STREAMKEEPERS
MODULE 3
Water Quality Survey

PROJECT APPROVAL
- Not required

TRAINING
- Recommended

TIME COMMITMENT
- 2 days to ongoing

NUMBER OF PEOPLE
- 2 or more

TIME OF YEAR
- Low flow/High flow

This water quality survey involves water testing to determine the chemical composition of your stream.

REVISED 2024

Pêches et Océans Canada
Fisheries and Oceans Canada
Canada

Welcome to Streamkeepers

The Department of Fisheries and Oceans Canada (DFO) Community Involvement Program provides training modules. These modules encourage "hands on" environmental activities in watersheds in British Columbia. Volunteer groups, First Nations, schools, and individuals are using this material to monitor and restore local waterways. Your local Fisheries and Oceans Community Advisor can provide more information.

Project Purpose

This module provides instructions on measuring dissolved oxygen, pH, temperature, and turbidity using commercially available kits and simple equipment. The data are incorporated into a water quality index. You will sample water at several locations during at least two seasons of the year.

Information about water quality helps you identify and evaluate problem areas in your watershed. If you decide to develop a restoration project, water quality monitoring will help you evaluate the effectiveness of your effort. Water quality monitoring is useful with many other Streamkeepers projects, as well. Enter your data into the Streamkeepers database to share with others and watch for trends.

Overview

Water quality surveys provide information about the chemical composition of water. The background water chemistry determines the kinds of plants and animals that can live there. Water quality changes reflect watershed changes. This type of monitoring is not designed to detect transient problems like toxic chemical spills. You would measure these only if you happened to be sampling at the time of a spill. The Observe Record Report Module (**Module 9**) provides advice on collecting samples from a pollution event.

Urban, agricultural, resource, and industrial developments often remove natural vegetation along streams and in other areas of a watershed. When buildings and paved surfaces replace natural vegetation, there is less ground surface available to absorb precipitation. Sediment, nutrients, and contaminants wash into streams, and degrade water quality. Water temperature and flow fluctuate more widely and composition of the stream bed changes. Some species of plants and animals die because they cannot adapt to these changes. Pollution-tolerant species become established.

Community and high school groups have used water quality surveys to detect and address major problems. This module adapts sampling methods developed by Mitchell and Stapp (1994) for the Rouge River in Detroit, Michigan. By the 1980's, the Rouge River had suffered from years of abuse. Once, it even caught on fire! Students at Detroit high schools analyzed stream water for dissolved oxygen, temperature, pH, turbidity, fecal coliform, nitrate, phosphate, biological oxygen demand, and total solids. They studied local community attitudes and shared the information among schools. They identified problems with raw sewage, industrial outfalls, poor land management, and erosion. These students learned to contact the appropriate agencies, use the media to raise community awareness about problems and solutions, and organize community projects. The Rouge River is dramatically cleaner now.

Measuring a few key characteristics at critical times of the year can help you identify problems in the watershed and select appropriate restoration projects. Long-term monitoring helps detect changes in watersheds before severe damage has occurred.

Project Guidance and Approval

You need no formal approval. A Streamkeeper course offers training for this module. Contact your Community Advisor for advice about equipment and similar projects in your watershed. This is a good project to coordinate with other groups in the same watershed. Enter your data into the Streamkeepers database. You may wish to share information with other groups or government agencies.

Level of Effort

Two to four people can sample one location. Divide larger groups and send smaller groups to various locations. The project works well with high school students or adults. Water quality measurements take about a half an hour per site.

Time of Year

Take samples during at least two seasons of the year - when stream flow is very low and sample when flows are high during the peak runoff period. For coastal streams, this is some time between November and February, during the extended period of heavy rainfall. For inland streams, this is between May and July, during the freshet that accompanies snow melt. Sample more often if you have the resources (every two to four months). If you suspect that turbidity may be a problem after heavy rainfall, sample before, during, and after a storm. Stream conditions may be cold and wet, with fast flows or potentially contaminated water.

Personal Safety

Concern for personal safety is essential when working outdoors. Always tell someone where you are going and when you will return. Work in pairs, never alone. Supervise children in and around streams. Carry emergency phone numbers for police, poison control centre, and ambulance. Take contact info for emergency response agencies and a way to communicate with them.

Carry a first aid kit. When working in remote areas, carry a survival kit containing at least a lighter, fire starter, candle, and flares.

Do not attempt to wade fast water or water higher than your knees. Watch out for slippery stream beds, undercut banks, waterfalls, and fast flowing areas. Log jams can be unstable, so take care to walk around them. Warn everyone, especially children, about urban hazards such as syringes, needles, broken glass, and condoms. Remove them with tongs and place them in a special hazardous materials bucket. Avoid foul smelling areas, spills of unknown substances, or containers of hazardous or unidentified materials. Contact emergency response agencies or municipal crews for removal. Get permission to cross or use private property.

Health

Do not drink stream water. Although it may look pristine, it can harbour bacteria and parasites that will make you sick. Do not expose cuts and wounds to stream water. Know the symptoms and treatment for hypothermia.

Clothing

Dress for the weather and stream conditions. Wear waders or boots with felts. Wear a personal floatation device (PFD) when working on larger streams.

Handling Chemicals

Keep all chemicals away from young children. Avoid contact with skin, eyes, nose, and mouth. Read the label on each container before use, especially any precautionary notes or first aid information. In case of an accident or suspected poisoning, call the Poison Control Centre immediately and have the name of the chemical. Wear goggles. Use test tube caps or stoppers, not your fingers, to cover test tubes during shaking or mixing. Close all containers tightly immediately after use. Do not interchange caps from different containers. Thoroughly rinse test tubes with creek water before and after each test. Deposit all solid and liquid chemical waste into separate labeled, covered containers. Dispose of them safely at home.

Material and Equipment

Ask the DFO Community Advisor about sources of equipment, such as sharing among groups or borrowing from schools. See Module 9 (Observe Record Report) for equipment used to collect samples..

- **data sheets**
- **clipboard and paper**
- **Fiberglass tape and folding metre stick**
- **felt pen, pencils**
- **eyewash bottle**
- **goggles**
- **rubber gloves**
- **bucket or garbage pail**
- **pH Hach kit or paper or meter**
- **dissolved oxygen Hach kit or meter**
- **turbidity tube, La Motte kit or meter or metre stick**
- **thermometer 0.5C divisions**
- **container with lid for chemical waste**

Background Information

A. TEMPERATURE

Temperature is very important to aquatic life. Most aquatic organisms are cold blooded, so their body temperatures are the same as the water temperature. Table 1 describes the kinds of stream life at various temperatures. Water temperature increases when the sun shines directly on a stream. Shading from trees, water surface area and volume, turbidity, stream bed colour, and orientation to the sun all affect the amount of sunlight absorbed by water.

TABLE 1 Optimal Stream Life At Various Temperatures	
TEMPERATURE RANGE	**TYPES OF STREAM LIFE**
20 - 25C (warm)	**lots of plant life; high fish disease risk; warm water fish (bass, carp, crappie, catfish, bluegill); caddisflies, dragonflies**
13 - 20C (cool)	**plant life; moderate fish disease risk; trout, salmon, sculpins; stoneflies, mayflies, caddisflies, water beetles, water striders**
5 - 13C (cold)	**plant life; low fish disease risk; trout, salmon, sculpins; stoneflies, mayflies, caddisflies**

Warm water contains less oxygen than cold water. When the water temperature increases, the concentration of dissolved oxygen decreases.

As the temperature rises, animals use oxygen at a faster rate - the metabolic rate doubles with each 10C increase. Plants grow faster and produce more oxygen. However, their decomposition consumes more oxygen. As the water temperature increases, animals become stressed and are more likely to succumb to contaminants, parasites, and disease. Organisms die or leave the area when they cannot adapt to the new conditions.

Shading helps keep summer water temperatures low. Shaded streams are cooler than unshaded streams. In late summer, the water temperature increases between early morning and late afternoon. In unshaded streams, the daily increase can be as great as 10C. Water loses heat very slowly even when it flows into shaded areas.

Removal of streamside vegetation is a major cause of temperature problems in British Columbia streams. Logging, agriculture, dyking, and urban development often remove streamside vegetation. This adds sediment to the stream from erosion. Besides causing other water quality problems, sediment absorbs heat from the sunlight thereby raising water temperature. Planting streamside vegetation helps correct the problem.

Water withdrawal for irrigation purposes often reduces stream flow during the summer, when flows are already at minimum levels. Low water flows contribute to problems with daily temperature fluctuation because there is less water to buffer the impact of high temperatures.

Thermal pollution from industrial sources also causes increased water temperatures. In addition discharges of water used as coolant may contain toxic antifouling agents or chlorine from municipal water sources.

B. DISSOLVED OXYGEN

Oxygen is essential for aquatic life as well as terrestrial animals. The amount of oxygen dissolved in water affects the number and kind of animals found there. Healthy streams are saturated with oxygen (90 to 110% saturation) during most of the year.

There are several causes of reduced dissolved oxygen levels in streams. Problems most often occur during the summer low flow period. Warm water holds less oxygen than cold water and shallow water heats up more quickly than deep water. Slow flowing water has little surface turbulence, so little oxygen mixes into the water. Organic wastes such as sewage and agricultural runoff consume oxygen as they decompose. Fertilizers from gardens and farmlands provide nutrients for algae and initially, the algae grow quickly and add oxygen to the water. However, later they decompose and consume oxygen.

During the summer low flow period, dissolved oxygen concentrations often fluctuate during the day. When water temperature increases during the day, the oxygen level decreases by late afternoon. Algal photosynthesis during blooms can increase the oxygen level during the day. Animal and plant respiration can depress the oxygen level during the night.

Planting stream bank vegetation helps to increase oxygen levels in streams. Foliage provides shade and roots absorb nutrients. Controlling sources of sewage, manure, and fertilizers also helps. Fencing keeps activities away from streams. Building structures in streams helps to aerate the water.

C. pH

The pH scale measures the relative acidity or alkalinity of any substance. The scale ranges from very strong acid, at pH 0, to very strong base, at pH 14 (Figure 1). Pure water has a neutral pH of 7, with an equal concentration of H+ (hydrogen) and OH- (hydroxyl) ions. Acidic water has a high concentration of hydrogen ions and a low concentration of hydroxyl ions. The reverse occurs in alkaline water. For example, vinegar at pH 3 compared to distilled water at pH 7 is ten thousand times more acidic.

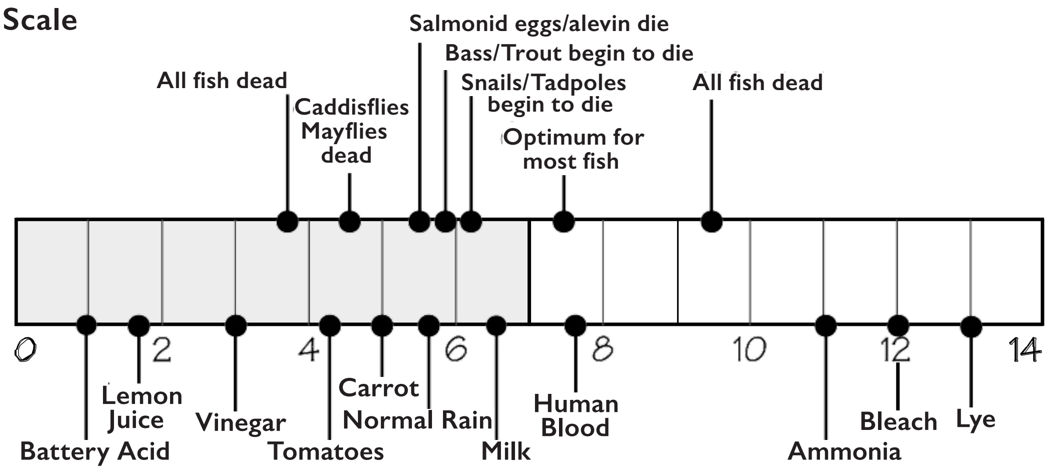
The pH scale is logarithmic, so a one unit difference in pH reflects a tenfold change in acid or alkaline concentration.

Most aquatic organisms are sensitive to small pH changes and prefer a pH of 6.0 to 8.5. Waters with a pH beyond this range usually do not have enough species to maintain a food web. There are some specially adapted communities that inhabit water outside this pH range. They inhabit naturally acidic streams that drain hot springs or have high levels of tannic acid, or very productive alkaline lakes and streams.

Stream pH level depends on the geology of the surrounding area, and usually falls between 6.5 and 8.0. Streams that drain soils with high mineral content usually are alkaline, whereas streams that drain coniferous forests usually are acidic. Algal photosynthesis during a bloom can cause increased pH.

Air pollution from automobile and industrial emissions creates "acid rain" when nitrous oxide and sulphur dioxide dissolve in rainwater. Rain is normally acidic (pH 5.0 to 5.6), because water absorbs carbon dioxide from the air and transforms it into a weak acid. Heavy rainfall, snow melt, and road runoff can affect pH.

Figure 1
pH Scale



D. TURBIDITY

Turbidity is a measurement of the cloudiness caused by sediment, microscopic organisms, and pollutants. These suspended particles restrict light penetration in the water, which in turn affects algal growth and oxygen production. Sediment can clog gills or other breathing structures of fish and benthic invertebrates. When sediment settles to the stream bottom, it can smother fish eggs and ruins habitat used by fish and aquatic insects.

Some waters are naturally turbid and their communities have adapted to these conditions. Turbidity is high in streams that drain glaciers and streams in geologically young areas.

Turbidity normally increases during and after rain storms or rapid snow melt. Severe problems with turbidity occur in areas where urban development, logging, and agriculture have disturbed the watershed and caused erosion. You can assess the extent of the problem by comparing turbidity before, during, and after times of heavy runoff. You also can compare turbidity upstream and downstream of suspected point sources of pollution.

E. WATER QUALITY INDEX

You can use a simplified water quality index to compare results from different streams or from different sites on the same stream. This water quality index combines results from temperature, pH, dissolved oxygen, and turbidity tests. The original American index also considers levels of coliform, biological oxygen demand, total solids, phosphate and nitrate.

Procedure

You may have established reference sites already while surveying the stream (Modules 1 and 2). Sample the water at the reference sites. You may be interested in sampling other locations as well. If you wish to investigate a specific pollution problem, sample immediately upstream and downstream of the problem, and, if possible, further downstream in a recovery area. If you wish to compare results from year to year, make sure to keep the location, time of day, and weather and stream conditions consistent. Record the stream location and condition information on the Data Sheet.

Follow the instructions included with the meter or sample kits.

• Do the test immediately after you take a sample.

• Do the calculations when you have finished all the tests.

Never sample water you have walked through and disturbed. Start at the site furthest downstream and work your way upstream. Sample the water upstream of where you walk. Collect a large 20 litre bucket of water to use for cleaning the bottles.

Take temperature, dissolved oxygen, and pH samples in shallow fast-moving water midway across the stream, so you have well-mixed water samples. This is not safe during the peak flow period, so take samples from a riffle area while standing on a stable stream bank.

Take water from below the surface. Collect water for dissolved oxygen and pH tests in the small bottles included in the kits. Rinse the sample bottles with stream water, then collect the samples. After the test, clean the bottle using water from the bucket. Discard the first rinse water in the liquid waste container. Put all dry chemical and packaging waste in the dry waste container. Take a turbidity measurement at midstream if you are using a turbidity meter. Move to a deep, slow-moving pool if you are using a tape measure.

Data Sheet STEP 1

Temperature

Take temperature readings twice a day (air and water) if you suspect problems with daily temperature fluctuations. Measure as early in the morning and late in the afternoon as possible. If you suspect thermal pollution, take temperature readings upstream and downstream of the source within a very short time span.

After taking air temperature take water temperature. Lower the thermometer 10 cm below the water surface and keep it submerged for two minutes. Read the temperature while the thermometer is still in the water. Record the temperature readings on the Data Sheet PART A. Calculate temperature differences for times of day or sites.

▶ **Record the differences in water temperature on Data Sheet STEP 1**

Data Sheet STEP 2

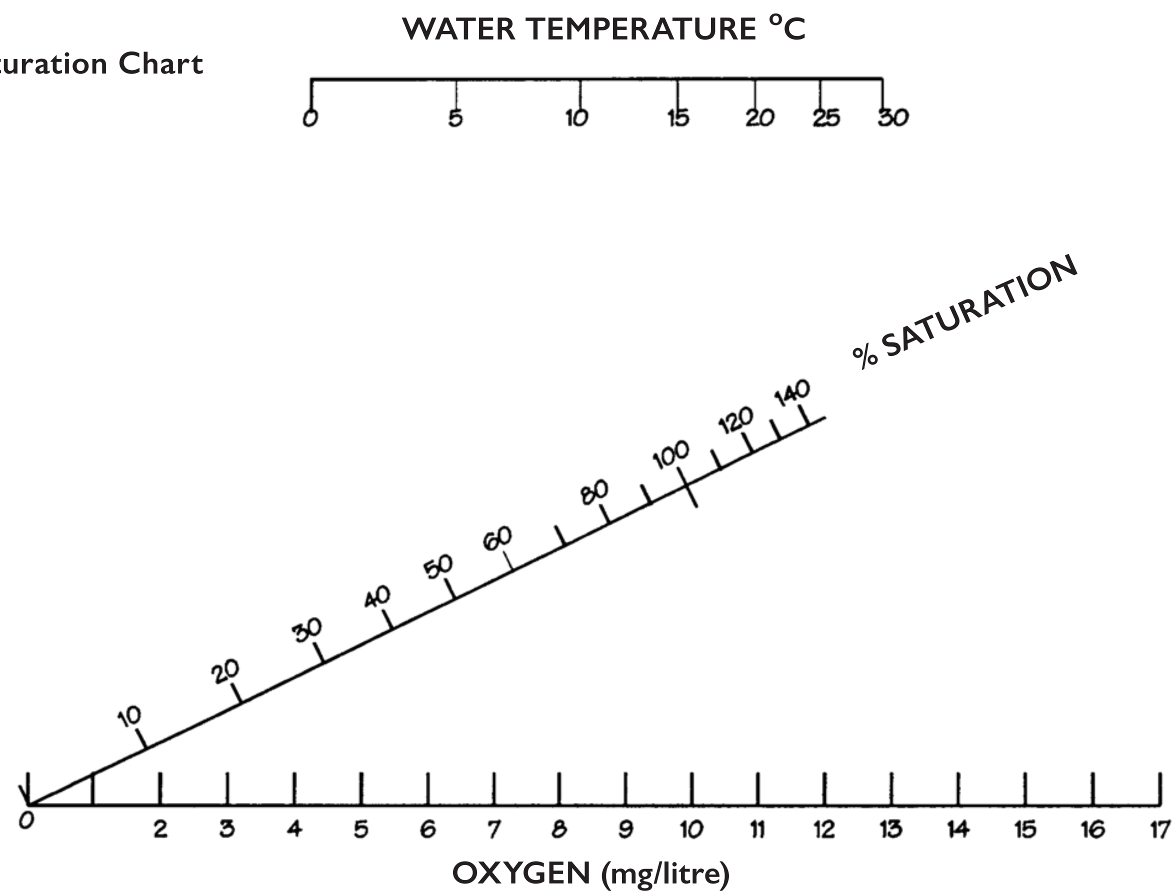
Dissolved Oxygen

Take the dissolved oxygen sample in late afternoon, when you are measuring temperature. The oxygen level generally is at its lowest for the day then. Follow the instructions and safety procedures included in the Hach kit. Collect the water samples carefully so you do not introduce air from agitation or bubbling.

The test results are in parts per million (ppm) or milligrams per litre (mg/l). Use the temperature and oxygen concentration data to calculate percent saturation using **Figure 2**. Use a ruler to join up the oxygen and temperature readings. Read the percent saturation value where the ruler crosses the middle line.

▶ **Record the concentration and percent saturation on Data Sheet STEP 2**

Figure 2
Oxygen Saturation Chart



Data Sheet STEP 3

pH

Measure pH in late afternoon, when you are measuring the temperature. Follow the directions included with the Hach pH kit. If you are using pH paper instead of the Hach kit, dip the paper in the stream water, then match the colour to the chart included with the paper. Repeat the test to check for reliability. If you use a pH meter make sure you calibrate it properly.

▶ **Record this on the Data Sheet STEP 3**

Data Sheet
STEP 4

Turbidity

Measure turbidity at peak flood time during the high flow period, when water clarity is likely to be poorest. Knowing normal background turbidity levels is important for comparison. Measure turbidity at other times during the season, when turbidity is not a problem. During low flow periods, measure turbidity when you are taking a late afternoon temperature reading.

Measure turbidity at midstream if you are using a turbidity meter. Follow the instructions on the La Motte turbidity kit. The results are in Jackson Turbidity Units (JTU's). Other types of turbidity meters give results in nephelometric turbidity units (NTU's). NTU and JTU units are interchangeable.

You can use a tape measure to measure turbidity. Do the measurement in a deep, quiet area, but be careful not to stir up sediment. In very shallow water, collect water and do the procedure in a bucket or garbage can. Focus on the number one near the end of the tape and lower it until you cannot see the number. Read the depth at the water surface and subtract one to get the true depth visibility. You may wish to use a turbidity tube if you have shallow streams.

▶ **Record this value on Data Sheet STEP 4**

Data Sheet
STEP 5

Q-Values and Water Quality Index

There are charts of Q-values versus results for the four parameters. Find the Q-value by reading up from your observed result to the point where it meets the curved line, then read across to the Q-value on the left-hand side. Record the Q-value in the table beside the corresponding result. Multiply the Q-value by the weighting factor for each characteristic. Add the results for all four values to get the Total Water Quality Index for the site.

▶ **Record the results on the Data Sheet STEP 5**

Collecting, Reporting and Evaluating Information

Compare the water quality rating for your sites with the Table on the Interpretation Sheet. Rate water quality as good, acceptable, marginal, or poor. Keep accurate records of your data. Share information with other groups working in the watershed.

▶**Enter your data into the the Streamkeepers Database.**
http://www.streamkeepers.info/

Before you react strongly to evidence of poor water quality, remember that your survey uses simplified versions of scientific methods and equipment. Although the results of your tests usually are reliable, there are exceptions to any rule. Sometimes stream conditions appear abnormal, but are in fact natural in a particular area. Make sure you have reliable background data to compare with data from problem sites. If the calculated Q-value is less than 50 for any parameter, it may be cause for concern. Data from habitat and invertebrate surveys (Modules 2 and 4) may provide support for the conclusions you have reached from your water quality surveys. Be prepared to contact an agency with the appropriate expertise, for assistance.

You can monitor water quality over many years. Once you have collected baseline data, you may find improvement or deterioration in water quality at specific locations. The water quality results allow you to identify problems, choose suitable rehabilitation projects, and evaluate the success of those projects.

Public Relations

You can clean up streams, monitor their condition, and undertake enhancement projects, but you need the support of your community for these projects to succeed. Talk about your project with others whenever and wherever you can, including at schools and public meetings. Place signs at visible projects and share fun facts on your social media pages. Contact radio stations, television stations, and newspapers. Module 10 contains specific information about increasing community awareness and working with the media.

Stream Location and Conditions

Enter the data: Streamkeepers Database, www.streamkeepers.info

Stream Name/Nearest Town	Date Watershed code
Organization Name	Stream Section #
Contact Name	Phone:
Crew Names	Email:

GPS (use degrees decimal if available): Latitude Longitude

Survey Start Time: Survey End Time:

Location (distance from known stream landmark, directions to benchmark)

Time: ______ Weather ☐ clear ☐ shower (1-2.5 cm in 24 hr.) ☐ snow ☐ overcast ☐ storm (<2.5 cm in 24 hr.) ☐ rain on snow

Water turbidity (cm visibility) ________________________ Temperature ^{o}C (leave thermometer 2 min.) air __________ water ______________

Measurements taken every m

Bankfull Channel width (m) Average depth (m)

Wetted Channel width (m) Average depth (m)

Left Bank	0.10															**Right Bank**
Wetted Depth																Wetted Depth
Bankfull Depth																Bankfull Depth

Step 1 Temperature: Keep thermometer in water 2 min. and take the reading while it is still in the water

Use this section if you are concerned about daily temperature changes.

Time of day	air (0C)	water (0C)
a.m.		
p.m.		
Difference in water temp.		

Use this section if you are concerned about temperature differences between sites.

Site	air (^{0}C)	water (^{0}C)
upstream		
downstream		
Difference in water temp.		

Step 2 Dissolved oxygen: Take samples with a Hach kit when you take the late afternoon temperature reading. Determine % saturation from figure

Concentration (mg/l)	
% saturation	
Equipment (if not Hach kit)	

Step 3 pH: Take samples when you take the late afternoon reading.

pH reading	
equipment	

Step 4 Turbidity: Measure turbidity in a deep quiet area. Be careful not to disturb sediment. Use a turbidity meter or tape measure.

Turbidity (JTU, NTU, or cm)	
Background turbidity (if known)	
Turbidity increase over background	
equipment	

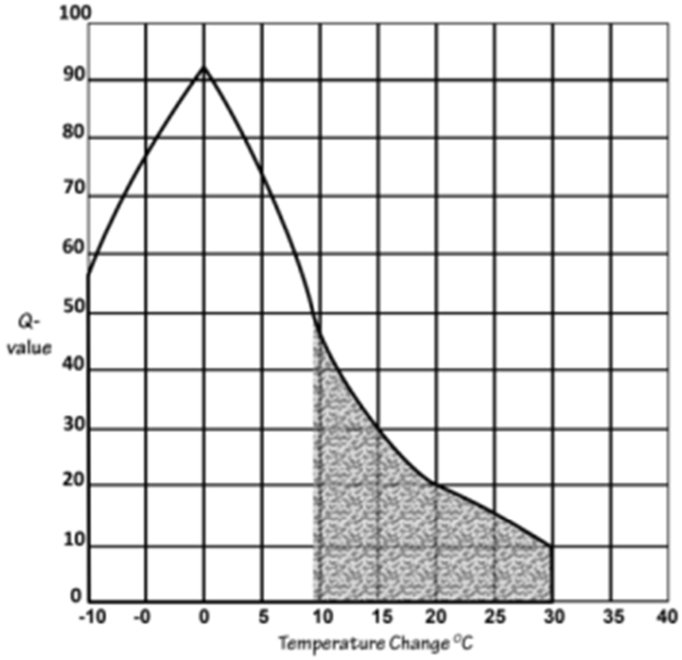
Step 5 Water quality index:

Fill in the table below with data and Q-values. Multiply the Q-value by the weighting factor to get the partial index value for each characteristic. Add up all four values to get the Water Quality Index. Rate water quality at your site using the chart at the bottom

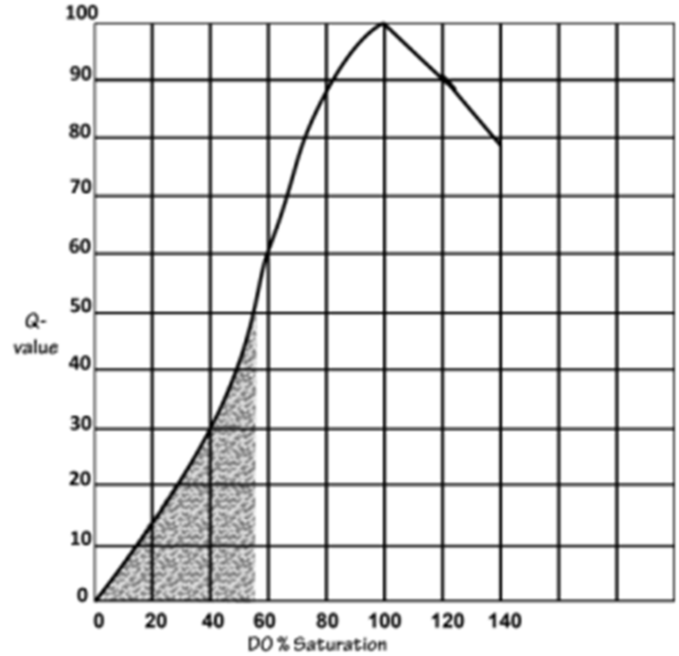
Chemical Test	Result	Q-value	Weighting Factor	Index Value
temperature change			x 0.10 =	
oxygen saturation			x 0.17 =	
pH (units)			x 0.11 =	
Turbidity (JTU, NTU, or cm			x 0.08 =	
Total = Water Quality Index				

Water QualityChart	
Good	40-45
Acceptable	30-40
Marginal	20-30
Poor	<20

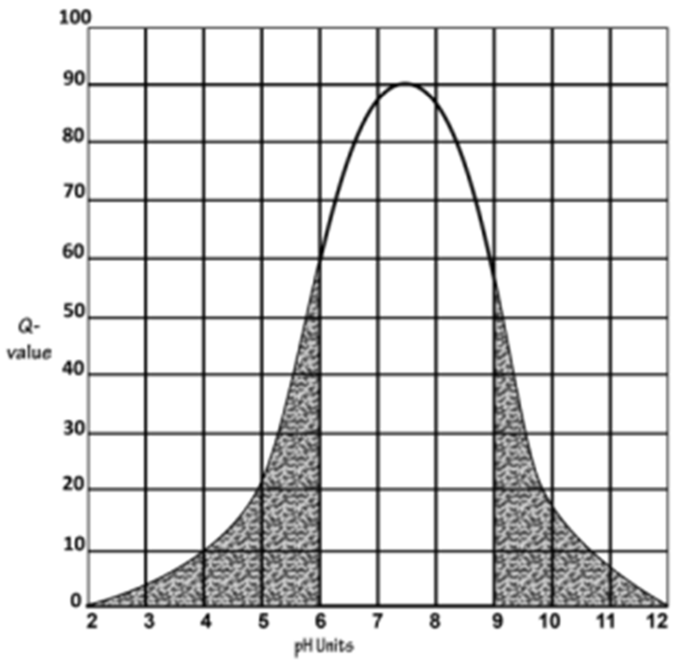
Temperature Results Test



Dissolved Oxygen (DO) Test Results



pH Test Results



Turbidity Test Results

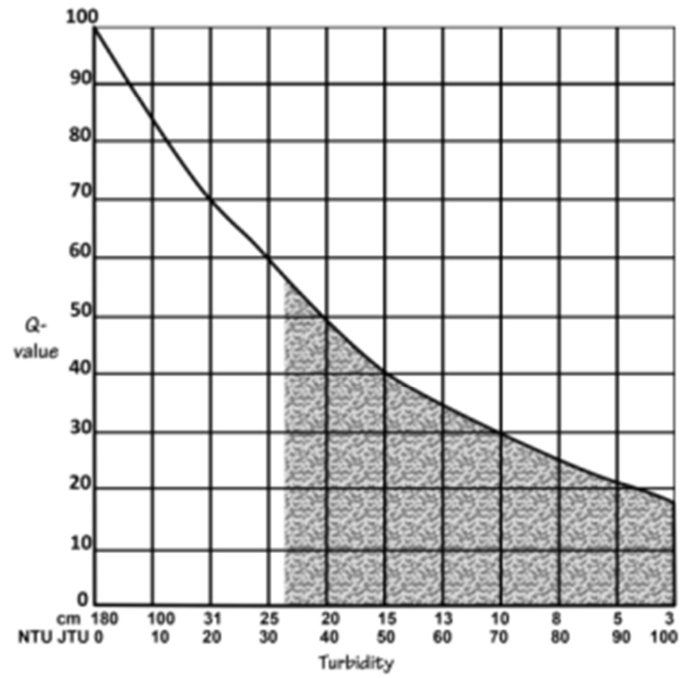


Figure 1 pH Scale

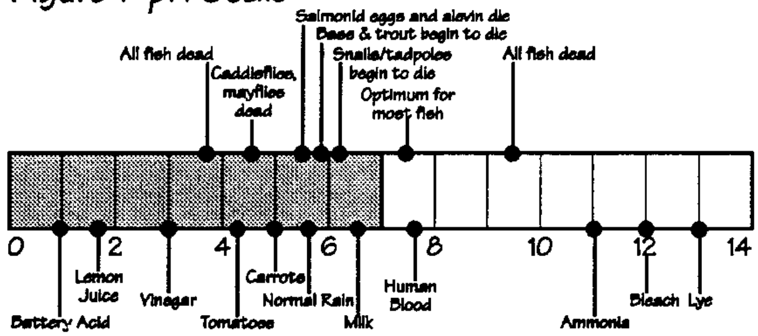


Figure 2
Oxygen Saturation Chart

from Field Manual for Water Quality Monitoring, M.K. Mitchell and W.B. Stapp, page 26