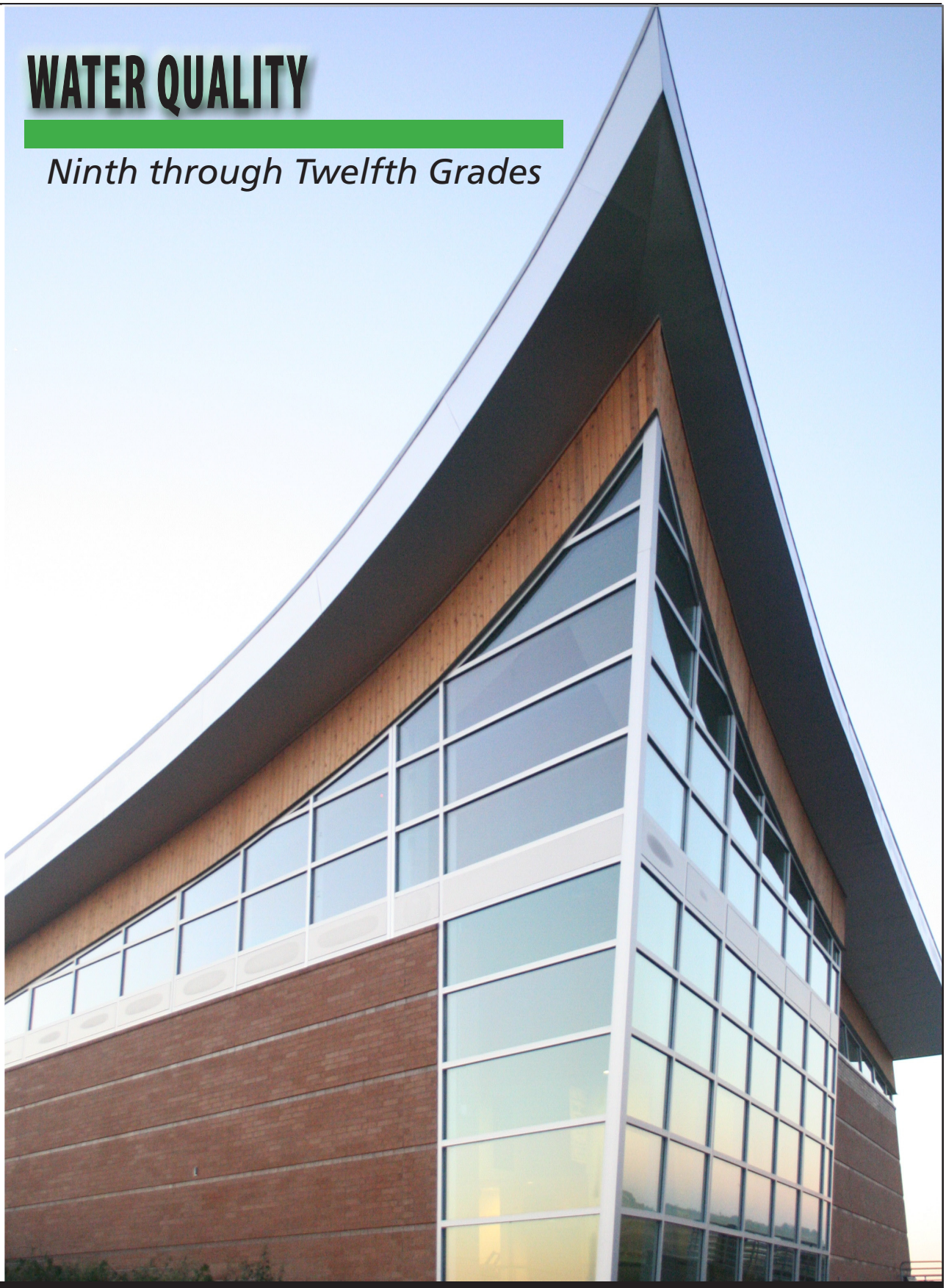
Free Land was the Cry!

WATER QUALITY

Ninth through Twelfth Grades



Homestead

National Park Service
U.S. Department of the Interior

Homestead National Monument
of America, Nebraska

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Our thanks to the following people for their contributions to our project:

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Some of the ideas in this lesson may have been adapted from earlier, unacknowledged sources without our knowledge. If the reader believes this to be the case, please let us know, and appropriate corrections will be made. Thank you.

PROGRAM DESCRIPTION

Have you ever looked at a glass of water and wondered how old the water was? The water in the glass may have fallen from the sky as rain just a few days ago, but the water itself has been around in one form or another pretty much as long as the earth has.

The water in your glass was part of the oceans that immigrants crossed to come settle in America. It was part of the rivers and streams that homesteaders crossed to settle the west. And you thought your parents were old!

The earth has a limited amount of water, so it keeps going around and around and around in what is called the "Water Cycle". Because of the cyclical nature of water, we must be careful with our water use in both quantity and quality. Activities and field experiences in this program help students answer these questions about the water cycle, watersheds and how they can help maintain a healthy water cycle.

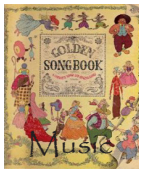
SPECIAL ICONS

Indicates a reproducible handout is included

Indicates an additional science activity

Indicates an additional math lesson

Indicates an additional social studies lesson



Indicates an additional music or art activity

Indicates an additional language arts lesson

CURRICULUM OBJECTIVES

- Students can describe basic processes of a watershed.
- Students can describe several impacts on water quality.
- Students develop potential ideas for avoiding loss of water quality.
- Students will conduct scientific experiments.

NATIONAL STANDARDS

NL-ENG.K-12.4 COMMUNICATION SKILLS

- Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

NL-ENG.K-12.7 EVALUATING DATA

- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g. print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

NL-ENG.K-12.8 DEVELOPING RESEARCH SKILLS

- Students use a variety of technological and information resources (e.g. libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

NL-ENG.K-12.11 PARTICIPATING IN SOCIETY

- Students participate as knowledgeable, reflective, creative and critical members of a variety of literacy communities.

NL-ENG.K-12.12 APPLYING LANGUAGE SKILLS

- Students use spoken, written, and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).

NS.9-12.1 Science as Inquiry

As a result of activities in grades 9-12, all students should develop

- Ability to do scientific inquiry
- Understanding about scientific inquiry.

NS.9-12.3 LIFE SCIENCE

As a result of their activities in grades 9-12, all students should develop understanding of

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms.

NS.9-12.6 PERSONAL AND SOCIAL PERSPECTIVES

As a result of activities in grades 9-12, all students should develop understanding of

- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society.

NSS-G.K-12.1 THE WORLD IN SPATIAL TERMS

As a result of activities in grades K-12, all students should

- Understand how to use maps and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- Understand how to use mental maps to organize information about people, places, and environments in a spatial context.
- Understand how to analyze the spatial organization of people, places, and environments on Earth's surface.

Pre-Visit Activity #1 (suggested)

THE WATERSHED CONCEPT

The water on the Earth is stored in the oceans, ice caps and glaciers, groundwater, lakes, atmosphere, rivers, plants, animals and soil. It is the movement of this water, via precipitation, runoff, evaporation, transpiration and infiltration that has the potential to move pollutants from one place to another. Watersheds are the land area draining water (through runoff) into a particular stream, river or lake. Discuss with students the watershed concept and vocabulary.

Watershed vocabulary:

- Condensation
- Evaporation
- Groundwater
- Infiltration
- Permeable
- Precipitation
- Runoff
- Transpiration
- Water Cycle
- Watershed
- Water Table

Ask the students what they think their local watershed area is.
Have students visit the Environmental Protection Agency Surf Your Watershed website to discover the area of your local watershed. Visit: http://cfpub.epa.gov/surf/locate/index.cfm.

Other Activities

Enrichment Activities

Visit Bell Museum website in small groups and complete the interactive games.

http://bit.ly/bYN9Hd

The intermediate level of this game asks students to make decisions affecting water quality that must be balanced with other concerns.

DEFINING WATER QUALITY

Pre-Visit Activity #2 (suggested)

Resource management is a primary goal of the National Park Service and Homestead National Monument of America. Resource management is managing the land so it is healthy for tomorrow and educating people about its resources and how they can help. Homestead monitors the quality of the water in Cub Creek which flows through its boundaries. Water quality monitoring is important because the data shows how effective management practices are.

Water quality tests take place both in the creek or body of water and in a laboratory. In this activity students will discuss the different tests and why they are important in water quality.

Dissolved oxygen, conductivity, pH, turbidity, temperature and flow rate tests are all conducted in the water.

Dissolved oxygen is important because fish need oxygen to survive. Cold water holds more dissolved oxygen, so temperature plays an important part in the dissolved oxygen test. The more dissolved oxygen, the better the water tastes.

Microsiemans is the unit of measure used in a **conductivity** test. A high conductivity means there is more dissolved material which may have more contaminants. In this test 0-800 microsiemans is good water to drink, 800-2500 microsiemans will give the water a salty taste and anything over 2500 microsiemans is not suitable for use.

Flow rate is the speed or rate at which water is taken from a watercourse or the speed at which it flows past a point, usually measured in gallons per hour or cubic feet per second (cfs).

pH measures how basic or acidic the water is. The scale begins at 1 with the most acidic and ends with 14 as the most basic. Seven would be a neutral reading. Fish prefer to live in water that is between 6.5 and 8.2.

Turbidity measures the water's clarity. Natural water has a clarity of 80-120 cm. Sources that change the turbidity in the water are sediment, excessive algae and physical disturbance of stream beds.

Alkalinity, phosphates, sulfates and nitrates are tested in a laboratory.

Alkalinity buffers the water against sudden changes in the pH. It is important to aquatic life because alkalinity keeps the pH in the water constant, which the fish need.

Phosphates are needed for plant growth. High levels in the water increase the plant growth.

If you have ever smelled rotten eggs around water, you are smelling the **sulfates** in the water. High levels of sulfates in the water won't hurt humans, but it does make the water taste bad.

Nitrates get into the water from fertilizers, manure, septic systems and car exhaust. High levels of nitrates can cause serious illness and sometimes death in humans.

Students can practice this vocabulary by doing the crossword puzzles in the Additional Resources section.

Pre-Visit Activity #3 (suggested)

IS YOUR CREEK OR POND HEALTHY?

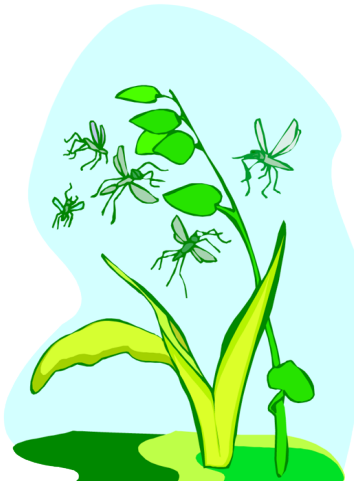
If you see pollution or trash in/around a creek, pond or other body of water you may think it is unhealthy right away. But what if there were no obvious indicators such as trash? How would you tell how healthy the creek or pond was? With macroinvertebrates of course!

Macroinvertebrates are small, but visible with the naked eye, animals without backbones. Water bodies have communities of aquatic macroinvertebrates. The species composition, species diversity and abundance of the macroinvertebrates in a given water body can provide valuable information on the relative health and water quality of a waterway.

Macroinvertebrate assemblages are good indicators of localized conditions. Because many benthic (of or relating to or happening on the bottom of a body of water) macroinvertebrates have limited migration patterns or a sessile mode of life, they are particularly well-suited for assessing site-specific impacts (upstream-downstream studies).

Macroinvertebrates integrate the effects of short-term environmental variations. Most species have a complex life cycle of approximately one year or more. Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.

Degraded conditions can often be detected by an experienced biologist with only a cursory examination of the benthic macroinvertebrate assemblage. Macroinvertebrates are relatively easy to identify to family; many “intolerant” taxa can be identified to lower taxonomic levels with ease.



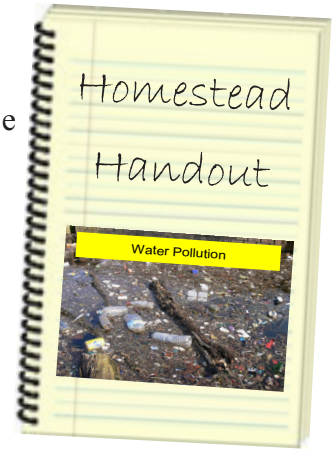
Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects. Benthic macroinvertebrates also serve as a primary food source for fish, including many recreationally and commercially important species.

Benthic macroinvertebrates are abundant in most streams. Many small streams which naturally support a diverse macroinvertebrate fauna, only support a limited fish fauna.

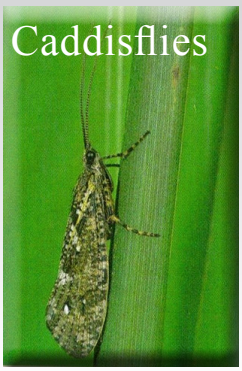
IS YOUR CREEK OR POND HEALTHY?

Pre-Visit Activity #3 (suggested)

Listed below are various benthic macro-invertebrates. Using the Benthic Macro-invertebrate Worksheet in the Additional Resources research their pollution tolerance and if time allows (and you are assigned) draw the life cycle of three of the benthic macroinvertebrates. Additional information may be found at the Environmental Protection Agency website at http://www.epa.gov and the Bonneville Power Administration website under the Kids in the Creek Link at http://bit.ly/a56UfO.



Alderfly
Aquatic Sowbug
Aquatic Worms
Backswimmer
Black Fly
Caddisflies
Clam and Mussel
Cranefly
Crayfish
Damselfly
Dobsonfly
Dragonfly
Fishfly
Freshwater Scud
Horsefly
Leech
Left Handed Snail
Mayfly
Midge
Mosquito
Predacious Diving Beetle
Riffle Beetle
Sowbug
Stonefly
Water Boatman
Water Penny
Water Scorpion
Waterstrider
Whirligig Beetle



Water Quality Testing

Homestead National Monument of America is part of the Cub Creek Watershed. The Cub Creek Watershed is located in Gage and Jefferson counties in Nebraska. It encompasses 92,350 acres and is approximately 35 miles in length. Most of the land is in agriculture production with crops such as corn, milo, wheat and alfalfa. There are several water control structures and dams in place to keep the flow in check.

Through this activity students will help Homestead National Monument of America monitor the water quality of Cub Creek. Students will be given the proper gear to wear such as waders etc. and will be asked to conduct most of the tests in the water.

Students will begin by discussing why water quality monitoring is important.

Students will conduct dissolved oxygen, conductivity, pH, flow rate, temperature and turbidity tests.

Students will end their discussions with why they should care about water quality monitoring.

RANGER-LED EXPERIENCE

Creek Critters

Macroinvertebrates are aquatic insects that live in the water. Each one has a different tolerance to water pollution. Testing for macroinvertebrates is relatively easy because it requires few people and inexpensive gear. Sampling also has a minimal detrimental effect on the resident biota.

Macroinvertebrate testing is also good because macroinvertebrates do not move much. They are also very sensitive to change and the sampling results are easy to interpret.

Students, with the help of a park ranger, will take a sampling of Cub Creek or Graff pond at Homestead National Monument of America. By examining the macroinvertebrates in the sample, students will be able to determine the health of the creek or pond.

Post-Visit Activity #1 (suggested)

WATER QUALITY ANALYSIS

After students run their water quality tests in the water either at Homestead National Monument of America or another site, they will take the data and water samples back to a laboratory environment. There they will run tests for alkalinity, nitrates, sulfates and phosphates.

- Write a report on the quality of the water in Cub Creek at Homestead National Monument of America or other site you may have visited.
- Analyze, graph and discuss your results.
- Ask students to discuss the importance of grassland to water quality and the water cycle.
- How would the environment at Homestead be different if the land was still farmed?
- How would it affect the water cycle?
- Be sure to compare and contrast groundwater and surface water as you discuss these questions.

Write a short report about homesteaders and the water cycle.

Potential topics:

- What ONE thing did homesteaders do that was most damaging to the water cycle?
- What was the best thing that they did?
- Which implement or invention changed the water cycle the most (for better or worse)?

CHARACTER EDUCATION

Caring

Students who practice good citizenship are motivated by more than self-interest and greed. They are genuinely concerned for the needs of others. They recognize their duty to contribute to making life better at home, at school, in the neighborhood, and for the whole planet.

5 Minute Focus

Water quality testing is done on a regular basis in many areas to help monitor water pollution.

- What can you do to help prevent water pollution?
- How does your family help prevent water pollution?

ADDITIONAL RESOURCES

Bragg, Thomas B. "The Physical Environment of Great Plains Grasslands." *The Changing Prairie: North American Grasslands.* Ed. by Anthony Joern and Kathleen H. Keeler. New York: Oxford UP, 1995. 49-81.
A thorough and somewhat technical examination of the geography and physical characteristics of the prairie, including precipitation and water cycle (including evapotranspiration and soil conditions) as well as fire on the prairie, plants, and the intersection of all of these. Charts and maps further clarify.

Cain, Kathleen. *The Cottonwood Tree: An American Champion*. Boulder: Johnson Books, 2007.
http://herb.umd.umich.edu
Ethnobotany site; input prairie plant names, database returns American Indian uses for the plant, along with tribal affiliation.

Gruchow, Paul. *Grass Roots: The Universe of Home*. Minneapolis: Milkweed Editions, 1995.

Knopp, Lisa. "In the Corn." *Interior Places*. Lincoln: U of Nebraska P, 2008. 103-119.

Knopp, Lisa. "The Memory of Trees." *The Nature of Home*. Lincoln: U of Nebraska P, 2002. 29-38.

Ladd, Doug. *Tallgrass Prairie Wildflowers 2: A Field Guide to Common Wildflowers and Plants of the Prairie Midwest* (Falcon Guides Wildflowers). Falcon, 2005.

Least Heat Moon, William. *PrairyErth (a deep map)*. Boston: Houghton Mifflin, 1991. "With the Grain of the Grid," 279-287 (Osage Oranges). "In Kit Form: The Cottonwood Chapter," 326-333 (cottonwoods). "Beneath a Thirty-Six-Square Grid," 194-201 (grasses). "Ex Radice," 237-243 (grasses).

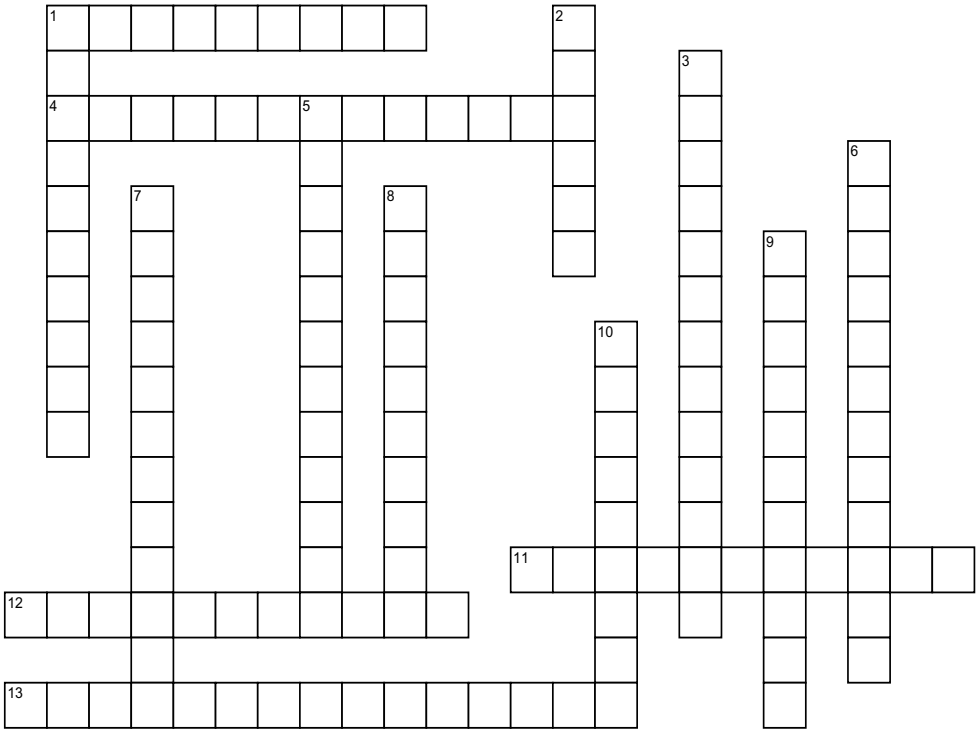
Name _____

Benthic Macroinvertebrates

Indicate whether the benthic macroinvertebrate has a low, moderate or high tolerance to water pollution.

Alderfly	Low	Moderate	High
Aquatic Sowbug	Low	Moderate	High
Aquatic Worms	Low	Moderate	High
Backswimmer	Low	Moderate	High
Black fly	Low	Moderate	High
Caddisflies	Low	Moderate	High
Clam and Mussel	Low	Moderate	High
Cranefly	Low	Moderate	High
Crayfish	Low	Moderate	High
Damselfly	Low	Moderate	High
Dobsonfly	Low	Moderate	High
Dragonfly	Low	Moderate	High
Fishfly	Low	Moderate	High
Freshwater Scud	Low	Moderate	High
Horsefly	Low	Moderate	High
Leech	Low	Moderate	High
Left Handed Snail	Low	Moderate	High
Mayfly	Low	Moderate	High
Midge	Low	Moderate	High
Mosquito	Low	Moderate	High
Predacious Diving Beetle	Low	Moderate	High
Riffle Beetle	Low	Moderate	High
Sowbug	Low	Moderate	High
Stonefly	Low	Moderate	High
Water Boatman	Low	Moderate	High
Water Penny	Low	Moderate	High
Water Scorpion	Low	Moderate	High
Waterstrider	Low	Moderate	High
Whirligig Beetle	Low	Moderate	High

Water Quality



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ACROSS

1 The land area over which water drains into a particular stream, river or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge.

4 The giving off of water by plants.

11 (1) The physical process by which a liquid (or a solid) is transformed to the gaseous state. (2) Process in which water from land areas, bodies of water, and all other moist surfaces is absorbed into the atmosphere as a vapor.

12 Is a scale for showing the quality of an environment by indicating the types of organisms present in it.

13 The cyclic transfer of water vapor from Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to Earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.

DOWN

1 The uppermost level of water in the saturated part of an aquifer.

2 Water from precipitation that is not absorbed but flows over the land, carrying sediment and other materials to streams, lakes and other bodies of water.

3 Water from the atmosphere that falls to the ground as rain, snow or sleet, or hail.

5 Water soaking into the ground.

6 The process by which a gas or vapor changes to a liquid or solid.

7 Water that is on Earth's surface, such as in a stream, river, lake or reservoir.

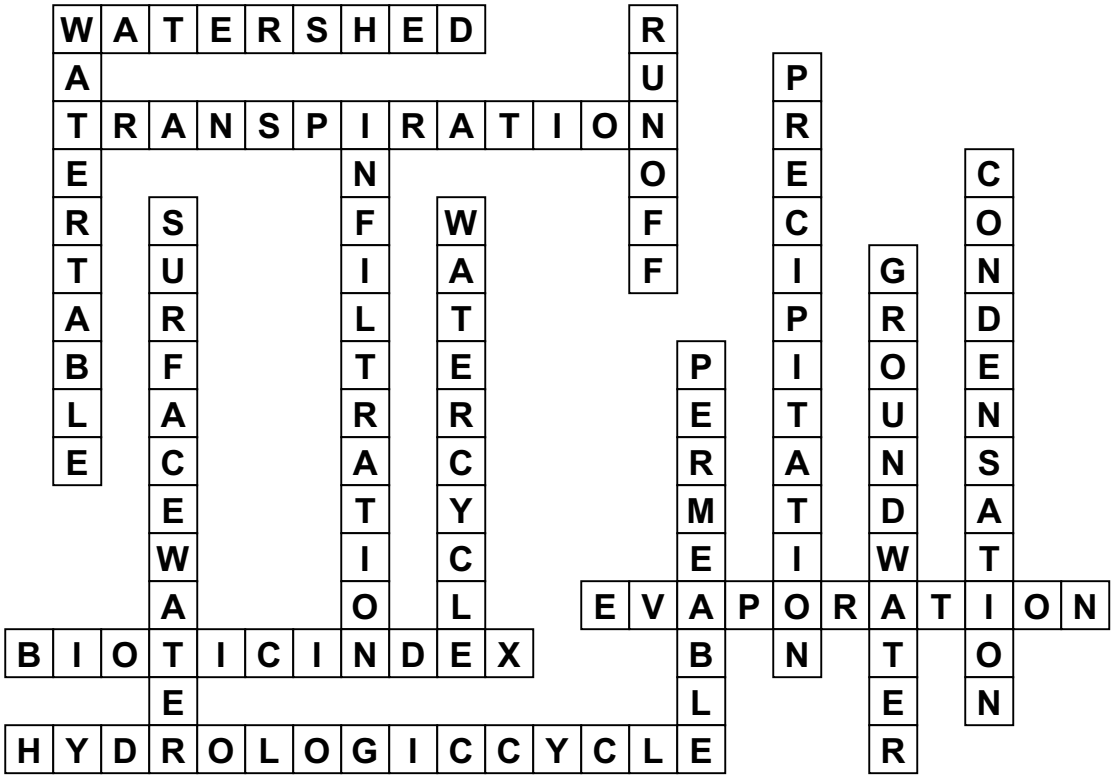
8 The path water takes through its various states-gas, liquid, and solid-as it moves through-out Earth's systems (oceans, atmosphere, ground water, streams, etc.); also known as the hydrologic cycle.

9 (1) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up Earth's crust.

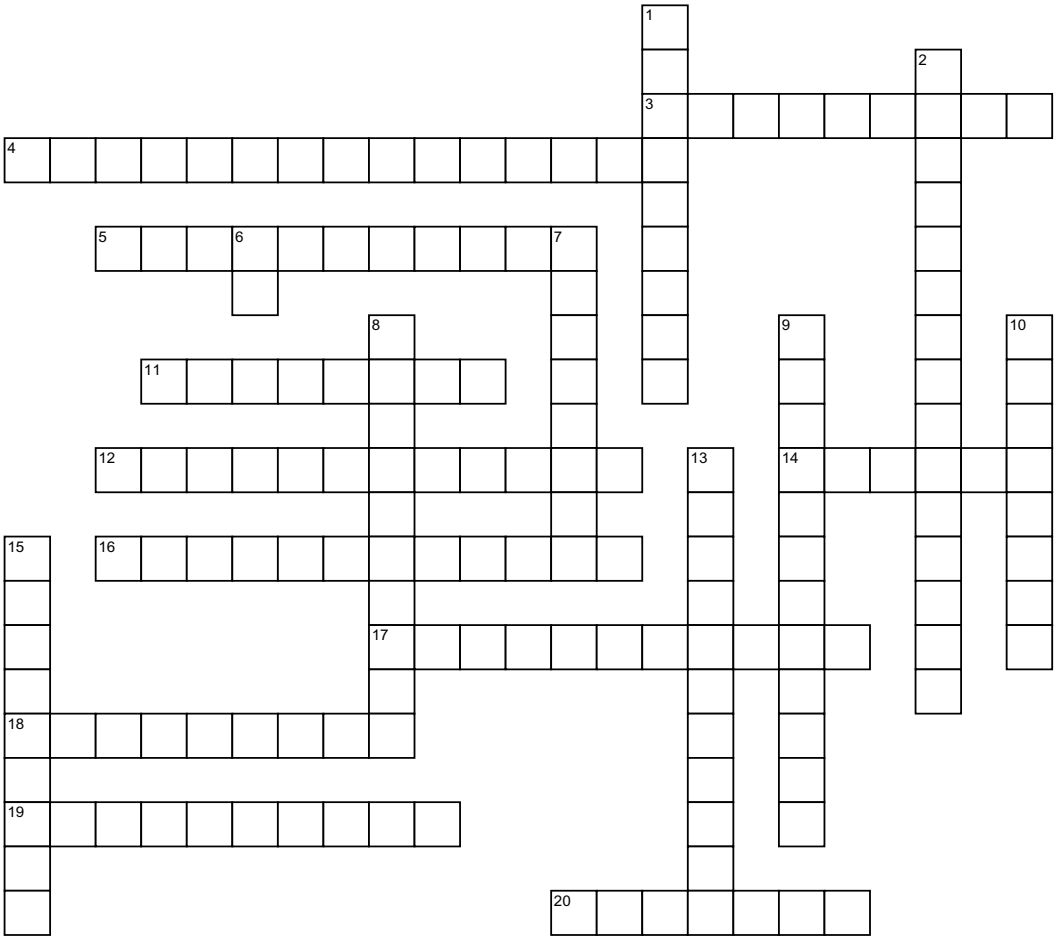
10 A substance which passes water easily.

Water Quality

Solution:



More Water Quality Definitions



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ACROSS

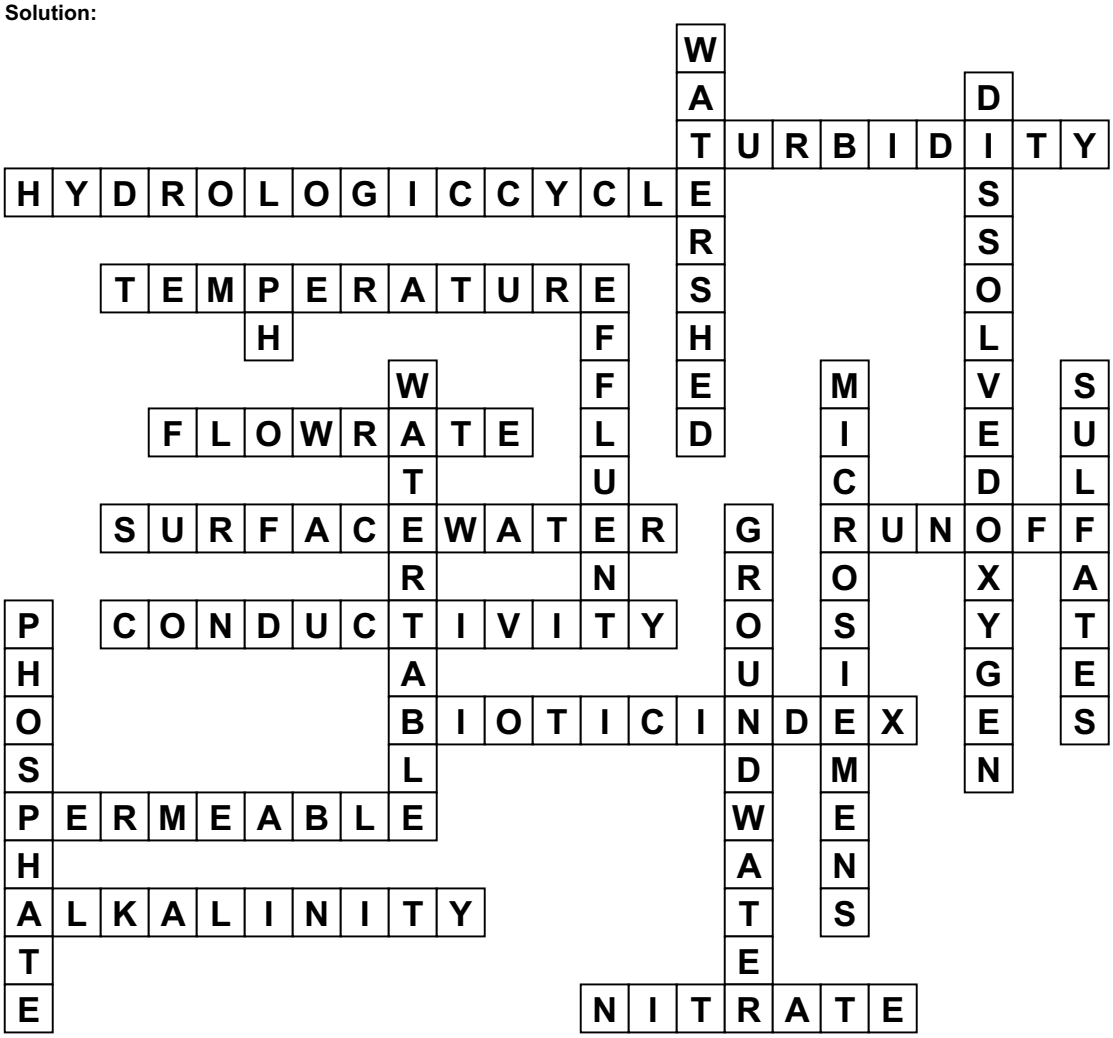
3 The cloudy appearance of water caused by the presence of suspended and colloidal matter.
4 The cyclic transfer of water vapor from Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to Earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.
5 The degree of hotness or coldness of a body or environment.
11 The speed or rate at which water is taken from a watercourse or the speed at which it flows past a point, usually measured in gallons per hour or cubic feet per second (cfs).
12 Water that is on Earth's surface, such as in a stream, river, lake or reservoir.
14 Water from precipitation that is not absorbed but flows over the land, carrying sediment and other materials to streams, lakes and other bodies of water.
16 The ability or power to conduct or transmit heat, electricity, or sound.
17 Is a scale for showing the quality of an environment by indicating the types of organisms present in it.
18 A substance which passes water easily.
19 Is a measure of the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate.
20 A salt of nitric acid; a common water pollutant.

DOWN

1 The land area over which water drains into a particular stream, river or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge.
2 The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation.
6 A measure of the acidity or alkalinity of a solution; generally referred to as the concentration of hydrogen ions dissolved in water; mathematically defined as the negative of the logarithm of the hydrogen ion concentration.
7 Flowing out or flowing away.
8 The uppermost level of water in the saturated part of an aquifer.
9 Is a measure of electric conductance.
10 A chemical compound containing the bivalent group SO4.
13 Water that flows or seeps downward and saturates soil or rock, supplying springs and wells.
15 Salt of phosphoric acid, often found in fertilizers.

More Water Quality Definitions

Solution:



Water Quality Vocabulary

Alkalinity: Is a measure of the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate.

Benthic: Of, pertaining to, or living on the bottom or at the greatest depths of a body of water. Also known as benthonic.

Biotic index: Is a scale for showing the quality of an environment by indicating the types of organisms present in it.

Condensation: The process by which a gas or vapor changes to a liquid or solid; also the liquid or solid so formed.

Conductivity: (1) The ability or power to conduct or transmit heat, electricity, or sound. (2) The conductance of a material.

Dissolved Oxygen (DO): The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odors. DO levels are considered the most important and commonly employed measurements of water quality and indicators of a water body's ability to support desirable aquatic life.

Effluent: (1) Flowing out or flowing away. (2) Something that flows out or forth, especially a stream flowing out of a body of water. (3) A stream that flows out of a larger stream, a lake, or another body of water. (4) A waste liquid discharge from a manufacturing or treatment process, in its natural state or partially or completely treated, that discharges into the environment. (5) The outflows from sewage or industrial plants etc.

Evaporation: (1) The physical process by which a liquid (or a solid) is transformed to the gaseous state. (2) Process in which water from land areas, bodies of water, and all other moist surfaces is absorbed into the atmosphere as a vapor.

Flow rate: (1) The speed or rate at which water is taken from a watercourse or the speed at which it flows past a point, usually measured in gallons per hour or cubic feet per second (cfs). (2) The rate, expressed in gallons or liters-per-hour, at which a fluid escapes from a hole or fissure in a tank. Such measurements are also made of liquid waste, effluent, and surface water movement.

Groundwater: (1) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.

Hydrologic cycle: The cyclic transfer of water vapor from Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to Earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.

Infiltration: Water soaking into the ground.

Microsiemens: Is a measure of electric conductance.

Nitrate: A salt of nitric acid; a common water pollutant.

Water Quality Vocabulary

Permeable: A substance which passes water easily.

pH: A measure of the acidity or alkalinity of a solution; generally referred to as the concentration of hydrogen ions dissolved in water; mathematically defined as the negative of the logarithm of the hydrogen ion concentration.

Phosphate: Salt of phosphoric acid, often found in fertilizers.

Precipitation: Water from the atmosphere that falls to the ground as rain, snow or sleet, or hail.

Runoff: Water from precipitation that is not absorbed but flows over the land, carrying sediment and other materials to streams, lakes and other bodies of water.

Sulfates: A chemical compound containing the bivalent group SO4.

Surface water: Water that is on Earth's surface, such as in a stream, river, lake or reservoir.

Taxon: Plural is taxa. In biology it is a term used to denote any group or rank in the classification of organisms. For example, class, order, family.

Temperature: The degree of hotness or coldness of a body or environment (corresponding to its molecular activity).

Transpiration: The giving off of water by plants.

Turbidity: The cloudy appearance of water caused by the presence of suspended and colloidal matter. Technically, turbidity is an optical property of the water based on the amount of light reflected by suspended particles.

Water Cycle: The path water takes through its various states-vapor, liquid, and solid-as it moves through-out Earth's systems (oceans, atmosphere, ground water, streams, etc.); also known as the hydrologic cycle.

Watershed: The land area over which water drains into a particular stream, river or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge.

Water table: The uppermost level of water in the saturated part of an aquifer.