Volume 15, Issue 2 April-June 2011

Verde Watershed CURRENTS

VERDE WATERSHED ASSOCIATION

MACRO-RAINWATER HARVESTING IN THE PRESCOTT ACTIVE MANAGEMENT AREA: SOME ESSENTIAL CONSIDERATIONS

"Macro-rainwater harvesting...could provide enhanced groundwater recharge, but its effectiveness as a tool for artificial recharge must require verification.

Article on Pg. 1

Introduction

Legislation was recently (2011; SB 1522) offered in the Arizona State Legislature to authorize groundwater pumping credits in Active Management Areas (AMAs) for macro-rainwater harvesting. The proposed legislation, which would have permitted pumping credits equal to half of the amount of harvested water, did not become law. However, a similar future legislative effort is likely.

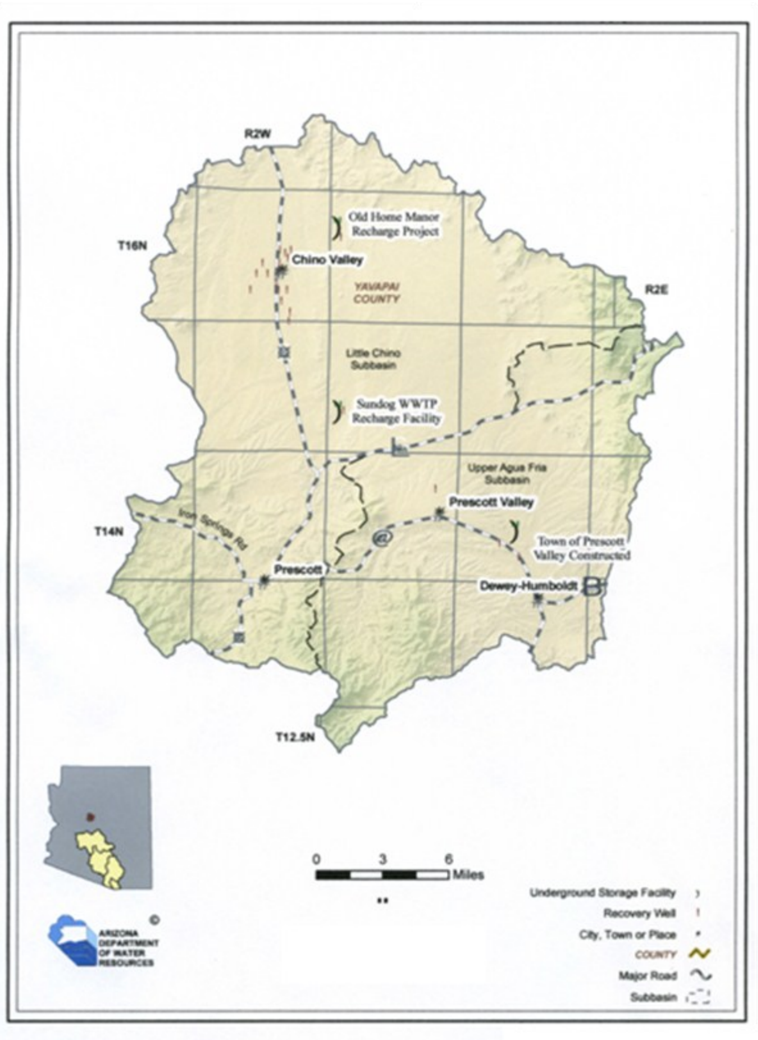
Critical issues that should be addressed in the legislative process and in the application of any resulting law include: (1) limitations related to surface-water rights; (2) verifiable accounting of potential decrease in natural groundwater recharge as a result of macro-rainwater harvesting; (3) verifiable accounting for any loss of appropriated natural runoff; (4) verifiable increase in groundwater recharge as a result of macro-rainwater harvesting; (5) environmental and water-quality implications; (6) cost effectiveness.

What is macro-rainwater harvesting?

"Macro-rainwater harvesting" in the context of the above-mentioned legislation refers to capturing rainfall before it enters established gullies and washes as runoff and directing it to sites from which it can infiltrate to an aquifer. If productive, it could provide enhanced groundwater recharge, but its effectiveness as a tool for artificial recharge must require verification.

(Continued on page 2)

(Continued from page 1) **MACRO-RAINWATER HARVESTING**



Map of the Prescott AMA showing Little Chino and upper Agua Fria sub-basins and locations of incorporated communities and artificial recharge facilities. From ADWR (2010).

Why might macro-rainwater harvesting be desirable in the Prescott AMA?

More than a decade ago the Arizona Department of Water Resources declared the Prescott AMA to be out of safe yield. That means that more groundwater is being withdrawn from the Prescott AMA aquifer system than is returned by both natural and man-driven recharge. The annual overdraft in recent years is more than 11,000 acre-feet per year. The immediate economic consequence of the ADWR decision is that barring availability of a grandfathered water supply, new subdivisions seeking approval for a certificated of adequate water supply must obtain an alternative source of water for this designation or the subdivision cannot be built. Macro-rainwater harvesting, if sanctioned by the State Legislature as a source of alternate water, could permit additional pumping of groundwater to support new subdivisions. Alternatively—or in addition—it could be used to reduce the annual overdraft and move the AMA toward the goal of achieving safe yield.

Approximately 98 percent of the annual precipitation that falls on the Little Chino sub-basin part of the Prescott AMA returns to the atmosphere via evapotranspiration. An estimated 1.6 percent becomes natural recharge to the AMA aquifer system following infiltration below the ground. (Blasch and others, 2006). Infiltration occurs both locally in the area of precipitation and from runoff entering the valley floor. Annual per-

(Continued on page 3)

centages of evapotranspiration and natural recharge in the southeastern (upper Agua Fria sub-basin) part of the Prescott AMA are no doubt comparable. The goal of macro-rainwater harvesting would be to reduce evapotranspiration by increasing the amount of water that infiltrates to become groundwater recharge during a given precipitation event.

How might macro-rainwater harvesting be implemented?

Douglas McMillan and Richard Shroads of Civiltec Engineering, Inc. in Prescott have suggested a three-step process for macro-rainwater harvesting in the Prescott AMA (see http://www.azhydrosoc.org/MemberResources/Symposia/2010/AHS_2010_Hydro_Symposium_Proceedings/Support_pages_documents/Abstracts/Rainwater_Harvesting/McMillan%20-%20Macro%20Harvesting.pdf). The steps are: (1) harvesting rainwater that would otherwise be lost to evapotranspiration; (2) transporting the harvested rainwater to an area where it can infiltrate so as to replenish the aquifer; and (3) recharging the aquifer.

In greater detail, the proposed Civiltec plans are (1) to harvest rainwater from impervious surfaces (roofs, streets, etc.) in developed areas or (2) to modify the ground surface in undeveloped areas so as to impede infiltration in situ and to develop and enhance local runoff ; and (3) deliver the accumulated rainwater to an area where it can infiltrate to the aquifer. In undeveloped areas "*Runoff would be enhanced by changing the topography of the land and increasing ground surface impermeability. Topographic modifications involve the construction of sloped earthen mounds and swales. Soil impermeability would be increased by either compacting the top soil, applying chemical bonding agents such as common road dust palliatives or installing polyethylene membrane sheets. Harvesting of rainwater below the surface involves the installation of perforated pipe drainage systems…[Macro-rainwater harvesting] would be applied on a large scale potentially involving multiple square miles of land*".

Issues that must be considered

(1)**Surface-water rights.** Surface water is defined in Arizona as: " *Waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewaters, or surplus water, and of lakes, ponds and springs on the surface.*" (Arizona Revised Statutes § 45-101). Surface water in the Prescott AMA as well as in the upper and middle Verde watersheds is largely if not completely appropriated. Thus rainwater or snowmelt that runs off in natural channels, gullies, or washes is out of bounds for macro-rainwater harvesting. This prohibition requires, at a minimum, that macro-rainwater harvesting can be implemented in undeveloped areas only on the interfluves between gullies and washes that have been carved by and serve to transport runoff. However, a critical legal questions remains: Is overland flow, prior to its entry into natural channels, a component of appropriated surface water? It is worth noting that overland flow is the major contributor to the runoff that collects "in streams, canyons, ravines or other natural channels". Thus, in spite of any legal uncertainty about whether overland flow is appropriable, diversion of overland flow in treated areas will inevitably substantially diminish the volume of surface water that exits the PrAMA.

(2) Accounting for lost natural infiltration that occurs in areas treated to increase impermeability. Reducing the permeability of large areas of undeveloped land to enhance the runoff from those areas necessarily reduces or eliminates the occurrence of natural infiltration in those areas. It is imperative from both a cost-benefit standpoint and especially for issuance of pumping credits in AMAs to verifiably account for the lost natural infiltration.

(Continued on page 4)

(continued from page 3) **MACRO-RAINWATER HARVESTING**

(3) Accounting for any loss of appropriated natural runoff. McMillan and Shroads propose delivery of the accumulated rainwater to an area where it can infiltrate to the aquifer. If the harvested rainwater is delivered via or to any natural channel, a verifiable accounting of the amount of harvested runoff in the channel is required to derive appropriate credit for the harvested component of the runoff and to preclude loss of appropriated surface water.

(4) Accounting for the amount of harvested water that actually recharges. Harvested rainwater is collected when it rains, and intermittent washes flow in response to rain or snowmelt. If harvested water is added to a channel that also transports natural runoff, there will be some enhanced infiltration because of higher than natural stream stage and increased wetted area of the stream. At the same time, not all of the delivered water will infiltrate. The problem is how one measures the increased infiltration.

Harvested water could be directed to engineered infiltration basins located elsewhere than in the beds of washes. In this case, however, one is left with the problem discussed immediately above, accounting for any loss of appropriated surface water during transport.

In addition, the sizes of the collection areas would have to be large in order to harvest any reasonable amount of water. Capture of 1,000 acre-feet per year from an area that annually receives 18 inches of precipitation (about the average annual value for the Prescott area) requires a collection area of 667 acres (slightly more than one square mile) assuming that all of the precipitation can be captured. Capture of 1,000 acre-feet from a single event would require an even larger collection area. Monsoon rains are locally distributed and rainfall amounts vary, perhaps in a general range of 0 to 3 inches per event. Suppose, the average rainfall or snowmelt event produces 2 inches of rainfall equivalent. Collection of 1,000 acre-feet of harvestable water from such an event would require collection of all surface water from an area of 6,000 acres (or about 9.4 square miles).

Infiltration basin(s) for collection of 1,000 acre-feet of harvested water from a single event would also be large. For instance, temporary storage of 1,000 acre-feet of water captured from a single storm would require 167 acres (slightly more than ¼ square mile) assuming a water depth of about 6 feet or 333 acres (slightly more than ½ square mile) assuming a water depth of about 3 feet. Also, water delivered to such basins, especially from summer monsoon rains, will be subject to high rates of evaporation. Finally, because their purpose would be to collect periodic rainfall events, they would remain dry for extended periods of time and would require periodic maintenance in order to maintain their ability to support infiltration.

An alternative to infiltration basins and transport of harvested water to them might be to have recharge induced directly from the subsurface perforated-pipe systems envisioned for the treated collection areas. Water that infiltrates into the ground is used by plants, and is also subject to evaporation by the sun to depths of about 3 feet or so, which is about the lower limit of the root zone in grasslands. If the perforated-pipe systems deliver water below the root zone and the zone of evaporation, the delivered water continues downward under the pull of gravity and becomes groundwater recharge.

Irrespective of the mechanism for achieving recharge of the harvested water, it is imperative from both a cost-benefit standpoint and especially for issuance of pumping credits in AMAs to account verifiably for the amount of induced recharge.

(5) Environmental and water-quality implications. Water that runs off from roofs, streets, parking lots, etc., in developed areas is the major source of pollution to our nation's steams, and, if specifically gathered for recharging groundwater, it would carry the risk of introducing man-made contaminants to our groundwater.

(Continued on page 5)

(Continued from page 4) **MACRO-RAINWATER HARVESTING**

Careful attention to water-quality and the risk of groundwater degradation from recharge of contaminated water requires careful analysis and potential regulation.

Treatment of large grassland areas to reduce infiltration on the interfluves between drainage channels in undeveloped areas may have important environmental consequences. Simply, the grassland interfluves are natural habitat for a variety of plants, invertebrates, and vertebrates. How much destruction of such habitat is acceptable?

Infiltration basins require topographic modification and, if they are to minimize loss of water by transpiration, the elimination of vegetation. The environmental impact must be understood.

(6) Cost. Establishment of the infrastructure to harvest and recharge rainfall in sufficient quantity to significantly enhance groundwater storage will be expensive. Once the infrastructure is in place maintaining it for successful and efficient production of enhanced recharge over the long term will represent a continuing expense. Consideration of these costs with respect to the benefits of macro-rainwater harvesting is essential.

Preliminary steps

Investigations and pilot projects to understand the advantages, limitations, and likely costs of macro-rainwater harvesting are the critical next step. In order to serve as a major tool for bringing AMA groundwater budgets out of the red and into the black, macro-rainwater harvesting needs to produce, on average, a net quantity of thousands of acre-feet per year of induced recharge. How many acres of ground surface would have to be modified to achieve effective immediate capture of, on average, thousands of acre-feet per year of rainfall? What does that mean in terms of environmental impact? How much reduction of appropriable surface-water flow from diversion of overland flow is acceptable? What is the magnitude of natural recharge lost as a consequence of treating these large areas of ground surface to reduce their permeability? How much net recharge can be obtained by harvesting water from roof tops, roads, and parking lots and what is an acceptable level of contamination? Is there a method of pre-treatment of urban runoff that would be environmentally and economically acceptable? How many acres of ground surface would have to be modified to create the infiltration basins that would be needed as the immediate receptacles for, on average, thousands of acre-feet per year of harvested rainwater? What does that mean in terms of environmental impact? What is the expected magnitude of loss via evapotranspiration of harvested rainwater during residence in infiltration basins? What are the costs for development and long-term management of these facilities? Would in-situ infiltration via perforated pipes, as described above, be an effective and less costly alternative?

Before legalizing the amount of pumping credits in AMAs that can be awarded for macro-rainwater harvesting, it is imperative to address and answer these questions.

References

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By Edward W. Wolfe and William Meyer

Yavapai County Water Advisory Committee (WAC) Update

Current Yavapai County Water Advisory Committee (WAC) priorities include the Central Yavapai Highlands Water Resource Management Study (CYHWRMS) with the Arizona Department of Water Resources (ADWR) and U.S. Bureau of Reclamation, and the Northern Arizona Regional Groundwater Flow Model recently released by the USGS.

The CYHWRMS study team is now focusing on analyzing alternatives to meet unmet future water demands that were identified in earlier phases. A draft Phase 2 report that identifies potential sources of water to meet future demands will be posted on the WAC website during the month of July 2011. The WAC website has additional information on the study in general and specific results of Phase 1 (http://www.co.yavapai.az.us/Content.aspx?id=20562)). We anticipate that the alternative development phase will continue throughout most of 2011. The alternative evaluation criteria include environmental, economic, legal and institutional analyses as well as Reclamation's four tests-of-viability (completeness, effectiveness, efficiency and acceptability). The TWG typically meets on the first Thursday of each month at 10:30 following the meeting of the Technical Committee of the WAC.

The Model Report for the current USGS Northern Arizona Regional Groundwater Flow Model has been released, and the WAC has received one general presentation from the USGS regarding model basics and the construction of this model. The model report can be found on the USGS website (http://pubs.usgs.gov/sir/2010/5180/). The WAC anticipates continued effort to explore the model, build understanding and confidence in the model, and direct future resources towards model data gaps. We also expect continued discussion on the applicability of the model to water-resource management. The WAC has prepared a set of scenarios for the model that will investigate a range of groundwater pumping conditions in the Big Chino, Little Chino and Verde Valley areas. While a completion date is not determined, it appears the scenario runs will occur sometime in the fall.

The WAC has re-evaluated its written assessment of situational analysis, critical planning assumptions, key objectives and operational tactics. The revised assessment is now posted on the WAC website and is intended as a general statement on the objectives of the WAC. Specific actions and interpretation of the general statements will be developed at WAC meetings and through pursuit of individual projects. The strategic planning is intended to provide a basis for evaluating the appropriateness of WAC projects and expenditures of funds and time.

Please contact the WAC Coordinator, John Rasmussen, for meeting dates, details on any of the WAC activities or if you would like to be added to the WAC email-recipient list (john.rasmussen@co.yavapai.az.us or 928-442-5199).

Prepared by John Rasmussen

A Dry Winter on the Verde

The La Niña event this winter (below normal sea surface temperatures over the equatorial Pacific) lived up to its name with below normal conditions over the winter/spring runoff season. For the January through May 2011 period, the Verde only received 3.73 inches of precipitation, which was only 58% of normal. Interestingly, February, April, and May actually saw near normal precipitation. It was the anomalously dry January that dramatically skewed the season. This January was the second driest on record since 1951. The lack of winter precipitation resulted in below-normal runoff. The Verde system produced only 127,000 acre feet of water, which is quite a bit less than the seasonal median value of 178,000 acre feet. In comparison, last year the Verde saw 510,000 acre feet of water over the same period. This leads us to the big question, what does the North American Monsoon have in store for the Verde? At times, dry winters can be followed by wet summers. However, current climate indicators suggest no real clear direction for monsoon rains. This sentiment is echoed in the official National Weather Service seasonal forecast, which indicates equal chances of below normal, normal, or above normal precipitation for the Verde watershed.

Prepared by the Salt River Project

Membership Form for Verde Watershed Association

Government units	$100 per year	Make Checks Payable to:
Business for profit	$100 per year	**Verde Watershed Association**
Civic groups and non-profits	$50 per year	**P.O. Box 4001**
Individuals	$25 per year	**Cottonwood, AZ 86326**

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