Water Quality Training

For Amerindian Rangers

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1. INTRODUCTION

Environmental Management is best assisted through Environmental Monitoring. Monitoring refers to collecting information by means of activities such as recording observations, making measurements and laboratory analysis of samples collected at a specific location or site of interest. Monitoring commonly involves visiting the site of interest to collect information according to a specific schedule and over a pre-specified length of time. Often, instruments are used to make "field" measurements at the site of interest and samples of air, water, plants or animals are collected and later analyzed at a laboratory. In this chapter we deal with monitoring specific to water quality.

Water is our most valuable, natural resource it has many diverse and important values - providing habitat sources for wildlife, water for households, water for mining purposes, factories and farms and recreational and educational benefits for us all. It has been said that approximately three fourth of the earth's surface is covered by water. However, what we do not realise is that only a very small portion of this water is for domestic use.

Historically, water was considered to be an unlimited resource and its long term quality and availability were taken for granted. The combination of this belief with a quest for development led to the exploitation of our natural resources and a continual decline in the health of our waterways. Furthermore, the fauna and flora that relied on healthy creek and river systems for survival suffered greatly and their numbers have gradually declined.

It is important to understand that we all live within a catchment area and that our day-to-day activities have the potential to impact on the health of our waterways. A catchment is the area from which all run-off-water flows to a low point to form a creek or river. It is bounded by natural features such as hills and mountains. Consider the roof of a shed as a catchment area and the gutters and downsizes as the river or creek. Everything that is on the roof, such as leaves and twigs, is washed away with the rainfall. This is how litter and pollutants are washed into our Waterways. Every Catchment is different, varying in size and land use types. Some catchments may contain large areas of natural reserves and mountainous terrain, while others maybe mostly urbanized. Catchment areas can be broken down into subcatchment areas for individual creek and river systems. You can plot your subcatchment area with the help of a topographic map. By starring at the mouth of the creek, trace back along the high points, indicated by the contour lines, outlining your subcatchment area.

Water Quality Monitoring allows us to collect regular data of water quality to assess the impacts of activities on the overall health of the catchment. Areas of concern can then be investigated and action plans developed in order to minimize the problem. Water Quality Monitoring provides and avenue by which we can assess the water quality of a given creek or river in order to understand the effects of human activity on the health of the catchment area. Monitoring also helps to evaluate the effectiveness of catchment management initiatives.

From water quality monitoring we can learn:

- Detrimental impacts on waterways as a result of the different land use types that exist within the catchment area
- Scientific analysis of water quality parameters in determining the health of the catchment
- Physical characteristics of waterways and the diversity of fauna and flora that rely on this fragile ecosystem for survival.
- Catchment management issues.

2. DESIGNING A WATER QUALITY MONITORING PROGRAM

The first step in designing a water quality monitoring program is to determine the purpose of the monitoring. This will help you select which parameters to monitor. The program steering committee should make this decision based on factors such as:

- Types of water quality problems and pollution sources that will likely be encountered
- Cost of available monitoring equipment
- Precision and accuracy of available monitoring equipment
- Capabilities of the monitoring personnel

Source	Common Associated Pollutants
Cropland	Turbidity, phosphorus, nitrates, temparature, total solids
Forestry harvest	Turbidity, temperature, total solids
Grazing land	Fecal bacteria, turbidity, phosphorus, nitrates, temperature
Industrial discharge	Temperature, conductivity, total solids, toxics, pH
Mining	pH, alkalinity, total dissolved solids, turbidity
Septic systems	Fecal bacteria, nitrates, phosphorus, dissolved oxygen/biochemical oxygen demand, conductivity, temperature
Sewage treatment plants	Dissolved oxygen and biochemical oxygen demand, turbidity, conductivity, phosphorus, nitrates, fecal bacteria, temperature, total solids, pH
Construction	Turbidity, temperature, dissolved oxygen and biochemical oxygen demand, total solids, and toxics
Urban runoff	Turbidity, phosphorus, nitrates, temperature, conductivity, dissolved oxygen and biochemical oxygen demand

Table 1

Sources and associated pollutants Water quality monitoring program should be geared to the types of watershed land uses most often encountered.

The parameters most commonly monitored in streams include **temperature, pH, turbidity, conductivity/total dissolved solids, total alkalinity, total solids, dissolved oxygen, stream flow, fecal bacteria, phosphorus and nitrates.** Of these, **temperature, pH, turbidity, Total dissolved solids, dissolved oxygen and stream flow** are the most basic and should form the foundation of almost any water quality monitoring program and are discussed here in detail.

Relatively inexpensive and simple-to-use kits are available from scientific supply houses to monitor these pollutants. Many monitoring programs use these kits effectively. Meters and sophisticated lab equipment may be more accurate, but they are also more expensive, less flexible (e.g., meters generally have to be read in the field), and require periodic calibration. This chapter discusses specific equipment and sampling considerations for each parameter, and usually describes several approaches to monitor them.

3. WATER SAMPLING

Preparation of Sampling Containers

Reused sample containers and glassware must be cleaned and rinsed before the first sampling run and after each run by following either Method A or Method B described below. The most suitable method depends on the parameter being measured.

Method A: General Preparation of Sampling Containers

The following method should be used when preparing all sample containers and glassware for monitoring conductivity, total solids, turbidity, pH, DO and total alkalinity. Wear latex gloves!

1. Wash each sample bottle or piece of glassware with a brush and phosphate-free detergent.
2. Rinse three times with cold tap water.
3. Rinse three times with distilled water.

Method B: Acid Wash Procedure for Preparing Sampling Containers

This method should be used when preparing all sample containers and glassware for monitoring nitrates and phosphorus. Wear latex gloves!

1. Wash each sample bottle or piece of glassware with a brush and phosphate-free detergent.
2. Rinse three times with cold tap water.
3. Rinse with 10 percent hydrochloric acid.
4. Rinse three times with distilled water.

Recording Sample Location

Why is the exact location of the sampling site important?

Water quality data are not useful if the sampling location is unknown, incorrect, or mismatched. It is important to know the location of the site where samples of water or bottom sediment samples are taken for analysis. The location provides information that makes it possible for other samples to be taken at the same place at a later time, to make comparisons, and for others to find the site. Use benchmarks of sampling sites depending on the need for future use and always record the geograpgic coordinate location (latitude and longitude)

What is latitude and longitude?

Navigational charts use latitude and longitude coordinates to mark positions. Latitude and longitude are indicated by degrees, minutes and seconds. Each degree has 60 minutes (‘); each minute has 60 seconds (“). Latitude is measured in degrees north or south relative to the equator. The equator is 0° latitude and the poles are 90° N and 90° S latitudes. Longitude is measured in degrees east and west of the Prime Meridian which is an imaginary line running from the North Pole to the South Pole through Greenwich, England. Data Sheets have blank spaces for latitude and longitude for each sampling station. These geographic coordinates can be inferred from topographic maps or directly read from Global Positioning (GPS) devices.

What is a Global Positioning System?

A more recent advance has been the Global Positioning System (GPS). This is satellite navigation and positioning system that can be accessed by a relatively inexpensive GPS receiver that can be used anywhere in the world. Developed by the U.S. Department of Defense, the first satellites for the system were deployed in 1978.

GPS consists of 28 satellites orbiting the earth, five ground stations, and GPS receivers. Ground stations monitor satellites in "known" positions and triangulation is used to determine position. The distances between the GPS receiver and a satellite are determined by a timing-signal process where the signal's travel time multiplied by the speed of light equals distance. Each satellite continuously transmits a unique high frequency radio timing signal sequence or a binary code. Signal travel time is determined by the difference between the GPS receiver's internal signal generation and the arrival of the satellite's signal.

Collecting Samples

In general, sample away from the stream bank in the main current. Never sample stagnant water. The outside curve of the stream is often a good place to sample, since the main current tends to hug this bank. In shallow stretches, carefully wade into the center current to collect the sample.

A boat will be required for deep sites. Try to maneuver the boat into the center of the main current to collect the water sample.

When collecting a water sample for analysis in the field or at the lab, follow the steps below.

For Whirl-pak® Bags

1. Label the bag with the site number, date, and time.
2. Tear off the top of the bag along the perforation above the wire tab just prior to sampling (Fig. 1). Avoid touching the inside of the bag. If you accidentally touch the inside of the bag, use another one.
3. *Wading.* Try to disturb as little bottom sediment as possible. In any case, be careful not to collect water that contains bottom sediment. Stand facing upstream. Collect the water sample in front of you. *Boat.* Carefully reach over the side and collect the water sample on the upstream side of the boat.
4. Hold the two white pull tabs in each hand and lower the bag into the water on your upstream side with the opening facing upstream. Open the bag midway between the surface and the bottom by pulling the white pull tabs. The bag should begin to fill with water. You may need to "scoop" water into the bag by drawing it through the water upstream and away from you. Fill the bag no more than 3/4 full!
5. Lift the bag out of the water. Pour out excess water. Pull on the wire tabs to close the bag. Continue holding the wire tabs and flip the bag over at least 4-5 times quickly to seal the bag. Don't try to squeeze the air out of the top of the bag. Fold the ends of the wire tabs together at the top of the bag, being careful not to puncture the bag. Twist them together, forming a loop.
6. Fill in the bag number and/or site number on the appropriate field data sheet. This is important! It is the only way the lab coordinator knows which bag goes with which site.
7. If samples are to be analyzed in a lab, place the sample in the cooler with ice or cold packs. Take all samples to the lab.

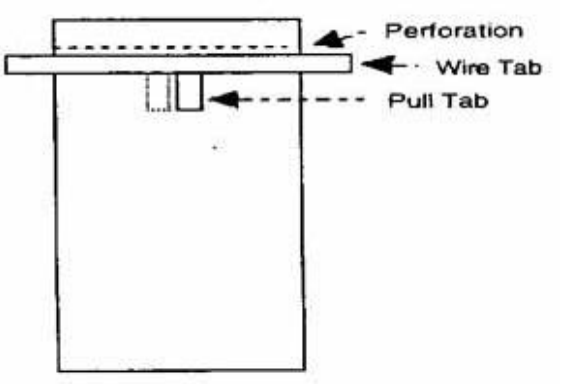


Figure 1

Sketch of a Whirl-pak® bag
Technicians can be easily trained to use these factory-sealed, disposable water sample collection bags.

For Screw-cap Bottles

To collect water samples using screw-cap sample bottles, use the following procedures (Fig. 2 and 3):

Figure 2

Getting into position to take a water sample
Technicians should sample in the mail current, facing upstream.

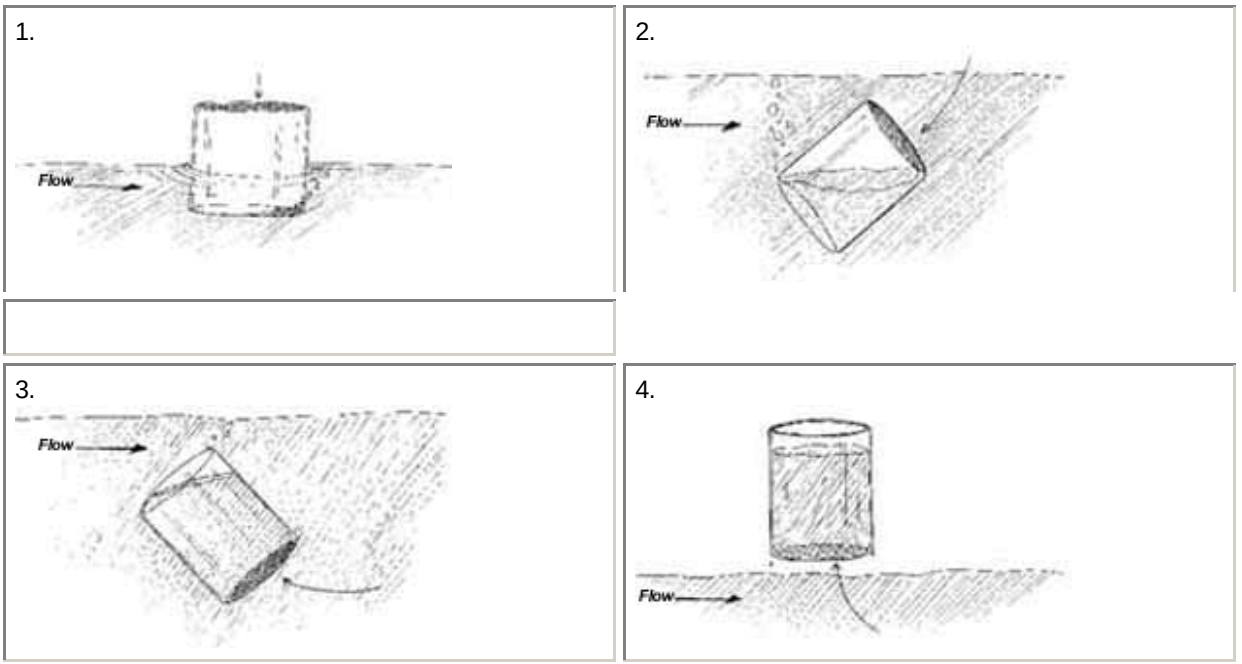


Figure 3

Taking a water sample
Turn the bottle into the current and scoop in an upstream direction.

1. Label the bottle with the site number, date, and time.
2. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap. If you accidentally touch the inside of the bottle, use another one.
3. *Wading.* Try to disturb as little bottom sediment as possible. In any case, be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you. You may also tape your bottle to an extension pole to sample from deeper water.
   Boat. Carefully reach over the side and collect the water sample on the upstream side of the boat.
4. Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream. Collect a water sample 8 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.
5. Turn the bottle underwater into the current and away from you. In slow-moving stream reaches, push the bottle underneath the surface and away from you in an upstream direction.
6. Leave a 1-inch air space (Except for DO and BOD samples). Do not fill the bottle completely (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.
7. Fill in the bottle number and/or site number on the appropriate field data sheet. This is important because it tells the lab coordinator which bottle goes with which site.

If the samples are to be analyzed in the lab, place them in the cooler for transport to the lab.

Sampling water at Depth

Two kinds of sampling bottles are used for depth water sampling: Van Dorn water sampling bottles and, Kemmerer water samplers. The idea behind these samplers is to allow water to be collected at a known depth. The Van Dorn bottles are used for sampling at various depths.

What are Van Dorn water sampling bottles?

The Van Dorn bottles provide a means of obtaining water samples at selected depths below the surface. It consists of an open ended clear plastic or PVC cylinder that can be attached to the hydrographic wire (the steel wire wound on the winch) in the case of vessels or to a rope/cable in case of boats and lowered to any desired depth. The bottles also provide a platform to which thermometers can be attached to record the temperature of the water at the location of each Van Dorn bottle.

Each end of the cylinder is fitted with a rubber cover. The Van Dorn bottle is attached to the line with the covers pulled out and twisted back and around to the side. The bottle is lowered to a pre-selected depth and left there until the thermometers attached inside come to thermal equilibrium with the water at that depth. The water sample is taken by dropping a "messenger" down the line. When the weight hits the catch on the upper Van Dorn bottle, the catch releases the rubber end covers. The two ends snap around and seal off the ends.

When the bottle is tripped, it is retrieved and returned to the storage rack. Water sample can then be taken for analysis and the temperature read from the attached thermometer. You may be able to see organisms in the water samples through the clear walls of the Van Dorn bottles.

When it is time to lower the Van Dorn bottles into the water, a decision is made about the depth to which to send the bottles. This decision is based upon the depth of the water at the station and the number of samples needed. Normally only two water samples (surface and bottom) are taken. Van Dorn bottle could be used to obtain a mid-depth or near surface samples. In shallow areas, typically only one water sample is taken.

Van Dorn sample bottles are well suited for general-purpose sampling at any depth. They are made in both a horizontal and vertical design with the horizontal most used for discrete point sampling at a given depth. The vertical bottle design is typically used for stratification studies with multiple or single samplers suspended by cable/rope.

A drain valve is provided for sample removal in both horizontal and vertical configurations. The advantage of the vertical configuration is that the water within the open bottle is flushed out as the bottle is lowered, so one can be guaranteed the water collected was collected from the indicated depth. The advantage of the horizontal configuration is that a very narrow depth range is sampled. Vertical configurations are most commonly used. The horizontal configuration should be used when samples are taken near bottom at the sediment-water interface, or when samples are required from a narrow band of the depth profile (i.e., chemocline, thermocline).

The sampling sequence recommended is to obtain the field measurements first (temperature, DO, conductivity). These are often necessary prerequisite for locating the depths from which the water samples should be taken (i.e., if three deep samples are required at a site then it might be necessary to know the depths of the major stratified zones - epilimnion, thermocline, hypolimnion).

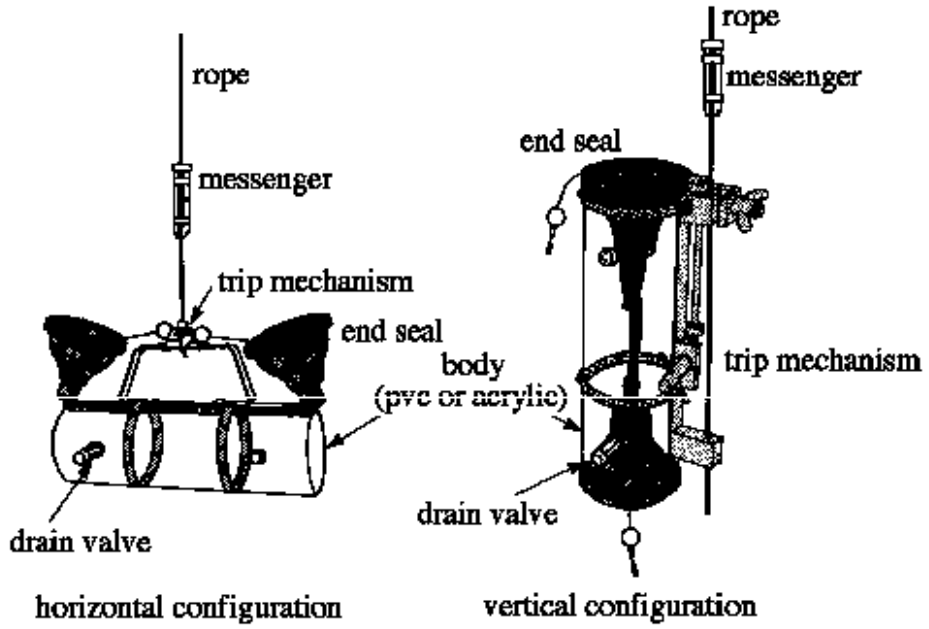


Figure 1. Van Dorn sampler

Alpha and Beta Van Dorn Type

Two types of each (of the vertical and horizontal design) are available depending upon the need for trace metal and organics sampling. Alpha Van Dorn bottle is used for general physical, chemical and biological sampling while Beta water samplers can be used for trace metals and organics.

Horizontal Beta Water Sampler

FEATURES

- Large volume - from 2.2 to 8.2 liters
- Amber latex closing tube for cleanliness
- Kits include bottle, plastic carry case, messenger & cable line (100 ft.)
- Bottles & bottles with cases also available

Intended for deep or shallow waters, these “horizontal” bottles are pulled sideways just before closing. This ensures a representative water sample for that specific depth of water. They cannot be used in series because their release mechanisms are at the end of a line or cable. They are ideal, however, for sampling at the thermocline, at other stratification levels, or just above the bottom sediments.

Beta bottles come in your choice of transparent acrylic or opaque PVC. PVC is more durable and less costly, but the acrylic allows you to view the contents immediately. A thermometer can be mounted to acrylic Beta™ bottles.

Horizontal Alpha Water Samplers

FEATURES

- Blue seals of durable, flexible, high-grade polyurethane resin with attached safety line
- Foolproof 316 SS trip head for durability
- Kits include bottle, plastic carry case, messenger & cable line (100 ft.)
- Bottles only & bottles with cases available

Intended for shallow or deep waters, these bottles are called “horizontal” because they descend horizontally, parallel to the bottom and are pulled sideways to close. This ensures a representative water sample for that specific depth. They are ideal, however, for sampling at the thermocline, at other stratification levels, or just above the bottom sediments.

These popular and versatile bottles come in your choice of transparent acrylic or opaque PVC. PVC is more durable and less costly, but the acrylic allows you to view the bottle contents immediately. This sampler requires a messenger and line for operation.

Instructions for the use of Van Dorn bottles

(1) Ensure the sampling bottle is clean.

(2) Open the sampler by raising the end seals.

(3) Set the trip mechanism.

(4) Lower the sampler to the desired depth.

(5) Send the messenger down to "trip" the mechanism that closes the end seals.

(6) Raise the sampler to the surface.

(7) Transfer the water sample from the Van Dorn bottle to individual sample containers via the drain valve. Take care to avoid contact with the drain spout as contamination at this stage often occurs.

(8) Rinse bottles 3 times (if they have not been pre-washed), and collect sample (see section 4.1.1).

(9) Filter and/or preserve the samples as required once at shore.

Water depth determination

How is the depth of the water determined?

The reasons why it is important to know the depth of the water below the surface is to be able to relate scientific findings to the depth of the water from which samples are taken. Many water quality parameters such as temperature and dissolved oxygen vary with depth as well as with the time of day. The depth of light penetration, which is influenced by turbidity, has an effect on the productivity of plants in an aquatic ecosystem. Various depths in a lake or river host different assemblages of benthic (bottom-dwelling) organisms. Plankton and fish move from one depth to another based on changing environmental conditions.

A simple and old fashion method for finding the depth of water is to lower a weight attached to a rope over the side of the boat. When the weight touches the bottom, the rope becomes slack. The rope is then pulled back on-board and the length of the rope needed to touch the bottom is determined. This is a slow method and is not very useful if the boat is moving very fast. If the water is very deep, it is difficult to retrieve the rope unless a mechanical winch is used.

A faster and continuous method for determining the depth of a body of water is to use sound waves. Sound travels at a very fast speed in water, about 1500 meters per second in fresh water, so there is little delay in measuring the depth of water. For example if the water is 50 meters (about 150 feet) deep, sound waves will take approximately 0.07 seconds to leave and return to the vessel.

What is SONAR?

The technique for determining the depth of water is called SONAR. This is an acronym for Sound Navigation And Range. The use of sound in water to determine the direction and distance to underwater features was developed during World War II when it became a basic method for detecting the presence of submarines when they were submerged. SONAR is still used for that purpose, but is also used to determine the depth of water in water quality monitoring expedition.

The principle is very simple. On-board the vessel or the boat is a sending unit that produces a short burst of sound in the water directed toward the bottom. The sending unit then becomes a receiving unit that detects the presence of the sound reflected from the bottom. Within the sending/receiving unit is a means of measuring the time between the pulse sent out and the reflected echo from the bottom. Since the speed of sound in water is known, the simple equation "d/2 = vt" is used to find the depth "d". The letter "v" represents the speed of sound in water and the letter "t" is the total time for the sound to leave and return to the vessel.

The depth "d" is divided by 2 in the equation because the time "t" is the total time from the vessel to the bottom and then from the bottom back to the vessel. This calculation is done automatically by the depth finder. The depth to the bottom can be given as a numerical value or as the position of a line on a screen or a strip of paper.

4. WATER TEMPERATURE

What is the significance of temperature data?

The rates of biological and chemical processes depend on temperature. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will move in the stream to find their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die. Temperature is measured in de-grees Fahrenheit (F) or degrees Celsius (C).

For fish, there are two kinds of limiting temperatures the maximum temperature for short exposures and a weekly average temperature that varies according to the time of year and the life cycle stage of the fish species. Reproductive stages (spawning and embryo development) are the most sensitive stages. Table 1.2 provides temperature criteria for some species.

Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.

Causes of temperature change include weather, removal of shading streambank vegetation, impoundments (a body of water confined by a barrier, such as a dam), discharge of cooling water, urban storm water, and groundwater inflows to the stream.

Table 1.2

Maximum average temperatures for growth and short-term maximum temperatures for selected fish (°C and ° F)

Species	Max. weekly average temp. for growth (juveniles)	Max. temp. for survival of short exposure (juveniles)	Max. weekly average temp. for spawning [a]	Max. temp. for embryo spawning [b]
Atlantic salmon	20 °C (68 °F)	23 °C (73 °F)	5 °C (41 °F)	11 °C (52 °F)
Bluegill	32 °C (90 °F)	35 °C (95 °F)	25 °C (77 °F)	34 °C (93 °F)
Brook trout	19 °C (66 °F)	24 °C (75 °F)	9 °C (48 °F)	13 °C (55 °F)
Common carp	---	---	21 °C (70 °F)	33 °C (91 °F)
Channel catfish	32 °C (90 °F)	35 °C (95 °F)	27 °C (81 °F)	29 °C (84 °F)
Largemouth bass	32 °C (90 °F)	34 °C (93 °F)	21 °C (70 °F)	27 °C (81 °F)
Rainbow trout	19 °C (66 °F)	24 °C (75 °F)	9 °C (48 °F)	13 °C (55 °F)
Smallmouth bass	29 °C (84 °F)	---	17 °C (63 °F)	23 °C (73 °F)
Sockeye salmon	18 °C (64 °F)	22 °C (72 °F)	10 °C (50 °F)	13 °C (55 °F)

a - Optimum or mean of the range of spawning temperatures reported for the species
b - Upper temperature for successful incubation and hatching reported for the species
c - Upper temperature for spawning

(Brungs and Jones 1977)

Sampling and Equipment Considerations

Temperature in a stream will vary with width and depth. It can be significantly different in the shaded portion of the water on a sunny day. In a small stream, the temperature will be relatively constant as long as the stream is uniformly in sun or shade. In a large stream, temperature can vary considerably with width and depth regardless of shade. If it is safe to do so, temperature measurements should be collected at varying depths and across the surface of the stream to obtain vertical and horizontal temperature profiles. This can be done at each site at least once to determine the necessity of collecting a profile during each sampling visit. Temperature should be measured at the same place every time.

Temperature is measured in the stream with a thermometer or a meter. Alcohol-filled thermometers are preferred over mercury-filled because they are less hazardous if broken. Armored thermometers for field use can withstand more abuse than unprotected glass thermometers and are worth the additional expense. Meters for other tests, such as pH (acid ity) or dissolved oxygen, also measure temperature and can be used instead of a thermometer.

The procedures for measuring temperature consist of the following tasks.

Preparing before leaving for the sampling site

In addition to the standard sampling equipment and apparel, when measuring temperature you will need:

- A thermometer or meter
- A data sheet for temperature to record results

Measuring the temperature
In general, sample away from the stream bank in the main current. The outside curve of the stream is often a good place to sample since the main current tends to hug this bank. In shallow stretches, wade into the center current carefully to measure temperature. If wading is not possible, tape your thermometer to an extension pole or use a boat. Reach out from the shore or boat as far as safely possible. If you use an extension pole, read the temperature quickly before it changes to the air temperature.
If you are doing a horizontal or vertical temperature profile, make sure you can safely reach all the points where a measurement is required before trying.
Measure temperature as follows:

1. Place the thermometer or meter probe in the water as least 4 inches below the surface or halfway to the bottom if in a shallow stream.
2. If using a thermometer, allow enough time for it to reach a stable temperature (at least 1 minute). If using a meter, allow the temperature reading to stabilize at a constant temperature reading.
3. If possible, try to read the temperature with the thermometer bulb beneath the water surface. If it is not possible, quickly remove the thermometer and read the temperature.
4. Record the temperature on the field data sheet.

Waterproof Digital Pocket Thermometer PT0300: Temperature Determination

Waterproof Digital Pocket Thermometer

CAD22.00

Suggested Retail Price:
CAD22.00

This Marathon Digital Pocket Thermometer has both Centigrade and Fahrenheit operation and is capable of maintaining Minimum and Maximum readings.

Features:

- Waterproof
- Maintains Minimum and Maximum Temperature readings.
- Protective pocket clip for storage.
- 2 year battery life (1.5V lithium battery)
- Centigrade or Fahrenheit operation

Specifications:

- Operating Temperature: -10°C to +200°C (14°F to +392°F).
- Accuracy: +/- 1°C
- Resolution: 0.1°C
- 107 mm long Pointed Stainless Steel probe.
- Response Time: 5-8 seconds to read temperature, updates every 1 second.

Reference:	PT0300
Manufactured by:	Marathon
Year:	2003
Description	Waterproof Digital Pocket Thermometer PT0300

Made in USA

Digital Pocket Thermometer PT0207

PT0207 digital pocket thermometer

CAD15.00
USD9.75 (Estimated price)

Suggested Retail Price:
CAD27.40
Our Regular Price:
CAD27.40

Digital thermometer with pivoting head and auto-off and low battery indicator ideal for reading temperatures in difficullt places.

Features:

- Pivoting Head turns unit on/off
- Auto shut off after 1 hour
- Memory for highest and lowest temperature
- comes supplied with pocket clip/sleeve
- Centrigrade or Fahrenheit operation
- Low battery indicator

Specifications:

- Range: -50° to 150°C (-58° to 302°F)
- Accuracy: +/- 1 °C (-30° to 150°C) otherwise +/- 2°C
- 128 mm Stainless Steel pointed probe.
- 1 sec. sensing time
- Overall Size: 170 x 35 x 15 mm.

Reference:	PT0207
Size, Capacity:	170 x 35 x 15mm
Year:	2001
Description	Digital Pocket Thermometer PT0207

Made in China

5. TURBIDITY

What is Turbidity?

Turbidity is an absence of clarity or brilliance. Turbidity, or cloudiness, in water is caused by a variety of suspended materials. The material can be both organic (plankton, sewage) and inorganic (silt, clay). The suspended material will scatter and absorb light passing through the water. The light scattered back to the observer can be affected so that the water will have a color dependent upon the type and amount of suspended matter. The cloudiness and color can be observed also if a sample of water in a transparent container is held between the observer's eye and a light source. It is this fact that is used in the turbidity meter.

What is a Turbidity Meter?

The turbidity meter measures the clarity of a water sample. A beam of light is shown through the water sample. The turbidity, or its converse clarity, is read on a numerical scale.

The turbidity meter contains a source of light, a photocell, and a meter. The path of the light is 90 degrees to the direction in which the photocell points. When a sample is placed in the light beam, light scattered by the suspended material in the sample is detected by the photocell. The photocell converts the scattered light into an electrical current that is sent through the meter. The position of the needle on the meter or a digital read-out gives an indication of the turbidity of the water sample.

Turbidity determined by the technique described above is referred to as the nephelometric method from the root meaning "cloudiness". This word is used to form the name of the unit of turbidity, the NTU. This acronym stands for Nephelometric Turbidity Unit.

The meter reading cannot be used to compare the turbidity of different water samples unless the instrument is calibrated. The aquatic science instructors calibrate the meter regularly. Calibration consists of adjusting the meter reading to a known value when a standard sample is placed in the light beam. A standard suspension is often made from a polymer called Formazin which has greater reproducibility.

Turbidity can be measured in many ways. Visual methods include, the comparative methods, the Secchi disk method and the Jackson Candle method. However, determination using Turbidimeters is the preferred method for measuring turbidity. More accurate values of turbidity are measured using Nephelometers: Nephelometers, such as the 2020.

Comparative methods are used in shallow water and determine turbidity by matching the turbidity of a water sample to a standard of known turbidity either with a “target” at the bottom of a tube or with a turbidity comparator. In the deeper waters of lakes, ponds, rivers and estuaries the Secchi disk is often used to measure turbidity.

What is the significance of turbidity?

Turbidity relates to the effect that suspended particles have on water clarity. High turbidity readings (low clarity) can indicate erosion and sedimentation problems. Mining activities can increase turbidity significantly if not done properly (in the absence of settling ponds). Rainfall and runoff can increase the suspended solid load in a river and make the river appear cloudy or muddy. High biological productivity related to increases in nutrients and temperature can result in increases of diatoms and other algae that contribute to turbidity. Turbidity meters can be used to estimate plankton density.

River plumes that are rich in organic matter and suspended solids are clearly differentiated from normal river waters as they enter. Turbidity readings vary from river to river. In Guyana pristine fresh water rivers it ranges 2-5 NTU for the dry season.

Elevated turbidity can cause an increase in temperature since suspended particles absorb heat. Reduction of light penetrating the water column due to turbidity can decrease the rate of photosynthesis. This, in turn, can decrease the amount of dissolved oxygen in the water. As suspended particles settle, they can impair the habitat needed for fish spawning and aquatic macroinvertebrates. They can also clog the gills of fish and the breathing apparatus of invertebrates. Particles serve as places of attachment for harmful microorganisms and toxic materials. Turbidity in drinking water is decreased through the process of flocculation, which involves addition of alum or a mixture of iron, lime, and chloride to cause solids to settle out.

Lamotte 2020 portable turbidity meter

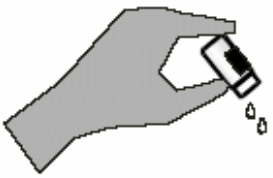
TECHNICAL SPECIFICATIONS

Range	0 to 1100 NTU
Resolution	0.01 at 0 to 11 range, 0.02 0.1 at 11 to 110 range, 0.03 1 at 110 to 1100 range
Response Time	3 seconds
Accuracy	± 2% of reading below 100 NTU, ± 3% above 100 NTU
Power	9V alkaline battery, or AC adapter
Dimensions (HWD)	2.625" x 3.375" x 6.375"

Procedures for Turbidity Determination

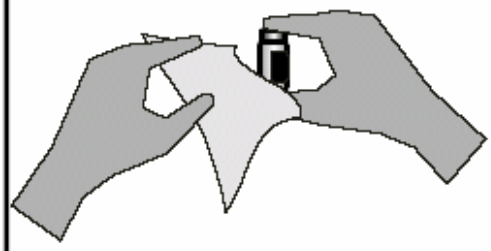
1. Fill a clean container with at least 50 mL of sample water and cover. Set sample aside to allow sample to equilibrate to air temperature and let gases escape. Avoid contaminants. Analyze as soon as possible.

2. Rinse an empty turbidity tube with a portion of the sample. Shake out excess water.

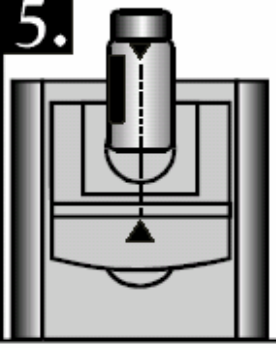


3. Fill the turbidity tube (0286) to the neck by carefully pouring the sample down the side of the tube to avoid creating bubbles.

4. Cap the tube and wipe tube dry with a clean lint-free tissue.



5. Open the 2020 lid. Align the indexing arrow on the tube with the indexing arrow on the meter. Insert the turbidity tube into chamber.



6. Close the lid. Push the **READ** button. The turbidity in NTU units will be displayed within 5 seconds.

7. The 2020 will turn off automatically 2 minutes after the last button push. To turn the meter OFF manually, hold the **READ** button down for at least 1 second. Release the button when OFF is displayed.

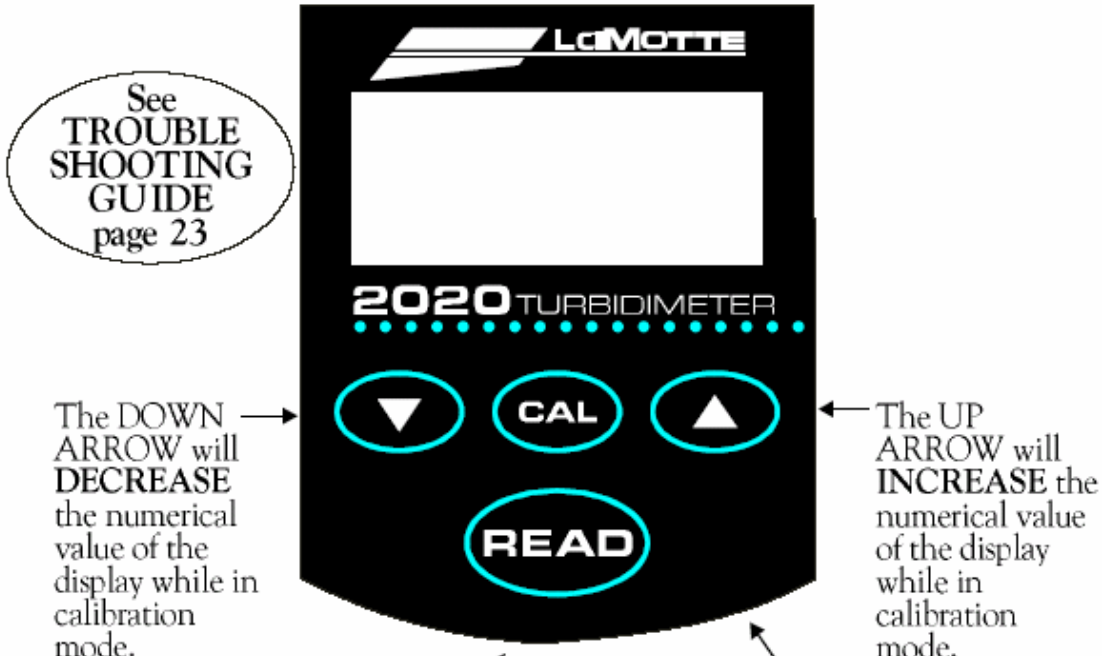
Note

If the sample is higher than 1100 NTU, it must be diluted and retested. See pages 20-22.

THE KEYPAD

The DISPLAY will display turbidity reading with the following resolution:
0.00 - 10.99 NTU; 11.0 - 109.9 NTU; 110 - 1100 NTU

- When the **READ** button is first pushed, a number will be briefly displayed that indicates the software version number.
- A walking dash "-" will be displayed when measurement is taking place.
- The display will flash after the **CAL** button has been pushed during the calibration procedure until the **CAL** button has been pushed again to enter the adjusted value.
- "OFF" will be displayed after the **READ** button has been held down for 1 second. The meter will turn off when the button is released.
- "Er1" will be displayed when the battery voltage is very low.
- "Er2" will be displayed when measured turbidity is over range (1100 NTU).
- "Er3" will be displayed when the bulb has burned out or the tube is misaligned.
- "BAT" will be displayed when the battery voltage is getting low. Readings are reliable. Replace battery as soon as possible.
- "$" will be displayed when the meter is in EPA mode.



See TROUBLE SHOOTING GUIDE page 23

The DOWN ARROW will **DECREASE** the numerical value of the display while in calibration mode.

The UP ARROW will **INCREASE** the numerical value of the display while in calibration mode.

The READ button is used to turn the meter ON and to take readings. Pressing the button for 1 second will cause the meter to display OFF. Releasing the button when OFF is displayed turns the meter OFF.

The CAL button is used for **CALIBRATION** procedures and to change between standard operating mode and EPA mode.

DILUTION PROCEDURES
If a sample is encountered that is higher than 1100 NTU, a careful dilution will bring the sample into the acceptable range. However, there is no guarantee that halving the concentration will exactly halve the NTU values. The particulates often react in an unpredictable manner when diluted.

TESTING TIPS
1. Samples should be collected in a clean glass or polyethylene container.
2. Samples should be analyzed as soon as possible after collection.
3. Discard tubes that are badly scratched.
4. Gently mix sample by inverting before taking a reading but avoid introducing air bubbles.
5. Turbidity readings will be affected by electric fields around motors.
6. Carbon in the sample will absorb light and cause low readings.
7. Observe shelf life recommendations for turbidity standards.
8. The turbidimeter should be placed on a surface free from vibration. Vibrations can cause high readings.
9. Excessive color in a sample will absorb light and cause high readings. The user should verify if a certain level of color will cause a significant error at the level of turbidity being tested.

6. TRANSPARENCY

What is water transparency?

Transparency of water relates to the depth that light will penetrate water. The transmission of light into a body of water is extremely important since the sun is the primary source of energy for all biological phenomena. Light is necessary for photosynthesis, a process that produces oxygen and food for consumers. It is common practice for biologists to consider the depth of the euphotic zone (the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants) to be 2.7 times (roughly 3 times) the limit of visibility. As light penetrates water, it becomes attenuated and altered in its spectral composition. The change that occurs is from predominantly yellow light at the surface to blue-green at depth in clear water or yellow-green in waters having a high concentration of dissolved organic material. Transparency is measured by a variety of methods: secchi disk, transparency tube and etc.

What is a Secchi Disk?

The Secchi disk is a very simple device about 20 cm in diameter made of metal or plastic. It is a black and white disk that is lowered by hand into the water to the depth at which it vanishes from sight (Figure). The distance to vanishing is then recorded. The clearer the water, the greater the distance. Deeper, slower moving rivers are the most appropriate places for Secchi disk measurement although the current might require that the disk be extra-weighted so it does not sway and make measurement difficult.

The line attached to the Secchi disk must be marked according to units designated by the monitoring program, in waterproof ink. Many programs require technicians to measure to the nearest 1/10 meter. Meter intervals can be tagged (e.g., with duct tape) for ease of use.

The Secchi disk provides a means for determining the limit of visibility that is based on contrast. The upper surface of the Secchi disk is divided into four quadrants that are alternately black or white. An

eyebolt is located at the center of the disk on the upper side so that a line can be tied to the disk. This makes it possible to lower the disk into the water from a boat or dock. A weight is attached to the underside of the disk so that the equipment will sink below the surface. This line is marked every 0.5 meter making it possible to determine the depth at which the Secchi disk disappears from sight as it is lowered into the water.

The Secchi readings are a semi-quantitative measure of water transparency since a variety of factors such as the time of day, sky and water surface conditions, and differences between observers will give varying depths for the same location. It is possible that each person will have a different opinion of the depth at which the disk disappears from sight. That is why it is important that Secchi disk records contain information about the conditions under which the readings were taken.

Standard conditions for Secchi disk measurements include a clear sky, sun directly overhead, and minimal waves or ripples. These measurements must be taken on the shaded and protected side of the vessel. Any deviations from these conditions should be clearly stated in the data. It is interesting to note that visibility in water is roughly twice the Secchi depth since the light must travel twice through a column of water equal in length to the Secchi depth from the surface to the disk and then back up again after being reflected from the disk.

What is the significance of Secchi disk readings?

Secchi disks are standard tools for inland lake and slow-moving rivers monitoring along with measurements of chlorophyll a and phosphorus. Volunteer groups in North America take Secchi disk readings to indicate the current status of their lake and to compare with data from previous years. The Secchi disk provides a measure of the amount of suspended inorganic and organic matter in the water.

Transparency readings in oligotrophic or low nutrient lakes are often greater than 15 feet (5 meters) whereas eutrophic or nutrient rich lakes have readings less than 7.5 feet (2.5 meters). Water clarity is related to amounts of suspended particles (turbidity) as well as amounts of phytoplankton and zooplankton.

Instructions for measuring transparency using Secchi disk:

- Check to make sure that the Secchi disk is securely attached to the measured line.
- Lean over the side of the boat and lower the Secchi disk into the water, keeping your back toward the sun to block glare.
- Lower the disk until it disappears from view. Lower it one third of a meter and then slowly raise the disk until it just reappears. Move the disk up and down until the exact vanishing point is found. Attach a clothespin to the line at the point where the line enters the water. Average the two depths, the depth at which the Secchi disk disappeared and the depth at which it reappeared.
- Record the measurement on your data sheet. Repeating the measurement will provide you with a quality control check. The Secchi depth is also known as the Secchi transparency.

The key to consistent results is to train technicians to follow standard sampling procedures and, if possible, have the same individual take the reading at the same site throughout the season.

Transparency Tube

The transparency tube is a clear, narrow plastic tube marked in units with a dark pattern painted on the bottom. Water is poured into the tube until the pattern disappears (Figure). Some monitoring programs in the USA are testing the transparency tube in streams and rivers. They use tubes marked in centimeters from top to bottom, and has found tube readings to relate fairly well to lab measurements of turbidity and total suspended solids (although they do not recommend the transparency tube for applications where precise and accurate measurement is required or in highly colored waters).

Instructions for measuring transparency using Transparency tube:

- Collect the sample in a bottle or bucket in mid-stream and mid-depth if possible. Avoid stagnant water and sample as far from the shoreline as is safe. Avoid collecting sediment from the bottom of the stream.
- Face upstream as you fill the bottle or bucket.
- Take readings in open but shaded conditions. Avoid direct sunlight by turning your back to the sun.
- Carefully stir or swish the water in the bucket or bottle until it is homogeneous, taking care not to produce air bubbles (these will scatter light and affect the measurement). Then pour the water slowly in the tube while looking down the tube.
- Measure the depth of the water column in the tube when the symbol just disappears.

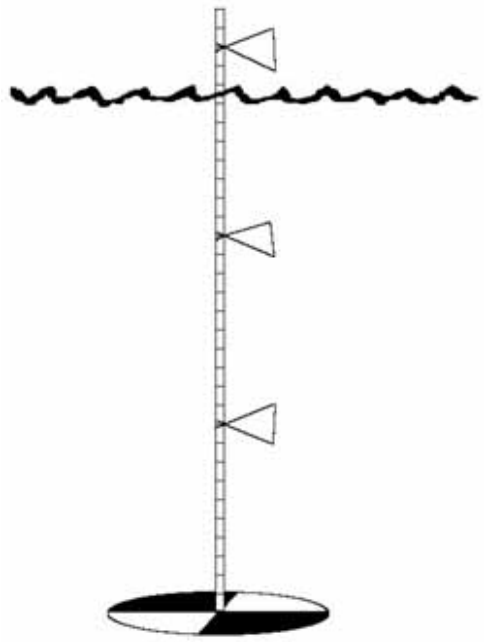


Figure 1.10

Using a Secchi disk to measure transparency
The disk is lowered until it is no longer visible. That point is the Secchi disk depth.

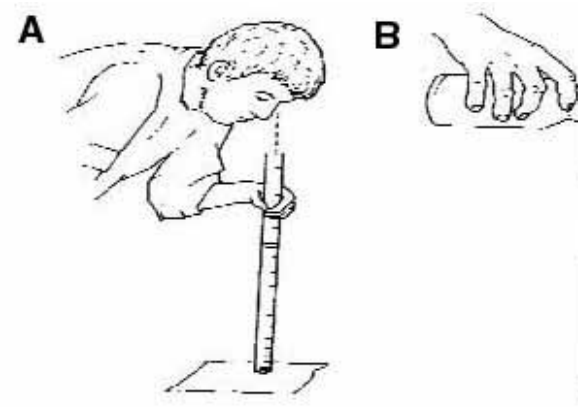


Figure 1.11

Using a transparency tube
(A) Prepare the tranparency tube to take a reading. Place the tube on a white surface and look vertically down the tube to see the wave pattern at the bottom.
(B) Slowly pour water sample into the tube stopping intermittently to see if the wave pattern has disappeared.

Turbidity Wedge

The Triton Turbidity Wedge provides environmental monitors and resource managers with standardized, instantaneous measures of turbidity in effluent and natural watercourses. This practical tool enables on-site evaluation of water quality impacts arising from waste discharges, construction, forestry, land development, agriculture, mining and other activities.

An economical alternative to turbidity meters, when accurate readings are not required, with no electronics or moving parts to wear out, the Triton Turbidity Wedge is a ruggedly durable and dependable water quality instrument for any setting. Ideal for fieldwork, it is sturdy, easy to use, and requires no power source, manuals or calibration equipment.

The Triton Turbidity Wedge measures visibility attenuation (water clarity) and the reduction of light penetration due to the presence of suspended sediments, other particulates and dissolved matter in solution. Measurements of visual clarity correspond to the distance (cm) through the water column at which the inset scale can be read. The more turbid the water, the lower the measurement of visual water clarity.

Determining compliance with water quality standards, regulations and objectives requires quantitative measurement. Whether measuring water clarity at point sources, comparing sites located upstream and downstream of a particular site, or comparing changes in water quality over time, the Triton Turbidity Wedge provides consistent, reliable estimates of turbidity.

The Triton Turbidity Wedge has been calibrated using solutions containing suspended particulates from natural watercourses. A linear regression curve was developed to calibrate the highly significant correlation between measurements of visual clarity (cm) and standard formazin turbidity units.

The Triton Turbidity Wedge is simple to use and instructions are engraved on the back of each unit. The wedge is filled with water and the scale is viewed horizontally through the water column. Visual clarity (1 to 21 cm) is measured as the highest number visible on the scale. Turbidity (61 to 1,350 NTU) is estimated using the conversion table engraved on the back of each unit.

The Triton Turbidity Wedge provides a simple, cost-effective standard tool for measuring water quality. It can be used on-site for environmental monitoring and as a decision tool for temporarily halting work in sensitive areas, evaluating the success of sediment management or water treatment measures, locating point sources, determining the need to collect water samples, and assessing ambient environmental quality.

Triton Turbidity wedge

7. Total Dissolved Solids (TDS)

What is TDS?
This is a water quality measure comprize dissolved solids, or that portion of the solid matter found in a water sample that passes through a filter.

Dissolved or inorganic materials include calcium, bicarbonate, nitrogen, phosphorous, iron, sulfur, and other ions found in a body of water. A constant level of these materials is essential for the maintenance of aquatic life because the density of the total solids determines flow of water in and out of an organism's cells, also, many of these dissolved ions, such as nitrogen, phosphorous, and sulfur are building blocks of molecules necessary for life.

How is TDS measured?
TDS is the mass of the solids that are dissolved in a sample of water. This quantity is found in the laboratory by evaporating the water in a sample and determining the mass of solids left in the container after all the water is gone. Total dissolved solids (TDS) are measured in milligrams per liter.

A convenient way to measure TDS in the field is usually by a device that measures the conductivity of the water. TDS mg/L = 0.64 x EC µS/cm. The greater the conductivity of the water the more dissolved material there is in the water. Conductivity is a measure of the ability of water to pass an electrical current and is affected by the presence of dissolved solids. As the level of TDS rises, the conductivity will also increase. Discharges to water can change the conductivity depending on the discharge. A failing sewage system could raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity because oil does not conduct electrical current very well.

A conductivity meter is used to measure the ability of the water sample to conduct electricity. The specific conductance is measured by passing a current between two electrodes (one centimeter apart) that are placed into a sample of water. The unit of measurement for conductivity is expressed in either microSiemens (uS/cm) or micromhos (umho/cm) which is the reciprocal of the unit of resistance, the ohm. The prefix "micro" means that it is measured in millionths of a mho. MicroSiemens and micromhos are equivalent units. Distilled water has a range of conductivity from 0.5 to 2 umhos/cm. Drinking water is generally between 50 to 1500 umhos/cm and domestic wastewater may have conductivities above 10,000 umhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 mhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. The warmer the water, the higher the conductivity with an increase of about 1.9% per Celsius degree. Conductivity is reported at standard temperature of 25.0° C.

Sources of TDS
Many sources can affect the natural balance of TDS in water ways. One example is runoff from urban areas, fertilizers from lawns, and many other types of materials. Another source are wastewater treatment plants which can add phosphorous, nitrogen, and organic matter to rivers. Mountainous watersheds are less affected by urban factors, but are more affected by the

surrounding rocks and soils which can give off broken down minerals that make up the rocks and soils.

Some examples of sources of suspended include leaves and other plant materials, soil particles from urban runoff and soil erosion, and decayed plant and animal matter that is converted into particulate matter within the river.

Changes in Aquatic Life

High concentrations of TDS can lower water quality and cause water balance problems for individual organisms. On the other hand, low concentrations may limit growth of aquatic life. Phytoplanktons, for example, are totally dependent upon nitrates and phosphates that are dissolved in the water.

High concentrations of dissolved solids can lead to laxative effects in drinking water and impart an unpleasant mineral taste to the water. High concentrations of TDS also: reduce water clarity, contribute to a decrease in photosynthesis, bind with toxic compounds and heavy metals, and lead to an increase in water temperature through greater absorption of sunlight by surface waters.

Instructions for use of a Conductivity Meter:

1. Using specially marked beakers, obtain samples of water from the water sampling devices (Van Dorn Bottles). Use the beaker marked **COND T** to obtain 250 mL of the top water sample from the Van Dorn bottle marked "T". Use the beaker marked **COND B** to obtain 250 mL of the bottom water sample from the Van Dorn bottle marked "B". Be sure to match the symbols on the beakers with the same symbol on the Van Dorn bottle (the symbol "T" for top and "B" for bottom).
2. Bring the beakers containing the water samples back to the conductivity lab station. Measure the top water sample first then measure the bottom water sample.
3. Remove the conductivity meter probe from the deionized (D.I.) water storage container. Rinse the probe with D.I. water from the plastic squeeze bottle, catching the rinse water in the large beaker labeled **WASTE WATER**. Blot away excess D.I. water from the probe with paper toweling before lowering the probe into the top water sample.
4. Place the conductivity meter probe in the beaker with the top water sample. Lower the probe into the water sample so that the tip is completely submerged.
5. Press the ON/OFF (I/O) key to turn on the conductivity meter. When "READY" appears, read and record the readings in uS/cm on the data sheet (COND T).
6. Remove the probe from the top water sample and position the probe over the **WASTE WATER** beaker. Rinse the probe with D.I. water from the plastic squeeze bottle and blot away excess D.I. water with paper toweling.
7. Repeat steps 4 through 6 with the bottom "B" sample. Record the reading in mS/cm for the bottom sample in the appropriate place (COND B) on the data sheet. Remove the probe from the water and rinse the probe with D.I. water over the **WASTE WATER** beaker. Place the probe in the beaker of D.I. water.
8. Rinse the sample beakers and stir bar with D.I. water, wipe dry with paper toweling and store as they were when you started.

8. pH

What is pH?

A natural body of water can be acidic, neutral, or basic. Many factors determine this condition including the composition of the material forming the basin holding the water, acidity of rain falling into the water, and the condition of water flowing into the body of water from streams, rivers, or storm runoff. The standard measurement used to indicate acidic or basic conditions is called pH.

Ions are electrically charged atoms or groups of atoms that are capable of conducting an electrical current in a solution. Pure water has a small number of water molecules will break up into positively charged hydrogen atoms (H+) and negatively charged hydroxyl ions (OH-). Since an equal number of negative and positive ions will be formed, the water remains electrically neutral; it is neither acidic or alkaline. Careful measurements show that pure water at 25°C ionizes so that 0.0000001 mole of positive hydrogen ions are liberated per liter of water. This number when written in scientific notation becomes 1 X 10-7. If this number is expressed on a negative logarithmic scale, it becomes 7.

The pH scale is a series of numbers ranging from 0 to 14 which denote various degrees of acidity or alkalinity. Values below 7 and approaching 0 indicate increasing acidity. Values from 7 to 14 indicate increasing alkalinity. Since the scale is logarithmic, the difference between pH 5 and pH 6 is not one but rather ten, that is, pH 5 is ten times more acidic than pH 6.

How is pH measured?

There are several ways to measure pH, which include pH paper, pH pen, and pH meters. For pH paper, strips of paper are saturated with an indicator that changes color with varying degrees of acidity. The color of the paper is compared to a color scale that is specific to the range and type of paper used. This means of determining pH measures only to about 1 pH unit; however, it is inexpensive. A pH pen is basically a simple electrode similar to that found in a pH meter. Both measure electrical potential associated with the hydrogen ion activity across an electrode immersed in the water sample. Accuracy ranges from 0.1 to 0.01 pH units.

A basic pH meter will have a device to measure voltage, a glass electrode to immerse in the water, a reference electrode that provides a constant electric potential, and a temperature compensation device. The pH readings are temperature dependent. The results are given in either pH units or millivolts (mv).

Many kinds of pH probes and meters have been used for pH determination. Specific instructions for the models will come with the instruments. Before they are used, calibration will be done for the equipment. Two or three standard buffers (pH 4, pH 7 and pH 10) are used to calibrate the pH probes (pens) and pH meters.

What is the significance of pH?

Changes on pH can be associated with wastewater discharges and sources of pollution. However, natural changes in pH occur with variations in levels of carbon dioxide. Carbon dioxide is very soluble in water. It enters the water from the atmosphere and is also generated from animal and plant respiration and decomposition. Dissolved carbon dioxide can combine with water to yield carbonic acid. Plants reduce amounts of carbon dioxide through photosynthesis making surface waters more basic.

Water quality standards generally call for a pH between 6.0 to 9.0. A pH between 6.7 and 8.6 will support a well-balanced fish population. Only a very few species can tolerate pH values less than 5.0 or greater than 9.0.

Effects of pH on fish and aquatic life*		
Limiting pH values		
Minimum	**Maximum**	**Effects found in some scientific studies**
4.0	10.1	Limits for the most resistant fish species
5.0	9.0	Tolerable range for most fish
4.5	9.0	Trout eggs and larvae develop normally
4.6	9.5	Limits for perch
4.1	9.5	Limits for trout
--	8.7	Upper limit for good fishing waters
5.4	11.4	Fish avoid waters beyond these limits
6.0	7.2	Optimum (best) range for the fish eggs
7.5	8.4	Best range for the growth of algae
** Water Quality Criteria, California Water Quality Control Board 1963.*		

The actual effect of adding a highly acidic pollutant to a body of water is related to the acid neutralizing or buffering capacity of the water which is reflected in alkalinity measurements. For example, the water of Lake Michigan has a much higher buffering capacity than lakes threatened by acid rain. The limestone (calcium carbonate) in the Lake Michigan basin is a natural buffer that helps to maintain soil and water pH near neutral.

Instructions for measuring pH:

1. Using the specially marked beakers from the rack at the pH lab station, obtain samples of water from the water sampling devices (Van Dorn Bottles). Use the beaker marked **pH T** to obtain 50 mL of the top water sample from the Van Dorn bottle marked "T". Use the beaker marked **pH B** to obtain 50 mL of the bottom water sample from the Van Dorn bottle marked "B". Be sure to

match the symbols on the beakers with the same symbol on the Van Dorn bottle (the symbol "T" for top and "B" for bottom).

2. Bring the beakers containing the water samples back to the pH lab station and place them in the appropriate places in the rack. Measure the top water sample first then measure the bottom water sample. If a pH pen is used, turn the pen on, place the pen in the sample, and record the reading. Rinse with deionized water and repeat two more times. Turn off the pen when finished.
3. If a pH meter is used, remove the pH probe from the pH probe storage container. Rinse the pH probe with deionized (D.I.) water from the plastic squeeze bottle, catching the rinse water in the large beaker labeled **WASTE WATER**. Blot away excess D.I. water from the probe before lowering the probe into the top water sample.
4. Tilt the beaker containing the top "T" water sample and slide the white stir bar into the beaker. Turn the stir plate dial on and adjust the numbered stir plate dial until the stir is rotating smoothly and stirring the water sample.
5. Place the pH probe in the beaker with the top water sample, which is being stirred on the magnetic stir plate. Lower the probe into the water sample so that the tip is completely submerged, but not touching either the sides of the beaker or the rotating stir bar.
6. Press the ON/OFF (I/O) key on the pH meter to turn on the meter. When "READY" appears, read and record the numbers. At this point the reading on the meter display is the one that is to be recorded on the data sheet (pH T).
7. Remove the pH probe from the top water sample and position the probe over the **WASTE WATER** beaker. Rinse the probe with D.I. water from the plastic squeeze bottle and blot away excess D.I. water with paper toweling. Retrieve the stir bar from the top water sample and blot dry with paper toweling. Place the stir bar in the beaker containing the bottom water sample.
8. Repeat step 7 with the bottom "B" sample. Record the reading in pH units for the bottom sample in the appropriate place (pH B) on the data sheet. Round off pH units to one decimal place (>/= .05 would be .1 and <.05 would be .0).
9. Remove the probe by lifting up on the probe arm and rinse the probe with D.I. water over the **WASTE WATER** beaker. Place the probe in the pH probe storage container.
10. Remove the stir bar from the bottom water sample. Empty both top and bottom water samples into the sink. Rinse the sample beakers and stir bar with D.I. water, wipe dry with paper toweling and store as they were when you started.

OAKTON® pHTestr 1-2 Instructions

Before you begin:

If necessary, remove plastic strips between batteries and contacts.

Remove electrode cap. To condition electrode, immerse electrode in electrode storage solution, buffer or tap water for at least 30 minutes before use. DO NOT use de-ionized water.

Calibration

Calibration should be done regularly, typically every day that the Testr is used.

pHTestr 1: you can calibrate at up to one point (pH 4, 7, or 10).
pHTestr 2: you can calibrate at up to three points (pH 4, 7,and 10).

1. Switch unit on (ON/OFF button).
2. Dip electrode into chosen buffer (pH 4, 7, or 10). **DO NOT immerse above color band!**
3. Press CAL button to enter Calibrate mode. 'CA' flashes on the display. Then, a pH value close to the buffer value will flash.
4. After at least 30 seconds (about 30 flashes) **press the HOLD/CON button** to confirm calibration. The display will show 'CO' and then switch to the buffer value reading.
5. Repeat with other buffers if necessary. (pHTestr 2 only). Rinse electrode in tap water before dipping into next buffer.

Calibration Troubleshooting:

Failure to press HOLD/CON to confirm calibration (step 4 above). Pressing the CAL button will resume measuring mode but will not enter the calibration value.

Insufficient sampling time. The testr needs at least 30 seconds sampling time to reach a stable calibration point. Wait at least 30 seconds before pressing HOLD/CON.

Failure to re-hydrate the electrode. A dry electrode will give fluctuating readings, causing errors.

pH Testing:

1. Remove cap from electrode. Switch unit on (ON/OFF button).
2. Dip the electrode into the test solution. Stir once and let the reading stabilize.

Caution: Never immerse the electrode above color band! This will damage instrument electronics!

3. Note the pH or press HOLD/ CON button to freeze the reading. Press HOLD/CON again to release the reading.
4. Press ON/OFF to turn off Testr. If you do not press a button for 8.5 minutes the Testr will automatically shut off to conserve batteries.

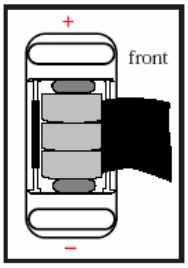
Instrument Maintenance:

- Rinse the electrode with tap water or electrode storage solution after each measurement.
- In aggressive chemicals, dirty or viscous solutions, and solutions with heavy metals or proteins, take readings quickly and rinse electrode immediately afterward.
- Periodic soaks in warm pH 4 buffer will help remove contaminants.
- If possible, keep a small piece of paper or sponge in the electrode cap—moistened with clean water or electrode storage solution (NOT de-ionized water)—and close the cap over the electrode.

NOTE: Testr life is dependent on meter and electrode care. If the electrode is exposed to materials that contaminate the reference junction, testr life will be shortened.

Replacing batteries:

1. Flip up battery compartment lid.
2. Remove old batteries; replace with fresh ones. Note polarity (shown in battery compartment and in picture at right).
3. Recalibrate Testr after battery change.



Error Messages:

ER1 Weak batteries—replace

ER2 Wrong or bad buffer value, or electrode is failing.

OR Over range signal, or electrode is not in contact with solution, or electrode is failing.

Specifications

	pHTestr 1	pHTestr 2
Range	–1.0 to 15.0 pH	
Resolution	0.1 pH	
Accuracy	±0.2 pH	±0.1 pH
Calibration	1 point (pH 4.0; 7.0; or 10.0)	3 points (pH 4.0; 7.0 and 10.0)
ATC	No	Yes
Operating Temperature	0 to 50°C (32 to 122°F)	
Functions	ON/OFF; HOLD; CA (Calibrate); CO (Confirm display); auto buffer recognition; auto-shutoff after 8.5 min. of nonuse	
Power	Three 1.5 V batteries (included). 40 hours continuous use (approx. 1200 tests per battery set)	
Dimensions	5.9" x 1.7" x 1" (151 x 42 x 24 mm)	
Weight	3.25 oz (90 gms)	

Warranty:

The pHTestr 1-2 are warranted against defects in materials and workmanship for a period of 6 months from the date of purchase. If repair, adjustment or replacement is necessary and has not been the result of abuse or misuse within the 6 month period, please return the Testr—freight pre-paid—and correction will be made without charge. Out of warranty products will be repaired on a charge basis.

Return of Items:

Authorization must be obtained from your OAKTON Distributor before returning items for any reason. When applying for authorization, please include information regarding the reason the item(s) are to be returned.

Note: We reserve the right to make improvements in design, construction and appearance of products without notice. Prices are subject to change without notice.

OAKTON® Waterproof pHTestr 1 & 2 Double Junction Instructions

Before you Begin:

Remove electrode cap. To condition electrode, immerse electrode in electrode storage solution, buffer or tap water for at least 30 minutes. DO NOT use de-ionized water.

Calibration:

Calibration should be done regularly, typically every day that the Testr is used.

pHTestr 1: Calibrate at one point (either pH 4, 7, or 10).
pHTestr 2: Calibrate at three points (pH 4, 7, 10).

1. Press ON/OFF button to switch unit on.
2. Dip electrode 1/2" to 1" into chosen buffer (pH 4, 7, or 10).
3. Press CAL button to enter Calibrate (CA) mode. 'CA' flashes on the display. Then, a pH value close to the pH buffer value will flash repeatedly.
4. After at least 30 seconds (about 30 flashes) **press the HOLD/CON button** to confirm calibration. The display will show 'CO' and then switch to the buffer value reading.
5. Repeat with other buffers if necessary (pHTestr 2 only). Rinse electrode in tap water before dipping into next buffer.

Calibration Troubleshooting:

Failure to press HOLD/CON to confirm calibration (step 4 above). Pressing the CAL button will resume measuring mode but will not enter the calibration value.

Insufficient sampling time. If the Testr does not have a long enough exposure to the buffer, a stable calibration point will not be reached. Wait at least 30 seconds before pressing HOLD/CON.

Failure to re-hydrate the electrode. A dry electrode will give fluctuating readings while it re-hydrates in a buffer, causing errors.

pH Testing:

1. Remove cap from the electrode and press the ON/OFF button to switch Testr on.
2. Dip the electrode 1/2" to 1" into the test solution. Stir once and let the reading stabilize.
3. Note the pH or press HOLD/ CON button to freeze the reading. Press HOLD/CON again to release the reading.
4. Press ON/OFF to turn off Testr. If you do not press a button for 8.5 minutes the Testr will automatically shut off to conserve batteries.

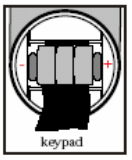
Instrument Maintenance:

- Rinse the electrode with tap water or electrode storage solution after each measurement.
- In aggressive chemicals, dirty or viscous solutions, and solutions with heavy metals or proteins, take readings quickly and rinse electrode immediately afterward.
- Periodic soaks in warm pH 4 buffer will help remove contaminants.
- If possible, keep a small piece of paper or sponge in the electrode cap—moistened with clean water or electrode storage solution (NOT de-ionized water)—and close the cap over the electrode.

When you need a new electrode, see "**Electrode Replacement**" at right.

Replacing the batteries

1. Open battery compartment lid (with attached lanyard loop).
2. Remove old batteries; replace with fresh ones. Note polarity(shown in battery compartment and in picture at right).
3. Recalibrate Testr after battery change.



Error Messages:

ER1 Weak batteries—replace

ER2 Wrong or bad buffer value, or electrode is failing.

OR Over range signal, or electrode is not in contact with solution, or electrode is failing.

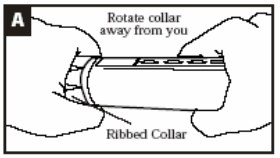
Specifications

	WP pHTestr 1	WP pHTestr 2
Range	–1.0 to 15.0 pH	
Resolution	0.1 pH	
Accuracy	±0.2 pH	±0.1 pH
Calibration	1 point (pH 4.0; 7.0; or 10.0)	3 points (pH 4.0; 7.0 and 10.0)
ATC	No	Yes
Operating Temperature	0 to 50°C (32 to 122°F)	
Functions	ON/OFF; HOLD; CA (Calibrate); CO (Confirm display); auto buffer recognition; auto-shutoff after 8.5 min. of nonuse	
Power	Three 1.5 V batteries (included). 24 hours continuous use (approx. 720 tests per battery set)	
Dimensions	6.5"L x 1.5" dia. (165 x 38 mm dia.)	
Weight	3.25 oz (90 gms)	

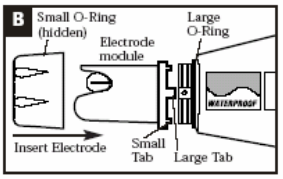
Electrode replacement:

You can replace the electrode module at the fraction of the cost of a new Testr. When the Testr fails to calibrate, gives fluctuating readings in buffers, shows error messages 'E2' or 'OR' in a buffer, and the procedures in the Maintenance section do not help, you need to change the electrode.

1. With dry hands, grip the ribbed Testr collar with electrode facing you. Twist the collar counter clockwise. *(see diagram A)*. Save the ribbed Testr collar and O-ring for later use.



2. Pull the old electrode module away from the Testr.
3. Align the four tabs on the new module so they match the four slots on the testr. *(see diagram B)*.



4. Gently push the module onto the slots to seat it in position. Push the smaller O-ring fully onto the new electrode module. Push the collar over the module and thread it into place by firmly twisting clockwise.

Warranty:

Each waterproof pHTestr 1 and 2 double junction meter body is warranted against defects in materials and workmanship for a period of 12 months from the date of purchase; the electrode module is warrantied for a period of 6 months from the date of purchase. If repair, adjustment or replacement is necessary and has not been the result of abuse or misuse within the 6 month period, please return the Testr—freight prepaid—and correction will be made without charge. Out of warranty products will be repaired on a charge basis.

Return of Items:

Authorization must be obtained from your OAKTON Distributor before returning items for any reason. When applying for authorization, please include information regarding the reason the item(s) are to be returned.

Note: We reserve the right to make improvements in design, construction and appearance of products without notice. Prices are subject to change without notice.

OAKTON® pHTestr 3 Instructions

Before you begin:

If necessary, remove plastic strips between batteries and contacts.

Remove electrode cap. To condition electrode, immerse electrode in electrode storage solution, buffer or tap water for at least 30 minutes before use. DO NOT use de-ionized water.

Calibration

Calibration should be done regularly, typically every day that the Testr is used. You can calibrate at up to three points (pH 4, 7,and 10).

1. Switch unit on (ON/OFF button).
2. Dip electrode into chosen buffer (pH 4, 7, or 10). **DO NOT immerse above color band!**
3. Press CAL button to enter Calibrate mode. 'CA' flashes on the display. Then, a pH value close to the buffer value will flash.
4. After at least 30 seconds (about 30 flashes) **press the HOLD/CON button** to confirm calibration. The display will show 'CO' and then switch to the buffer value reading.
5. Repeat with other buffers if necessary. (pHTestr 2 only). Rinse electrode in tap water before dipping into next buffer.

Calibration Troubleshooting:

Failure to press HOLD/CON to confirm calibration (step 4 above). Pressing the CAL button will resume measuring mode but will not enter the calibration value.

Insufficient sampling time. The testr needs at least 30 seconds sampling time to reach a stable calibration point. Wait at least 30 seconds before pressing HOLD/CON.

Failure to re-hydrate the electrode. A dry electrode will give fluctuating readings, causing errors.

pH Testing:

1. Remove cap from electrode. Switch unit on (ON/OFF button).
2. Dip the electrode into the test solution. Stir once and let the reading stabilize.

Caution: Never immerse the electrode above color band! This will damage instrument electronics!

3. Note the pH or press HOLD/ CON button to freeze the reading. Press HOLD/CON again to release the reading.
4. Press ON/OFF to turn off Testr. If you do not press a button for 8.5 minutes the Testr will automatically shut off to conserve batteries.

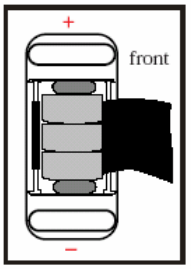
Instrument Maintenance:

- Rinse the electrode with tap water or electrode storage solution after each measurement.
- In aggressive chemicals, dirty or viscous solutions, and solutions with heavy metals or proteins, take readings quickly and rinse electrode immediately afterward.
- Periodic soaks in warm pH 4 buffer will help remove contaminants.
- If possible, keep a small piece of paper or sponge in the electrode cap—moistened with clean water or electrode storage solution (NOT de-ionized water)—and close the cap over the electrode.

NOTE: Testr life is dependent on meter and electrode care. If the electrode is exposed to materials that contaminate the reference junction, testr life will be shortened.

Replacing batteries:

1. Flip up battery compartment lid.
2. Remove old batteries; replace with fresh ones. Note polarity (shown in battery compartment and in picture at right).
3. Recalibrate Testr after battery change.



Error Messages:

ER1 Weak batteries—replace

ER2 Wrong or bad buffer value, or electrode is failing.

OR Over range signal, or electrode is not in contact with solution, or electrode is failing.

Specifications

	pHTestr 3
Range	0.0 to 14.99 pH
Resolution	0.01 pH
Accuracy	±0.02 pH at room temperature; ±0.05 pH at temperature extremes
Calibration	3 points (pH 4.0; 7.0; and/or 10.0)
ATC	Yes
Operating Temperature	0 to 50°C (32 to 122°F)
Functions	ON/OFF; HOLD; CA (Calibrate); CO (Confirm display); auto buffer recognition; auto-shutoff after 8.5 min. of nonuse
Power	Three 1.5 V batteries (included). 20 hours continuous use (approx. 600 tests per battery set)
Dimensions	5.9" x 1.7" x 1" (151 x 42 x 24 mm)
Weight	3.25 oz (90 gms)

Warranty:

The pHTestr 3 is warranted against defects in materials and workmanship for a period of 6 months from the date of purchase. If repair, adjustment or replacement is necessary and has not been the result of abuse or misuse within the 6 month period, please return the Testr—freight pre-paid—and correction will be made without charge. Out of warranty products will be repaired on a charge basis.

Return of Items:

Authorization must be obtained from your OAKTON Distributor before returning items for any reason. When applying for authorization, please include information regarding the reason the item(s) are to be returned.

Note: We reserve the right to make improvements in design, construction and appearance of products without notice. Prices are subject to change without notice.

OAKTON® Waterproof TDSTestrs 1-4 Instructions

Before you Begin:

Remove electrode cap. Switch unit on for 15 minutes to stabilize the batteries. Soak electrodes for a few minutes in alcohol to remove oils.

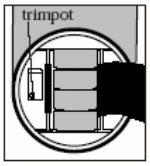
Calibration:

Select a calibration standard appropriate for your waterproof TDSTestr:

TDSTestr 1: between 300 ppm and 1990 ppm
TDSTestr 2: between 3 ppt and 10.00 ppt
TDSTestr 3: between 300 µS and 1990 µS
TDSTestr 4: between 3 mS and 19.90 mS

It is best to select a standard close to the test solution value, and one that has a similar chemical make-up to the test solution.

1. Pour calibration standard into two separate containers and tap or deionized water into a third.
2. Rinse electrode in the deionized water, then rinse it in first container of standard, then dip it into the second container of standard.
3. Switch unit on (ON/OFF button). Wait several minutes to allow display to stabilize.
4. Using a small screwdriver, adjust the trimpot (located inside the Testr's battery compartment) until the display reads the same value as the standard.



5. Rinse the electrode in the tap or deionized water and proceed with testing.

TDS Testing:

1. Remove cap from electrode. Switch unit on (ON/OFF button).
2. Dip the electrode into the test solution. Stir once and let the reading stabilize.
3. Allow time for the Automatic Temperature Compensation to correct the readings for solution temperature changes.
4. Note the reading once the display is stable. If the solution is above the range of the TDSTestr, the display will show

5. Press ON/OFF to turn off Testr. Replace cap.

Instrument Maintenance:

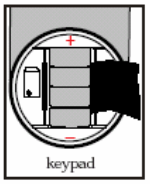
- To improve performance, clean the stainless steel electrodes by periodically rinsing them in alcohol for 10-15 minutes.
- Replace all 4 batteries if the display becomes faint or disappears, or if the readings are unstable or constant.
- If drift is detected while electrodes are continuously exposed to solution for longer than one hour, allow electrode to fully dry off periodically.

NOTE: Testr life is dependent on meter and electrode care. If the electrode is exposed to damaging materials, electrode life will be shortened.

When you need a new electrode, see "**Electrode Replacement**" on insert in back of box.

Changing batteries

1. Open battery compartment lid (with attached lanyard loop).
2. Remove old batteries; replace with fresh ones. Note polarity (shown in battery compartment and in picture at right).



3. Recalibrate Testr after battery change.

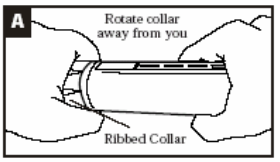
Specifications

TDSTestr	1	2	3	4
Range	0 to 1990 ppm	0 to 10.00 ppt	0 to 1990 µS	0 to 19.90 mS
Resolution	10 ppm	0.10 ppt	10 µS	0.10 mS
Accuracy	±2% full scale			
Calibration	1-point calibration with trimpot			
Calibration Standard	300 to 1990 ppm	3 to 10.00 ppt	300 to 1990 µS	3 to 19.90 mS
Operating Temperature	32 to 122°F / 0 to 50°C			
ATC	32 to 122°F / 0 to 50°C (1.11% per °F / 2% per °C)			
Power	Four 1.5V alkaline batteries (Eveready A76BP; supplied) 100 hrs. continuous use Alternate replacement Model Eveready 303 silver oxide, 70 hrs. continuous use.			
Dimensions	6.5" L x 1.5" Dia. (165 x 38 mm)			
Weight	3.25 oz (90 gms)			

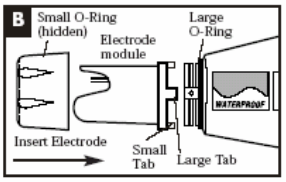
Electrode replacement:

You can replace the electrode module at the fraction of the cost of a new Testr. When the Testr fails to calibrate, gives fluctuating readings in buffers, shows error messages 'E2' or 'OR' in a buffer, and the procedures in the Maintenance section do not help, you need to change the electrode.

1. With dry hands, grip the ribbed Testr collar with electrode facing you. Twist the collar counter clockwise. *(see diagram A)*. Save the ribbed Testr collar and O-ring for later use.



2. Pull the old electrode module away from the Testr.
3. Align the four tabs on the new module so they match the four slots on the testr. *(see diagram B)*.



4. Gently push the module onto the slots to seat it in position. Push the smaller O-ring fully onto the new electrode module. Push the collar over the module and thread it into place by firmly twisting clockwise.

Warranty:

The waterproof TDSTestr 1-4 meter body is warranted against defects in materials and workmanship for a period of 12 months from the date of purchase; the electrode module is warrantied for a period of 6 months from the date of purchase. If repair, adjustment or replacement is necessary and has not been the result of abuse or misuse within the time period, please return the Testr—freight pre-paid—and correction will be made without charge. Out of warranty products will be repaired on a charge basis.

Return of Items:

Authorization must be obtained from your OAKTON Distributor before returning items for any reason. When applying for authorization, please include information regarding the reason the item(s) are to be returned.

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9. DISSOLVED OXYGEN

What is dissolved oxygen?

Oxygen gas dissolves freely in fresh water. Thus, oxygen from the atmosphere as well as that produced as a by-product of photosynthesis may increase the dissolved oxygen concentration in water. Oxygen is removed from the water through the processes of respiration (by both plants and animals) as well as other chemical reactions, including the decomposition of organic wastes entering the water.

The distribution of dissolved oxygen (DO) within an aquatic environment may vary horizontally or vertically and with time. Its distribution is dependent upon atmospheric contact, biological activity, wave and current actions, thermal phenomena, waste inputs and other characteristics of a lake or stream. High levels of oxygen are likely in surface water on windy days. Dissolved oxygen levels are also temperature and pressure dependent. Cold water holds more oxygen than warm water.

There are biological processes in water that consume oxygen such as respiration by organisms and decomposition of organic matter by microorganisms. The oxygen consumed by these processes is called the Biological Oxygen Demand or BOD. When demand for oxygen is high and oxygen production from photosynthesis is not occurring such as before sunrise, dissolved oxygen readings can be low. Photosynthesis contributes to an increase in dissolved oxygen levels during the day. Deep areas of a lake or stream would be expected to yield low dissolved oxygen readings.

How is dissolved oxygen measured?

Since an adequate supply of oxygen is necessary to support life in a body of water, a determination of the amount of oxygen provides a means of assessing the quality of the water with respect to sustaining life. A standard chemical method to determine the amount of oxygen dissolved in a water sample is a type of titration, the Azide Modification of the Winkler Method. Precisely measured amounts of chemicals (reagents) are added to a water sample until a color change is achieved. A color change (or electrical measurement for other types of titration) marks the endpoint of the test. Another way to measure dissolved oxygen is to use a dissolved oxygen (DO) meter and probe. Units for measuring dissolved oxygen are parts per million (ppm) or milligrams per liter (mgL).

Because the solubility of oxygen in water is dependent upon temperature, pressure, and ionic concentrations, it is also important to calculate percentage saturation. The accompanying nomogram will permit you to quickly approximate oxygen saturation values. The saturation point indicates the level at which water will not generally hold any more oxygen at a given temperature. Supersaturation occurs when the water holds more oxygen molecules than usual for a given temperature. Sunny days with lots of photosynthesis or turbulent water conditions can lead to supersaturation. A water sample is "saturated" at 100% and "supersaturated" above 100%.

What is the significance of dissolved oxygen?

Dissolved oxygen levels provide information about the biological, biochemical, and inorganic chemical reactions occurring in aquatic environments. Most aquatic organisms are highly dependent upon dissolved oxygen and will experience stress, or perhaps even be eliminated from a system, when dissolved oxygen levels fall below about 3.0 ppm (parts per million). Trout species normally require an oxygen concentration greater than 10 ppm (10 mgL) whereas carp can live in water containing as little as 1-2 ppm (1-2 mgL) oxygen.

Poor water quality is also indicated by low percent saturation readings. Levels below 60% may happen with rapid biological processes such as decomposition or high temperatures. Supersaturation can be a problem for organisms in that blood oxygen levels can increase resulting in gas bubbles in the blood.

Guideline for Interpretation of Dissolved Oxygen Readings

For mg/L:

0-2 mg/L:	not enough oxygen to support life
2-4 mg/L:	Only a few kinds of fish and insects can survive
4-7 mg/L:	acceptable for warm water fish
7-11 mg/L:	very good for most stream fish including cold water fish

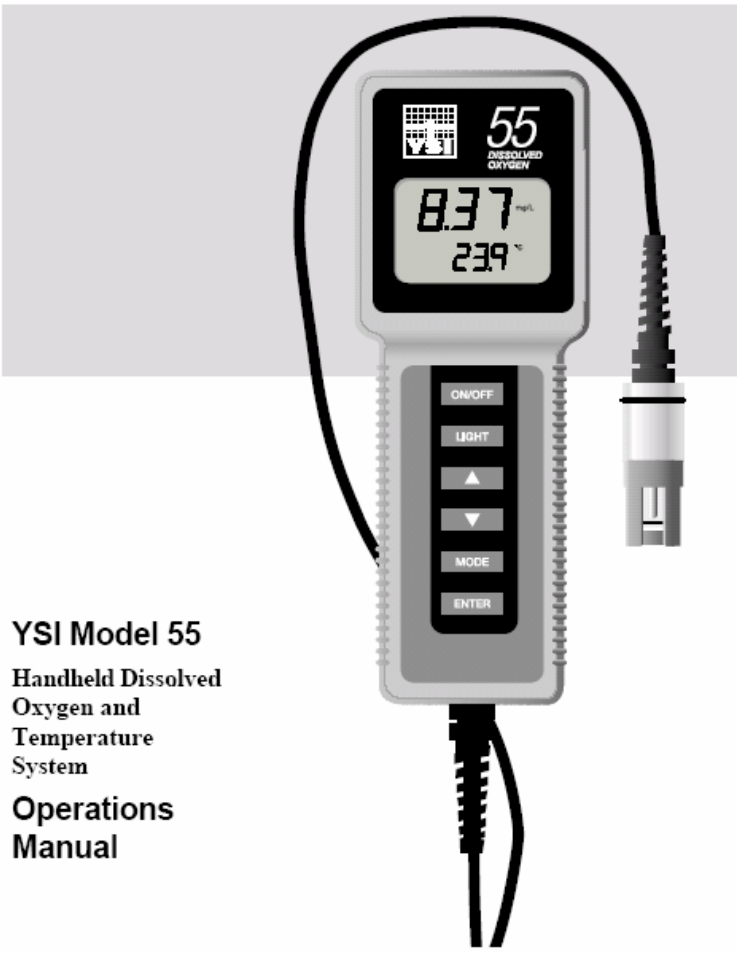
For percent saturation:

Below 60%:	poor; water too warm or bacteria using up DO
60-79%:	acceptable for most aquatic organisms
80-125%:	excellent for most aquatic organisms
112% or more:	too high, may be dangerous to fish

Adapted from *Testing the Waters*, S. Behar, River Water Network, 1996

Instructions for Dissolved Oxygen determination: YSI Model 55 Do Meter

YSI *incorporated*



YSI Model 55

Handheld Dissolved Oxygen and Temperature System

Operations Manual

1. General Description

The YSI Model 55 Handheld Dissolved Oxygen System is a rugged, micro-processor based, digital meter with an attached YSI dissolved oxygen probe. The YSI Model 55 is designed for field use and is available with cable lengths of 12, 25 or 50 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The large Liquid Crystal Display (LCD) is easy to read and is equipped with a back-light for use in dark or poorly lighted areas. The Model 55's micro-processor allows the system to be easily calibrated with the press of a few keys. Additionally, the micro-processor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the function of the instrument circuitry and the quality of the readings you obtain. The system simultaneously displays temperature in °C and dissolved oxygen in either mg/L (milligrams per liter) or % air saturation. The system requires only a single calibration regardless of which dissolved oxygen display you use. You can switch back and forth from % air saturation to mg/L with a single push of the **MODE** key.

A calibration chamber is built into the instrument. A small sponge in the chamber can be moistened to provide a water saturated air environment which is ideal for air calibration. This chamber is also designed for transporting and storing the probe. When the probe is stored in the chamber, the moist environment will prolong effective membrane performance and probe life.

The instrument is powered by six AA-size alkaline batteries. A new set of alkaline batteries will

provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

The YSI Model 55 instrument case is splash resistant. You can operate your Model 55 in a steady rain without damage to the instrument.

2. Specifications

Probe Operating Environment

Medium: fresh, sea, or polluted water
Temperature: -5 to +45oC
Depth: 0 to 12, 0 to 25 or 0 to 50 feet (depending on cable length)
Meter Ambient Operating/Storage Temperature: -10 to +50oC
Material: ABS, Stainless Steel, Acrylic, and other materials.
Dimensions:
Height:9.5 inches (24.13 cm)
Thickness: 2.2 inches (5.6 cm)
Width: 3.5 inches max. (8.89 cm)
Weight: 1.7 pounds (0.77 kg)
Power: 9 VDC - 6 AA-size Alkaline Batteries (included)
Approximately 100 hours operation from each new set of batteries
Water Tightness: Meets or exceeds IP65 standards

Extensive testing of the YSI Model 55 suggests the following typical performance:

Temperature

Sensor Type.....Thermistor
Range.....-5 to +45oC
Accuracy.....± 0.2oC
Resolution.....0.1oC

Dissolved Oxygen % Saturation

Sensor Type.....Membrane covered polarographic
Range.....0 to 200 % air saturation
Accuracy.....± 2 % air saturation
Resolution.....0.1 % air saturation

Dissolved Oxygen mg/L

Sensor Type.....Calculated from % air saturation, temperature and salinity.
Range.....0 to 20 mg/L
Accuracy.....± 0.3 mg/L
Resolution.....0.01 mg/L

3. Calibration

Dissolved oxygen calibration must be done in an environment with a known oxygen content. Since the amount of oxygen in the atmosphere is known, it makes an excellent environment for calibration (at 100% relative humidity). The calibration/storage chamber contains a moist sponge to create a 100% water saturated air environment.

3.1. Before Calibration

Before you calibrate the YSI Model 55, complete the procedures discussed in the *Preparing the Meter* and *Preparing the Probe* chapters of this manual.

To accurately calibrate the YSI Model 55, you will need to know the following information:

- The approximate altitude of the region in which you are located.
- The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Sea water has a salinity of approximately 35 parts per thousand (ppt). If you are not certain what the salinity of the sample water is, use a YSI Model 30 Salinity-Conductivity-Temperature meter to determine it.

3.2. The Calibration Process

1. Ensure that the sponge inside the instrument's calibration chamber is wet. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required after turning the instrument on).

3. To enter the calibration menu, use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time.

4. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude **EXAMPLE:** Entering the number 12 here indicates 1200 feet.

5. When the proper altitude appears on the LCD, press the **ENTER** key. The Model 55 should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current DO reading (before calibration) should be on the main display.

6. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 40 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the LCD (zero for fresh water), press the **ENTER** key. The instrument will return to normal operation.

Once the calibration process is complete, the only keys which will remain operational are the **MODE** key, the **LIGHT** key and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/L mode or the % air saturation mode by pressing the **MODE** key. If you are working in a dark area and have difficulty reading the LCD, press and hold the **LIGHT** key to activate the back-light of the YSI Model 55. The **ON/OFF** key turns the instrument on or off.

For best results:

- Each time the Model 55 is turned off, re-calibrate before taking measurements.
- Calibrate at a temperature within ±10°C of the sample temperature.

10. STREAM FLOW

Stream flow, or discharge, is the volume of water that moves over a designated point over a fixed period of time. It is often expressed as cubic feet per second (ft^3/sec) or cubic meter per second (m^3/sec).

The flow of a stream is directly related to the amount of water moving off the watershed into the stream channel. It is affected by weather, increasing during rainstorms and decreasing during dry periods. It also changes during different seasons of the year, decreasing during the summer months when evaporation rates are high and shoreline vegetation is actively growing and removing water from the ground. August, September, October and November are usually the months of lowest flow for most streams and rivers in Guyana.

Water withdrawals for irrigation purposes can seriously deplete water flow, as can industrial water withdrawals. Dams used for electric power generation, particularly facilities designed to produce power during periods of peak need, often block the flow of a stream and later release it in a surge.

Flow is a function of water volume and velocity. It is important because of its impact on water quality and on the living organisms and habitats in the stream. Large, swiftly flowing rivers can receive pollution discharges and be little affected, whereas small streams have less capacity to dilute and degrade wastes. Stream velocity, which increases as the volume of the water in the stream increases, determines the kinds of organisms that can live in the stream (some need fast-flowing areas; others need quiet pools). It also affects the amount of silt and sediment carried by the stream. Sediment introduced to quiet, slow-flowing streams will settle quickly to the stream bottom. Fast moving streams will keep sediment suspended longer in the water column. Lastly, fast-moving streams generally have higher levels of dissolved oxygen than slow streams because they are better aerated.

The most accurate measure of stream flow is achieved with a current meter used at multiple points along the cross section of the stream. However, simpler methods may be used if the flow estimates need only be approximate (cross-sectional area, a roughness factor, and floating object provide a gross estimate of flow).

Measuring and Calculating Stream Flow

Preparing Equipment Before leaving to Field Site
In addition to the standard sampling equipment and apparel, when measuring and calculating flow, include the following equipment before leaving for the sampling site:

- Ball of heavy-duty string, four stakes, and a hammer to drive the stakes into the ground. The string will be stretched across the width of the stream perpendicular to shore at two locations. The stakes are to anchor the string on each bank to form a transect line.
- Tape measure
- Waterproof yardstick or other material to measure water depth
- Twist ties (to mark off intervals on the string of the transect line)
- An orange and a fishing net (to scoop the orange out of the stream)
- Current meter
- Stopwatch (or watch with a second hand)
- Calculator (optional)

Using the Method of Float Object
This section describes one method for estimating flow in a specific area or reach of a stream using a float (an object such as an orange, cork, ping-pong ball, pine cone, etc.) to measure stream velocity (see figure).

Time with a stopwatch how long it takes for an orange (or some other object) to float from the upstream to the downstream transect. The orange at the upstream transect should be positioned so that it flows into the fastest current. The clock stops when the orange passes fully under the downstream transect line. Once under the transect line, the orange can be scooped out of the water with the fishing net. This "time of travel" measurement should be conducted at least three times and the results averaged--the more trials you do, the more accurate your results will be.

Calculating flow involves solving an equation that examines the relationship among several variables including stream cross-sectional area, stream length, and water velocity. One way to measure flow is to solve the following equation: $Q = (AxLxC)/T$

Where

Q: Discharge

A: Average cross-sectional area of the stream (stream width multiplied by average water depth).

L: Length of the stream reach measured (usually 20 ft.)

C: A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams). This allows you to correct for the fact that water at the surface travels faster than near the stream bottom due to resistance from gravel, cobble, etc. Multiplying the surface velocity by a correction coefficient decreases the value and gives a better measure of the stream's overall velocity.

T: Time, in seconds, for the float to travel the length of L.

The flow will be recorded on a data sheet.

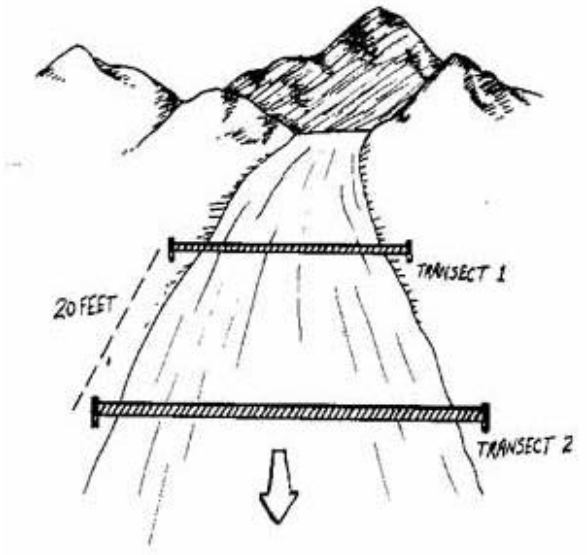


Figure 4

A diagram of a 20-foot transect

Using Current Meter (Flow Probe)
The most accurate measure of stream flow is achieved with a current meter used at multiple points along the cross section of the stream.

(a) Follow flow meter instructions as per the manufacturer's directions for storage, transportation, calibration, and use.
(b) Extend a measuring tape at right angles to the direction of flow and measure the width of the cross section. Record measurements on a data sheet. Leave the tape strung across the stream.
(c) Divide the width into segments using about 20 points of measurement. If previous flow measurements have shown uniform depth and velocity, fewer points may be used. Smaller streams may also require fewer points. Measuring points should be closer together where depths or velocities are more variable. Cross sections with uniform depth and velocity can have equal spacing.
(d) Record the distance (from the initial starting bank) and the depth of each point.
(e) Record the current velocity at each measuring point.

(f) Calculate flow as a summation of flows in partial areas using the following equation:
$q_n = v_n d_n (b_{n+1} + b_{n-1})$
2
where:
q = discharge in partial area n [m^3/sec]
v = average current velocity in partial area n [m/sec]
d = mean depth of partial area n [m]
b_{n+1} = distance from point to the following point [m]
b_{n-1} = distance from point to the preceding point [m]

The flow will then be recorded in a data sheet.

Note: Horizontal and vertical variation of stream velocity may influence stream-flow measurements. To correct for vertical differences, hydrologists have determined depths that can yield acceptable estimates of the mean velocity over a vertical profile. If the depth exceeds 0.8 m, it is recommended that velocities be measured at 20 percent and 80 percent of full depth and averaged to estimate mean velocity. In the depth range 0.1 -0.8 m, take the velocity at 60 percent of the full depth (measured from the surface) as an estimate of the mean over the profile.

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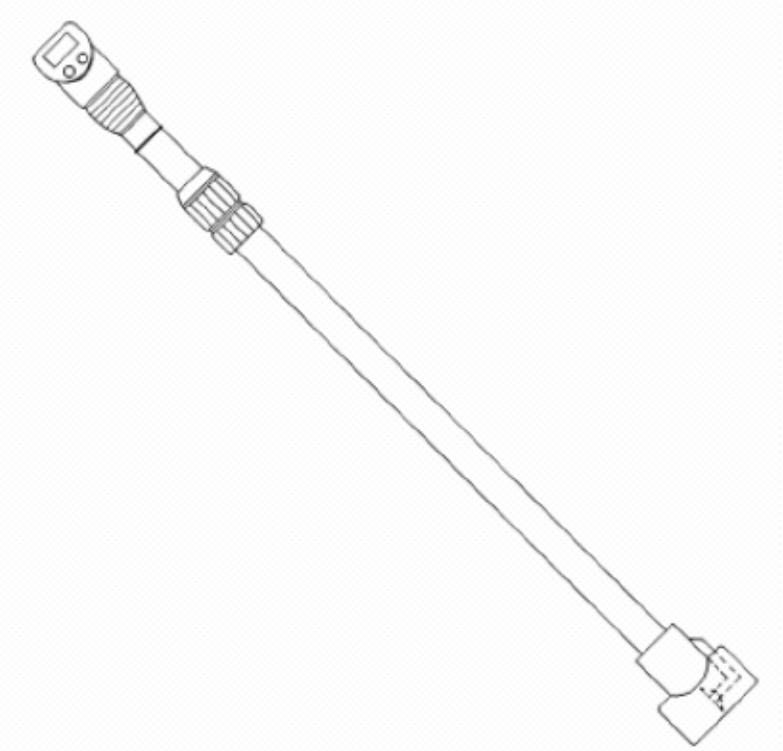
FP101-FP201 Global Flow Probe

User's Manual



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Level • Flow • Samplers • Water Quality • Weather • Remote Monitoring • Control

I. Instructions for Flow Rate determination: Global Flow Probe

1. Make sure the Flow Probe's propeller turns freely by blowing strongly on the prop.
2. Point the propeller directly into the flow you wish to measure. Face the arrow inside the prop housing downstream. The FP101 probe handle is a two piece rod expandable from 3' to 6', and the FP201 is a three section rod expandable from 5' to 15'. To expand the rod for correct placement in flow, loosen the locking nut on the handle, pulling out the top piece and retightening the nut.
3. Use the bottom button to scroll through the functions until "AVGSPEED" appears. The top number is the instantaneous velocity to the nearest .5 ft/second. The lower display is the average velocity. Pressing the top button for 3 seconds will clear the average and start a new reading. While taking an average reading the maximum velocity will also be recorded. Pushing the bottom button until "MAXSPEED" is displayed causes the lower display to indicate this value. While on this screen, pressing the top button for 3 seconds will clear this value. While on the average or maximum screens pressing the top button for 5 seconds will clear both of these functions.
4. To make a measurement, place the propeller at the desired measuring point and hold the top button for 3 seconds to clear the value or 5 seconds to clear both average and maximum values. Hold the probe in place until the reading becomes steady and remove the probe from the water. The average and maximum velocities remain in their respective screens. These values are only updated while the propeller is turning. See the Average Velocity section for more information.
5. Measure/calculate the cross-sectional area of your flow stream in square feet or square meter. If you are measuring flow in round pipes, measure the depth of water and use the enclosed tables to determine crosssectional area (see Appendix B: Calculations for Flow in Partially Filled Pipes). If you are measuring flow in another channel type, manually measure water depth at several points across the flow. These measurements are most easily recorded by drawing a diagram on graph paper with a scale of 1 square foot per graph paper square. Cross-sectional area (in square feet) can then be found by counting the number of squares in the stream.
6. The average velocity (calculated with the Flow Probe in feet/second) times the cross-sectional area (square feet) equals flow in cubic feet per second (cfs), or $Q = V \times A$.
7. If the propeller gets fouled while measuring flow, clean it until the prop turns freely and start over.

II. Average Velocity

The Flow Probe is used to measure the average water velocity.

Streamflow velocity varies for two reasons:

1. The velocities vary throughout the flow's cross-section. In general, the velocities are greater in the center of the flow and less near the bottom and sides of the channel.
2. The water surges in velocity with time. In a smooth running stream, the velocity at a specific point can easily vary 1-2 feet per second over the period of a minute. This pulsating or surging of flow should be averaged to obtain an accurate average flow reading (leave the probe in the flow through a series of flow surges). The Flow Probe can be used in three ways to determine average velocity in a stream.
    a. For small streams and pipes, the probe can be moved slowly and smoothly throughout the flow during average velocity measurement. Move the probe smoothly and evenly back and forth from top to bottom of the flow so that the probe stays at each point in the flow for approximately the same amount of time. Keep moving the probe for 20-40 seconds to obtain an accurate average value that accounts for surging. (Move the probe as if you were spray painting and attempting to get an even coat of paint over the entire surface.)

The Flow Probe uses true velocity averaging. When the average and maximum velocities are zeroed by pushing the top button, a running average is started. As long as the probe remains in the flow, the averaging continues. One reading is taken per second, and a continuous average is displayed. For example, after 10 seconds, 10 readings are totaled and then divided by 10 and this average is displayed.

Once the average reading becomes steady, the true average velocity of the stream is obtained. When you pull the probe from the water, this average value is frozen on the display until it is reset.

b. For larger streams and rivers where the Flow Probe can't easily be moved throughout the flow, divide the stream into subsections 2-3 feet wide. We recommend dividing subsections on your graph paper diagram of the flow profile. Run a measuring tape across the stream for reference. Obtain a vertical flow profile at the center of each subsection: zero the averaging function and move the Flow Probe vertically from the surface to the bottom, up and down, slowly and smoothly for 20-40 seconds to obtain a good average. The average velocity (obtained with the Flow Probe) times the area of the subsection (use your graph paper diagram) equals the flow for the subsection (Q=VxA).Once the flow of each subsection is obtained, add all of the subsection flows to obtain the Total Streamflow.
c. For the USGS "6 tens method", the Flow Probe is placed at the center of the subsection at a depth from the surface of 0.6 of the total depth. The Flow Probe is held in place and the average velocity is obtained over a period of 40 seconds. The 0.6 depth is assumed to be the average velocity point for the vertical profile. Therefore, this average is similar to that obtained in technique 2 (above) however; we feel that technique 2 is more accurate.

III. Computer Operation

a. The Flow Probe is calibrated at the factory. When you receive the product, you may wish to set the computer's clock (see Computer Setup), otherwise you should not have to alter any of your computer settings. You will have to recalibrate the computer when you change the unit's battery (See Appendix A: Computer Setup). Normal battery life for the Flow Probe is 3 years or more.
b. The Flow Probe computer has a simple 2-button operation. The bottom button scrolls between functions and the top button resets the function's value. Pressing the top button for 3 seconds zeros the average and maximum velocities. With a little practice, the buttons can be pushed with the hand holding the top of the probe.
c. The computer functions are as follows:
    - Velocity: The upper display number is the instantaneous velocity to the nearest .5 foot (or meter, depending on units being used) per second.
    - The lower display number is used for the following functions: average velocity(AVGSPEED), maximum velocity(MAXSPEED), stop watch(STPWATCH) and CLOCK.
    - The bottom button scrolls between these functions, and also DIST/DAY, RIDETIME, TRIP UP, and TOTALODO which are not used for this application.
    - Push the top button for 3 seconds to reset the displayed function.

Push for 5 seconds to reset all velocity functions.

Stop watch: While STPWATCH is displayed, pressing the top button once will start the stopwatch. Pressing a second time stops the watch. Holding the button for 3 seconds clears it.

Clock: The computer returns to the clock function after a period of inactivity for the probe.

IV. Instrument Specifications

Range: 0.3-15 FPS (0.1-4.5 MPS)
Accuracy: 0.1 FPS
Averaging: True digital running average. Readings taken once per second.

Display: LCD

Sensor Type: Protected Turbo-Prop propeller with electro-magnetic pickup.

Weight: 2 Lbs (10 lbs. U.S., 14 lbs. international shipping weight)

Size: Length: FP101 3' to 6'; FP201 5' to 15' Materials: PVC, anodized aluminum, stainless steel bearing Power: Internal watch type batteries/1 year life Operating Temperature: 0° to 120° F Carrying Case: The Flow Probe is shipped in a padded carrying case.

Appendix A: Computer Setup

The BC1200 has the capability to switch between 2 different calibration factors. To change between the calibrations remove the computer from the flow probe head by twisting 45 degrees counter clockwise and lifting. The indented gray button in the upper left corner on the back is to switch between CAL I and CAL II. In the upper left corner of the display, I is displayed for CAL I and II is displayed for CAL II.

Note:
I = ft/sec, calibration # = 0053
II = m/sec, calibration # = 0016

The indented gray button on the upper right is used to enter the calibration mode. Press and hold it for 5 seconds to enter calibration mode.

TO RESET THE CALIBRATION:
(Calibration #'s are factory set. Resetting is only required after changing the battery.)

Press bottom button until CLOCK or TOTALODO is not displayed on screen.
Press the left indented gray button to select CAL I.
Turn computer over and press and hold the right indented gray button for 5 seconds and "set language" flashes on display.
Press top button to select language.
Press bottom button to accept.
Press top button until "SET M" is displayed.
Press bottom button to accept. The calibration factor is now displayed.
Pressing the top button will change the value of the flashing digit.
Pressing the bottom button will accept this value and move to the next digit.
Set the calibration factors as follows:

- Feet/second: 0053 (CAL I)
- Meters/second: 0016 (CAL II)

Press indented right button on back for one second to store.
Repeat above procedure for Cal II. (Only the cal number will be required)

(NOTE: after battery replacement and additional screen displaying SET ODO will follow the forth digit of the cal number. Ignore this and press the indented gray button to store settings)

TO SET CLOCK
Press bottom button until clock appears at the bottom of the screen.
Turn computer over and press and hold the right indented gray set button (S) for 5 seconds or until clock flashes.
Press top button until hour is reached.
Press bottom button to move to minutes.
Press top button until desired number is reached.
Press bottom button to move to single minutes.
Press top button until desired single minute is reached.
Turn computer over and press right indented gray set button for 1 second to save.

11. BOTTOM SAMPLING

In order to obtain a rough analysis of the bottom material in a body of water, a variety of devices have been invented. Among them are grab samplers, dredges, corers, and drills. The PONAR Grab sampler is the main bottom sampling device used to study the composition of the bottom of a lake or river: A Phleger Corer is sometimes used where the stratification of the sediment layers is studied

Dredges and grab samplers make it possible to obtain samples of material found on the bottom of a body of water (ocean, lake, or river). Dredges are weighted nets that are dragged over the bottom to scrape off samples of the surface material. This technique is satisfactory for obtaining bulk materials.

The grab sampler provides a means to obtain a somewhat quantitative and undisturbed sample of the bottom material. It takes a bite of known surface area and penetration depth, providing the bottom material is neither too hard or nor too soft. It is called a grab sampler because of the manner in which it obtains samples.

What is a PONAR Grab Sampler?

The PONAR grab sampler consists of two opposing semi-circular jaws that are normally held open by a trigger mechanism. The sampler is lowered to the bottom where contact with the bottom sets off the trigger and a strong spring snaps the jaws shut trapping a sample of the bottom inside. Fine copper screen covers the top of the jaws so that the trapped material will not wash out as the sampler is retrieved.

The sampling crew normally places the PONAR grab sampler on the boat at the start of the work. It is placed in an out of the way location until a sample of the bottom material is desired. Samples are taken while the boat is on station and not moving through the water.

The grab sampler is "cocked", that is, the jaws are opened and the trigger is set. The sampler is then swung over the side and lowered to the bottom. The jaws snap shut upon reaching the bottom and a sample of material is obtained.

As long as the PONAR sampler is hanging freely from the boat, the trigger mechanism will keep the jaws open. However, as soon as there is slack in the line, the trigger will be released. When the rope attached raise the PONAR grab sampler, the jaws will close thus taking a "bite" (sample) from the bottom of the lake.

When a successful PONAR grab sample is brought aboard, the sampler is lowered into a rectangular stainless steel box that has a very fine screen on the bottom side. The contents of the PONAR grab sampler will be empted into the stainless box and rinse the grab sampler with a hose to make sure that the entire sample is rinsed into the stainless steel box. The bottom sample is now ready for examination

NOTE: The PONAR grab sampler is a piece of equipment that is operated by the deckhand if in a vessel trip or by pulling if in a boat trip. It is very heavy. Please stay out of the way when it is being used.

How is bottom material studied?

The material brought up from the bottom can be examined in several ways. A quick visual inspection can give a qualitative description of the kind of material retrieved: sand, silt, clay, mud, decayed organic, or a combination. In many cases, the sample will reveal the presence of small animals. These can be found by

washing the fine sediments through the fine mesh screen and leaving the organisms on the screen where they can be picked from the screen and placed in a plastic Petri dish. When all of the organisms have been collected in the Petri dish the dish can be taken and examined under the stereo microscope. With the video camera attached the entire group will be able to see these bottom (benthic) organisms on the color monitor. Students may be able to identify some of the organism by checking the laminated diagrams of typical benthic organisms that are on display in and around the microscope area.

The composition of bottom sediment can also be studied by separating the samples through the use of a graded series of fine-mesh brass sieves. The sediment particles sort out by size:

Sediment Class	**Diameter (mm)**
Sand	2.00 to 0.05
Very coarse	2.00 to 1.00
Medium	1.00 to 0.10
Very fine	0.10 to 0.05
Silt	0.05 to 0.002
Very coarse	0.05 to 0.02
Medium	0.02 to 0.01
Very fine	0.01 to 0.002
Clay	0.002

Sediment that is sand will have distinct grains that are easily seen and felt. Silt will form a cast when moist but will not form a ribbon when moist. Clay is sticky and plastic when wet and forms a ribbon when squeezed. Some sediment samples may have high concentrations of organic matter (muck) indicating slow decomposition rates and low oxygen conditions.

What is found in the bottom material?

Samples taken from Lakes provide the possibility of observing anaerobic decay. This is especially true in high latitude countries in a summer season when biological oxygen demand depletes oxygen in the water above the bottom. If anaerobic decay is present, the odor of hydrogen sulfide (hard boiled or rotten egg odor) can be detected. The material from the bottom of such lakes seldom has a great diversity of easily detected life forms. Chironomid (midge fly) larvae are sometimes found. They can be identified by their blood red color leading to the common name "bloodworms." The presence of erythrocruorin in their blood causes the red color in these organisms. The erythrocruorin may enable them to withstand lower oxygen levels as the chemical has a high affinity for whatever oxygen is present. Bloodworms live head down in tubes on soft bottoms where they feed on bottom organic matter. They have a complex life cycle.

For instance, Lake Michigan provides many possibilities for bottom material study. Near shore, the material is basically sandy. Oligochaetes (segmented worms related to earthworms), fingernail clams, and scuds (small shrimp-like arthropods) are commonly found. Some samples will have zebra mussels. Farther out from the shore, the sand is mixed with silt and/or clay. At greater depths, the sediments are a mixture of clay and fine?grained sediment. Samples taken from the bottom of other bodies of water may show a greater species diversity.

In a river where a strong current is present, the bottom material will most likely be sandy or rocky. In still water, silt is commonly found. Shells are usually found in these samples. Streams can harbor many benthic macroinvertebrates including a great variety of immature insects, sponges, flatworms, roundworms, annelids, and mollusks.

Water and Sediment samples are also analyzed for toxic metals such as Mercury, Lead, Chromium, Cadmium, Beryllium, Arsenic, Aluminum, Antimony, Cobalt, Copper, Iron, Manganese, Molybdenum, Nickel, Selenium, Silver, Tin, Vanadium, and Zinc. Toxic metals, including "heavy metals," are individual metals and metal compounds that negatively affect people's health. In very small amounts, many of these metals are necessary to support life. However, in larger amounts, they become toxic. They may build up in biological systems and become a significant health hazard.

Bottom Sampling Dredges

Standard Ponar Grab/Ponar Dredge

Features

- Center pivot for low bottom disturbance
- Tapered scoop edges for a clean cut
- Heavy duty hinges for high impact work
- Hefty scoop volume: 8200 mL
- 316 SS scoops and underlip or all 316 SS
- Removable stainless steel top screens
- Self-releasing pinch-pin™

Widely used in fresh and salt water for taking samples of hard bottoms such as sand, gravel, consolidated marl or clay, this sturdy dredge is a deliberately heavy device for biting deep into the bottom and has proven success at invertebrate recovery. The simple design means it is simple to use. Heavy-duty hinges and hinge pin can absorb thousands of bottom impacts. Self-closing scoops have center pivot closing action.

When the scoops strike the bottom, their tapered cutting edges penetrate well with very little sample disturbance. An attached underlip wipes the scoop clean of pebbles and cobble that would interfere with closing. By the same token, removable side plates prevent the lateral loss of sample as scoops close. This well-regarded self-closing sampler uses our patented spring-loaded pinch-pin™ that releases when cable or line slackens. A safety pin replaces the pinch-pin™ when not in use to prevent injury.

Removable screens on top of each scoop allow water to flow through as it descends. This lessens the frontal shock wave and reduces surface disturbance. Both screens are covered with neoprene rubber flaps that close during retrieval. Choose all stainless steel for severe conditions. Ship wt: 67 lbs. Crane and winch recommended due to working weight.

Specifications

Materials	316 stainless steel
Fasteners	18-8 SS
Empty weight	23 kg (50 lbs)
Full weight	34kg (75 lbs)
Sample area	229 x 229 mm (9 x 9")
Volume	8.2 Liter

Ekman Dredges

Features

- Scoops overlap to reduce sample loss
- Dependable release closing
- 316 or 18-8 stainless steel construction
- Lightweight yet stable due to wide base
- Extra weights available
- Center pivot for low bottom disturbance
- Safe, reliable closing mechanism
- All stainless steel construction
- Extra weights fit standard and tall Ekmans
- Extension handles replace messengers in shallow water
- Kits include 45-B10 messenger, 62-C15 line and case.
- Sampler and cases also available separately
- Heavy duty springs on tall and large versions.
- Wide base yields good stability despite its light weight

This is the grab to choose for soft, finely divided littoral bottoms that are free from vegetation, such as sticks and decayed leaves (or with short, erect vegetation only) as well as intermixtures of sand, stones and other coarse debris. The specialized function of this dredge is the taking of quantitative and qualitative samples of macroscopic bottom fauna to determine the productivity of soft bottoms, particularly those composed of finely divided muck, mud, ooze, submerged marl and fine peaty materials. Versatile and durable, it is suited for preliminary as well as more precise observation. It is not

recommended for rocky or sandy bottoms or moderate macrophyte growth because small pebbles or macrophyte stems prevent proper jaw closure.

Two thin, hinged overlapping lids on top open during descent to let water pass through. They close during retrieval and are held shut by water pressure to reduce washout. The closing springs easily unhook from their loaded position for safe handling during transportation and storage. An important and distinguishing feature of the Wildco® design is the messenger-operated Twin-pin™ scoop release mechanism. This release is very reliable, has few working parts and is the best of its type in the field. To operate, attach to a line and pass through the trip mechanism. Set the springs over the knobs and pull the jaws completely apart. Lower the dredge till it rests on the bottom and send a messenger down the line, allowing the springs to close the scoops. These samplers require a messenger and line (not included, except in kits) for operation.

12. GLOSSARY OF TERMS

ACID - Any substance that can donate a hydrogen atom or proton (H+) to any other substances. Examples are vinegar and hydrochloro acid.

ACCURACY - The closeness of a measured value to a true value.

AFT DECK - Area in the back (stern) of the vessel as opposed to the area in the front of the vessel (bow).

ALGAE - Simple, photosynthetic aquatic plants that lack true roots, stems or leaves.

ALGAL BLOOMS - Extensive growth of algae in a body of water often due to increased nutrients such as nitrates and phosphates from fertilizers.

ALKALINITY - Alkalinity is a measure of the capacity of water to neutralize acids. This is known as the buffering capacity of water that is the ability of water to resist a change in pH when acid is added. Alkalinity in water is due primarily to the presence of bicarbonate, carbonate, and hydroxide ions.

AMBIENT TEMPERATURE - The current temperature of the surroundings. Ambient water temperatures may differ from the ambient air temperature.

BEAKER - Container with a spout used to transport, pour, and/or mix liquids or solids.

BENTHOS - A term applied to organisms that live on or in the bottom of a body of water and its sediment (benthic zone).

BLOODWORMS - Midge fly larvae found in the bottom of lakes. Their red color is due to a chemical similar to the hemoglobin that is found in human blood.

BUFFER - Standard solutions of a known value, such as pH 7 and pH 10, used to calibrate pH meters. Buffers resist changes in pH.

BUFFERING CAPACITY - The buffering capacity of water refers to the ability of the water to neutralize acids. Limestone (calcium carbonate) is a natural buffer that helps to maintain soil and water pH near neutral.

CALIBRATION - Determination of the correct value of each setting on an instrument by comparison with a standard or known value.

CONDUCTIVITY - The measure of a substance's ability (in our case, water) to carry electricity. Conductivity depends on the concentration of charged particles (ions) and temperature. It is measured in micromhos (mmho/cm).

CONDUCTIVITY METER - An instrument consisting of two electrodes (positive and negative) that measure the flow of electricity between them.

CONSUMERS - Organisms that eat other organisms or plants for nutrition.

CUVETTE - A special container (sample cell) used to hold a small volume of water for certain measuring instruments such as turbidity meter.

DATA - The information (numerical and observational) gained through research.

DEIONIZED WATER - Water that has had all of its charged particles (ions), other than hydrogen and hydroxide ions, removed.

DENSITY - The ratio of the mass of a substance to its volume.

DEPTH SOUNDER - An instrument that sends and receives impulses indicating how deep the water is as well as the bottom contours.

DETRITUS - Dead and decomposing organic matter.

DIATOMS - Single-celled microscopic plants with hard "shells" of silica.

DIGITAL TITRATOR - An instrument used in the dissolved oxygen analysis that delivers a measured amount of chemical solution (titrant) to the water sample.

DISSOLVED OXYGEN - Oxygen gas molecules dissolved in water that are available for living organisms to use. Abbreviated DO. Measured in parts per million (ppm). DO solubility varies with water temperature and pressure.

ECOSYSTEM - A system of interrelated organisms and their physical and chemical environment. It includes both the biotic (living) community and the abiotic (non-living) environment.
ERLENMEYER FLASK - Container having a wide bottom and smaller neck and mouth; used to mix liquids.
EROSION - The wearing away of land surfaces by running waters, glaciers, winds, and waves. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber cutting.
EUTROPHIC LAKE - A lake that has high concentrations of nutrients; often shallow with periods of low oxygen.
EUTROPHICATION - The natural or artificial addition of nutrients to a body of water resulting in increased growth of plants. Acts as an aging process in a body of water and may cause decreases in dissolved oxygen. Accelerated aging of lakes by human activity is called cultural eutrophication.
EXOTIC SPECIES - Species or organisms found beyond their natural range or zone of potential dispersal. They have been intentionally or accidentally introduced outside their natural ranges. Also referred to as non-indigenous species. Examples are the zebra mussel, spiny waterflea, and sea lamprey.
FOOD CHAIN - A series of feeding relationships where organisms at one level serve as food for a higher level of organisms.
FOOD WEB - The many interconnected food chains of a biological community.
FOREL-ULE COLOR SCALE - A uniform way to measure the color of water using glass tubes filled with colored solution. (See water color scale).
GLOBAL POSITIONING SYSTEMS (GPS) - A system of satellites, ground stations, and GPS receivers. Ground stations monitor satellites in "known" positions and triangulation is used to determine such things as latitude and longitude or the location of a given area, a vessel or other vehicles.
GRADUATED CYLINDER - A cylindrical-shaped piece of laboratory equipment that is marked in units for measurement of liquids.
HEAD - Restroom and toilet. Unisex. Make sure door is locked when in use.
HERO PLATFORM - A special restricted area extending out from the side of the vessel from which instruments are lowered into the water.
HYPOTHESIS - A tentative statement made to test logical or empirical consequences.
INDICATOR SPECIES - Certain organisms, in part, that help determine water quality (clean versus polluted).
IONS - Electrically charged atoms or groups of atoms that are capable of conducting an electrical current in water. They may be positively or negatively charged. In neutral water, there are equal concentrations of hydrogen (H+) ions and hydroxyl (OH-) ions. Salt water has significant amounts of sodium (Na+) and chloride (Cl-) ions.
LABORATORY - Area inside the vessel where various tests are run and special equipment is maintained and used to collect data.
LATITUDE - A geographical measurement made up of degrees, minutes, and seconds. It is measured north or south with reference to the equator. This measurement is obtained from the GPS.
LIFE VEST - A garment worn to help a person float in case they fall in the water. Also known as a Personal Flotation Device (PFD).
LIMNOLOGY - The science of studying freshwater. Limnologists study freshwater systems and oceanographers study marine (salt-water) systems.
LOGARITHMIC SCALE - A scale in which each unit increment represents a tenfold increase or decrease such as a pH scale.
LONGITUDE - A geographical measurement made up of degrees, minutes, and seconds. It is measured east or west of the Prime Meridian.
MAGNETIC COMPASS - A device for determining directions by means of a magnetic needle swinging on a free pivot and pointing to the magnetic North.

MICROORGANISMS - Organisms too small to be seen with the unaided eye, including bacteria, protozoans, yeasts, viruses, and algae.
MICROSCOPE - An optical device used to magnify very small objects. It may have one eyepiece (monocular) or two eyepieces (binocular or stereoscopic).
MILLIGRAMS PER LITER - A unit (abbreviated as mg/L) used to measure dissolved oxygen and other chemicals. It is a measure of concentration, not absolute amounts. [Note: 1 mg/L = 1 ppm]
NITRATE - A salt of nitric acid (HNO3). Nitrates are often highly soluble and can be reduced to form nitrites and ammonia.
NUTRIENT - Chemical substances such as nitrates, phosphates, or potassium that are necessary for plant growth.
OLIGOTROPHIC LAKE - Deep, clear lake with low nutrient supplies and little organic matter characterized by high transparency and high dissolved oxygen levels.
ORGANISM - Any living being such as plants, animals, fungi, bacteria, etc.
PARTS PER MILLION - A unit (abbreviated as ppm) used to measure dissolved oxygen and other chemicals. It is a measure of concentration, not absolute amounts. For example, one inch in sixteen miles is one ppm. [Note: 1 mg/L = 1 ppm]
PELAGIC - Open water zone.
PERCENT OXYGEN SATURATION - Percent of the potential amount of dissolved oxygen that water will hold at a given temperature.
pH - A numeric value that indicates relative acidity and alkalinity on a scale of 1 to 14. A pH value of 7.0 is neutral. Acids have pH values less than 7, bases have pH values greater than 7. Acid rain has a pH of less than 5.6.
PHLEGER CORER - A weighted hollow tube used to sample the bottom sediment layers.
PHOTOSYNTHESIS - Production of food (carbohydrates) and oxygen by plants from carbon dioxide and water in the presence of chlorophyll and sunlight.
PILOT HOUSE - The area or compartment in which the captain operates the ship.
PLANKTON - Plants (phytoplankton), animals (zooplankton), and other organisms that drift in the water column. They are often microscopic but range in size from single-cells to large oceanic jellyfish.
PLANKTON NET - A funnel-shaped device of fine meshed cloth which will permit water to pass through it, but not microscopic organisms.
PLUME LINE - The point of separation between river water and Lake water due to such factors as temperature, turbidity, or microorganisms.
POLLUTANT - Any substance introduced to the environment that adversely affects the usefulness of a resource.
PONAR GRAB SAMPLER - A weighted, metal, jaw-like device used to take a "bite" out of the lake or river bottom. Used to collect bottom material or benthos.
PORTSIDE - When facing the front (bow) of the vessel, the left side.
PRECISION - Degree of variation among a set of repeated measurements obtained under similar conditions.
PRODUCER - An organism such as a plant which makes its own food through the process of photosynthesis.
RADAR - Use of radio waves to provide information about objects on or above the surface of water; RAdio Direction And Range.
SAND DUNES - Mounds of sand created by wind picking up sand and depositing it when an obstacle is encountered.
SEASONAL TURNOVER - A change in a lake that usually occurs in spring and fall when more dense, cooler or heavier surface water sinks forcing warmer and less dense bottom water upward. This results in a stirring and mixing of nutrients.

SECCHI DISK - A small (20 cm) disk which is used to measure the transparency of water. It is lowered into the water until it is no longer visible.
SEDIMENT - Materials such as soil, sand, and silt that are washed from land into water, usually after rain. The particles are deposited in areas where the water flow is slowed such as in harbors, wetlands, and lakes.
SIDE DECK - The right (starboard) or left (portside) passage from the front (bow) to the back (stern) on the vessel; off limits.
SOLUBILITY - The relative ability of a substance (solid or gas) to dissolve in water or another liquid.
SOLUTION - A homogeneous mixture containing two or more substances.
SOLVENT - A substance that dissolves another substance to form a solution.
SONAR - Use of sound to determine depth of water as well as direction and distance to underwater features; SOund Navigation And Range.
STANDARD - A prepared sample with a known value.
STARBOARD - When facing the front (bow) of the vessel, the right side.
SUSPENSION - A mixture in which very small particles of a solid remain suspended without dissolving.
THERMAL STRATIFICATION - Separation of water into different temperature layers. Upper layer: EPILIMNION, middle layer: THERMOCLINE, and bottom layer: HYPOLIMNION.
THERMOMETER - Used to determine temperature. May be calibrated in the Celsius and/or Fahrenheit Scale. For scientific purposes, the Celsius Scale is used.
TITRATION - The addition of small, precise quantities of chemical to a sample until an endpoint such as a color change is reached. The dissolved oxygen test involves a titration procedure using a digital titrator to add drops of a chemical to the water sample.
TRANSPARENCY - The depth that light will penetrate water. A Secchi disk is used to measure the limit of visibility in water bodies such as lakes.
TRIBUTARY - A stream or river that flows into a larger stream, river, or lake.
TURBIDITY - A measure of how particles suspended in water affect its clarity. Microorganisms, soil particles, plankton, or other organic/inorganic matter causes the cloudy or muddy appearance of water.
TURBIDITY METER - An instrument used to measure water clarity as related to light scattered by particles suspended in water. Light scattered by the suspended material is detected by a photocell. The photocell converts the scattered light into an electrical current that is sent through the meter producing a numerical reading in NTUs.
VAN DORN SAMPLING BOTTLE - A plastic cylinder with stoppers at each end that is used to collect water samples at various depths.
WATER COLOR SCALE - A number of standard colors (the Forel-Ule Scale) compared with lake water. The resulting number is related to water quality, dissolved or suspended matter, and biological productivity.
WATER COLUMN - Vertical arrangement of water from the surface to the bottom of a water body.
WATER CYCLE - Movement of water from the air to land and water and back to the air. Evaporation, transpiration, condensation, infiltration, and runoff are all parts of the water (hydrologic) cycle.
WATER QUALITY - The physical, chemical, and biological characteristics of water as they relate to the use of the water.
WATER SAMPLERS - Metal or plastic cylinder-shaped containers with stoppers at each end used to collect a sample of water at selected depths or at the water's surface. Van Dorn bottles, and less frequently, Kemmerer water samplers, are used on the vessels.
WATERSHED - The land area in which water drains toward a lake, stream, or river at a lower elevation.
WINCH - An electric powered hoist used for lowering and raising sampling equipment. The winch line is also called the hydrographic wire. VERY DANGEROUS. HANDS OFF.
YELLOW LINES - Warning marks on the aft (rear) and side decks of the vessels over which passengers are NOT to step unless with an instructor.