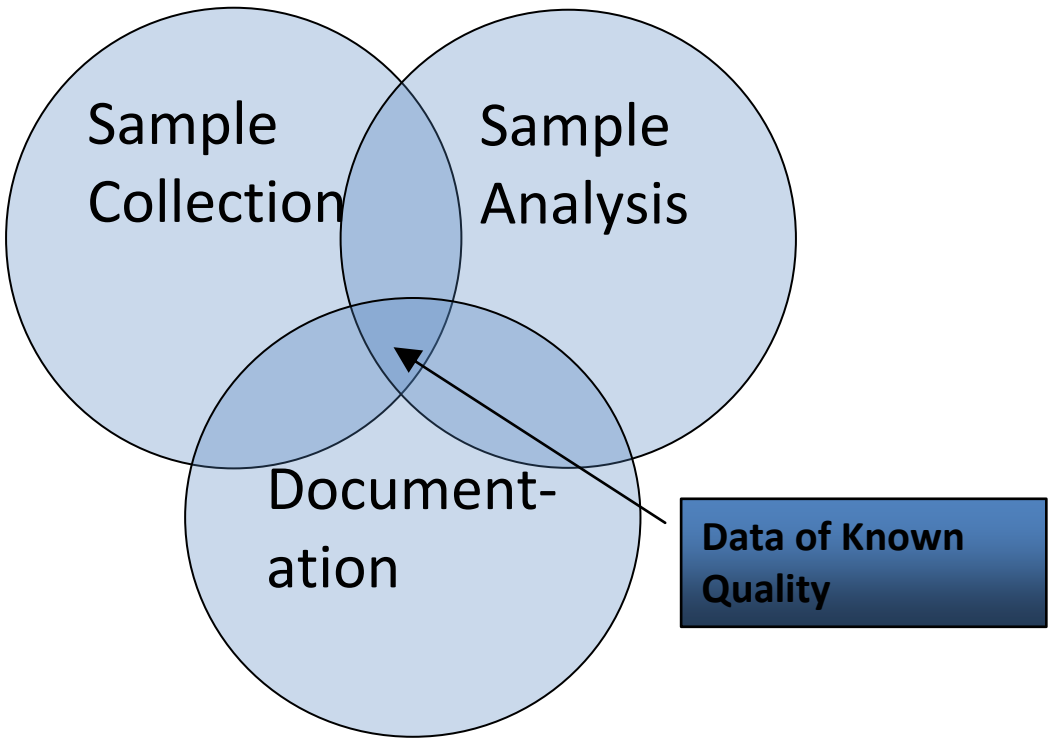
Oregon Department of Environmental Quality Laboratory

Volunteer Program

Steve Hanson
Lab: 503.693.5700
Direct: 503.693.5737

The Volunteer Monitoring Program's goal is to involve Oregonians in identifying and solving the state's water quality problems. The program provides support including technical assistance in monitoring design, equipment use, data management and analysis.



Documentation: making your monitoring count.

Without proper documentation even the best field monitoring losses its value. Elements of the sampling that must be documented are discussed below.

Sample location: Latitude and longitude using a GPS with a known datum are important as is a complete description of the location. Photos are extremely valuable and should be referenced to the site. Record this information on the field sheet or in your field notebook.

Sample collection methods: Temperature, conductivity, pH and dissolved oxygen may be measured in the waterbody itself if sufficient depth exists. Otherwise a sample container will be needed. If multiple bottles are filled at different sites make sure to designate on the field sheet and/or bottles which bottles go with which site. When possible label bottles on the lid and bottle, but never just on the lid.

Quality Control: Results from duplicate samples, standards checks, meter calibrations, and routine maintenance must all be recorded. These quality control results document the quality of the values you generate in the field. The results of the quality control tests should be kept with the equipment and the field values.

Meter maintenance and QC checks: Meters that require routine maintenance should have binders or log books with records of when the maintenance was conducted. Calibration records and accuracy checks must be clearly recorded on the field sheet or log book with the date and time they were conducted, the analyst, the standards used and results measured. QC data must be kept to resolve any future questions about data quality.

> NOTE: *Calibrations vs Accuracy Checks*: Calibrations adjust an environmental meter so it knows what measured signal (for example some milli volt reading) represents in terms of environmental parameter (for example pH). Calibrations should be verified using accuracy checks before samples are analyzed. Accuracy checks should also be conducted when you are finished analyzing to verify whether the calibration is still good.

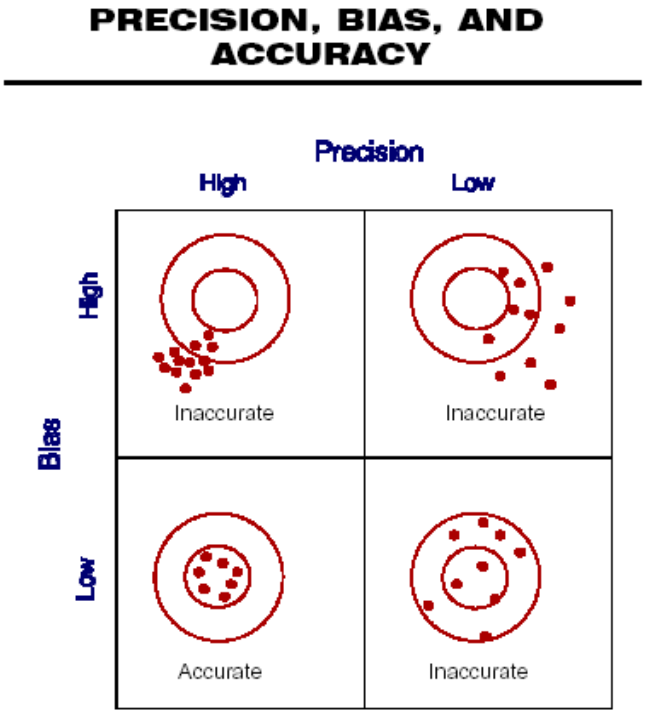
Sample results: The sampling results should be accompanied with all the other data so it can be clearly and unquestionably determined the location, sequence, equipment, and appropriate quality control checks that apply for assessing the quality of the results.

Required Quality Control Measurements for Common Water Quality Parameters Conducted by ODEQ Volunteer Monitoring Program Participants

PARAMETER	ACCURACY (1) When (2) How (3) Data Quality Levels	PRECISION (1) When (2) How (3) Data Quality Levels
Grab Temperature	(1) Annually (2) 5 temperature water baths (3) Acceptable level is difference from master thermometer of ≤ 0.5 C°	(1) Every day or at 10% of sampling sites, whichever is greater[1] (2) Duplicate samples, in stream measurements are done sequentially (3) A level difference between duplicates of ≤ 0.5 C°
Specific Conductivity	(1) Bracketing your sample results, preferably at the start and end of each day (2) Tests against secondary standard in the ranges of 1400 and/or 140 µS/cm plus a test of DI water (3) A level is difference from standard of ≤ 7% of standard value	(1) Every day or at 10% of sampling sites, whichever is greater[1] (2) Duplicate samples, in stream measurements are done sequentially (3) A level is relative percent difference[1] ≤ 10%
pH	(1) Bracketing each day's samples at a minimum. (2) Tests against 7 and 10 buffers, recalibrate if off by 0.1 from buffer (3) A level is difference from buffer of ≤ 0.2 S.U.	(1) Every day or at 10% of sampling sites, whichever is greater[1] (2) Duplicate samples (3) A level is difference between duplicates of ≤ 0.3 S.U.
Dissolved Oxygen by Luminescent Sensor Probes	(1) Start and end of each monitoring day with saturated air check and calibration if necessary followed by calibration verification before and after sampling (2) Comparisons against Winkler, saturated water or saturated air. (3) A level is difference from theoretical of ≤ 0.3 mg/L for both results bracketing data. **NOTE:** criteria for comparison against air saturated water is +0.4 to -0.3 mg/L	(1) Every day or at 10% of sampling sites, whichever is greater[1] (2) Duplicate samples (3) A level difference between duplicates of ≤ 0.3 mg/L
Turbidity	(1) Before and after each sampling day (2) Tests against calibration verification standards. A blank with DI water is also advised (3) A level is difference from standard of ≤ 10% of standard	(1) Every day or at 10% of sampling sites, whichever is greater[1] (2) Duplicate samples (3) A level is relative percent difference between duplicates is ≤ 20%

1. Under monitoring programs where samplers only collect 1 -2 stations per sampling event, each sampler should have duplicate for all parameters on their first sampling (for each season if only seasonal sampling is done); and duplicates for all parameters for ≥ 10% of the samples they collect or once every 6 months(whichever is greater).

Quality Assurance: identifying how "good" your data is.
Before data is used as information to make management decisions, people must have some measured level of confidence in the values. You can measure the level of confidence in data values by implementing quality assurance procedures. Quality assurance includes the suite of procedures conducted to document the accuracy and precision of testing. Any scientific measurement on its own means very little without knowing how "good" the number is.



To determine how good a measurement is we analyze a measurement's *accuracy* and *precision.* Accuracy defines how close a measurement is to the true value, and precision describes how close to a single value you can get with multiple measurements. The figure shows accuracy, precision and bias (http://www.epa.gov/owow/monitoring/volunteer/qapp/qappch3.pdf). Bias is consistent inaccuracy. Being able to define your accuracy and precision allows you to deduce appropriate information from your results.

Keeping track of accuracy, precision and bias during each sampling event allows you to correct problems as you go. No environmental measurement will ever be 100% accurate, precise and free of bias; however, each method will have a predicted level of accuracy and precision that you can strive for. The predicted level of accuracy and precision are usually defined in the specifications for a given piece of equipment or a method.

The DEQ recommends monitoring organizations use duplicate samples, checks against standards, and split samples as quality control measures of precision and accuracy.

Duplicate samples involve taking two samples at the same location and time and analyzing them both. Comparing the two numbers gives you a measurement of precision. DEQ recommends collecting duplicate samples at 10% of your sites or once a day, whichever gives the greatest number of duplicate samples.

Standards checks involve checking a measurement against a known value or standard. Standards checks give a measurement of accuracy. Standards are available for many measurements including pH, conductivity/salinity and turbidity. Standards checks are a valuable tool for identifying if your equipment is working properly.

Split sampling is when two sampling teams collect independent samples at the same location and time and analyze them using their own methods. You can then compare the values of the separate results as a measure of precision. Split samples are an excellent way of identifying problems with protocols, equipment or chemicals. Split sampling dissolved oxygen tests is particularly valuable since testing the accuracy of a dissolved oxygen measurement is difficult.

Grab Sample Collection: getting a representative piece of the whole.

The goal of sample collection is to safely collect a small portion of water that is representative of the larger water body. Safety should always be the number one concern when selecting a sample site. Do not sample from a site that is hazardous; instead, find an alternative site that will give you the same information or devise a new sampling procedure to collect your sample safely.

FIELD SAFETY: Wading

No sample is worth endangering yourself or co-workers. When wading always work with a partner and follow these guidelines.

- Wear personal flotation devices when wading in streams with depths over your chest or fast velocities.
- Wear appropriate foot wear and move slowly checking for unstable substrate or unexpected holes. A wading rod can be used to help assess streambed conditions.
- Use caution when wading in streams with swift current. As you get deeper your ability to keep a grip on slick substrate will be reduced and you may be pushed off your feet by slower velocities. Even shallow water at high velocities can be dangerous. Do not attempt to wade in a stream for which values of depth multiplied by velocity equal or exceed 10 ft^2/sec.
- Be aware of hazards upstream that could drift down to you and hazards like logs or boulders downstream that could pin you if you drift downstream.
- Avoid hip boots that are tight around the ankles and waders that are tight around the chest—these may be difficult to remove in an emergency situation. Be aware of the possibility of slipping and going underwater (feet up, head down) while wearing them. Wear a hip belt with waders to help prevent filling the waders with water.
- Watch for changes in river stage, especially when working downstream from a control structure. If working directly below a dam, contact the gate operator before entering the stream.
- Watch for sand channels that can shift under foot and become quicksand.

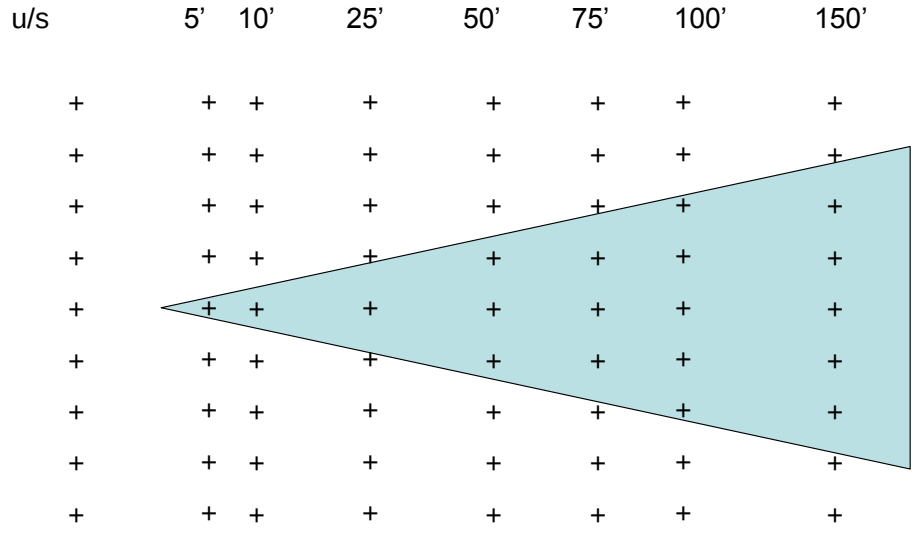
Waterbody types

Flowing Rivers: In flowing rivers and streams representative samples can be taken by collecting water from mid-channel where the water is moving swiftly and there is plenty of mixing. To collect water from a representative point you may need to wade into the stream or collect the sample from the shoreline with a sampling device. If you must disturb the streambed to access the water, make sure you sample upstream from the disturbance. Also avoid sampling from backwater areas not representative of the flowing water. Point your body upstream and collect the sample in front of you. Do not collect the water downstream from where you walked in the stream. If you must sample from the shore you should do so in a reach that has swift water moving close to shore and take extra care not to kick up sediment from the streambank that may get into your samples

Characterizing Discharges to a Streams: When trying to document the impact of a discharge to a stream the best approach is to make representative measurements of the stream above the discharge, the discharge itself, and the stream below the discharge. Special care should be taken when measuring below a discharge because complete mixing in a stream can require a significant linear distance. If you are uncertain about the mixing, then multiple samples can be taken across the stream.

If a discharge has significantly different conductivity or temperature from the receiving stream, then transects across the stream can be used to map out the area of impact. This method is used by the DEQ when conducting mixing zone studies as described below:

> **Conductivity mapping** will consist of measuring conductivity along transects upstream of the discharge and at several points downstream of the discharge. These will not be limited to edge of the zone of immediate dilution and mixing zone. Locations will be determined in the field, however, the locations will likely include measurements u/s of the outfall, 5' d/s, 10'd/s, 25' d/s, 50' d/s, 75' d/s, 100' d/s, and 150 or 200' d/s (see figure below). Conductivity measurements will be vertically profiled as depth allows. Each measurement will include a 30 second range to account for variability within the plume and its mixing.



Conductivity mapping will usually involve walking through the stream from upstream to downstream. This should be avoided if the mapping cannot be done without kicking up sediment that would impact subsequent samples. If the discharge has a significantly different turbidity or color from the stream, then photos can be useful.

Lakes and Estuaries: The best way to collect samples from slack water environments like lakes and estuaries is to sample off shore from a boat. If this is not practical, sample from a dock or build a sampling device on the end of a pole that will allow you to fill your sample bottle several feet away from the shore. A sampling device can be constructed from an old broom stick or aluminum pole with some type of clamp or other contraption to hold a sample bottle in place fastened to the end of the pole. Be conscientious of how the bottle is held in place that the device does not compromise the integrity of the sample, especially if sampling something like bacteria that can be easily contaminated.

Lakes and estuaries may be stratified, meaning they will not have uniform properties from top to bottom. In lakes, the upper surface of the lake will absorb heat and develop a thermocline or stratification based on temperature. Because cold water is denser than warm water, the cold water sinks and forms a distinct layer through which there will be very little mixing of dissolved chemical constituents. In estuaries the salty seawater is denser than freshwater and can form a similar boundary between dense salty water and the fresh water. Consider the potential for stratification when deciding where to sample. If possible test for stratification with a thermistor or conductivity/salinity meter by lowering the probe at set intervals and looking for large changes. You may wish to sample only the top layer of water or to collect from multiple locations in the water column.

Collecting water

When collecting water samples submerge the bottle under the surface and allow the bottle to fill. If you are using the same bottle at multiple sites to collect water make sure you rinse the bottle thoroughly with each site's water. A triple rinse with site water is recommended. When sampling lakes or estuaries, dump rinse water away from where you will be collecting your sample. If you are collecting a dissolved oxygen sample, minimize turbulence as the water flows into the bottle by gentling rotating the bottle into the water. The sample should flow smoothly into the bottle without generating bubbles.

Field Data Sheet

Survey Name:

Survey Team:

Survey Date: Start time: End time:

Weather:

Samples Received by Lab Date/Time: Name:

Field Data Reviewed ☐ Yes by: Entered into Database ☐ Yes by:

ITEM	SITE ID	SITE DESCRIPTION	QC TYPE[1]			TIME HH:MM	Temp °C	SpCond µS/cm	Turb NTU	pH S.U.	DO mg/L	DO%sat %	*E.coli* MPN/dL		Note #
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

NOTES:

SURVEY QUALITY CONTROL TEST RESULTS

Precision control limits based on differences between duplicates		Abs	RPD[3]	RPD	Abs.	Abs.		Log Diff	
	A	≤ ±0.5	≤ ±7%	≤ ±20%	≤ ±0.3	≤ ±0.3		≤ ±0.6	
	B	≤ ±2	≤ ±10%	≤ ±30%	≤ ±0.5	≤ ±1		≤ ±0.8	
	C	> ±2	> ±10%	> ±30%	> ±2	> ±2		> ±0.8	
SURVEY PRECISION									
SURVEY ACCURACY See page 2 for accuracy data		na						na	

Survey Comments

[1] **S**= sample; **P**= sample duplicate primary; **D**= sample duplicate; **SB**= sample blank; **SPT**= split sample

[2] Abs.Diff= Absolute difference between two results

[3] RPD= Relative Percent Difference = absolute difference between two results ÷ average of the two results

Sampling Survey Accuracy QC Check Information

Survey Description:_____ Survey Date:_____ Survey Team:_____

pH Meter #:	**Pre Check Acc Date/Time:**					**Pre** Data Quality Level	**Post Check Acc Date/Time:**					**Post** Data Quality Level	Data Quality Criteria in % Diff	**Accuracy Data Quality Level**
Analyst Initials:	Std	Temp °C	Theor Value	Read	Abs Diff		Std	Temp °C	Theor Value	Read	Abs Diff			
Comments:													A ≤ ± 0.3	
													B ≤ ± 0.5	
													C > ± 0.5	

Turbidity Meter #:	**Pre Check Acc Date/Time:**				**Pre** Data Quality Level	**Post Check Acc Date/Time:**				**Post** Data Quality Level	Data Quality Criteria in % Diff	**Accuracy Data Quality Level**
Analyst Initials:	Std Value	Read	Abs. Diff	% Diff		Std Value	Read	Abs. Diff	% Diff			
Comments:											A ≤ ±10%,	
											B ≤ ±30%	
											C > ±30%	

Conductivity Meter #:	**Pre Check Acc Date/Time:**					**Pre** Data Quality Level	**Post Check Acc Date/Time:**					**Post** Data Quality Level	Data Quality Criteria in % Diff	**Accuracy Data Quality Level**
Analyst Initials:	Std Value	Temp °C	Read	Abs. Diff	% Diff		Std Value	Temp °C	Rea d	Abs. Diff	% Diff			
Comments:													A ≤ ± 7%	
													B ≤ ±15%	
													C > ±15%	

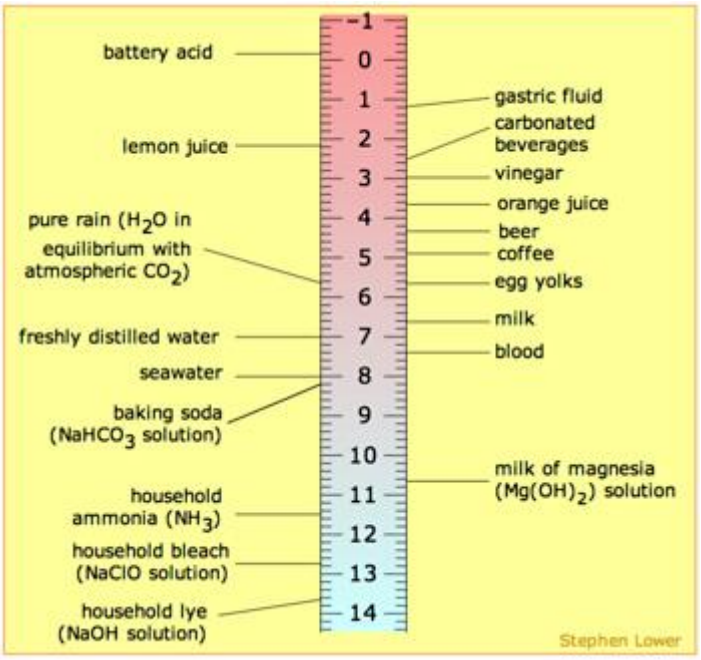
DO Meter #:	**Date**	**Time**	**METHOD:** SatAir, HachWink[1], WetWink, Meter[2],SatH_20	**Atm. Press or Elev.**	**Expected Value**	**Temp. Read** (°C)	**DO Read** (mg/L)	**DO Sat Read** (%)	**Diff.**	**Data Quality Criteria**	**Accuracy Data Quality Level**
Analyst Initials:											
Comments:										**Saturated Air/ Water:** A ≤ +0.4 or-0.3,+0.4 B ≤ ± 0.5; E ≤ ± 1	
										Comparison to Winkler or audit meter[1]: A ≤ ± 0.5 mg/L: B ≤ ± 1.0 mg/L; E ≤ ± 2.0 mg/L	

[1]Hach Winkler shows a bias of 2% to 4% below the standard wet modified Winkler, data quality criteria may be adjusted

[2]If a meter is used to audit another meter, specify the meter ID

pH: The measure of how acidic or basic a solution is

RANGE: pH is measured on a scale from 0 to 14 with 0 being very acidic, 14 being very basic and 7 being neutral. In stream or lake water the values are usually between 6 and 9. pH below 6.5 and above 9.0 can be harmful to some aquatic life.



From http://www.sciencebuddies.org/science-fair-projects/project_ideas/Chem_img074.jpg

MEASUREMENT METHOD: A pH meter should be checked for accuracy in pH buffer before use and calibrated if it reads more than 0.1 pH units from the temperature adjusted theoretical pH buffer value. Of all the common field meters, a pH meter is the most likely instrument to need calibration.

The pH probe is very delicate. The probe must stay moist and clean. The life of the probe will be prolonged by rinsing the probe thoroughly after use and storing the probe in pH storage solution or if necessary pH 4 buffer when the probe is not in use.

EQUIPMENT CARE: pH instruments require a lot of care. A quality pH probe will only last about 2 years. If the probe is not cared for well, it will work for a much shorter time period. Pay close attention to instructions when handling a pH meter. Always keep the pH probe "wet" by keeping the tip of the probe stored in storage solution When you store the probe make sure the probe is resting in a way that the tip of the probe points down (to keep the tip of the probe covered in storage solution).

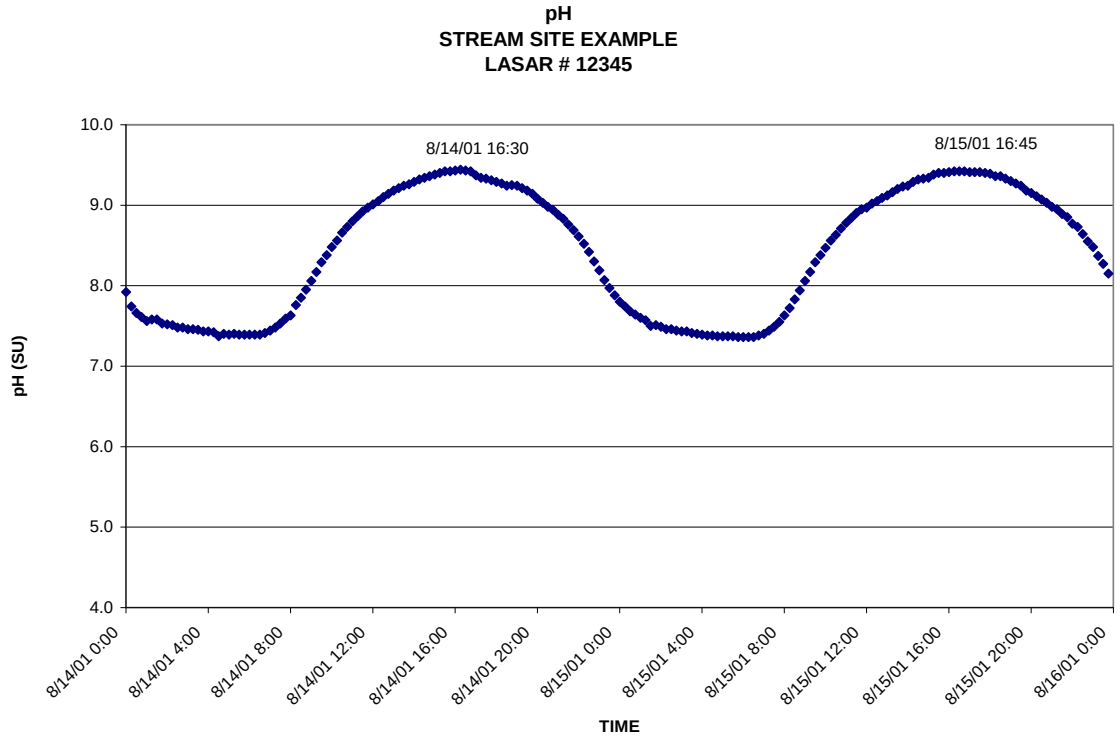
QUALITY CONTROL: Calibrate the pH meter with 7 and 10 or 7 and 4 standard buffers whenever accuracy checks indicate a calibration has drifted. Test the meter occasionally throughout the day against the buffers to make sure the meter is still reading close to the buffer value. If the meter starts to read 0.1 units from the buffer value, recalibrate the meter. Always test the meter against the buffers at the end of the day. It is important to always **record all calibrations and buffer tests** on the field sheet or in the meter book with the date and time of each test.

THEORY: How "acidic" or "basic" something refers to the amount of H+ (hydrogen ions) in a solution. When something is acidic there are lots of H+ ions, when something is basic there are few H+ ions. The

number associated with pH is actually a negative logarithm of the concentration of H+ ions. The hydrogen ions come from water (H_20). Therefore a pH of 7 means that 1 out of every 10,000,000 water molecules as divided up to form one H+ and one OH-. For a pH of 6 the ratio of dissociated water molecules changes to 1 out of every 1,000,000.

WHAT AFFECTS pH?

The basic foundation for a stream's pH is the local geology that determines the types of minerals in a stream. Surface water pH will rise and fall daily as algae photosynthesize and respire CO_2. Algae growing during the daylight hours consume acid forming CO_2 from the water for photosynthesis. Removing CO_2 causes increased pH during the day. After the sun starts to get low on the horizon, algae stop using as much CO_2 .and the pH goes down in the late afternoon early evening. Once there is no more sunlight hitting the stream, then the algae start releasing CO_2 just like animals when we breathe. That is why it is important to always record the time a pH sample is taken as well as the actual pH value.



pH Figure: Typical pattern of changes in pH over the course of two warm sunny days in a stream with lots of algae.

Geology- The earth a stream flows over and through interacts with the stream and can affect the pH of the stream and how susceptible the stream is to changes in pH. In general, the streams of the cascades and west of the cascades have little ability to resist changes in pH. Some streams with low buffering capacity and large amounts of certain decaying vegetation that release the brownish/red colored tannic acids may also get pH values lower than 7.

Acid rain- Rain with a pH of less than 5.65 is considered acid rain and can cause some water bodies to have low pH. Some industrial pollutants, abandoned mines or industrial discharges could release chemicals that would change the pH of a stream.

Turbidity: The measure of how much a water sample scatters or absorbs light

RANGE: Turbidity is commonly measured in units of nephometric turbidity units (NTU). Turbidity values range from less than 1 NTU for very clear water to over 1000 NTU in very turbid water. In Oregon it is uncommon to measure values over 150 NTU. During summer low flows turbidities are in the single digits for a "clear" stream.

MEASUREMENT METHOD: We measure turbidity using a portable Hach 2100P or 2100Q turbidimeters. Samples are collected from the stream and poured into a clean glass vial that fits into the turbidimeter. The turbidimeter measures the amount of light scatter and gives a turbidity reading in NTU's. There are optical turbidity probes but these are expensive to purchase and keep calibrated and are not always comparable to historical sample NTU method. As long as you use a consistent method (calibrated meter or probe) for your study you can make valid assessments of relative clarity.

EQUIPMENT CARE: The glass vials should be kept clean and free of fingerprints or other marks. Clean the vials with a non-scratching cloth like an eyeglass cleaner. Each turbidimeter should have a small bottle of silicone oil that can be applied to fill small irregularities in the glass. If a glass vial develops obvious scratches, the vial should not be used. Sample vials should not be stored for long periods with sample in them nor should they be left for extended periods in the meter.

QUALTIY CONTROL: The meter should be calibrated every 3- 6 months and the calibration accuracy verified before and after each sampling event.

THEORY: Suspended matter, such as clay, silt, fine organic and inorganic matter, soluble colored organic compounds, plankton and other microscopic organisms contribute to the turbidity of natural waters.

WHAT AFFECTS TURBIDITY: Turbidity can be increased by erosion suspending soil particles, suspended algae and the presence of organic chemicals like tannins. Turbidity measurements are particularly valuable during storm events and in the days after a storm to monitor how quickly a stream returns to its background turbidity.

Some environmental situations may produce extremely high turbidities that exceed the range of the meter. These conditions can be further documented with photos of samples in glass bottles and photos of the waterbody impacted. Such very high turbidity values may be estimated by diluting the sample but it is important to recognize that dilution is expected to somewhat change the way sample water interacts with light.

Dissolved Oxygen (DO): the measure of the amount of oxygen dissolved in a solution

RANGE: DO concentration is measured in units of mg of oxygen per a liter of water (mg/L) and can range from 0 mg/L up. Rarely will DO reach above the upper teens and usually not over 14 mg/L. Normal range for DO in streams is 8 to 12 mg/L. Salmonids cannot survive in water with a DO of less than 6 mg/L. DO can also be measured in percent saturation which should be close to 100% ± 10%. See the "What affects DO" section below for more info.

MEASUREMENT METHOD: DO can be measured using the chemical Winkler method or using different types of probes—electrometric or optical. The Winkler method uses a series of basic and acidic reactions to create iodine in equal parts to the amount of oxygen that was dissolved in the sample. The iodine, which has a strong color, is titrated out to determine concentration. Electrometric probes require dissolved oxygen to migrate across a permeable membrane and react with an anode and cathode to generate an electrical current that is converted to oxygen concentration. The optical luminescence probe operates on the principle defined in the Hach 10360. *This luminescence-based sensor procedure measures the light emission characteristics from a luminescence-based reaction that takes place at the sensor-water interface. A light emitting diode (LED) provides incident light required to excite the luminophore substrate. In the presence of dissolved oxygen the reaction is suppressed. The resulting dynamic lifetime of the excited luminophore is evaluated and equated to DO concentration.*

The table below list some major pros and cons to the various methods.

Method	Pros	Cons
Winkler	Wet chemical method is standard method. Visible process you can see working Can be very accurate with right equipment and technique	Safety and waste Need to do regularly to have good reliable technique Chemicals must be managed to maintain integrity No instream option More time consuming / sample Cost is per sample
Electrometric	Can measure instream Easy measurement Instream option No per sample cost	Maintenance and QC Time consuming, sometime challenging QC Some technique variability (stirring) moderate capital cost
Optical	Most stable probe method Instream option No per sample cost	Capital cost Time consuming, sometime challenging QC

EQUIPMENT CARE:
The Winkler chemical method requires careful tracking and storage of the reagents used for the method. All required glass or plasticware should be kept clean. Electrometric probes require maintenance to maintain a permeable membrane and conditions around the anode and cathode of the probe. Manufacturer's instructions for each probe must be followed, are not always easy, and sometimes are time consuming. The optical probes should be handled carefully but require little maintenance, although some manufacturers will require the luminophore cap be replaced every year.

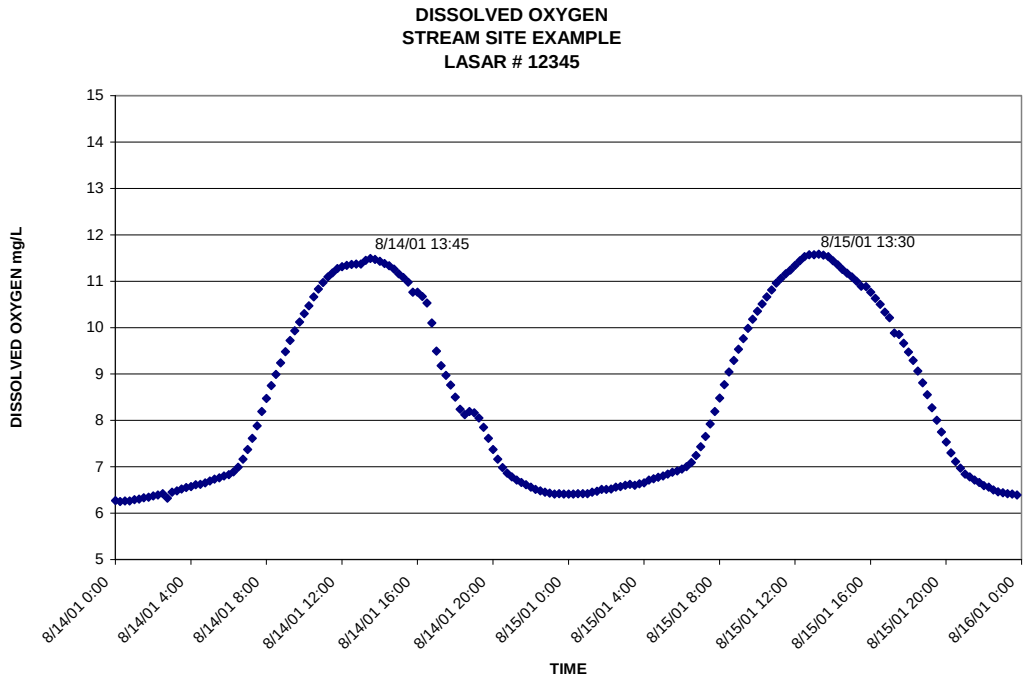
WHAT AFFECTS DO:
DO is measured both as concentration (mg/L) and as a percent saturation. How much oxygen is in water is largely determined by physical characteristics- salinity of the water (coastal thing), temperature of

water and how much oxygen is available in the air to dissolve (function of elevation and barometric pressure).
Examples:

1. Pure water at sea level- 50°F= 11.3 mg/L at 75°F = 8.4 mg/L.
2. Elevation 1300 ft (Welches, OR)- Less dense air means less oxygen in the air, 50°F water only want to get o 10.8 mg/L
3. Salintiy – Less room for oxygen DO concentration lowered, 50°F salinity of 32 (common for sea water) drops from 11.3 to 9.1 mg/L

All three of these examples ranging from 8.4 to 11.3 mg/L are at equilibrium with atmosphere and are therefore "saturated" which would measure as 100% saturation. The physical conditions of temperature, pressure and salinity impact concentration but NOT saturation.

Both DO concentration and saturation are impacted by photosynthesis and respiration in water. A large amount of algae photosynthesis results in lots of oxygen pumped into water causing high DO concentrations and saturations greater than 100%. After the sun goes down, then plants are only respiring and consuming oxygen and dissolved oxygen concentrations and saturations can get very low (try to keep oxygen percent above 90%-otherwise may be excessive productivity). In addition to plants, bacteria and other organisms breaking down excessive organic matter will consume oxygen. The majority of this activity happens at the bottom of a waterbody where the organic matter deposits and decays.



DO Figure: Fluctuations in DO over the course of 2 sunny days in a stream with lots of algae.

Dissolved oxygen in tidal areas- The diurnal patterns of waters that are influenced by the tides will be more complex than shown in the DO Figure above. In tidally influenced areas DO will generally dip down as high tide approaches. This can be the result of slowed water velocity, increased temperature, or increased salinity.

EXAMPLE CALCULATION FOR DISSOLVED OXYGEN SATURATION:

Measured DO **(MDO) = 9.6 mg/L**
Measured Water Temperature **(T) = 11.4°C**
Elevation (estimated from map) = 600 ft.

1. Use DO Saturation Table to find correction values for temperature and elevation.

(a) Look up DO 100% Sat. values-
Approximate the DO100 value from the table, extrapolate roughly where your temperature would be between the values listed.
11.5 = 10.95 & 11.0 = 11.10. Estimate
100%DO value for 11.4 ≈ 10.98.

(b) Look up Elevation Correction Factor (EF) –
If the site elevation is more than 500 ft in elevation, find the closest elevation from the table, 600 ft
EF = 1.02

2. Calculate DO Saturation

$$DOSAT = \frac{MDO}{DO100} \times EF \times 100$$

$$DOSAT = \frac{9.6}{10.98} \times 1.02 \times 100$$

$$DOSAT = 89\%$$

2. Use barometric pressure and temperature to determine oxygen concentration.

Oxygen saturation tables are the easiest way to estimate dissolved oxygen concentration in water saturated air (calibration standard or accuracy check standard) or air saturated water (accuracy check standard). Stable temperature conditions are required to accurately predict concentrations from temperature and barometric pressure, saturated air standards should be slightly vented to allow some small contact with atmospheric pressure without loss of the water saturated air.

Using the meter generated true barometric pressure reading find the column in the table that is closest to your measured pressure. Match this column with the row that most closely represents the temperature of the air or water standard measured by your probe. You may wish to use some extrapolation to estimate the theoretical DO concentration to nearest tenth of a mg/L.

Saturation tables are available from the USGS at
http://water.usgs.gov/owq/FieldManual/Chapter6/6.2_contents.html.

Percent Saturation Table				Elevation Correction		Salinity Correction			
Water Temperature C	DO 100% Saturation	Water Temperature C	DO 100% Saturation	Elevation in feet	Elevation Factor	Salinity (ppth)	Salinity Factor	Salinity (ppth)	Salinity Factor
0.0	14.60	20.5	9.10	0	1.00	0.0	1.00	20.5	1.15
0.5	14.40	21.0	9.00	500	1.02	0.5	1.00	21.0	1.15
1.0	14.20	21.5	8.90	750	1.03	1.0	1.01	21.5	1.16
1.5	14.00	22.0	8.80	1000	1.04	1.5	1.01	22.0	1.16
2.0	13.80	22.5	8.75	1250	1.05	2.0	1.01	22.5	1.17
2.5	13.65	23.0	8.70	1500	1.05	2.5	1.02	23.0	1.17
3.0	13.50	23.5	8.60	1750	1.06	3.0	1.02	23.5	1.17
3.5	13.30	24.0	8.50	2000	1.07	3.5	1.03	24.0	1.18
4.0	13.10	24.5	8.45	2250	1.08	4.0	1.03	24.5	1.18
4.5	12.95	25.0	8.40	2500	1.09	4.5	1.03	25.0	1.19
5.0	12.80	25.5	8.30	2750	1.10	5.0	1.04	25.5	1.19
5.5	12.65	26.0	8.20	3000	1.11	5.5	1.04	26.0	1.19
6.0	12.50	26.5	8.15	3250	1.12	6.0	1.04	26.5	1.20
6.5	12.35	27.0	8.10	3500	1.13	6.5	1.05	27.0	1.20
7.0	12.20	27.5	8.00	3750	1.14	7.0	1.05	27.5	1.20
7.5	12.05	28.0	7.90	4000	1.15	7.5	1.05	28.0	1.21
8.0	11.90	28.5	7.85	4250	1.16	8.0	1.06	28.5	1.21
8.5	11.75	29.0	7.80	4500	1.17	8.5	1.06	29.0	1.22
9.0	11.60	29.5	7.70	4750	1.19	9.0	1.07	29.5	1.22
9.5	11.45	30.0	7.60	5000	1.20	9.5	1.07	30.0	1.23
10.0	11.30	30.5	7.55	5250	1.21	10.0	1.07	30.5	1.23
10.5	11.20	31.0	7.50	5500	1.22	10.5	1.08	31.0	1.23
11.0	11.10	31.5	7.45	5750	1.23	11.0	1.08	31.5	1.24
11.5	10.95	32.0	7.40	6000	1.24	11.5	1.08	32.0	1.24
12.0	10.80	32.5	7.35	6250	1.25	12.0	1.09	32.5	1.25
12.5	10.70	33.0	7.30	6500	1.26	12.5	1.09	33.0	1.25
13.0	10.60	33.5	7.25	6750	1.27	13.0	1.09	33.5	1.25
13.5	10.50	34.0	7.20	7000	1.29	13.5	1.10	34.0	1.26
14.0	10.40	34.5	7.15	7250	1.30	14.0	1.10	34.5	1.26
14.5	10.30	35.0	7.10	7500	1.31	14.5	1.11	35.0	1.27
15.0	10.20	35.5	7.05	7750	1.32	15.0	1.11	35.5	1.27
15.5	10.10			8000	1.34	15.5	1.11	36.0	1.28
16.0	10.00					16.0	1.12	36.5	1.28
16.5	9.85					16.5	1.12	37.0	1.29
17.0	9.70					17.0	1.12	37.5	1.29
17.5	9.60					17.5	1.13	38.0	1.29
18.0	9.50					18.0	1.13	38.5	1.30
18.5	9.45					18.5	1.14	39.0	1.30
19.0	9.40					19.0	1.14	39.5	1.31
19.5	9.30					19.5	1.14	40.0	1.31
20.0	9.20					20.0	1.15		

Conductivity/Salinity: The measure of how well water conducts an electric current

RANGE: We measure fresh water conductivity in units of microSiemens per cm (µS/cm). Fresh water conductivity values range from less than 1 µS/cm to the thousands of µS/cm. In Oregon the normal range extends from less than 50 to several 100 µS/cm. Salinity is a measure of the amount of salt in the water and is usually expressed as parts per thousand (ppth) or $^{0}/_{00}$. Salinity in an estuary ranges from 0 to more than 30 ppt.

Because fresh water is less dense than saltwater, estuaries commonly have lower salinity near the top of the water column and higher salinity near the bottom. Measuring a profile of salinity measurements at different depths is a valuable way of identifying different zones of biologically available habitat. Salinity also changes horizontally, decreasing from where the estuary meets the ocean to the end of the tidally influenced portion of the stream. The figure below shows how salinity changes across an estuary.

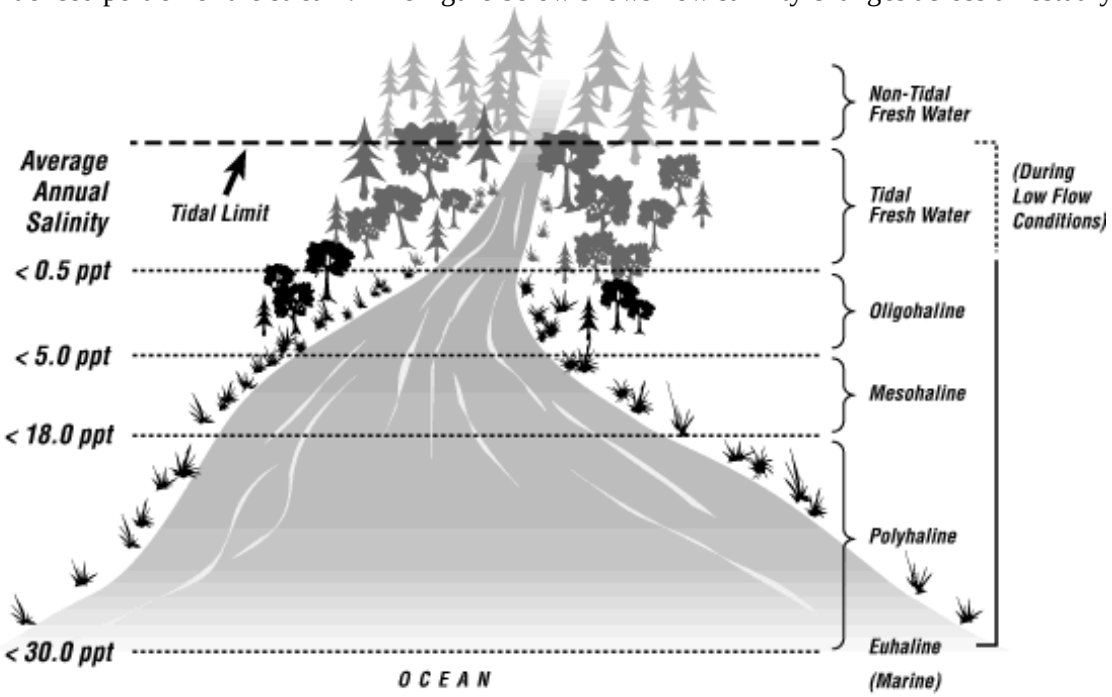


Figure 14-1. *Estuarine salinity slowly increases as one moves away from freshwater sources and toward the ocean.*
(http://www.epa.gov/owow/estuaries/monitor/chptr14.html)

MEASUREMENT METHOD: We measure conductivity and salinity with conductivity meters. Follow protocols described in the meters manual for calibrations, calibration verifications (accuracy checks), and sample measurements. Because conductivity changes in the same solution at different temperatures, we measure specific conductivity which is conductivity corrected to 25 degrees Centigrade.

Salinity is measured in the same way as conductivity. Most conductivity meters will automatically convert to salinity when they encounter water with high enough conductance.

EQUIPMENT CARE: Rinse the probe well with DI water between uses. Keep the probe clean. When using the probe in saline waters take extra care to make sure the probe is rinsed very well before making measurements in fresh water. At the end of the day thoroughly rinse the probe with DI water and dry.

QUALTIY CONTROL: Before and after each sampling day check the meter against standards and record the results on the field sheet or in the meter log book. Conductivity generally will not need frequent calibration.

Fecal Bacteria Indcator

From: https://www.idexx.com/water/products/colilert.html

See the link above for tutorial videos and more information.

Introduction

Colilert* simultaneously detects total coliforms and E. coli in water. It is based on IDEXX's patented Defined Substrate Technology* (DST*). When total coliforms metabolize Colilert's nutrient-indicator, ONPG, the sample turns yellow. When E. coli metabolize Colilert's nutrient-indicator, MUG, the sample also fluoresces. Colilert can simultaneously detect these bacteria at 1 cfu/100 mL within 24 hours even with as many as 2 million heterotrophic bacteria per 100 mL present.

Storage

Store at 2–30°C away from light.

Quanti-Tray* Enumeration Procedure

1. Add contents of one pack to a 100 mL water sample in a sterile vessel.
2. Cap vessel and shake until dissolved.
3. Pour sample/reagent mixture into a Quanti-Tray* or Quanti-Tray*/2000 and seal in an IDEXX Quanti-Tray* Sealer.
4. Place the sealed tray in a 35±0.5°C incubator for 24 hours.
5. Read results according to the Result Interpretation table below. Count the number of positive wells and refer to the MPN table provided with the trays to obtain a Most Probable Number.

Results Interpretation

Appearance	Result
Less yellow than the comparator1	Negative for total coliforms and E. coli
Yellow equal to or greater than the comparator	Positive for total coliforms
Yellow and fluorescence equal to or greater than the comparator	Positive for E. coli

• Look for fluorescence with a 6-watt, 365-nm UV light within 5 inches of the sample in a dark environment. Face light away from your eyes and towards the sample.

• Colilert results are definitive at 24–28 hours. In addition, positives for both total coliforms and E. coli observed before 24 hours and negatives observed after 28 hours are also valid. Procedural Notes

• If a water sample has some background color, compare inoculated Colilert sample to a control blank of the same water sample.

• If sample dilutions are made, multiply the MPN value by the dilution factor to obtain the proper quantitative result.

• Use only sterile, nonbuffered, oxidant-free water for dilutions.

• Colilert is a primary water test. Colilert performance characteristics do not apply to samples altered by any pre-enrichment or concentration.

• In samples with excessive chlorine, a blue flash may be seen when adding Colilert. If this is seen, consider sample invalid and discontinue testing.

• Aseptic technique should always be followed when using Colilert. Dispose of in accordance with Good Laboratory Practices.

Quality Control Procedures

1. One of the following quality control procedures is recommended for each lot of Colilert:
    A. IDEXX-QC Coliform and E.coli 3 : Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa
    B. Quanti-Cult*4 : Escherichia coli, Klebsiella pneumoniae and Pseudomonas aeruginosa.
    C. Fill three sterile vessels with 100 mL of sterile nonbuffered oxidant-free water and inoculate with a sterile loop of ATCC5 strains, Escherichia coli ATCC 25922 or 11775, Klebsiella pneumoniae ATCC 31488 and Pseudomonas aeruginosa ATCC 10145 or 27853.
2. Follow the P/A Procedure or Quanti-Tray Enumeration Procedure above.
3. Results should match the Result Interpretation table above.