These contaminants can cause slower response time and, as such, pH and pH/ORP sensors should be cleaned **before** the scheduled monthly calibration.

pH and pH/ORP cleaning method

Stepwise methods to conduct a clean of the sensing elements of pH and pH/ORP probes is provided below.

Please Note: Do not physically scrub or swab the glass bulb. The bulbs are fragile and will break if pressed with sufficient force.

1. Remove sensor from bulkhead using a small metal sensor installation tool (**Figure 13**).
2. Rinse the sensor with clean RO water and ensure any outward signs of dirt and debris are removed.
3. Soak sensor for 10-15 minutes in a mild solution of RO water and Decon (**Figure 8**).
4. Take the sensor out of solution and rinse with RO water. Inspect for build-up of algae or calcification on sensor tip.
5. If no build-up is seen move on to calibration of the sensor in **Section 6.3.1**. and post calibration sensor check in **Section 6.3.4**.
6. If contaminants remain or if response time during calibration or post-calibration spot check does not improve (pH sensor has been in the calibration solution for over 1 minute and stabilisation has not occurred), soak the sensor in one molar (1 M) hydrochloric acid (HCl) for 30-60 minutes (**Figure 8**).

   Please ensure instructions on the HCl chemical safety data sheet is followed.
7. Rinse the sensor in clean tap water.
8. Soak the sensor in clean tap water for 60 minutes, stirring occasionally. Repeat the rinse in clean tap water.
9. Attach the sensor to the bulkhead using a small metal sensor installation tool (**Figure 13**).
10. Repeat the calibration of the sensor in **Section 6.3.1**. and post calibration sensor check in **Section 6.3.4**.
11. If contaminants remain or if response time during calibration or post-calibration spot check does not improve, soak the sensor for one hour in a 1:1 dilution of chlorine bleach and tap water.

    Please ensure instructions on the chlorine bleach chemical safety data sheet is followed.
12. Rinse the sensor in clean tap water.
13. Soak the sensor in clean tap water for 60 minutes, stirring occasionally. Repeat the rinse in clean tap water.
14. Attach the sensor to the bulkhead using a small metal sensor installation tool (**Figure 13**).
15. Repeat the calibration of the sensor in **Section 6.3.1**. and post calibration sensor check in **Section 6.3.4**.
16. If contaminants remain or if response time during calibration or post-calibration spot check does not improve, the sensor will need to be replaced. **Contact a Water Quality Project Officer for advice.**

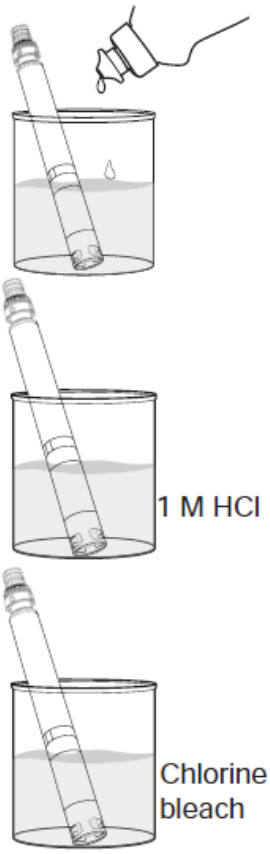

Figure 71 pH and pH/ORP sensor maintenance

pH - pH/ORP sensor maintenance

1. Remove the sensor from the bulkhead and soak for 10 to 15 minutes in a mild solution of clean water and dish soap (Figure 71).
2. Rinse the sensor with clean tap water and inspect.
3. If contaminants are removed, attach the sensor to the bulkhead and test the response time (ProDSS sensor installation/removal on page 9).

   OR

   If contaminants remain or response time does not improve, continue to the hydrochloric acid (HCl) soak in step 4.
4. Soak the sensor for 30 to 60 minutes in one molar (1 M) HCl.

   NOTE: *HCl reagent can be purchased from most chemical or laboratory distributors. If HCl is not available, soak in white vinegar.*

⚠ **CAUTION:** To prevent injury, carefully follow the HCl manufacturer's instructions.

5. Rinse the sensor in clean tap water.
6. Soak the sensor in clean tap water for 60 minutes, stirring occasionally. Repeat the clean tap water rinse.
7. Attach the sensor to the bulkhead and test the response time. If response time does not improve or biological contamination of the reference junction is suspected, continue to the chlorine bleach soak in step 8.
8. Soak the sensor for approximately one hour in a 1:1 dilution of chlorine bleach and tap water.
9. Rinse the sensor with clean tap water.
10. Soak the sensor in clean tap water for one hour or longer. Repeat the clean tap water rinse.

Figure 8 Stepwise procedure for cleaning the sensing elements on pH and pH/ORP sensors (ProDSS User Manual, 2016)

6.2 Calibration preparation

1. Prepare the calibration record sheet by filling in details such as date of calibration, operator-performing calibration and last calibration date.
2. Clear adequate space for calibration process, preferably next to a sink or waste disposal and wipe down all surfaces in the workspace.
3. Check calibration reagents for date of manufacturing, this will help you establish if the reagent is still fit for purpose and within date. Any open bottles should be initialled with the date the solution was opened and the person who opened it. Once a solution is opened, the life span of the reagent is reduced significantly (see manufacturing specification on bottle). Ensure any calibration solutions used are within the specified shelf life (sealed or opened).
4. Ensure all the required PPE is available (see Section 5 above).

6.3 YSI ProDSS calibration

6.3.1 Calibration

1. Turn on the ProDSS by pressing the button with the green power symbol at the bottom right of the keypad.

2. Once powered, the display will list the parameters for the installed probes. To check that the temperature sensor is working for temperature adjusted calibrations, place the sonde into a bucket of water with another temperature gauge (either a digital thermometer or another ProDSS). Record results in the calibration worksheet (**Figure 6**). If the temperatures are more than 1-degree different contact a Water Quality Project Officer for advice.
3. Select the calibration option, second from the left at the top of the ProDSS keypad (**Figure 9**).
4. Scroll through and select the parameter that requires calibration (**Figure 11**).
5. Select the corresponding reagent for the parameter requiring calibration.
6. Place a small volume of calibration standard inside the calibration cup. Insert the sonde into the calibration cup and twist the black tightening ring to seal the calibration cup. Shake the calibration cup containing the sonde and standard, turning the sonde upside down in the process to ensure a thorough rinse with the calibration solution.
7. Unscrew the calibration cup and tip out the standard, slightly shake the sonde to remove excess standard. To avoid contamination after the rinse, **do not** let the sonde touch anything until the calibration cup is sufficiently filled with the clean calibration standard.

Repeat steps 6 & 7 three times to ensure an adequate rinse

8. Fill clear calibration cup to the lower standard marker, tipping the calibration cup slightly to avoid bubbles forming in the solution during the pour (**Figure 10**). This indicator ensures you have enough volume to cover all probes adequately with the exception of conductivity which needs to be filled to the second standard marker to ensure the vent holes towards the top of the sensor are covered.
9. Insert sonde bulkhead in calibration cup.
10. Ensure there are no bubbles on the sensors as this can affect sensor readings. If there are bubbles present, remove the sonde and insert again.
11. The ProDSS display screen will show calibration settings and values (**Figure 12**). This value on the top of the display screen should align with the value of the calibration solution you are using. The ProDSS should automatically update calibration values when changing between calibrations solutions and adjust for solution temperatures. As this is not always the case, it is best practice to check that your calibration standard matches the calibration value on the ProDSS. Calibration values can be adjusted by changing the calibration value at the top right of the display screen.
    At the bottom of the screen is a graph displaying real-time calibration values against the post-calibration value. Your pre-calibration value needs to hold steady or produce a consistent flat line on the output graph before accepting the calibration. This can take several minutes, sometimes longer to stabilise.
12. Once the readings have stabilised for at least 45 seconds, record calibration details displayed on the ProDSS handheld in the calibration worksheet before following prompts and continuing with the calibration.

If you have any difficulties during calibration or the sensors are not stabilising (taking longer than 10 min to stabilise) then contact a Water Quality Project Officer for advice.

6.3.2 Calibration tips

Temperature/conductivity adjusted calibrations

Always ensure there is a temperature and conductivity sensor on the sonde when calibrating any sensors. Many calibration standards require temperature and/or conductivity corrections. This cannot be done without a temperature and conductivity probe installed on the sonde. If you do not have a temperature and conductivity probe installed it will produce an inaccurate calibration.

Conductivity sensors

When calibrating conductivity sensors always calibrate as specific conductivity. This will enable the YSI ProDSS handheld to compensate for the standards temperature and will allow for the simultaneous calibration of salinity. If you calibrate using conductivity this function will not be enabled.

Acceptable cell constant ranges

Highest Accuracy: 5.0 to 6.0

Acceptable: 4.5 to 6.5

Dissolved oxygen sensors

Dissolved oxygen sensors should be calibrated every day of use. Calibrating in % saturation will simultaneously calibrate mg/L and ppm.

Dissolved oxygen sensors use barometric pressure to calibration the level of dissolved oxygen in the water. Because of this it is recommended that the dissolved oxygen calibration is left for 15 min to stabilise. This allows the handheld and sensor to adjust for local barometric pressure conditions. You can check the accuracy of the local barometric pressure on the handheld by comparing with local weather data on bom.gov.au.

pH sensors

Always start your calibration with pH 7. The calibrations for pH 4 and pH 10 are formed by their relationship with pH 7 so it is important that pH 7 is calibrated first. The QC score for the pH sensor is also derived by the gradient or "delta slope" in mV between each calibration point. If the slope is too great the sensor will not perform within specification and will produce at unsatisfactory QC score.

Acceptable mV ranges

pH 7 mV value = 0 mV +/- 50 mV

pH 4 mV value = +165 mV to +180 mV from pH 7 mV value

pH 10 mV value = -165 mV to -180 mV from pH 7 mV value

Please note:

The mV span between pH 4 and pH 7 and pH10 should be approximately 165 to 180 mV. If the mV span drops below 160, clean the sensor and recalibrate.

ORP

ORP needs to be calibrated each day of use. If using a pH/ORP combined sensor calibrate pH first to ensure it is working.

ISE sensors

Exposure to the high ionic content of pH buffers can cause a significant, but temporary, drift in the ammonia, nitrate, and chloride sensors. Therefore, when calibrating the pH/ORP sensor, it is recommended that any ISE modules are removed from the sonde bulkhead and the ports are plugged. After pH calibration is complete, replace the ISE sensor and proceed with their calibration with no stabilisation delay.

Nitrate ISE sensors have been producing inaccurate results and have been indefinitely removed from use in WTMIP water quality monitoring. See Appendix B for nitrate sensor validation results.

If further details on the calibration process of chloride or ammonia ISE sensors is required, please see YSI ProDSS user manual.

Figure 9. YSI Handheld (photo YSI.com)

Figure 10. Calibration cup and markers (photo YSI.com)

Figure 11. Calibration home screen (photo YSI.com)

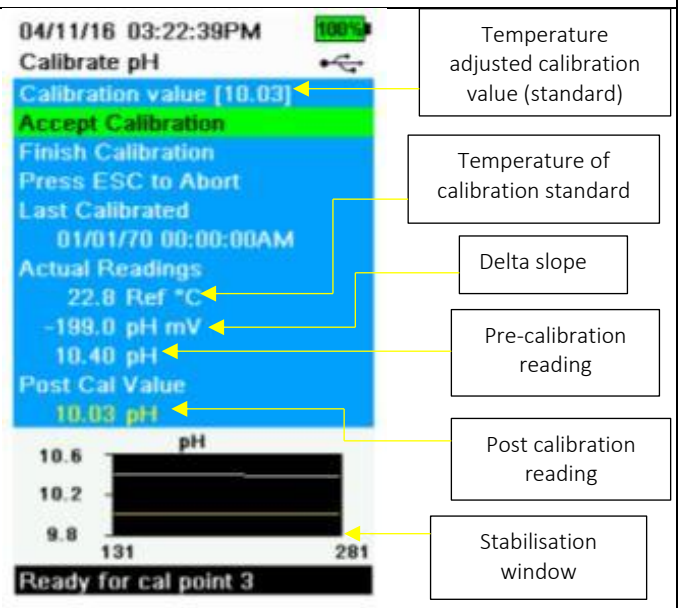

Figure 12. Example of a calibration screen (photo YSI.com)

6.3.3 Post calibration check

Connect the ProDSS back into KorDSS software to check the QC score of the handheld sonde after calibration.

1. Using the YSI ProDSS port to USB cable, attach the cable to the YSI and into the USB port on the Toughbook. Open the program KorDSS on the Toughbook desktop and select "Connect to Sonde" on the far right-hand side of the home screen.
2. At the bottom of the screen a green, yellow or red bar will show up showing the combined QC score of the sonde and sensors. Green is good, Yellow is a warning (sensors either nearing the end of their life or requiring calibration) and Red is a failed QC score. Note the QC score for the unit in the calibration worksheet.
3. If the QC score is yellow or red, at the top of the screen select "sensors" and it will display individual sensors. Record in the calibration worksheet any sensors that are coloured yellow or red. Yellow sensors are still within

specifications and are ok to be deployed. Red sensors are unfit for use and will need to be removed and replaced (either the whole sensors or the module depending on the type).

Contact a Water Quality Project Officer if the unit generates a yellow or red QC score.

6.3.4 Cross checking calibration solutions

Cross checking of calibration solutions is required after each sensor calibration to ensure the continued quality of calibration solutions and rule out the possibility of contamination or concentration through evaporation.

The stepwise procedures below outline the procedure for calibration solution checks.

1. Conduct the sensor calibration as outlined in **Section 6.3.1**.
2. Select a bottle of the same calibration solution used in Step 1, but produced by a different manufacturer, and place a small volume of solution inside the calibration cup (i.e. if you used YSI branded calibration solution for the initial calibration then use Australian Chemical Reagents (ACR) calibration solution for the spot check and vice versa). Insert the sonde into the calibration cup and twist the black tightening ring to seal the calibration cup. Shake the calibration cup containing the sonde and standard, turning the sonde upside down in the process to ensure a thorough rinse with the calibration solution.
3. Unscrew the calibration cup and tip out the standard, slightly shake the sonde to remove excess standard. To avoid contamination after the rinse, **do not** let the sonde touch anything until the calibration cup is sufficiently filled with the clean calibration standard.

Repeat steps 2 & 3 three times to ensure an adequate rinse.

4. Fill the clear calibration cup to the lower standard marker, tipping the calibration cup slightly to avoid bubbles forming in the solution during the pour (**Figure 10**). Filling to this marker ensures you have enough volume to cover all probes adequately with the exception of conductivity which needs to be filled to the second standard marker to ensure the vent holes towards the top of the sensor are covered.
5. Insert sonde bulkhead into the calibration cup.
6. Ensure there are no bubbles on the sensors as this can affect sensor readings. If there are bubbles present, remove the sonde and insert again.
7. The ProDSS display screen will show calibration settings and values (**Figure 12**). This value on the top of the display screen should align with the value of the calibration solution you are using. The ProDSS should automatically update calibration values when changing between calibrations solutions and adjust for solution temperatures. As this is not always the case, it is best practice to check that your calibration standard matches the calibration value on the ProDSS. Calibration values can be adjusted by changing the calibration value at the top right of the display screen.
   At the bottom of the screen is a graph displaying real-time calibration values against the post-calibration value. Your pre-calibration value needs to hold steady or produce a consistent flat line on the output graph before accepting the calibration. This can take several minutes, sometimes longer to stabilise.
8. Once the readings have stabilised for at least 45 seconds, record calibration details in the calibration worksheet.
9. If the results from the two calibration standards are within the sensor tolerances (**Table 3**), then the standards are of acceptable quality and no further action is needed. If the standards are not of acceptable quality, repeat the above **steps 1 to 8** with fresh un-opened standard solutions.
10. If the results from the two calibration standards are of acceptable quality. Re-calibrate the sensor with the fresh calibration standards following the steps in **section 6.3.1**.

If after re-testing with fresh calibration solution results are outside the sensor tolerances it is possible the sensors may require maintenance or replacing. It is also possible that the batch of calibration solutions received are of poor quality. Contact a Water Quality Project Officer for advice.

Table 3 YSI ProDSS sensor tolerances (Xylem, 2018)

Sensor	Tolerance
YSI pH	±0.2 pH units
YSI pH/ORP	±20 mV

YSI Turbidity	±2% of reading
YSI Conductivity	0 - 100 mS/cm: ±0.5% of reading or .001 mS/cm, whichever is greater 100 - 200 mS/cm: ±1.0% of reading.
Temperature	±0.2 degrees Celsius

6.3.5 Checking the operation of the pH and pH/ORP sensing elements

The sensing element of the pH and pH/ORP sensor is the reference junction. Occasionally dirt, debris and calcification of the sensor can block the reference junction causing inaccurate or unstable readings. The following test can be performed to determine if the reference junction of a pH electrode is making adequate contact with the sample solution.

To check the operation of the pH and pH/ORP sensing element, follow the stepwise procedure below.

1. Dilute 1 part of pH 6.88 buffer with 9 parts of MilliQ (i.e. a 1:10 dilution).
2. Measure the pH of the diluted buffer. The result should be 7.06 ± 0.02 pH units. Record results in the calibration worksheet (**Figure 6**).
3. If the value obtained is outside of these limits, then repeat the pH and pH/ORP sensing element clean described in **Figure 9** and perform the appropriate clean required as per the instructions supplied.
4. Re-calibrate the pH and/or pH/ORP sensor (see **Section 6.3.1**). Record results in the calibration worksheet (**Figure 6**).
5. Repeat **Steps 1** to **2**. If the value obtained is still outside 7.06 ±0.02 pH, then the electrode should be replaced. Record results in calibration worksheet along with a note in the maintenance sheet of sensor performance and notify a Water Quality Technician of the performance of the sensor.

6.3.6 Short term storage of sensors (under 4 weeks)

Store the ProDSS handheld and sonde with sensors back in the designated pelican case. Ensure the calibration cup housing the sensors has a small amount of water (1-5 mm) to ensure a humid environment for sensors. This is suitable for short term storage of no more than 4 weeks after field use, calibration and maintenance.

7. Acquiring Field Readings

7.1 Field equipment

- Site documents (hard copy or digital) with sample locations.
- PPE.
- YSI ProDSS and sturdy waterproof case.
- Sampling pole.
- Non-powdered vinyl disposable gloves, stored within sealed zip-lock bags to prevent contamination.

7.2 Procedure

1. Before heading into the field ensure any daily calibrations that may be required are completed (eg. Dissolved Oxygen and ORP).
2. Once on-site put-on task appropriate PPE and inspect the site for potential hazards.
3. Attach the ProDSS bulkhead to the sampling pole using the clamp. Unravel sufficient cable to extend the sonde bulkhead as close as possible to the centre of the stream avoiding vegetation, backwaters and eddies.
4. Turn the meter on and place the sonde in the water to a depth of 0.2 m (to reduce impact surface slicks) upstream from, or beyond the area of disturbance. Avoid touching the substrate and allow any water disturbed by the movement of the sonde to flow past you.
5. Gently shake the sonde to release any air bubbles that may be on the sensors.
6. Allow the readings to stabilise, this may take up to 5 min.

7. Once readings have stabilised check that “log one sample” is highlighted and hit enter. You may have to hit enter twice if the screen has lost illumination. Once to turn the screen light on and the second time to log the sample. The display screen will then display at the bottom of the screen “one sample logged”. Remove the sonde from the water.
8. To access measurement records from the ProDSS handheld, select file on the main handheld, save data, view data. Scroll down and across using the arrows to view all data logged.
9. Record the measured values directly into the laboratory Chain of Custody form (for LSM sampling) or in a notebook and save the reading if a memory function is available.
10. Record the following details: site details (e.g. site code, site name, waterway, GPS co-ordinates), date and time of measurement, all measured values, any factors that may have affected the measurement (e.g. presence of an algal bloom, recent rainfall etc.).
11. Store sonde back into the pelican case ensuring there is enough water in the calibration cup to create a humid environment for the sensors.

Note: Sometimes sampling can be conducted in a safer manner, or a more representative measurement can be taken by lowering the sonde into the water from a riverbank, bridge or boat. Generally, if sampling in a tidal area, sampling is to be conducted on the ebbing (outgoing) tide.

8. ProDSS maintenance

8.1 Battery replacement

The ProDSS uses a rechargeable lithium-ion (Li-Ion) battery pack as a power source. The battery comes pre-installed in the ProDSS and does not need to be replaced until the user deems the battery charge capacity unacceptable. The battery is shipped at less than 50% full capacity and charging the battery is not required before first use.

1. Power down ProDSS by pressing power button with green power symbol and disconnect charger if connected.
2. Put the ProDSS face down on a table or bench. Using a Phillips head screwdriver remove the four screws fixing the battery casing to the main body of the unit.
3. Remove the rear casing, be mindful of not damaging the rubber seal.
4. Removed faulty or dead batteries and replace with new rechargeable Li-Ion batteries (see manufacturing specifications).
5. Replace rear casing and fasten screws according to manufacturer’s specifications.

8.3 Sensor replacement

The following stepwise procedure outlines the removal of sensors for maintenance or replacement of faulty units.

1. Remove protective housing from sonde bulkhead.
2. Identify sensor for replacement.
3. Unscrew fastening ring at base of sensor (end connected to the sonde bulkhead). Insert sensor tool (see **Figure 13**) into rotating nut at the base of the sensor, turn in an anticlockwise direction and unscrew until free.
4. Hold sensor firmly, be careful not to touch sensitive areas at the end and side of sensor. Pull gently and the probe will dismount from the bulkhead.
5. To install new sensor, follow instructions accompanying replacement sensor or follow steps six through eleven.
6. Remove new probe from packing.
7. Locate lubricant supplied with new sensor and apply to O-rings on port end of sensor.
8. Remove new sensor from box, remove sensor from long term storage container.
9. Align new sensor with communication port, insert and push gently until seated.
10. Fasten sensor by inserting sensor tool (see **Figure 14**) into holes of fastening ring as outlined in **step 2**, turn in clockwise direction until tight, do not use excessive force.
11. Re-connect sonde housing to sonde bulkhead as outline in **section 6.1 step 4** of Pre-calibration preparation.
12. Sensor replacement complete.

NOTICE: The ProDSS bulkhead and sensor connectors are not wet-mateable. Make sure that the sensor and bulkhead connectors are clean and dry before sensor installation.

NOTE: *Sensor ports on the bulkhead (4 port cables only) are numbered (Figure 5). If multiple sensors of the same type are installed, the sensor port number will be added to the Run screen display to clarify the measurement value of each sensor.*

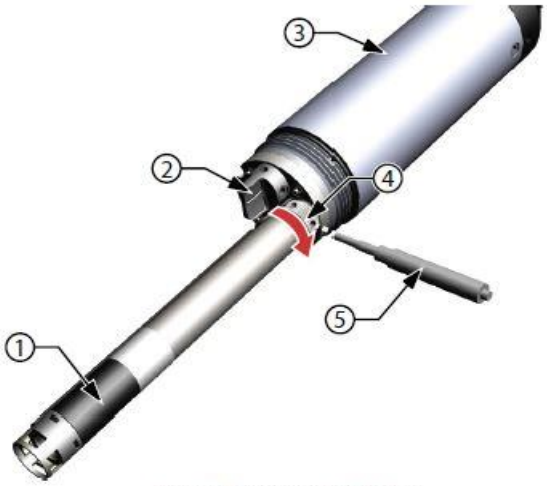

Figure 4 Sensor installation

1	Sensor	**4**	Sensor retaining nut
2	Port plug	**5**	Sensor installation/removal tool
3	Bulkhead (4 port pictured)		

Sensor installation

The ports on the ProDSS bulkhead are universal; therefore, you can install any sensor into any port.

NOTE: *A conductivity/temperature sensor (626902) must be installed in a 4 port ProDSS cable for accurate measurement of all parameters except turbidity and TSS. All sensors, including conductivity/temperature, must be ordered separately.*

1. Remove the port cover shipped with ProDSS cables. This cover fits over the bulkhead to protect the sensor connectors from contamination and damage during shipment. This cover can be kept for long-term cable storage.
2. Inspect the bulkhead port for contamination. If the port is dirty or wet, clean it with compressed air.
3. Apply a thin coat of o-ring lubricant to the sensor o-rings. Wipe off excess o-ring grease with a lint-free cloth.

9

Figure 13. Sensor installation (ProDSS User Manual, 2016).

8.4 Module replacement

8.4.1 pH module replacement

The following stepwise procedure from the ProDSS user manual 2016 outlines the removal of pH sensor modules for the replacement of old or faulty units.

1. Remove the protective housing from sonde bulkhead.
2. Identify sensor for replacement.
3. Unscrew fastening ring at base of sensor (end connected to the sonde bulkhead). Insert sensor tool (see Figure 13) into rotating nut at the base of the sensor, turn in an anticlockwise direction and unscrew until free.
4. Hold sensor firmly, be careful not to touch sensitive areas at the end and side of sensor. Pull gently and the probe will dismount from the bulkhead
5. Follow sensor specific module installation instructions provided by module supplier (Figure 14).
6. Align sensor with new module to the communication port, insert and push gently until seated.
7. Fasten sensor by inserting sensor tool (see Figure 15) into holes of fastening ring as outlined in step 2, turn in clockwise direction until tight, do not use excessive force.
8. Re-connect sonde housing to sonde bulkhead as outlined in section 6.1 step 4 of Pre-calibration preparation.
9. Sensor module replacement complete.

ProDSS sensor module replacement

ProDSS pH, pH/ORP, ammonium, chloride and nitrate sensors feature replaceable sensor modules. These modules can be replaced by the user as needed. Typical working life of a pH or pH/ORP sensor module is 18 to 24 months. Typical working life of ammonium, chloride and nitrate sensor modules is 4 to 8 months.

Perform the pH - pH/ORP and ISE sensor module replacement in a clean, dry laboratory environment.

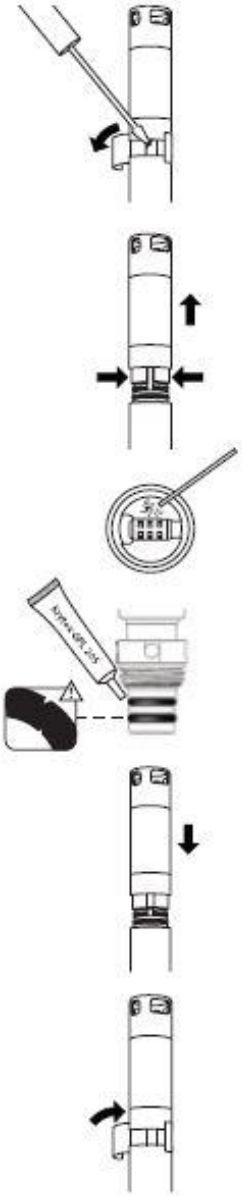

Figure 78 pH - pH/ORP sensor module replacement

Module replacement

1. Peel off and discard the sticker that covers the junction of the sensor body and the module (Figure 78).
2. With a small, flat-blade screwdriver, carefully remove the small rubber plug from the gap in the hard plastic ring at the base of the sensor module.
3. Using two fingers, squeeze the sensor module's hard plastic ring so that it compresses the gap left by the rubber plug.
4. Steadily pull the sensor module straight from the sensor body, rocking slightly if necessary.

   NOTICE: The o-ring is unusable after removal from the sensor body. Do not reinstall the removed sensor module or o-ring after removal. Dispose of the module according to you organization's guidelines or return it to YSI for recycling (Service information on page 82).
5. Inspect the sensor connector port for debris or moisture. If detected, remove it with lint-free cloth or a light blast of compressed air.
6. Visually inspect the two new o-rings for nicks, tears, contaminants or particles. Discard damaged o-rings.
7. Without twisting, carefully install the new o-rings over the threads and into the o-ring grooves.
8. Apply a thin coat of o-ring lubricant to the o-rings only. Wipe any excess from the threads and sensor module.

   NOTICE: If a sensor module is removed for any reason, the o-rings must be replaced.
9. Align the prongs on the base of the sensor module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation.
10. Push the sensor module firmly into position until it clicks. Wipe any excess o-ring lubricant from the assembled components.
11. Wrap the junction of the sensor module and sensor body with the new sticker included in the sensor module kit. The sticker helps keep the sensor module junction clean and retain the rubber plug throughout deployment.
12. Write the replacement date on the sticker.
13. Calibrate the sensor (pH/ORP on page 39 or ISE calibration 3-point on page 45).

Figure 14 pH module replacement (ProDSS User Manual, 2016).

8.4.2 Dissolved oxygen sensor cap replacement

The following stepwise procedure outlines the removal of DO sensor cap for the replacement of old or faulty units

1. Remove the protective housing from sonde bulkhead.
2. Identify sensor for replacement.
3. Unscrew fastening ring at base of sensor (end connected to the sonde bulkhead). Insert sensor tool (see **Figure 13**) into rotating nut at the base of the sensor, turn in an anticlockwise direction and unscrew until free.
4. Hold sensor firmly, be careful not to touch sensitive areas at the end and side of sensor. Pull gently and the probe will dismount from the bulkhead.
5. Follow sensor specific DO sensor cap installation instructions provided by module supplier (**Figure 16**).
6. Align sensor with new module to the communication port, insert and push gently until seated.
7. Fasten sensor by inserting sensor tool (see **Figure 13**) into holes of fastening ring as outlined in step 3, turn in clockwise direction until tight, do not use excessive force.
8. Re-connect sonde housing to sonde bulkhead as outline in **section 6.1 step 4** of Pre-calibration preparation.
9. Sensor cap replacement complete.

Maintenance and storage

Figure 66 ProDSS ODO cap replacement

Sensor cap replacement - ProDSS ODO Sensors

1. Turn the used sensor cap counterclockwise to remove it from the sensor.

   NOTE: If possible, do not use a tool to remove the cap from the sensor. If necessary, carefully turn the cap counterclockwise with pliers until it breaks loose. Do not use the pliers on the sensor body. Make sure to not damage the sensor cap threads.

2. Without using tools, remove the used o-ring from the sensor body (pinch the o-ring out, then roll it upward over the threads), then discard it.
3. Clean the sensor threads with a clean, lint-free cloth.
4. Visually inspect the new o-ring for nicks, tears, contaminants or particles. Discard damaged o-rings.
5. Without twisting it, carefully install the new o-ring over the threads and into the o-ring groove.
6. Apply a thin coat of o-ring lubricant to the o-ring only. Wipe any excess from the threads and sensor body.
7. Clean the sensor window with a clean, lint-free cloth.
8. Make sure the new sensor cap cavity is completely dry, then carefully finger-tighten the cap clockwise onto the sensor. The o-ring should be compressed between the sensor cap and body, not pinched.

   NOTICE: Do not over-tighten the sensor cap. Do not use tools.

9. Store the ODO sensor in a moist environment.

   NOTE: If the o-ring is pinched, remove and discard it. Repeat steps 3 to 8.

Figure 15. DO sensor cap replacement (ProDSS user manual 2016).

General considerations

- Sensors on sondes should be kept moist or wet at all times (depending on the sensor), and not be allowed to dry out. See the manufacturer's manual for specific directions on storing and transporting your instrument. Distilled water should not be used.
- Do not allow the sonde to touch the substrate as there is a risk of damage to the sensors from sticks, rocks, debris and anoxic sediments. Touching the bottom can also stir up sediments into the water column, changing the characteristics of the water being sampled. Depth can be determined in a boat by using the depth sounder. Thoroughly clean the sonde if it has accidently contacted with the substrate before taking any further readings.
- Verify that the instrument you are using compensates for factors such as temperature when measuring electrical conductivity, or whether results need to be adjusted by calculation (see Background information on water quality measurements using *in situ* water quality instruments document).
- Under natural conditions such as high algal density during sunlight, it is possible to have dissolved oxygen (DO) super-saturation (more than 100% DO).

Appendix A - References

DES 2018. Monitoring and Sampling Manual: Environmental Protection (Water) Policy. Brisbane: Department of Environment and Science Government.

DSITI 2017. Standard Operating Procedure FM010 Quality assurance and quality control procedures associated with the collection of water samples.

Xylem 2018. ProDSS multiparameter water quality filed instrument: Catalog W86-02 Revision B.

YSI 2013. pH Meters – Troubleshooting Calibration Problems with 12 practical steps. https://www.ysi.com/ysi-blog/water-blogged-blog/2013/04/ph-meter-calibration-problems-check-out-these-12-tips

YSI 2016. ProDSS user manual Rev D.

YSI 2016. ProDSS Instrument QSG Rev B.

YSI 2017. EXO user manual web Rev D

Appendix B - Nitrate sensor validation

Performance of the ProDSS ion selective electrode (ISE) nitrate sensor was assessed at the commencement of the routine grab sampling program. Field measured nitrate (NO_3_N) concentrations were compared to laboratory measured NO_3_N from grab samples collected at the time the ProDSS measurements were made. Data from January 2019 (39 comparisons) was used in the assessment as these data were collected after initial teething issues with the care and maintenance of the ISE sensors had been resolved. Data from freshwater sites only were used in the assessment. The January 2019 results, therefore, provide a good representation of the highest level of accuracy achievable with the use of the ISE sensors in WTMIP field monitoring.

The results of the comparisons are presented in **Figure 15**. ISE measured NO_3_N differed greatly from laboratory measured NO_3_N with ISE results ranging from 23-2000% of the laboratory measured results (R^2 = 0.24). In most cases the ISE sensors overestimated NO_3_N relative to the laboratory result (slope = 1.18). Based on these results it was decided that the ISE sensors did not generate results of adequate accuracy for use in the WTMIP, and field-based nitrate measurements using the ProDSS were suspended.

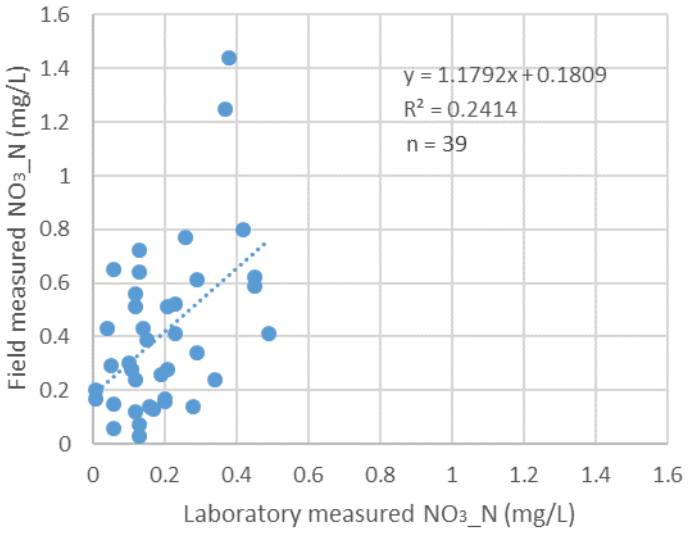

Figure 15 Relationship between nitrate measurements made using the ProDSS ion selective electrode and laboratory measured nitrate.

The assessment is documented in the Excel file 'MIP LSM_NSV checks_proDSS_analysis' saved under MIP/Knowledge & Info/Data storage on SharePoint.

Version Control

Document History	Date	Amendment:	Amended by:	Reviewed by:	Approved by:
Version WTMIP 1.0	11/03/2020	SOP prepared from reference documents cited in above document.	Chris Algar & Emma-Lee Harper (Terrain NRM)	Alicia Buckle (Terrain NRM) Romain Kobel (Terrain NRM) Dr. Ryan Turner (QLD Government, Department of Environment & Science).	Charles Hammond WTMIP Manager 11/03/2020

Terrain NRM and WTMIP partner organisations acknowledge the Water Quality and Investigations team at Queensland Government Department of Environment and Science for providing SOPs from the Great Barrier Reef Catchment Loads Monitoring Program as model documents for the development of WTMIP SOPs.