RECLAMATION
Managing Water in the West

Arroyos Ground-Water Recharge Project
San Xavier District

Draft Environmental Assessment

U.S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office

March 2009

TABLE OF CONTENTS

FIGURES AND TABLES

CHAPTER 1 - PURPOSE AND NEED

1.1 Introduction

The Bureau of Reclamation (Reclamation) has prepared this Environmental Assessment (EA) to analyze potential effects to physical, biological, and cultural resources that may result from using Central Arizona Project (CAP) water for long-term, in-channel, ground-water recharge within the San Xavier District (SXD) of the Tohono O'odham Nation. The project would affect two ephemeral drainages, designated Arroyos 15 and 19, that cross the CAP Reach 6 Pipeline in the southeastern portion of the SXD.

The EA was prepared in accordance with the National Environmental Policy Act (NEPA), Council on Environmental Quality regulations (40 CFR 1500-1508), Department of the Interior NEPA regulations (43 CFR 46), and Reclamation NEPA Handbook (2000 draft edition). Reclamation is the lead Federal agency pursuant to NEPA. The SXD is a cooperating agency for the preparation of this EA.

This document is organized into six chapters:

- ***Chapter 1 – Purpose and Need****:* This chapter presents information on the history of the proposed action/project, the purpose of and need for the action, and the lead agency's proposal for achieving that purpose and need. This section also describes public involvement in the NEPA process.
- ***Chapter 2 – Comparison of Alternatives, including the Proposed Action****:* This chapter provides a detailed description of the lead agency's proposed action; alternative methods for satisfying the stated purpose and need; and significant issues raised by the public, project proponents, and other agencies.
- ***Chapter 3 – Affected Environment and Environmental Consequences****:* This chapter describes the environmental effects of implementing the proposed action and other alternatives, including no action. Within each section, the affected environment is described first, followed by a discussion of the potential effects of each alternative. The discussion also includes specific mitigation measures that are required to minimize potential adverse effects.
- ***Chapter 4 – Agencies and Persons Consulted****:* This chapter identifies persons who contributed to the preparation of this EA and lists agencies and persons consulted during the NEPA process.
- ***Chapter 5 – Environmental Laws and Directives****:* This chapter lists Federal environmental laws and directives that are relevant to the project.
- ***Chapter 6 – Literature Cited****:* This chapter lists documents used in preparation of this EA.
- ***Appendices –*** The appendices provide more detailed information to support the analysis presented in this EA.

1.2 Project Location

The Arroyos ground-water recharge project area is located on the SXD, approximately 4 miles south of Tucson in eastern Pima County, Arizona (Figure 1). The SXD is one of 11 political subdivisions of the Tohono O'odham Nation.[1] Geographically separated from the main reservation, the SXD contains nearly 72,000 acres, consisting mostly of undeveloped and uninhabited desert. In addition to Tucson, other nearby communities include South Tucson and Sahuarita.

Project activities would affect 4,000- to 5,000-foot segments of Arroyos 15 and 19 along the east side of the CAP Reach 6 Pipeline. Arroyos 15 and 19 are located within the northeast quarter of Section 16, the southeast quarter of Section 9, and the southwest quarter of Section 10, Township 16 South, Range 13 East (Figure 2). A new monitoring well (RIPZ-21) is proposed in a location that is outside the Arroyos project area in Section 34, Township 15 South, Range 13 East. Prominent landmarks bordering the area include Interstate Highway 19 (I-19) to the east, the CAP Reach 6 Pipeline to the west/southwest, the ASARCO Mission Mine Complex tailings ponds to the south, and Black Mountain and the San Xavier Cooperative Farm to the north.

1.3 Background

Water Supply Reliability

The Southern Arizona Water Rights Settlement Act of 1982 (SAWRSA), as amended by the Arizona Water Settlement Act of 2004, obligates the Secretary of the Interior, through Reclamation, to deliver 50,000 acre-feet per year (AFY)[2] of CAP water to the SXD. Section 303(a)(3) of SAWRSA specifies that a water management plan be developed for future uses of CAP water in the SXD. Similar in effect to water management plans developed under State law, the SXD plan will identify strategies for ensuring future reliability of the CAP water supply on the SXD through the utilization of artificial ground-water recharge and recovery. Preparation of the water management plan will be funded by Reclamation in accordance with Section 308 of SAWRSA.[3]

The primary objectives of artificial ground-water recharge and recovery on the SXD are to: (1) establish reliability of the CAP water supply for the 1,100-acre San Xavier Cooperative Farm, and (2) satisfy the CAP reliability obligation identified for SXD under the Tucson Aqueduct System Reliability Investigation, Tucson Reliability Division (TRD). Secondary objectives include aquifer restoration and riparian habitat enhancement. In accordance with the TRD, Reclamation is committed to providing "as

[1] The SXD Council is the elected body that makes and/oversees policy decisions for the SXD. The Tohono O'odham Legislative Council is the governing body for the entire Tohono O'odham Nation and must authorize the use of CAP water within the SXD.

[2] Acre-foot (AF) refers to the volume of water that will cover an area of 1 acre to a depth of 1 foot; equivalent to 43,560 cubic feet.

[3] Resolution No. 96-126 of the Tohono O'odham Legislative Council authorized the SXD to contract with Reclamation to prepare the water management plan and to conduct a water resource study.

reasonably reliable a supply" of CAP water to Tucson-area CAP users (including the SXD) as is available to Phoenix-area users during short-term, annually scheduled, maintenance outages on the CAP aqueduct.

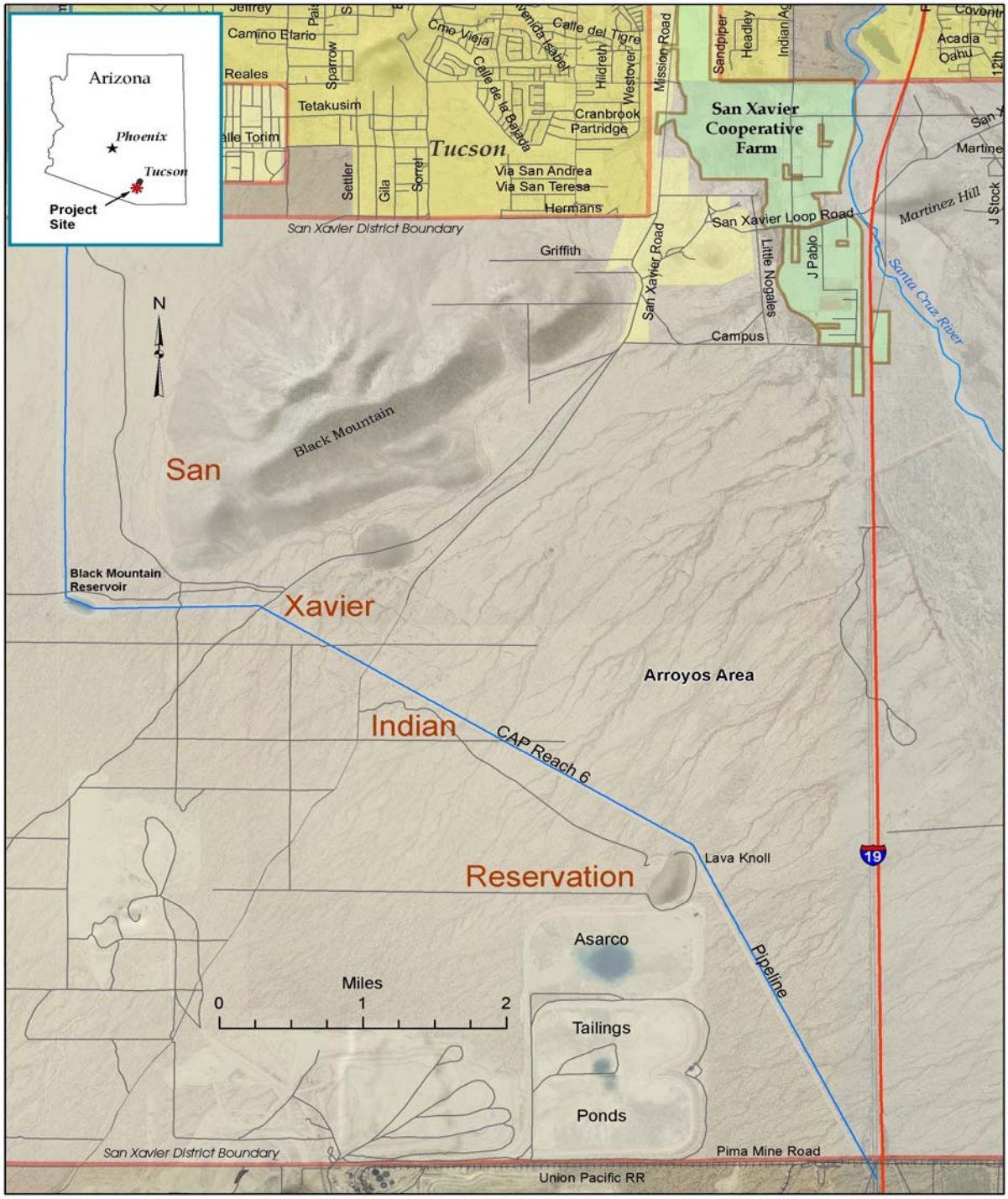


Figure 1. Project location map.

Ground-water Recharge Feasibility Investigations

A preliminary study conducted in 2000 identified six potential ground-water recharge sites on the SXD. These consisted of two abandoned Arizona Department of Transportation (ADOT) borrow pits adjacent to I-19, two sites within the Arroyos Area, the Santa Cruz River Terrace Site, and the Northwest Recharge Site west of Black Mountain (Figure 2).

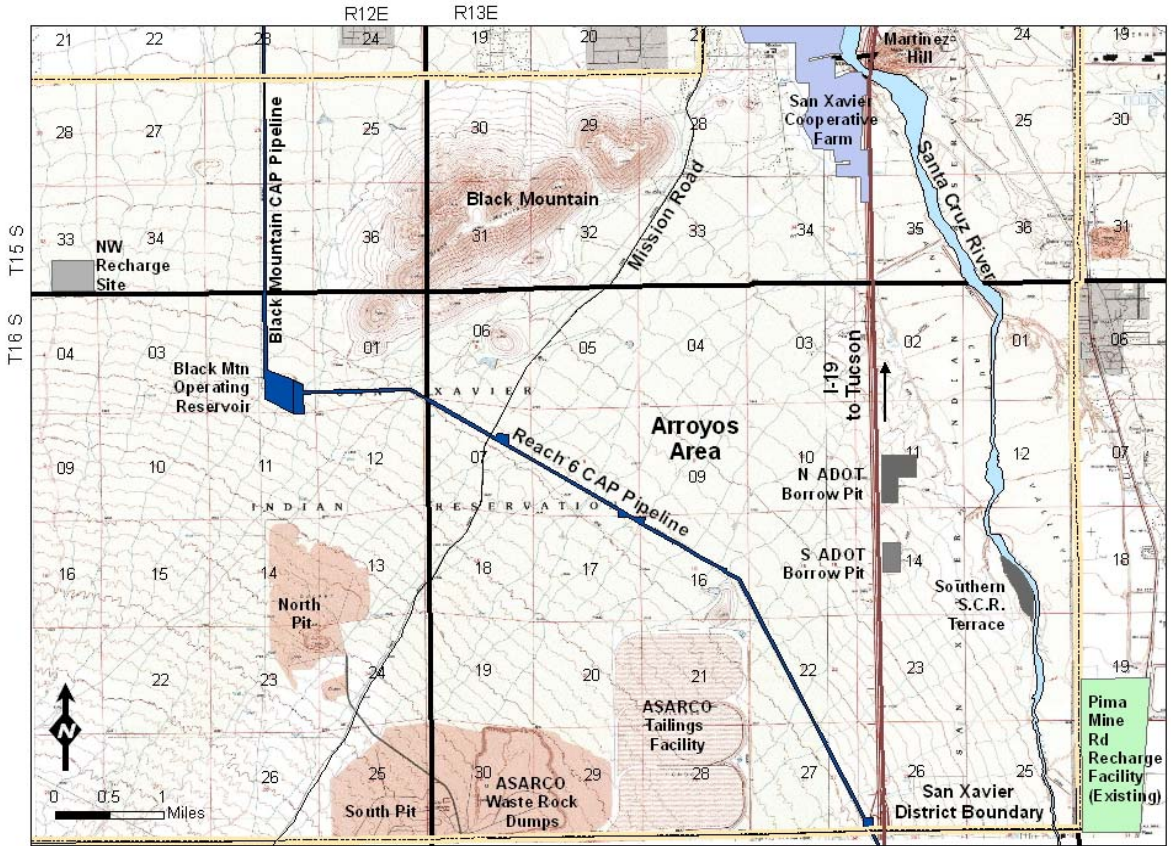


Figure 2. Preliminary study sites.

In 2001, the SXD and Reclamation initiated feasibility-level investigations at the six study locations. The investigations involved soil and short-term infiltration testing to determine if site characteristics were suitable for a permanent recharge facility. Boreholes were drilled at each site to collect geotechnical information and to install monitoring wells and piezometers for the collection of ground-water data. Analysis of test data indicated soils in the Arroyos Area yielded favorable surface infiltration rates and a comparatively smaller overall percentage of silt and clay in the vadose (unsaturated) zone.[4] Based on these test results, SXD and Reclamation determined that additional investigations in the Arroyos Area were warranted.

[4] The vadose zone refers to the unsaturated portion of the earth between the land surface and the aquifer. Saturated bodies such as perched ground-water may exist in this unsaturated zone.

Ground-water Recharge Pilot Investigations

Constructed Basin Recharge. During a 6-month period in 2003, an infiltration test was conducted in an artificial basin in the northern portion of the Arroyos Area. Approximately 40 AF of water was drawn from the Manhole 15 blow-off valve on the CAP Reach 6 Pipeline and conveyed through a temporary aboveground, high-density polyethylene (HDPE) pipeline to a constructed 10,000-square-foot basin. Infiltration rates at the test site ranged from ½ to 1 foot per day, with a 45-day response time for the water to reach the aquifer. A 4-foot, ground-water level rise was observed in monitor wells installed down-gradient of the basin. No major impeding layers were detected within the vadose zone. Test results indicated that conditions at the Arroyos Area were favorable for a large-scale basin recharge project; however, shallow spreading basins in this area would require a significant amount of land (14 to 17 acres) to meet the minimum CAP-water TRD requirement of 2,820 AFY.

In-Channel Recharge. As an alternative to basin recharge, the SXD and Reclamation investigated the infiltration rates of natural drainages within the Arroyos Area. Artificial in-channel recharge has the decided advantage of lower start-up costs, fewer adverse environmental impacts, and potential enhancement of riparian habitat. The arroyos along the Reach 6 CAP Pipeline between Mission Road and the Lava Knoll exhibited conditions that appeared highly favorable for long-term recharge, such as excellent storage potential (depth to water is approximately 200 feet), good access, and close proximity to a CAP water source. Arroyo 19 was selected for the in-channel pilot recharge test because of favorable channel and geologic characteristics, in addition to the long-term storage potential at this site.[5]

The in-channel recharge pilot test involved discharging CAP water into the main Arroyo 19 channel and an eastern tributary. Arroyo 19 crosses the Reach 6 pipeline near CAP Manhole 19 and continues in a northeasterly direction, eventually passing under I-19 before spilling onto the Santa Cruz River (SCR) floodplain. At the Reach 6 Pipeline, the Arroyo 19 channel is highly braided and undefined; therefore, the initial discharge point was placed several hundred feet downstream from the CAP pipeline at a location where the main channel is well-defined and sufficiently wide. A second discharge point was placed on a tributary to Arroyo 19.

Almost ½-mile of HDPE pipe was fused together to construct the aboveground delivery system. Eight-inch-diameter pipe was installed from the valve at Manhole 19 on the Reach 6 CAP Pipeline to a location where the system was bifurcated into two 6-inch-diameter delivery lines serving both the main arroyo channel and its tributary. Monitoring wells and piezometers (RIPZ-10, RIPZ-11, RIPZ-16, RIPZ-17, RIPZ-18, and RIPZ-19) were installed to provide hydrogeologic information and to define ambient

[5] The arroyos located adjacent to each blow-off valve on the CAP Reach 6 Pipeline are referred to by the adjacent manhole number. The arroyos along the pipeline between Mission Road and the Lava Knoll are numbered 7, 9, 11, 13, 15, 17, and 19.

ground-water conditions prior to recharge and for ground-water monitoring during the test.

Discharge structures consisted of an off-channel excavation for perforated 6-inch-diameter HDPE pipe, geotextile liner, and riprap (Figure 3 and Appendix A). A geofabric envelope was installed to evenly distribute discharge flow and hold the riprap in place.

Figure 3. Discharge structure on Arroyo 19.

The Arroyo 19 pilot test began on November 30, 2004, and continued through 2008. During the first 4 years of operation, an average discharge rate of approximately 400 gallons per minute (gpm) was maintained at each discharge point. Operating protocol required periodic discontinuation of flows to dry the channels and remove algae, encrustation, and fines that otherwise would reduce infiltration rates. Flow rate was controlled and metered at the CAP pipeline connection and at each of the two discharge points.

Down cutting into the sandy channel sediments became apparent when discharge rates initially approached 400 gpm. This problem was resolved when small check dams were installed at various intervals within the arroyo channel. The check dams were constructed of non-woven geotextile fabric, HDPE pipe sections, steel pipe anchors, and

rocks (Figure 4 and Appendix B). In addition to stabilizing the streambed, the check dams increased infiltration by spreading water flow more uniformly across the channel, increasing retention time, and decreasing water velocities.

Figure 4. Check dam on Arroyo 19.

By August 2006, ground-water mounding was quite evident in the Arroyos project area. Ground-water level rises of 68 feet were observed in a monitor well (RIPZ-16) located near the central portion of the recharge area, with a rise of 5 feet recorded approximately 5,400 feet down-gradient from the main arroyo discharge point. Surface infiltration rates ranging from 7 to 13 feet per day (average of 8 feet per day) were consistent throughout the test period.

Pilot test data indicate that it is feasible to recharge and store significant volumes of CAP water in the aquifer beneath the Arroyos Area. During the initial 18 months of testing, 2,061 AF of CAP water was discharged to Arroyo 19, with an estimated 1,773 AF entering the aquifer. Based on these results, Reclamation estimates that 1,300 AFY of CAP water could be recharged to the aquifer at the Arroyo 19 site.

1.4 Purpose and Need for Action

The purpose of the proposed project is to provide a viable and efficient system for long-term ground-water recharge within SXD. Replenishing the aquifer with CAP water would provide a stored water supply which would be available to the San Xavier Cooperative Farm during short-term, planned CAP delivery system outages. This provision of stored water is considered by SXD to be a critical need of the farm. Implementation of the project would also satisfy the CAP reliability obligation identified for SXD under the TRD.

1.5 Public Involvement

The Council on Environmental Quality defines scoping as "…an early and open process for determining the scope of issues to be addressed and for identifying significant issues related to a proposed action" (40 CFR 1501.7). Scoping is an important underpinning of the NEPA process that encourages public input and helps focus the environmental impact analysis on relevant issues. Distribution of scoping information typically heralds the beginning of the public component of the NEPA process.

To encourage public participation, Reclamation posted a scoping notice on its Phoenix Area Office web site (http://www.usbr.gov/lc/phoenix) and mailed scoping information regarding the proposal to potentially interested individuals, organizations, and agencies on August 7, 2008 (see Chapter 4). Reclamation also submitted news releases to the *Arizona Republic* and eight other news media outlets. One letter of comment was received during the 30-day scoping period. The respondent expressed support for the project.

SXD held a public meeting with the affected allottees at the San Xavier District Center on March 5, 2009. Attendees were informed of the upcoming EA and invited to comment on the possible environmental consequences of the proposed project.

CHAPTER 2 - DESCRIPTION OF ALTERNATIVES

This chapter describes the alternatives considered for the proposed recharge project in greater detail. It includes the proposed action and no action.

2.1 No Action

Section 102(2)(E) of NEPA requires that no action must be considered as an alternative in an environmental review whenever there are unresolved conflicts about the proposed action with respect to alternative uses of available resources. A description of no action is also customarily used to provide the baseline for comparison of environmental effects of the action alternatives against conditions that are representative of the status quo. As considered in this EA, if no action is taken, Reclamation would not assist the SXD in the development of a long-term recharge project in the Arroyos Area. CAP water would not be discharged into Arroyos 15 and 19, and reliability obligations identified under the TRD for CAP water delivery to the SXD would not be met through the current proposal.

2.2 Proposed Action

The proposed action consists of developing a long-term (20 years or more) artificial in-channel recharge project involving Arroyos 15 and 19. Review and approval of the project would be coordinated through appropriate levels of the SXD and Tohono O'odham Nation (see Section 3.1). Allottee approvals and a renewable 20-year lease would be obtained through the Bureau of Indian Affairs (BIA) for construction, in-channel recharge, and monitoring on affected Indian trust allotments (see Section 3.6).

Arroyo 19. Existing pilot test infrastructure installed at Arroyo 19 would be utilized for long-term recharge (Figure 5). Approximately 420 feet of HDPE pipeline previously installed adjacent to the CAP Reach 6 Pipeline service road would be buried to provide greater protection against roadside damage and vandalism. Repair and replacement of existing check dams would be needed periodically to maximize operational effectiveness. Installation of additional check dams may also be required to enhance recharge potential and control channel erosion in the future.

The existing unpaved road along Arroyo 19 may require periodic light grading to maintain the driving surface. If the need arises, aggregate base material would be applied and/or runoff berms constructed in areas of potential erosion.

Arroyo 15. A 20-foot-wide, unpaved road would be built on the east side of the Arroyo 15 channel to provide access for construction and operation. Segments of this road may require stabilization with aggregate base material to minimize erosion and dust emissions. Once the road is in place, a new piezometer (RIPZ-20) would be installed with a truck-mounted rotary drill. Geologic samples would be extracted from the boreholes during drilling. SXD also proposes to deepen a retired stock well (RIPZ-21) located approximately 2.3-miles northeast of Arroyo 15 for ground-water monitoring (Figure 8).

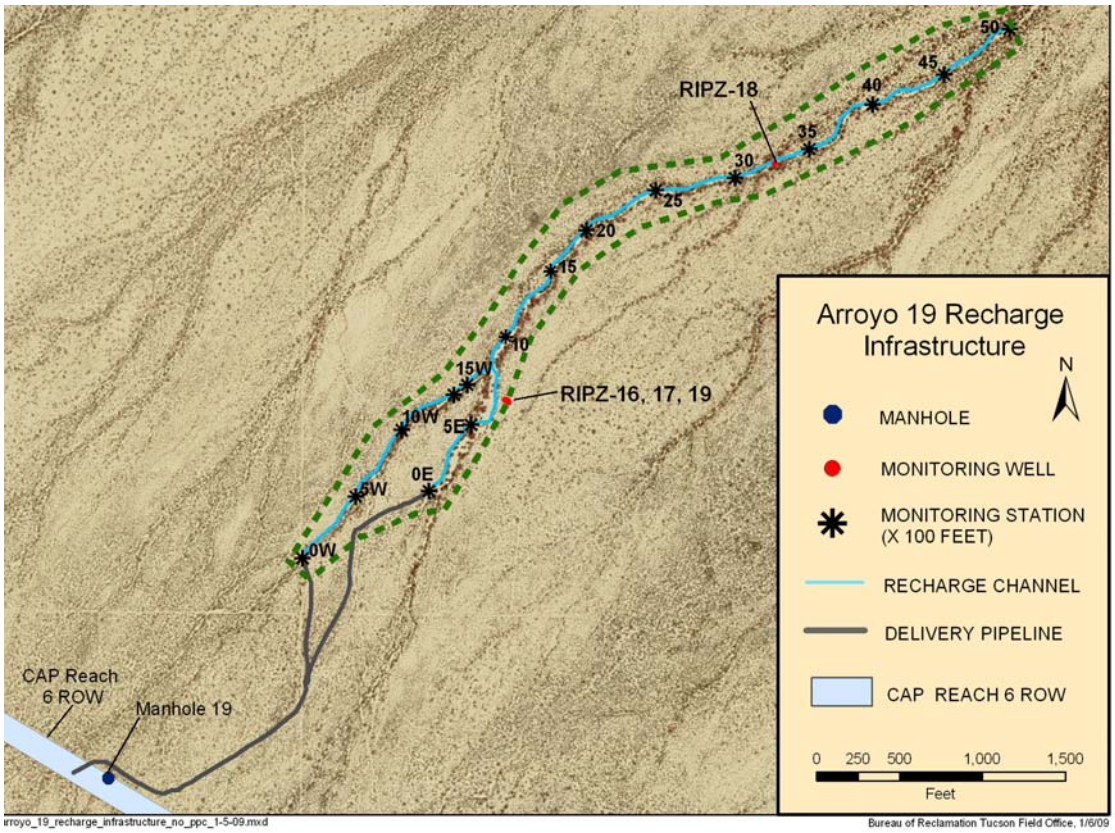


Figure 5. Existing Arroyo 19 recharge infrastructure.

Approximately 3,300 feet of 6-inch- and 4-inch-diameter HDPE pipe would be installed between the valve at Manhole 15 on the CAP Reach 6 Pipeline and the last discharge point (Figure 6). Most of the water delivery system would be placed aboveground; however, approximately 200 feet of pipe just beyond the Reach 6 Pipeline service road would be buried for security purposes. A small tee and valve would be installed in the 6-inch-diameter delivery pipeline downstream from the main flow meter in order to draw water for temporary water supplies during construction and drilling and to provide a water supply for a permanent cattle watering tank to be placed outside the perimeter fence. At a distance of approximately 400 feet from the Reach 6 pipeline, a 6-inch-diameter HDPE lateral would tee off the delivery system to supply water to the first discharge point. The delivery system would be reduced from 6-inch- to 4-inch-diameter pipe approximately 500 feet from the Reach 6 pipeline. Flanges would be installed for possible future installation of tees (and discharge points) at distances of approximately 1,000, 1,700, 2,600, and 2,900 feet down-gradient from the first discharge point.

The discharge structures would follow the same general design used in the Arroyo 19 pilot test (see Figure 3 and Appendix A); however, the effectiveness of other materials and designs may be tested and applied at selected sites. Discharge structures would consist of a perforated 6-inch-diameter HDPE pipe place in an excavated trench and

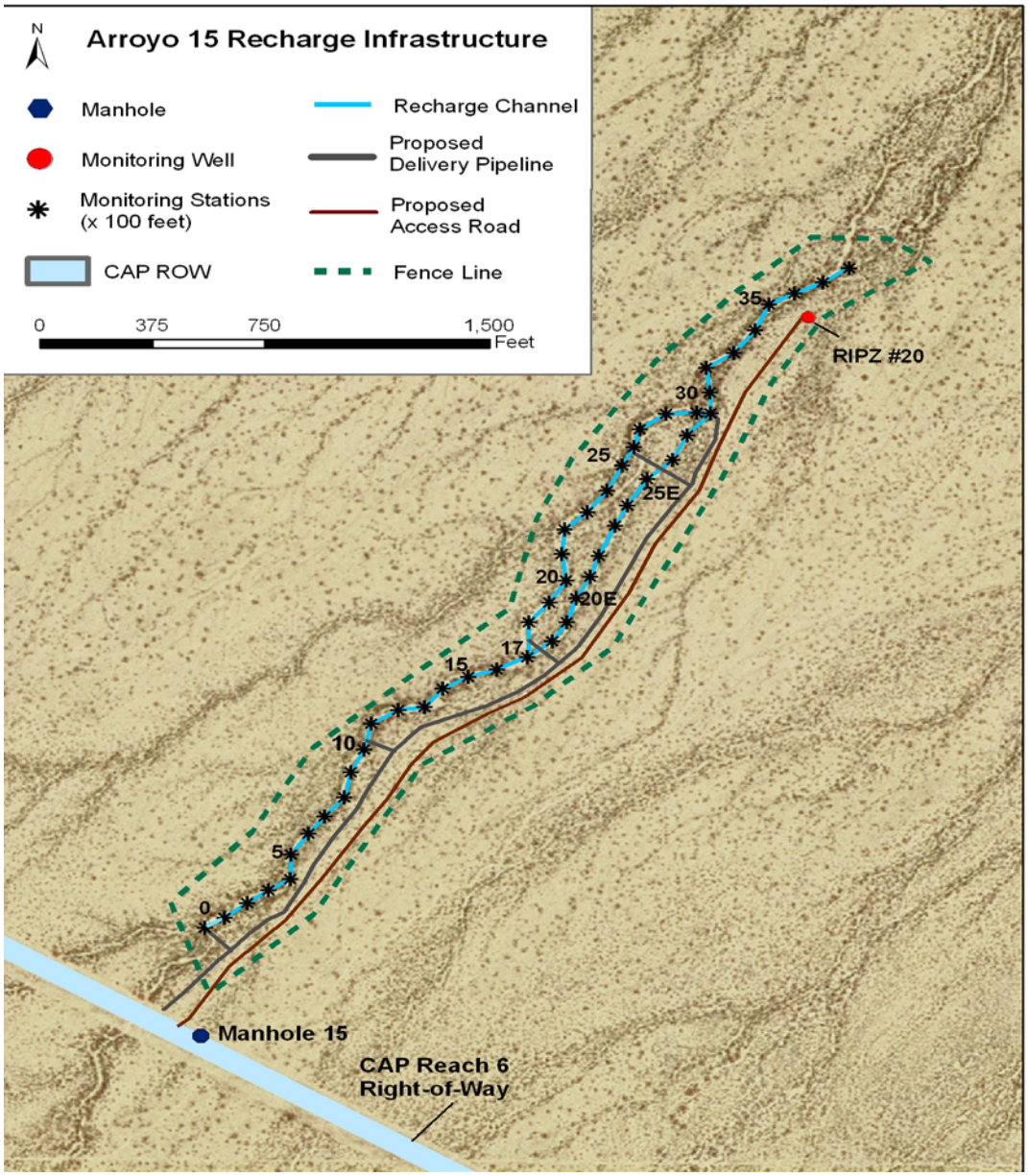


Figure 6. Proposed Arroyo 15 recharge infrastructure.

buried in riprap. Maximum capacity of each discharge outfall structure is estimated to be approximately 2.5 cubic feet per second (cfs).

A flow meter would be installed at the Manhole 15 valve on the CAP Reach 6 Pipeline to measure discharges into the water delivery system. An additional flow meter would be installed on the 4-inch pipeline to measure flows downstream of the first discharge point. Both flow meters would be housed in locking vaults.

Several check dams would be constructed at appropriate locations within the channel before any water is discharged. Additional check dams may be necessary if operational releases result in channel downcutting. Check dam construction would follow the same

design utilized in the Arroyo 19 pilot test (see Figure 4 and Appendix B); however, the effectiveness of other materials and designs may be tested and applied at selected sites.

Operation. Discharge rates in each arroyo would range from ½ to 2 cfs or greater depending on channel conditions. Flows would be adjusted to achieve sufficient wetting of the channel while obviating problematic conditions such as streambed erosion. If channel monitoring indicates that significant down cutting is occurring, the discharges would be reduced or discontinued until check dams or other appropriate flow control structures are installed. System shutdown would be required periodically for maintenance. Installation of remote flow control valves would be evaluated in the future so that discharges can be terminated quickly in the event of a large storm or emergency. When practicable, channel maintenance such as drying and scraping of streambed clogging materials and/or building or repairing check dams would be scheduled to coincide with CAP maintenance outages.

Reclamation estimates that the combined recharge volume from both arroyos would meet the minimum CAP-water TRD requirement of 2,820 AFY, which is equivalent to a total volume of 56,400 AF during the initial 20-year lease.

Perimeter Fences. Arroyos 15 and 19 would be enclosed by separate three-strand-barbed and one-strand, nonbarbed-wire perimeter fences to exclude livestock and prevent trampling of channel banks, check dams, and riparian vegetation. Walk-in and vehicle access gates would be installed at appropriate locations within the fences. A CAP-water-supplied, cattle watering tank would be placed outside the fences near the main discharge points to Arroyos 15 and 19 to deter livestock from attempting to enter the fenced areas. Fencing would enclose the wetted portions of the arroyos and all discharge points, affecting portions of ten Indian trust allotments. Approximately 78 acres (30.7 acres at Arroyo 15 and 47.1 acres at Arroyo 19) would be fenced (Figure 7).

Monitoring and Data Collection. Personnel from SXD would collect routine field measurements, channel monitoring data, and water quality samples according to guidelines described in the SXD *Arroyos Recharge Project Operations and Maintenance Manual*. The SXD would monitor CAP water delivery flow rates and volumes, the length and width of channel flows, erosion, bank wetting, soil electrical conductivity (EC), and ground-water level and ground-water quality data. Weekly flow meter readings and flow length measurements would be taken at each site.

The SXD would conduct ground-water quality sampling at Arroyos 15 and 19 biannually during the first year of operation, and then annually for the life of the project. Sampling parameters would include: total dissolved solids (TDS), total organic carbon, sulfate, carbonate, bi-carbonate, chloride, nitrate, nitrite, flouride, calcium, sodium, magnesium, potassium, iron, arsenic, Silica, and possibly perchlorate. Perchlorate would be dropped as a monitoring constituent if CAP sampling results continue to be below the laboratory detection limit of 1.0 µg/L.

Depth to ground-water measurements would be collected from RIPZ-10, RIPZ-11, RIPZ-16, RIPZ-18, RIPZ-20 (proposed), and RIPZ-21 (proposed) on a weekly or bi-weekly basis; and from RIPZ-1, RIPZ-4, RIPZ-7, CPR6-6, and CPR6-8 on a quarterly basis. Pressure transducers and data loggers may be installed in ground-water wells RIPZ-16, RIPZ-18, RIPZ-20, and RIPZ-21 to record depth to ground-water level measurements on a long-term, continuous basis. Ground-water measurements collected from CPR6-6, CPR6-8, and RIPZ-10, would be used to provide information on up-gradient hydrogeologic conditions. Monitoring well locations are shown in Figure 8.

Surface water flows would be monitored visually during field inspections to detect existing or potential problems. Potential salt buildup in soils would be monitored by visual inspections on a monthly basis and by collecting soil EC measurements at pre-selected sampling locations every 6 months to a year. Algal growth and the presence of mosquito larvae in potential mosquito breeding habitat would also be monitored monthly by visual inspections.

2.3 Alternatives Considered but Not Analyzed in Detail

Several additional possible sites for in-channel recharge are located in the Arroyos Area. Arroyos south of the Lava Knoll and at Manhole 21 were eliminated from consideration because of their close proximity to the ASARCO well field cone of depression and tailings ponds. Water recharged in arroyos south of the Lava Knoll could be captured by the ASARCO cone of depression and recovered by ASARCO-owned wells, providing no benefit to the SXD. Arroyos located west of Mission Road were eliminated from consideration due to shallow bedrock conditions and a greater distance from the potential recovery areas.

The arroyos along the Reach 6 CAP Pipeline between Mission Road and the Lava Knoll are considered to have the greatest potential for recharge because of a favorable storage conditions, good access, and close proximity to a CAP water source. However, shallower depths to bedrock at Arroyos 7, 9, 11, and 13 make these arroyos less favorable than Arroyos 15 or 19. Arroyo 17 has a small and undefined channel, substantially reducing its utility for in-channel ground-water recharge.

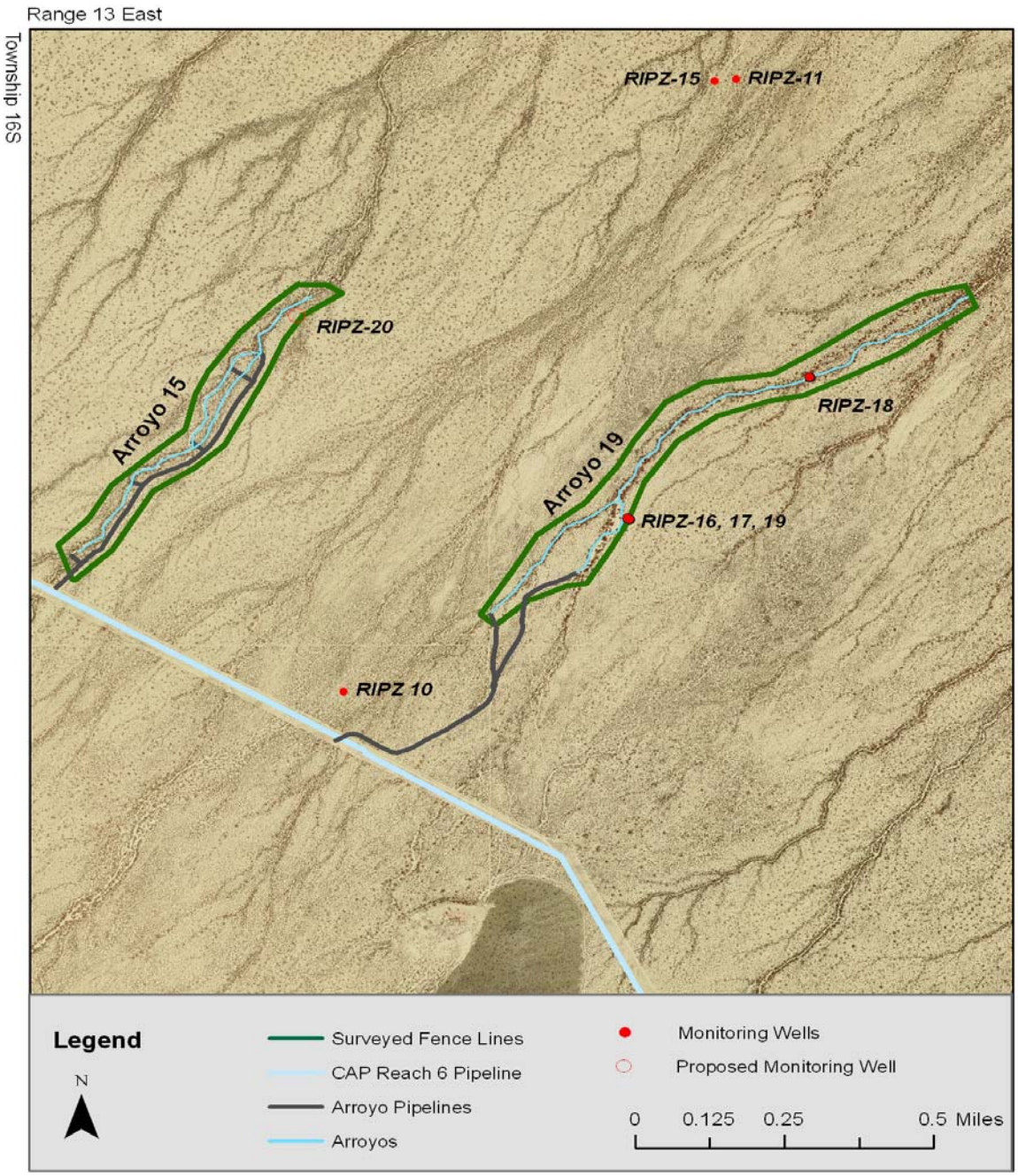


Figure 7. Proposed perimeter fences.

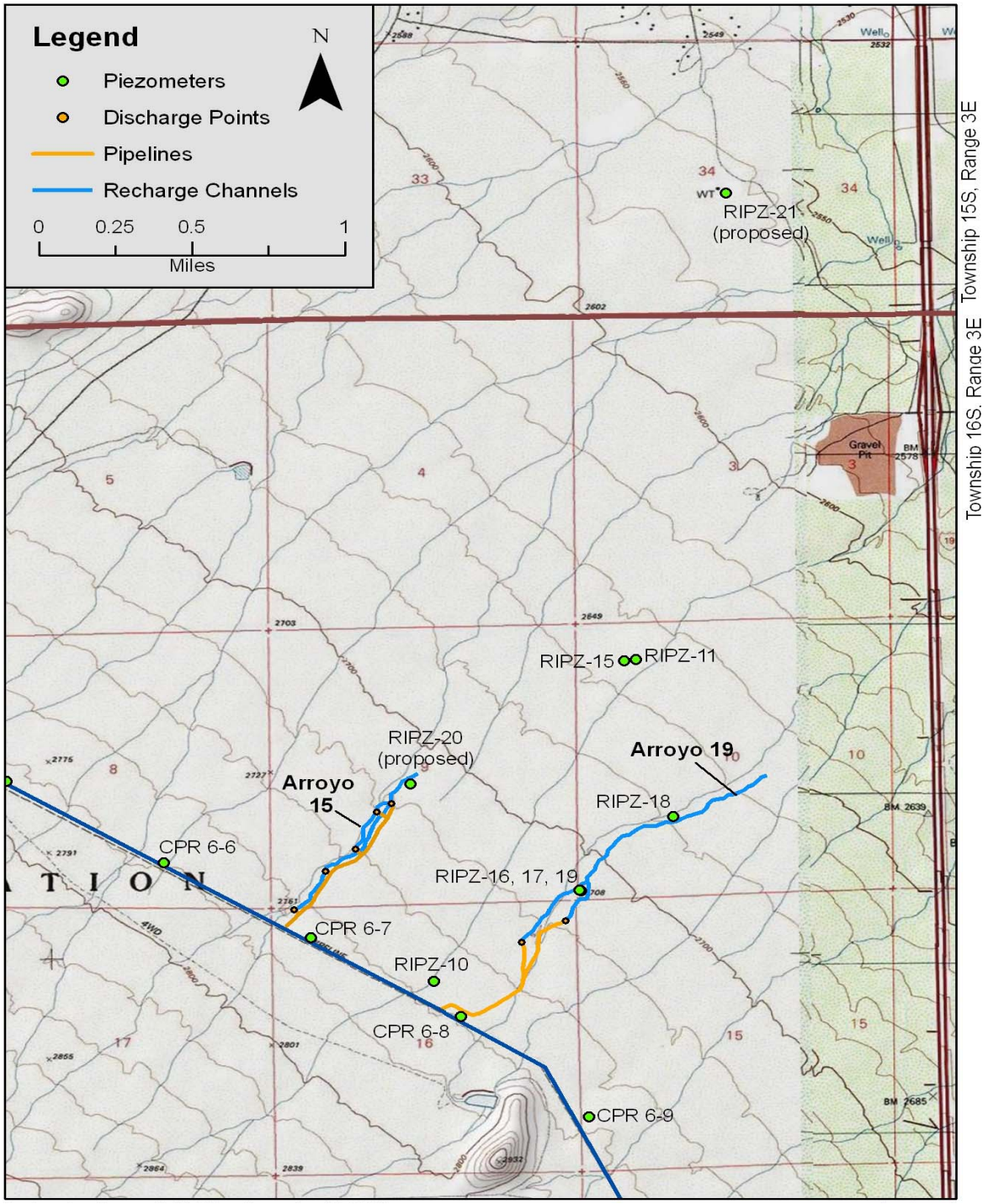


Figure 8. Existing and proposed monitoring wells in the Arroyos Area.

CHAPTER 3 - AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter presents the existing conditions in the project area and the environmental consequences that can be expected from implementing the proposed action versus no action. Implementation of the proposed action is not expected to substantially affect the following resources, which are not addressed in this EA: air quality, noise, socioeconomics, and aesthetics.

3.1 Land Use

3.1.1 General Setting

In 1992, SXD adopted the *General Plan for Land Use and Transportation*. This plan established guidelines for future development on SXD and provides a summary of different land uses that may be pursued within specified zones. The project area is located in a zone classified as "open space." Open space zones are intended to protect natural and cultural resources and maintain a landscape that is largely undeveloped. With the exception of the CAP Reach 6 Pipeline and an associated service road, the Arroyos Area consists of undeveloped Indian trust allotments. There is no agricultural, residential, or commercial development within this area. Grazing by livestock occurs on open range throughout much of SXD, including the project area; however grazing will be curtailed on lands east of Mission Road once SXD implements a new Range Management Plan that is currently under development.

The ASARCO Mission Mine Complex (Mission Complex) straddles the southern boundary of the SXD. One of the largest mining operations in Arizona, the Mission Complex is a copper mining network with an underground mine and two open pits. Three large tailings ponds and several mine dumps are located on land leased from the Indian landowners approximately 1 mile south of the Arroyos project area. Leachate from these tailings has contributed to elevated levels of sulfate, TDS, and hardness in the aquifer below and adjacent to the ponds. Surface drainage from a break in a tailings pond dike in 1990 released large volumes of material into wash complexes that drain toward the SCR. Extensive soil sampling for metals contamination following this event indicated that the discharge did not result in hazardous metal levels in soils on the SXD (Shaffer 1993).

3.1.2 Affected Environment

The project area encompasses approximately 78 acres and would affect portions of 9 Indian trust allotments along the east side of the CAP Reach 6 Pipeline. Except for the presence of infrastructure associated with the CAP Pipeline and Arroyo 19 recharge pilot project, the dominant land-use character of the area consists of undeveloped open space. Once the Range Management Plan is executed, the Arroyos Area would be closed to grazing, and all livestock would be moved to the area west of Mission Road.

Vehicle access to the area is provided by a service road that parallels the CAP Pipeline. The 100-foot-wide permanent easement for the CAP Pipeline is the only existing easement or right-of-way in the vicinity of the project area.

3.1.3 Environmental Consequences

No Action

Under the No Action alternative, existing land use patterns within the project area would prevail into the foreseeable future. Livestock grazing would likely be discontinued in the Arroyos Area in accordance with SXD's Range Management Plan.

Proposed Action

As a prerequisite to implementation of the proposed project, the SXD would conduct an internal District-level review within the Administration and Planning Departments and seek allottee approvals and a SXD Council resolution. A 20-year lease would be requested through the BIA for construction, in-channel recharge, and monitoring on affected Indian trust allotments within the Arroyos project area.

Appropriate approvals from the Tohono O'odham Nation would be sought by the SXD, including approvals for use of CAP water for the project, installation of monitoring wells/piezometers, and accrual of credits for CAP water that is recharged for TRD reliability purposes. SXD anticipates these approvals would be contained in a single Tohono O'odham Nation Legislative Council resolution encompassing the entire project.[6]

Following construction, minor visual impacts to the natural character of the landscape would result from the aboveground water conveyance pipe and service roads along Arroyos 15 and 19. The project area would be fenced to exclude livestock, although this action may be unnecessary in the long term if the SXD discontinues grazing in the Arroyos Area. No substantial changes in existing land use or reasonably foreseeable future land use would result from the project.

Cumulative Effects

No cumulative effects on land use are anticipated.

[6] The Tohono O'odham Nation (TON) is in the process of establishing a Water Resources Department which will implement the TON Water Code. Once the Code is implemented, a permit system for drilling wells and for recharge will be put into place; consequently, permits may have to be obtained through this new process rather than through the TON Legislative Council.

3.2 Water Resources

3.2.1 General Setting

The SXD lies within the 3,866-square-mile Tucson Active Management Area (AMA). Designated under the Arizona Ground-water Management Code, the statutory goal of the AMA is to reduce overdraft and attain "safe yield" of ground-water supplies by 2025. Safe yield is a balance between ground-water withdrawal and ground-water recharge which, from a practicable standpoint, encourages reduced use of ground water in favor of renewable supplies, such as CAP water. The amount of ground water in storage in the Tucson AMA is estimated at 12.7 million AF (Arizona Department of Water Resources [ADWR] 1999).

The Tucson AMA consists of two ground-water sub-basins: the northern part of the Upper Santa Cruz sub-basin and the Avra Valley sub-basin. The Upper Santa Cruz sub-basin is the primary source of ground water in SXD and is designated a Sole Source Aquifer by the U.S. Environmental Protection Agency (EPA) under Section 1424(e) of the Safe Drinking Water Act.[7] Natural and incidental flows into the Santa Cruz sub-basin include mountain-front recharge; stream infiltration; ground-water underflow from outside the sub-basin; and recharge from agricultural, municipal, and industrial sources. The regional ground-water flow pattern is from the margins of the basin toward the SCR and beneath the SCR from south to the north-northwest through basin-fill alluvial deposits. Local deviation from the general flow pattern occurs in the southeastern portion of the SXD where ground water flows toward and into the ASARCO Mission Mine Complex well field cone of depression. An additional deviation results from the Pima Mine Road (PMR) recharge facility's ground-water mound, which trends west and northwest below the SCR toward the Arroyos Area.[8] Monthly recharge from the PMR facility ranges from 2,000 to 2,500 AF, which is approximately nine times the recharge volume estimated for the proposed Arroyos project.

Sustained net withdrawals in the Upper Santa Cruz sub-basin have had negative consequences for ground-water supplies. Since 1940, maximum ground-water level declines in the Upper Santa Cruz sub-basin have ranged from 200 feet in the Tucson area to 150 feet in the Green Valley/Sahuarita area (ADWR 1999), reflecting severe overdraft of the regional aquifer from agricultural, mining, and urban pumpage (Betancourt and Turner 1988). Ground-water depths within the sub-basin currently range from less than 100 feet to over 600 feet below the land surface. The depth to ground-water across the SXD ranges from 20 feet where bedrock occurs near the surface to about 400 feet in the

[7] The Sole Source Aquifer program was created to protect drinking water supplies in areas with few or no alternative sources to the ground-water resources. EPA review is required for any federally funded proposal that could affect a designated sole-source aquifer.

[8] The PMR recharge facility is jointly owned by Tucson Water and the Central Arizona Water Conservation District and is used to recharge the aquifer with CAP water. The facility is located adjacent to the southeast corner of the SXD (Figure 2). Permitted maximum recharge capacity is 30,000 AF per year.

ASARCO well field area, and as much as 700 feet or more west of the Avra Valley fault (Rogers 2001).

Despite attempts to maximize the use of renewable water supplies and artificial recharge, a numerical ground-water flow model of the Tucson AMA projects continued deficits, with an annual overdraft of between 14,000 and 20,000 AF by 2025 (Mason and Bota 2006). The flow model projects a net loss of ground-water storage of 1,000,000 AF in the Santa Cruz sub-basin by 2025 due to increasing rates of municipal pumpage driven by urban growth.

Water quality of the regional aquifer on SXD is generally good, with relatively few exceedances of primary drinking water standards. However, a number of off-reservation entities, as well as on-reservation farming practices and recharge with CAP water, have affected ambient aquifer water quality. Ground-water contaminants of concern on SXD include trichloroethylene (TCE), TDS, sulfate, and nitrate.

TCE is a volatile organic compound that was widely used by industrial facilities in the southern part of Tucson as a metal degreaser and in electroplating processes. Improper disposal of TCE in unlined ditches and waste pits prior to the early 1970s created a plume of ground-water contamination that affects the south side of Tucson and the extreme northeastern part of SXD.[9] This TCE plume is actively being remediated through extraction and treatment. The general movement of the plume is in a north/northwestern direction away from SXD.

Elevated levels of TDS and sulfate from the ASARCO Mission Mine Complex tailings ponds have affected ground-water quality in the southeastern portion of the SXD. A plume of high TDS and sulfate has migrated north and east of the tailings ponds and has been reported by SXD as extending to the Lava Knoll near the Arroyos project area. TDS and sulfate concentrations exceeding 1000 mg/L and 500 mg/L, respectively, have been reported from some monitoring wells located within this plume (PAG 2002). The plume's northward expansion may be retarded by pumping from the ASARCO well field (the ground-water gradient from the tailings ponds is to the east and southeast into the well field's cone of depression).

The PMR recharge facility owner/operator has recorded exceedances of primary water quality standards for nitrate in some of their monitoring wells (AHS 2001). These higher levels are part of a nitrate plume that is migrating north/northeast, affecting the eastern portion of SXD generally east of the SCR. Agricultural and mining activity that is up-gradient to these wells may be the source of contamination. Nitrates above regulatory levels have not been detected in the Arroyos Area.

3.2.2 Affected Environment

Surface Water. The Arroyos project area washes are tributary to the SCR; however, only the largest storm runoff events carry sufficient flow to reach the main river channel (a

[9] The TCE contamination plume constitutes part of the Tucson International Airport Area Superfund site.

total distance of approximately 2.5 miles). In the lower reaches of the Arroyos Area, the alluvial fan upon which the washes are situated begins to flatten, and the channels become progressively shallower and more braided with poorly defined multiple threads. Runoff from Arroyos 21 to 23 is carried under I-19 and discharged directly onto an abandoned ADOT borrow pit as sheet/overland flow. Flows from Arroyos 1 to 19 are captured by the West Branch of the SCR, a tributary that runs north through the San Xavier Cooperative Farm via a constructed floodway and empties into the SCR north of San Xavier Road.

Surface flow in the SCR and its tributaries is ephemeral throughout SXD. Flow events are highly episodic, generally corresponding to runoff from major monsoon and winter storms. Flood waters carried by the SCR provide some recharge to the regional aquifer, which is hydraulically disconnected and approximately 100 feet or more below the river channel. Estimates of 200- to 400-AF per mile of recharge in the river channel during floods have been reported (Osterkamp 1973).

Ground Water. The regional aquifer below the Arroyos Area is considered unconfined, with semi-confined (perched) conditions occurring in some areas. Depth to the regional ground-water table in the project area is generally 180 to 200 feet, although perched ground water is present at 75 feet in monitoring well RIPZ-7. Perched ground water also occurs near the SCR, south and southwest of Martinez Hill. Near the CAP Reach 6 Pipeline, the saturated thickness of the aquifer is very thin (on the order of ten to tens of feet) and thickens eastward across the project area to about 100-feet saturated thickness near RIPZ-11 and RIPZ-18. Approximately 350 feet or more saturated thickness occurs beneath I-19, near RIPZ-1 and RIPZ-4, beginning at a depth of 150 feet.

The Arroyo 19 pilot test has imposed quantitative and qualitative effects on the shallow and regional ground-water systems in the Arroyos project area. Prior to recharge in Arroyo 19, the surface of the water table between the CAP Reach 6 Pipeline and RIPZ-11 dropped relatively uniformly in a general north-northeast direction from elevation 2,550 to 2,450. Since November 2004, ground-water levels at well RIPZ-16 (approximately 700 feet down-gradient from the east discharge point in Arroyo 19) have risen 68 feet, forming an ovate-shaped mound that extends approximately 5,000 feet past monitor well RIPZ-11.

On the east side of I-19, water levels in monitoring wells RIPZ-1 and RIPZ-4 have been rising since summer 2002, before the start of the short-lived basin pilot test and the on-going Arroyo 19 pilot test. This rise probably results mostly from the growing aquifer mound emanating from the PMR facility, which is gradually expanding north and northwest under the SCR towards the outer fringe of the Arroyos Area.

Water Quality. CAP water is a mixture of water from the Colorado River, Bill Williams River, and Agua Fria River; however, the Colorado River is the principal source. Except

for turbidity, water supplied through the CAP at the San Xavier pumping plant meets all primary drinking water standards under the Safe Drinking Water Act.[10]

TDS levels in CAP water often exceed the secondary (non-enforceable) drinking water standard of 500 mg/L.[11] In 2007, the TDS concentration in the CAP system ranged from 600 to 768 mg/L, with an average of 680 mg/L (CAP 2008). Typical historic levels of approximately 300 mg/L TDS are reported in ground water on the SXD (Rogers 2001 and 2004).

Ground-water sampling in the project area prior to and during the pilot recharge test has demonstrated the impact of CAP water on ambient aquifer quality. The regional aquifer below the Arroyos Area is increasingly becoming more like the CAP water in terms of salinity levels, similar to the effects seen in other Tucson- and Phoenix-area recharge projects using CAP source water. Specifically, the first changes observed in monitoring well samples were an initial spike in the concentrations of TDS, sulfate, and some other salts greater than those concentrations typical of the CAP water being introduced into the recharge facility and substantially greater than the ambient aquifer quality prior to CAP recharge. Recharge with CAP water initially leaches soluble salts out of the vadose zone into the regional aquifer as a "first flush." As CAP recharge continues, the salinity levels in the regional aquifer taper off with concentrations approaching the original CAP water levels. In areas farther away from the infiltrating CAP water, the ground-water quality eventually equilibrates to salinity concentrations characteristic of a blend of ambient ground water and CAP water.

Colorado River water in the CAP system has been shown to contain perchlorate, a common ingredient in the manufacture of propellants and explosives. The levels of perchlorate detected in the CAP system are traced to Las Vegas Wash, a tributary of the lower Colorado River, that receives contaminated ground-water seepage from a chemical manufacturing facility operated by Kerr-McGee Chemical Corporation in Henderson, Nevada (EPA 2004). Concentrations of perchlorate in Colorado River water immediately upstream of the intake to the CAP system have steadily declined from a high value of 9.7 ug/L in June 1999 to the most recent value of 2.0 ug/L in October 2007, a result of ongoing remediation efforts at the Kerr-McGee facility (CAP 2008). Monitoring of CAP water quality at the San Xavier pumping plant detected no perchlorate in 2007 (CAP 2008). Continued remediation by Kerr-McGee is expected to result in further reduction of perchlorate levels in Colorado River water entering the CAP system.

Recharge with CAP has the potential to release low concentrations of perchlorate into ground water. In May 2005, six months after the Arroyo 19 pilot test began, a perchlorate level of 2.2 ug/L was detected in one of the Arroyos Area wells, RIPZ-16. Perchlorate levels in recharged ground water have subsequently dropped below the

[10] The CAP is not subject to the Safe Drinking Water Act because it does not deliver potable water directly to the consumer.

[11] Secondary standards are non-enforceable guidelines that are recommended to reduce contamination that may cause cosmetic (rust/corrosion) or aesthetic (odor or taste) effects in drinking water systems.

detection limit (Rogers 2006), reflecting the downward trend in perchlorate concentrations in Colorado River water supplied to the CAP.

There currently is no enforceable health standard for perchlorate in either Federal or State of Arizona regulations, although the state has an advisory health-based guidance level of 14 µg/L. The EPA has set an official reference dose level of 0.0007 mg/kg/day (a drinking water equivalent of 24.5 µg/L), which is a scientific estimate of a daily exposure of perchlorate that is not expected to cause adverse health effects in humans.

3.2.3 Environmental Consequences

No Action

Under the No Action alternative, existing water resource trends would prevail into the reasonably foreseeable future. Ground-water depletion would likely continue past 2025 because of withdrawals by municipal and industrial entities located outside the SXD.

Proposed Action

Surface Water. Recharge with CAP water would support prolonged periods of continuous flow in Arroyos 15 and 19. A reach length of approximately 4,000 to 5,000 feet in Arroyos 15 and 19 would carry active flow most of the year, except during maintenance shutdowns.

Ground Water. An existing three-dimensional, numerical ground-water flow model was modified and run to estimate how the regional ground-water system may respond to Arroyos Area recharge with CAP water over a number of years. The model accounts for the cumulative hydrologic interplay between the CAP water recharge of 2,820 AFY in Arroyos 15 and 19, the recharge from the PMR facility, and pumping impacts from on- and off-reservation entities, including ASARCO, the City of Tucson, and the SXD.

The regional model used in this preliminary Arroyos work is the "Tres Rios Del Norte (TRDN) B" model, a predictive model simulating the period from 2000 through 2025.[12] Preliminary ground-water modeling showed the 2,820 AFY Arroyos ground-water mound piles up quickly with a biradial symmetry after several years of recharging. Eventually, the mound would rise near the surface beneath the channels of Arroyos 15 and 19 and dissipate quickly in the first mile from the point of recharge, then begin to flatten approximately 1.5 miles north of the project area, past RIPZ-11. Water mounding along the arroyo channels would eventually coalesce with the mounding occurring from the PMR recharge facility.

[12] The TRDN B model is a derivative of the ADWR's Baseline Transient Period MODFLOW model, which simulates the period from 1940 (pre-development period of steady-state hydrologic conditions) to 1999. This model incorporates annually about 47,000 AF of effluent recharge in the Santa Cruz River north of the Roger Road WTP, between 2000 to 2025. The TRDN B was produced by Errol L. Montgomery & Associates, Inc., for the City of Tucson, Town of Marana, and the U.S. Corps of Engineers for TRDN Project planning (E.L. Montgomery & Associates Baseline and Effluent Recharge Alternative Reports 2002).

SXD and Reclamation anticipate that CAP water recharged in the Arroyos Area would be recovered for reliability purposes using wells on or near the San Xavier Cooperative Farm.

Water Quality. The quality of the regional aquifer within the ground-water mound eventually would reflect a blend of ambient water and CAP water, most notably causing localized increases in TDS. Concentrations of TDS in the regional aquifer would approach that of CAP water at the point of recharge and diminish to near ambient levels at the outer fringes of the recharge mound as a result of dilution. No exceedance of Federal primary drinking water standards in ground water would occur.

The closest down-gradient drinking water wells are operated by the Tohono O'odham Utility Authority (TOUA), approximately 4 miles north of the project area.[13] These wells provide potable water to residents, schools, and government buildings on the SXD, including the Indian Health Services clinic. Four of five active TOUA wells are located at depths equal to or greater than 300 feet; one is screened at a depth of 165 feet. The proposed action is not likely to induce substantial changes in other water quality parameters at these wells. No water quality effect to other drinking water wells is anticipated.

Perchlorate contamination is not expected to be problematic for recharge with CAP water. In 2007, there were no detectable levels of perchlorate as measured by the Central Arizona Water Conservation District at the San Xavier pumping plant (CAP 2008). Perchlorate has not been detected in Arroyos Area monitoring wells since May 2005, despite 4 years of in-channel recharge associated with the pilot test. Remediation of perchlorate-tainted ground-water in the Las Vegas Valley will continue to reduce concentrations of perchlorate in Colorado River water entering the CAP system.

Cumulative Effects

Between now and 2025, the ground-water model indicates that notable ground-water level changes would occur in the zone between the Arroyos Area and PMR recharge facilities. In 2000, the 2,500-foot-elevation contour line for the PMR facility's ground-water mound extended north of Pima Mine Road approximately 1.5 miles. By year 2025, the 2,500-foot elevation, ground-water contour shifts an additional 3 miles northwards due to the combined build-up effects of Arroyos and PMR recharging and envelops both the Arroyos and PMR facilities (Figure 9). The 2,350- to 2,450-foot, ground-water elevation contours all shift to the north side of the San Xavier Cooperative Farm, but at increasingly flatter gradients as the effects diminish with distance. Based on the ground-water model projection, ground-water levels in the farm area would recover nearly 50 feet by 2050, increasing the supply of water available to TOUA and SXD wells. After several years of recharge from the Arroyos and PMR facilities, TDS concentrations in the

[13] Active TOUA wells are located near San Xavier Road on the west side of the SCR (wells SXV-3 and 4) and south of Martinez Hill on the east side of the SCR (wells ORD-1, 2, and 3). A sixth well near San Xavier Road is equipped with a pump but is not operational (well SXV-2).

TOUA wells would increase somewhat over pre-recharge levels, reflecting a blend of CAP water and ambient ground water. Coalesced mounding from the Arroyos and PMR facilities might also retard or prevent further migration of the ASARCO TDS and sulfate plume onto the SXD. This would protect water quality on the SXD from potential long-term degradation that might otherwise result from northward migration of this contamination plume. The incremental effect to ground-water quality both on and off the SXD would be minor (see Appendix C).

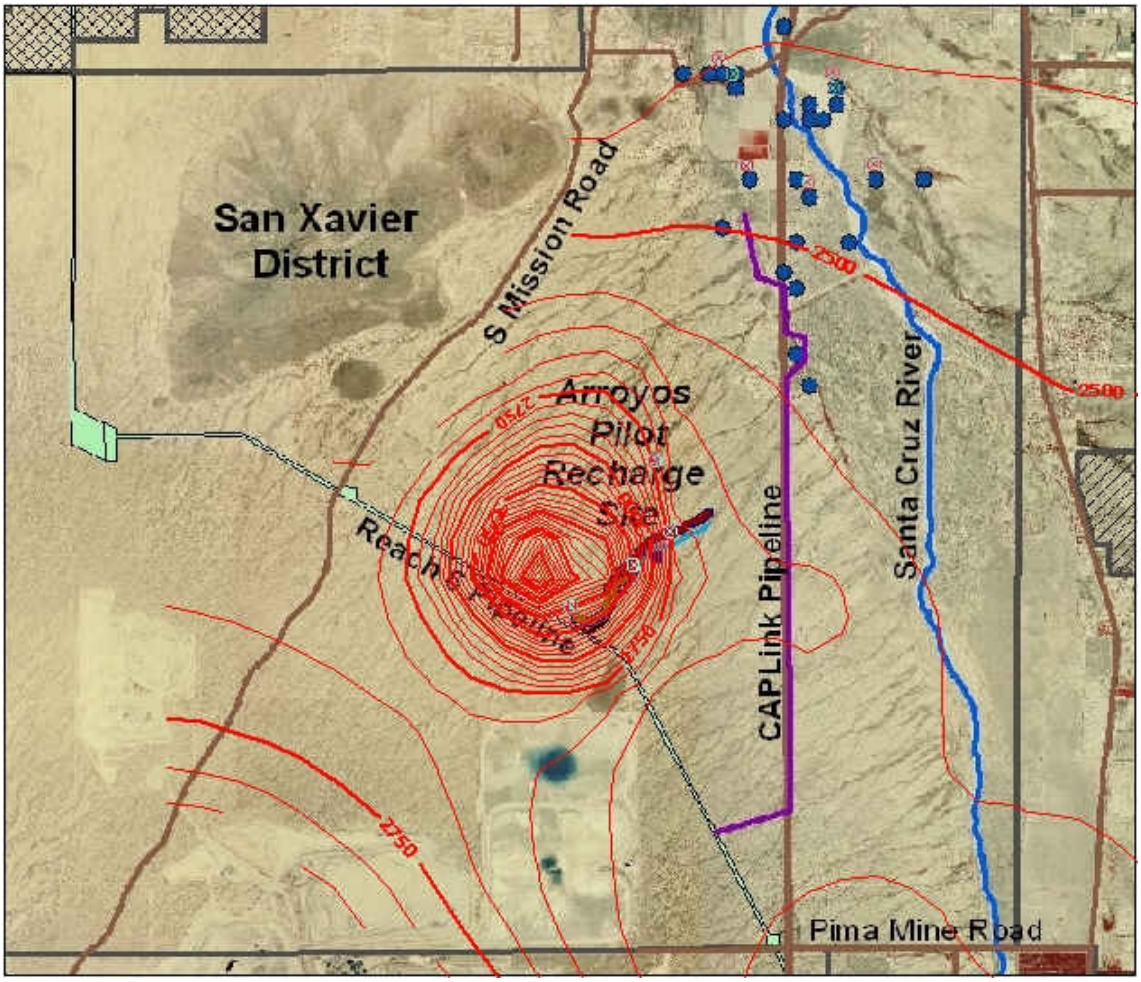


Figure 9. Anticipated 2025 ground-water mounding resulting from combined Arroyos and PMR facility recharge.[14]

3.2.4 Mitigation

- Check dams would be installed where appropriate to control channel down cutting.

- CAP water discharges would be discontinued during storm events.

[14] TOUA and San Xavier Cooperative Farm wells (both active and inactive/capped) are located within the area affected by rising ground-water levels. These wells are denoted as dots in the figure above.

3.3 Geology and Soils

3.3.1 General Setting

SXD straddles the southern pediment extension of the Tucson Mountains, a plunging and erosionally dissected fault block range bounded by the down-dropped, northwest trending Avra and Santa Cruz faults, and abruptly terminated by a northeast trending fault, defined by a line between Black Mountain and Martinez Hill (Davidson 1973; Hollet and Garrett 1984). This area constitutes a small part of the Basin and Range physiographic province, which occupies nearly 45 percent of Arizona's land surface.

The Tucson Mountain Range, Black Mountain, and the shallow bedrock extension onto SXD form a divide between two deep alluvial-filled structural basins: the Tucson AMA's subdivided Altar and Avra Valley ground-water sub-basins to the west and the Upper Santa Cruz sub-basin to the east. This divide not only separates the major surface drainages of Altar and Brawley Washes in Avra Valley, and the SCR and Rillito River in the Upper Santa Cruz (Tucson) valley, but also acts as the ground-water (no-flow) barrier between the Avra Valley and Upper Santa Cruz sub-basins.

3.3.2 Affected Environment

The Arroyos Area is situated on the western margin of the Upper Santa Cruz sub-basin in a region of cross-cutting fault displacements (down dropped, tilted, and elevated blocks). Down dropping of the blocks between mountain ranges formed deep troughs that filled with water-deposited material eroded from the mountains during the Tertiary and Quaternary periods. In the Arroyos Area, upper-basin fill (Upper Tinaja beds, Fort Lowell Formation, and surficial deposits) are generally less than 300-feet thick, underlain with volcanic bedrock, Helmet Fanglomerate, or lower basin fill. Sediments near the land surface consist of younger alluvial fan and colluvial (slopewash) deposits which are classified by Hendericks (1986) as belonging to the Tubac-Sonoita-Grabe Association. Recent alluvium occurs in the sand-filled arroyo channels.

Materials encountered in borings conducted in the project area consist of unconsolidated silty gravelly sands and sandy clays from the land surface to depths ranging from 145 to 175 feet, with moderately to strongly cemented gravelly sand below these levels to bedrock. The bedrock surface is approximately 200-feet deep along the Reach 6 Pipeline alignment between Manholes 15 and 19 and deepens in a northeasterly direction through the project area to approximately 230 feet. No significant thicknesses of dense silt and clay were identified in the unsaturated zone. Zones of caliche of variable density were encountered but appeared to be discontinuous and disseminated.

3.3.3 Environmental Consequences

No Action

Under the No Action alternative, existing geologic and soil conditions would prevail in the Arroyos Area into the reasonably foreseeable future.

Proposed Action

Implementation of the proposed project would directly affect approximately 4.4 acres of surface soils consisting primarily of Tubac gravelly, loamy, and sandy soils. The Arroyo 15 pipeline would occupy a 3,000-foot-long corridor along the east side of the Arroyo 15 channel. No substantial changes to the Arroyo 19 infrastructure would be required.

Overall, soil impacts would be minor. Soil disturbances resulting from construction would be restricted to the narrow impact corridors associated with buried portions of the water delivery pipeline, wells, roads, and fence lines. Aboveground portions of the water delivery system would be hand laid to preclude any ground disturbance. Service roads would be stabilized with an aggregate base material where appropriate. The potential for erosion is generally limited by the low relief of the land surface and, in some areas, the high gravel content of soils. Following construction, impacts would be confined to pedestrian trails that access monitoring stations on the arroyos, service roads entering the project area, and the arroyo channels receiving CAP water. Downcutting into the sandy channel bed of the arroyos would be controlled by the installation of check dams and regulation of flow rates. There would be a potential for minor precipitate deposits in soils along the channels due to recharging with CAP water. However, periodic natural flooding in the stream channels has been shown to remove these deposits and prevent long-term build-up of salts.

Cumulative Effects

The potential effect of the proposed action on soils would be incrementally reduced by the exclusion of cattle from the fenced areas. Over the long term, the exclusion of livestock would improve soil conditions by precluding trampling of soils along the arroyos and protecting riparian vegetation from grazing.

3.3.4 Mitigation

- Aggregate base material would be applied to access roads to control erosion
- Project area would be fenced to prevent trampling of channel banks by livestock
- Check dams would be installed to control channel erosion

3.4 Biological Resources

3.4.1 General Setting

Ground-water depletion coupled with increased urban and rural development has resulted in a general decline in the abundance and diversity of native plants and wildlife along the SCR. SXD's Natural Resource Committee has expressed concern that development and resource exploitation within surrounding areas has reduced local biodiversity and destroyed the vast riparian environment that once contributed to the economy and traditions of the Tohono O'odham people.

In 1990, SXD prepared a "Vision Document" to assist with planning future development. Considerable emphasis was placed on preserving open space. The following paragraph summarizes SXD's vision statement for natural resources:

> *The District believes that future development must be balanced with the protection of the natural resources. The District is interested in the preservation of open spaces by maintaining the hills, washes, and sacred areas in an undeveloped state. The District will encourage the use of native plants for landscaping. Efforts to restore damaged habitats such as the Santa Cruz River will be studied.*

3.4.2 Affected Environment

Vegetation. SXD encompasses two primary vegetation communities, the Sonoran Desertscrub and the Semidesert Grassland which is the dominant vegetation type. The Semidesert Grassland community is a perennial grass-shrub-dominated landscape, where the grass cover has been reduced by encroachment of a wide variety of shrubs, trees, and stem succulents (Brown 1994). Such a "disclimax" grassland is often the result of natural or human-induced intervention into cyclic fire patterns. However, in the Tucson area, widespread livestock grazing and increasing aridity caused by a decrease in rainfall and increase in temperature are considered to be the cause (Turner 1974). Typical grass species on SXD include needle grama (*Bouteloua aristidoides*), grama grass (*Bouteloua* spp.), bush muhly (*Muhlenbergia porteri*), and three awn (*Aristida* spp.). Nongrass species are more typical of the paloverde-cacti-mixed scrub association and include mesquite (*Prosopis velutina*), white-thorn acacia (*Acacia constricta*), catclaw acacia (*Acacia greggii*), foothill paloverde (*Parkinsonia microphylla*), burroweed (*Isocoma tenuisecta*), four-wing saltbush (*Atriplex canescens*), and triangle-leaf bursage (*Ambrosia deltoidea*). The Semidesert Grassland community occurs primarily in the southern and western parts of SXD.

Two vegetation associations (paloverde-cacti-mixed scrub and creosote bush-bursage) occur within the Sonoran Desertscrub community. The paloverde-cacti-mixed scrub association occurs on the hills and bajadas such as Black Mountain. The primary plant species within this habitat type are foothill paloverde, blue paloverde (*Parkinsonia florida*), saguaro (*Cereus giganteus*), catclaw acacia, ocotillo (*Fouquieria splendens*),

barrel cactus (*Ferocactus wislizenii*), brittlebush (*Encelia farinosa*), triangle-leaf bursage, and various cholla (*Opuntia* spp.). This habitat type is noted for its rich diversity of bird species (Brown 1994).

The creosote-bursage association occupies the lower elevational gradients and is much simpler in structure than the paloverde-cacti-mixed scrub community. It is composed mainly of shrubs and dwarf shrubs such as creosote bush (*Larrea tridentata*), triangle-leaf bursage, and saltbush (*Atriplex* spp.) with a few cacti such as cholla and prickly pear (*Opuntia* spp.). This habitat type occurs around the north and west bases of Black Mountain on the alluvial plains (Cornett & Associates with Tierra Madre Consultants 1985).

The SCR crosses the eastern border of the SXD boundary and is ephemeral, flowing only during flood events. Ground-water pumping resulted in a lowering of the water table and subsequent downcutting of the SCR channel. The lowered water table resulted in the demise of gallery cottonwood and willow forests (which helped to stabilize the channel banks) resulting in a widening of the SCR channel. The existing vegetation consists primarily of mesquite, whitethorn acacia, and four-wing saltbush. The large mesquite bosques of the past no longer exist, having been replaced by smaller, scrubbier mesquite.

Desert arroyo communities are scattered throughout SXD and contain distinct assemblages of plants which have higher moisture requirements than those in the surrounding desert. These include mesquite, blue paloverde, white-thorn acacia, desert hackberry (*Celtis pallida*), wolfberry (*Lycium* spp.), and canyon ragweed (*Ambrosia ambrosioides*).

Baseline vegetation sampling to determine percent cover and height of perennial plants on Arroyos 15 and 19 was conducted in September 2006. A minimum of 25 transects (20-meter [m] long) were sampled every 30 m along each arroyo for a minimum distance of ½-mile. The total percent of cover along both arroyos averaged 67%. Vegetation was sampled again in the fall of 2008. The total percent of cover declined for both transects, likely due to the ongoing drought conditions. The total percent of cover on Arroyo 19 declined from 67% to 61.6%; whereas, the total percent of cover on Arroyo 15 declined from 67% to 49.8%. Arroyo 15 received no supplemental CAP water which probably accounts for the greater decline in cover. The reduction in cover for Arroyo 15 alone was significant at the P=0.01 level. Cover on both arroyos was greater closest to the channel. The three dominant plant species observed along the arroyos were mesquite, creosote bush, and white-thorn acacia. Other species included blue paloverde, desert hackberry, cat-claw acacia, climbing wartclub (*Commicarpus scandens*), little-leaf paloverde, perezia (*Acourtia wrightii*), and sacred datura (*Datura meteloides*). Arroyos 15 and 19 are located within the Semidesert Grassland community, and plant species that occur outside of the influence of the drainage corridor have been described above.

Wildlife. Limited development has taken place within the project area. Surveys conducted by Cornett & Associates and Tierra Madre Consultants (1985) on SXD

provide a good description of the local wildlife resources in the project area, the results of which are described below.

The diversity of wildlife species can be directly correlated to vegetation diversity and structure. This has been widely documented with avian species (MacArthur and MacArthur 1961, Carothers et al. 1974, Anderson and Ohmart 1977, Anderson et al. 1983). The paloverde-cacti-mixed scrub community contains an extremely diverse collection of plants (Crosswhite and Crosswhite 1982), and when combined with the Semidesert Grassland habitat, the SXD supports a diverse array of wildlife.

Common birds found on the SXD include the curve-billed thrasher (*Toxostoma curvirostre*), mourning dove (*Zenaida macroura*), Say's phoebe (*Sayornis saya*), Abert's towhee (*Pipilo aberti*), ladder-backed woodpecker (*Dendrocopos scalaris*) , Gila woodpecker (*Melanerpes uropygialis*), northern mockingbird (*Mimus polyglottos*), verdin (*Auriparus flaviceps*), rufous-winged sparrow (*Aimophila carpalis*), and black-throated sparrow (*Amphispiza bilineata*). In addition to resident species, the Sonoran Desert provides wintering and migratory habitat for various bird species. White-crowned (*Zonotrichia leucophris*) and Brewer's sparrows (*Spizella breweri*), as well as raptors like the northern harrier (*Circus cyaneus*), descend into the Sonoran Desert for the winter. Reclamation conducted seasonal avian surveys on Arroyos 15 and 19 during 2006. A list of the birds observed can be found in Appendix D.

The Sonoran Desert also exhibits a wide diversity of mammal species (Crosswhite and Crosswhite 1982). The SXD is host to three rabbit species, the desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), and the antelope jackrabbit (*Lepus alleni*). Typical desert mammals include the highly desert-adapted Merriam's kangaroo rat (*Dipodomy merriami*), the ubiquitous white-throated woodrat (*Neotoma albigula*), coyote (*Canis latrans*), and the collared peccary (*Pecari tajacu*).

A wide variety of reptile species occur throughout the SXD, but the number of amphibian species is limited. Common lizards include the western whiptail (*Aspidoscelis tigris*), side-blotched lizard (*Uta stansburiana*), and the poisonous Gila monster (*Heloderma suspectum*). The variety of small mammals provides an abundant prey source for coachwhip (*Masticophis flagellum*), western diamondback (*Crotalus atrox*), and gopher (*Pituophis catenifer*) snakes. Desert tortoise (*Gopherus agassizii*) are limited primarily to Black Mountain. Three species of amphibians identified by Cornett & Associates (with Tierra Madre Consultants 1985) include red-spotted (*Anaxyrus punctatus*), Sonoran green (*Anaxyrus retiformis*), and Couch's spadefoot toads (*Scaphiopus couchii*).

Special Status Species. A compilation of federally listed, proposed, and candidate species that occur in Pima County was retrieved from the U.S. Fish and Wildlife Service (FWS) web site which was last updated on April 8, 2008. Pima County lists 15 species as endangered or threatened, 3 candidates, 2 species which have Conservation Agreements and 1 species proposed for de-listing. Section 7 of the Endangered Species Act (ESA) requires consideration of only listed and proposed species. The known ranges of the following species occur outside of the project area: Kearney blue star (*Amsonia*

kearneyana), Nichol Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*), Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*), masked bobwhite (*Colinus virginianus ridgewayi*), Mexican spotted owl (*Strix occidentalis lucida*), Sonoran pronghorn (*Antilocapra americana sonoriensis*), and ocelot (*Leopardus pardalis*). There is no habitat in the project area for the following species: Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*), California brown pelican (*Pelecanus occidentalis californicus*), southwestern willow flycatcher (*Empidonax traillii extimus*), yellow-billed cuckoo (*Coccyzus americanus*), jaguar (*Panthera onca*), Chiricahua leopard frog (*Rana chiricahuensis*), desert pupfish (*Cyprinodon macularius*), Gila topminnow (*Poeciliopsis occidentalis occidentalis*), Gila chub (*Gila intermedia*), and the Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*). Table 1 lists only those species that may occur near the project area.

Impacts to federally listed aquatic species associated with recharge projects were considered under the "Reinitiated Biological Opinion on the Transportation and Delivery of Central Arizona Project Water to the Gila River Basin in Arizona and New Mexico and Its Potential to Introduce and Spread Nonindiginous Aquatic Species" dated May 15, 2008 (FWS 2008) and will not be considered further in this EA.

Table 1. Federally listed species that may occur near the project area.

STATUS	**SPECIES**
Endangered	Lesser long-nosed bat *Leptonycteris curasoa yerbabuenae*
Endangered	Pima pineapple cactus *Coryphantha scheeri* var. *robustispina*

Lesser long-nosed bat - The lesser long-nosed bat was listed as endangered on September 30, 1988 (53 FR 38456). In Arizona, this species is found from the Picacho Mountains to the Agua Dulce Mountains in the southwest and the Galiuro and Chiricahua Mountains in the southeast (Hinman and Snow 2003).

Lesser long-nosed bats are found in desert grassland and shrubland up to the oak transition zone. They forage in habitat that includes saguaro, ocotillo, paloverde, organ pipe cactus (*Cereus thurberi*), and later in the summer among agaves (*Agave* spp.). Lesser long-nosed bats feed on nectar and pollen from saguaros and agaves forming a mutualistic relationship with these plants (FWS 1991). They feed on ripe cactus fruits at the end of the flowering season. They cannot tolerate prolonged exposure to cold, do not hibernate, and spend winters in Mexico. Daytime and maternity roosts are located in caves and abandoned mines.

Known threats to this species include disturbance of roost sites and loss of food resources through over harvesting of agaves in northern Mexico, spread of agriculture, and livestock grazing. Lesser long-nosed bat roosts occur in both the Santa Rita and Rincon Mountains. The nearest recorded maternity roost to the project area is located in the Rincon Mountains approximately 16 miles to the northeast (Ms. Sabra Schwartz, Arizona Game and Fish Department, pers. comm.). No roost sites occur in the project area.

Pima pineapple cactus (PPC) - The PPC was listed as endangered on September 23, 1993 (58 FR 49875). This cactus is also known as the stout-needled mulee cactus or Sheer's strong-spined cory cactus. It is a low-growing, round cactus with finger-like projections called tubercles extending outward from the stem. The tubercles are marked with a prominent groove on the upper side, a characteristic of the genus *Coryphantha*. The spine cluster has one slightly hooked central spine and 10 - 15 straight strawberry-colored radial spines. The large yellow flowers have a narrow floral tube; the fruit is green (Ecosphere 1992).

Ecosphere (1992a) documented the current distribution of the cactus as west to the Baboquivari Mountains, east to the Santa Rita and Patagonia Mountains, north to Tucson, and south into Sonora, Mexico. Plants have also been located on the west side of the Baboquivari Mountains on the Tohono O'odham Nation.

In general, PPC is found in open patches of habitat within the semidesert grassland and Sonoran desertscrub vegetation communities from 2,300-feet to 5,000-feet elevation (Ecosphere 1992). PPC appears to be most abundant in the ecotonal boundary between these two communities (FWS, draft recovery plan, unpublished). This species seems to prefer deep alluvial soils of granitic origin (Ecosphere 1992a). They are most often found on south- or east-facing slopes (with less than 5 percent slope) between 2,500-feet and 3,800-feet elevation (Ecosphere 1992a). Associated vegetation includes primarily mesquite, triangle-leaf bursage, burroweed, chain fruit cholla (*Opuntia fulgida*), barrel cactus, cane cholla (*Opuntia spinosior*), and purple-fruited prickly pear (*Opuntia phaeacantha*). Few grasses are associated with this species (Mills 1991).

The main threat affecting this cactus is habitat loss from construction associated with a rapidly growing human population (FWS, draft recovery plan, unpublished). The second cause is the introduction of nonnative species such as Lehman's lovegrass (*Eragrostis lehmanniana*) which outcompetes native grasses and forms monotypic stands (FWS draft recovery plan, unpublished). The spread of nonnative grasses has modified the patchy distribution of grass to contiguous stands resulting in increased losses of cacti as a result of fire. Other potential impacts include grazing and illegal collection of this species.

Surveys – PPC surveys were conducted as follows: five surveyors, spaced 25-feet apart, walked single file along the proposed alignment. A single PPC was identified by SXD personnel during the April 28, 2004, survey of Arroyo 19 for the pilot project. This cactus was located 300 feet from any construction activity. It was fenced to preclude potential impact during arroyo operations and to provide protection from cattle grazing.

A single PPC was found on Arroyo 15 by SXD personnel late in 2005 while flagging the access road and pipeline alignments in anticipation of the PPC survey. The cactus was located within 5 feet of the proposed road alignment.

Surveys for the Arroyo 15 access road and pipeline alignment were conducted by Reclamation and SXD personnel on May 10, 2006, according to the protocol described above. One additional PPC was identified outside of the road alignment.

Additional surveys were conducted (utilizing the protocol described above) by Reclamation and SXD personnel on July 9, 2008, along the perimeter fence alignments for Arroyos 15 and 19. One additional PPC was located directly on the proposed fence alignment for Arroyo 15.

3.4.3 Environmental Consequences

No Action

Under the No Action alternative, there would be no water discharged into the drainage and no associated pipeline, road, or fence features constructed. No vegetation impacts would occur along the existing drainage as a result of the construction. Conversely, there would be no enhancement of vegetation from the discharge of water or removal of cattle.

Proposed Action

Vegetation. Approximately 420 feet of the existing Arroyo 19 pipeline in and adjacent to the Reach 6 corridor would be buried to a depth of approximately 1 foot. The Reach 6 corridor was previously disturbed for installation of the CAP pipeline. Although vegetation has re-established along the corridor, it remains less densely vegetated than the adjacent undisturbed areas. The majority of the buried pipeline lies outside the CAP right-of-way on undisturbed land. The pipe was originally placed in a non-linear alignment to avoid large trees and cacti. However, approximately 420 feet of the pipe along the CAP right-of-way would be buried in as straight of an alignment as possible. Impacts associated with trench excavation would be limited to the loss of small shrubs and cacti. Trees and saguaros would be avoided. Any small cacti impacted could be immediately replanted back on top of the excavated area. Construction of additional check dams would have negligible impacts to the existing vegetation.

Similar to Arroyo 19, 200 feet of pipeline at the beginning of Arroyo 15 along the Reach 6 corridor would be buried. The remainder of the 3,100-foot pipeline for Arroyo 15 would be placed on top of the ground. The pipeline is flexible and can be hand-placed to avoid most vegetation. No vegetation was impacted when the Arroyo 19 pipeline was emplaced. Construction of the 20-foot-wide, 0.65-mile-long access road east of Arroyo 15 would result in the loss of 1.6 acres of semi-desert grassland habitat. The road, which is located east of the dense wash vegetation, would be sited to avoid trees and large cacti. Impacts would primarily be limited to shrubs such as creosote bush, saltbush, acacia, and prickly pear cacti. Loss of a narrow, linear strip of semidesert grassland habitat would have little impact in the overall environment. No impact to vegetation would occur from installation of the piezometers because these locations are open, sparsely vegetated, and located adjacent to the proposed access road.

Construction of Arroyos 19 and 15 perimeter fences (11,695 feet and 8,119 feet respectively) would result in minor loss of 1.6 acres of habitat at Arroyo 19 and 1.1 acres of habitat at Arroyo 15. The greatest impact would occur at the densely vegetated drainage crossings. Vegetation outside of the drainage channels is relatively open with scattered trees and shrubs. A 6-foot-wide path would be cleared with a backhoe to provide access for fence construction and future maintenance. Chainsaws may be utilized in the dense mesquite and white-thorn acacia vegetation along the drainage crossings. The benefits provided by cattle exclusion would outweigh any negative impacts from the loss of the narrow strips of habitat.

The discharge of water into the arroyo would have a beneficial effect on vegetation immediately adjacent to the channel. Existing vegetation would become more robust due to the supplemental water supply. It can be anticipated that with continued discharge of water to the arroyo, water-dependent vegetation would begin to establish along the drainage. Riparian tree species such as Goodding willow (*Salix gooddingii*), Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus arizonae*), or netleaf hackberry (*Celtis reticulata*) may become established over time increasing the vegetative diversity and complexity of the site. Although in the 4 years since CAP was first discharged into Arroyo 19, no riparian dependent trees have become established. Other riparian dependent species such as cattail (*Typha* latifolia), seepwillow (*Baccharus salicifolia*), and barnyard grass (*Echnochloa crus-galli*) have been identified along Arroyo 19.

Salinity – Buildup of soluble soil salts in soils has historically caused problems in the more arid regions where inadequate rainfall leads to little natural leaching. The negative impacts of salt are apparent in many areas and are becoming increasingly prevalent and serious as land use intensifies and water becomes more limited and more concentrated with salts (Anderson et al. 2004). Soil salinity is a measure of the total amount of soluble salt in the soil. As salinity levels increase, it becomes more difficult for plants to extract water from the soil. High soil salinity can cause nutrient imbalances, result in the accumulation of elements toxic to plants, and reduce water infiltration (Kotuby-Amacher et al. 1997). The application of CAP water, with its higher salinity levels, has the potential over time to negatively impact the vegetation adjacent to the arroyos. However, salinity increases are largely the result of capillary actions. Since the water is discharged directly into the wash and not applied to the adjacent land surface, salinity increases may be limited to the channel edge.

Soil salinity is determined by measuring the EC of a solution extracted from a water-saturated paste (Kotuby-Amacher et al. 1997). According to Anderson et al. (2004), when EC levels exceed 8 millimhos/centimeter (mmhos/cm) growth of mesquite can be affected. This value was recorded for the lower Colorado River and pertains to sites where ground-water depth was less than 3 meters. Ground-water depths at Arroyo 19 are considerably deeper (approximately 200 ft). However, we believe the 8 mmhos/cm value for mesquite is an acceptable limit for the Arroyo Recharge area. Arroyo 19 soil salinity measurements recorded from July 2004 through December 2005 ranged from 0.09 mmhos/cm to 4.2 mmhos/cm. The average ranged from 0.14 mmhos/cm to

2.7 mmhos/cm (Rogers 2006). These levels are below the 8 mmhos/cm limit where vegetation impacts could occur. Monitoring by SXD has shown that soil salinity levels increased over time when there was no corresponding rainfall event (Rogers 2006). Salinity levels were sharply reduced after the summer monsoon flood events (Scott Rogers, SXD, pers. comm.). Consequently, future flood events may serve to moderate soil salinity levels along the recharge sites.

Wildlife. Impacts to wildlife resources from the proposed project would be predominately beneficial. There would be no long-term disturbance to wildlife from pipeline, piezometer, or check dam installation. The loss of small mammals and herptefauna from construction of the maintenance road would be negligible. Construction-related noise disturbances would be short term in nature. No negative impacts to wildlife are expected from routine monitoring activities. Construction of the perimeter fence would have a short-term impact to large mammals until they become acclimated to the presence of the fence. Negative effects would be mitigated by the use of standard wildlife compatible fencing which includes a smooth-bottom wire and increased spacing between the bottom wire and the ground. The exclusion of cattle through fence construction would have negligible beneficial effects on local wildlife due to the limited area protected within the linear strips.

The continual discharge of water into the arroyo would supply wildlife in the immediate area with an additional source of water. Changes to wildlife diversity would be observed at a much slower rate. Species such as mule deer (*Odocoileus hemionus*), coyote, bobcat (*Lynx rufus*), and javelina will take advantage of the newly established water source, but no changes in the population density would be expected. As the vegetation diversity and density changes over time, the arroyo may increase in importance as a stop for migratory birds. The lush vegetation and potential increase in insect abundance could provide food, water, and shelter for neotropical migrants such as yellow, yellow-rumped, orange-crowned and Wilson's warblers, northern and hooded orioles, and summer and western tanagers. It is unlikely that the Arroyos 15 and 19 could support a breeding population of riparian dependent birds due to the limited size. However, stop-over habitat for migratory species, during spring and fall migration, is important in the Sonoran Desert. Seasonal avian surveys were conducted between March 2006 and April 2007 on Arroyos 15 and 19 and Arroyo 23 (a dry arroyo located approximately ¾-mile east of Arroyo 19). Preliminary information indicates that the species abundance (number of individuals) of migrating warblers is greater on Arroyo 19 than on either Arroyos 15 or 23. The increased abundance is most likely due to the presence of water, as other habitat variables (vegetation cover and plant species diversity) are similar.

Mosquitoes. Concerns have been raised that the application of water into a dry arroyo will create mosquito breeding habitat and subsequently increase the potential for vector-borne diseases such as West Nile Virus. Not all mosquitoes carry disease; there are many species of mosquitoes that are simply considered "nuisance mosquitoes." The following information was summarized from a conversation with Craig Levy (Program Manager, Vector and Zoonotic Disease Section, Arizona Department of Health Services).

There are only two species of mosquitoes (*Culex tarsalis and C. quinquefasciatus*) in Pima County that act as vectors for West Nile Virus and St. Louis Encephalitis. Both of these species prefer slow-moving water, such as backwater areas or habitats with grassy margins. Based on aquatic habitat conditions at Arroyo 19 after 4 years of CAP discharge, neither of these conditions is expected to be prevalent at Arroyo 15. The water velocity is sufficient to deter mosquito breeding along the channel. There is neither aquatic vegetation development within the channel nor grass-lined banks adjacent to the channel to slow water and provide mosquito breeding habitat. It can be assumed that aquatic conditions on Arroyo 15 would develop similarly to Arroyo 19; consequently, the potential for development of suitable mosquito breeding habitat is small.

There are several other species of mosquitoes (*Culiseta* sp., *Psorophora columbia, P. signipennis,* and *P. howardii; Anopheles freeborni/hermsii; and A. franciscanus and Aedes vexans*) present in Pima County, but they are all non-vectors and associated primarily with floodwater habitats. One other mosquito, (*Aedes eqyptii),* present in Tucson, acts as a vector for Dengue Fever. However this species breeds only in small sources of water in urban backyards and will not be of concern on the arroyo project.

Special Status Species. The proposed project will not affect the lesser long-nosed bat and will have primarily beneficial effects for the PPC. This conclusion is based on surveys conducted by Reclamation and SXD personnel and habitat conditions in the project area. A Biological Assessment (BA) which concluded “no effect” to the lesser long-nosed bat and "may affect not likely to adversely affect" the PPC was submitted to the FWS on March 3, 2009. Reclamation requested FWS concurrence with our determination for the PPC.

Lesser long-nosed bat - There are no roost sites within or near the project area. The closest maternity roost is located in the Rincon Mountains approximately 16 miles to the northeast (Ms. Sabra Schwartz, Arizona Game and Fish Department, pers. comm.). Foraging habitat occurs in the project area but would not be impacted. There would be no effect to the lesser long-nosed bat from the proposed project.

Pima pineapple cactus (PPC) - There would be no adverse effects to the five PPC located in the project area from construction activities. Three PPC will not be affected by project features. Both the Arroyo 15 road and perimeter fence were realigned to avoid impacts to the remaining two PPC. Realignment of the access road and the perimeter fence provided a 25-foot and 30-foot buffer (respectively) between the features and each PPC. Loss of a 20-foot-wide, 0.65-mile linear strip of habitat from construction of the Arroyo 15 access road would have a discountable effect on PPC. PPC in the arroyo project area are widely dispersed. Permanent loss of this narrow habitat would not result in any quantifiable impact to the local PPC population. Construction of the perimeter fences would result in loss of a 6-foot-wide strip (totaling 2.7 acres) of habitat. As mentioned above, the loss of such a narrow strip of habitat on the widely dispersed PPC will have discountable effects. The subsequent exclusion of cattle grazing from 78 acres of habitat would have a beneficial effect on the three existing PPC and any PPC established in the future by eliminating the potential for trampling of individual plants.

In addition, all five PPC would be individually protected by fencing to preclude accidental disturbance by personnel engaged in fence repairs or recharge monitoring activities or trampling by cattle for the two PPC located outside of the Arroyo 15 perimeter fence.

Cumulative Effects

The proposed action would have no adverse cumulative effect to vegetation and wildlife resources over the projected term of the project. Although the project itself may result in beneficial effects to wildlife and vegetation, they would most likely be overshadowed by the increased pace of development in Pima County. Pima County has been experiencing rapid growth and development over the last 30 years resulting in the direct loss of wildlife habitat. The rate of development is not expected to decrease in the foreseeable future. The SXD (approximately 71,000 acres) comprises only 1 percent of the area within Pima County (approximately 5,877,760 acres). Potential long-term improvements to linear strips of habitat (~1 mile in length) along Arroyos 15 and 19 would be negligible when compared to the size of Pima County. On a more localized scale, if SXD eliminates cattle grazing in the vicinity of the arroyo project area, beneficial effects will occur with respect to local vegetation, wildlife, and PPC resources.

Summary of Environmental Consequences

The impacts to vegetation, wildlife and special status species are summarized in Table 2 below. There would be minor loss of vegetation from construction of the perimeter fence, maintenance road, and pipeline excavation. Beneficial impacts to wildlife and vegetation would occur as a result of cattle exclusion upon completion of the perimeter fencing. The discharge of water would enhance the existing habitat for migratory birds and local wildlife species. There would be no effect to the federally endangered lesser long-nosed bat and a beneficial affect on the PPC from the elimination of cattle grazing.

Table 2. Summary of effects to biological resources.

Activity	Arroyo 15	Arroyo 19
Pipeline Installation	No effect to wildlife. Discountable effect to PPC. Minor loss of vegetation.	No effect to wildlife. Discountable effect to PPC. Minor loss of vegetation.
Road Construction	Negligible impact to small mammals and herptefauna. No effect to the lesser long-nosed bat and discountable effects to PPC. Minor loss of 1.6 acres of vegetation.	No road construction is proposed for this site.
Perimeter Fence	Beneficial effect to PPC, wildlife, and vegetation from elimination of cattle grazing on 30.7 acres. Minor loss of ~1.1 acres of vegetation.	Beneficial effect to the PPC, wildlife, and vegetation from elimination of cattle grazing on 47.1 acres. Minor loss of ~1.6 acres of vegetation.
Water Discharge	Beneficial effects to neotropical birds and local wildlife	Project already in operation.
Piezometer Installation	No effect to vegetation, wildlife, or special status species.	Previously installed.

Check Dam Construction	No effect to vegetation, wildlife, or special status species.	No effect to vegetation, wildlife, or special status species.

3.4.4 Mitigation

- All work in the immediate area would cease if any federally listed species are observed in the construction area. Reclamation and FWS biologists would be notified immediately.

- Construction personnel would be instructed not to collect, disturb, or molest wildlife species during construction. Personnel would be advised of legal consequences associated with collection or disturbance of a protected species.

- All PPC would be protected by fencing prior to the start of construction activities.

- The Arroyo 15 road alignment would be relocated to avoid PPC and provide a minimum 25-foot buffer.

- The Arroyo 15 fence would be realigned to avoid PPC and provide a 30-foot buffer.

- The contractor will not deviate from the fence construction right-of-way during ingress, egress and construction of the fence.

- Wildlife compatible fencing would be utilized for the perimeter fence.

- Monitoring for the presence of mosquito larvae would be conducted.

3.5 Cultural Resources

3.5.1 General Setting

History. The earliest known human occupation of southern Arizona began about 11,000 BC. This Paleoindian culture was characterized by small mobile bands of hunter-gatherers that focused on hunting now-extinct megafauna. Although isolated Paleoindian projectile points have been recovered from the nearby Santa Cruz and Altar Valleys, no evidence of a Paleoindian occupation of the project area has been collected,

An increased reliance on gathered plant resources is characteristic of the Archaic period beginning around 8500 BC. The early Archaic remained a time of mobile hunting and gathering. By 4500 BC, Archaic groups were beginning to settle more permanently along the Santa Cruz River and other water sources; and, by 1200 BC, pit house villages were established by agricultural fields in the valley. Archaic procurement and camp sites were located away from the major river valleys. No Archaic sites have been identified in the immediate project area, but use of the area during that time is indicated by the

recovery of isolated diagnostic projectile points on the bajada as well as archaeological sites in the adjacent valleys.

An agricultural economy, combined with hunting and wild plant collecting, continued to be followed throughout the rest of the Early Agricultural and Hohokam period (ending ca AD 1450) in southern Arizona. During this time, social organization became more complex, as did settlement patterns and material culture. Long distance trade, shell work, irrigation agriculture, decorated pottery, and public ceremonial structures became hallmarks of the Hohokam. During the Rincon period (ca. AD 950-1150), Tucson Basin Hohokam populations expanded to areas away from ancestral villages along major watercourses. Many of the sites in and around the project area were established during this time period. The bajada area was probably used throughout the Hohokam period, but was involved only peripherally in the population aggregation found in the Santa Cruz Valley.

Spanish missionaries, including Father Eusebio Kino, first visited the San Xavier area in the 1690s. On the Santa Cruz, they found the village of Bak (W:ak), inhabited by a group of Piman-speaking (O'odham) people they knew as the Sobaipuri. The river provided water for irrigation ditches watering extensive cultivated fields supporting corn, beans, squash, and other native crops Although the mission of San Xavier del Bac was initially started by Kino, it wasn't until later in the 18th century that the present mission was built. At this time, the village was increasingly settled by Tohono O'odham from the Papagueria, with the Sobaipuri population remnants absorbed into the larger group. The area remained O'odham after the Gadsden Purchase when southern Arizona became part of the United States. The San Xavier Reservation was created by executive order in 1874 and became a district of the larger Tohono O'odham Reservation in 1916. In the 20th century, the bajada around the project area was apportioned into allotments and used primarily for collecting plant resources and cattle grazing.

Cultural Resource Investigations. In 1983 and 1984, Cultural and Environmental Systems (CES) completed a large Class III archaeological survey of over 18,500 acres of the SXD along the Santa Cruz floodplain and adjoining Sierrita and Black Mountain bajada (Cultural and Environmental Systems 1987). The San Xavier Archaeological Project recovered evidence of Archaic, Hohokam, O'odham, Spanish, Mexican, and American occupations. Sites recorded in the area of the proposed Arroyo 15 Recharge Project represent a more limited range of occupation, including Hohokam resource procurement sites and historic water control features. For the most part, the Hohokam procurement sites are represented by a light artifact scatter associated with the remnants of roasting pits and seem to represent campsites that may have been visited on a seasonal basis. The water control features are made up of long, low, linear berms that cross the bajada slope and impede the flow of surface runoff; they were created to improve cattle grazing.

Arizona State Museum (ASM) completed the linear survey for the Tucson Aqueduct Phase B portion of the CAP for Reclamation in 1984 (Downum, Rankin, and Czaplicki 1986). They located two additional Hohokam resource procurement sites in the vicinity

of the project area. More recently, Reclamation completed intensive archaeological surveys for two earlier phases of the Arroyos Recharge Project. Heathington (2002) did not find any new sites in the project area for the pipeline rights-of-way and basin associated with Phase I. Donaldson (2004) did not find any new sites during the survey of the Arroyo 19 in-channel pilot recharge project but did identify four sites previously recorded by CES. None of the sites were directly impacted by the recharge project.

Archaeological investigations on the SXD closer to the Santa Cruz River have recovered evidence of more substantial occupations by Archaic, Hohokam, O'odham, and Hispanic settlers. ASM completed projects at the Punta de Agua (Greenleaf 1975) and San Xavier Bridge (Ravesloot 1987) sites, as well as the Punta de Agua Ranch (McGuire 1979). A portion of the Punta de Agua site (Locus F) was also excavated within the right-of-way for the CAP-Link pipeline that connects the San Xavier Cooperative Farm to the CAP. These and other excavations reveal a relatively dense Hohokam occupation of the upper river terrace. Testing prior to the development of the San Xavier Cooperative Farm by Archaeological Consulting Services (ACS) provided evidence of more limited use of the floodplain for habitation prehistorically, but extensive evidence of early historic irrigation (Effland et al. 1989; Stokes et al. 2007).

3.5.2 Affected Environment

Cultural Resources within the Arroyo 15 Project Area: A Class III (intensive) survey was conducted within project area for the Arroyo 15. The survey included areas needed for the access road, perimeter fence, pipeline, monitoring wells, and discharge points. No archaeological sites or significant cultural resources were identified within these areas. Previous surveys conducted by CES and ASM identified several prehistoric Hohokam sites more than ¼-mile from the proposed perimeter fence alignment. These sites are outside the area of potential effect. Similarly, historic water control structures are located well away from the project area.

Cultural Resources within the Arroyo 19 Project Area: The previous CES survey identified, and recent Class III surveys confirmed, the presence of four prehistoric archaeological sites within the immediate project area. Three of these are located outside of areas needed for construction and operation of recharge facility infrastructure. The access route to monitoring well RIPZ-20 would pass within the boundaries of the fourth site, but this route avoids areas with cultural resources. No known cultural resources are located along the initial 420 feet of pipeline that would be buried.

3.5.3 Environmental Consequences

No Action

Environmental factors, including cattle grazing and surface and channel erosion, would continue to affect any resources in the area. Minimal impact to cultural resources would be anticipated as the result of not implementing the Arroyo 15 recharge project.

If the Arroyo 19 recharge pilot remained an unfenced temporary facility, it would have an indirect negative impact on the cultural resources because of the increased number of cattle attracted to this new water source. Archaeological sites located near the revived washes in particular may be affected by the formation of trails and subsequent erosion or by the trampling of features and surface artifacts resulting from increased use of the area by cattle. Maintaining the recharge pilot itself, and the water flow associated with it, would directly impact any known cultural resources to a minimal degree.

Proposed Action

Implementing the Arroyo 15 recharge project would not impact any known cultural resources or archaeological sites. The excavation of a shallow trench for the first 200 feet of pipe could potentially uncover buried cultural deposits, but there are no surface indications of such a possibility. The excavation would be monitored because of this possibility. The additional 3,300 feet of surface pipe would not affect any cultural resources. Placement of a monitoring well (RIPZ-20) and associated access road within the Arroyo 15 area would not affect any known cultural resources. The creation of a new water source would probably attract an increased number of cattle to the area; therefore, placement of a fence to prevent cattle from trampling the arroyos would be likely to create cattle trails just outside the fenced perimeter. The layout of the fence would be configured to avoid directing livestock movements through sites located just outside of the fenced perimeter.

Efforts to transform the Arroyo 19 project site into a more permanent facility would include burying the first 420 feet of the pipeline. The excavation would not impact any known cultural resources, though it should be monitored in case of buried cultural remains. Addition of a road directly connecting the two discharge points would be designed to avoid any known cultural resources with a margin of at least 30 feet as a safety buffer. A planned extension of the access road along the northern portion of the fenced area would not affect any known cultural resources. Maintaining the rest of the project would have minimal affect on the known cultural resources as long as traffic remains on existing rights-of-way. The installation of a perimeter fence would exclude livestock and prevent the trampling of known sites located within the enclosed area. The layout of the fence would also be configured to avoid directing livestock movements through sites located just outside of the fenced perimeter.

Cumulative Impact

No cumulative impact on cultural resources is anticipated.

3.5.4 Mitigation

- Any excavation would cease in the case of the discovery of buried cultural features, including burials, and Reclamation and SXD cultural resource official would be notified.

- Fence lines would be placed to avoid any potential disturbance by cattle to known archaeological sites in the Arroyo 15 and Arroyo 19 areas.

3.6 Indian Trust Assets

3.6.1 General Setting

Indian trust assets are legal interests in assets held in trust by the United States through the Department of Interior, BIA, for Indian tribes or individual Indians. The United States has an Indian trust responsibility to protect and maintain rights reserved by or granted to Indian tribes or individual Indians by treaties, statutes, and Executive Orders. This trust responsibility requires that all Federal agencies, including Reclamation, take actions reasonably necessary to protect trust assets.

"Assets" are anything owned that has monetary value. The asset need not be owned outright but could be some other type of property interest, such as a lease or a right-of-way. They can be real property, physical assets, or intangible property rights. Common examples of trust assets may include lands, minerals, hunting and fishing rights, water rights, other natural resources, and money. "Legal interest" means there is a primary interest for which a legal remedy, such as compensation or injunction, may be obtained if there is improper interference. Trust assets do not include things in which a tribe or individual have no legal interest, such as off-reservation sacred lands in which a tribe has no legal property interest. It should be noted that other Federal laws pertaining to religious or cultural laws should be addressed if impacts to such lands were to occur from Reclamation actions.

3.6.2 Affected Environment

Trust assets of the Tohono O'odham Nation that would be affected by the proposed action include CAP water, ground water, and land resources. Facility infrastructure such as fences and pipelines would affect 9 Indian trust allotments.

3.6.3 Environmental Consequences

No Action

Under the No Action alternative, existing uses of land and water resources by the Tohono O'odham Nation and SXD would continue into the foreseeable future, although livestock grazing may be discontinued in the Arroyos Area. Indian trust allotments outside of the Arroyo 19 pilot test project area would not be affected by the proposed project.

Proposed Action

Approximately 2,820 AFY of the SXD's CAP water allocation would be dedicated to ground-water recharge in the Arroyos Area. This water would be available for recovery by the San Xavier Cooperative Farm through wells located on or near the farm.

Appropriate approvals from the Tohono O'odham Nation would be sought by the SXD, including approvals for use of CAP water for the project.

Allottee approvals and a 20-year lease would be obtained by SXD through the BIA for construction, in-channel recharge, and monitoring at Arroyos 15 and 19. Potentially 9 allotments would be included in the lease, including the four allotments already in the Arroyo 19 pilot project area. The affected allotments are currently undeveloped, except for existing infrastructure that was installed for the Arroyo 19 pilot test. Range cattle would be excluded from fenced portions of the project area to protect riparian vegetation and recharge infrastructure.

Long-term benefit to trust assets would accrue from enhancement of riparian resources along Arroyos 15 and 19, aquifer recharge, and application of a beneficial use (i.e., recharge) to previously unused land. No concerns related to the protection of trust assets have been identified.

Cumulative Effects

The incremental, long-term effect from recharge in the Arroyos Area combined with artificial recharge from other sources, such as the San Xavier Cooperative Farm and the off-reservation PMR facility, would be to reverse declining ground-water levels in the SXD. This would enhance the value of water resources on the SXD that otherwise would continue to degrade as a result of continued overdraft of the regional aquifer.

3.7 Environmental Justice

3.7.1 General Setting

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," was issued by the President of the United States on February 11, 1994. This order established requirements to address Environmental Justice concerns within the context of agency operations. As part of the NEPA process, agencies are required to identify and address disproportionately high and adverse human health or environmental effect on minority or low-income communities. Federal agencies are directed to ensure that Federal programs or activities do not result, either directly or indirectly, in discrimination on the basis of race, color, or national origin. The order also requires that "the responsibilities set forth shall apply equally to Native American programs."

Tohono O'odham community members represent the only EO 12898 population residing near the project area.

3.7.2 Affected Environment

The project area potentially consists of 9 Indian trust allotments which are located on undeveloped and uninhabited desert. Lands bordering the project area are also uninhabited. Projected future land use of the area is retention of the "open space" character, with few roads and other infrastructure.

3.7.3 Environmental Consequences

No Action

Under the No Action alternative, existing conditions would prevail into the foreseeable future.

Proposed Action

The Arroyos recharge project would allow the SXD to utilize a portion of their CAP water allocation to improve ground-water conditions. This would indirectly improve the dependability of farm operations during periods of CAP system outages by providing an assured water supply, thereby promoting economic self-sufficiency. No SXD community members or minority populations would be exposed to disproportionately high-adverse health or environmental effects resulting from implementation of the proposed project.

Cumulative Effects

No cumulative effects on EO 12898 populations are anticipated.

CHAPTER 4 - AGENCIES AND PERSONS CONSULTED

List of Agencies and Persons Contacted

ASARCO
Arizona Department of Environmental Quality
Arizona Department of Water Resources
Arizona Game and Fish Department
Arizona State Historic Preservation Office
Bureau of Indian Affairs (Papago Agency and Western Regional Office)
Center for Biological Diversity
Central Arizona Water Conservation District
City of Tucson
Hopi Tribe
Natural Resources Conservation Service
Pima Association of Governments
Pima County Board of Supervisors
Sierra Club
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Tohono O'odham Nation

CHAPTER 5 - LIST OF PREPARERS

List of Preparers

John McGlothlen, Reclamation, NEPA Specialist
Diane Laush, Reclamation, Wildlife Biologist
Marci Donaldson, Reclamation, Archaeologist
Brad Prudhom, R.G., Reclamation, Hydrogeologist
Scott Rogers, R.G., SXD, Hydrologist

Other Contributors

Deborah Tosline, R.G., Reclamation, Hydrologist
Rodney Tang, Reclamation, Civil Engineer

CHAPTER 6 - RELATED ENVIRONMENTAL LAWS/DIRECTIVES

The following is a list of Federal laws, Executive Orders (EOs), and other directives that apply to the action alternatives discussed in this EA:

National Environmental Policy Act (NEPA) of 1969, as amended - This law requires Federal agencies to evaluate the potential environmental consequences of major Federal actions. An action becomes "federalized" when it is implemented, wholly or partially funded, or requires authorization by a Federal agency. The intent of NEPA is to promote consideration of environmental impacts in the planning and decision-making process prior to project implementation. NEPA also encourages full public disclosure of the proposed action, accompanying alternatives, potential environmental effects, and mitigation.

This EA was prepared in accordance with the requirements of NEPA, the Council on Environmental Quality regulations, and the Department of the Interior regulations implementing NEPA. Scoping information was posted on Reclamation's Phoenix Area Office Web site and distributed to potentially interested individuals, organizations, and agencies on August 7, 2008.

Fish and Wildlife Coordination Act (FWCA) of 1934, as amended - The FWCA provides a procedural framework for the consideration of fish and wildlife conservation measures in Federal water resource development projects. Coordination with the FWS and State wildlife management agencies are required on all major Federal water development projects.

This project does not meet the level of a major project; therefore no coordination act report is required.

Endangered Species Act (ESA) of 1973, as amended - The ESA provides protection for plants and animals that are currently in danger of extinction (endangered) and those that may become so in the foreseeable future (threatened). Section 7 of this law requires Federal agencies to ensure that their activities do not jeopardize the continued existence of threatened or endangered species or adversely modify designated critical habitat.

A BA which concluded "no effect" to the lesser long-nosed bat and may affect but is not likely to adversely affect the PPC was submitted to the FWS on March 3, 2009.

Migratory Bird Treaty Act (MBGA) of 1918, as amended – The MBTA is the domestic law that implements the United States' commitment to the protection of shared migratory bird resources. The MBTA prohibits the take, possession, import, export, transport, selling, or purchase of any migratory bird, their eggs, parts, or nests.

Implementation of the project would not violate provisions of the MBTA and may provide some long-term benefit to species protected under this act.

Clean Air Act (CAA) of 1963, as amended - The CAA requires that any Federal entity engaged in an activity that may result in the discharge of air pollutants must comply with all applicable air pollution control laws and regulations (Federal, State, or local). It also directs the attainment and maintenance of National Ambient Air Quality Standards (NAAQS) for six different criteria pollutants, including carbon monoxide, ozone, particulate matter, sulfur oxides, oxides of nitrogen, and lead.

Air quality in the project area is in attainment of NAAQS. Short-term construction emissions associated with the proposed action would have localized and minor effects.

Clean Water Act (CWA) of 1977, as amended - The CWA strives to restore and maintain the chemical, physical, and biological integrity of the nation's waters by controlling discharge of pollutants. The basic means to achieve the goals of the CWA is through a system of water quality standards, discharge limitations, and permits. Section 404 of the CWA identifies conditions under which a permit is required for actions that result in placement of fill or dredged material into waters of the United States. In addition, a 401 water quality certification and 402 National Pollutant Discharge Elimination System (NDPES) permit are required for activities that discharge pollutants to waters of the U.S.

The proposed project qualifies for Section 404 permit coverage under Nationwide Permit No. 18 (Minor Discharges). Water quality certification under Section 401 and coverage under the NPDES storm-water general permit would be obtained from EPA prior to construction.

National Historic Preservation Act (NHPA) of 1966, as amended - Federally-funded undertakings that have the potential to affect historic properties are subject to Section 106 of the NHPA. Under this act, Federal agencies are responsible for the identification, management, and nomination to the National Register of Historic Places of cultural resources that would be affected by Federal actions. Consultation with the Advisory Council on Historic Preservation and the State Historic Preservation Office (SHPO) is required when a Federal action may affect cultural resources on, or eligible for inclusion on, the National Register.

Cultural resource surveys of the area of potential effect were conducted by Reclamation in accordance with NHPA Section 106. The SHPO concurred with Reclamation's no effect determination for the following components of the project: Arroyo 19 including roads, pipeline, monitoring wells, and in-channel construction (SHPO letter dated June 10, 2004); Arroyo 15 including roads, pipeline, monitoring wells, and in-channel construction (SHPO letter dated June 22, 2006); and the perimeter fences for Arroyos 15 and 19 (SHPO letter dated October 15, 2008).

Farmland Protection Policy Act (FPPA), as amended - The FPPA requires identification of proposed actions that would adversely affect any lands classified as prime and unique farmlands. The Natural Resources Conservation Service administers this act to preserve farmland.

There is no unique or prime farmland designated on the SXD. The San Xavier Cooperative Association operates the San Xavier Cooperative Farm on 1,100 acres approximately 3 miles north of the project area.

Resource Conservation and Recovery Act, as amended (RCRA) - RCRA establishes thresholds and protocols for managing and disposing of solid waste. Solid wastes that exhibit the characteristic of hazardous waste, or are listed by regulation as hazardous waste, are subject to strict accumulation, treatment, storage, and disposal controls.

Construction of recharge infrastructure is not expected to generate hazardous waste as defined and regulated under RCRA. All construction equipment would be periodically inspected for leaks to minimize the possible impact of hazardous materials (petroleum, oil, and lubricants) on the environment. Any significant leaks would be promptly corrected. Construction debris would be disposed of in accordance with State and Federal regulations at an EPA-approved landfill.

EO 11988 (Floodplain Management) - This Presidential directive encourages Federal agencies to avoid, where practicable alternatives exist, the short- and long-term adverse impacts associated with floodplain development. Federal agencies are required to reduce the risk of flood loss; minimize the impacts of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility.

This project will not result in any increased risk of flooding to the local community.

EO 11990 (Wetlands) - This Order directs Federal agencies, in carrying out their land management responsibilities, to take action that will minimize the destruction, loss, or degradation of wetlands, and take action to preserve and enhance the natural and beneficial values of wetlands.

The project would not affect wetlands.

EO 12898 (Environmental Justice) – This EO, dated February 11, 1994, established requirements to address Environmental Justice concerns within the context of Federal agency operations. As part of the NEPA process, agencies are required to identify and address disproportionately high and adverse human health or environmental effect on minority or low-income communities. Federal agencies are directed to ensure that Federal programs or activities do not result, either directly or indirectly, in discrimination on the basis of race, color, or national origin.

The project area encompasses uninhabited land within the SXD. No disproportionate impact to low-income or minority populations as defined by EO 12898 would result.

EO 13045 (Protection of Children from Environmental Health Risks and Safety Risks) - Requires that proposed Federal projects identify and assess the environmental health risks and safety risks that may disproportionately affect children.

The project area encompasses uninhabited land within the SXD. No disproportionate impact to children as defined by EO 13045 would result.

Secretarial Order 3175 (Indian Trust Assets) - Indian Trust Assets are legal interests in assets held in trust by the U.S. Government for Indian tribes or individual Indians. Trust Assets are anything owned that has monetary values, including lands, minerals, water rights, hunting rights, other natural resources, money, or claims.

The project area encompasses Indian trust land within the SXD. A 20-year lease would be sought by SXD through BIA before project implementation could proceed.

CHAPTER 7 – LITERATURE CITED

Anderson, B.W. and R.D. Ohmart. 1977. Vegetation structure and bird use in the lower Colorado River Valley. Pages. 23-24 in R.R. Johnson and D.A. Jones, technical coordinators, Importance, preservation, and management of riparian habitat: A symposium. USDA Forest Service General Technical Report RM-43. Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

Anderson, B.W., R.D. Ohmart, and J. Rice. 1983. Avian and vegetation community structure and their seasonal relationships in the lower Colorado River Valley. Condor 85:392-405.

Anderson, B.W., PE. Russell, and R.D. Ohmart. 2004. Riparian Vegetation: An account of two decades of experience in the arid southwest. Avvar Books. Blythe, California. 268 pp.

Arizona Department of Water Resources (ADWR). 1999. Third management plan for Tucson Active Management Area 2000-2010. December 1999.

Arizona Hydrological Society (AHS). 2001. 10th Biennial symposium on artificial recharge of ground water. Pima Mine Road Recharge Project Fact Sheet, pgs. PMR-1 through PMR-8 in handout booklet, CAP and City of Tucson.

Brown, D. E. 1994. Biotic communities of the American southwest - United States and Mexico. University of Utah Press. Salt Lake City, Utah. 342 pp.

Carothers, S.W., R.R. Johnson, and S.W. Aitchison. 1974. Population structure and social organization of southwestern riparian birds. American Zoologist 14:97-108.

Central Arizona Project (CAP). 2008. 2007 Annual water quality report. Phoenix, Arizona.

Cornett & Associates with Tierra Madre Consultants. 1985. San Xavier Planned Community Biological Survey and Impact Assessment. Prepared for Santa Cruz River Properties, Inc. Palm Springs, California.

Crosswhite, F. and C. Crosswhite. 1982. The Sonoran Desert. In: G. Bender (ed) Reference Handbook on the Deserts of North America. pp 163-319. Greenwood Press. Westport, Connecticut.

Cultural and Environmental Systems. 1987. The San Xavier archaeological project (six volumes). Southwest Cultural Series No. 1. Cultural and Environmental Systems, Tucson.

Davidson, E.S. 1973. Geohydrology and water resources of the Tucson Basin, Arizona; U.S. Geological Survey, Water Resources Investigations Report 1939-E.

Donaldson, M. 2004. Cultural resources survey for the Arroyo 19 in-channel recharge test, San Xavier reliability study, Pima County, Arizona. Unpublished Bureau of Reclamation Report, DI-BR-PXAO-ICRS-04-016.

Downum, C. E., A. G. Rankin, and J. S. Czaplicki. 1986. A class III archaeological survey of the Phase B corridor, Tucson Aqueduct, Central Arizona Project. Arizona State Museum Archaeological Series #168. University of Arizona, Tucson.

Ecosphere Environmental Services, Inc. 1992. Final Report: A survey for threatened and endangered plant species at three proposed reservoir sites and associated pipelines. Contract No. 0-CS-32-01950. Farmington, New Mexico. 69 pp.

Ecosphere Environmental Services, Inc. 1992a. Final Report: A range study of *Coryphantha scheeri* var. *robustispina*. Contract No. 0-CS-32-01950. Farmington, New Mexico. 82 pp.

Effland, R. W., A. Rankin, J. Schuster, and M. Waters. 1989. Cultural resources investigations for the San Xavier rehabilitation project: a study of changing adaptations along the Santa Cruz River floodplain. Cultural Resources Report No. 41. Archaeological Consulting Services, Tempe.

Glass, M. (Compiler). 2001. Archaeological investigations at AZ BB;13:16(ASM)-Locus F, Tohono O'odham Indian Reservation, San Xavier District, Pima County, Arizona. Cultural Resources Report No. 124. Archaeological Consulting Services, Tempe.

Greeleaf, J. C. 1975. Excavations at Punta de Agua in the Santa Cruz River Basin, Southeastern Arizona. Anthropological papers No. 26. University of Arizona Press, Tucson.

Heathington, C. 2002. Archaeological survey of the Arroyos Site, San Xavier Pilot Recharge Project. Unpublished Bureau of Reclamation Report, DI-BR-PXAO-ICRS-02-37.

Hendricks, D. M. 1986. Arizona soils. University of Arizona Press, Tucson.

Hinman, K.E. and T.K. Snow, eds. 2003. Arizona Bat Conservation Strategic Plan. Nongame and Endangered Wildlife Program Technical Report 213. Arizona Game and Fish Department. Phoenix, Arizona.

Hollet, K.J. and J.M.Garrett. 1984. Geohydrology of the Papago, San Xavier, and Gila Bend Indian Reservations, Arizona, 1978-1981: U.S. Geological Survey, Hydrologic Investigations Atlas HA-660, two sheets.

Kotuby-Amacher, J., R. Koenig, and B. Kitcher. 1997. Salinity and plant tolerances. Utah State University Extension. http://extension.usu.edu/files/agpubs;/salini.htm. Logan, Utah.

Mabry, J. B. (editor). *1998.* Archaeological investigations of Early Village Sites in the Middle Santa Cruz Valley: Analysis and Synthesis. Anthropological Papers No. 19. Center for Desert Archaeology, Tucson.

MacArthur, R.H. and J.W. MacArthur. 1961. On bird species diversity. Ecology 42:594-598.

Mason, D.A. and L. Bota. 2006. Regional ground-water flow model of the Tucson active management area – Tucson, Arizona: simulation and application. Arizona Department of Water Resources Modeling Report No. 13. Phoenix, Arizona.

McGuire, R. H. 1979. Rancho Punta de Agua: excavations at a historic ranch near Tucson, Arizona. Contributions to Highway Salvage Archaeologica in Arizona No. 57. Arizona State Museum, University of Arizona, Tucson.

Mills, G. S. 1991. Miscellaneous notes on *Coryphantha scheeri robustispina*. Unpublished report to Fish and Wildlife Service. 30 pp.

Osterkamp, W.R. 1973. Ground-water recharge in the Tucson area, Arizona, U.S. Geological Survey, Miscellaneous Investigations Series Map I-844-E, one sheet.

Pima Association of Governments (PAG). 2002. Upper Santa Cruz basin ground water and land use. Final Project Report.

Ravesloot, J. C. (editor). 1987. The archaeology of the San Xavier Bridge Site (AZ:BB:13:14) Tucson Basin, Southern Arizona. Prepared for Arizona Department of Transportation. Arizona State Museum Archaeological Series No. 171. University of Arizona, Tucson.

Rogers, S. 2001. The feasibility of artificial recharge within the San Xavier District, Draft report to Bureau of Reclamation. San Xavier District.

Rogers, S. 2004. San Xavier District and Bureau of Reclamation recharge feasibility investigations report on long-term infiltration testing, July-December, 2003. San Xavier District.

Rogers, S. 2006. San Xavier District and Bureau of Reclamation recharge feasibility investigations report on San Xavier Arroyo 19 in-channel recharge testing November 2004 – December 2005. San Xavier District.

Shaffer, M. 1993. Evaluation of soil contamination, San Xavier Indian Reservation. Unpublished report.

Stokes, R. J., L. M. Schilling, K. L. Fangmeier, M. S. Droz, A. R. Gregory, and T. L. Pinter. In prep. Final report of intensive testing for the San Xavier District farm rehabilitation project, Tohono O'odham Nation, Pima County, Arizona. Archaeological Consulting Services, Tempe.

Turner, R. 1974. Map showing vegetation in the Tucson, Arizona, area. Miscellaneous Investigations Series. Map I-844-H. U. S. Geological Survey. Reston, Virginia.

U.S. Environmental Protection Agency (EPA). 2002. Perchlorate environmental contamination: toxicological review and risk characterization. NCEA-1-0503. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2004. Perchlorate monitoring results Henderson, Nevada, to the lower Colorado River. June 2004 report. EPA Region 9. San Francisco, California.

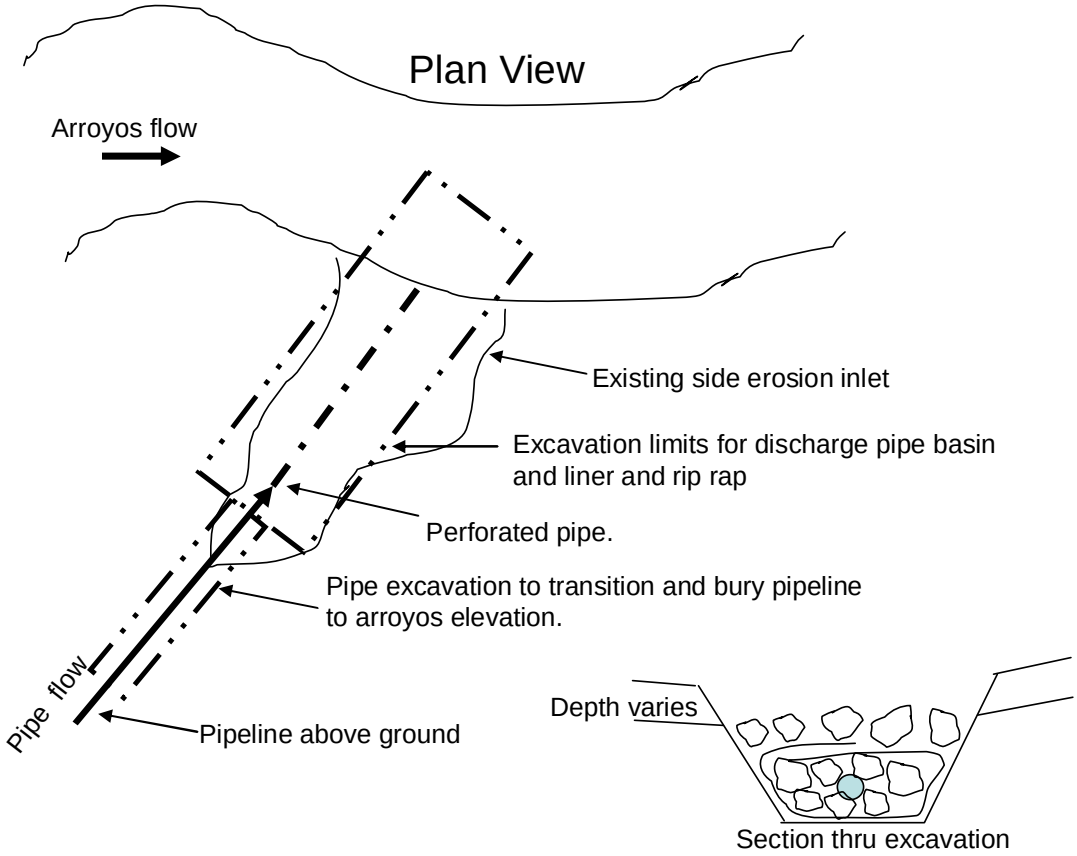
U.S. Fish and Wildlife Service (FWS). 1991. Endangered and threatened species of Arizona summer 1991. Fish and Wildlife Service. Arizona State Office. Phoenix, Arizona. 106 pp.

U.S. Fish and Wildlife Service (FWS). 2008. Reinitiated Biological Opinion on the Transportation and Delivery of Central Arizona Project Water to the Gila River Basin in Arizona and New Mexico and its Potential to Introduce and Spread Nonindiginous Aquatic Species. 22410-2007-F-0081. Arizona Ecological Services Office, Phoenix.

Appendix A

Standard Discharge Structure Design

Arroyos Discharge Structures – Types I – San Xavier District Arroyos Project – CAP, Reach 6 Pipeline



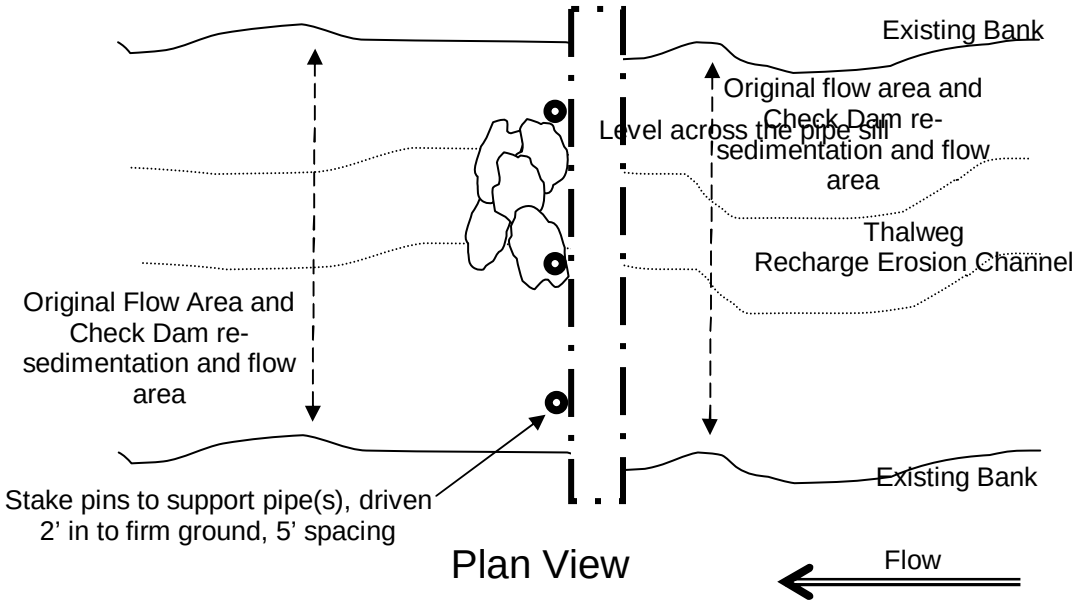
Notes:
Existing side erosion inlets are used as existing excavated openings into arroyos for the discharge structure.
Excavation for perforated pipe and (non-woven) geotextile liner with rip rap. Slope of excavation is horizontal or sloped to depth of Arroyos. Width approx 3' to 5', length is length of perforated discharge pipe plus 5', for 2 cfs discharge capacity or less.
Perforated pipe length (10'), number and size of hole perforations determined by discharge (total open area), discharge head, and anticipated air release during start up and normal operations. Interior pipe baffles and an end cap are also installed. Elevation of pipe is 4 to 6" above excavated invert. See cross section.
This layout was used at San Xavier Arroyos Manhole #19 project on both discharge arms.

3/2/06, draft, rlt 1

Appendix B

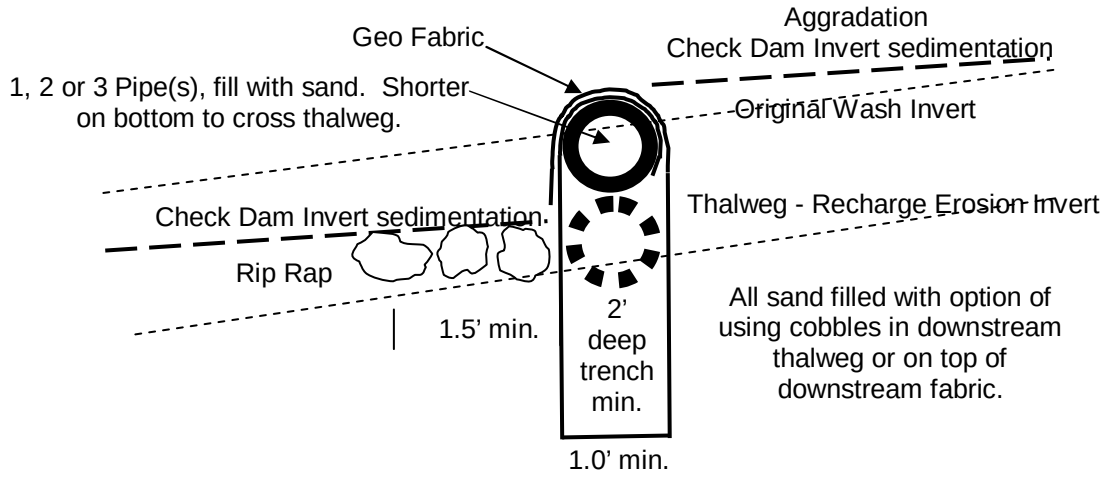
Standard Check Dam Design

Check Dam Installations
Arroyos Recharge Projects



Plan View

Flow



Profile View

Bureau of Reclamation

Appendix C

Cumulative Ground-Water Influences

Table C-1. Ground-water Influences from Entities Adjacent to the SXD

Portion of District	Existing Ground-water Flow Regime and Water Quality Trends	Potential Incremental Impact from Arroyos Area Recharge
Southeast		
Pima Mine Road (PMR) Recharge Facility (permitted 30,000 AFY recharge)	Shallowest depth to ground-water (dtw) is 50 to 70 feet (mound varies from elevation 2,520 to 2,580) in regional aquifer (2001); lobate mound (ground-water ridge) expands north along regional ground-water flow direction between the SCR and Old Tucson Nogales Hwy; flow is to the north, northeast, and northwest (expanding below SCR into Arroyos Area) except flow in S portion of PMR mound flow to S, SE, and SW into ASARCO well field cone of depression. Nitrate levels in some areas of SXD east of the SCR exceed Arizona Water Quality Standards; in 2001, the nitrate plume mimicked extent of PMR mound (elliptical with major axis trending north-south along regional flow dispersion direction) generally east of SCR; nitrate contamination likely from agricultural sources (Green Valley, Sahuarita, FICO pecan groves) and mining operations.	Arroyos mound formation would be linear and narrow, trending northeast, and may form a minor hydraulic barrier to PMR mound expansion into Arroyos Area. Coalescence of the PMR and Arroyos mounds expected to build up regional ground-water levels in the constricted aquifer basin between Black Mountain and Martinez Hills, raising ground-water levels in the San Xavier Cooperative Farm area.
ASARCO Mission Mine Complex well field and tailings ponds	Cones of depression formed from ASARCO's well field are superimposed upon an otherwise generally flat, north/northwest sloping regional water-table (13,500 AFY average ground water pumped from well field; SXD 2001); dtw across the cone varies from 125 to 400 feet in the western portions of the cone; inflection contour between the PMR mound and ASARCO cone occurs just west of the Cymet Facility along Pima Mine Road at elevation 2,500 (CAP 2001); cone may be migrating north, although PMR recharge should slow north/northeast advance. High TDS, sulfate, fluoride from tailings ponds; plume generally trending north but west of the SCR; effects so far not apparent in Arroyos area wells which may be due to "strong-sink" capture by the well field cone.	No impact. ASARCO operations are generally hydrologically upgradient of the Arroyos Area; Arroyos recharge should also help reduce the regional flow gradient from the northern fringes of the ASARCO cone of depression (in a ground-water divide area) which would slow migration of the cone and contaminant plume towards the Arroyos Area; additionally, any Arroyos recharge water which might be pulled back into the cone will only help to fill it in.

Table C-1. Ground-water Influences from Entities Adjacent to the SXD (cont.)

Portion of District	Ground-water Flow Regime and Water Quality Trends	Potential Incremental Impact from Arroyos Area Recharge
Northeast		
Santa Cruz Well field Over 5,000 AFY GW pumped historically since 1960's (SXD 2001)	A closely spaced cluster of City of Tucson wells situated mostly N-S are located within 1-mile east of the SXD boundary; other than the local ground-water depression cones from the well field pumping, and mounding from the PMR facility, the 2005 dtw in these wells averaged about 153 feet, with the maximum 275 feet and minimum 67 feet (ground-water level el. 2,478 to 2,577 feet, average is 2,530 feet; Tucson Water 2006); (general ground-water flow direction and gradient is to northwest and relatively flat; ADWR 2006).	Low beneficial impact. Arroyos recharge is projected to help ground-water levels rise and recover towards the north and northeast portions of the SXD – the hydrologic benefits should be mostly northward toward the San Xavier Cooperative Farm, although some benefit to the city wells (in conjunction with the PMR mound which is probably a more immediate and effective source of recharge) is possible; USGS subsidence models have predicted that by 2025 in the Santa Cruz well field area, as much as 4 feet of subsidence is possible (WRRC 1999), and any additional sources of ground-water recharge (including the Arroyos project) will help slow subsidence and drawdowns.
San Xavier Cooperative Farm (Ground-water pumping after 1993 averaged approximately 200 AFY; historical withdrawals unknown.)	Depth to water at the farm ranges from 100 to 150 feet (2,400- to 2,450-foot elevation). Pumping has not altered local flow patterns in the regional aquifer to any great degree as evidenced by contour maps (SXD 2001 and 2006) and flow vectors generally north towards Martinez Hill Gap (SXD 2006). Perched water near the SCR south/southwest of Martinez Hill occur above the regional aquifer. Historical incidental recharge from irrigation on the farm helps to replenish the regional aquifer, but clayey and silty soils at the surface impede rapid infiltration. Quality of the regional aquifer in the farm area as reported from TOUA wells is good.	Arroyos recharge is projected to promote recovery of ground-water levels in the farm area and increase transmissivities allowing any recovery wells to be more productive. Preliminary modeling using 2,820 AFY Arroyos recharge from 2006 to 2025 showed about 50 feet of recovery in some farm wells. Arroyos recharge should lessen well interference effects among competing (TOUA and farm) wells by increasing the aquifer-saturated thickness.
TOUA Wells (Four TOUA drinking water wells are active and pump small volumes – about 150 AFY.)	TOUA wells (SXVs 1 and 2 [both inactive]; and ORDs 1 and 2 [active]) have recent dtw between 125 and 145 feet (2,366 to 2,385 elevation), these are located a little further west of Martinez Hill than SXVs 3 and 4. SXVs 3 and 4 should have slightly lower (15 to 30 feet) ground water el.; ORDs 1 and 2 located due south of Martinez Hill just east of the river; all are pumping where aquifer has relatively flat gradient and flow directions diverging northwest/north through the Martinez Gap. Water quality is good.	Similar effect as above for San Xavier Cooperative Farm wells, except recovery effects may be less (masked by closer farm pumping) and without potential water logging/salt build-up effects. Water quality effect would be to increase TDS concentrations to a level reflecting a blend of CAP water and ambient ground water.

Table C-1. Ground-water Influences from Entities Adjacent to the SXD (cont.)

Portion of District	Ground-Water Flow Regime and Water Quality Trends	Potential Incremental Impact from Arroyos Area Recharge
TARP/Raytheon TCE Plumes/SXD Industrial Park (TCE remediation pump, treatment, and re-injection in 1998 was 4,340 AF ground water extracted and 4,280 AF re-injected (SXD 2001). Tucson Water operates nine extraction wells and a treatment facility near Irvington Road in the southern portion of Tucson, east of I-19.)	Depth to water in the extreme northeast corner of the SXD varies from between 100 to 150 feet on both sides moving out from Martinez Hill, and increases to about 200 feet dtw to the north/northeast (ground-water elevation 2,300 to 2,500 feet). The ground-water flow diverges around Martinez Hill with shallower gradients and north/northeast flow in the Martinez Hill Gap (SCR notch between Black Mountain and Martinez Hill) and steep gradients on the immediate eastern side of the Hill with north/northwest flow directions. These split ground-water flows converge northwards beyond Martinez Hill (SXD 2001 and ADWR 2006). Areas of shallow perched water occur adjacent to Martinez Hill (SXD 2001). The TCE contaminant plumes reflect these general flow directions with the principal dispersion axis of the main plume northwest away from the SXD. TCE is being managed/remediated and has not been detected in any SXD wells.	No impact. Arroyos recharge should build up ground-water level elevations and increase gradients (and thus volumetric quantities) over time, but these increased flows are expected to be recovered for reliability. Any recharged water above the recovered volume will tend to move through the Martinez Gap flow path area rather than on the east side of Martinez Hill where the hydraulic head pressure response could alter flow conditions relevant to the TCE contamination pump and treat operation. In the unlikely event that Arroyos recharge water migrated to the remediation site, the CAP water/ambient aquifer blend would be of superior quality and thus would tend to dilute the TCE.
Portion of District	Ground-Water Flow Regime and Water Quality Trends	Potential Impact from Arroyos Area Recharge
Sunward Materials Sand & Gravel Pit	In SCR floodplain alluvium; CAWCD/Tucson monitor alert levels for PMR permit	No impact. Pit invert elevation is greater than 100 feet above Arroyos mound elevation in the regional aquifer, and the pit is located upgradient of the Arroyos Area.
Farmers Investment Company (FICO) (28,026 AF avg. GW pumped 1987-1995; irrigated acreage 5,909 acres (WRRC, 1999)	FICO, historically and currently a significant agricultural pumper, near Sahuarita, now holds a GSF permit for 20,000 AFY of CAP water (ADWR TMP 2005), although currently no CAP water is being taken. FICO's pumping impacts are far upgradient of the Arroyos project area, and are more closely associated (and buffered) hydrologically, with the PMR recharge facility and ASARCO pumping, both of which occur spatially between the FICO and Arroyos sites.	No impact. PMR mound should help act as hydraulic barrier boundary condition precluding Arroyos water from migrating towards FICO well field. ASARCO well field would be more apt to hydrologically influence Arroyos than FICO.

Table C-1. Ground-water Influences from Entities Adjacent to the SXD (cont.)

Northwest		
Private and municipal wells	A number of small capacity wells for domestic use occur just north of the northern SXD boundary, about midway between Black Mountain and Ryan field, and south of Drexel Road. Others are located west of the SXD, including some city-owned wells in the Avra Valley sub-basin. Depth to water in an area east of the Avra Valley fault (northwest of Black Mountain), where the ground water is "perched" on a bedrock pediment (shelf), is less than 200 feet. The source of water in this area is local mountain-front recharge from the flanks of Black Mountain and recharge from local drainages. The regional ground water in the northwest portion of the SXD moves west/northwest and drops in elevation steeply across the fault into Avra Valley where dtw exceeds 500 to 600 feet. The SXD's Northwest Windmill well, located in the extreme northwest corner, has a recent dtw of 510 feet , and water levels have declined about 50 feet since the 1960s (SXD 2006).	No impact. Arroyos recharge replenishes the north/northeast moving component of regional ground-water flow into the Upper Santa Cruz sub-basin, which is hydrologically isolated from the regional flow field west of Black Mountain.
Pasqua-Yaqui	Same discussion as above for private/municipal wells.	No impact. Same discussion as above for private/municipal wells.
Southwest		
Private/stock wells	A number of hand-dug stock wells have dtw of 10 to 40 feet (SXD 2006); this area has shallow bedrock conditions (and thus shallow, but fairly steep ground water) due to the north trending pediment extension of the Sierritas across the SXD. The flow direction is northerly with a hydraulic gradient of about 200 to 300 feet/mile; the gradient decreases dramatically towards the extreme northwest corner (see the Northwest section above).	No impact. Same discussion as above for the Northwest district area

Appendix D

Avian List

BIRD SPECIES OBSERVED ALONG ARROYOS 15, 19 AND 23

**All Species observed between 28 March 2006 - 3 April 2007

AMERICAN KESTREL
ASH-THROATED FLYCATCHER
BARN SWALLOW
BEWICK'S WREN
BLACK PHOEBE
BLACK-HEADED GROSBEAK
BLACK-TAILED GNATCATCHER
BLACK-THROATED GRAY WARBLER
BLACK-THROATED SPARROW
BLUE-GRAY GNATCATCHER
BREWER'S SPARROW
BROWN-HEADED COWBIRD
BULLOCK'S ORIOLE
CACTUS WREN
CANYON TOWHEE
CHIHUAHUAN RAVEN
COMMON RAVEN
COMMON YELLOWTHROAT
COOPER'S HAWK
CORDILLERON FLYCATCHER
CRISSAL THRASHER
CURVE-BILLED THRASHER
DUSKY FLYCATCHER
ELF OWL
GAMBEL'S QUAIL
GILA WOODPECKER
GILDED FLICKER
GRAY FLYCATCHER
GREAT HORNED OWL
GREATER ROADRUNNER
GREEN-TAILED TOWHEE
HERMIT THRUSH
HOODED ORIOLE
HOUSE FINCH
HOUSE WREN
LADDER-BACKED WOODPECKER
LESSER GOLDFINCH
LESSER NIGHTHAWK
LINCOLN'S SPARROW
LOGGERHEAD SHRIKE
LUCY'S WARBLER
MACGILLIVRAY'S WARBLER
MOURNING DOVE
NORTHERN CARDINAL
NORTHERN MOCKINGBIRD
NORTHERN ROUGH-WINGED SWALLOW
ORANGE-CROWNED WARBLER
PACIFIC SLOPE FLYCATCHER
PHAINOPEPLA
PURPLE MARTIN
PYRRHULOXIA
RED-TAILED HAWK
RED-WINGED BLACKBIRD
ROUGH-WINGED SWALLOW
RUBY-CROWNED KINGLET
RUFOUS-WINGED SPARROW
SOLITARY VIREO
SUMMER TANAGER
TOWNSEND'S WARBLER
TURKEY VULTURE
VERDIN
VIOLET-GREEN SWALLOW
WARBLING VIREO
WATER PIPIT
WESTERN TANAGER
WESTERN WOOD PEWEE
WHITE-CROWNED SPARROW
WHITE-THROATED SWIFT
WHITE-WINGED DOVE
WILSON'S WARBLER
YELLOW WARBLER
YELLOW-RUMPED WARBLER