WPIC Panel Discussion Sept. 13,2007:
Alternatives for water in highly appropriated areas

Aquifer Storage and Recovery – Montana Feasibility

Kirk Waren
Montana Bureau of Mines and Geology
1300 W. Park St.
Butte, MT 59701
Phone: 406 496-4866
kwaren@mtech.edu

Introduction

The phrase "aquifer storage and recovery" (ASR) refers to an aquifer that is used as a storage reservoir where water can be placed and later extracted. There are four necessary parts of an ASR project. They are;

1. An available water source
2. Aquifer storage space
3. A recharge mechanism (wells, infiltration ponds, trenches, canals, fields, etc.)
4. A recovery mechanism

ASR already occurs inadvertently in aquifers beneath Montana's irrigated lands. Water is stored as a result of conveyance and operational water losses associated with irrigation. Water is recovered as the stored water returns to streams, commonly known as irrigation return flow. This passive aquifer storage and recovery activity has altered stream-flow conditions throughout Montana. Water users and stream flows already benefit from this ASR activity in many parts of Montana.

Montana ranks 16th in the nation amongst states for total fresh water withdrawals (See Figure 1), withdrawing an estimated 9,300,000 acre-feet per year from surface and ground-water sources (data from the year 2000). 96% of these withdrawals are used for irrigation. In contrast, Montana ranks 41st in the nation amongst states for fresh ground water withdrawals (Figure 2), withdrawing about 188,000 acre-feet per year, or 2 percent of total water withdrawals, from ground-water sources. Compared to other states, Montana's groundwater resources are used very modestly, except in a few places.

The development and implementation of water management strategies are limited in Montana. While some substantial efforts have been made by watershed groups for some areas, management options available are typically limited due legal, technical, and financial constraints. An example of a legal constraint is that ground-water and surface-water are legally separate sources, so ground-water can not be diverted instead of surface

water during times of water shortage. Technical constraints include a lack of data and interpretive studies to specifically develop potential solutions to problems. Financially, money has generally not been applied to any large scale efforts to solve water shortage problems in Montana using advanced water management strategies.

ASR represents one element, or tool, that can be used in efforts to manage surface-water and ground-water resources conjunctively. **Conjunctive use is the deliberate, planned, and coordinated use of surface and ground-water resources with the intent of balancing those resources.** This definition is provided in the Utah State Water Plan. As evident in Figure 2, California uses more ground water than any other state. In California, conjunctive use strategies exist and funding is in place to further design and construct conjunctive use strategies throughout the state (see the 2007 California Groundwater Coalition handout attached at the end of this document). Conjunctive water use, with ASR, can result in an increased usable water supply.

A simple example ASR project would be this: A stream is low on water chronically, or nearly every year, due to surface-water withdrawals for irrigation. To address the problem, several large diversions that irrigate lands rather distant from the stream are provided with high capacity wells to use late in the irrigation season during the time of low stream-flow. Thus, the surface-water diversion is stopped when stream-flow gets low, and the stream-flow is restored. The impacts of the wells to stream-flow are delayed and found to occur largely during winter months. Any residual impacts to the stream in the following year are of little consequence now that the late-season low-flow condition in the stream has been remedied.

Issues:

What are other states doing when faced with a limited amount of available water?

Generally, other states facing water supply problems direct funding and management efforts to address the problems. Solutions are highly variable, and some are more universal or applicable at other places than others. Methods include the construction and use of reservoirs, the development and use of ground-water, and advanced water-management strategies.

California ranks first in both total fresh-water withdrawals and ground-water withdrawals. **The state of California does not regulate or manage groundwater.** Instead, the state's water laws allow ground-water management locally by a variety of water agencies, county ordinances, and court adjudication. Water agencies include county and municipal water districts, water conservation districts, irrigation districts, water replenishment districts and ground-water management districts, to name a few. Ground-water management plans are being developed in defined basins and sub-basins throughout the state. ASR projects are implemented locally by various entities. Aquifer storage activities include the development of artificial recharge infiltration basins, construction of levees in river channels to increase infiltration, capturing storm water that would otherwise flow to the ocean, and injecting treated recycled water. **The state, in**

turn, maps the state's ground-water resources, maintains the states water-well database, conducts investigations, collects ground-water data, and provides technical and financial assistance to the various local entities that manage ground-water resources. A pamphlet from the 2007 California Groundwater Coalition is being distributed along with this report to the Water Policy Interim Commitee. It is of interest to note that even in the state that uses the most ground-water resources in the nation, many of the same issues that face Montana continue to be perfected there. Note that this one pamphlet addresses conjunctive use and its increased reliance on ground-water storage, the benefits of conjunctive use such as reduced overdraft, subsidence, and saline intrusion into the state's ground-water basins, improved water quality, increased stream flow, improved habitats, impacts of climate change, etc.

Arizona has a permitting process in place for ASR projects. Separate permits are required and issued for underground storage facilities, water storage, and recovery wells. There are also long-term water storage accounts affiliated with the permits. There are currently over 60 active, permitted underground water storage facilities in the state. These projects are operated by irrigation districts, municipalities, water districts, conservation districts, and water storage companies. Volumes of water storage permitted are mostly in the range of hundreds of acre-feet to about 25,000 acre-feet, but a few are for 100- to 200-thousand acre feet.

New Mexico recently initiated an active water resource management program to develop basin-scale water management districts within the state. These districts will have water masters, and be used to address emerging water shortage problems.

Nevada state law provides criteria for establishing ASR projects. There are about sixteen active recharge applications and permits in Nevada, with a total potential recharge of 93,709 acre-feet per year.

Utah permits ASR projects, and there are currently about five projects permitted to store and recover water in the state. Utah published a portion of the state water plan in July, 2005, entitled **"Conjunctive Management of Surface and Ground Water in Utah."** This document has direct relevance to the types of water issues and problems that Montana faces. It includes chapters on issues relating to aquifers, conjunctive management strategies and solutions, a review of past and present conjunctive management strategies in the state, prospective conjunctive management projects, and provides some conclusion and recommendations for future water management efforts in Utah. This document notes that overall, ASR has been found to be more cost effective than above-ground storage projects, and is an important element of conjunctive use strategies that can increase the usable water supply.

What are the pros and cons associated with ASR and surface storage?

There are indeed pros and cons associated with each storage method.

ASR pros:

Minimal structural elements
Availability of large capacity reservoirs (aquifers)
Minimal evaporation loss
Require little land area
No danger of catastrophic failure
Uniform water temperature
May provide increased flows in streams to support fish, riparian habitat, and aesthetic purposes
Water can be put into storage at one location and removed at another.

ASR cons:

Aquifer storage sites must be identified
Water must be pumped for many uses
Water may be minerized
Water quality of the aquifer may be impacted
Possible local disruption of return flows and springs
Recharge water may require treatment
Possible damage to riparian habitat
Reduction in overall stream flow
High water table problems
Possible water right implication

Surface-water storage pros:

Little or no water treatment required
Power head available
Large flows
Maximum flood control value
Water generally of low mineral content
Multiple use, irrigation and recreational opportunities
Water available by gravity flow

Surface water storage cons:

Large land area required
Few now sites available
High evaporation loss
Fluctuating water temperature
Easily contaminated
Water must be conveyed
Ever present danger of catastrophic failure
Water must be at least filtered for human consumption, possibly more aggressive treatment

Are there water quality concerns that must be addressed when looking at new and different approaches in Montana?

Yes. All water management strategies and options including conjunctive use schemes and ASR activities must consider water quality implications and address potential problems. The nature of problems and means to address them will vary in different basins. Water quality monitoring networks should be an integral part of water resource data collection.

Is there water available for some type of storage or would storing water adversely affect a prior appropriator?

The question of whether there is water available for storage without affecting a prior appropriator must be answered for specific sites, basins, or locations. Obviously, water that is unappropriated should be sought for storage. Most commonly, it would be water available in times of excess, for example spring runoff. While improved efficiencies will result in more consumptive use, a key objective is to ensure that the timing of impacts downstream does not happen during times of stream flow shortages. In fact, proper management can create increased flows downstream during times of shortages.

Does it matter if a water user does not use the same drop of water that the water user was responsible for placing in the storage facility or in the aquifer through ASR?

No, it generally does not matter that a water user may use a "different drop" of water than that placed in storage. However, there will likely be some limit to where the water can be withdrawn; in most cases it would probably need to be withdrawn from the same aquifer.

Conclusion:

The utilization of Montana's ground-water resources is in its infant stages, as evident in Figure 2. Aquifer storage and recharge (ASR) is an important element or tool for the conjunctive management of surface- and ground-water resources. Eventually, specific situations will likely be identified in Montana in which ASR can be applied to help resolve water management problems. ASR methods may vary drastically, from small, permitted facilities or water operation changes to large, publicly-funded projects. Some type of water policy or legislative changes may need to be undertaken to allow such activities. Such changes could include a permitting procedure for relatively small, private or public facilities for a variety of purposes, such as reclaiming waste water, or mitigating the impacts of a pumping well. Alternatively, much larger scale, publicly funded projects could perhaps be implemented by incorporating them into specific basin closure laws or other watershed-specific water management framework.

Additional Comment:

In light of the panel session title: "Alternatives for water in highly appropriated areas," Utah's state water plan may be especially useful for Montana's Water Policy Interim Committee. Utah administers water rights in a manner similar to Montana, and many of the same types of problems exist in both states. One of guiding principals of Utah's water plan is that local stakeholders are key players in the development of water management plans. This concept is clearly implemented in California, where ground water is regulated entirely by local entities. Montana's basin closure laws and watershed planning groups seem like a logical starting point for solving water shortage problems in Montana. The problems of individual basins need to be specifically identified and the goals of water management need to be developed. Funding is needed for such management efforts, data gathering and interpretation, and projects to more effectively develop Montana's water resources.

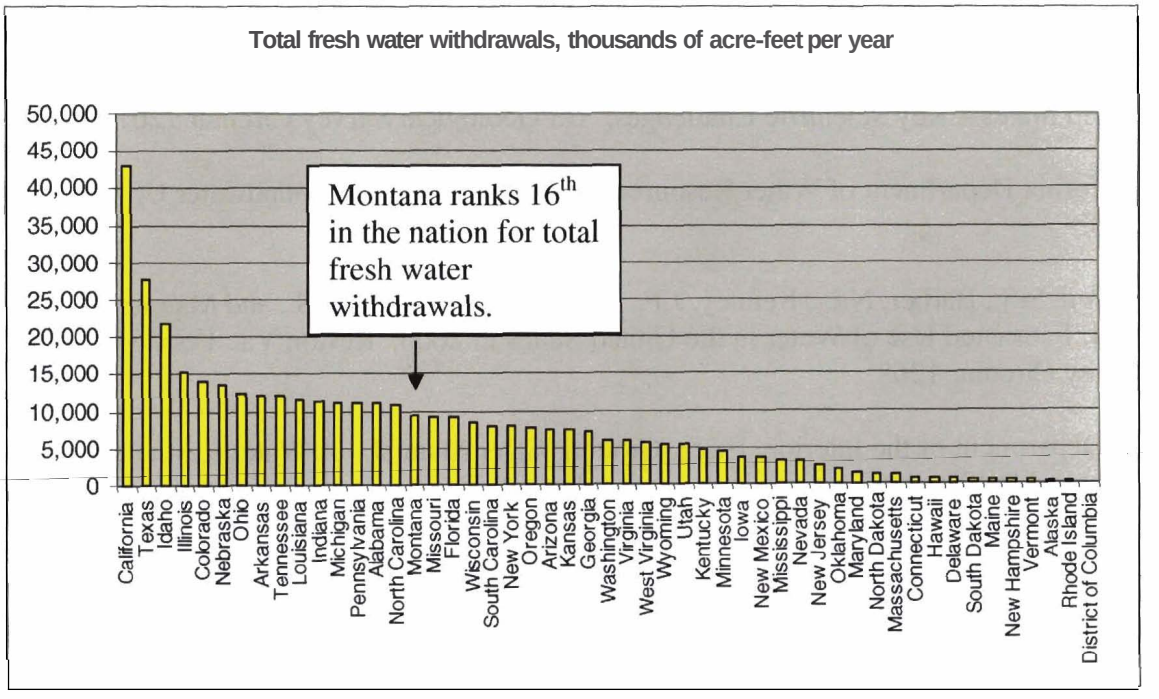


Figure 1.

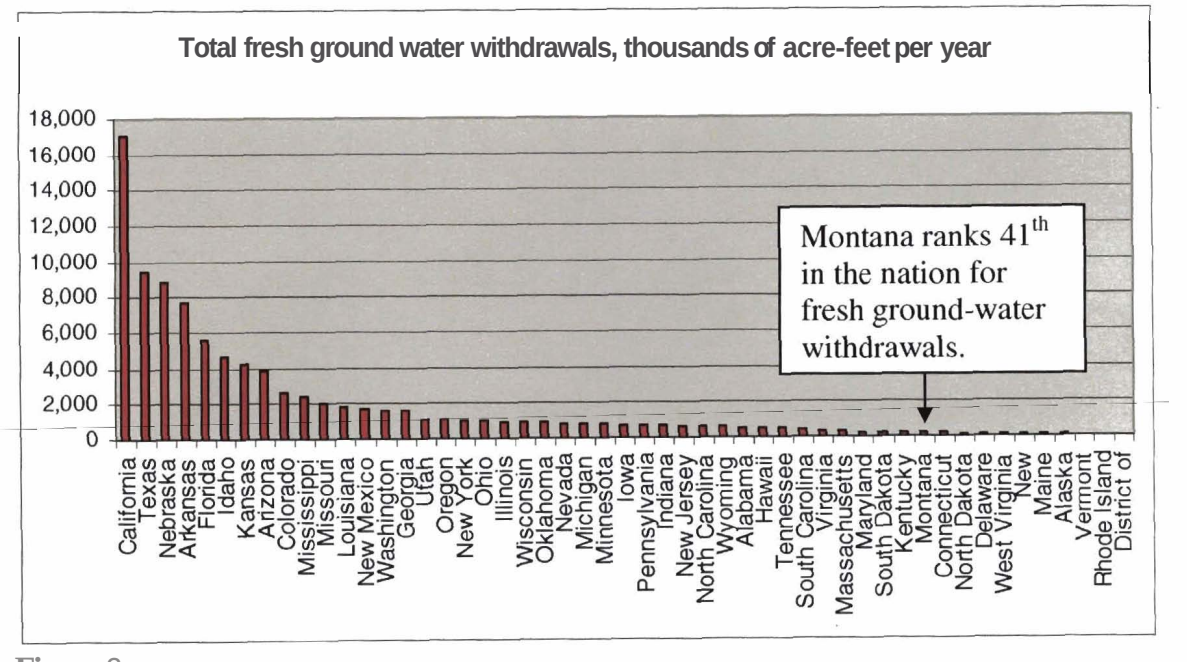


Figure 2.

Information sources:

Anderson, Mark T. and Woosley, Lloyd H., Jr., 2005; Water availability for the Western United States – Key Scientific Challenges: US Geological Survey Circular 1261.

California Department of Water Resources, 2003; California's Groundwater Update 2003.

Hutson, S.S., Barber, N.L., Kenney, J.F., Linsey, K.S., Lumia, D.S., and Maupin, M.A., 2004; Estimated Use of Water in the United States in 2000: Reston Va., US Geological Survey Circular 1268.

US Department of the Interior, 1985; Ground Water Manual – A Water Resources Technical Publication.

Utah Division of Water Resources, 2005; Conjunctive Management of Surface and Ground Water in Utah, July 2005; Utah State Water Plan.

Western Governor's Association, 2006. Water Needs and Strategies for a Sustainable Future.

GROUNDWATER RESOURCES ASSOCIATION
of California

The 2007 CALIFORNIA GROUNDWATER COALITION is a joint one-year initiative of the Groundwater Resources Association of California, the Association of Ground Water Agencies, and American Ground Water Trust. Collectively, Coalition organizations include over one thousand members located throughout California with technical, legal, and professional groundwater and related expertise. The Coalition has been formed at the urging of California state and local elected officials who believe that increased efforts are needed to educate and inform policy makers and the public about California's groundwater resources and the role groundwater plays in providing a safe and reliable water supply for California.

MISSION: The Coalition's mission is to 1) educate policy makers about groundwater; 2) represent groundwater interests and promote the benefits of comprehensive groundwater management and use in legislative and other policy arenas; and, 3) promote a fair share of funding for statewide groundwater programs, including 2006 and 2008 water bonds.

PRINCIPLES: While groundwater issues can be highly technical and complex, the Coalition's education and outreach program is based on the following five basic principles:

1. Groundwater development, conjunctive use, and groundwater storage have the capability to provide increased water supply reliability for California in the near future.
2. Groundwater management and monitoring are essential to the successful development and protection of the state's groundwater resources for current and future generations.
3. New infrastructure is needed to obtain statewide benefit from groundwater resources utilization and replenishment.
4. Groundwater cleanup in many areas of the state is needed to eliminate contamination and ensure high quality water, and to allow for the sustainable development and use of groundwater supplies.
5. Funding is needed to ensure the effective management and use of the state's groundwater resources.

Groundwater Resources Association of California www.grac.org GRA Liaison, Tim Parker
Association of Ground Water Agencies www.agwa.org AGWA Liaison, John Rossi
American Ground Water Trust www.agwt.org AGWT Liaison, Terry Foreman

For more information contact Hatch & Parent at 916-441-1232

WB012007006 SCC353200.TH.03 CGC_brochure_alunkd 3/07

2007 California Groundwater Coalition

ASSOCIATION OF GROUND WATER AGENCIES

GROUNDWATER RESOURCES ASSOCIATION
of California

AMERICAN GROUND
WATER TRUST

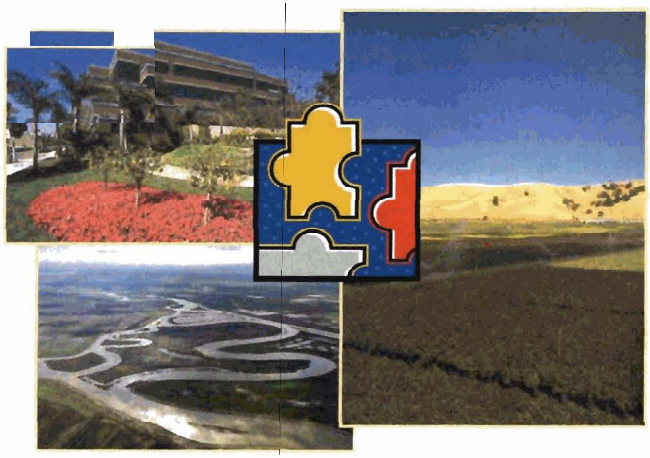
"When the well's dry, we know the worth of water."
Benjamin Franklin,
Poor Richard's Almanac, 1746

Groundwater is a Key Piece of the State's Water Puzzle

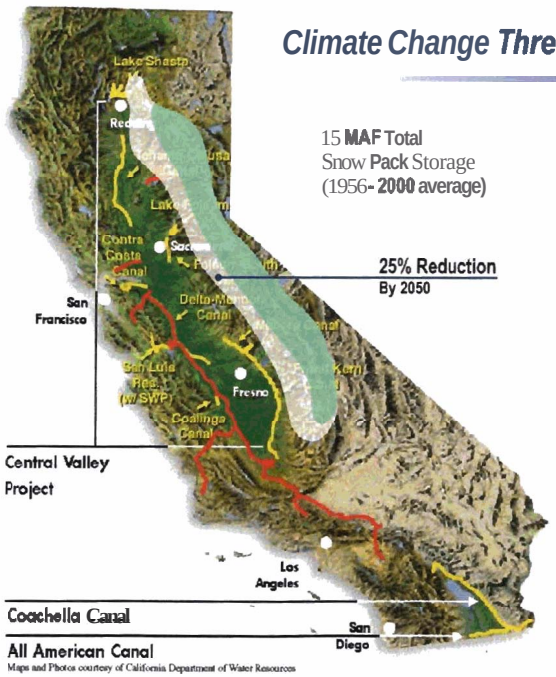
Groundwater is one of the State's most important natural resources.

- Providing drinking water for nearly half of our citizens
- Providing water for agriculture
- Providing water for the environment

Groundwater meets 30% of California's water needs in an average year and 40% during times of shortage.



Climate Change Threatens Water Supply Reliability



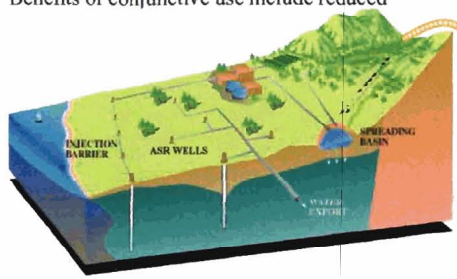
Maps and Photos courtesy of California Department of Water Resources

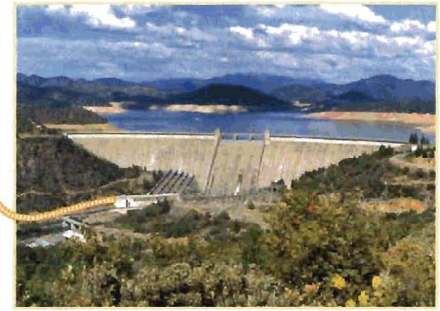
Reduction in Snowpack due to Climate Change

Current trends and climate models suggest loss of at least a quarter of the snowmelt runoff by 2050. Warmer weather would ultimately mean changes in precipitation timing and amounts, changes in urban and agricultural water demands, more flooding in the winter, and less runoff from snow during the spring. With greater conservation measures and by expanding the state's water management and delivery system, including investment in groundwater storage and conveyance facilities, California can prepare for these changes.

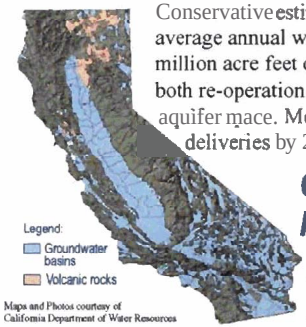
Conjunctive Use is an Effective Water Management Tool

Conjunctive use – the coordinated management of surface water and groundwater resources – is critical to water supply reliability in the future. Conjunctive use means relying more on our groundwater storage basins in California. Benefits of conjunctive use include reduced overdraft, subsidence, and saline intrusion into the State's groundwater basins, and, improved water quality and environmental benefits in the form of increased stream flows and improved habitats.





Groundwater Basins Can Provide Storage and Increased Water Supply



Maps and Photos courtesy of California Department of Water Resources

Conservative estimates of groundwater storage benefits are that we could increase average annual water deliveries throughout the State by 500,000 acre feet by using 9 million acre feet of "new" groundwater storage. New groundwater storage includes both re-operation of existing groundwater storage and recharging water into de-watered aquifer mace. More aggressive estimates are that we could increase average annual water deliveries by 2 million acre feet using 20 million acre-feet of new storage.

Cleanup and Monitoring is Needed to Ensure High Quality Groundwater Resources

Based on Department of Health Services data, 10-15 % of our water supply wells have had at least one chemical exceedance of the maximum contaminant level. In agricultural areas, many wells have been impacted by nitrate. Tools and technologies are available to cleanup our groundwater. More investment in groundwater monitoring, protection, and cleanup is needed to increase future water supply reliability and ensure high water quality standards.

More Funding is Needed!

A review of past water bond grant and loan program applications provides an indication of the types of groundwater and conjunctive use projects water agencies are pursuing. Funds are needed for groundwater basin feasibility studies and design, and, new infrastructure including groundwater spreading basins, aquifer storage and recovery wells, public supply wells, treatment facilities and piping for conveyance.

More state funding of groundwater programs will save dollars on other more expensive water supply alternatives, and, leverage local dollars. As an example, under the Prop 13 Groundwater Storage and Recharge Program, $200 million of state funding will leverage a local cost share in excess of $1 billion and produce an estimated annual yield of 300,000 acre-feet.