MANY TRIPS TO PHOENIX

Overview

This activity introduces three major sources of the Valley of the Sun's water supply: surface, groundwater, and imported. Students use comprehension and maps skills to decide the recent past of a water molecule, H_2O. Then they synthesize their knowledge, thinking and creative skills to create a future for their molecule of water.

Subjects: Science, Social Studies. Depending on student/teacher interests, the following could be incorporated: Dance, Dramatic Arts, Language Arts, Music, &/or Visual Arts

Group Size: teams of four

Estimated Teaching Time: two hours minimum

Curriculum Framework: IA, ID, IIA, IIIA1, IIIA2, IIIB1, IIIB2, IIIB3, VIIA, VIIB

Environmental Education Framework: Goals IA, IIA, IIIA, IVA, IVB, VA

Vocabulary: aeration, agricultural users, aquifer, canals, coagulation, conservation, dams, desalination, evaporation, filtration, groundwater, industrial users, infiltration, irrigation, percolation, precipitation, Pumpkinville, recharge, reclaimed water, reservoirs, residential users, rivers, runoff, sedimentation, streams, surface water, water cycle, water table, wells, xeriscape

Objectives

Students will:

- identify the sources of the Valley of the Sun's water as groundwater, surface, and imported water, and apply that knowledge in a mapping and sequencing exercise.
- using any format they choose, create or design the future of a water drop, illustrating their knowledge of Arizona geography, water supplies, treatment, usage and cycling through a water drop's travels.

Background

More than two billion people on our planet do not have a good water supply. Phoenix is fortunate to have surface and groundwater supplies. The water that reaches the faucets of homes in the Valley of the Sun actually comes from three sources: local surface water supplies, imported surface water, and groundwater (underground aquifers).

In the Phoenix area, most people get their water from public utilities. These companies or government organizations are responsible for providing a water supply able to meet high demand periods during the

summer and meet the water needs of ever-increasing populations. They are responsible for maintaining a water distribution system that includes:

a. getting water from a natural source (river or aquifer),
b. storing water in reservoirs, towers, or recharged aquifers,
c. treating water to improve its quality, and
d. distributing the water through water mains, pump stations and feeder lines to homes and other use areas.

The Salt River Project (SRP) supplies water to most of the Phoenix area from **surface waters** stored in reservoirs behind dams on the Salt and Verde Rivers. For most of the year, except during floods, the Salt River is an empty bed where it winds through Phoenix. The Project serves central Arizona and the Salt River Valley as both a public utility and a successful multi-purpose water reclamation project, distributing annually about one million acre-feet of water. Waters from the Gila, San Pedro and Agua Fria Rivers also supply Phoenix. See related activity: **Surface Water? Dam it up!**

Imported water from the Colorado River first flowed to the Phoenix area through the Central Arizona Project in 1985. The idea of importing water from the Colorado River was generated about the time Arizona became a state in 1912. It took more than 30 years for the plan to reach Congress for authorization, and another 20 years for Arizona to win court battles (with California and Nevada) and congressional battles before the CAP was approved in 1968. In 1912, the purpose of bringing Colorado River water to Phoenix was for agricultural uses, primarily irrigation. By 1968, one-third of the use was estimated to be for municipal and industrial purposes. By 1990 the proportion of municipal and industrial use of the CAP water had grown to more than 60%, and continues to increase. CAP water substitutes for some groundwater use. Extra CAP water is stored behind the New Waddell Dam on the Agua Fria River and in artificial recharge basins.

Groundwater supplies are found in hydrologic basins or aquifers throughout Arizona. In the recent past, most waters for farming, industry and use by a growing population were pumped from aquifers by deep wells. The vast amounts needed lowered water tables drastically, causing land to subside in some areas. In 1980, Arizona passed the Groundwater Management Act to control the severe overdraft occurring in some parts of the state. The Act requires conservation by all water users in Phoenix, Prescott, Tucson, and Pinal County. Cities throughout the Valley of the Sun encourage conservation through educational programs, rebate programs (for installing low-water-use toilets and landscapes), and ordinances (such as laws requiring low-flow plumbing fixtures). See related activity: **There's Water Underground**.

State-wide, Arizona's water supply comes in the following percentages from these sources: groundwater (45%), instate rivers (30%), surface water from the shared Colorado River (19%), imported

surface water (CAP 6%), and treated wastewater (1%). The amount of surface and groundwater used by Valley communities varies greatly. The water you use every day may come from only one or a combination of sources. About 85% of Mesa's water comes from surface supplies, for example. Over 70% of Mesa's surface supplies come from the Salt and Verde Rivers through SRP, the rest from the Central Arizona Project. The other 15% of Mesa's water comes from groundwater wells that the city owns and runs only when necessary, usually in the summer. In contrast, 100% of the water used in the cities of Gilbert, Goodyear, and Peoria is pumped from the ground. In 1992, Tempe used only surface water. The percentage breakdowns for other Valley cities in 1992 were: Chandler (44% groundwater, 66% surface water), Glendale (37% groundwater, 63% surface water), Phoenix (7% groundwater, 93% surface water), and Scottsdale (41% groundwater, 59% surface water).

Phoenix residents have not always been known as conservative water users. Many new residents tried to create green-lawned oases in the desert. All users can reduce water consumption. Through efficient water use by all users and careful water management, the luxury of an adequate water supply should continue to meet projected growth in the Valley of the Sun.

In the first part of this activity, students review several ways water gets to the faucets of Phoenix-area residents. In Part 2, students are asked to synthesize their water knowledge and use their creativity to get a water molecule to Mexico.

The Colorado River water once flowed into the Pacific Ocean via the Sea of Cortez in the Gulf of California at Puerto Peñasco (Rocky Point), Sonora, Mexico. The Colorado River cannot reach the ocean any longer because so much of it is removed by water-hungry states of the U.S. The water that does reach Mexico is so filled with salt and other minerals that it is unsuitable for irrigation let alone drinking. By international treaty, the United States is obligated to guarantee at least 1.5 million acre-feet of Colorado River water to Mexico. A desalination plant built in Yuma operated from May 1992 until January 1993, when it was closed because massive flooding along the Gila River damaged canals that carry drainage water to the facility. When it was operational the plant removed salt from the water and dumped the processed water into the Colorado River where it flowed into Mexico. No one is certain when or if the plant will reopen.

The second part of the activity can also serve as an authentic assessment piece by encouraging students to include all components of the curriculum framework you may have covered in your water unit: water properties and importance, history, local resources, treatment and quality, water users, conservation, and problems and issues.

Materials

Part 1: WHERE HAS YOUR H_2O BEEN?

- clear container of water for teacher to display
- clear container of water for each team (only a few drops is fine)
- WATER MOLECULE CARDS, cut up, distribute one card per team
- Maps of AZ (those included show groundwater - on *Counties and Groundwater Basins of Arizona* and *World Map*; and surface water and imported water on *Arizona Surface Water Features* and *The Colorado River and Watershed*; teacher should provide state road maps and an atlas)
- colored pencils
- flip chart paper

Part 2: GET YOUR H_2O TO MEXICO

- costumes, art or writing supplies depend upon methods of presentation selected

Procedure

Part 1: WHERE HAS YOUR H_2O BEEN?

1. Place small, clear containers of water with each team. **Warn students not to drink the water because they do not know where it came from.** Introduce the activity by holding up a clear container of water and reading this introduction.

   "Hey, Hey you. I'm talking to you. I'm a water molecule. I'm in this container. My name's H_2O, two Hydrogen, one Oxygen. I need your help. My family and I really want to go to Mexico, but here we are back in Phoenix again. At least now we are together in this one room. There's at least one of my closest H_2O family members in each container around this room. Each of us has a story to tell about how we got to Phoenix this time. Your teacher worked really hard getting all of us together, so pay attention.

   Most of us have been around forever. Remember the water cycle? We just keep moving around: floating in the sky, flowing underground, riding rivers, going up in trees, freezing and falling as snow. Sometimes we're groundwater moving underground between particles of soil and through rocks. Sometimes we're called surface water, flowing over the ground in rivers or streams or even in the ocean. We even get labeled imported surface water when someone takes us from one place to another we could never reach naturally.

   I've been to Phoenix seven times. Around the world a couple of times, at least, but I've never been to Mexico. None of us has and we really want to go. Here's the deal: Before I trust you to get me to Mexico I want to make sure you understand water and a little bit about maps. Prove to me you can read a map by figuring out where we have been and then I'll trust you to get me to Mexico. Listen to your teacher now."

2. Explain that each team will be given a story told by an H_2O family member, and access to maps. The teams should read their water molecule's story, draw the trip on the map, and use chart paper and marking pens to show the experiences their molecule has had getting to the classroom. Each team will be responsible for a two-minute class presentation about their molecule's trip to Phoenix.

3. Give students at least fifteen minutes to prepare their presentations. Stress that they are to show how the molecule got to Phoenix and what happened to it along the way. As students are preparing, ask through which water cycle component(s) their molecule traveled. In which part of the water cycle did their molecule spend the most time? Has their molecule been surface, imported or groundwater? Where did their molecule travel? What was happening historically during those travels? By what processes were their molecules managed by people - stored, pumped, treated, diverted?

4. Let students volunteer to present each molecule's adventure, allowing two minutes to perform. During the performances, the other teams should use different colored pencils to mark their maps, showing each trip and adding the colors and H_2O names to the map legend. By the end of the presentations, students should have a sense of the variety of ways water can get to Phoenix.

Part 2: GET YOUR H_2O TO MEXICO

1. Congratulate students for figuring out how their H_2Os got to Phoenix. Now it is time to get their H_2O family member to Mexico. Students are now responsible for managing their water molecule's trip to Mexico.

2. Teams may create a verbal or visual display of the ways their molecule will make it to Mexico. Suggested formats include: story, poem, skit, video, mural for billboard, sculpture, song, brochure, T-shirt design, bumper sticker, or a comic strip. You might require five specific water vocabulary words that students should use in their drop's adventure. Let students know if they may check the glossary or their water notes to complete the activity.

3. Also let students know there is a complication: the Colorado River no longer flows all the way to the Gulf of California in Mexico. Unless there has been flooding, the river dries up miles from the ocean.

4. Have students perform or display their drip's trip to Mexico.

5. Provide awards for teams that use all the components of the water cycle; or whose molecule is groundwater, surface water and imported water; or that visits the greatest number of water users; or provides the greatest ecological, economic and social value in their travel to Mexico.

Extensions

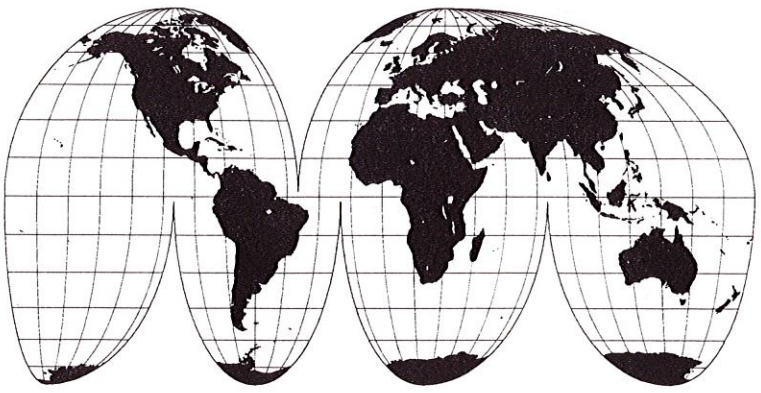
1. Have students check at home to learn if they use well or municipal water. Call your local water utility to learn the exact source of water used in the school and the students' homes. Find out how the water is treated before it reaches the faucets and after it leaves the school as wastewater. Map and discuss your findings.

2. Research water delivery systems throughout history (including the Roman's aqueducts). Investigate how people fought fires in the past in this country and in previous civilizations.

Evaluation

1. Describe three major sources of Phoenix area water supplies.

2. Explain one way a water drop might get from Arizona to Mexico. You may use the map below to support your explanation.



Resources

Arizona Department of Water Resources. **What is Groundwater?**

Arizona Department of Water Resources. 1991. **Second Management Plan, 1990-2000: Phoenix Active Management Area.**

Henry F. Dobyns. 1989. **Indians of North America: The Pima-Maricopa.** NY: Chelsea House Publishers.

Flint, Timothy. **The Personal Narrative of James Ohio Pattie of Kentucky**. Cincinnati: John H. Wood, 1831. [Reprinted in paperback edition in NY: Lippincott, 1962.

Hardt, A.L. 1989. **Phoenix: America's Shining Star.** Windsor Publications.

National Geographic Society. 1993. **Water Matters: Every Day, Everywhere, Every Way.**

Rossi, Terry Sue, City of Peoria, Engineering Division. Personal correspondence and 2/14/94 FAX.

Trimble, M. **Arizona: A Cavalcade of History.** Tucson: Treasure Chest.

University of Arizona. **Arizona WET: Water Education for Teachers.** Tucson: College of Agriculture, Water Resources Research Center.

Van Der Werf, Martin. 1993. **"Desalting plant: White elephant of desert"** in **The Arizona Republic** p. A8, 11-14-93.

Wagoner, J.J. 1975. **Early Arizona: Prehistory to Civil War**. Tucson: University of Arizona Press.

WATER MOLECULE CARDS

CAP H_2O

You can call me the imported surface water molecule, too. I fell out of the sky as snow last December in Colorado and didn't melt until April. As I was floating down the Gunnison and Colorado Rivers, I figured I would make it to Mexico this time. The Colorado River is more than 150 miles from Phoenix! But NO! I got forced into a pipe and pushed through mountains and canals as part of the Central Arizona Project or CAP Then I got stored behind the New Waddell Dam on the Agua Fria River. I was in there for months until your teacher pulled me out.

Part 1: Where has your H_2O been?

Directions: Show your H_2O molecule's trip on the map, and use chart paper and marking pens to show the experiences it has had getting to your classroom. Each team will be responsible for a two-minute class presentation about their molecule's trip to Phoenix.

Part 2: Get your H_2O to Mexico

Directions: Show how your team is going to manage to get your molecule to Mexico. Be specific. Be creative. Let us know how long the trip will take. Include at least five words or symbols from the following list: *aeration, agricultural users, aquifer, canals, coagulation, conservation, dams, desalination, evaporation, filtration, groundwater, industrial users, infiltration, irrigation, percolation, precipitation, recharge, reclaimed water, reservoirs, residential users, rivers, runoff, sedimentation, streams, surface water, xeriscape, water cycle, water table, wells.*

HOHOKAM H_2O

I have been groundwater for the last fifteen hundred years. Did you hear that? Fifteen hundred years underground! The last time I was above ground the Hohokam people were living in the Salt River Valley. They dug canals from the river and as I was flowing by, I got caught and poured on some corn (they called it maize). I sank underground, reaching the water table of the aquifer, and kept going - sometimes horizontally, sometimes down through all kinds of soil and rocks - moving only a few inches a year. I finally moved into holes in a pipe and was pumped 300 feet out of a well yesterday. YEAH! Your teacher found me at the well head.

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WATER MOLECULE CARDS

MONSOON H_2O

I don't know where to start . . . Well, a few years ago I broke off an iceberg in Glacier Bay in Alaska and started this long trip, being pushed in circles and finally south in the Pacific Ocean by the California current. Saw grey whales, sea otters, lots of neat stuff. I was sure I would make it to Mexico, but when I got near San Diego I evaporated into a fast-moving band of clouds. I got blown around a lot and hung over the Sea of Cortez in the Gulf of California for a few days. If only I could have gotten lots of other molecules together and rained, I would have been in Mexico. The winds eventually carried me and those clouds over the Sonoran Desert to Phoenix where I became part of your August monsoon rains. I was flowing down a rain gutter in the street when your teacher collected me and saved me in a jar until now.

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PUMPKINVILLE H_2O

I have been underground for more than one hundred years. Really! I was above ground in 1869 when Phoenix was called Pumpkinville. It was summer, monsoon season, and I was near the Verde River. It looks different now. Huge trees lined the river banks then. A couple times I got poured on the ground to irrigate pumpkins and hay, transpired by those plants or evaporated from the ground into clouds, only to become part of the next rain storm. Finally I soaked down too far to evaporate. And I just kept going - sometimes horizontally, sometimes down through all kinds of soil and rocks - moving only a few inches a year. I finally moved into holes in a pipe and was pumped 300 feet out of a well yesterday. YEAH! Your teacher found me at the well head.

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WATER MOLECULE CARDS

WASTE WATER H_2O

You could also call me reclaimed or recycled water because a week ago someone was brushing her teeth with me. Reusing or reclaiming water is a great way to stretch the water supply of Phoenix. If more water was reclaimed to irrigate crops and big grassy areas like parks and cemeteries, more fresh water would be left for drinking. Anyway, I went down the drain with a bunch of toothpaste, through a series of pipes to a place where I went through aeration, coagulation, sedimentation (or settling) and filtration. Then I was piped with other reclaimed water to a golf course. They were going to use me to irrigate the 18th green until your teacher scooped me up in this container.

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RECHARGED H_2O

Some of my friends call me "Artificial." Instead of naturally recharging groundwater supplies by percolation of rainwater or some other kind of precipitation, I got put back into the ground by people. They did it on purpose! I came to Phoenix with the Central Arizona Project (out of the Colorado River) last winter when there was lots of water. Because there was extra water, experts (hydrologists) decided to store water until it was needed. They spread a bunch of water molecules on a dry canal not far from the Granite Reef Dam. We soaked down to the water table of the aquifer. They tested the water yesterday by pumping me and some others up to the surface. That's where your teacher found me.

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WATER MOLECULE CARDS

SALT RIVER H_2O

I fell from the sky during a snow storm a few years ago. I landed on a cactus in the most beautiful place I've ever seen, the Salt River Canyon on the San Carlos Indian Reservation in the White Mountains. I did my best to stay in some smaller streams of that watershed, but pretty soon I was moving as fast as surface water goes. Went through the Roosevelt Lake and around that Dam very easily. The trip through Apache Lake was very fast, too. Then I got caught in the pumped-storage unit of the Horse Mesa Dam. That's where the same water gets used repeatedly to generate electricity. Round and round, up and down, turning the turbines connected to the generator to make electricity for the people who live in Phoenix. Your teacher visited the dam, gathered this water sample, and got me away from all that.

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VERDE RIVER H_2O

HI! I got to Arizona a few months ago and have been making my way to Phoenix along the Verde River ever since. I was part of a little rainstorm north of Camp Verde, not far from Flagstaff. I joined with some other water molecules in the watershed and flowed over the surface to Horseshoe Lake and over the dam there. Things were easy until I hit Bartlett Reservoir behind Bartlett Dam. I didn't think I was ever going to get out of there. Finally, someone ordered a lot of water, and I moved by remote control through the canal system of the Salt River Project. It took about six hours to get to the Granite Reef Diversion Dam and another four hours to get to Scottsdale. There a zanjeros (zan-hair'-ohs), or ditch tender, opened the gates on a lateral or small canal I was traveling on. Had it not been for your teacher rescuing me, I would have been irrigating a field. Who knows how long it would take me to get to Mexico?

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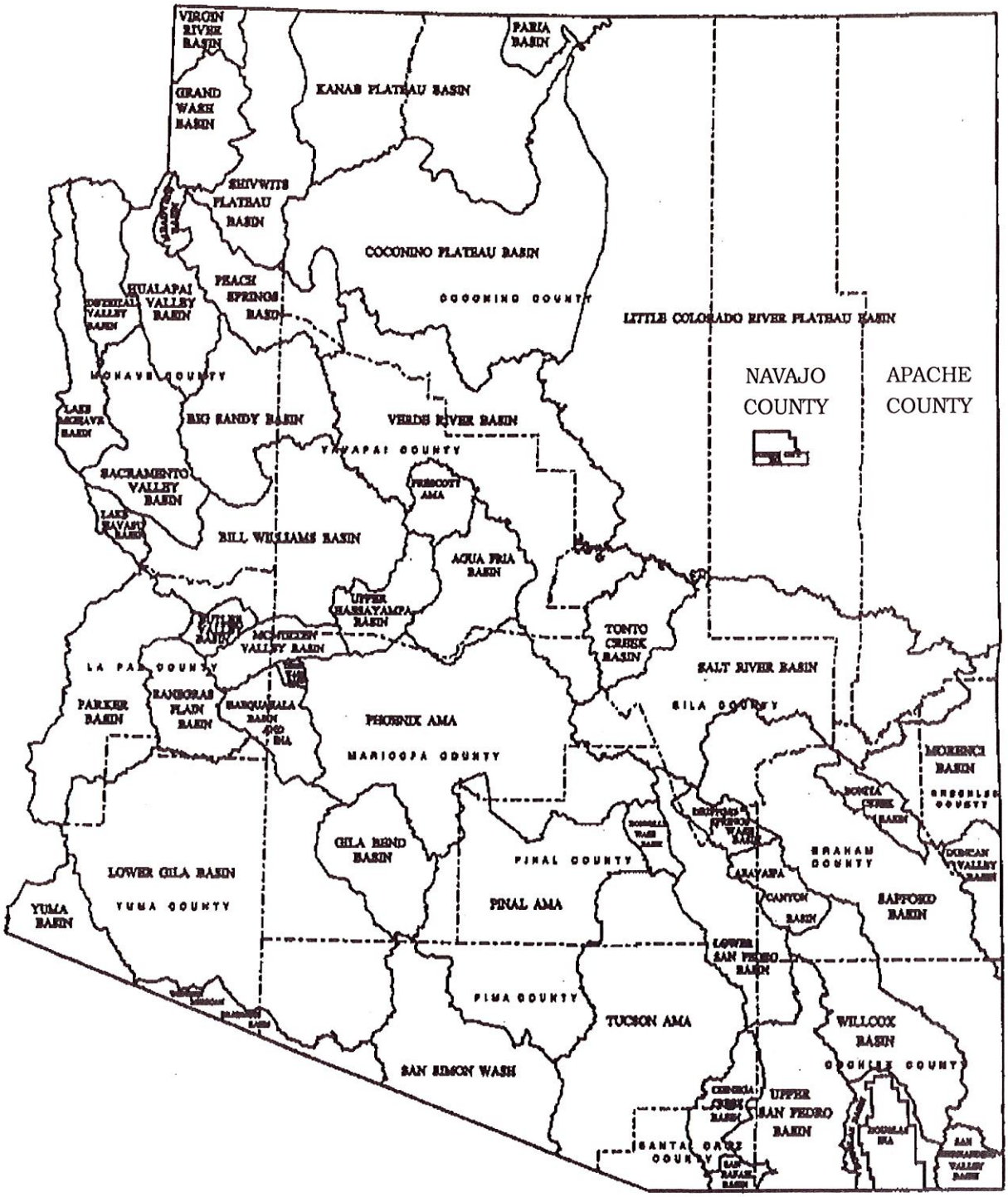
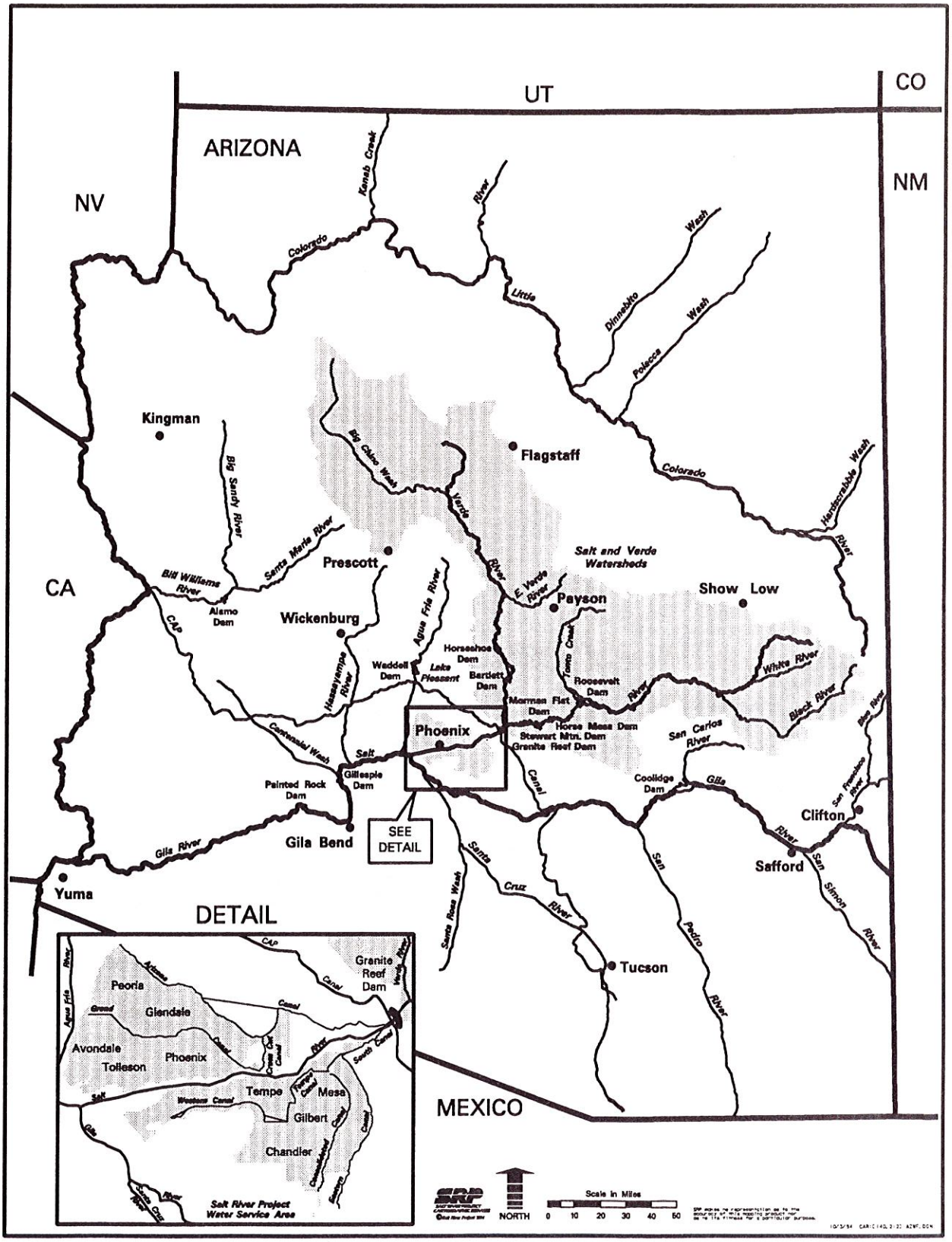
MANY TRIPS TO PHOENIX - STUDENT PAGE

COUNTIES AND GROUNDWATER BASINS OF ARIZONA

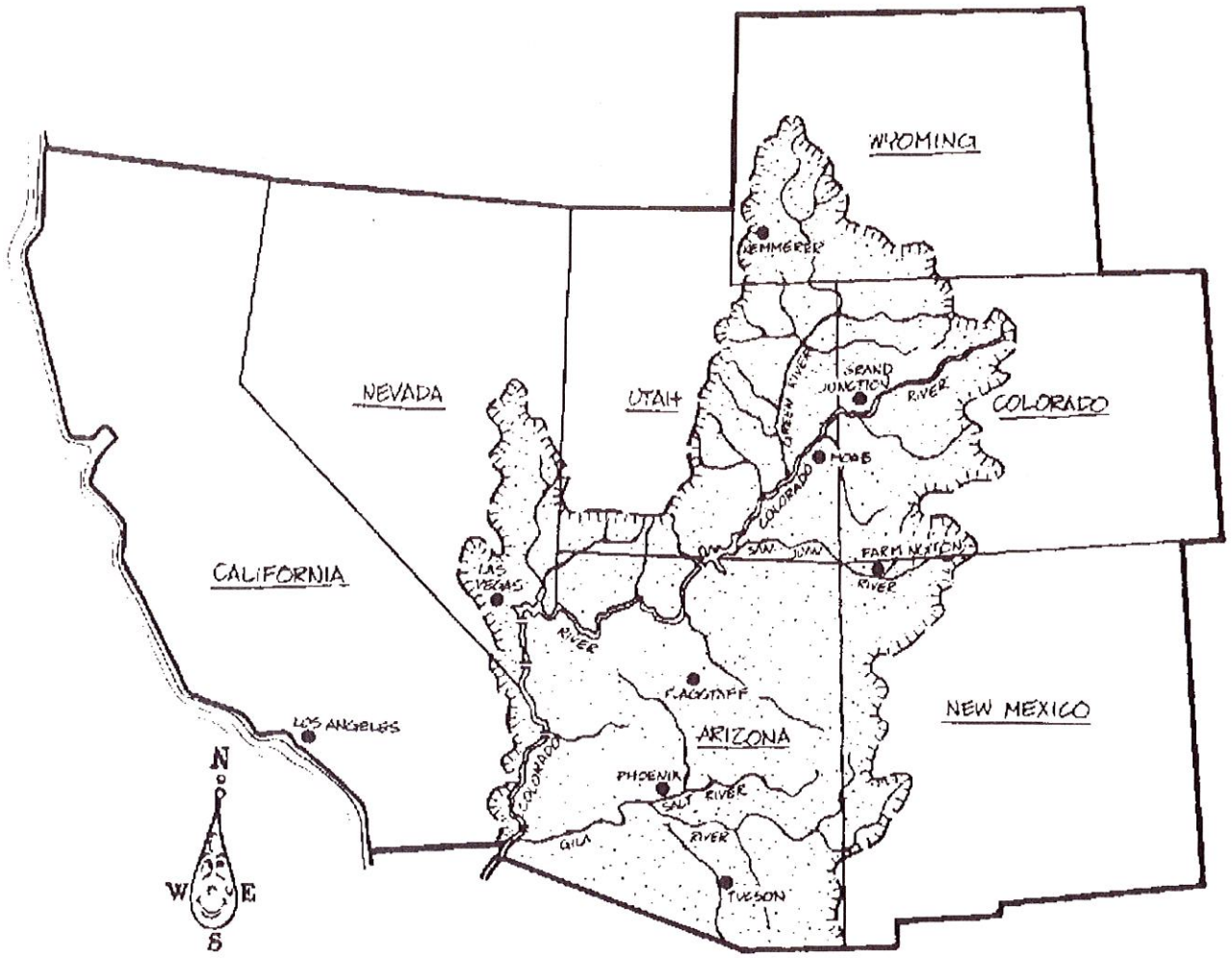


SRP MAP
AZ Surface Water Features



MANY TRIPS TO PHOENIX - STUDENT PAGE

COLORADO RIVER AND WATERSHED



WORLD MAP