



ARIZONA TRI-UNIVERSITY  
RECHARGE AND WATER  
RELIABILITY PROJECT REPORT

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CONCLUSIONS

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The following is an integrated summary of the project team's conclusions, noting that these relatively simple conclusions can be misleading if they are not taken in the full context of this report. We recommend that these be viewed as a high-level summary, but that actions or decisions that depend on these findings must be considered in light of management objectives, land ownership, water rights, and hydrogeological realities. The leaders of our project are available to assist with interpretation.

1. Warming is having a profound effect on the hydrologic cycle in Arizona, increasing losses to evapotranspiration, reducing soil moisture and decreasing recharge. Statewide, total water in storage is declining over time. Recharge is critical to reliable water supplies.
2. Snowpack-dominated areas are experiencing the most significant changes, including reduced snowpack and earlier peak runoff.
3. More than 95% of the precipitation that falls in the state is lost through evapotranspiration. Reducing ET by even small percentages could yield significant supply increases.
4. There are consequences associated with changing the hydrologic cycle, and it is imperative that environmental assets be protected in the context of any proposed new capture and storage projects. We have provided a section called "[Guiding Principles for Enhancing Recharge and Habitat](#)" to address this issue.
5. There is strong evidence that extreme events, including heat waves, drought, floods and wildfires will increase in intensity over time. Flood-related extremes may provide new opportunities as well as new challenges. Engaging flood control districts in partnerships to maximize capture and recharge of increased flows is one option that can be considered.
6. Changes in precipitation intensity and frequency affect recharge rates.
7. Land management decisions at multiple scales can be adjusted to take advantage of a new framework proposed in this report: Opportunistic Recharge Enhancement. This involves integrating recharge considerations into fire management, road-building, land and infrastructure development, flood control and other resource management activities.
8. There are a multitude of capture and recharge options available that are identified in the Capture and Recharge Opportunities Matrix (see [Appendix F](#)).
9. Drywells and detention basins appear to be much more effective at inducing infiltration than has been previously recognized. Although additional monitoring of actual aquifer impacts associated with these features is warranted, initial evidence is strong.
10. Increasing the length of time that floodflows are held in retention basins, though discouraged due to concerns about insect vectors, is likely to increase recharge rates.

11. Thirty-two percent (32%) of surface water flows in the state originate as groundwater outflow; while surface water recharges groundwater basins in other areas. These fundamental aspects of water in Arizona are not well recognized by the public or by our existing legal system, which treats surface water and groundwater as if they were separable.
12. Considering the dramatic implications of water supply issues statewide, there is a significant need to strategically expand monitoring so that there is better evidence of changes in groundwater levels, real-time monitoring of surface water flows in more locations, and measuring evaporation/transpiration across multiple land cover types.
13. The water supply information that is provided for each basin in this report provides a great starting point for more detailed water supply and demand planning activities. More work is needed to evaluate potential next steps.
14. Partnerships will be critical to move quickly towards more reliable water supply conditions. In particular, it is important that federal agencies and Tribes, who collectively manage the largest percentage of the Arizona landscape, be directly engaged in these activities.
15. We strongly suggest that resource managers test the Decision Support Framework we have provided. We believe that following this step-by-step process may lead to some surprising and innovative solutions. **In the absence of this kind of “decision-tree” approach to selecting capture and storage options, here are some general “rules of thumb”:**
  - a. The area of the state with the highest potential for generating large volumes of water for capture and storage is the Mogollon Rim/Transition Zone, because of its significantly higher volumes of precipitation relative to ET.
  - b. Capturing water before it evaporates can significantly increase water supplies in some locations within the state. Because water evaporates from every basin, there are options for capture in many locations, but volumes generated may be very limited in most of the alluvial basins in the southern and western parts of the state.
  - c. There are multiple ways to enhance recharge of water in natural systems across the state. Those that in particular warrant further review are:
    - i. an analysis of karst topography and areas of significant rock fissures (with high recharge potential) in the vicinity of potential capture locations
    - ii. identification of mountain-front recharge areas that could be enhanced to receive larger volumes of recharge
    - iii. improvements in floodplain management practices to maximize capture/retention and recharge, rather than evaporation, of floodflows
    - iv. implementation of the Opportunistic Recharge Enhancement concepts mentioned above, including incorporation of recharge objectives as a co-benefit in infrastructure design, particularly road building, forest thinning and, fire management to minimize interception losses and maximize snowpack retention

- d. The most productive ways to maximize capture and recharge within urbanized areas are:
  - i. Designing capture and recharge into new land development policies in order to maximize urban enhanced recharge and protect areas that naturally have high recharge rates, such as floodplains and ephemeral channels
  - ii. Maximizing the use of dry wells for flood control, especially in areas with known connectivity to the regional aquifer
  - iii. Promoting retention basins designed for depth over area, with low-clay soils and minimal evapotranspiration by plants to encourage recharge