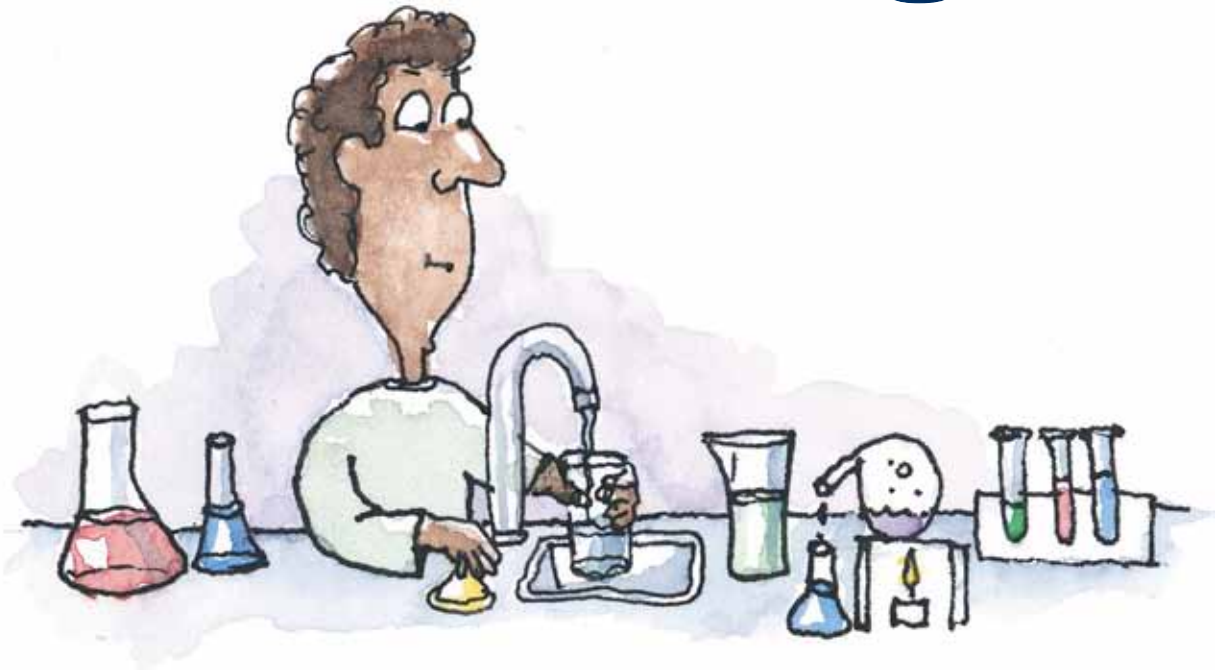


Intermediate Student Guide
to
**Water Quality
Monitoring**



Developed in cooperation with the Texas Stream Team.



GBRA

Guadalupe-Blanco River Authority
flowing solutions

Monitoring Manual

Intermediate School Level

Introduction to Student Field Guide

The Guadalupe-Blanco River Authority and Texas Stream Team encourages ordinary folks to be curious about how clean the water is in their creeks, rivers, and ponds. The program teaches citizens how to spot problems in water quality.

Before we get started, we should discuss the term “water quality”. When we observe a water body like a creek or river, we look at the condition of the water – does it appear clear? Does it have a smell? Is the water moving, or is it still? Answering these types of questions tell us about the quality of the water.

Did you ever stop to think about water as being healthy or non-healthy? Sure you did! Just think about it.... You’ve likely seen nice clean streams or rivers.... These are examples of ‘good’ water quality. You may have also observed water that is not too appealing...or ‘poor’ water quality. When you make these simple observations, you are judging the health of the water.

Ok, we’ve made it pretty clear -- when we are involved in water quality studies, we are determining the health of a body of water. This guide will assist you in learning how to identify if there are any problems in water quality. You will work with a nearby creek, river, or lake – your teacher will decide what your study area will be.

You will learn how to conduct simple tests. Some of these tests are the same identical tests that scientists conduct on a daily basis. After you have conducted these tests over a few months, you will be able to ‘judge’ if the water is doing well or if it is doing poorly. In a way, you are the doctor! You and your classmates will get to make a diagnosis.

The easy part is learning the steps of how to conduct the tests, and then conducting the tests on a regular basis. The hard part really comes after that decision... if it is clean, what can we do to keep it clean? If it is poor water quality, what can we do to improve it?

As you record your observations over a long period of time, the information you gather can tell you a lot about both the water and the land surrounding the water. Let's face it, you are learning about your environment! And learning about your environment is important. We all need a clean environment to stay healthy.... And so do our plant and animal friends!

GBRA and Texas Stream Team encourage everyone to ask:

What questions do we want to answer about the environment?

What part of the environment are we most concerned with?

What can I do to help preserve and protect the environment?

This curriculum guide works in conjunction with the
LaMotte:

Green Low Cost Water Monitoring Kit - #5886.

<http://www.lamotte.com/pages/edu/5886.html>

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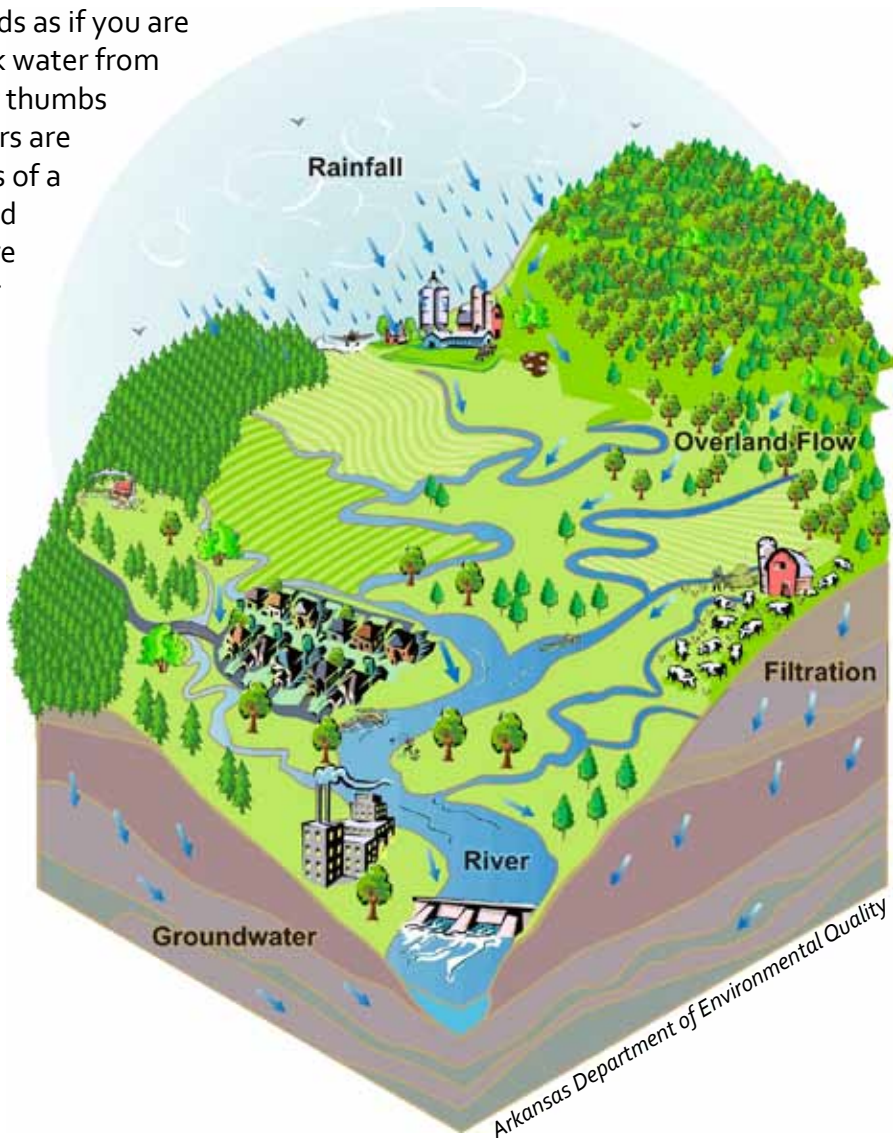
**This booklet was provided by the
Guadalupe-Blanco River Authority.**

What is a Watershed?

True or False: You live in a watershed.

True. Everyone lives in a watershed. A watershed is simply an area of land that drains the rainwater into one location such as a stream, river, lake, or wetland. This means that the runoff from streets, fields, and lawns will eventually drain into those streams, rivers, lakes, or wetlands.

Cup your hands as if you are going to drink water from a faucet. Your thumbs and forefingers are like the ridges of a watershed and your palms are like the water body that catches the rainwater.



Watersheds can vary in size and shape from a couple of square miles to hundreds of thousands of miles. We all live, work, and play in watersheds, and what we do affects everything and everyone else in the watershed.

How do we measure the quality of our waters?

Doctors use instruments like thermometers and stethoscopes to check your health. Scientists use instruments like Secchi (sek'-ee) disks, chemicals, probes, nets, gauges and meters to determine how healthy the water is. They take measurements of the physical and chemical condition of the water and the health of the critters that live in it.

What is the quality of our waters?

There are more than 3,600,000 miles of rivers and streams in the United States. If all the rivers and streams were placed end-to-end, they could wrap around the earth 144 times! Since there are so many water bodies in the nation, scientists are only able to monitor a small percentage of them. When scientists monitor the waters around the nation, they give one of the following scores:

GOOD-The water body fully supports its intended uses

IMPAIRED-The water body does not support one or more of its intended uses.

Of all the water bodies that scientists monitor around the nation, 45% are rated as impaired!

What is Nonpoint Source Pollution?

True or false?

Factories are the major source of pollutants in our waters.

False. Thirty years ago that statement was true, but since then we've made a lot of progress reducing pollution from factories and sewage treatment plants. Although these can still pollute in some areas, today most of the problems in our waters come from polluted runoff draining into rivers, lakes, and bays after a rain storm. Rain washing over the landscape carries dirt, oil, fertilizer, pesticides, and animal waste and many other substances off streets and farms and into our waterways. This form of pollution is called *nonpoint source pollution* because it comes from many different places, rather than a single source that one can point to (*point source pollution*).

As we pave over natural areas to make parking lots, driveways and roads (known as impervious surfaces) the rainwater doesn't slowly soak into the ground like it would naturally. Instead it is channeled into gutters, culverts and storm drains. Unfortunately, these tend to be easy places for people to illegally dump used motor oil, trash, and yard waste.

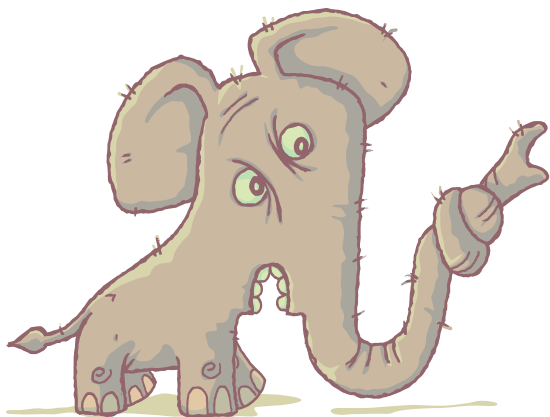
These pollutants then are channeled directly into our streams, wetlands, bays and lakes.





And there's more. Across the planet, humans have modified (straightened and physically altered) streams to flow in a certain path. Some streams have even been lined with concrete. Lining streams with concrete makes water rush faster after a rainstorm (increasing erosion and flooding), and makes it difficult or impossible for plants and aquatic creatures to live and thrive.

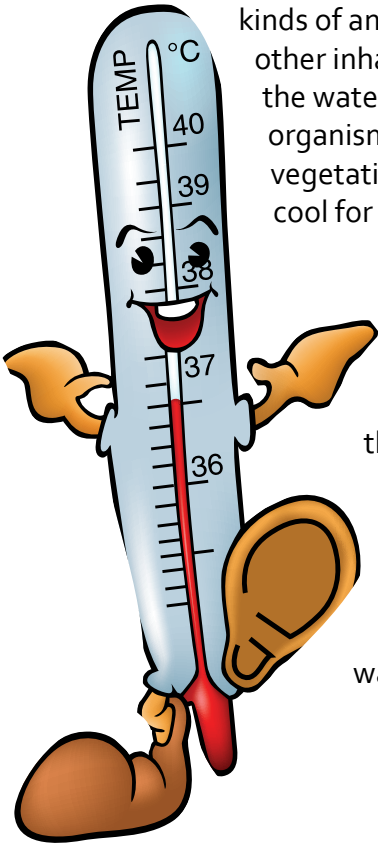
Its Time to Measure Water Quality!



**REMEMBER TO USE
SAFETY RULES WHEN
USING CHEMICALS!**

Temperature

When you don't feel well, chances are the first thing someone does is take your temperature. Just as taking your temperature can tell if you are sick, taking the temperature of a water body can tell if the stream is healthy. Scientists measure water temperature for several reasons. First, it determines the kinds of animals that can survive in a stream; different fish and other inhabitants require different temperatures of water. If the water temperature gets too hot or too cold for some organisms, they will die. A healthy cluster of trees and vegetation next to a stream or river helps keep temperatures cool for trout and other fish.



Thermal pollution is when warm water is added to a water body. Have you ever experienced a hot parking lot or sidewalk in the middle of summer? Just imagine what happens when water runs over these surfaces. It is warmed much like water in a pot on a stove is warmed. Once this warmed water enters a water body, it can threaten the health of the water body. Another example of thermal pollution is when industries use water to cool very hot machinery. After using the water to cool the machinery, the warm water is cooled and put back into the water body.

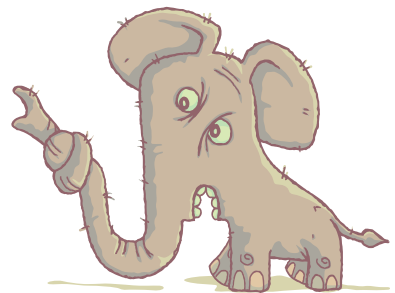
Temperature can also affect the chemistry of the water. For example, warm water holds less oxygen than cold water. You will learn more about this when we test for dissolved oxygen.

Air temperature is another important observation that scientists record. Air temperature affects water temperature and can explain seasonal variations in your observations of water temperature, dissolved oxygen, and nutrients. The warmer the air temperature, the warmer the water temperature; this could decrease the amount of dissolved oxygen, and increase the growth rate of fertilized plants.

Measuring Water Temperature

(Note: Use the thermometer on the strip provided.)

1. Place the thermometer four inches below the water surface for one minute. You may find that the thermometer is already attached to the inside of the container.
2. Read the temperature as degrees Celsius (the number that is in the green rectangle is the temperature) and record it on p. 18 **AND** p. 21.



Dissolved Oxygen - or “D.O.” (pronounced dee-oh)

“D.O.” tells us how much oxygen is available in the water for fish and other aquatic organisms to breathe. Healthy waters generally have high levels of dissolved oxygen (some areas, like swamps, naturally have low levels of “D.O.”). Just like human beings, aquatic life needs oxygen to survive. Oxygen is added to water two ways. First, oxygen is mixed in from the air above through rain, wind, and waves. Water that moves faster has more dissolved oxygen because it has more contact with air than still water. Second, underwater plants and algae add oxygen to the water; it is released during photosynthesis.

Several factors can affect how much oxygen is in the water. These include temperature, the amount and speed of flowing water, the plants and algae that produce oxygen during the day and take it back at night, pollution in the water, elevation (or atmospheric pressure), and the composition of the stream bottom. Gravelly or rocky bottoms stir up the water more than muddy ones do, creating bubbles that put more oxygen into the water.



Measuring "D.O."

1. Record the temperature of the water on p. 21. Then circle it on the first column on the chart on p. 22
2. Submerge the small tube into the water. Carefully remove the tube from the water, keeping the tube full to the top.
3. Drop two Dissolved Oxygen tablets into the tube. Water will overflow when tablets are added.
4. Screw the cap on the tube. More water will overflow as the cap is tightened. Check and make sure there are no air bubbles in the tube.
5. Mix by inverting the tube over and over until the tablets have dissolved. This will take about 4 minutes.
6. Wait about 5 more minutes for the color to develop.
7. Compare the color of the water in the test tube to the Dissolved Oxygen color card. Record this number on the chart on p. 21, and then circle it on the chart on p. 22.
8. Use the % Saturation Chart on p. 22 to find the percentage of the water saturated with Dissolved Oxygen. First locate the temperature of the water on the chart. Next locate the Dissolved Oxygen result at the top of the chart. The % Saturation of the water is the point where the temperature row and the "D.O." column intersect.
9. Be sure to record your results to the data table on p. 21 and again on p. 18.



pH

Scientists measure the pH (potential of hydrogen) to determine the concentration of hydrogen in the water. The pH ranges from 0 (very acidic) to 14 (very basic), with 7 being neutral. For example, a lemon is acidic and soap is basic. Most waters range from 6.5 to 8.5. Most aquatic life is adapted to specific pH levels and may die if the pH of the water changes even slightly.

Polluted air from automobile tailpipes and industry smokestacks combines with water while in the atmosphere to form acids that then fall to the earth as acid rain. In addition to acids absorbed from the atmosphere, rainwater picks up pollutants from driveways, fertilizers on our lawns, and wastes from our pets. These pollutants can affect the pH of the water, making it more acidic.

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WHEN USING CHEMICALS!**



Measuring pH

1. Fill the test tube to the 10mL line with water.
2. Add one pH Wide Range tablet.
3. Cap and mix by inverting until the tablet has dissolved. Bits of the tablet may remain.
4. Compare the color of the water in the test tube to the pH color card. If it doesn't exactly match a color on the card, you may have to estimate! Record the results on p. 18.

Acids	Battery Acid	1
	Lemon Juice	2
	Soda Pop	3
	Tomatoes	4
	Coffee	5
	Milk	6
Bases	Pure Water	7
	Sea Water	8
	Baking Soda	9
	Detergent	10
	Household Cleaners	11
	Soap	12
	Bleach	13
	Drain Cleaner	14

pH Scale



Turbidity

Scientists measure the clarity of the water to determine how many particulates (tiny particles of matter) are floating around. If you're sitting on a dock of a pond on a warm summer day, you might be able to see the bottom. That pond would have low turbidity. On the other hand, if you visit the dock after a rainstorm when all the muck has been stirred up, you won't be able to see the bottom; now the pond has high turbidity.

Dirt is commonly listed as a leading cause of pollution in our rivers and streams. That's right, dirt is pollution. When rain washes dirt into streams and rivers, it smothers the little critters in the stream and kills any fish eggs clinging to rocks. Dirt can also clog the gills of fish, suffocating them. Also, if the plants that use the sun to make food (photosynthesis) can't get enough sunlight because the water is murky, they die.

Most of the dirt washing into lakes and streams comes from activities that remove trees and shrubs and leave the dirt or soil exposed. Examples of exposed dirt and soil include fields that have just been plowed, construction sites that have been bulldozed, and areas that have been logged or mined. Erosion is the problem that occurs when fast-moving water erodes the banks of streams. The water moves faster because the vegetation that would slow it down has been replaced with pavement and buildings.

The solution is to stop the dirt from getting into the stream in the first place by protecting soils and disturbing the land as little as possible. Farmers are using different methods to grow their crops so they leave less soil exposed, and they plant vegetation in fields that are not being used. Construction workers are putting up silt fences and hay bales to trap the dirt and contain it while they build. Developers can design new home sites that leave more natural areas and use less pavement to reduce the amount of dirt they disturb.

Measuring Turbidity

The water testing kit container is used to perform the Turbidity test.

1. The Secchi disk icon sticker should already be placed on the inside bottom of the large white jar, slightly off center.
2. Find the turbidity fill line located on the outside label of the jar. Fill the jar to this turbidity fill line.
3. Hold the Turbidity Card on the top edge of the jar. Compare the color of the Secchi disk in the container to those on the card.
4. Record the result as Turbidity in JTU on p. 18. If it is not a perfect match, you may have to estimate!



secchi disk

Nitrates

Nitrates are a measure of the amount of nutrients (nitrogen in this test) in a water body. Nutrients are important to the health of plants, fish, and animals as well as to humans. Without nutrients no life forms would grow. Unfortunately, too many manmade nutrients being washed into a body of water could cause some big problems.

Nutrients are commonly listed as the number one cause of water quality problems in our streams, rivers, lakes, and ponds. They have caused impairment in more than 3.8 million acres! (That's almost 30 football fields!) The two most common nutrients are nitrogen and phosphorus, which cause algae to grow and can turn water green.



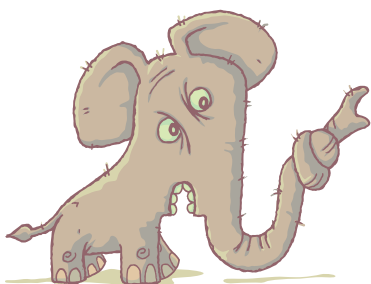
Where do nutrients come from?

The major sources of nutrients are runoff containing fertilizers and animal waste from farms and cities (lawn fertilizers can wash away in heavy rain), wastewater treatment plants, and failing septic systems.

All drinking water contains some level of nitrates, but drinking water containing high nitrate levels can affect the ability of our blood to carry oxygen. This is especially true for infants who drink formula made with water containing high levels of nitrates.

What's being done to control nutrients?

Farmers are learning new ways to apply fertilizers and manage livestock. Homeowners are being educated about maintaining their lawns and septic systems. Cities and towns are fixing their sewage treatment plants.



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Measuring Nitrates

1. Fill the test tube to the 5mL line with water.
2. Add one Nitrate tablet.
3. Cap and mix by inverting until the tablet has dissolved. Bits of the tablet may remain in the test tube.
4. Wait 5 minutes for the color to develop.
5. Compare the color of the water to the Nitrate color card. If it is not a perfect match to one of the colors on the card, then you may have to estimate! If the water does not change color, record the result as 0 (zero).
6. Record the result as ppm Nitrates, on p. 18.

Phosphates

Phosphate (phosphorus) is a nutrient needed for plant and animal growth.

Phosphorous can enter the environment through natural events, such as forest fires and fallout from volcanic eruptions. This amount is small when compared to human-caused enrichments of phosphorous in the water. Phosphorous can be introduced into the environment through human activities such as: fertilizers, human and animal wastes, and industrial wastes.

High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity, and decreased dissolved oxygen levels. The number of aquatic plants growing in a particular area is dependent on the amount of phosphorous available. In an aquatic ecosystem, inorganic phosphate is rapidly absorbed by algae and larger plants, resulting in algae blooms. Algae blooms can create an imbalance in the amount of oxygen in the water, and can impact water quality.

Measuring Phosphates

1. Fill the test tube to the 10 mL line with water.
2. Add one Phosphorous tablet.
3. Cap and mix by inverting until the tablet has disintegrated. Bits of the tablet may remain in the test tube.
4. Wait 5 minutes for the color to develop.
5. Compare the color of the water to the Phosphate color card.
If the water does not develop a color, record the result as 0 (zero) ppm.
If you do have a color, but it doesn't exactly match one of the colors on the card, you will need to estimate! Discuss with your group. Record the result as ppm Phosphates on p. 18.

Monitoring Test Results:

Month			
Water Temperature	°C	°C	°C
pH			
Turbidity	JTU	JTU	JTU
Nitrates	ppm	ppm	ppm
Phosphates	ppm	ppm	ppm
Dissolved Oxygen	% Saturated	%Saturated	%Saturated

Ranking Test Results

Test Factor	Result	Rank
Dissolved Oxygen	91-110% Saturated	4 (excellent)
	71-90% Saturated	3 (good)
	51-70% Saturated	2 (fair)
	<50% Saturated	1 (poor)
pH	5	1 (poor)
	6	3 (good)
	7	4 (excellent)
	8	3 (good)
	9	1 (poor)
	10	1 (poor)
Nitrate	5 ppm	2 (fair)
	20 ppm	1 (poor)
	40 ppm	1 (poor)
Phosphate	0-1 ppm	4 (excellent)
	2 ppm	3 (good)
	3-4 ppm	2 (fair)
Turbidity	0 JTU	4 (excellent)
	40 to 100 JTU	3 (good)
	Over 100 JTU	1 (poor)

Student Monitoring Guide Questions:

1. Describe a watershed.

2. What is nonpoint source pollution? Name some examples.

3. What do the scores of "GOOD" and "IMPAIRED" mean to scientists?

4. How many miles of river and streams are in the U.S.? What percent are considered "IMPAIRED"?

5. Why is temperature important to the health of a water body?

6. How is oxygen added to water?

7. What factors affect the amount of DO in water?

8. What manmade factors affect the pH of water?

9. How does high turbidity affect the health of aquatic organisms?

10. Where do manmade nitrates come from and how can they affect the health of humans?

Extension:

Over time, collect a sufficient amount of data about the water near your home or school. You can use it to create a graph and analyze the overall health of your water body and how it changes throughout the year.

TEKS Correlation

Science Grade 4

1(a)(b); 2(a)(b)(c)(d)(e); 4(a)(b); 5(a)(c)

Science Grade 5

1(a)(b); 2(a)(b)(c)(d)(e)(f); 4(a)(b); 5(a)(d)

Science Grade 6

1(a)(b); 2(a)(b)(e); 4(a)(b)

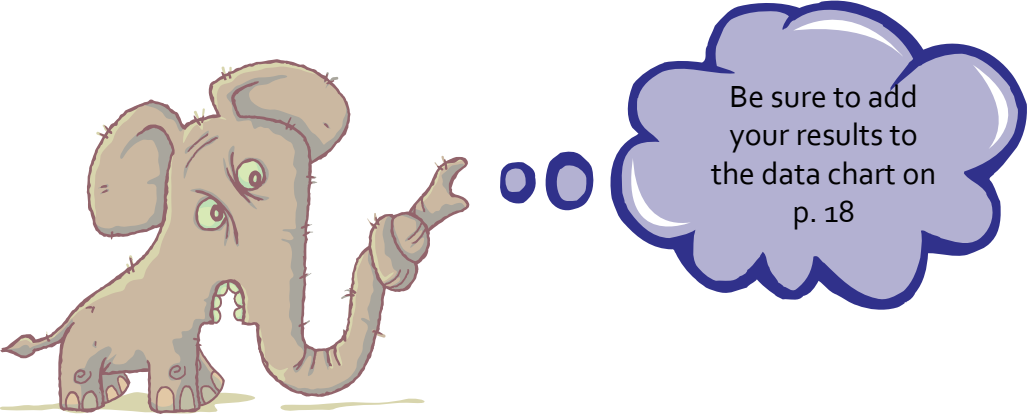
Dissolved Oxygen:

Locate the temperature of the water on the side of the % Saturation Chart. (p. 22)
Locate the Dissolved Oxygen result of the water at the top of the chart. (p. 22)
The % Saturation of the water is where the Temperature row and the Dissolved Oxygen column intersect.

For example: If the water temperature is 16°C and the Dissolved Oxygen result is 4 ppm, then the % Saturation is 41.

Record the temperature, dissolved oxygen and % Saturation on the chart below.
Also record the % Saturation on p. 18.

Month			
Water Temperature	°C	°C	°C
Dissolved Oxygen	ppm	ppm	ppm
% Saturation	%	%	%



% Saturation Chart

Dissolved Oxygen (ppm)

Temperature (°C)		0 ppm	2 ppm	4 ppm	6 ppm	8 ppm
	9	0	17	34	51	67
	10	0	18	35	53	71
	11	0	18	36	54	72
	12	0	19	37	56	74
	13	0	19	38	57	76
	14	0	20	39	59	78
	15	0	20	40	60	80
	16	0	21	41	61	81
	17	0	21	41	62	83
	18	0	21	42	63	84
	19	0	22	43	65	86
	20	0	22	44	66	88
	21	0	23	45	68	91
	22	0	23	46	69	92
	23	0	24	47	71	95
	24	0	24	48	72	96
	25	0	25	48	73	98
	26	0	25	49	74	99

*Calculations based on solubility of oxygen in water at sea level.

Adapted from the following resources:

LaMotte Low Cost Water Monitoring Kit Instruction Booklet

What's Up With Our Nation's Waters? (U.S. EPA)

Watershed Owner's Stream Walk Guide (TCEQ GI-218)

You can help water quality by composting your yard clippings and leaves, picking up your pet's waste, not over fertilizing your yard, conserving water, not washing your car on the street, and spreading the word about water quality and why it matters!

Texas Stream Team is a network of volunteer monitors throughout the state of Texas. To find out more about water quality monitoring in your area, or to get involved with a local monitoring group, please contact us.

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**Texas
Stream
Team**

Caring for Our Waters



*Prepared in cooperation with the Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency*