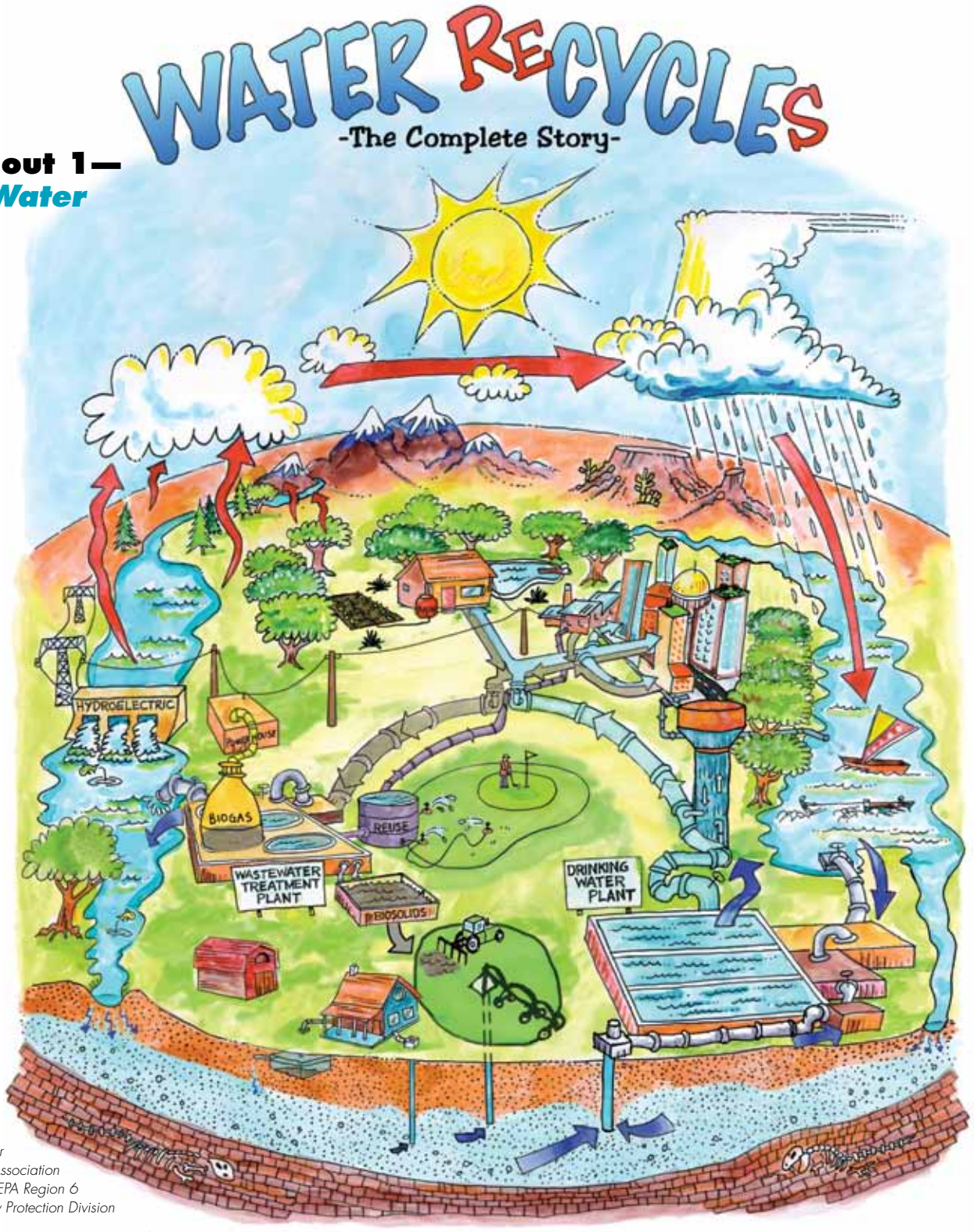
Student Handouts

Handout 1— *The Water Cycle*



Source: Water Environment Association of Texas and EPA Region 6 Water Quality Protection Division

Water ReCycleS: The Complete Story

Water

Water (which has a chemical formula of Dihydrogen Monoxide or H2O) covers 71 percent of Earth's surface. Almost all of that is saltwater in our oceans. Freshwater accounts for only 3 percent of total water and more than two-thirds of it is frozen in glaciers. Liquid freshwater (groundwater, lakes, streams, rivers), which is what people use to drink, farm, clean, and use for most tasks, makes up less than 1 percent of all the water on Earth! Most of the water we need to live is groundwater (about 99 percent) so understanding the water cycle and learning that water is a limited resource is important for teachers, students, and all Texans.

ReCycle

The word "recycle" calls to mind images of paper grocery bags filled with newspapers or a collection of crushed aluminum cans, plastic containers, and glass bottles. Most of us do not connect water with recycling. Yet, the water (or hydrologic) cycle is a good example of recycling. Water recycling means reusing treated wastewater for helpful purposes such as lawn and crop watering, industrial processes, toilet flushing, and replenishing a ground water basin (referred to as ground water recharge).

The Water Cycle

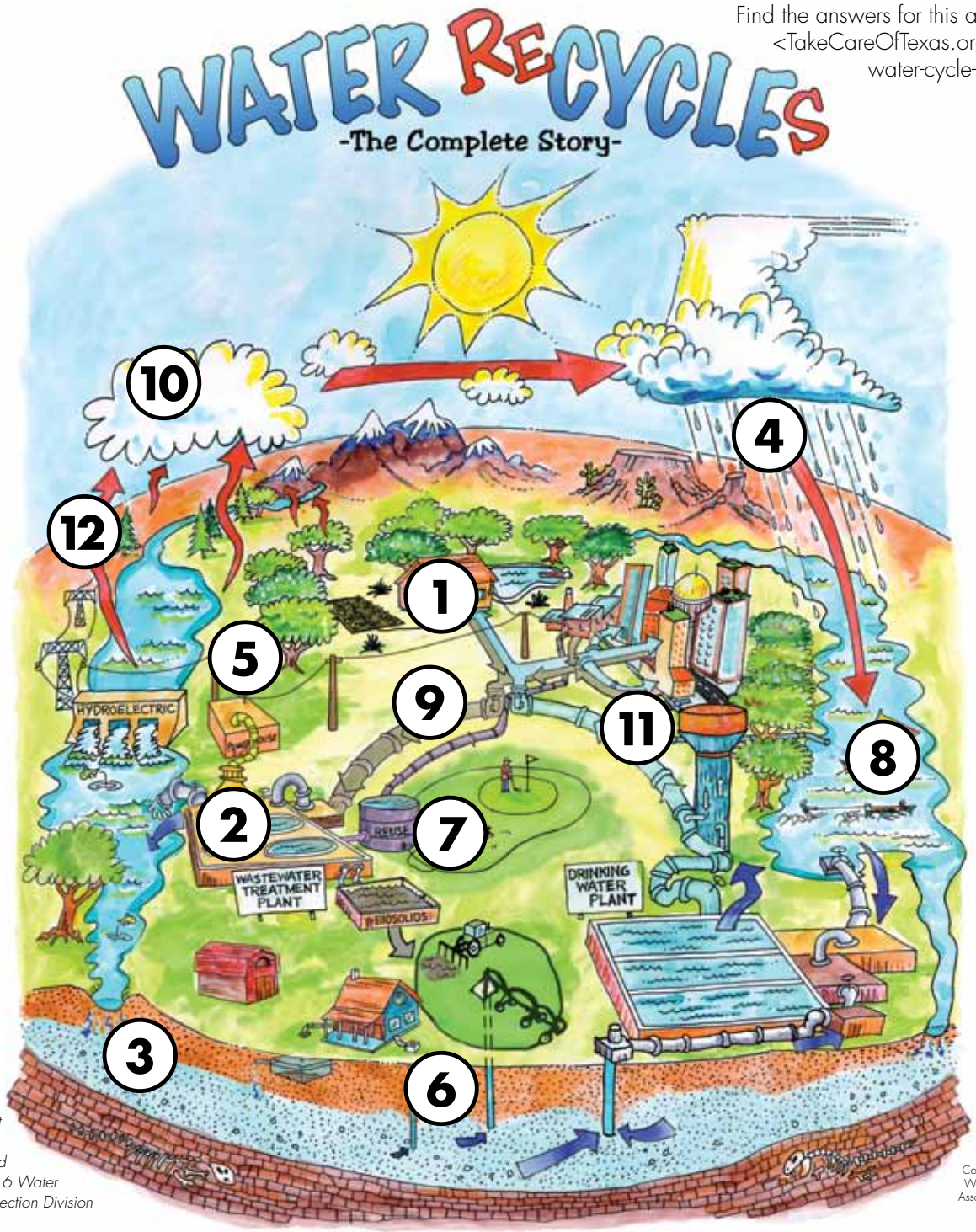
In its basic form, the cycle is simple. The sun's energy converts liquid to vapor (evaporation). The water vapor, being lighter than air, rises in the atmosphere until the cooler temperatures turn it into tiny droplets of water (condensation). These droplets come together to form clouds. In the clouds, the droplets combine to form larger drops. When these drops reach a larger size, gravity pulls them back to Earth's surface (precipitation). Though the water cycle can be much more complex, knowing the basics will help you understand where water comes from and where it goes.

Humans and The Water Cycle

This poster, Water ReCycles, is for "learners" of all ages, both in and out of a formal classroom. Most of us learn about water and the water cycle in grade school. However, even as adults, we often have trouble recognizing and understanding the ways humans affect the natural water cycle. By including the pumps, pipes, and treatment plants (infrastructure) in this poster, you can see these "two water cycles"—natural and human-affected—and how they relate to one another. Look at the poster for examples of water recycling that Texans can do at home, such as using a rain barrel to harvest rainwater.

The poster on the previous page also includes elements that show some of the complex water-related issues we face today, such as stormwater pollution and hydroelectric power generation, among others. We hope this poster encourages you to study and discuss these issues.

Find the answers for this activity at <TakeCareOfTexas.org/kids/water-cycle-poster>.



Source: Water Environment Association of Texas and EPA Region 6 Water Quality Protection Division

Fill in the blanks from these words:

sludge **precipitation** **power plant** **ground water** **reuse** **surface water** **sewage** **rain barrel** **condensation** **drinking water** **evaporation** **infiltration**

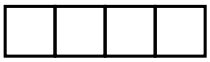
1 _____	4 _____	7 _____	10 _____
2 _____	5 _____	8 _____	11 _____
3 _____	6 _____	9 _____	12 _____

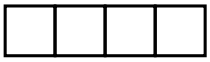
Bonus: **What do the dinosaur bones represent?**

How and Why Do We Recycle Water?

Unscramble the words to identify words related to water use and the environment.

Find the answers for this activity at <TakeCareOfTexas.org/kids/water-cycle-poster>.

nira 

wson 

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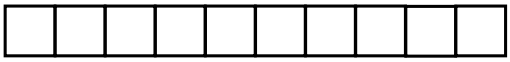
avsihretng 

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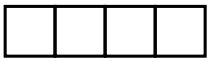
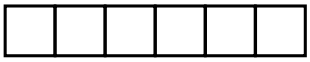
isol 

salptn 

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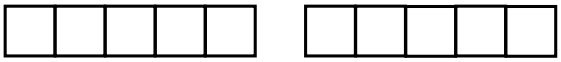
ropwe nlatp 

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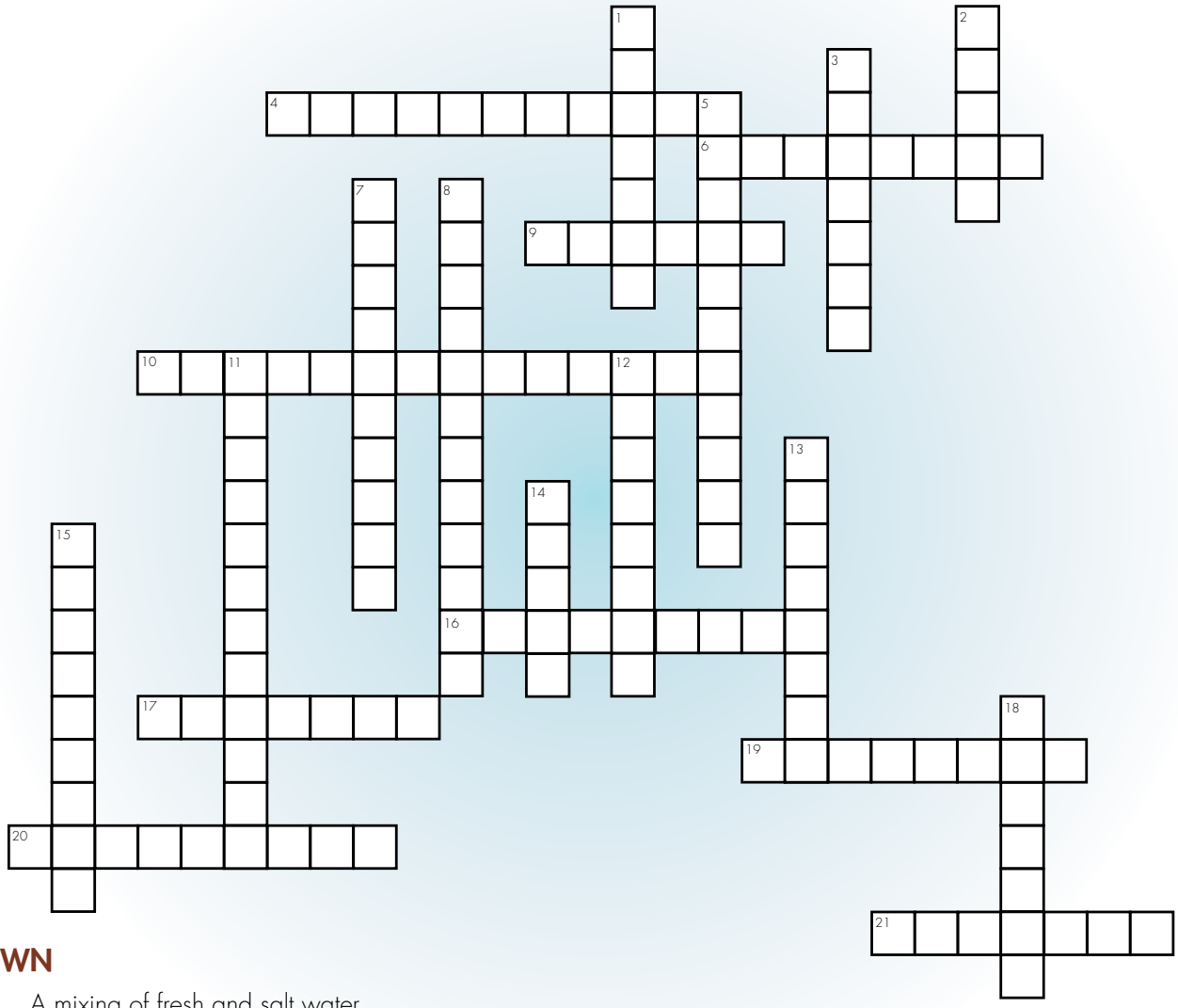
Use the numbered letters from above to find the answer!
What letter is missing?

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Water, Land Use, and Wastewater Treatment

Find the answers for this activity at <TakeCareOfTexas.org/kids/water-cycle-poster>.



DOWN

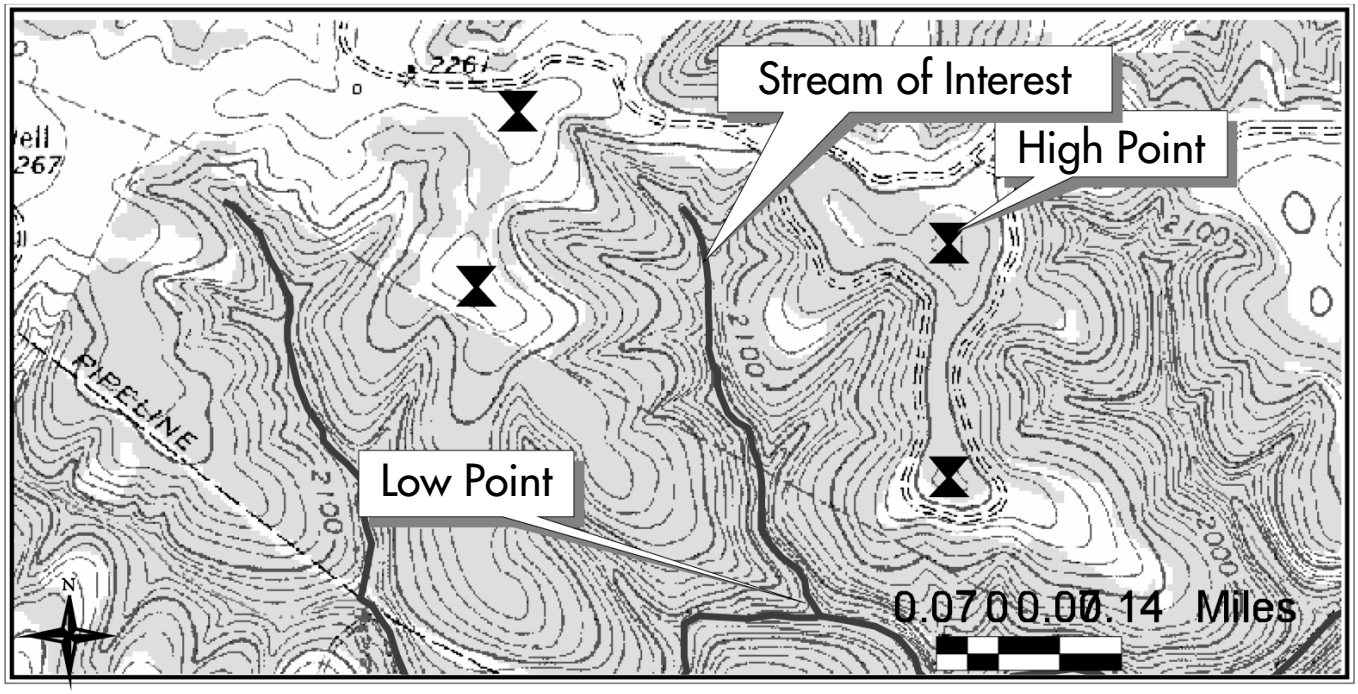
1 A mixing of fresh and salt water
2 Used in disinfection of water
3 Aids coagulation
5 Lawn fertilizer, oil drained from cars, septic tank overflows
7 What a rain barrel is used for
8 Erosion from logging, road construction
11 Fertilizers or manure draining into a stream
12 Numerous types of chemicals and products
13 Widely used disinfectant
14 Landscape irrigation with effluent
15 A lake containing a high concentration of dissolved nutrients
18 Water that is safe to drink

ACROSS

4 Water that remains below the land surface
6 Treated wastewater
9 Muddy water
10 Straightening and deepening of stream or river channels
16 Any natural or artificial holding area
17 Stratum of the earth composed of water layered between rock
19 The mixing or agitation of wastewater
20 Nutrient-rich, stabilized by-product used as fertilizer
21 An area that is regularly saturated by surface water

Handout 2—*Area Watershed Survey*

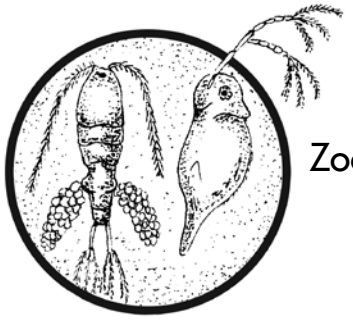
Environmental investigators surveyed the stream in this topographic map and discovered water pollution. Help the investigators find the pollution source by drawing the stream's watershed boundaries.



Handout 3—*The Aquatic Food Web*

A food chain links an organism to one source of food whereas a food web links organisms to many of its food sources. Draw arrows between the sun, plants, and animals to show the flow of food or energy and the different paths it can take through the food web.

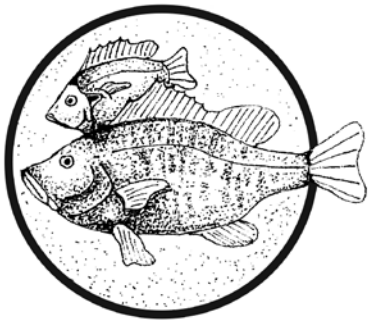
Aquatic Insects



Zooplankton

Phytoplankton

Scavengers



Fish

Decomposers

Aquatic Plants

Nitrogen
Phosphorus

Nutrients

Sunlight

Use the word bank to complete the following paragraphs.

WORD BANK				
Decomposers	Sun	Primary consumers	Nutrients	Food web
Photosynthesis	Food	Secondary consumers	Primary Producers	Water
Tertiary consumers	Omnivores	Carbon dioxide	Detritivores	Respiration

Aquatic food webs for surface water ecosystems begin with the _____, the source of light. Certain wavelengths of light are absorbed by _____ (also called autotrophs). Through a process called _____, primary producers use this light to convert _____ and _____ into carbohydrates and oxygen. The primary producers will use a portion of the carbohydrates and oxygen during _____—the process in which carbohydrates and oxygen are converted into carbon dioxide, water, and energy. Primary producers can grow and reproduce if energy and certain nutrients are available.

Animals must also respire so they can create energy to move, grow, etc. Since animals cannot produce their own _____ like the primary producers, they must consume (eat) their food. Animals that eat primary producers are called _____ (herbivores, or plant eaters). Animals that eat primary consumers are called _____ (carnivores, or meat eaters). The secondary consumer group may contain more than one level of carnivore; therefore, a food web may have _____—animals that eat secondary consumers. In addition, a food web may also contain _____—animals that eat plants and meat.

Animals that eat dead organic materials are called _____ (scavengers). They are an important part of the food web because they help in decomposition by shredding and eating dead organic materials. _____ (bacteria and fungi) are the final link in the _____; they break down dead material and release _____ that can be used by primary producers.

Handout 4— *Water Pollution*

As an environmental investigator, you receive a phone call about possible pollution in a stream. Using your *Student Reference Tables*, enter the possible pollutant(s) and its source for each of the water pollution scenarios below. The pollutants can be nutrients, oxygen-demanding substances, suspended solids, sedimentation, or toxic substances.

	Scenario	Possible Pollutant(s)	Possible Pollutant Source(s)
1	A rainbow film is on the surface and a nearby ditch carries stormwater from the highway into the stream.		
2	There is a musty odor; animal feedlots and construction sites are nearby.		
3	A storm caused trees to fall into the stream over a month ago; the water now resembles coffee.		
4	There is a faint odor of bleach; aquatic plants near an outfall are very light colored.		
5	Water is bright green; next to the stream are very lush residential yards and a construction site.		
6	A stream near a construction site is very turbid and light brown. Also nearby is a residential area.		
7	There is a smell of rotten eggs; a road and an old residential area (that uses septic systems) are next to the stream.		
8	An unusual smell is coming from the stream, very sharp and pungent. Nearby are a city and outfalls for both an industrial source and a wastewater-treatment plant.		
9	The stream contains fungus that feels slimy and resembles the texture of cotton. It is found near an outfall.		
10	The bottom of a stream became very muddy and the water is turning green. Nearby are forests and also croplands.		

Handout 5—*Survey: On-Site Sketch (page 1)*

Date:	Time:	Air Temperature:
Team Member Names:		
Stream Name:		
Stream Location:		
Weather Conditions: ❑ Clear ❑ Cloudy ❑ Raining ❑ Other: _____		

Stream Characteristics

Appearance:	Bed Coating:	Odor:
❑ Scum (color: _____)	❑ Orange to red	❑ Rotten eggs
❑ Foam (color: _____)	❑ Yellowish	❑ Musky
❑ Muddy (color: _____)	❑ Black	❑ Pungent
❑ Milky (color: _____)	❑ Dark brown	❑ Chlorine
❑ Clear	❑ Brownish tan	❑ Other: _____
❑ Oily sheen	❑ No coating	❑ None
❑ Other: _____		

Habitats:

❑ Pool	❑ Undercut banks	❑ Log piles
❑ Riffle	❑ Rock ledges	❑ Plant beds
❑ Wetlands	❑ Tree roots	❑ Large boulders
❑ Backwaters	❑ Logs or stumps	❑ Artificial objects

❑ Other: _____

Substrate composition is mostly:

❑ Clay/silt ❑ Sand ❑ Gravel ❑ Cobble ❑ Bed rock ❑ Other: _____

Cover:

❑ Fully exposed (0% to 25% of the stream is shaded from the sun)
❑ Partially exposed (25% to 50%)
❑ Partially shaded (50% to 75%)
❑ Fully shaded (75% to 100%)

Bank Vegetation:

Trees: _____%	Plants: _____%	Exposed: _____%
Shrubs: _____%	Root mats: _____%	

Structures or Barriers:

❑ Upstream dam	❑ Downstream dam	❑ Bridge(s)
❑ Island(s)	❑ Waterfall(s)	❑ Other: _____

Litter (estimated amount by size):

Paper, items smaller than a can:	❑ 0–5	❑ 5–10	❑ 10–50	❑ +50
Can-,bottle-sized items:	❑ 0–5	❑ 5–10	❑ 10–50	❑ +50
Items bigger than a can (tires, carts, etc.):	❑ 0–5	❑ 5–10	❑ 10–50	❑ +50

Handout 5—*Survey: On-Site Sketch (page 2)*

Biological Characteristics

Algae location: ❑ Everywhere ❑ In spots

The algae are: ❑ Attached ❑ Floating ❑ Other: _____

Animals:

❑ Fish ❑ Amphibians ❑ Reptiles

❑ Shore birds ❑ Waterfowl ❑ Mammals

❑ Mollusks (clams, etc.) ❑ Insects ❑ Crustaceans (crayfish, etc.)

Types of animals present: _____

_____

_____

Water Sources

Watershed (runoff from):

❑ Pasture, grazing lands ❑ Croplands ❑ Woodlands

❑ Homes, residential areas ❑ Factories ❑ Stores

❑ Surface mining ❑ Underground mining ❑ Logging

❑ Roads

❑ Construction activities (explain): _____

❑ Other: _____

❑ Channelized areas (explain): _____

Channelized substrate composition: ❑ Concrete ❑ Cobble ❑ Vegetation

❑ Mud ❑ Other: _____

Channelized bank composition: ❑ Concrete ❑ Cobble ❑ Vegetation

❑ Exposed soil ❑ Other: _____

Point sources (outfalls or discharge pipes from):

❑ Wastewater-treatment plant ❑ Industry (explain): _____

❑ Residential (explain): _____

❑ Unknown ❑ Farm lots ❑ Other: _____

Water Uses

Intake pipe takes water to:

❑ Water-treatment plant (drinking water)

❑ Industry (explain): _____

❑ Irrigation system ❑ Livestock ❑ Unknown

❑ Other: _____

Recreational Activities:

❑ Swimming ❑ Fishing ❑ Other: _____

Handout 5—*Survey: On-Site Sketch (page 3)*

Sketch the stream and surrounding area. Show in your sketch the different habitats in the stream (pool, riffles, etc.), structures that disrupt the flow of water (such as dams and bridges), human-built structures (buildings, roadways, etc.), any point sources (such as a discharge pipe), and the north arrow. Make sure to describe the characteristics of the stream bank, riparian zone, and adjacent land uses.

Handout 6—*Survey: Invasive Species—Aquatic Plants*

Check the survey area for the following invasive species. For more information about Texas invasive species, visit <texasinvasives.org>.

Submerged

❑ Hydrilla

- Dark-green plant with long branching stems.
- Leaves have toothed margins and midrib spines.
- Flowers are inconspicuous and white on long stalks.

❑ Parrotfeather milfoil

- Reddish-brown stems and olive-green leaves divided into feather-like segments.
- Often extends above the water surface approximately 10 centimeters.

Emergent

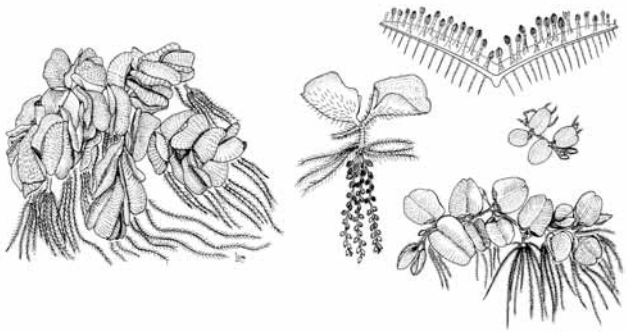
❑ Alligator weed

- Perennial plant with leaves approximately 10 cm long.
- Each leaf is long, narrow, and elliptical.
- White, clover-like flowers appear near the tip of the plant.

Floating

❑ Giant salvinia

- Green aquatic fern with a chain-like appearance that can form dense floating mats.
- Each leaf (frond) is approximately 13 millimeters wide and 25 mm long.
- The upper surface of the leaf contains coarse, white hairs.
- Underwater are brown, thread-like leaves that resemble roots.



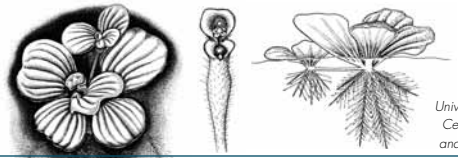
Source: University of Florida Center for Aquatic and Invasive Plants

❑ Water hyacinth

- Free-floating plant with spongy stems and light-blue (or even violet) flowers.
- Beneath the plant are numerous dark, fibrous roots.
- The plant is dark green and ranges from 10 cm to almost 1 meter high.

❑ Water lettuce

- Plant with floating leaves that are thick, hairy, ridged, and light green.
- Resembles an open head of lettuce.



Source: University of Florida Center for Aquatic and Invasive Plants

Handout 7— *Survey: Physical Properties*

Date:	Time:	Air Temperature:
Team-Member Names:		
Stream Name:		
Stream Location:		
Weather Conditions: ❑ Clear ❑ Cloudy ❑ Raining ❑ Other: _____		

Temperature

Water Temperature: _____°F

Convert to Celsius using the following equation: (_____°F – 32) x 5/9 = _____°C

Factors affecting water temperature: _____

_____

pH

pH: _____

The water is: ❑ Acidic ❑ Neutral ❑ Basic (Alkaline)

Factors affecting pH: _____

_____

Dissolved Oxygen

Dissolved Oxygen: _____ ppm (mg/L)

Factors affecting dissolved oxygen: _____

_____

Flow

Width (W): _____ meters (m)

Average depth (D): _____ m

Time the cork traveled two meters: _____ seconds (s)

Calculate velocity (V) by entering the time above into following equation:

$$\frac{2 \text{ meters}}{\text{\_\_\_\_\_ seconds}} = \text{\_\_\_\_\_ } m/s$$

Calculate flow using the following equation:

$W \times D \times V =$ _____m × _____m × _____ m/s = _____ m^3/s

Handout 8— *Survey: Chemical Properties*

Date:	Time:	Air Temperature:
Team-Member Names:		
Stream Name:		
Stream Location:		
Weather Conditions: ❑ Clear ❑ Cloudy ❑ Raining ❑ Other: _____		

E. coli

E. coli concentration: _____

Factors affecting the *E. coli* concentration: _____

_____

Nutrients

Phosphorus concentration: _____

Nitrogen concentration:_____

Factors affecting phosphorus and nitrogen concentrations:_____

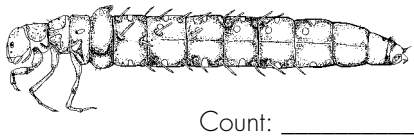
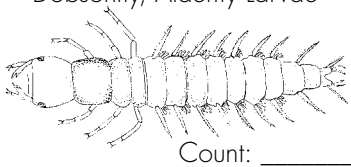
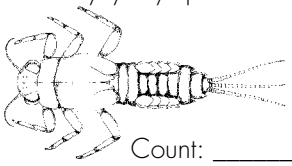
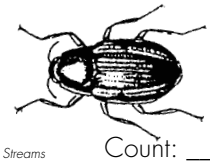
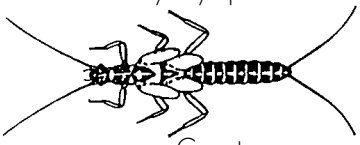
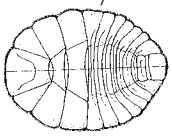
_____

_____

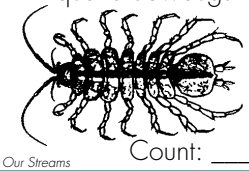
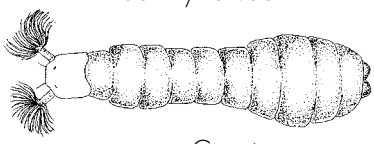
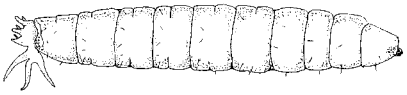
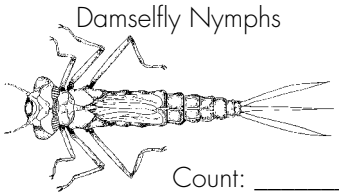
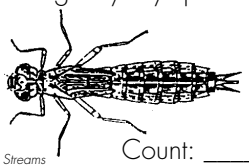
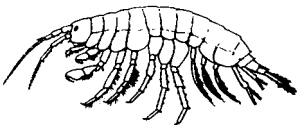
Handout 9— *Survey: Biological Properties*

Date:	Time:	Air Temperature:
Team=Member Names:		
Stream Name:		
Stream Location:		
Weather Conditions: ❑ Clear ❑ Cloudy ❑ Raining ❑ Other: _____		

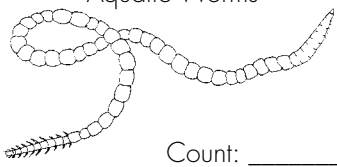
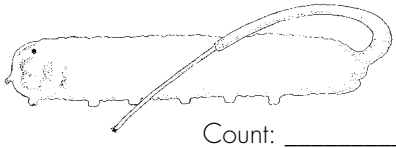
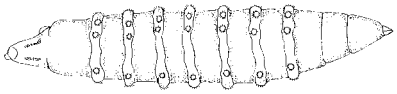
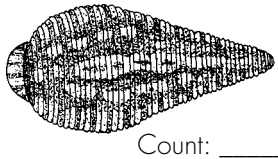
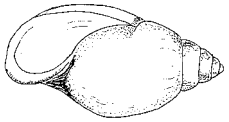
Intolerant Species (sensitive to poor stream conditions)

Caddisfly Larvae  Count: _____	Dobsonfly, Alderfly Larvae  Count: _____	Mayfly Nymphs  Count: _____
Riffle Beetles  *Source: Save Our Streams* Count: _____	Stonefly Nymphs  *Source: Save Our Streams* Count: _____	Water-Penny Larvae  Count: _____

Intermediate Species (moderately tolerant to degraded habitat and water quality)

Aquatic Sowbugs  *Source: Save Our Streams* Count: _____	Black-Fly Larvae  Count: _____	Crane-Fly Larvae  Count: _____
Damselfly Nymphs  Count: _____	Dragonfly Nymphs  *Source: Save Our Streams* Count: _____	Scuds  *Source: Save Our Streams* Count: _____

Tolerant Species (most tolerant to degraded habitat and water quality)

Aquatic Worms  Count: _____	Drone-Fly Larvae (Rat-Tail Maggots)  Count: _____	Horsefly Larvae  Count: _____
Leeches  Count: _____	Midge-Fly Larvae  Count: _____	Pouch Snails  Count: _____

Total Species Count

Intolerant: _____	Intermediate: _____	Tolerant: _____

Student Reference Tables

The following tables can help you determine if there is possible pollution in your stream by only using your senses. Use *Table 1—Physical Indicators of Water Pollution* to help determine the possible pollutant and then use *Table 2—General Land Uses That Might Affect Water Quality* to help determine the possible pollution source.

Table 1—Physical Indicators of Water Pollution

If you see the color(s) ...	The issue could be ...
Muddy tan to light brown	Suspended solids (silt and clay) due to: • upstream erosion of the banks and substrate due to channelization, • stormwater from logging or construction sites with inadequate erosion and sediment controls, or • Stormwater from one or more areas with soil erosion, such as poorly maintained croplands and rangelands, riparian zones with removed vegetation, exposed banks, etc.
Pea green, bright green, yellow, brown, brown-green, brown-yellow, blue-green	An algal bloom due to high nutrient content (phosphorus, nitrogen, or both). Water color is dependent on the dominant plankton type.
Tea or coffee	Dissolved decaying matter originating from the organic portion of the soil. This is usually seen in woodland or swampy areas.
Milky white	Paint (from a construction site) or milk (from a food processing site).
Dark red, purple, blue or black	Fabric dyes or inks from paper or cardboard manufacturers.
Milky gray or black	Oxygen depletion from raw sewage or other oxygen-demanding substance; a rotten-egg or hydrogen sulfide odor might be present.
Clear black	Turnover of oxygen-depleted bottom waters or sulfuric acid spill.
Orange-red	Deposits on stream beds often associated with oil-production areas, but not always (check for petroleum odor). The color could be due to iron in the water.
White, crusty deposits	Common in dry or arid areas where the evaporation of water leaves behind salt deposits. These deposits are also associated with brine water discharge (from oil production areas); check to see if the stream has a petroleum odor or an oily sheen along the banks.
If you smell ...	**The odor is from ...**
Rotten eggs or hydrogen sulfide	Raw sewage (oxygen-demanding substance) or oxygen-poor sediment.
Chlorine	Treated effluent, swimming pool overflow, or industrial discharges.
Sharp, pungent odor	Chemicals or pesticides.
Musty odor	Presence of raw or partially treated sewage or livestock waste (organic-demanding substances). Musty odor could also be caused by algae.
If you see on the surface ...	**Possibly caused by ...**
Tan foam	Water containing organic materials with high flow or wave action. This harmless foam can be in small patches to very large clumps.
White foam (thin or billowy)	Soap in treated effluent, possibly around a wastewater outfall.
Yellow, brown, black film	Pine, cedar, and oak pollens that form a film on the surface of ponds, backwater areas, or slow-moving water of streams.
Rainbow film	Oil or other fuel type. Sheens are common after rains when oil and gas residue wash off streets. Other sources include spills, pipelines, and oil and gas-production areas.

Table 2 — General Land Uses That Might Affect Water Quality

Land Use Type	Potential Effects
Woodland	Erosion from logging, road construction, or clear cutting may cause muddy waters.
Agricultural Land (croplands, pastures, feedlots, etc.)	Fertilizers or manure draining into a stream may increase the nutrient content and cause excessive algal and aquatic plant growth. Sedimentation may occur from soil erosion. Streams may also receive pesticides and herbicides in the runoff.
Cities and Towns	Depending on the activities occurring in the city or town, urban runoff might carry a variety of contaminants such as oil, pesticides, metals, and chemicals.
Industry	Industries have numerous types of chemicals and products that could cause color changes to the water, excessive algal growth, odors, absence of aquatic life, fish kills, elevated organic matter levels, and sewage fungus.
Wastewater-Treatment Plants	Effects may include excessive algal growth, white foam, sludge deposits (fluffy dark brown or gray solids), absence of fish and insects (or the abundance of tolerant forms), variable dissolved-oxygen levels, chlorine odor (and possible bleached vegetation near the outfall), sewage fungus, and elevated levels of *E. coli*.
Construction	Runoff from construction sites can cause water to become muddy and turbid.
Residential	Runoff from residential areas may contain fertilizers (nutrients), oil drained from cars (toxic substances), raw sewage from septic systems that overflow or leak (oxygen-demanding substances), detergents used to wash cars (toxic substances), and even litter (cans, bottles, paper, etc.).