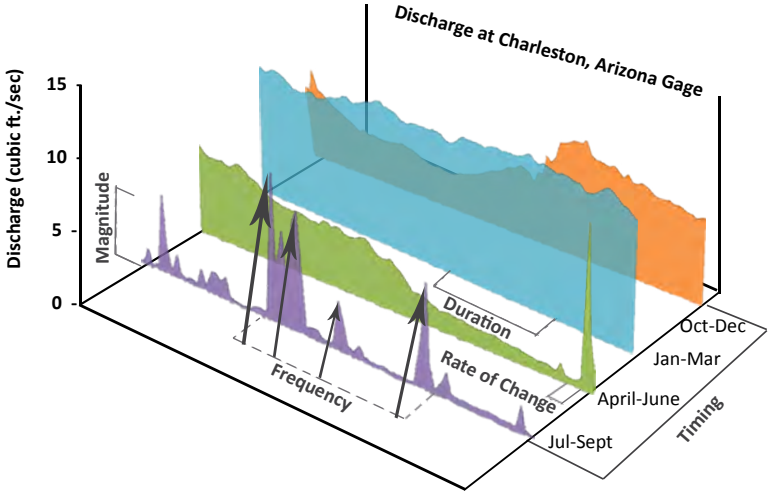
Water Resources Research Center
A University of Arizona Water Resources Research Center Project

Environmental Flows and Water Demands: Southeastern Arizona Region

Water is an increasingly scarce resource and is essential for Arizona's future. With Arizona's population growth and continued drought, citizens and water managers have been taking a closer look at water supplies in the state. Municipal, industrial, and agricultural water users are well-represented demand sectors, but water supplies and management to benefit the environment are not often considered. This bulletin explains the water demands of the environment in the Southeastern Arizona Region, an area that includes the Cienega Creek, Douglas, Lower and Upper San Pedro, Morenci, Safford, and Willcox groundwater basins, as well as the Tucson and Santa Cruz Active Management Areas (AMAs).



Data Source: USGS stream gage data

Figure 1. **Elements of Environmental Flow Occurring in Seasonal Hydrographs**

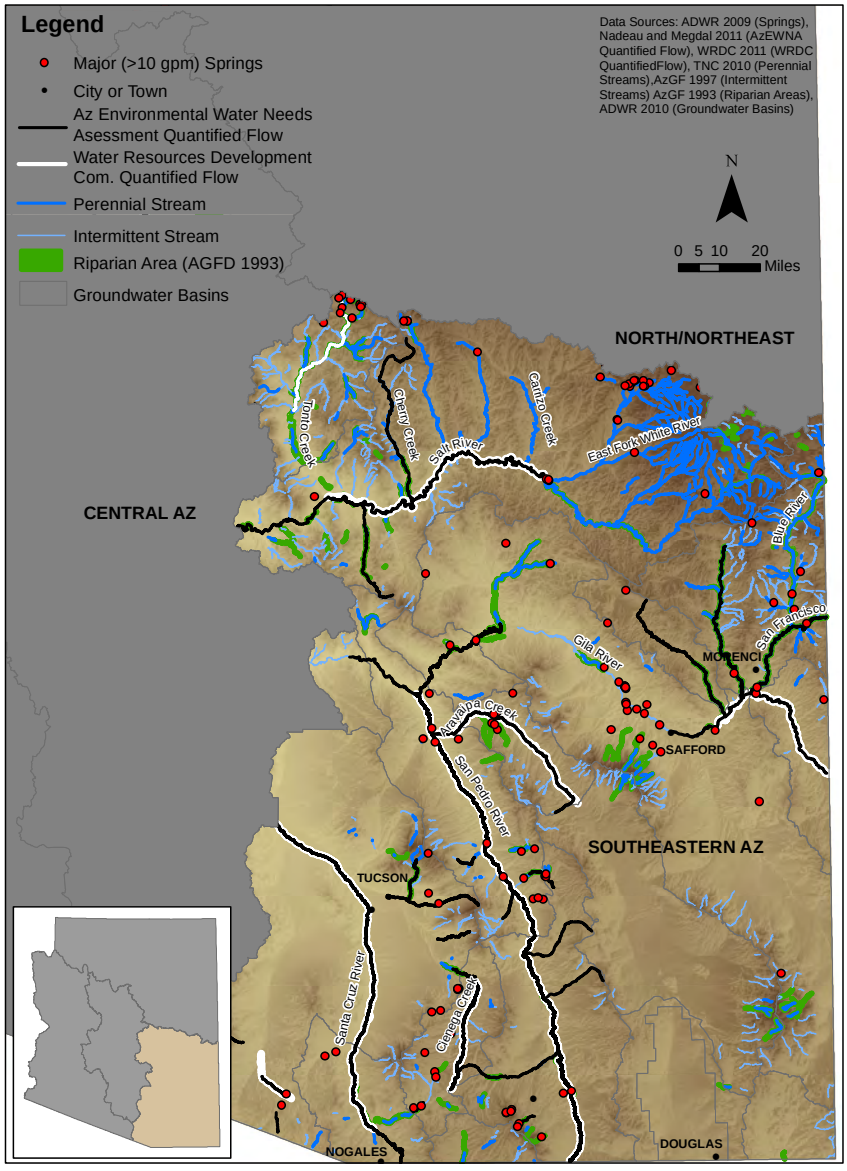


Figure 2. **Streams with Quantified Flows/Demands and Surface Water Resources in the Southeastern Arizona Region**

This Southeastern Arizona Region bulletin also introduces information essential for considering environmental water demands in discussions about water management. Environmental water demands (or environmental flow) refers to how much water a freshwater ecosystem needs to sustain itself. Arizona's native animals and plants are dependent on dynamic flows, which are commonly described according to five elements: magnitude, duration, frequency, timing and rate of change. For example, seasonal flood events (e.g. timing) and constant flows (e.g. duration) cue important biological events, like reproduction. The five elements of environmental flows are displayed in Figure 1 through a hydrograph of the San Pedro River's flows over the course of a year.

To consider the environment alongside other water sectors, we must first study the water demands of ecosystems. In Figure 2 the streams where studies have quantified the current amount of streamflow that supports the environment (gray lines) and environmental water demands (black lines) are displayed in relation to key surface water resources. This region contains perennial (those that flow year-round) and intermittent (those that flow only part of the year) streams, riparian areas, and many major springs.

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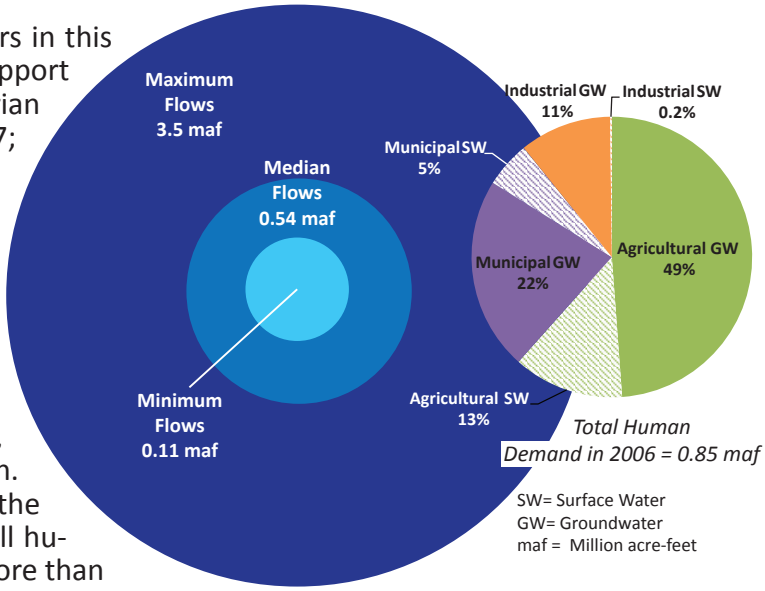
Humans have an interconnected and dependent relationship with the environment. Nature provides recreation opportunities, economic benefits, and water supplies to sustain our communities. Homebuyers in this region will pay more to live near riparian areas that support native species; and in some cases proximity to a riparian area will increase home values by 5.8% (Bourne, 2007; Bark et al., 2009).

How water is used in the Southeastern Arizona Region is shown in Figure 3 by comparing the relative scale of human water demands by sector to existing minimum, median, and maximum flows available in the environment. The total size of the pie chart of human demands (far right) reflects the 0.85 million acre-feet annually withdrawn or diverted by all sectors (municipal, industrial, and agricultural) by water source in the region. Median annual flows for the gaged rivers in the region are about sixty percent of the amount used by all human demand sectors, while maximum flood flows are more than four times greater. Surface water imported from the Colorado River is included in human surface water demand but not in the current streamflow quantities shown on Figure 3. Although human and environmental demands are not always mutually exclusive, some streams in the region no longer contain perennial flows because of water use by humans.

***Figure 3:* Human Demand and Current Flow in the Southeastern Arizona Region (circle size indicates relative amount of water)**

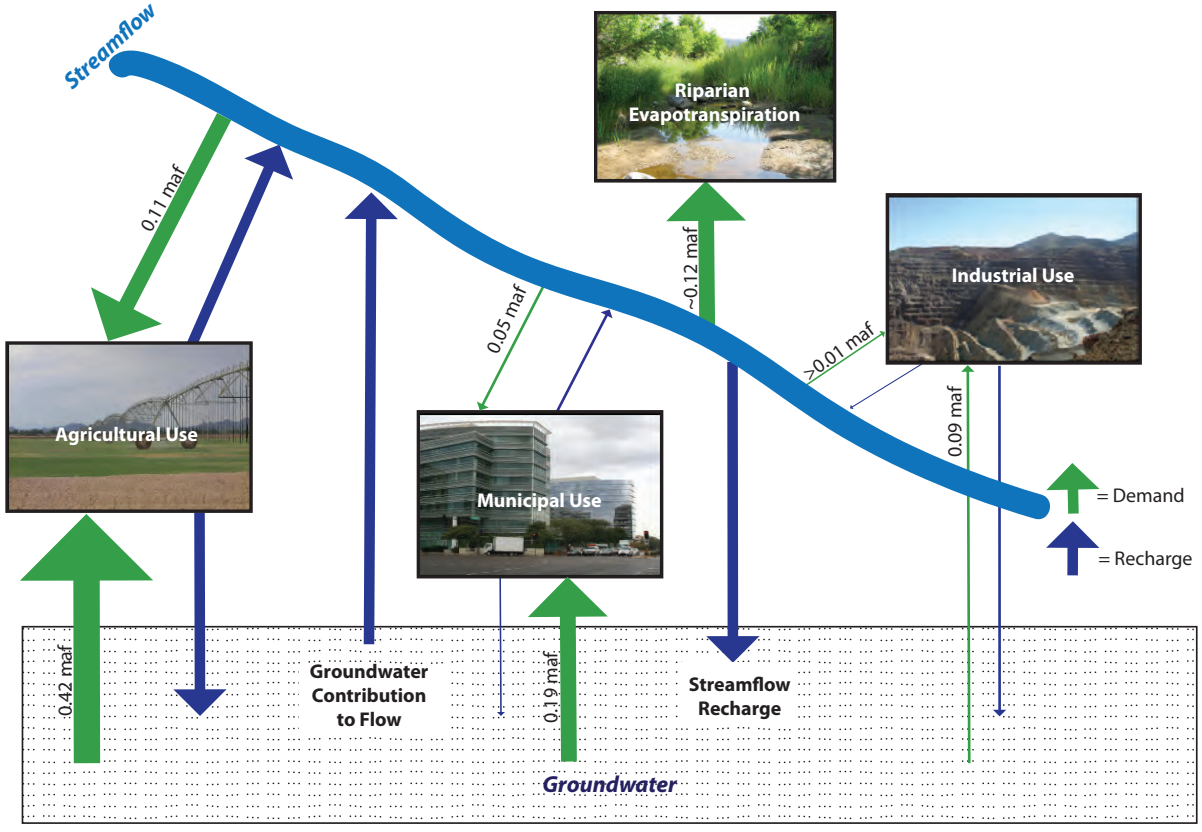


**In 2006 an additional 0.016 maf of effluent was also used to meet demand*

Data Sources: ADWR 2010 (streamflow as measured by stream flow gages), WRDC 2011 (human demand)

Figure 4 shows the Southeastern Arizona Region's median streamflow as a single "stream" and how it interacts with groundwater and human demands. Outflows to human and environmental demands are marked by green arrows, while flows into the environment are represented by blue arrows. Note that all human sectors return some water to the environment after use. Also, water traveling through a river to farming or domestic uses downstream can support aquatic and riparian ecosystems (streamside) along the way. These connections between environmental and human demands can create opportunities for water management that is mutually beneficial.

***Figure 4:* Water Demand and Use in the Southeastern Arizona Region (Arrows indicate relative size of demand and recharge)**



Data Source: WRDC 2011

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In the Southeastern Region more stream reaches have intermittent flow (53%) than perennial flow (47%). In this region only 18% of all stream reaches have been studied: 21% of all perennial and 15% of all intermittent stream reaches. There are 49 known studies (38 quantitative and 11 qualitative) in this region that characterize some aspect of environmental water demands. These studies provide information on the water quality, flood frequency, and depth to groundwater needed to support native species. Only one study, on Rincon Creek, provides quantified recommendations for minimum daily flow volumes by month intended to support aquatic species and bottomland plants (NPS, 2008). The recommended flows are made with the assertion that these flow levels will also support native mammals and birds.

Table 1b categorizes available information for select streams in the region by the elements of flow that have been studied. Although some Southeastern Arizona streams have been studied for five flow elements, these studies focus on the demands of either riparian or aquatic species but do not address the flow demands and responses for the whole ecosystem. Twenty-five of the 38 quantitative studies in this region examined multiple species' needs, and 6 of them quantified both environmental flow demands and ecological responses to flow. More studies in this region describe ecological responses to flow components than provide actual flow prescriptions.

***Table 1*: Flow Components Studied and Information Gaps for Select Perennial Streams in the Southeastern Arizona Region**

River Name	Magnitude	Duration	Frequency	Timing of Flow	Rate of Change	Water Quality*
	(% Studied)					
Arivaca Creek	S	S	NS	NS	S	NS
Aravaipa Creek	S	S	NS	NS	S	S
Babocomari River	S	NS	NS	S	NS	NS
Cienega Creek	S	S (88%)	S	S (88%)	S (88%)	NS
Cherry Creek	S	NS	NS	NS	NS	NS
Eagle Creek	S	NS	NS	NS	NS	S
Gila River	S (49%)	NS	NS	S (49%)	NS	S (22%)
Pinto Creek	S	S	S	NS	NS	NS
Rincon Creek	S	S (61%)	S	S (61%)	S	NS
Sabino Creek	S	NS	S	NS	S	NS
Salt River	S	NS	NS	NS	NS	S
San Francisco River	S	NS	NS	NS	NS	S
San Pedro River	S	S	S	S	S	S
Santa Cruz River	S	S	NS	NS	S	S
Sonoita Creek	S	NS	S	NS	S	NS

* Does not include studies of water quality alone, these studies were not reviewed for this report. S= Entire stream surveyed, S= Reach (% of stream surveyed), NS= Not surveyed

Data Source: Nadeau and Megdal 2011

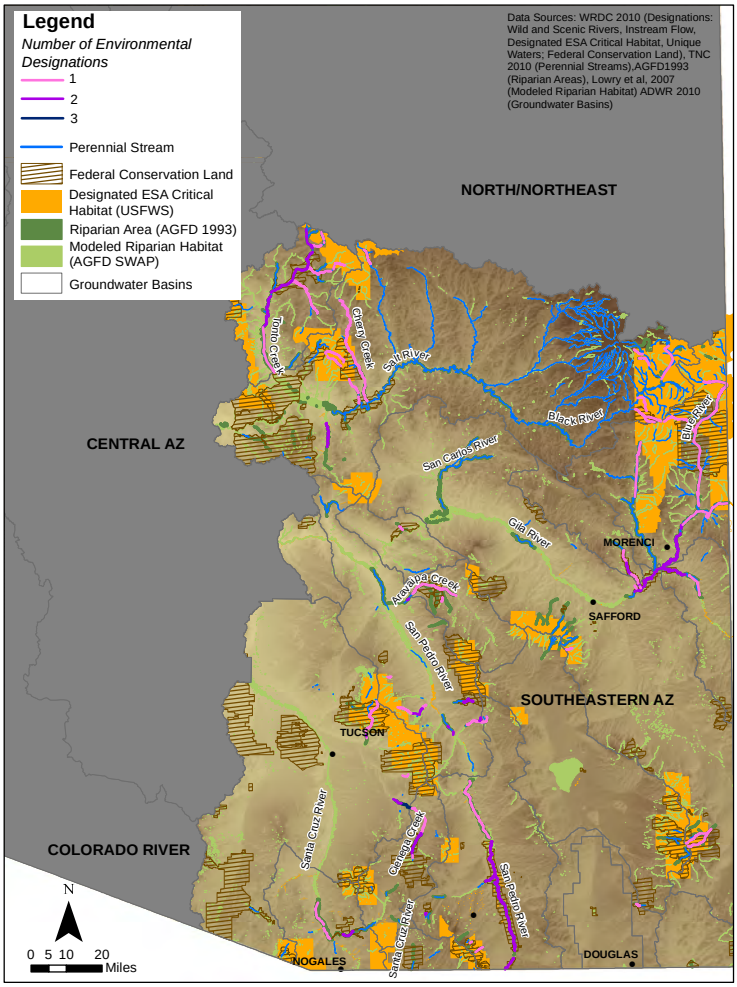

***Figure 3:* Environmental Resources and Designations in the Southeastern Arizona Region**

Official designations by the state and/or federal government are made to protect stream reaches with high environmental values. These designations include Wild and Scenic Rivers, Instream Flow Permits and Applications, Arizona Department of Environmental Quality Unique Waters, Endangered Species Act Critical Habitat, and Federal Conservation Lands such as National Forest Wilderness or National Parks. Many stream reaches, such as on the San Pedro River, have multiple designations (see Figure 3 for the number of designations on stream reaches in this region). Having many designations on one reach can be an indication of an area with significant environmental resources. Different designations provide different types of protections for environmental flows, but having three designations does not necessarily mean the reach is better protected than a reach with one designation.

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Statewide, ecosystem-level flow requirements remain poorly understood. Small scale studies that prescribe flows for a single reach exist for some areas, but cannot be applied across basins or regions. Two areas of agreement have emerged from studies done across the state: (1) riparian areas need both access to sufficient groundwater and carefully-timed flood flows to maintain water levels for established plants and for new plant growth; and (2) change to any element of flow can impact Arizona's aquatic and riparian ecosystems if flows are altered beyond the range of tolerance of native species.

Gila River near Three Way, Arizona.
Photo Credit: Arizona Department of Water Resources

The Southeastern Arizona Region has a wealth of natural resources in its streams, springs, and riparian areas. Water demands of the environment in this region have been studied more than all other regions in the state combined, however, the majority of these studies are on one river, the San Pedro. Even with the available information, this region lacks clear, measurable management objectives for all but one of its streams.

Information available in the region on the relationships between components of flow and biological factors can be used for considering potential impacts of future water decisions. By comparing various environmental flow demands, such as species-specific water demands, with current conditions, areas needing protection or restoration can be identified. These pages present a brief overview of the information available for the Southeastern Arizona Region; more detailed information to help inform planning efforts throughout this region is available by contacting the WRRC.

How you can apply this information

Those working to address the demands of all water sectors in Arizona can apply this information to:

- Determine how environmental flows interact with other demand sectors regionally,
- Identify factors putting environmental flow demands at risk,
- Identify studies needed to address key information gaps about environmental flows,
- Determine local priorities for ecosystems, and then identify water needed to preserve or restore those,
- Develop scenario analyses for water planning that incorporate the environment, and
- Share the information widely to increase understanding of regional resources and challenges.

Contact Info

For assistance applying information about environmental water uses and needs in water planning, questions about methods used to create this bulletin or requests for our environmental water demand data please contact:

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The WRRC offers public presentations about this information as well as direct support for water planning processes as part of our Connecting the Environment to Arizona Water Planning (EnWaP) project.

wrrc.arizona.edu

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