NORTH CENTRAL ARIZONA WATER DEMAND STUDY

Phase I Report

An examination of water use, water conservation and alternative supplies in non-reservation communities on the Coconino Plateau

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(incorporates corrections based on stakeholder comments on the March 2002 Draft Report)

by

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A report submitted to the Coconino Plateau Water Advisory Council

LIST OF ACRONYMS

Arizona Corporation Commission	ACC
Arizona Department of Environmental Quality	ADEQ
Arizona Department of Economic Security	ADES
Arizona Department of Water Resources	ADWR
Census county division	CCD
Census designated places	CDP
Canyon Forest Village	CFV
Covenants, conditions and restrictions	CC&Rs
Commercial, institutional and industrial; e.g., "CII water conservation."	CII
Capital improvement plan	CIP
Doney Park Water Company	DPW
Evapotranspiration—the water requirement of plants and associated soils	ET
Forest Highlands Water Company	FHWC
Gallons per capita	GPC
Gallons per capita per day	GPCD
Gallons per day	GPD
Gallons per flush	GPF
Gallons per minute	GPM
Grand Canyon National Park	GCNP
Kachina Village Improvement District	KVID
Municipal and industrial	M&I
Million gallons	MG
Million gallons per day	MGD
Million gallons per year	MGY
Memorandum of understanding	MOU
Named population places	NPP
National Pollution Discharge Elimination System	NPDES
Northern Arizona University	NAU
Planning and Management Consultants, Ltd.	PMCL
Public service announcement	PSA
Pounds per square inch	psi
Polyvinyl chloride—a material used in pipes	PVC
Rocky Mountain Institute	RMI
Small business enterprise	SBE
South Grand Canyon Sanitary District	SGCSD
Tusayan Water Development Association	TWDA
Ultra low-flush toilet; a toilet designed to use 1.6 gallons per flush or less	ULFT

I. EXECUTIVE SUMMARY

Water resource stakeholders on the Coconino Plateau are wrestling with the question of how to provide sufficient water for current and future needs. Recent droughts, environmental concerns, population and economic growth all raise concerns over the adequacy of water supplies. A pipeline to tap Colorado River water is under study. Conservation and alternative supplies such as wastewater reclamation are important water management strategies in local communities, but have received little attention at the regional level to date.

The *North Central Arizona Water Demand Study, Phase I*, contributes to the discussion by reviewing how water is currently provided and used for residential, commercial, municipal, and industrial purposes on non-reservation lands of the Coconino Plateau, in the area roughly bounded on the south by the Mogollon Rim, on the north by the Colorado River, on the west by the Aubrey Cliffs, and on the east by the communities of Winona toward the south and Page to the north. Specifically, the following communities are included in the study area:

- Bellemont
- Doney Park (including Timberline, Fernwood, Cosnino, Winona)
- Flagstaff
- Flagstaff Ranch
- Forest Highlands
- Fort Valley
- Grand Canyon Village
- Kachina Village
- Mountainaire
- Page
- Parks
- Red Lake
- Tusayan
- Valle
- Williams

This report also describes and evaluates water conservation activities in the study area, and summarizes current and anticipated implementation of alternative supply systems. It sets out a recommended water demand forecasting methodology for a proposed Phase II study.

CURRENT WATER DEMAND

In the year 2000, total water demand in the study area amounted to roughly 5,842 million gallons, or 17,930 acre-feet. This includes both potable and nonpotable demand. In these figures, potable demand is represented for most communities by total drinking water production, which includes metered water use, unmetered use (e.g., fire hydrants) and unaccounted-for water (e.g., distribution system leaks). In some small communities, only metered water-use data could be obtained. Unmetered and unaccounted-for uses in these communities are considered small, so the omission of these uses does not substantially affect the overall demand figures. The figures above and in Table I-1 below also do not include Valle and the rural households supplied by standpipes in Valle. The study team could not obtain water production or metered water use from the two water systems in Valle. Again, because of this community's small size, the overall water-use figures are not substantially affected. Table I-1 uses the "greater than or equal to" figure ( ) to indicate where the slight underestimation occurs. Nonpotable demand includes two components, raw water use and use of reclaimed wastewater effluent. Total demand in the study area in 2000 breaks down as follows:

TABLE I-1
TOTAL DEMAND IN THE STUDY AREA IN 2000

	Millions of gallons	*Acre-feet*	*Portion of Total Demand*
Potable demand	4,667.2	14,323	80%
Nonpotable demand			
Raw water	247.2	759	4%
Reclaimed wastewater	928.0	2,848	16%
Total demand	5,842.4	17,930	100%

Water use in most study area communities is predominantly residential and commercial. Because of the strongly tourist-oriented economy of the region, hotels and other tourist services are significant portions of water demand in many communities. Parks, golf courses and other community landscapes are substantial water users in Flagstaff, Page, Williams and the gated communities of Forest Highlands and Flagstaff Ranch (under construction). Irrigation of private landscapes in most communities of the study area appears to be somewhat reduced, compared to more urban areas of the southwestern U.S. In the more rural communities, substantial numbers of homes have no irrigated landscape. Industrial and institutional (e.g., university, hospital, etc.) uses are substantial only in Flagstaff.

Water use in the study area varies significantly from season to season. Landscape irrigation, seasonal home occupancy and tourist traffic result in substantially higher water use in the summer than in winter. For most communities, demand in the peak summer month is about 1.5 to 2.5 times greater than in the low winter month. For Tusayan and Page the increases are roughly 3 and 4 times, respectively.

WATER SUPPLIES

Many communities in the study area rely on ground water for most or all of their water supply. A few communities, notably Bellemont and Fort Valley, have access to perched aquifers at a depth of a few hundred feet. Well depths in other locations are much deeper, from 600–1,100 feet in the southeast (Mountainaire and Kachina Village), to over 3,000 feet in the west and north

(Williams, Valle and Tusayan). Drilling deep wells is costly (over $1 million per well) and risky. Groundwater pumping has also raised concerns over potential impacts on the seeps and springs along the south rim of the Grand Canyon that are supplied by regional aquifers.

Three study area communities use surface water. Page relies entirely on surface water from Lake Powell, though the city is about to develop its first groundwater wells. Williams was entirely reliant on surface water until a few years ago. Its five reservoirs are unreliable in extended dry periods. Williams now has three producing wells. Flagstaff also uses surface water. In wet years Lake Mary has provided as much as 70 percent of the city's water supply. In most years it provides less, and has come close to drying up in a few years. Page and Williams treat most of their surface supplies for potable purposes and use some raw surface water for golf course irrigation. Flagstaff treats all of its surface water for potable uses.

Several portions of the study area, especially Parks and Red Lake, continue to develop despite lack of any local water supplies. Surface water sources do not exist in these locations, and depth to groundwater makes drilling of individual or small community wells cost-prohibitive. These areas instead rely on hauling of water from standpipes in Flagstaff, Doney Park, Bellemont, Williams, Valle and Tusayan.

Alternative supplies are already important, and growing, as a water source in the study area. Wastewater reclamation and reuse, accomplished via treatment at a centralized wastewater treatment plant and reclaimed water redistribution lines to points of use, is now practiced in seven communities: Flagstaff, Forest Highlands, Grand Canyon Village, Page, Tusayan, Valle and Williams. Reclaimed wastewater now provides for 16 percent of total water demand in the study area. More notably, it provides substantial service in at least six communities:

TABLE I-2
COMMUNITIES USING RECLAIMED WASTEWATER AS A SIGNIFICANT SUPPLY

	Reclaimed wastewater portion of total demand
Flagstaff	15%
Forest Highlands	19%
Grand Canyon Village	22%
Page	22%
Tusayan	40%
Williams	19%

Development now underway at the Bellemont Travel Center and Flagstaff Ranch will include wastewater reclamation as an important water supply. Flagstaff is aggressively seeking to move additional customers from potable supplies to its substantial reclaimed water supplies. Forest Highlands has in place an agreement to draw reclaimed water from Kachina Village as needed and available. Williams plans to add reclaimed water storage in the future, increasing its wastewater reuse substantially. And Grand Canyon Village, Tusayan and Valle all have in place the infrastructure to allow for increased use of reclaimed water.

Rainwater harvesting is another important alternative supply. A five-acre Hypalon catchment basin at the Grand Canyon airport in Tusayan provides virtually all the *potable* water used by the airport complex and a dozen nearby homes. This system meets 6 percent of the total water demand in Tusayan. A second notable system is under construction at Flagstaff Ranch. It will use a French drain (a trench filled with gravel and bottomed with a perforated pipe to capture drainage) to divert local pavement and subsurface runoff to a holding pond for golf course irrigation. It is likely that a number of individual homes in the study area, particularly in water hauling locales, practice rooftop rainwater harvesting, but the contribution of these systems cannot be easily quantified.

In addition to increased rainwater harvesting and expanded use of centralized wastewater facilities to reclaim water, the future will likely see onsite wastewater treatment and graywater reuse making contributions to local water supplies. The Arizona Department of Environmental Quality (ADEQ) has recently enacted regulatory changes that will make use of onsite wastewater and graywater supplies more permissible and less costly. The potential for alternative supplies to meet an increasing portion of total water demand in the study area is significant and merits further study.

WATER EFFICIENCY AND CONSERVATION

The sophistication, level of effort, and corresponding results of water efficiency and conservation activities—"water demand management"—vary substantially throughout the study area. Flagstaff has the most extensive and notable water efficiency and conservation program. Its efforts are commensurate with those of other similarly sized and situated water utilities. Flagstaff's educational programs—e.g., televised public service announcements, newspaper inserts and school programs—also benefit other Coconino County communities by raising conservation consciousness beyond the city limits as well as within. Williams has recently made important strides in building an efficiency and conservation program. Page, for its size and concern over adequacy of current supplies for future growth, is remarkable for not having implemented a serious water efficiency and conservation program. In most other communities, conservation rate structures, or simply the high price of water, provide the main motivating factor for customers to implement water efficiency measures or practice water-wise behaviors. It appears that high prices have become a conservation tool mostly by default, because of the high cost of providing water in this region, rather than as a conscious water conservation strategy. Only Doney Park Water Company (DPW), Flagstaff and Kachina Village have what the study team considers to be effective conservation rate structures.

With a few exceptions, *active* intervention to increase water efficiency by local water providers or planning and building officials is very limited in the study area. Active intervention includes incentives such as rebates, giveaways and bill credits; regulations on fixtures, landscape, irrigation systems, etc.; audits and technical assistance; system measures such as ongoing distribution leak testing; and other programs. Even educational programming—a fairly low-cost, but largely *passive* approach—is nonexistent or thin in many study area communities.

The county and some local governments do have in place some regulations on fixtures. However, in almost all cases, these regulations are vague—they simply require "low flow" fixtures, without specifying flow rates. Thus, local plumbing standards, unless more vigorously specified and enforced on a case-by-case basis in development reviews, simply default to the national plumbing standards in place since 1994. Those standards no longer represent best available technology.

Much more could be done in the study area with respect to water-efficient technologies and water-wise behaviors and landscaping choices. The potential for study area stakeholders to produce significant additional water savings in existing development, and to reduce the water demand of new development, is significant. This report identifies 23 efficiency and conservation *measures*—technologies and management practices that reduce water demand—that are probably appropriate in the study area. Additional industry-specific measures would be available in the commercial, institutional and industrial sectors. The report also identifies 20 applicable *implementation techniques*—ways of encouraging or requiring end-users to adopt efficiency and conservation measures. These measures and programs should be further studied for their suitability and water savings. Some are appropriate for implementation by individual water systems, while others could be mounted through regional cooperation.

DEMAND FORECASTING

Recent water resource planning efforts in the study area have used the estimates of future water demand developed by the Arizona Department of Water Resources (ADWR) in its *Phase 1 – North Central Arizona Regional Water Study* report (1999, hereafter referred to as the ADWR Water Supply Study). The report provides a very brief discussion of water demand for each community, but the methodology used to estimate the water demand for each area is not well documented.

The authors of *this* study *(The North Central Arizona Water Demand Study – Phase I Report)* have many reservations about the ADWR demand estimates, which are detailed later. Further, the ADWR Water Supply Study attempts to estimate the new supply increment needed over current supplies. Those estimates do not account for recently developed supply sources in Tusayan and Williams. They also make problematic assumptions about needs for new sources: Tusayan, Williams, and Grand Canyon National Park are assumed to completely abandon their existing supplies and wastewater reuse systems in favor of a new supply source.

Additional water demand forecasts are reported in the *Flagstaff Area Regional Land Use and Transportation Plan* (2001), the *Page General Plan Update* (BRW, Inc. and Sunregion Associates, Inc. 1995), and the *Final Statement for Tusayan Growth* (U.S. Forest Service 1999). In most cases, the assumptions and methods used for the demand forecasts in these documents are not clear.

A more thorough analysis of future water demand is highly recommended. Assumptions and linkages between water use, population growth and other growth factors should be carefully researched and clearly specified. Contributions that water conservation and alternative supplies could make to the overall water resources situation should be evaluated.

This report outlines the demand forecasting methodology proposed for Phase II of *The North Central Arizona Water Demand Study*. Phase II is designed to provide water resource managers and decision-makers with information about future water demand and potential effects of demand management and alternative supply options. The intent is to provide a thorough and accurate assessment of water demand under baseline and conservation/alternative supply scenarios. Given the available data and local water use patterns, the authors recommend that the demand forecasting system include two separate analyses:

- *Forecasting of potable water demand with water-use models.* These models will be based on population projections, in conjunction with water-use rates determined through analyses of the local determinants of water demand. The sophistication of these analyses will vary by location and water-use sector according to the availability of necessary data.

- *Forecasting of nonpotable water demand and displacement of potable water demand with nonpotable alternative supplies.* Currently available data does not permit modeling of nonpotable use. The forecasts will instead be developed through an assessment of existing and potential applications of alternative supplies.

The authors propose using the population projections of the Arizona Department of Economic Security (ADES) as the future population input for water demand modeling. This data set employs the most credible methodology and provides internal consistency for both county-level population projections and subcounty projections that closely match water system geographies. Alternative population scenarios could also be evaluated, if desired.

The potable water demand models in Phase II will employ a methodology that: (a) allows for adjustment of model inputs to reflect expected changes or defined scenarios for future local economic conditions; and (b) allows for specification of water conservation scenarios. The methodology will do so by employing factors for water use per account and accounts per population. The overall procedure will be as follows:

1. Conduct regression analysis to determine appropriate baseline water-use rates (water use per account) for each location and sector (customer class) where adequate data exists. For example, an attempt will be made to "normalize" historic water-use rates for historic variations in weather and changes in water rates.

2. Assemble a system of specific models of potable water demand for each community and sector using water-use rates based on statistically significant regression results or other approaches for communities/sectors where regression analysis is not feasible or effective.

3. Adjust the models for expected future changes in demographic and economic conditions.

4. Estimate future potable water demand by location using the models and population projections (i.e., estimate baseline water demand).

5. Estimate water demand by location for scenarios of increased water efficiency and conservation activity.

6. Conduct sensitivity testing and forecast demand under additional scenarios as needed and appropriate.

Forecasts of nonpotable water demand must reflect the physical configurations of water infrastructure and patterns of water use in each community. The social acceptability of alternative supplies must also be considered. The study team will meet with water system managers in each community to discuss opportunities and constraints for using raw water and various alternative supplies, and to obtain their informed judgments on future new uses of nonpotable water and future displacement of potable water uses with nonpotable supplies. In addition, past and emerging experiences of communities around the country with the full range of alternative supplies will be examined, as reflected in the water resources and water conservation literature.

Total water demand forecasts will be developed for each study area community and three proposed forecast scenarios:

- Baseline (current and planned demand management and alternative supply activities);

- Moderate conservation and alternative supply investment (increased activity); and

- Aggressive conservation and alternative supply investment (a full range of state-of-the-art measures and programs).

This report presents a proposed workplan for Phase II, and notes a number of issues and concerns that must be resolved prior to initiation of Phase II. Costs for Phase II will depend on how some of these questions are to be addressed, the number of forecast scenarios, etc. The estimated cost range is $75,000 to $150,000.

RECOMMENDATION

Effective programs across the country have conclusively shown that water efficiency and conservation should be considered a "supply" of water—an already developed resource that when tapped can help defer, downsize or avoid altogether costly new water supply infrastructure. This is especially true when water efficiency and conservation are considered together with water reuse and other alternative supplies in a thorough, integrated evaluation of available options for meeting water needs.

Demand management and conventional and alternative supplies must all be considered if a community or region is to develop the most cost-effective approach to meeting human and environmental water needs. Conventional supply options, from new wells to an imported water pipeline, are getting considerable attention in the study area. As with any integrated water resource planning process, a detailed and accurate water demand forecast is required to (1) provide an understanding of both current and anticipated water-use patterns and (2) establish the baseline for the analysis of alternatives. The Phase II water demand study is recommended, in order to provide both a better understanding of future needs, and to add a sound evaluation of water conservation and alternative supply development to the "resource mix" available for consideration by regional water stakeholders.