

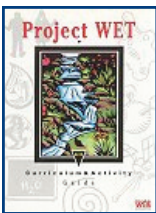
# Arizona Water Map Curriculum Guide

## *Arizona Water Map Curriculum Guide Summary*

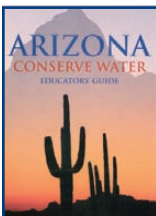
The **Arizona Water Map** is an educational tool for all ages. The **Arizona Water Map Curriculum Guide** is designed to assist educators in using the Map to teach about Arizona water resources and enhance the traditional curriculum for middle and high school students. Graphics, maps and charts for students to interpret replace lengthy sidebar descriptions on this Map edition. The Arizona NEMO (Non-point Education for Municipal Officials) program produced the maps and graphics that are part of this curriculum guide.

### Referenced Lesson Plans

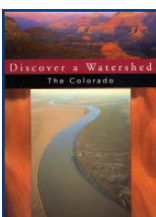
Arizona Project WET (APW) is a program of University of Arizona (Arizona Cooperative Extension, the Department of Agricultural Education and the Water Resources Research Center). APW offers a comprehensive set of Guides and lessons for teaching about Arizona's water resources. A description of each Guide follows. Lessons from these Guides are suggested as vehicles to teach the concepts covered in the nine graphic discussion pages. In addition, expository text about each graphic provides relevant reading designed for the explanation stage of instruction, following engagement and exploration.



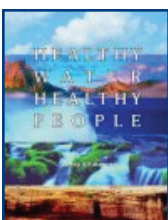
The **Project WET Curriculum and Activity Guide** is a nationally acclaimed publication offering lessons that creatively teach the physical and chemical properties of water and how those allow water to move through life and earth systems. The lessons teach about water as a natural resource, its integral role in human development through time and the management of this precious resource. The abbreviation PW denotes lessons from this book.



The **Arizona Conserve Water Educators' Guide** offers relevant lessons that explore Arizona's water resources and wise water use. We conserve water because we live in an arid to semi-arid state, endowed with the third highest biodiversity of any U.S. state. Arizona is beautiful and that beauty depends on water. Lessons cover the interconnection of all water supplies and water users and spotlight conservation inside and outside the home, including water reuse, water audits and new technologies. Ten true Arizona water conservation stories provide evidence that conservation is both important and smart business. The abbreviation ACW denotes lessons from this book.



The **Discover a Watershed: The Colorado Educators' Guide** offers lessons about the watershed that we live in. Arizona is the only state that lies almost entirely within the Colorado River watershed. This Guide tells the story of Arizona from the beginning of Roosevelt Dam in 1902, to negotiation of the Colorado River compact, through the present. It tells of innovation and enterprise in ensuring Arizona's future water supplies, and of how changes to Arizona's natural systems have caused unintended consequences affecting the watershed within which we live. The abbreviation DAW denotes lessons from this book.



The **Healthy Water, Healthy People Water Quality Educators' Guide** raises the awareness and understanding of water quality concepts and their relationship to personal, public, and environmental health. The interactive lessons interpret water quality concepts and promote diverse learning styles, with foundations in the inquiry process and scientific investigation. A Field Monitoring Guide describes eleven common water-testing parameters. The abbreviation HWHP denotes lessons from this book.

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 1: Arizona Water Map



#### Expository Text

The importance of water is never more evident than in this semi-arid to arid state known as the heart of the desert southwest. It is a land of extremes. Topography varies across the state from snowy mountaintops to scorching deserts, providing for great biodiversity. On the map, low elevations are delineated in brown moving to forest green for the highest elevations. Lime green areas are agricultural lands. Pink areas designate the Phoenix and Tucson greater metropolitan areas and cities are marked with orange circles, though not all cities are included. Other map features include counties, mountain ranges, National Parks, Native American Reservations and Riparian Conservation Areas.

Reservoirs, important surface water supplies across the state, are dark blue on the map. The reservoirs on the Colorado River and the 6 reservoirs around the Phoenix metro area, part of the Salt River Project water supply, account for most of the surface water used in the state. The Central Arizona Project (CAP) canal is delineated with a thick yellow line from Lake Havasu on the western boundary of Arizona to south of Tucson. Lake Pleasant is a CAP storage reservoir north of Phoenix.

Groundwater is as important to the state as any other water source. The withdrawal, use, and transportation of groundwater in the state are highly regulated in five designated active management areas (AMAs), where management goals and conservation are mandated. On the Arizona Water Map, these areas are shown in shades of purple and include the Phoenix, Pinal, Prescott, Santa Cruz and Tucson AMA's. The magnitude of overdraft in these AMAs led to their designation. Outside AMAs, persons may generally withdraw and use groundwater for any reasonable and beneficial use, subject to the groundwater transportation laws.

In areas designated as irrigation non-expansion areas (INAs), irrigation acreage expansion is prohibited and metering and reporting requirements apply to certain groundwater withdrawals. There are three INAs: the Douglas INA, Joseph City INA and Harquahala INA, also shown in shades of purple on the map.

Arizona currently uses its entire allocation of Colorado River water by storing some of the CAP water in the ground. This is done by allowing CAP water to flow to recharge basins where it can percolate into permeable ground. Groundwater recharge facilities are designated with green bulls-eye symbols.

#### Major Concepts:

- Water is the lifeblood
- Maps synthesize data
- Surface water and ground water are both important to Arizona's water supply

#### Vocabulary:

- semi arid to arid
- topography
- reservoirs
- groundwater basin
- overdraft
- renewable
- irrigation
- allocation
- recharge
- percolate
- permeable

#### Arizona Project WET Lesson Links:

- Read the Layperson's Guide to Arizona Water a publication of the Water Resources Research Center download at: [http://ag.arizona.edu/azwater/publications.php?rcd\\_id=50](http://ag.arizona.edu/azwater/publications.php?rcd_id=50)

Arizona Academic Standards Correlation:  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

#### Objectives

Students will:

- Interpret a map
- Develop questions that arise from study of the map
- Distinguish unfamiliar features
- Report on a topic derived from the above reading

#### Suggested Extensions

- Review and recognize map reading skills

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 2: Physiographic Provinces



#### Major Concepts:

- Arizona's geography is extremely diverse
- Great biodiversity is found in Arizona's biomes
- Water resources vary in each province

#### Vocabulary:

- physiographic
- topography
- geologic
- basin
- aquifer
- alluvial
- range
- plateau
- conifer

#### Arizona Project WET Lesson Links:

- Arizona Biomes (ACW p. 8-9)
- *Estivation, Xerophytes, and Ephemerals* (ACW p. 91)
- Plant List by Province (ACW pp. 141-143)

#### Arizona Academic Standards Correlation:

<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

#### Expository Text

Geographers view Arizona in terms of three major physiographic regions or provinces: the Colorado Plateau, the Central Highlands Transition Zone and the Basin and Range Province. These regions have distinct topography and geologic origins. The Colorado Plateau in northern and eastern Arizona ranges from 4,000 to 9,000 feet above sea level – its rock formations and deep canyons are known around the world; the Grand Canyon is one of them. The Mogollon Rim forms the edge of the Colorado Plateau in Arizona.

The region below the Rim, called the Central Highlands, is characterized by extensive forests of ponderosa pine and mixed conifers. Unlike the Colorado Plateau to the north, granitic and metamorphic rocks are exposed in many areas. The heat, pressure and water associated with metamorphism caused intense mineralization of nearby rocks, particularly limestone, forming copper minerals. These valuable copper deposits are still being mined in the Clifton-Morenci area and the Globe-Miami area.

The Basin and Range Province includes the south and western portions of the state and is recognized by successive mountain ranges, so called "sky islands" isolated from each other by broad basins. Many sky islands (like the Santa Catalinas, Pinalenos and Huachucas) exceed an elevation of 9,000 feet above sea level.

Water resources vary in each of these provinces. The Colorado Plateau consists of mostly layered hard rock, sandstone and limestone. The transition zone has a mixture of both fractured rock and alluvial basins. Fractured rock aquifers are much more limited than the aquifers in the Basin & Range. Much of the surface water runs seasonally mostly in the winter and following summer thunderstorms. Vast sand and gravel alluvial aquifers, in the basins between mountain ranges, characterize the Basin and Range Province. Surface water is scarce in this province. Aquifers are discussed in detail in Graphics 6, 7 and 8.

#### Objectives

Students will:

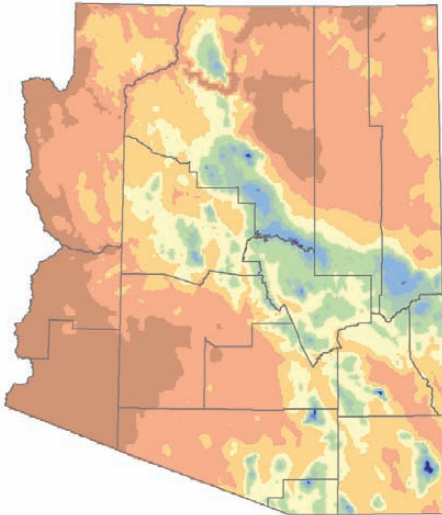
- Define physiographic
- Interpret a map and describe the three provinces in Arizona
- Analyze the diversity of life found within Arizona and examine the causes for that biodiversity
- Compare and contrast the three physiographic provinces found in Arizona

#### Suggested Extensions

- Read excerpts and engage in the suggested lesson
- Report on a city in Arizona and identify the physiographic province in which it is found
- Discuss the different biomes (and plants and animals) in Arizona and identify the provinces in which they are found

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 3: Annual Precipitation



#### Major Concepts:

- Precipitation in Arizona varies greatly mostly due to differences in elevation
- Snowpack is important to Arizona's water supply

#### Vocabulary:

- arid
- precipitation
- elevation
- topography
- monsoon
- range
- snow pack
- rain gauge

#### Arizona Project WET Lesson Links:

- Arizona Climate Data for Arizona Cities and Towns (ACW pp. 306-307)
- Compare the "Vegetation and Average Annual Max Temperature maps to the Annual Precipitation Map" for Arizona (found at: [http://cals.arizona.edu/arizonawet/resources/adapt-apply-documents/arizona\\_geographic\\_maps.pdf](http://cals.arizona.edu/arizonawet/resources/adapt-apply-documents/arizona_geographic_maps.pdf))

Arizona Academic Standards Correlation:  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

#### Expository Text

Precipitation in Arizona varies from 3 inches to more than 35 inches in any one location in a year. The high elevations like the north rim of the Grand Canyon, the San Francisco Peaks, the Central Highlands, and the highest of the sky islands get the most rainfall. The driest places exist along the Colorado River on the western border of the state and in the lowest elevations extending out from Yuma where annual rainfall is no more than 3 inches a year.

Precipitation varies from one side of the state to the other, mostly due to elevation differences. Precipitation is highly variable across Arizona due to topography and seasonal weather patterns. This is especially true during the monsoon season, when thunderstorms can produce localized heavy rainfall.

Most of Arizona receives less than 12 inches of rain a year. This makes areas with higher precipitation, like the White Mountains, critical areas for the state. Arizona water managers monitor snow pack closely because it is responsible for generating surface water that supports streamflows and fills reservoirs.

Rain gauges, both electronic and manually read, are used to track precipitation across the state. Large gaps exist over many parts of the state though. Filling in the gaps would provide valuable information for climate and drought monitoring and for resource management decision-making.

#### Objectives

Students will:

- Compare Annual Precipitation Map to the Physiographic Provinces Map (Graphic 2)
- Interpret two maps
- Describe the areas that receive the most precipitation in a year
- Describe the areas that receive the lowest precipitation in a year
- Assess the reasons for the variation in precipitation across the state
- Explain how precipitation data is collected

#### Suggested Extensions

- Join Rainlog.org (<http://rainlog.org/>), a cooperative rainfall monitoring network for Arizona. Data collected through this network is used for a variety of applications, from watershed management activities to drought planning at local, county, and state levels. All participants need is a rain gauge and access to the Internet. Volunteers select a rain gauge, install it at home or school, collect daily total rainfall amounts and report the data through the online data entry form.
- Use rainlog data to analyze the distribution or uniformity of the rainfall in your area of the state. (see *The Thunderstorm* (PW p. 196))
- Write a report about Arizona that compares and contrasts the annual precipitation map, the average annual maximum temperature map and the vegetation map for Arizona.

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 4: Watersheds



#### Expository Text

A watershed is the land area that drains water to a particular stream, river or lake. Watersheds are named after the river that drains the land. If the definition of a watershed is the land area that drains water in to a water body, then what is the boundary? The high points or ridges form the boundary. A drop of water falling on one side of the ridge flows to one watershed and a drop of water falling on the other side flows to another watershed. Recall the watershed definition: when we manage a watershed, what do you think we manage? We manage the land, for the health of the river system, ecosystem and the entire watershed system.

Streams (flowing bodies of water of any size) often start near the ridge tops and flow to the lowest point, driven by gravity. As the tributaries flow they join other small streams, growing larger and more powerful and eventually join the main stem which will carry them to the ocean. For Arizona the main stem is the Colorado River.

Why do rivers flow north? Why do rivers flow in the direction that they do? The simple answer is: Gravity works! On the Watershed Map, trace your finger along the rivers in Arizona following the direction that the red arrows point. In which direction does the river nearest to you flow? The rivers in southern Arizona flow north and west into the Gila. The Salt, Verde and Agua Fria also flow to the Gila from the north. The Little Colorado River, with its headwaters at Mount Baldy in the White Mountains, drains a vast area of the Colorado Plateau. They all flow to the Colorado River.

A riparian area is the land area directly sustained by a body of water; usually with visible vegetation or other physical characteristics showing this influence. The word riparian pertains to the banks of a river, stream, waterway, or other typically flowing body of water, as well as to plant and animal communities along such bodies of water. The term is also commonly used for other bodies of water, e.g. ponds, lakes etc., although littoral is the more precise term for such stationary bodies of water.

#### Objectives

Students will:

- Interpret the state watershed map
- Recognize the direction of flow of all large rivers in the state
- Summarize the surface water flow in Arizona
- Describe the importance of watershed management

#### Suggested Extensions

- Describe the Colorado River Watershed
- Demonstrate one aspect of a watershed system in Arizona
- Report on the management of the local watershed that you live in
- Assess some aspect of the watershed that you live in

#### Major Concepts:

- Watershed management is important because we all live in a watershed
- Rivers in Arizona flow to the Colorado River
- Riparian areas are important to Arizona's biodiversity

#### Vocabulary:

- watershed
- ridge
- tributary
- drainage
- gravity
- riparian
- littoral

#### Arizona Project WET Lesson Links:

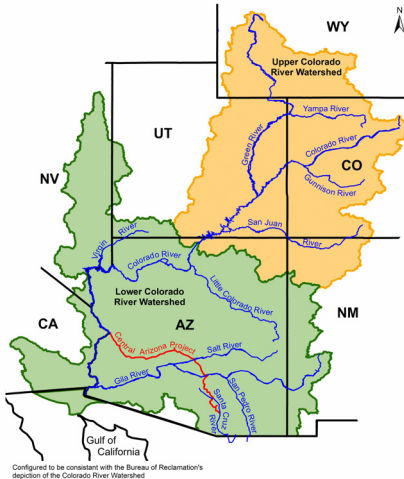
- Read: *A Journey Through the Colorado River Watershed* (DAW pp. 1-73)
- *Branching Out* Adaptation (PW p. 129)
- *Color Me a Watershed* (PW p. 223)
- *Seeing Watersheds* (DAW p. 80)

#### Arizona Academic Standards Correlation:

<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 5: Colorado River Basin



#### Expository Text

About 244,000 square miles of land is drained by the Colorado River. This area is called the Colorado River Watershed. It stretches from the mountains of Colorado (Rockies) and Wyoming (Wind River Range) south and west through Utah, New Mexico, most of Arizona, and small parts of Nevada and California. In Mexico it drains parts of Sonora and Baja California. A watershed is the land area that drains water in to a particular water body.

The Colorado River travels 1,450 miles from headwaters to the delta, flowing through a variety of ecosystems on its way. About 85 percent of the Colorado's water originates in the mountains of Colorado, yet communities and ecosystems as far south as Mexico rely on its' flow. More than 25 million people in Denver, Phoenix, Las Vegas, Los Angeles, Tijuana and other cities use its water as do people in rural areas (DAW, 2005). The river irrigates 1.8 million acres of land producing 15 percent of U.S. crops; over 80 percent of winter vegetables eaten in the U.S. are grown with its water in Yuma and Imperial Irrigation Districts (DAW, 2005).

In most years, its entire flow is stored in reservoirs or consumed and does not reach the delta at the Gulf of California, also known as the Sea of Cortez. Every drop of water is allocated (distributed according to plan) under the Colorado River Compact, and by treaty with Mexico. In 1922, negotiators of the Compact were able to agree upon dividing the watershed into two basins, the Upper and Lower. Each basin would receive 7.5 million acre feet, thus protecting the upper basin states water rights, which developed more slowly, and paving the way for the construction of dams in the lower basin. An acre-foot of water is 325,851 gallons, about the amount of water that two families of four use in a year.

Despite problems like evaporation, dams and reservoirs are an important part of the Colorado River plumbing system. They provide water storage, hydroelectric power and flood protection. Without the water storage provided by reservoirs, there would not be enough water in the river in most years to meet all of the allocations. Yet hydromodification has greatly impacted the ecosystems. Altering the flow regime, temperature, sediment transport, etc. have contributed to habitat destruction and alteration.

#### Objectives

Students will:

- Interpret the map
- List the Upper and Lower Basin States
- Discuss the pros and cons of a managed river system
- Assess the Colorado River's importance to western states

#### Suggested Extensions

- Evaluate an issue currently affecting the Colorado River system and its inhabitants and report on it using digital technology

#### Major Concepts:

- The Colorado River Watershed is extremely important to Arizona
- The Colorado River is a managed system

#### Vocabulary:

- watershed
- acre-foot
- irrigation
- reservoirs
- allocated
- dams
- hydroelectric power
- hydromodification

#### Arizona Project WET Lesson Links:

- *Seeing Watersheds & Blue Beads* (DAW p. 180)
- *Sharing the Shed* (DAW p. 244)
- *Plumbing the Colorado* (DAW p. 277)
- *Reading the Rings* (DAW p. 148)
- *An Invited Guest* (DAW p. 224)

#### Arizona Academic Standards Correlation:

<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 6: ADWR Water Basins



#### Major Concepts:

- Groundwater is an important source of water in Arizona
- Groundwater pumping is regulated by state law

#### Vocabulary:

- groundwater basin
- unconfined aquifer
- confined aquifer
- aquitard
- water table
- pump
- artesian
- overdraft
- regulation

#### Arizona Project WET Lesson Links:

- *Who's Right* (ACW p. 179)
- *Get the Ground Water Picture* (PW p. 136)
- Check out groundwater flow models from APW: <http://cals.arizona.edu/arizonawet/resources/checkouts.html>

Arizona Academic Standards Correlation:  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

#### Expository Text

About 40 percent of Arizona's water use comes from groundwater sources. Groundwater lies beneath the earth's surface in natural basins called aquifers. An aquifer is a geologic formation that is water bearing. Formations that are much less permeable, called aquitards, retard the flow of water. An unconfined aquifer is a partially filled aquifer exposed to the land surface and marked by a rising and falling water table. The water table is the uppermost level of water in the saturated part of the aquifer. Water saturated permeable layers of rock, bounded above and below by impermeable layers, are called confined aquifers. As you drill deeper into the earth there are many confined aquifers. If a well taps into a confined aquifer and the water level in the well stands above the top of the aquifer, it is an artesian well. Springs, like hot springs, can also be artesian.

In the 1940's, Arizona began large scale pumping of groundwater. In most cases, the water stored in these underground reservoirs has been in place for thousands of years. Throughout this century, groundwater has been pumped out more rapidly than it is being replenished, creating a condition called overdraft. Though a large amount of water remains stored in Arizona's aquifers, its availability is limited by location, depth and quality. Groundwater basins are delineated based on similar aquifer characteristics. On the map, blue areas delineate high volume producing aquifers.

The withdrawal, use, and transportation of groundwater in the state are regulated under the Arizona Groundwater Code. The Code's goals are: 1) to control groundwater overdraft in certain parts of the state; 2) to provide a means to allocate groundwater to meet state needs; and 3) to augment groundwater supplies through the development of new water supplies. The Code contains regulatory provisions applicable statewide, such as well drilling requirements and restrictions on groundwater transport. It also contains provisions applicable only in certain designated areas – AMAs.

Pink stipled areas delineate areas of high salinity due to agricultural practices as well as naturally occurring formations.

#### Objectives

Students will:

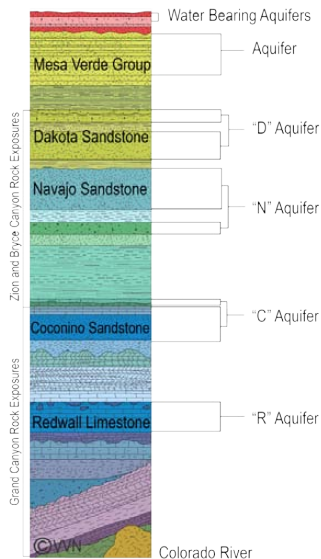
- Interpret the map and identify which basin they live in
- Distinguish between an unconfined and confined aquifer
- Design a ground water system
- Demonstrate how an artesian well or spring works

#### Suggested Extensions

- Research area wells at ADWR's groundwater data base: <http://arcims.azwater.gov/gwsi/waterresourcedata.aspx>
- Create a local cross-section using well log data
- Determine the local depth to groundwater

## ARIZONA WATER MAP CURRICULUM GUIDE

# Graphic 7: Colorado Plateau Aquifers



## Expository Text

The Colorado Plateau Province is characterized by mostly level, horizontally stratified sedimentary rocks that have been eroded into canyons and plateaus, and by some high mountains. Sedimentary formations (including thick sandstone and limestone formations) are stacked on top of one another forming four regional aquifers and many localized aquifers. Due to erosion, no location in Arizona has all of these layers present. In descending order, the regional aquifers are the D-, N-, C- and R-aquifers. Each has a very large areal extent and provides water to the people who live there. Main recharge areas are along the Mogollon Rim and the eastern side of the state. About 508 million acre-feet (maf) is estimated to be in storage in Little Colorado River Plateau aquifers (ADWR, 1990).

The C-aquifer is the largest and most productive aquifer in the Plateau Province with an areal extent of approximately 21,655 square miles. It is named for its primary water-bearing unit, the Coconino Sandstone. It is utilized as a supply south of the Little Colorado River and along the eastern edge of the basin by Flagstaff, Heber, Overgaard, Show Low, Snowflake and Concho. North of the river the C-aquifer is too deep to be economically useful or is unsuitable for most uses because of high concentrations of total dissolved solids (salinity). ADWR estimates that 413 maf are stored in the aquifer (ADWR, 1989).

The N-aquifer occurs north of the Little Colorado River and has an areal extent of 6,250 square miles. Storage estimates vary from 166 maf to 293 maf (ADWR, 1989 and USGS, 1996). Navajo Sandstone and Wingate Sandstone are the main water-bearing units in the aquifer. It is generally unconfined, but there are artesian conditions in the Black Mesa area and near Window Rock. N-aquifer water quality is good and it is a source of supply for the Navajo and Hopi reservations.

The D-aquifer is the smallest in areal extent, occurring over about 3,125 square miles. It is estimated that there are 15 maf in storage (ADWR, 1989). The D-aquifer is composed of the Dakota, Cow Springs and Entrada sandstones. There is some connection to the underlying N-aquifer. Water quality is marginal to unsuitable for domestic use due to high concentrations of dissolved solids. Local aquifers are important for domestic uses where the regional aquifers are too deep or have unsuitable water quality.

## Objectives

Students will:

- Identify distinctive characteristics of Colorado Plateau aquifers
- Examine a geologic column
- Summarize the importance of groundwater in this arid region
- Explain differences between the Colorado Plateau aquifers and the Basin and Range aquifers

### Major Concepts:

- Colorado Plateau aquifers are important sources of water in northern Arizona
- Plateau aquifers are found in some sandstone and limestone layers

### Vocabulary:

- aquifer
- groundwater
- sedimentary
- limestone
- sandstone
- siltstone
- shale
- total dissolved solids

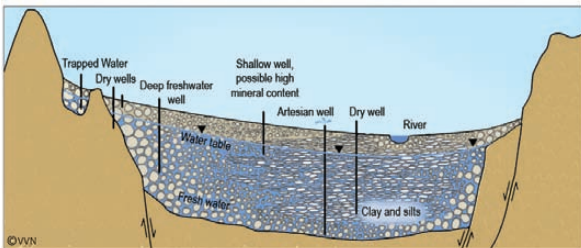
### Arizona Project WET Lesson Links:

- *Rock Sandwich Stone Soup* (DAW p. 114)
- Research Plateau Province aquifers (Volume 2): [http://www.azwater.gov/dwr/Content/Find\\_by\\_Program/Rural\\_Programs/content/water\\_atlas/default.htm](http://www.azwater.gov/dwr/Content/Find_by_Program/Rural_Programs/content/water_atlas/default.htm)

Arizona Academic Standards Correlation:  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 8: Alluvial Aquifer



#### Expository Text

The Basin and Range Province is characterized by broad, gently sloping alluvial basins separated by north to northwest trending fault block mountains. Around 15 to 18 million years ago, the mountain ranges we see today in this province developed and the valleys between them began to fill up with sediment. Stream alluvial deposits and sediment basin fill originating from the bordering mountains are the principal water bearing materials in these basins. They are characterized by small to moderate amounts of mountain-front recharge, streamflow infiltration, and significant underflow in and out of basins. Groundwater flows tend to move inward from the edges of the basin and higher elevations, then down gradient towards the outflow portion of the basin, and then out of the basin in the general direction of river drainage.

The Basin and Range Province contains deep alluvial aquifers and significant volumes of water in storage. However, since aquifer recharge rates are relatively low and pumping volumes have been large, many aquifers in this Province are in an overdraft condition. Overdraft is a condition where groundwater is pumped in excess of recharge. The definition of safe yield is to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an AMA and the annual amount of natural and artificial groundwater recharge. Subsidence is the settling or collapsing of the ground surface that occurs when soil that once had water filling pore spaces becomes dried out and collapses due to the weight of overlying material. It can occur when an aquifer is in overdraft. Fissure cracks can occur along the margins of an area where subsidence has occurred.

#### Objectives

Students will:

- Construct a cross-section of an alluvial aquifer
- Describe the ground water/surface water connection
- Summarize the alluvial aquifer system
- Report on the local aquifer status

#### Suggested Activities:

- Experiment with groundwater flow models
- Develop an inquiry lesson or science fair project that illustrates the groundwater system

#### Major Concepts:

- Basin and Range aquifers are found in large sediment filled basins
- Recharge rates to these aquifers are generally low
- Due to the pumping of large volumes of water in some areas, aquifers are overdrafted
- Land subsidence and fissure cracks can occur in areas where groundwater overdraft has occurred

#### Vocabulary:

- alluvial
- groundwater
- aquifer
- aquitard
- well
- artesian
- fault block
- infiltration
- gradient
- underflow
- recharge
- overdraft
- safe yield
- subsidence
- fissure cracks

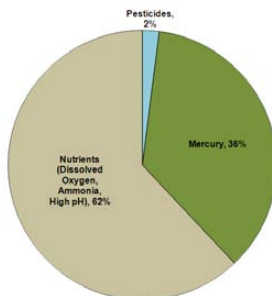
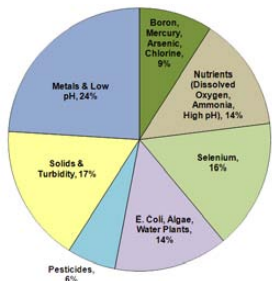
#### Arizona Project WET Lesson Links:

- *Get the Ground Water Picture* (PW p. 136)
- *San Pedro Connection* (ACW p. 71)
- Check out groundwater flow models from Arizona Project WET: <http://cals.arizona.edu/arizonawet/resources/checkouts.html>

Arizona Academic Standards Correlation:  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

**ARIZONA WATER MAP CURRICULUM GUIDE**

## Graphic 9: Arizona Lake & Stream Pollutants

**Impaired Lake Pollutants**

**Impaired Stream Pollutants**

**Major Concepts:**

- Water quality standards for the state are set by ADEQ
- Non-point Source pollution originates from multiple sources

**Vocabulary:**

- non-point source pollution
- mercury
- nutrients
- nitrogen
- phosphorus
- artesian

**Arizona Project WET Lesson Links:**

- Read: HWHP Field Monitoring Guide & check out water testing kits: <http://cals.arizona.edu/arizonawet/resources/checkouts.html>
- *There is No Point to This Pollution* (HWHP p. 136)
- *Setting the Standards* (HWHP p. 107)
- *Sum of the Parts* (PW p. 267)

**Arizona Academic Standards Correlation:**  
<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

### Expository Text

The U.S. Clean Water Act protects surface water from pollution. The amount of protection depends on a water body's designated uses. Designated uses include domestic water source, fish consumption, full and partial body contact, aquatic and wildlife (for cold and warm water and for effluent-dependent and ephemeral water), agricultural irrigation and agricultural livestock watering.

Water quality describes the chemical, physical and biological characteristics of water, and directly affects water use. Human uses of land and water along with natural factors affect the quality of water resources. The Arizona Department of Environmental Quality (ADEQ) establishes the state's water quality standards, and monitors and assesses water quality conditions statewide to determine the degree to which these standards are met.

Non-point Source (NPS) Pollution originates from land use activities, from maintenance of homes and gardens to more complex activities, such as farming, timber harvesting, and construction. Sources of NPS pollution are difficult to quantify. Dumping used motor oil in backyards, or having excess lawn chemicals run off yards contributes to NPS pollution. Storm drains often lead directly to lakes, streams, rivers, and wetlands.

Over the past several years, ADEQ has found increasing evidence of mercury contamination in many lakes and some streams throughout the state, as seen in the pie charts. As a result of this monitoring, ADEQ has issued fish consumption advisories on at least 12 water bodies in widely varying locations throughout the state including Alamo Lake, Upper and Lower Lake Mary, Lyman Lake and Parker Canyon Lake. Mercury has a direct affect on the nervous system and can have toxic effects on humans and wildlife.

Excessive levels of nutrients introduced into water bodies can decrease dissolved oxygen, increase production of algae and cause a rapid growth of lake vegetation. Algal blooms and large amounts of decaying algae consume oxygen in the water and can cause fish kills. Nutrients can also cause an increase in pH and consequently formation of ammonia, which is highly toxic to fish and aquatic life. Other pollutants of concern include suspended sediments, metals, selenium, boron, arsenic, E. Coli and pesticides.

### Objectives

Students will:

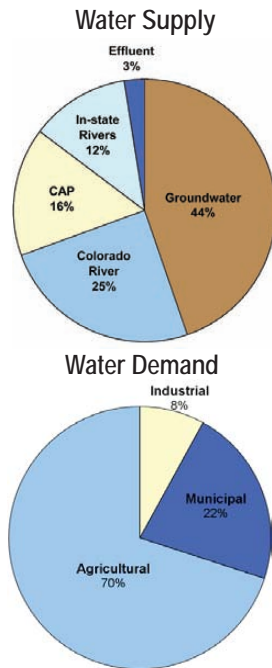
- Identify contaminants of concern to Arizona water bodies and describe the potential sources of these contaminants
- Define non-point source pollution and explain its significance
- Analyze a contaminant of concern to Arizona water bodies

### Suggested Activities:

- Conduct all lessons in Healthy Water, Healthy People Educators' Guide and describe a water quality related career path

## ARIZONA WATER MAP CURRICULUM GUIDE

### Graphic 10: Water Supply & Water Demand



#### Expository Text

Most of Arizona's water supply is surface water from the Colorado River and from in-state rivers such as the Gila, Salt and Verde. Of course, Central Arizona Project (CAP) water is surface water too. Groundwater is an important water supply throughout the state, but through increased CAP use the state has reduced the amount of groundwater pumped. Reclaimed water or "effluent" is a growing water supply for irrigation and industrial users.

Central Arizona Project is designed to bring 1.5 million acre-feet of Colorado River water per year to Pima, Pinal and Maricopa counties. CAP carries water from Lake Havasu near Parker to the southern boundary of the Tohono O'odham Indian Reservation southwest of Tucson. It is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines and is the largest single resource of renewable water supplies in the state of Arizona.

Water is used for many purposes in Arizona. Most of the water is used for agriculture in central and southwestern Arizona. Municipal uses include residential, commercial and some industrial uses. Mining, electrical power generation, dairies and feedlots comprise most of the industrial water demand. There are also environmental uses (e.g. wetland inhabitants) of water that are difficult to measure. Water use by riparian vegetation can be significant in some areas. Nonconsumptive uses of water include hydroelectric power generation and recreation such as boating, fishing and swimming.

Water demand is expected to increase as Arizona's population grows. Arizona is the second fastest growing state, increasing from 3.6 million to 5.1 million inhabitants (40%) between 1990 and 2000. By July 2006, an additional 1 million people lived in Arizona. Rapid population growth impacts water supplies and infrastructure in some areas of the state. Arizona's population is expected to exceed 11 million by 2050.

#### Major Concepts:

- Groundwater and CAP water are extremely important to Arizona's water supply
- Agriculture is the largest water user

#### Vocabulary:

- reclaimed water
- aqueduct
- effluent
- nonconsumptive
- hydroelectric
- population

#### Arizona Project WET Lesson Links:

- "Arizona Water Web" (ACW p. 190)
- Read *Home Grown Tomatoes* (ACW p. 289) & *Sundance Farms* (ACW p. 299) about agricultural water conservation

#### Arizona Academic Standards Correlation:

<http://cals.arizona.edu/arizonawet/standards/azstandardscorr.html>

#### Objectives

Students will:

- Interpret pie charts
- Summarize the data shown in the charts
- Identify 5 ways to conserve water at home and school
- Identify 5 ways to conserve water in agriculture
- Evaluate water supply and demand in Arizona
- Describe water-oriented careers in Arizona

#### Suggested Activities:

- Brainstorm and discuss water supply and water use using data from the Arizona Department of Water Resources web site: <http://www.azwater.gov/dwr/>
- Construct a graphic, poster, brochure, etc. designed to communicate the amount of water used indirectly to produce different things (see *Arizona Water Web* (ACW p. 190))



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**COLLEGE OF AGRICULTURE AND LIFE SCIENCES**  
**TUCSON, ARIZONA 85721**

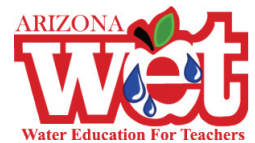
**KERRY SCHWARTZ**  
*Associate Specialist, Dept. of Agricultural Education, Water Resources Research Center*

**KRISTINE UHLMAN, RG**  
*Area Assistant Agent, Natural Resources, Water Resources Research Center*

**CONTACT:**  
**KERRY SCHWARTZ**  
[kschwart@cals.arizona.edu](mailto:kschwart@cals.arizona.edu)

This information has been reviewed by University faculty.  
[cals.arizona.edu/pubs/water/az1501j.pdf](http://cals.arizona.edu/pubs/water/az1501j.pdf)

Other titles from Arizona Cooperative Extension can be found at:  
[cals.arizona.edu/pubs](http://cals.arizona.edu/pubs)



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