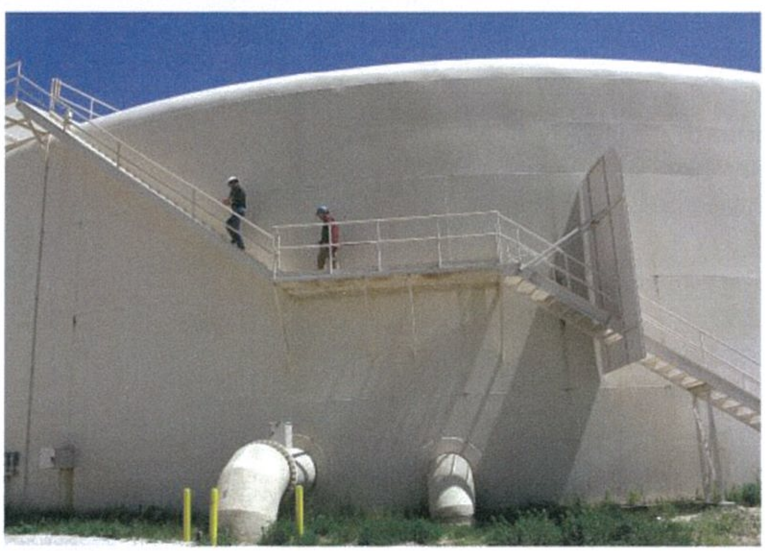
Battling Evaporation

We rely on evaporation. Imagine if your hair didn't dry after you shampoo. What if your bed sheets didn't dry out after being washed? Many plants and animals rely on evaporation to cool them down. We call it sweating in animals, and transpiration in plants. Transpiration helps move water to the leaves as well. Liquid water is pulled up from the ground as water in the leaves change into gas (water vapor) and move into the sky. How does evaporation work?

In its liquid state, all water molecules are in motion. When water molecules collide, one molecule will gain energy, and the other will lose energy. If the newly energized molecule is near the surface of the water, it might have enough energy to escape the liquid form and become water vapor. As the molecules with more energy escape, the molecules that remain will be those with lower energy levels, or less heat. That's why you feel cool as your sweat evaporates – molecules with high levels of heat evaporate, taking your heat with them.

Five factors affect how quickly fresh water evaporates:

1. **Heat** - Water molecules don't have to be heated for evaporation to occur. Water can evaporate at 0° Celsius (32° Fahrenheit), but it happens very slowly. The rate of evaporation increases as heat is added. When water boils, evaporation occurs very quickly.
2. **Surface Area** – Only molecules near the surface of the water can evaporate, so it follows that the more surface area in the body of water, the more quickly it evaporates.
3. **Humidity** – If the air has a lot of water vapor in it, then water molecules are more likely to condense back into liquid water, slowing down evaporation.
4. **Wind** – Air blowing over water causes more evaporation (think of hair dryer).
5. **Pressure** – More water molecules will evaporate when less air pressure is pushing on the liquid. Think of higher altitudes having "thinner" air and less pressure.



Evaporation is very interesting as an abstract concept. It is more interesting however, when we apply it to a concrete problem like how we store our drinking water in New Mexico. Once water from the aquifer or the river has been cleaned to drinking water standards, we store it in tanks we call reservoirs. Evaporation is minimal in these enclosed structures.

But how is it stored before it becomes drinking water? Over half of our drinking water is river water. This water is taken from tributaries of the San Juan River in northeast New Mexico. It flows into the Chama River, which carries the water to Heron Lake, El Vado Lake and ultimately to Abiquiu Lake where it is stored. What factors cause increased evaporation? Are they at play in our drinking water storage?

1. Heat – Is it hot in New Mexico? Yes.
2. Surface Area – The surface area of Abiquiu Lake is approximately 6 square miles. Is that big? Yes.
3. Lack of Humidity – Is the air dry in New Mexico? Yes.
4. Wind – Do we have a lot of wind? Yes.
5. Pressure – Abiquiu Lake is at an altitude of over 6,000 feet above sea level. Is air thin at that altitude? Yes.

It is clear that water will evaporate rather quickly from Abiquiu Lake. We know by measuring that we lose about 3 feet of water from the lake each year. This is a problem.


Abiquiu Lake

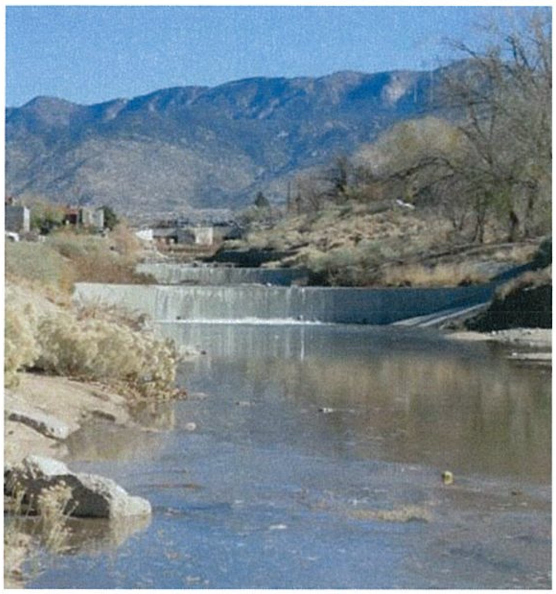
If the water were just evaporating from the lake and then falling back down as rain, it would not be such a problem. However, the water that evaporates is blown by winds to other states and the water is lost. Surely, there is a better way to store our water in New Mexico.

Scientists are looking at many options. Officials in drought-stricken Los Angeles, California released "shade balls" into the city's largest water utility reservoir. The 175-acre reservoir is covered with 96 million shade balls to help reduce evaporation. The shade balls are expected to stop evaporation of 300 million gallons of water per year. That is enough water for 8,100 people for a full year. It's almost like finding a new, small but consistent, source of water for Los Angeles' thirsty population.


http://news.nationalgeographic.com/2015/08/150812-shade-balls-los-angeles-California-drought-water-environment/

If only Albuquerque could find a way to eliminate or control evaporation that occurs in the lakes where we store our drinking water. Covering Heron, El Vado, and Abiquiu lakes with shade balls is probably not the best idea since these lakes are heavily used for recreation like fishing and boating. How could we stop losing 16.5% of our drinking water to evaporation?

Albuquerque is investing in Aquifer Storage and Recovery (ASR). In this scenario, we take water out of our storage lakes during the winter when our water usage is low because we are not watering lawns, parks or playing fields. The water can be stored underground, in the aquifer, where evaporation rates are small. Currently, we have two ASR projects underway.



The Bear Canyon ASR project is located at Spain and Wyoming NE.

The first project, the Bear Canyon Aquifer Storage and Recovery project is permitted and completed. During the winter, we can pipe 200 million gallons of non-potable water from the river up to the Bear Canyon Arroyo. The water is then released into the arroyo where it mimics the natural process of storm water flowing through the arroyo. That water sinks into the ground, infiltrating into the aquifer. It takes about 50 days for the water to reach the top of the aquifer.

During the summer when we need more water for our lawns, parks, and playing fields, we can pump the water up from the aquifer. Initial results from this project show that only about 1.5% of this ASR water is lost to evaporation, significantly less than the 16.5% of water lost to evaporation in lakes.

The second project, the Large Scale Project, is still in the planning and permitting phase. In winter months, cleaned river water would be pumped into the aquifer using wells near the Drinking Water Treatment Plant. These same wells would later be used to pump water up during the summer months when our water use is high. This project, called the Direct Injection Project could ultimately store 1.6 billion gallons of water per year.

ASR, in addition to a strong water conservation ethic, can help us make sure we will have enough water to provide for Albuquerque citizens for a long, long time. To learn more about Albuquerque's water use and how the Water Authority is planning for the future, watch this video: https://www.youtube.com/watch?v=Z6stQZw2L1M&feature=youtu.be

Vocabulary

1. Evaporation
2. Transpiration
3. Molecule
4. Aquifer
5. Surface Area
6. Humidity
7. Altitude
8. Storm Water
9. Arroyo
10. Infiltrate
11. Wells

Questions

1. Summarize the article about evaporation. What is evaporation? Why is it a problem here in NM? What can we do to lessen the impact of evaporation on our stored water?

2. ASR can minimize evaporation from 16.5% in lakes, to just 1.5% underground. The Large Scale ASR Project expects to store 2 billion gallons underground every year.

   How much water would we expect to lose in a year of storage of 2 billion gallons at Abiquiu lake (16.5% evaporation)?

   How much water would we expect to lose in a year of storage of 2 billion gallons in the aquifer (1.5%).

   How many more gallons of water would we have if we stored those 2 billion gallons underground?

3.

Compare and Contrast the two technical solutions to minimize evaporation. Under what circumstances would each solution work best? When is it most impractical?	
Shade Balls used in Los Angeles	Aquifer Storage and Recovery

4. The movie is about many other things, but think about the bear Canyon segment. The article is about many other things, but think about the Bear Canyon segment. What are the strengths of the video? What are the strengths of the article? What are their weaknesses?

5. Based upon your knowledge of the water cycle and New Mexico's climate, can you think of other ways we could "battle evaporation"?

Battling Evaporation Informational Text

Albuquerque Bernalillo County
Water Utility Authority

Summary: Students read about how the electricity they use is generated from fossil fuels and uranium. They learn about nonrenewable resources. They learn that it takes water to make electricity and it takes electricity to clean and deliver water.

Grade: Eight

Subject Areas: Reading Informational Science Text

Common Core Standards and Benchmarks

READING INFORMATIONAL TEXTS

Key Ideas and Details:

CCSS.ELA-Literacy.RI.8.2

Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.

CCSS.ELA-Literacy.RI.8.3

Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

Craft and Structure:

CCSS.ELA-Literacy.RI.8.4

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

Integration of Knowledge and Ideas

CCSS.ELA-Literacy.RI.8.7

Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.

NextGen Science Standards and Benchmarks

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

NM Science Standards and Benchmarks

III.II.8.2 Understand the unique role water plays on Earth, including:
• ability to remain liquid at most Earth temperatures • properties of water related to processes in the water cycle: evaporation, condensation, precipitation, surface run-off, percolation.