RECLAMATION

Managing Water in the West

Preliminary Assessment – Final Report

Green Valley Area Water Supply Study

Prepared for the Upper Santa Cruz Providers and Users Group Pima County, Arizona

U.S. Department of the Interior
Bureau of Reclamation
Lower Colorado Region
Phoenix Area Office
Glendale, Arizona

June 2017

Mission Statements

The mission of the Department of the Interior is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Prepared by

Bureau of Reclamation
Phoenix Area Office

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June 2017

Acknowledgements

Effective water resources management practices are essential to ensuring Arizona's Green Valley Area can sustain its water supply. The Bureau of Reclamation and its partners hope this Green Valley Area Water Supply Study serves as a successful planning tool to help the region prepare for the challenges of local water management in the future.

To that end, many thanks to all who provided content and comments:

Matthew Bailey (formerly with Farmers Investment Company)

Chad Fretz (Freeport-McMoRan)

Tim Gibson (Freeport-McMoRan)

Alex Richards (Freeport-McMoRan)

Robert Hedden (Green Valley Domestic Water Improvement District)

Kenneth Taylor (Community Water Company of Green Valley)

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Acronyms and Abbreviations

ACC	Arizona Corporation Commission
ADWR	Arizona Department of Water Resources
AFY	acre-feet per year
AMA	Active Management Area
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CO	Contracting Officer (Reclamation)
CWC	Community Water Company of Green Valley
DBPs	disinfection by-products
FICO	Farmers Investment Company
GSF	Groundwater Savings Facility
GVDWID	Green Valley Domestic Water Improvement District
LTSC	Long-Term Storage Credits
M&I	municipal and industrial
MF	microfiltration
mg/L	milligrams per liter
NIA	non-Indian agriculture
Reclamation	Bureau of Reclamation
RO	reverse osmosis
SDWS	Safe Drinking Water Standards
TDS	total dissolved solids
UF	ultrafiltration
USC/PUG	Upper Santa Cruz Providers and Users Group
USCWUG	Upper Santa Cruz Water Users Group
USF	Underground Storage Facility
WIFA	Water Infrastructure Finance Authority
WRM	Water Resource Management (Plan)

1.0 Background

The Tucson Active Management Area (Tucson AMA) is a groundwater basin subject to special regulation by the Arizona Department of Water Resources (ADWR) under the state's Groundwater Management Code. The Green Valley / Sahuarita area, located within Pima County, is situated in the southern, up-gradient portion of the TAMA's Upper Santa Cruz Sub-basin, as shown in Figure 1.

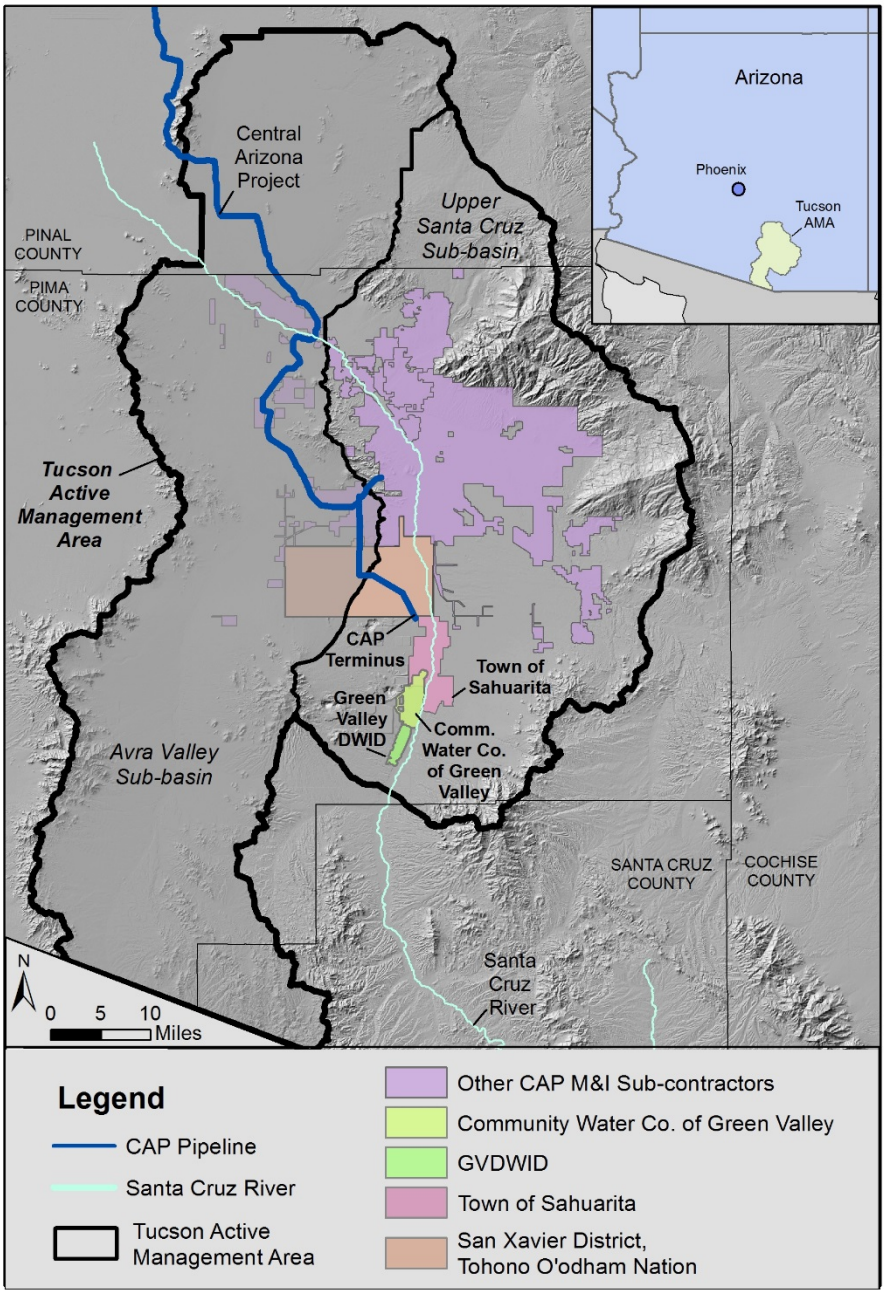

Figure 1 – Location of Green Valley / Sahuarita Area within the Tucson Active Management Area

The Central Arizona Project (CAP) is a 336-mile long water delivery system that conveys Colorado River water to central and southern Arizona, including areas within the Tucson AMA. It is operated by the Central Arizona Water Conservation District (CAWCD). Unlike most of the Tucson AMA, the Green Valley / Sahuarita area does not have physical access to renewable CAP water supplies, and relies on groundwater for its municipal, agricultural and industrial water needs. More water is being withdrawn than recharged in this area, and as a result, the local water table has dropped significantly (ADWR, 2010).

In 2007, a group of Green Valley area water providers and users from the municipal, agricultural and industrial sectors formed the Upper Santa Cruz Providers and Users Group (USC/PUG), a non-profit organization, in response to declines in the local aquifer and public concern for the sustainability of the water supply (Table 1). The mission of the USC/PUG is, "to bring CAP and other renewable water resources to the greater Green Valley / Sahuarita region to meet the long-term demands on the local aquifer supporting growth, lifestyle, and the environment."

Table 1: Members of the Upper Santa Cruz Providers and Users Group (USC/PUG)

Type	Name
Water Providers	Community Water Company of Green Valley (CWC)
	Green Valley Domestic Water Improvement District (GVDWID)
	Sahuarita Water Company
	Farmers Water Company
Agriculture	Farmers Investment Company (FICO)
Mining	Freeport-McMoRan Copper and Gold Inc.
Municipality	Town of Sahuarita

The USC/PUG requested the Bureau of Reclamation's (Reclamation's) assistance in developing a plan to utilize CAP water in the Green Valley / Sahuarita area. In response to the USC/PUG's requests, Reclamation initiated the Green Valley Area Water Supply Study (Study), an appraisal level study, in September 2011.

Under Reclamation policy, an appraisal level study identifies a problem / opportunity, compiles existing data, and develops a wide variety of alternatives to address the issue. Study partners then evaluate these alternatives and identify the most promising ones for further investigation. The evaluation considers technical issues and their associated effects in determining costs and benefits. Potential environmental, social, and cultural effects and mitigation needs are addressed. USC/PUG is providing data and staff time to Reclamation as a cost-share partner in this effort.

This *Preliminary Assessment Report* (Report) is the first step in the appraisal study process. It outlines the problem to be addressed, resources available to the Green Valley / Sahuarita area, and high-level descriptions of alternatives to address the problem. The Report Appendices also provide detail on two issues: Appendix I describes the capacity to convey water to the Green Valley area through the CAP terminus and other pipelines that connect to it. Appendix II details the screening process for appropriate recharge facility locations using soil maps. The Plan of Study agreed to by Reclamation and the USC/PUG is presented as Appendix III.

2.0 Introduction

2.1 Overview

The Green Valley / Sahuarita area is experiencing groundwater overdraft, a condition where more water is being withdrawn than recharged (USC/PUG, 2012). This overdraft is a consequence of groundwater pumping for mining, agriculture and municipal use and has significantly lowered the local water table (Arizona Department of Water Resources, 2012). If overdraft continues, groundwater levels may decline to the point where existing wells must be deepened or new wells must be drilled. Impacts associated with declining water levels also include increased costs (due to the need to pump water farther up to the surface), degraded water quality and land subsidence.

Overdraft can be mitigated by taking full advantage of available resources through a comprehensive water resource management (WRM) plan (Figure 2). (Note that the volume portrayed for environmental mitigation in this diagram is for demonstration purposes only.) A comprehensive WRM plan coordinates the use of all available supplies and demand management techniques. In the Green Valley / Sahuarita area, these include the use of conservation, intra-basin transfers of water, and treatment and use of new or under-used supplies. These supplies include impaired water, treated effluent and Central Arizona Project water.

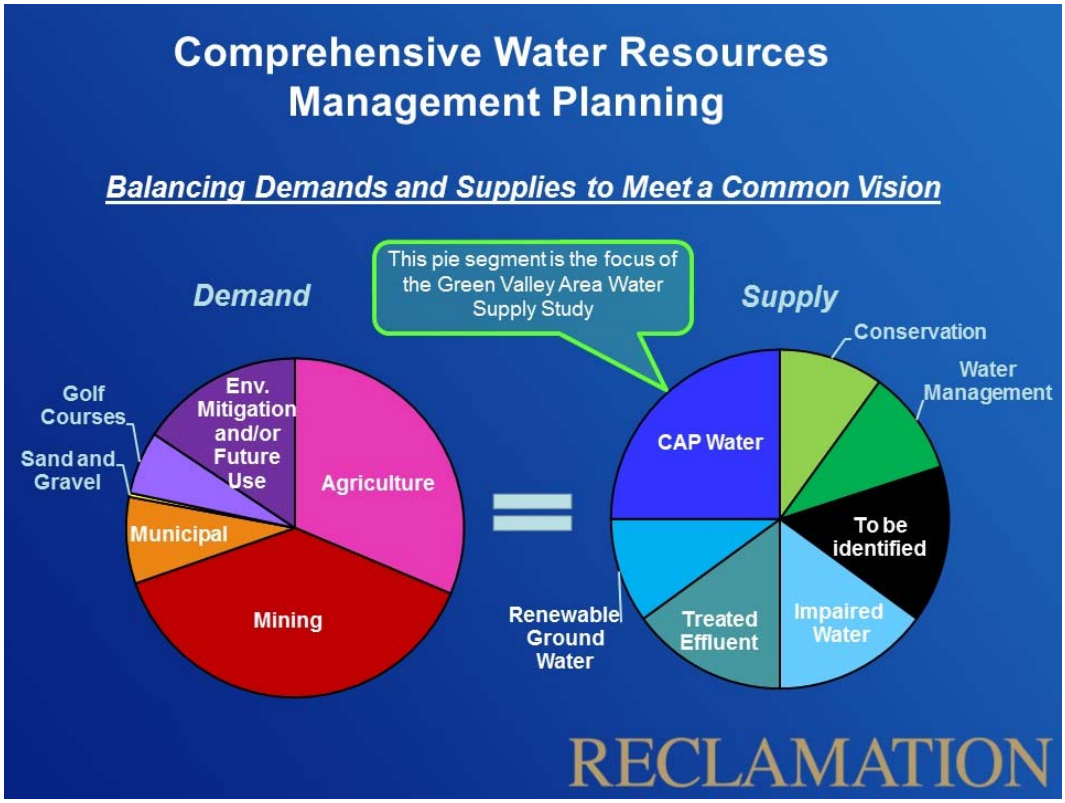

Figure 2 – Conceptual Diagram of a Comprehensive Water Resource Management Plan

CAP water has a junior priority relative to other Colorado River allocations. This means the water available to the CAP will be reduced if the Secretary of the Interior declares a shortage on the Colorado River. Details are outlined in the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordination Operations for Lake Powell and Lake Mead.*

To address the issue of potential shortages, CAP water is divided into pools with different priority levels. The priority level designates the order in which the pool is reduced or eliminated in times of shortage. Each CAP allocation is made from one of these pools: Indian, Municipal and Industrial (M&I), Non-Indian Agriculture (NIA), and Excess.

In times of shortage on the CAP system, the Excess pool is reduced first, followed by the NIA pool. The Indian and M&I pools, which have equal priority, are the last to be reduced. Two local water providers, the Community Water Company of Green Valley (CWC) and the Green Valley Water Domestic Improvement District (GVDWID), have CAP allocations with an M&I priority level. In addition, a local farming operation, Farmers Investment Company (FICO), has an Agricultural Settlement pool entitlement, which is part of the Excess pool. The service areas of these providers are shown in Figure 1.

Parts of the FICO property are permitted by ADWR to operate as a Groundwater Savings Facility (GSF). A GSF uses a renewable water source provided by another entity in lieu of pumping groundwater and generates Long Term Storage Credits (LTSCs) (see Section 3.1.1 for more details). However, due to a lack of infrastructure to transport CAP water to the Green Valley area, CWC, GVDWID and FICO have not been able to use their CAP allocations, and FICO has not been able to use its Agricultural Settlement pool allocation (Table 2), or operate as a GSF.

Information from Table 2 was extracted from the CAP's April 1, 2017 *CAP Subcontracting Status Report*. As seen in Table 2, the CWC and GVDWID CAP allocations are 2,858 and 1,900 acre-feet per year (AFY), respectively. FICO's CAP Agricultural Settlement pool allocation is 3,097 AFY, and will decline to zero in 2030 as the Agricultural Settlement pool water is reallocated. FICO is also permitted to accept up to 22,000 AFY of renewable water in its GSF.

Table 2: Current Status of CAP Entitlements in the Green Valley / Sahuarita area

CAP Priority Level	Entity	Amount (AFY)	Actual or Recommended for Reallocation by ADWR
Municipal and Industrial	Community Water Company of Green Valley (CWC)	2,858	Actual
Municipal and Industrial	Green Valley Domestic Water Improvement District (GVDWID)	1,900	Actual
Agricultural Settlement pool	Farmers Investment Company (FICO)	3,097	Actual (declining to zero in 2030)
Non-Indian Agriculture	Freeport-McMoRan	5,678	Recommended for reallocation
Non-Indian Agriculture	Hudbay Minerals, Inc.	1,124	Recommended for reallocation

The Arizona Water Settlements Act includes a provision authorizing ADWR to develop a recommendation to the Secretary of the Interior to reallocate up to 96,925 acre-feet of NIA water. In a 2014 letter to the Secretary of the Interior, ADWR recommended 5,678 AFY of CAP NIA priority water be reallocated to Freeport-McMoRan / Sierrita, Inc. and another 1,124 AFY reallocated to Hudbay Minerals Inc. These resources may be available for use in the Green Valley / Sahuarita area.

Data submitted by USC/PUG to Reclamation estimates that, in 2010, groundwater overdraft in the Green Valley area totaled 36,000 acre-feet. Therefore, use of existing CAP allocations can compensate for some local groundwater demand, but will not completely offset the overdraft. The USC/PUG has suggested that other entities may be interested in utilizing CAP water in the Green Valley area to further mitigate the overdraft. To this end, the USC/PUG has requested that the Study include plans for a range of volumes of CAP water.

Local use of CAP water is intended to be one component of a comprehensive WRM plan for the area, as depicted in Figure 2. Reclamation realizes that such a plan must be developed in cooperation with the USC/PUG, which is actively addressing the other components of the water supply (conservation, water intra-basin transfers, impaired water, treated effluent) in conjunction with other plans developed by the Town of Sahuarita and Pima County, which operate projects to recharge treated effluent from local wastewater treatment plants (Figure 3).

2.2 Problem Statement

The USC/PUG and Reclamation jointly developed a problem statement (below) to guide the appraisal study; this may also be viewed as an "opportunity" for solving a problem.

Overdraft of the aquifer in the Green Valley-Sahuarita area is significant and likely to increase in the future, resulting in impacts to water supply availability, water quality and water-dependent natural resources. Mining and agriculture's ongoing demand and an increasing municipal demand, combined with lack of renewable water supplies and infrastructure, contribute to overdraft of the aquifer. CAP water allocations are available for some water demand sectors, but have not been used due to the substantial costs, including water acquisition and infrastructure development (including pipeline expansion access) and operating costs. The Study partners wish to maximize the use of renewable CAP water in a hydrologically, economically and holistically sound manner. The partners envision a practical and cost-effective solution that would incorporate multiple benefits including:

- *Maintaining or improving availability of water supplies*
- *Reducing/eliminating overdraft of the aquifer*
- *Maintaining or improving water quality*
- *Environmental restoration/enhancement*
- *Flood control and erosion prevention*
- *Recreation (Open space and tourism)*
- *Balancing the spatial distribution of water resources within the Tucson Active Management Area*
- *Subsidence Reduction*

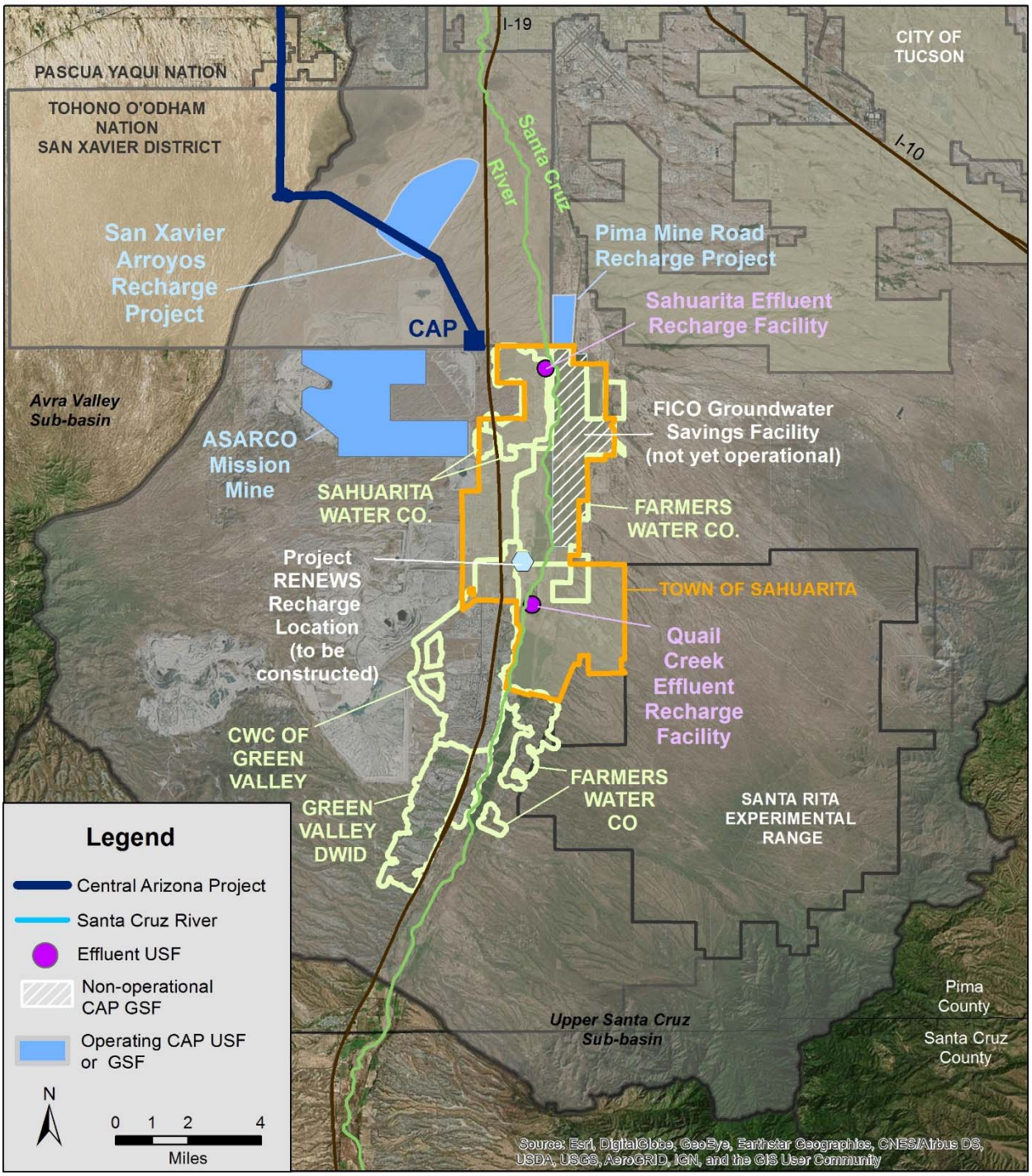

Figure 3 – Water Service Providers and Recharge Projects in the Green Valley / Sahuarita Area

2.3 Potential Contributors for Water and Funding

USC/PUG is pursuing cooperative relationships with entities that may be capable of directing CAP water to the local area and/or providing funding for its use. A preliminary list of these entities includes:

- Central Arizona Groundwater Replenishment District
- Freeport-McMoRan (owner of Sierrita Mine)
- Arizona Water Banking Authority
- Bureau of Reclamation (see below)
- Farmers Investment Company

Reclamation may be able to provide funding for water delivery infrastructure in the Green Valley area. The CAP authorization legislation, Public Law 90-537, authorized $100 million for construction of distribution and drainage facilities for non-Indian lands (Section 309(b)). This authorization was amended by Public Law 97-373, which added a local cost-share requirement of 20%. It also clarified that the $100 million would be adjusted for ordinary fluctuations in construction costs. This option is discussed further in Section 8.2.

2.4 Proposed CAP Pipelines

Two 36-inch diameter pipelines, privately funded by separate organizations, are planned to bring CAP water to the area. FICO and a joint effort between CWC and Hudbay Minerals, Inc. are each proposing separate pipeline infrastructure projects to bring additional CAP water into the area. The CWC and Hudbay Minerals, Inc. effort is also referred to as “Project RENEWS”. Freeport McMoRan has proposed a third pipeline; its size and route have not yet been determined to date. The proposed projects (Figure 4) are described below.

2.4.1. FICO Pipeline

This proposed pipeline will take advantage of FICO’s permitted 22,000 AFY of Groundwater Savings Facility storage (see Section 2.1. for more details on GSFs). The intent is for FICO to use CAP water directly, in-lieu of irrigating with groundwater. FICO’s 36-inch diameter pipeline will run from the CAP terminus at Pima Mine Road and I-19 east along Pima Mine Road and across the Old Nogales Highway, onto FICO property. The line will then run south within FICO property to just north of Sahuarita Road. Connections into the FICO GSF areas will enable CAP water to be delivered to FICO pecan groves.

2.4.2. CWC and Hudbay Minerals Inc. Pipeline (Project RENEWS)

This pipeline is being constructed to provide Hudbay Minerals, Inc. with the ability to recharge CAP water, in order to offset groundwater they will pump for their mining operation. CAP water will be recharged into a 70-acre recharge site located near Duval Mine Road. This recharge site has a permitted capacity of 3,000 AFY, but could be expanded to 7,000 AFY. The pipeline will begin at the CAP terminus at Pima Mine Road and I-19 and proceed east along Pima Mine Road to just west of the Old Nogales Highway. The pipeline will follow Old Nogales Highway in a right-of-way to the Duval Mine Road recharge site. The total distance of the pipeline will be just under 10 miles.

2.4.3. Freeport McMoRan Pipeline

This pipeline is expected to be built to accommodate CAP Non-Indian Agricultural pool water that the Arizona Department of Water Resources has recommended be allocated to Freeport McMoRan (Freeport), in addition to any other water Freeport may acquire. Freeport intends to use CAP water to offset groundwater currently being withdrawn from the local aquifer by the Sierrita Mine. Current plans are for the pipeline to be connected to the CAP terminus at Pima Mine Road and I-19. The size and route of the pipeline have not yet been determined.

The FICO and CWC/Hudbay Minerals (Project RENEWS) pipelines are the initial phase of an infrastructure project to bring renewable water resources into the Green Valley / Sahuarita area. It is expected that a single line will continue south from either the FICO or Project RENEWS pipelines. The size and location of the extended line cannot be determined until one or both of planned pipelines have operated for a while. The availability of CAP water will determine the timing and sizing of the extended pipeline.

3.0 Proposed Alternatives

Table 3 presents the range of alternatives for using CAP water in the Green Valley / Sahuarita area developed by Reclamation. Details on each type of use are provided in the sections below.

Table 3: Overview of CAP Water Management Alternatives in the Green Valley Area

Alternative Category	Sector	Specific Use
Direct Delivery	Agriculture	Groundwater Savings Facility
Direct Delivery	Mining	Direct mine use
Direct Delivery	Municipal and Industrial	Municipal use with primary treatment
Direct Delivery	Municipal and Industrial	Municipal use with reverse osmosis treatment for salinity reduction
Underground Storage and Recovery	Municipal and Industrial	Centralized Basin Recharge
Underground Storage and Recovery	Municipal and Industrial	Decentralized Basin Recharge
Underground Storage and Recovery	Municipal and Industrial	In-channel recharge in Santa Cruz River
Underground Storage and Recovery	Municipal and Industrial	Arroyos Recharge
No Federal Action	Municipal and Industrial Agriculture Mining	Continue to use groundwater, new infrastructure may be constructed without Federal assistance

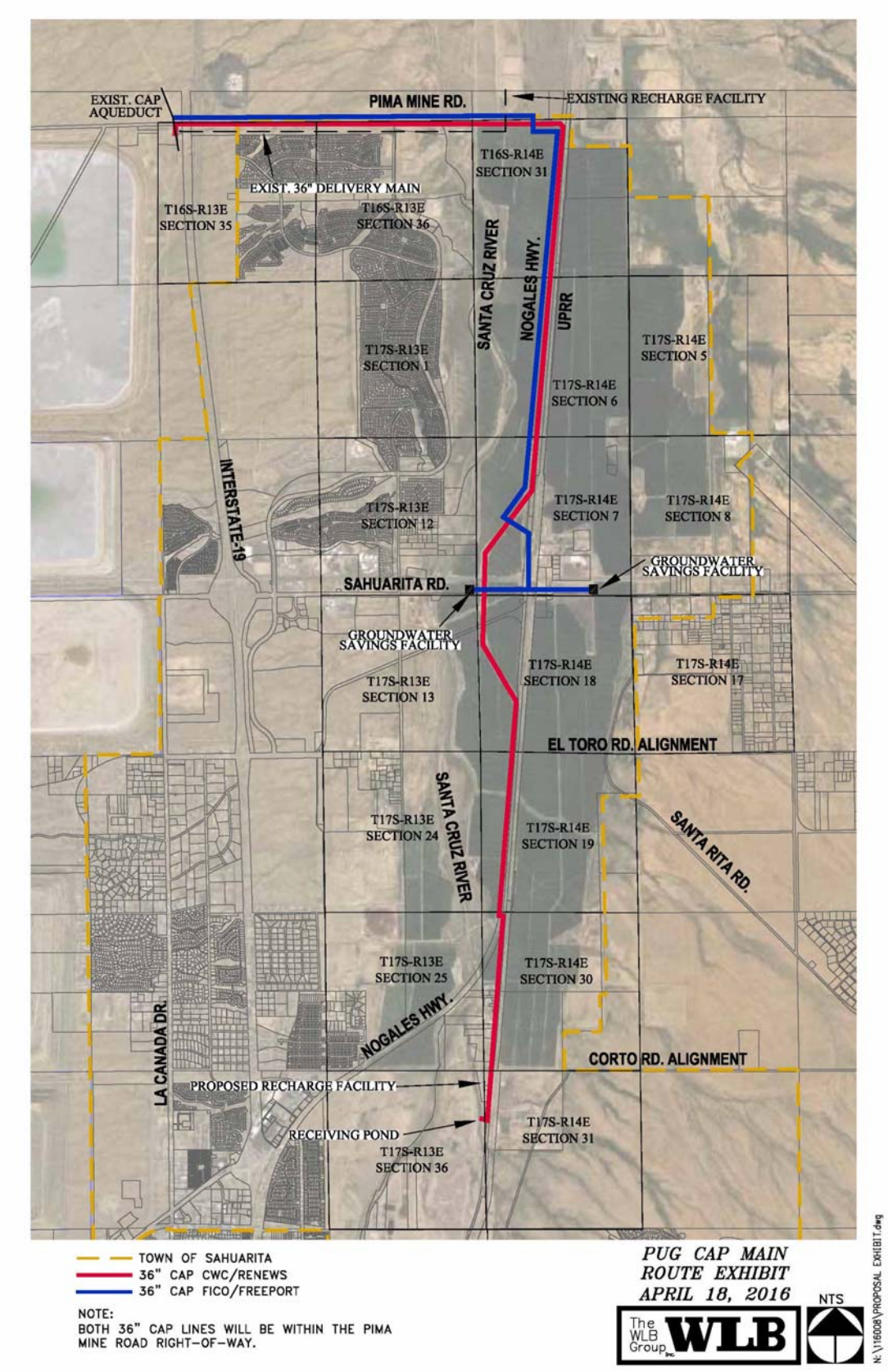

Figure 4 - Proposed CAP Pipelines

3.1 Direct Delivery Alternatives

3.1.1 Direct Agricultural Use of CAP Water in Lieu of Groundwater (FICO Groundwater Savings Facility)

3.1.1.1 Background

Within the Tucson AMA, approval of a subdivision plat by a city or town, or an authorization to sell lots requires an "Assured Water Supply" determination from ADWR. This determination can be acquired by obtaining service from a water provider with a "Designation of Assured Water Supply".

Water providers with a "Designation of Assured Water Supply" must prove that they have access to water of sufficient quality that is physically, legally and continuously available for 100 years for their service areas. (They must also demonstrate the financial ability to provide the water.) In addition, their supplies must be consistent with their AMA's management goals and management plan. The Tucson AMA's management goal is to reach "safe-yield" by 2025 and maintain it thereafter. ADWR defines safe-yield as "the long-term balancing of groundwater withdrawals with the amount of water naturally and artificially recharged to Active Management Area aquifers."

One way for a water provider to meet the safe-yield requirement is to deliver renewable supplies directly to their customers. Alternatively, a provider may pump groundwater as long as the volume pumped is offset by an equal amount of LTSCs, from the same AMA. These LTSCs are generated by recharging renewable supplies at a state-approved facility within the AMA. CAP water is considered a renewable supply.

LTSCs can be accrued by providing a renewable supply to a facility (usually a farm) as a substitute for groundwater pumping. As outlined in Section 2.1, this type of arrangement is known as a GSF. FICO is a large-scale agricultural user that currently pumps groundwater to irrigate its pecan orchards. A portion of the FICO irrigated lands is permitted by ADWR as a GSF, and may accept up to 22,000 AFY. Due in part to logistical difficulties in extending a pipeline from the Pima Mine Road CAP Recharge facility (Figure 4), there is no infrastructure to transport CAP water to FICO. When the new pipeline is complete, FICO will be able have CAP water delivered for use on its farm. Like all Tucson area CAP allocations, these deliveries are subject to an annual maintenance outage.

3.1.1.2 CAP Water Available to FICO

FICO can use two sources of CAP water: (1) FICO's CAP Agricultural Settlement pool allocation (3,097 AFY); and (2) CAP allocations from functioning as a GSF for contractual partners interested in accruing Long-Term Storage Credits. CAP water does not require treatment prior to being used on FICO lands.

As outlined earlier, the Agricultural Settlement pool (part of the Excess pool) has a lower priority than Municipal and Industrial pool, making it more vulnerable to cutbacks should a shortage be declared on the Colorado River. Moreover this pool is scheduled for re-allocation to other users, and is expected to be completely re-allocated by 2030. Therefore, this entitlement cannot be included in long-term water resources plans.

Once infrastructure is available to transport CAP water to its fields, FICO may store up to 22,000 acre-feet of CAP water in partnership with entities that hold Municipal and Industrial priority CAP allocations. This is referred to as using CAP water "in-lieu" of exercising its rights to pump groundwater. Under the GSF legal framework, FICO can partner with an entity with a CAP allocation and use that water on its GSF in lieu of pumping groundwater.

Typically, an Agricultural Settlement pool allocation holder must use their own CAP water if it is considered "reasonably available" before being able to accepting a partner's CAP water and generating Long-Term Storage Credits as a GSF. Recently, some irrigation districts have entered into forbearance agreements with the Central Arizona Water Conservation District (CAWCD) to store their Agricultural Settlement pool water in Lake Mead. ADWR has confirmed that in this case, the Agricultural Settlement pool would not be considered "reasonably available", and these districts can still function as GSFs (CAWCD, 2016)

Unlike other ADWR permitted storage facilities, a GSF does not require analysis of hydrologic impacts to other users. It is likely that the cessation of FICO's groundwater pumping will amplify the effects of the nearby Pima Mine Road and San Xavier recharge projects that have already raised local water levels.

FICO is also planning a long-term transition from agriculture to residential development across portions of its farm. This will affect the long term capability function as a GSF and should be incorporated into any planning of recharge alternatives.

3.1.2 Direct Mine Use of CAP Water (in Lieu of Groundwater)

The simplest version of this alternative, CAP water use by the ASARCO Mission Mine Complex, is already taking place. ASARCO is a permitted as a GSF. The Tohono O'odham Nation (Nation) currently delivers up to 10,000 AFY to the ASARCO mine for operations water supply, instead of pumping groundwater. The Nation receives LTSCs for ASARCO's in-lieu use of CAP water under the Arizona Revised Statutes, Section 45-841.01. However, this provision is limited to this particular facility and is unlikely to be expanded other facilities.

Replacing the use of pumped groundwater with CAP water at the Sierrita Mine, about 10 miles south of the ASARCO mine, was examined in the *1998 Sahuarita – Green Valley Area CAP Water Use Feasibility Analysis*, commissioned by the Upper Santa Cruz Water Users Group (USCWUG). The USCWUG study estimated that 20,000 AFY of CAP water could be used by the Sierrita Mine without affecting the groundwater withdrawals needed to control seepage from the mine's tailings impoundments. It was assumed at the time that the use of CAP water by the Sierrita Mine would have similar water quality issues as ASARCO, including the need to control pH and salinity, and the possible need to add chemicals to maintain levels of metal recovery. Reliability of the CAP supply and the need to maintain a redundant system during maintenance outages was also a concern for the mine.

The need to mitigate the underground plume of sulfate has led to the mine recycling water rather than using new supplies. Since the 1998 study, the owners of the Sierrita Mine have entered into a Mitigation Order with the Arizona Department of Environmental Quality to ensure no Green

Valley area drinking water exceeds 250 ppm sulfate at the tap. To address these requirements, Freeport developed a plan that uses mitigation wells to contain and reduce the sulfate plume. Freeport has installed and begun pumping from these wells for operations as part of this mitigation plan. Pumping from these recently installed mitigation wells will continue into the foreseeable future. This effectively eliminates the need of the Sierrita Mine for additional water supplies.

Indirect CAP delivery through storage and future recovery is an option for the Sierrita Mine, which would enhance the sustainability of aquifer levels in the Green Valley / Sahuarita area, as evidenced through its 2013 application to ADWR for an NIA CAP industrial pool allocation. ADWR has since recommended to Reclamation an allocation of 5,786 AFY for Sierrita Mine, which would be used to recharge and recover CAP water in the future for mining purposes. The planned location of this use is not yet known.

3.1.3 Direct Delivery for Municipal Use

As aquifer levels decline, existing wells must be deepened or new wells must be drilled to provide a steady supply of water for municipal use. Direct delivery of CAP water for municipal use would eliminate this concern for CWC and GVDWID. Direct delivery would also protect CWC and GVDWID customers from water quality problems associated with the local sulfate plume.

CAP subcontractors are responsible for treating raw water to meet the appropriate standards for end use. In the case of municipal use, primary treatment is required to ensure the water meets Safe Drinking Water Standards (SDWS). If used directly, CWC and/or GVDWID would be responsible for constructing and operating these treatment facilities. While primary treatment to the Environmental Protection Agency's SDWS is the least expensive option, secondary treatment to enhance the quality of the delivered water should also be considered.

CAP water has a higher mineral content (commonly called salinity) than Green Valley area groundwater. While not hazardous, high salinity water may taste salty. It also reduces the effectiveness of detergents and may make it necessary to replace plumbing fixtures, home appliances, and car radiators more frequently. Salinity can be reduced by adding nanofiltration or reverse osmosis to the treatment train. This option is discussed below in Section 3.1.3.2.

System reliability is a significant concern for a direct delivery alternative. Each year, the CAP undergoes a maintenance outage for approximately 30 days. Deliveries to Phoenix area subcontractors are unaffected due to the redundancy provided by dual discharge lines on pumping plants. In contrast, Tucson relies on a single discharge line, and Tucson area subcontractors do not have direct access to CAP water during this period. Under a direct municipal use alternative, some form of storage would be necessary to maintain deliveries during maintenance outages.

Under a 1986 agreement, Tucson area subcontractors are entitled to the same level of reliability as those in Phoenix, in the form of storage facilities sized to hold a 30-day supply. (Outages longer than 30 days are the responsibility of the subcontractor.) In 2011, many of Tucson's larger

CAP subcontractors signed an agreement with the CAWCD to provide this level of reliability for them. This agreement did not include CWC and GVDWID, and this obligation remains outstanding.

3.1.3.1 Treatment Options for Municipal Use (Without Salinity Reduction)

Municipal use of CAP water would require primary treatment to SDWS (*2011 Annual CAP Water Quality Report*, p. 32). Several methods are available, including conventional treatment (rapid sand filtration), slow-sand filtration and membrane filtration, all of which would be followed by disinfection. Short descriptions of each method are presented below.

3.1.3.1.1 Conventional Treatment

In conventional treatment, chemicals are used to enhance the flocculation (clumping) of particles and to disinfect the water. As particles flocculate, they become heavier and settle out. A conventional treatment train would begin by pumping water from a CAP turnout to a raw water storage reservoir, followed by flocculation, rapid sand filtration, and disinfection. The treated water would then be stored in a finished water reservoir prior to delivery.

3.1.3.1.2 Slow-sand Filtration

While slow-sand filtration is relatively uncommon in the U.S., it has been used for water treatment since the early 19th century in major world cities. Slow-sand filtration provides high quality water under variable conditions and is widely recognized as a low cost, low labor, and chemical-free process. Slow-sand filters are expected to remove Giardia cysts, Cryptosporidium oocysts, algae, bacteria, viruses, and turbidity (cloudiness). A diagram of the process is presented in Figure 5.

The system components consist of the following:

- A supernatant layer of raw water
- A bed of fine sand, usually 1.5 to 3.5 feet
- A system of supported underdrains
- An inlet and outlet structure
- Filter regulation and control instrumentation and valves

When the sand bed is mature, a thin layer called the schmutzdecke forms on the surface. The schmutzdecke contains a great variety of microorganisms that break down organic matter. The water in the filter slowly passes through the porous sand bed. As it flows, the physical and biological quality of raw water improves through a combination of biological assimilation and physical filtration. The filter layer eventually clogs, but can be restored by scraping off the top few inches of the sand filter bed.

Slow-sand filtration is effective when high quality water is applied. It does not require coagulation involving coagulant chemical feeders, rapid mixers and flocculators, or sedimentation basins with sludge removal equipment. Operation requires only the adjustment of flow to the plant, the monitoring of pressure loss and turbidity, and the regular removal of the quarter-inch-thick schmutzdecke.

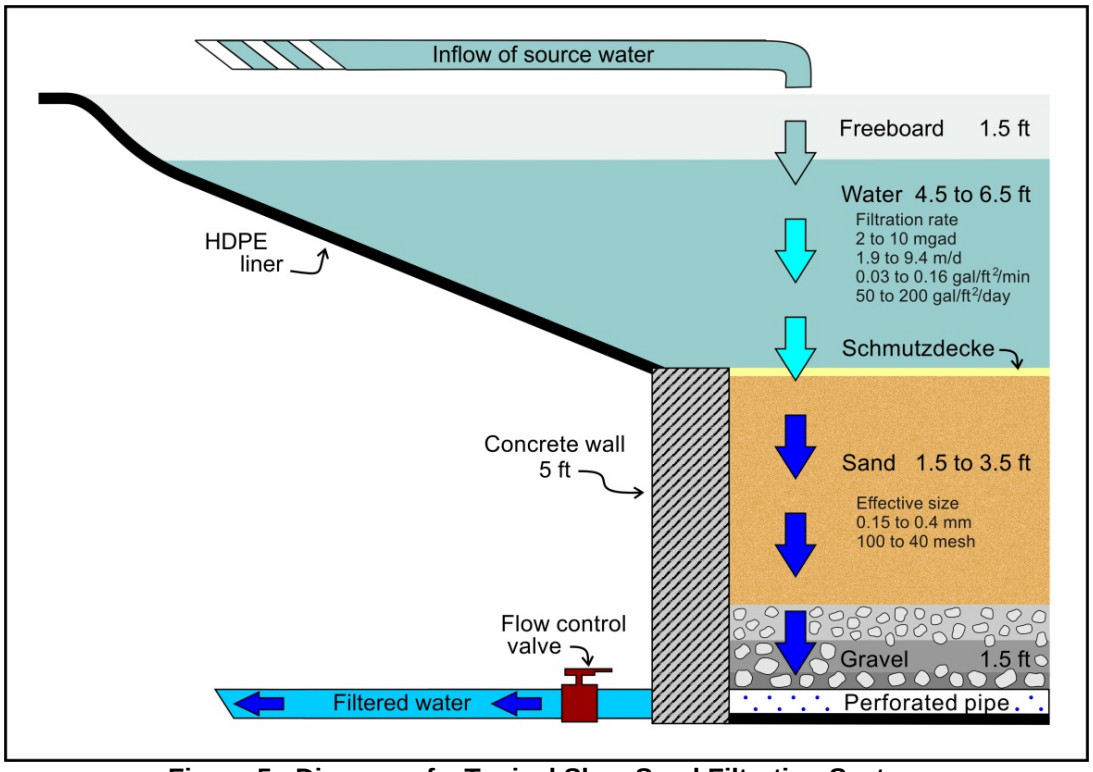

Figure 5 - Diagram of a Typical Slow-Sand Filtration System

3.1.3.1.3 Microfiltration and Ultrafiltration

Microfiltration (MF) and ultrafiltration (UF) are barrier membrane filtration processes. Raw feedwater flows through walls of membrane fibers. Constituents that are larger in diameter than the holes in the membrane are left behind in the feedwater.

The filtered water (filtrate) passes out of the membrane as “product water”. The remaining feedwater carries the solids out as wastewater. MF removes particles greater than about 0.2 micron diameter. UF removes solids down to about 0.01 micron diameter, or 10 percent of the size of the particles removed by MF (see Figure 6).

Because MF and UF provide absolute barriers to microorganisms, they serve as a “physical disinfectant” by removing protozoa (Giardia and Cryptosporidium) cysts, bacteria, and viruses (see Figure 5). MF and UF are also very effective as pretreatments to reverse osmosis (RO) because they remove particulate material that may foul or plug RO membranes.

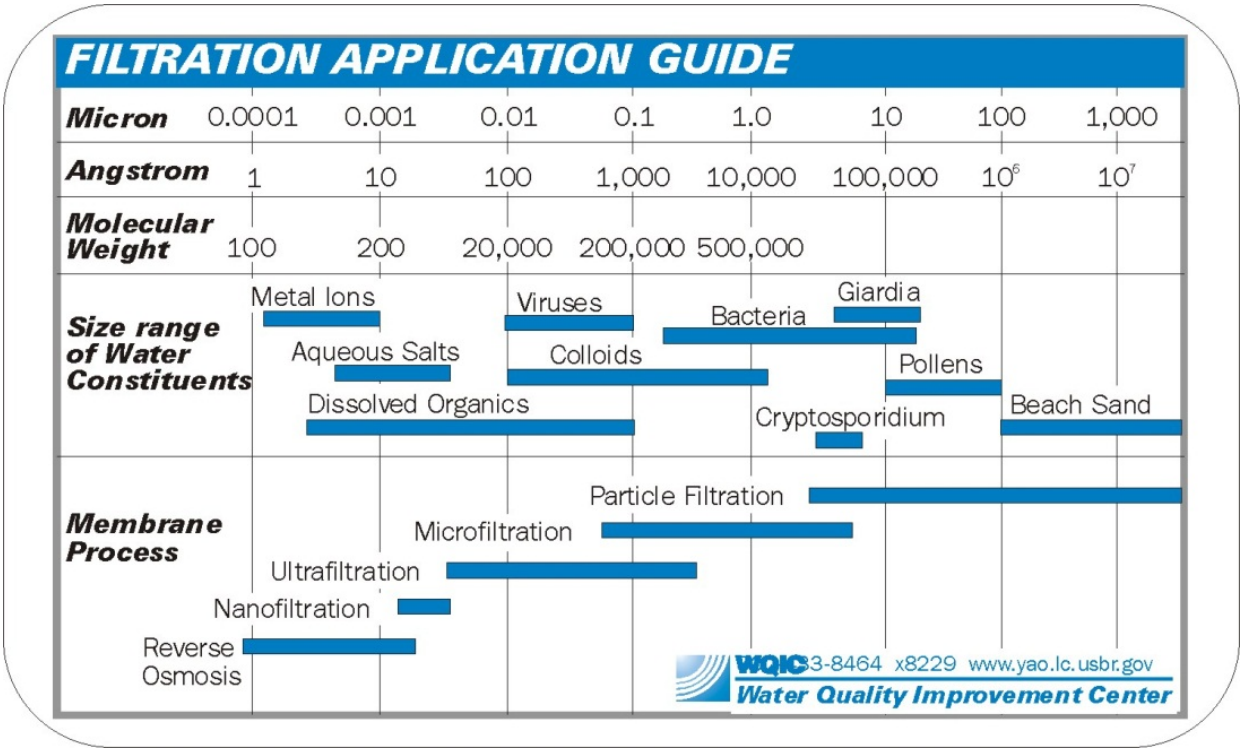

Figure 6 - Typical Water Constituents and Processes for Removal

3.1.3.2 Municipal Treatment with Salinity Reduction (Reverse Osmosis Treatment)

CAP water has a higher salinity, or dissolved mineral content, than Green Valley area groundwater (Central Arizona Project, 2011; Community Water Co. of Green Valley, 2012). Salinity or mineral content refers to the concentration of all types of dissolved solids, and is measured as milligrams of dissolved solids per liter of water. In 2011, the average Total Dissolved Solids (TDS) concentration of CAP water was 625 milligrams per liter (mg/L), almost three times that of the groundwater delivered by CWC (211-218 mg/L).

High salinity water may taste salty and has other undesirable impacts. It reduces the effectiveness of detergents and may make it necessary to replace plumbing fixtures, home appliances and car radiators more frequently. Customers often avoid salinity effects by installing water softeners and home filtration systems, or by purchasing bottled water. Two studies (Dames and Moore, 1995, and Bookman-Edmonston, 1998) estimated considerable economic benefits of using low salinity waters for municipal uses.

Primary treatment to SDWS does not reduce salinity, which must be addressed by secondary treatment. The most commonly used method to treat salinity is RO. In order for RO to operate efficiently, the quality of the influent water must be better than that of drinking water. Specifically, the raw water must first undergo treatment, such as microfiltration, to remove tiny particulates that “foul” membranes.

In RO, pressure is applied on the feedwater side of a membrane, forcing water molecules through to the opposite side. Since ions of the dissolved solids are larger in diameter than the water

molecules, they rarely pass through the RO filter. The total dissolved solids concentration of the RO product water is therefore much lower than that of the feedwater. Additionally, RO removes waterborne microorganisms (cryptosporidium, giardia and viruses), as well as organic and inorganic contaminants (see Figure 6).

Organic matter that is naturally present in water reacts with chlorine to form disinfection by-products (DBPs), which are known carcinogens. RO removes this organic matter that can react with chlorine to generate DBPs. Present water concentration regulations for DBPs, including trihalomenthanes and haloacetic acid, are readily met with RO treatment. Because of the very low organic matter levels associated with RO treatment, the use of free chlorine, instead of very long lasting chloramine, becomes an option for disinfecting the finished water.

RO generates a reject or concentrate stream containing the dissolved solids originally present in the feedwater. Concentrate management is a significant portion of the total cost for inland RO treatment. In 2004, Reclamation and the City of Tucson conducted a study of RO of CAP water and analyzed a variety of options for concentrate management. Further information on the details of performing RO on Tucson area CAP water is documented in the Bureau of Reclamation 2004 report, *Reverse Osmosis Treatment of Central Arizona Project Water for the City of Tucson Appraisal Evaluation*.

4.0 Proposed Recharge for Storage and Recovery Alternatives

Recharge projects can have many purposes, the most common of which is to store water for later recovery and use. These projects provide many ancillary benefits. By maintaining or raising aquifer water levels, they keep groundwater pumping costs down, reduce the need to deepen wells, and help to prevent subsidence. Recovery of stored water can often be accomplished with existing wells and delivery systems, reducing overall costs.

Required treatment of recovered water depends on its use. As water percolates through clean soil in a recharge project, a process called “soil aquifer treatment” takes place. Soil aquifer treatment has been shown to reduce the concentration of natural organic matter, which is a precursor to harmful DBPs. As mentioned above, the reduction of organic matter allows water providers more flexibility in disinfection methods and may permit the use of free chlorine rather than more persistent chloramine**.**

Recharge for storage can be combined with other water use alternatives, such as direct delivery. Groundwater recharge projects can be designed to provide reliability during outages, as well as opportunities for environmental restoration and enhancement. Reclamation has developed such a project on the San Xavier District of the Tohono O’odham Nation (Figure 3).

Arizona’s Underground Water Storage, Savings and Replenishment Program permits two types of facilities: Groundwater Savings Facilities and Underground Storage Facilities. Groundwater

Savings Facilities are described in Chapter 3. An Underground Storage Facility (USF) stores water in the aquifer for later recovery and use.

The design and operation of USFs is highly regulated. The development of a recharge project (Figure 7) includes an evaluation of a site's geomorphology, hydrogeology, water quality, and geochemistry. The state of Arizona also requires groundwater modeling to ensure the project will not negatively impact nearby water and land owners. The costs of a site investigation, groundwater modeling study, and permitting can be substantial.

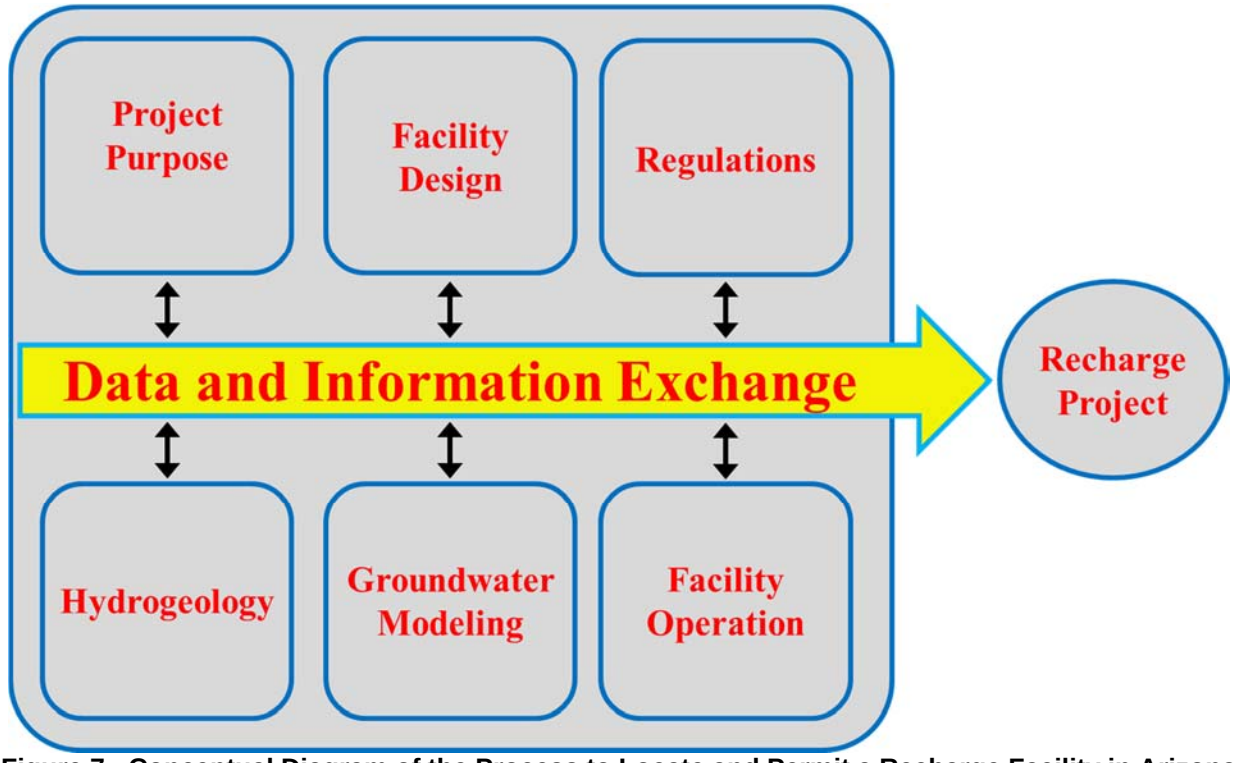

Figure 7 - Conceptual Diagram of the Process to Locate and Permit a Recharge Facility in Arizona

As discussed above, Arizona allows entities storing water in a permitted recharge facility (either a USF or GSF) within an AMA (such as the Tucson AMA shown in Figure 2) to earn LTSCs. These credits can be recovered anywhere within the same AMA to establish an Assured Water Supply for municipal water needs, fulfill groundwater replenishment obligations, firm future supplies, or provide a new water source for industry. LTSCs can also be marketed to other parties with these types of needs.

There are two USFs that store CAP water near the Green Valley area: the San Xavier Arroyos Recharge Project and the Pima Mine Road Recharge Project (Figure 8). These projects have caused nearby groundwater levels to rise as aquifers have been replenished, and this trend is expected to continue. As mentioned previously, FICO's farm is permitted as a GSF, or in-lieu recharge facility, where groundwater pumping is replaced by a renewable water source. Groundwater levels are anticipated to rise once FICO starts operating its GSF, which is planned for 2018.

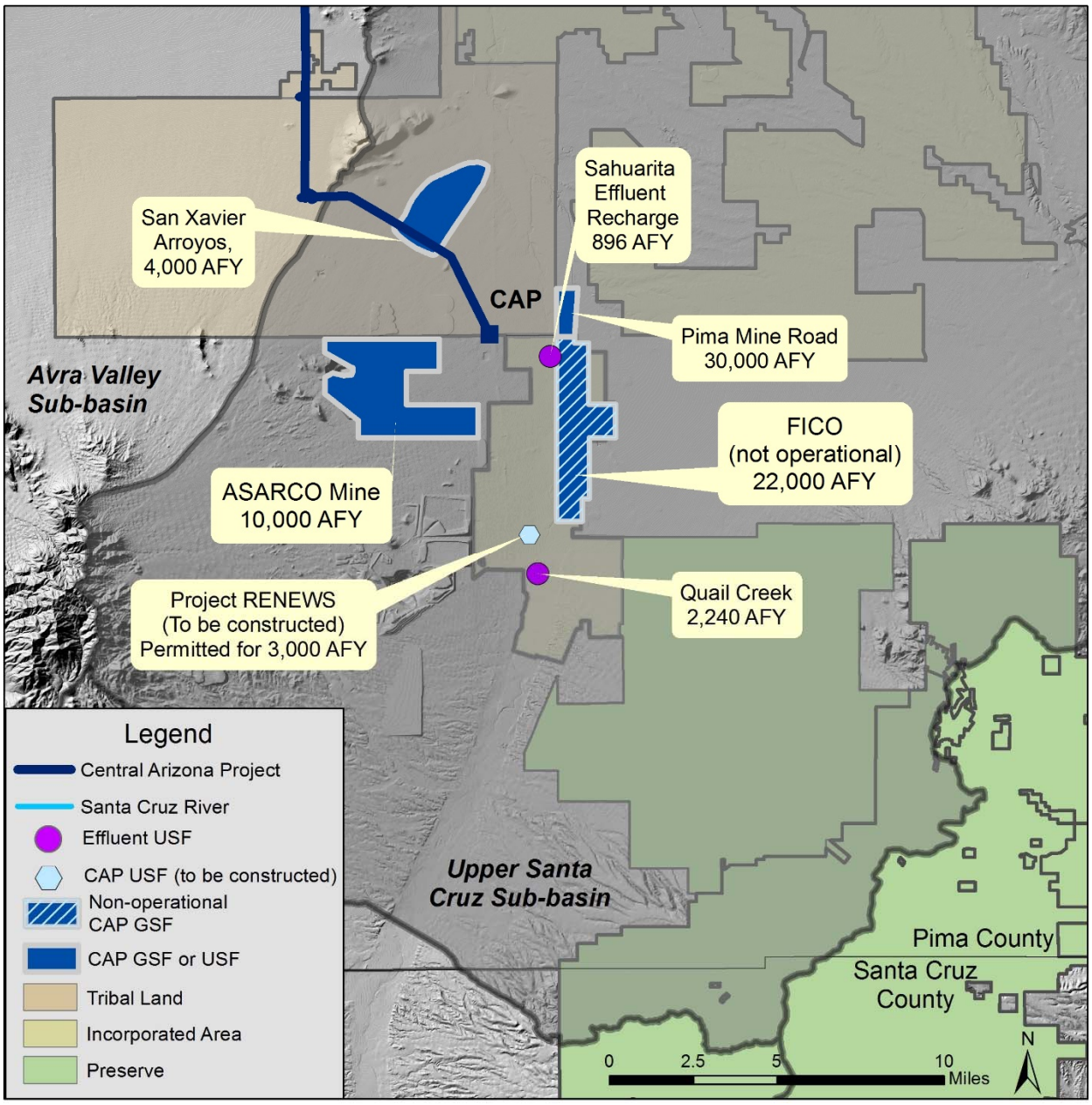

Figure 8 - Locations of Planned and Existing Recharge Projects in the Green Valley Area

4.1 Basin Recharge Facility

The typical recharge facility in Arizona is often a set of basins on a single property; therefore, impacts to groundwater are concentrated in one area. As noted above, the development of a recharge facility involves substantial investigation, modeling and permitting costs. These costs can be minimized by concentrating basins in one location.

4.1.1 Expand Community Water Company Recharge Facility

A new recharge facility and associated delivery infrastructure, Project RENEWS, is being constructed to recharge CWC's CAP allocation in Green Valley. The design has been permitted for a capacity of 3,000 acre-feet per year. However, it is being planned for the eventual recharge of up to 7,000 AFY. The site will provide recharge capacity to the area for use by all interested parties.

To date, Project RENEWS has completed three reaches of the 36-inch pipeline. Pipe is in the ground in the vicinity of Sahuarita Road and beneath Interstate 10. Another segment is attached to the new Pima Mine Road Bridge that crosses the Santa Cruz River. The next step is to construct the connection to the CAP pipeline. Technical work on this part of the project is underway with CAP staff. The next phase will include construction of the pipeline between the completed segments and the recharge sites. Construction of the recharge site and the recovery infrastructure (a 20-inch pipe to a nearby Community Water Company well) are still outstanding.

Right-of-ways for the facility have been secured and ADWR has issued permits for construction, storage and recharge at the site. Final arrangements regarding the land are being coordinated with the Arizona State Land Department and should be completed soon. Further expanding this facility to recharge additional CAP water would take advantage of the ongoing hydrogeologic investigations, modeling and permitting efforts, which would substantially reduce additional costs. Once the facility begins to operate, even more data will be available to possibly expand the facility.

4.1.1.1 De-Centralized Recharge Basin Facility

A "de-centralized" basin recharge facility is a system of basins distributed over a large area that would diffuse the hydraulic impacts of recharge. Because of land costs and the need for water distribution infrastructure, this is recharge facility design is not typically used in Arizona. Such a facility would be highly innovative, but permitting and hydrogeologic investigations could be more difficult and intensive. The major benefit of such a facility is that a large volume could be recharged with less concentrated hydraulic impacts to the aquifer. However, higher annual operations and maintenance costs might be expected on this type of a facility.

4.1.1.2 Direct Recharge into the Santa Cruz River

The main channel of the Santa Cruz River could also be used to recharge CAP water into underground aquifers. Such a facility would operate as an Underground Storage Facility. Water would be discharged into the main channel of the river and be allowed to flow downstream for infiltration to the underlying aquifer. Due to of the presence of non-native fish in CAP water, measures would be required to prevent the introduction of invasive fish species into the watershed tributaries. These features could also facilitate in-channel recharge. This type of facility could utilize land that otherwise could not be used due to flood risks.

Pima County and the Town of Sahuarita have approved FICO's Specific Plans for converting their agricultural land to a blend of residential, open space and agricultural uses, called Sahuarita Farms, over the next forty to fifty years. The Sahuarita Farms plan includes a "Santa Cruz River Master Plan" that includes the area of the Santa Cruz River within two FICO-owned properties. The plan includes potential recharge areas, riparian restoration, and flood control.

Any recharge project would need to be managed to avoid exacerbating flood conditions and impacting nearby land users. Both a Pima County Floodplain Use Permit and an U.S. Army Corps of Engineers 404 Permit would be required to operate a recharge facility within the river channel. More details on this alternative can be found in the Specific Plans and *Tucson Recharge Feasibility Assessment, Phase A, Task 5*, a 1988 report by CH2M Hill for Tucson Water.

4.2 In-Channel (Arroyos) Recharge Facility

An in-channel recharge project discharges water into historic arroyos (washes) and allows water to infiltrate into the ground as it flows. Small check dams or other flow control structures are used to slow down and spread out the water to increase infiltration rates. These structures also help maintain sediment balance in the channels. This concept has been successfully deployed on the San Xavier District of the Tohono O'odham Nation, as shown in Figure 9 below.

Figure 9 - View of San Xavier Arroyos CAP Recharge Project with Check Dam

This type of facility allows recharge to be diffused over a wide area, which typically provides greater storage. It also promotes the establishment of biotic communities along the newly wetted channels. The canopy cover provides habitat benefits and reduces evapotranspiration rates. While this type of facility has many benefits, it is not suited for an urbanized area. Flood control features do not always facilitate in-channel recharge, and there are limits on the extent of land available for infiltration.

Other benefits of arroyos-based recharge include:

- Enhancement of riparian corridors
- Recreational opportunities associated with trails and bird watching
- Cost-effective facilities

5.0 No Federal Action Alternative – Continue Operating Wells for Water Supply

In this alternative, the Green Valley / Sahuarita area water users would continue to operate their well systems to meet mining, agricultural and municipal demands, and no Federal action would be taken to deliver CAP water supplies. It is possible that other entities might construct infrastructure to transport CAP to the Green Valley / Sahuarita area, but this would most likely take place more slowly without cost-share or financing from the federal government. If no infrastructure is constructed to mitigate the groundwater overdraft and demand increases over time, existing wells may need to be deepened, or additional wells may need to be installed to maintain existing pumping capacity.

Although it is possible to meet local water needs exclusively with groundwater, such an alternative may not be acceptable to members of the USC/PUG or Green Valley area residents. As discussed earlier, the consequences of continuing to lower the water table include increased pumping costs, and an increased risk of subsidence. As water quality regulations become more restrictive, the costs of additional treatment at the wellhead for constituents such as arsenic or radon must be considered. (At present, the addition of chlorine is usually all that is required at most wellheads.)

Issues which will be considered for this alternative include:

- Impacts of operating existing wells
- Increased energy needs for pumping wells as depth to water increases
- Installation of new wells and collector piping needed to meet future demand
- Costs of expected water treatment
- Ground subsidence

6.0 Evaluation of Alternatives

6.1 Scenarios

An appraisal level study allows for multiple scenarios involving one or more CAP water use alternatives within a comprehensive water resources management plan. The base case will be an

evaluation of the potential uses of CWC and GVDWID CAP allocations. While this will not fully address the supply-demand imbalance, it is a realistic, low volume alternative. Additional supplies can be factored into many of the alternatives to better address the groundwater overdraft in the Green Valley / Sahuarita area. Therefore, it is important to gather as much information as possible regarding other entities that may have an interest in providing water or funding facilities in this area.

6.2 Criteria

In later phases of this Study, Reclamation and the USC/PUG will develop criteria that will be used to evaluate each alternative, including the "No Federal Action" alternative. Generally, these criteria address an alternative's effectiveness at solving the problem, its implementability, and its cost. While some alternatives may not be implementable at the present time, they may provide an example of projects to pursue in the future. Cost analyses will be performed using existing information. If one or more alternatives are selected for further investigation, more detailed cost estimating can be performed in the form of a Congressionally authorized Feasibility Study.

7.0 Integration with a Comprehensive Water Resources Management Plan

As discussed earlier, the utilization of CAP water in the Green Valley / Sahuarita area is just one component of a comprehensive water resources plan. While the USC/PUG has specifically requested Reclamation's assistance with regard to CAP water, it is recommended that projects be developed that promote conservation, intra-basin transfer of water from areas of excess to areas of deficit, and the use of impaired water and treated effluent. Two examples of such projects are described below.

7.1 Reverse Osmosis of Sulfate Plume

The reuse of water that is impaired by sulfates could provide additional water supplies for the area. Currently Freeport intends to reuse the sulfate-impaired groundwater for ore processing at the Sierrita Mine. If additional impaired water was available, it could be treated with reverse osmosis and used for direct delivery or recharge as appropriate. A treatment train would have to be designed specifically for this water source. At present, there is no estimate of the amount of water available for treatment; this could be investigated further in later phases of the Study.

7.2 Reverse Osmosis of Mine Process Water

Used mine process water could provide an additional supply if available. Currently, used process water is sent to holding ponds following the extraction of the minerals, which is then recovered and reused in the processing facilities. Excess water, if available, could be treated and used for direct delivery or recharge as is appropriate, thereby mitigating loss of some of the water that had

been extracted for mine operations. In this scenario, a treatment train would have to be designed specifically for this water source. However, given the current water demand by the Sierrita Mine, no excess mine process water is available for treatment.

8.0 Organization and Finance Issues[1]

8.1 Type of Organization

The facilities in any of these alternatives will need an appropriate organizational structure and financial resources to support construction and operation. The ADWR and CAWCD also have regulatory requirements. Organizational options fit into three categories: investor owned, nonprofit, and governmental. Each presents advantages and challenges so further analysis is warranted.

An investor owned model is the simplest from a political and public relations standpoint. An existing corporation, or one formed for the purpose, managed by its staff and board, would be responsive to the needs of its investors. If the organization is deemed a public service corporation, the Arizona Corporation Commission (ACC) would regulate it and set rates. Financing would take the form of investor capital, bank loans and corporate bonds. Ongoing expenses and debt service would be met through rates charged to users of the system.

A nonprofit corporation has some similar characteristics. The ACC would most likely regulate it and set rates. Financing could be in the form of bank loans and corporate bonds. Ongoing expenses and debt service would be met through rates charged to users of the system. It would also be managed by its staff and board that would be responsive to its members, if appropriate. (Arizona nonprofits can also be created without members.) In either case, it would be important to identify the stakeholders and determine how members of the board would be selected.

A governmental model would be significantly different from the previous options. The local community has expressed strong preference for a locally controlled organization. For this reason, an organization not under ACC oversight would be best received. Consequently, a governmental organization may be preferable.

Reclamation or CAWCD could also own the system. If the CAWCD takes ownership, liquidating the financial interests of the constructing organizations would be a critical step. Some donation of capital items may be possible, but it is more likely that the constructing organizations would want to recover their costs. If the Bureau of Reclamation owns this system, but it is operated by CAWCD, questions of finance and control would have to be answered by negotiations among the parties.

[1] This section was authored by Ken Taylor, Community Water Company of Green Valley

Arizona Revised Statutes, Title 48 offers several sub-options which might be suitable. All have some relationship to another organization, typically a County Board of Supervisors. All provide for citizen input through petitioning or elections. Financing can be done through tax-free revenue bonds and in some cases, general obligation bonds. The Water Infrastructure Finance Authority of Arizona (WIFA) Clean Water Revolving Fund is a possible source of loans. The primary means of repayment is through user charges, although property taxes may also be a possibility.

Title 48 authorizes many types of districts and outlines the powers and limitations of each. Though there may be other possibilities, the following three special districts seem best suited for the contemplated facilities. A Community Facilities District (Chapter 4, Article 6) may be empowered to perform many functions, with water project construction and operation among them. It would require approval of the Pima Board of Supervisors, a petition, and an election. It has bonding and taxing authority. A Domestic Water Improvement District (Chapter 6, Article 4) is designed to provide potable water at the retail utility level. It may also be capable of constructing and operating wholesale drinking water systems servicing retail utilities.

In addition, a Multi-jurisdictional Water Facilities District can construct and operate water infrastructure, but may not provide water at the retail level. It can incorporate private and governmental water utilities within its service area. It requires approval by the Board of Supervisors and an election, which will also elect the board. It must create and operate within a general plan containing project and financing details. The ACC would not regulate the district, but ACC-regulated utilities incorporated within the district must have ACC approval prior to actions in conjunction with the district.

8.2 Financing Options

Whichever organizational format is put in place, it must have a constant and reliable revenue generating capability, otherwise public or private funding will not be available. Lending institutions must be satisfied the debt can be serviced and an annual debt ratio can be maintained.

8.2.1 Water Infrastructure Finance Authority

The Water Infrastructure Finance Authority (WIFA) can provide advantageous financing for both publicly and privately held drinking water systems through its Drinking Water Revolving Fund. Grants of up to $35,000 are also available for planning and designing systems. More information about WIFA can be found at www.azwifa.gov/.

Even though governmental entities can issue tax-free bonds, they cannot be issued without approval of owners of 51% of the assessed value within the franchise area of the governmental organization. Any type of tax-free bonds will have a reserve requirement equal to one year of interest and principle payments. Even WIFA loans have this same requirement. In fact, WIFA loans have a “parity” requirement that requires reserves of all loans issued by any organization having a WIFA loan.

The Pima County Board of Supervisors must approve any of the governmental options above. The Board has typically supported any type of governmental organization and is expected to have minimum involvement in its functioning provided the organization is well managed and retains community support.

Either the CAWCD or Reclamation could own this system. In this case, liquidating the financial interests of the constructing organizations would be a critical step. Some donation of capital items may be possible, but it is more likely that the constructing organizations would want to recover their costs. If Reclamation owns the system with operation by CAWCD, questions of finance and control would have to be answered by negotiations among the parties.

8.2.2 Bureau of Reclamation Financing

Section 309(b), Appropriation Authorization of the Colorado River Basin Project Act, Public Law 90-537 as amended by Public Law 97-373, authorized $100 million to construct CAP distribution and drainage facilities for non-Indian lands. Authorization provides the legal basis for Congress to appropriate funding, but does not provide funds in and of itself. Public Law 97-373 subsequently authorized the $100 million to be indexed to reflect ordinary fluctuations in construction costs and placed a 20% non-Federal cost-sharing requirement on the program. Repayment contracts are required for any funds provided under this program.

Reclamation concluded that this authority applied to both irrigation, and municipal and industrial water distribution systems. As of 1997, the total Federal cost to date for all programs under this authority was $242.5 million.

8.2.2.1 Status of Program

Only one M&I system – for the Chaparral City Water Company in Fountain Hills, AZ – has been constructed to date under this authority. This system has been repaid in full. In addition, nine irrigation distribution systems have been built. Due to the challenges irrigation districts faced in meeting their repayment obligations under this program, Reclamation ceased to accept any further requests. (This debt was subsequently addressed in the Stipulated Settlement between the U.S. and the Central Arizona Water Conservation District.) Reclamation did not request appropriations for this program in FY 1997, and no further appropriations have been requested since then.

It may be possible to request appropriations under this authorization for such a financing arrangement through the Reclamation budget process (Figure 10). Internal requests for appropriations are typically submitted in August for three fiscal years in advance. For instance, a request submitted in August 2017 could be incorporated in the FY 2020 budget at the earliest. If this appropriation was included in the final FY 2020 budget, funds could be available as early as October 2019.

8.2.2.2 Interest Rates and Terms

Reclamation's policy on interest rates applied for municipal and industrial water systems is detailed in the Financing Section of the Reclamation Manual's Directives and Standards. The document can be accessed at: www.usbr.gov/recman/fin/fin06-31.pdf

The term of the Chaparral City Water Company financing was 20 years. Further investigation of the authority is required to see if other repayment periods could be used for a project in the Green Valley area.

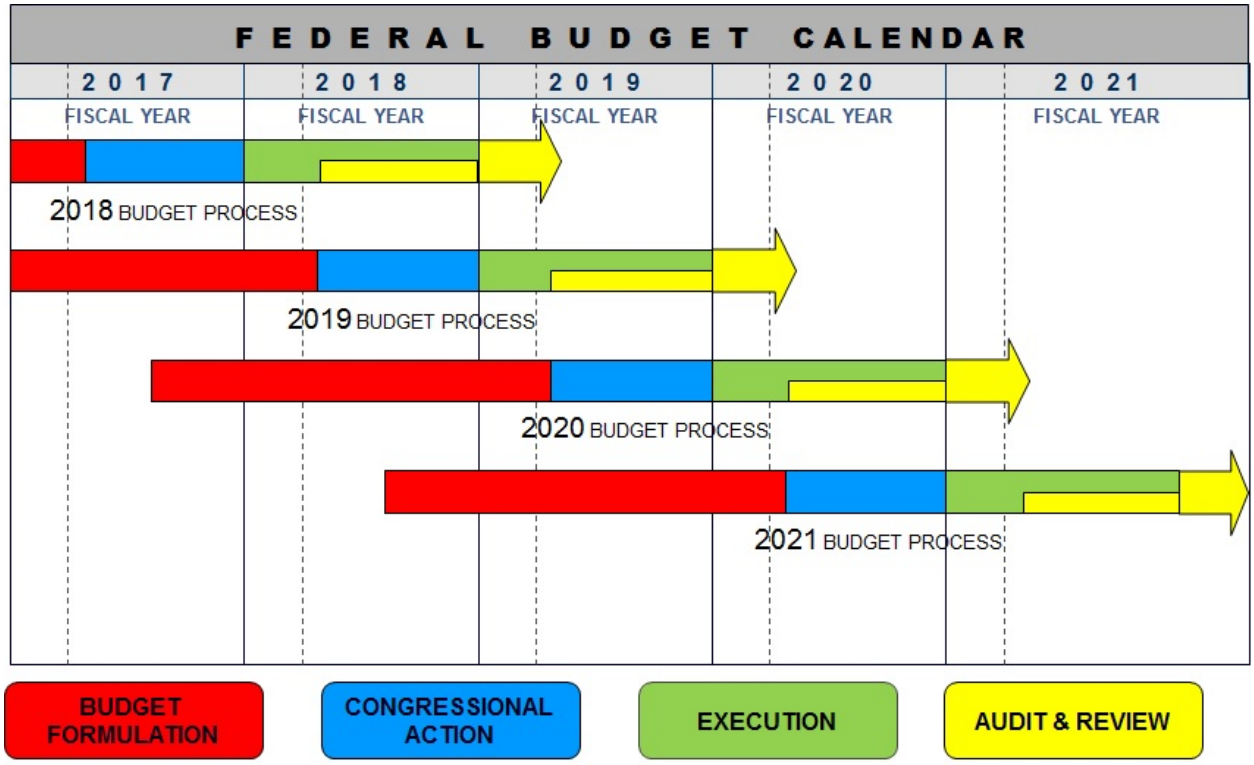

Figure 10 - Overview of Reclamation Budget Process

8.2.2.3 Details of the Chaparral City Water Company Agreement

8.2.3.3.1 Project Cost

The repayment contract for the Chaparral distribution system was executed in late 1984. The total cost of construction was $4,115,000, plus interest during construction. Chaparral contributed $823,000 up front. Reclamation contributed $3,292,000. This sum did not include interest during construction. The interest rate during construction was 3.342 percent per annum compounded from the date of expenditure of Federal funds for construction to the date of notice of completion. This sum was added to the repayment obligation.

The repayment contract allowed for Chaparral's contribution to be "in-kind" goods or services, including construction management services, subject to approval by Reclamation's Contracting Officer (CO). Charges exceeding the estimated project cost were to be assumed by Chaparral. Chaparral was required to establish a line of credit of not less than $200,000 to cover cost overruns and to establish a reserve fund to cover unforeseen extraordinary costs. The contributions to this reserve fund could be adjusted

to reflect changes in the risk and uncertainty associated with the project, per Reclamation policy.

8.2.3.3.2 Payment Details

The first payment was due in the year after Reclamation provided Chaparral with a notice of substantial completion. Chaparral committed to ensuring sufficient rate increases to allow the repayment of its obligations in-full and on-time. The CO had the right to compel Chaparral to undertake these actions if necessary, also a Reclamation policy. The agreement provided that no water would be made available to Chaparral if it was in arrears of its payments to Reclamation for an extended period of time, per Reclamation law.

8.2.3.3.3 Ownership and Maintenance

Upon substantial completion of the project, Chaparral became responsible for its care, operation and maintenance. The title remained in the name of the United States. In the case of serious deficiencies in maintenance, the CO had the power to issue a written notice to Chaparral to make repairs. If repairs were not made, the CO had the rights to effect repairs, with costs payable by Chaparral.

If the CO determined that Chaparral operated the works in violation of the contract, Reclamation had the right to take over the maintenance of the project. Chaparral was obligated to repay the cost of this maintenance to Reclamation. This is also a standard Reclamation policy.

8.2.3.3.4 Confirmation of Contract

Per Reclamation law, the agreement provided that Chaparral obtain a final decree of a court of competent jurisdiction of the State of Arizona approving and confirming the contract as lawful, valid and binding. The contract was not binding on Reclamation until the decree was obtained and a final judgment was issued by the Superior Court of the State of Arizona.

8.2.3.3.5 Termination

Under Reclamation law, Reclamation reserved the right to terminate the contract if Reclamation's CO determined that the project was unlikely to be completed within the total project cost within 60 days of the first contract bid opening. It also had the right to terminate if Chaparral had not secured sufficient funding to make its financial contribution. Termination did not relieve Chaparral of its repayment obligation.

8.2.3 Summary

Based on this preliminary investigation, it appears that Reclamation may be able to request an appropriation to finance an M&I distribution system for CAP water. This may be an avenue to provide CAP water to the Green Valley / Sahuarita area. Further research on the viability of such a request is warranted if the study partners are interested and have the ability to meet the requirements of the authorization.

9.0 Next Steps

This document has outlined a wide spectrum of potential uses for CAP water in the Green Valley / Sahuarita area. The USC/PUG has provided a large amount of information to Reclamation regarding the water resource conditions of the area. However, specific issues must be addressed in order for Reclamation to proceed in the evaluation of certain appraisal level alternatives. These are listed below in order of importance:

A. Refine potential amounts of CAP water available

USC/PUG representatives should meet with groups that have the ability to acquire CAP water that could be used in the area, and begin discussions as to how much water might be available. Reclamation will also need information on any limitations that may be attached to these supplies.

B. Investigate potential of expanding planned CWC Recharge Site

The USC/PUG should investigate whether this option is possible.

C. Investigate interest in developing a Santa Cruz River Underground Storage Facility

The USC/PUG should contact Pima County, FICO, and/or Freeport to assess whether there is interest in this alternative. This could be part of the Santa Cruz River Management Plan that envisions recharge areas, riparian restoration and flood control along the River.

References

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Appendices

Appendix I: Capacity of the Southernmost Portion of the Central Arizona Project

Appendix II: Summary of Potential CAP Recharge Sites

Appendix III: Plan of Study (September 2011)

Appendix I: Capacity of the Southernmost Portion of the Central Arizona Project

Introduction

The Central Arizona Project (CAP) is a 336-mile system that conveys water from the Colorado River to Central Arizona. The system consists of open canals, siphons, and pipelines that move water from Lake Havasu at an elevation 447 feet, to Tucson, elevation 2795 feet. The amount of water that can be delivered through the CAP at a particular place and time depends on the physical capacity of the system, legal entitlements and scheduling constraints. Each of these limitations is described for the southernmost portion of the CAP, beginning at the Snyder Hill and Black Mountain Pumping Plants through the terminus.

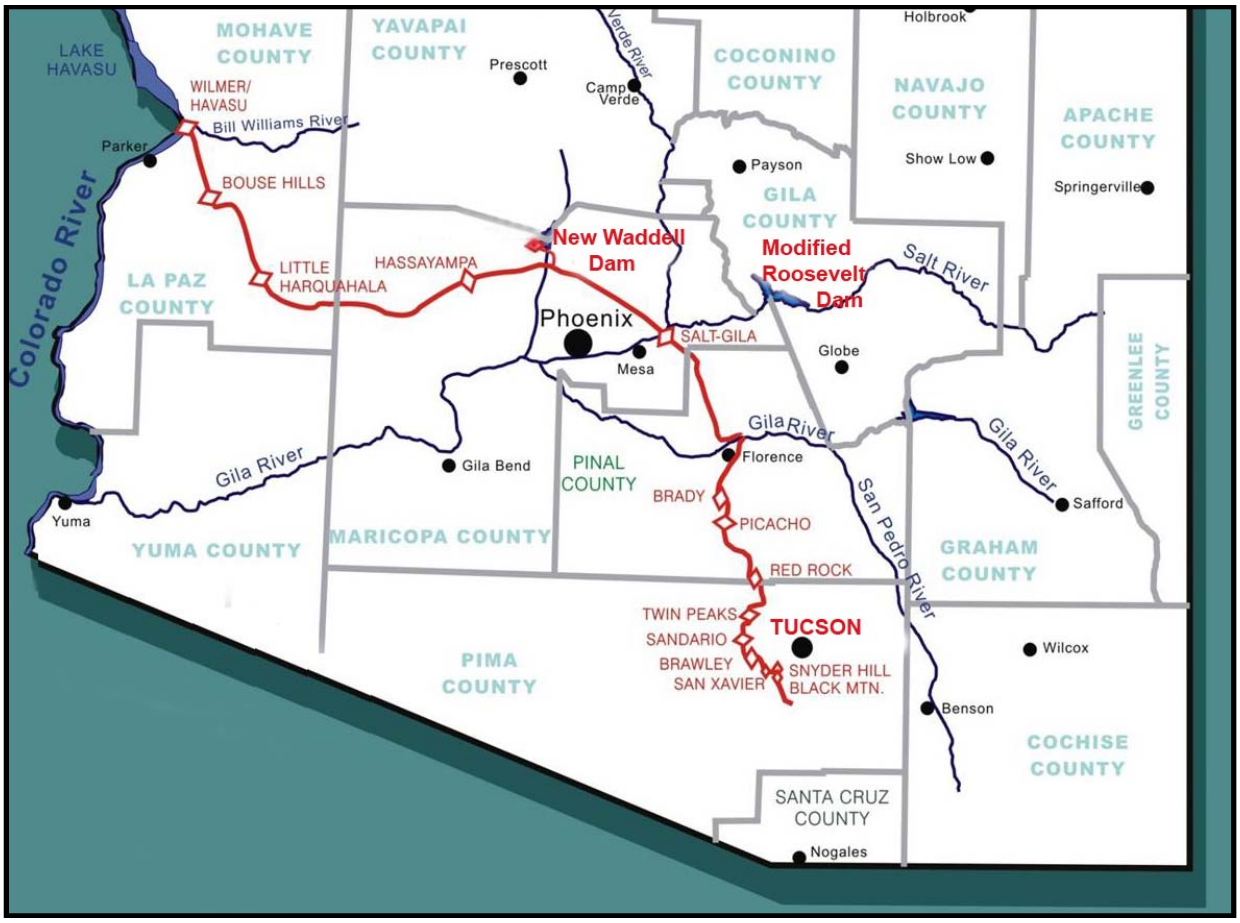


Figure I-1 - Overview of CAP System

Physical Capacity

Physical capacity is the amount of water that can be delivered by the infrastructure currently in place. The major infrastructure features that determine the CAP's physical capacity are detailed below.

Pumping Plants
The CAP uses 15 pumping plants that lift water at strategic locations and allow it to flow to the next pumping plant by gravity. Each plant draws water from a forebay and pushes it out through a discharge pipeline. Deliveries at any point in the system are limited by the capacity of the nearest upstream pumping plant.

Pumping Plant Discharge Lines
The water lifted by the pumps flows through a discharge pipeline up to the point at which gravity flow resumes. These discharge lines must be built to withstand the pressure of the water and pumps. The length of the discharge line is controlled by the local geography and elevation.

Operating Reservoirs
An operational reservoir provides storage that helps to facilitate predictable deliveries.

Canal and Pipeline Capacity
Each section of canal or pipe is designed and constructed to convey a specific amount of water. The size of the aqueduct or pipe is typically the greatest constraint on capacity, but the pipeline material is also an important factor. A pipe or canal with a smooth texture can convey more flow than the same size feature with a rough texture.

Canal Check Structures
Check structures are used to control the water surface elevation in the canal and maintain proper flow conditions. The sections of canal upstream and downstream of check structures act as distinct sub-systems, called pools.

Canal Siphons
Siphons enable the CAP to cross under a river or large drainage way. Siphons are large, gravity driven pipelines designed to pass deep underground and re-emerge out of the flood way.

Turnouts
Turnouts are locations where water is taken off the CAP for some type of use. Uses include agriculture, a municipal delivery system or a recharge project. The size and design of a turnout will determine the amount of water that can be delivered.

Pipeline Blowoff Valves
Blowoff valves are located at low points in the pipeline and help to fully drain the pipeline for maintenance. Blowoffs can be modified to act as turnouts, but their capacity is limited.

Physical Capacity in the Tucson area

The Central Arizona Project begins at Lake Havasu and ends south of Tucson, near Pima Mine Road and Interstate 19. In Tucson, the CAP splits into two systems at the Lower Raw Water Impoundment (LRWI), which is located at Ajo Highway and Tucson Estates Boulevard. One system uses the Snyder Hill Pumping Plant to move treated CAP water for the City of Tucson

through the Tucson Mountains to the City's Clearwell Reservoir. The other system begins at the Black Mountain Pumping Plant, which delivers water south into the 7.4 mile long Black Mountain Discharge Line and into the 248.6 acre-foot Black Mountain Operating Reservoir (BMOR). The BMOR delivers water via the Reach 6 pipeline to the Terminus at Pima Mine Road.

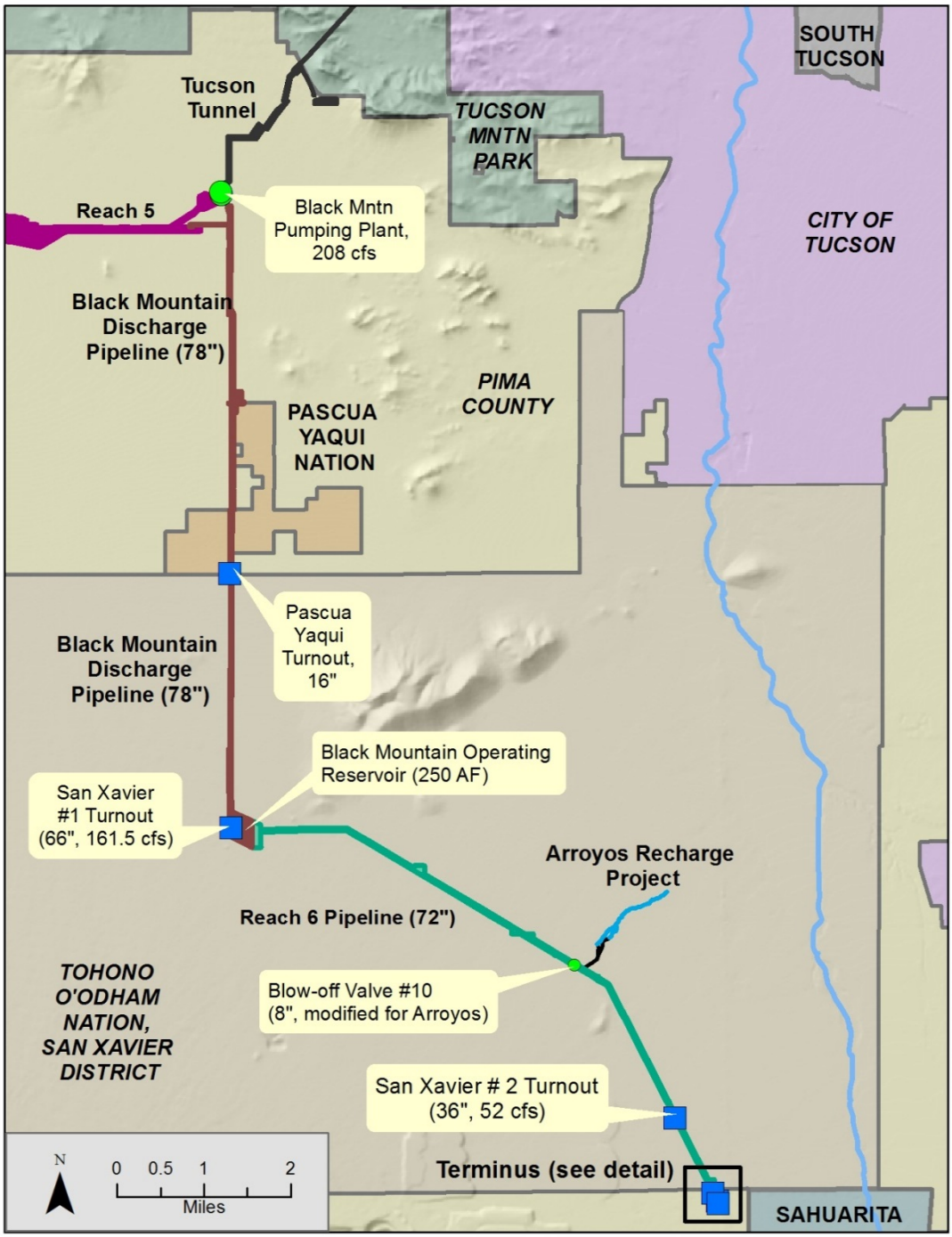


Figure I-2 – Map of CAP below Black Mountain Pumping Plant

The Pascua Yaqui Tribe, the San Xavier District of the Tohono O'odham Nation, the ASARCO Mission Mine, and the Pima Mine Road Recharge Facility currently receive water from either the Black Mountain Pipeline or Reach 6. Figure I-2 shows this section of the CAP, from the Snyder Hill and Black Mountain pumping plants to the Terminus.

The flow rate of each piece of infrastructure is described below in cubic feet per second (cfs). While this value can be converted into an annual delivery volume of acre-feet, annual deliveries are affected by maintenance schedules, the availability of supplies and the ability to schedule deliveries. When available, the annual volume of water received by projects is reported.

Black Mountain Pumping Plant

The Black Mountain Pumping Plant, the last pumping plant on the CAP, is located adjacent to the Snyder Hill Pumping Plant and the City of Tucson's Hayden-Udall Water Treatment Plant. It contains three large pumps and two smaller pumps, which deliver a combined flow of 208 cfs[1]. Figure I-3 shows the Black Mountain Pumping Plant.

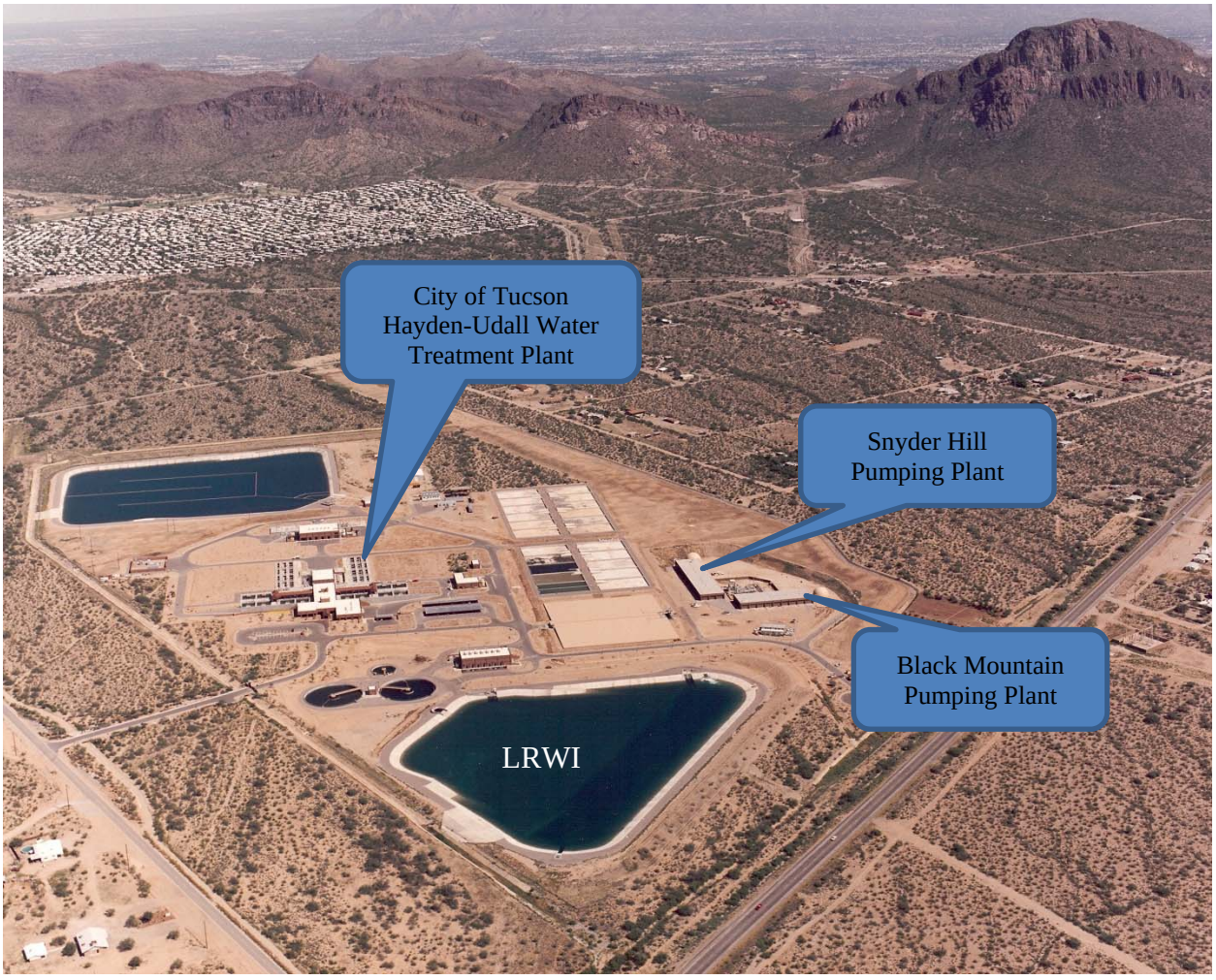


Figure I-3– Snyder Hill and Black Mountain Pumping Plants

Black Mountain Discharge Pipeline

The Black Mountain Discharge Pipeline is 7.4 miles long and has a diameter of 78 inches. It connects the Black Mountain Pumping Plant to the Black Mountain Operating Reservoir.

Pascua Yaqui Turnout

The Pascua Yaqui Tribe has a turnout off the Black Mountain Discharge Pipeline (see Figure I-2). It was originally constructed with a 10-inch diameter for 10 cfs, but was upsized in 2012 to a 16-inch diameter turnout[2].

Black Mountain Operating Reservoir (BMOR)

The BMOR is filled by the Black Mountain Pumping Plant, via the Black Mountain Discharge Pipeline. It is a ten-foot deep oval reservoir than can hold up to 248.6 acre-feet. The BMOR feeds the Reach 6 Pipeline and San Xavier Turnout #1. Figure I-4 shows the BMOR and San Xavier Turnout #1.

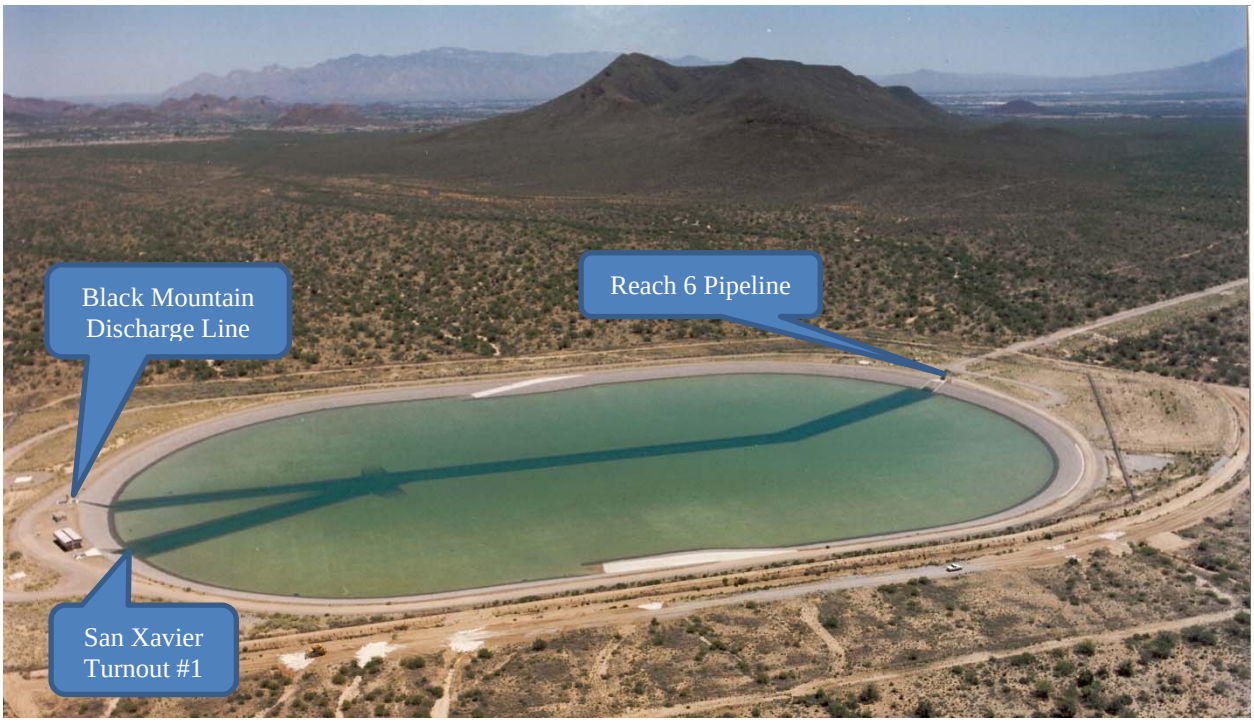


Figure I-4 - Black Mountain Operating Reservoir

San Xavier Turn Out #1

San Xavier Turnout #1 has a 66-inch diameter and is located off of the west side of the BMOR. It was designed to deliver 161.5 cfs, but is not currently used as a delivery point. Turnout #1 was designed to serve a new farm on the San Xavier Reservation, authorized under the 2004 Arizona Water Settlements Act (AWSA). Pursuant to the AWSA, the tribe elected not to have the new farm constructed. Without the new farm, there is no use for the turnout.

Reach 6 Pipeline

The Reach 6 pipeline delivers water from the BMOR to the terminus of the CAP. It was originally designed to convey water at a rate of 200 cfs to an elevation of 2795 feet, which would

have required the entire pipeline to be 72 inches in diameter. However, the last 1,200 feet of the pipeline were reduced to 54-inch diameter pipe to go under an existing rail line. This limits the delivery volume. This design change reduced the delivery capacity through the pipeline terminus and the elevation to which water can be delivered (Design Summary, Tucson Aqueduct Reach 6 Pipeline, Phase A, B, and C Central Arizona Project, Tucson Division, Arizona, December 1991).

The Reach 6 Pipeline has three components. The first section is composed of 72-inch diameter reinforced concrete pipe, followed by a 54-inch diameter reinforced concrete pipe and then by a 54-inch diameter steel pipe. Each of these pipe types have different characteristics and associated design flows. Each pipe's capabilities are described below.

Reach 6 Pipeline – 72-inch Diameter Pipe

The first 7.1 miles of the 7.3-mile pipeline is 72-inch diameter reinforced concrete pipe, designed to convey 200 cfs. The San Xavier District Arroyos Recharge Project and San Xavier Turnout #2, which deliver water to the San Xavier Farm, are located on this part of the pipeline[5].

San Xavier District Arroyos Recharge Project

The San Xavier District uses a modified blowoff valve to recharge Central Arizona Project water on the District. Blowoffs on the Reach 6 pipeline are eight inches in diameter. The project currently recharges approximately 1,300 AFY.

San Xavier Turnout #2

The San Xavier Turnout #2 is a 36-inch diameter turnout designed to deliver 52 cfs[6]. It delivers water to the San Xavier Cooperative Farm.

Figure I-5 - Transition from 72-inch to 54-inch Pipe near CAP Terminus

Reach 6 Pipeline – 54-inch Diameter Pipe

The Reach 6 pipeline reduces to 54-inch diameter for the final 1,200 feet. The 54-inch reinforced concrete portion of the pipe crosses Pima Mine Road and the Southern Pacific Railroad through a 78-inch casing as it approaches the terminus on the south side of Pima Mine Road. The designed flow capacity in the pipeline is 159 cfs [5]. The Pima Mine Road Recharge Project and the ASARCO Mission Mine have turnouts from this part of the pipeline.

Pima Mine Road Recharge Project Pipeline

The 36-inch diameter Pima Mine Road Recharge Project Turnout follows Pima Mine Road to the east. Currently the pipeline capacity is limited to 47 cfs by a 24-inch section that is hung from the Pima Mine Road Bridge. Flows can reach 62.83 cfs but this is not recommended for long-term use[7].

ASARCO Turn Out – 8-inch Modified Blowoff

The ASARCO Mission Mine takes from a modified blowoff[8]. Blowoffs on the Reach 6 pipeline are eight inches in diameter.

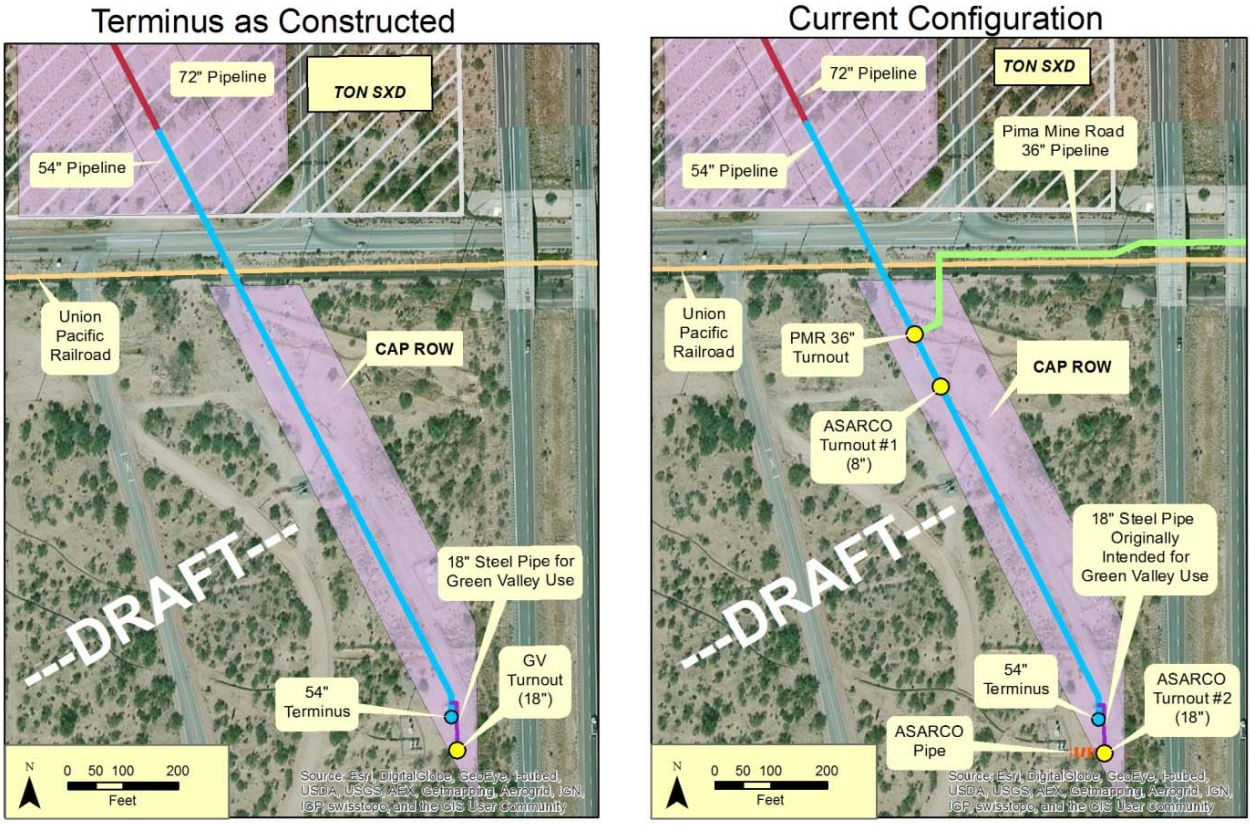


Figure I-6 - CAP Terminus as Constructed and Current Configuration

Reach 6 Pipeline – 54-inch Diameter Steel Pipe

The 54-inch diameter pipeline ends just before a vault that contains valves and flow measurements for this pipe and an 18-inch diameter pipe that is used by ASARCO. Prior to entering the vault, the pipe material changes from reinforced concrete to steel. An 18-inch diameter turnout comes off this portion of the pipeline, and both pipes enter the vault. See Figure

I-7 for a plan view of the terminus vault. The 54-inch diameter steel pipe has a design flow of 125 cfs[4].

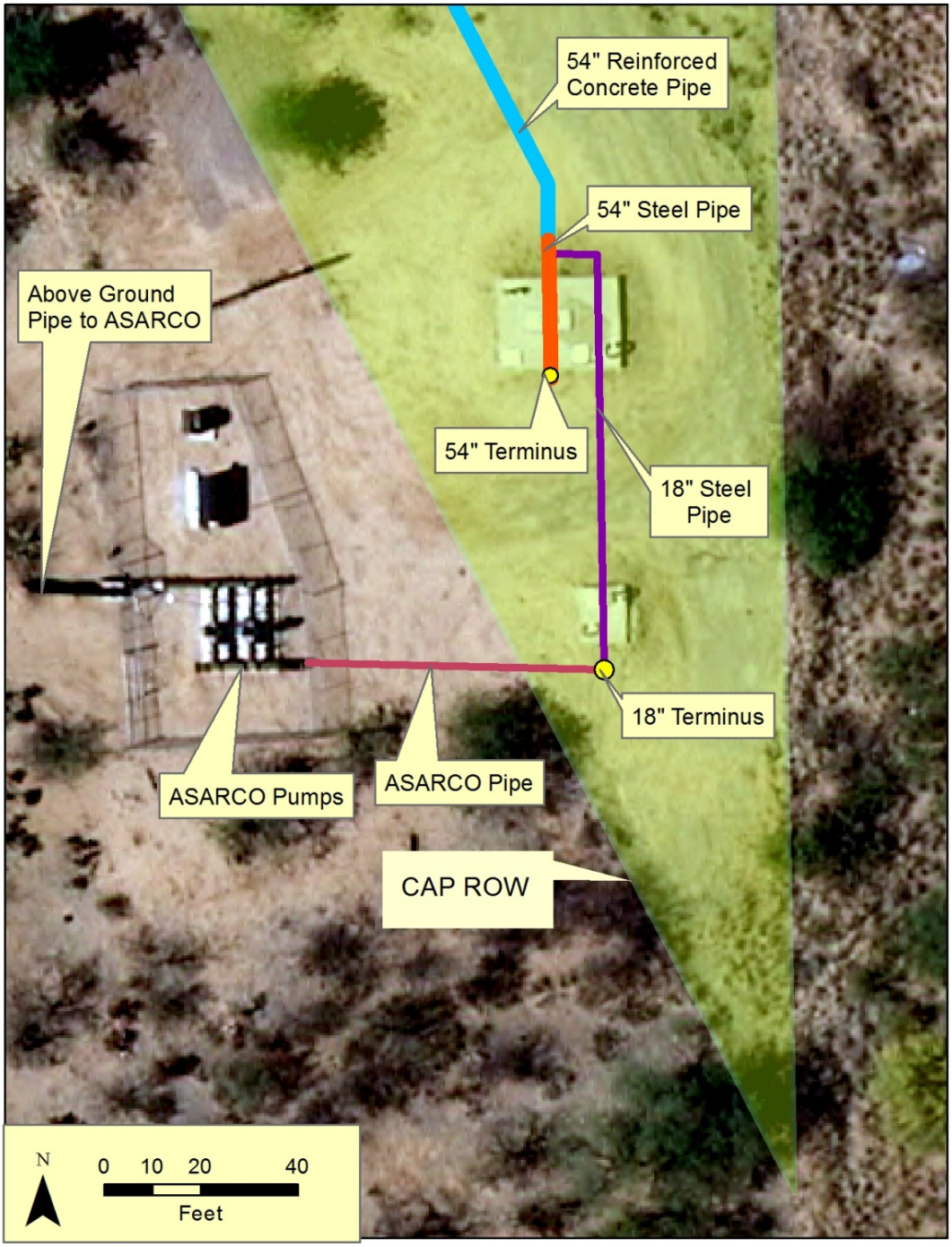


Figure I-7 – Plan View of CAP Terminus

ASARCO 18-inch Turnout

The ASARCO Mission mine has connected to an 18-inch turnout that was originally intended for use by Green Valley[7, 9]. The turnout was unused for over a decade when ASARCO connected to it. The design capacity is 9 cfs. This capacity is constrained by the steel piping, and the flow is kept low to prevent damage[10].

54-inch Terminus

The Reach 6 pipeline ends as a blind flange just south of the terminus vault. The design capacity of the 54-inch diameter steel pipe at the terminus is 125 cfs.

Summary Table

		Diameter (in)	Design Flow cfs
Black Mountain Discharge Pipeline		78	200
Turnouts	Pascua Yaqui	16	
Black Mountain Operating Reservoir		-	-
Turnouts	San Xavier #1 Turnout	66	162
Reach 6 Pipeline		72	200
Turnouts	MH-3 - Modified Blowoff	8	
	MH-15	8	
	MH-19 (Arroyos)	8	4
	San Xavier #2 Turnout	36	52
Reach 6 Pipeline	72" to 54" Transition	54	159
Turnouts	Pima Road Recharge Project Turnout	36	47-62
	Manhole 31 Modified Blowoff ASARCO Turn Out #1	8	
	18" Terminus ASARCO Turn Out #2	18	9
	54" Terminus	54	127

** Preliminary Data. Data may not accurately reflect infrastructure or designs**

Legal Entitlements

Most CAP project water has been allocated to sub-contractors, including municipalities, tribes and irrigation districts. Sub-contractors have agreements with the Central Arizona Water Conservation District that set forth the terms of delivery and costs. Water that is not CAP project water would require a wheeling agreement to set the cost and terms of delivery.

Currently the deliveries in Reach 6 are limited to CAP project water. The table below is a summary of the allocations in the Tucson area and their 2012 deliveries, developed by the Southern Arizona Water Users Association.

CAP STORERS	ALLOCATION	2012 DELIVERIES	2012 DELIVERIES	USAGE PLAN
Municipal & Industrial	**AF**	**AF**	**PERCENT**	
Arizona State Land	14,000	0	0%	To be determined: preliminary discussions to utilize in Oro Valley, City of Tucson and Marana
AVRA Water Co-op	808	0	0%	Undecided: may store w/Tucson Water
CWC of G V	2,858	0	0%	100% by 2015
FWID	2,873	2,400	84%	2,800 ordered for 2013
GV DWID	1,900	375	20%	100% by 2015
Marana	1,528	1,528	100%	Took Full Delivery in 2012
Metro Water	13,460	11,236	83%	100% by 2013
Oro Valley	10,305	5,000	49%	Will take 7,000 in 2013
Spanish Trail	3,037	180	6%	Usage as they grow
Tucson Water	144,172	144,172	100%	Took Full Delivery in 2012
Vail Water	1,857	1,857	100%	Took Full Delivery in 2012
M&I TOTAL	**196,798**	**166,748**	**85%**	
FEDERAL DELIVERIES				Does not include CAP stored outside TAMA
TON - Schuk Toak	16,000	13,895	87%	
TON - San Xavier	50,000	6,428	51%	51% includes SX, ASARCO, LSCRP and PMR
TON-ASARCO		7,170		
TON-LSCRP		8,684		
TON-PMR		3,000		
Pascua Yaqui/SAVSARP	500	351	70%	Access through Tucson Water
FEDERAL TOTAL	**66,500**	**39,528**	**59%**	
EXCESS CAP				
AG SETTLEMENT POOL	**ENTITLEMENT**			
BKW Farms	2,500	1,635	65%	
Cortaro-Marana	5,750	0	0%	
FICO	3,097	0	0%	100% by 2014
Kai Farms	1,000	1,000	100%	
EXCESS TOTAL	**12,347**	**2,635**	**21%**	
ARIZONA WATER BANKING AUTHORITY				
AWBA Intrastate		34,161		
AWBA Interstate		0		
AWBA TOTAL		**34,161**		
2012 CAP USAGE by M&I and Federal	**263,298**	**206,276**	**78%**	M&I and Federal
TOTAL 2012 CAP USAGE		**243,072**		M&I, Federal, Ag Pool and AWBA

Table I-1 - CAP Allocations in the Tucson Active Management Area

References

1) Central Arizona Project, Tucson Aqueduct, Operation and Capacity Summary Revised; October 25, 2011.

2) CAWCD Active Land Use Crossing Report, Q3 2012.

3) Bureau of Reclamation Drawing 344-D-16463.

4) Design Summary, Tucson Aqueduct Reach 6 Pipeline, Phase A, B, and C Central Arizona Project, Tucson Division, Arizona, December 1991.

5) Preliminary Design Summary Tucson Aqueduct Reach 6 Pipeline – Phase A, B and C Central Arizona Project Tucson Division Arizona December 1991 – III. C Hydraulic Design.

6) Preliminary Designers' Operating Criteria San Xavier CAP-LINK Pipeline, August 2001.

7) Pima Mine Road Recharge Improvement Project Technical Memorandum – 2 Hydraulics Final August 5, 2010 Black & Veatch.

8) Reclamation Drawing 344-D-16907.

9) Reclamation Drawing 344-D-16912.

10) Preliminary Design Summary Tucson Aqueduct Reach 6 Pipeline – Phase A, B and C Central Arizona Project Tucson Division Arizona December 1991- V. D. Design Decisions.

Appendix II: Summary of Potential CAP Recharge Sites

Frank Postilion
Hydrologist
Pima County Regional Flood Control District
May 2, 2011

USC-PUG Meeting Request

At an earlier November 4 meeting, Mark Seamans of Sahuarita Water suggested that this committee search for potential recharge sites in the Green Valley area. These would be sites other than CWC's proposed sites near the Green Valley Wastewater Treatment Facility. They suggested publicly held land. Frank Postillion indicated sites closer to the Santa Cruz River would have probably greater infiltration rates and sites north of Canoa Ranch would have greater storage capacity since depth to water north of Canoa Ranch is deeper than 100 feet below land surface (bls). The committee suggested that Mr. Postillion evaluate sites based on ownership, storage capacity, infiltration rates, and other factors he knows would be critical, and show several potential sites or areas.

Frank Thompson suggested that maybe some sites could be integrated into the upcoming River Master Plan that FICO is developing. Some of these sites could be potential multi-purpose venues to include recreation and education.

Potential CAP Recharge Sites in Green Valley Area

The following is the results of a conceptual examination of potential recharge sites done by Frank Postillion. Three major factors were used for area/site evaluation: Natural Resource Conservation Service (NRCS) Hydrologic Soil Groups (an indicator of surficial infiltration rate), storage capacity (depth to water) and land ownership. This evaluation is limited and cursory and only serves as a beginning in the search for potential CAP recharge sites south of Sahuarita Road. Other criteria that will need inclusion in future evaluations include: mounding potential; groundwater quality; perched water table conditions and subsurface impeding layers; floodplain concerns; proximity to other recharge sites; proximity to landfills and waste disposal sites, environmentally sensitive areas (cultural resources and biological); and potential to enhance riparian habitat. These were discussed in a Scope of Work (SOW) written for the USC/PUG in July 2008 by Mr. Postillion.

Five areas of evaluation were considered south of Sahuarita Road. Pima County MapGuide was used to compile an overlay of NRCS soils and land ownership. The Arizona Department of Water Resources (ADWR) Groundwater Site Inventory data base was used to estimate recent depth to water in the areas of evaluation. Other considerations included the need for at least a 500-foot setback from the banks of the Santa Cruz River and trying to locate a site outside the 25-year floodplain to avoid potential damages to the off-channel basins from flooding.

Below is a summary of the preliminary findings. The maps summarize the following discussion. The evaluation focused on off-channel recharge sites. In-channel recharge appears feasible over the entire area. However, issues with invasive biological species in the CAP and wetting/drying cycles to keep CAP in the area would need to be resolved.

Area 1A: Sahuarita South: Extends from Sahuarita Road south approximately two miles. The most promising potential recharge areas are along the floodplain terraces of the Santa Cruz River extending 2000-3000 feet from east to west. Surficial soils consist of mostly Group B (moderate infiltration). However, Group A (high infiltration) soils are abundant about one mile south of Sahuarita Road for a 200-500 feet wide area adjacent to the Santa Cruz River (SCR). Depth to water is about 230-240 feet below land surface (bls), indicating good storage potential. Most of the land in this area is owned by Farmers Investment Company (FICO). The areas west of the SCR and within 1-1.5 miles south of Sahuarita Road are not planted in pecans and are vacant. Some land owned by AMAX is west of La Villita Road and also may be amenable to basin recharge of CAP.

Area 1B: South of 1A to Duval Mine Road/Old Nogales Highway: Extends south from 1A to Duval Mine Road/Old Nogales Highway. This area is limited by pecan groves and would serve as a good Groundwater Savings Facility (GSF). Soils Group B good infiltration) extends along the SCR floodplain terraces and may be amenable to off channel basins. The storage capacity is good (water levels 240-280 feet bls), and most land is owned by FICO. Some land is also owned by Pima County and the State of Arizona. This land will be described in further detail in Area 1C.

Area 1C: South of Duval Mine Road to south of Effluent Recharge Sites: This area has good potential for off-channel recharge basins with Soils A(high infiltration) as wide as 1000 feet along the SCR as far south as the Green Valley Wastewater Treatment Facility. Pima County owns land south of Duval Mine/Old Nogales Highway running about 1,500 feet south to State land. This land has A and B soils and may be amenable to off-channel recharge as long as it is 500 feet from the bank of the SCR. Large portions of State land (400+ acres) occupy the area south of Duval Mine/Old Nogales Highway. This area has surficial Group A soils (high infiltration) along the floodplain terraces and B soils farther away from the SCR. These areas appear amenable for recharge basins. However, because of the proximity to the Green Valley Wastewater Treatment Facility (GVWWTF) percolation ponds and the Quail Creek effluent recharge ponds, a rigorous evaluation of mounding potential is needed. Depth to water in this area is 170-190 feet bls, and with several recharge sites competing, water level recovery in this area could be significant and limit the amount of CAP storage capacity.

Area 2: South of Effluent Recharge Sites: Area 2 runs south of the effluent recharge sites to the alignment of Esperanza Road. The northern portion of this area is privately held under trust affiliations (Landmark Title 7916-T, Quail Creek), and is vacant from west of the Old Nogales Highway to 1000 feet west of the SCR. The infiltration rates are moderate with Soils Group B, and depth to water varies from 190-200 feet bls. Some of these areas near the floodplain terrace not suitable for development could potentially be amenable to off-channel recharge. Two washes east of the SCR may be amenable to in-channel recharge. FICO has pecan orchards immediately

south of the private land, and this area is better for a GSF, although FICO has not, at this time, obtained one for the Continental Farm. Some of the golf courses west of the SCR would benefit from direct use of CAP (Haven and Country Club of Green Valley).

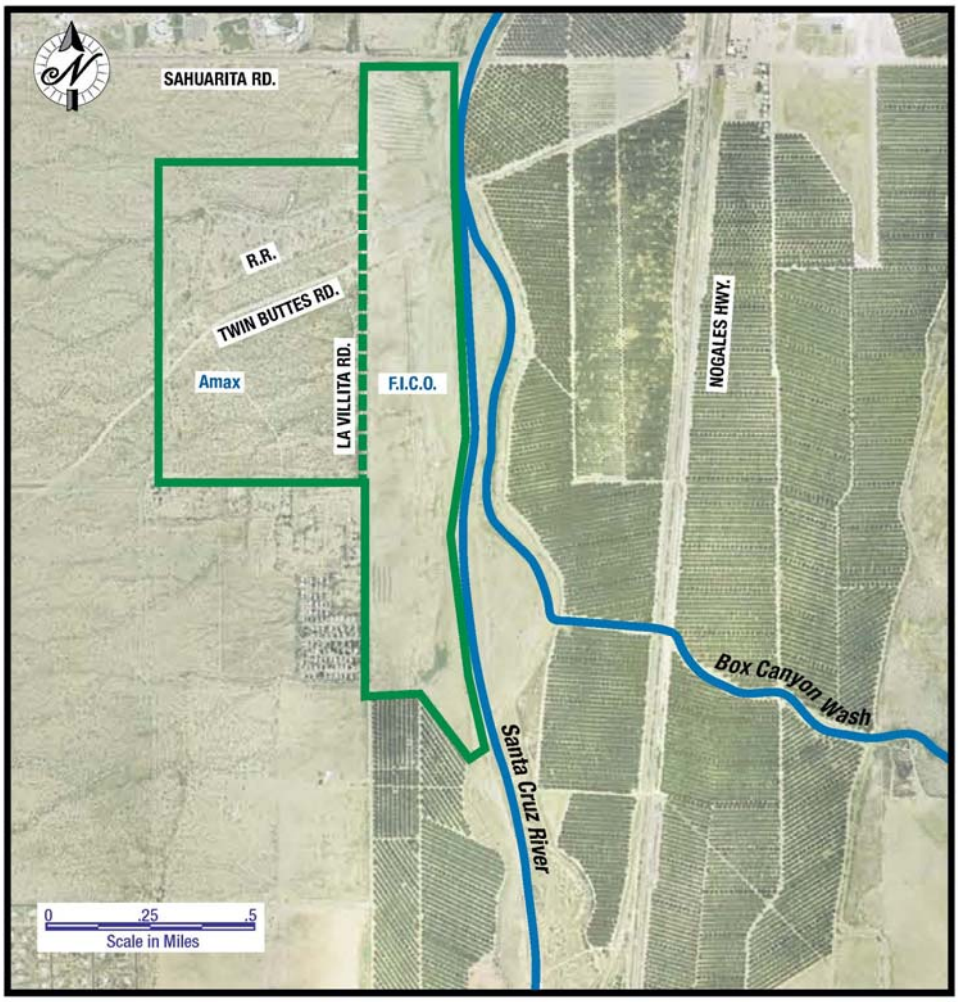
Area 3: Continental Road Vicinity: This area is dominated by developed lands and FICO orchards. However, one area owned by FICO is wide (1000 feet) and long (one mile) along the SCR and may be conducive to in-channel recharge with soils ranging from Group A to B. Depth to water in this area is 180-200 feet. In addition, the area would also be useful for GSF on the pecans.

Area 4: South of Continental: This area is dominated by developed lands, FICO orchards and golf courses. In-channel recharge opportunities may exist for a wide, flatter floodplain, high infiltration rates (Group A soils) and one owner. GSF opportunities with FICO exist in this area. Limitations on storage capacity could be an eventual problem in this area, with a depth to water of 140-150 feet bls, unless a recovery plan is implemented.

Area 5: Northern Canoa Ranch Area: This area has large recharge potential, dominated by Group A soils and large tributary washes, including Esperanza Wash. However, depth to water is shallow (120-140 feet bls), so unless recovery is implemented, recharge could be rejected. Potential options include river bed recharge into Esperanza Wash and recharge basins near the FICO/Canoa Ranch border. A large vacant parcel owned by the Santa Rita Springs HOA also appears amenable to recharge.

CAP Recharge Sites, Pre-screening

Area 1-A *Sahuarita South*



Profile

Soils: N.R.C.S. soils group B - *Good infiltration*

Ownership: F.I.C.O. on East, Amax on West

Depth to water: 230 - 240 feet - *Good storage*

Overall: Floodplain terrace west of Santa Cruz River, suitable for off channel basins.

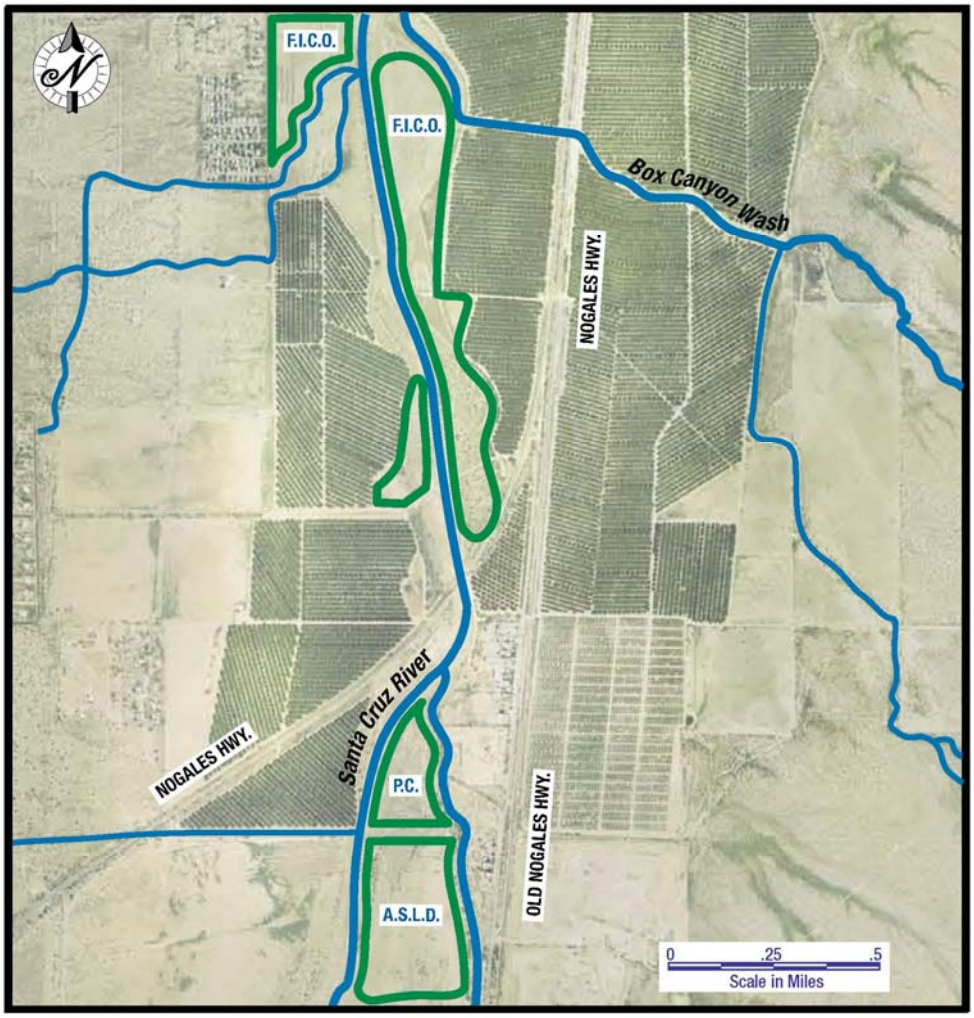
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-1 - CAP Recharge Sites Pre-screening, Sahuarita South

CAP Recharge Sites, Pre-screening

Area 1-B *Sahuarita South to Duval Mine Road*



Profile

Soils: N.R.C.S. soils group B - *Good infiltration*

Ownership: Mostly F.I.C.O., Some Pima County (PC) and State of Arizona (ASLD)

Depth to water: 240 - 280 feet - *Good storage*

Overall: Smaller areas of floodplain terrace. Long off-channel basins.

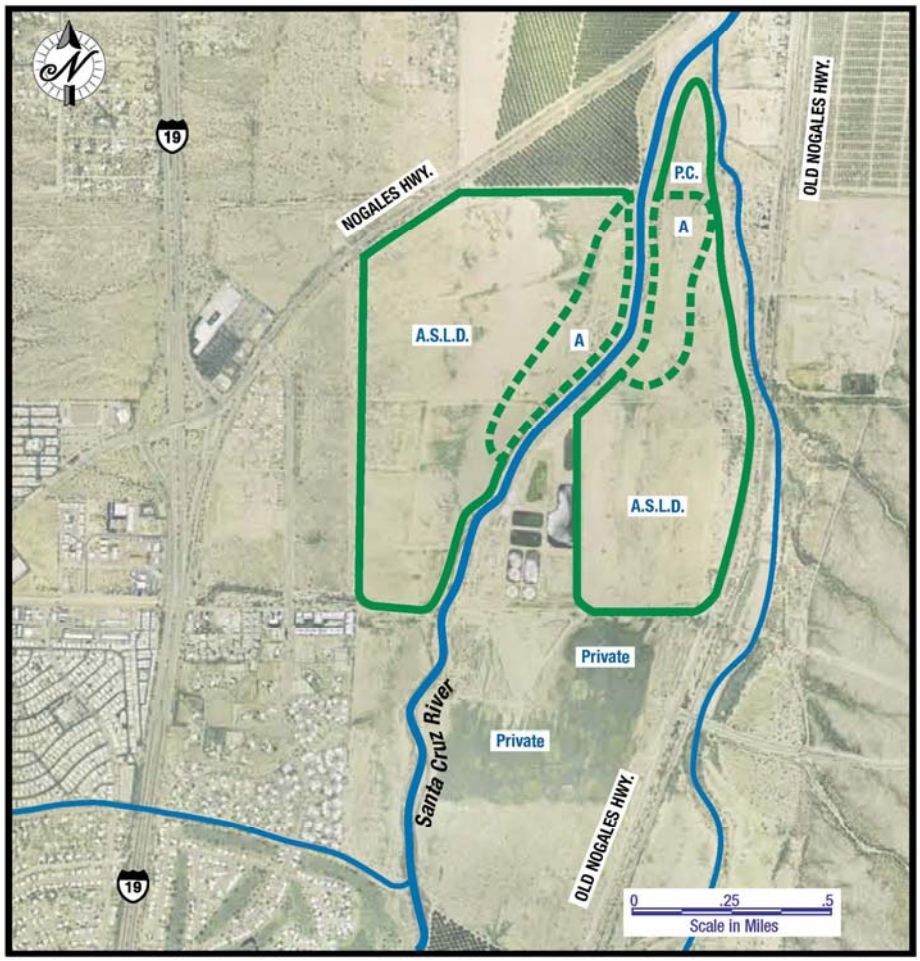
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-2 - CAP Recharge Sites Pre-screening, Sahuarita South to Duval Mine Road

CAP Recharge Sites, Pre-screening

Area 1-C *South of Duval Mine Road to effluent recharge site*



Profile

Soils: Mostly N.R.C.S. soils group B - *Good infiltration*

Where marked, N.R.C.S. soils group A - *Very good infiltration*

Ownership: State of Arizona (A.S.L.D.), far north Pima County (P.C.)

Depth to water: 170 - 190 feet - *Moderate storage*

Overall: Floodplain terraces east and west of Santa Cruz River, suitable for off channel basins. Effluent recharge sites may compete and reduce storage capacity. Private land to south, acquisition issue.

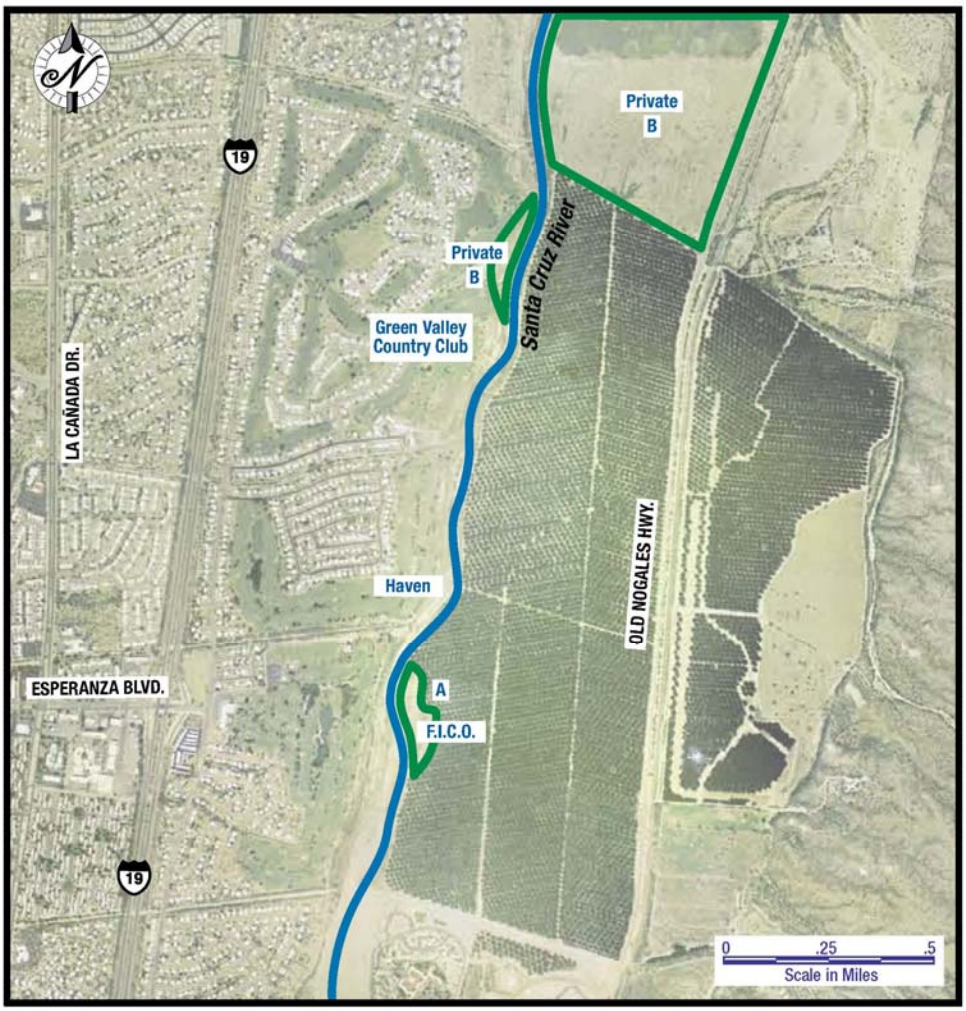
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-3 - CAP Recharge Sites Pre-screening, South of Duval Mine Road to Effluent Recharge Site

CAP Recharge Sites, Pre-screening

Area 2 *South of effluent recharge site*



Profile

Soils: N.R.C.S. soils group A - *Very good infiltration* B - *Good infiltration*

Ownership: F.I.C.O., Haven or other private owners.

Depth to water: 190 - 200 feet - *Moderate storage*

Overall: Not much available overbank except north of Haven & F.I.C.O. Private land good for basins. Possible in-channel recharge or water savings with F.I.C.O.

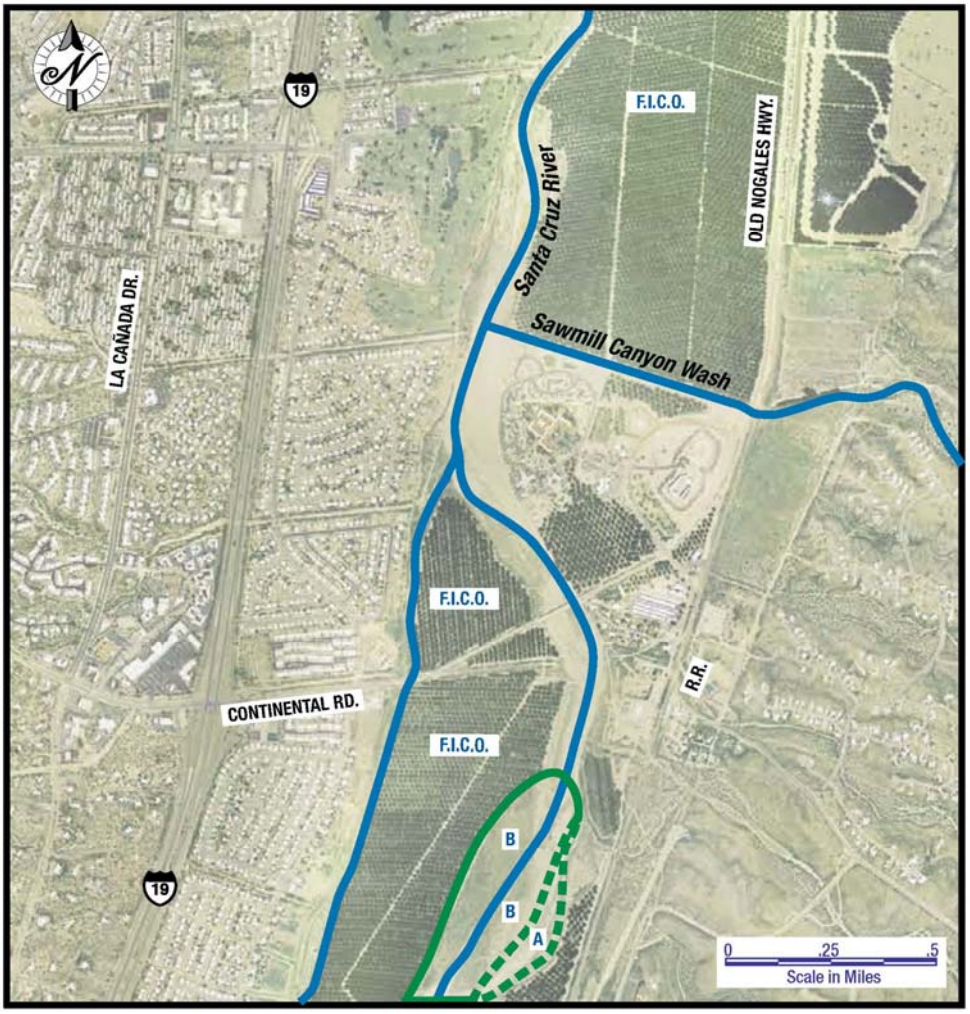
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-4 - CAP Recharge Sites Pre-screening, South of Effluent Recharge Site

CAP Recharge Sites, Pre-screening

Area 3 *Continental Road Vicinity*



Profile

Soils: N.R.C.S. soils group A - *Very good infiltration,* N.R.C.S. soils group B - *Good infiltration*

Ownership: F.I.C.O.

Depth to water: 180 - 200 feet - *Good to moderate storage*

Overall: Floodplain terrace, suitable for off channel basins. Water savings at Continental Farm, possible in-channel

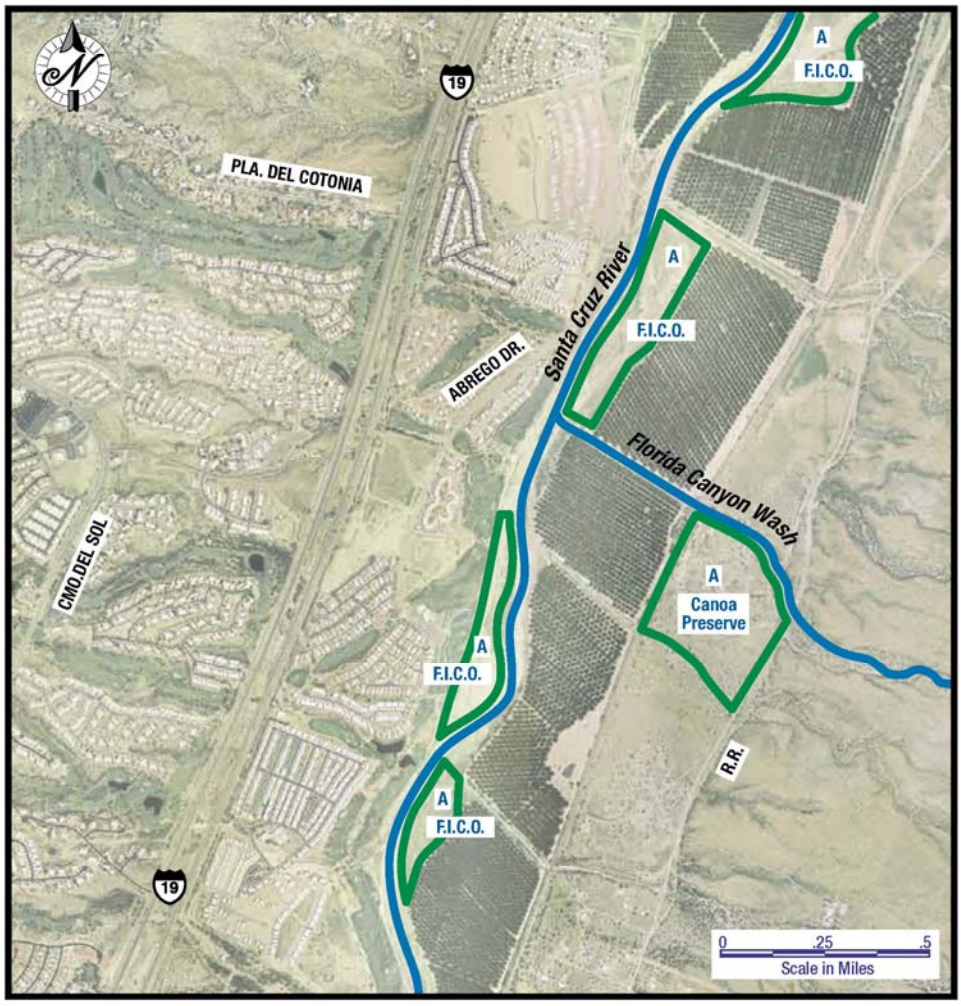
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-5 - CAP Recharge Sites Pre-screening, Continental Road Vicinity

CAP Recharge Sites, Pre-screening

Area 4 *South of Continental*



Profile

Soils: N.R.C.S. soils group A - Very good infiltration, N.R.C.S. soils group B - Good infiltration

Ownership: Mostly FICO

Depth to water: 140 - 150 feet - Moderate to poor storage

Overall: Floodplain terrace, along Santa Cruz River good for elongated basins. Water savings project may be better.

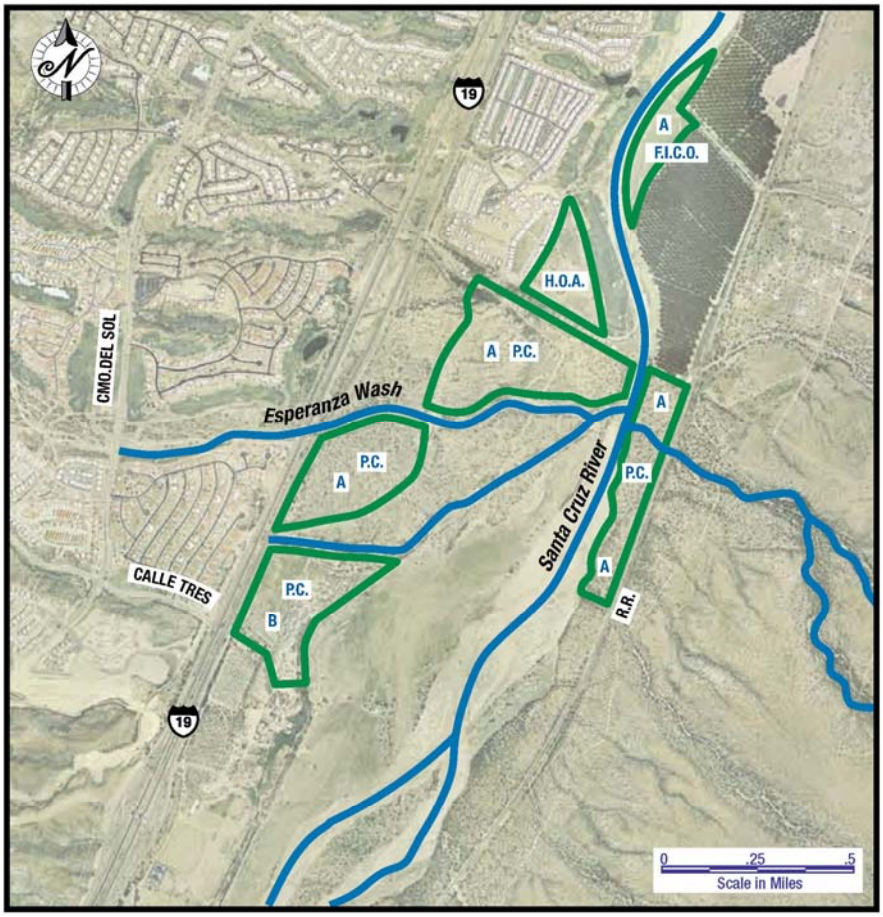
Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-6 - CAP Recharge Sites Pre-screening, South of Continental

CAP Recharge Sites, Pre-screening

Area 5 *Canoa Ranch Area*



Profile

Soils: N.R.C.S. soils group A - Very good infiltration, N.R.C.S. soils group B - Good infiltration

Ownership: F.I.C.O. and Pima County (P.C.), private H.O.A. north of Canoa Ranch.

Depth to water: 120 - 140 feet - Moderate to poor storage

Overall: Possible Canoa Ranch off-channel basins east and west of Santa Cruz River, H.O.A. area and F.I.C.O. overbank to the north.

Area for potential recharge sites

Santa Cruz River main channel and tributaries

Figure II-7 - CAP Recharge Sites Pre-screening, Canoa Ranch Area

Appendix III: Plan of Study (September 2011)

1.0 Introduction

1.1 Background

The Green Valley / Sahuarita region of the Arizona Department of Water Resources (ADWR) Tucson Active Management Area (TAMA) includes the watershed delineated on the south by northern portion of Santa Cruz County and following the Santa Cruz River north to Pima Mine Road. The watershed is generally characterized as having a groundwater mining deficit.

The mission of the area's water users and providers is to bring CAP and other renewable water resources to the greater Green Valley / Sahuarita region to meet the long-term demands on the local aquifer supporting growth, lifestyle, and the environment.

1.2 Purpose of the Plan of Study

The Plan of Study (POS) is a guide for the preparation of an appraisal level analysis of long-term alternatives for the Green Valley / Sahuarita area. Identifying the water resource management problems facing the Green Valley / Sahuarita area is a crucial first step. The appraisal study provides brief investigations of a long list of alternatives that may solve the identified problems. Alternatives are then evaluated in terms of three main factors: effectiveness (are objectives met?), implementability (technical and administrative constraints), and costs (capital and O&M). Alternatives are eliminated from consideration during this phase, and supporting documentation is produced as to why. The end result is a "short list" of potential solutions.

The POS will function in the following areas:

- Charts the course of action
- Suggests the general conduct of the activities
- Identifies major milestones
- Identifies and defines significant technical components
- Develops an overall schedule and cost

As the study progresses, it is recognized that it may be necessary to modify or add to the identified items and proposed actions.

1.3 Scope and Purpose of the Study

The purpose of the study is to evaluate alternatives which would bring renewable resources to the Green Valley / Sahuarita area. The evaluation will consider technical issues and their associated effects in determining costs and benefits. Potential environmental, social, and cultural effects and mitigation needs will be addressed. However, the scope of this effort does not include a National Environmental Policy Act (NEPA) compliance document.

Specific subjects to be addressed in the study include:

1. Determine CAP water availability and sources to use to offset area aquifer overdraft.
2. Identify possible entities to recharge CAP water in USC/PUG geographic area.
3. Identify and evaluate possible recharge and recharge/recovery sites from Pima Mine Road to Canoa Ranch area.
4. Identify and evaluate use of CAP water for possible conservation and riparian sites.
5. Evaluate viability of recharging CAP water directly into Santa Cruz River.
6. Evaluate benefits of agriculture and mining operations using CAP water directly.
7. Determine pipeline alternatives for delivering CAP water from privately owned pipelines to Canoa Ranch area.

An appraisal level assessment utilizes existing data and information to the fullest extent possible. However, additional data will be generated to the extent needed to recommend a plan. As applied to this study, "appraisal level" refers to an investigation which will generate sufficient information to allow the selection of a preferred plan. (The plan could consist of multiple alternatives.) Hydrology, engineering, economics, environmental, and social effects of the alternatives must be sufficiently addressed to recommend a plan. A plan may also be disqualified if determinations show it to be economically, technologically, or environmentally impractical.

2.0 Study Approach

2.1 Roles and Responsibilities

Reclamation, in coordination with the Upper Santa Cruz Providers and Users Group (USC/PUG), will provide overall study management and direction. Reclamation will provide a Study Manager to manage and coordinate the interdisciplinary team performing the technical analyses.

Specifically Reclamation will provide expertise in the identification and analysis of the following:

* Environmental issues and concerns
* Engineering
* Recreation
* Cultural resources
* Hydrology
* Water treatment
* Economics
* Cost estimating
* Report writing

It is anticipated that Green Valley Domestic Water Improvement District, the Town of Sahuarita and USC/PUG will provide representatives to participate in the overall study management and direction.

2.2 Planning Process Summary

2.2.1 Develop Purpose and Need Statement

Identify the problem(s) and opportunities in a statement framed in terms of the specific study objectives. The purpose of this step is to begin to define the alternatives that may address the problem(s). The purpose and need statement will focus the planning effort for the Green Valley / Sahuarita region. Additionally, the objectives will help to define the boundaries within which the

alternatives will be formulated. Ultimately, only options and alternatives that meet the objectives will be considered in the investigation.

The purpose and need statement and water utilization objectives will be developed through a collaborative effort between the Reclamation and USC/PUG. The Study Manager will coordinate input and review with team members.

2.2.2 Develop Long List of Potential Alternatives

A long list of alternatives will be developed from existing studies as well as from new ideas. The long list will come mainly from USC/PUG but may be supplemented with creative ideas and input from the entire planning team.

2.2.3 Develop Short List of Alternatives

The long list of alternatives will be screened to reduce the list to a short list consisting of the three or four most promising alternatives. This will be accomplished by comparing the long list of alternatives on the basis of effectiveness, ability to implement, and cost.

2.2.3.1 Screening Criteria and Weighting Factors

There are many factors, such as cost, technical, legal, and political issues, that influence the decision making process and enter into the alternative screening and selection process. The interdisciplinary team will develop selection criteria, including weighting factors, to be used in the process of screening, ranking, and alternative selection. The screening criteria and associated weighting factors will be provided for concurrence prior to their application. The performance of an alternative will be measured against the weighted criteria and displayed in a matrix along with other technical evaluation results deemed appropriate.

Each alternative on the long list will be screened using the following criteria:

Effectiveness: Effectiveness is a measure of how well an alternative meets the study objectives. Factors considered in the evaluation include technical feasibility, impact to human health and the environment, and reliability.

Ability to Implement: Ability to implement encompasses both technical and administrative feasibility of an alternative. The primary purpose of this screening criterion is to identify any technical, administrative, social, and environmental constraints which could preclude or impede implementation. Site specific considerations include land use, hydrology, geology, regulatory requirements, and permitting requirements.

Cost: Relative capital and operation and maintenance (O&M) costs are used, rather than detailed estimates, in comparing alternatives in this screening step. An alternative which is comparable to another in effectiveness and ability to implement but is significantly more expensive may not rank as high. The results of the evaluation will be displayed in the form of a matrix and will be used in the preferred plan selection process.

The entire process described above will be documented in an appraisal report. The basis for moving forward with the more promising alternatives and the reasons for dropping alternatives from further consideration will be documented.

2.2.4 Future actions

The next logical step is to analyze the selected alternative(s) in more detail (feasibility level). This level of analysis is not included as a part of the study.

3.0 Sources of Information

To the maximum extent possible, this investigation will rely on existing data from previous studies and analysis relevant to the study area. The interdisciplinary team will evaluate the data and determine its use in the study. Some existing data will be directly applicable and some may only require updating. Any data that may become available during the study process will also be incorporated.

4.0 Technical Evaluations

All work performed for this study will make maximum use of existing data and information, with new analysis or data collection undertaken only when a review of existing information reveals it to be incomplete or inadequate for use. Team members may coordinate with entities that have undertaken studies in the area for the purpose of obtaining additional information.

4.1 Water Needs Assessment

Water demands for the future will be evaluated with respect to water supplies expected to be available. Any deficit will be described as to its intensity, frequency of occurrence, and expected duration. The “without project” condition is the present water supply and demand modified for the most likely condition expected to exist in the future. Water quality is a critical factor in supply evaluations and must be addressed in sufficient detail to permit differentiation among demand sectors or available water supply sources. Lastly, a determination of the future without project water (surplus or deficit) will be determined as part of the overall study.

4.2 Cultural Resources Assessment

The cultural resources assessment will be conducted at a level of detail needed to analyze alternatives and to determine if potential impacts would pose a threat to the viability of that alternative, or if the cost of compliance and mitigation would be excessive. Existing information will be used to assess the project area in terms of known cultural resources, expected cultural resources, and areas that may be considered sensitive.

4.3 Environmental Resources Assessment

Potential environmental impacts will be addressed to the extent that they are likely to be a key factor in the development of viable alternatives. In the case of potentially adverse impacts on specific resources, mitigation requirements and associated costs will be estimated. The critical need at this level of study is to identify issues which could eliminate an alternative based upon its

adverse effect on a specific resource, or that would significantly increase overall project costs by incurring excessive mitigation costs. Resources considered in the assessment will include, but will not be limited to: wetlands, wildlife, vegetation, air and water quality, threatened and endangered species, and visual resources.

4.4 Technical Writing/Editing/Graphics

This will include writing, editing, desktop publishing, map preparation and other graphics, proofreading, organization of appendices (if any), and printing reports.

4.5 Resource Management

The Study Manager will function as the interdisciplinary team leader and be responsible for ensuring (through coordination with the Upper Santa Cruz Providers Users Group) that the study is completed in a manner that meets the objectives. Work activities and associated expenditures by team members will be monitored and controlled to ensure that the products are provided on time and within agreed upon budgets. All work commitments and products will receive the proper peer review. Specific responsibilities include:

- Tracking work accomplishments and budget as the study progresses
- Coordinate the review and revision of draft documents
- Coordinate development of the final report and supporting documentation

5.0 Deliverables

5.1 Preparation of Reports

A draft and final report will be prepared documenting the study process and the findings. The final report will include a recommended plan of action to accomplish the objectives identified for the study. Objectives to be accomplished include:

1. Identification and evaluation of all options for CAP water utilization in the USC/PUG geographic area.
2. Prioritization of options identified in Item #1.
3. Identification and evaluation of possible CAP water pipeline locations south of Sahuarita Road to the Canoa Ranch area.

5.2 Supporting Documents

All technical disciplines will generate supporting documentation, as appropriate, to present the details of their individual analysis and evaluation.

5.3 Coordination Activities

Coordination activities will include bi-monthly progress meetings, financial status reports as needed, documentation of telephone conference calls, team meetings, and meetings with Reclamation, the Upper Santa Cruz Providers Users Group, the Green Valley Domestic Water Improvement District, the Town of Sahuarita and USC/PUG.