STANDARD OPERATING PROCEDURE

Measurement of Water Quality from Shrimp Farms and Inland Waters

Version	1.0	**Date of Issue**	05-12-2025

Purposes

This Standard Operating Procedure (SOP) describes standardized methods for **on-site measurement** and **laboratory-based analysis** of water quality variables relevant to aquaculture systems, especially shrimp ponds, canals, and adjacent waterways. It outlines pre-field preparation, field sampling, sample preservation, transport, storage, laboratory analysis, and quality assurance/quality control (QA/QC).

Scope

This SOP applies to:

- Shrimp farms (intensive, semi-intensive, rice-shrimp, mangrove-shrimp)
- Surrounding natural waters (streams, rivers, canals)
- Farmer-led citizen-science measurements
- Research monitoring programs requiring reproducible and comparable data

It covers two categories of measurements:

1. **In-situ measurements** using multiparameter field probes.
2. **Laboratory analyses** of collected water samples for nutrient, carbon, and organic matter concentrations.

Responsibilities

Before conducting a monitoring campaign, define:

- **Objectives** of monitoring (baseline, seasonal variation, pollution hotspot identification, farm-operation monitoring, etc.)
- **Variables to measure** (Table 1)
- **Monitoring frequency** (daily, weekly, per crop cycle stage)
- **Sampling sites** and spatial resolution
- **Laboratory capabilities and holding-time constraints**
- **Documentation and QA/QC responsibilities**

Table 1. Water Quality Variables

In-situ (Field Probes)	Laboratory Analysis
Temperature	Ammonium (NH_4^+-N)
Dissolved oxygen (mg/L, % sat.)	Nitrite (NO_2^--N)
pH	Nitrate (NO_3^--N)
Electrical conductivity	Total nitrogen (TN)

Turbidity	Ortho-phosphate (PO_4^{3-}-P)
Chlorophyll-*a* fluorescence	Total phosphorus (TP)
Date	Total carbon (TC), TIC, TOC
Time	Chemical oxygen demand (COD)
Site metadata	Biochemical oxygen demand (BOD)

Prerequisites

Before conducting a monitoring campaign, define:

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Responsibilities of each team:

- **Field Team:** Site selection, on-site measurements, water sampling, correct labelling, proper preservation.
- **Laboratory Team:** Sample logging, storage, processing, analyses, QC/QA.
- **Data Manager:** Ensures standardized data entry, annotation, and metadata archiving.

Required equipment and materials

Field Measurement Equipment

- Multiparameter probe (e.g., YSI 6-series or equivalent)
- Calibration solutions:
    - pH 4, 7; conductivity 1412 μS/cm; turbidity 0 & 100 NTU; DO barometric calibration
- Large bucket (15–20 L), pitcher, rinse water
- Waders or boots, long gloves
- Field notebook + waterproof pens
- Barometer or built-in atmospheric pressure sensor
- Cooling boxes with ice packs

Sample Collection Materials

- HDPE bottles (50 mL)
- Amber glass bottles (10–50 mL, carbon analyses)
- Syringe filters (0.45 μm PES), syringes (50 mL)

	• Sulfuric acid (H_2SO_4) for COD preservation • Labels, permanent markers • Disposable gloves • Bucket & pitcher for sample homogenization
Related documents	1. APHA, 2022. Standard methods for the examination of water and wastewater. American Public Health Association (APHA): Washington, DC, USA. 2. Ho, L., Thas, O., Van Echelpoel, W., Goethals, P., 2019. A Practical Protocol for the Experimental Design of Comparative Studies on Water Treatment. Water 11, 162. 3. van Loosdrecht, M.C., Nielsen, P.H., Lopez-Vazquez, C.M., Brdjanovic, D., 2016. Experimental Methods in Wastewater Treatment. IWA Publishing

Procedure

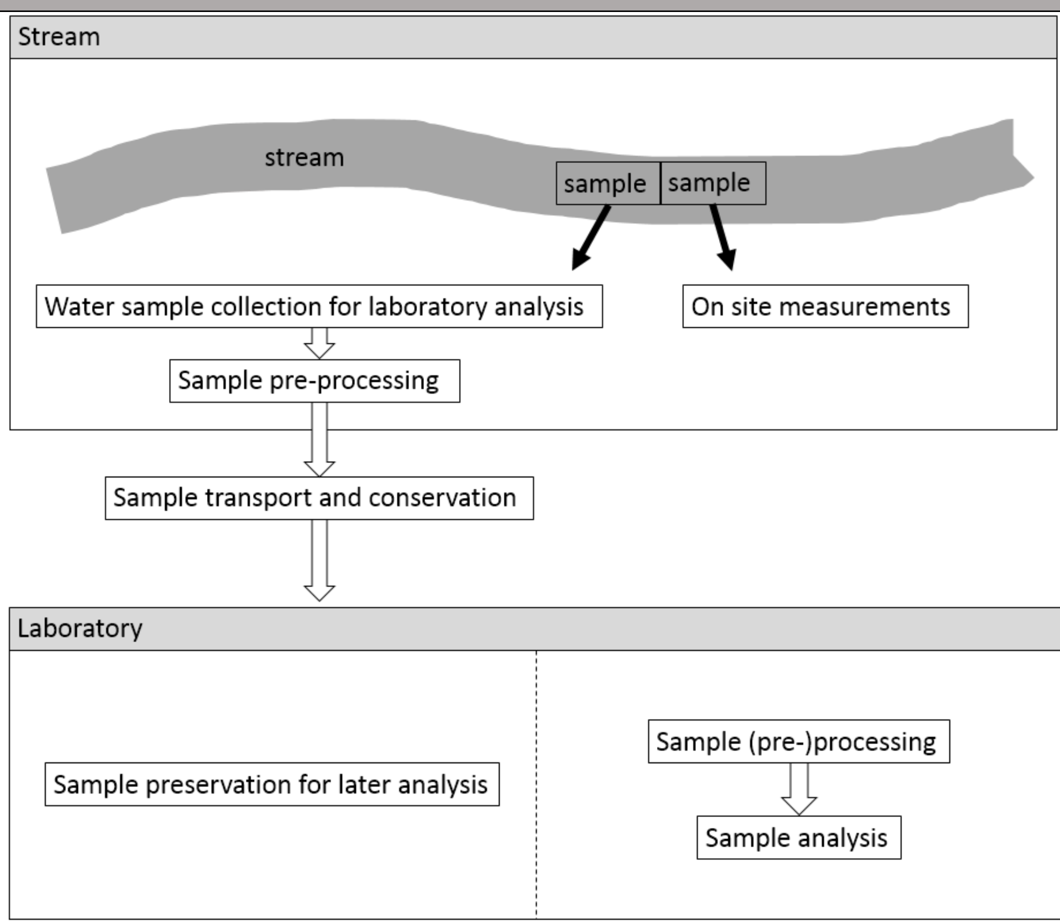

Figure 1. Procedural steps from sample collection to analysis.

Step 1: Pre-Field Preparations	1. **Check and calibrate probes** according to manufacturer instructions and frequencies (pH, DO, EC, turbidity, chlorophyll). Calibration logs must be kept.
	2. **Prepare sampling kits**:
	    o Label all recipients in advance
	    o Pre-preserve COD bottles with sulfuric acid (or prepare acid pipettes for field acidification)
	3. **Charge electronic devices** and verify data-logging settings (recommended: 30 measurements at 5-second intervals).
	4. **Freeze ice packs** and prepare cooling boxes.
	5. **Print field protocols** and check access permissions for sampling sites.

Step 2: Field Measurements (In-situ Probes)	**1. Site Selection (per visit)** Choose a location that is: • Well-mixed and representative • Free from sediment disturbance, vegetation, or recent livestock/farmer activity • Safe to access **2. Measurement Steps** 1. **Calibrate DO sensor** for local barometric pressure. 2. Rinse gloves and bucket 2–3× with sample water. 3. Collect water in a bucket unless conditions allow safe direct in-stream measurement. 4. Rinse probe sensors with sample water. 5. Immerse probe at least 10 cm depth; allow 2–3 minutes temperature acclimation. 6. Stabilize readings for 2–10 minutes. 7. Log ~30 measurements at 5-second intervals. 8. Record the final values in the field notebook as backup. **Important:** • Avoid aerating the sample. • Do not expose sensors to debris or turbulence. • Keep the bucket shaded to reduce temperature drift
Step 3: Water Sample Collection for	**1. General Collection Rules** • Wear clean disposable gloves; avoid contact between skin and sample.

Laboratory Analyses

- Homogenize water in the bucket gently using the pitcher.
- Never submerge bottles directly into the bucket.
- Rinse bottles 2–3× with sample water (unless pre-preserved).
- Fill bottles as required (with or without headspace).
- Store immediately in cooling box at 1–4°C and in the dark.

2. Filtration

For nutrients (NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}):

1. Fill syringe from pitcher;
2. Rinse syringe (no filter attached) with sample;
3. Attach new 0.45 µm PES filter;
4. Discard first 2 mL filtrate;
5. Rinse sample bottle with filtrate;
6. Fill bottle with filtered sample.

3. Preservation Overview

Variable Group	Preservation	Holding Time
NH_4^+, NO_2^-	Cool 1–4°C; analyze ASAP (<24h)	<24h or freeze (−20°C) 1 month
NO_3^-, PO_4^{3-}	Cool 1–4°C	<24h or freeze (−20°C)
TN, TP	Cool and dark	<24h or freeze
COD	Acidify to pH≤2 with H_2SO_4	Up to 7 days cooled or freeze
BOD	No preservation; analyze immediately (<6h)	If needed: <24h cooled
TOC/TIC/TC	Glass, PTFE-lid; analyze immediately	Freeze only if necessary

Step 4: Transport & Storage

1. Transport all samples in cooling boxes (1–4°C).
2. Keep all glass bottles protected from impacts and light.
3. Upon arrival, separate samples for:
   - Immediate analysis (≤6 h)
   - Next-day analysis (≤24 h)
   - Long-term storage (freezing −20°C)

Step 5: Laboratory Procedures

1. Sample Processing

1. Split collective sample (if taken) into separate bottles for Groups A–C.
2. Filter nutrient samples immediately if not already done in the field.

	3. Allow reagent kits and samples to reach room temperature before analysis. **2. Spectrophotometric Analysis (Hach/Lange cuvette tests)** • Follow manufacturer instructions. • Include **one analysis blank** and **at least one standard** per test run. • Use test standards within 30–60% of the test detection range. • Prepare dilution series for highly contaminated samples. • For colored or turbid samples, run **sample-specific blanks** and correct results accordingly. **3. Sample Analysis (use APHA standard methods)**

Quality management

QA / QC procedures

1. Probe Calibration

Sensors must be calibrated:

Sensor	Frequency
Conductivity	Weekly
pH	Weekly + 2-day verification
DO	Before each field day if elevation changes >50–100 m
Turbidity	Weekly
Chlorophyll	Weekly

A calibration log must include:

- Date/time
- Standard concentration
- Sensor drift
- Notes on anomalies

2. QC for Laboratory Data

Check data reliability using:

Blanks

- **Analysis blank:** deionized water; detects contamination and baseline drift.
- **Sample-specific blank:** detects color/turbidity interference.

Standards

A result is reliable if standard values fall within ±20% of expected performance (efficiency-corrected).

Plausibility Checks

- TN ≥ sum(NH_4^+ + NO_2^- + NO_3^-)
- TP ≥ PO_4^{3-}
- TC ≥ TIC and TC ≥ TOC
- COD ≥ BOD

Corrections

- Turbidity sensor correction: add +0.5 NTU or the most negative recorded value to ensure true minimum = 0 NTU.
- Sample blank subtraction required when color interference occurs.

3. Documentation

Field notebooks must record:

- Date, time, GPS coordinates
- Environmental observations
- Probe calibration verification
- Sampling conditions
- Deviations from SOP

Laboratory notebooks must record:

- Holding times
- Standard and blank results
- Dilutions, spikes, errors
- Observed anomalies with cuvette tests

Version Log

Version	Authors	Changes	Release Date
1.0	Long Ho	Initial SOP for Water Quality Monitoring	05-12-2025

Bibliography

APHA, 2022. Standard methods for the examination of water and wastewater. American Public Health Association (APHA): Washington, DC, USA.

Ho, L., Thas, O., Van Echelpoel, W., Goethals, P., 2019. A Practical Protocol for the Experimental Design of Comparative Studies on Water Treatment. Water 11, 162.

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