Chapter 28

Your Questions Answered

Author's Note: I want to address a few of the many questions I have received. I think these questions have a general interest, so I wanted to share them and my answers with you.

Question 1: I have a question about the area of ELY – it's water? Since the west is going through terrible drought, would that town be worse off?

Response: Many places in the west are experiencing the effects of the drought. It is probably most felt on surface water, where lower amounts of precipitation have caused decreased streamflow (Lake Mead and Lake Powell are dropping in stage because less water is coming in). We tend to see drought effects quickly in surface water because it is more reactive to climate conditions (same reason we get flash floods during heavy precipitation). The drought is affecting ground water and we do see a decrease in ground-water levels in many places, but the impact is less visible than in surface water because most aquifers are huge reservoirs of water and it takes time to show large changes. Most of rural Nevada uses ground water, and therefore, the drought, although important, has less immediate impact than it might on larger cities that use surface water. Natural events, like drought and wet periods, usually have limited extent (a few years to decades) which will allow ground-water levels to rise and fall dependent on the climatic conditions. I think you need to look at long term records (water levels over many decades) to get a good handle on what the water conditions will be over the long run. Typically, natural changes in ground-water levels related to climate are much less than human-induced changes due to pumping.

Question 2: It appears to me, eyeballing popular maps and driving the Sunnyside cutoff, that the White River flows to the south to the Pahranagat Lakes--and that those lakes, when full, empty into the Muddy/Virgin/Lake Mead water bodies. If so, that would make the White River Valley part of the Colorado River drainage, not part of the hydrologic Great Basin. Can you confirm whether that is the case? I would guess that in all the Colorado River litigation someone has made a determination about that, even if the White River does not materially contribute to the Las Vegas / Imperial Valley water supply. (If the Pahranagat Lakes don't drain, what keeps them fresh?)

Response: The area we refer to as the Great Basin was originally defined by Fremont (1845). "The intermediate region between the Rocky mountains and the next range [the Sierra Nevada] containing lakes, with their own system of rivers and creeks, (of which the Great Salt Lake is the principal), and which have no connexion with the ocean, or the great rivers which flow into it" (Fremont, 1845). In this classic definition, the Great Basin encompasses most of Nevada, western Utah, and parts of California, Oregon, Idaho, and Wyoming.

You are correct in that the White River flows to Pahranagat Lakes and that in the past, surface runoff continued south to the Muddy River and the Colorado River. Most delineations of the Great Basin (hydrographic, physiographic, and floristic), however, include the White River in the Great Basin. The hydrographic or classic definition of Fremont includes the White River because Pahranagat Lakes have not had surface discharge to the Muddy River in historic times. This definition is similar to the Great Salt Lake that once was connected to the Snake River during a past high stand. In contrast, Meadow Valley Wash (east of the Pahranagat Lakes), and Muddy River Springs and Las Vegas Valley (south of Pahranagat Lakes) are often excluded from the delineation of the Great Basin in the classic definition because surface runoff has historically reached the Colorado River. For a detailed history and delineation of the Great Basin, I suggest you read Grayson (1993).

Other delineations of the Great Basin region consider ground-water flow. The ground-water flow system in the White River drainage is similar to surface runoff in that it also flows to the south. However, unlike surface runoff, ground water presently is flowing into the Colorado River drainage. The contributing area for the ground water that flows into the Colorado River drainage, as estimated from ground-water budgets, ground-water levels, and chemistry, is thought to extend as far north as Butte Valley, northwest of Ely, although ground water may take centuries to millennia to travel from the northern end to the Colorado River drainage. This ground-water flow system known as the White River flow system is a series of basins made up of carbonate rock that extend from within White Pine County down to the area around Muddy Springs. In the White River flow system, many springs (such as Muddy Springs, Ash Spring, and Crystal Spring) are fed by discharge from the carbonate aquifer (as shown from geochemical analysis). Some delineations of the Great Basin include Meadow Valley Wash, the Muddy Springs region, and Las Vegas Valley because ground-water flow connects these areas with areas within the Great Basin.

Other delineations exclude all basins that contribute either surface runoff or ground-water flow to the Colorado River drainage (including those that contribute ground-water flow to the White River flow system) even though surface drainage in several of the basins has no outlet to the ocean. If one accepts the classic definition of Fremont (1845), then the White River should be within the Great Basin; however, if one also considers ground-water flow as part of the delineation, then the White River flow system could be excluded from the delineation. The difficulty in excluding the White River flow system from adjacent areas in the Great Basin is that the boundary of the White River flow system is not known exactly (the area does not need to follow topographic divides) and the boundary could change as a result of ground-water pumping either within the White River flow system or in adjacent areas.

In response to your last question as to why the Pahranagat Lakes contain freshwater, the most likely answer is that ground water moves water into and out of the lake in a manner similar to the Ruby Marshes (Lakes) in Ruby Valley. As in the Ruby Marshes, inflow to the lakes is a dominant feature, and therefore a large supply of freshwater coming into the lakes limits the salinity concentrations. Flow from Ash and Crystal Springs supply water to the Pahranagat Lakes. However, these lakes probably also receive ground-water inflow from the surrounding mountains. I'm not an expert on the local hydrogeology of these valleys but I assume that Pahranagat Lakes are flow-through lakes, which means that the lakes both have input and output to the underlying aquifers, and as such serve as a window to the aquifers. During periods of high lake levels (during the past glacial period), there can be spillover to surface runoff from Pahranagat Lakes to the south. **Much of this response was with the assistance of Dave Prudic, U.S. Geological Survey.**

Question 3: In the chapter on precipitation and its enclosed map, by my estimate, it seemed that Elko had more water than Ely. Am I correct? Which towns/cities have the most precipitation?

Response: The map that shows precipitation distribution indicates that most precipitation falls in very high elevations. In the Ely area, that would be around Great Basin National Park on some of the higher peaks. In the Elko area, that would be in the Ruby Mountains and other high peaks. If you look at the precipitation record for the city of Ely (period of record 1897–2003) it gives an average annual precipitation of 9.53 inches. The record for Elko (at the airport, period of record 1890–2003) also is an annual average of 9.53 inches. So, the two cities have virtually the same precipitation amounts over the long period of record. See the interactive web page at http://www.wrcc.dri.edu/summary/mapnv.html and click on any area for which you want to see weather records.

Please keep in mind that once the precipitation falls in the mountains, where it ends up as streamflow and ground water greatly depends on numerous variables. It is hard to make any conclusions about which town has more water based on just a precipitation distribution map.

Question 4: The question is related to cooking foods, and especially adjusting cooking temperatures at high altitudes. Specifically, when adjusting a cooking thermometer to freezing (32° F sea level) and boiling (212° F at sea level), are there adjustments for high altitudes?

Response: Let me take off my USGS ball cap and put on my Julia Child chef hat. I did some simple calculations for the elevation at Ely (6260 feet at the airport) and found that for that altitude, water boils at around 200° F (verses 212° F for sea level). This can be a problem because it often takes longer to cook foods according to the instructions because boiling is reached at lower temperatures.

When I worked in the Andes of Peru back in the 1980s, we had a base camp at 17,000 feet. We used pressure cookers to cook our food because at that high altitude, water boiled at lower temperatures and food didn't cook properly. The pressure cookers increased the pressure in the cooking vessel and therefore allowed higher temperatures to be reached before boiling occurred.

There are stories of Tibetan monks who usually drank their tea when the cup of water was boiling because at their high altitude, this was a lower temperature. When these monks went to visit other places closer to sea level, they would burn their mouths trying to drink the tea at that boiling point, which was much hotter.

The freezing point for water at Ely's altitude is about the same as at sea level. Therefore, one could use a bucket of slushy ice water and be at the normal temperatures for calibrating a cooking thermometer.

Pressure does play a part in changing freezing points, which is often illustrated using the ice skate example. In this example, the pressure at the edge of the skate blade on the ice, along with friction and other factors, actually causes melting to occur at that point and therefore allows glide.

Likewise in temperate climates, many glaciers, which are masses of ice, are actually wet at their bases because of the pressure melting caused by the weight of the overlying ice mass. Water at the base of some of these glaciers has been credited with causing surging or relatively rapid movement of the glacier.

In the two examples given, other factors affect the melting, but these are kept simple to illustrate the point. Also, these two conditions described are much more extreme pressure differences than that caused by altitude in Ely.

Question 5: Does White Pine County have that much water to share with the Southern Nevada Water Authority?

Response: That is a really important question and there is not a simple answer. What quantity is enough to provide for the exportation of water and preservation of the resource? That really is a societal decision, not just a science issue. The input of a wide variety of groups, such as the general public, White Pine County residents and water managers, SNWA, the State, Department of the Interior agencies (BLM, NPS, and USFWS), legal authorities, environmental groups, and various other groups all need to be considered in determining beneficial use and adequate protection of the resource.

As hydrologists, we can estimate how much water is available in an aquifer and how pumping will affect water levels in an aquifer, but to determine what amount of withdrawal is enough and what potential effects are acceptable are decisions for society, and especially of interest to the people and water managers in White Pine County.

In White Pine County, a large carbonate aquifer system exists that is many thousands of feet thick in places. This bedrock aquifer is overlain by unconsolidated alluvial sediments that form the aquifers used for most local needs (irrigation and domestic users). In the deep carbonate aquifer, there is a vast amount of water (studies need to be done to further quantify this amount, but present estimates show it to be quite large).

It is probable that large amounts of water can be pumped from this bedrock aquifer and any effects, such as declining water levels, might not be observed for many years or even longer. Initially, water withdrawn would come mainly from storage in the aquifer and not from present recharge. However, it is not known how much water can be pumped from the aquifer without creating significant water-level declines until aquifer tests are completed.

Aquifer tests (pumping the aquifer for sustained periods of time and measuring related declines in water levels) are needed to assess storage and permeability of the aquifer so that potential effects of pumping can be determined. SNWA has proposed an aquifer test at a MX missile well site in Lincoln County.

As a hydrologist, I would agree that aquifer tests are needed before we can make accurate estimates of the aquifer properties. But many people have asked what would happen to the water pumped during this long (maybe years) aquifer test? Some people have raised this question because, as they would argue, if the water is pumped south, either as water supply to Clark County or flow to Lake Mead, then there could become a dependence on the water and the test could become a permanent process. I don't know what the plans are at this time (if the aquifer test will occur and, if so, how the pumped water will ultimately be used during the test).

Also, what is the hydraulic connection between the deep bedrock aquifer and the shallow alluvial aquifers where most existing wells are located? Will pumping from the deep aquifer affect the shallow aquifers and potentially lower water levels and dry up present irrigation and domestic wells?

Conceptually, the alluvial and carbonate aquifers are connected in places, but the degree and location of connection are unknown for many basins. Deep wells that extend through the alluvium and into the bedrock are scarce, so our knowledge of the hydraulic connection is really limited. I feel there needs to be a better understanding of this connection before one can be certain that the impact is minimal. This also relates to concerns from the BLM about reducing the water table in the alluvial aquifers and affecting the habitat for sage grouse and other animals and plants.

An additional question being asked is: What affects pumping would have on the springs in the discharge zone? The bedrock aquifer is a large flow system and it discharges in a series of springs in eastern and southern Nevada, such as Muddy Springs. If the water is lowered in the aquifer, will the spring discharge decline, or the springs dry up? This is a question NPS and USFWS want answered because they are responsible for the wildlife, including threatened and endangered species that live in these springs. Conceptually, spring discharge could be reduced by pumping from the bedrock aquifer, but no one is entirely certain at this point by how much or at what point in time. Estimating potential impacts to spring discharge will depend, in part, on how the system is conceptualized. Hopefully, more data and more studies will allow for better understanding of the aquifer system.

Now, as for the question about what is acceptable to society when weighing the pros and cons of water exportation. In reality, it may be a very long time before any effects are noticeable in the aquifer. Along those lines, once changes are observed in such a huge system, it may be very difficult to reverse those changes (the response either way could be quite delayed).

As I've stated before, you can't stress a system without changing it. Potential effects include declining water levels in bedrock and alluvial aquifers, declining spring discharges, and reducing ground-water discharge to lakes and playas. In some cases, such as water lost to evaporation from playas, this might not be a concern to many people. Because so much of the water in the hydrologic cycle in the Great Basin is lost to ET, a reduction in this loss might be insignificant to many people, and maybe even unnoticeable. However, no one can predict the effects with complete certainty until the system is stressed (such as an aquifer test) and we actually observe the changes. Then, information from the aquifer test is put into a transient flow model for the aquifer system and responses to stresses are modeled.

Let's put the issue in a different perspective (a little less scientific). Suppose you had a huge bank account that you plan to use to ensure the stable future for you and your family. Now, probably there is enough money in your account for you to consider sharing with others who need some extra help or for investing for economic gain. But how much is enough and yet still secure your own future and protect your present way of life? Any additional spending from your account affects the balance, but how much is acceptable, or even noticeable, considering there are many inputs and outputs from your account?

Obviously, each of us would answer this differently and there is a huge spectrum of possible choices that could be offered. This is why water use and potential exportation is an issue for society and not strictly a science issue. Scientists can quantify how much is there, but how it is used and what is acceptable is a decision for society.

Wheeler Peak and Spring Valley from Highway 50. Photograph by M.L. Strobel, USGS.


Lake Tahoe, from the Gondola fire burn area. Photograph by K.K. Allander, USGS.