Unit VI. Utah Water Information

This unit provides the educator a foundation of watershed principles. Natural and human influences on water quality are highlighted.

Sections

1. The Water Cycle

2. Watersheds

3. Water Pollution

4. Water Laws

Each section contains:
- background information
- illustrations that can be copied for overheads and handouts
- resources for further investigation
- lesson plans

VI-1. The Water Cycle

Key terms

aquifer	groundwater	surface runoff
capillary action	percolation	transpiration
condensation	pore spaces	watershed
discharge	precipitation	water table
evaporation	sublimation	

What is the water cycle?

Did you know that the water we see all around us never gets destroyed and new water never gets created? Instead, it constantly recycles and moves around in a process called the water cycle. Water in every form, or *state* – gas, liquid or solid – is a part of the water cycle. The sun's energy powers this cycle, causing water to **evaporate** and rise into the atmosphere in the form of water vapor. When the vapor **condenses** in the form of rain and snow, gravity pulls it back to earth. Once on earth, gravity continues to force water downhill as **surface runoff** or **ground water** until the sun's energy can evaporate it and raise it back up. These are only a few of the paths through the water cycle. Explore others in Figure VI-1 below. Descriptions of the three water cycle zones and the processes that occur in each follow.

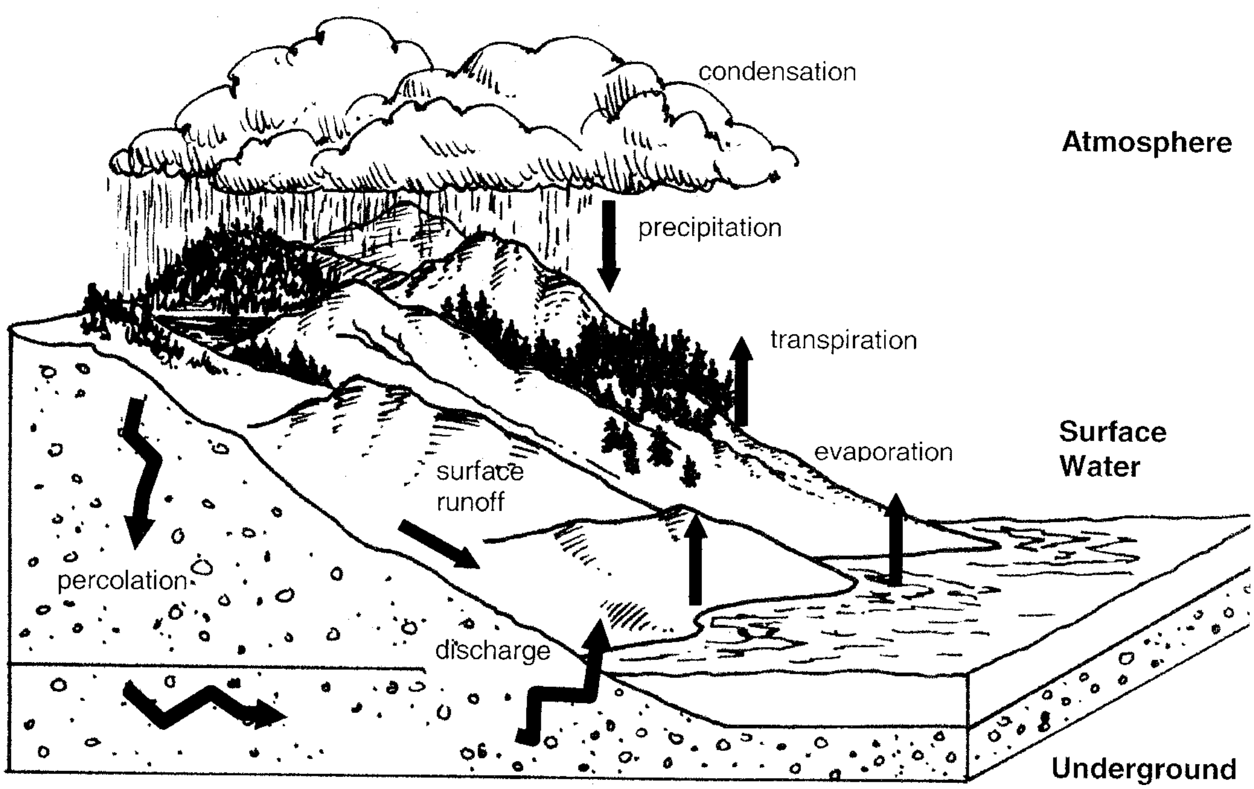


Figure VI-1. The water cycle – note how water moves between the atmosphere surface, water and groundwater.

The water cycle zones

The water cycle occurs every place that water is found. We can divide these places into three *water cycle zones.*

Atmosphere – This includes all the water contained in the thin envelope of gas that surrounds the earth (**precipitation**, condensed water in clouds and water vapor).

Surface Water – This includes all the water contained in water bodies (oceans, streams, rivers, lakes, and wetlands), organisms (plants, animals, you and me), surface layers of soil, and ice (glaciers and polar ice caps).

Underground – Everything below the surface layer of soil. The water found here, groundwater, can be found in the **pore spaces** in soil or in small cracks in rock (contrary to a common belief that groundwater sits in large, underground caves). The top of the groundwater is called the **water table**. The water table is the shallowest point where you can find a steady supply of water. Above the water table, the pore spaces are not completely filled with water. If the area of wet soil and rock is large we call it an **aquifer**.

Table VI-1 A drop in the bucket
This table shows where water is located within the water cycle and how long it spends in each area. Notice the relatively tiny amount of drinkable water on Earth.

Water Source	% of Total
Oceans	97.2
Icecaps/glaciers	2.0
Groundwater	.62
Freshwater lakes	.009
Inland seas	.008
Atmosphere	.001
All rivers	.0001

Paths through the water cycle

Evaporation: When water is heated by the sun, its surface molecules energize. This energy breaks the attractive force that binds the molecules together and allows them to rise as invisible vapor into the atmosphere.

Condensation: The sun's energy causes water vapor in the atmosphere to rise. As it rises it cools and eventually condenses on tiny dust and ice particles. When vapor condenses it turns back to a liquid or solid. The tiny drops then collect and form clouds which are moved around by air currents.

Precipitation: Clouds that are filled with condensed water vapor drop their heavy load in the form of rain, snow, sleet or hail. Air temperature, which decreases as you go up, also affects precipitation. Cool air cannot hold as much water as warm air. Therefore, when air currents or mountains cause clouds to rise, the clouds are more likely to precipitate.

Surface runoff: Evaporation and **discharge** (see below) send water to the earth's surface where it travels over the land. Runoff collects in streams and rivers, ponds and lakes and eventually flows to ocean (unless it evaporates or moves underground).

Percolation: Percolation describes the action of water as it moves through spaces in the soil and rock. Percolating water may stay near the surface, move downward through cracks, or move back up to the surface in discharge areas. Water that percolates upward is either pulled upward by **capillary action** or forced upward by solid layers of rock.

Discharge: Water moves to the surface from underground in discharge areas. These are areas on the landscape that sit lower than the water table. Discharge areas include springs as well as some streams, lakes and wetlands.

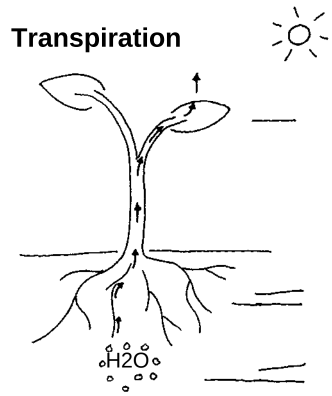
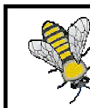


Figure VI-2. Transpiration occurs when water moves from a plant into the atmosphere

Transpiration: Water vapor enters the atmosphere from plant leaves in a process called transpiration. Transpiration occurs because water moves from areas of lesser concentration to areas of greater concentration. Since there is usually less moisture in the air than in the soil, water will be sucked through the plant and into the air – just like through a straw!

How does the water cycle affect water quality?

Water is sometimes called the "universal solvent," meaning that more materials (gases, solids and liquids) dissolve in water than in any other substance on earth. Because of this, water is constantly picking up pollutants in various forms. Because water is constantly on the move through the water cycle, these pollutants can be carried by the water far beyond their initial source. For example, surface runoff polluted by motor oil or antifreeze may move through the soil and contaminate ground water. The pollution may then travel through the soil and re-appear at the surface in a spring far away. For another example, look to the skies. Water in the atmosphere may dissolve sulfur containing gases to form sulfuric acid, which falls to the earth as acid rain.



How can we help?
Natural water purification processes, like distillation, percolation or transpiration, clean much more water than humans can through water treatment facilities. However, natural purification is a slow process compared to the rate at which we "use" or pollute our clean water. We can help the process along in many ways. We can use less water (e.g., take shorter showers) and reduce pollution (e.g., use of home and garden chemicals).

Just as water can transport pollutants, it can also clean itself of them.

- As water percolates through the ground, soil particles may filter out some pollutants.
- Transpiration by plants moves nutrients and other dissolved substances with the water, which are then incorporated into the plant tissues.
- When water changes from liquid to gas (evaporation), individual water molecules break away, leaving pollutants behind. This action is called **distillation.** Note, however**,** that although water can clean itself through distillation, the pollutants are not removed from the environment. In fact, they may concentrate and become more dangerous.

What influences the water cycle?

Many factors influence how water moves through the water cycle. These include the sun, gravity, geography and watershed factors such as topography, soil characteristics and the amounts and types of vegetation close to and away from the stream.

The Sun

The energy of the sun powers the water cycle. Increases in energy lead to increases in evaporation rates, air temperature (warmer air holds more water), and transpiration rates.

Heat energy allows to hold more water. This is one reason the tropics are humid. Since air cools as it rises what do you think will happen to water-filled clouds as they rise?

The amount of energy an area receives depends on:

- *Location on the globe.* The sun strikes the equator at a direct angle, sending it a maximum amount of energy (higher latitudes receive the sun at an angle).
- *Length of day.* Long summer days receive more of the sun's energy.
- *Season*. As the northern or southern hemisphere tilts away from the sun during their winter months, they receive the sun's rays at less direct angles.

Gravity

Water in any state – solid, liquid or gas – has mass, just like you and me. Therefore, gravity affects it. For example, snow falls from the sky on to a mountaintop where it melts and descends to the lowest point in the watershed. Gravity may continue to pull it down through the soil and into an aquifer.

Geography

As previously mentioned, your location on the globe strongly affects the behavior of the water cycle.

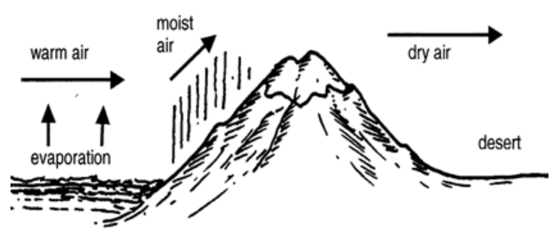
- Rainfall increases nearer the equator and in bands around the earth at about 60 degrees North and South latitude. Dry regions on earth occur at about 30 degrees North and South latitude.
- Rainfall increases in regions near large bodies of water (which supply water that evaporates and becomes precipitation). Without the Great Salt Lake, the Wasatch Front would be even drier.

Topography

Topography is the shape of the land's surface, but it affects the water cycle in all three zones. The "rain shadow" is an example of how topography can affect water in the atmosphere. Mountains also affect surface and underground processes. Water that runs swiftly down a steep mountain has much less chance to work its way into the soil than water that moves slowly across a flat plain. Low points on the surface allow water to pool and increase its chance of entering the underground zone.

Figure VI-3. Rain Shadows

One reason Utah is the second driest state in the nation is because we are in a "rain shadow." Warm air currents pick up water from the Pacific Ocean and travel east, or inland. When this warm air climbs over the Sierra Nevada Mt.'s in California it cools and drops its moisture. The drier air continues on towards us.



Soil and rock

The soil and underlying rock material in an area affect how water moves from the surface to underground. Course material, such as gravel and sand, consists of large particles with large **pore spaces** (open areas between the particles). Water passes through this material and into the underground zone.

Some soil types, such as clay, consist of tiny grains which pack together tightly and leave tiny pore spaces. If these soils are on the surface they can keep precipitation from percolating downward. If they are located underground, they can help trap layers of groundwater and form aquifers. Layers of solid rock, or bedrock, have the same effect.

Engineers often rely on natural clay and rock layers to contain landfills and underground stores of harmful material, such as toxic waste.

Vegetation

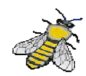
Plants move a tremendous amount of water through transpiration. Every day an actively growing plant transpires five to ten times as much water as it can hold at one time. Transpiration is one way the water cycle helps to clean water: when plants transpire they take up **nutrients** and other minerals that are in the water. Also, plants and litter (dead plant material) help maintain moisture in the soil by catching and holding surface runoff and by lowering evaporation rates.

How do humans influence the water cycle?

We rely on water for not only drinking and washing but for industry, recreation, food production and much, much more. When we use water we alter the “natural” water cycle in many ways. Some of our uses simply re-direct water or send it on a different path. Other uses may degrade the quality or future availability of water.

Atmospheric pollution

Sometimes we pollute water before it ever reaches the ground. Automobile and industry emissions, such as sulfur and nitrogen oxide, mix with atmospheric water to form acids – “acid rain.” Luckily, Utah doesn’t experience many of the negative effects of acid rain because our **basic** soils help neutralize the acid levels. Across the nation tighter pollution controls have gone a long way toward reducing atmospheric pollution.



Riding a bike, walking, and taking public transportation are great ways to help reduce atmospheric pollution. It’s something we can do right now to make a difference.

Development

Water cannot percolate through hard surfaces such as roads, parking lots or roof tops. When we pave over large areas of a watershed, we increase the volume and intensity of surface runoff, and also increase the amount of pollutants washed directly into our streams. Aquifers, where we get much of our drinking water in Utah, can dry up when precipitation cannot percolate into the soils to re-supply the groundwater.

Agriculture

Agriculture is the largest user of water in Utah. Water that may have originally flowed as surface runoff in rivers is diverted for irrigation. This water then transpires through crops, evaporates into the air, or percolates down through the soil. Wise watering practices, such as watering during cool times of the day, reduce the loss of water to evaporation and keep more water in the soil for plants to use. It is also important to water our lawns in this manner. Lawn watering is the largest use of water in Utah’s cities.

The widespread conversion of farm irrigation systems from ditch irrigation to more efficient sprinkler systems has saved a tremendous amount of water over time. This also protects our water quality, because there is less surface erosion and runoff of pollutants into our streams.

Water treatment

All drinking water must first pass through a water treatment facility before the public can use it for drinking water. We also clean up sewage and waste water before releasing it back into rivers and lakes. Water treatment is a very expensive process though. By not polluting we help reduce the cost of water treatment and ensure the safety of our water supplies.

Resources for further investigation

Environment Canada – This extensive but easy-to-navigate web site is operated by Environment Canada (Canada's equivalent to the U.S. Environmental Protection Agency). Find information and lesson plans to help your students further investigate the water cycle. Also, find information and resources on different water body types, water management, and water and culture. Classes looking to study the effects of cold climates and winter weather on water will find this site useful. Contact: http://www.ec.gc.ca/water/en/nature/prop/e_cycle.htm

Project WET (Curriculum and Activity Guide) – Project WET provides hands-on activities for students of all ages to investigate the many aspects of the water cycle. Project WET, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057; (406) 994-5392; email: rwwet@msu.oscs.montana.edu

Bibliography

Edelstein, Karen, Nancy Trautman, and Marianne Krasny. Watershed Science for Educators. Cornell University. New York. No date.

Environment Canada. "Fresh Water: The Hydrologic Cycle," The Nature of Water. www.ec.gc.ca/water/en/nature/prop/watercycle.htm. January, 1999.

Farthing, Patty, et. al. The Stream Scene: Watersheds, Wildlife and People. Oregon Department of Fish and Wildlife. Portland, OR. 1999.

Mitchell, Mark, and William Stapp. Field Manual for Water Quality Monitoring. Thompson-Shore Printers. Dexter, MI. 1994.

Project Learning Tree. Project Learning Tree Environmental Education Activity Guide. American Forest Foundation. Washington, DC. 1995.

Project WET. Project WET Curriculum and Activity Guide. The Watercourse and Council for Environmental Education. Bozeman, MT. 1995.

Spielmaker, Debra. Dirt: Secrets in the Soil! Utah Agriculture in the Classroom. Logan, UT. No date.

United States Geological Survey. "Earth's Water: Rivers and Sediment." Water Science for Schools. http://ga.water.usgs.gov/edu/earthriversed.html. No date.

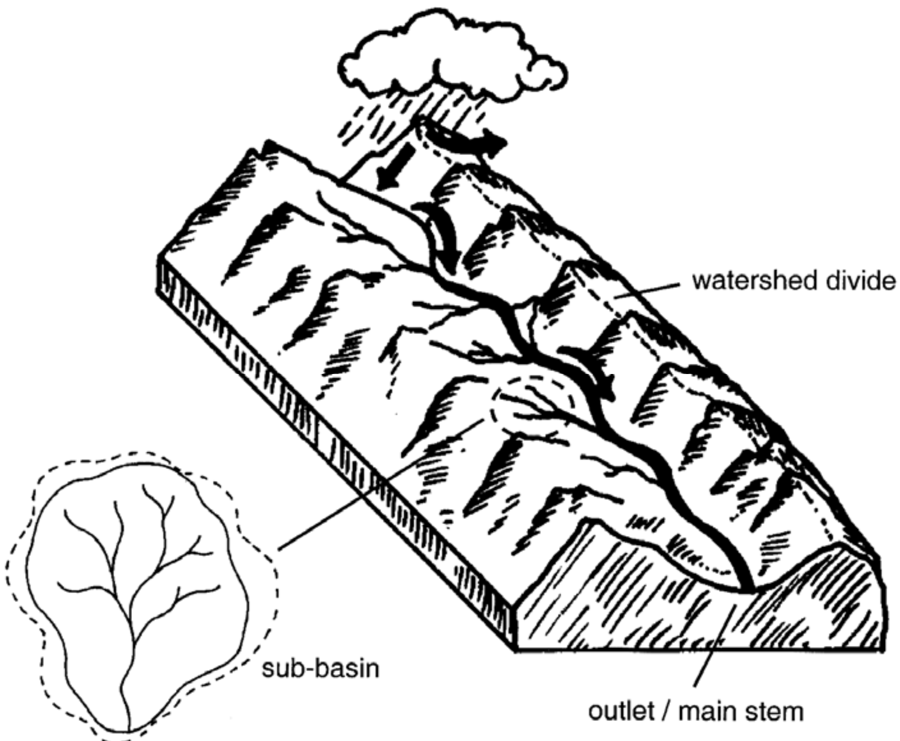
VI-2. Watersheds

Key Terms			
divide	outlet	stream order	tributary
floodplain	river system	sub-basin	turbidity
impoundment	streamflow	topography	watershed
mainstream			

What is a watershed?

Have you ever looked at your local stream and wondered where it comes from, where it goes, and what influences its travels? The characteristics of your stream's **watershed** determine these factors and more.

Figure VI-4. Example of a watershed and sub-basins within that watershed.



A watershed, also known as a "drainage" or "basin," is a geographical area that *collects* water, *stores* it and *releases* it. The water, along with all the materials it carries – sediment, organic matter and dissolved materials – collects in a common water body, or **outlet**. If the outlet is a stream or river, we call it the **mainstem** of the watershed. The mainstem can be as small as a creek or as large as the Colorado River, depending on the size of the watershed. A **divide** is the boundary between two watersheds.

Watersheds are interconnected systems. Each watershed consists of smaller watersheds – **sub-basins -** and is also part of a larger watershed. Therefore, all watersheds – big and small –

throughout Utah, and even the world, form a single, connected system. You can see how smaller watersheds are nested inside larger ones in Figure VI-4.

Because all the water in a watershed collects in a single outlet, activities throughout the watershed can influence water downstream. Clear-cutting a mountainside (chopping down every tree) can increase erosion and increase stream temperatures, which damage fish populations downstream and diminish recreation opportunities. Cleaning up toxic chemicals from a mining site may improve **macroinvertebrate** populations in nearby streams, strengthening entire food chains. Since all watersheds are connected, these actions can have a ripple effect far beyond the local area.

The Great Salt Lake is an example of a watershed that does not connect through a flowing outlet. Water only leaves this watershed by draining underground and evaporating.

The Great Divide – The Rocky Mountains form the Continental Divide - the major watershed divide on the North American continent. Water that falls on the west heads toward the Pacific Ocean; water that falls on the east slope heads toward the Atlantic Ocean. Two rain drops that fall only inches apart may end up thousands of miles away from each other.

The River System

Your stream probably has streams, or **tributaries**, that feed water into it. Your stream is also probably a tributary for a larger stream. We call this branching pattern a **river system**.

Smaller streams, often called headwater streams, usually start in the upper reaches of the watershed. These streams (denoted by a "1" or "2" in Figure VI-5 below):

- Are small, steeper and more **erosive**;
- do not grow much plant material in the stream, but rather receive this material from leaves and sticks which fall into the channel; and
- are cooler because they are more shaded or closer to the water source (snow or recent rain).

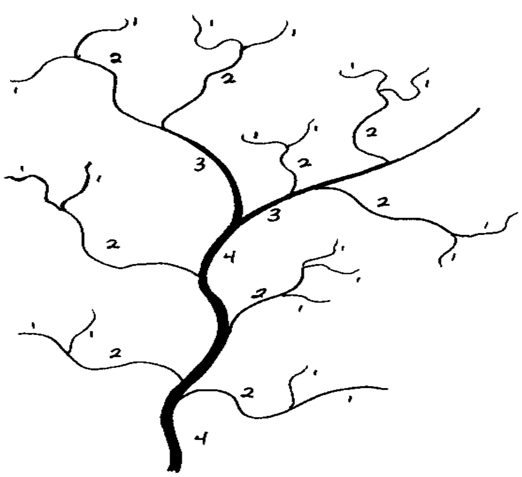


Figure VI-5. River system showing how small streams combine to form larger ones.

Larger streams (denoted by a "3" or "4"):

- have more flow, are less steep and more depositional (sediment drops out of the river);
- generate more of their plant material within the channel through photosynthesis by algae or larger aquatic plants;
- are warmer because they've had more time to absorb heat and often are less shaded;
- are more **turbid** because they have more suspended silt, clay and algae; and
- are wider relative to their depth.

A stream's size affects the types of macroinvertebrates found in it. To see this relationship, refer to Figure IV-7, "Functional Feeding Groups," in the Macroinvertebrates section (IV-4B).

What natural influences affect a watershed?

Climate determines *how much* water (in the form of precipitation) enters the watershed. Soil, **topography**, and vegetation affect *how* water travels through the watershed. These watershed factors continually influence each other. Many of these interrelationships are discussed in this section. Look for others as you investigate natural influences in the watershed.

Climate

The seasonal cycles of precipitation and temperature control water delivery and **streamflows**. In the Intermountain West we receive most of our precipitation in short bursts as snow and rainstorms. In the East precipitation is distributed more evenly throughout the year.

Often climate is affected by the watershed. The Great Salt Lake combines with the high, abrupt peaks of the Wasatch Range to alter climate. Cold air currents that move west to east pick up heat and moisture from the relatively warm lake. As the water-filled air runs into the Wasatch Range it is forced upward and becomes cooler. Since cool air cannot hold as much water as warm air, it releases it in the form of snow. The snow then melts in the spring and summer and returns to the lake to start the cycle again. We call this weather phenomenon the **lake-effect**.

Soil

Soil is a mixture of *mineral*s (rock, clay, sand, silt) *organic matter* (living and decomposing organisms); *moisture*; and *air pockets*.

Soil interrelates with other parts of the watershed:

- *Climatic processes*, such as freezing and thawing and wind and water erosion, break down rocks to form the fine mineral ingredients of soil.
- *Plants and animals*, when they die, decay and produce organic matter that forms mainly in the upper layer of soil – the topsoil. Plants thrive in nutrient-rich organic soils. Soil bacteria, worms, insects and burrowing animals also help break down and mix soil components.
- *Topography* greatly affects the types and locations of soils present in the watershed. Steep slopes generate high-energy streams capable of eroding soil.

It's all in the mix
On average, half of a soil's volume is solid material (minerals and organic matter). The other half is water and air. The exact mixture of these ingredients helps determine how well the soil can support plant life and withstand erosion. For example, loose soil - soil with a lot of pore spaces – erodes easily. Hard packed soil doesn't contain much air or water, which is essential to plants.

Topography

Topography, the shape of the surface of the land, greatly affects how watersheds function.

Contour and Slope

The contour and slope of a watershed affects the amount of precipitation that runs off the surface verses how much infiltrates into the soil. Steep, confined slopes are more likely to produce rapid runoff, little infiltration and heavy erosion. Plants have a hard time surviving in such areas. Streams below may experience higher flows and turbidity levels.

Orientation

A watershed's orientation to the sun alters how much water it will retain. Steep slopes that face the sun lose water more rapidly (they have higher rates of **evaporation** and **transpiration).** Both plants and streamflow levels are changed. Wind removes moisture as well. Slopes that face prevailing winds tend to be drier.

All controlling factors – climate, soils, topography, vegetation - in a watershed are interrelated. Look out at the slopes of a nearby hill or mountain. Do you notice different types of vegetation on the south side verses the north side? Because north slopes receive less sun, they hold water longer (it takes longer to evaporate). Vegetation types that need more water will be found in greater abundance on those slopes verses the south-facing slopes. The vegetation, then, in turn, affects the soil. Plant roots hold the soil together, reducing erosion rates.

What differences do you notice in vegetation on steep verses shallow slopes?

Vegetation

The types, number and locations of plants and trees in a watershed depends upon climate, soil and topography. Much of Utah, especially desert areas, has a dry climate and nutrient-poor soil. In these areas, we find sparse vegetation that consists of few trees and mostly grasses and shrubs. By comparison, western Oregon, with a very wet climate and nutrient-rich soils, has lush vegetation and dense stands of large trees.

Vegetation affects the watershed by:

- preventing erosion and helping water to infiltrate into the soil
- providing nutrients and cooler temperatures for the soil
- creating soil by chemically breaking down rock and by physically breaking it down with root systems.

The deserts of Utah don't have an abundance of vegetation to stabilize the soil. They depend on cryptobiotic soil crust to perform many of these functions. Cryptobiotic soil crust consists of a mixture of mosses, algae, and lichen that weave a thin "mat" through the surface of the soil. The crust keeps wind and water from eroding the soil. It also provides a home for seeds to establish, traps water for plants to use and places nitrogen into the soil to help plants grow.

? What combination of natural influences on a watershed would you expect to produce a very wet environment?

[a wet climate; organic-rich soils; shallow slopes; dense vegetation]

What human influences affect a watershed?

Humans can influence how the watershed functions through different land uses. Land use can affect the soils, topography and vegetation which, in turn, affects the quantity, quality and timing of water moving through the watershed.

Development

If you compare urban areas – places where humans live closely together and have developed, or changed the environment considerably – with natural areas you will see many differences. When we develop urban areas, especially near water, we not only change how the area looks but also the way watersheds function.

- Covering vegetation and soils with impermeable surfaces such as roads, houses and parking lots prevents groundwater from being re-supplied, which reduces water storage. Erosion rates and flood severity also rise. Pollutants, such as motor oil, that collect on these surfaces may wash into nearby streams and move through the watershed.
- Encasing stream channels in concrete such as pipes, diversion ditches, or storm drains increases water temperatures and the severity of floods.
- Loss of **riparian** vegetation increases stream water temperatures and turbidity levels. Riparian vegetation also serves as an important pollution filter and helps to reduce the severity of floods.
- Clearing land for residential, commercial and industrial purposes can increase erosion and increase the delivery of pollutants (fertilizers, pesticides, septic tank sewage) to streams.

Agricultural and grazing practices

Farming and livestock grazing are common activities in watersheds throughout Utah. With proper management, these uses can benefit humans and the ecological health of the land as well. However, improper management can negatively influence the watershed.

- Overgrazing and leaving cropland bare can increase erosion rates and turbidity levels in nearby streams.
- Overgrazing riparian zones can increase water temperature, reduce wildlife habitat and increase stream bank erosion. A healthy riparian area is especially important in agricultural areas because the plants trap and filter pesticides and fertilizers before they reach the stream.
- If a lot of manure and fertilizer reach the stream, **eutrophication** may result. Eutrophication – over fertilization – results when too many nutrients in the water cause excessive plant growth. When the plants die, organisms decompose them and use up large amounts of oxygen in the process. This can lead to fish kills and other negative impacts.
- Runoff that may carry pesticides to the stream can also reach streams via surface runoff and kill aquatic organisms as well as the nonaquatic organisms that feed on them.

A remarkable comeback
DDT was a commonly-used pesticide in the 50's and 60's. DDT took a long time to break down; it hung around long enough to be picked up by runoff and moved around the watershed. In the process, DDT was consumed by fish. The DDT passed on to fish-eating raptors, such as the bald eagle and osprey, and prevented them from reproducing. Today, DDT is outlawed, and these birds are making a remarkable comeback.

Many farmers and ranchers use methods which help protect our streams, including biological methods for pest control, wind breaks and healthy riparian areas to help stem the flow of harmful material to streams.

Forestry

Forestry management methods impact the watershed and the water quality of streams.

- Constructing roads near streams and clear cutting on steep slopes can increase erosion and turbidity levels.
- Removal of trees, and the shade they provide, can increase water temperature.
- Fire suppression can create forests of mostly conifer trees, such as Douglas-fir, and few deciduous trees, such as aspen. Conifers use more water, leaving the forest and streams drier.

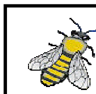
A valued resource
Municipalities and government agencies place a very high value on their water supply. Little Cottonwood, Big Cottonwood and Parley Canyons (in the Wasatch Mountain Range east of Salt Lake City) provide water for more than 400,000 people. To protect this precious resource, the US Forest Service, which manages most of the land in the canyons, restricts the kinds of activities that can occur there. Grazing, logging and mining, which can degrade water resources, are not allowed. Even dogs and horses are prohibited since they can introduce diseases dangerous to humans.

Fortunately, forestry practices are becoming more conscious of environmental effects. Many logging operations now avoid riparian areas when they build their roads and log. To reduce erosion, they can remove trees without skidding across the ground or through streams and may also log in winter when the soil is frozen.

Mining

Mining, extracting mineral resources from the earth, involves either stripping away soil or rock layers or tunneling into the ground. This can pose serious threats to water quality.

- Runoff may **leach**, or wash, acidic water and heavy metals into streams. These chemicals and metals may occur naturally, but, when they are unearthed and exposed to air or water, they can become toxic. Many types of mining also introduce chemicals (such as cyanide for gold mining) that may escape into the environment.
- Mining operations often leave behind large quantities of waste rock; extracted metals may constitute as little as 1% of the material that is excavated. Exposed waste rock may continue leaching for decades.



The Monitoring Acid Rain Youth Program (MARYP) is an education program which monitors forest stations across North America to determine levels of rainfall acidity and potential impacts on forest ecosystems. Students collect rainwater at a study site twice a week for eight weeks and do simple pH testing in the classroom. Results are sent to a lab for complete analysis. Soil samples can also be collected and tested. It's a valuable addition to any monitoring program. Contact MARYP at (705) 748 1647.

The mining industry is increasing its efforts to control waste materials and toxic chemicals to protect surrounding watersheds.

Industry

Industrial emissions can alter watersheds and streams both near and far.

- Polluted precipitation, also known as "acid rain," increases the acidity of water in many industrial areas. The main contributors to acid rain are sulfuric acid (produced by coal burning industries) and nitric acid (produced by automobile engines). Luckily, here in Utah our buffering soils help to decrease the effects of acid rain.
- Dumping of industrial pollutants directly in to bodies of water – also known as **point-source pollution** – can have intense and immediate effects. Refer to the "Water Pollution" section VI-3, for more information on point-source and **nonpoint-source pollution**.

Dams and reservoirs

Here in Utah, the second driest state in the nation, dams and reservoirs provide important services. They help us to:

- store water for agriculture, industry and drinking
- control floods
- generate power
- provide recreational opportunities

However, dams and reservoirs dramatically alter the stream or river and its surrounding watershed.

- Dams turn free-flowing streams and rivers into lake-like environments. Surface temperatures increase, bottom temperatures decrease and dissolved oxygen levels drop.
- Sediment and organic matter is trapped upstream of the dam, producing clear water downstream. For naturally turbid rivers, such as the Colorado and San Juan Rivers, this clear water changes the physical structure of the channel. Instead of supplying sediment to the **floodplains** and channels, the stream scours it away. This results in a narrower, faster channel.
- Dams, by design, reduce downstream flooding. Without flooding, backwaters and side channels, which are important fish nurseries, can't form. Also, beaches and riparian zones fail to receive essential supplies of sediment.

> Dams block the travel of migrating fish, such as the Colorado Pike Minnow, a Utah native. For this reason, the Minnow, which can grow to be 4 ft long, has trouble breeding successfully. It is now one of four endangered fish in Utah. Many dams are now installing fish ladders, devices that let fish swim around the dam, to help them out.

Utah Watersheds

Refer to Figure VI-6. You will see how Utah's watersheds compare to other western watersheds. Figure VI-7 illustrates the major watersheds and mainstream rivers within Utah.

Where does our water come from?

Utah depends primarily on precipitation for its water supply. Heavy snowfall in the mountains melts in late spring, filling streams and rivers which, in turn, fill reservoirs and aquifers.

Utah's water supply also varies considerably from place to place. Some mountain areas may receive as much as 50 inches of precipitation in a year while the desert areas receive less than 10 inches. Desert soils, which lack organic matter and vegetative cover, have a difficult time trapping runoff. Much of the precipitation runs directly into an outlet without first infiltrating the soil for use by vegetation.

How do we use our water?

In Utah, most of the water that we use is for agriculture (87%). Cities and towns use 9%. Industries use the rest (4%). Water held in reservoirs helps supply all of these uses. If we don't receive enough precipitation to fill the reservoirs then crop production falls, **aquifers** shrink and some communities are forced to restrict their water use. To meet the demands of a growing population, Utah is turning to another form of stored water in the watershed – ground water.

What are Utah's major watersheds?

Two principal watersheds divide Utah: the Great Basin and the Colorado River Watersheds. The Colorado River watershed flows into the Sea of Cortez in Mexico. The Great Basin watershed has no outlet – it terminates in inland bodies of water, such as the Great Salt Lake and Sevier Lake. The Great Basin is the only major watershed in the United States that does not empty into an ocean. A third major watershed, the Columbia River Basin, occupies a small portion of northwest Utah.

> The divide between Utah's two major watersheds generally runs north-and-south. It cuts across the western end of the Uinta Mountains and through the High Plateaus. Once in the southwestern corner of the state, it heads westward towards Nevada. See Figure VI-6.

The Great Basin System

The Great Basin System collects water from a vast area of the West, including five Utah watersheds (three of which – the Bear, Jordan and Weber – flow into the Great Salt Lake).

Bear River Watershed – The Bear River Watershed is the largest of the watersheds that feed in to the Great Salt Lake. The Bear River begins in the northwest region of the Uinta Mountains in Utah. On its 500+ mile journey the river heads north into Wyoming and Idaho before turning south and reentering Utah. It enters the northeast portion of the Great Salt Lake about 90 miles from its point of origin!

Cedar/Beaver Watershed – The Cedar/Beaver Watershed drains the Beaver River and several other small streams. Although it encompasses a fairly large portion of southwest Utah, the watershed collects little water. Of its 2,000+ river miles, only 332 flow year round.

Jordan River Watershed – The Jordan River is only 40 miles long and also ends in the Great Salt Lake. It receives water from the Provo River, which drains part of the Uinta and Wasatch Mountains, and the Spanish Fork River, which drains portions of the southern Wasatch Mountains.

> **Water quality issues in Utah's watersheds.**
>
> Bear River Watershed – nutrients, dissolved oxygen,
>
> Cedar/Beaver – riparian habitat loss, temperature, phosphorus
>
> Jordan River Watershed – metals, riparian habitat loss, turbidity
>
> Sevier River Watershed – salinity, phosphorus, riparian habitat loss, salinity
>
> Weber River Watershed – turbidity, nutrients, and habitat loss
>
> Colorado River Watershed – salinity, metals, pH, temperature
>
> Source: Utah Division of Water Quality. "Utah's 2000 303(d) List of Stream and Waterbodies Needing Total Maximum Daily Load Analyses"

Sevier River Watershed – The Sevier River is the only major river that feeds into Sevier

Lake, a large **playa** in west-central Utah. However, due to agricultural demand, water from the Sevier River rarely reaches Sevier Lake; this leaves Sevier Lake dry at times. The Sevier River Watershed drains the high plateaus of central and western Utah – the Paunsaugunt, Fish Lake and Wasatch Plateaus – as well as Sanpete Valley.

Weber River Watershed – The Weber River begins in the northwest corner of the Uinta Mountains and also ends in the Great Salt Lake. Its major tributary is the Ogden River. The watershed drains Ogden and eastern Weber County.

The Colorado River System

The main stem of the Colorado River System is the Colorado River itself. The Colorado originates on the western slope of the Continental Divide in Rocky Mountain National Park and empties into the Sea of Cortez in Mexico. The major tributary of the Colorado, the Green River, originates in the Wind River Range in Wyoming. The Green has many large tributaries of its own – the Yampa, Duchesne, Uinta, White, San Rafael and Price Rivers.

The Colorado and Green Rivers meet in Canyonlands National Park, where they have carved deep canyons out of the soft sedimentary rock. Below the confluence with the Green, the Colorado is fed by the Dolores, Dirty Devil, Escalante and San Juan Rivers. Lake Powell, the reservoir created by Glen Canyon Dam, backs-up the last 150 miles of the Utah portion of the Colorado River.

The Most Regulated River in the World - The Colorado River is the largest water body in the Southwest - the driest region of the nation. Industry, agriculture and major cities (Los Angeles, Phoenix, Las Vegas) depend heavily on it. To supply water for all these different demands we have developed an extensive system of dams, aqueducts, pipes and reservoirs. In fact, this system of **impoundments** is so extensive that the Colorado is considered the most regulated river in the world. It is truly the life blood of the Southwest. Figure VI-8 illustrates the regulation of the Colorado River Watershed.

Figure VI-8 The Colorado River Watershed... and it's Plumbing

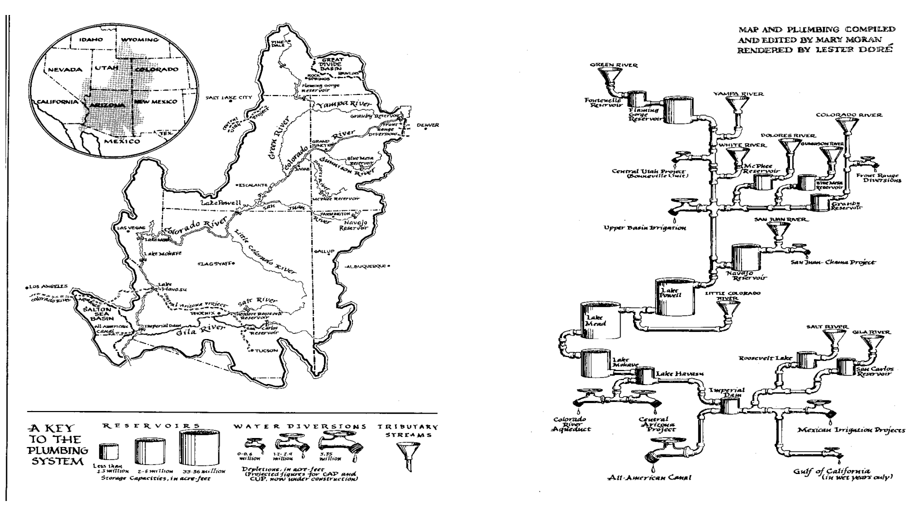
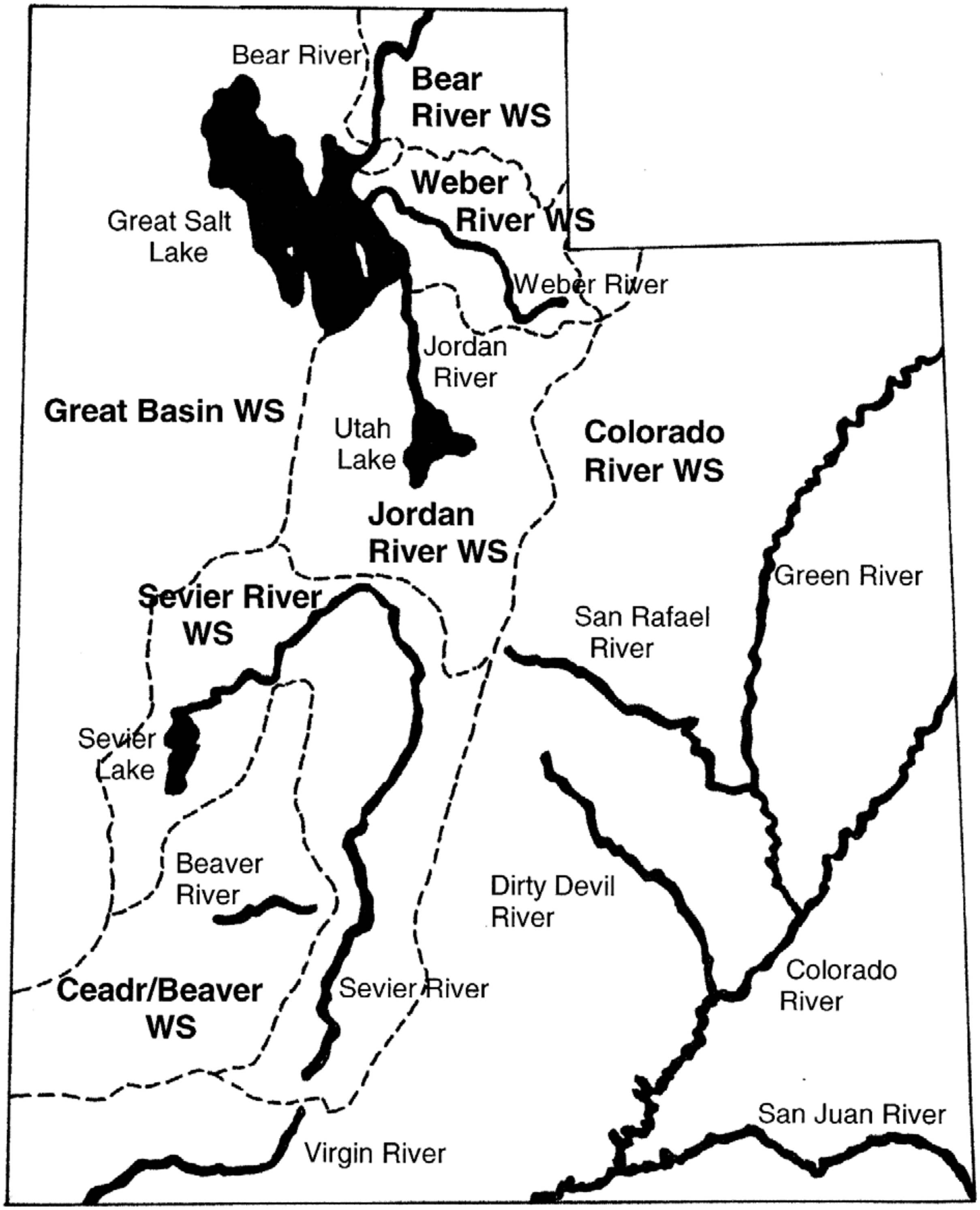


Figure VI-6 Major Western Watersheds

— — — Watershed Boundary

Source: Walhquist, Wayne (ed.). Atlas of Utah. 1981

Figure VI-7 Utah Watersheds



Resources for further investigation

"**C.U.P. Water Facts**." – This Utah water information pamphlet lists: how much water it takes to produce various food items; how much water is used by different industries and people in Utah; how much water is used for various household activities and the capacity of Utah reservoirs. Contact: Central Utah Water Conservancy District, 355 W 1300 S, Orem, UT 84057

Science in Your Watershed – This site will help you find scientific information organized on a watershed basis. Real-time water flow data is provided for most river sections in UT. Watershed groups are provided access to experts to answer questions. Although this site contains extensive scientific data it is easy to navigate and presents useful information in an understandable style. Contact: www.water.usgs.gov

Surf Your Watershed – Point and click on the interactive mapping tool to find an environmental profile for every major watershed and river in Utah and the nation. You'll get information on your watershed's health, river corridor restoration efforts, water flow, pollutants, land use, groundwater profiles, monitoring groups and much more. Links to other watershed education sites. Contact: www.epa.gov/surf2/locate

Water Science for Schools – This is an exhaustive, but easy-to-use web site on water and water education. Find information on most watershed-related concepts. Contact: www.ga.water.usgs.gov/edu/

Bibliography

Central Utah Water Conservancy District. "C.U.P. Water Facts." Pamphlet. No date.

Edelstein, Karen, Nancy Trautman, and Marianne Krasny. Watershed Science for Educators. Cornell University. New York. No date.

Environment Canada. The Nature of Water. www.ec.gc.ca/waer/en/nature/prop/e_cycle.htm. January, 1999.

Environmental Protection Agency. Volunteer Stream Monitoring: A Methods Manual (EPA 841-B-97-003). Office of Water. Washington, DC. 1997.

Farthing, Patty, et al. The Stream Scene: Watersheds, Wildlife and People. Oregon Department of Fish and Wildlife. Portland, OR. 1999.

Mitchell, Mark, and William Stapp. Field Manual for Water Quality Monitoring. Thompson-Shore Printers. Dexter, MI. 1994.

Oregon Watershed Improvement Coalition. "Watersheds: Their Importance and Functions." Pamphlet. No location. No date.

Project WET. Project WET Curriculum and Activity Guide. The Watercourse and Council for Environmental Education. Bozeman, MT. 1995.

US Geological Survey. Water Science for Schools. www.ga.water.usgs.gov/edu/. No date.

Utah Division of Water Quality. "Utah's 2000 303(d) List of Stream and Waterbodies Needing Total Maximum Daily Load Analyses." Utah Department of Environmental Quality. 2000

Walhquist, Wayne (ed.). Atlas of Utah. Brigham Young University Press. Provo, UT. 1981

VI-3. Water Pollution

Key Terms

beneficial use	nonpoint source pollution	sediments
distillation	nutrients	suspended solids
metals	point source pollution	total dissolved solids

What is "polluted" water?

There is no single definition of polluted water or clean water. Ask a roomful of people what polluted water is and you will get a roomful of answers. Clean water to a chemist might be distilled water (water with all the salts and minerals removed). But, humans get sick if they drink only distilled water. Clean water to you might be the water coming out of your kitchen faucet. But, for fish this water is highly polluted (too much chlorine and not enough oxygen). Whether we define water as polluted or clean depends upon how the water is being used, often call the water's **beneficial use**.

What use is it?
The uses of a stream or water body are called its **beneficial uses**. Beneficial uses of water bodies include drinking water, agriculture, recreation, fish and wildlife, aesthetics, and mineral extraction. Within each state, all stream segments, lakes and reservoirs are assigned one or usually more beneficial use designations. The goal of water quality regulations is to protect the waters of the state so they can support these beneficial uses. To find out more about designated beneficial uses, refer to "Water Laws," section VI-4.

What's the big deal?

Pollutants can prevent us from supporting the beneficial uses of a stream. Sometimes this occurs dramatically, through a single event (e.g., a large discharge of chemicals ruins a town's water supply). Sometimes it is less noticeable and occurs over a longer period of time (e.g., a steady stream of lawn chemicals runs into a neighborhood stream and harms aquatic organisms). When we degrade a stream's water quality the natural communities that are harmed may take many years to recover.

What types of pollutants are there?

Water pollution can come from many different human (and natural) sources. We divide these sources into two main groups – **point source pollution** and **nonpoint source pollution**.

Point source pollution

As the name suggests, the source for this type of pollution can be easily identified, or "pointed at." A point source usually enters the stream

Point vs. Nonpoint

Much progress has been made in the US to prevent pollution from "point sources." However, approximately 40 percent of our surveyed rivers, lakes, and estuaries still are not clean enough to meet basic uses such as fishing or swimming, according to the U.S. Environmental Protection Agency (USEPA). Nonpoint sources are contributing to much of this problem.

through a pipe from industrial facilities such as municipal wastewater treatment plants. Very large agricultural operations may also contribute point source pollution. Point source pollution can include sewage, chemicals, nutrients and heated water.

Nonpoint source pollution

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from a wide area or multiple sources; you must “wave” at it instead of being able to “point” at it. It is, therefore, harder to identify and locate than point source pollution. Nonpoint source pollution results when **surface runoff** picks up pollutants and carries them into a water body or underground. It can also result from airborne pollution that deposits in water bodies.

Nonpoint source pollution includes:

- excess fertilizers, herbicides, and insecticides from agricultural lands and housing areas
- oil, fuel, and toxic chemicals from households, urban runoff and industry
- sediment from poorly-managed construction sites, agriculture and timber operations, and from degraded streambanks
- salt from irrigated farmland and acid drainage from abandoned mines
- bacteria and nutrients from animal feeding operations, and faulty septic systems
- atmospheric deposition from automobile and industrial output.

How do we sort out all the sources of pollutants in a watershed?

Often, a specific pollutant, for example phosphorus, comes from many sources. Phosphorus enters water from point sources, such as municipal wastewater treatment plants. It also may enter water attached to soil particles when erosion occurs, from malfunctioning septic tanks, from animal feeding operations, or from runoff from over-fertilized yards or golf courses.

Scientists try to determine the total amounts (called loads) that enter a stream from each of these sources. This helps them identify the largest sources and helps them prioritize clean up efforts.

What kinds of pollutants affect Utah’s streams?

The five leading causes of impairments to Utah’s streams and rivers are **nutrients**, **total dissolved solids (salts)**, **sediments**, habitat alterations and **metals**. Excessive nutrients, like nitrate and phosphorus, can remove oxygen from water by causing algal blooms. Salts can make water unsuitable for drinking water or irrigation. Sediment covers fish spawning areas and macroinvertebrate habitat. Metals can be toxic to aquatic life. Habitat alterations can harm aquatic wildlife populations and increase runoff into streams.

Here are pollutants of concern for some Utah watersheds.

- **Bear River Watershed**: Bear River and some tributaries in Cache and Box Elder Counties – nutrients, sediments.
- **Weber River Watershed**: Chalk Creek – sediments, nutrients and habitat loss. East Canyon Creek – nutrients, habitat loss.
- **Upper Colorado River Watershed**: Montezuma Creek and Fremont River – total dissolved solids. Portions of San Juan River – metals.
- **Lower Colorado River Watershed**: Santa Clara River and portions of the Virgin River – total dissolved solids.
- **Utah Lake-Jordan River Basin**: Little Cottonwood Creek – metals. Jordan River – total dissolved solids. Diamond Fork and Sixth Water Creeks – nutrients and habitat loss.

How much pollution does it take to affect the water quality of a stream?

Many factors determine the influence of a pollutant on a stream. Greater water volume may dilute pollutants (e.g., dissolved nutrients or solids). Dense riparian vegetation and healthy soil will filter pollutants before they reach the stream.

The nature of the pollutant also plays a major role in how it affects the stream. Some pollutants, like **suspended solids** – undissolved minerals – must reach relatively high concentrations (50 parts per million) before they are harmful. Other pollutants pose a significant threat at very small concentrations. Chemical fertilizers containing nitrate can be dangerous to infants in quantities as small as 10 parts per million. Trichloroethylene (TCE), a common industrial solvent, is more dangerous than nitrate at even smaller concentrations! TCE, is considered a pollutant in drinking water at 2.7 parts per billion and is harmful to fish at .81 parts per billion!

What do we mean when we describe pollution concentrations in "parts per million?" The box below will help you to understand these incredibly small concentrations.

Table VI-2. "A Drop in the Bucket" - Trace Concentrations

It may take only a very small quantity of a pollutant to create a dangerous or life threatening situation. Such small relative amounts are known as "trace concentrations." Environmental scientists express these trace concentrations as "parts per,…" indicating the amount of pollution relative to the total amount of the material in which the pollution is contained. The following table compares trace concentration levels to other common measurements.

	a trace concentration of 1 part per million equals	**a trace concentration of 1 part per billion equals**	**a trace concentration of 1 part per trillion equals**
length	1 inch in 16 miles	1 inch in 16,000 miles	1 inch in 16 million miles
area	1 sq. ft. in 23 acres	1 sq. ft. in 36 sq. miles	1 sq. ft. in 250 sq. miles
volume	1 drop of lemon in 252 cups of tea	1 drop of lemon in 15,750 cups of tea	1 drop of lemon in 500,000 barrels of tea
time	1 minute in 2 years	1 second in 32 years	1 second in 320 centuries
money	1 cent in $10,000,000	1 cent in $10 billion	1 cent in $10 trillion

adapted from: Lori LarMarche, Stayton High School in Streamkeepers

How does nature keep water clean?

Processes such as erosion, algal blooms and mineral leaching can affect the water quality of a stream, often dramatically. A well-functioning natural system will usually adjust to these processes. Nature even cleans up some human messes. A well-functioning stream or lake cleans up pollutants by filtering, trapping sediment and other means. How much pollution it can handle is called its *assimilation capacity,* and this changes with the size of the waterbody, the surrounding geology and vegetation and the climate. The following components of the system help to clean up water pollution.

Riparian Vegetation
As water flows through the riparian zone, vegetation traps sediment and pollutants before they can reach the stream. The plants in these areas also take up nutrients from runoff and shallow groundwater. Finally, riparian vegetation shades a stream, which keeps temperatures low. These are especially important functions for streams that run through areas of intense agriculture or development.

Soil
Many dissolved pollutants attach to tiny soil particles or other dissolved minerals. When these particles sink to the bottom, the pollutants are removed from the water. However, these pollutants still represent a problem to organisms living in the stream bottoms. Also, if the water chemistry changes or streamflow increases, these particles may be suspended back into the water column. For example, phosphorus attaches to aluminum and calcium in soils and sinks to the bottom as a solid. But, if oxygen concentrations or pH get too low, the phosphorus re-dissolves into the water.

Biological Uptake
The living organisms in a waterbody (fish, **macroinvertebrates**, plants, bacteria, etc.) remove materials from the water and excrete other materials back into the water. This changes the water's composition. For example, plants remove nitrate and dissolved phosphorus as well as other nutrients and minerals. When the plant dies, these nutrients may be released back into the water, but often not in a dissolved form that would be considered a pollutant.

What can we do to keep our streams clean?
We know humans impact water quality by introducing pollutants into the environment. We also have the power to clean up those pollutants. Even better, we can prevent them from entering our streams and lakes in the first place. Read below to find out how people can help stop water pollution.

Controlling point source pollution
Pollution from point sources is often highly concentrated and quite harmful. Fortunately, these sources can be identified and controlled. If the pollution exceeds acceptable limits, then the responsible party can be made to reduce or eliminate it. Oftentimes fines will be levied until the responsible party complies.

Strict Federal and State regulations help to stop water pollution before it happens. Point sources are required to get a permit from the Environmental Protection Agency (EPA) or State water quality agency. This "permit to pollute" tells them how much and which types of pollutants they can be discharged.

Controlling nonpoint source pollution
Nonpoint sources are more difficult to identify and control due to their widespread nature. For example, a stream may run through municipal areas, industry and agriculture, all within a relatively small area. Contamination of that stream must first be traced to one of these sources. Then, it must be determined where within that source the pollution is coming from. If the source is lawn fertilizer from a suburb, the challenge then is to educate each homeowner about the dangers of over-fertilizing.

The complex nature of nonpoint source pollution cleanup requires individuals, households and communities to take responsibility for their own actions. The difficulty of enforcing nonpoint source regulations increases the importance of individual and community responsibility.

Here are a few things we can do:

- Use *less harmful alternatives* instead of hazardous materials at home. For example, a weak vinegar solution, or even water, makes a good substitute for glass cleaner. Baking soda and vinegar can help to unclog drains instead of toxic drain cleaners.
- *Reduce your use* of hazardous materials. Use only the amount needed and share leftovers with others.
- *Recycle*! Recycling is a good way to handle some types of hazardous wastes. Contact your local recycler to find out what materials they will accept.

> **Recycling and water quality**
> Did you know it takes the energy from 12 oz of gasoline to produce an aluminum can?! But, it only takes 2 oz to recycle a can into a new one! By recycling just one can, you prevent the pollution generated by burning 10 oz of fuel.

- Follow directions to ensure that you *handle, store, and dispose of hazardous chemicals properly*. Take hazardous waste to a handling center – don't dump them down the storm drain or throw them away with your regular garbage. Take special care when handling and discarding the following household items:
    - paint removers
    - pesticide and insecticide cans
    - paint thinners
    - herbicide containers
    - fingernail polish removers
    - auto fluids (antifreeze, batteries)
    - used oil and oil filters
- Keep an eye out for local *toxic roundups*. Most communities collect unwanted, hazardous household waste once or twice a year. They dispose of the material properly instead of sending it to the landfill where it may leak into surface and groundwater supplies.
- *Educate others about pollution*. Share what you have learned about pollution prevention with you friends, family, school and community. Posters, collages, and poems are just a few ways to teach others. Refer to "Stewardship," section V-3, for more ideas.

> Composting lawn clippings and table scraps is a great way to convert these materials back to a useful form. When these materials are reused in gardens, it improves your soil. It also keeps the nutrients and organic materials contained in this waste from finding their way into our streams.

Sometimes we feel as if we can't make a difference in our world. Using these tips and others we can make a difference. Revisit "Drop in a Bucket" from above to remind yourself of just how little pollution it takes to degrade water quality. Now, think about how much water you've helped just by properly disposing of a cup of chemicals or by recycling just one drink container. When you teach others about water pollution you multiply that effect. You <u>can</u> make a difference.

Resources for Further Investigation

Environmental Defense Fund (EDF) – Enter your zip code on the home page to find the types, sources and amounts of pollutants being released into your community. The site will also rank your county against other counties in the State and across the nation in these categories. Find in-depth information on air and water pollution, industrial pollutants, animal waste, pollution standards and criteria, and more. There is also a section on how to take action against pollution in your particular community. www.scorecard.org

---------- This EDF site has information on water pollution and personal actions to prevent water pollution. There's a separate section for kids and teachers. www.edf.org/programs/PPA/TakeAction/pollprev.html

Home Environmental First Aid Kit – This 22 page guide contains a number of suggestions that every person can use to make a difference in handling household pollutants. The publication also provides colorful illustrations and facts about keeping groundwater healthy and the benefits of energy and water conservation. City of Anaheim, Public Utilities Department, Environment and Safety Division, (714) 254-4279.

Water Conservation and Nonpoint Source Pollution – A compilation of background material, lesson plans and activities for studying water pollution and conservation. International Office for Water Education, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200. (800) 922-4693.

Bibliography

Agricultural Research Service, U.S. Department of Agriculture. "Agricultural Phosphorus and Eutrophication." ARS-149, July, 1999.

California State Water Quality Control Board. Water Quality Criteria. State Water Quality Control Board, Sacramento, CA. 1963.

Environmental Protection Agency. "Polluted." Office of Wetlands, Oceans and Watersheds. EPA-841-F-94-005, 1994

Mitchell, Mark and William Stapp. Field Manual for Water Quality Monitoring. Thompson-Shore Printers. Dexter, MI. 1994.

Moore, J.A., and J.R. Miner. "Stream Temperatures: Some Basic Considerations." Oregon State University Extension Service. May, 1997.

Murdoch, Tom, et al. Streamkeeper's Field Guide. Everett, WA. Adopt-A-Stream Foundation. 1996.

University of Wisconsin – Environmental Resources Center. Give Water a Hand. College of Agriculture and Life Science, Madison, WI. 1997.

Utah Division of Water Quality. 1996 Water Quality Assessment Report to Congress (538-6146). Salt Lake City, UT. 1996.

IV-4. Water Regulations

Key Terms

prior appropriation doctrine	riparian doctrine
water quality criteria (numeric and narrative)	water quality standards
	total maximum daily load (TMDL)

How do we define water quality?

Every state, has regulations to protect water quality. But, how do we define water quality? In "Water Pollution," section VI-3, we learned that there is no single definition for "good" or "poor" water quality. A fish would find water from your faucet to be highly polluted (too much chlorine and not enough dissolved oxygen). Conversely, you would get quite sick drinking water in which some critters thrive.

In order to define the water quality of a stream, lake or **reservoir** we must first determine how the water body is to be used - its **beneficial uses**.

Clean Water Act
In response to public concern about water quality in our Nation's waters, Congress enacted landmark legislation in 1972. This statute, the Clean Water Act, greatly expanded and built upon existing laws to control and prevent water pollution. The Environmental Protection Agency (EPA), enforces the act by requiring individual states to meet water quality standards. States must report their water quality conditions to the EPA every 2 years.

What are beneficial uses?

Within Utah, each waterbody is assigned a beneficial use(s) designation that defines how that waterbody is to be used. These uses may include: drinking, agriculture (e.g., irrigation, animal watering), recreation (e.g. swimming), fish and wildlife habitat, aesthetics, and mineral extraction. Refer to Tables 3 and 4 for beneficial use designations in Utah.

Table VI-3. Beneficial Use Designations in Utah (Partial List)

Class 1 - Drinking water designations
- 1C – Domestic purposes with prior treatment (drinking water)

Class 2 – Protected for recreation and aesthetics
- 2A – Primary contact recreation (swimming)
- 2B – Secondary contact recreation (boating, wading)

Class 3 – Protected for aquatic wildlife
- 3A – Coldwater species of game fish and other aquatic life
- 3B – Warmwater species of game fish and other aquatic life
- 3C – Nongame fish and other aquatic life
- 3D – Waterfowl, shore birds and other water oriented wildlife

Class 4 – Protected for agricultural uses (irrigation and stock watering)

Class 5 – Protected for the Great Salt Lake only (primary and secondary contact recreation, aquatic wildlife and mineral extraction)

Table VI-4. Examples of Stream and Lake Designations in Utah

Bear River from GSL to Utah - Idaho border – 2B, 3B, 3D, 4

Deer Creek Reservoir - 1C, 2A, 2B, 3A, 4

Fish Lake - 2B, 3A, 4

Flaming Gorge Reservoir (Utah portion) - 1C, 2A, 2B, 3A, 4

Great Salt Lake - 5

Hyrum Reservoir - 2A, 2B, 3A, 4

Jordanelle Reservoir - 1C, 2A, 3A, 4

Lake Powell - 1C, 2A, 2B, 3B, 4

Logan River and tributaries from Cutler Reservoir to headwaters - 2B, 3A, 3D, 4

Pineview Reservoir - 1C, 2A, 2B, 3A, 4

Porcupine Reservoir - 2B, 3A, 4

Utah Lake - 2B, 3B, 3D, 4

Weber River and tributaries from GSL to Slaterville Diversion – 2B, 3C, 3D, 4

Willard Bay Reservoir - 1C, 2A, 2B, 3B, 3D, 4

[Visit the Utah Division of Water Quality web site for a complete listing]

http://www.eq.state.ut.us/eqwq/dwq_home.ssi]

What are water quality standards?

Once we have designated the beneficial uses for a waterbody, we must then determine the maximum or minimum concentration of chemicals (e.g., nitrate) or other properties (e.g., turbidity) that can exist in the waterbody while still supporting the beneficial use. The specific criteria that are set for each beneficial use are called **water quality standards**. When a State water quality management agency (e.g. Utah Division of Water Quality, Utah Division of Drinking Water) collects water samples, they compare the values they measure with the standard. Water quality standards come in two forms – **numeric criteria** and **narrative criteria**.

Numeric criteria

Numeric criteria are chemical, physical or biological properties of water typically expressed in concentrations (e.g. mg/L). Refer to Table VI-5 for numeric criteria for *Utah Stream Team* water quality parameters.

Narrative criteria

Narrative criteria state that no material may be put in State waters that will degrade the water quality. For example, "all waters should be free from substances… that: 1) settle to form objectionable deposits; 2) float as debris, scum, oil, or other matter to form nuisances; …" While not as specific as numeric criteria, narratives can provide powerful blanket protection for water bodies. They can also be loosely interpreted, which can cause debate over their use.

An **indicator** is another way to gauge water pollution. Indicators are not legal criteria, but rather a sign that there may be a problem. For example, a nitrate concentration of 4 mg/L *indicates* a potential pollution problem. When these levels are exceeded, further studies are required.

Table VI-5. Numeric Criteria for Utah Stream Team Water Quality Parameters

Turbidity – an increase of more than 10 Nephelometric Turbidity Units (NTU's) over natural levels is unacceptable for recreation and aesthetics (2A), warmwater fisheries (3B), and coldwater fisheries (3A)
- an increase of more than 15 NTU's over natural levels is unacceptable for nongame fish and other aquatic life (3C), waterfowl (3D)

Temperature – maximum temperature of 27ºC for warmwater fisheries (3B), nongame fish and other aquatic life (3C)
- maximum temperature of 20ºC for coldwater fisheries and other aquatic life (3A)

pH – range of 6.5 to 9.0 for drinking water (1C), recreation (2A), aquatic wildlife (3A-3D), and agriculture (4)

Dissolved Oxygen (30 day average)
– minimum concentration of 5.0 mg/L for nongame fisheries (3C), waterfowl (3D)
-- minimum concentration of 5.5 mg/L for warmwater fisheries (3B)
-- minimum concentration of 6.5 mg/L for coldwater fisheries (3A)

Nitrate – maximum concentration of 4 mg/L is a pollution indicator

Ammonia – varies with pH and temperature

Total Phosphorous – a concentration over .05mg/L is a pollution indicator in streams
- a concentration over .025 mg/L is considered a potential problem in lakes

Utah's Watershed Approach

Utah's Division of Water Quality uses a watershed approach to protect its waters. This means that when the state determines that a stream or river is polluted, activities throughout the entire upstream watershed are evaluated to determine their possible contribution to the problem. This way all the sources of a given pollutant – both point and nonpoint – are taken into consideration.

If the Division of Water Quality determines that a stream is too polluted, then they work with the entire watershed to find a solution. The maximum amount of pollutant allowed in the stream is often identified in these cases. This is called a Total Maximum Daily Load (TMDL), which is simply the maximum amount of a given pollutant that a river, lake or reservoir can handle before its beneficial uses are affected. The TMDL becomes a goal, and the agency and watershed groups work land owners, businesses and other sources of the pollutant in the watershed to reduce their contributions and to finally meet the TMDL goal.

What regulations affect water use?

Water quality standards are regulations which protect the quality of water. There are different kinds of laws which determine whether water can be removed from a waterbody (e.g., for irrigating or for cooling water at a power plant). These other laws are older than water quality regulations and developed differently in different parts of the country depending on water availability.

Prior Appropriation

Most Western states, including Utah, follow the **prior appropriation doctrine**. When pioneers settled Utah they claimed rights to streams (or other waterbodies). Under this doctrine, they were allowed to divert a specified amount of water from a public water source for their own use. The first person or family to claim rights had priority to use the water over those who followed. In dry years the first claimant, or first few claimants, may have been the only ones to be able to draw water. We call this doctrine, which still exists today, the "first in time, first in right" doctrine. Most western states, including Utah, also apply the prior appropriation doctrine to groundwater.

Riparian doctrine

The **riparian doctrine**, or common law doctrine, gives a private land owner certain rights to water that borders or crosses his/her property. These rights include use of water for household needs, live stock, recreation (including fishing) and power generation. This type of water law is found in eastern states, where water is more plentiful.

Resources for Further Investigation

Introduction to Water Quality Standards – This Environmental Protection Agency publication provides general information about the water quality standards program. Information is also included about where to obtain additional information about water quality standards. Contact: U.S. Environmental Protection Agency, Office of Water Quality, Office of Science and Technology, Standards and Applied Science Division (4305), 401 m St, SW, Washington, DC 20460; www.epa.gov

A Guide to Wetland and Stream Permitting in Utah – This guide provides an overview of the major permits, regulatory laws, policies and programs that apply to Utah's water bodies, and the agencies that oversee each. Contact: Utah State University Extension Service, 4900 Old Main Hill, Utah State University, Logan, UT 84322-4900; (435)797-2465, Fax: (435)797-2443; nancym@ext.usu.eduwww.ext.usu.edu/natres/wq/inde.g.htm

Standards of Quality for Waters of the State – This State of Utah web site provides a complete listing of designated beneficial uses and numeric water quality criteria for State waters. Find your waterbody here. http://www.rules.state.ut.us/publicat/code/r317/r317-002.htm#H8

USGS Guide to Federal Environmental Laws and Regulations - Water Quality – This web site provides an overview of all major federal laws involving water quality. http://water.usgs.gov/eap/env_guide/h2o_quality.html

Bibilography

Daugs, Don. Water Education…with an Emphasis on Deer Creek Reservoir – Provo River Drainage Area. Mountainland Association of Governments. Provo, UT. No date.

Office of Water - Environmental Protection Agency. Introduction to Water Quality Standards (EPA-823-F-99-020). Environmental Protection Agency. Washington, DC. 1999.

State of Utah. Rule R317-2. Standards of Quality for Waters of the State. http://www.rules.state.ut.us/publicat/code/r317/r317-002.htm#H8

United States Geological Survey. "Water Quality Standards and Implementation Plans" [303 (33 U.S.C. 1313)]. USGS Guide to Federal Environmental Laws and Regulations - Water Quality. http://water.usgs.gov/eap/env_guide/h2o_quality.html

Utah Division of Water Quality. 1996 Water Quality Fact Sheet. Utah Department of Environmental Quality. Salt Lake City, UT. 1996.

State of Utah. Rule R317-2. Standards of Quality for Waters of the State. http://www.rules.state.ut.us/publicat/code/r317/r317-002.htm#H8