Volume 1 of 4 : Draft Feasibility Report
Volume 2 of 4 : Draft Feasibility Report Technical Appendices
Volume 3 of 4 : Draft Feasibility Report Technical Appendices
Volume 4 of 4 : Draft Environmental Impact Statement

Va Shly'ay Akimel
DRAFT Salt River Ecosystem Restoration Study

Prepared by:

U.S. Army Corps of Engineers
South Pacific Division
Los Angeles District

In partnership with:

Salt River Pima-Maricopa Indian Community

and the

City of Mesa

GREAT SEAL SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY

Va Shly'ay Akimel Restoration Project

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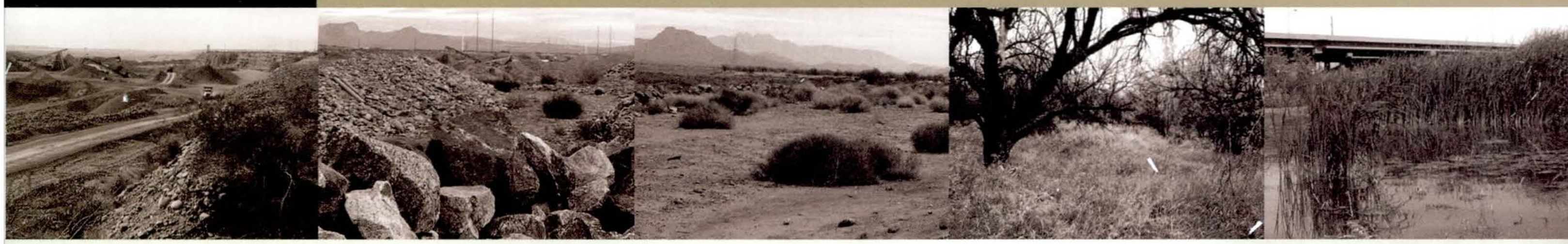
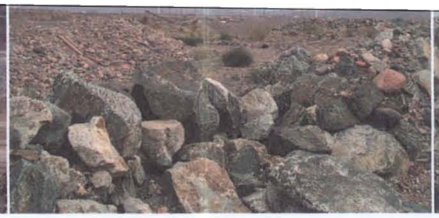



Loop 101 and Loop 202


S.R. Materials Group (SRSR) mining, Beeline Plant.


Lehi Cemetery, looking north toward Saddleback Mountain.


Looking northeast toward Red Mountain.

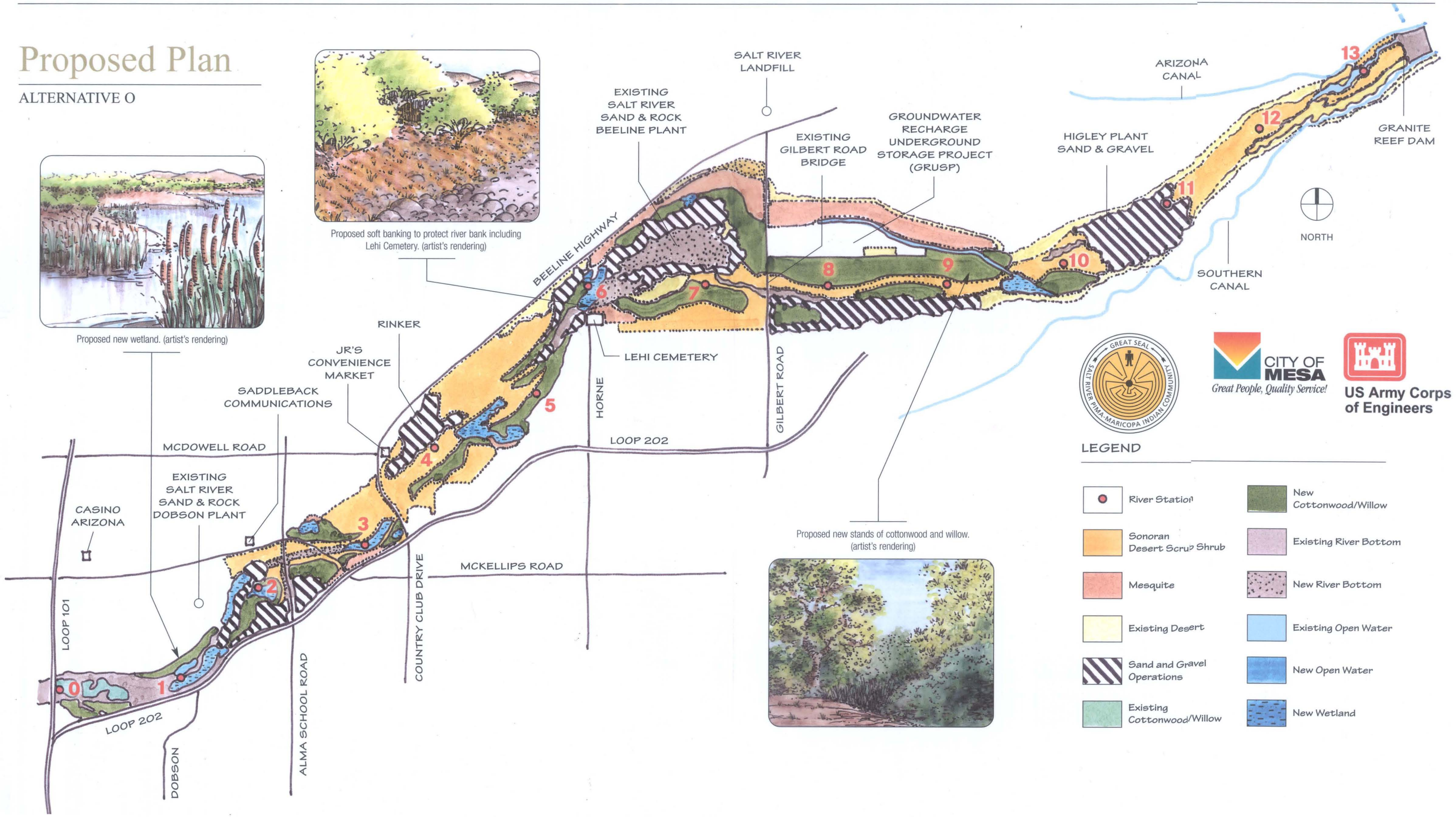

Unmined area near Alma School Road, looking northeast.


Existing wetlands west of the Granite Reef Dam.


Granite Reef dam looking southwest.

Proposed Plan

ALTERNATIVE O



Proposed new wetland. (artist's rendering)

Proposed soft banking to protect river bank including Lehi Cemetery. (artist's rendering)

Proposed new stands of cottonwood and willow. (artist's rendering)

The Plan

Two options are under consideration: Status Quo & Alternative O.

Without the Project/Status Quo:

This option continues the riverbed in its current state. It does not bring new plants or a new source of water to the Salt River within the Community. The 14 miles of riverbed will continue to be dry and not support native vegetation.

Sand & Gravel: The dry Salt riverbed continues to support sand and gravel mining operations. Mining operations may, however, be moved in the future.

Water: The dry riverbed continues to be subject to periodic flooding. Flooding, wind and water in combination with the sand and gravel mining pits continue to degrade, erode and alter the riverbed.

Sacred Sites: While not being disturbed today, sacred sites are not protected and, most likely, will be subject to degradation.

Recreation: The riverbed area is not served by recreational paths.

With the Project/Alternative O

Native trees including cottonwood, willow, ironwood, palo verdes and mesquite will be introduced into the riverbed along with other natural vegetation familiar to the area. The water source will be routed to the plants through a combination of drip irrigation, surface irrigation and/or channeled irrigation runoff. While the water will be sufficient to support native vegetation, there will not be a continuous, flowing river. In places, the banks of the river will be built up and landscaping added to minimize erosion of the riverbank and encourage natural flow channels of the river.

Sand & Gravel: The SRPMIC administration will continue to work closely with Sand & Rock operations to discuss how to work together to preserve this business yet accommodate the restoration.

Water: Water is available from the SRPMIC's Water Rights Settlement Act. It has been determined that, since SRPMIC cannot sell or lease or trade any of the water rights settlement, excess water is available which may be used by this project. No effluent (treated sewage water) will be used. The SRPMIC has studied the possibility of using irrigation discharge water, flows from storm events and any other water that drains into the riverbed, including the possibility of drilling new wells from existing water sources for the project's use.

Sacred Sites: The sites have been identified. The sites will not be released to the general public and will be protected under the restoration projects. The SRPMIC is committed to protecting sacred sites and resources that remain along the riverbed. Alternative O was designed to avoid sensitive sites.

Recreation: The SRPMIC will be the sole authority to determine whether or not to include any recreational trails in this project as the primary focus of the Va Shly'ay Akimel Restoration project is ecosystem restoration, not recreation. A recreational component could include hiking, biking and horseback riding trails and the decision to consider recreation could be made at a later time by the SRPMIC Tribal Council.

The Project

Introduction

The free-flowing Salt River as it flows through the Salt River Pima-Maricopa Indian Community (SRPMIC) was altered many years ago by the construction of dams upstream. This project study area extends approximately 14 miles from the Granite Reef Dam to the Pima Freeway. Most of this area is on the Salt River Pima-Maricopa Indian Community but a small portion is located within the jurisdiction of the City of Mesa and Maricopa County.

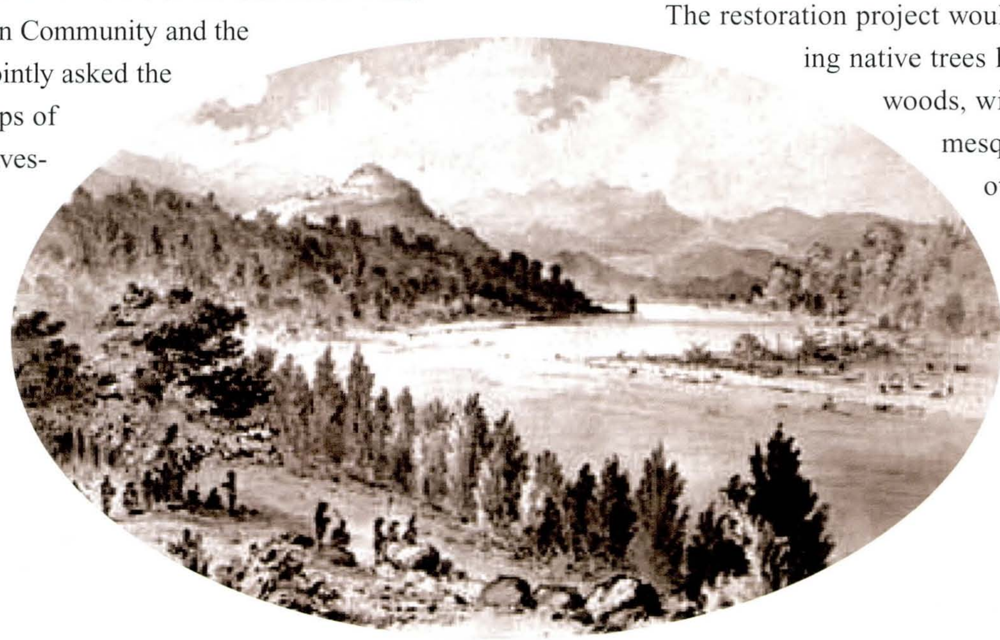
Over the years, the riverbed has been altered further by sand and gravel mining and by floods. As a result, the land-water (or riparian) corridors that have unique communities of plants and animals living near the river, and that serve a variety of functions for both people and the environment, have disappeared. At present, the Salt River cannot support riparian native plants.

In 1999 the elected officials of the Salt River Pima-Maricopa Indian Community and the City of Mesa jointly asked the U.S. Army Corps of Engineers to investigate whether the dry riverbed could be restored. A restoration project of this size is eligible for Federal funding if it has a local sponsor or sponsors.

The SRPMIC and the City of Mesa secured $2,375,000 in Federal appropriations to study the feasibility of the Va Shly'ay Akimel project. The SRPMIC partnered with the U.S. Army Corps of Engineers and the City of Mesa to examine the current state of the riverbed, identify a plan to introduce new plants with a supportable water source, and define a timetable during which the restoration work would be done. The feasibility study will be completed in 2004.

Thirty-two alternatives were initially created. After careful analysis, the list was narrowed to six alternatives. All six were screened and further analyzed. "Alternative O" has been selected as the preferred plan.

The restoration project would include planting native trees like cottonwoods, willows and mesquites; as well as other plants native to the area and providing a source of water to support them.



Bartlett's drawing "On the Salinas" made near his camp on the Salt River, north of the Mesa Grande Ruins. From ***Bartlett's West*** by Robert V. Hine.

Salt River Pima-Maricopa Indian Community
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Scottsdale, AZ 85256

US Army Corps of Engineers

U.S. Army Corps of Engineers
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Phoenix, AZ 85012-1936

CITY OF MESA
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City of Mesa
Jim Huling or Gordon Haws
P.O. Box 1466
Mesa, AZ 85211-1466

The Future

Just as it took many years for the Salt River and the riverbed to be altered, it will take many years for the river to heal itself. This ecosystem restoration project will be the stepping stones in beginning the process. The time line for the construction of the ecosystem restoration project, is estimated to be 8 years.

During restoration and the on-going life of the project, the federal government will not take ownership of any tribal lands involved in the Va Shly'ay Akimel project.

All tribal lands used for the project remain the property of the SRPMIC.

Project construction costs will be split 65% / 35% between the federal government and the two local sponsors.

The decision of whether or not to move ahead on the project will be made by the SRPMIC Tribal Council.

PROJECT TIME LINE

January 2001	Request made by the SRPMIC and the City of Mesa for Federal feasibility funding to study riverbed restoration.
January 2002	Technical work completed to identify alternatives.
March 2002	Mesa public meeting held.
March 2003	Alternative plans presented to Mesa City Council.
March 2004	Mesa City Council adopts Alternative "O" as the preferred plan.
March-May 2004	Public review and other agency review.
August 2004	Feasibility study scheduled to be completed. Study may move into design phase if approved by SRPMIC Tribal Council after consideration and recommendations by the Community.

For additional information, please call Jim Huling at 480-644-5796 or Gordon Haws at 480-644-3380.

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Va Shly'ay Akimel Salt River

Ecosystem Restoration Feasibility Study

Maricopa County, Arizona

Volume 1 of 4: Draft Feasibility Report

Prepared by:

U.S. Army Corps of Engineers
South Pacific Division
Los Angeles District

In partnership with:

Salt River Pima-Maricopa
Indian Community

and the

City of Mesa

With technical assistance from:

TETRA TECH, INC
17770 Cartwright Road, Suite 500
Irvine, CA 92614

April 2004

EXECUTIVE SUMMARY

This report summarizes technical and feasibility study planning efforts undertaken to date to establish existing, future without-project, and future with-project conditions within the Va Shly'ay Akimel Salt River study area in Maricopa County, Arizona, to examine the measures and alternatives developed, and to present a tentatively recommended plan. This draft Feasibility Report serves to document plan formulation efforts in the development of potential alternatives for ecosystem restoration. These efforts will culminate in a complete feasibility report that identifies and recommends an implementable solution to improve the overall ecological health of the river and reestablish a more stable, less degraded, and sustainable condition.

The primary problem and focus of much of the efforts discussed in the report relates to the severe degradation and loss of riparian habitat along the Salt River. Historically, the study area supported significant biological resources including extensive riparian and marsh habitats. Urban development, diversion of water to support agriculture, and domestic livestock grazing have eliminated or altered most of the natural vegetation communities that occupied the study area leaving only scattered remnants of the original vegetation communities. Modifications of the river system, such as damming and flow diversion, currently do not allow flows through the study area except during flood events. In addition, sand and gravel mining operations have induced additional changes to the river channel and hydrology. As diversions of water increased, the perennial flows in the river ceased, causing the groundwater table to drop. These changes in hydrological conditions caused the natural riparian ecosystem to decline resulting in only small, isolated fragments of this former habitat to remain. Furthermore, the changes in hydrology have also allowed saltcedar, an invasive non-native plant species with minimal habitat value, to become established in the region. Today, the study area consists of a highly disturbed riverbed with minimal extant native vegetation. It is expected that growth and development will increase the demand for local water supply, taxing groundwater and surface water resources, which could limit the availability of water for existing vegetative use or for ecosystem restoration in future years.

This draft Feasibility Report includes identification of problems, opportunities, constraints, and planning objectives. A wide range of technical issues were analyzed with the goal of developing an accurate description of historic, existing, and future without-project conditions within the study area. This baseline assessment serves to identify, confirm, and refine problems, opportunities, and planning objectives and to guide the formulation of solutions. The major technical areas of focus for the study include hydrology and hydraulics, vegetation and wildlife habitat, cultural resources, projections on growth and development, and water availability and extent, particularly in reference to its effect on the riparian zone. Chapter 4 of this report details all of the areas of evaluation that comprise the without-project conditions. Detailed documentation of technical studies is included in the study's Technical Appendices, under separate cover.

This report also develops and discusses potential solutions as a guide to potential Federal and non-Federal involvement in a restoration project and as a resource to assist in the decision-making of local government and others. This report provides a description and discussion of the likely array of alternative plans, including their benefits, costs, and environmental effects, and outputs. Chapter 5 of this report presents the results of the plan formulation process used in the development of alternatives. Preliminary assessments of the impacts of each alternative are also presented in Chapter 5. Ultimately, a feasibility report will be prepared and distributed to decision-makers and stakeholders that will identify, evaluate, and recommend a coordinated, implementable solution (Selected Plan) that best meets the planning objectives of a comprehensive ecosystem restoration through the study area. This study effort is a joint partnership of the Salt River Pima-Maricopa County Indian Community; the City of Mesa; and the Corps of Engineers, Los Angeles District.

A wide variety of management measures were identified for use in developing full-scale alternatives. Various combinations of these measures formed the first array of five preliminary alternative plans. After the initial screening of the preliminary alternative plans, a second array of 16 more refined alternative plans were developed. Each alternative plan was then independently evaluated and compared to the No Action Alternative. Resulting from this evaluation were three action plans and the No Action Alternative carried forward into the final array for further analysis and comparison (used as the basis for selecting the recommended plan).

Based on the cost-effectiveness and incremental cost evaluation, together with the analysis of impacts in the system of accounts and associated evaluation criteria, Alternative O2 is the plan that reasonably maximizes net ecosystem restoration benefits by having the maximum amount of restoration benefits compared to costs. Therefore, Alternative O2 is identified as the NER Plan and is presented as the recommended plan to be considered for implementation.

The total first cost of the project is currently estimated at between $139,145,000 and $141,011,000 under October 2004 prices ($137,794,000 for ecosystem restoration; and $1,351,000 to $3,217,000 for recreation). Based on the requirements of WRDA 1986, cost-sharing for ecosystem restoration features including of all lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) would be 65 eprcent Federal and 35 percent non-Federal. Thus, the Federal share is currently estimated at $90,241,600 to $91,174,600, depending on the recreation plan selected ($89,566,100 for ecosystem restoration and $675,500 to $1,608,500 for recreation).

Preliminary analysis indicates that each of the recreation options previously described appears to be economically justified. It should be noted, however, that the costs presented are preliminary and require further refinement. In addition, any potential real estate requirements associated with the cultural center need to be determined. Cost sharing for the recreation plan would be 50 percent Federal and 50 percent non-Federal, or 0 percent Federal and 100 percent non-Federal, depending upon the features. USACE guidance (ER 1105-2-100, Appendix E) specifies that the level of financial participation by the Corps in recreation development may not increase the Federal cost of the project by more than 10 percent. The cost for all operations and maintenance would be the responsibility of the non-Federal sponsor. In addition, all water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsor. The value of this water has been estimated at $1,283,000 annually.

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LIST OF ACRONYMS

AAC	average annual cost
AAFCU	average annual functional capacity unit
ac-ft	acre-feet
ADEQ	Arizona Department of Environmental Quality
ADMP	Area Drainage Master Plan
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game & Fish Department
AMA	Active Management Area
ANPP	Arizona Nuclear Power Project
APS	Arizona Public Service Company
ASA	Assistant Secretary for the Army
ASU	Arizona State University
BIC	Buckeye Irrigation Company
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CAFOs	concentrated animal feeding operations
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
DPI	Direct Production Investment
EA	Environmental Assessment
EDC	engineering during construction
EIS	Environmental Impact Statement
EL	Environmental Laboratory
EPA	US Environmental Protection Agency
EQ	Environmental Quality
ERDC	Engineering Research and Development Center
ESRV	East Salt River Valley
FCDMC	Flood Control District of Maricopa County
FCIs	Functional Capacity Indices
FCTC	Flood Control Technical Committee
FCUs	Functional Capacity Units
FEMA	Federal Emergency Management Agency
gpm	gallons per minute
GRIC	Gila River Indian Community
GRUSP	Granite Reef Underground Storage Project
GWSI	Ground Water Site Inventory
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic Modeling
HSI	Habitat Suitability Index

HTRW	Hazardous Toxic Radioactive Waste
HU	Habitat Unit
HV	Habitat Value
IDC	interest during construction
LAU	Lower Alluvial Unit
LERRDs	lands, easements, rights-of-way, relocations, and disposal areas
LPP	Locally Preferred Plan
MAG	Maricopa County Association of Governments
MAU	Middle Alluvial Unit
mgd	million gallons per day
MM	Modified Mercali Intensity Scale
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NPV	net present value
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRPA	National Recreation and Parks Association
NWWRP	Northwest Water Reclamation Plant
OHV	off-highway vehicles
OSE	Other Social Effects
PED	preconstruction engineering design
PIR	Phoenix International Raceway
PYs	Project Years
RCP	reinforced concrete pipe
RED	Regional Economic Development
RID	Roosevelt Irrigation District
RWCD	Roosevelt Water Conservation District
S&A	supervision and administration
SBIN	Surface Braided Irrigation Network
SCORP	Arizona Statewide Comprehensive Outdoor Recreation Plan
SHPO	State Historic Preservation Officer
SPD	South Pacific Division
SROG	Multi-City Subregional Operating Group
SRP	Salt River Project
SRPMIC	Salt River Pima Maricopa Indian Community
SRS&R	Salt River Sand & Rock
SWPPP	storm water pollution prevention plan
TDS	total dissolved solids
TRRMP	Tres Rios River Management Plan

TYs	Target Years
UAU	Upper Alluvial Unit
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
VSA	Va Shly'ay Akimel
VOCs	Volatile Organic Compounds
WQRAF	Arizona Water Quality Revolving Assurance Fund
WSRV	West Salt River Valley
WWTP	Wastewater Treatment Plant

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CHAPTER I
STUDY AUTHORITY

This report was prepared as an interim response to the following authorities provided by Congress:

a. House Resolution 2425 (HR 2425), dated May 17, 1994, (Figure 1, below) which states:

> *"... the Secretary of the Army is requested to review reports of the Chief of Engineers on the State of Arizona ... in the interest of flood damage reduction, environmental protection and restoration, and related purposes."*

b. The second authority is given in Public Law 761, Seventy-fifth Congress, dated June 28, 1938, known as Section 6 of the Flood Control Act of 1938 of Public Law 761, which reads in part as follows:

> *"The Secretary of War is hereby authorized and directed to cause preliminary examination and surveys ... at the following localities: ... Gila River and tributaries, Arizona."*

The Energy and Water Development Appropriations Act of 2001 (Public Law 106-377, dated October 17, 2000) provided $150,000 for the Corps of Engineers to evaluate opportunities for environmental restoration and related matters on the Salt River in Arizona.

H.S. House of Representatives

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

SUITE 2165 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4472

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

RESOLUTION

State of Arizona
Docket 2425

Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That, the Secretary of the Army is requested to review the reports of the Chief of Engineers on the State of Arizona, published as House Document 331, Eighty-first Congress, First Session; Senate Document 116, Eighty-seventh Congress, Second Session; Senate Document 127, Eighty-Seventh Congress, Second Session; House Document 625, Seventy-Eighth Congress, Second Session, House Document 648, Seventy-Eighth Congress, Second Session; Senate Document 63, Eighty-eighth Congress, Second Session; and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of flood damage reduction, environmental protection and restoration, and related purposes.

Adopted: May 17, 1994

ATTEST: [signature]
NORMAN Y. MINETA, Chair

Figure 1. House Resolution 2425

CHAPTER II
STUDY INFORMATION

2.1 Study Purpose and Study Scope

The Va Shly'ay Akimel Salt River Restoration Study is being conducted by the U.S. Army Corps of Engineers (USACE), Los Angeles District, the Salt River Pima-Maricopa Indian Community (SRPMIC), and the City of Mesa, Arizona. The purpose of this study is to identify whether there is a Federal interest in implementing an ecosystem restoration project along the Salt River from Granite Reef Dam downstream to the Pima Freeway (SR101). This study identifies feasible ecosystem restoration alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable. The SRPMIC and the City of Mesa, as non-Federal sponsors, support the proposed project purpose to provide ecosystem restoration, passive recreation, and other related outputs.

This report describes the existing conditions in the project area, the future without-project condition, and the future with-project condition. Conditions that exist at the time of the study are collectively called the existing condition. The without-project condition is the same as the "no action" alternative, and describes what is expected to happen in the absence of Federal action. The future with-project condition describes what is expected to happen if each alternative plan is implemented. The significant natural, economic, and social resources described in the existing and future without-project condition are compared to the future with-project condition in order to identify differences among alternatives.

Alternative plans are being developed to provide for restoring a diversity of riparian habitat to a more natural state. This report is intended to ultimately be a complete decision document that presents the results of the feasibility phase of the General Investigation effort. Specifically, this feasibility report will:

- Provide a complete presentation of study results and findings, so that readers can reach independent conclusions regarding the reasonableness of recommendations;
- Assure compliance with applicable statutes, executive orders, and policies, in accordance with budgetary priorities; and

- Provide a sound and documented basis for decision-makers at all levels to judge the need and justification for the recommended solution(s).

2.2 Need for the Project/Proposed Action

The SRPMIC, the City of Mesa, and the Corps of Engineers together are conducting the feasibility study to identify and define environmental degradation, flooding, and related land and water resource problems and to develop solutions to restore the environment.

The primary problem is the severe degradation and loss of riparian habitat along the Salt River since the early 20th century. The Salt River once flowed perennially and supported substantial growth of cottonwoods, willows, and mesquites. The river channel carried abundant water that supported early irrigation projects. Increasing appropriation of surface and ground water to support expansion of agriculture and growing urban populations resulted in the transformation of the Salt River to a dry river that flows only ephemerally in response to storm runoff.

As a result of this change, stands of native riparian habitat are rare in the study area. Loss of riparian habitat is extremely significant in the arid southwest. Historically comprising a mere three percent of the landscape, over 95 percent has already been lost in Arizona. This type of river-connected riparian and fringe habitat is of an extremely high value due to its rarity. Arid southwest riparian ecosystems are designated as a critically endangered habitat type. It has been estimated that 75 to 90 percent of all wildlife in the arid southwest is riparian dependent during some part of its life cycle. As a direct consequence of the extent of the lost or degraded riparian habitat, the area has experienced a major reduction in species diversity and in the population of remaining species. In addition, destruction of native riparian habitat facilitates an increase in invasive plant species that are more tolerant of disturbed conditions. Such plants consume more water than do native vegetation because of their ability to occupy a greater areal extent on the landscape, placing additional strains on limited water supply.

Presently, there are still adjacent parcels of undeveloped land in the Salt River area, and potential sources of water for restoration still exist. As long as these conditions remain unchanged, there is an opportunity to accomplish significant restoration in the study area. Restoration options have the potential to increase riparian habitat acreage and quality thereby expanding wildlife diversity and quantity, controlling invasive plant species, and providing an ecological resource that is significant and valuable to the SRPMIC and to the region.

2.3 Study Area

The study area is geographically located in Maricopa County, Arizona, and includes portions of the SRPMIC and the City of Mesa, 18 miles east of the City of Phoenix (see Figure 2). The study area is approximately 14 miles long, extending from immediately downstream of the Granite Reef Dam to the Pima Freeway (SR101), and averages approximately 2 miles wide and consists of approximately 17,435 acres. The study area lies within the sovereign Salt River Pima-Maricopa Indian Community and the jurisdiction of J.D. Hayworth of the Arizona 5th Congressional District.

The Va Shly'ay Akimel project is one of four ecosystem restoration projects that are at various stages of progress, from the planning phase to construction, conducted by the Corps and various local sponsors along the Salt River downstream of Granite Reef Dam. Figure 3 shows the location of the Va Shly'ay Akimel project relative to these other projects.

The Rio Salado project, just downstream from Va Shly'ay Akimel, was the first of this series of projects to be authorized. This project is currently under construction. The Rio Salado Oeste project is immediately downstream of the Rio Salado project and is currently in the feasibility study phase as well. The Tres Rios project, just downstream from Rio Salado Oeste, is currently in the engineering and design stage.

2.4 History of the Investigation

In response to the study authority, the reconnaissance phase of the study was initiated in November 2000. This phase of the study resulted in the finding that there was a Federal interest in continuing the study into the feasibility phase. The SRPMIC and the City of Mesa, as the non-Federal sponsors, and the USACE initiated the feasibility phase of the study in August 2001. This is the first USACE ecosystem restoration study undertaken with a sovereign Native American Indian community as a non-Federal sponsor.

Figure 2. Project Study Area

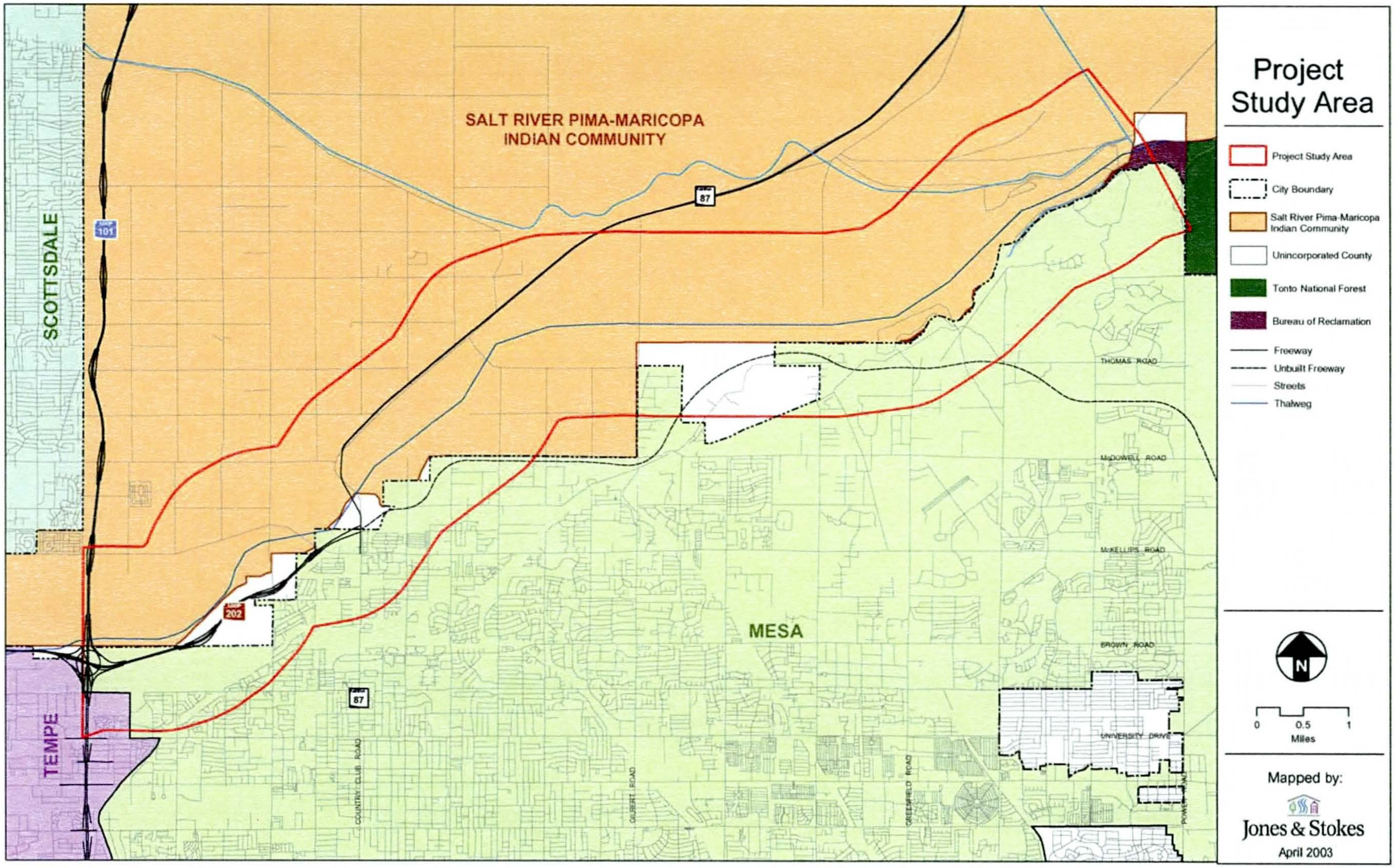
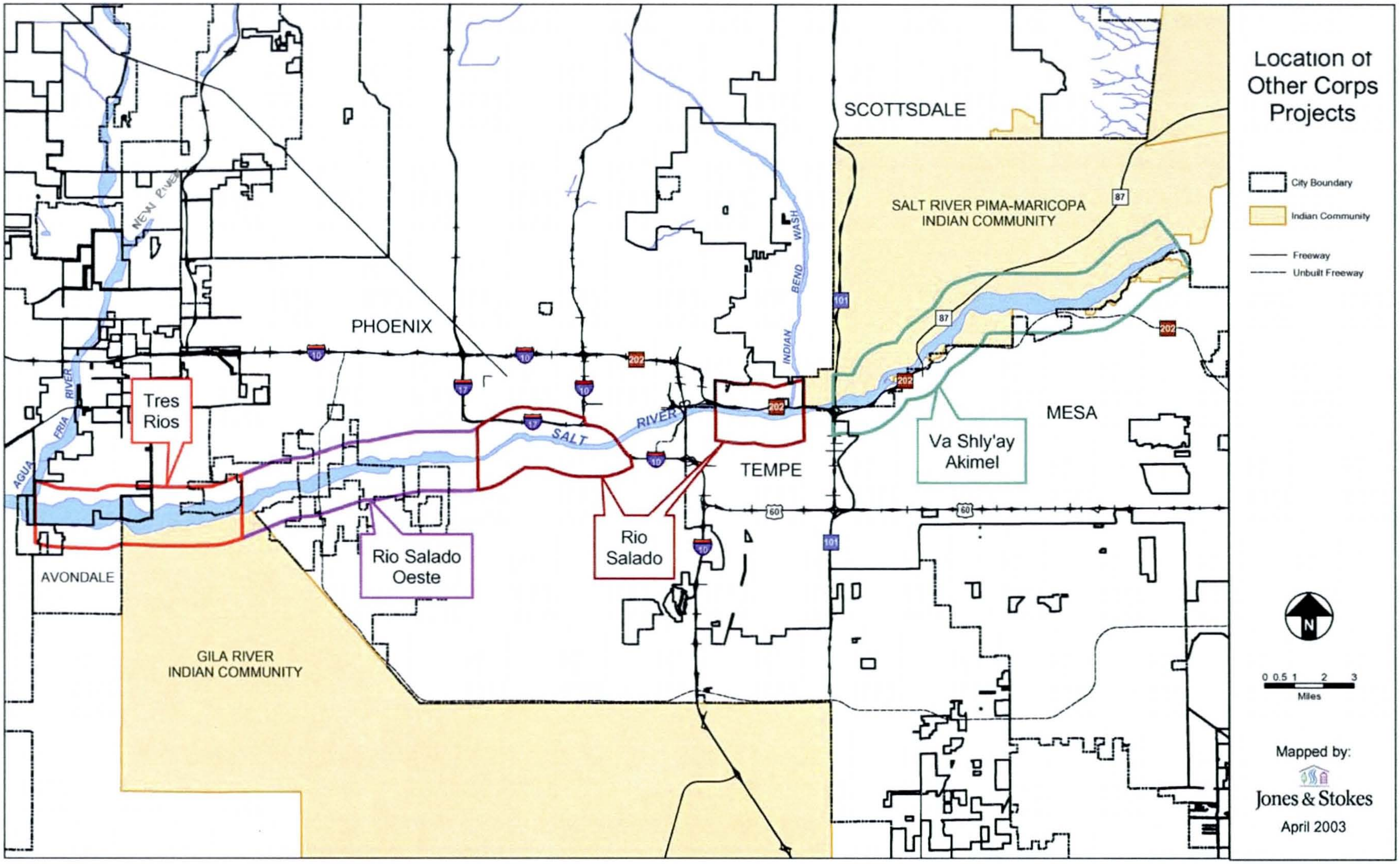


Figure 3. Location of Other Corps Projects



2.5 Planning Process and Report Organization

The Corps planning process consists of six steps defined in the Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies established in 1983 by the Water Resources Council. The process identifies and responds to problems and opportunities associated with the study objectives and specific Federal, state, and local concerns. The planning process culminates in the selection of a recommended plan or the alternative of no action. The process involves a systematic approach to making determinations at each step so that the interested public and decision-makers are fully aware of the basic assumptions employed. The data and information analyzed, the areas of risk and uncertainty, the reasons and rationales used, and the significant implications of each alternative plan are all exposed through this process. The six steps listed below are addressed in this report and are contained in the chapters shown. These steps are further described in Chapter V, Plan Formulation.

(1) Specify water and related land resources problems and opportunities (Chapter V)

(2) Inventory, forecast, and analyze water and related land resources conditions within the study area (Chapter IV)

(3) Formulate alternative plans (Chapter V)

(4) Evaluate the effects of the alternative plans (Chapter V)

(5) Compare the alternative plans (Chapter V)

(6) Select the recommended plan based upon the comparison of the alternative plans (Chapter V and presented in Chapter VI)

The final product of this feasibility study is this Feasibility Report and an Environmental Impact Statement (EIS) that will serve as the basis for obtaining Congressional authorization of the plan components determined to be feasible and cost-effective.

The requirements identified in this report may change as project features are further refined during the Pre-construction Engineering and Design (PED) Phase of the project. The project features including actual lands required and estates to be acquired in those lands may change after approval of the feasibility report. As project features are further refined in subsequent implementation efforts, the USACE will review the siting determination for the various project features set out in the report in accordance with established policies. This review may result in changes in design or land requirements for specific project features, while maintaining the overall benefit levels presented in the recommended plan. If there are substantive changes in the recommended plan and/or the requirements of this project based on more detailed analysis, then the Los Angeles District will prepare necessary documentation.

CHAPTER III

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

Prior to the beginning of this feasibility study, many efforts had been conducted to identify, quantify, and seek funding to implement solutions to help alleviate flooding and improve environmental quality in the Salt River ecosystem. This chapter discusses these studies and reports that have been prepared on issues relating to the Salt River study area. Also included in this chapter are existing projects and structures located within the study area.

3.1 Prior Studies and Reports

The Salt River has been the subject of numerous water resource and environmental resources studies. Past efforts of interest to this feasibility study have been conducted by the USACE and other Federal, state, and local agencies. These studies focused on issues including flood protection, water conservation, recreation and urban development, environmental assessments, and fish and wildlife habitat restoration. Recent, ongoing, and planned studies that lie within the Salt River study area have been identified and are described in the following sections. Relevant information contained in these studies is incorporated into this feasibility study.

3.1.1 Water Resources Studies or Reports

In 1974, the Maricopa Association of Governments (MAG) completed an overall conceptual plan for a Salt River redevelopment. The plan outlined water use and implementation recommendations and called for specific plans for two demonstration projects.

In 1978, the USACE conducted a study that extended along the Salt River from the Gila River confluence to Granite Reef Dam. The study evaluated problems and alternative possibilities relating to flood damage reduction, wastewater, floodwater conservation, and fish and wildlife recreation. The study focused specifically on the 16-mile reach between 27th Avenue in Phoenix and Country Club Road in the City of Mesa.

In 1981, the USACE investigated water and related land resources issues in the Phoenix Metropolitan area as a result of severe flooding along the Salt and Gila Rivers. Issues discussed included water quality, flood damage reduction, water conservation, and fish and wildlife enhancement. None of the projects proposed by local agencies, with the exception of flood damage reduction along the Salt and Gila Rivers, were found to warrant Federal interest. The flood damage reduction measures presented included flood proofing, relocation, floodplain regulations, preparedness planning, channel excavation, and evaluation of hydraulic structures.

A Rio Salado Development District was created in the late 1970s and early 1980s. Their function was to investigate and implement a regional redevelopment of the Salt River. Maricopa County voters defeated the resolution to create a continuing tax authority for the District, so that it no longer exists. However, several studies were conducted by the District before its dissolution, one of which was a published memorandum in 1982, which provides a basis for the determination of a source of water for the redevelopment project. The memo identifies potential sources, gives general background on these sources, and provides a preliminary analysis of each.

In 1982, Water Resources Associates, a private engineering consulting firm, conducted a study that evaluated the potential water sources and flood damage reduction options for a regional redevelopment of the Salt River. Sources for domestic water included obtaining Central Arizona Project (CAP) allotment and obtaining water rights from surface and groundwater and from lands within the district. The source identified for aesthetic and recreational water was low quality groundwater. Flood management plans were based on an existing condition scenario and of an upstream flood damage reduction design condition.

In 1982, Carr, Lynch Associates, a private engineering consulting firm, also conducted a study, which evaluated the potential water sources and flood damage reduction options for a regional project within the Salt River. This study included discussion on the physical structure of the project and its surroundings, the social structure, the economic situation, water supply, and flood damage reduction.

In 1989, Simons, Li & Associates, Inc., a private engineering consulting firm (now Tetra Tech, Inc.), prepared a report on the channelization of the Salt River through Tempe, Arizona. The study addressed issues related to channel design, determined appropriate hydraulic design criteria, and presented several alternative design concepts. The engineering analysis included the evaluation of alternative river sections, alignments, and profiles. In addition, the study identified potential impacts due to the proposed changes.

In 1989, the USACE completed the *Salt-Gila Reconnaissance Report*. This study focuses on the flooding problems and associated solutions downstream from the confluence of the Verde and Salt Rivers to Gillespie Dam. No analyzed solution was economically justified; therefore, the study did not proceed to the feasibility phase.

In 1992, the USACE completed the *Central Maricopa County Reconnaissance Study*. This study described and analyzed flooding problems and water resource opportunities within the Phoenix metropolitan area to develop a wide range of alternatives that would reduce the severity of or totally eliminate flooding problems. Twenty-three flooding problems were identified within Central Maricopa County. Two areas determined to have Federal interest included a flood damage reduction project on the Dysart Drain near Luke Air Force Base, and water quality and environmental restoration project on the Salt River near 91st Avenue. The restoration project was Tres Rios, which was not recommended to proceed to the feasibility phase at that time.

In 1993, the U.S. Bureau of Reclamation (USBR) completed the *Conceptual Design for the Tres Rios Demonstration Wetlands*. The design was completed in cooperation with the City of Phoenix, Arizona Game and Fish Department (AGFD), Arizona Department of Environmental Quality (ADEQ), Maricopa County Parks and Recreation, Maricopa County Flood Control District, and the U.S. Environmental Protection Agency (USEPA). The study evaluates methods for reclaiming water from sewage effluent from the 91st Avenue regional wastewater treatment plant and develops plans for using the reclaimed water directly or through exchange mechanisms. This report presents a conceptual design for a constructed wetland demonstration project designed to improve the quality of treated effluent currently being discharged to the Salt River.

In 1994, Arizona State University (ASU) completed a geomorphic assessment of the Salt River for the USACE. The assessment supports a reconnaissance-level geomorphologic evaluation of the lower Salt River and a portion of the Gila River. The study discusses the environmental history, hydrologic system, geomorphic system, and engineering features of the Salt River.

In 1994, the USACE completed a bank stabilization study on the Salt River. The study focused on that portion of the Salt River located entirely within the Salt River Pima-Maricopa Indian Community, east of Scottsdale, within Maricopa County. Flood events in 1992 and 1993 caused erosion of landfill material into the Salt River. Several flood protection measures and alternatives were considered. The study concluded that there was no Federal interest in participating in installation of bank stabilization at this location. With funding from the Federal Emergency Management Agency (FEMA), the SRPMIC initiated construction of bank stabilization of two of the landfill sites.

In 1994, the Flood Control District of Maricopa County completed a land use and structures inventory. The inventory was published in a report, which listed the various structures, utilities, and land use conditions along the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam

In 1995, the USACE completed the reconnaissance phase of the Rio Salado, Salt River, in Arizona, which included an assessment of the problems and opportunities and an evaluation of alternatives for a 33-mile portion of the Salt River. In April 1998, the USACE completed the *Feasibility Report and Environmental Impact Statement for the Rio Salado, Salt River, Arizona.* This report identified plans that provide environmental restoration benefits and serve the public interest. The project is currently in the PED phase with construction of some components underway.

In 1996, the USACE, in cooperation with USBR, completed an analysis of various release plans for the operation of the modified Roosevelt Dam. As a result of this effort, new hydrology, which showed significant reductions in discharge downstream, was developed for the lower Salt and Gila Rivers.

In April 2000, the USACE completed the *Feasibility Report and Environment Impact Statement for Tres Rios, Arizona.* This study examined a portion of the Salt River and Gila River from 83rd Avenue downstream to the Agua Fria River. The study selected a plan that includes environmental restoration and flood damage reduction components. The project is currently in the PED phase.

The USACE is currently conducting a feasibility study that is examining the water resource opportunities along the Salt River, in Phoenix, Arizona, between 19th and 83rd Avenues. The study area is located between the authorized Rio Salado project area and the Tres Rios feasibility study area. The project, Rio Salado Oeste, is approximately eight river miles in length. The non-Federal sponsor is the City of Phoenix. The study area includes portions of the City of Phoenix, Maricopa County, as well as state and Federal lands.

The Flood Control District of Maricopa County (FCDMC) has teamed up with the cities of Phoenix, Tolleson, and Avondale to prepare an area drainage master plan (ADMP) for the southwest valley area of Maricopa County. The *Durango ADMP* quantifies the extent of flooding problems and develops a solution to the identified flooding problems. This master plan addresses much of the land to the north of the project area and potential for flooding problems due to interior drainage. The following is a website link to the ADMP: http://www.fcd.maricopa.gov/Projects/DurangoADMP/

The FCDMC has also completed the *Laveen Area ADMP*. The study area is in the southwestern portion of the metropolitan Phoenix area within Maricopa County, Arizona, and is 39 square miles in the City of Phoenix and unincorporated Maricopa County. The focus area for this portion of the ADMP is the 16 square miles west of 43rd Avenue. The entire area bounded by the Salt River on the north, 7th Avenue on the east, South Mountain Park on the south, and the Gila River Indian Reservation boundary on the west is the contributing area for the hydrology. The project has been completed and components of it are in planning and pre-design. The following is a website link to the ADMP: http://www.fcd.maricopa.gov/Neighborhood/ProjectDetails.asp?wPROJECT=32

3.1.2 Recreation and Urban Development Studies or Reports

In 1985, Carr, Lynch Associates, a private engineering consulting firm, completed a master plan for a regional redevelopment of the Salt River corridor. The master plan involves a major reclamation of nearly 10,000 acres of land, including transformation of the present riverbed into a regional park and development of its banks, cultural, and educational uses. This master plan document was never implemented.

In 1997, as required by state law, Maricopa County prepared a comprehensive plan "to conserve the natural resources of the County, to ensure efficient expenditure of public funds, and to promote the health, safety, convenience, and general welfare of the public" (Maricopa County, 1997). The plan provides a guide for decisions made by the planning and zoning commission and the Board of Supervisors concerning growth and development. The Salt River itself is identified as "Proposed Open Space" on the land use map. This designation recognizes that natural resources and open spaces are important to the quality of life in the county and, if acquired, are intended to be planned and managed to protect, maintain, and enhance their intrinsic value for recreational, aesthetic, and biological purposes.

There is strong support for protecting natural and cultural resources and for environmental education in Arizona. In the 1994 Statewide Comprehensive Outdoor Recreation Plan (SCORP) survey, 94 percent of respondents stated that parks and recreation areas are important to their everyday lifestyles. Seventy-five percent favor preserving rivers and stream-side habitats, even if it means limiting some uses of privately-owned lands. A separate study conducted by the Arizona Game & Fish Heritage Fund (*Attitudes Toward Urban Wildlife Management, Volume 1, May 1995*) supports these statistics. A statewide survey was conducted of 1,200 residents. In the Heritage Fund survey, 89 percent of respondents stated that the continued presence of wildlife in their town is important to them. The importance placed on protecting water-based habitat and recreation areas can be attributed to the limited amount of surface water available. Arizona has approximately 113,642 square miles of land surface, but only about 360 square miles are water-covered.

In 2002, the City Council and voters within the City of Mesa approved a Master Plan for the city of Mesa titled, "Mesa 2025-A Shared Vision." The *Mesa 2025* publication provides feedback on the attitudes of local residents regarding recreation. Surveys conducted for the study concluded that residents desire more parkland, particularly more passive recreation facilities. Participants support the City taking an active roll in identifying and pursuing a variety of partnerships with public and private entities to create new recreation facilities.

3.1.3 Environmental Assessment Studies or Reports

In accordance with the requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality, environmental assessment studies have been prepared for a number of studies or reports previously described. These include feasibility studies that were conducted or being completed by the USACE for ecosystem restoration projects along the Salt River from Granite Reef Dam. The studies include the Rio Salado (1995), Tres Rios (2000), and Rio Salado Oeste (current).

3.2 Existing Water Projects

The following projects and structures are located within the Salt River watershed. Figure 4 shows the location of the Va Shly'ay Akimel project relative to these other projects.

3.2.1 Salt River Project System

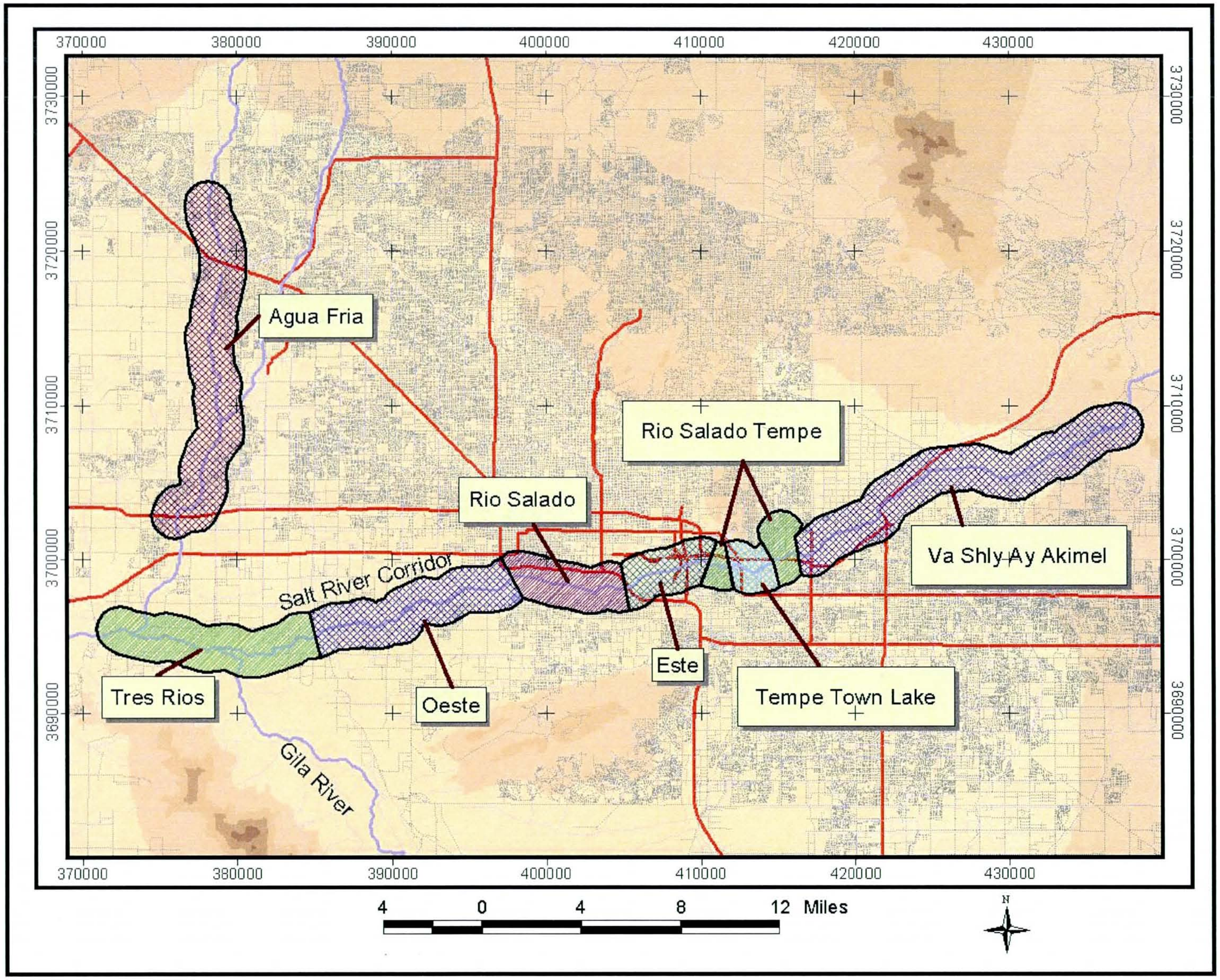
Flows in the Salt River are controlled by a series of upstream dams built by USBR and operated by the Salt River Project (SRP). The SRP system is comprised of six reservoirs and seven dams on the Salt and Verde Rivers. The dams include Roosevelt Dam, Horse Mesa Dam, Mormon Flat Dam, Stewart Mountain Dam, and Granite Reef Dam on the Salt River. On the Verde River, the dams are Horseshoe Dam and Bartlett Dam. The reservoirs receive runoff from a combined watershed of more than 12,600 square miles.

Roosevelt Dam is the oldest and largest in the SRP system. Congress originally authorized it in 1903 for water supply and power generation. The construction of the dam was completed in 1911. In 1978, Congress authorized the modification of Roosevelt Dam. The modifications were to include a new storage allocation for flood damage reduction. The modifications to the Dam began in 1989 and were completed in 1996. Roosevelt Dam has been operated under a new Water Control Manual since 1997.

3.2.2 Tres Rios Demonstration Project

The Phoenix Metropolitan area is serviced by a regional wastewater treatment plant located at 91st Avenue and the Salt River. The plant discharges approximately 154 million gallons per day (mgd) of effluent to the Salt River. The treatment plant is operated by the City of Phoenix on behalf of the Multi-City Subregional Operating Group (SROG). The SROG represents a consortium of cities including Phoenix, Mesa, Glendale, Tempe, Scottsdale, and Youngtown. In 1992, USBR was authorized by Sections 1605 and 1608 of Public Law 102-575 to participate in the development of a demonstrations wetlands project at the 91st Avenue plant. In 1995, the SROG and USBR built the Tres Rios Demonstration Project within the floodway of the Salt River below the 91st Avenue plant. The project provides final treatment of approximately 2 mgd of effluent within 10 acres of constructed wetlands.

Figure 4. Existing Water Projects



3.2.3 Salt River Channelization

west of 40th St.

In 1996, the Arizona Department of Transportation (ADOT) and the MCFCD completed channelization of the Salt River from 48th Street to Price Road, a distance of approximately 7.5 miles. The channelization included soil cement and gabion bank protection with grade control and drop structures. The channelization is designed to convey floodwaters and eliminate erosion and channel migration. The design capacity is 250,000 cubic feet per second (cfs) with one foot of freeboard at Rural (Scottsdale) Road Bridge. The construction also included construction of a defined confluence with Indian Bend Wash. *

3.2.4 Tempe Town Lake

The City of Tempe, together with private developers, constructed Tempe Town Lake on the Salt River. The project includes two inflatable dams within the Salt River bed, which serve to confine approximately 3,500 acre-feet of lake water. The project features also include an extensive seepage control system, which consists of multiple groundwater pumps. As the lake infiltrates into the riverbed, the pumps recover the water and convey it back into the lake.

* - South bank Levee from Price to Country Club Dr (SR87)
- North bank Levee from Price to Alma School Rd.

CHAPTER IV
EXISTING CONDITIONS

In conducting this feasibility study, a wide range of technical issues were analyzed with the goal of developing an accurate description of historic, existing, and future without-project conditions in the Va Shly'ay Akimel study area. Available information was initially collected about existing studies and projects that could assist in the preparation of the inventory of historic and existing conditions and the forecasting of future without-project conditions to characterize the baseline conditions for the study area. Without a good understanding of the existing condition, one cannot understand what constitutes an improvement from a degraded condition. The information presented under baseline conditions is used to formulate alternative measures that address the watershed problems and opportunities discussed in Chapter V, Plan Formulation. Major technical areas of focus for the study include hydrologic and hydraulic studies, environmental studies related to biological resources, cultural resources, economic analysis, and recreation.

4.1 Historic Conditions

The Salt River has diverse characteristics and is considered by many to be the most vibrant natural feature of the Phoenix metropolitan area. It originates at Mount Baldy in the White Mountains where streamlets of water from the Black River form its eastern sides, while the White River begins on the western side of the mountain. Over the next hundred miles, the Salt River, unregulated, gathers up the waters of smaller streams, such as Carrizo, Canyon, and Tonto Creeks, before manmade structures control its flow. Eventually the Salt River joins the Verde River before merging with the Gila River. The Salt River watershed drains approximately 14,500 square miles. The water's brackish taste, acquired by the stream flowing over salt beds, gave the river its name.

During the past 150 years, the lower Salt River has undergone natural and artificial modifications beginning with Native American settlements and continuing to present day urban growth. The river's present form is the result of both natural climatic variations occurring during these years and human activities that manipulated the river. To study the sequence of changes to the Salt River, the following discussion is broken into periods that reflect unique combinations of human activities and natural climatic variation.

Native American Use (circa 500 B.C. to 1867 A.D): Native American peoples developed simple, small-scale agriculture along the Salt River. This gradually evolved into large agricultural irrigation systems, drawing water from the Salt River into an extensive canal system. Salt River Valley populations rose steadily and then fell in the 1400s when inhabitants largely abandoned the canal system and local towns. Reasons for this depopulation are still debated, but some archeologists have speculated that extensive drought periods, punctuated by damaging floods, proved to be too great a strain on the local irrigation system. From the late 1400s to 1867, human use of the lower Salt River was sporadic and small in scale.

Farming Settlements and Canal Companies (1867-1911): Non-Native American settlement of the Salt River Valley began in the late 1860s when immigrants began irrigating lands near the Salt River to grow hay for the U.S. Army at Fort McDowell. The number of both local canal systems and cultivated acres increased steadily for the rest of the nineteenth century until the extremely severe drought of 1898-1904. One response to the drought was to begin building a huge upstream water storage dam at the confluence of the Salt River and Tonto Creek, about 60 miles east of downtown Phoenix. During this period, farmers' diversion drastically reduced the river's summer flow. The effects on river flows from late fall through spring would have been modest. Annual winter and spring high flow would have been largely unaffected. Exotic phreatophytes began establishing themselves along the river during this period.

Salt River Project (SRP) and the Capturing of the Salt and Verde Rivers (1911-1941): During this period, people constructed the infrastructure to capture water above the valley and to divert water more efficiently from the river into the canal systems. The view of the time was that this avoided "wasting" the water by leaving it in the river. The Federal Government built Roosevelt Dam (1904-1911) to store and regulate Salt River flows on behalf of the local landowners who organized themselves as the Salt River Valley Water Users Association (later the SRP). The USBR also built Granite Reef Diversion Dam to divert water from the Salt River into a now unified and re-plumbed system of irrigation canals. The SRP built three more storage dams on the Salt River from 1923 to 1931. These dams now controlled the river in all but the wettest years, and SRP released from the reservoirs only the amount of water needed for diversion to canals at Granite Reef Dam.

Until the 1930s, there was no upstream storage on the Verde River. High Verde flows in winter and spring continued to send water past Granite Reef and down the Salt River channel through the valley. The completion of Bartlett Dam on the Verde in 1938 finally cut off this unregulated source of flow. In the 1920s, Waddell Dam cut off flows into the Salt-Gila from the Agua Fria River, and farmers built Gillespie Dam downstream on the Gila. Gillespie Dam allowed efficient diversion of irrigation return flows and groundwater seepage from the Gila for use of farmland to the south and west.

Dams now captured most river flows upstream, but groundwater tables along the river remained high. These two factors combined to support increasingly extensive and dense stands of riparian vegetation, dominated by phreatophytes. This was also a relatively wet period for the Salt and Verde watersheds, with many years of above average precipitation and few droughts. A very wet 1941 marked the end of the period with major river flows released from overfilled storage reservoirs upstream.

Mid-Century Drought, Groundwater Development, and Urban Growth (1942-1977): A prolonged series of slightly-to-very dry years characterized much of 1942 through 1977, with only a couple of notable exceptions in the 1960s and 1970s. At the same time, the Phoenix area saw unprecedented urban growth alongside a still extensive agricultural economy. High water demands and low surface water supplies prompted a rapid increase in the number of groundwater wells. The rapid rise in the amount of groundwater pumped resulted in a rapid fall in groundwater levels. There was increasing concern about long-term water supplies and insufficient water conservation. With water tables falling below the phreatophytes' root zone and with no surface flows in the river, much of the riparian vegetation disappeared. This prolonged period without much water in the river also encouraged the construction of unbridged river crossings and bridges designed to handle only small floods. Short memories and dry rivers also encouraged encroachment into the floodplain by buildings and landfills.

Flood Flows, Effluent Supplies, and Increased Water Management (1978-present): Heavy rain and flooding in 1978, 1979, and 1980 broke the severe drought of 1976 and 1977 across much of the western United States. This proved to be the beginning of an abnormally wet period that ran through 1995, although there were two very dry years in the early 1990s. In many river segments, these major floods in 1978, 1979, 1980, 1983, 1993, and 1995 scoured away accumulated sediments and caused some lateral shifting of channels. The floods also destroyed many inadequate bridges and prompted construction of many new and larger replacements. There was significant damage to commercial structures and a few residential areas that had encroached on the river. Renewed awareness of the river's potential also prompted channelization and bank protection in some areas. These floodflows raised groundwater tables near the river, at least temporarily.

For decades, the Arizona legislature had unsuccessfully wrestled with the problem of increasing water demand and declining groundwater tables. The legislature finally agreed with Federal agencies that this long-term problem deserved state government intervention. It enacted the Groundwater Management Act of 1980, providing some controls on groundwater pumping, requiring water conservation measures, and encouraging effluent re-use. The Act generally forced water providers to be more sophisticated in their water management and ultimately resulted in a highly organized structure of controls, credits, procedures, and regulatory permits governing conveyance, use, and storage of groundwater.

Urban growth had a significant effect of increasing one source of water supply to the river: effluent-based streamflow. Treatment plants returned a portion of treated effluent to the Salt River channel in southwest Phoenix, causing the river to support riparian vegetation once again. Finally, Tempe and then Phoenix began projects to use the broad, largely barren river channel in the center of the metropolitan area. These projects feature artificial lakes and streams for recreational use and enhanced development.

4.2 Existing/Baseline Conditions

Existing conditions are defined as those conditions that exist within the study area at the time of the study. The future without-project condition, which is the same as the "no action" alternative, is a projection of how these conditions are expected to change over time and form the basis against which plan formulation alternatives are developed, evaluated, and compared. Baseline conditions refer to the without-project conditions expected at the time that a project would be implemented, sometimes 2 to 5 years subsequent to completion of the feasibility study.

4.2.1 Geology, Topography, and Geomorphology

The Salt River floodplain is located within the gentle, flat slopes of the Phoenix basin of the Salt River Valley. The area is geomorphically located within the Gila Lowland Section of the Sonoran Desert Subprovince, a part of the Southern Basin and Range Physiographic Province. This province is characterized by broad, gently sloping, connected alluvial valleys (basins) bounded by moderately high, rugged, northwest- to southeast-trending mountain ranges. During the late Miocene epoch (Tertiary period), the mountain ranges were extensively dissected, uplifted, and downdropped by northwest- to southwest- and east- to west-trending sub-parallel normal faults. Extensive volcanic activity accompanied the faulting. These sedimentary and volcanic rocks lie unconformably upon an ancient Precambrian igneous and metamorphic basement complex. The complex is composed predominantly of igneous granite and diorite, metamorphosed schist, gneiss, and volcanic rock and underlies basin terrace and alluvium at depths of 10,000 feet or greater. The Tertiary rocks are made up of volcanic basalt, andesite, rhyolite, sedimentary sandstone, siltstone, and conglomerate.

From the late Miocene until the late Pliocene, the ranges deeply eroded and filled their downdropped areas (basins) with sediments, which were later consolidated into sedimentary rocks. From the end of the Pliocene until recent (Holocene) time, the basins, including the Salt River Valley, filled with unconsolidated and occasional semi-consolidated sediment eroded from the ranges. The thickest accumulations of valley alluvium formed during the early to middle Quaternary period.

The predominant surface materials within the Va Shly'ay Akimel project area consist of Quaternary-age river sediment deposited as alluvium and terraces and, to a lesser extent, sheetwash-deposited alluvium and slope-deposited colluvium. Quaternary sediments consist of:

- Salt River Valley alluvium and terraces – unconsolidated to well-cemented gravel and boulders interbedded with irregular silt, sand, and gravel lenses; and

- Colluvium – loose- to well-cemented silt, sand, clay, and gravel.

The Quaternary alluvium and colluvium deposits range in thickness from about 275 to 4,500 and 5 to 250 feet (east to southwesterly across the site), respectively. Thick layers of alluvium have accumulated within the major streams, tributaries, and floodplains of the Salt River. Streambed alluvium and terraces are flanked, covered, and underlain by thinner layers of wind- and sheetwash-deposited alluvium and bedrock colluvium. Terrace deposits range from about 5 to 250 feet thick and also consist of unconsolidated silt, sand, gravel, and boulders to highly cemented caliches. Terrace deposits are considered older than the alluvium within the Salt River. The contacts between the two types of deposits are gradational at depth (undifferentiated) and overlie the thick Tertiary sedimentary and volcanic rocks that lie beneath the basin as discussed earlier. They interface with Tertiary rocks along mountain ranges and inselbergs. Salt River Valley terrace deposits lie exposed above the Salt River channel in locations throughout the project area.

The Va Shly'ay Akimel study area extends a total of approximately 14 miles along the Salt River, which flows west into the Phoenix Basin from the Superstition and Goldfield mountain ranges. The study area extends west from Granite Reef Dam to the Pima Freeway (SR101) and is characterized by relatively flat terrain with slopes ranging from 0 to 2 percent. The width of the Salt River floodplain in the project area ranges from approximately ¼ mile to 1.0 mile wide.

Soils

As discussed above, the interior floor of the Salt River Valley is comprised of thick layers of alluvium. This land is nearly level and generally has a hummocky appearance. The alluvium consists of stratified, recently deposited stream sediment in the channels of the Salt River. The U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) categorizes the soils in the vicinity of the river channel in a group known as the hypothermic torrifluvents association, a group of soils that are well-drained to excessively well-drained soils that exist on nearly level or gently sloping surfaces. The texture of the surface layer ranges from gravelly sand, or very gravelly sand, to fine sandy loam. The material beneath the surface layer is very gravelly sand to very fine sandy loam or loam. These soils are often redistributed by blowing wind and the shifting of stream channels, making mapping of individual areas as soil units infeasible. Permeability ranges from very rapid to moderate; runoff is slow and soils are fine enough that they may become airborne during wind events.

Gradient

$\frac{9.5}{5280} = 0.0018$ ft/ft.

The average gradient of the lower Salt River between Granite Reef Dam and the confluence with the Gila River is about 9.5 feet of vertical drop per mile of horizontal distance, although there are numerous local variations. The gradient has decreased to a small degree because of erosion in the upper reaches and deposition in the lower reaches.

Faults and Seismicity

Faults in central Arizona are generally short, discontinuous, normal faults, some of which have been interpreted to displace Quaternary formations. Most fall within the Jerome-Wasatch Structural Zone, an approximately 47-mile-wide band that extends from Utah into Mexico. In Utah, the zone is associated with current earthquake activity and displays evidence of abundant Quaternary faulting. In Arizona, the zone includes the Main Street Fault in the northwest corner of the state and the Verde Fault, located approximately 56 miles north of the Va Shly'ay Akimel study area.

The Va Shly'ay Akimel study area is located in an area of low seismicity as referenced in Zone 1 of the Seismic Zone Map of the Contiguous States (U.S. Army Corps of Engineers, 1983). DuBois, *et al.* (1982) list 29 earthquakes with maximum epicentral intensities between II and VI on the Modified Mercalli Intensity Scale (MM) which have occurred within a 100-mile radius of the study area from 1870 through 1980 (I-III represent slight shaking; and IV-VI represent non-damaging, widely perceptible shaking). The largest of these known earthquakes occurred southeast of Ajo in 1961, northeast of Globe in 1969, and northwest of Prescott in 1976. The 1961 event, 95 miles from the study area, had a Richter magnitude of 4.7 (no known reports from the Phoenix area). The 1969 event, 72 miles from the study area, had a Richter magnitude between 4.4 and 5.1 (assigned an MM intensity of II at Phoenix). The 1976 event, 81 miles from the site, had a Richter magnitude of 5.1 (assigned an MM intensity of IV at Phoenix).

From 1980 through 1998, numerous small earthquakes are listed within a 100-mile radius of the project. All of these are at the extreme limits of the search area, including the Jerome-Prescott area to the north, and the Mogollon Rim area to the northeast. The highest Richter magnitude quake occurred along the Mogollon Rim in 1989, registering a 3.4 value.

The largest known earthquake to occur in Arizona was of Richter magnitude 5.7 recorded in 1959 near Fredonia, 240 miles from the study area. The seismic historical record for the last 125 years indicates that only one major damaging earthquake (1887 Sonora, Mexico) has occurred and was located outside the 100-mile radius. This earthquake measured a Richter magnitude of 7.2, and was located more than 255 miles from Tempe, AZ, causing rockfalls (MM VI) near the study area. The most recent (1974) nearby events, the "New River earthquakes," located 15 miles north of the study area, had recorded Richter magnitudes of only 2.5 and 3.0 (DuBois, *et al.*, 1982).

In conclusion, the study area is located within a region of low seismicity and ground rupture and shaking are not expected to significantly impact the restoration project.

Subsidence

Earth fissures and subsidence are both produced by groundwater withdrawal or pumping of groundwater, where the ground compresses (subsides) as water is withdrawn and the soil loses the support of water between soil particles (pore space). Earth fissures develop when the soil subsides differentially and separates. Available information suggests that subsidence in the project area has not occurred. The area has not been affected by subsidence due to its upstream location and the presence of two recharge facilities.

Sources of Construction Materials

Two stone borrow sites have been identified as sources of construction material and are available for use. The two quarries have produced stone for previous USACE flood damage reduction projects at the Arizona Diversion Canal and Indian Bend Wash areas. Stone from both quarries exhibit a good service record and passed all rock quality compliance tests. These two quarries are the Sun State Rock and Materials and the Salt River Sand and Rock.

4.2.2 Hydrology and Hydraulics

4.2.2.1 Surface Water Hydrology

In the lower Salt River Valley, the annual average rainfall is approximately 8 inches; rainfall at the highest elevations of the watershed maximizes at a mere 14 inches annually (U.S. Geological Survey, 1991). Compound the low annual precipitation rates in this arid region with the increased demands from the urbanization and population, and it is not surprising that Federal, state, and local agencies, communities, and private industry have made large investments over the years in engineering projects to gain some measure of control over water resources.

(a) Dam System

During the 20th century, as mentioned earlier, the Phoenix metropolitan area has changed from an agricultural region to an urban region, resulting in significant changes in the physical characteristics of the rivers in the area. Agricultural and urban activities have given rise to an intricate network of structures associated with the river used for irrigation, drainage, erosion protection, and flood damage reduction. Numerous upstream dams on the Salt and Gila Rivers have radically altered the natural hydrologic regime of the rivers. Table 1 provides a listing of the major dams and reservoirs in the Gila River Basin.

Table 1. Major Dams and Reservoirs in the Gila River Basin

Dam	River	Reservoir	Date of Origin	Storage (acre-feet)
Waddell	Agua Fria	Lake Pleasant	1927	165,000[a]
Bartlett	Verde	Bartlett Lake	1939	182,000
Horseshoe	Verde	Horseshoe Lake	1949	141,000
Stewart Mountain	Salt	Saguaro Lake	1930	71,000
Mormon Flat	Salt	Canyon Lake	1938	59,000
Horse Mesa	Salt	Apache Lake	1927	248,000
Roosevelt	Salt	Roosevelt Lake	1911	1,600,000[b]
Coolidge	Gila	San Carlos Lake	1928	1,222,000
Painted Rock	Gila	Painted Rock Lake	1959	2,500,000

[a] Indicates original storage capacity before modifications that is presently underway to expand capacity.
[b] Black, pers. comm.
Source: Graf, *et al.*, 1994.

The SRP operates seven dams and storage reservoirs within the Salt River watershed. Stored water is allocated for hydropower, municipal and industrial supply, and agriculture. Modifications to the Theodore Roosevelt Dam also include an allocation for flood damage reduction. The total space for water-supply storage behind these dams is approximately 1.9 million acre-feet (ac-ft), with an additional 560,000 ac-ft for flood damage reduction behind Roosevelt Dam. Before 1938, an average of 413,000 ac-ft of water flowed through the channel annually (U.S. Army Corps of Engineers, 1997). The estimated pre-development, average annual watershed yield was about 1,250,000 ac-ft (U.S. Geological Survey, 1991). Since 1965, the channel has carried an average of only 293,000 ac-ft of water per year, with less than 10,000 ac-ft in almost three-fifths of the years (U.S. Army Corps of Engineers, 1997). The Modified Theodore Roosevelt Dam is the largest facility and receives drainage from approximately 5,800 square miles. The Verde River is the principal tributary and watershed of the Salt River (6,700 square miles). Its flows are partially controlled by Horseshoe Dam (located furthest upstream) and Bartlett Dam (approximately 25 miles upstream of the confluence with the Salt River), which provide an additional 310,000 ac-ft of storage. New Waddell Dam is located on the Agua Fria River northwest of Phoenix and downstream of the project study area.

Since Bartlett Dam began operating on the Verde River in 1938, the lower Salt River has contained water only as a result of controlled or uncontrolled releases from the Granite Reef Diversion Dam. Granite Reef Diversion Dam is located about 3 miles downstream of the Salt-Verde confluence and is the most downstream SRP dam. The purpose of this facility is to divert upstream reservoir releases into the Arizona Canal (for the area north of the Salt River) and the South Canal (for the area south of the Salt River). The canals crisscross the Phoenix metropolitan area for water delivery to agricultural, municipal, and industrial uses. There are no releases during climatically drier years, such as the period between 1942 and 1964, and the Salt River is dry during those times except for local stormwater and irrigation runoff, groundwater emergence, and effluent.

Hydrologic modeling used to develop a water-control plan for the Modified Theodore Roosevelt Dam indicates that water would have spilled over Granite Reef Diversion Dam in only 34 of 105 years under the current configuration of dam operations (U.S. Army Corps of Engineers, 2000). The resulting frequency of spills is approximately once every three years. When water is spilled over Granite Reef Diversion Dam, the flow is typically sustained for several days or more and is of significant magnitude. Since 1965, there have been about two releases per year, and they have lasted an average of 22.5 days, with a peak mean daily flow of 13,960 cfs. The median predicted spill pattern at Granite Reef Diversion Dam has a peak discharge of 28,000 cfs, a 5-day average flow rate of 15,000 cfs, and a 10-day average flow rate of 10,000 cfs (U.S. Army Corps of Engineers, 2000).

Under historic natural conditions, flows peaked in late winter (February and March), supplied by storms and snowmelt. Flows were lowest in June, averaging only 6 percent of the mean high flows in February. Data for 1965 through 1993 show flows occurring most frequently during March and April and least frequently during July and August, much like the natural flow pattern. The system of dams upstream of the study area effectively delays the flows by one month. This delay becomes insignificant, however, compared to the overall effect on the length of periods without flow in a river that is perennial under natural conditions.

(b) Discharge Rates

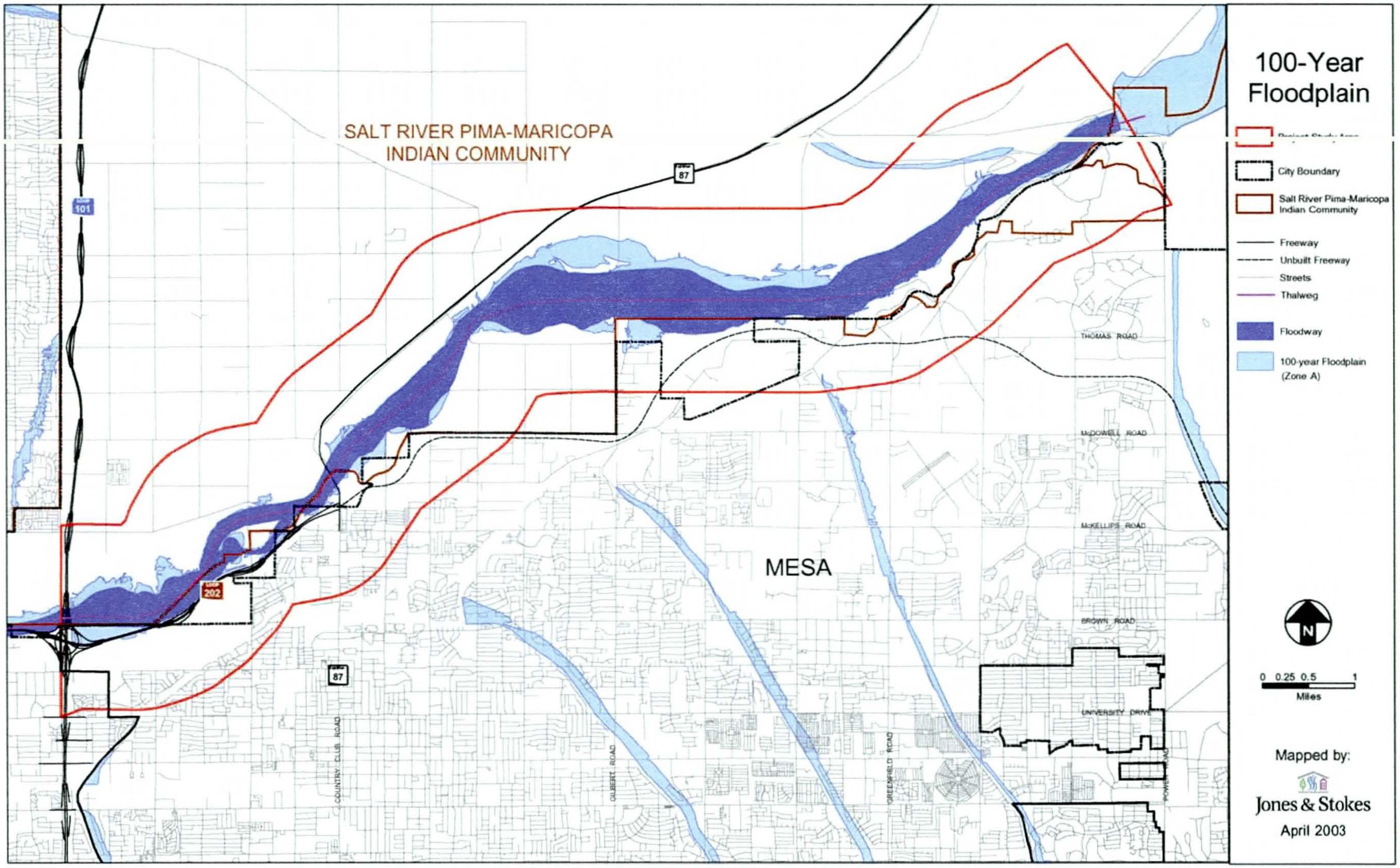
During periods of serious flooding, large volumes of water are released from upstream dams and may cause flood damage in the study area. Recent damaging floods with flows exceeding 100,000 cfs occurred in the lower Salt River in 1978, 1980, 1983, and 1993. These floods resulted in damages to residences and agricultural areas in and around the study area. Figure 5 shows the limits of the 100-year floodplain within the study area.

Previous studies show that the magnitudes of peak annual discharges on the Salt River are comparable to those of peak flows before Bartlett Dam began operating, but high flows have occurred less frequently since 1938. The mean peak annual discharge was 32,000 cfs before 1938 and has been 16,500 cfs from 1938 to the present (Jones & Stokes, 2000). Since 1938, the peak discharge has been greater than 10,000 cfs in only a quarter of the years, whereas before 1938, flows exceeded 10,000 cfs in two-thirds of the years. Upstream dams have exacerbated the high-flow conditions that have occurred by delaying the release of runoff into the river. Prior to damming, a peak annual discharge greater than 100,000 cfs occurred in only one year on record, while three such flows have occurred in the past 22 years. Table 2 shows estimated flow values for various frequencies and durations within the Salt River at Granite Reef Dam and downstream in the Phoenix metropolitan area at Central Avenue (U.S. Army Corps of Engineers, 1997).

The peak 100-year flood flow at Granite Reef Dam is 175,000 cfs, which is slightly larger than what would occur in downstream reaches due to channel infiltration. The data also indicate that the 5-year frequency flow produces measurable flow in the channel downstream of Granite Reef Dam, but the channel would remain dry in the Phoenix area due to upstream storage in the watershed and channel infiltration.

and peak flow attenuation

Figure 5. 100-Year Floodplain within the Study Area



Although flooding is a natural and even vital process in natural riparian systems, it is of particular concern in downstream reaches of the Salt River because of the prevalence of saltcedar, an exotic nuisance species. Saltcedar is very effective at spreading into disturbed areas and can generally establish itself more rapidly than native riparian species with one exception. If flooding occurs during spring when cottonwood and willow are dispersing seeds, native vegetation can outcompete saltcedar whose germination period is May to September. As an example of this process, after the 1993 flood, additional native vegetation established itself in the river downstream of Phoenix.

Table 2. Frequency-Duration Values for the Salt River (at Central Avenue)

Duration	Frequency (Years)						
	500	**200**	**100**	**50**	**20**	**10**	**5**
Discharge (cfs) Exceeded for Specified Duration, Salt River at Central Avenue [1]							
Peak	240,000	202,000	166,000	135,000	87,000	53,000	20,200
1 Day	190,000	145,000	100,000	70,000	40,000	21,000	8,000
3 Day	100,000	75,000	60,000	40,000	22,000	11,000	3,500
5 Day	70,000	55,000	40,000	29,000	15,000	7,000	2,100
10 Day	46,000	33,000	25,000	18,000	10,000	5,200	1,500
30 Day	25,000	19,000	15,000	10,000	5,300	2,700	800
60 Day	14,000	9,000	7,000	5,000	2,800	1,400	(0) [2]
Discharge Exceeded for Specified Duration, Salt River at Granite Reef Dam							
Peak	250,000	210,000	175,000	150,000	100,000	60,000	22,000 ← at Granite Reef

[1] Discharges exceeded for specified frequencies, with durations greater than or equal to 1 day, are approximately equal throughout the Rio Salado Project reach. Central Avenue is used as a reference location.

[2] During the 5-year event, the upstream release from the Salt River Project reservoirs does not last for 60 days. A flow rate of approximately 200 ft^3/s is exceeded for 53 days during this event. Results are based upon simulation of Balanced Hydrographs.

Source: U.S. Army Corps of Engineers, 1997

(c) Interior Drainage

Interior drains that discharge into the Salt River between Granite Reef Diversion Dam and the Pima Freeway (SR101) may have implications on a project. In general, there are two concerns for how these drains affect the project. The first involves potential damage to the restored habitat caused by high discharge velocities or frequent inundation. The second consideration is that interior drains may provide a water source for habitat restoration.

Two types of interior drains were evaluated in this analysis: canal drains and storm drains. The interior drains were evaluated to assess the potential damage that their flows may cause to a habitat restoration project. A summary of the interior drains identified within the project area and their locations is provided in Table 3. Detailed information is presented in the Interior Drainage Appendix (Knight Piésold and Co., 2002a). In general, it is determined that the peak flow rates and discharge velocities from the interior drains are sufficient to create localized damage at the outlet of each drain. However, this damage is not expected to extend beyond the immediate vicinity of the pipe outlet. There is little evidence to suggest that flows from these drains have historically done more than wet the riverbed in the immediate vicinity of the drain outlet. Additionally, the maximum flow rates that could potentially discharge from these drains are significantly smaller in magnitude and occur less frequently than Salt River flood flows. The Salt River is expected to spill over Granite Reef approximately once every three years, and the 5-year peak discharge from these spills is expected to exceed 20,000 cfs (U.S. Army Corps of Engineers, 1998). In comparison to this, there is little advantage to providing extensive protection from the interior drainage discharge.

The interior drains were also evaluated to assess the potential for using these flows as a water source to support and nourish the restored vegetation. For this evaluation, these drains were each evaluated based on the quantity, reliability, and quality of flow that is or may be available for habitat restoration. The water source analyses are described in further detail in the Water Budget Appendix (Knight Piésold and Co., 2002c). The average monthly and annual volumes of water released from some of the interior drains are of sufficient magnitude to be considered as a potential water source. The three canal drains have historically supplied a significant amount of water to the Salt River. These drains, however, do not flow consistently, and releases into these drains may not be reliable. The Price Drain has historically supplied a relatively consistent flow to the river. However, long-term records are not available to measure this supply. The Evergreen Drain, Hennessey Drain, Tempe Drain, and Price Drain are all included in the water budget analyses.

Table 3. Summary of Interior Drains

CANAL DRAINS

Interior Drain	Outlet Type and Dimensions	Section	Township	Range	Location Description	Flow Records
Evergreen Drain	trapezoidal channel	23	T2N	R5E	Horne Road at Arizona Canal	Yes
Hennessey Drain	trapezoidal channel	28	T2N	R6E	Between Val Vista and Greenfield	Yes
Tempe Drain	trapezoidal channel	17	T1N	R5E	Between Dobson and Alma School	Yes
SRP Laterals	open channels				Throughout study area	No
SRPMIC Laterals	open channels				Throughout SRPMIC	No
RWCD Laterals	open channels				Outside of study area	No

STORM DRAINS

Interior Drain	Outlet Type and Dimensions	Section	Township	Range	Location Description	Flow Records
Price Drain	trapezoidal channel	18	T1N	R5E	East side of Price Road Freeway	Yes
Tempe Drain	trapezoidal channel	8	T1N	R5E	Between Val Vista and Greenfield	Yes
Price Road Freeway Local Drainage	72-inch pipe	18	T1N	R5E	West side of Price Road Freeway	No
Dobson Road Storm Drain	72-inch pipe	8	T1N	R5E	Along Dobson Road	No
McLellan Road Storm Drain	48-inch pipe	8	T1N	R5E	Along McLellan Road	No
Country Club/McKellips Storm Drain	72-inch pipe	4	T1N	R5E	Country Club Drive	No
Red Mountain Freeway Local Drainage	N/A				Along Red Mountain Freeway	No
Natural Drainage	N/A				East of Gilbert Road	No
Alma School Storm Drain	60-inch pipe	5	T1N	R5E	Alma School Road	No

Source: Knight Piésold and Co., 2002a

4.2.2.2 Surface Water Quality

Contaminants in the surface waters and groundwater of Arizona fall into seven categories: volatile organic compounds (VOCs), pesticides, metals, nutrients, ions, microorganisms, and radiological substances. Water quality issues exist for all water sources in the lower Salt River, namely contamination by VOCs and various metals, ions, nutrients, and herbicides. As previously discussed, surface water naturally provides the main source of recharge for groundwater. Shallow groundwater in other reaches of the river often emerges in the channel, creating surface flows. Effluent from wastewater treatment plants (WWTPs) and other industries contribute to both surface and subsurface flows. Thus, contaminants do not remain in one part of the system and may affect all water sources.

The quality of water from storm drains varies depending on the length of time between storm events, the amount of flow, and the source of storm water runoff. Runoff often contains a significant amount of sediment that is washed from undeveloped land and other sources, as well as chemical contaminants or pollutants. The types of chemical pollutants would vary depending on the land uses within the particular drainage area. Potential water quality impacts associated with runoff from industrial sites are projected to be minimal because the compliance requirements of storm water NPDES permits require each industrial site to have a storm water pollution prevention plan (SWPPP). Runoff from turf areas has the potential to contain pesticide and fertilizer residuals. Runoff from paved areas can contain hydrocarbon products, metals, and anything spilled on the pavement (Jones & Stokes, 2002).

Flows in the Salt River originating upstream of the project area are generally of good quality. However, local Salt River flows maintain high amounts of mineral content and total dissolved solids (TDS). When flood flows do occur, they can contain pollutants of concern derived from tributary stream inflow, erosion of sediments, and landfills. Large quantities of water in flood flows can dilute the concentration and transport the contaminants through the study area downstream areas. However, there is very little information on the chemical constituents in flood flows (Jones & Stokes, 2003).

The Salt River water contains a sodium chloride character both above and below the SRP system dams due to salt springs upstream of the lakes. Verde River water has a lower amount of TDS than found in the Salt River water, so it tends to dilute higher TDS concentrations from the Salt River when the flows combine. The quality of water would be sufficient to support native fish species if historic base flows were still available within the river. However, local stormwater entering the Salt River at numerous locations in the study area has the potential to degrade the surface quality of water in the system due to the contaminants listed in Table 4. Additional water quality data can be found in the EIS.

Table 4. Types of Water Contaminants in the Lower Salt River

Contaminant Category	Principal Contaminants	Typical Sources	Potential Health Impacts
Volatile organic compounds (VOCs)	Organic solvents Trichloroethene (TCE) Tetrachloroethylene (PCE) 1,1,1 Trichloroethane (TCA) Chloroform 1,1 Dichloroethane (DCE) 1,1 Dichloroethane (DCA) Benzene	Landfills Underground storage tanks Airports High technology industry	Carcinogen
Pesticides	Dibromochloropropane (DBCP) Ethylene dibromide (EDB)	Agriculture (soil fumigants) Urban runoff	Toxics Carcinogen
Metals	Arsenic Barium Boron Chromium Copper Iron Lead Manganese Selenium Zinc	Landfills Mines Metal finishing Natural origin	Toxics Carcinogen
Nutrients	Nitrate	Agriculture (fertilizers) Wastewater treatment Septic tanks Industrial manufacturing	Methemoglobinemia (blue-baby disease)
Ions	Total dissolved solids (TDS) Sulfate Chloride Fluoride	Mines Agriculture Natural origin	Taste, hardness Laxative effect Toxics
Micro-Organisms	Fecal coliform	Septic tanks Wastewater treatment	Infectious disease
Radiological		Mines Natural origin	Carcinogen

Source: Graf, *et al.*, 1994

Concentrated animal-feeding operations (CAFOs) can produce very poor quality runoff if the site drainage is not controlled. Animal wastes can drain from the site into storm drains or irrigation systems, including both water supply laterals and drainage canals. The principal pollutant of concern from such operations is nitrate. Bacterial pathogens and other microbiological pollutants, biochemical oxygen demand (BOD), total suspended solids, and nutrient loads can also be generated at a CAFO site. CAFO sites are not located within the Salt River channel; however, uncontrolled runoff from CAFO operations can enter the Salt River through canals and storm drainage systems adjacent to the river and within sub-area watersheds.

Regulations are in place to require control of CAFO discharges by means of an agricultural general permit of the Arizona Aquifer Protection Permit program (Arizona Administrative Code, Title 18, Chapter 9, Article Z [R18-9-201 to 203]). CAFO discharges are also regulated through NPDES permits under the Clean Water Act. The NRCS has a pilot program to provide funding to control CAFO discharges at selected sites.

4.2.2.3 Groundwater Hydrology

Groundwater resources are most affected by geologic conditions that determine infiltration capacity, water-bearing characteristics, confinement boundaries, and subsurface flow. As discussed in the Geology Section, the Salt River Valley lies within the basin and range physiographic province and is characterized by broad alluvial valleys separated by rugged mountains. The valley is underlain by a wide variety of unconsolidated to variably consolidated sedimentary deposits that are several thousand feet thick in places. The sediments include unconsolidated clay, silt, sand and gravel, caliche, gypsum, mudstone, siltstone, sandstone, conglomerate, and anhydrite. Discontinuities in lateral lenses and interbedded deposits may exist in older units where high-angle faults exist. Rainfall on the valley floor is generally insufficient to contribute to groundwater recharge (U.S. Geological Survey, 1991).

Groundwater is regulated by the Arizona Department of Water Resources (ADWR), and the groundwater basin underlying lower Salt River Valley is identified as the Phoenix Active Management Area (AMA). The Phoenix AMA comprises two distinct but interconnected alluvial groundwater basins: West Salt River Valley (WSRV) and East Salt River Valley (ESRV). These two units are divided by subsurface geologic outcroppings located near Priest Road in Tempe. Both basins generally comprise three

Papago Buttes

separate hydrogeologic aquifer-layer units. The USBR, the USGS, and ADWR have independently identified these units, although the descriptions and nomenclature used by these agencies differ slightly. The three hydrogeologic units are (1) the Lower Alluvial Unit (LAU), (2) the Middle Alluvial Unit (MAU), and (3) the Upper Alluvial Unit (UAU). Groundwater within the aquifer units is generally unconfined. Composed mainly of deposits of gravel, sand, and silt, the UAU typically ranges in thickness from 100 to 300 feet under the Salt River but thin out at contacts with exposed bedrock. The unit is thinnest near mountain fronts and bedrock outcrops, such as Tempe Butte and lower Papago Park. The MAU is overlain by the UAU and comprises mainly of clay, silt, and mudstone with some interbedded sand and gravel especially developed near margins of the basin. The LAU underlies the MAU and consists mainly of conglomerate and sand near basin margins and mudstone and anhydrite distal from edges of the basin. Volcanic rocks are interbedded within the stratigraphic section (Knight Piésold and Co., 2002b). Historically, surface flows from streams and washes provided most of the water that recharges the UAU. Presently, minor recharge sources such as seepage from canals and irrigated land, underflow along major streams, and rainfall have become more important.

(a) Groundwater Depths

Depth to groundwater has fluctuated greatly since development of the Salt River Valley began in the late 1890s, as demonstrated below in Table 5. Initially, diversion of water from the river for irrigation led to a rise in the water table. Canal seepage locally raised the water table as much as 20 feet above the natural water table. As development proceeded, groundwater became an important water source for agriculture. More than 75 percent of the pumped groundwater in the Salt River Valley is now used for agriculture. Drought conditions and pumping between 1895 and 1905 caused a decline in the well levels of 8 to 20 feet in the Mesa-Tempe area. The water table declined steadily from the 1930s into the 1960s as a result of increased pumping. Long-term groundwater withdrawal since the 1940s has resulted in a general decline in water levels from 200 to 300 feet throughout the Phoenix Basin. However, water-level declines have usually been less than 50 feet near the Salt River. The magnitude of declines varied spatially from a few feet in some places to a few hundred feet in others. Where shallow bedrock forces water to the surface, depth to groundwater is only 10 to 30 feet greater than in the early 1900s. Figure 6 presents the depth to groundwater contours for the project area.

Table 5. General Depths (feet) to Groundwater near the Lower Salt River

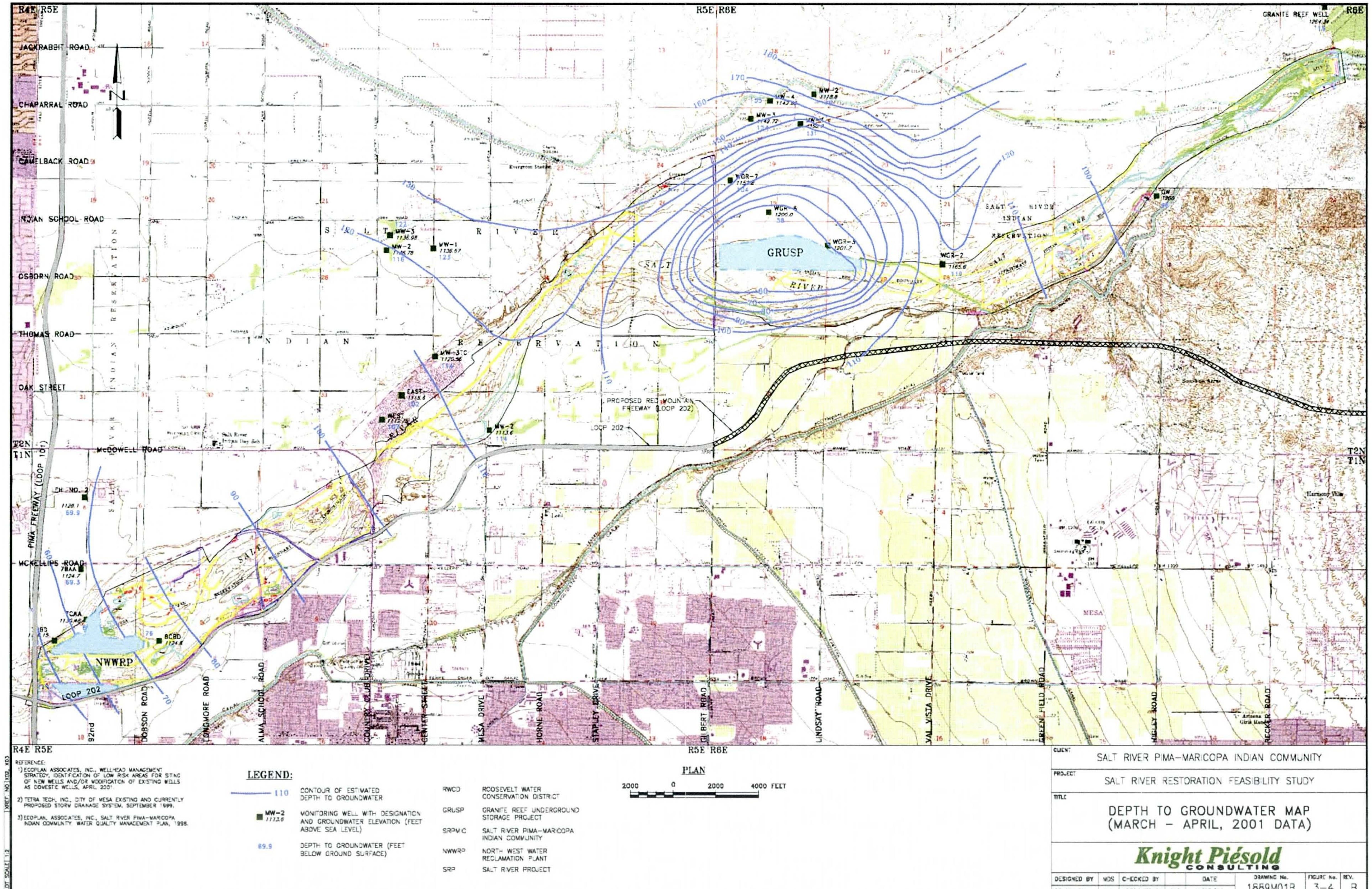
Year	Granite Reef Dam to McKellips Road	McKellips Road to Mill Avenue	Mill Avenue to I-10	I-10 to 23rd Avenue	23rd Avenue to 91st Avenue	91st Avenue to Agua Fria River
1900	0–40	0–10	0–40	ND	ND	ND
1913	10–50	0–10	0–10	0–10	0–10	0–10
1945	50–150	0–50	0–10	10–50	10–50	0–10
1952	100–140+	20–80	40–60	40–60	20–40	<20–40
1964	ND	ND	ND	80–100	60–80	40–60
1972	ND	ND	ND	60–80	40–60	<20–40
1986	190–250	90–140	10–60	ND	ND	ND

ND = no data.

Sources:
1900 and 1986 Thomsen and Miller, 1991
1913 and 1945 McDonald, *et al.*, 1947
1952: Wolcott, 1952
1964 and 1972 U.S. Bureau of Reclamation, 1976

During the 1980s, pumping of groundwater declined in the Salt River Valley. Data for seven wells along the Salt River for 1987 through 1992 indicate that, while recent groundwater levels have not exhibited a distinct upward or downward trend, they have fluctuated considerably. Depth to groundwater decreases downstream, from an average of approximately 260 feet near Granite Reef Dam to less than 10 feet near Buckeye. For the period from 1987 to 1992, upstream water levels fluctuate the most from year to year, on average 7 to 19 feet, and exhibit the greatest range in levels.

Figure 6. Depth to Groundwater Map



Based on available records (Haws, 2002; Lluria, 2002; Corell and Corkhill, 1994), the current annual rates of recharge at these three sites of focused recharge are shown in Table 6.

Table 6. Annual Recharge Rates

Site	Recharge Rate (ac-ft/yr)
GRUSP	90,000
Granite Reef Wetland	475
NWWRP	18,000

In addition to sites of focused recharge, aquifer recharge in the model is also considered to occur from irrigation, with rates dependent on land use. Three categories of land use are defined in the model: (1) urban, (2) agricultural, and (3) mixed agricultural and residential. Urbanized land use occurs primarily south of the Salt River Channel and immediately west of the SRPMIC in the cities of Mesa, Tempe, and Scottsdale. Agricultural land with heavy irrigation occurs in the southeast end of the model area, and within the SRPMIC north of the Evergreen Canal. Land immediately north of the Salt River channel in the western portion of the Community is used primarily for mixed agricultural/residential use.

Based on the available records (Corell and Corkhill, 1994), the annual rates of recharge used in the model are shown in Table 7.

Table 7. Recharge Rates Used in Model

Site	Recharge Rate (ft/yr)
Urban	1.00
Agricultural	1.87
Mixed Agricultural/Residential	0.94

Effectively no recharge activity has occurred during the model period 1998 through present within the channel of the Salt River itself (except for recharge associated with the NWWRP), as the river channel is dry in the area of interest. Also, no infiltration is considered within natural open space areas.

4.2.2.4 Groundwater Quality

At present, all of the Hazardous and Toxic Waste (HTW) contamination to the groundwater within or near the project has been attributed to VOCs leaching into the groundwater. VOC leaching has occurred from either mismanaged storage, pumping into groundwater, or improper dumping of VOCs and related chemical compounds at Superfund sites located within or near the project boundaries. VOCs have been detected within the UAU and MAU, but not the LAU or Red Unit. There is no direct evidence that surface water recharge from the Salt River has contaminated the three alluvial aquifers with HTW unless such recharge has been associated with the Superfund sites (U.S. Army Corps of Engineers, 2000).

4.2.3 Water Budget and Sources Analyses

In streams in the western United States, almost all the water is fully appropriated for a wide range of uses outside the stream channel, such as irrigation and municipal water supplies. However, the presence of water within streams is now recognized as having an important value. Most natural resource values in riparian areas derive either directly or indirectly from streamflow conditions. Direct benefits derive from the existence of surface water in channels and include such things as aquatic habitat, wildlife drinking water, recreation water, and aesthetics. Examples of indirect benefits include moist riparian soils, which in turn support water-dependent vegetation, and habitat benefits associated with the morphology and physical composition of channels and floodplains.

The water budget within the study area consists of various types of inflows, outflows, and consumptive uses. Table 14, presented at the end of this section, presents a summary of the analyses.

4.2.3.1 Inflows/Water Sources

The success of any habitat restoration project is largely dependent upon the amount and quality of water that is available to sustain project features and activities. A sufficient and reliable source of suitable water must be developed to support the aquatic, wetland, and upland plant habitat that historically existed in the study area. Several potential water sources were identified for the Va Shly'ay Akimel study area. Two of these involve groundwater resources, while the remaining six involve primarily surface water. The identified potential groundwater and surface water sources are summarized below.

Table 8. Potential Sources of Water

Groundwater	Surface Water
- In-situ groundwater	- Salt River flood flows
- Pumped groundwater	- Stormwater discharges
	- Effluent, irrigation return flows
	- Canal drains
	- Discharges from sand and gravel mining operations
	- SRP water

Each source is assessed based on various factors, including the quantity, reliability, and quality of flow available for habitat sustainability. In general, the sources were classified into the following four categories.

- *Dependable source.* A source is dependable if it is available on a continuous basis to meet the water demands of the habitat area and has acceptable water quality. Dependable sources constitute the baseline water supply.

- *Supplemental source.* A source may be considered supplemental if it is available to augment the dependable baseline source. This could include infrequent and unreliable flows that can be put to beneficial use when they are available but cannot be relied upon as a dependable base flow. The supplemental flow must also have good water quality.

- *Problem Source.* Problem sources must be accounted for but may not be suitable as a water supply for the Salt River Restoration Project. These flows may inhibit the restoration project by potentially damaging restored vegetation or hindering the water quality within the Salt River.

- *Unacceptable Source.* A source is considered unacceptable if it has poor water quality or is not desirable for riparian habitat restoration.

In this report, water rights are discussed as related to the SRPMIC and as related to non-Indian lands. The difference is that water rights established by the State of Arizona do not apply to the SRPMIC lands, but Federal water rights and court adjudications do apply. Non-Indian lands are subject to state water rights, Federal water rights, and court adjudications.

In the analysis of potential water sources below, each section relates the water source to the following topics:

- Description of source
- Quantity analyses
- Quality analyses
- Water rights
- Assessment of source

(a) In-Situ Groundwater

Description of Source

In-situ groundwater is defined as groundwater that can be utilized, in place, by riparian vegetation. For this to occur, the groundwater table must be within the root zone depth of the desired plant species. The depth to groundwater, as well as the water table fluctuations, is an important factor for establishing and maintaining riparian habitat.

In a few areas downstream from Granite Reef, the water table is still sufficiently close to the surface so that riparian vegetation can access this water through its root systems. These habitat areas in the Salt River suggest that in-situ groundwater may be a potential source of water for a project. Figure 7 shows the Salt River upstream of Granite Reef; this area is similar to the historical conditions throughout the Salt River Valley.

Figure 7. Salt River Upstream of Granite Reef

Quantity Analyses

The water table is variable throughout the study area and is impacted by both hydrogeologic and anthropogenic factors. One of these anthropogenic factors is Granite Reef Dam. The dam was constructed to divert Salt River water into the Arizona Canal and the Southern Canal. This dam marks the upstream boundary of the study area. Although not intended to be a storage reservoir, this dam incidentally retains some water at all times.

Small flood flows can be released to the Salt River through radial gates while larger flood flows are allowed to pass over the dam crest. SRP has reported that water seeps through the radial gates because they do not form a tight seal with the granite bedrock. The result is a continuous flow of water downstream from the dam. SRP does not monitor the seepage and does not have flow records. Figure 8 shows the seepage downstream of Granite Reef.

Figure 8. Seepage Downstream of Granite Reef

The local geology maintains this seepage as a surface flow. A bedrock shelf overlain by a veneer of sedimentary materials extends downstream from the dam. The seepage is sufficient to saturate these alluvial sediments to maintain a continuous surface flow. This flow has been sufficient to establish and support abundant wetland vegetation. In addition, areas of open water provide riparian and aquatic habitat. This pattern continues for approximately one mile downstream. The existing wetland areas are shown on Figure 9. Figure 10 shows the wetlands areas that extend for approximately one mile downstream from the dam.

The depth to bedrock shelf rapidly increases at the basin border fault, located approximately 1.5 to 2.0 miles downstream. As the bedrock depth increases, the surface flow that supports wetland vegetation upstream becomes subsurface water. Regional groundwater pumping has resulted in a general lowering of the water table throughout the area. In addition, dams located on the Verde River and Salt River upstream prevent perennial flow in the river channel and limit natural recharge. The result is that the general groundwater depth beneath the Salt River ranges from 60 to 80 feet below the surface for the majority of the study area (Knight Piésold, 2002a). Figure 11 shows the Salt River near Greenfield Road.

Figure 9. Water Budget Map

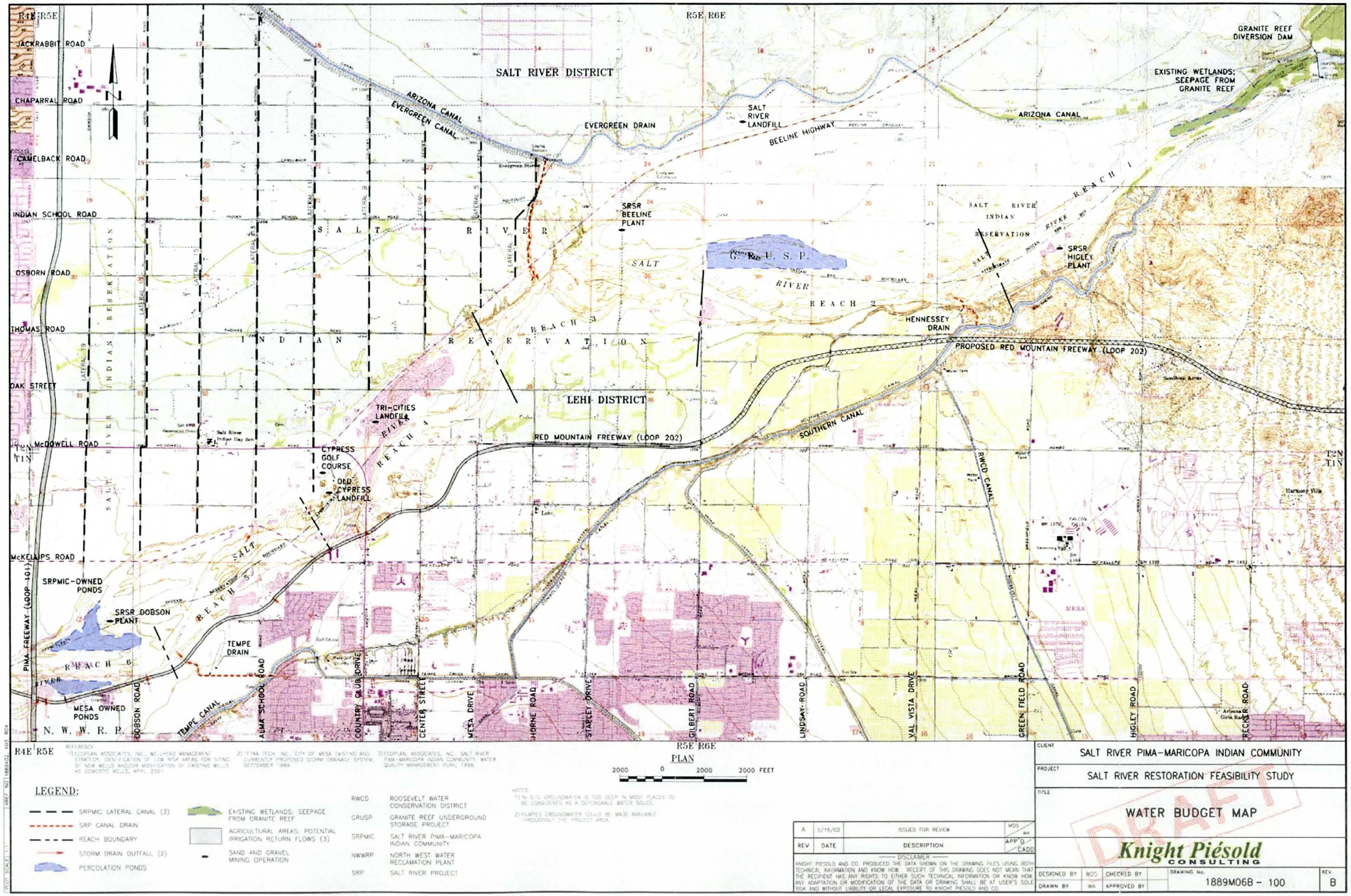


Figure 10. Wetlands Downstream of Granite Reef

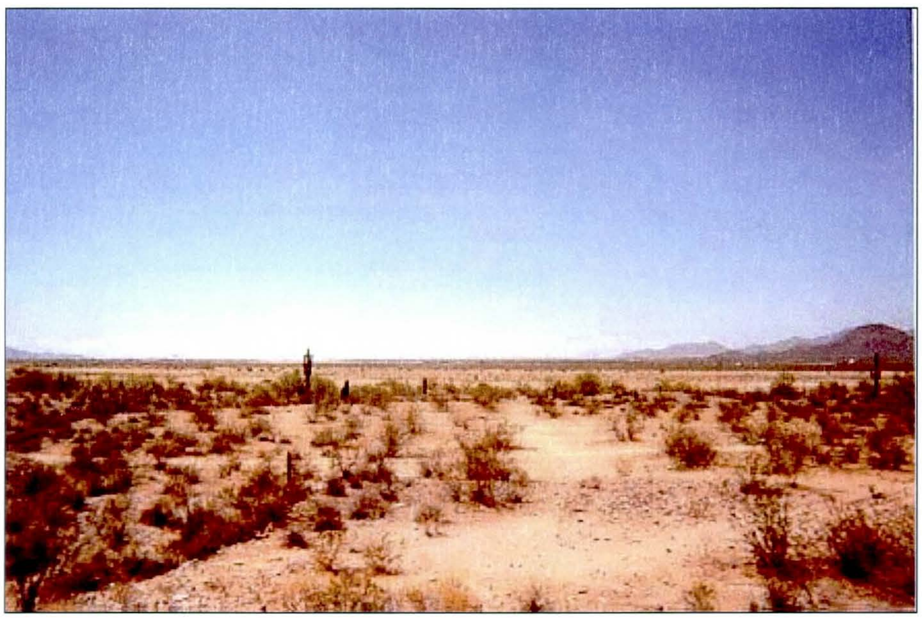


Figure 11. Salt River near Greenfield Road

90,000 AF/yr / 216 Acres = 416.7 ft/yr = 13.7 in/day.

There are two groundwater recharge projects in the study area that have local impacts on the groundwater table. Toward the downstream end of Reach 2, SRP is recharging water into the upper alluvial aquifer through the GRUSP. SRP is recharging nearly 90,000 ac-ft of water annually. These recharge ponds encompass an area of approximately 216 acres.

Their recharge permit allows them to recharge as much as 200,000 ac-ft/yr; however, this rate would produce a groundwater mound that could impact other facilities. SRP has to limit the amount of water recharged in order to maintain the groundwater level at least 25 feet below the bottom of the Salt River Landfill on Gilbert Road and State Route 87. This results in a water level that is about 50 to 60 feet below the river channel in the immediate GRUSP area. The GRUSP site is shown on the Water Budget Map.

The second recharge project is located near the downstream end of the project area. At this site, effluent from the NWWRP, which is owned and operated by the City of Mesa, is being discharged into a series of recharge ponds where the effluent is allowed to infiltrate into the Salt River sediments. An average of 3,300 acre-feet of water has been recharged annually into these ponds. The SRPMIC owns five ponds on the north side of the river totaling 75 acres. These ponds have received an average of 330 ac-ft of effluent each month since their establishment in May 2001. Mesa owns four ponds on the south side of the river totaling 27 acres; these ponds have received an average of 140 ac-ft of effluent each month since January 2000. The groundwater mound that results from this recharge raises the local water table in this area to within 50 to 60 feet below the river bed. The NWWRP and the percolation ponds are shown on the Water Budget Map.

Quality Analyses

Long-term irrigation practices and landfills within the Salt River Valley have historically influenced water quality in the upper alluvial aquifer. High salinity, chloride, and nitrate concentrations were occasionally found in the shallow groundwater near irrigated or formerly irrigated areas. Also, some landfills have historically caused elevated levels of volatile halocarbons. More recently, the SRPMIC has developed a water quality management plan to protect and enhance surface water and groundwater quality (EcoPlan, 1997; 1998). Since groundwater quality monitoring began in the 1980s, the water quality has significantly improved. Monitoring results from the first quarter of 2002 indicate that maximum contaminant levels for volatile halocarbons were not exceeded in any of the sampled wells (Schmidt and Associates, 2002). In addition, the concentrations of many volatile halocarbons were the lowest since monitoring commenced. It should also be noted that there are no Superfund sites within the study area. In-situ groundwater is generally suitable for agricultural uses and should be adequate for a project.

Water Rights

The SRPMIC owns and controls the groundwater beneath their land as agreed in the Water Rights Settlement Agreement of 1988. The SRPMIC is not governed by state water rights. The Federal government has established this right and has restricted pumping on non-Indian lands to prevent groundwater withdrawals from beneath the SRPMIC lands. SRPMIC groundwater use is also restricted through the Water Rights Settlement Agreement of 1988. Groundwater beneath the non-Indian lands is a state resource, and use is regulated via several groundwater rights and pumping permits.

Consumptive use of groundwater by vegetation (in-situ groundwater) is not included in state groundwater rights categories. There are no water rights to define or restrict the direct use of groundwater by vegetation for habitat restoration projects in central Arizona. In-situ groundwater, when available, can be used as a part of a restoration project water supply.

The seepage at Granite Reef is surface water and, until it percolates into the ground, could be subject to surface water appropriation rights. If this seepage flow is diverted before it percolates and used as a part of the water supply for a project, it is possible that a downstream water user with rights to Salt River flow could protest. A claim by downstream water users would be difficult to uphold because all of the seepage percolates into the ground about one mile downstream from the dam and is currently not available for diversion by downstream water users. If this water were used as a part of a project, it probably would be channeled to support vegetation along the north and south river banks just downstream from the dam, rather than being diverted and delivered to a location further downstream. The channelization is not a diversion and may not be subject to water appropriation regulations. In general, the use of the seepage flow to support in-stream vegetation does not appear to be contrary to existing water rights.

this will no doubt have to survive a challenge in court.

Assessment of Source

In-situ groundwater can provide a reliable source of water for the area immediately downstream from Granite Reef. In this area, seepage from the dam forms a local perched water table near the surface. Currently, wetland plant species are growing along this reach of the river and extend for approximately one mile downstream. This source of water could be used to restore native riparian vegetation in this area. This local supply is considered a dependable water source for Reach 1.

For the remaining study area, in-situ groundwater would not provide a reliable source of water. The intent of a project would be to restore habitat areas for cottonwood, willow, and mesquite trees; these species require that the depth to groundwater be less than approximately 20 feet for survival. The depth to groundwater, however, exceeds 60 feet for most of the remaining area. In-situ groundwater is considered to be an unacceptable source of water for the remainder of the study area.

(b) Pumped Groundwater

Description of Source

Pumped groundwater is groundwater that lies below the root zone of the desired vegetation and must be pumped to the surface to be utilized. After the water is pumped to the surface, a distribution system must be developed to deliver this water to certain areas of the habitat restoration project. There are several legal and institutional implications that pumped groundwater could have for a project.

Quantity Analyses

Groundwater in sufficient quantity to supply water wells is present throughout the majority of the study area. This is demonstrated by the location and number of existing wells. Some of these wells are shown on the Water Budget Map. The only area where groundwater is not present in sufficient quantity to supply a well is the initial two miles of the Salt River downstream from Granite Reef. Bedrock is shallow in that area, and the saturated sediments may not contain sufficient water to maintain well pumping.

Pumped groundwater can be provided using existing wells or new wells. The advantage of using an existing well is that the costs associated with constructing the well have been committed. The constraint is that the location of some wells requires construction of a distribution pipeline and may require a booster pump. The advantage of drilling a new well is that it could be located at a point within a project to minimize distribution pipeline costs. The constraints are the costs associated with constructing a new well and meeting the state regulations if the new well is located on non-Indian lands.

Pumped groundwater is available on a continuous basis and, in sufficient quantity, could provide a dependable supply of suitable water for a project. One implication of using pumped groundwater is the impact that this pumping may have on other nearby groundwater wells. The SRPMIC has flexibility in using groundwater as a source for the project. For the City of Mesa, the primary impact of using groundwater would be that all pumped groundwater that is committed to this project would have to be replaced in the City's water portfolio with another water source to maintain the City's assured water supply designation.

Quality Analyses

Groundwater quality varies somewhat throughout the upper, middle, and lower alluvial units with the highest quality found in the lower units. As stated above for in-situ groundwater, groundwater from all alluvial units is generally suitable for agricultural purposes and is expected to be adequate for a project.

Water Rights

The SRPMIC regulates pumping of groundwater from beneath its land. They control where wells may be drilled and for what purposes groundwater may be used. The SRPMIC could permit the use of water from existing wells or the drilling of new wells to supply a project. However, the SRPMIC is restricted in the quantity of groundwater it can pump and the total quantity of water it can use in any year through the Water Rights Settlement Agreement of 1988. This means that the SRPMIC can commit pumped groundwater to a restoration project but may need to reduce water use for another purpose.

Similar to SRPMIC, the City of Mesa is also restricted in its ability to use groundwater. Under the Groundwater Management Act, the City of Mesa must maintain an Assured Water Supply designation. The City has already committed all available groundwater resources to maintaining this designation. This means that if the City were to meet any of its pumped groundwater to the restoration project, the City would have to purchase other water to replace the groundwater in its water portfolio.

Assessment of Source

When the physical availability of pumped groundwater is considered, it is a dependable or supplemental water supply. There are no projections that the aquifer would be depleted, and water rights do not prevent its use for a project. However, institutional commitments by the SRPMIC, Mesa, or SRP must be made to allow groundwater pumping.

(c) Salt River Flood Flows

Description of Source

The Va Shly'ay Akimel study area is downstream from Granite Reef, which is below the confluence of the Salt River and the Verde River. In the past, as previously mentioned, both rivers were perennial with consistent flow rates. The construction of dams and water storage reservoirs upstream allowed for the development of water resources to supply water for irrigation and urban use in the Phoenix Valley. Most of the time, all of the flow in the Salt River is diverted at Granite Reef into the Arizona Canal and Southern Canal. The riverbed downstream is typically dry. Figure 12 shows the Salt River at Alma School Road.

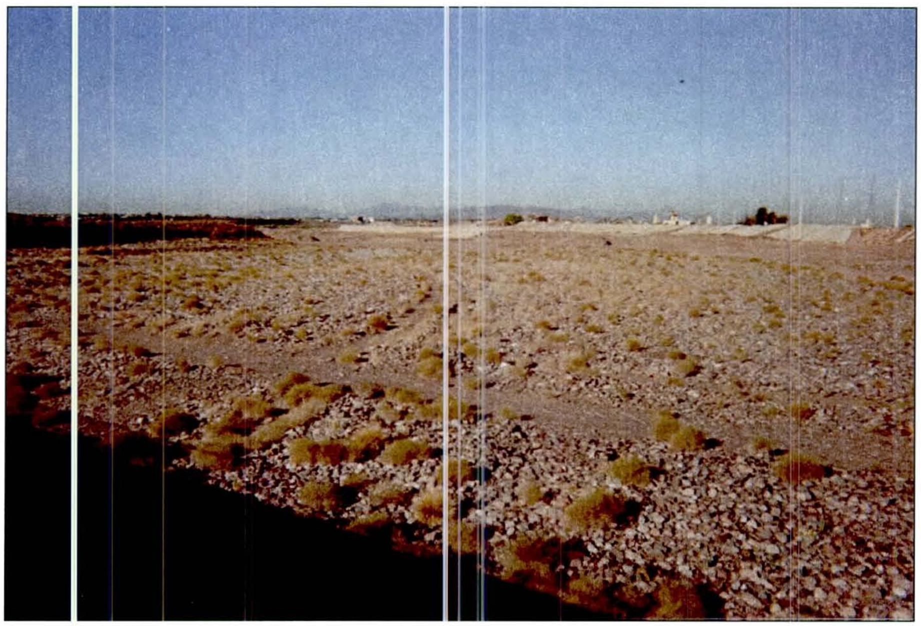


Figure 12. Salt River at Alma School Road

The river, however, is still subject to floods because the reservoirs on the Verde River have no dedicated flood capacity, and only one of the four reservoirs on the Salt River has flood capacity. Due to the design of the dams, only limited flows can be released in anticipation of floods. When the water level reaches the spillway at Granite Reef, substantial quantities of water are released, causing the downstream reaches of the Salt River to flood.

Quantity Analyses

The river downstream of Granite Reef can be dry for long periods. For example, the Salt River flooded in 1941 and then was dry until it flooded again in 1966. The next flood occurred in 1973. The periods from 1978 to 1984 and from 1991 to 1995 were wet periods. Since 1995, there have been no flood releases. Figure 3-1 in the Interior Drainage Appendix (Knight Piésold and Co., 2002a) summarizes historic releases at Granite Reef (Tres Rios River Management Plan Water Supply Technical Committee, 1997). This information demonstrates that, in the past, flood flows were more frequent and of less magnitude. Changes in the watershed and construction of additional dams have changed the pattern of flooding. Most of the largest recorded floods have occurred since 1978. Figure 3-1 also demonstrates that there is no pattern to the frequency, duration, or magnitude of the flood flows.

Quality Analyses

The Tres Rios River Management Plan Water Quality Technical Committee (1998) reviewed the water quality records for the Salt River and focused on the Granite Reef sampling location. That study found no chemical water quality issues associated with Salt River water. However, during flood periods, sediments represented a water quality problem; the sediment load exceeded the standard established for the designated uses of the river. However, the problem was not because the sediments represented contamination. There are no known water quality issues that would prevent flood flows from being used as a water source for a project (Knight Piésold and Co., 2002c).

Water Rights

Salt River floodwater is subject to surface water rights for diversion. A right filed with the state or established by adjudication is required. However, during a flood, all diversion rights are typically fulfilled. Generally, all water demands are diverted into the two canals at Granite Reef; a flood typically represents surplus water. Consequently, in order to encourage its use, SRP does not charge water users a fee to use Salt River floodwater.

Assessment of Source

Flood flows do not occur on a regular basis or in predictable quantities; therefore, they do not represent a dependable water source. While the water may be available, it may be difficult to incorporate flood flows into a project. Flood flows do represent a supplemental source because they recharge the groundwater and replicate historic conditions in the river. Aquifer recharge is an indirect use of flood flows. During or shortly after a flood, it is possible that the water table would rise to the point where the vegetation roots can access it. However, when the flood subsides, the water table will return to depths greater than the root zone.

Flood flows have additional benefits to the natural habitat of the river. Small flows will saturate the soils and spread seeds to encourage the seedling germination and development of cottonwood and willow trees. Moderate flood flows will remove some vegetation and maintain open areas in the river channel. The removal of vegetation is a natural occurrence in river systems. These flows can also redistribute sediments in the channel and help to replace nutrients in the riverbed soils.

Large floods, on the other hand, represent a problem source. The magnitude of these flows can damage restored habitat areas, degrade the reconstructed channels, and deposit excessive amounts of debris throughout the project. The peak flow in the vicinity of the study area on the Salt River occurred during the 1980 flood event at Jointhead Dam in Phoenix, AZ. The peak discharge was estimated at 170,000 cfs. This flood caused extensive damage in the Salt River Valley. Flows of this magnitude are neither predictable nor preventable.

(d) Stormwater Discharges

Description of Source

Stormwater discharges represent runoff from urban and rural areas due to rainfall events. In general, stormwater can enter the Salt River through defined outfall points from stormwater drainage systems or as overland flow runoff from areas immediately adjacent to the river, as shown in Figure 13.

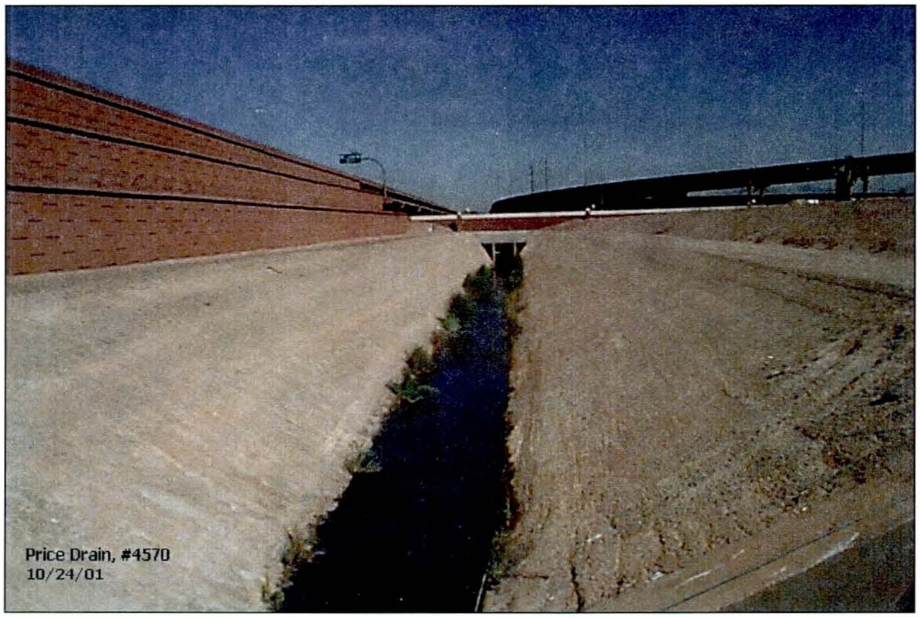


Figure 13. Price Drain

Quantity Analyses

The existence of wetland plant species near the outfall of the SRPMIC storm drain near Alma School Road supports the observation that at least 1 to 2 cfs flows from this drain periodically. However, no flow records for this drain currently exist, and the exact drainage area that contributes runoff to the drain is not known. According to SRPMIC personnel, water rarely flows from this drain as most runoff from the SRPMIC is typically diverted to other water users such as sand and gravel mining operations. However, the presence of wetland plant species indicates that this runoff is sufficient to maintain this vegetation.

Flow records for the Price Drain indicate that the mean flow to the river for the period from February 2001 to April 2002 was approximately 4.4 cfs. The peak flow during this period was 691 cfs. The records also show that there were only 24 days in which the average daily flow was less than 1 cfs, and there were only seven days in which the average day flow was less than 0.5 cfs. Based on these facts, it is apparent that this drain receives flows from sources other than storm water runoff. It is possible that this drain collects lawn irrigation return flows from residential areas as well as return flows from other water users within the tributary area.

To quantify the average monthly and annual volumes of runoff from ungaged storm drains, the approach used in the Rio Salado project (U.S. Army Corps of Engineers, 1998) was used to estimate the average annual volume of runoff. To estimate the average monthly volume of runoff, the annual amount was distributed according to the monthly rainfall distribution in the Phoenix area (Schmidli, 1996). This approach is described in detail in the Interior Drainage Appendix (Knight Piésold and Co., 2002a). Table 9 summarizes the average annual runoff volumes from the storm drains.

Quality Analyses

Stormwater discharges from urbanized metropolitan areas are generally of poor quality. The quality varies depending on the land uses within the tributary area, the magnitude and duration of the storm event, and the length of time between consecutive storm events. Sediment and chemical pollutants tend to accumulate between storms and are washed from the streets, parking lots, ditches, or other features during the proceeding event; this occurrence is termed the "first flush." The quality of the first flush water is generally poor. As the runoff continues, the water quality improves. The City of Mesa has reported that the base flow from the Price Drain may not have this first flush water quality problem

Assessment of Source

Rainfall events are infrequent in the Phoenix area, so stormwater runoff would generally not be considered as a dependable water source for a project. However, the Price Drain may be a dependable water supply. This drain has produced a consistent base flow, which can be incorporated into the restoration project. In addition, the Alma School Drain has produced sufficient flow to support a small area of wetland plant species; unfortunately, there are no records to further evaluate this flow.

The remaining storm drains represent two categories of water supply: problem and supplemental. The first flush runoff generally has poor water quality and may not be suitable to nourish restored vegetation. In addition, the peak flow rates emanating from these drains during major storm events may damage the habitat areas. These flows are both problem sources. After the first flush, the water quality generally improves. This runoff could be a supplemental source. Furthermore, there is potential for cleaning this water with constructed wetlands.

Table 9. Storm Drain Average Annual Runoff Volumes (ac-ft)

Interior Drain	Drainage Area (mi^2)[1]	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Price Drain[2,3]	31.2	195.7	201.5	257.0	64.3	35.0	38.0	242.4	280.4	251.2	189.8	192.8	292.0	2,240
Tempe Drain[2,3]	10.0	64.6	66.6	84.9	21.2	11.6	12.5	80.1	92.6	83.0	62.7	63.7	96.5	740
Price Road Freeway Local Drainage[2,3]	0.4	2.6	2.7	3.4	0.9	0.5	0.5	3.2	3.8	3.4	2.5	2.6	3.9	30
Dobson Road Storm Drain[2,3]	1.8	12.2	12.6	16.1	4.0	2.2	2.4	15.1	17.5	15.7	11.9	12.0	18.3	140
McLellan Road Storm Drain[2,3]	1.0	7.0	7.2	9.2	2.3	1.3	1.4	8.7	10.0	9.0	6.8	6.9	10.4	80
Country Club / McKellips Storm Drain[2,3]	3.7	26.2	27.0	34.4	8.6	4.7	5.1	32.5	37.5	33.6	25.4	25.8	39.1	300
Red Mountain Freeway Local Drainage[2,3]	unknown							minimal						
Natural Drainage[2,3]	2.0							minimal						
Alma School Storm Drain	unknown	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Percent of Annual Rainfall:		8.7	9.0	11.5	2.9	1.6	1.7	10.8	12.5	11.2	8.5	8.6	13.0	100.0

1. Drainage areas were estimated based on the drainage delineations made by personnel from the City of Mesa.
2. Monthly storm water runoff distributions were assumed to follow the monthly pattern of rainfall.
3. Annual runoff volumes were computed from the drainage area vs. average annual runoff relationships developed for the Rio Salado Study (Figure 3-3).

(e) Effluent

Description of Source

Treated effluent represents a drought-tolerant water supply. During water shortage periods, most water conservation measures control the external use of water such as lawn watering, car washing, and landscape irrigation. These uses do not contribute to wastewater flow, so the amount of wastewater will only be reduced slightly during most drought periods.

Quantity Analyses

The City of Mesa owns and operates the NWWRP located near the downstream end of the study area (Haws, 2002). The NWWRP currently produces about 8.5 to 9.0 million gallons per day (mgd) of effluent; however, the plant was recently expanded to a design capacity of 18 mgd. The effluent will be discharged to three locations:

- Four City-owned percolation ponds on the south side of the river (south ponds)
- Five SRPMIC-owned percolation ponds on the north side of the river (north ponds)
- Directly to the Salt River, just north of the plant site

In the future, a fourth receiving source will be a 36-inch reclaimed water line that is being constructed in conjunction with the Red Mountain Freeway (Loop 202). This reclaimed water line will provide landscape water for the freeway, and potentially other uses, and will eventually deliver water to the Roosevelt Water Conservation District (RWCD) canal system east of Val Vista Drive.

Historically, the plant has discharged an average of 3,300 ac-ft of water into the percolation ponds. The five SRPMIC-owned ponds, totaling 75 acres, have received an average of 3,330 ac-ft of effluent each month since their inception in May 2001. The four Mesa-owned ponds, totaling 27 acres, have received an average of 140 ac-ft of effluent each month since January 2000. Effluent has also been discharged directly into the river.

Quality Analyses

The quality of the effluent from the NWWRP meets aquifer recharge standards, surface water quality standards, and NPDES requirements. Arizona has taken over the NPDES permitting; the program is called AZPDES. Having met all three of these authoritative standards, the quality of effluent is suitable for restoration uses.

Water Rights

The producer of effluent retains ownership until it is discharged and no longer under the control of the producer. If effluent is discharged to a river channel, a downstream water user can file for an appropriation to divert the water just like any other surface water source. The water user may be granted the surface water right to divert the effluent; however, this right does not guarantee that the effluent producer would continue to discharge to the river channel. The producer still has control as to where the effluent is discharged.

Normally, when effluent is discharged to the river, the producer loses control and hence the right to the effluent. However, if the receiving water channel is designated to be a part of the conveyance system, the producer can maintain the right to the flow. This could occur if the City of Mesa (Mesa) discharged effluent to a receiving channel in the Salt River with the intent to transport the flow to the restoration project.

When Mesa discharges the effluent to the recharge ponds, they retain control of the effluent and maintain the right to this water. Once the effluent is recharged, Mesa's right to this effluent is protected pursuant to groundwater recharge legislation statutes.

Assessment of Source

Effluent from the NWWRP could be a dependable or supplemental supply for portions of a project. The water source is drought tolerant and can meet water quality standards for restoration. However, Mesa, which controls the right to the effluent flow, has already committed this water for other uses to meet its assured water supply designation. Currently, Mesa owes a substantial water debt to the RWCD. Once the reclaimed water line to the RWCD canal line is in place, Mesa intends to use the majority of the effluent from the NWWRP to fulfill this debt. Mesa receives long-term storage credits from this delivery as well as from water recharged through the percolation ponds. Therefore, use of reclaimed water for habitat restoration would mean a depletion of the long-term storage credits that Mesa uses to comply with Assured Water Supply requirements and to meet current and future demands.

The direct use of effluent could be used in the western and central portions of the study area where gravity flow and the reclaimed water distribution system can be used to deliver the effluent. It may not be cost effective, however, to deliver effluent to the eastern portions of the project near Granite Reef. However, indirect use of effluent could be achieved throughout the study area by using recovery wells to pump groundwater accounted for as recharge credits. It must be noted that no effluent would be used within the SRPMIC, nor in any way that would cause it to flow into the SRPMIC.

(f) Irrigation Return Flows

Description of Source

The Va Shly'ay Akimel study area lies adjacent to irrigated agricultural lands, therefore, the potential exists to use irrigation return flows as a water source for the ecosystem and habitat restoration. Irrigation return flows constitute the water delivered to the agricultural areas that is not consumed by crops, evaporated, or infiltrated into the soils. These flows can occur under two scenarios, which are explained in further detail in the Water Budget Appendix (Knight Piésold and Co., 2002c).

Quantity Analyses

Under the current configuration, the SRPMIC supplies approximately 60,000 ac-ft of irrigation water to agricultural users annually.

Approximately 14,000 ac-ft of this water are delivered to the areas north of the Arizona Canal. The canal intercepts all runoff from this area; therefore, irrigation return flows from this area are not a potential source of water for the restoration project.

The remaining 46,000 ac-ft are delivered to farms, the Cypress Golf Course, and individual homeowners for lawn irrigation. Table 10 identifies water delivered to these entities.

Table 10. SRPMIC Irrigation Water Use

Water User	Annual Water Use (acre-feet) 1999	2000	2001
Associated Farms	18,511	27,009	27,061
Rogers Farms	9,130	17,731	16,645
Taylor Farms	13,786	0	0
Juan Montiel Farm	57	170	142
Lehi Farm	2,249	1,952	1,892
Cypress Golf Course	177	164	109
Homeowners Lawn Irrigation	125	91	31
Total Irrigation	**44,035**	**47,117**	**45,880**

The amount of irrigation return flow generated from these water users is not currently monitored and is difficult to quantify. SRPMIC personnel have suggested that approximately 10 percent of the water delivered to the farms may become irrigation return flow.

Quality Analyses

The quality of the irrigation return flows can meet the needs of a restoration project in most cases. The water is Salt River water and, as demonstrated previously, the quality is acceptable. In some locations, irrigation drainage water can be saline, but that problem usually occurs far downstream in the western portions of the SRP service area.

Localized water quality problems could occur if surface runoff drainage enters the irrigation drain canals and transports contaminants from surrounding areas into the drain canals. Examples of localized water quality problems include elevated suspended solids, TDS, Fertilizers, or on occasion, herbicides/pesticides. A review of the aerial photographs indicates no concentrated animal feeding operations in the area that could contribute contaminated runoff into the drainage canal system.

Water Rights

Irrigation return flows discharged to the river become available for use by other water users. If this water is diverted and directed for a restoration project, it could be utilized to support wetland and riparian habitat.

Assessment of Source

Irrigation return flows may provide a supplemental source of water for habitat restoration. However, nearly all irrigation return flow from within the SRPMIC are currently diverted to other water users, so this water is not available without an institutional decision to allocate this water to the project by the SRPMIC. In addition, several factors prohibit irrigation return flows from being a reliable source. Typically, only the amount of water necessary for irrigation is delivered to the fields, which minimizes the tail water amount. In addition, storm events that produce significant runoff are rare so that surplus canal water is not available on a regular basis. The irrigation flows that do occur, however, only take place during the irrigation season. When the flows are available, they could be incorporated to supplement the water supply for a project. Since all irrigation within the study area takes place within the western portion of the SRPMIC, irrigation return flows would only be available to Reach 2.

(g) Canal Drains

Description of Source

Canal drains are typically constructed along the major canals in the area to provide a means to discharge water from the canal other than the designated delivery turnouts. During storm events, the canals inadvertently intercept stormwater runoff. If this stormwater runoff is significant, water may need to be released from the canal to prevent overflowing the canal banks. Also, the major canals occasionally convey more water than is needed by the downstream water users; in this case, the excess water can be released through the canal drains. Three significant canal drains were identified within the study area, namely the Evergreen Drain, Hennessey Drain, and Tempe Drain. Each of these canal drains is operated by SRP. These drains are shown on the Water Budget Map. Figures 14 and 15 show the turnouts to the Evergreen Drain and Hennessey Drain, respectively.

Figure 14. Evergreen Drain Turnout

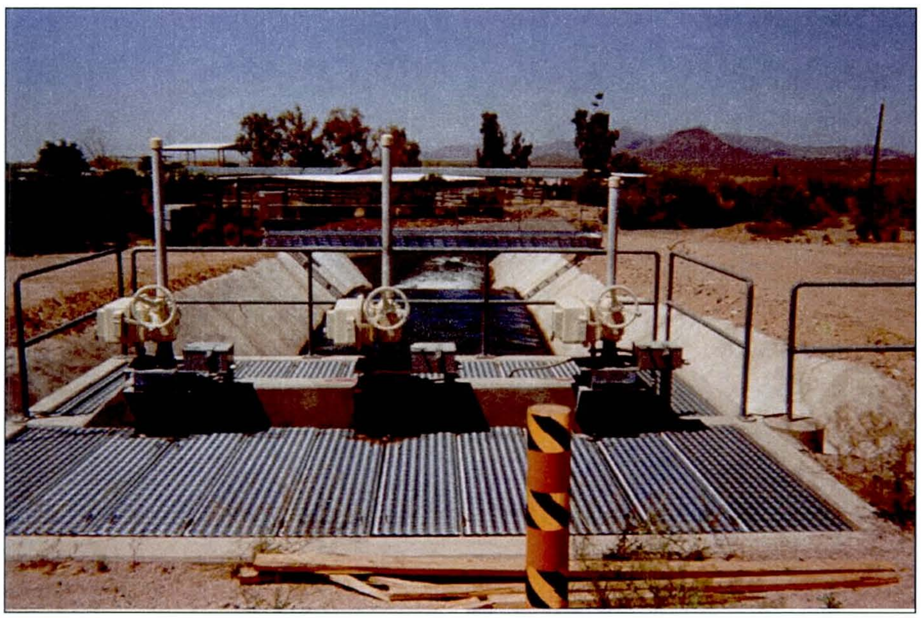


Figure 15. Hennessey Drain Turnout

There are also several lateral canals that could ultimately drain into the Salt River. These canals, however, are generally relatively small and rarely have a surplus of water. There are no flow records available for these canals. Given the size and infrequent water surplus of these canals, they are not considered to be a potential water source for a project. These lateral canals are shown on the Water Budget Map.

The RWCD diverts water from the Southern Canal at a pumping station located approximately five miles downstream of Granite Reef. Irrigation water is pumped from the Southern Canal into the Roosevelt Canal, which then flows toward the southeast. The areas irrigated by the RWCD irrigation water are located in eastern Mesa, eastern Chandler, and Gilbert. Because these areas are located a great distance from the Salt River and south of the Southern Canal, there are no canal drains that return water to the Salt River.

Quantity Analyses

Flow records for the SRP drains were evaluated for the period from January 1992 through December 2001. These records indicate that, for the Evergreen Drain, the average monthly volume of flow for this period ranged from 10.9 ac-ft in May to 74.5 ac-ft in September, with an average annual total of 566.5 ac-ft. For the Hennessey Drain, the average monthly volume of flow ranged from 2,264.3 ac-ft in April to 4,937.4 ac-ft in August with an average annual total of 45,930.7 ac-ft. For the Tempe Drain, the average monthly volume of flow ranged from 8.0 ac-ft in December to 2,607.2 ac-ft in January with an average annual total of 10,880.2 ac-ft. Table 9 summarizes the average monthly and annual volumes of flow for these drains for the period of record evaluated.

Quality Analyses

The water discharged from canal drains is generally high quality and suitable for habitat restoration.

Water Rights

Irrigation return flows discharged to the river become available for use by other water users. If this water is diverted and directed into a project, it could be utilized to support wetland and riparian habitat.

Assessment of Source

Canal drains may provide a supplemental source of water for a project. The amount of water released through these drains is relatively consistent from month to month; however, releases typically only occur for a few days each month. These releases are controlled by SRP and are not expected to be reliable. Canal drains are typically only utilized when a surplus of water exists in the major canals. When these releases do occur, however, they could be used to supplement habitat restoration.

(h) Sand and Gravel Mining Operations Releases

Description of Source

There are four mining operations identified within the study area; these operations use water to process aggregate materials. Three of these mining operations are operated by the Salt River Sand and Rock (SRS&R), while the other is operated by United Metro Materials Corporation. The SRS&R Dobson Plant, shown in Figure 16, is located north of the river between the Pima Freeway (SR101) and Dobson Road. The SRS&R Beeline Plant is located south of the Beeline Highway (US 87) between Horne Road and Gilbert Road. The SRS&R Higley Plant is located north of the Southern Canal between Greenfield Road and Higley Road. The United Metro operation is located south of the Beeline Highway on the east side of Country Club Road. None of these operations appear to discharge water to the Salt River (Knight Piésold and Co., 2002c).

Quantity Analyses

The SRPMIC provides water to Salt River Sand and Rock for use in their Dobson Plant. The SRPMIC has provided approximately 450, 800, and 1,200 ac-ft of water to this plant during 1999, 2000, and 2001, respectively. This water is used for processing aggregates and stored in holding ponds when not in use. No water appears to be discharged into the Salt River; however, inspection of aerial photography indicates that ponded water exists in the Salt River channel immediately adjacent to the Dobson Plant. The origin of this water is unknown, but it could be processing discharge, rainwater ponding, or water from another source including groundwater.

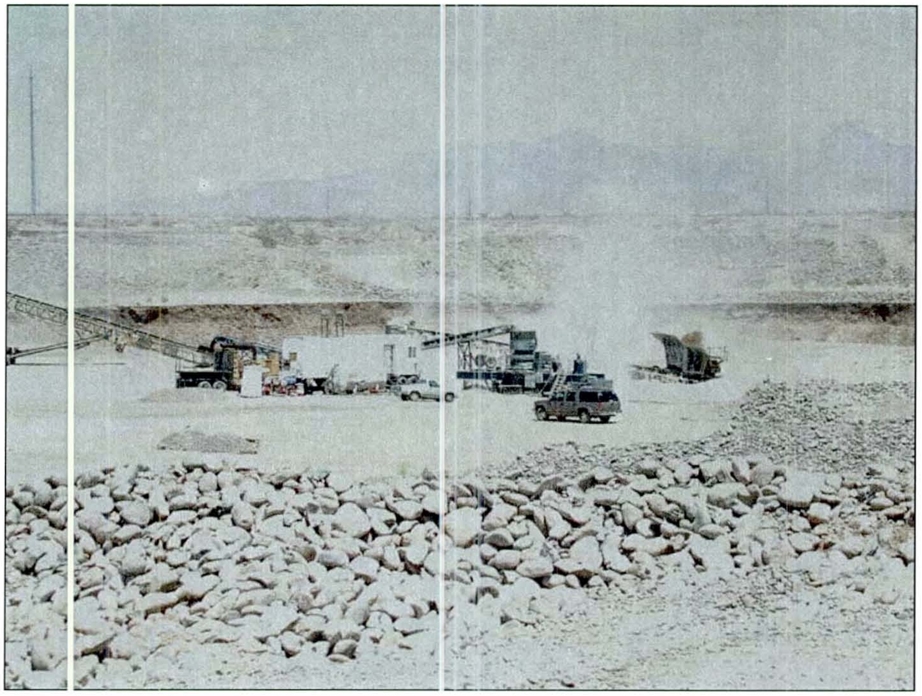


Figure 16. Sand and Gravel Operation at Dobson Plant

Quality Analyses

The quality of water discharged from sand and gravel mining operations is dependant partially on the original water supply. The most significant water quality impairment due to these mining operations is sediment.

Water Rights

Discharges from sand and gravel mining operations released to the river become available for use by other water users. If this water is diverted for restoration purposes, it could be utilized to support wetland and riparian habitat.

Assessment of Source

Discharges from sand and gravel mining operations are not considered to be a potential water source for a restoration project. There are no operations that currently appear to discharge excess water into the Salt River.

(i) Salt River Project and Central Arizona Project Water

Description of Source

SRP delivers water to the SRPMIC lands as well as non-Indian lands. SRP canals are subject to a two- to four-week dry-up period every year to allow for maintenance activities. The Arizona Canal and Southern Canal have separate dry-up periods. Figures 17 and 18 show the Arizona Canal and Southern Canal, respectively.

CAP water is diverted from the Colorado River and transported across Arizona. The CAP system crosses the Salt River immediately downstream of Granite Reef, and there are turnouts that allow CAP water to be diverted into the SRP system. The CAP canal is not subject to periodic dry-up periods, but because the SRP system is needed to transport to the project area, the SRP dry up can impact the delivery.

Quality Analyses

The quality of both SRP and CAP water is suitable for use in a project. Quality is not a constraint.

Figure 17. SRP's Arizona Canal

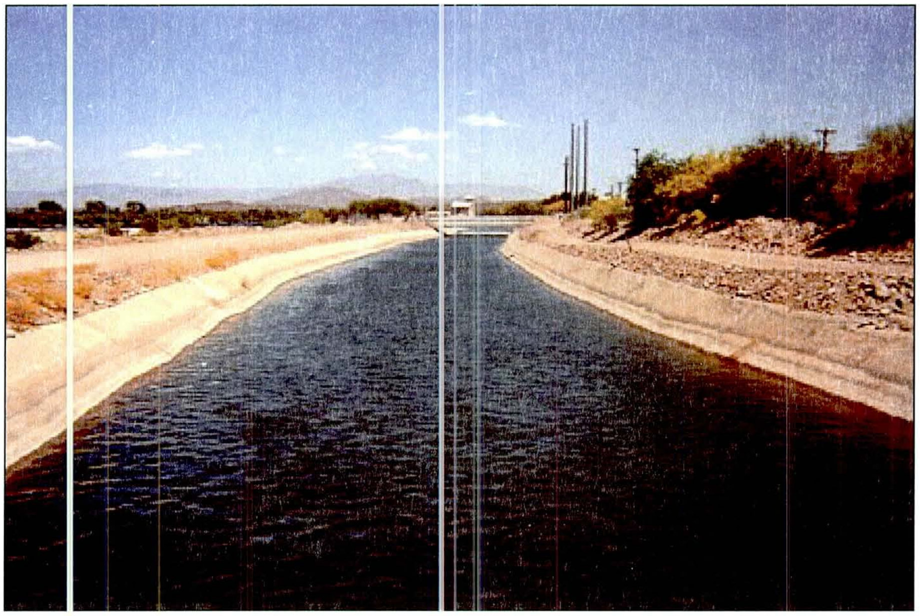


Figure 18. SRP's Southern Canal

Water Rights

SRP is a delivery organization. The water rights associated with lands within the SRP area are tied to the land. These water rights were established by the Kent Decree and relate to normal flow of surface water and stored water. SRP lands also have pumped rights gained when a landowner has funded the development of wells. Lands in the Salt River do not have SRP rights, and SRP could not provide water to these lands. SRP delivers water to the SRPMIC, and the rights for this water were also established by the Kent Decree. There may be more flexibility to allow use of SRPMIC water on lands within the river.

Rights to CAP water are established by allocations made by the Secretary of Interior. The SRPMIC has a contract with the Federal Government for CAP water. Mesa has a subcontract with the Central Arizona Water Conservation District (CAWCD) and the USBR for delivery of CAP water.

Assessment of Water Source

SRP water delivered to non-Indian lands should not be considered as a potential water source, as it is already committed. CAP water delivered to Mesa should also not be considered as a potential water source, as it is also committed. Use of Mesa's CAP subcontract water for habitat restoration would mean a depletion of the water the City uses to comply with Assured Water Supply requirements and to meet current and future demands. In addition, excess CAP water supplies are not projected to be available in the very long term.

There is a potential to use water delivered by SRP to the SRPMIC and the SRPMIC's CAP allocation to supply a project. These are institutional decisions that must be made by the SRPMIC rather than a water supply issue. If committed to a project, this water could be diverted at Granite Reef or via a pump station to supply the eastern portion of the project area. Deliveries to the central and western portion of the project could use the SRPMIC's irrigation water delivery system.

If SRP or CAP water is committed to a restoration project, it would be a dependable supply for most of the year. However, a supplemental supply may be needed to augment the flow during the SRP dry up periods. The need for a supplemental supply can be defined in the plan formulation stage when habitat alternatives are developed and the vegetation mix is proposed. The water demand of the vegetation may be very low when the dry up occurs, and the demand for supplemental water may be small or eliminated.

4.2.3.2 Outflows

Two primary water demands were identified that are associated with a river restoration project. These include consumptive use by wetland vegetation and evaporation from open water bodies. Consumptive use is defined as the water needed to account for plant evapotranspiration, which is the water required by the plant for growth and the water that may be evaporated from the plant itself and the soil in the immediate area surrounding the plant.

The following information quantifies the average annual and monthly water demands associated with the water uses. When the project alternatives are finalized, the total demands can be projected by multiplying the per acre demands by the number of acres of vegetation and open water.

(a) Evapotranspiration

Water Demands of Vegetation

The water demand of vegetation varies depending on the individual and mix of species within a habitat unit. In the Tres Rios project (U.S. Army Corps of Engineers, 2000), the average annual evapotranspiration of river vegetation was projected to equal 3.7 acre-feet per acre (ac-ft/ac). This general rate accounted for a mix of vegetation species that is similar to the expected mix for this project (Greeley and Hansen, 2001). The monthly demand is calculated as a percentage of the annual demand and defines the seasonality of the required water supply. The values shown in Table 11 below are based on water demand projections for the Tres Rios project.

Table 11. Consumptive Use for Salt River Habitat

Month	Percent of Annual Demand (%)	Consumptive Use (ac-ft/ac)
January	5	0.19
February	5	0.19
March	5	0.19
April	10	0.37
May	10	0.37
June	15	0.56
July	15	0.56
August	15	0.56
September	5	0.19
October	5	0.19
November	5	0.19
December	5	0.19

The root zone depth of vegetation is also an important criterion when assessing the adequacy of water supplies to meet demands. If the roots of plants have access to groundwater, it reduces the irrigation demand. Plants have different requirements depending on the phase of development, seeding, sapling, and maturity. Table 12 (Wass, 2002) presents the root zone information for several species common within the Salt River channel environment. The table also presents the desirable ranges of depth to groundwater (or depth of inundation for aquatic plants) for establishment and growth. These data will be used in assessments of in-situ groundwater and to calculate irrigation demands during alternative development.

Table 12. Riparian and Constructed Wetland Vegetation Requirements

	Vegetation Type	Seedling Establishment	Sapling Growth	Mature Survival
	Trees (Groundwater Depth Requirements)			
Cottonwood	Populus fremontii (Fremont cottonwood)	Moist soils in March/April	0.66 to 6.6 feet	16.5 feet
Willow	Salix gooddingii (Gooding willow; black willow)	Moist soils in April/May	0.66 to 6.6 feet	10 feet
Mesquite	Prosopis sp.	< 4 inches	3.3 to 33 feet	< 33 feet
Salt Cedar	Tamarix sp.	Moist soils in May to September	0.66 to 8.2 feet	33 feet
	Common Aquatic Plants (Inundation Depth Requirements)			
Shallow Emergent Marsh	Scirpus validus, Scirpus americanus, Scirpus acutus, Sagittaria greggii, Sagittaria latifolia, Alisma triviale, Typha latifolia	Saturated soils to 2 inches	Saturated soils	Saturated soils to < 2.6 feet
Deep Emergent Marsh	Typha domingensis, Scirpus californicus, Phragmites australis	Saturated soils to 2 inches	Saturated soils	Saturated soils to < 4.9 feet
Floating Aquatic	Hydrocotyle sp., Ludwigia palustrus, Polygonum hydropiperoides, Potamogeton sp. Rorippa, Nasturtium-aquaticum	Moist soils to 4 inches	Moist soils to 8 inches	Moist soils to 8 inches
Transitional Marsh Plants	Eleocharis parishii, Eleocharis macrostachya, Equisetum laevigatum or similar sp., Cyperus niger, Cyperus laevigatus, Cyperus erythorhizos or similar sp., Juncus balticus, Juncus bufonius, Juncus tenuis var. Dudleyi, Juncus interior, Juncus torreyi, or sim	Moist soils to 4 inches	Moist soils to 4 inches	Moist soils to 4 inches

(b) Evaporation Losses

A restoration project within the study area may include open water bodies, riparian wetlands, constructed wetlands, and marsh areas. A portion of the water demand is to make up for evaporation losses in these habitat types. In the central Arizona area, the annual evaporation averages 72.4 inches or 6.03 feet per year, shown in Table 13. However, evaporation is seasonal with the greatest evaporation in the summer months (Cooley, 1970).

Table 13. Seasonal Evaporation from Open Water

Month	Evaporation (ac-ft/ac)
January	0.18
February	0.26
March	0.42
April	0.55
May	0.75
June	0.83
July	0.83
August	0.75
September	0.58
October	0.44
November	0.33
December	0.18
ANNUAL	**6.03**

4.2.3.3 Water Sources Assessment Summary

Table 14 summarizes the potential water sources identified and evaluated to support the proposed restoration effort in the study area.

Table 14. Water Sources Assessment Summary

Water Source	Description/Location	Quantity Available	Availability	Supply Designation	Discussion/Issues
In-Situ Groundwater					
Regional water table	Throughout the study area; all reaches	None	Not available	Unacceptable	Regional groundwater is too deep for use by the desired vegetation. Depth exceeds 30 feet, which is the limit for mesquite.
Local or perched water table	Extends from Granite Reef Dam approximately 1 mile downstream; Reach 1	Not measured	Continuous	Dependable	Local supply available at the surface from Granite Reef to about one mile downstream.
Pumped Groundwater					
Community Lands	Throughout the Community; all reaches	Pending	Continuous	Dependable or Supplemental	Requires a reallocation of water resources to project by the Community.
Non-Indian Lands					
Irrigation Grandfather Rights	Tied to specific parcels of land for growing crops.	Not Available	None	Unacceptable	IGR water must be used on a historically specified parcel of land.
Type I Non-Irrigation Rights	Tied to specific parcels of land for changes in land use.	Not Available	None	Unacceptable	Type I water cannot be used off of the specific land parcel.
Type II Non-Irrigation Rights	Pumping for uses not associated with historic farmland.	Pending	Continuous	Dependable or Supplemental	Requires purchase and transfer of Type II right.
Groundwater Permits	Pumping for new uses.	Not Available	None	Unacceptable	Project can not meet permit requirements and conditions.
Service Area Right	Pumping for public water providers.	Not available – already committed	None	Dependable or Supplemental	Pumped water will impact Mesa's overall water resources unless credits to offset the pumping are purchased or developed.
Salt River Flood Flows					
Direct Use	Flow in the Salt River due to spills over Granite Reef Dam; all reaches	Quantity varies with each flood event	Approximately once every 3 years	Problem	Due to the unpredictable nature of the flood flows, they are not a dependable supply, and may cause damage to restored areas.

Water Source	Description/Location	Quantity Available	Availability	Supply Designation	Discussion/Issues
Indirect Use	Groundwater recharge due to flood flows in the Salt River; all reaches	Quantity varies with each flood event	During floods and for a short time after	Supplemental	Recharge of groundwater allows for indirect use; and, surface soil saturation will augment seed germination.
Stormwater Discharges					
Alma School Road Storm Drain	Storm runoff from the Community, outfalls along the west side of alma School Road; Reach 5	1 to 2 cfs estimated (no flow records available)	May be fairly continuous	Supplemental	Wetland vegetation is present indicating a fairly continuous flow; flow monitoring may permit reclassification as a dependable source.
Natural Surface Drainage - SRPMIC	Uncontrolled surface runoff from the Community; all reaches	Minimal	During or immediate after rainfall events	Problem	Runoff is of insufficient quantity with no dedicated collection system; most runoff is uncontrolled overland flow.
Price Drain	Storm runoff from Mesa, outfalls along the east side of the Pima Freeway (Loop 101); Reach 6	Averages 4 cfs; ~ 2,500 ac-ft/yr	Continuous	Dependable	Continuous base flow may be a dependable source; however, water quality may be a concern due to storm water runoff.
Tempe Drain (see Canal Drains)	Storm runoff from mesa, outfalls between Dobson Road and Alma School Road; Reach 5	(See Canal Drains)			This drain serves as a canal drain and intercepts storm water runoff from Mesa.
Price Road Freeway Local Drainage	Storm runoff from Mesa, outfalls along the east side of the Pima Freeway (Loop 101); Reach 6	~ 30 ac-ft/yr	During or immediate after rainfall events	Unacceptable to Supplemental	First flush is unacceptable due to potential water quality problems, but the remainder of the flow can be a supplemental water source.
Dobson Road Storm Drain	Storm runoff from Mesa, outfalls along the east side of Dobson Road; Reach 6	~ 140 ac-ft/yr	During or immediate after rainfall events	Unacceptable to Supplemental	First flush is unacceptable due to potential water quality problems, but the remainder of the flow can be a supplemental water source.

Water Source	Description/Location	Quantity Available	Availability	Supply Designation	Discussion/Issues
McLellan Road Storm Drain	Storm runoff from Mesa, outfalls west of Alma School Road; Reach 5	~ 80 ac-ft/yr	During or immediate after rainfall events	Unacceptable to Supplemental	First flush is unacceptable due to potential water quality problems, but the remainder of the flow can be a supplemental water source.
Country Club/McKellips Storm Drain	Storm runoff from Mesa, outfalls along Country Club Road; Reach 5	~ 300 ac-ft/yr	During or immediate after rainfall events	Unacceptable to Supplemental	First flush is unacceptable due to potential water quality problems, but the remainder of the flow can be a supplemental water source.
Red Mountain Freeway Local Drainage	Storm runoff from the Red Mountain Freeway (Loop 202); Reach 3, 4, 5, and 6	Minimal	During or immediate after rainfall events	Problem	Runoff is of insufficient quantity with no dedicated collection system; most runoff is uncontrolled overland flow.
Natural Surface Drainage - Mesa	Uncontrolled runoff between Gilbert Road and Granite Reef Dam, south of the Salt River; Reach 1 and 2	Minimal	During or immediate after rainfall events	Problem	Runoff is of insufficient quantity with no dedicated collection system; most runoff is uncontrolled overland flow.
Effluent					
Direct Use	Effluent from the NWWRP discharged directly into the project; Reach 6.	Not available – already committed	None	None	The quantity and availability of effluent water is subject to an institutional commitment by Mesa; Mesa has existing commitments for this effluent.
Indirect Use	Effluent from the NWWRP recharged into the groundwater; Reach 6.	Not available – already committed	None	None	Mesa has incorporated the recharge credits for this effluent into its long-term water plan; it would require a reallocation to the project. Indirect use requires wells to recover the recharged water.
Irrigation Return Flows					
Irrigation Tailwater	Excess water applied to crops within the western portion of the Community; Reach 4, 5, and 6	Minimal	Irrigation season	Supplemental	Supply only available during irrigation season; unreliable because irrigation practices are designed to reduce the tailwater quantity.

Water Source	Description/Location	Quantity Available	Availability	Supply Designation	Discussion/Issues
Irrigation Drainage	Excess water in lateral canals within the Community; Reach 4, 5, and 6	Minimal	Irrigation season	Supplemental	Supply only available during irrigation season; unreliable because irrigation practices are designed to reduce the tailwater quantity.
Canal Drains					
Evergreen Drain	Drains the Arizona Canal, outfalls west of Horne Road; Reach 4	averages < 1 cfs; ~567 ac-ft/yr	In-frequent	Supplemental	Flow is due to controlled releases by SRP; releases only occur once or twice each month and are not reliable.
Hennessey Drain	Drains the Southern Canal, outfalls east of Val Vista Road; Reach 4	averages 63 cfs; ~ 45,921 ac-ft/yr	In-frequent	Supplemental	Flow is due to controlled releases by SRP; releases have occurred frequently in the past but only for two days since Nov. 2001; may not reliable in the future.
Tempe Drain	Drains the Tempe Canal, outfalls between Dobson Road and Alma School Road; Reach 5	averages 15 cfs; ~ 10,880 ac-ft/yr	In-frequent	Supplemental	This canal intercepts storm water so flow is due to controlled releases by SRP as well as rainfall events; releases occur on average 4 times each month and are not reliable.
Sand & Gravel Mining Releases					
	Within the Salt River; all reaches	None	Not available	Unacceptable	No known discharges from these operations.
Salt River Project & Central Arizona Project Water					
	Throughout the project area; all reaches	Pending	Pending	Dependable to Supplemental	The quantity and availability of water supply is subject to institutional commitments by SRP or CAP.

Source: Knight Piésold, 2002a

4.2.4 Vegetative Habitat

Historically, the study area supported significant biological resources including extensive riparian and wetland habitats within the floodplain. Urban development, sand and gravel operations, diversion of water to support agriculture, and domestic livestock grazing have eliminated or altered most of the natural vegetation communities that occupied the project study area leaving only scattered remnants of the original vegetation communities. Modifications of the river system, such as damming and flow diversion, currently allow no natural flow through the project study area except during flood events. The Salt River below Granite Reef Diversion Dam is essentially devoid of vegetation.

At one time, mesquite occurred along the outer bank of the river, at the extreme edge of the natural riparian vegetation. The willow and cottonwoods were located inward of the mesquite, adjacent to the low-flow channel and closer to where there was a more continuous flow of water. Some channel areas were barren, while others had vegetation in strips along the low-flow channels and abandoned high-flow channels. The bottomlands of the Salt River supported a variety of vegetation, including trees, shrubs, marsh plants, and some grasses. Large cottonwood, willow, and alder trees grew along the margins of the river, and mesquite, greasewood, Palo Verde, and sagebrush covered the low terraces. Dense mesquite and other shrubs made crossing the bottomland impossible in places, while in other locations the vegetation was more scattered. Large, dense mesquite forests or bosques are found along abandoned lakes, lake edges, and river floodplains in southern Arizona. Mesquite bosques were once the most abundant riparian type in the Southwest. Most modern mesquite bosques are large (typically one mile long and 600 feet wide), but these are small compared to pre-development bosques, which extended for miles. Mesquite bosques usually are found on the drier habitat types within the riparian continuum. The locations for this setting are floodplains or low terraces several yards above the streambed and up to 45 feet above the water table. There were several species of fish in the waters similar to those found in the Gila River. The river had many channel meanders, sand bars, and backwater areas that were conducive to riparian growth.

These once optimal conditions for gallery forests of cottonwoods and willows no longer exist. The elimination of natural base flows reduced Salt River flows from a distinct seasonal pattern, with highest flows occurring in December and January and lowest flows in October to summer or fall rainfall-related flood events. The groundwater table beneath the river dropped. The soil moisture in the riverbed was virtually eliminated, and the native cottonwoods, willows, and riparian ecosystem rapidly died out. Most areas of the Salt River are barren today. What little vegetation that does exist is mostly limited to saltcedar, an exotic non-native species with little habitat value. Vegetation communities in the project study area have been highly modified from their original state and currently contain a mosaic of degraded natural communities and man-made artificial communities. Included in this reach of the Salt River are a large number of open water areas, mostly the result of gravel mining. Adjacent to several of these is dense vegetation including some cottonwood and willows as well as the occasional cattail or bulrush.

4.2.4.1 Cover Types

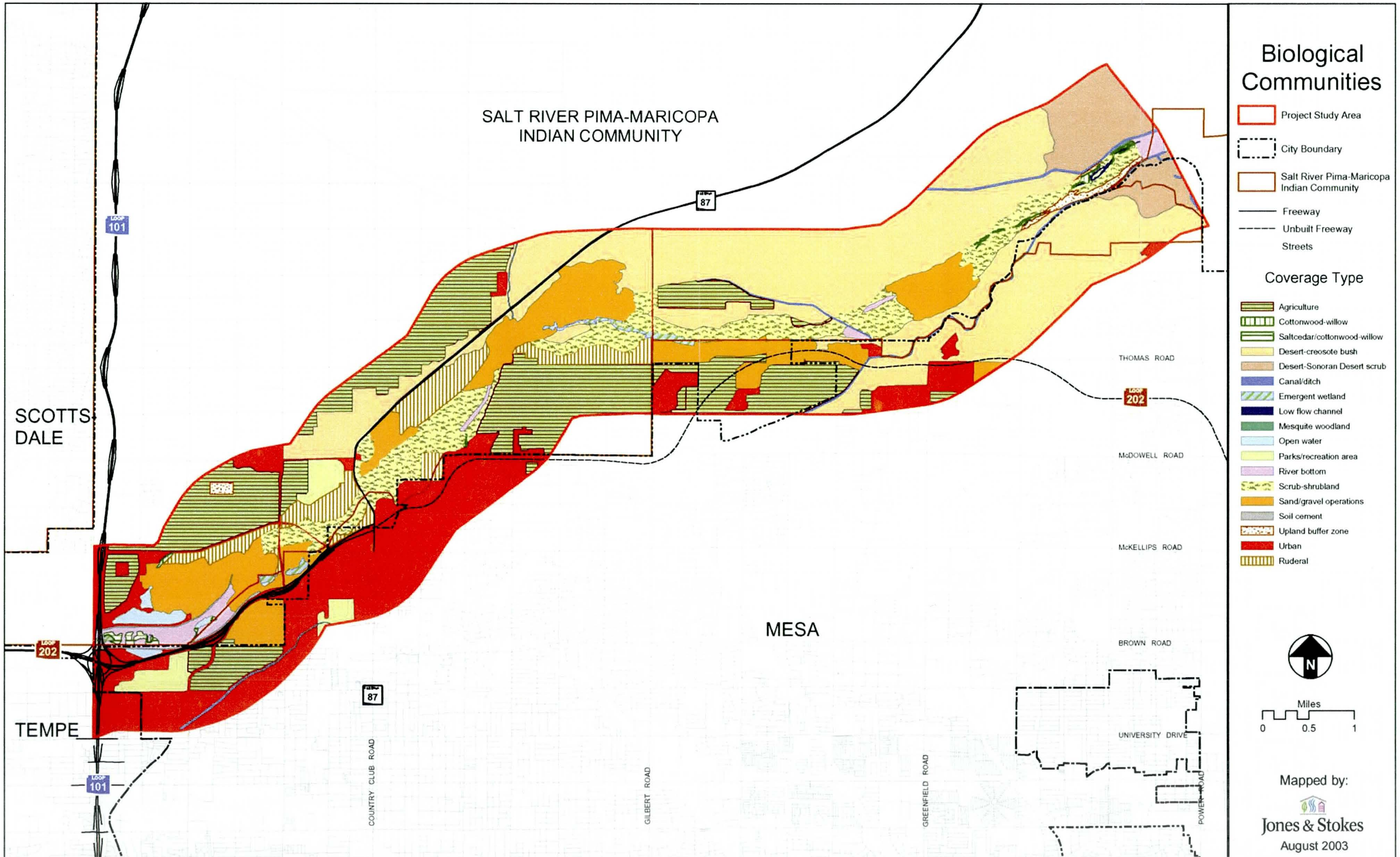
A classification system of cover types was developed for this study and is mainly based upon vegetation cover. For the length of the study reach and one mile on either side of the thalweg, or center of the river channel, cover types were mapped. Figure 19 depicts cover types found within the project area.

Scattered remnants of natural vegetation remain, those cover types include cottonwood-willow forest, mesquite, scrub shrub lands, and emergent wetlands. Of those cover types, scrub shrub lands are the most dominant covering approximately 1,400 acres in the 17,435 acre study area. The scarcest is cottonwood-willow forest, which is found within merely 40 acres, of which 31 acres are dominated by saltcedar.

(a) Cottonwood-Willow Forest

Cottonwood-willow forest is uncommon in the project study area occupying less than 1 percent of the total study area. This cover type is representative of high-quality riparian habitat in Arizona. Riparian habitats are defined as habitats or ecosystems that are associated with adjacent bodies of water (rivers, lakes, or streams) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. They are further characterized by having diverse assemblages of plant and animal species in comparison with adjacent upland areas.

Figure 19. Biological Communities



Because of the modification of the Salt River system, the lower groundwater elevations compounded by the loss of perennial surface flows have contributed to the decline in cottonwood and willow species. These same conditions have also favored the establishment and dominance of saltcedar. Structural types of most stands of cottonwood-willow within the study area show evidence of disturbed and early successional conditions consistent with past histories of water diversion, infrequent severe floods, and land clearing. These plant species are also found in habitats that are narrow, linear strands of vegetation oriented in the main direction of water flow that may occur in riverine flood channels and along the banks of streams.

In terms of height, basal area, and density, Fremont's cottonwood and Gooding's willow are dominant canopy species in the cottonwood-willow associations in the study area, along with saltcedar. The cottonwood-willow riparian habitat is patchy in the study area and much of the original stands of this habitat have been replaced by the invasive and non-native saltcedar, as shown in Figure 20.

Figure 20. Saltcedar Growth

Cottonwood-willow forest, although uncommon in the study area, stands out as the most important remnant wildlife habitat in the area. This cover type supports the densest and most diverse wildlife communities in valleys and deserts. Cottonwoods and willows provide substantial nesting support for large birds, such as the great blue heron, red-tailed hawk, American kestrel, western screech owl, great horned owl, and northern flicker. The remaining cottonwood-willow habitats are especially important for resident and migratory neotropical songbirds since theses and other native riparian habitats have high wildlife value and have substantially declined throughout the western United States. Furthermore, many native wildlife species, especially riparian-dependent or riparian/marsh-dependent birds, such as the southwestern willow flycatcher, an endangered species, summer tanager, and western yellow-billed cuckoo, require large tracts of native riparian trees and shrubs for cover, nesting, and foraging.

(b) Scrub-Shrublands

Scrub-shrublands, shown in Figure 21, are common and are present within the active channel of the river occupying 8 percent of the project study area. They are dominated by various combinations of burrobush, rabbitbush, quailbush, saltbush, and occasionally by creosote bush. Many of these areas have been highly disturbed from off-highway vehicle (OHV) traffic and gravel mining activities and contain little or no vegetation cover. If the total vegetation cover was less than 10 percent, the area was mapped as unvegetated river bottom; if water was present, it was mapped as low-flow channel.

Scrub-shrublands as they occur in the study area offer moderate wildlife value. The shrub and scrubland vegetation provides foraging and resting cover for small and medium-sized mammals, snakes and lizards, and various terrestrial birds including Gambel's quail, greater roadrunner, loggerhead shrike, curve-billed thrasher, and verdin.

Figure 21. Scrub-Shrublands Dominated by Saltbush and Rabbitbush

(c) Emergent Wetlands

Emergent wetlands are uncommon in the study area, occupying less than 1 percent of the study area on lands in the floodplain of the Salt River near the Mesa wastewater treatment plant, near the Granite Reef Dam, and in scattered areas around gravel mining operation ponds that have been abandoned or are not routinely cleared of vegetation. Emergent wetlands support high-quality wildlife habitat and support a large diversity of wildlife species. In addition, the federal- and state-listed Yuma clapper rail has historically been recorded in small numbers in the emergent wetlands found along the Salt River above and below Phoenix.

(d) Low-Flow Channels

Low-flow channels in the Salt River have been almost entirely eliminated, occurring in less than 1 percent of the project study area. These features are characterized by either seasonal or perennial open water and are generally unvegetated when present. As shown on Figure 22, vegetation, when present, consists of scattered patches of Bermuda grass, salt heliotrope, and sedges. Low-flow channels do not represent a significant value to wildlife and are rare in the study area.

Figure 22. Wetland/Emergent below Granite Reef Dam

(e) Mesquite Woodlands

Mesquite woodlands historically occurred over large areas within the river floodplain and on higher terraces of the river. These communities have been nearly eliminated from the river ecosystem by changes to natural processes. Currently, only small fragmented stands of scattered mesquite woodlands remain along the Salt River. Mesquite is common throughout the region, but has been reduced to remnant patches just below Granite Reef Dam.

(f) River Bottom

The river bottom type was located in one percent of the total study area. This cover type is largely unvegetated and is characterized by cobble in the active channel of the Salt River. River bottom habitat provides low wildlife value since the vegetation is sparse or grows in clumps. However, the habitat is used by many wildlife species, such as snakes and lizards, for foraging or sunning.

4.2.4.2 Habitat Evaluation

(a) Functional Analysis

The Functional Analysis Tool was chosen for habitat evaluation on the Salt River because of its ability to provide an analysis of processes and conditions necessary for restoration and maintenance of riparian and wetland habitat. It examines habitat based on physical and biological parameters. The tool was developed by scientists and the Engineering Research and Development Center's (ERDC) Environmental Laboratory under its wetlands research program. Under this assessment procedure, the focus is narrowed to (1) the functions a particular type of wetland will perform and (2) the characteristics of the ecosystem and landscape controls of those functions.

In arid regions, biological resources are typically concentrated along riparian systems. This feasibility study relies on the results of a broad analysis of processes and conditions necessary for support of riparian habitat. Riparian components including size, substrate characteristics, and species composition are considered in quantification of the biological resource function and value.

This approach treats the biota of an area as being the outcome of an ecological process. It also merges these biological events with hydrologic and geologic processes at work in a region. Wetlands under this method are measured in terms of functional capacity. This concept is based on the inherent capacity of a wetland to perform a function under its physical, chemical, and biological components; the level of functioning is determined by interactions between the wetland and surrounding environment. The inherent capacity of a wetland is dynamic and its functional capacity is based on an assessment model defining the relationship between the ecosystem and landscape-scale variables and functional capacity. The assessment method develops a Functional Capacity Index (FCI). The FCI is a quantitative estimate of functional capacity for a wetland. The ideal goal of an FCI is to quantify and produce an index that reflects functional capacity at the site. The results of an FCI analysis can be quantified based on a standard 0.0-1.0 scale, where 0.0 represents the lowest functional capacity for the wetland and 1.0 represents highest. The Functional Capacity Unit (FCU) is a measure of the ability of a wetland to perform a certain function and is calculated by multiplying an FCI by the corresponding wetland area that is producing that FCI. When evaluating and comparing alternative ecosystem restoration plans or scales of plans, the with-project FCU is compared to the future without-project FCU. The net change in FCU represents increases in the biological function of the ecosystem directly attributable to the implementation of alternative plans.

Applying this approach, the Salt River was classified as Riverine Overbank. The Salt River is also characterized regionally as arid and Southwestern. As such, the functions developed in an existing Riverine Overbank Subclass model were modified for Arizona low gradient rivers to be applied in the standard approach for this study.

The model for Arizona was further calibrated in a workshop with the ERDC's Environmental Laboratory; the USACE Los Angeles District; local sponsor representatives from the SRPMIC, City of Mesa, City of Phoenix, City of Tucson, Town of Marana, Pima County Flood Control District, AGFD, USFWS; and representatives from the scientific community. Field sampling results based on the calibration of the model during the workshop were utilized in the analysis of alternatives.

As a first approximation, the approach uses seven wetland classes (groups) as shown below. Detailed descriptions of these groups can be found in the HGM Assessment Appendix.

- Depression
- Tidal Fringe
- Lacustrine Fringe
- Slope
- Mineral Soil Flats
- Organic Soil Flats
- Riverine

The level of variability in the classes presented above is still usually too immense to develop assessment models that can be rapidly applied while still being sensitive enough to detect changes in function at a level of resolution appropriate to the USACE planning process in Arizona. As such, the three classification criteria (geomorphic setting, water source, and hydrodynamics) were applied at a smaller, regional geographic range to identify regional wetland subclasses.

The resulting regional riverine wetland subclasses adopted for the Va Shly'ay Akimel project were all associated with low-gradient perennial and ephemeral river systems in Arizona. Within these regional subclasses, homogenous zones exhibiting analogous vegetative species, geographic similarities, and physical conditions that make the area unique were defined as a Partial Wetland Assessment Area (PWAA). In all, 19 PWAAs were defined for the Va Shly'ay Akimel Project on the basis of species recognition and dependence, soil types, and topography. The dominate vegetative cover types within the PWAAs included Cottonwood-Willow, Wetland Marsh, Mesquite, and Scrub-Shrub. River Bottom was defined as the active channel and included pool/riffle aquatic areas and open areas characterized by sand, cobble, and/or gravel. During the planning and project formulation processes, various combinations of PWAAs were located within the project area and used to develop a range of restoration alternatives.

(b) Wetland Functions Evaluated

A desired result of this study process was to assess the functional values of wetland habitat types (PWAAs) currently existing within the project area. Further, estimates of the functional values were needed for PWAAs at selected times in the future considering the without-project scenario, as well as with-project. Wetlands perform a wide variety of functions, although not all wetlands perform the same functions, nor do similar wetlands perform the same functions to the same level of performance. The ability to perform a function is influenced by the characteristics of the wetland and the physical, chemical, and biological processes within the wetland.

Wetland characteristics and processes influencing one function often also influence the performance of other functions within the same wetland system. The ten functions evaluated with Functional Capacity Index (FCI) models used in this study are found in Table 15.

Table 15. Wetland Functions Evaluated

Wetland Function (symbol)	Description
Function 1: Maintenance of Channel Dynamics (CHANNELDYN)	Physical processes and structural attributes that maintain characteristic channel dynamics. These include flow characteristics, bedload, in-channel coarse woody debris inputs, channel dimensions, and other physical features (e.g. bank vegetation, slope).
Function 2: Dynamic Surface Water Storage/Energy Dissipation (WATSTORENR)	Dynamic water storage and dissipation of energy at bankfull and greater discharges. These are a function of channel width, depth, bedload, bank roughness (coarse woody debris, vegetation, etc.), presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels.
Function 3: Long-Term Surface Water Storage (WATSTORLNG)	The capability of a wetland to temporarily store/retain surface water for long durations; associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow, and/or channelized flow from uplands, or direct precipitation.
Function 4: Dynamic Subsurface Water Storage (WATSTORSUB)	Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table.
Function 5: Nutrient Cycling (NUTRIENT)	Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes.
Function 6: Detention of Imported Elements and Compounds (ELEMENTS)	The detention of imported nutrients, contaminants, and other elements or compounds.
Function 7: Detention of Particles (DETPARTICL)	Deposition and detention of inorganic and organic particulates (> 0.45 μm) from the water column, primarily through physical processes.
Function 8: Maintain Characteristic Plant Communities (PLANTS)	Species composition and physical characteristics of living plant biomass. The emphasis is on the dynamics and structure of the plant community as revealed by the species of trees, shrubs, seedlings, saplings, and herbs and by the physical characteristics of the vegetation.
Function 9: Maintain Spatial Structure of Habitat (HABSTRUCT)	The capacity of the wetland to support animal populations and guilds by providing heterogeneous habitats.
Function 10: Maintain Interspersion and Connectivity (INTERSPERS)	The capacity of the wetland to permit aquatic organisms to enter and leave the wetland via permanent ephemeral surface channels, overbank flow, or unconfined hyporheic gravel aquifers. The capacity of the wetland to permit access for terrestrial or aerial organisms to contiguous areas of food and cover.

(c) Selecting and Modifying the Models

As previously indicated, the subclass model used for this study is the Arizona Riverine Overbank Model. In using a functional analysis tool, wetland functions are identified and expressed in terms of a mathematical model, or FCI model. Several FCI models are usually selected for an assessment, and justifications are given that address the applicability of the FCI model to the wetland functions, as well as the regional model. Some models selected are often associated directly with the proposed restoration improvements for the project, such as plant communities or habitat structure. Other models may be selected that focus on water functions, such as water storage or channel dynamics, or biogeochemical functions, such as nutrient cycling or detention of particles.

Models can be single formula, considering only a few variables, or multiple formula, considering many variables. An example of a single-formula model is the dynamic subsurface water storage function, which considers the depth to saturated soil. An example of a multiple-formula model is the dynamic surface water storage and energy dissipation function, which considers water variables such as frequency of flooding and the flood-prone area, as well as habitat variables such as total vegetation volume and coarse woody debris. For the Arizona Riverine Overbank Model, ten FCI models were selected that can be sorted into three general groups. Four FCI models were selected that focus on water functions, three models were selected that focus on biogeochemical functions, and three models were selected that focus on habitat functions. These FCI model functions are listed in Table 16, along with the associated variables, defined in Table 17, for each function formula. The HGM Assessment Appendix provides details of the mathematical calculations used for each function. It is important to note that many of the variables are applicable to several of the functions in all three of the groups.

Table 16. FCI Function Models, Variables, and Performance Target

Function Group	Code	Name	Variable Association
Water	CHANNELDYN	Function 1: Maintenance of Channel Dynamics	FPA Q SED
Water	WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	FPA FEQ TOPO
Water	WATSTORLNG	Function 3: Long Term Surface Water Storage	PORE SUBIN TOPO
Water	WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	DEPSATSED
Biogeochemical	NUTRIENT	Function 5: Nutrient Cycling	CWD DECAY FWD
Biogeochemical	ELEMENTS	Function 6: Detention of Imported Elements and Compounds	FREQ LITTER PORE
Biogeochemical	DETPARTICL	Function 7: Detention of Particles	FPA FWD SED
Habitat	PLANTS	Function 8: Maintain Characteristic Plant Communities	SPECRICH TVV WIS
Habitat	HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	FWD LITTER VEGSTRATA
Habitat	INTERSPERS	Function 10: Maintain Interspersion and Connectivity	FREQ TOPO TRIB

Table 17. Variables Used in Assessment

Variable Code	Variable Description	Variable Code	Variable Description
AGSA	Algal Growth Surface Area as an indicator of past inundation	LITTER	Abundance of leaf litter and other detrital matter in the FPA
BUFFCOV	Percent of native vegetation cover in the buffer	PORE	Soil pore spaces available for storing subsurface water. Performance is related to soil texture and permeability
BUFFLENGTH	Percent of area with sufficient buffer	Q	Alterations of hydroregime that affect the assessment area
BUFFWIDTH	Width of Buffer (m)	SED	Extent of sediment delivery to the water/wetland from culturally accelerated sources
CONTIG	Contiguous vegetation cover between waters/wetlands and uplands (%)	SHRUB	Abundance as measured through vegetation volume of shrubs (multiple stems, woody species)
CWD	Abundance of dead and down woody debris ≥ 2.5" in diameter (coarse)	SPECRICH	Species richness
DECAY	The presence of coarse woody debris in various stages of decomposition.	SUBIN	Subsurface flow into the water/wetland via interflow and return flow
DEPSATSED	Depth of saturated sediments (m)	SURFIN	Surface inflow to the wetland via sheetflow
FPA	Floodprone area as defined by the projection of a horizontal plane at a level twice the bankfull thalweg depth	TOPO	Macro (large scale) and microtopographic (small scale) relief. Macrotopography generally refers to large-scale features such as secondary channels and in-channel ponds. Microtopography generally refers to small-scale features such as pit-and-mound and hummock-and-hollow patterns
FREQ	Frequency of inundation	TREE	Abundance as measured through vegetation volume of trees
FWD	Abundance of dead and down woody debris < 2.5" in diameter (fine)	TRIB	Presence of connected tributaries
HERB	Abundance as measured through vegetation volume of herbaceous species	VEGSTRATA	Number of vegetation layers present
INVASIVES	Abundance of invasive species	WIS	Wetland indicator score
LANDUSE	Type of adjacent land use		

(d) Environmental Output

Conducting an HGM analysis requires that a baseline inventory be conducted, variable means and/or modes calculated, and cover-type acreages quantified. The next step is to describe the baseline conditions in terms of FCUs. The value of each variable expressed as a mean or mode are applied to the Variable Subindex graphs as dictated by the model documentation. For example, if the percent of ground cover in the PWAAs at Site X were 50 percent on average, the value "20" was entered into the "X axis" on the Variable Subindex curve below, and the resultant VSI score (Y axis) was recorded (VSI = 1.0).

The process is repeated for every associated variable and PWAA per model. The individual VSI scores are then entered into the FCI formula on a PWAA-specific basis, and individual PWAA FCIs are generated. Each result, referred to as the PWAA FCI is then weighted by the relative area (RA) of the PWAA. In this model, the RA is a mathematical process used to weigh the various applicable cover types on the basis of quantity. To derive the relative area of a model's cover type, the following equation can be utilized:

Relative Area (RA) = Cover Type Area / Total Area

where:

Cover Type Area = only those acres assigned to the cover type (or PWAA) of interest
Total Area = the sum of the acres utilized in the model

Results from the remaining associated PWAAs are combined in an additive manner. Mathematically, this can be expressed using the following relationship:

$$FCI_{Subclass\ Model} = \sum (PWAA\ FCI \times RA)_X$$

where:

PWAA FCI = Results of the PWAA FCI calculation,
X = Number of PWAAs associated with the model, and
RA = Relative area of each PWAA

The final step involves multiplying the FCI result by the habitat acres (PWAA acreage associated with the model). The final results (FCUs) quantify the quality and quantity of the wetlands at the site for the baseline conditions (TY0).

Table 18 shows the PWAA cover-type acreages for baseline conditions. Table 19 shows the baseline acreages for other cover types in the study area. Table 20 and Figures 23 and 24 present the baseline condition results for the Va Shly'ay Akimel study area.

Table 18. Baseline Acreages for Partial Wetland Assessment Areas

Cover Type	Acres
Cottonwood-willow Forest	69.50
Mesquite	4.10
Emergent Wetlands	-
Lower Sonoran Desert (Scrub shrub)	2,057.10
River Bottom	334.60
Total	**2,465.30**

Table 19. Baseline Acreages for Other Cover Types

Cover Type	Acres
Agricultural Cropland	249.70
Desert	961.90
Ditches	56.50
Open Water	100.50
Parks	9.60
Sand and Gravel	1,651.60
Soil Cement	33.90
Urban	341.60
Total	**3,405.30**

Table 20. Baseline Conditions Analysis Results

Function	Name	Baseline FCI	Baseline FCU
Fxn 01	Maintenance of Channel Characteristics	0.333	689
Fxn 02	Dynamic Surface Water Storage/Energy Dis.	0.423	955
Fxn 03	Long-Term Surface Water Storage	0.048	72
Fxn 04	Dynamic Subsurface Water Storage	0.083	131
Fxn 05	Nutrient Cycling	0.384	805
Fxn 06	Detention of Imported Elements and Compounds	0.333	726
Fxn 07	Detention of Particulates	0.311	701
Fxn 09	Maintain Characteristic Plant Communities	0.602	1,353
Fxn 10	Maintain Spatial Structure of Habitat	0.399	889
Fxn 11	Maintain Interspersion and Connectivity	0.377	854

Figure 23. Baseline FCIs for Va Shly'ay Akimel

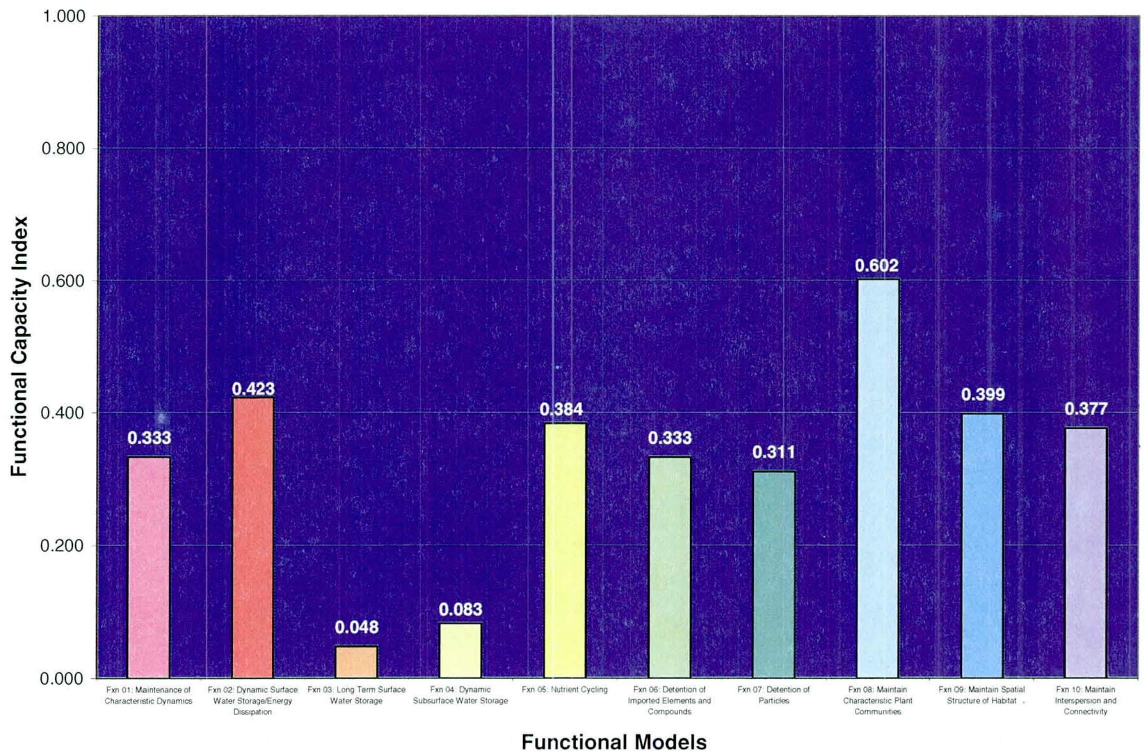
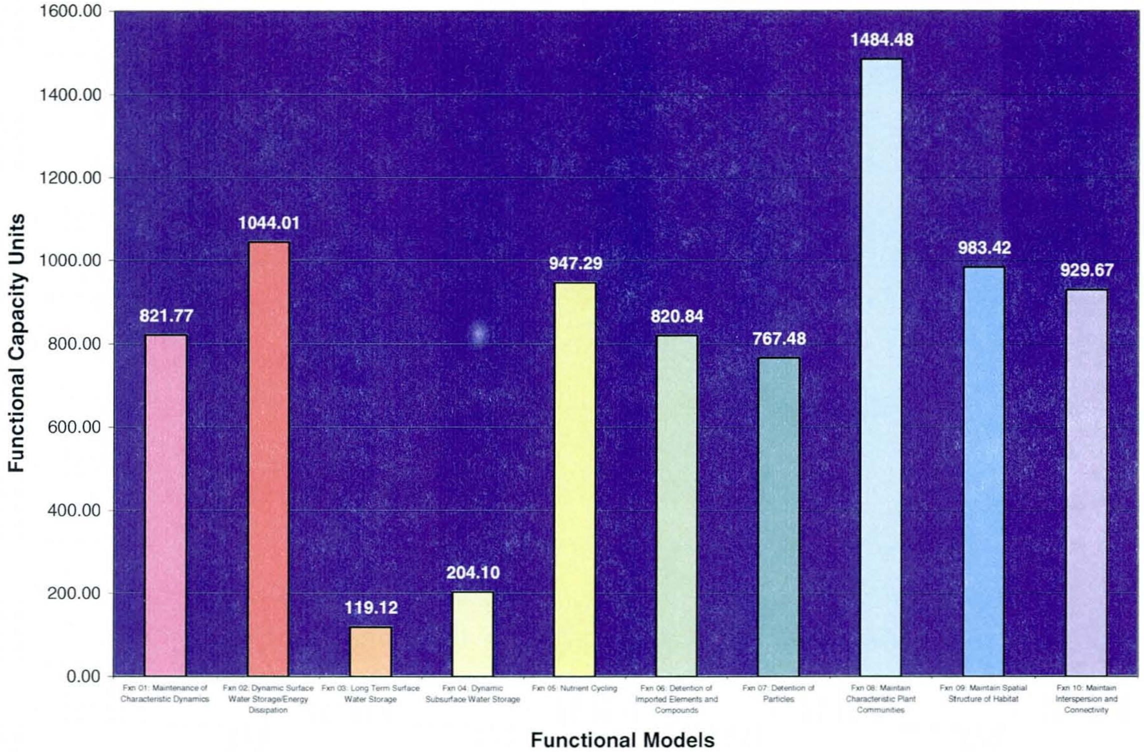


Figure 24. Baseline FCUs for Va Shly'ay Akimel



4.2.5 Hazardous, Toxic, or Radioactive Waste

The presence of hazardous, toxic, or radioactive wastes (HTRW) within the study area was evaluated for this study effort. If conceptual or planned study area activities would require moving or result in mobilizing HTRW-contaminated water or soil, the situation needs to be qualified and quantified. This is done so that associated costs can be estimated and a team decision made regarding the viability of continuing to include suspect or contaminated zones within the overall study plan. General examples of conceptual activities that have to be considered are the increase in groundwater elevation that might result by the direction of irrigation water in such a way that the water reaches and mobilizes previously-immobile contaminants. Actions that could mobilize contaminants in adjoining property must also be considered.

A Phase I Environmental Site Assessment (*hereafter*, "Phase I EA") for this study was completed by Liesch (2002) under contract to SRPMIC, as an in-kind services product. By necessity, a Phase I EA is a generalized document when it addresses a study area of this size in the early stages of conceptual alternative evolution. The Liesch (2002) effort included database searches, aerial photo examination, interviews, a walk-over survey, visits to some of the businesses and quarries, a listing of all uses of land in the study area, and an assessment of the overall findings. Leisch (2002, p. i), in the Phase I EA, compiled a list of over 50 different sites of "development" and/or "utilization", apparently so as to completely document existing and known past land use and practices in the study area. Because analysis of the entire study area would be problematic, the investigations focused on the areas slated for potential study alternative inclusion, and their adjacent properties, plus those areas that could be potentially affectdd by project implementation. Leisch (2002, pp. ii, 30, 31) concluded that 14 specific businesses or landfills were "environmental issues", and that an unspecified number of unspecified properties also had "environmental issues" regarding ASTs[1], USTs[2], and potential TSD[3] issues; plus environmental issues at unspecified locations throughout the study area regarding debris dumping, other illegal dumping, and the potential interactions between study area activities and existing irrigation runoff water, wastewater recharge ponds, water wells, septic tanks, water wells. In addition, the Corps' Geology & Investigations Section added several other items to a list of sites that required additional research and assessment.

All Existing Groundwater Recharge Sites

There are three separate, existing groundwater recharge sites in the study area (Sites 4, 17, and 53 on Figure 25). There are existing regulatory controls for at least one of the sites (the GRUSP), and probably for all of the sites, to guarantee that the local recharge-elevated groundwater surface does not increase to within 25 feet of the bottom of an existing landfill. The specific regulations involved were determined. Since all potential alternatives could include irrigation, many for the entire project life, interaction between ongoing groundwater recharge of other projects and irrigation of the study area was considered during the data collection phase. Definition of groundwater interaction with identified HTRW sites, particularly landfill leachate issues, was evaluated. Groundwater

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[1] AST is "above ground storage tank".

[2] UST is "underground storage tank".

[3] TSD is "treatment, storage and disposal".

impact from irrigation runoff ponds ("Site" 5, of unspecified number and locations) was also factored into this analysis.

Increase in Proclivity to Overbank Flooding

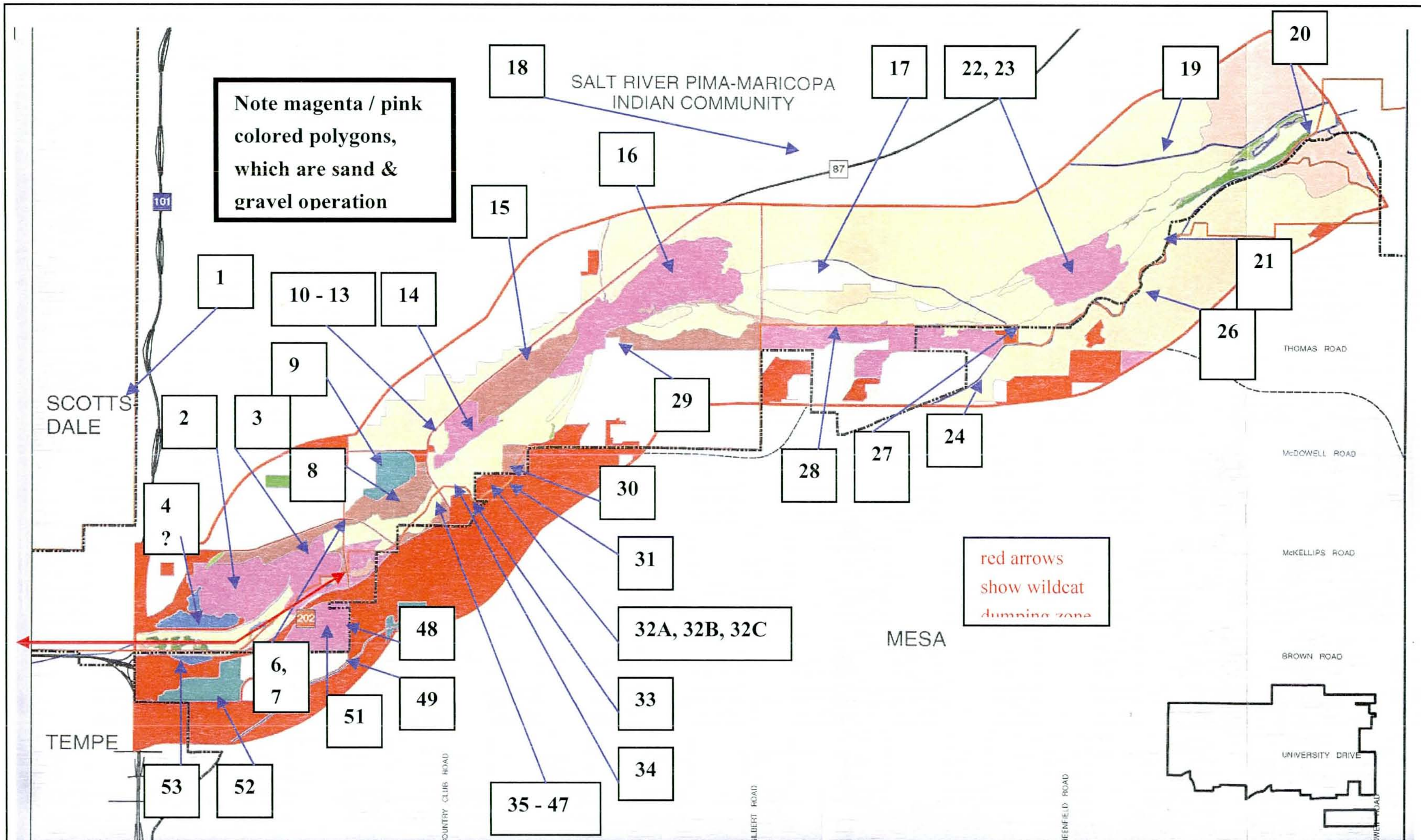
The effect that potential irrigation measures might have on increases in local groundwater elevation, and its potential for decreasing the capacity for infiltration during high-flow events on the Salt River, was also evaluated.

Landfills (Sites 8, 11, 15, 18, 30, 31, 32C)

Nearly all the sites are *formerly* used landfills; Site 18, the active Salt River landfill, is the lone exception (location provided by SRPMIC staff, May 2003). The sites are on or near the banks of the Salt River and, in some instances, in the river bottom a small distance outward from the banks. Some multiple locations, administratively, may be part of a ingle landfill, as noted by Liesch (2002), who recognizes five different landfills, but provides documentation suggesting two others. One of the landfills is being petitioned for Brownfields funding and another is a younger Resource Conservation and Recovery Act (RCRA) illegal dump site (dumped drums, at least partially cleaned up). All sites for which there is any information are unlined, so there is concern regarding what might be leached from them if restoration plantings on top of them are irrigated or if the water added to this study area to support wetlands, etc. raises the local groundwater surface elevation.

Two other landfill-related issues exist. Potential riverbank erosion needs to be addressed. There may or may not be riverbank hardening now or in the conceptual plans for those landfills that might be at risk of bank breaching at higher river flows. This needs to be specified. A reported debris pile at Site 2 (Salt River Sand and Rock quarry) is the load from one such breach. The risks of others to be breached are not addressed. These data gaps should be filled.

Figure 25. Activities in and near the Study Area with Potential Environmental Concerns



Land use activities in and near the Va Shly'ay Akimel study area, reported in the Phase I EA (Leisch, 2002). These include e some that are or at one time had potential to be HTRW sites, some that are non-hazardous waste sites, and some that are unrelated to environmental concerns. See Table 21 for Site Names and the Geotechnical Appendix for details on the numbered sites. See Geotechnical Appendix Sections 8, 9 for assessment of potential problems.

Table 21. Site Names for Figure 25

Site	Site Name	Site	Site Name
1	North Indian Bend Wash and South Indian Bend Wash	30	North Center St. landfill
2	Salt River Sand & Rock, MESA OPERATIONS	31	Vulcan demolition debris landfill
3	Vulcan asphalt batch plant and maintenance yard	32A	Mesa Police dept. firing range
4	SRPMIC's 5 groundwater recharge ponds	32B	Mesa (City) storage yard
5	Six or seven irrigation runoff detention ponds	32C	"Old Mesa" North Center St. landfill (under Mesa Police firing range)
6	Arizona Propane	33	ADOT storage yard
7	Saddleback Communications	34	Bingo Hall / Ray station
8	Cyprus landfill	35	Cashway Concrete and Materials
9	Cypress golf course	36	Valley Wide Contracting
10	RV storage facility	37	Alumi-Cover Awning Company, Inc.
11	Dumped drum site	38	Allpride Marble and Granite 556 W McKellips Rd
12	JRs Convenience Store	39	Carports, Etc.
13	Enviro-Systems	40	Superstition Springs Crushing
14	United Metro	41	Redburn Tire Company
15	Tri-Cities landfill and SRP methane gas power plant	42	Pete's Diesel Repair
16	Salt River Sand and Rock Beeline Plant	43	Little Dealer-Little Prices
17	Granite Reef Underground Storage Project	44	Karl Watkins
18	Salt River landfill	45	Contreras Contractors
19	Arizona Canal	46	Car Smart
20	Granite Reef dam	47	Artistic Ice Creations
21	Primate Research Center	48	Tevizo Hay Company
22	Salt River Sand & Rock, HIGLEY OPERATIONS	49	Sunward Materials / BCW
23	Salt River Sand and Rock offices	50	Unspecified other businesses at unspecified addresses
24	South Canal	51	Cemex quarry operations
25	Southern canal	52	Mesa Northwest Wastewater Treatment Plant
26	Talley Defense Systems	53	City of Mesa's 2 groundwater recharge ponds
27	horse farm	54	Non-specific residential property locations
28	Chandler Ready Mix quarry	55	Non-specific agricultural land locations
29	Lehi Cemetery	56	Hwy 202 constr. & storage area

Rocket Propellant or Fuel Issue

The Talley Defense Systems site (Site 26) used propellant; was actively testing explosive materials as recently as 2002; has had numerous RCRA treatment, storage, and disposal (TSD) violations; has had a fire in a half ton of undefined materials; is in the watershed; and is less than a quarter mile from the river. It is *possible* that the rocket propellant enhancer *perchlorate*, a regulated substance and troublesome contaminant if it gets into the groundwater, is or has been used there and that some may have been lost into the environment in the processes of use, TSD violations, or the fire. This possibility was investigated and in general, information gathered about the operation and the materials used and tested on the site. The concern to this study would be what contaminants are actually present, if any, and which of those might be mobilized by the study's potential to raise local groundwater elevations. Active explosives testing has ceased (Personal communication, SRPMIC staff, May 2003).

Known and Possible RCRA Sites

A known RCRA site called the "drum site" (Site 11) was investigated. The concern is the documented illegal drum dumping, some with RCRA materials in them, some removed, and some completely disintegrated on site with contents winding up on the surface. The interests include what may have leached into the study area, how deep it has gone, and what might alternative plans mobilize, if anything, by raising the groundwater surface either locally or by irrigating plantings on the surface. It may even turn out to have been remediated during either the expansion of the adjoining SRPMIC golf course or Arizona Department of Transportation's (ADOT) past re-routing of the Country Club Drive Bridge. The Phase I assessment raised but did not address these possibilities. At a separate location, there is an issue with the surface debris scraped off the Arizona Propane site (Site 6); more information should be obtained to verify that it is not an RCRA site.

National Priorities List (NPL) Groundwater Contamination Site

The site may be an important concern. However, the Phase I EA, limited to what is in the NPL general database, does not verify whether this site has been remediated. If remedial actions have taken place, there will be other available documentation, which should be obtained at this stage of the study. The site (Site 1, designated with a large blue rectangle) is the Indian Bend Wash NPL site, with trichloroethylene (TCE) in the groundwater. This site adjoins the downstream end of the study area, where some alternatives may impact it by increasing the local water table through irrigating proposed plantings. This potential impact needs to be determined. The interaction between the many existing groundwater recharge ponds adjoining or near the NPL site and potential study irrigation impacts could be crucial or could be a non-issue.

"Wildcat" Dumping

"Wildcat," or uncontrolled, random dumping of materials has occurred in and along the river in the study area, including soils, concrete, old tanks, asphalt, household debris, and vegetation waste, according to the Phase I assessment. The debris is found between approximately the Alma School Road crossing and the Hayden Road crossing about 3½ miles downstream (Personal communication, SRPMIC staff, May 2003), totaling about 2¼ river miles as impacted in the study area. The sites, along with precise locations, should be cataloged. At worst, what may reasonably be expected are small RCRA-type issues or some small hydrocarbon-contaminated soil issues. Soil removal likely would be the remediation, if any is needed. Gathering more data would be the first step. Somewhat related, although not wildcat dumping, is a large debris pile reported at the Mesa (Dobson) Operations sand and gravel production area (Site 2). Debris, according to the Phase I assessment, were washed out from landfilled waste that were freed when banks surrounding unspecified upstream landfill(s) were breached during past floods.

Leaking Underground Storage Tanks (LUSTs)

There are eleven LUST properties among the sites of environmental concern. However, according to the regulatory database summary in the Phase I assessment, eight of those properties have been remediated and are "case closed" and no longer under regulatory oversight as an environmental concern. Only one involved any groundwater contamination (Site 33). There is no suggestion that any sites currently are under remediation. Site 48 is classed as "undefined" in the regulatory database reported in the Phase I assessment. However, the status of Site 14 (United Metro) is unclear, as is that of Site 2 (Salt River Sand and Rock, Metro [or Dobson] Operations). Other regulatory file data reportedly exist showing that all three of these sites have been resolved (Personal communication, SRPMIC staff, May 2003). These data have not yet been made available for incorporation into this document. Further research into regulatory oversight files, such as those of the Arizona Department of Environmental Quality (ADEQ), in Phoenix, may be useful in these cases. Five of the LUST sites are clustered in a commercial business district along Country Club Drive at Highway 202 and along McKellips Road near Country Club Drive; two others are along Alma School Road. Four others are in or adjacent to the Salt River bottom, associated with the sand and gravel quarry or batch plant operations. Those sites in or adjacent to the Salt River include Site 3 (Vulcan), which is "case closed;" Site 28 (Chandler Ready Mix), which is also "case closed;" Site 14 (United Metro), status uncertain; and Site 2, Salt River Sand and Rock, Metro (or Dobson) Operations, status uncertain.

Sand/Gravel/Cement/Asphalt Quarry and Plant Operations (Sites 2, 3, 14, 16, 22, 23, and 51)

These are located in the Salt River or adjacent to it; some have relatively minor, or potential, or anticipated TSD issues according to the Phase I assessment. There are seven such locations, most owned by SRPMIC, but most with three or four operating lessees. Boundaries of the operations (presumably the quarry perimeters) are shown on Figure 25. Most of the sites were defined by Liesch (2002) as having minor TSD issues related to washing and maintaining vehicles and chemical storage. Not all were visited by Liesch and one (Site 16) was not listed in Liesch (2002), so there are unknowns to be addressed. The sites possibly could release chemicals into the environment if flooding occurs; however, the likely impact would be small. Whether this risk is acceptable would have to be determined.

Regulated Materials Use

Numerous sites (among the 56 listed in the Geotechnical Appendix) use some types of regulated materials, which could become hazardous waste if released into the environment. These sites are not listed as problem sites in any regulatory database, and most, if not all, have *no* environmental problems associated with them. For the purposes of USACE criteria, a complete listing of these sites and the materials they use, treat, store, or dispose of was compiled. Much, if not all, of this information is in the Phase I assessment.

4.2.6 Cultural Resources

A complete records and literature search report was submitted by Archaeological Research Services (ARS) on the study area. The report by ARS determined that there are 233 previously identified historic and prehistoric sites located within the study area. Prehistoric agricultural canal systems are also located along and near the river. Although there have been 329 separate cultural resources projects and studies conducted over the years, major areas are yet to be surveyed. Most of these sites have not been evaluated for the National Register of Historic Places (NRHP). In reviewing the map provided by ARS, many of these sites are located near areas likely to be preferred areas for restoration.

In formulating a restoration plan, the SRPMIC has expressed a desire to avoid impacts to their cultural resources. Towards that goal, a field survey was conducted of parcels not previously inventoried. The survey covered 1,000 acres, which included areas selected by the SRPMIC, the City of Mesa, and the USACE. The areas selected appeared to be potential areas for restoration. As a result of this survey, 33 historic and prehistoric archaeological sites were identified. Of these sites, 20 were evaluated as eligible for the NRHP. Thirteen were evaluated as indeterminate, requiring additional studies to evaluate.

Statistical Research, Inc. (SRI) conducted a Class III Cultural Resources Survey and archaeological testing on the Salt River Pima-Maricopa Indian Community in November 2003 of an additional 300 acres. SRI completed the survey in December 2003 and submitted a draft report entitled, *A Class III Cultural Resources Survey and Testing Recommendations for the Proposed Salt River Restoration Project, Maricopa County, Arizona in* January, 2004. This report summarized the survey results and contained a testing plan concerning six archaeological sites, SRPMIC 90, 105, 108, 109, 112, and 113

Only one feature, a historical-period bell-shaped storage pit, was identified in the trench profiles at SRPMIC-109. Excavation of the pit resulted in the recovery of three mid-to-late nineteenth century ollas, a small jar, and two bowls. Each of the ollas was capped with a large metal can. A possible stove pipe, a metal spoon, metal cup, and metal pan were also preserved exposure of a small trash scatter that rested on the same surface into which the storage pit was dug. Artifacts in this trash scatter include four cans and an intact wine bottle with a push-up base and hand-applied finish.

Testing at SRPMIC-105 was negative. No buried features or artifacts were encountered during the testing. One 20-m long north-south trench was also excavated through a large hummock, but again no buried artifacts or features were exposed.

At SRPMIC-108 all artifacts within the surface collection units were collected, along with a small chipping station. Between 10 and 30 cm of sediment were removed and two small shallow pits were exposed. Both pits were excavated. The fill in Feature 15 was ash-stained and collected *en-masse* for flotation analysis. Both backhoe trenches were placed on the lower Lehi terrace along the drainage that bisects the site. No artifacts or features were exposed in the southernmost trench. The northernmost trench, however, contains a cultural deposit that is ash-stained and replete with fire-cracked rock. This stratum is best interpreted as a rake-out accumulation associated with a nearby buried roasting pit or horno. One roasting pit, Feature 1, was visible at the surface during a previous survey. It was bisected during testing and contains large amounts of wood charcoal and fire-cracked rock.

Testing of SRPMIC-90 involved the excavation of two 10-m long trenches in an artifact concentration at the east end of the site, along with the mechanical scraping of a 5-by-25-m area in another artifact concentration at the west end of the site. These excavations were placed in areas containing relatively high densities of surface artifacts. A series of 5-by-5-m surface collection units were placed over the areas to be mechanically excavated. All artifacts within these units were collected. No buried features or artifacts were encountered in the first artifact concentration. Two small, shallow thermal pits, however, were exposed in the 5-by-25-m mechanical stripping unit placed in the other artifact concentration. Both of these pits were completely excavated and the fill from each of them was collected en-masse for flotation analysis.

Testing efforts at SRPMIC-112 and 113 focused on determining the age and function of two ditches that could be followed across the west end of the parcel. Each of these ditches was designated a site number during the survey. Backhoe trenches were excavated across both ditches. Styrofoam was found in the bottom of SRPMIC-112 and no subsurface expression of SRPMIC-113 could be found. The styrofoam in SRPMIC-112 rested on the bottom of the ditch only 15–20 cm below the modern surface. A large gravel deposit was found to exist immediately beneath both ditches. As such, neither of them would have conveyed water, nor could they have held water for long. SRPMIC-112 and 113, therefore, are considered modern drainage ditches.

Prior to project implementation, additional studies may be required. In addition to survey work, sites that could not be evaluated based on survey information would require additional studies. This would probably consist of test excavations to determine their subsurface potential to contain important information.

4.2.7 Socioeconomics

4.2.7.1 Flood Damages

(a) Historical Flood Damages

The highest recorded flow in the vicinity of the study area since the construction of the SRP system occurred in February 1980, when 170,000 cfs was reported at Jointhead Dam. Jointhead Dam is located downstream of the study area at 48th Street in the City of Phoenix. All bridges along the Salt River were forced to close during that flood except the Central Avenue Bridge in the City of Phoenix. Subsequent to that event, most of the remaining bridges crossing the Salt River have been rebuilt to withstand flow rates of 200,000 cfs and greater.

High releases (approximately 130,000 cfs) were also experienced in 1993. Winter floods during the first three months of 1993 caused extensive damage to property and crops throughout Maricopa County. Total flood damages throughout the state during this storm were estimated at over $250 million in current dollars.

Information regarding damage estimates specific to the study reach was not available. However, current hydrologic data for the Salt River through the study area shows that peak discharges for the 100-year event are approximately 172,000 cfs. Current hydraulic analysis indicates that there are very few structures in the 100-year floodplain. Therefore, it is likely that damages throughout the study area reach were limited during these storms.

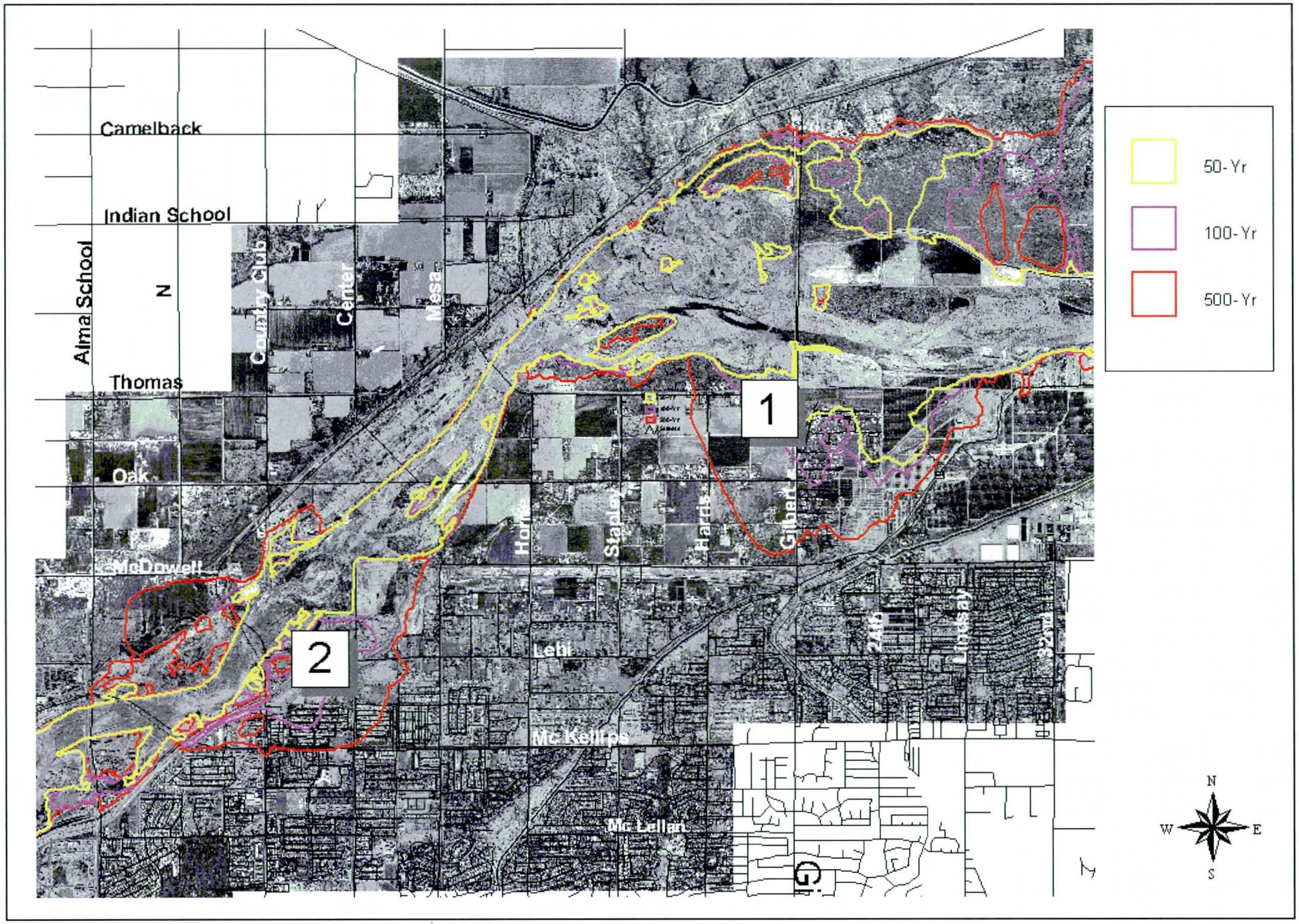
(b) Floodplain Boundaries

Before determining potential damages within the floodplain, an inventory of structures susceptible to damage and estimates of the value of these structures must first be developed. Figure 26 shows the Base Year (2011) floodplain boundaries. As shown on Figure 26, the floodplain is primarily confined within the channel, with the exception of two "breakout" areas (labeled "1" and "2"). Breakout Area 1 extends south of the Salt River and is generally bounded by Lehi Road on the east, Harris Street on the west, and

McDowell Road on the south. This area is rural and comprised primarily of residential properties east of Gilbert Road and agricultural properties west of Gilbert Road. The other area subject to potential flooding, Breakout Area 2, is also located on the south side of the Salt River, west of Mesa Drive and north of McKellips Road. This area includes more dense development, including mobile homes as well as some commercial and industrial properties. Even for most of these two areas, the probability of flooding in any given year is generally less than one percent.

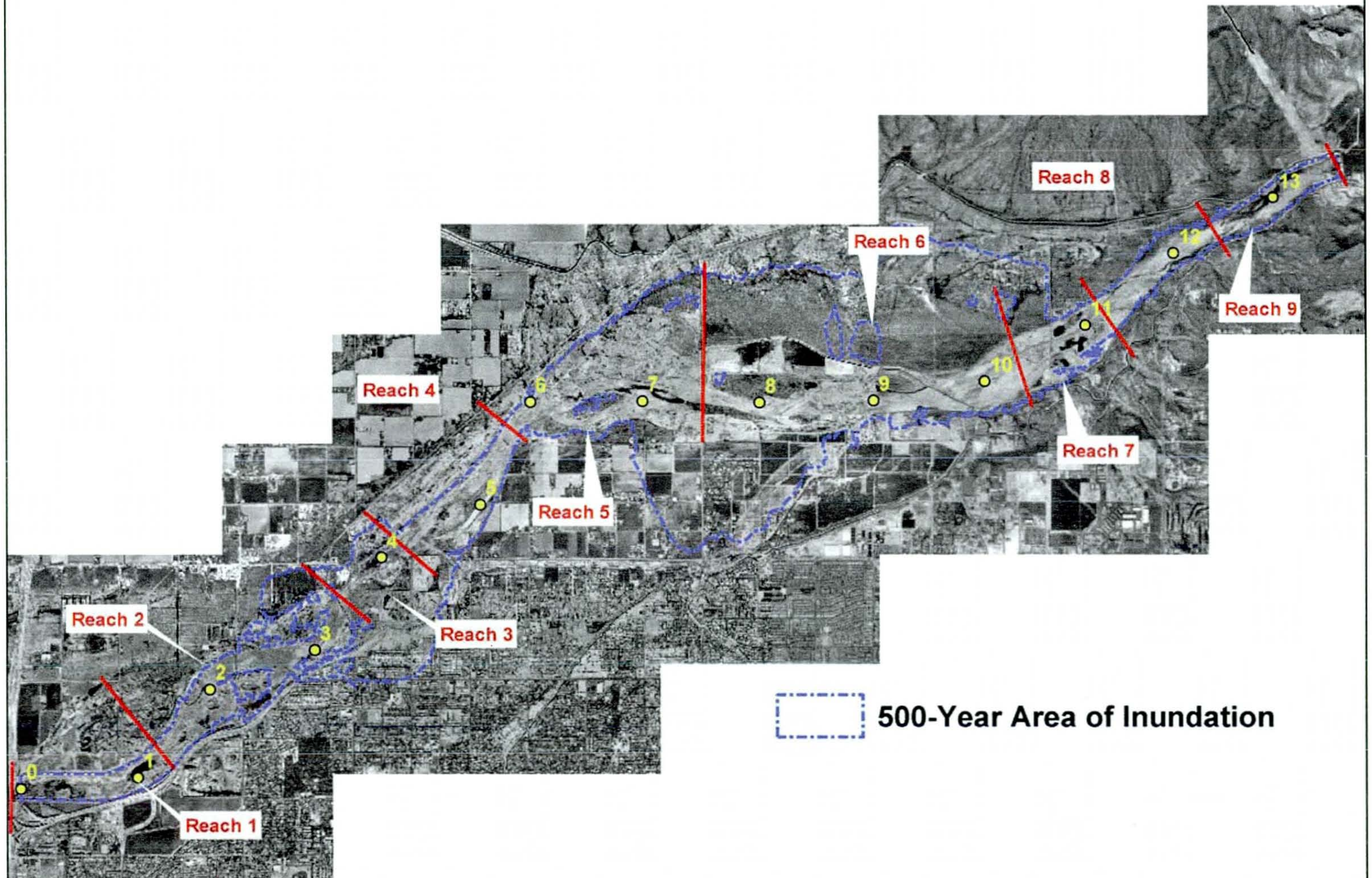
The floodplain is further segmented into sub-areas, or reaches, for analysis purposes. Critical factors used to determine reach boundaries include discharge/frequency characteristics, overflow spatial characteristics, and economic activity. Figure 27 shows floodplain reach boundaries.

Figure 26. Base Year (2011) Floodplain Delineations



Breakout areas "1" & "2"

Figure 27. Reach Delineations



As shown in Figure 27, Reaches 2, 3, and 6 contain all of the floodplain structures. Reaches 2 and 3 include large mobile home parks containing hundreds of mobile home units, as well as commercial and industrial structures along the main streets of McKellips, County Club, and Center. Reach 6 includes large agricultural lots west of Gilbert Road with very few structures. Reach 6 east of Gilbert Road includes rural residential development with some agricultural acreage as well.

(c) Number of Structures

The number of structures in the 100- and 500-year floodplains was determined based upon an analysis of aerial photography, parcel maps, real estate assessor's data, and a site survey. As shown in Table 22, there are approximately 883 structures in the Va Shly'ay Akimel floodplain. Of these, 90 percent are residential (SFR/MH). Roughly 236 structures are located within the 100-year floodplain boundaries (about 27 percent of the structures in the 500-year floodplain). Most floodplain structures are located in the downstream breakout area (Reaches 2 and 3). Most of these structures are residential, primarily mobile homes.

Table 22. Number of Structures

Structure Type	100-Year	500-Year
SFR	66	151
MH	137	636
Industrial	18	57
Office/Commercial	13	35
Public	2	4
Total	**236**	**883**

(d) Value of Structures and Contents

Content values were estimated as a percentage of depreciated structure value for each structure. Content ratios by structure type were based upon values derived for several Los Angeles District feasibility studies. Table 23 provides a summary of floodplain structure and content value by category.

Table 23. Value of Structures and Contents by Structure Type – 500 Year Floodplain
(in $Millions)

Structure Type	Structure Value	Content Value	Total
SFR	17.5	8.7	26.2
MH	14.8	7.4	22.2
Industrial	4.0	6.8	10.8
Office/Commercial	6.1	7.3	13.4
Public	0.8	0.3	1.1
Total	**43.2**	**30.5**	**73.7**

As shown in Table 23, the total estimated value of property in the floodplain is about $73.7 million. Residential properties account for about 66 percent of this total, even though they represent about 90 percent of the total number of structures. This is attributable to the relatively low value of the residential properties (primarily mobile homes) relative to commercial and industrial structures.

(e) Project Structure and Content Damages

Risk-Based Analysis

A risk-based analysis (RBA) procedure has been used to evaluate without-project flood damages in the study area. Guidance for conducting RBA is included in the Corps of Engineers Regulation 1105-2-101 (1 March 1996). The guidance specifies that the derivation of expected annual flood damage must take into account the uncertainty in hydrologic, hydraulic, and economic factors. Risk and uncertainty are intrinsic in water resource planning and design. They arise from measurement errors and the inherent variability of complex physical, social, and economic situations. The focus of RBA is to concentrate on the uncertainties of variables having the largest impact on study conclusions.

The following are the primary sources of uncertainty for flood damage analysis studies.

- Discharge/Probability: Discharge/probability uncertainty for this study has been estimated for each reach using the graphical method, based upon an equivalent record length of 105 years.

- Stage/Discharge: Standard deviations of error for stages associated with a range of discharges were provided for each reach. The error values generally increase in value from about 0.1 feet for the 5-year event up to about 0.7 feet for the 100- to 500-year events.

- Geotechnical Features: Soil cement levees are located immediately upstream of the SR 101/202 interchange.

- Structure Elevation: Ground elevations for each structure were derived from a 10-foot interval digital elevation in GIS format (used in turn to generate 4-foot contour interval shape files). First floor elevations above ground level were estimated during a field survey. The error associated with the first floor elevation estimates is assumed to be normal, with a mean of 0 and a standard deviation of 2.94 feet.

- Structure Values: The errors associated with structure value estimates are assumed to be normal, with a mean of 0 and standard deviations ranging from 10 to 21 percent (depending on structure type), based upon upper and lower ranges of Marshall and Swift factors.

- Inundation Depth/Percent Damage: Damage percentages for both structures and contents are based upon corresponding structure values.

As calculated by the HEC-FDA program, without-project damages by event for base year (2011) conditions are shown in Table 24. The non-damaging event is approximately the 10-year event. Most reaches do not incur damages until less frequent events. Damages calculated for the 25-year event are approximately $2 million. Damages increase significantly for the 50- and 100-year events, with only a marginal increase for the 500-year event.

Table 24. Damages by Reach and Event (Base Year 2011)
(in $1,000s)

Reach	10	25	50	100	500
2	-	4	223	650	650
3	-	265	2,298	4,344	4,452
6	70	1,293	4,379	5,812	5,812
Total	**70**	**1,562**	**6,900**	**10,806**	**10,914**

Expected annual damages by reach and structure type are shown in Table 25. Damages to residential structures and contents (SFR/MH) represent over 71 percent of total damages. Most damages occur in Reach 6 even though more structures are located in Reaches 2 and 3. This is due to the higher probabilities of flooding in the upstream reach. In addition, the residential structures in Reaches 2 and 3 are mostly mobile homes, which have a lower value than single-family residences located in the upstream reach.

Table 25. Expected Annual Damages by Reach and Structure Type (Base Year 2011)
(in $1,000s)

Reach	SFR/MH	Ind/Ag	Office/Com	Public	Total
2	2.4	9.4	3.6	-	15.4
3	53.3	21.0	32.1	1.9	108.3
6	177.7	13.2	2.6	-	193.5
Total	**233.4**	**43.6**	**38.3**	**1.9**	**317.2**

4.2.7.2 Population Trends

The study area is located in Maricopa County and extends through the SRPMIC and adjacent City of Mesa. As of the year 2000, Maricopa County had a population of 3.07 million. From 1995 to 2000, County population grew by over 543,000, representing an average annual growth rate of nearly four percent.

The City of Phoenix is by far the largest in the county in terms of population. Phoenix's population grew from about 1.15 million in 1995 to over 1.32 million in 2000, or by about 2.7 percent on an annual basis. About 43 percent of the County population resides within the City of Phoenix, although this ratio is declining, due to higher growth rates outside the city.

The City of Mesa was incorporated over 100 years ago. Between 1930 and 1960, the City's population and land area grew by about 30,000 and 12.7 square miles, respectively. By 1980, the City's boundaries expanded to over 66 square miles, and the population increased to over 152,000. The City now encompasses over 128 square miles and is Arizona's third largest in terms of population, following Phoenix and ~~Tempe~~. TUCSON Mesa's population as of 2000 was 396,375. This value represents an average annual increase of about 3.2 percent over the 1995 population of 338,117.

The SRPMIC is home to the Onk Akimel Au-Authm (Pima) and Xalchidom Pii-pash (Maricopa) Indians, descendants of the Hohokam Indians. The Community covers an area of nearly 84 square miles and shares boundaries with the cities of Mesa, Tempe, Scottsdale, Fountain Hills, and metropolitan Phoenix. The population of the SRPMIC was 6,405 as of the year 2000, according to the U.S. Census. From 1990 to 2000, population increased by 1,553, or an average annual rate of about 2.8 percent. Thus, the combined population of the communities adjacent to the study area (Mesa and SRPMIC) exceeds 400,000.

4.2.8 Land Use

The land use pattern is made up of a patchwork of jurisdictional and political boundaries between the City of Mesa, unincorporated areas of Maricopa County, and the SRPMIC. Remnant County islands are located in two locations within the study area and are completely surrounded by the City and the SRPMIC. These lands are within the City's sphere of influence and would likely be annexed by the City as growth and development reaches the area.

Several gravel mining operations are located along the Salt River, with processing operations occurring along its banks. The river contains a large groundwater recharge basin in the central portion of the study area, just east of North Gilbert Road.

The land area north of the Salt River is generally within the SRPMIC. Upland areas south of the river are generally within the City's jurisdiction, but islands of unincorporated areas of the County are also present. A clear contrast is evident between the rural and open character of the upland areas north of the river, within the SRPMIC, and the more urbanized area south of the river, within the City's sphere of influence.

Created by Executive Order in 1879, the SRPMIC consists of 52,600 acres, located 15 miles northeast of the City of Phoenix. The SRPMIC is home to nearly 6,000 enrolled members representing two pre-American Sovereign Indian tribes, the Pima and Maricopa. The SRPMIC maintains 19,000 of its acres as natural preserves. The secondary land use is agriculture, which supports a variety of crops, including cotton, melons, potatoes, brown onions, and carrots (SRPMIC, 2002). The majority of the central and eastern portions of the study area that are located directly north of the Salt River are a combination of natural preserve areas and agricultural lands. Gravel mining and processing, two closed landfills, and other industrial operations have a significant influence on land use patterns in the western portion of the study area that is located along the north banks of the river. Other land uses are scattered intermittently throughout the area along the north banks of the river, including a shooting range, a recreational vehicle park, private farms, and a commercial golf course.

The west and central portions of the study area south of the river and within the City's sphere of influence are largely made up of very low-density rural residential uses to higher-density suburban residential uses. Industrial and commercial development, with some agricultural uses, has a strong influence on land use patterns in the eastern portion of the study area. The south banks of the river are also scattered with gravel mining and processing operations.

4.2.9 Real Estate

The proposed restoration activities would occur primarily within the Salt River floodplain. Although the proposed project is being undertaken by the USACE, the State, County, City, and SRPMIC have jurisdictions over planning and development decisions within their respective political boundaries in the study area.

State of Arizona

The State of Arizona adopted growth management legislation, known as "Growing Smarter" and "Growing Smarter Plus," in response to concerns about the rates of population growth in communities throughout the state. This legislation requires all cities in Arizona to update their General Plans.

Maricopa County

Portions of the study area are within unincorporated areas of the County and are governed by County planning and development activities.

City of Mesa

The City of Mesa General Plan defines the direction of growth and the type of development that is desired and expected to occur in Mesa between 1996 and 2016.

SRPMIC

The SRPMIC is considered a sovereign nation and is not under the regulatory or political jurisdiction of any of the local governments in the area or the U.S. federal government. All land use activities are guided by the SRPMIC's established procedures and activities. Three general categories of land with their respective estimated values were used in this study:

- River channel land - $5,000 per acre
- Farmland outside and above river channel - $7,500 per acre
- Sand and gravel operations - $15,000 per acre

4.2.10 Recreation

Recreation along the Salt River corridor is highly dependent upon the availability of surface water and riparian habitat, both of which are dependent upon the supply and availability of groundwater. The Salt River through the SRPMIC and the City of Mesa *currently* consists of dry river bottom. As a result, virtually no formal recreation activities take place. The only improved recreation area is Riverview Park, which is adjacent to the Salt River at the west end of the study area. The 51-acre park includes lighted softball fields, basketball and volleyball courts, picnic facilities, ramadas, and a three-acre urban fishing lake. Riverview Golf Course (a nine-hole course) is adjacent to the park. Annual attendance is estimated at approximately one million persons. The SRPMIC has a limited number of outdoor recreation facilities near the study area. The two primary facilities include the Salt River Baseball Field and the Salt River Little League Field. Other existing and planned recreation facilities along the Salt River downstream of the study area include Tempe Town Lake, the Rio Salado Project, and the Tres Rios Project.

Recreation options likely to be considered for this study would be passive in nature, complementing the primary project purpose of providing habitat restoration along the Salt River. Many factors contribute to making the proposed riparian habitat area extremely attractive in terms of recreation potential. They include:

- Potential to integrate a trail system for hiking and biking
- Availability of access roads for joint-use as above

- Availability of suitable areas for bird-watching, photography, and other viewing activities
- Potential use of area for cultural education
- Potential use of area for environmental education
- Advantages of large areal scale of project to provided diverse activities in an un-crowded setting
- Potential to foster stewardship
- Unique opportunities to focus recreation in a riparian-dominated environment

4.3 Future Without-Project Conditions

The future without-project condition is defined as that condition expected to exist over the 50-year period of analysis in the absence of any action taken (by the Federal Government) to solve the stated problems. It consists of the base year (2011) conditions projected to a future year, utilizing reasonable assumptions of how the base year conditions may change if no Federal action takes place. The future condition year for this study is 2060. Forecasting this condition is vitally important to the evaluation and comparison of alternative plans and the identification of impacts (both beneficial and adverse) attributable to proposed Federal actions. The future without-project condition forecast provides a description of anticipated actions external to the project and the anticipated consequences of these actions.

The future without-project condition has several general assumptions. First, the wetland and riparian biotic communities will in general degrade over time with reduced water supply and the influx of invasive/exotic species. Urban encroachment will continue, resulting in loss of buffer and native vegetative communities. Continued commercial activities within and immediately adjacent to the channel disrupt hydrologic regimes and cause the degradation of existing habitat and impact the recruitment of native riparian cover types.

For the purposes of this analysis, it is assumed that no new ecosystem restoration or flood damage reduction projects would be constructed in the absence of a Federally cost-shared and locally supported project.

4.3.1 Hydrology and Hydraulics

The future without-project HEC-RAS model was run to simulate the 5-, 10-, 20-, 50-, 100-, 200-, and 500-year flood events. Table 26 presents the discharges along the Salt River at Gilbert Road Quarry Pit used in the simulations.

Table 26. Future Without-Project Condition Flow Distribution

Return Event	Total Flow (cfs)	Flow in Main Channel (cfs)	Flow in Gilbert Road Quarry Pit (cfs)
5-year	21,000	0	21,000
10-year	58,000	4,659	53,341
20-year	95,000	22,000	73,000
50-year	145,000	52,580	92,720
100-year	172,000	69,058	102,942
200-year	207,000	94,703	112,297
500-year	246,000	121,316	124,684

Note: Discharges for a given event differ from those shown in Table 2. Table 2 presents different locations along the Salt River (i.e. at Central Avenue and at Granite Reef Dam).

The models indicate that the Gilbert Road Quarry pit captures 100 percent of the flow for the 5-year event, 92 percent of the 10-year event, 77 percent of the 20-year event, 64 percent of the 50-year event, 60 percent of the 100-year event, 54 percent of the 200-year event, and 51 percent of the 500-year event discharge.

The models also showed that under the future without-project conditions, the water surface elevations would be lower between River Stations 0.00 and 10.95 when compared to the existing conditions for all flow events. The long-term scour of the riverbed throughout most of the study area would gradually result in an increase in channel capacity and lead to this lowering of the water surface elevation. Between River Stations 10.95 and 11.99, the models for the 5- through the 50-year events produce higher water surface elevations. The difference ranges from 2 feet at River Station 10.95 to 0.5 feet at River Station 11.99. The reverse of conditions between River Station 0.00 and 10.95 would occur in this reach. Gradual deposition of sediment would result in an increase in the water surface elevation. Upstream of River Station 11.99, the water surface elevations either remain the same or are lower than those in the existing conditions.

Floodplain inundation limits were delineated for the 5-, 10-, 20-, 50-, 100-, 200-, and 500-year flood events. In general, inundation areas for the future without-project condition are smaller than those in the existing condition except between River Stations 10.95 and 11.99 for the 5- through 50-year peak flow events. Detailed maps with the contours, cross sections, and inundation areas are included in the *Hydraulic and Sedimentation Analysis Final Without-Project Analysis Report* (WEST, 2002).

In the short term, gravel mining in the river would cause degradation upstream and downstream of the gravel pits and aggradation within the gravel pits. Long-term channel responses are entirely dependent on future development in and around the channel. Aggradation and degradation would continue to occur as long as gravel mining operations exist in the vicinity of the channel. With no additional gravel mining, the channel would reach a state of equilibrium only after all the gravel pits are accessed through the natural migration of the river system or if restoration activities have been conducted.

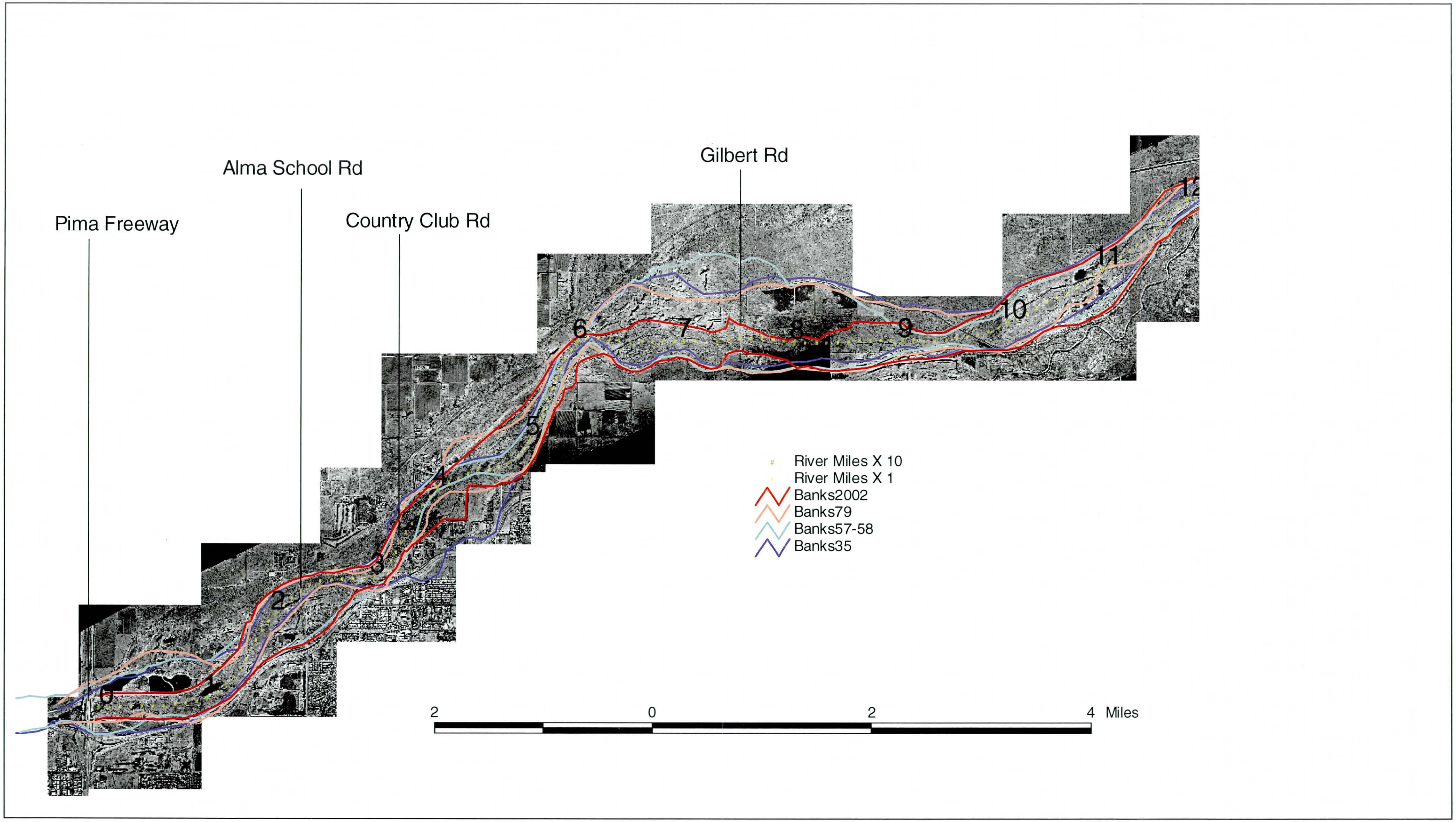
4.3.1.1 Erosion Analysis

The Lehi Cemetery is located on SRPMIC property on the south side of the Salt River just north of Thomas Road. There are concerns that bank erosion occurring near the cemetery would affect or damage it in the near future. To address these concerns, an engineering analysis was conducted to determine (1) if there is erosion occurring at Lehi Cemetery and (2) if so, at the rate at which it is occurring and how long it would take to impact the cemetery.

Based on aerial photos from 1935, 1957, 1979, and 2002, it was determined that the south bank has been migrating south, towards Lehi Cemetery. This migration can be attributed to flow events, which have periodically occurred (on average once every three years) in the Salt River. Mining may have also contributed to the erosion.

Using the location of the bank line position from the aerial photos (Figure 28), the long-term erosion rate was estimated to be, on average, 11 feet per year. This rate is dependent on the frequency, discharge, and duration of flow events and on channel geometry. Due to the current hydrologic condition (continuing drought conditions and increased storage in the Salt River watershed upstream of the Granite Reef Dam), the erosion rate may be less. Based on the estimated erosion rate, Lehi Cemetery would be impacted by erosion in approximately 33 years. That is, the south bank line would reach the cemetery in approximately 33 years.

Figure 28. Historic Channel Bank Locations (Superimposed on 2002 Imagery)



4.3.2 Environmental Resources

4.3.2.1 Biological Resources

In general, the condition and quality of biological resources within the Va Shly'ay Akimel study area are expected to decline. In this particular study, two key factors were used to predict the future without-project conditions: continued urban development and continued sand and gravel mining activities within the channel.

(a) Urban Development

The City of Mesa plans extensive commercial and residential development on land within their jurisdiction, along the entire southern bank of the Salt River. This urban development would increase the demand for local water supply, taxing ground and surface water resources. As other demands for water increase, the availability of water for existing vegetative use, or future vegetation expansion, decreases. The SRPMIC plans for some development on the north side of the river, within their jurisdiction, but it is not expected to be extensive.

Increased urban development increases the amount of treated effluent water and surface runoff available. Currently, the existing vegetation found at the Pima Freeway (SR101) is supported entirely by treated effluent and surface runoff.

Other effects of increased urban development are an increase in building and human encroachment within the river, an increase in trash and debris that makes its way into the channel, and an increase in undesirable recreational activities within the river, such as use of off-highway vehicles.

(b) Sand and Gravel Mining Activities

The sand and gravel mining operations are a vital component of the SRPMIC economic base. Therefore, it can be assumed that these activities would continue through the project life timeframe. High-quality materials exist within the main channel as well as the overbank areas, so mining activities may expand to encompass new areas both inside and outside the main channel.

Mining activities affect the river in two important ways: by changing the behavior of the channel system and by creating disturbances that prohibit vegetation establishment. The process of sand and gravel mining creates large pits, or quarries, in areas where the material has been excavated. These quarries can be up to 50 feet deep and many acres in areal extent. If material is taken from the main channel, the invert level can change dramatically, leaving large reservoirs of water during high-flow events. The instability within the channel created by the uneven invert surface also leads to upstream and downstream headcutting, or erosion, during high-flow events, which causes local damage where the material is removed and could cause downstream damages where the material is eventually deposited. As surface area is lost in excavation activities or lost due to erosion as a result of excavation activities, less area with the proper substrate is available for vegetation growth. The deep quarries also keep water flows further from the surface, therefore not available to surface vegetation that might rely upon the soil moisture provided by surface flows.

(c) Vegetation

Cottonwood-willow

Cottonwood-willow stands rely on fine soils near the main channel and currently exist in only disturbed, patchy areas, often dominated by saltcedar. If no restoration efforts are conducted, a continued decline in the quantity and quality of most areas of cottonwood-willow stands will occur due to a continued decrease in available surface water and groundwater and continued surface disturbance caused by the sand and gravel operations. Two exceptions to this are the areas immediately downstream of the Granite Reef Diversion Dam and the area at the Pima Freeway (SR101). The Granite Reef Diversion Dam currently seeps enough water to support riparian vegetation, including cottonwood-willow stands. Although this area has a heavy infestation of saltcedar, it does support healthy, native species. This habitat quality would likely remain high, assuming seepage from the dam continues. The second exception, the habitat found at the Pima Freeway (SR101), is supported by treated effluent and stormwater discharge. As urban development increases, so will these two water supply sources. However, in the absence of Federal action and if surface water needs increase more rapidly than effluent and stormwater discharge rates, this water source may be redirected and used elsewhere. If this occurs, the habitat would lose its water source and decline rapidly.

Mesquite

Mesquite currently exists only in small patches just below the Granite Reef Diversion Dam, likely relying on the seepage from the dam and the relatively high water table level at that location. Given the expected decline in available surface water elsewhere and the extremely low water table in the rest of the project site, mesquite would not expand its range within the project site.

Sonoran Desert Scrub Shrub

Scrub shrub occupies approximately 8 percent of the study area, mostly in the active channel of the river. The quality and quantity of the existing scrub shrub would likely decrease through mining disturbance and human encroachment. Mining activities remove all vegetation as part of the excavation operation; therefore, removal of scrub shrub would occur where mining currently exists and in all areas of expansion. The quality of scrub shrub would also decline given the magnitude of off-road vehicle use and use of the river channel for recreational purposes.

Wetlands

Wetlands occur in less than 1 percent of the study area, and those that exist are of generally poor quality. Again, the two exceptions are the area immediately below the Granite Reef Diversion Dam and the area at the Pima Freeway (SR101). Like the cottonwood-willow stands, if the water remains available to these sites, the wetlands can be expected to remain. Other wetland areas within the project site are of very poor quality and characterized by either seasonal or perennial open water and generally unvegetated. Open water wetlands are often associated with abandoned or stagnant quarry operations. While it is expected that these types of wetlands would remain, they would likely migrate alongside mining activities. Wetlands would be filled with material as others are created. Because of the disturbance associated with these wetlands, little vegetation is expected to establish or flourish, yielding a low-quality habitat.

4.3.2.2 Habitat Value

The Functional Capacity Units (FCUs) for each function were estimated for Target Years (TYs) 1, 6, 26, and 51. These projected values were then converted into average annual FCUs (AAFCUs). As shown in Table 27 and Figure 29, habitat values are projected to decline considerably (by about 13 percent) through TY 51. The AAFCUs for without-project conditions total 718.

Factors considered in the projection of without-project conditions include the continuing degradation of the river by incision, sand and gravel mining activities, and most importantly, urban development. The impacts were forecasted in terms of acreage losses as well as impacts associated with degrading water quality and vegetation composition and structure.

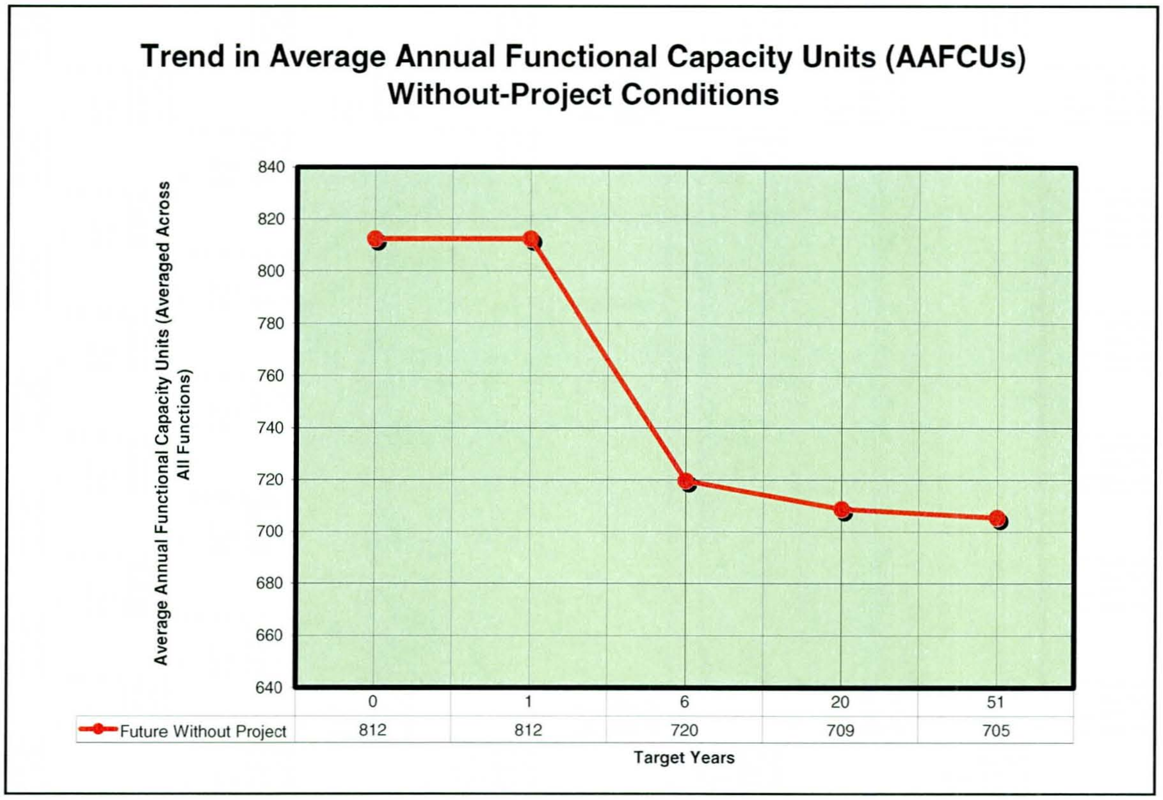
Increased urban development, whether residential or commercial, will lead to habitat degradation (and thus, a decline in AAFCUs) in a variety of ways. The most prominent degrading factors are: overall loss in habitat acreage, changes in the local hydrologic regime, and increases in human disturbance. Losses in habitat acreage would occur through development of land that might otherwise support various habitat types. Urbanization requires land surface, therefore any habitat that once occupied a site will be lost through land clearing, construction related activities, and replacement of the habitat by residences, commercial buildings, streets, and parking lots. What open space remains is generally of highly degraded quality, diversity, and extent. Urbanization also creates an increase in impervious land surface (pavement, asphalt, and concrete replacing pervious open space), which in turn affects local hydrologic regimes. Increasing the amount of impervious surfaces prevents precipitation from penetrating into the ground, thereby increasing overland flow. Overland flow carries pollutants from road surfaces, roofs, and parking lots, into drainage ditches. The debris and sediment it carries as it moves over the land, eventually empties into existing or restored habitat areas or the river channel itself, where it can be carried downstream into other areas. These pollutants and sediments can contaminate existing vegetation directly, or alter conditions enough to prevent new vegetation from establishing. The loss of infiltration also prevents that water from being available on-site to support vegetation, eliminates shallow soil moisture recharge, and decreases the volume of deeper aquifer groundwater recharge. Trees and other vegetation that depends on these water sources is thereby eliminated. Finally, with an increase in development, one can assume an increase in human disturbance, whether through increased noise and activity on the channel banks or through more direct disturbance caused by individuals entering into the channel or riparian zone itself for recreational activities.

In terms of acreage, at TY 6, 288 acres of the existing PWAA would be lost and converted to residential, industrial, and transportation cover types. This includes 50 percent of the 69.5 acres of cottonwood-willow forest PWAA. Cover type acreage does not vary, except for the remnants of the existing cottonwood-willow forest, until the TY 51. Between TY 26 and TY 51, it was assumed that the remaining 30.6 acres of cottonwood-willow forest would become newly developed river bottom areas within the active channel.

Table 27. Without-Project AAFCUs

Function	TY1	TY6	TY26	TY51	AAFCUs
1	822	762	650	648	689
2	1,044	951	951	940	955
3	119	70	70	63	72
4	204	125	125	125	131
5	947	793	794	800	805
6	821	718	718	720	726
7	767	697	698	693	701
8	1,484	1,345	1,345	1,339	1353
9	983	883	883	880	889
10	930	851	851	844	854
Average	**812**	**720**	**709**	**705**	**718**

Figure 29 Without-Project AAFCU Trend Chart



4.3.3 Land Use

An analysis of the City of Mesa's Draft General Plan indicates an average density for residential lands of about five dwelling units per acre, based upon existing land use plans. At this density ratio, about 17,780 acres of residential lands would need to be developed to accommodate future population increases through 2050. The ratio of commercial, industrial, and public land uses relative to residential land uses is about 58 percent, which would correspond to a required additional 10,300 acres of non-residential development. The Draft General Plan indicates that about 23 percent of the city's 172-square-mile planning area (or over 25,000 acres) is currently undeveloped. Hence, it is likely that the City would be built out within the next 50 years. In addition, the SRPMIC lands north of the Salt River downstream of Mesa Drive could see an increase in residential development as well as some commercial development along freeway corridors.

4.3.4 Recreation

Recreational opportunities within the study area would remain substantially unchanged, and recreational experiences would not be enhanced. In addition, land use and planning policies to enhance and restore biological habitat and riparian areas and provide flood damage reduction and recreational opportunities in open-space areas would not be realized.

4.3.5 Economics

4.3.5.1 Structure and Content Damages

Hydrologic and hydraulic analyses were conducted for future without-project conditions to determine the impacts of processes such as sedimentation and channel degradation and the resulting impacts on potential flooding. Updated water surface profiles and stage/discharge uncertainty data were used to determine expected annual damages under future conditions. The results are summarized in Table 28.

Table 28. Without-Project Expected Annual Damages – Future Conditions (2060)
(in $1,000s)

Reach	SFR/MH	Ind/Ag	Office/Com	Public	Total
2	1.2	5.3	2.1	-	8.6
3	23.5	13.4	19.8	1.0	57.7
6	24.1	1.4	-	-	25.5
Total	**$48.8**	**$20.1**	**$21.9**	**$1.0**	**$91.8**

Without project expected annual damages decrease from about $317,000 under Base Year conditions to about $92,000 under future (2060) conditions, a drop of over 71 percent. As shown in Table 28, the most dramatic decline was in Reach 6, which shows a damage reduction of about 87 percent relative to base year (2011) conditions. In general, water surface elevations are lower throughout the study area under future conditions (refer to Hydraulics and Hydrology Appendix for details). The long-term scour of the riverbed throughout most of the study area produces this lowering of the water surface elevation. Figure 30 presents the difference between the 500-year base year and future conditions.

Equivalent annual damages, shown in Table 29, were computed based upon forecast annual damages using a discount rate of $5^5/_8$ percent. As shown below, equivalent annual damages total approximately $251,000, with over 71 percent of damages associated with residential structures and over 57 percent located within Reach 6.

Table 29. Without-Project Equivalent Annual Damages
(50 Years, $5^5/_8$%, in $1,000s)

Reach	SFR/MH	Ind/Ag	Office/Com	Public	Total
2	2.0	8.2	3.2	-	13.4
3	44.6	18.8	28.5	1.7	93.6
6	132.8	9.8	1.8	-	144.4
Total	**$179.4**	**$36.8**	**$33.5**	**$1.7**	**$251.4**

4.3.5.2 Emergency and Cleanup Costs

(a) Clean-up, Debris Removal, and Public Infrastructure Repairs

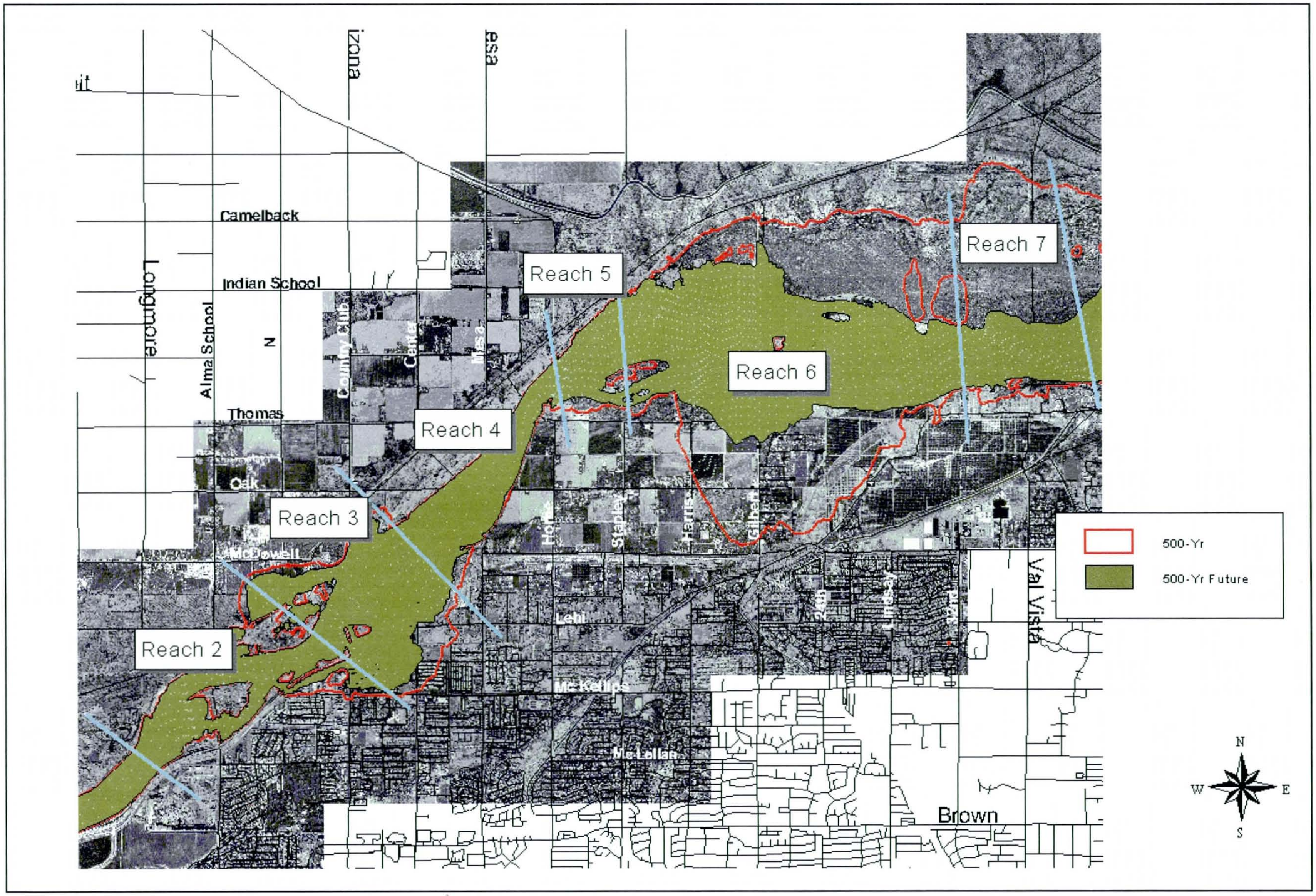
Emergency costs related to public infrastructure repairs, debris removal, and post-flood clean-up have been calculated by applying an average per-acre cost to the number of developed acres inundated by flood events. Based upon several recent Los Angeles District studies[4], per-acre costs for these items may range from $1,250 to $7,500 per acre. In accordance with this range, $5,000 per acre has been assumed for this analysis. Expected annual cleanup costs by reach are presented in Table 30.

Table 30. Without-Project Expected Annual Cleanup Costs by Reach
(in $1,000s)

Reach	Expected Annual Costs ($)
2	1.4
3	5.1
6	38.0
Total – All Reaches	**44.5**

[4] The two primary studies relied upon were the Lower Mission Creek, Santa Barbara County, California, and Rio de Flag Feasibility Studies, Coconino County, Arizona (WRDA 2000 studies), which included per-acre cleanup cost estimates. Other studies analyzed typically included cleanup cost estimates per flood frequency (based upon historical damages in the given study area and not necessarily associated with the number of acres impacted).

Figure 30. Base Year (2011) vs. Future (2060) Conditions 500-Year Floodplain



(b) Temporary Evacuation, Relocation, and Housing Assistance Costs

An Internet database search of FEMA disaster reports for flood and storm damage was performed. Data was collected and analyzed for ten recent flood disasters, including the October/November 2000 flooding in Maricopa and La Paz Counties in Arizona. For these ten disasters, 18,799 housing assistance claims were approved for a total payout of $27.93 million. This represents an average amount per claim of approximately $1,500.

To estimate temporary housing costs by flood event for this study, the number of houses and mobile homes inundated by frequency was ascertained through an analysis of HEC-FDA output files, and the per-housing-unit claim of $1,500 was applied. Table 31 shows expected annual without-project temporary housing costs.

Table 31. Without-Project Expected Annual Temporary Housing Costs by Reach
(in $1,000s)

Reach	Expected Annual Costs ($)
2	1.3
3	4.9
6	2.7
Total – All Reaches	**8.9**

4.3.5.3 Agricultural Damages

The expected annual flood damages upon production losses and factors in the monthly probabilities of major flood events are shown in Table 32. As shown, expected annual damages are minimal when reflecting the low probability of inundation, the seasonal nature of flooding, and a range of potential durations. In addition, the damages to the orchards could actually be lower than the values shown if the durations were short. For purposes of this analysis and based on available information, it is assumed that without-project expected annual damages is $1,600.

These losses do not account for potential income/revenue losses. To accurately assess revenue impacts, it would be necessary to analyze the potential for replanting, as well as whether the replanting would result in reduced yield. Due to the limited flood impacts to agricultural areas, this additional analysis was not conducted. However, estimates of the maximum expected annual losses for each crop under the assumption that flood events occurred after all production expenses were incurred but before any of the harvest could be sold have been developed. Even with these values, expected annual damages only total $3,100.

Table 32. Estimate of Crop Production Losses by Flood Event – Reach 6

(Adjusted for Seasonal Flood Probabilities and Potential Duration Impacts)

Flood Event	Cotton ($)	Alfalfa ($)	Citrus ($)	Nursery Tree Farm ($)	Total ($)
50	200	700	39,300	0	40,200
100	500	2,000	51,200	0	53,700
200	2,100	7,100	66,200	3,400	78,800
500	2,300	7,600	77,400	30,300	117,600
EAD	**20**	**70**	**1,430**	**90**	**1,600**

In addition to direct production losses, flooding of agricultural areas would also require cleanup. Cleanup costs per acre could vary significantly, depending on the stage of production cycle and the duration and timing of the flood event. Cleanup costs were derived by applying a cost per acre of $1,000 to the acreage estimates shown in Table 33. Resulting average annual agricultural cleanup costs total $5,700. Adding this to the estimated average annual production losses results in total average annual agricultural damages of $7,300.

Table 33. Estimate of Floodplain Crop Acreages – Reach 6

(Acreage within Floodplain Demarcation Line)

Flood Event	Cotton*	Alfalfa**	Citrus	Nursery Tree Farm
50	13	7	86	0
100	38	19	112	0
200	135	67	145	0.3
500	144	72	170	2.3

*Assumed to be $^{2}/_{3}$ of the current fallow acres

** Assumed to be $^{1}/_{3}$ of the currently fallow acres

4.3.5.4 Flood Damage Analysis Summary

As presented in Table 34, total future without-project equivalent annual damages total approximately $360,000. Nearly two-thirds of the total damages are concentrated in Reach 6. Even though this reach contains fewer structures than the downstream breakout area, this area has a higher probability of flooding. Furthermore, the floodplain boundaries for the 50- through 500-year floods are significantly higher within this reach. As a result, structure/content and cleanup damages are higher in this area. Temporary housing costs are higher in the downstream breakout area due to the much greater number of structures, which is the basis for these costs.

Table 34. Without-Project Equivalent Annual Damages

(in $1,000s)

Reach	Structure & Content	Cleanup	Temporary Housing	Agricultural*	Total
2	13.4	1.4	1.3	0	16.1
3	93.6	5.1	4.9	0	103.6
6	144.4	38.0	2.7	7.3	192.4
Total	**251.4**	**44.5**	**8.9**	**7.3**	**312.1**

*Including direct production losses and cleanup

CHAPTER V
PLAN FORMULATION AND EVALUATION

This chapter presents the results of the plan formulation process used in the development of restoration alternatives for the Va Shly'ay Akimel Salt River study area. This chapter describes the analysis used to arrive at the final set of alternatives as well as the decision making process that leads to the selection of a recommended plan. Alternative plan development includes identification of all reasonable solutions to address the identified problems and an initial screening to eliminate inefficient and ineffective solutions. These solutions include operational changes or project features or "measures," that form the building blocks of an alternative plan.

5.1 Planning Process

This section presents the rationale used in the development of this plan. The Corps of Engineers' six-step planning process specified in ER 1105-2-100 (Planning Guidance Notebook) is used to develop, evaluate, and compare the array of candidate plans that are considered. The plan formulation process includes the following steps:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Existing and future without-project conditions are identified, analyzed, and forecasted. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. The study team formulates alternative plans that address the planning objectives. An initial set of alternatives is developed and is evaluated at a preliminary level of detail.

4. Alternative project plans are evaluated for effectiveness, efficiency, completeness, and acceptability. The impacts of alternative plans are evaluated using the system of accounts framework specified in the Principles and Guidelines and ER 1105-2-100.

5. Alternative plans are compared. Cost-effectiveness and incremental cost analysis is used to prioritize and rank ecosystem restoration alternatives. A public involvement program obtains public input to the alternative identification and evaluation process.

6. The plan with the greatest net benefits is selected for recommendation if at least one plan exists demonstrating Federal interest.

5.2 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the planning setting, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. Planning objectives are statements of what a plan is attempting to achieve; they communicate to others the intended purpose of the planning process. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected future without-project conditions.

5.2.1 Public Concerns

Local experience with similar restoration projects and public input were considered during all phases of plan formulation. The main areas of concern were technical considerations based upon the specifics of the study area; coordination of measures, elements, and alternatives developed under this project with ongoing development within the study area; flood damage reduction considerations in improving or maintaining the existing level of protection; and local efforts in restoration and flood damage reduction. The plan formulation effort included extensive involvement by the local sponsors (SRPMIC and the City of Mesa) and agencies (e.g., U.S. Fish and Wildlife Service, Flood Control District of Maricopa County, Arizona Game and Fish, and Arizona Department of Water Quality). Numerous plan formulation workshops and public scoping meetings were held during the feasibility phase. These workshops and meetings introduced the project to the public, gave individuals and agencies an opportunity to identify issues for consideration in this feasibility report, and solicited input on the project. Public comments recorded at the meetings provided a good sense of the public's concerns and issues as well as the magnitude of each concern. Below are the initiatives the public and local officials would like to address through the study.

- Increase native riparian quality for both plants and animals.
- Attract migratory birds into these better habitats.
- Gradual creation of a continuous biological corridor.
- Foster the reestablishment of species native to the riparian communities and augment overall species diversity.
- Create physical settings in the river bottom that promote reestablishment of cottonwood-willow gallery forests and mesquite bosques.
- Eliminate invasive and non-native plant species.
- Restore vegetative communities within the river corridor to a more natural state.
- Increase acreage of functional seasonal wetland habitat.

Flood control not listed

5.2.2 Problems

The analysis of a wide range of technical issues identified a number of problem areas in the study area that have resulted from a variety of natural and human-induced changes. These problems are negatively affecting environmental resources, water resources, and local and regional economies of the area. These problems are summarized below.

- Degraded river and adjacent overbank areas.

- Degraded native riparian plant species and wildlife habitat. Perennial base flow conditions, critical to the needs of native vegetation, no longer exist in the river corridor through the study area.

- Average depth to groundwater beneath the river channel is much greater than historic conditions. Riparian vegetation that depends on groundwater has largely disappeared from the river channel.

- Hydrologic changes in the river system have impacted the surface/groundwater interactions and sedimentation dynamics that are important for sustaining and recruiting riparian vegetation.

- Land use changes, including landfills and mineral extraction (sand and gravel mining), have degraded and contributed to continued degradation of the river corridor.

- Recreation along the Salt River corridor is highly dependent upon the availability of surface water and riparian habitat, both of which are dependent upon the supply and availability of groundwater. The Salt River through the SRPMIC and the City of Mesa consists of dry river bottom. As a result, virtually no formal recreation activities take place on either the SRPMIC lands or the city-owned lands.

5.2.3 Opportunities

Based upon information obtained in the without-project assessment and understanding of public's concerns, opportunities were identified. Opportunities are desirable conditions that can be accomplished to some degree by management actions or policies. These are summarized below.

- There is an opportunity to take advantage of existing open water bodies in the river and adjacent properties as potential restoration sites.

- There is an opportunity to link other upstream and downstream restoration projects to provide a continuous habitat corridor. These include the authorized Rio Salado and Tres Rios Projects.

- There is an opportunity to restore and create conditions for sustainable riparian habitat in and around Va Shly'ay Akimel study area.

- There is an opportunity to increase the acreage of functional seasonal wetland habitat within the study area.

- There is an opportunity to increase habitat diversity by providing a mix of habitats within the river corridor including the riparian fringe and buffer.

- There is an opportunity to promote groundwater recharge.

- The study area provides a unique opportunity to enhance resource-based recreation and environmental education. The restoration of the Salt River would provide an opportunity for visitors to enjoy this unique resource while developing an awareness, knowledge, and understanding of desert riparian habitat and Native American culture.

5.3 Planning Objectives and Constraints

5.3.1 Federal Planning Objectives

Principles and Guidelines state that the Federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways to contribute to this objective. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Ecosystem restoration is also one of the primary missions of the Corps of Engineers Civil Works Program. The Corps' objective is to contribute to National Ecosystem Restoration (NER) through increasing the net quality and/or quantity of desired ecosystem resources. NER measurements are based upon changes in ecological resource quality as a function of improvement in habitat quality or quantity and expressed quantitatively in physical units or indexes (not monetary units).

This feasibility study determines if environmental restoration and recreation in this reach of the Salt River in Maricopa County, Arizona, meets the Federal objectives stated above. This is be accomplished by developing and evaluating measures and alternatives in order to recommend an implementable solution. To be consistent with the Federal objectives, any recommended solution presented in the Feasibility Report must address environmental restoration measures that result in an increase in net value to the NER. The recommended solution may also result in net NED benefits from recreation.

5.3.2 Specific Planning Objectives

Specific planning objectives were identified for this feasibility effort through coordination with local and regional agencies, the public involvement process, site assessments, review of prior studies and reports, and review of existing water projects. The specific objectives for environmental restoration within the study area have been identified as follow:

- Restore the riparian ecosystem to the degree that it supports native vegetation and wildlife through the Salt River from immediately downstream of the Granite Reef Dam to the Pima Freeway (SR 101).

- Establish a functional floodplain in unconstrained river reaches of the study area that is ongoing and mimics the natural processes found in other naturalized riparian corridors in Arizona.

- Provide passive recreation opportunities for visitors of all ages, abilities, and backgrounds that are in harmony with the SRPMIC's management of its culture and native ecology.

- Create awareness through ongoing educational opportunities of the significance of the cultural resources relating to the Salt River.

- Create awareness through ongoing education opportunities of the significance of the Salt River ecosystem.

- Create awareness through ongoing educational opportunities of the ecological connection between other ongoing riparian restoration projects along the Salt River.

5.3.3 Planning Constraints

In order to develop environmental restoration alternatives that will best meet the established objectives, the existing constraints must be considered. The following planning constraints have been identified for consideration in developing alternatives.

- Availability of Water - A principal constraint on many restoration projects in the arid southwest is the limited availability of water to support establishment and maintenance of healthy riparian habitats. In addition, the steady growth in the area surrounding the project creates increasing competition for water and land resources needed for ecosystem restoration.

- Water Rights - Water rights established by the State of Arizona do not apply to the SRPMIC lands; however, Federal water rights and court adjudications do apply. Non-Indian lands are subject to state water rights, Federal water rights, and court adjudications.

- Maintenance of Floodway Capacity - Restoration of riparian habitat should be formulated in such a way that it would not reduce the capacity of the Salt River to convey peak flows. Additionally, restoration features should also avoid inducing flooding in areas not currently subject to flood inundation, or to significantly increase flood depths in areas currently subject to inundation.

- Endangered Species - Under the Endangered Species Act (ESA), any potential project would be prohibited from jeopardizing the continued existence of threatened or endangered species or destroying or adversely modifying their habitat. Furthermore, ecosystem restoration projects may potentially attract endangered or threatened species. Projects should be sited so that their habitation by those species does not adversely impact the ability to preserve the flood damage reduction functions and maintenance of the channels.

- Local Acceptability - Any plan must be acceptable to local residents and consistent with local planning efforts.

- Vector Control - Restoration features must be configured to prevent development of a vector control problem.

- Effluent - The use of effluent as a water source may potentially be a consideration for restoration efforts only in the area within the City of Mesa due to cultural constraints within the SRPMIC.

- HTRW - Landfills and associated hazardous and toxic waste issues would need to be incorporated into plan formulation efforts.

5.4 Alternative Development and Evaluation Process

The Va Shly'ay Akimel feasibility study process involved successive iterations of alternative solutions to the identified ecosystem degradation problems. These solutions were based upon the study objectives and constraints and were formulated to address problems and opportunities identified in the early phases of the study process. In the application of Federal guidelines used in the formulation of water resources projects, the following feasibility criteria were used:

Technical Feasibility: Solutions must be technically capable of performing the intended function, have a reasonable certainty of addressing the problem, and conform to USACE technical standards, regulations, and policies;

Environmental Feasibility: Solutions must comply with all applicable environmental laws, including the National Environmental Policy Act;

Economic Feasibility: Solutions must be economically justifiable in that the economic benefits or, in the case of ecosystem restoration NER (non-monetary) benefits, must exceed the economic costs, in accordance with applicable regulations, policies, and procedures; and,

Public Feasibility: Solutions must be publicly acceptable as evidenced by a cost-sharing, non-Federal sponsor and further documented through an open public involvement process that incorporates the public's input into the formulation of the solutions.

In the initial phase of the study, measures were developed to satisfy these four criteria. The initial list of measures (Section 5.5) to be evaluated was based on input from the public and non-Federal sponsors, study team input based on experience with similar restoration opportunities, technical considerations based upon the physical characteristics of the study area, and considerations for maintaining existing levels of flood protection to adjacent properties along the study reach. Preliminary management measures addressed ecosystem restoration, channel stability and maintenance or improvement of flood protection, public education, and recreation. Some measures were quickly identified as inappropriate for the study area, and were not included in the initial group of measures forwarded for combination in the list of preliminary alternatives.

Combination of measures created a preliminary array of five alternative plans addressed in Section 5.5.2. After the initial analysis and screening of the preliminary alternative plans, a secondary array of sixteen more refined alternative plans were developed (Section 5.6 and Section 5.6.2). Key features common to the sixteen alternatives are described in more detail in Section 5.6.1. Each alternative plan was then independently evaluated and compared to the No Action Alternative (Section 5.7). From this evaluation three action plans and the No Action Alternative were carried forward into the final array for further analysis and comparison (Section 5.8) to be used as the basis for selecting the recommended plan (Section 5.9).

5.5 Preliminary Management Measures and Alternatives

5.5.1 Preliminary Management Measures

Management measures are structural or non-structural features, activities, or policies that can be implemented at a geographic site to address one or more planning objectives or constraints. A wide variety of management measures were identified for use in developing full-scale alternatives. The initial list of measures includes:

a. In-Channel Vegetation

- Restoration of riparian habitat areas in the channel.

b. Terracing

- Re-creation of terraces above the channel invert in conjunction with modification or removal of soil cement offers opportunities for habitat restoration, which maintains a connection to the channel.

c. Islands/Sand Bars/Oasis

- Modification of channel inverts to promote formation of sand bars and associated habitat.

d. Low-Flow Channel

- Reconfiguration and/or deepening of the existing low-flow channel with modifications to stabilize it would maintain and/or expand existing in-channel habitat areas. Not Flood Control

e. Modify/Distribute Incoming Flows

- Drainage flow modification to distribute flows over a wider area and thereby support more habitats.

f. Drop Structures/Weirs

- Placement of semi-permanent structures with associated weirs in the channel to aid in channel low-flow stabilization and creation of seasonal pools.
- Placement of structures and weirs in or near tributaries for water harvesting.

g. Cultural Education/ Interpretation/ Ecological Interpretation

- Establishment of passive recreation associated with restored areas including trails, viewing areas, and kiosks.
- Establishment of interpretative centers to provide instruction on historic agricultural practices.
- Establishment of interpretative centers to provide instruction on cultural resources and native ecology.

h. Active Recreation

- Sport centers, parks, ball fields, shooting ranges, biking, hiking, and rollerblading trails establishment.

i. Passive Recreation

- Walking, bird watching, interpretive signage to provide instruction on cultural resources, native ecology, and historical agricultural practices.

j. Soil Cement Removal

- Soil cement removal and replacement with banks laid back and stabilized by vegetation.

k. Soil Cement Modifications

- Soil cement modification to allow restoration of banks to a more natural state.

l. Berm or Wall along Buffer

- Construction of a low berm or wall in areas where damages might be induced because of restoration features or where it would benefit wildlife and the riparian areas to have a barrier between the restored areas and restoration features.

m. Open Water

- Restoration of year-round or seasonal pools or channel reaches with flowing water could be established to support restoration of aquatic habitat and benefit migratory waterfowl.

Each measure was evaluated in terms of the feasibility criteria. All criteria must be adequately met since any one criterion can serve to eliminate a measure from further consideration. Those measures satisfying all the criteria were carried forward for additional development and evaluation, while those that were shown not to meet the criteria were eliminated from further consideration. Measures that were carried forward were then combined in various configurations to form a preliminary set of alternatives that were formulated to address the group of goals and objectives established for potential projects. These preliminary alternatives were intended to be subjected to a more rigorous evaluation against the criteria presented above in plan formulation. Some measures became alternatives; others were combined to form alternatives; and some were eliminated from further consideration during the screening process.

Based on the preliminary screening of measures, it was determined that active recreation was not supported by the SRPMIC sponsor. However, passive recreation was determined to be technically, environmentally, potentially economically, and publicly acceptable. The City of Mesa expressed support of both active and passive recreation on city-owned lands within the study area. Two other measures were determined to be economically infeasible. These measures, soil cement removal and drop structures or weirs in the main channel to create pools, were not carried forward for further analysis.

5.5.2 Preliminary Alternatives

Five preliminary alternatives were developed from the screened measures group discussed above. These alternatives were developed to encompass the broadest range of potential alternatives that could be formulated to address ecosystem restoration opportunities within the study area. The alternatives vary with respect to water requirements, habitat focus, and total scale. A discussion of the preliminary alternatives follows.

5.5.2.1 Alternative 1: No Action

Under this alternative, the Federal government would take no action to restore any ecosystem functions or values within the study area, would not implement plans to address recreational opportunities, nor would it develop plans with potential incidental benefits associated with flood damage reduction. The No Action Alternative is the basis for comparison with all other alternatives, as it represents a condition, both current and future, under which nothing has been done to address the identified problems. By comparing the No Action Alternative to each formulated alternative, one may assess the advantages and disadvantages of the study alternatives in relation to current and future "without-project" conditions. All alternatives are evaluated against the No Action Alternative to determine the benefits and risks associated with each of the proposed alternatives.

5.5.2.2 Alternative 2: Restoration Based on Existing Water Budget

This alternative is the smallest-scale alternative and does not depend on new sources of water; rather, it strives to make better use of the available water sources for the purpose of ecosystem restoration. It would include active and passive capture and utilization of stormwater from various drains and utilizing seepage from Granite Reef Dam. Alternative 2 incorporates passive recreation, and provides no incidental flood damage reduction.

- Price Drain and Alma School Drain: Reconfigure drainage areas to allow for establishment of riparian communities, particularly improved cottonwood-willow habitat, and eradicate salt cedar; increase vegetation survival rate during drainage high-flow periods; allow smaller drains carrying stormwater and nuisance flows to be used to establish desert wash communities.

- Granite Reef Dam: Modification to current flow pattern to promote succession, greater habitat connectivity, and a wildlife corridor between upland and riparian areas.

- Recreation: Establish associated interpretive centers to provide instruction on cultural resources and native ecology.

5.5.2.3 Alternative 3: Restoration through Non-Structural Methods (Grade Improvement and Additional Water)

This alternative calls for improving the current cottonwood-willow/mesquite habitat and open water by altering the current gradient and supplying additional water. It would include passive capture of stormwater as well as a commitment of delivered water sources (i.e., SRP water, groundwater from existing and new wells). Recreation components would include passive recreation associated with interpretive signage to provide instruction on cultural resources, native ecology, and historic agricultural practices.

- Storm Drains: Reconfigure Price and Alma School drainage areas to allow for establishment of riparian communities, particularly improved cottonwood-willow habitat, and eradicate salt cedar; increase vegetation survival rate during drainage high-flow periods; allow smaller drains carrying stormwater and nuisance flows to be used to establish desert wash communities.

- Reach 1 – Granite Reef Dam to Gilbert Road: Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Buffer areas would be planted with mesquite and upland communities to promote habitat connectivity and a wildlife corridor between upland and riparian areas.

- Reach 2 – Gilbert Road to Pima Freeway (SR101): Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Interpretive signage would be established to provide instruction on cultural resources, native ecology, and instruction on historic agricultural practices.

5.5.2.4 Alternative 4: Restoration through Structural and Non-Structural Alternatives

This alternative is of a larger scale in that it calls for improving habitat. The nature of the improvements creates incidental flood damage reduction benefits. This alternative calls for improving the current cottonwood-willow/mesquite habitat and open water by in-channel restoration that creates a meandering channel lined with native grasses, cottonwood-willow corridors, and appropriate understory vegetation. In addition, it includes modification of bank protection and a buffer. It would include active and passive capture of stormwater as well as a commitment of delivered water sources (i.e., SRP water, groundwater from existing and new wells). Recreation components would include passive recreation associated with viewing areas and interpretive centers to provide instruction on cultural resources, native ecology, and historic agricultural practices.

- Storm Drains: Reconfigure Price and Alma School drainage areas to allow for establishment of riparian communities, particularly improved cottonwood-willow habitat, and eradicate salt cedar; increase vegetation survival rate during drainage high-flow periods; allow smaller drains carrying stormwater and nuisance flows to be used to establish desert wash communities.

- Reach 1 – Granite Reef Dam to Gilbert Road: Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Buffer areas would be planted with mesquite and upland communities to promote habitat connectivity and a wildlife corridor between upland and riparian areas. In-channel restoration may include meandering and braided channels lined with native grasses, cottonwood-willow corridors, appropriate understory vegetation when feasible, and a low-flow channel as appropriate. Recharge areas would foster habitat restoration.

- Reach 2 – Gilbert Road to Pima Freeway (SR101): Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Soil cement banks would be reconfigured to create a more natural bank and connection. Soil cement banks would be lowered where feasible with terracing that buffers sand and gravel operations and local community. A bioengineered flood control channel and sediment basin in flood-prone areas would be considered. Interpretive centers would be established to provide instruction on cultural resources, native ecology, and historic agricultural practices.

5.5.2.5 Alternative 5: Comprehensive Restoration

This alternative is of the largest scale and has the greatest water requirement and the greatest habitat focus. This alternative calls for improving habitat and providing incidental flood damage reduction benefits. It includes groundwater recharge areas, modification of bank protection, in-channel restoration, and buffer improvements. Recreation components would include passive recreation on SRPMIC lands and active and passive recreation on city-owned lands.

- Storm Drains: Reconfigure Price and Alma School drainage areas to allow for establishment of riparian communities, particularly improved cottonwood-willow habitat, and eradicate salt cedar; increase vegetation survival rate during drainage high-flow periods; allow smaller drains carrying stormwater and nuisance flows to be used to establish desert wash communities.

- Reach 1 – Granite Reef Dam to Gilbert Road: Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Buffer areas would be planted with mesquite and upland communities to promote habitat connectivity and a wildlife corridor between upland and riparian areas. In-channel restoration includes meandering and braided channels lined with native grasses, cottonwood-willow corridors, appropriate understory vegetation when feasible, and a low-flow channel as appropriate. Groundwater recharge areas would be used to foster habitat restoration. Open water in the form of seasonal pools or channel reaches with flowing water could be established to support restoration of aquatic habitat and benefit migratory waterfowl. Interpretive centers to provide instruction on cultural resources, native ecology, and instruction on historic agricultural practices would be established.

- Reach 2 – Gilbert Road to Pima Freeway (SR101): Revegetation on terraced areas would be graded from cottonwood-willow on the lowest level to mesquite communities up to desert wash vegetation at the highest level from the river. Soil cement banks may be reconfigured to create a more natural bank and connection. Soil cement banks would be lowered where feasible with terracing that provides a buffer from sand and gravel operations and local communities. A bioengineered flood control channel and sediment basin in flood-prone areas is a possibility. Berms or flood walls would be added at the outside edge of the buffer. These measures would be used for one of two reasons: either where increasing n-values induce overbank flows that may cause flood damages to developed areas or where there is a need for a barrier between restored and developed areas. Berms could be vegetated with appropriate native vegetation. Interpretive centers may be established to provide instruction on cultural resources, native ecology, and historic agricultural practices, as well as viewing areas and trails.

Raise the n-value, reduce channel capacity & build flood walls!!

This sure makes a lot of sense!!

5.6 Screening of Alternative Plans – Second Array

The five alternative plans initially identified were screened on the basis of technical feasibility, economic justification, environmental quality, and public acceptance. The plans were presented to, and coordinated with, the USACE Los Angeles District, the SRPMIC, the City of Mesa, and participating resource agencies. This resulting screening relied primarily on the informed judgment of technical and resource agency staff, use of empirical data, and the degree of acceptability expressed by stakeholders. Based on this screening process, additional ideas and considerations were proposed, and a secondary array of alternatives was developed. Initial alternatives 2 through 5 were reformulated and further developed as more refined alternatives with their primary components incorporated into the second array of alternatives. To avoid confusion, these alternatives were lettered rather than numbered.

In order to provide the level of detail necessary to compare the secondary array of alternatives, more detailed engineering, design, cost estimating, incremental evaluation, analysis of potential project impacts, and the development of preliminary cost-effectiveness analyses, were developed for each remaining alternative. The resulting information was utilized to make plan formulation decisions regarding the potential removal of alternatives from further consideration, or their forwarding into a final array of alternatives subject to further refinement and analysis.

As discussed above, the initial screening of Preliminary Alternatives 1 to 5 resulted in a secondary array of alternatives comprising 14 ecosystem restoration alternatives (Alternatives A to N), as well as the No Action Alternative. Based on coordination and review by the SRPMIC and the City of Mesa of these 14 alternatives, it was recognized that an additional alternative was warranted. This alternative, discussed hereafter as Alternative O, was considered in order to address the opportunity for additional vegetation in Reaches 1 and 2. The secondary array of alternatives, Alternatives A to O, including the No Action Alternative (Alternative P), is presented in Table 35 and discussed in the following sections.

Table 35. Second Array of Alternatives

Alternative	Name	Vegetation Proposed	Level of Vegetation Restoration
A	LOAD	Xero-Riparian Dominate	Minimal
B	MEAD		Moderate
C	HIAD		Extensive
D	MINE	Meso-Riparian Dominate (Cottonwood, Mesquite, and Xero-Riparian)	Moderate
E	VHAD		Extensive
F	MAX		Maximum
G	CWAD	Cottonwood Dominate	Extensive
H	MSAD	Mesquite Dominate	Extensive
I	CHNL	Cottonwood Dominate	Moderate
J	BRAD		Extensive
K	NODL		Maximum
L	POCK	Cottonwood and Mesquite Dominate	Moderate
M	WET	Hydro-Riparian Dominate	Extensive
N	-	Meso-Riparian Dominate	Maximum
O	-		Maximum
P	No Action	-	-

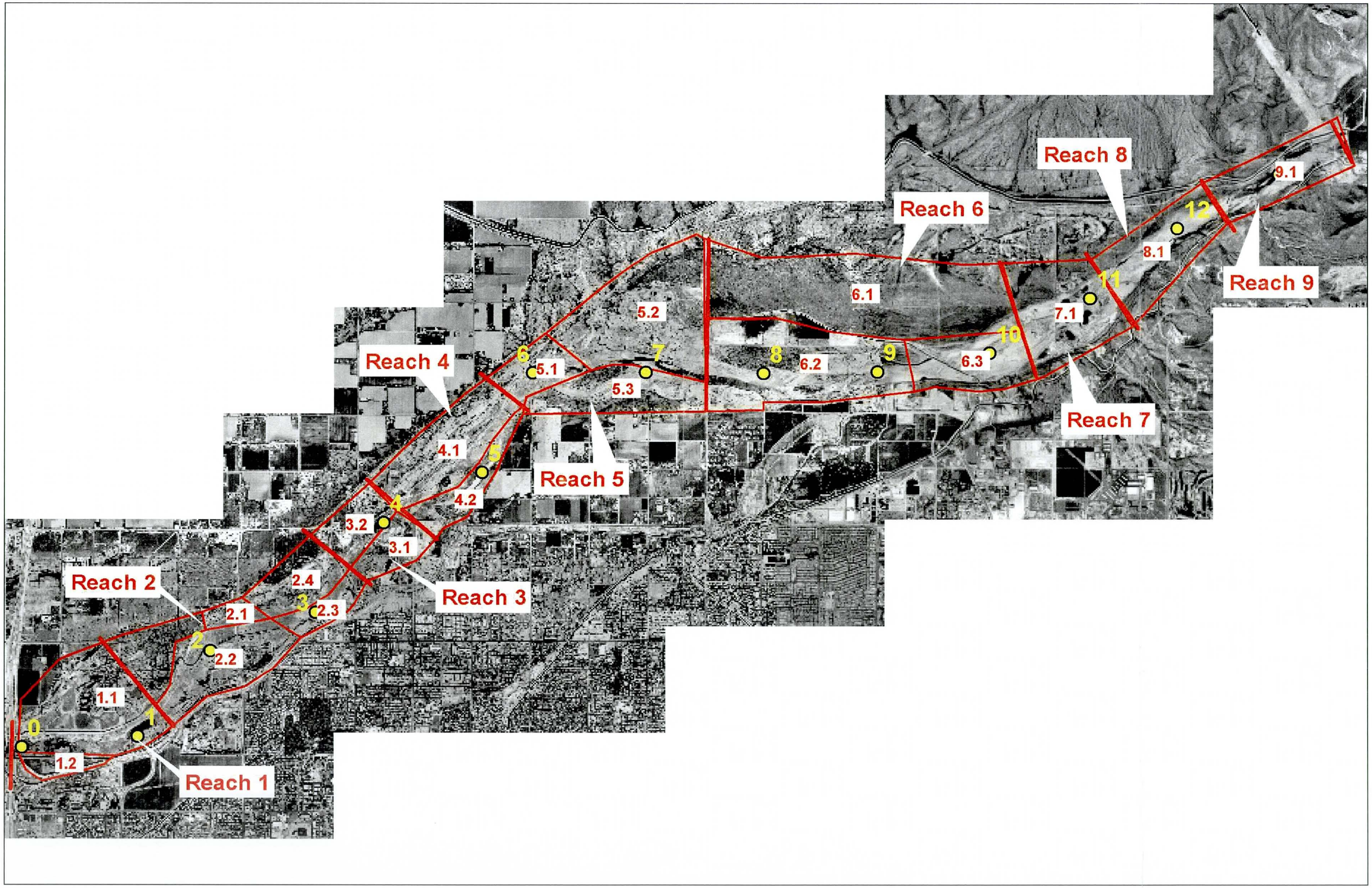
5.6.1 Features Common to the Alternative Plans – Second Array

The study area was divided into nine distinct reaches, each of which was divided into sub-area locations that could undergo specific restoration efforts. Figure 31 shows an aerial image of the study area identifying the nine distinct reaches and sub-area locations used in this report. The following features, which are discussed in more detail in the following sections, were applied to all of the alternatives, as they form the minimum structural support for any ecosystem restoration alternative and do not affect the design of the vegetation or irrigation systems.

Table 36. Reach Description

Reach	Description
1	*From the Pima (SR101) Highway to immediately downstream of Longmore Road* Portions of this reach are characterized by the existing high quality habitat.
2	*From immediately downstream of Longmore Road to the Beeline Highway river crossing* This reach is characterized by the disturbances of the Salt River Sand and Rock (SRS&R) Dobson Plant without interfering with the existing vegetation in Reach 1.
3	*From the Beeline Highway river crossing to the downstream edge of the Old Tri-City landfill* This reach is characterized by a landfill and a United Metro quarry. Because of the limitations of these two features, this reach was identified independently.
4	*From the downstream edge of the Old Tri-City landfill to the downstream edge of Lehi Cemetery* This reach is characterized by the landfill.
5	*From the downstream edge of Lehi Cemetery to Gilbert Road* This area encompasses the reach of river that contains the SRS&R Beeline One Plant and its downstream area of effect.
6	*From Gilbert Road to immediately upstream of the Hennessey Drain* This reach can be characterized by the water available through the Hennessey Drain, the channels flowing from the drain, and the GRUSP site. Any vegetation planned for Reach 6 can be supported by the Hennessey Drain or GRUSP water.
7	*From immediately upstream of the Hennessey Drain to the upstream edge of the SRS&R Higley Plant* This reach is characterized by the existing mining operations. Because of the disturbance associated with such activities and the assumed eventual failure of any vegetation planted in this area, no features were planned.
8	*From the upstream edge of the SRS&R Higley Plant to the end of the existing riparian vegetation* This reach has existing quality scrub shrub habitat. While scrub shrub habitat is of a lower wildlife value, it is still part of the southwestern greater river ecosystem. Given the proximity to the quarry plant, the disturbances associated with it, and the relative habitat health, it was determined that Reach 8 did not warrant additional planning.
9	*From the existing riparian vegetation to the Granite Reef Diversion Dam* Because ecosystem restoration is the purpose of this project, areas with no or declining riparian vegetation were given the highest priority. The area within Reach 9 has high quality existing riparian habitat; thus, activities are limited to invasive species control.

Figure 31. Va Shly'ay Akimel Location Map – Reaches and Project Sub-areas



5.6.1.1 Water Sources

There are six possible water sources for a potential project: (1) SRP water, (2) groundwater from existing and new wells, (3) stormwater runoff, (4) City of Mesa Wastewater Treatment Facility effluent water, (5) irrigation tailwater, and (6) surface water available for use by the SRPMIC via existing water source locations (Figure 32). The alternatives would rely primarily on surface water and groundwater from the SRPMIC and very limited use of effluent from the City of Mesa to nourish habitat *only* in the vicinity of the WWTP (Table 54). According to the SRPMIC staff, 30,000 acre-feet/year (ac-ft/yr) of water could be allocated to the project. The water requirements from the various sources for each of the alternatives are discussed in more detail in Section 5.7.1.

5.6.1.2 Water Distribution System

The water distribution system refers to the infrastructure needed to deliver water (i.e. surface water or groundwater) from the source (i.e. irrigation canal or well) to the newly-restored vegetated areas of a given alternative. The distribution system is not the same as the irrigation system required by a given alternative, which may also differ from alternative to alternative. Surface water from the SRPMIC would be the primary source of water. A new well, proposed near Gilbert Road, was also examined as a water source option. The system was design to utilize stormwater and irrigation tailwater whenever it is available.

Surface water would enter the study area by way of irrigation canals controlled by the SRPMIC. SRPMIC would then distribute the water to satisfy water demands within the project area. A flow diversion structure would be required to store and divert surface water from the irrigation channels to the water distribution drain, a 12-inch buried pipe (Figure 33). The diversion structures would divert both project water and excess water to the project area. In general, the location of the distribution pipes varies for each alternative. In addition, Alternatives B, C, E, G, and H require an additional distribution channel, which is 40 feet wide with a maximum depth of 3 feet. The distribution channel would be lined and would convey excess irrigation water to the vegetated areas within the 10-year area of inundation. After significant flow events, segments of the channel would require maintenance.

Figure 32. Water Source Location Map

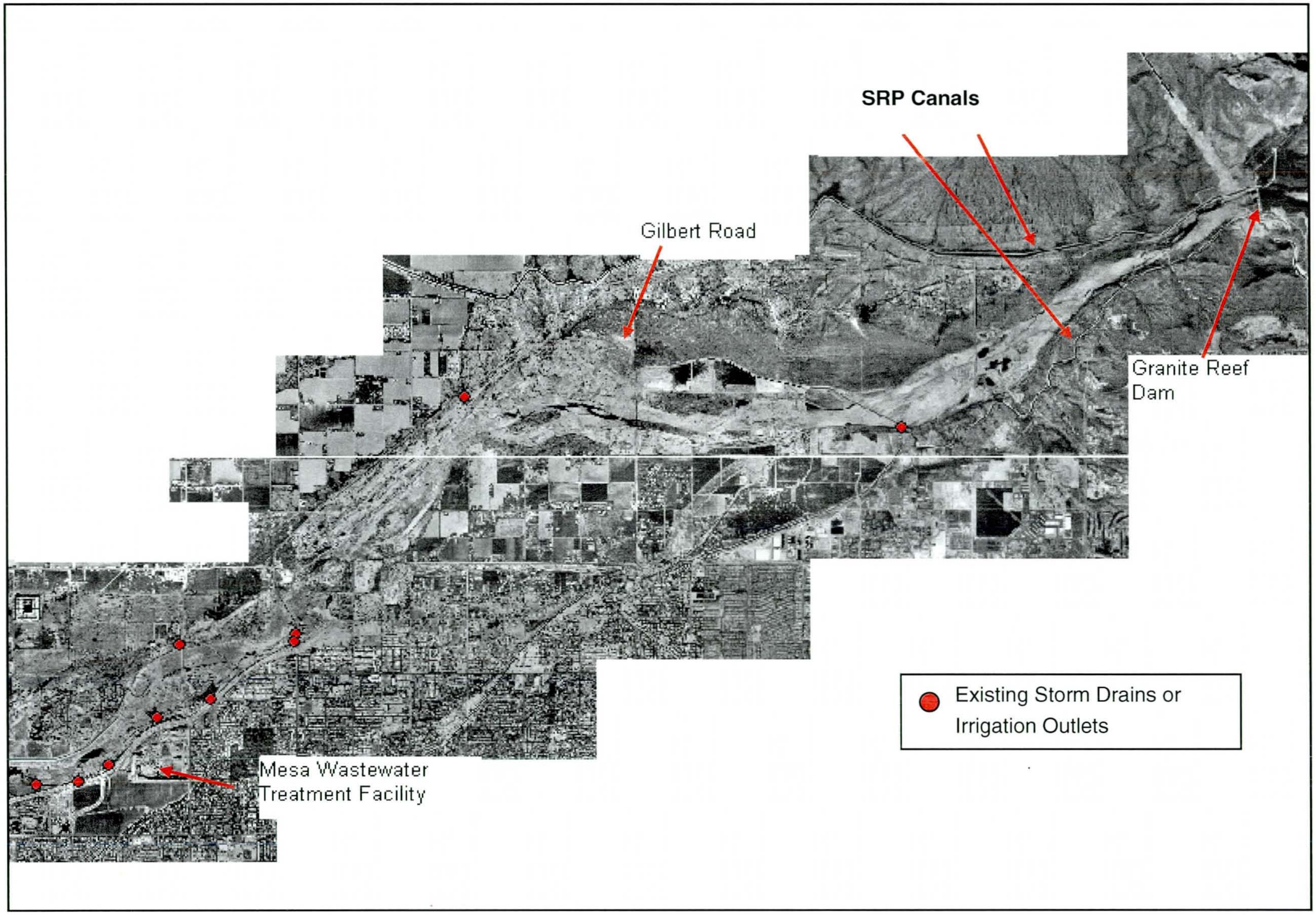
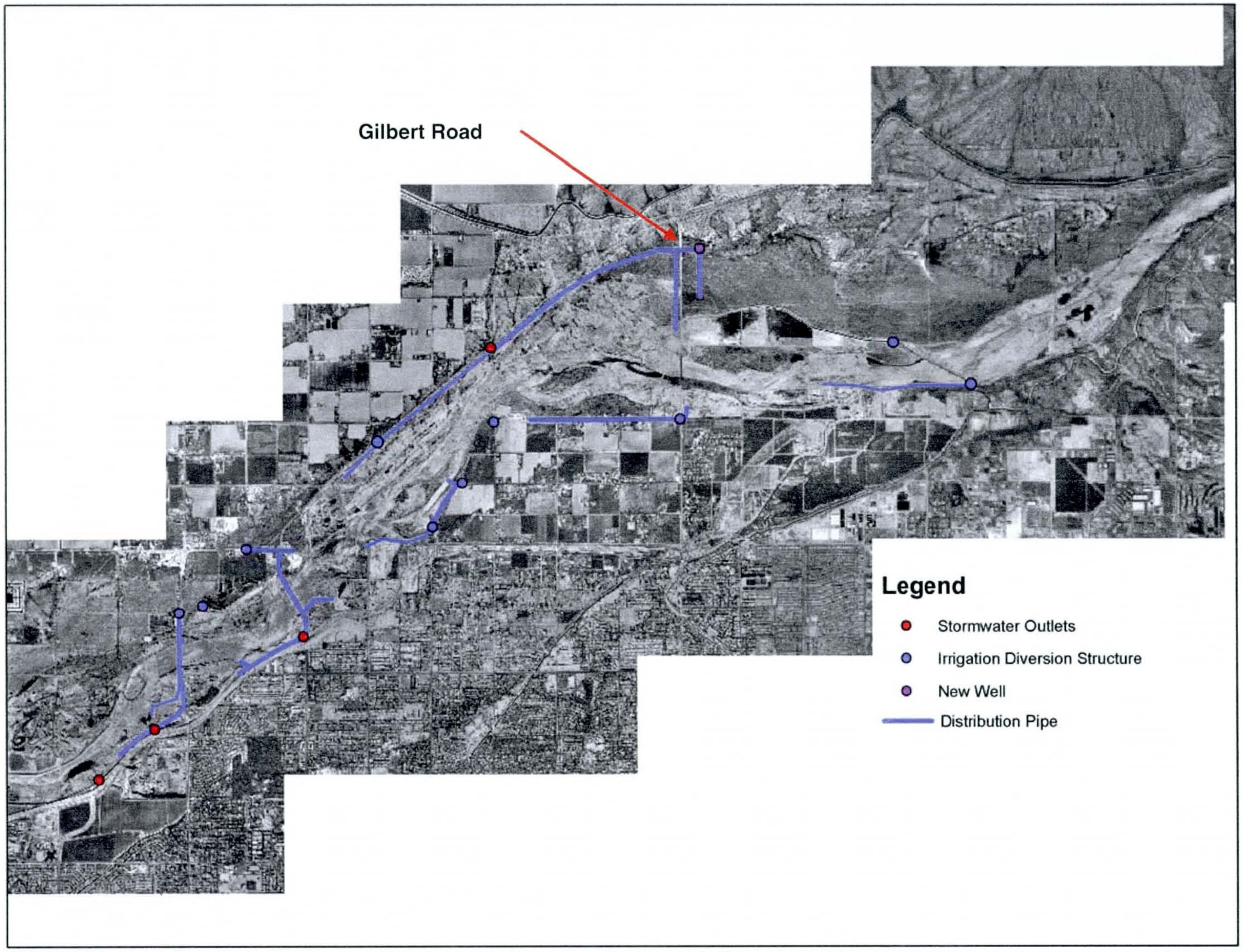


Figure 33. Location of Water Surface Sources, New Wells, and Distribution Pipes



Note: Not all alternatives require all the surface water sources, wells, and distribution pipes shown. In general, the location of the distribution pipes varies for each alternative.

5.6.1.3 Irrigation Techniques

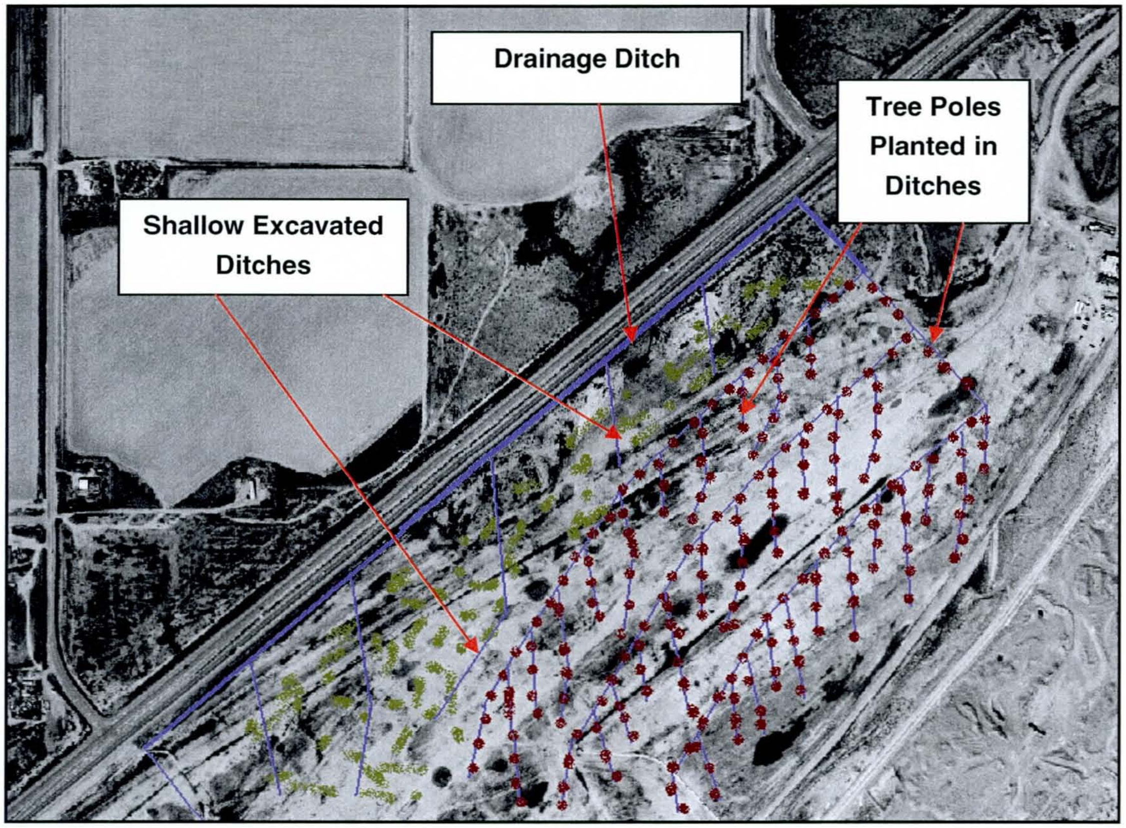
Surface water from stormwater sources, irrigation canals and ditches, would be diverted to the proposed newly-vegetated areas by a network of lined irrigation channels and buried pipes. The size of the channel and pipe would depend on site-specific conditions such as flow requirements and terrain. Pumps are needed in some cases to distribute water. To irrigate certain vegetated areas, a Surface Braided Irrigation Network (SBIN), flood irrigation, or drip irrigation could be used. Figure 34 depicts the layout of the SBIN irrigation method. Additional information about these irrigation systems, and their associated water usage, are discussed in Section 5.7.1 and the Water Budget Analysis Appendix.

The SBIN distributes water through a network of shallow ditches, 6 inches deep and 2 to 3 feet wide. Maintenance of these lined channels may be necessary after larger flow events. Water distribution would need to be manually controlled for the life of the project.

The flood irrigation method consists of inundating an area by overland flow. This method has a low irrigation efficiency, defined as vegetation water demand divided by total water demand (vegetation water demand plus water losses), but has low constructions costs and operations and maintenance requirements. Water distribution would need to be manually controlled for the life of the project.

Drip irrigation is a common system for irrigation; however, it is not an advantageous method for promoting recruitment of desirable vegetation types and irrigation of large areas. It is recognized that some drip irrigation may be needed in the beginning for establishing plants.

Figure 34. Surface Braided Irrigation Network (SBIN) Diagram



5.6.1.4 Reshaping

Many of the alternatives would require surface reshaping. The four types of reshaping categories incorporated in this project are discussed below.

- *Channelization* refers to the material moved in the process of constructing the 200-foot-wide, low-flow channel.

- *Surface Reshaping* refers to the material moved to alter significant features such as large mounds, filling quarry pits, and reducing the side slopes of the quarry walls.

- *Vegetation Reshaping* refers to the minor soil reshaping required for planting purposes and to ensure that gravity irrigation systems would be feasible. It is assumed that 2 feet of surface soil material would be moved per acre of vegetated area. This assumption was based on the relatively flat terrain for most of the project feature areas.

- *Irrigation Reshaping* refers to the construction of irrigation ditches needed in the flood irrigation, the SBIN irrigation methods (2 to 3 feet wide and 6 inches deep), and the construction of the drainage ditches (15 feet wide and 3 feet deep). Flood irrigation would require only a leveling of surface soil to ensure even water distribution while a SBIN would require minor surface soil reshaping to form shallow trenches for the water to flow through. A minimal amount of reshaping for a drip irrigation system is expected.

5.6.1.5 Vegetation

Five vegetation types were evaluated: Cottonwood/Willow, Mesquite, Wetlands, Sonoran Desert, and River Bottom. The requirements for implementing each vegetation type are as follow:

(a) Cottonwood/Willow (CW)

CW stands are restricted to the near overbank area of streams and rivers or other areas with saturated soil conditions. They require a water table or saturated soil conditions 1 to 10 feet (Anderson, 1995) below the ground surface and have an average annual water demand range from 4 to 8.5 feet. It was assumed that the average annual water demand is 6.3 feet. Soils range from finer sediments to sandy soils. In areas where grading may be required, uneven grading is most beneficial, allowing for depressions where sediment can collect and shelter seeds for establishment. Due to the relatively high water demands of CW, a drip irrigation system may be used to help ensure establishment. Once established, CW stands would rely on flood irrigation or a SBIN for their water needs.

(b) Mesquite (MS)

MS is commonly found 5 to 20 feet above the river channel where water is adequate, and generally occur in soils approximately 10 to 45 feet above the water table (Arizona Department of Water Resources, 1994). However, occasional saturated soil conditions are necessary 1 to 3 feet below the surface as this is where 90 percent of the mesquite roots are found (www.desertmuseum.org). The average annual water demand range for MS is between 2 and 4 feet. It was assumed that the average annual water demand is 3.0 feet. Soils can be fine to gravelly with some rocky areas. A drip irrigation system may be necessary to establish the MS. However, once established, the MS would rely on flood irrigation or a SBIN for its water needs. Previous restoration efforts have shown that MS can survive on natural precipitation alone, even when groundwater is not available. However, this cannot be assumed true for all locations. Therefore, a site-specific evaluation should be performed before determining if or how much supplemental water is required.

(c) Wetland (WT)

WT areas can consist of open water, submerged vegetation, or shorelines, all requiring a high water table level at or near the surface. The average annual water demand range for WT is between 9 and 16 feet. It was assumed that the average annual water demand is 9 feet.

Due to the porous soils found in this project area, lining the WT would be required to maintain surface water. Excavation and layering of a silt clay soil substrate overlain by coarser material is also recommended. This soil structure would reduce disturbance of the soil-clay layer by reducing piping of fine material and reducing turbulent forces acting on the layer.

Storm drain outlets located near WT would require erosion control measures at the outlets to prevent scouring. To distribute water from the WT laterally, a series of drainage ditches would be constructed from the WT to divert water to other areas that require irrigation. The ditches would be semi-elliptical in shape with a top width of 4 feet and maximum depth of 2 feet. The drains would increase lateral dispersion of runoff to maximize the stormwater benefit.

The WT would also be designed with an outlet channel leading to the main channel. The preliminary design of the outlet channel calls for a 20-foot bottom width, 3-foot maximum depth, 2:1 side slopes, 300-foot length, and large cobble bottom. The design discharge (Q) is 400 cfs. Not all proposed WT would require an outlet channel.

(d) Sonoran Desert (SD)

The specific vegetation species can vary depending upon the site's soil type. However, proposed vegetation types would not require saturated soil conditions and would have an average annual water demand between 0.5 to 2.5 feet. It was assumed that the average annual water demand is 2.0 feet. The SD may need to be periodically irrigated with a supplemental water source the first 5 years to establish the vegetation. Once established, SD should be sustained by annual precipitation or with periodic inundation, via flood irrigation, during extreme drought periods.

(e) River Bottom (RB)

RB would require only surface reshaping including partially filling large depressions and excavating large mounds to reduce possible impacts to restoration efforts. River bottom areas may also require hydro-seeding with a variety of native xeric river bottom shrub species to help establish vegetation. While RB areas are frequently dry, they are capable of sustaining xeric vegetation types, as seen in areas along the Salt River within or near the project site. These plants would be sustained with natural precipitation and any tailwater that may enter the river from other feature irrigation systems; thus, irrigation would not be required.

In addition to the planting of the vegetation, some reshaping may be necessary to provide the proper landscape to maintain and encourage the future propagation of the vegetation.

5.6.1.6 River Channelization

Some alternatives would require segments of the Salt River to be enlarged or better channelized, to offset a reduction in potential water conveyance created by the presence of additional vegetation within the main channel. The river bottom would be excavated to form a low-flow channel with a bottom width of approximately 200 feet, 1V:3H side slopes, and a depth of 4 to 8 feet. The channel would be free to migrate. The excavated material would be used to create benches along the channel to fill quarry pits and vary the local topography to encourage vegetation growth and reduce flood and consequent erosion damage to proposed newly-revegetated areas. Maintenance of the channel may be necessary after flow events. A 200-foot buffer on both sides of the low-flow channel would be incorporated to allow for the migration of the low-flow channel.

Portions of the low-flow channel would be designed with a semi-impervious soil substrate to support wetland areas. Sonoran desert vegetation would be planted along the low-flow channel to increase stability of the overbank area.

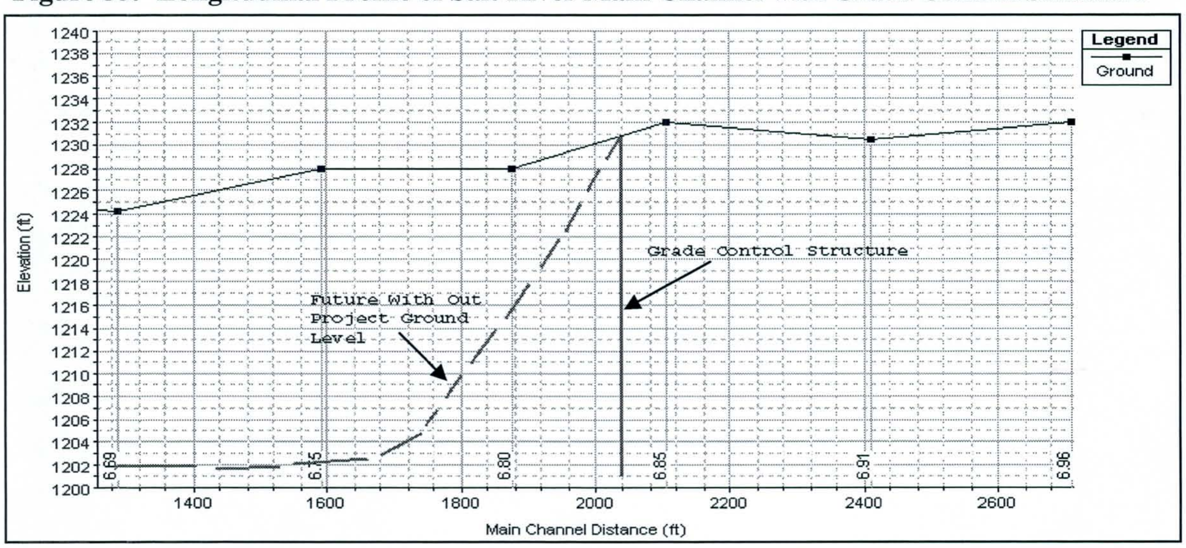
Buried guide dikes would need to be constructed in the overbank area perpendicular to the thalweg (center line) of the channel. Groins would act as a lateral control to prevent excess migration of the low-flow channel.

5.6.1.7 Grade Control Structures

A grade control structure would be needed to protect newly-restored areas of the channel subject to erosion as a result of extensive in-channel mining activities that occurred in the past downstream of the bridge. These sand and gravel mining activities created a "nickpoint", an area where an abrupt change in elevation and slope occurred. Over time, water flowing over this nickpoint resulted in upstream migration of a "headcut", causing degradation and incision of the channel bed upstream. Results from the hydraulic and sediment analyses indicate that the headcut would eventually damage restoration features located upstream of the former mining site, and could also potentially undermine the bridge at Gilbert Road. While the grade control structure would help reduce the degree of upstream channel migration and, by stabilizing the river system minimize impacts to newly-restored habitat, its likely degree of increased protection to Gilbert Road bridge was deemed minimal, and its benefits monetarily were judged to be only incidental.

The grade control structure would span the entire width of the riverbed and have sufficient toe-down to survive the anticipated scour resulting from a full range and magnitude of flood events expected during the period of analysis. It would be approximately 10 feet tall with a 20-foot toe depth (for a total height of 30 feet). The width and length of the structure would be 8 feet and 1,100 feet, respectively. Riprap would be placed on the downstream end to prevent erosion. Figure 35 shows the longitudinal profile of the Salt River with the structure.

Figure 35. Longitudinal Profile of Salt River Main Channel with Grade Control Structure



Concerns initially raised over the long-term stability of the Alma School drop structure required additional hydraulic modeling. More than 20 feet of scour occurred between River Stations 2.10 and 2.29, where the headcut from previous sand and gravel mining activities migrated upstream to this grade control structure. In the hydraulic analysis (WEST; 2002), the grade control structure was determined to remain intact throughout the entire period of analysis, although the toedown depth of the grade control structure is less than the computed scour depth at this location. While this analysis indicates that the grade control structure could fail under certain conditions, current designs submitted to modify the existing structure by the Maricopa County Department of Transportation indicate that solution of this problem is part of the future "without-project" condition, and this feature was therefore not included in any of the alternatives.

5.6.1.8 Buried Guide Dikes

Buried guide dikes would be used to control lateral migration of the low-flow channel under each alternative. Guide dikes are trapezoidal soil cement structures that would be constructed perpendicular to the low-flow channel, and below the grade of the existing channel invert. The guide dikes would have a top width of 5 feet, bottom width of 20 feet, and have an average length of 700 feet. The length of the guide dikes would depend on the position of the guide dikes with respect to the second terrace. The locations of the guide dikes are shown in Figure 36.

5.6.1.9 Bank Stabilization

Several areas require bank stabilization to stabilize the river, reduce erosion, and provide protection for newly-established vegetation. Four general bank stabilization measures are included in the alternatives: riprap, buried groins, bendway weirs (wingdams, groins), and soil cement. The bank stabilization locations are shown in Figure 37. Application of each stabilization measure depends upon the local hydraulic, scour, and deposition conditions and proximity to newly-restored areas.

Figure 36. Guide Dikes Locations

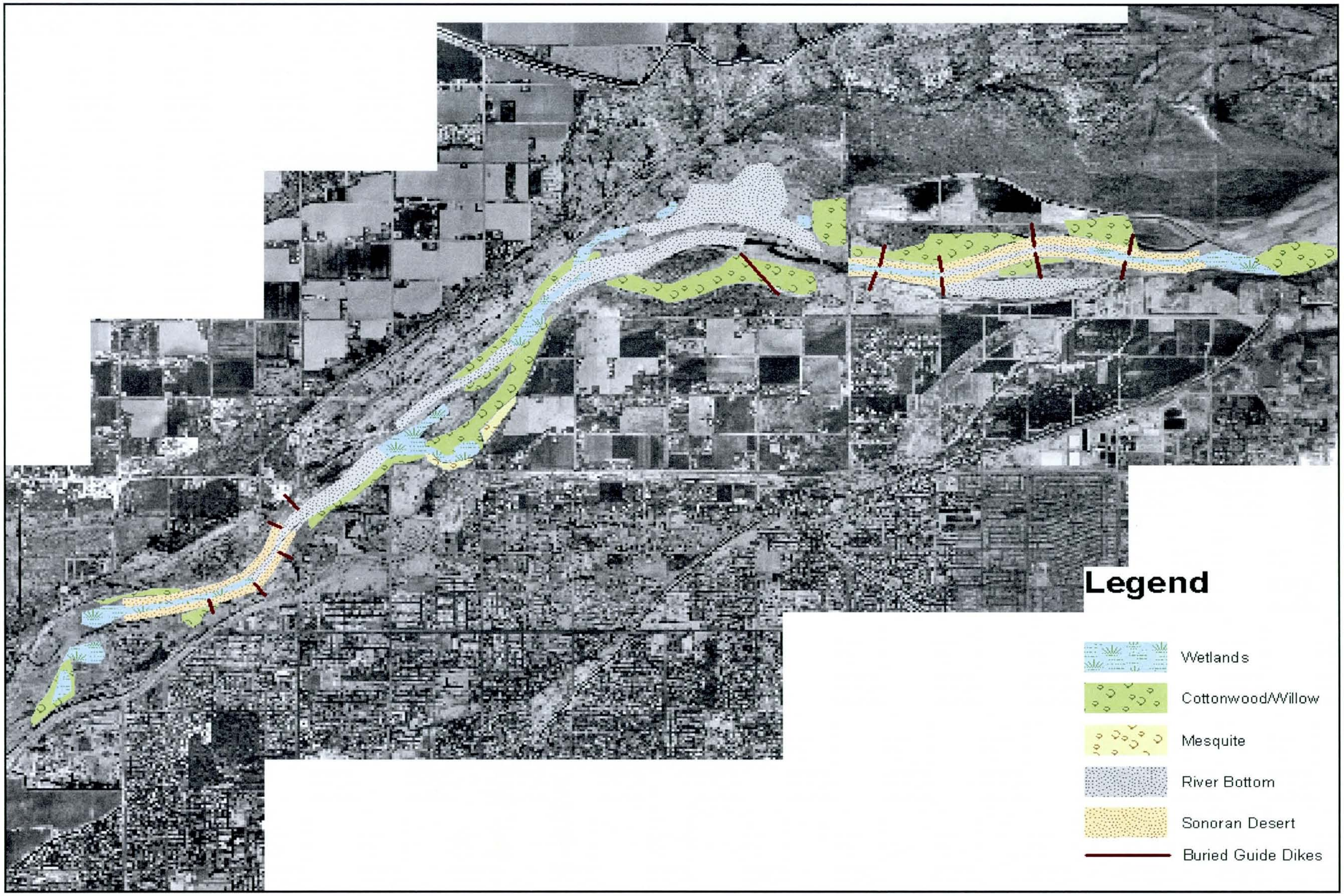
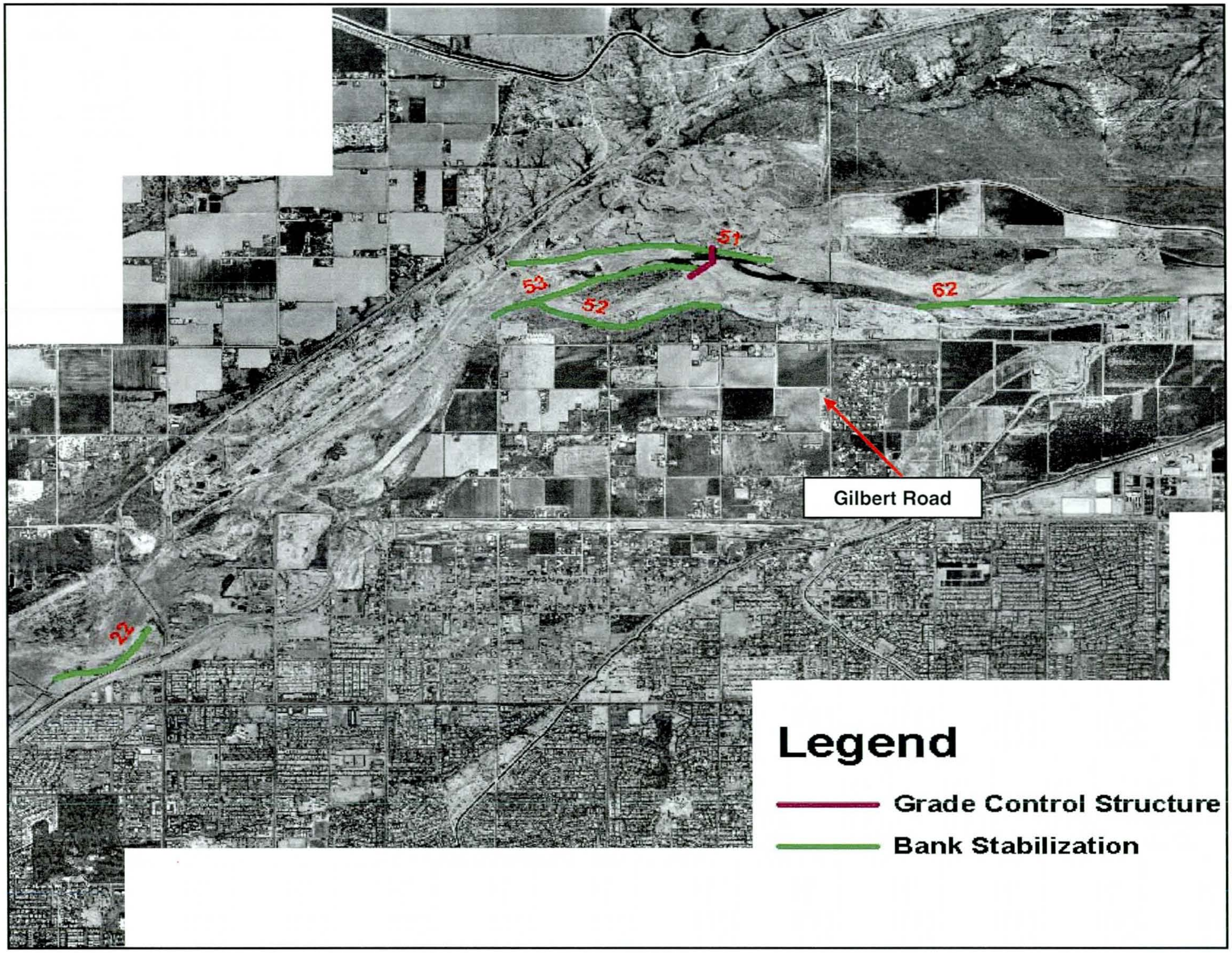


Figure 37. Channel Stabilization Locations



Locations 22, 51, 52, 53, and 62 include measures directed at channel stabilization.

- Location 22 would require channel stabilization measures along the south bank. This is necessitated by the geometry of the Salt River, which exhibits a 45-degree change in direction at this location. To prevent further southerly migration of the river, resulting in damage to proposed restoration features, protection of the south bank with soil cement, as shown on Figure 37, is recommended. The soil cement protection would be 3,000 feet long, 40 feet tall, and 6 feet deep.

(South bank soil cement protects the Fwy @ this location)

- Location 51 would require riprap and soil cement to stabilize this reach of channel. Because of the elevation difference between the main channel and the quarry pit invert, river migration is anticipated to move north into the quarry pit. As mentioned above, this lack of stabilization measures would result in headcut migration, extending upstream through an area of newly-restored habitat. Implementation of this measure would provide incidental benefit to the Gilbert Road Bridge (WEST, 2002)

  On-going headcutting would affect project features downstream. To ensure that this does not occur, the quarry would be reshaped. Guide channels/spillways would be constructed to control water flow into and out of the quarry area. The reconnection of surface water sources to the quarry would increase river bottom habitat, and provide more suitable conditions to establish CW, SD, and MS. It may also provide incidental benefits from groundwater recharge. The soil cement structure would be 6,500 feet long, 30 feet tall, and 6 feet deep.

- Location 52 would require channel stabilization measures due to on-going migration of the channel into important restoration areas. Location 52 is sited along the south bank of Reach 5 extending from just downstream of Gilbert Road to Lehi Cemetery. Although Lehi Cemetery is a culturally sensitive area currently threatened by river migration, it is also the site of several project features in certain alternatives. To prevent impacts to newly-established vegetated areas, buried guide dikes and cottonwood and other dense riparian vegetation would be established to potentially reduce shear stresses along the south bank. The structure would be 5,000 feet long, 30 feet tall, and 6 feet deep.

- Location 53 would be necessary to stabilize the channel at this location. The soil cement structure would be 5,500 feet long, 30 feet tall, and 6 feet deep.

- Location 62 would require channel stabilization measures along the south bank in Reach 6. An abandoned quarry on the south bank, with a maximum depth below riverbed of 50 feet, is oriented so that the quarry pit could encourage the river to be redirected south into the pit, causing bank erosion along the south bank and a headcut migration upstream and downstream of the quarry (WEST, 2002). The headcut would adversely affect any attempts at vegetation establishment within Reach 6 and may incidentally affect the Gilbert Road Bridge. This feature would require two measures to prevent this from occurring. First, the pit would be partially filled with material resulting from upstream channel enlargement activities. Second, the south bank of the river would be stabilized with soil cement north of the quarry.

Additional bank stabilization needed to stabilize segments of the river outside of those required for re-establishment of the ecosystem was not pursued.

5.6.1.10 Levee

@ 3 mile levee?

A levee measure was examined to potentially protect the Lehi area near Gilbert Road. The levee would need to be 15,000 feet long, extending from Reach 5 to Reach 6, and would be 6 feet high. However, a levee could not be economically justified due to the minimal damage resulting from a 100-year event, and only slightly more from a 500-year flood event.

5.6.1.11 Cultural Center

A cultural center, intended to provide SRPMIC members and visitors with information regarding the historic way of Pima-Maricopa Indian Community life, was examined as a potential component of a larger river restoration project. The exact location of a center has yet to be determined; however, it would be placed relatively close to the river, so that the river and its associated vegetation can be visually highlighted in the area surrounding the center. Materials historically and culturally important to the SRPMIC may be planted in the area surrounding the center, as well as highlighting the native river vegetation. It is understood that a cultural center may be implemented with no Federal cost-sharing.

5.6.2 Second Array of Alternatives

Table 37 presents a comparison of restoration features proposed in each alternative. The alternatives are described in detail in the sections following Table 37.

Table 37. Comparison of Second Array of Alternatives

Alternative	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reaches 8 & 9	Increase in AAFCUs	Water Sources	Water Demand
A	No activity	No activity	No activity	No activity	SD	SD	No activity	Invasive species removal	373	3 new irrigation diversion structures	992 ac-ft/yr
B	No activity	MS and SD	No activity	SD	MS and SD; spillway at the SRS&R Beeline One Plant	MS and SD	No activity	Same as Alt. A	594	5 new irrigation diversion structures; 1 new well	2,172 ac-ft/yr
C	No activity	CW, MS, and SD; wetland; bank stabilization	No activity	SD	SD, CW, and 2 small pockets of MS; SRS&R Beeline One Plant reshaped and converted to new river bottom	Two water distribution channels created; CW, MS, and SD	No activity	Same as Alt. A	771	6 new irrigation diversion structures	3,696 ac-ft/yr
D	No activity	No activity	No activity	CW, MS and SD; main channel reshaped and converted to new river bottom	SRS&R Beeline One Plant and main channel reshaped and converted to new river bottom; grade control structure; CW, MS, and a wetland feature	No activity	No activity	Same as Alt. A	573	6 new irrigation diversion structures; 1 new well	3,629 ac-ft/yr
E	CW; invasive species control	SD and CW; old quarry at Alma School Road converted to new river bottom; bank stabilization	No activity	MS	CW, MS, and SD; wetland created at the Evergreen Ditch outlet; main channel reshaped to allow for river bottom establishment and increase channel conveyance capacity	CW, MS, and SD	No activity	Same as Alt. A	917	7 new irrigation diversion structures;1 new well	4,540 ac-ft/yr
F	No activity	CW, MS, CW; bank stabilization for south bank between Country Club Road and Alma School Road	CW; channelization	MS, SD, CW	SRS&R Beeline One Plant reshaped and converted to river bottom; two spillways constructed; bank stabilization; CW, MS, and SD; grade control structure	CW and MS; wetland	No activity	Same as Alt. A	1,035	11 new irrigation diversion structures; 1 new well	8,304 ac-ft/yr
G	CW; invasive species control	Distribution channel; MS and SD; bank stabilization between Country Club Road and Alma School Road	Wetland, CW, and MS	CW, SD, and MS; main channel reshaped and seeded to reestablish river bottom	CW, MS, and SD; SRS&R Beeline One Plant reshaped and converted to new river bottom; spillway and low-flow channel	CW, MS, and SD; wetland	No activity	Same as Alt. A	943	9 new irrigation diversion structures; 1 new well	5,690 ac-ft/yr
H	No activity	Wetland; MS and SD; channel reshaped and seeded to create new river bottom; bank stabilization between Country Club Road and Alma School Road	Wetland, MS, and SD	MS and SD; main channel reshaped and reseeded to reestablish new river bottom	SRS&R Beeline One Plant and main channel reshaped and converted to new river bottom; MS, SD, and CW	MS and SD; wetland	No activity	Same as Alt. A	867	9 new irrigation diversion structures; 1 new well	4,032 ac-ft/yr

Alternative	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reaches 8 & 9	Increase in AAFCUs	Water Sources	Water Demand
I	No activity	SW and two wetland features; bank stabilization between Country Club Road and Alma School Road; buried dikes	Wetland	Wetland, CW, and MS	SRS&R Beeline One Plant reshaped and converted to new river bottom; CW and two wetlands; bank stabilization; grade control structure	Low-flow channel; CW and wetland; buried guide dikes	No activity	Same as Alt. A	661	9 new irrigation diversion structures	4,920 ac-ft/yr
J	No activity	Wetland, CW, and MS; bank stabilization between Country Club Road and Alma School Road	CW; abandoned quarry reshaped to establish new river bottom	MS, SD, CW, and wetland	SRS&R Beeline One Plant reshaped and converted to new river bottom; CW, MS, and SD; wetland; bank stabilization; main channel reshaped for river bottom establishment and increase channel conveyance capacity	CW, MS, and wetland	No activity	Same as Alt. A	872	11 new irrigation diversion structures; 1 new well	6,087 ac-ft/yr
K	No activity	Wetland, MS, and CW; bank stabilization between Country Club Road and Alma School Road	Wetland, CW, SD, and MS	MS, SD, and CW	CW, MS, SD, and wetlands	DW, MS, and wetland	No activity	Same as Alt. A	627	11 new irrigation diversion structures; 1 new well	6,304 ac-ft/yr
L	No activity	Wetland, CW, and MS; bank stabilization between Country Club Road and Alma School Road	No activity	CW, MS, and wetland	SRS&R Beeline One Plant reshaped and converted to new river bottom; CW, MS, and wetlands; grade control structure	CW, MS, and wetlands	No activity	Same as Alt. A	758	7 new irrigation diversion structures; 1 new well	5,602 ac-ft/yr
M	No activity	Wetlands, CW, and MS	Drainage channel constructed	MS, CW, SD, and wetlands	SRS&R Beeline One Plant reshaped and converted to new river bottom; wetlands, CW, and MS; grade control structure; bank stabilization	CW and wetlands	No activity	Same as Alt. A	829	11 new irrigation diversion structures; 1 new well	6,488 ac-ft/yr
N	CW	Wetlands, CW, and MS	Drainage channel constructed	CW, MS, and wetland	SRS&R Beeline One Plant reshaped and converted to new river bottom; CW, MS, SD, and wetland; grade control structure	CW and MS	No activity	Same as Alt. A	913	9 new irrigation diversion structures; 1 new well	7,736 ac-ft/yr
O	Wetlands and CW	Wetlands, CW, MS	Drainage channel constructed	CW, MS, and wetland	SRS&R Beeline One Plant reshaped and converted to new river bottom; CW, MS, and SD; grade control structure	CW, MS, and wetland	No activity	Same as Alt. A	963	9 new irrigation diversion structures; 1 new well	8,550 ac-ft/yr
P	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

5.6.2.1 Alternative A

Alternative A provides a vegetation plan that obligates the least amount of water; 992 acre-feet/year (Table 38). Sonoran desert scrub shrub, which is adapted to survive on relatively little rainfall, is the sole vegetation type planned. Scrub shrub establishment is limited to the areas between the Hennessey Drain and the eastern end of the Tri-City landfill. Limiting the size of vegetation establishment allows for a lower project cost. This also limits the potential net habitat value to 373 FCUs (Table 58). Mechanical features include reshaping of the SRS&R Beeline One Plant to increase the stability of the area to create new river bottom acreage. No structural features are proposed. The proposed restoration features in each reach are described below and are shown in Figure 38.

Reach 1

- No activity is planned for this reach. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- No activity is planned in this area.

Reach 3

- No activity is planned in this area.

Reach 4

- No activity is planned in this area.

Reach 5

- A new well drilled in Reach 6 would provide water to Sub-areas 5.1 and 5.2 for the SD in and around the new river bottom created by reshaping the SRS&R Beeline One Plant. The SD would be irrigated by a SBIN. It can also be supplemented by overland flow from water diverted from the Evergreen Drain during storm event.

- In Sub-area 5.3, on the western end of the south bank, a small area of SD would be established along the upland area. The SD would be irrigated with a SBIN using diverted surface water.

Reach 6

- Within Sub-area 6.1, SD would be planted on both the north and south side of the GRUSP site. The SD would be irrigated using a SBIN and water diverted from the Hennessey Drain. Because the vegetated areas are near the GRUSP site, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- In Sub-area 6.3, SD would be established at the Hennessey Drain, where the north and south GRUSP channels diverge. This area would be irrigated using a SBIN and/or flood irrigation. SRPMIC surface water from the Hennessey Drain would be used as a water source.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Three new irrigation diversion structures, no new WWTP diversion structure, and no new wells are proposed for this alternative.

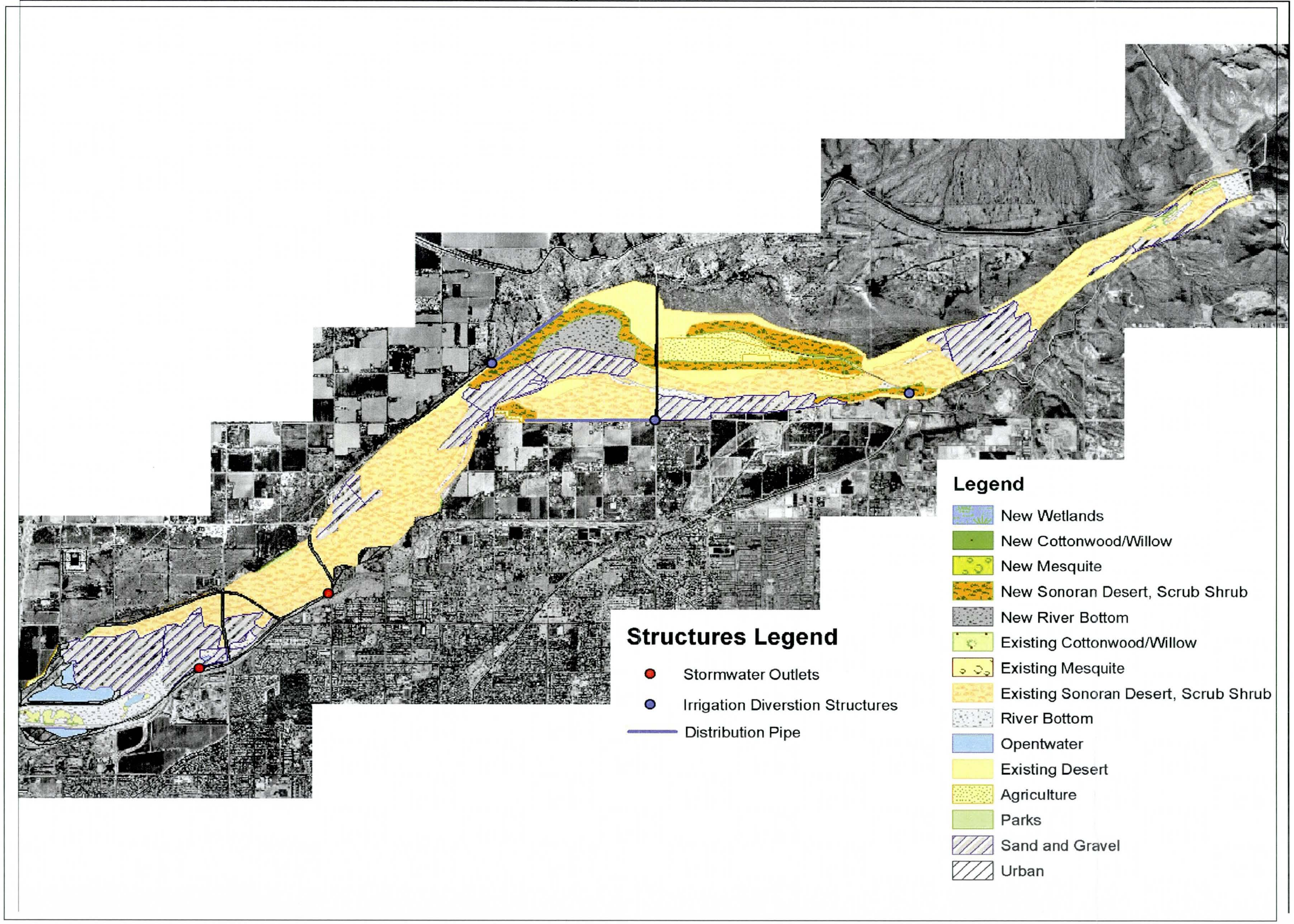
Water Demand

As presented in Table 38, the total annual evapotranspiration demand for Alternative A is 992 acre-feet.

Table 38. Vegetated Area and Evapotranspiration Rate – Alternative A

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	0	0
3	0	0
4	0	0
5	198	396
6	298	595
Total	**496**	**992**

Figure 38. Alternative A



5.6.2.2 Alternative B

Alternative B provided slightly more vegetation than Alternative A with an increase in the Sonoran desert scrub shrub including areas of mesquite. The water demand is still considerably lower relative to other alternatives at 2,172 acre-feet/year (Table 39). This alternative provides a net habitat value of 594 FCUs (Table 58). Vegetation establishment would be concentrated around SRS&R Beeline One Plant and the existing GRUSP site. However, the area around Hennessey Drain and a portion of the Tri-City landfill are also planned for vegetation establishment. Alternative B also proposes a single area of bank stabilization with a spillway at the SRS&R Beeline One Plant site. The area within the quarry would be reshaped and converted to new river bottom. The proposed restoration features in each reach are described below and are shown in Figure 39.

Reach 1

No activity is planned for this reach.

Reach 2

- Along the south bank in Sub-area 2.3, a small MS bosque and SD area would be constructed near the Country Club Storm Drain on the existing river bottom. The area would be located in a high-velocity area and would suffer damages during flow events every 3 years on average. However, these flow events would allow the transport of seeds further downstream, aiding establishment of new areas.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- No activity is planned in this area.

Reach 4

- Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, SD can be established. The area would be irrigated using surface water or stormwater redirected from the Evergreen Drain to the terrace via a SBIN.

Reach 5

- In Sub-areas 5.1 and 5.2, water diverted from the new groundwater well would irrigate the SD surrounding the new river bottom created by reshaping the SRS&R Beeline One Plant, as well as the small pocket of MS just west of Gilbert Road. Both the MS and SD would be irrigated by a SBIN. Some areas of vegetation can also be irrigated by overland flow from water diverted from the Evergreen Drain during storm events.

- To allow water into and out of the new river bottom within the SRS&R Beeline One Plant, a spillway would be constructed. The general shape of the spillway consists of a 200-foot bottom width trapezoidal structure, with a maximum depth of 10 feet, and 1:1 side slopes. A low-flow channel would be constructed in the spillway with a 40-foot bottom width, a maximum depth of 4 feet, and 1:3 side slopes. Riprap or soil cement would be placed on both sides of the structure to prevent scouring from occurring. The north bank would be armored using soil cement and/or riprap to increase conveyance in the north.

- In Sub-area 5.1, an MS bosque would be created on a terrace at the Evergreen Ditch outlet. The new groundwater well can be used for additional water, if necessary. The MS can be irrigated by a SBIN.

- In Sub-area 5.3, on the western end of the south bank, SD would be established along the upland area. The SD would be irrigated with a SBIN using diverted surface water.

Reach 6

- Within Sub-area 6.1, MS and SD would be planted both north and south of the GRUSP site, and MS and SD would be planted north of the GRUSP site. The vegetation planted to the north of the GRUSP site would be irrigated with groundwater extracted from a new well distributed with the SBIN. Surface water, also distributed using a SBIN, would be diverted from a new outlet to supply water to the vegetation south of the GRUSP site. Because the vegetated areas are near the GRUSP site, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed. A section of the distribution channel would be installed to extend the Hennessey Drain East to supply water to Sub-area 5.2.

- In Sub-area 6.3, MS and SD would be established at the Hennessey Drain outlet. These areas would be irrigated using a SBIN and/or flood irrigation. SRPMIC surface water from the Hennessey Drain would be used.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Four new irrigation diversion structures, one new WWTP diversion structure, and one new well are proposed for Alternative B.

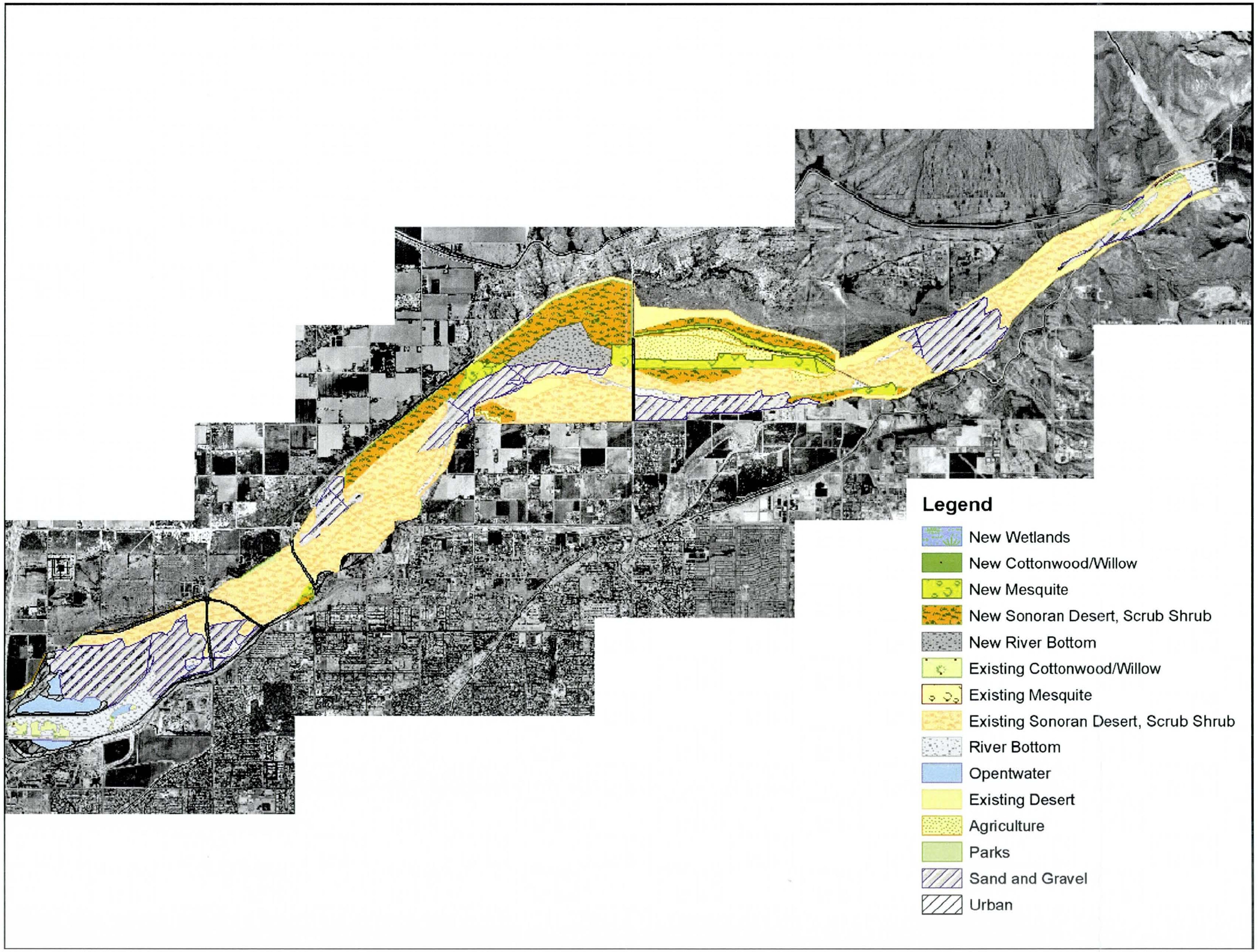
Water Demand

As shown in Table 39, the total annual evapotranspiration demand for Alternative B is 2,172 acre-feet.

Table 39. Vegetated Area and Evapotranspiration Rate – Alternative B

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	18	46
3	0	0
4	121	242
5	432	929
6	382	956
Total	**952**	**2,172**

Figure 39. Alternative B



5.6.2.3 Alternative C

Alternative C increases the vegetation establishment both in size and complexity. While Alternative C is dominated by Sonoran desert scrub shrub, areas of mesquite, cottonwood-willow, and wetlands are also created. While the inclusion of cottonwood-willow and wetland features increases the water demand to 3,696 acre-feet/year (Table 40), this alternative provides a net habitat value of 771 FCUs (Table 58). Vegetation planting extends from the Hennessey Drain to the western end of the Tri-City landfill, with two smaller areas of vegetation between County Club Road and Alma School Road. Alternative C also proposes two areas of bank stabilization. The SRS&R Beeline One Plant and portions of the main channel immediately downstream of the quarry would be reshaped and converted to new river bottom. The proposed restoration features are described below and are shown in Figure 40.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- A small wetland feature with CW, MS, and SD extending downstream would be created in Sub-area 2.3, near the Country Club Storm Drain. The wetland would be constructed near the drain on the existing river bottom and would need to withstand stormwater runoff. MWWTP water would be dispersed using the SBIN to the CW and MS. Stormwater would function as the secondary source of water.

- MWWTP water supports the small wetland feature created in Sub-area 2.2 at Alma School Road downstream of the old quarry. The wetland would support CW to the west and SD to the east, distributing water using a SBIN. The quarry would be reshaped to create new river bottom.

- Bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. Bank stabilization is necessary to prevent further erosion, which affects the newly established vegetation, and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

No activity is planned for this reach.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, SD could be established in this area. The area would be irrigated using surface and stormwater, distributed by a SBIN.
- No activity is planned for Sub-area 4.2.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to new river bottom in Sub-area 5.2. During high flow events, water would be allowed to spill into the area. No spillways or bank stabilization features are proposed. Sub-area 5.2 would support areas of SD, CW, and two small pockets of MS on the overbank area. All vegetation would be irrigated using surface water diverted from the north drainage channel, distributed using a SBIN.
- The main channel, extending into Sub-area 4.1, would also be reshaped to allow for the establishment of river bottom. Another alternative is to allow naturally occurring flow events to reshape the river bottom. The advantage of mechanical reshaping is to utilize material in the construction of proposed features.
- Sub-area 5.1 would support a wetland feature created at the Evergreen Ditch outlet with MS and CW, buffering it to the south, and SD, buffering it to the east and west. The wetland would need to be designed to handle storm flow and disperse storm water laterally. To disperse the storm water, side drains would be constructed to convey water during storm events. The vegetation would be irrigated using surface water and stormwater runoff using a SBIN.

- Sub-area 5.3, located along the south bank, would be vegetated with SD and a small pocket of MS found at the western edge that extends into Sub-area 6.2. The vegetation would be irrigated using surface water, distributed by a SBIN.

Reach 6

- Two water distribution channels would be created using SRP water originating from the Hennessey Drain. One would follow the north bank; the second would follow the south bank. These, supplemented by stormwater, would supply water to Sub-areas 6.1, 6.2, and 6.3.

- The north distribution channel flows through Sub-area 6.1, located on the north bank outside the 10-year floodplain. It would be flanked by CW, MS, and SD, irrigated with a SBIN, and constructed to expand the width of the vegetation areas. Because the vegetated areas are near the GRUSP, water that has infiltrated can also be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed. The south distribution channel, in Sub-area 6.2, would be flanked with CW, MS, and a small pocket of SD, just east of Gilbert Road. These vegetation stands would also be irrigated using surface water distributed using a SBIN. In order to vegetate the south bank, the quarry would need to be filled and reshaped. The southern bank at the quarry would then be stabilized. Soil cement is recommended.

- Sub-area 6.3 would have a wetland feature and would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW, taking advantage of the saturated soil conditions, and would be irrigated using a SBIN and/or flood irrigation. SRPMIC surface water from the Hennessey Drain would serve as the source of water.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Four new irrigation diversion structures, one new WWTP diversion structure, and no new wells are proposed for Alternative C.

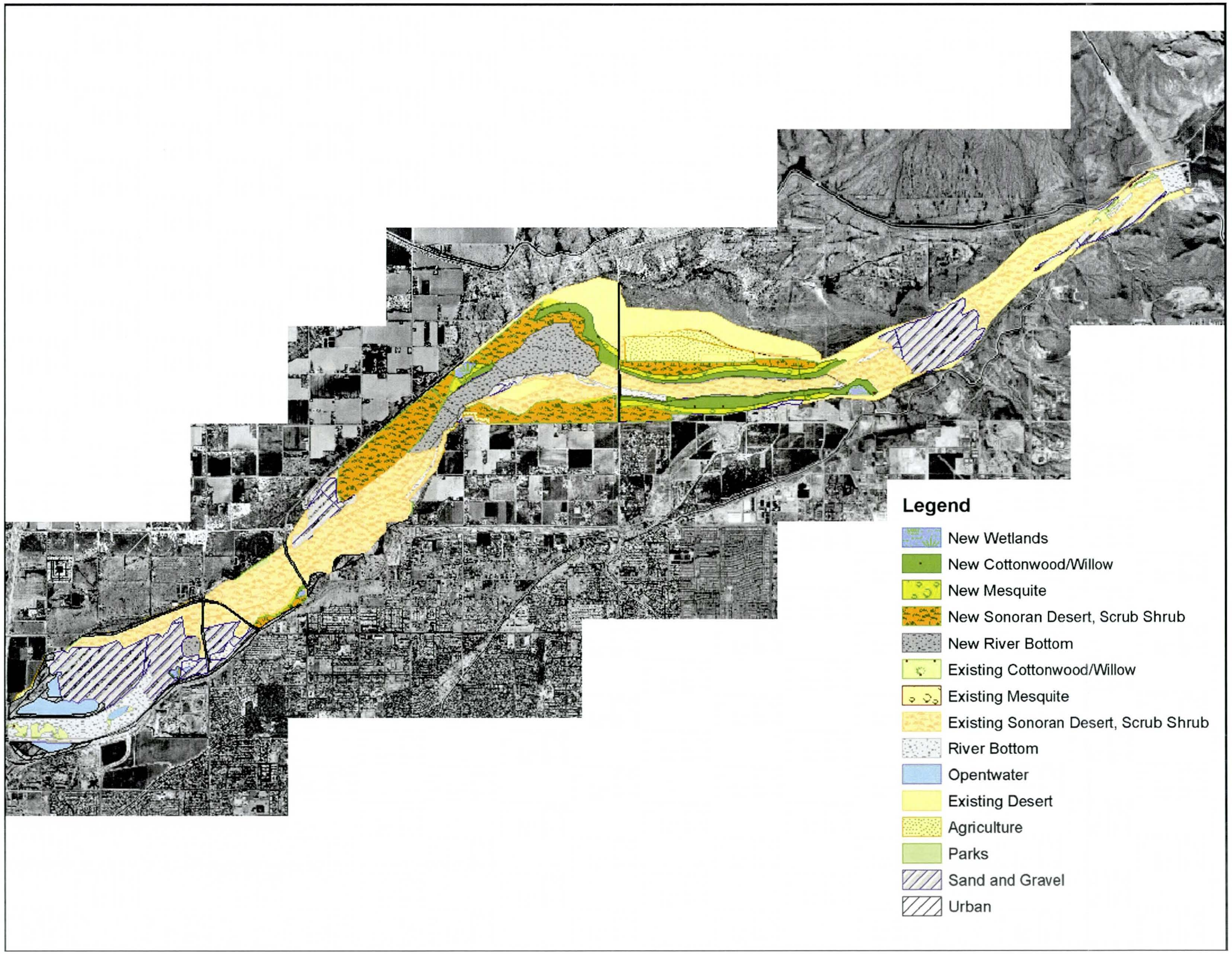
Water Demand

As presented in Table 40, the total annual evapotranspiration demand for Alternative C is 3,696 acre-feet.

Table 40. Vegetated Area and Evapotranspiration Rate – Alternative C

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	36	136
3	0	0
4	243	486
5	435	1,290
6	439	1,785
Total	**1,152**	**3,696**

Figure 40. Alternative C



5.6.2.4 Alternative D

Alternative D reduces the affected project area while still providing a complex vegetation plan. All project features fall between Gilbert Road and Country Club Road. A greater proportion of cottonwood-willow stands and wetlands are proposed, relative to the mesquite and Sonoran desert scrub shrub. Alternative D provides a net habitat value of 573 FCUs (Table 58). Although cottonwood-willow stands make up a larger proportion of the total vegetated areas, the water demand does not vary significantly from Alternative C due to the reduced project area. The water demand for this alternative is 3,629 acre-feet/year (Table 41). To create new river bottom acreage, the SRS&R Beeline One Plant would be reshaped along with portions of the main channel south and downstream of the quarry. Structural features would include two areas of bank stabilization. Both structures would help stabilize the area near the quarry. A grade control structure is also proposed near the quarry. The proposed restoration features in each reach are described below and are shown in Figure 41.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- No activity is planned for Reach 2.

Reach 3

- No activity is planned for Reach 3.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. MS and SD could be established in this area depending on water quality issues including potential leachate and methane production. The main channel would be reshaped and converted to new river bottom, with a wetland feature in the main channel and a small strip of CW on the northern edge of the main channel. The area would be irrigated using surface and storm water, distributed by a SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and an elongated wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant Pit would be reshaped and converted to river bottom in Sub-area 5.2. The north bank would be stabilized. Soil cement is recommended. CW and MS would be established to the north of the pit, on the overbank area. Both vegetation types would be irrigated using groundwater extracted from a new well. The water would be distributed using a SBIN.

- The main channel would be reshaped and converted to new river bottom. A grade control structure would also be placed in Sub-area 5.2, in the main channel at the center point of the SRS&R Beeline One Plant. This structure would help protect the channel and newly-restored riparian areas upstream from headcutting due to the extensive mining that has occurred downstream. The structure would span the entire width of the riverbed and be designed to the estimated scour depth.

- Immediately downstream from the grade control structure, an area of soil cement bank stabilization would begin and continue for approximately 5,500 feet. The structure would be 30 feet high and 6 feet deep, and would be used to offset erosion concerns due to mining that is occurring within the main channel, along the island located immediately south of the SRS&R Beeline One Plant.

- Sub-area 5.3, located along the south bank, would be vegetated with CW, MS, and a wetland feature. The wetland feature would be immediately west of Gilbert Road. The CW would buffer the wetland feature to the west, with MS buffering it to the south. Surface water and stormwater would be used to irrigate these areas, distributed by SBIN.

Reach 6

- No activity is planned for Reach 6.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Six new irrigation diversion structures, no new WWTP diversion structure, and one new well are proposed for Alternative D.

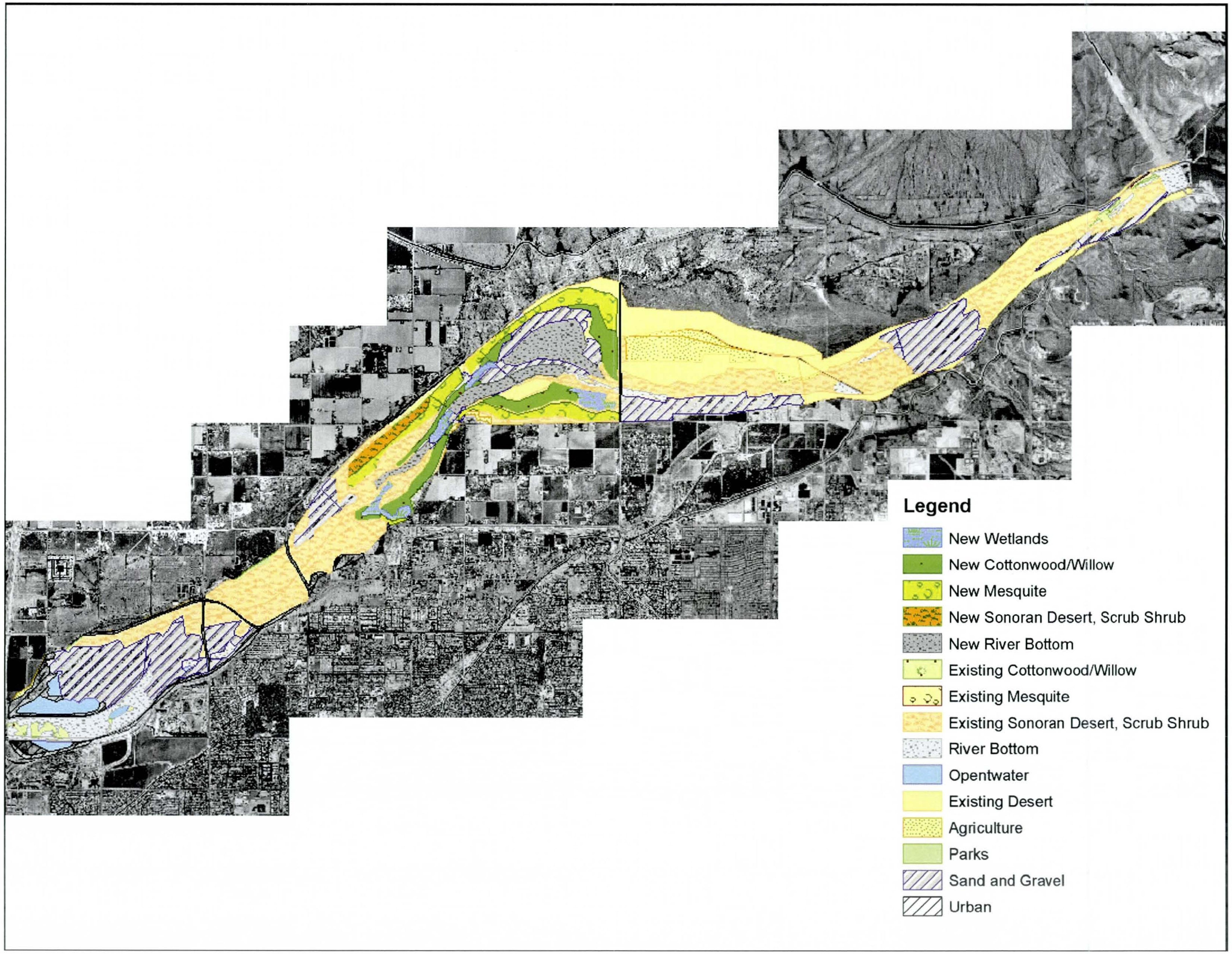
Water Demand

As presented in Table 41, the total annual evapotranspiration demand for Alternative D is 3,629 acre-feet.

Table 41. Vegetated Area and Evapotranspiration Rate – Alternative D

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	0	0
3	0	0
4	272	1,361
5	467	2,268
6	0	0
Total	**739**	**3,629**

Figure 41. Alternative D



5.6.2.5 Alternative E

Alternative E includes all four vegetation types: Sonoran desert scrub shrub, mesquite, cottonwood-willow, and wetlands. Most of the proposed vegetation would be located upstream and downstream of Gilbert Road. Sonoran desert scrub shrub dominates downstream of Gilbert Road while cottonwood-willow dominates upstream of Gilbert Road. The wetlands are limited to two drain outlets while mesquite dominates the Tri-City landfill. Because of the large and contiguous stand of cottonwood-willow planned, the water demand for this alternative increases to 4,540 acre-feet/year (Table 42). This alternative provides a net habitat value of 917 FCUs (Table 58). Three areas of bank stabilization are proposed. Reshaping in the SRS&R Beeline One Plant and portions of the main channel to create new river bottom is also proposed in Alternative D. The proposed restoration features are described below and are shown in Figure 42.

Reach 1

- Sub-area 1.2 is a recharge area on the south side of the river and would be converted to a CW stand. The irrigation system currently used for recharge purposes can be used or modified to irrigate the CW vegetation. The water source for this area would be MWWTP water.

- The only measure applied in the main channel of the river is the eradication of invasive vegetation species, if no threatened or endangered species are associated with them, followed by possible enhancement plantings to avoid reoccurrence of invasive plants. It is also important to ensure existing or a sufficient percentage of existing water currently discharging into the river along Reach 1 be maintained.

Reach 2

- In Sub-areas 2.1 and 2.2, between Country Club Road and Alma School Road along the north bank and within the channel, SD would be established and irrigated using a SBIN and surface water or MWWTP water. A wetland and small CW stand would also be established and irrigated using runoff from the golf course.

- Along the south bank, Sub-area 2.3, a wetland feature would be constructed near the Country Club Storm Drain on the existing river bottom. The wetland feature would need to withstand stormwater runoff. CW would be planted immediately adjacent to the wetland near a drainage channel. The area would be located in a high-velocity area and would suffer damages during flow events at an average of every three years. However, these flow events would allow the transport of seeds and vegetative propagules further downstream, aiding establishment of new areas.

- The old quarry at Alma School Road would be converted to new river bottom.
- Bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. Bank stabilization is necessary to prevent further erosion, which affects the newly established vegetation, and possible damage to Highway 202.
- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- No activity is planned in this area.

Reach 4

- Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, MS can be established. The area would be irrigated using surface water or stormwater redirected from the Evergreen Drain to the terrace via a SBIN. Local sponsors have expressed their interest in potentially creating a nursery in this area.

Reach 5

- The distribution from Reach 6 would continue downstream to Reach 5 Sub-area 5.2. The north distribution channel would provide water to CW plants, MS, and SD in and around the new river bottom created by reshaping the SRS&R Beeline One Plant. The MS and SD would be irrigated using a SBIN with groundwater from a new well as a source.

- Sub-area 5.1, which is predominantly wetland, would be created at the Evergreen Ditch outlet on a terrace. Groundwater from a new well can be used for additional water, if necessary. The wetland would need to be designed to handle storm flow and disperse storm water laterally. To disperse the storm water, side drains would be created and allowed to convey water during storm events. Irrigation of the CW and MS surrounding the wetland could be done by a SBIN.

- In Sub-area 5.3, on the south bank from Gilbert Road to Lehi Cemetery, SD would be established along the upland area. The SD would be irrigated with a SBIN using diverted surface water. Bank stabilization along this south bank is recommended to prevent erosion and the loss of newly established vegetation. Soil cement is recommended.

- The main channel would be reshaped to allow for the establishment of river bottom and to increase channel conveyance capacity. Another alternative is to allow naturally occurring flow events to reshape the river bottom. The advantage of mechanical reshaping is to utilize material in the construction of proposed features.

Reach 6

- SRP water currently flows from the Hennessey Drain to the GRUSP site via an existing drainage channel. The channel flows along the north side of the GRUSP site. The drainage channel would be extended past Gilbert Road to supply water to Sub-area 5.2.

- Within Sub-area 6.1, CW would be planted south of the GRUSP site, and MS and SD would be planted north of the GRUSP site. The CW would be irrigated using a SBIN. Water from the drainage channel would be diverted to the SBIN for CW use. MS and SD would be planted north of the drainage channel and irrigated using a SBIN and/or a drip system. Groundwater from a new well would be the source of water. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed. A section of distribution channel would be installed to extend the Hennessey Drain East to supply water to Sub-area 5.2.

- Sub-area 6.2, located on the south bank, would require reshaping of an old quarry and seeding to establish SD. MS would be planted upstream of the quarry outside of the 20-year floodplain. The area would be irrigated using a SBIN with water diverted from the Hennessey Drain. The south bank would be hard-banked with soil cement or coarse rock to prevent headcutting that could compromise the establishment of the vegetation.

- In Sub-area 6.3, at the GRUSP diversion, a wetland and CW area would be established. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW, taking advantage of the saturated soil conditions, and would be irrigated using a SBIN and/or flood irrigation. SRPMIC surface water from the Hennessey Drain would be used to irrigate this area.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Four new irrigation diversion structures, two new WWTP diversion structures, and one new well are proposed for Alternative E.

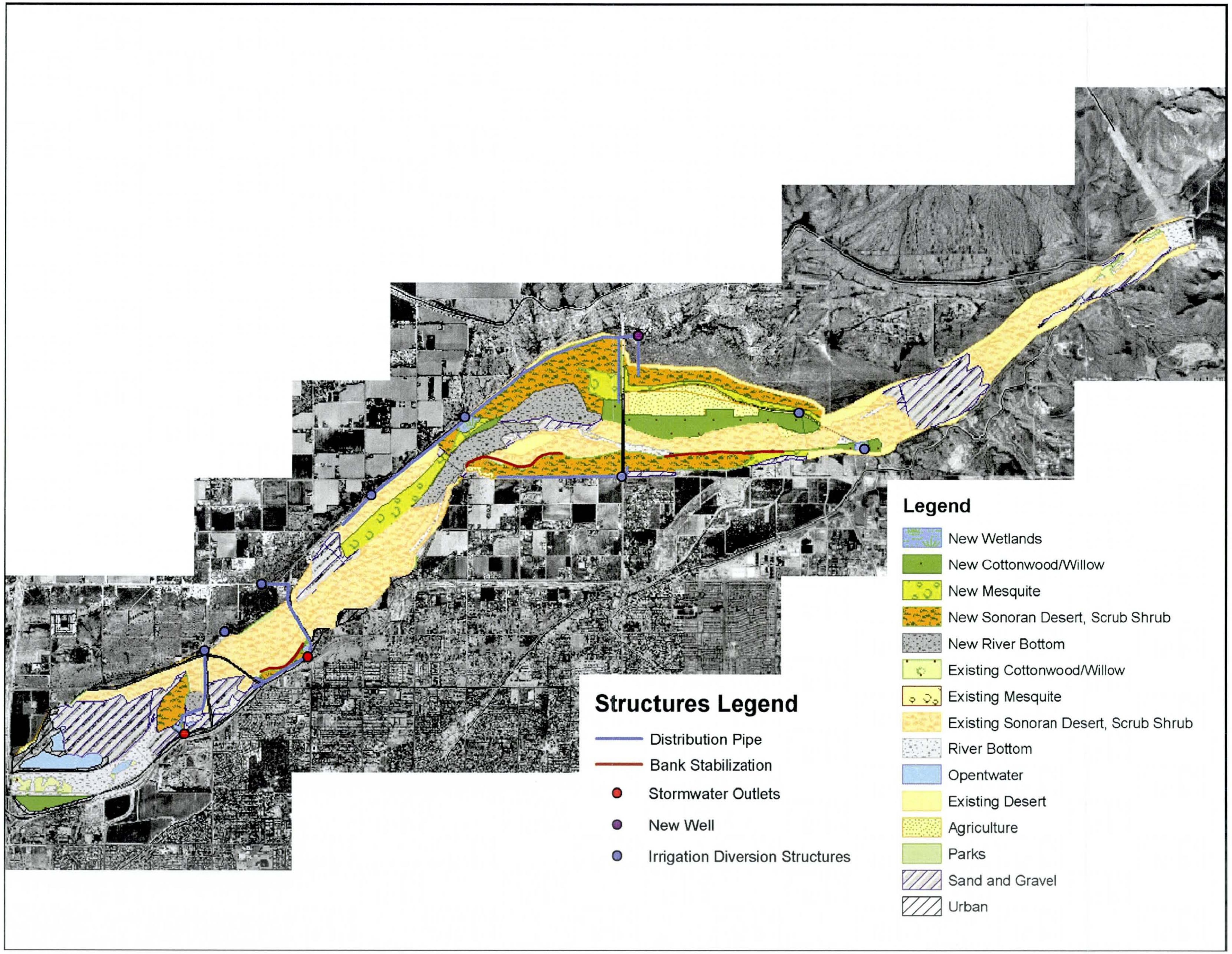
Water Demand

As presented in Table 42, the annual evapotranspiration demand for Alternative E is 4,540 acre-feet.

Table 42. Vegetated Area and Evapotranspiration Rate – Alternative E

Reach	Area (acres)	Evapotranspiration (ac-ft)
1	38	242
2	98	261
3	0	0
4	128	384
5	577	1,461
6	575	2,191
Total	**1,416**	**4,540**

Figure 42. Alternative E



5.6.2.6 Alternative F

Alternative F is the most expansive alternative. A low-flow channel would be created from Hennessey Drain down to Gilbert Road and from Country Club Road downstream to Alma School Road. The low-flow channel would support Sonoran desert scrub shrub and wetlands. However, cottonwood-willow would be the dominant vegetation type with sufficient acreage of mesquite. The water demand of this alternative is highest at 8,304 acre-feet/year (Table 43). However, Alternative F also produces the most net habitat value at 1,035 FCUs (Table 58). Four areas of bank stabilization are proposed. A grade control structure would also be placed near the SRS&R Beeline One Plant. Extensive reshaping of the quarry and portions of the main channel from Gilbert Road to Country Club Road would provide new river bottom. The proposed restoration features are described below and are shown in Figure 43.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by CW on the south side and MS on the north side. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by runoff from a golf course located north of the Salt River, if it is of sufficient quality. The channelized river would support an in-channel wetland in this area that would terminate with a larger wetland immediately downstream of Alma School Road.

- Along the south bank, Sub-area 2.3 would support a wetland feature, MS, and two small pockets of CW. A stand of CW would surround the wetland. A second stand begins in the eastern edge of Sub-area 2.3 and extends slightly into Sub-area 2.2. MWWTP water would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff. The wetland would be surrounded by CW and irrigated using a SBIN.

- Similar to Alternatives C and E, bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- A channel would be constructed to drain Reach 4.2 to supply water to the in-channel wetland and CW vegetation of Sub-area 3.1. Water would be dispersed to the CW using the SBIN.

- The river would also be channelized throughout Reach 3, connecting the low-flow channel in Reach 4 to one in Reach 2.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, MS, SD, and a small stand of CW could be established in this area. The area would be irrigated using surface water and stormwater by way of the SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and a wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently. The western wetland feature would also serve as an upstream starting point for a second reach of channelized river bottom supporting two wetland features within the channel and SD on the benches.

Reach 5

- The SRS&R Beeline One Plant Pit would be reshaped and converted to river bottom in Sub-area 5.2. Two spillways would be constructed to allow water flow into and out of the pit from the river. CW, MS, and SD would be located on the overbank area. The SD and MS would be irrigated using groundwater from a new well. The CW would be irrigated using surface water diverted from the North Drainage Channel. The water would be distributed using SBIN. The north bank would also be stabilized in this area. Soil cement is recommended.

- The channel in Sub-area 5.1 and the western half of Sub-area 5.3 would be reshaped and converted to river bottom. A wetland feature and MS would be established at Evergreen Drain. The MS would be irrigated using groundwater from the new well. The wetland would be supported by runoff from Evergreen Drain.

- Sub-area 5.3, located along the south bank, would be vegetated with CW and MS. Surface water and stormwater would be used to irrigate these areas. The south bank CW and MS would continue eastward, ending at Gilbert Road. The CW and MS would be irrigated with a SBIN.

- A grade control structure would be placed in Sub-area 5.2 in the main channel at the center point of the SRS&R Beeline One Plant. This structure would help protect the channel and newly-restored riparian area upstream from headcutting due to the extensive mining that has occurred downstream. The structure would span the entire width of the riverbed and be designed to the estimated scour depth.

Reach 6

- CW and MS would be established in Sub-area 6.1. The MS would be irrigated using surface water from the North Canal. The CW would be irrigated using surface water from the Hennessey Drain. For both areas, the water would be distributed using a SBIN or flood irrigation method. The MS is located on the north bank, immediately outside of the active channel, outside of the 10-year floodplain. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- In Sub-area 6.2, located on the south bank of the river, CW would be planted in an abandoned quarry depression directly east of Gilbert Road and within the 5-year floodplain, between a larger quarry and the channel. The area would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation. The larger quarry located further upstream along the south bank would be reconnected to the Salt River with two spillways. No reshaping is recommended due to the volume of material required to fill the quarry back to channel invert level. It is recommended that the south bank be armored to ensure that the quarry does not affect the current channel layout.

- Sub-area 6.3 would have a wetland feature, which would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW to the east, taking advantage of the saturated soil conditions, and would be irrigated using surface water from the Hennessey Drain and a SBIN or flood irrigation. The wetland would also serve as the upstream starting point of the low-flow channel. The larger wetland feature would narrow down to fit within the channelized portion of the river. The river channelization would continue downstream to approximately Gilbert Road, with two wetland features within the channel and SD on the benches – one at the eastern end and the other at the western end. Surface water from the Hennessey Drain would be used to irrigate the features.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Nine new irrigation diversion structures, two new WWTP diversion structures, and one new well are proposed for Alternative F.

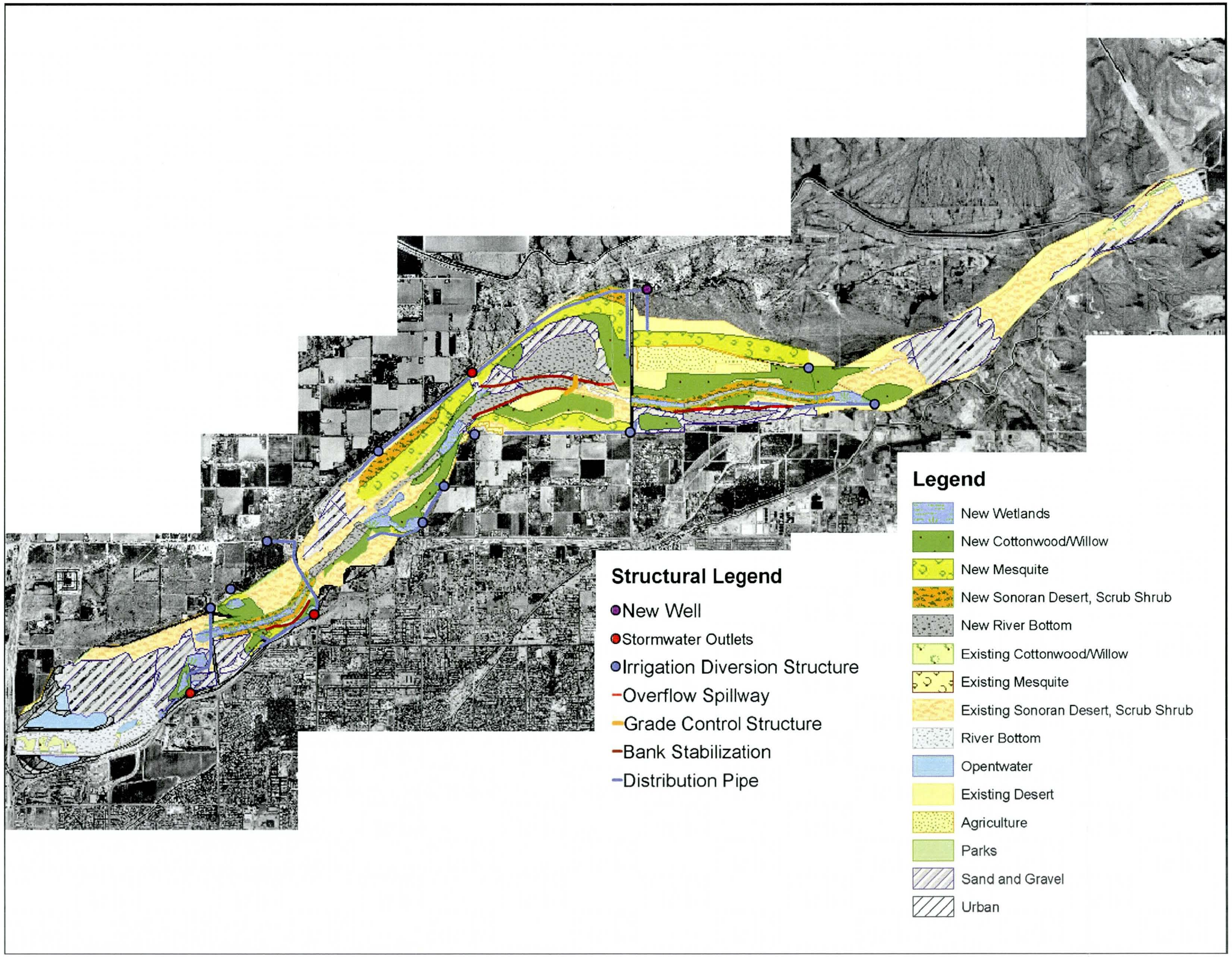
Water Demand

As presented in Table 43, the annual evapotranspiration demand for Alternative F is 8,304 acre-feet.

Table 43. Vegetated Area and Evapotranspiration Rate – Alternative F

Reach	Area (acres)	Evapotranspiration (ac-ft)
1	0	0
2	233	1,298
3	29	181
4	344	1,668
5	495	2,204
6	610	2,952
Total	**1,711**	**8,304**

Figure 43. Alternative F



5.6.2.7 Alternative G

Alternative G is similar to Alternative F. However, it does not have a low-flow channel, and some stands of cottonwood-willow are replaced with more xeric vegetation, decreasing the water demand to 5,690 acre-feet/year (Table 44). The vegetation plan, which is dominated by mesquite and cottonwood-willow, results in a net habitat value of 943 FCUs (Table 58). The SRS&R Beeline One Plant and portion of the main channel near Horne Street and Alma School Road would be reshaped to create new river bottom. Four areas of bank stabilization are planned for Alternative G. The proposed restoration features are described below and are shown in Figure 44.

Reach 1

- Sub-area 1.2 is a recharge area on the south side of the river, which would be converted to a CW stand. The irrigation system currently used for recharge purposes can be used or modified to irrigate the CW vegetation. The water source for this area would be MWWTP water.
- Similar to Alternative E, the only measure applied in the main channel of the river is the eradication of invasive vegetation species, followed by possible enhancement plantings to avoid reoccurrence of invasive plants. It would also be important to ensure existing water or a sufficient percentage of the existing water currently discharging into the river along Reach 1 be maintained.

Reach 2

- Sub-area 2.3 would be restored like Alternative E.
- A distribution channel would be constructed from the Country Club wetland and would extend downstream along the south bank. To supply water to the diversion channel, MWWTP water can be diverted from an existing line going north along Highway 202 at Country Club Road. A wetland feature would be created from Alma School Road downstream past the old quarry. The quarry would be converted into a dry lake. Water from the diversion channel would flow into these features and act as the water supply.
- On the south terrace, outside the 10-year floodplain, MS and SD would be established and irrigated using stormwater. The irrigation system would be a combination of flood irrigation and SBIN or drip system.

- The channel would be reshaped and seeded to create a new river bottom.

- Bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- Diversion channels from Reach 4 would converge and discharge remaining water into Sub-area 3.1, supporting a wetland feature and CW and MS vegetation. Water would be dispersed to the CW and MS using the SBIN. Additional water can come from groundwater wells, if necessary. Because no wells are in the vicinity, a new one may need to be constructed. Sub-area 3.1 is confined by a landfill (Old Tri City).

Reach 4

- The north diversion channel would continue downstream merging with the Evergreen Drain into Reach 4, Sub-area 4.1. The channel would now be located within the 10-year floodplain. To maintain the channel configuration, periodic rechannelization of the diversion channel would be required, on average, every three years. CW would be planted along both channels. To increase the CW width, a SBIN would be created. Water sources for the channel are the Evergreen Ditch and water from Reach 5. The CW would be susceptible to damage because the stands would be located in or near the main channel and would experience high velocities and shear stresses during flow events. However, these flood events would transport seed and vegetative propagules downstream, allowing for natural recruitment of new areas.

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, SD and MS can be established. The area would be irrigated using surface water or stormwater redirected from the Evergreen Drain to the terrace.

- The north diversion channel would split at the upstream boundary of Reach 4 and distribute water to Sub-area 4.2, the south bank outside of the main channel. The south channel would supply water to CW and a small mesquite stand. Again, a SBIN would be constructed to expand the CW stand along the drainage channel. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

- An upstream portion of the main channel would be reshaped and seeded to reestablish river bottom. Another alternative is to allow naturally occurring flow events to reshape the river bottom. The advantage of mechanical reshaping is to utilize material in the construction of proposed features.

Reach 5

- The north diversion channel from Reach 6 would continue downstream to Reach 5. The channel would provide water to CW and MS in and around a dry lake that would be created out of the SRS&R Beeline One Plant. Fill material would be required to raise portions of the quarry bottom to support MS plants. The MS and SD would be irrigated using surface water diverted from the North Drainage Channel, distributed using SBIN.

- The SRS&R Beeline One Plant would be reshaped and converted to river bottom. To allow water to flow into and out of the dry lake during high flow, four spillways would be constructed. The general shape of the spillway consists of a 100-foot bottom width trapezoidal structure, with a maximum depth of 8 feet and 1:1 side slopes. A low-flow channel would be constructed in the spillway with a 40-foot bottom width, a maximum depth of 4 feet, and 1:3 side slopes. Riprap or soil cement would be placed on both sides of the structure to prevent scouring from occurring. The north bank would be set back and armored using soil cement and/or riprap to increase conveyance in the north.

- Sub-area 5.1, predominantly wetland, would be created at the Evergreen Ditch outlet on a terrace. The wetland outlet would connect with the north diversion channel. Groundwater wells can be used for additional water, if necessary. The wetland would need to be designed to handle storm flow and disperse stormwater laterally. To disperse the stormwater, side drains would be constructed to convey water during storm events.

- Irrigation of the CW and MS surrounding the wetland could be done by a SBIN. The north diversion channel would continue downstream reconnecting to the Evergreen Ditch drain. Groundwater wells can be used for additional water, if necessary.

- The south diversion channel would extend downstream from Reach 6 to Sub-area 5.3. CW would be planted along the channel. MS would be planted along the south bank. Surface water would be used to irrigate the MS and SD, distributed with a SBIN.

- The main channel would be reshaped to allow for the establishment of river bottom and to increase channel conveyance capacity. Another alternative is to allow naturally occurring flow events to reshape the river bottom.

Reach 6

- SRPMIC surface water coming from the Hennessey Drain would be diverted to two diversion channels along the north and south banks. This, supplemented by stormwater and well water, would supply water to Sub-areas 6.1, 6.2, and 6.3.

- The north distribution channel flows through Sub-area 6.1, which is located on the north bank outside the 10-year floodplain. The CW would be irrigated using a SBIN supplied by the north diversion channel. The MS and some of the CW could be maintained using the saturated soil conditions located around the south side of the GRUSP site. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- Sub-area 6.2, located on the south bank, would have the south diversion channel flowing on a terrace. The channel invert elevation would be above the existing channel bed, outside the 10-year floodplain. CW would be planted along the channel, with SBIN constructed to expand the width of the CW and MS. SD would buffer the CW. In order to vegetate the south bank, the quarry needs to be filled and reshaped.

- In Sub-area 6.3, wetland features would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW, taking advantage of the saturated soil conditions, and would be irrigated using SBIN and/or flood irrigation. SRPMIC surface water from the Hennessey Drain would be used to irrigate this area.

Reach 7

- The proposed restoration effort for this alternative is identical to Alternative A.

Reaches 8 and 9

- The proposed restoration effort for this alternative is identical to Alternative A.

Water Sources

Seven new irrigation diversion structures, two new WWTP diversion structures, and one new well are proposed for Alternative G.

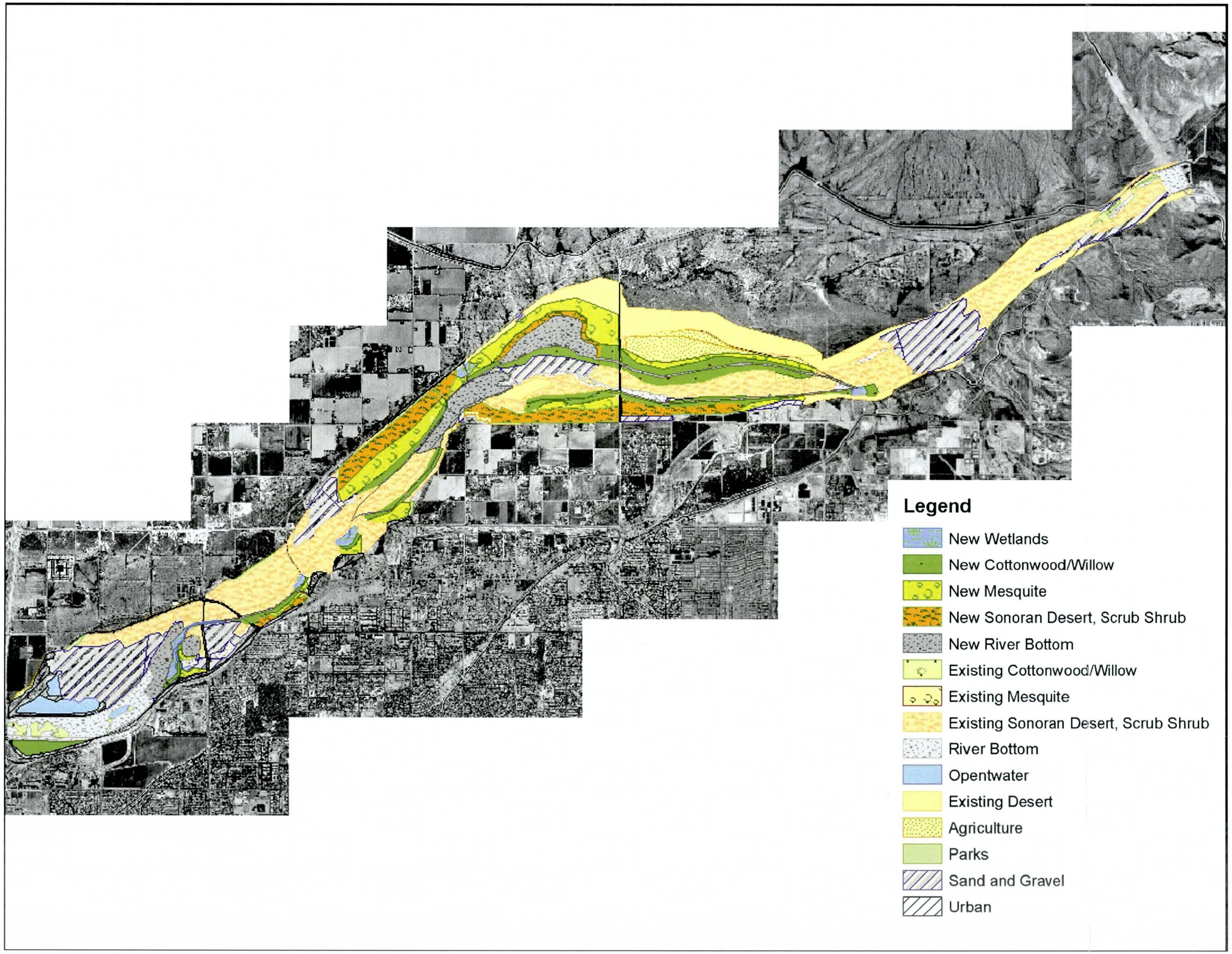
Water Demand

As presented in Table 44, the annual evapotranspiration demand for Alternative G is 5,690 acre-feet.

Table 44. Vegetated Area and Evapotranspiration Rate – Alternative G

Reach	Area (acres)	Evapotranspiration (ac-ft)
1	37	234
2	101	554
3	31	207
4	327	1,083
5	519	1,840
6	368	1,773
Total	**1,383**	**5,690**

Figure 44. Alternative G



5.6.2.8 Alternative H

Alternative H keeps the amount of vegetated areas high but replaces all of the cottonwood-willow stands with mesquite. The other acreages are dominated by Sonoran desert scrub shrub with small areas of wetlands. Because of the drier vegetation, the water demand is 4,032 acre-feet/year (Table 45), which is relatively low given the amount of vegetated area. This alternative provides a net habitat value of 850 FCUs (Table 58), reflecting the high habitat value of mesquite. Alternative H has four areas of bank stabilization with one spillway at the SRS&R Beeline One Plant stabilization site. The SRS&R Beeline One Plant and two relatively large sections of the main channel would also be reshaped to create new river bottom. The proposed restoration features are described below and are shown in Figure 45.

Reach 1

- No activity is planned is this reach. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Along the south bank, Sub-area 2.3, a wetland feature would be constructed near the Country Club Storm Drain on the existing river bottom. The wetland feature would need to be able to withstand stormwater runoff. It appears that the wetland area is protected from main channel flow. MS would be planted on the south bank along a drainage channel and would be buffered to the south by SD. The area would be located in a high-velocity area and would suffer damages during flow events, on average, every three years. However, these flow events would allow the transport of seeds and vegetative propagules further downstream, aiding establishment of new areas.

- Similar to Alternative G, a distribution channel would be constructed from the Country Club wetland and would extend downstream along the south bank. To supply water to the drainage channel, MWWTP water can be diverted from an existing line going north along Highway 202 at Country Club Road. A wetland feature would be created from Alma School Road downstream past the old quarry. The quarry would be converted into a dry lake. Water from the diversion channel would flow into these features and act as the water supply.

- On the south terrace, outside the 10-year floodplain, MS would be established and irrigated using stormwater and MWWTP water. The irrigation system would be a combination of flood irrigation and SBIN or drip system.

- The channel would be reshaped and seeded to create a new river bottom.

- Bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- Distribution channels from Reach 4 would converge and discharge the remaining water into Sub-area 3.1, supporting a wetland feature and a small area of MS and SD vegetation. Water would be dispersed using the SBIN to both.

- Sub-area 3.1 is confined by a landfill (Old Tri-City) and would not be planted.

Reach 4

- The north distribution channel would continue downstream merging with the Evergreen Drain into Reach 4, Sub-area 4.1. The channel would now be located within the 10-year floodplain. To maintain the channel configuration, periodic rechannelization of the diversion channel would be required, on average, every three years. MS would be planted along the channels. To increase the MS width, a SBIN would be created. Water sources for the channel are the Evergreen Ditch and water from Reach 5. The MS would be susceptible to damage because the stands would be located in or near the main channel and would experience high velocities and shear stresses during flow events.

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, SD and MS can be established. The area would be irrigated using surface water or stormwater redirected from the Evergreen Drain to the terrace.

- The north distribution channel would split at the upstream boundary of Reach 4 and distribute water to Sub-area 4.2, the south bank outside of the main channel. The south channel would supply water to MS. Again, SBIN would be constructed to expand the MS stand along the diversion channel. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

- An upstream portion of the main channel would be reshaped and seeded to reestablish river bottom. Another alternative is to allow naturally occurring flow events to reshape the river bottom.

Reach 5

- In Sub-area 5.2, the SRS&R Beeline One Plant would be reshaped and converted to river bottom. To allow water to flow into and out of the dry lake during high flow, four spillways would be constructed. The general shape of the spillway consists of a 100-foot bottom width trapezoidal structure, with a maximum depth of 8 feet and 1:1 side slopes. A low-flow channel would be constructed in the spillway with a 40-foot bottom width, a maximum depth of 4 feet, and 1:3 side slopes. Riprap or soil cement would be placed on both sides of the structure to prevent scouring from occurring. The north bank would be set back and armored using soil cement and/or riprap to increase conveyance in the north.

- The north distribution channel from Reach 6 would continue downstream to Reach 5. The channel would provide water to MS on the southern side of the abandoned SRS&R Beeline One Plant pit. Groundwater from a new well would provide water to MS around the north side of the SRS&R Beeline One Plant. Fill material would be required to raise portions of the quarry bottom to support MS plants. In Sub-Area 5.2, MS can also be irrigated by overland flow from water diverted from Evergreen Drain during storm events, as a supplemental source.

- Sub-area 5.1, which is predominantly wetland, would be created at the Evergreen Drain outlet on a terrace. The wetland outlet would connect with the north distribution channel. Groundwater from the new well can be used as a supplemental source of water, if necessary. The wetland would need to be designed to handle storm flow and disperse stormwater laterally. To disperse the stormwater, side drains would be constructed to convey water during storm events. MS and a small area of CW would be established around the wetland. These areas would be irrigated by a SBIN. The north distribution channel would continue downstream reconnecting to Evergreen Drain.

- The south distribution channel would extend downstream from Reach 6 to Sub-area 5.3. MS would be planted along the channel. Surface water would be used to irrigate the MS, distributed with a SBIN. SD would be established along the upland area; the SD would also be irrigated by a SBIN. Bank stabilization along this southern bank is recommended to prevent erosion and the loss of newly-established vegetation. Soil cement is recommended.

- The main channel would be reshaped to allow for establishment of river bottom and to increase channel conveyance capacity. Another alternative is to allow naturally occurring flow events to reshape the river bottom.

Reach 6

- SRPMIC surface water coming from Hennessey Drain would be diverted to two channels along the north and south banks. This, supplemented by stormwater, would supply water to Sub-areas 6.1, 6.2, and 6.3.

- The north distribution channel flows through Sub-area 6.1, located on the north bank outside the 10-year floodplain. MS would be established and would be irrigated using a SBIN. The MS areas could also be maintained using the saturated soil conditions located around the south side of the GRUSP site. Because the vegetated area is near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- Sub-area 6.2, located on the south bank, would have the south diversion channel flowing on a terrace. The channel invert elevation would be above the existing channel bed, outside the 10-year floodplain. MS would be planted along the channel, with a SBIN constructed to expand the width of the MS. SD would buffer the MS. In order to vegetate the south bank, the quarry would need to be filled and reshaped. The southern bank at the quarry would be stabilized. Soil cement is recommended.

- In Sub-area 6.3, a wetland feature would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland, which would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. Water from Hennessey Drain would be diverted to this area. MS would surround the wetland taking advantage of the saturated soil conditions. It would be irrigated using a SBIN and/or flood irrigation using SRPMIC surface water from Hennessey Drain as source.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Eight new irrigation diversion structures, two new WWTP diversion structures, and one new well are proposed for Alternative H.

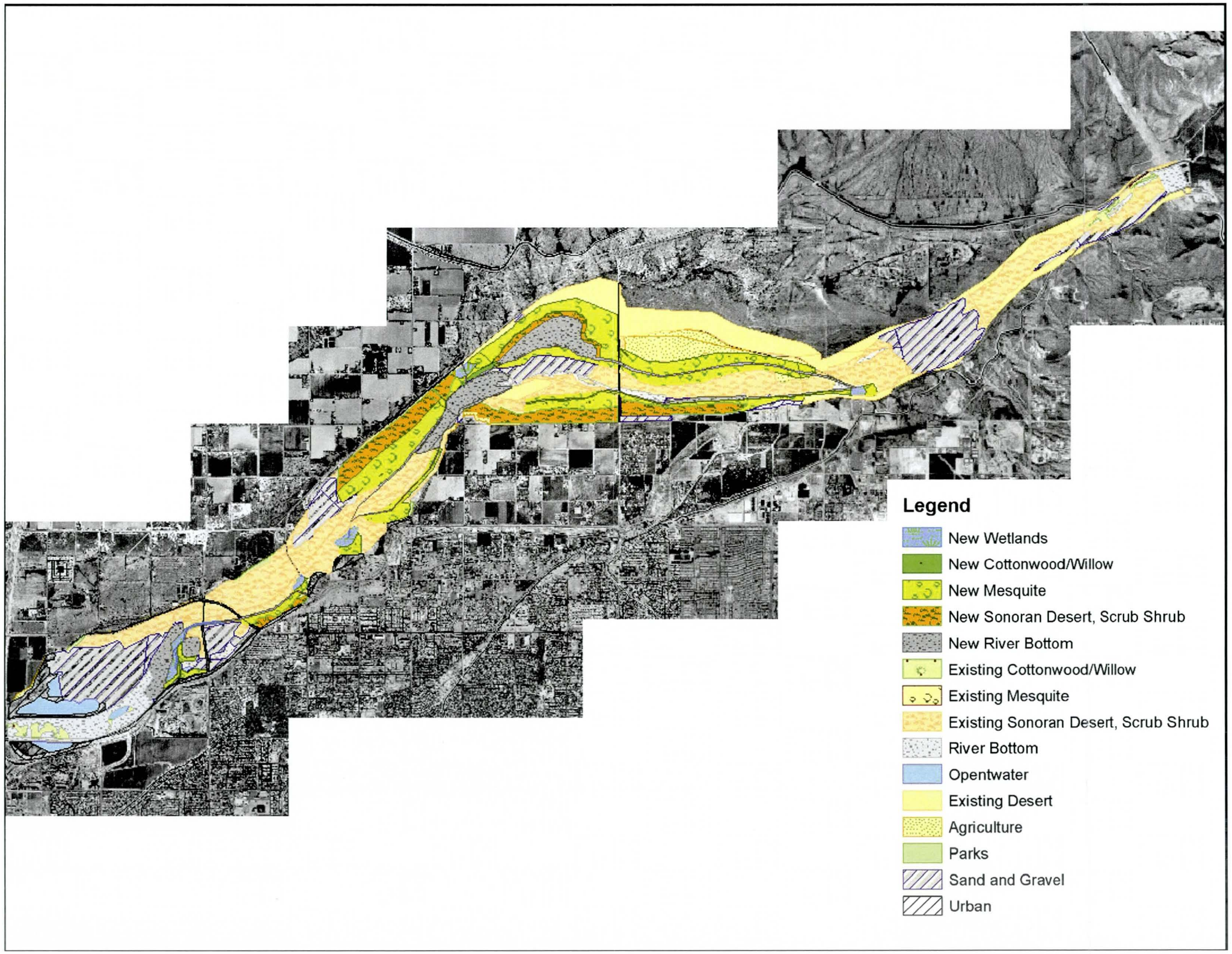
Water Demand

As presented in Table 45, the annual evapotranspiration demand for Alternative H is 4,032 acre-feet.

Table 45. Vegetated Area and Evapotranspiration Rate – Alternative H

Reach	Area (acres)	Evapotranspiration (ac-ft)
1	0	0
2	101	463
3	32	190
4	328	865
5	520	1.471
6	358	1.043
Total	**1,338**	**4.032**

Figure 45. Alternative H



5.6.2.9 Alternative I

Alternative I places all vegetation within the main channel and is dominated by cottonwood-willow, with some areas of wetlands and Sonoran desert scrub shrub. A low-flow channel would be constructed from Hennessey Drain downstream to Gilbert Road and from approximately Country Club Road downstream to Alma School Road. Sonoran scrub shrub sits on the benches of the low-flow channel and wetlands are housed within it. This alternative provides a net habitat value of 675 FCUs (Table 58), and the water demand is 4,920 acre-feet/year (Table 46). There are several structures within this alternative: four areas of bank stabilization, guide dikes to control water flow and protect areas of the river channel, and a grade control structure for ensuring minimization of incision and provision of stability to the channel and riparian area upstream. The proposed restoration features are described below and are shown in Figure 46.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a small strip of CW buffering the low-flow channel on the north side of the riverbank. An in-channel wetland feature in Sub-area 2.1 would serve as the termination point of the low-flow channel. Sub-area 2.3 would support a small CW stand on the south side of the riverbank. MWWTP effluent would be used to support the vegetation.

- MWWTP effluent would support two wetland features created in Sub-area 2.2 at Alma School Road downstream of and within the old quarry. The downstream wetland would be surrounded by CW and irrigated using a SBIN.

- Like the other alternatives, bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Buried guide dikes may need to be constructed in the overbank area throughout Sub-area 2.2 and Sub-area 2.4 perpendicular to the thalweg. The groins would act as a lateral control to prevent excess migration of the low-flow channel. Exact locations of the guide walls have yet to be determined.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- Sub-area 3.1 would support a wetland feature that would mark the upstream segment of the low-flow channel that would be constructed from Sub-area 3 to Alma School Road in Sub-area 2.2. A strip of CW would buffer the channel on the south side of the riverbank.

Reach 4

- Sub-area 4.1 would support an in-channel wetland with a strip of CW to the north and west. The wetland would be within the low-flow channel and constructed to maintain the surface water level. The CW would be irrigated with surface water redirected from a surface water outlet, distributed using flood irrigation or a SBIN.

- Sub-area 4.2 would support CW, MS, and a wetland feature. Two surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and irrigation system would occur less frequently.

Reach 5

- In Sub-area 5.2, the SRS&R Beeline One Plant Pit would be reshaped and converted to river bottom. The north bank would be set back and armored using soil cement and/or riprap to increase conveyance to the north. A stand of CW and two small wetlands would also be established on the overbank area at Gilbert Road. These would be irrigated using groundwater diverted from the new well in Sub-area 6.1. The water would be distributed using a SBIN.

- The main channel would be reshaped and converted to new river bottom, beginning at the midpoint of SRS&R Beeline One Plant and ending at the downstream end of Sub-area 4.1. An area of soil cement bank stabilization would also begin at the mid-point of the SRS&R Beeline One Plant, on the south side of the channel, and continue for approximately 5,500 feet downstream. The structure would be 30 feet high and 6 feet deep and would be used to offset erosion concerns due to mining occurring within the main channel along the island located immediately south of the quarry.

- A grade control structure would help reduce the upstream headcut migration and stabilize the river system improving the likelihood of success of vegetation established upstream and downstream. The grade control structure would need to span the entire width of the riverbed and be designed to the estimated scour depth. The structure would be 8 feet deep, 10 feet high with a 20-foot toe depth (total height of 30 feet), and 1,100 feet long. Riprap would be placed on the downstream end to prevent erosion.

- Sub-area 5.3, located along the south bank, would be vegetated with CW. Surface water and stormwater would be used to irrigate this area, distributed using flood irrigation or a SBIN.

Reach 6

- A low-flow channel would be constructed beginning just downstream of Hennessey Drain and ending at Gilbert Road through Sub-areas 6.1, 6.2, and 6.3. The low-flow channel would have a bottom width of approximately 200 feet, 1V:3H side slopes, and a depth of 4 to 8 feet. This would increase conveyance to offset the decrease in conveyance due to the establishment of vegetation in the riverbed. The low-flow channel would contain two wetland features: one in Sub-area 6.3 where the low-flow channel begins, the other at the western edge of Sub-area 6.2, at Gilbert Road, where the low-flow channel ends. The low-flow channel would be buffered on both sides by SD, which would be planted on the benches created just outside of the low-flow channel.

- Two pockets of CW would be established in Sub-area 6.1: one at the eastern edge and the other at the western edge. Both CW pockets would fall immediately outside of the 5-year floodplain. The CW would be irrigated using surface water from Hennessey Drain. The water would be distributed using a flood irrigation method or the SBIN. In the center of Sub-area 6.2, located on the south bank of the river, a small pocket of CW would be established. This would be irrigated using surface water and stormwater when available, distributed by flood irrigation or a SBIN. Just south of the CW stand, the quarry pit would be reshaped and converted to new river bottom. To protect the new vegetation, the south bank would be stabilized using soil cement.

- Sub-area 6.3 would have a wetland feature bordered by CW to the east. The wetland would be constructed on the riverbed, near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. This wetland would also serve as the furthest upstream point of the low-flow channel. The CW would be irrigated by SRPMIC surface water from Hennessey Drain.

- Buried guide dikes may need to be constructed in the overbank area throughout Sub-areas 6.2 and 6.3, perpendicular to the thalweg. The groins would act as lateral control to prevent excess migration of the low-flow channel. Exact locations of the guide walls have yet to be determined.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Six new irrigation diversion structures, two new WWTP diversion structures, and no new wells are proposed for this alternative.

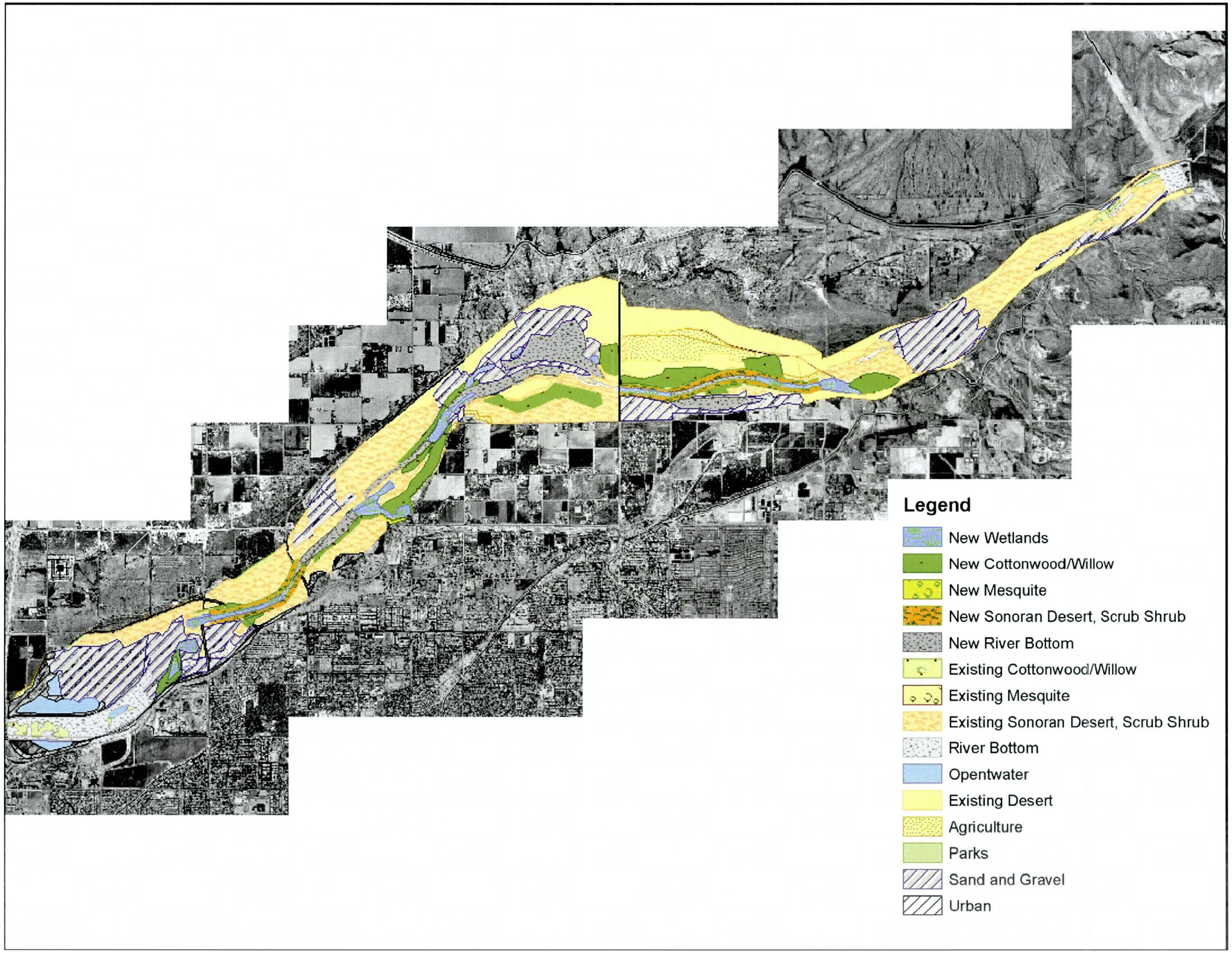
Water Demand

As presented in Table 46, the total annual evapotranspiration rate for Alternative I is 4,920 acre-feet.

Table 46. Vegetated Area and Evapotranspiration Rate – Alternative I

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	156	853
3	17	105
4	168	1,204
5	164	1,103
6	314	1,656
Total	**819**	**4,920**

Figure 46. Alternative I



5.6.2.10 Alternative J

Alternative J has several large stands of cottonwood-willow and mesquite, with smaller areas of Sonoran desert scrub shrub and wetlands. The high proportion of cottonwood-willow increases the water demand to 6,087 acre-feet/year (Table 47). Alternative J provides a net habitat value of 872 FCUs (Table 58). There are three areas of bank stabilization with a single spillway in the stabilization area at SRS&R Beeline One Plant. Five areas (three quarries and two areas within the main channel) would be reshaped to create new river bottom. The proposed restoration features are described below and are shown in Figure 47.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by CW on the south side and MS on the north side. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by runoff from a golf course located north of the Salt River, if it is of sufficient quality.

- Along the south bank, Sub-area 2.3 would support a wetland feature, MS, and two small pockets of CW. A stand of CW would surround the wetland. Another stand would start in the eastern edge of Sub-area 2.3 and extend slightly into Sub-area 2.2. MWWTP effluent would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- MWWTP effluent would also support the wetland feature created in Sub-area 2.2 at Alma School Road downstream of the old quarry. The wetland would be surrounded by CW and irrigated using a SBIN. The quarry would be reshaped to create new river bottom.

- Like the other alternatives, bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the EST (2002) report presents a conservative estimate of future conditions.

Reach 3

- A drainage channel would be constructed to drain Reach 4.2 to supply water into the wetland and CW vegetation of Sub-area 3.1. Water would be dispersed to the CW using the SBIN. The abandoned quarry would be reshaped in the main channel to establish new river bottom.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, which is the site of an old landfill. Depending on water quality issues including potential leachate and methane production, MS and SD could be established in this area. The area would be irrigated using surface water and stormwater, distributed by a SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and a wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to it and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to new river bottom in Sub-area 5.2 The quarry pit would have CW, MS, and SD established to the north and east, located on the overbank area. All three vegetation types would be irrigated using groundwater diverted from the new well in Sub-area 6.1. The water would be distributed using a SBIN.

- Sub-area 5.3, located along the south bank, would be vegetated with CW, MS, and a wetland feature at Gilbert Road. Surface water and stormwater would be used to irrigate these areas. A SBIN would irrigate the CW and MS in this area.

- An area of soil cement bank stabilization would begin at the midpoint of the SRS&R Beeline One Plant, on the south side of the channel, and continue for approximately 5,500 feet downstream. The structure would be 30 feet high and 6 feet deep and would be used to offset erosion concerns due to mining that is occurring within the main channel, along the island located immediately south of SRS&R Beeline One Plant.

- The main channel would be reshaped to allow for the establishment of river bottom and to increase channel conveyance capacity. Another alternative is to allow naturally occurring flow events to reshape the river bottom. The advantage of mechanical reshaping is to utilize excavated material in the construction of proposed features.

Reach 6

- CW and MS would be established in Sub-area 6.1. The MS would be located on the north bank, immediately outside of the active channel, outside of the 10-year floodplain. It would be irrigated using groundwater from a new well located in Sub-area 6.1. The CW, located closer to the main channel, would be irrigated using surface water from Hennessey Drain. In both areas, the water would be distributed using a flood irrigation method or the SBIN. Because the vegetated areas are near the GRUSP site, water that has infiltrated the soil can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- Area 6.2 is located on the south bank of the river. CW would be planted in an abandoned quarry depression directly east of Gilbert Road. The area would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation. The abandoned quarry immediately upstream of the newly established CW would be reshaped and converted to new river bottom.

- In Sub-area 6.2, located on the south bank of the river, CW would be planted in an abandoned quarry depression directly east of Gilbert Road. The area would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation. The abandoned quarry immediately upstream of the newly established CW would be reshaped and converted to new river bottom. The southern bank would be stabilized to prevent erosion, and soil cement is recommended.

- Sub-area 6.3 would have a wetland feature, which would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW, taking advantage of the saturated soil conditions, and would be irrigated using a SBIN and/or flood irrigation. SRPMIC surface water from Hennessey Drain would be used to irrigate this area.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Nine new irrigation diversion structures, two new WWTP diversion structures, and one new well are proposed for this alternative.

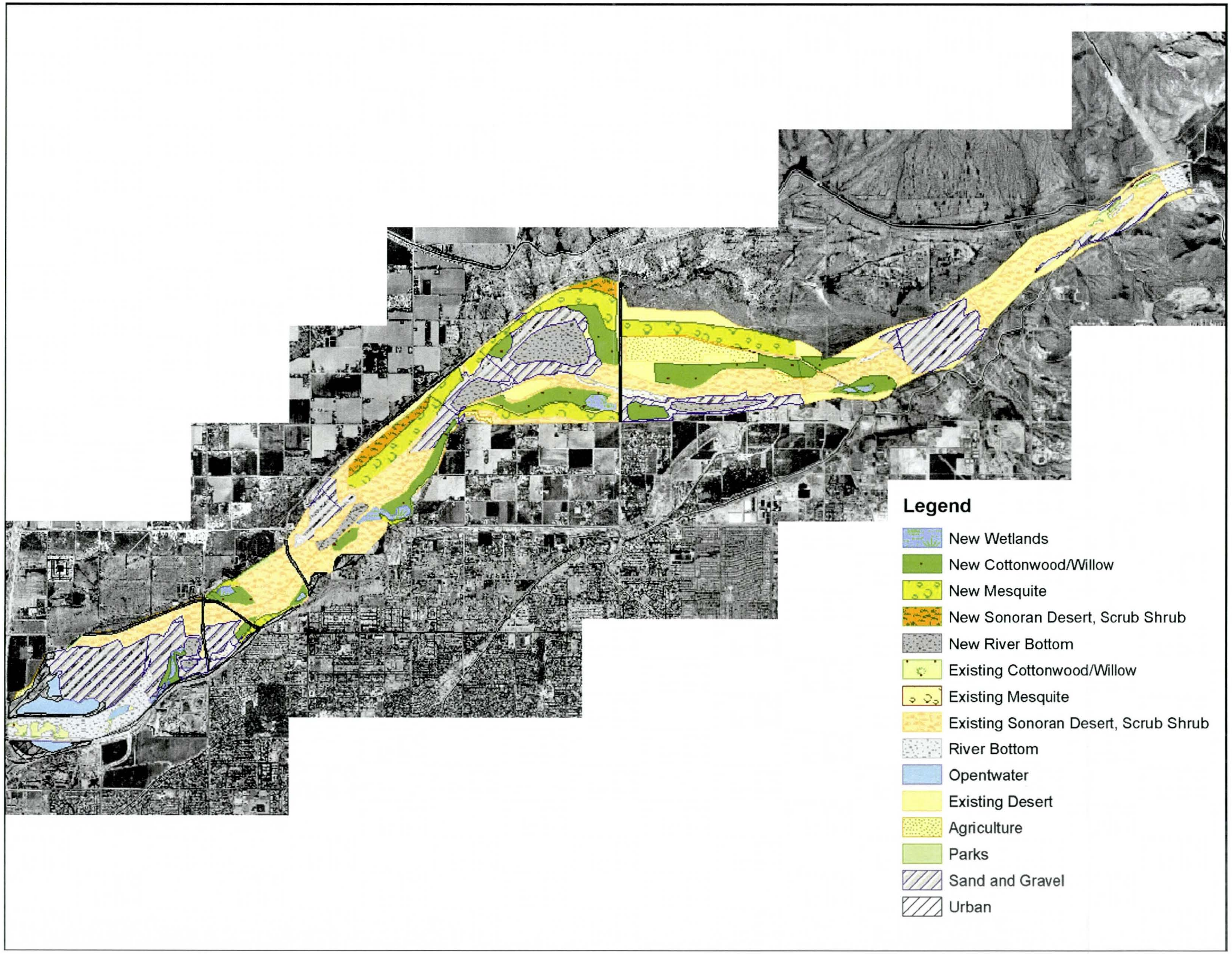
Water Demand

As presented in Table 47, the total annual evapotranspiration rate for Alternative J is 6,087 acre-feet.

Table 47. Vegetated Area and Evapotranspiration Rate – Alternative J

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	112	693
3	20	124
4	270	1,113
5	475	2,117
6	409	2,040
Total	**1,285**	**6,087**

Figure 47. Alternative J



5.6.2.11 Alternative K

Alternative K is dominated by cottonwood-willow and mesquite with fewer Sonoran desert scrub shrub acreage. Because of the prevalence of water-dominate vegetation, the water demand is higher at 6,304 acre-feet/year (Table 48). This alternative provides a net habitat value of 627 FCUs (Table 58). This alternative is structurally simple with no reshaping or bank stabilization features. The proposed restoration features are described below and are shown in Figure 48.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by MS and CW on the north and south sides, respectively. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by runoff from a golf course, located north of the Salt River, if it is of sufficient quality.

- Similar to Alternative J, Sub-area Area 2.3 would support a wetland feature, MS, and two small pockets of CW along the south bank. One stand of CW would surround the wetland; a second stand would start in the eastern edge of Sub-area 2.3 and extend slightly into Sub-area 2.2. MWWTP effluent or groundwater would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- MWWTP effluent would support the wetland feature created in Sub-area 2.2 at Alma School Road downstream of the old quarry. The wetland would be surrounded by CW and irrigated using a SBIN.

- Similar to the other alternatives, bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- A drainage channel would be constructed to drain Reach 4.2 to supply water to the wetland, CW, and SD vegetation of Sub-area 3.1. Water would be dispersed to the features using a SBIN.

- Sub-area 3.2 would support small stands of CW, MS, and SD. They would be supported by SBIN, using redirected surface water outlets as a source.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, MS and SD could be established in this area. The area would be irrigated using surface water and stormwater by SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and a wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- CW, MS, and SD would be established in the overbank of Sub-area 5.2, with the MS extending into Sub-area 5.1. The CW acreage would be restricted to a single stand on the north side of the river immediately outside of the 5-year floodplain at Gilbert Road. A wetland would be constructed at the Evergreen Drain outlet, within the 5-year floodplain. All three vegetation types would be irrigated using surface water diverted from the North Drainage Channel distributed using SBIN. The vegetation planted in Sub-area 5.2 can also be irrigated by overland flow from water diverted from Evergreen Drain during storm events or supplemented by groundwater extracted from a new well, if necessary.

- Sub-area 5.3, located along the south bank, would be vegetated with CW, MS, and two wetland features. A wetland would be established just west of Gilbert Road, and another on the western edge of Sub-area 5.3. CW would buffer the two wetlands to the west and east, respectively. MS would buffer the CW to the south. Surface water and stormwater, distributed by a SBIN, would be used to irrigate these areas.

Reach 6

- CW, MS, and a wetland feature would be established in Sub-area 6.1. The MS is located on the north bank immediately outside the active channel, outside the 10-year floodplain, and would be irrigated using groundwater extracted from a new well. The CW and wetland feature would be established on the north bank, immediately outside of the 5-year floodplain and partially within the 5-year floodplain, and would be irrigated using SRPMIC surface water from Hennessey Drain. In both areas, the water would be distributed using a flood irrigation method or a SBIN. Because vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- Sub-area 6.3 would have a wetland feature, which would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The CW would take advantage of the saturated soil conditions and would be irrigated using a SBIN or flood irrigation supplied by SRPMIC surface water from Hennessey Drain.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Nine new irrigation diversion structures, two new WWTP diversion structures, and a new well are proposed for this alternative.

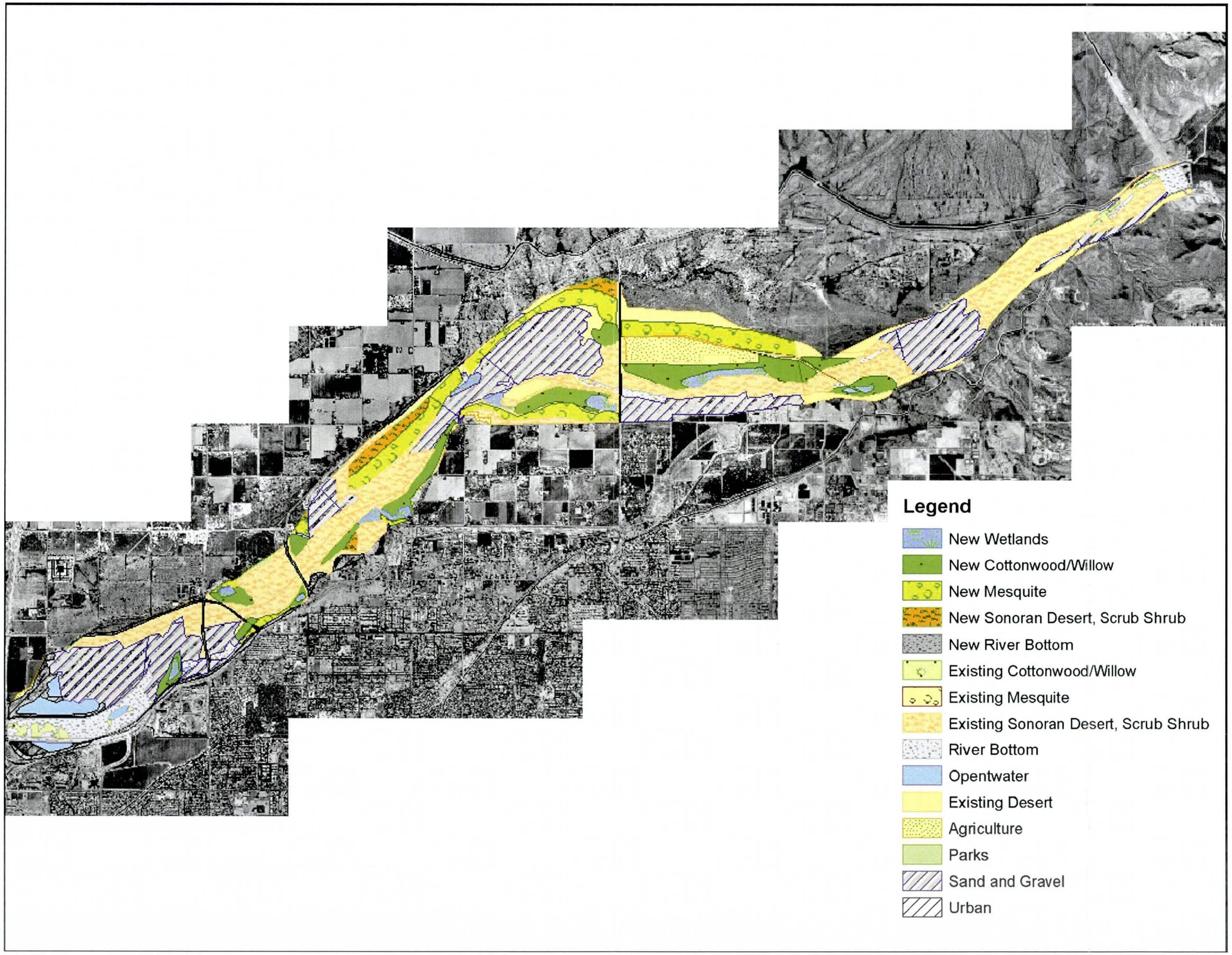
Water Demand

As presented in Table 48, the total annual evapotranspiration rate for Alternative K is 6,304 acre-feet.

Table 48. Vegetated Area and Evapotranspiration Rate – Alternative K

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	108	652
3	68	306
4	270	1,113
5	416	1,852
6	445	2,381
Total	**1,301**	**6,304**

Figure 48. Alternative K



5.6.2.12 *Alternative L*

Alternative L places vegetation in less contiguous, distinct pockets. However, the vegetation is dominated by cottonwood-willow with several areas of wetlands, which are both valuable habitat types. Alternative L provides a net habitat value of 758 FCUs (Table 58). The water demand is 5,602 acre-feet/year (Table 49), relatively high due to the cottonwood and wetlands. Two bank stabilization areas, with a single grade control structure, are planned. SRS&R Beeline One Plant would also be reshaped to create new river bottom. The proposed restoration features are described below and are shown in Figure 49.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by a large CW stand on the south side and a smaller MS stand on the north side. The CW would follow the river upstream for most of Sub-area 2.4. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by golf course runoff if it is of sufficient quality.

- Along the south bank, Sub-area 2.3 would support a wetland feature, MS, and two small pockets of CW. One stand of CW would surround the wetland; a second stand would start at the eastern edge of Sub-area 2.3 extending slightly into Sub-area 2.2. MWWTP effluent would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- MWWTP effluent would support the two wetland features created in Sub-area 2.2, at Alma School Road downstream of the old quarry. The downstream-most wetland would be surrounded by CW and irrigated using a SBIN, while the upstream wetland would be a stand-alone feature.

- Similar to the other alternatives, bank stabilization is recommended for the south bank between Country Club Road and Alma School Road. Soil cement is the recommended method. The bank stabilization is necessary to prevent further erosion and possible damage to Highway 202.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and Sedimentation Analysis* (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- No vegetation establishment is planned for Reach 3 in this alternative.

Reach 4

- A small CW stand would be established in Sub-area 4.1, immediately downstream of the wetland located in Sub-area 5.1. No other vegetation would be planted in this area.

- Sub-area 4.2, along the downstream portion of the south bank, would support CW, MS, and a wetland feature. The wetland would be located entirely in the 5-year floodplain. A south bank surface water outlet would supply water to the SBIN used to irrigate the vegetation. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to river bottom in Sub-area 5.2. The north bank would be set back and armored using soil cement and/or riprap to increase conveyance to the north.

- Sub-area 5.2 would also have CW, MS, and two wetland features. One wetland would be located at Gilbert Road within the 5-year floodplain. It would be buffered to the north by CW, which would be buffered by MS. The second wetland would be located immediately upstream of the Evergreen Drain outlet, with a portion of it falling within Sub-area 5.1. This would also be buffered by CW and MS to the north. All three vegetation types would be irrigated using surface water diverted from the

North Drainage Channel, with groundwater extracted from a new well as a secondary source. The water would be distributed using a SBIN.

- A drop structure would be placed in Sub-area 5.2 in the main channel at the center point of SRS&R Beeline One Plant. This would help protect the newly-restored channel and riparian area upstream from headcutting due to the extensive mining that has occurred downstream. The structures would span the entire width of the riverbed and be designed to the estimated scour depth.

- Sub-area 5.3, located along the south bank, would be vegetated with CW, MS, and a large wetland feature at Gilbert Road. Surface water and stormwater would be used to irrigate these areas. The water would be distributed by a SBIN.

Reach 6

- Large areas of CW and MS and two small wetlands would be established in Sub-area 6.1. The MS would be irrigated using surface water from the North Canal. The CW and wetlands would be irrigated using surface water from the Hennessey Drain. For all areas, the water would be distributed using a flood irrigation method or the SBIN. The MS is located on the north bank, outside the 10-year floodplain. The CW and wetlands are located immediately south of the MS, just outside of the 5-year floodplain. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Four new irrigation diversion structures, two new WWTP diversion structures, and a new well are proposed for this alternative.

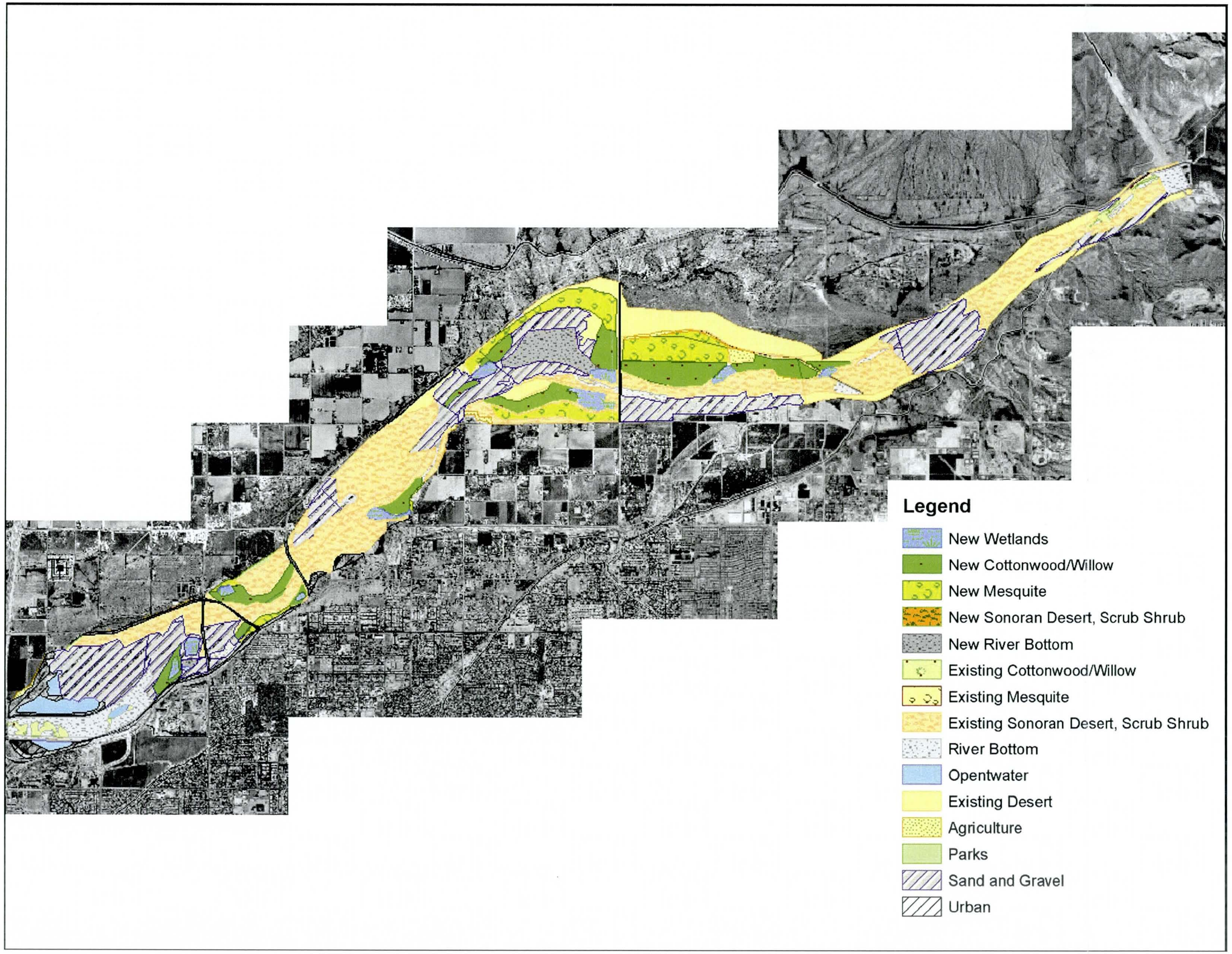
Water Demand

As presented in Table 49, the total annual evapotranspiration rate for Alternative L is 5,602 acre-feet.

Table 49. Vegetated Area and Evapotranspiration Rate – Alternative L

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	157	1,001
3	0	0
4	56	389
5	446	2,294
6	379	1,918
Total	**1,037**	**5,602**

Figure 49. Alternative L



5.6.2.13 Alternative M

Alternative M is dominated by wetlands and plans for 12 separate features. Cottonwood/willow surrounds each wetland, allowing for significant acreage. Mesquite is also prevalent with smaller areas of Sonoran desert scrub shrub. Because wetlands and cottonwood-willow dominate this alternative, the water demand is relatively high at 6,488 acre-feet/year (Table 50). However, this alternative provides a high net habitat value of 829 FCUs (Table 58). Three areas of bank stabilization and a single grade control structure are proposed. Two quarries would be reshaped creating new river bottom. The proposed restoration features are described below and are shown in Figure 50.

Reach 1

- No activity is planned for Reach 1. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by CW on the south side and MS on the north side. These features would be supported by surface water outlets, and maintained using a SBIN. Additional water may be supplied by runoff from a golf course located north of the Salt River, if it is of sufficient quality.

- Along the south bank, Sub-area 2.3 would support a wetland feature, MS, and two small pockets of CW. One stand of CW would surround the wetland; a second stand would start at the eastern edge of Sub-area 2.3 and extend slightly into Sub-area 2.2. MWWTP effluent or groundwater would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- In Sub-area 2.2, MWWTP effluent would support the wetland feature created at Alma School Road, downstream of the old quarry. The wetland would be buffered on the south side by CW and irrigated using a SBIN.

- Some concern has been raised regarding the Alma School drop structure. Currently, there has been a design to modify the existing structure. The possible loss of the structure due to scouring and eventual undermining of the structure is documented in the *Final Without-Project Analysis Report, Va Shly'ay Akimel Hydraulic and*

Sedimentation Analysis (WEST, 2002). Additionally, the WEST (2002) report presents a conservative estimate of future conditions.

Reach 3

- A drainage channel would be constructed to drain Reach 4.2 to supply water to the wetland of Sub-area 3.1.
- Sub-area 3.2 is protected by a landfill and therefore would not be altered.

Reach 4

- A large portion of Sub-area 4.1 is located on a terrace north of the channel, the site of an old landfill. Depending on water quality issues including potential leachate and methane production, MS and SD could be established in this area. The area would be irrigated using surface and stormwater via a SBIN.
- Sub-area 4.2, along the south bank, would support CW, MS, and a series of four wetlands. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. There would be four total wetland features, the first three in succession heading downstream and surrounded by CW and the final and largest wetland at the downstream end of Sub-area 4.2 and into Sub-area 3.1. A small stand of MS would buffer the downstream CW and a portion of the adjacent wetland. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to river bottom. The north bank would also be set back and armored using soil cement and/or riprap to increase conveyance to the north.
- Sub-area 5.2 would have a small wetland feature within the 5-year floodplain at Gilbert Road, buffered by CW and MS to the north. The MS would extend around the perimeter of SRS&R Beeline One Plant, downstream into Sub-area 5.1 past the Evergreen Drain. There would also be a small wetland feature at the Evergreen Drain outlet. The MS would be irrigated using groundwater extracted from a new well and distributed with either a flood irrigation method or a SBIN. The CW and wetland feature would be irrigated using surface water diverted from the North Drainage

Channel. The water would be distributed using a SBIN. The vegetation planted in Sub-area 5.2 can also be irrigated by overland flow from water diverted from Evergreen Drain during storm events.

- The grade control structure would be placed in Sub-area 5.2 in the main channel at the center point of the SRS&R Beeline One Plant. This structure would help protect the newly-restored channel and riparian area upstream from headcutting due to the extensive mining that has occurred downstream. The structure would span the entire width of the riverbed and be designed to the estimated scour depth.

- Immediately downstream from the grade control structure, an area of soil cement bank stabilization would begin and continue for approximately 5,500 feet. The structure would be 30 feet high and 6 feet deep and would be used to offset erosion concerns due to mining that is occurring within the main channel, along the island located immediately south of SRS&R Beeline One Plant.

- Sub-area 5.3, located along the south bank, would support three wetland features and would be surrounded by CW and buffered to the south with MS. Surface water and stormwater, distributed by a SBIN, would be used to irrigate these areas.

Reach 6

- Sub-area 6.1 would be planted with CW and two wetland features. Both would be irrigated using surface water from Hennessey Drain and distributed using a flood irrigation method or a SBIN. The MS would be irrigated using groundwater extracted from a new well. The water would be distributed using flood irrigation or a SBIN. The eastern wetland would be placed within the 5-year floodplain, while the western wetland would be placed immediately outside of the 5-year floodplain. The CW stands would buffer and connect both wetland features. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- In Sub-area 6.2, located on the south bank of the river, CW would be planted in an abandoned quarry depression directly east of Gilbert Road. The area would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation. A larger quarry located further upstream along the south bank would be reshaped and converted to new river bottom. It is recommended that the south bank be armored to ensure that the quarry does not affect the current channel layout.

- Similar to Alternative C, Sub-area 6.3 would have a wetland feature, which would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be surrounded by CW, taking advantage of the saturated soil conditions, and would be irrigated using a SBIN or flood irrigation. SRPMIC surface water from Hennessey Drain would be used to irrigate this area.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Eight new irrigation diversion structures, two new WWTP diversion structures, and a new well are proposed for this alternative.

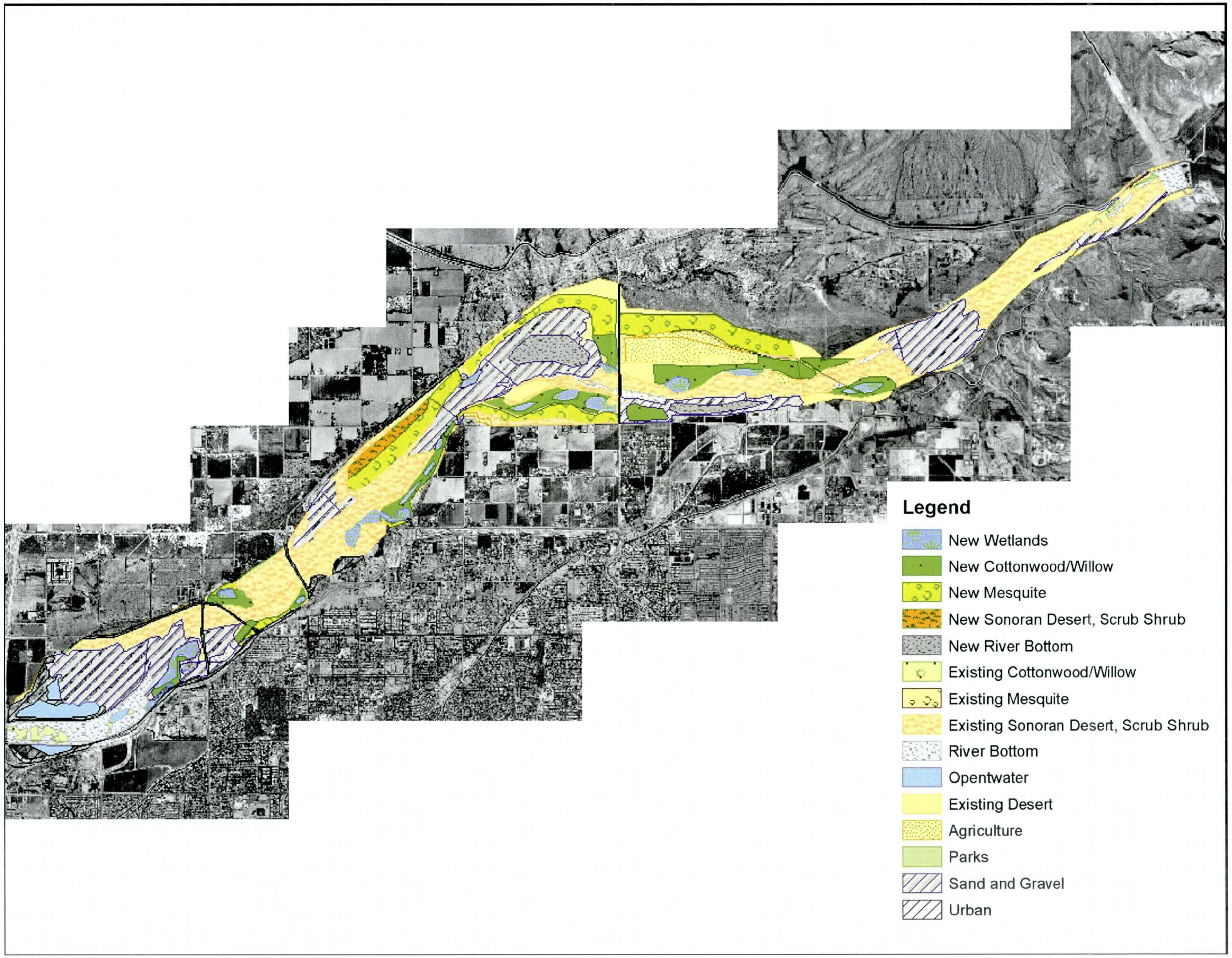
Water Demand

As presented in Table 50, the total annual evapotranspiration rate for Alternative M is 6,488 acre-feet.

Table 50. Vegetated Area and Evapotranspiration Rate – Alternative M

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	0	0
2	139	948
3	16	147
4	271	1,157
5	407	1,900
6	453	2,336
Total	**1,285**	**6,488**

Figure 50. Alternative M



5.6.2.14 Alternative N

Alternative N is similar to Alternative F. However, it does not have any structural features. Furthermore, this alternative proposes additional vegetation. The water demand is 7,736 acre-feet/year (Table 51). Alternative N provides a net habitat value of 913 FCUs (Table 58). The proposed restoration features are described below and are shown in Figure 51.

Reach 1

- The CW stand adjacent to the wetlands of Sub-area 2.2 would continue westward into Sub-area 1.1 within the main channel. The percolation ponds found immediately outside of the southern bank in Sub-area 1.2 would be planted with CW. This area would be supported using the existing irrigation infrastructure and MWWTP effluent. No activity is planned for the northern side of Reach 1 within the Indian Community. The SRPMIC has expressed an interest in commercially developing this area.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by CW to the west, south, and east, and MS to the north. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by runoff from a golf course located north of the Salt River, if it is of sufficient quality.

- Along the south bank, Sub-area 2.3 would support a small wetland feature and small areas of CW and MS. One stand of CW would surround the wetland; a second stand would start at the eastern edge of Sub-area 2.3 and extend slightly into Sub-area 2.2. MWWTP effluent would be used to support the vegetation. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- MWWTP effluent would support the two wetland features created in Sub-area 2.2 at Alma School Road downstream of the old quarry. The western-most wetland would be flanked by CW to the west that would continue into Sub-area 1.1. The CW would be irrigated using a SBIN. A small area south of the wetlands would be reshaped and converted to new river bottom.

Reach 3

- A channel would be constructed to drain Reach 4.2 to supply water to the CW vegetation in Sub-area 3.1. Water would be distributed using the SBIN.

Reach 4

- The majority of Sub-area 4.1 would be left unvegetated due to the existence of the Tri-City Landfill. However, a narrow strip of CW would be established along the north bank at the edge of the main channel. The area would be irrigated using surface water and stormwater using a SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and a large wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel, so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to new river bottom in Sub-area 5.2. CW, MS, and a small pocket of SD would be located on the overbank area. The MS and SD would be irrigated using groundwater from a new well. The CW would be irrigated using surface water diverted from an irrigation canal. The water would be distributed using a SBIN.

- The channel in Sub-area 5.1 and the western half of 5.3 would be reshaped and converted to new river bottom. A wetland feature and CW would be established at Evergreen Drain. The CW would be irrigated using groundwater from the new well. The wetland would be supported by runoff from Evergreen Drain.

- Sub-area 5.3, located along the south bank, would be vegetated with CW and a small stand of MS. Surface water and stormwater would be used to irrigate these areas. Irrigation of the CW and MS would be done by SBIN.

- A grade control structure would be placed in the main channel at the center point of SRS&R Beeline One Plant in Sub-area 5.2. This structure would help protect the newly-restored channel and riparian area upstream from headcutting due to the extensive mining that has occurred downstream. The structure, approximately 1,500 feet long, would span the entire width of the riverbed and be designed to the estimated scour depth.

Reach 6

- Large areas of CW and MS would be established in Sub-area 6.1. The CW is located south of the GRUSP site and would be irrigated using SRPMIC surface water from Hennessey Drain. The MS is located on the north bank, immediately outside of the active channel, outside the 10-year floodplain, and would be irrigated using ground water from the new well. In both areas, the water would be distributed using a flood irrigation method or the SBIN. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- In Area 6.2, located on the south bank of the river, two areas of CW would be planted: one in an abandoned quarry depression directly east of Gilbert Road and within the 5-year floodplain and a second narrow strip along the southern edge of the main channel. Both areas would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation.

- Sub-area 6.3 would have a wetland feature, which would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be flanked by a relatively large CW stand to the east, taking advantage of the saturated soil conditions, and would be irrigated using surface water from Hennessey Drain and a SBIN or flood irrigation.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Nine new irrigation diversion structures, two new WWTP diversion structures, and a new well are proposed for this alternative.

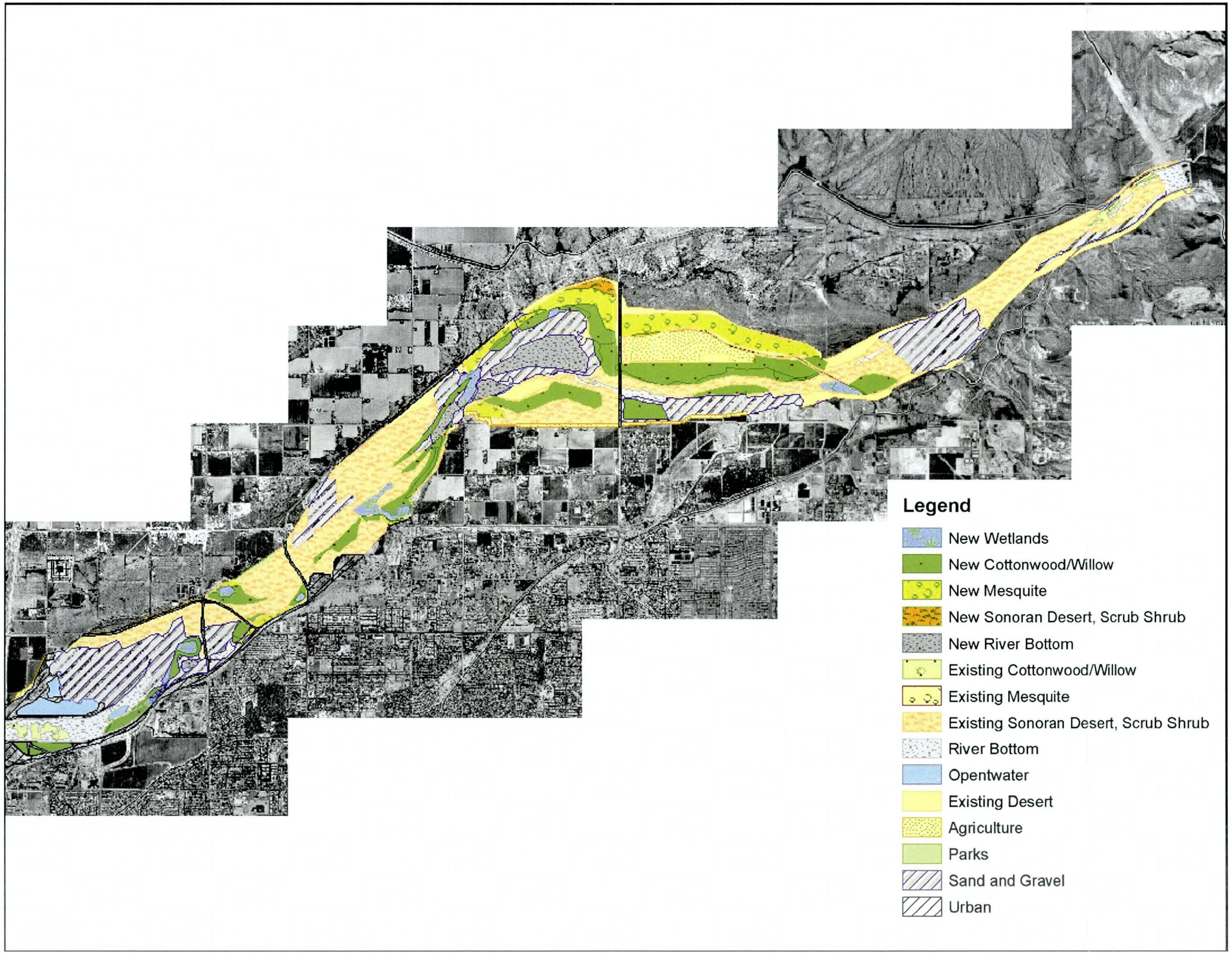
Water Demand

As presented in Table 51, the total annual evapotranspiration rate for Alternative N is 7,736 acre-feet.

Table 51. Vegetated Area and Evapotranspiration Rate – Alternative N

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	51	320
2	141	905
3	29	181
4	152	1,057
5	434	2,224
6	580	3,048
Total	**1,387**	**7,736**

Figure 51. Alternative N



5.6.2.15 Alternative O

Alternative O is similar to Alternative N. However, this alternative proposes additional vegetation in Sub-areas 1 and 2. The water demand is 8,550 acre-feet/year. Alternative O provides a net habitat value of 963 FCUs. The proposed restoration features are described below and are shown in Figure 52.

Reach 1

- Sub-area 1.1 would support four wetland features and three CW stands. One wetland would continue from Sub-area 2.2 while a second smaller wetland would be located to the north within the main channel and would connect with a CW stand to the north. The remaining two wetland features would be created to the west of the existing quarry, above the hardbank. A CW stand would be established within the main channel, at the far west end of Sub-area 1.1. Finally, a small CW stand would be established to the north of the existing quarry. The percolation ponds found immediately outside of the southern bank in Sub-area 1.2 would be planted with CW. This area would be supported using the existing irrigation infrastructure.

Reach 2

- Sub-area 2.4 would support a wetland feature surrounded by CW to the west, south, and east. These features would be supported by surface water outlets and maintained using a SBIN. Additional water may be supplied by a golf course located north of the Salt River, if it is of sufficient quality.

- Along the south bank, Sub-area 2.3 would support two wetland features and small areas of CW and MS. One small stand of CW would surround the wetland; a second larger stand would be established in the eastern edge of Sub-area 2.3 and extend into Sub-area 2.2. The wetland would be constructed near the Country Club Storm Drain on the existing river bottom and would need to withstand stormwater runoff.

- In Sub-area 2.2, three wetland features would be created at Alma School Road downstream of the old quarry. The small wetland to the west would be flanked by CW to the north while the larger wetland to the east would be surrounded by a CW stand. The CW would be irrigated using a SBIN. A small area, south of the wetlands, would be reshaped and converted to new river bottom.

Reach 3

- A channel would be constructed to drain Reach 4.2 to supply water to the CW vegetation in Sub-area 3.1. Water would be dispersed using a SBIN.

Reach 4

- The majority of Sub-area 4.1 would be left unvegetated due to the existence of the Tri-City Landfill. However, a narrow strip of CW would be established along the north bank at the edge of the main channel. The area would be irrigated using surface water and stormwater via a SBIN.

- Sub-area 4.2, along the south bank, would support CW, MS, and a large wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding CW and MS. Sub-area 4.2 is relatively protected from the main channel so damages to the channel and the irrigation system would occur less frequently.

Reach 5

- The SRS&R Beeline One Plant pit would be reshaped and converted to new river bottom in Sub-area 5.2. CW, MS, and a small pocket of SD would be located on the overbank area. The MS and SD would be irrigated using groundwater from a new well. The CW would be irrigated using surface water diverted from an irrigation canal. The water would be distributed using a SBIN.

- The channel in Sub-area 5.1 and the western half of Sub-area 5.3 would be reshaped and converted to new river bottom. A wetland feature as well as CW would be established at the Evergreen Drain. The CW would be irrigated using groundwater from the new well, and the wetland would be supported by runoff from the Evergreen Drain.

- Sub-area 5.3, located along the south bank, would be vegetated with CW and a small stand of MS. Surface water and stormwater would be used to irrigate these areas. Irrigation of the CW and MS would be done by a SBIN.

- A grade control structure would be placed in Sub-area 5.2, in the main channel at the center point of the SRS&R Beeline One Plant. This structure would help protect the newly-restored channel and riparian area upstream from headcutting due to the extensive mining that has occurred downstream. The structure would span the entire width of the riverbed, approximately 1,500 feet, and would be designed to the estimated scour depth.

Reach 6

- Large areas of CW and MS would be established in Sub-area 6.1. The CW is located south of the GRUSP site and would be irrigated using SRPMIC surface water from the Hennessey Drain. The MS is located on the north bank immediately outside the active channel and the 10-year floodplain and would be irrigated using groundwater from the new well. In both areas, the water would be distributed using a flood irrigation method or a SBIN. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. It is not known to what areal extent this water source will support riparian vegetation. A more detailed analysis is needed.

- In Sub-area 6.2, located on the south bank of the river, two areas of CW would be planted: one in an abandoned quarry depression directly east of Gilbert Road and within the 5-year floodplain, and a second narrow strip along the southern edge of the main channel. Both areas would be irrigated using surface water and stormwater when available. Flood irrigation is the preferred method of irrigation.

- Sub-area 6.3 would have a wetland feature. This would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be flanked by a relatively large CW stand to the east, taking advantage of the saturated soil conditions, and would be irrigated using surface water from the Hennessey Drain and a SBIN or flood irrigation.

Reach 7

- No changes were proposed in Reach 7 because of the Higley Quarry Plant. It was assumed that any vegetation planted would be damaged due to in-channel mining operations. The continual quarrying of the SRS&R Higley Plant would cause scouring to occur along the main channel downstream, particularly in Reach 6. This could potentially damage any attempts to establish vegetation along Reach 6. To reduce the effect of the Higley mining operations, the quarry operators should be encouraged to preserve a narrow corridor unaltered by mining within the existing main channel or to create a channel at grade to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9

- Invasive plant species, primarily saltcedar (*Tamarisk sp),* would be removed if no threatened or endangered wildlife species are found associated with it. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place. Because of the relative good habitat health in this reach, no other changes to the current conditions were proposed.

Water Sources

Nine new irrigation diversion structures, no new WTTP diversion structure, and one new well are proposed for Alternative O.

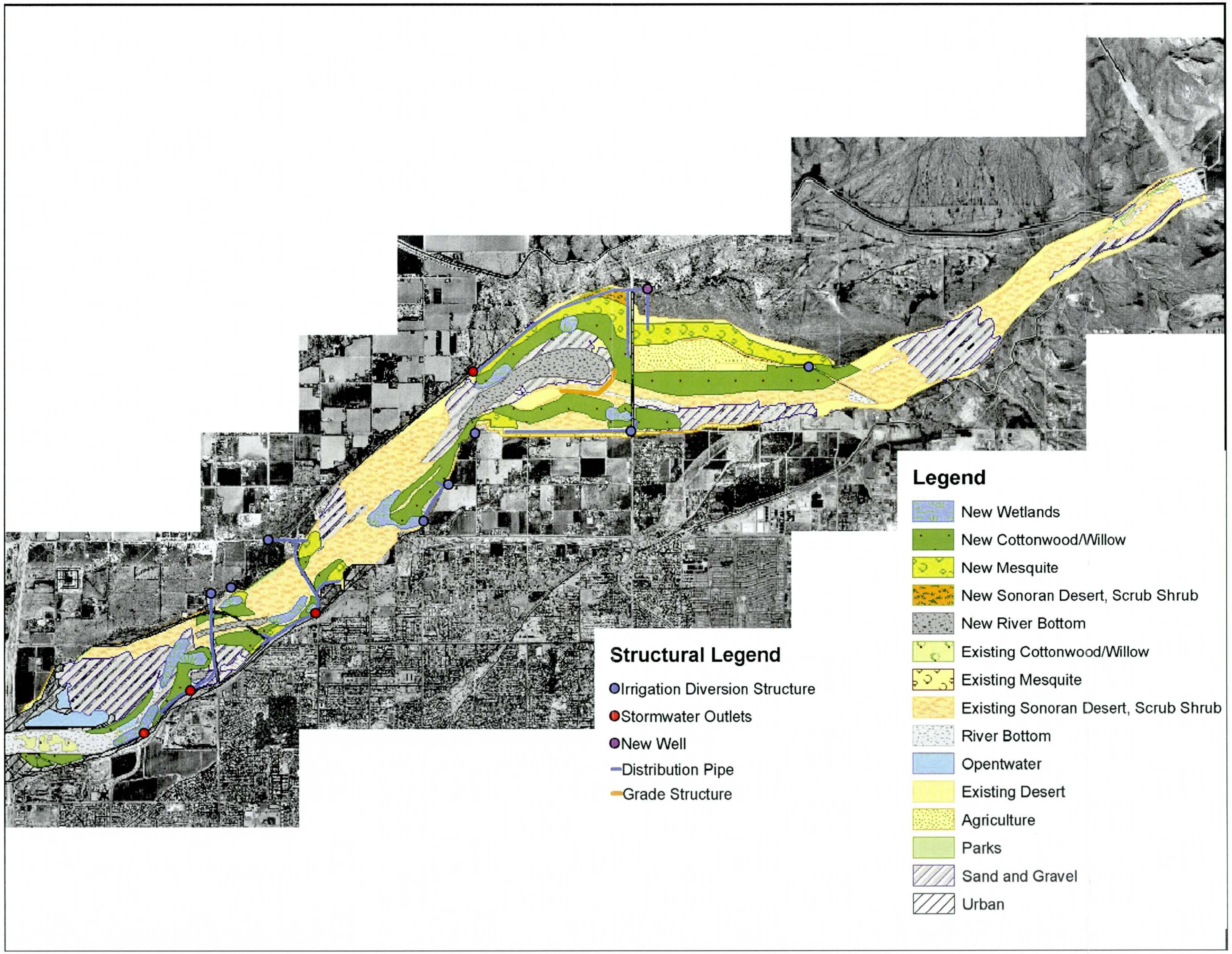
Water Demand

As presented in Table 52, the total annual evapotranspiration demand for Alternative O is 8,550 acre-feet.

Table 52. Vegetated Area and Evapotranspiration Rate – Alternative O

Reach	Area (acres)	Evapotranspiration (acre-ft)
1	66	475
2	226	1,565
3	29	181
4	152	1,057
5	434	2,224
6	580	3,048
Total	**1,486**	**8,550**

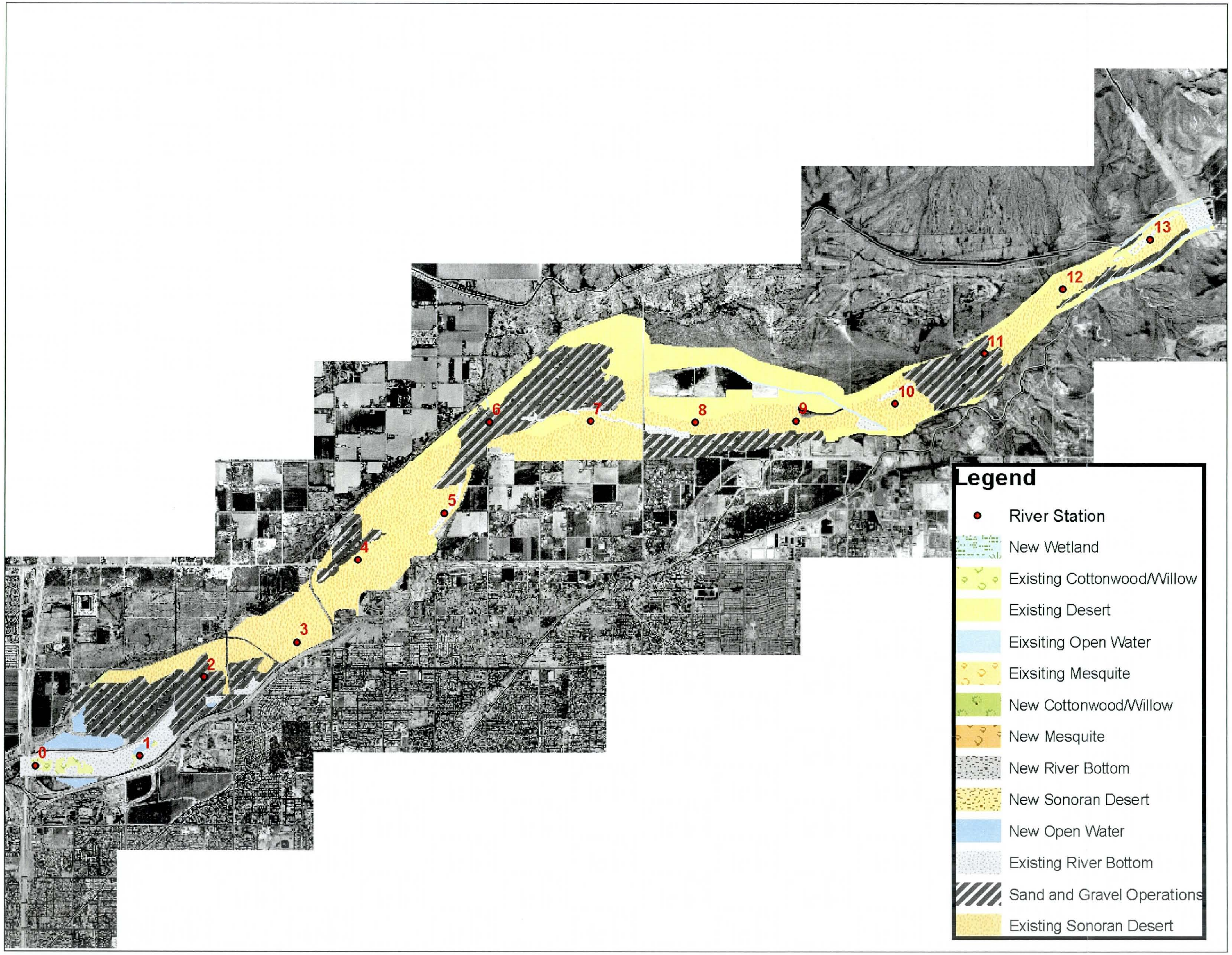
Figure 52. Alternative O



5.6.2.16 Alternative P: No Action Alternative

The No Action Alternative is carried forward and analyzed to provide a basis from which to assess the advantages and disadvantages of the other study alternatives. Under this alternative, the Federal government would take no action to provide ecosystem restoration within the study area and would not develop plans with potential incidental benefits associated with flood damage reduction, recreation, or water quality and supply. As previously discussed, habitat diversity and quality are expected to decline if no restoration efforts are conducted at the study area. A continued decline in the quantity and quality of most areas of cottonwood-willow stands, mesquite, scrub shrub, and wetlands is expected due to a continued decrease in available surface water and groundwater and continued surface disturbance caused by the sand and gravel operations (Figure 53). Habitat values in the study area are projected to decline (by about 13 percent) from 812 FCUs to 705 FCUs in the next 50 years. All of the restoration alternatives were evaluated against the No Action Alternative to determine the benefits and risks associated with each of the proposed alternatives.

Figure 53. Alternative P



5.7 Comparison and Evaluation of the Second Array of Alternatives

Each plan was independently evaluated and compared to the No Action Alternative. In this evaluation, factors such as short- and long-term environmental impacts, short- and long-term environmental benefits, costs, and implementability are taken into consideration. Using a cost-effectiveness and incremental cost analysis, the National Ecosystem Restoration (NER) Plan was identified.

5.7.1 Water Budget

Water budget for the alternatives was determined based on the evapotranspiration rate for each of the vegetation types including irrigation system inefficiency. Infiltration losses for the wetlands were taken into account. The water budget assumed that precipitation, agriculture tailwater, and stormwater runoff did not contribute to irrigation of the vegetated areas, as these areas require a continual and predictable supply of water.

5.7.1.1 Vegetation Water Demand

Table 53 presents the annual water demand for each of the vegetation types proposed for each alternative. As shown, the total water demand ranged from 992 ac-ft/yr for Alternative A to as high as 8,550 ac-ft/yr for Alternative O.

Table 53. Annual Vegetation Water Demand (ac-ft/yr)

Alt	WT		CW		MS		SD		TOTAL	
	Area (ac)	Water Demand	Area (ac)	Water Demand	Area (ac)	Water Demand	Area (ac)	Water Demand	Area (ac)	Water Demand
A	0	0	0	0	0	0	496	992	496	992
B	0	0	0	0	267	802	685	1,370	952	2,172
C	29	260	238	1,500	166	497	720	1,440	1,152	3,696
D	103	930	259	1,635	313	939	63	126	739	3,629
E	52	229	287	1,808	296	888	808	1,615	1,416	4,540
F	187	1,682	701	4,418	558	1,673	266	531	1,711	8,304
G	64	578	470	2,959	454	1,363	395	790	1,383	5,690
H	64	578	9	55	870	2,609	395	790	1,338	4,032
I	196	1,765	443	2,788	6	18	174	348	819	4,920
J	82	735	556	3,501	556	1,668	92	183	1,285	6,087
K	146	1,318	493	3,103	558	1,675	104	208	1,301	6,304
L	143	1,286	495	3,117	400	1,199	0	0	1,037	5,602
M	222	2,002	412	2,598	587	1,762	126	126	1,285	6,488
N	131	1,178	853	5,371	380	1,139	47	47	1,387	7,736
O	200	1,798	883	5,566	380	1,139	47	47	1,486	8,550
P	-	-	-	-	-	-	-	-	-	-

5.7.1.2 Water Sources

The water requirements (Table 54) from the various sources were based on water source location, proximity to vegetated areas, and water availability. The largest source of water is the SPRMIC surface water. Groundwater is designed to support large areas of vegetation in Sub-areas 5.2 and 6.1. Effluent would only be used to support vegetation located in Sub-area 1.2, well outside the SPRMIC. As previously discussed, precipitation, stormwater runoff, and agriculture tailwater were not accounted for in the water demand estimates.

Table 54. Water Source Requirement (ac-ft/yr)

Alternative	Effluent	SRPMIC Groundwater	SRPMIC Surface Water	TOTAL
A	0	0	992	992
B	0	787	1,385	2,172
C	0	676	3,021	3,696
D	0	887	2,742	3,629
E	242	1,419	2,879	4,540
F	0	1,331	6,973	8,304
G	234	943	4,513	5,690
H	0	782	3,250	4,032
I	0	0	4,920	4,920
J	0	1,249	4,838	6,087
K	0	1,350	4,954	6,304
L	0	1,072	4,530	5,602
M	0	1,228	5,259	6,488
N	174	1,804	5,757	7,736
O	174	1,804	6,571	8,550
P	-	-	-	-

5.7.1.3 Irrigation System Inefficiency

Inefficiencies in the drip irrigation and surface braided irrigation network systems were taken into account in the analysis by assuming that the former was 80 percent efficient and the latter was 50 percent efficient. This takes into account infiltration losses and conveyance losses from the sources (irrigation diversion structures) to vegetation location. To improve efficiency, liners could be used; these were not analyzed in the current design. Table 55 presents the increase in water demand for each alternative with the irrigation inefficiencies.

Table 55. Water Demand with Irrigation Inefficiencies (ac-ft/yr)

Alternative	Water Demand without Inefficiencies	Drip Irrigation	SBIN
A	992	1,240	1,983
B	2,172	2,715	4,345
C	3,696	4,620	7,393
D	3,629	4,537	7,259
E	4,540	5,675	9,080
F	8,304	10,380	16,607
G	5,690	7,113	11,381
H	4,032	5,040	8,064
I	4,920	6,150	9,840
J	6,087	7,609	12,174
K	6,304	7,880	12,608
L	5,602	7,002	11,204
M	6,488	8,110	12,976
N	7,736	9,669	15,471
O	8,550	10,668	17,100
P	-	-	-

5.7.2 Cultural Resources

Activities involved in constructing features to accomplish ecosystem restoration under Alternatives A though O would involve ground disturbances to varying degrees depending on specific locations within the project area. Defined restoration activities include reshaping and grading for irrigation, planting of vegetation, river channelization, construction of grade control structures, and bank stabilization, all of which were determined may have an adverse effect on National Register of Historic Places (NRHP) sites.

The restoration activities described above would move artifacts, ecofactual materials, and features from their original provenance. This displacement would either destroy or significantly diminish the scientific value of any information potential and adversely affect NRHP eligibility. Additionally, the newly planted vegetation would create adverse effects as the plants grow and develop root systems. Roots are a common form of archeological site disturbance. Furthermore, increasing the levels of water in the soil would change the soil chemistry and possibly increase the degradation of important perishable ecofactual remains.

The results of the SRI Class III Cultural Resources Survey and archaeological testing done within the project site resulted in a series of recommendations. SRI recommend that the information potential of SRPMIC-90, 105, 112, and 113 has been exhausted. The two thermal pits and surface artifacts at SRPMIC-90 are best interpreted as the remains of a small Colonial period farmstead. The residential locus of this site, however, has been destroyed as part of road construction. No buried features were encountered at SRPMIC-105. SRPMIC-112 and 113 were determined to be modern drainage ditches. As such, these sites cannot contribute significantly towards our understanding of past lifeways within the project area. SRI, therefore, recommended that SRPMIC-90, 105, 112, and 113 are ineligible for inclusion in the National Register of Historic Places (NRHP).

SRI evaluated SRPMIC-108 and 109 as eligible for listing on the National Register of Historic Places. A large subsurface deposit of ash-stained soil and fire-cracked rock was identified at SRPMIC-108. This deposit likely represents rake-out debris from a nearby roasting pit or horno. SRI recommended that this part of the site be mechanically stripped and that the feature(s) be excavated. The excavation of a small roasting pit during testing at this site indicates that organic preservation is excellent in this portion of the site. SRPMIC-108 could, therefore, contribute significantly towards our understanding of prehistoric subsistence in the project area.

SRPMIC-109 represents the remains of a small mid-to-late nineteenth century historic Piman farmstead in Parcel 3. SRI also recommended that this site be mechanically stripped in order to determine the subsurface limits, structure, and contents of this site. SRPMIC-109 can contribute significantly towards our understanding of historic period Piman pottery production, agricultural activities, and settlement in the project area.

In addition, archival research indicates that several prehistoric canals have been mapped in the project area. No evidence of these canals or associated field systems are evident on the surface or in subsurface excavations conducted by SRI. There possible existence, however, should be considered during construction, or an effort should be made to locate these features, if there is a data recovery phase.

Consultation to identify traditional cultural properties has yet to be conducted. The SRPMIC would identify these types of resources. Other tribes may also be consulted to obtain their views also.There are locations within the land area required for several alternatives that contain historic and prehistoric resources. Additional studies will be necessary to evaluate the NRHP eligibility (significance) of these sites. If any of these sites are found to be eligible, modifications to the design will be required. If design changes are not feasible, mitigation measures will be required.

5.7.3 Hazardous, Toxic, or Radioactive Waste

As additional information on specific properties was gathered, assessed, and compared to the potential sites for restoration, the results of the environmental assessment were used to better guide plan formulation, particularly in the modification of alternatives to avoid potential impacts. Re-siting or elimination of features was necessary ro prevent or minimize the possibility of interactions between identified sites and the areas slated for potential ecosystem restoration. The results of the environmental assessment are presented below.

Talley Defense Systems site. Because of concerns with this site, plan formulation changed the footprints of all potential alternatives to avoid potential interactions. For instance, the initial planned constructed wetland near the Talley Defense site was deleted so as to reduce any chance of impact to restored resources by the Talley Defense site. Available data are highly inconclusive regarding whether or not any released contaminants from Talley Defense Systems operations have impacted the current environment, could impact the planned environmental restoration features of the Va Shly'ay Akimel study area, or any other parts of the study area that are downstream of Talley Defense Systems burn pits.

As a result, it must be assumed that there is risk for some perchlorate contamination in the study area, where excavation, construction, and groundwater level manipulation are planned. The two potential sources of contaminant release (based on available data) have to be assumed as the washwater pits at plant #3, and the burn pits. Due to the high mobility of perchlorate, no greater or lesser risk is assigned to one source or the other. The burn pits, while farther away from project features, probably saw more total release than did the washwater pits. To a lesser degree than assigned to perchlorate, a risk of contamination of the from heavy metals has to be considered as possible for the study area, foremost from cadmium, chromium, and lead from the washwater pits, and to a lesser degree (due to greater distance) from copper, lead, and possibly cadmium from the burn pits. Until direct sampling of soil and groundwater for these contaminants is undertaken in a manner that will determine contaminant concentrations (or the absence of contaminant) in the study area and in and near planned features, the presence or absence of contaminants will remain an unknown. Precautionary sampling and testing of soil to be moved and groundwater to be dewatered, for perchlorate and these heavy metals, would be undertaken during the PED phase, with study specifically oriented around the recommended plan. A line of exploratory borings immediately upstream of the upstream-most wetlands and/or constructed features would be undertaken. Such work would serve to remove most all of this potential risk with regard to the study at hand, by proving that contaminant migration did not proceed far enough downstream to impact the study area. The fact that project features could be down-gradient of surface runoff from the plant and are downgradient from the two known release areas has to be considered as increasing the risk to the study area, as the contaminants likely would travel such a route. However, the presence of Talley Defense's runoff retention basin would be expected to provide some manner of barrier to contaminant migration, especially the metals. The risk from halogenated and non-halogenated solvents probably should be considered a very low potential risk at this point, not worthy of follow-up at this time, based on available data about past practice at the facility. This should be tempered with the fact that no testing was done in any of the past studies for these potential contaminants of concern.

Landfills The five landfills within the study area are near the area of conceptual environmental features. All landfill sites for which there is any information are unlined, so there is concern regarding what might be leached from them if they are inundated as part of the conceptual environmental restoration. Potential riverbank erosion and breach of landfill contents deserves consideration as an issue. Only the Tri-Cities landfill has bank protection. As with the assessment of the Talley site, additional study of existing landfill issues will be done in the PED phase of study, as these studies would be focused directly on potential interactions with the recommended plan.

Drum dump site. The dump location has received partial cleanup under RCRA5 with the work done by ADEQ6 in May 1990. SRPMIC Environmental Services staff reports they are counting on the future EPA Brownfield cleanup of the underlying Cypress landfill to address the drum dump.

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[5] "RCRA" is "Resource Conservation and Recovery Act".

[6] "ADEQ" is "Arizona Dept. of Environmental Quality".

VOCs in groundwater, including the Indian Bend Wash Superfund sites. The North Indian Bend Wash and South Indian Bend Wash Superfund sites were evaluated for potential interactions with study alternatives. Monitoring of clean-up activities and monitor well test data by SRPMIC Environmental Services has led them to conclude that this site has not impacted the study area and likely will not in the future; pollutants are contained by current efforts and have not crossed into the study area (Ramirez, 2004, p. 2).

Analysis of the South Indian Bend Wash site indicates that the VOC groundwater contaminant plume in the Salt River is 1,350 ft down river from the downstream-most edge of the study area. That position places the groundwater contaminant plume from this Superfund site outside of the study area and should remove any potential risk of it contaminating the study area, based on the logic that groundwater beneath the Salt River is not going to travel in the upstream direction under any imaginable circumstance. SRPMIC Environmental Services has concluded that this site has not impacted the study area and cannot, due to the down-gradient location of all known pollutants (Ramirez, 2004, p. 4).

Two other VOC-groundwater contamination sites in the general vicinity of the Va Shly'ay Akimel study area appear to be incapable of impacting the study area, nor do they pose any foreseeable risk of doing so in the future, primarily due to their distance and their position down-gradient of the study area, with regard to groundwater flow direction. The South Mesa WQARF[7] site is successfully contained for the time being, via in-place remediation activities, according to data in the WQARF section on the ADEQ website as of March 19, 2004. The groundwater contaminant plume remains generally in the position shown in 1986 data attributed to K.D. Schmidt and Associates. That data suggest the plume is no closer to the study area than 23,000 ft to the southeast of the study area (about 4.3 miles). A second VOC-in-groundwater site is much closer to the southeast of the study area: the "Motorola Mesa WQARF" site, again according to data excerpted from the K.D. Schmidt & and Associates report mentioned above, is about 8,000 ft (1.5 miles) from the study area boundary. It has not been ascertained whether this site may have been completely cleaned up, and possibly dropped from the WQARF

[7] WQARF is "water quality assurance revolving fund", essentially a State "Superfund" site.

listings. Regardless, its distance and location down-gradient of known groundwater flow removes this site from being a potential risk to the study area.

DBCP contamination in groundwater. DBCP[8] (which is, "dibromochloropropane") has been detected in groundwater over a large area south of the Salt River (fig. 20), and this area is as close as 1,700 ft south of the study area boundary, directly south of the GRUSP. The location once was known as the "Mesa DBCP WQARF Site". According to data from a 1986 report by K.D. Schmidt and Associates, the DBCP-contaminated groundwater apparently remains south of the Salt River and the study area; data suggest that groundwater flow is southeastward, away from the study area.

LUSTs[9]. In the Phase I EA, eleven LUST properties are listed, including five clustered in a commercial business district along Country Club Dr. at the 202 highway, and along McKellips Rd. near Country Club Dr.; and two others along Alma School Rd. All of those are outside of the study area or at the study area periphery. Four others are in or adjacent the Salt River bottom, associated with the sand and gravel quarry or batch plant operations, and those are considered probably more important, as they are inside the study area. As with the above sites, additional study of these properties is warranted and will be done in the PED phase of study, as these studies would be focused directly on potential interactions with the recommended plan.

Table 56 provides an assessment of each of the alternatives and sites of potential impact to identified hazardous, toxic, and radioactive waste sites within the boundaries defined for each alternative. Numbered sites are shown in Figure 25.

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[8] DBCP is a soil fumigant, applied to control nematodes and applied to crops such as cotton, soybeans, fruits, nuts, vegetables (cucumbers, summer squash, cabbage, cauliflower, carrots, snap beans, okra), plus aster, shasta daisy, lawn grasses and ornamental shrubs. Formerly heavily used in the agriculture industry, its use was stopped in 1979 except for application to pineapple crops in Hawaii (stopped in 1985). EPA lists the following as the health effects related to exposure: when people are exposed to it at levels above the MCL for relatively short periods of time: kidney and liver damage and atrophy of the testes. Sources: http://www.epa.gov/OGWDW/dwh/c-soc/dibromoc.html; http://www.safetyinfo.com/safetyinfo/html/osha/Standards/z/1910_1044_APP_A.html

[9] "LUST" is the acronym for "**l**eaking **u**nderground **s**torage **t**ank".

Table 56. Sites of Potential Environmental Concerns

Alternative	Environmental Concerns
A	- Interaction between study-induced irrigation and the local GRUSP-supported water table must be determined. The GRUSP-supported water table must remain at least 25 feet below the bottom of the Tri-Cities landfill to avoid any leaching of landfill contents. - Planting on the Tri-Cities landfill is also a concern due to irrigation. Both leaching through the landfill and impacts of rising groundwater elevation from below in response to the irrigation need to be considered and documented. - The surface runoff from irrigation may impact the adjoining Chandler Ready Mix site. A detailed site map with the relative elevations of the river bottom and the Chandler operation needs to be obtained. - The same issues also apply to the Salt River Sand and Rock Beeline One operations. Details of the operation need to be determined and documented. - The downstream extent of the expected groundwater elevation change, if any, should be determined, to ensure that potential impacts stated above do not occur further downstream at other sites. - While more distant from the planned study actions than the sites discussed above, the nature of the substances used at the Talley Defense Systems needs to be further defined.
B	- Same as Alternative A. - Due to the increase area of irrigation, there is potential to impact an additional six sites. These sites include the United Metro operations and several landfills including the land fill under the drum site (Site 11*), the Cypress, North Center Street (Tri-Cities South), Old Mesa, and Vulcan demolition debris landfill. Additional research and evaluation of these sites would be needed.
C	- Same as Alternatives A and B. - Since more water would be added to the system, the potential to impact or be impacted by landfills, the GRUSP, and Tri-Cities landfill groundwater elevation limits, and quarry operations runoff, are enhanced.
D	- Same as Alternatives A and B. - The potential to impact or be impacted by the Chandler quarry drops out; the potential impact of the Talley Defense Systems site diminished sharply, both due to increased distance. - The potential impact to the Tri-Cities landfill and other landfills downstream is enhanced due to the additional water.
E	- Same as Alternative C. - Potential impacts of the Indian Bend Wash NPL site need to be evaluated.

Alternative		Environmental Concerns
F	-	Same as Alternatives C and D.
	-	The enhanced wetland areas increase the potential for interaction between study-elevated groundwater and the landfills beyond those of Alternatives A through E.
	-	Potential groundwater interaction with the Mesa Water Treatment Plant recharge and recharge ponds needs to be evaluated.
	-	Potential impacts of the Indian Bend Wash NPL site need to be evaluated.
G	-	Same as Alternative F.
H	-	Same as Alternative G with reduced need to close the data gap on the Indian Bend Wash NPL site.
I	-	Same as Alternative F.
J	-	Same as Alternative F but with less impact to the GRUSP site, from the Tri-Cities landfill, and from the group of five landfills on both banks of the river between Country Club Drive and the alignment of Extension Road.
K	-	Same as Alternative J.
L	-	Same as Alternative F with reduced emphasis on the Talley Defense Systems site and less impact to the Tri-Cities landfill.
M	-	Same as Alternative F.
N	-	Irrigation around the GRUSP site (Site 17).
	-	The largest of all planned wetlands construction adjoins the north side of the North Center Street landfill (Site 30) raises potential conflicts with inundating the landfill contents with the groundwater.
	-	The second largest of all planned wetlands construction nearly adjoins part of the Tri Cities landfill (Site 15), raising potential conflicts with inundating the landfill contents with the groundwater.
O	-	Same as Alternative N.

* Site numbers refer to Figure 25, Activities in and near the Study Area with Potential Environmental Concerns.

5.7.4 Biological Resources

5.7.4.1 Vegetative Cover Types

The existing cover types in the study area along with the proposed additional vegetation acreages for each alternative are presented in Table 57. As shown, the proposed restoration varies between approximately 680 acres for Alternative 2, to as much as 2,100 acres of riparian and scrub shrub habitat for the most extensive alternative, Alternative F.

5.7.4.2 Biological Risk and Uncertainty

The purpose of the Va Shly'ay Akimel Salt River Restoration Project is to re-establish a variety of habitat types that were once found along the Salt River system. The habitat types were chosen based on existing vegetation and historical evidence of what was previously found on site; they are expected to establish and flourish over time. However, because of the dynamic nature of natural systems, there is a certain level of risk and uncertainty associated with habitat restoration. As part of the plan formulation process, an array of alternatives was developed to show what environmental features were feasible within the study area. These alternatives were then compared and analyzed based on cost and expected environmental outputs. The environmental outputs are derived from a Hydrogeomorphic (HGM) model. While models are valuable tools, they are not foolproof, nor can they be considered an exact predictor. It is this risk and uncertainty that will be addressed.

Table 57. With-Project Cover Types and Acreages

	Existing					Proposed Additional Vegetation						With-Project Cover Types					
Alt	CW	MS	RB	Scrub Shrub	Total	CW	MS	RB	Scrub Shrub	WT	Total	CW	MS	RB	Scrub Shrub	WT	Total
A	69	4	332	2,057	2,462	-	-	152	496	-	648	69	4	484	2,553	-	3,110
B	69	4	327	1,866	2,266	-	345	166	686	-	1,197	69	349	493	2,552	-	3,463
C	69	4	321	1,536	1,930	240	233	394	733	29	1,629	309	237	715	2,269	29	3,559
D	68	4	313	1,587	1,972	260	390	286	63	103	1,102	328	394	599	1,650	103	3,074
E	69	4	326	1,699	2,098	286	374	289	821	52	1,822	355	378	615	2,520	52	3,920
F	68	4	271	1,041	1,384	701	619	416	266	187	2,189	769	623	687	1,307	187	3,573
G	69	4	309	1,387	1,769	473	521	423	407	64	1,888	542	525	732	1,794	64	3,657
H	69	4	308	1,387	1,768	9	951	437	407	64	1,868	78	955	745	1,794	64	3,636
I	68	4	281	1,392	1,745	442	89	369	174	196	1,270	510	93	650	1,566	196	3,015
J	68	4	303	1,419	1,794	556	622	296	92	82	1,648	624	626	599	1,511	82	3,442
K	68	4	310	1,428	1,810	494	635	-	104	146	1,379	562	639	310	1,532	146	3,189
L	67	4	322	1,648	2,041	495	477	152	-	143	1,267	562	481	474	1,648	143	3,308
M	68	4	301	1,443	1,816	414	664	158	63	222	1,521	482	668	459	1,506	222	3,337
N	67	4	274	1,546	1,891	853	380	201	24	131	1,589	920	384	475	1,570	131	3,480
O	67	4	254	1,497	1,822	883	380	225	24	200	1,712	950	384	479	1,521	200	3,537
P	69	4	335	2,057	2,465	-	-	-	-	-	0	69	4	335	2,057	-	2,465

*Acreages were determined from GIS maps of the various alternatives.

(a) Physical Factors

Natural systems are dynamic and change depending upon physical, chemical, and biological processes. While some of these factors can be controlled or compensated for, others cannot. Unpredictable physical changes may include changes in land use (e.g., sand and gravel operations), a dramatic alteration of the river course due to flood damages, or anthropogenic influences such as increases in trash and debris, structures, or human presence. These physical factors can affect established vegetation directly, through removal, or indirectly, via degradation. Sand and gravel operations have been present within the Salt River for many years. Discussions with the SRPMIC suggest they will remain a part of the river for at least the next 10 to 25 years, depending upon location. Therefore, any risk and uncertainty related to physical changes within the river channel that are associated with sand and gravel operations, can be expected to remain in place, potentially for the life of the project. Because the land on which the mining operations function is owned by the SRMPIC, the onus will fall upon them to direct the mining companies in terms of the location of future operations. The commitment to protect the established vegetation in the future, regardless of mining operations, will be outlined in the Project Cooperation Agreement, should this project be authorized.

Chemical and biological factors are often intertwined. A groundwater contamination would likely affect vegetation; a change in vegetation would likely affect the soil chemistry. A large flooding event would affect both. Uncontrollable weather events such as extreme temperatures, drought, or even extended rain can also affect the success of vegetation, not only within the project area, but also within the region. Hydraulic and hydrologic assessments estimate that during the 100-year storm event, approximately 90 percent of the vegetation within the 10-year floodplain will be uprooted. Floods of this magnitude have occurred most recently in 1978, 1980, 1983, and 1993. But as with most weather events, historic conditions are not always reliable predictors of future conditions. Under natural and expected project conditions, however, the vegetation will regenerate naturally. An Operations and Maintenance Plan is developed for each authorized project and would address what can be expected to occur after a damaging flood event should high levels of damage occur or should the vegetation not regenerate as expected.

(b) Biological Factors

The Va Shly'ay Akimel Ecosystem Restoration Project is perhaps most vulnerable to risk and uncertainty due to the large number of acres of newly established vegetation proposed. This project would likely use container plantings, pole plantings, and seed mixes to establish vegetation. While these methods are understood to be the most effective and successful means of establishment, there is a risk of mortality due to poor stock, a disease or insect infestation, excessive herbivory damage, unforeseen incompatibilities with regard to soil conditions, water demand, irrigation methods, etc. Any of the above factors can lead to a reduction in vegetation establishment or future success and consequently, in the extent to which the project achieves maximum benefit, measured in Average Annual Functional Capacity Units (AAFCUs). Other factors that may affect the AAFCU values are unusual weather patterns such as unusually long hot dry periods, flaws in the irrigation design, miscalculation of water demand, or error in soil requirements, to name a few. Nonetheless, U.S. Army Corps of Engineers' planning and construction process allows for contingency plans that would address such issues should they arise. Monitoring programs set success criteria standards and require replacement of vegetation until those criteria are met. A Monitoring and Adaptive Management Plan would provide a 5-year window to monitor the success of a constructed project and would allow for refinement to improve any features that may require it. Such refinements could include an adjustment of irrigation, water source, or vegetation type.

5.7.5 Environmental Benefits

Based on the individual features proposed for each alternative, the acreage and functional capacity indices were projected to derive with-project estimates of AAFCUs. Benefits are defined as the increase in AAFCUs for each alternative relative to the without-project conditions. As applied to the without-project conditions, the FCUs for each function have been estimated for TY 1 (year of construction), TY 6 (year the planting efforts are completed), TY 26 (year to capture significant anticipated ecosystem changes, and TY 51 (end of project) for the with-project condition for each alternative. These projected values were then converted into AAFCUs. In general, alternatives requiring moderate or minimum levels of vegetation restoration resulted in the least number of net AAFCUs, while those requiring maximum or extensive levels resulted in the highest number. The results, which range from 373 AAFCUs for Alternative A to 1,035 AAFCUs for Alternative F, are shown in Table 58.

Table 58. With-Project Average Annual Function Capacity Units – Second Array of Alternatives

Function	Without-Project	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I	Alt J	Alt K	Alt L	Alt M	Alt N	Alt O
1	689	1,088	1,250	1,317	1,114	1,452	1,368	1,371	1,362	1,108	1,280	1,175	1,204	1,235	1,288	1,316
2	955	1,362	1,578	1,772	1,589	1,942	2,084	1,975	1,860	1,771	1,902	1,710	1,839	1,899	1,977	2,038
3	72	383	636	863	683	954	1,227	1,051	1,011	803	973	833	816	934	963	1,023
4	131	203	371	431	514	527	825	683	666	720	771	750	823	908	783	788
5	805	1,129	1,227	1,397	1,326	1,495	1,658	1,555	1,398	1,407	1,522	1,377	1,476	1,472	1,617	1,656
6	726	1,001	1,095	1,192	1,080	1,293	1,313	1,280	1,187	1,135	1,234	1,130	1,202	1,202	1,291	1,316
7	701	1,086	1,322	1,513	1,323	1,655	1,804	1,692	1,659	1,365	1,602	1,417	1,453	1,531	1,613	1,677
8	1353	1,922	2,162	2,368	2,080	2,578	2,601	2,530	2,393	2,105	2,397	1,881	2,273	2,306	2,480	2,546
9	889	1,423	1,729	1,954	1,644	2,157	2,266	2,146	2,036	1,655	2,020	1,509	1,836	1,913	2,067	2,131
10	854	1,308	1,741	2,081	1,804	2,379	2,376	2,321	2,104	1,861	2,197	1,668	1,832	2,066	2,224	2,309
Average	**718**	**1,091**	**1,311**	**1,489**	**1,316**	**1,643**	**1,752**	**1,660**	**1,568**	**1,393**	**1,590**	**1,345**	**1,475**	**1,547**	**1,630**	**1,680**
Increase	--	*373*	*594*	*771*	*598*	*926*	*1,035*	*943*	*850*	*675*	*872*	*627*	*758*	*829*	*913*	*963*

5.7.5.1 Period of Analysis

In accordance with ER 1105-2-100 guidance, project benefits and costs will be compared at a common point in time. Since the alternatives have different implementation periods – in this case, ranging from ten months to three years – a common base year has to be established. Costs and benefits are then compounded or discounted to this established base year. In addition, the guidance states that those benefits that are accrued during project construction should be brought forward from the time the benefits start to the beginning of the period of analysis, which coincides with the end of construction.

FCU projections have been made from T1 through T51. Since T1 corresponds with the first year of construction, T1 through T3 correspond to the construction period of three years. Hence, T4 corresponds to the Base Year (PY 1). Data for T4 was interpolated from T1 and T6 values. Since FCU projections were made through T51, which corresponds to PY 48, data for PYs 49 and 50 were estimated to be approximately equivalent to PY 48 since very little change in FCUs occurs during this timeframe on an annual basis.

The results, which range from 389 AAFCUs for Alternative A to 1,084 AAFCUs for Alternative F, are shown in Table 59.

Table 59. With-Project Average Annual Function Capacity Units – Adjusted Results

	T0 – T50		PY1 – P50	
Alternative	**Average**	**Increase**	**Average**	**Increase**
Without-Project	718	-	711	-
A	1,091	373	1,100	389
B	1,311	594	1,330	619
C	1,489	771	1,518	807
D	1,316	598	1,339	628
E	1,643	926	1,677	966
F	1,752	1,035	1,795	1,084
G	1,660	943	1,697	986
H	1,568	850	1,602	891
I	1,393	675	1,418	707
J	1,590	872	1,625	914
K	1,345	627	1,369	658
L	1,475	758	1,503	792
M	1,547	829	1,578	867
N	1,630	913	1,666	955
O	1,680	963	1,717	1,006

5.7.6 Costs

The cost estimates were developed to a level of detail sufficient for economic evaluation in order to select a plan based on cost effectiveness and other criteria from among the alternatives evaluated. Cost estimates for Alternatives A through O were developed for both irrigation methods. Those alternatives developed with drip irrigation have been assigned as Group 1. For example, Alternative A with drip irrigation is analyzed as Alternative A1. Those alternatives developed with SBIN have been assigned as Group 2. Again, Alternative A with SBIN is now analyzed as Alternative A2. However, these irrigation methods do not affect or change the areas of land associated with the project features; thus, real estate costs remain the same for either method.

5.7.6.1 Real Estate

The proposed project features are generally located on areas of land best described as the river corridor and floodplain. On some portions of the project, terraces or banks that are situated above floodplains may be incorporated into the project and used for ecosystem restoration. The lands are all undeveloped with the principle economic or industrial use being sand and gravel extraction. Typically these operations occupy leased land of the SRPMIC. Should any such areas be incorporated into the project, it will be the responsibility of the SRPMIC to extinguish or otherwise terminate the mineral extraction rights or leases. Since the land is generally in a floodplain or if out of the actual floodplain is inside the river corridor, the land lies mostly vacant and unimproved. No residences or businesses will be relocated.

For project formulation purposes, three general categories of land with their respective estimated values were applied as follow:

- River Channel Land: $5,000 per acre
- Farmland outside and above river channel: $7,500 per acre
- Sand and Gravel Operations: $15,000 per acre (estimated residual value of extraction rights)

Table 60 summarizes the estimated real estate costs for each alternative.

@ $5,000/ac @ $15,000/acre @ $25,000/acre

Table 60. Real Estate Costs

Alternative	100-Year Mined Acreage	Associated Value ($)	100-Year Unmined Acreage	Associated Value ($)	Outside 100-Year Acreage	Associated Value ($)	Total Acreage	Total Land Value ($)
A1/A2	201	1,006,930	255	3,831,675	195	4,883,650	652	9,722,255
B1/B2	297	1,482,545	429	6,440,970	392	9,803,325	1,118	17,726,840
C1/C2	633	3,163,205	443	6,648,930	476	11,894,500	1,551	21,706,635
D1/D2	313	1,567,035	395	5,929,200	317	7,933,075	1,026	15,429,310
E1/E2	659	3,297,425	559	8,378,145	515	12,881,750	1,733	24,557,320
F1/F2	442	2,210,050	1,177	17,650,500	512	12,790,550	2,130	32,651,100
G1/G2	639	3,193,440	661	9,917,205	513	12,825,050	1,812	25,935,695
H1/H2	639	3,193,750	663	9,941,100	476	11,907,850	1,777	25,042,700
I1/I2	375	1,877,470	805	12,070,620	14	347,800	1,194.	14,295,890
J1/J2	340	1,697,805	740	11,102,115	507	12,672,300	1,586	25,472,220
K1/K2	56	278,590	729	10,933,230	519	12,965,700	1,303	24,177,520
L1/K2	258	1,289,690	717	10,752,210	217	5,434,600	1,192	17,476,500
M1/M2	250	1,250,455	701	10,509,045	495	12,371,200	1,445	24,130,700
N1/N2	374	1,867,850	901	13,508,460	314	7,849,200	1,588	23,225,510
O1/O2	406	2,031,435	972	14,579,340	334	8,338,650	1,712	24,949,425
P	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Real Estate Descriptions:
100-Year Mined: Land in the 100-year floodplain that has been mined.
100-Year Unmined: Land that is in the 100-year floodplain that could potentially be mined.
Outside 100-Year: Land that is outside of the 100-year floodplain (i.e., commercial, residential, parks and recreation, etc.)

5.7.6.2 Operation and Maintenance Considerations

The features of the Va Shly'ay Akimel Restoration Project are subject to damage by recurrent flood flows and periods of inundation. This would result in the need for periodic maintenance to ensure successful habitat restoration. Operation and maintenance costs include periodic sediment removal, control of invasive plant species, pump replacement, irrigation system maintenance, and monitoring of the landfill area. Operation and maintenance also includes periodic replanting of habitat areas damaged by flood flows.

In compliance with authorizing legislation and cost-sharing requirements, the non-Federal sponsors must assume responsibility for operation and maintenance of project features for as long as the project remains authorized. Table 61 presents the costs associated with the operation and maintenance of each alternative.

5.7.6.3 Associated Costs

For as long as the project remains authorized, the non-Federal sponsors must provide sufficient water for construction, operation, and maintenance of the project. The cost of providing such water is 100 percent associated non-Federal cost. Based on current and future water demand and cost analysis, a unit cost of $75 per acre-foot of (SRP) water was used. These annual costs are shown in Table 62.

5.7.6.4 Project Costs

Tables 63 and 64 show the estimated costs for two variations of each alternative: drip irrigation or braided irrigation, respectively. Based on USACE requirements, all construction cost estimates includes a 25-percent contingency. The planning, engineering, and design (PED) and engineering during construction (EDC) (11 percent of construction cost) was calculated based upon previous USACE experience over a wide range of designed projects that are of a scope and complexity consistent with the project under consideration. As required by the USACE regulations, a 6.5-percent supervision and administration (S&A) cost was taken on the construction cost. Monitoring (1 percent) and adaptive management (3 percent) were also included. The breakdown of costs for each alternative are presented in Tables 63 and 64.

Table 61. Annual Operation and Maintenance Costs

	Alt A1/A2	Alt B1/B2	Alt C1/C2	Alt D1/D2	Alt E1/E2	Alt F1/F2	Alt G1/G2	Alt H1/H2	Alt I1/I2	Alt J1/J2	Alt K1/K2	Alt L1/L2	Alt M1/M2	Alt N1/N2	Alt O1/O2
Control Invasive Vegetation	2,950	2,950	8,850	5,900	8,850	8,850	8,850	8,850	8,850	8,850	8,850	8,850	8,850	8,850	8,850
Low-Flow Channel	0	0	0	0	0	50,000	0	0	50,000	0	0	0	0	0	12,100
Wetland	0	0	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728	11,728
Water Well	0	30,400	0	30,400	30,400	30,400	30,400	30,400	0	30,400	30,400	30,400	30,400	30,400	30,400
Irrigation System Maintenance	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360
Patrol and Biological Survey	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
Refurbishment of Plants	22,678	37,566	44,000	18,037	52,877	46,417	42,896	40,747	21,492	34,030	32,720	24,680	30,624	35,784	36,691
Landfill Area	0	90,000	145,000	111,000	94,000	145,000	145,000	145,000	145,000	116,000	116,000	0	116,000	0	0
TOTAL	**56,588**	**191,876**	**240,538**	**208,025**	**228,815**	**323,355**	**269,834**	**267,685**	**268,030**	**231,968**	**230,658**	**106,618**	**228,562**	**117,722**	**130,729**

Table 62. Annual Associated Costs – Water

	Alt A1	Alt B1	Alt C1	Alt D1	Alt E1	Alt F1	Alt G1	Alt H1	Alt I1	Alt J1	Alt K1	Alt L1	Alt M1	Alt N1	Alt O1
Drip Irrigation System	93,000	203,700	346,575	340,275	425,625	778,425	533,400	377,925	461,250	570,600	591,075	525,225	608,175	725,175	800,850

	Alt A2	Alt B2	Alt C2	Alt D2	Alt E2	Alt F2	Alt G2	Alt H2	Alt I2	Alt J2	Alt K2	Alt L2	Alt M2	Alt N2	Alt O2
Braded Irrigation System	148,725	325,800	554,400	544,425	680,925	1,245,525	853,650	604,875	737,925	913,050	945,525	840,300	973,125	1,160,325	1,282,500

Table 63. Cost Summary – Second Array of Alternatives with Drip Irrigation

With-Project Average Annual Costs by Alternative (in $1,000s)															
	Alt A1	Alt B1	Alt C1	Alt D1	Alt E1	Alt F1	Alt G1	Alt H1	Alt I1	Alt 1J1	Alt 1K1	Alt L1	Alt M1	Alt N1	Alt O1
Construction	$25,106	$62,128	$96,590	$91,796	$90,579	$155,599	$141,758	$144,398	$139,815	$101,980	$91,673	$86,282	$137,022	$89,927	$94,607
Contingency (25%)	$6,277	$15,532	$24,147	$22,949	$22,645	$38,900	$35,440	$36,100	$34,954	$25,495	$22,918	$21,571	$34,255	$22,482	$23,652
PED/EDC (11%)	$2,762	$6,834	$10,625	$10,098	$9,964	$17,116	$15,593	$15,884	$15,380	$11,218	$10,084	$9,491	$15,072	$9,892	$10,407
S&A (6.5%)	$1,632	$4,038	$6,278	$5,967	$5,888	$10,114	$9,214	$9,386	$9,088	$6,629	$5,959	$5,608	$8,906	$5,845	$6,149
Monitoring/Adaptive Mgmt.	$1,431	$3,541	$5,506	$5,232	$5,163	$8,869	$8,080	$8,231	$7,969	$5,813	$5,225	$4,918	$7,810	$5,126	$5,393
Real Estate	$9,722	$17,727	$21,707	$15,429	$24,557	$32,651	$25,936	$25,043	$14,296	$25,472	$24,178	$17,477	$24,131	$23,226	$24,949
Total First Cost	**$46,930**	**$109,800**	**$164,853**	**$151,471**	**$158,795**	**$263,249**	**$236,021**	**$239,041**	**$221,502**	**$176,607**	**$160,037**	**$145,346**	**$227,197**	**$156,498**	**$165,157**
IDC	$1,049	$4,452	$8,963	$8,226	$8,642	$21,762	$19,500	$19,746	$18,268	$9,607	$8,708	$7,899	$18,769	$8,515	$8,987
Gross Investment	$47,979	$114,252	$173,816	$159,697	$167,437	$285,011	$255,522	$258,787	$239,770	$186,214	$168,745	$153,246	$245,965	$165,013	$174,144
Annualized Invest. Cost	$2,886	$6,872	$10,455	$9,606	$10,071	$17,143	$15,369	$15,566	$14,422	$11,200	$10,150	$9,217	$14,794	$9,925	$10,474
Associated Cost (Water)	$93	$204	$347	$340	$426	$778	$533	$378	$461	$571	$591	$525	$608	$725	$801
O&M	$57	$192	$241	$208	$229	$323	$270	$268	$268	$232	$231	$107	$229	$118	$131
Total Annual Cost	$3,035	$7,268	$11,042	$10,154	$10,726	$18,245	$16,172	$16,211	$15,151	$12,003	$10,971	$9,849	$15,631	$10,768	$11,406

Table 64. Cost Summary – Second Array of Alternatives with Braided Irrigation

With-Project Average Annual Costs by Alternative (in $1,000s)															
	Alt A2	Alt B2	Alt C2	Alt D2	Alt E2	Alt F2	Alt G2	Alt H2	Alt I2	Alt 1J2	Alt 1K2	Alt L2	Alt M2	Alt N2	Alt O2
Construction	$18,857	$50,120	$81,382	$82,485	$72,737	$134,040	$124,332	$127,527	$129,496	$85,777	$75,280	$73,203	$120,818	$72,451	$75,871
Contingency (25%)	$4,714	$12,530	$20,345	$20,621	$18,184	$33,510	$31,083	$31,882	$32,374	$21,444	$18,820	$18,301	$30,204	$18,113	$18,968
PED/EDC (11%)	$2,074	$5,513	$8,952	$9,073	$8,001	$14,744	$13,677	$14,028	$14,245	$9,435	$8,281	$8,052	$13,290	$7,970	$8,346
S&A (6.5%)	$1,226	$3,258	$5,290	$5,361	$4,728	$8,713	$8,082	$8,289	$8,417	$5,575	$4,893	$4,758	$7,853	$4,709	$4,932
Monitoring/Adaptive Mgt.	$1,075	$2,857	$4,639	$4,702	$4,146	$7,640	$7,087	$7,269	$7,381	$4,889	$4,291	$4,173	$6,887	$4,130	$4,325
Real Estate	$9,722	$17,727	$21,707	$15,429	$24,557	$32,651	$25,936	$25,043	$14,296	$25,472	$24,178	$17,477	$24,131	$23,226	$24,949
Total First Cost	**$37,668**	**$92,004**	**$142,314**	**$137,671**	**$132,354**	**$231,299**	**$210,196**	**$214,037**	**$206,209**	**$152,593**	**$135,743**	**$125,964**	**$203,183**	**$130,598**	**$137,390**
IDC	$844	$3,735	$7,744	$7,480	$7,212	$19,134	$17,376	$17,689	$17,010	$8,308	$7,394	$6,851	$16,793	$7,114	$7,485
Gross Investment	$38,512	$95,739	$150,058	$145,151	$139,566	$250,433	$227,572	$231,726	$223,219	$160,901	$143,137	$132,814	$219,976	$137,712	$144,875
Annualized Invest. Cost	$2,316	$5,759	$9,026	$8,731	$8,395	$15,063	$13,688	$13,938	$13,426	$9,678	$8,609	$7,989	$13,231	$8,283	$8,714
Associated Cost (Water)	$149	$326	$554	$544	$681	$1,246	$854	$605	$738	$913	$946	$840	$973	$1,160	$1,283
O&M	$57	$192	$241	$208	$229	$323	$270	$268	$268	$232	$231	$107	$229	$118	$131
Total Annual Cost	$2,522	$6,276	$9,821	$9,483	$9,304	$16,632	$14,812	$14,811	$14,432	$10,823	$9,786	$8,935	$14,433	$9,561	$10,127

5.7.7 Cost-Effectiveness and Incremental Cost Analysis

Cost-effectiveness (CE) and incremental cost analyses (ICA) were performed using the IWR-Plan software. CE/ICA identifies the least-costly solution for each level of output. The three criteria used for identifying non-cost-effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at the least cost.

ICA compares the incremental costs for each additional unit of output. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify large increases in cost relative to output. Table 65 summarizes average annual output and cost as well as annual cost per AAFCU for each alternative as determined by the initial ICA run.

Table 65. Average Annual Cost per Average Annual FCU

Alternative	AAFCU		AA COST (1,000s)		AAC/AAFCU (1,000s)
A1	389	$	3,035	$	7.8
A2	389	$	2,522	$	6.5
B1	619	$	7,268	$	11.7
B2	619	$	6,276	$	10.1
C1	807	$	11,042	$	13.7
C2	807	$	9,821	$	12.2
D1	628	$	10,154	$	16.2
D2	628	$	9,483	$	15.1
E1	966	$	10,726	$	11.1
E2	966	$	9,304	$	9.6
F1	1084	$	18,245	$	16.8
F2	1084	$	16,632	$	15.3
G1	986	$	16,172	$	16.4

Alternative	AAFCU	AA COST (1,000s)		AAC/AAFCU (1,000s)	
G2	986	$	14,812	$	15.0
H1	891	$	16,211	$	18.2
H2	891	$	14,811	$	16.6
I1	707	$	15,151	$	21.4
I2	707	$	14,432	$	20.4
J1	914	$	12,003	$	13.1
J2	914	$	10,823	$	11.8
K1	658	$	10,971	$	16.7
K2	658	$	9,786	$	14.9
L1	792	$	9,849	$	12.4
L2	792	$	8,935	$	11.3
M1	867	$	15,631	$	18.0
M2	867	$	14,433	$	16.6
N1	955	$	10,768	$	11.3
N2	955	$	9,561	$	10.0
O1	1,006	$	11,406	$	11.3
O2	1,006	$	10,127	$	10.1

As can be seen from this analysis, the alternatives that utilize the braided irrigation system (those designated with a "2" following the letter) are clearly more cost-effective than those utilizing drip irrigation (those designated with a "1" following the letter). However, it must also be pointed out that, although drip irrigation has a higher first cost, it also possesses greater cost efficiency in long-term water costs.

As previously discussed, alternatives are considered cost-effective if no other alternatives provide greater output for the same cost or provide the same output for a lesser cost. This step eliminates alternatives that are "non-cost effective" from further consideration. With the No Action Alternative comprising the first increment, seven alternatives were determined as cost-effective. These are presented in Table 66.

Table 66. Cost-Effective Alternatives

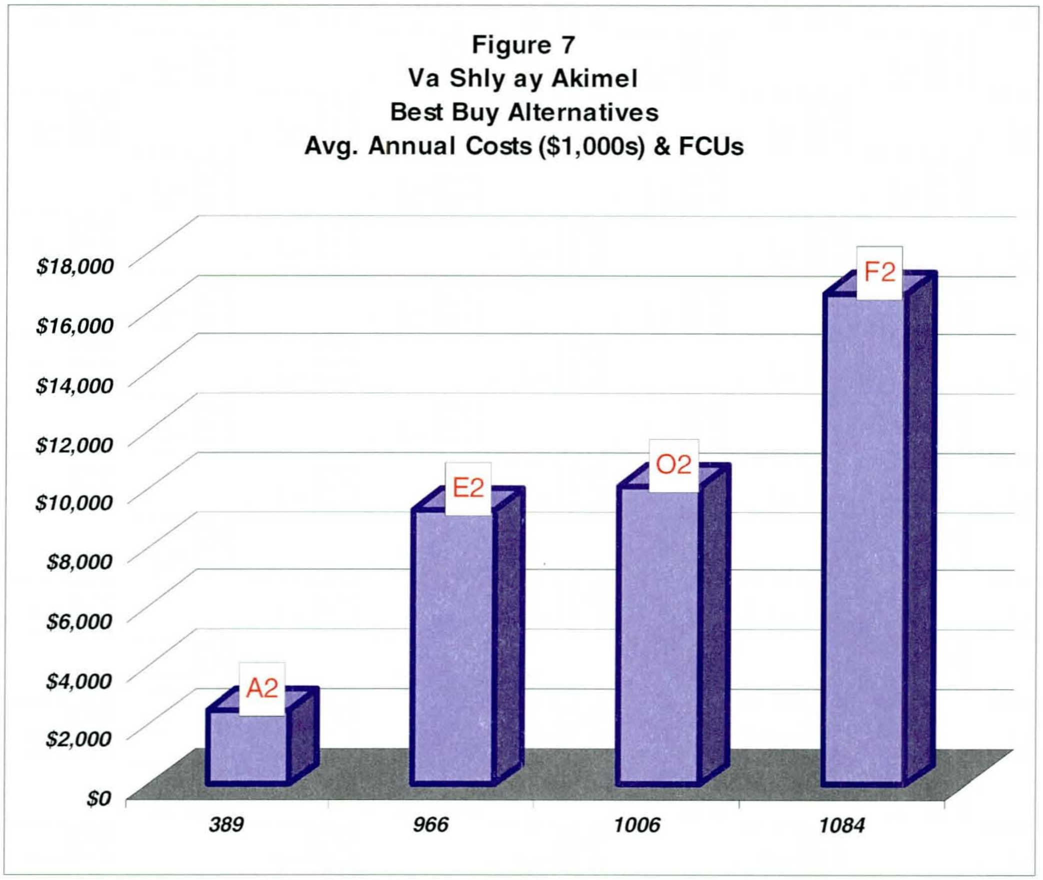
Alternative	AAFCU	AA COST ($1,000s)	AAC/AAFCU ($1,000s)
P	-	-	-
A2	389	2,522	6.5
B2	619	6,276	10.1
L2	792	8,935	11.3
E2	966	9,304	9.6
O2	1,006	10,127	10.1
F2	1,084	16,632	15.3

An incremental cost analysis was conducted on the set of cost-effective plans to identify the most efficient set of alternatives for providing the full range of restoration. These "best buy" combinations provided the greatest increase in FCUs for the least increase in cost. The analysis resulted in the identification of five best buy plans (including the No Action Alternative, "P"). Table 67 and Figure 54 present these alternatives, with the values for their average annual costs and outputs, ordered by increasing incremental cost per unit.

Table 67. Incremental Cost Analysis – Best Buy Alternatives

Alternative	AAFCU	Incremental AAFCU	AA Cost (1,000s)	Incremental AA Cost (1,000s)	Incremental AAC/AAFCU (1,000s)
P	-	-	-	-	-
A2	389	389	2,522	2,522	6.5
E2	966	577	9,304	6,783	11.8
O2	1,006	40	10,127	823	20.6
F2	1,084	78	16,632	6,505	83.4

Figure 54. Incremental Cost Analysis – Best Buy Alternatives Chart



With the No Action Alternative comprising the first increment, Alternative A2 has the lowest average annual cost per AAFCU and is therefore the first point on the ICA curve. ICA then determines which alternative has the lowest incremental average annual cost (relative to Alternative A2) per incremental increase in output (relative to Alternative A2). Based upon this methodology, Alternative E2 is identified as the next best buy plan. Alternative E2 provides an increase of 577 AAFCUs for an additional average annual cost of about $6.8 million. The next Best Buy plan is Alternative O2, which provides an additional 40 AAFCUs relative to Alternative E2, for an additional average annual cost of $823,000. As the largest of all plans in terms of output, Alternative F2 is also shown on the final list of alternatives under the ICA analysis. However, this can be somewhat misleading, since this alternative is included because it serves as an "end point" and not because it is necessarily a good buy. For example, Alternative F2 only provides an extra 78 AAFCUs relative to Alternative O2, but has a 64 percent higher cost. As a result, the incremental AAC/AAFCU for Alternative F2 is equal to $83,400, which is more than four times higher than the incremental AAC/AAFCU for Alternative O2. Hence, from an ICA perspective, it would seem difficult to justify the additional costs for Alternative F2.

Although the above alternatives represent the best buys of the proposed alternatives, it should be pointed out that there are several alternatives that have similar output and cost to these alternatives. For example, Alternative N2 provides similar output and has similar costs relative to O2. However, Alternative N2 does not provide the same array of habitats, nor the extent per habitat, and was therefore, dropped from the array.

The information provided through incremental cost analysis allows decision-makers to decide when it is no longer worth the additional cost to increase the level of output. This may be easily seen when examining Alternative F2, which costs substantially more for a less dramatic gain in habitat value.

5.7.8 Recreation

The development of ecosystem restoration alternatives also provides a unique opportunity to provide resource-based recreation and environmental education that integrates the community and the restored environment along the Salt River. The restoration of the degraded ecosystem along the Salt River channel will bring a riparian open space features to the rapidly expanding planning area. Drawing on a population base of over three million in the metropolitan Phoenix area, it is estimated that visitation to the study area could be significant. Primary use times for this unique resource would coincide with the "visitor season" between October and May when temperatures are moderate.

The goal of the environmental education and recreation component is to provide opportunities for visitors of all ages, abilities, and backgrounds to enjoy this unique resource while developing an awareness, knowledge and understanding of desert riparian habitat and its relationship to the surrounding environment. Additionally, it presents an opportunity to acknowledge and understand the influence of the Salt River on the environment and cultures throughout the Valley's history. Visitors to potential recreation facilities along the study area reach could participate in a variety of pursuits from enjoying scenic views, picnicking with the family, learning about the habitat, or exploring the resource on foot, by bicycle or horseback. Recognizing the diverse local society, an integrated project could employ design components ranging from areas adapted for special needs to multi-lingual signage.

5.7.8.1 Proposed Recreation Alternatives

Three recreational trail alternatives were developed. In addition to trailheads with small parking lots located approximately every four miles of trail length, all trail options include a larger parking lot and restroom facility, which would also feature utilities, lighting, a habitat interpretive center, picnic facilities, benches and signage. It should also be noted that the Local Sponsors have indicated a potential desire to locate a cultural center complex that may cost in excess of $10 million in the location designated for the parking and restroom facility. However, Federal cost sharing would be based upon the cost sharable options included in this analysis. More aggressive recreational components, such as lakes, sporting centers, parks, ball fields, etc. were rejected as out-of-harmony with the character of this project.

Recreation Alternative A: In Option A, a 7.77 mile trail (Trail #1) on the west end of the project would connect to the City of Mesa's Riverview Park where an existing underpass under the freeway is located. It would also connect to Dobson Road at the existing Dobson Road freeway underpass. From these connection points, trail users could proceed south on Dobson Road (using existing bike paths and sidewalks within the Dobson Road right-of-way) to connect to the City of Mesa's existing trail system along the Tempe Canal. In Option A, a trail on the south side of the river between Gilbert Road and Val Vista Drive would serve to connect residents living north of the Red Mountain Freeway (the 202 Freeway) to the City of Mesa's existing trail system along the South Canal. At Gilbert Road, trail users could use sidewalks and bike paths within the Gilbert Road right-of-way to access South Canal to the south. At Val Vista Drive, the trail would tie in to the South Canal at the existing underpass for the canal under the freeway. Thus, connection to the South Canal trail would be complete.

Recreation Alternative A would also include trail head signage, three parking lots, mileage markers, educational plaques along the trail system, concrete benches, rest stops, guard posts, and street crossing signage. It would also incorporate a restroom, habitat interpretive outdoor demonstration area, a 12' by 12' ramada, a small parking lot, four picnic tables, trash receptacles, benches and signs. These latter features are included as cost-shareable elements of a proposed Cultural Center, located within the footprint of the ecosystem restoration project. The proposed center, while not cost-shareable under the existing study authority, would be approximately 29,400 square feet in area, and would serve as the educational lynchpin of the project. Schools, environmental education, and other stakeholder groups would make use of the center to promote environmental awareness, and foster a greater sense of awareness of the importance of the environment to its community. The center's programs would foster campaigns that would create a sense of stewardship and "ownership" in the project's resources, to further enhance wise use of the area.

The estimated cost of Recreation Alternative A (without the Cultural Center) is $1,942,322.

Recreation Alternative B: Option B (Trail #2) is the same as Option A, with the exception that it deletes the trail on the south side of the river between Gilbert Road and Val Vista Drive, for a total of 5.13 trail miles. This option offers the fewest recreational opportunities of the three options that are presented, but is also the least costly. It includes the same features as Recreation Alternative A, but scaled to the shorter length of trail.

Recreation Alternative B would also include trail head signage, three parking lots, mileage markers, educational plaques along the trail system, concrete benches, rest stops, guard posts, and street crossing signage. As with Alternative A, it would also incorporate a restroom, habitat interpretive outdoor demonstration area, a 12' by 12' ramada, a small parking lot, four picnic tables, trash receptacles, benches and signs, associated with the proposed Cultural Center, located within the footprint of the ecosystem restoration project.

The estimated cost of Recreation Alternative B (without the Cultural Center) is $1,350,553.

Recreation Alternative C: Option C includes all of the features of Option A, plus a continuous trail on the south side of the river between the Pima/Price Freeway (Loop 101 Freeway) and Val Vista Drive. Total trail miles in this alternative is 13.64 miles. Of the three options, this option provides the most recreational opportunities. It provides for connectivity to the City of Mesa's existing trail systems on the east and west ends of the project and for connection to the arterial street grid.

Recreation Alternative C would also include trail head signage, three parking lots, mileage markers, educational plaques along the trail system, concrete benches, rest stops, guard posts, and street crossing signage. As with Alternatives A and B, it would also incorporate a restroom, habitat interpretive outdoor demonstration area, a 12' by 12' ramada, a small parking lot, four picnic tables, trash receptacles, benches and signs, associated with the proposed Cultural Center, located within the footprint of the ecosystem restoration project.

The estimated cost of Recreation Alternative C (without the Cultural Center) is $3,216,956.

Trails in all the recreation alternatives would be available for use by pedestrians, bicyclists and equestrians (i.e., "multi-use"). Motorized vehicles of all types would be prohibited, with the exception of project maintenance vehicles and motorized wheelchairs.

Details of the planned features associated with the trail improvements include:

- 12-foot wide dirt trail/path surfaced with decomposed granite, crushed aggregate or similar materials;
- Trail lined with boulders or curbing to define the trail location;
- Mileage markers;
- Plaques or similar markers at significant project features to educate the public relative to cultural, biological or environmental aspects of the project;
- Concrete benches located approximately every quarter mile;
- Bike stop/ rest stations spaced approximately one per mile (perhaps overlooking significant project features and having the plaques or markers discussed above);
- Integral art that highlights the cultural, biological and/or environmental theme of the project (e.g., artwork incorporated into the design of such things as ramadas, bike racks, the trail surface, etc.);
- Signs at major mile cross streets

5.7.8.2 Benefit Analysis

National Economic Development benefits arising from recreation opportunities created by a project are measured in terms of aggregate willingness to pay. Corps Principles and Guidelines describes three techniques which have been developed to estimate recreation demand and value. They include: 1) the Travel Cost Method; 2) the Contingent Value Method; and 3) the Unit Day Method. The Unit Day method was the method chosen for this analysis.

The Unit Day method does not attempt to account for the impact of price on visitation to a recreation site. Instead, an assigned user day value is applied to the total number of estimated visitors. User day values are simulated market values judgmentally derived from a range of values agreed to by Federal water resource agencies. It is intended to represent the user's average willingness to pay for a day of recreation activity at the site. When a properly formulated unit day value is applied to estimated use, an approximation of the area under the site demand curve is obtained, which is used in estimating recreation benefits.

A national schedule is available showing a range of values for both specialized and general recreation opportunities. A point rating system can be used to select a specific value from the published schedule of value ranges. Once alternatives have been formulated and recreation and environmental components identified and described, then unit day values can be selected with the input of Corps and local government agencies. These values are then applied to projected visitation.

(a) Visitation Projections

National Recreation and Parks (NRPA) standards for trail capacity and use range from 40 to 90 users per day per trail mile (or between 14,600 to 32,850 users per year per trail mile). The City of Mesa has estimated an average annual use of 40 users per day (or 14,600 per year) per mile, based upon use of existing trail systems, proximity to existing development and the unique features of the proposed environmental restoration project. This ratio reflects an average of 30 users per day per mile for the summer months of June through September, and 45 users per day per mile during the remaining months. Visitation for each recreation option has been estimated by applying this visitation factor to the proposed length of trails.

Transfers of visitation from competing facilities are expected to be minimal due to the unique recreation opportunities and setting offered at the restoration site. The primary transfers are expected to be in the categories of education field trips, bird watchers, passive nature watchers, joggers and recreational cyclists.

(b) Unit Day Point Value Estimates

Unit day values will be calculated by assigning points to each activity (based upon Federal guidelines) and then converting total points to dollar recreation values (per the conversion table included in Economic Guidance Memorandum 04-03). Point values are derived by ranking the potential recreation resource according to five different criteria:

Criteria Values	Key Variables	Range of Point
Recreation Experience	Number and type of activities	0 – 30
Availability of Opportunity	Number of similar opportunities nearby	0 – 18
Carrying Capacity	Adequacy of facilities for activities	0 – 14
Accessibility	Ease of access to and within site	0 – 18
Environmental	Aesthetic quality of site	0 - 20
TOTAL		0 – 100

Based upon the total number of points assigned, UDV's (FY 04) can range from $3.00 to $9.01 per recreation day.

Separate UDV point values were derived for trail features (included in all options) and the cultural center (included all options). The following shows the results.

Table 68. Unit Day Value Assessment

Trails Criteria	General Rec. - Max Points	Total Points	Discussion
Recreation Experience	30	20	Several general recreational activities, e.g., hiking, bike riding, horseback riding, but in high quality setting
Availability of Opportunity	18	8	Several trail systems within a one hour travel time, but few in similar environment (e.g., Rio Salado Project)
Carrying Capacity	14	8	Adequate facilities to conduct recreation without deterioration of the resource
Accessibility	18	15	Good access to site provided by roads due to urban setting & links to existing parks
Environmental	20	15	High quality esthetic setting adjacent to environmental restoration project
	100	66	UDV Dollar Equivalent = $7.17

Based upon the visitation estimates and UDV values discussed above, Table 69 shows the expected annual benefits for each of the proposed recreation options.

Table 69. Expected Annual Benefits for Recreation Alternatives

Benefits	Alternative 1	Alternative 2	Alternative 3
Trails			
Trail Length	7.8	5.1	13.6
Avg Users/Mile (Oct-May)	45	45	45
Avg. Users/Mile (June-Sept)	30	30	30
Avg. Users/Mile/Year	14,600	14,600	14,600
Estimated Annual Visitation	113,442	74,898	199,144
Less Transfers (5%)	5,672	3,745	9,957
Estimated Annual Visitation	107,770	71,153	189,187
Unit Day Value	$ 7.17	$ 7.17	$ 7.17
Annual Benefits	$ 772,495	$ 510,025	$ 1,356,091

(c) Recreation Costs & Benefit/Cost Analysis

Table 70 shows estimated costs for each recreation option. These values are approximate based upon information furnished by the City of Mesa and previous Corps reports. In addition, net benefits and benefit/cost ratios are also presented.

Table 70. Costs by Alternative and Benefit-Cost Analysis

Costs	Alternative 1	Alternative 2	Alternative 3
Trail Length (Miles)	7.77	5.13	13.64
Trail Construction Cost	$ 1,227,303	$ 812,027	$ 2,121,783
Restrooms/Interpretive Center	$ 135,730	$ 135,730	$ 135,730
Total Construction Cost	$ 1,363,033	$ 947,757	$ 2,257,513
Contingency (25%)	$ 340,758	$ 236,939	$ 564,378
PED/EDC (11%)	$ 149,934	$ 104,253	$ 248,326
S&A (6.5%)	$ 88,597	$ 61,604	$ 146,738
Total First Cost	**$ 1,942,323**	**$ 1,350,553**	**$ 3,216,957**
IDC (1 Yr Const. Period)	$ 53,880	$ 37,465	$ 89,239
Gross Investment	$ 1,996,203	$ 1,388,018	$ 3,306,196
Annualized Investment Cost	$ 120,068	$ 83,487	$ 198,862
O&M*	$ 388,500	$ 256,500	$ 682,000
Total Annual Cost	$ 508,568	$ 339,987	$ 880,862
Annual Benefits	$ 772,495	$ 510,025	$ 1,356,091
Net Benefits	$ 263,926	$ 170,038	$ 475,229
Benefit/Cost Ratio	1.52	1.50	1.54

** O&M Includes $50,000/mile of trail.

Table 70 shows that each of the recreation options appears to be economically justified. The Local Sponsors have not yet determined which plan they desire. Refinement of cost estimates and a designation of the Recommended Recreation Plan will be completed prior to completing the Final Feasibility Report.

Continued coordination between the Corps of Engineers and the non-Federal sponsors has been taking place to discuss which option or combination thereof to incorporate into the restoration project. The recreation component of the selected plan will be selected, and its cost-sharing apportionment discussed, following the public meeting.

5.8 Alternative Plans – Final Array

Since Alternatives A2, E2, O2, and F2 were determined to be economically justifiable, they have been carried forward into the final array of alternatives along with the No Action Alternative (Alternative P). The next step would be to compare these alternatives in terms of their contributions toward the four accounts under the System of Accounts as suggested by the U.S. Water Resources Council (USWRC). These plans are then compared against the four specific evaluation criteria: acceptability, completeness, effectiveness, and efficiency. The analyses will demonstrate which plan(s) would be the most rational choice for recommendation.

5.8.1 System of Accounts

A method of displaying the positive and negative effects of the various alternatives is to use the System of Accounts as suggested by the USWRC. The accounts are categories of long-term impacts, defined in such a manner that each proposed plan can be easily compared to another. The accounts used include National Economic Development, Environmental Quality which includes the National Environmental Restoration analysis, Regional Economic Development, and Other Social Effects.

5.8.1.1 National Economic Development (NED)

For all project purposes except ecosystem restoration, the alternative plan that reasonably maximizes net economic benefits consistent with protecting the Nation's environment will be selected. The Assistant Secretary of the Army for Civil Works may grant an exception when there are overriding reasons for selecting another plan based on other Federal, State, local, and international concerns. Because the only element of the analysis that generates monetary benefits is that associated with the proposed recreational features of the final array of alternatives, an NED analysis was only conducted for those alternative plans, any of the three of which may be incorporated into the final recommended plan. The NED analysis is presented in Table 71.

5.8.1.2 Environmental Quality (EQ)

The EQ account is another means of evaluating the alternatives to assist in making a plan recommendation. This account is intended to display the long-term effects the alternative plans may have on significant environmental resources.

Ecosystem restoration is a major objective of this study process. For single-purpose ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, will be selected. The selected plan must be shown to be cost-effective and justified to achieve the desired level of output. This plan will be identified as the NER Plan.

Ecosystem restoration measures used in formulating the NER alternative plan are based on a combination of monetary and non-monetary benefits compatible with the Planning and Guidance (P&G) selection criteria as outlined in ER 1105-2-100. There are no universal environmental outputs; however, the outputs must increase ecosystem value and productivity and quantity and quality of measurable outputs.

The NER analysis for alternatives is shown in Table 72, under the Environmental Quality (EQ) Account. Details about the generation of Average Annual Functional Capacity Units (AAFCUs) are presented in the HGM Assessment Appendix. Details on the cost estimate and cost-benefit comparison are presented in the Cost Appendix and Economic Appendix, respectively.

A comparison of this and other effects that the proposed plans may have on the EQ resources is shown in Table 72.

5.8.1.3 Regional Economic Development (RED)

The RED account is intended to illustrate the effects that the proposed plans would have on regional economic activity, specifically, regional income and regional employment. The comparison of possible effects that the plans may have on these resources is shown in Table 73.

5.8.1.4 Other Social Effects (OSE)

The OSE account typically includes long-term community impacts in the areas of public facilities and services, recreational opportunities, transportation and traffic, and man-made and natural resources. A comparison of the effects that the proposed alternatives would have on OSE resources is shown in Table 74.

Table 71. National Economic Development (NED) Account

Criteria	No Action	Recreation Alternative A	Recreation Alternative B	Recreation Alternative C
Total First Cost	0	$1,942,323	$1,350,553	$3,216,957
IDC	-	$53,880	$37,465	$89,239
Gross Investment	-	$1,996,203	$1,388,018	$3,306,196
Annualized Investment Cost	-	$120,068	$83,487	$198,862
O&M	-	$388,500	$256,500	$682,000
Total Annual Cost	-	$508,568	$339,987	$880,862
Annual Benefits	-	$772,495	$510,025	$1,356,091
Net Benefits	-	$263,926	$170,038	$475,229
Benefit-Cost Ratio	**-**	***1.52***	***1.50***	***1.54***

Table 72. Environmental Quality Account

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Average Annual FCU	711	1,100	1,677	1,717	1,795
Increase in AAFCU	-	389	966	1,006	1,084
Average Annual Cost ($1,000s)	-	2,522	9,304	10,127	16,632
Average Annual Cost ($1,000) per AAFCU	-	6.5	9.6	10.1	15.3
Hydrology and Water Quality	Existing flooding and flood damage will continue at approximately the same level of magnitude and frequency. Water quality is expected to decline as the watershed continues to urbanize. Water quality will also be affected by development and runoff from surrounding properties. Erosion would continue at current rate and extent.	Temporary construction and O&M impacts to water quality would be slightly less than Alternatives E2, O2, and F2 because of the smaller construction area. There would be an anticipated long-term improvement in water quality due to the cleansing effect of vegetation and wetlands. This would be less effective than alternatives E2, O2, and F2, due to lesser acreages involved. Hydraulic modeling demonstrated no increases in water surface elevations in the project area.	Temporary construction and O&M impacts to water quality would be larger than alternative A2, but only slightly less than O2. There would be an anticipated long-term improvement in water quality due to the cleansing effect of vegetation and wetlands. This would be slightly less effective than alternative O2, due to lesser acreages involved. Hydraulic modeling demonstrated increases in water surface elevations in the lower and middle project reaches (2, 4, and upper segment of 5) associated with the establishment of cottonwood-willow and wetland vegetation in the main channel.	Temporary construction and O&M impacts to water quality would be similar to Alternative F2. There would be an anticipated long-term improvement in water quality due to the cleansing effect of vegetation and wetlands. This would be less effective than alternative F2, due to lesser acreages involved. Hydraulic modeling demonstrated increases in water surface elevations in the lower and middle project reaches (2, 4, and upper segment of 5) associated with the establishment of cottonwood-willow and wetland vegetation in the main channel.	Temporary construction and O&M impacts to water quality due to temporary discharges of soil and sediment into the river channel. Channel reshaping and vegetation planting activities have potential to increase 100-year water surface elevations and increase the potential for flooding in the project area. Hydraulic modeling demonstrated increases in water surface elevations in the lower and middle project reaches (3, 4, 5, and 6) associated with the establishment of cottonwood-willow and wetland vegetation in the main channel.

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Air Quality	No construction-related emissions would be generated.	Temporary construction and O&M impacts to air quality; total quantities of emissions from channel excavation, bank stabilization, and riverbank restoration would be lower than Alternative F2.	Temporary construction and O&M impacts to air quality; total quantities of emissions from channel excavation, bank stabilization, and riverbank restoration would be slightly lower than Alternative O2.	Temporary construction and O&M impacts to air quality; total quantities of emissions from channel excavation, bank stabilization, and riverbank restoration would be lower than Alternative F2.	Temporary construction and O&M impacts to air quality.
Noise	No construction-related noise would be generated, no new project-related traffic would use area roadways, and no follow-on maintenance would occur.	Temporary construction-related noise generated; however, since the construction footprint for Alternative A2 is less than a third the size in Alternative F2, the duration of construction activities and noise impacts would be less than Alternative F2. New vehicle trips in the study area would be generated by recreational users traveling to visit the newly constructed site. This would contribute to traffic noise conditions on roadways.	Temporary construction-related noise generated; post-construction noise effects from new traffic and O&M activities would be identical to Alternative F2.	Temporary construction-related noise generated; post-construction noise effects from new traffic and O&M activities would be identical to Alternative F2.	Temporary construction-related noise generated; new vehicle trips in the study area would be generated by recreational users traveling to visit the newly constructed site. This would contribute to traffic noise conditions on roadways.

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Habitat and Wildlife Diversity and Numbers	The study area would continue to suffer from a lack of habitat and wildlife diversity. There would be a long-term decline in both habitat quality and quantity. There would be a long-term decline in wildlife diversity and numbers.	The study area would show a substantial increase in habitat and wildlife diversity. There would be an immediate increase in both habitat quality and quantity. There would be a long-term increase in wildlife diversity and numbers.	The study area would show a very substantial increase in habitat and wildlife diversity. There would be an immediate increase in both habitat quality and quantity. There would be a long-term significant increase in wildlife diversity and numbers.	The study area would show a very substantial increase in habitat and wildlife diversity. There would be an immediate increase in both habitat quality and quantity. There would be a long-term significant increase in wildlife diversity and numbers. This alternative would result in slightly more habitat and wildlife diversity and numbers than alternative E2, and considerably more than alternative A2.	The study area would show a very substantial increase in habitat and wildlife diversity. There would be an immediate increase in both habitat quality and quantity. There would be a long-term significant increase in wildlife diversity and numbers. This alternative would result in slightly more habitat and wildlife diversity and numbers than alternatives E2 and O2, and considerably more than alternative A2.
Vegetation	No Action would result in long-term habitat degradation and long-term increase in saltcedar. **Expected 17 percent decline in FCUs over period of analysis.**	There would be a substantial increase in the vegetation diversity and numbers of each type of vegetation within the study area. Increase in the CW due to the removal of saltcedar; Results in an **expected increase of 389 AAFCUs.**	Substantial increase in the habitat value in the region. Increase in the CW, new river bottom, and open water communities; results in an **expected increase of 966 AAFCUs.**	Substantial increase in the habitat value in the region. Increase in the CW, new river bottom, and open water communities; results in an **expected increase of 1,006 AAFCUs.**	Substantial increase in the habitat value in the region. Increase in the CW, new river bottom, and open water communities; results in an **expected increase of 1,084 AAFCUs.**

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Wildlife Species	No Action would result in long-term habitat degradation.	The primary benefit would be to riparian-obligate bird species from the removal of saltcedar to allow for CW growth.	The primary benefit would be to riparian-obligate bird species due to increases in Cottonwood-Willow and Mesquite communities. There would also be a substantial increase in habitat for shorebirds and waterfowl associated with the constructed wetlands. The benefit to wildlife species would be considerably greater than alternative A2.	The primary benefit would be to riparian-obligate bird species due to increases in Cottonwood-Willow and Mesquite communities. There would also be a substantial increase in habitat for shorebirds and waterfowl associated with the constructed wetlands. The benefit to wildlife species would be considerably greater than alternative A2. **Because alternative O2 establishes 883 acres of Cottonwood-Willow, and 200 acres of wetlands, versus only 287 acres of Cottonwood-Willow and 52 acres of wetlands under alternative E2, alternative O2 has significantly greater value to riparian obligates and other riparian-dependent species.**	The primary benefit would be to riparian-obligate bird species due to increases in Cottonwood-Willow and Mesquite communities. There would also be a substantial increase in habitat for shorebirds and waterfowl associated with the constructed wetlands. The benefit to wildlife species would be considerably greater than alternative A2. **Alternative F2 would establish slightly more habitat, but not a greater number of habitats than alternative O2. The number of wildlife species would be very similar to that generated under Alternative O2.**
Endangered Species	The decline in CW habitat value would result in the eventual decrease of optimal habitat available to the southwestern willow flycatcher and the Yuma clapper rail.	An increase in nesting and foraging habitat for the southwestern willow flycatcher, the western yellow-billed cuckoo, and the Yuma clapper rail is anticipated; O&M activities may produce	There would be a more significant increase in nesting and foraging habitat for the southwestern willow flycatcher, the western yellow-billed cuckoo, and the Yuma clapper rail under alternative E2; O&M activities may	There would be a more significant increase in nesting and foraging habitat for the southwestern willow flycatcher, the western yellow-billed cuckoo, and the Yuma clapper rail	There would be a slightly more significant increase in nesting and foraging habitat for the southwestern willow flycatcher, the western yellow-billed cuckoo, and the Yuma clapper rail

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
		potential short-term impacts.	produce potential short-term impacts.	under alternative O2; **However, because alternative O2 establishes 883 acres of Cottonwood-Willow, and 200 acres of wetlands, versus only 287 acres of Cottonwood-Willow and 52 acres of wetlands under alternative E2, alternative O2 has significantly greater value to riparian obligates and other riparian-dependent threatened or endangered species.** O&M activities may produce potential short-term impacts.	under alternative F2 than O2; **Alternative F2 would establish slightly more habitat, but not a greater number of habitats than alternative O2. The value of this habitat to threatened and endangered species would be very similar to that generated under Alternative O2.** O&M activities may produce potential short-term impacts.
Cultural Resources	No quantifiable analysis of direct impacts on cultural resources is possible; however, it is probable that site may be disturbed or lost both by other human actions that are not project-related and through natural processes such as erosion. Human disturbance of cultural and historic sites is likely to increase with increased development	Although a detailed cultural and historical resources analysis has not been completed, preliminary results indicate that the effect of alternative A2 would not be anticipated to be severe. More detail will be known upon completion of these analyses.	Same as Alt. A2.	Same as Alt. E2.	Same as Alt. O2.

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
	of the study area.				
Aesthetics	The existing aesthetic environment would likely decline somewhat over the period of analysis, due to the loss of habitat, increasing development, and associated impacts to aesthetic qualities.	Although limited, restoration activities would improve the aesthetic quality of the area.	Alternative E2 would significantly improve aesthetic quality of the study area. Additional riparian vegetation corridors, wetland and upland habitats, and increased wildlife would result in perceived higher aesthetic quality improvement between this and Alternative A2.	Alternative O2 would result in a slightly higher improvement in aesthetic quality of the study area over that of alternative E2. Additional riparian vegetation corridors, wetland and upland habitats, and increased wildlife would result in significantly higher aesthetic quality improvement between this and Alternative A2.	Alternative F2 would result in a slightly higher improvement in aesthetic quality of the study area over that of alternative O2. Additional riparian vegetation corridors, wetland and upland habitats, and increased wildlife would result in higher aesthetic quality improvement between this and Alternative A2 and somewhat more than E2.

Table 73. Regional Economic Development Account

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Employment	No impacts on employment.	10 months temporary increase in construction-related employment. The increased construction-related employment would have a corresponding short-term beneficial effect on the local economy.	Three years temporary increase in construction-related employment. The increased construction-related employment would have a corresponding short-term beneficial effect on the local economy.	Three years temporary increase in construction-related employment. The increased construction-related employment would have a corresponding short-term beneficial effect on the local economy.	Three years temporary increase in construction-related employment. The increased construction-related employment would have a corresponding short-term beneficial effect on the local economy.
Housing Stock and Business	Existing conditions would remain relatively unaffected.	Implementation of Alternative A2 would not require removal of any residences or displacement of businesses. The direct employment-related increase in personal income would result in associated short-term increases in spending on goods and services, temporarily benefiting both households and businesses within the local economy.	Same as Alternative A2.	Same as Alternative A2.	Same as Alternative A2.
Local Government Finance	No direct impacts on local government finance.	Non-Federal sponsor's initial investment of $13.5M for construction , $148,725 for water, and $56,588 for maintenance annually.	Non-Federal sponsor's initial investment of $47.8M for construction , $680,925 for water, and $228,815 for maintenance annually.	Non-Federal sponsor's initial investment of $50.7M for construction , $1,282,500 for water, and $130,729 for maintenance annually.	Non-Federal sponsor's initial investment of $87.65M for construction , $1,245,525 for water, and $323,355 for maintenance annually.

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Growth Inducing Impacts	No direct impacts on growth in the area.	Although the proposed action would not directly construct housing or other facilities that would result in growth, Alternative A2 could potentially induce growth as a result of new recreational opportunities. Any potential growth in this area would be limited by market factors that are unrelated to elements of the proposed action.	Same as Alternative A2.	Same as Alternative A2.	Same as Alternative A2.

Table 74. Other Social Effects Account

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Public Health and Safety	Safety threats associated with flood hazards would continue to exist for properties within the floodplain. This alternative would not provide vector control beyond existing levels; thus, existing vector problems would persist.	Temporary construction-related water quality impacts; standing water, which may be present for a short time following heavy rainfall or irrigation in various portions of the project area, may have the potential to temporarily increase mosquito breeding in the project area.	Same as Alternative A2.	Same as Alternative A2.	Same as Alternative A2.
Recreation	Recreation conditions would stay substantially the same. Recreational experiences would also not be enhanced.	Long-term recreation benefits associated with Alternative A2 would be reduced in comparison to those of Alternative F2. New habitat development is limited to SD vegetation types, which could lead to lower wildlife diversity and may attract fewer recreationists in the central and western portions of the project area.	Long-term beneficial effects of Alternative E2 will increase compared to those of Alternative F2 due to the addition of the multi-use trails in Reaches 1 and 6.	Long-term beneficial effects of Alternative O2 will increase compared to those of Alternative F2 due to the addition of the multi-use trails in Reaches 1 and 6.	The habitat restoration would create attractive open space that is conducive to the development of new recreational opportunities. The increase in passive open space would enhance the overall experience of recreationists, and O&M activities would maintain this benefit.

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Transportation	No impact to transportation would occur. Traffic conditions would continue to increase as the surrounding areas become more developed.	Temporary increase in traffic on existing roadways during construction; no impacts are anticipated on traffic and circulation. Under Alternative A2, 16 haul trips would occur per day to deliver materials from off-site to the project sites. Construction workers commuting to the project site would generate an additional 10 daily round trips on local arterial streets over a period of 5 years.	Temporary increase in traffic on existing roadways during construction; no impacts are anticipated on traffic and circulation. Under this alternative, 86 haul trips would occur per day to deliver materials off-site to the project sites. Construction workers commuting to the project site would generate an additional 15 daily round trips on local arterial streets over a period of 5 years.	Temporary increase in traffic on existing roadways during construction; no impacts are anticipated on traffic and circulation. Under this alternative, 86 haul trips would occur per day to deliver materials off-site to the project sites. Construction workers commuting to the project site would generate an additional 15 daily round trips on local arterial streets over a period of 5 years.	Temporary increase in traffic on existing roadways during construction; no impacts are anticipated on traffic and circulation. Under this alternative, 144 haul trips would occur per day to deliver materials off-site to the project sites. Construction workers commuting to the project site would generate an additional 25 daily round trips on local arterial streets over a period of 5 years.

5.8.2 Associated Evaluation Criteria

The selection of a recommended plan from the alternative plans requires a combination of decision-making factors. As suggested by the USWRC, the alternative plans are compared using the following criteria: completeness, effectiveness, efficiency, and acceptability. The evaluation of the alternative plans by established criteria are described below and are presented in Table 75.

5.8.2.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of the planned objectives. A complete alternative (1) meets the objectives, (2) needs no further actions for complete fulfillment of the project, (3) is consistent and reliable, (4) is capable of being physically implemented, and (5) mitigates unavoidable adverse environmental effects, as appropriate. All of the proposed recreation alternatives are fairly complete means of addressing recreation demand and opportunities within the study area. In general, all of the final alternatives are fully formulated and complete. No further measures are needed to allow for the functioning of the alternatives.

5.8.2.2 Effectiveness

Effectiveness is the extent to which an alternative resolves the identified problems and achieves the specified objectives. The proposed plans must restore the long-term health of the ecosystem structure, function, and dynamic processes in the Salt River. Alternatives A2, E2, O2, and F2 are effective, to varying degrees, in increasing habitat extent within the river corridor. This does not mean that they all increase habitat diversity, which is a measure of effectiveness. Alternative F2 is the most extensive of the three; Alternative A2's footprint is less than a third the size of Alternative F2. However, Alternative A2 only provides for establishment for one vegetation type: Sonoran desert scrub shrub. Alternative E2 is considerably more extensive than Alternative A2; however, it does not provide nearly the habitat acreages in Cottonwood-Willow and wetlands that Alternative O2 does, and therefore, cannot be considered as being nearly as effective. On the other hand, Alternatives O2 and F2 provide for establishment for a complete and diverse riparian system similar to the native riparian habitat typical of this area historically. The restored habitat areas of Alternatives O2 and F2 incorporate four different vegetation types: Sonoran desert scrub shrub, wetlands, cottonwood-willow, and mesquite. All of the proposed recreation alternatives are also effective means of addressing recreation demand and opportunities within the study area. The No Action Alternative is ineffective in meeting any of the planning objectives.

5.8.2.3 Efficiency

Efficiency is the extent to which an alternative is the most cost-effective means of addressing the identified problems while realizing the specified objectives consistent with protecting the Nation's environment. Cost effectiveness analysis is performed to identify the least cost alternative plans. The ranking is based on the average annual cost per average annual functional capacity unit. As previously presented in Table 68, Alternative A2 provides the greatest output per dollar spent, at $6,500 per AAFCU, although it provides the *least* increase in FCUs over the existing condition. Alternative E2, at $9,600 per AAFCU, is the second-most cost-effective alternative. Alternative O2 is the third most cost-effective of the final array, at $10,100 per AAFCU. Alternative F2 provides the highest output, however, at a cost of $15,300 per AAFCU. All of the proposed recreation alternatives are also efficient means of addressing recreation demand and opportunities within the study area. Each possesses a positive benefit to cost ratio, and generates significant net benefits. It appears that Recreation Alternative C is the most cost-effective of the three, but all three alternatives are justified. The No Action Alternative is the least cost alternative, but fails to restore valuable habitats, which have suffered historic losses and provide important habitat to many species. It also does not address un-met recreation demand in the study area. The No Action Alternative represents a lost opportunity for improving environmental quality and quality of life issues within the study area.

5.8.2.4 Acceptability

Acceptability is the workability and viability of an alternative to other Federal agencies, affected State, tribal, and local agencies; and public entities, given existing laws, regulations, and public policies. The comparison of acceptability is defined as acceptance of the plan by the local sponsor and the concerned public. Initial public support for Alternative A2 was judged to be poor. However, the relative acceptability of Alternatives A2, E2, O2, and F2 remains to be judged on the basis of feedback and tentative support indicated by the non-Federal sponsors after the public meeting. The recreation plans also appear at first impression to be acceptable means of addressing recreation opportunities within the study area and environs. While any plan could become the Recommended Plan in the Final Feasibility Report, this decision will depend on public acceptance as expressed through the public review process.

Table 75. Associated Evaluation Criteria

Criteria	No Action	Alternative A2	Alternative E2	Alternative O2	Alternative F2
Completeness	Does not meet objective.	Technically feasible; does not meet all habitat restoration objectives; provides only single habitat type restoration; limited size of vegetation establishment; least acreage of land required. Rank: Moderate	Technically feasible; meets habitat restoration objectives; includes all four vegetation types; acreage of land required is more than twice as in Alternative A2. Rank: High	Technically feasible; meets habitat restoration objectives; includes all four vegetation types; acreage of land required is more than twice as in Alternative A2. Rank: High	Technically feasible; meets habitat restoration objectives; includes all four vegetation types; acreage of land required is more than 3 times the size required in Alternative A2. Rank: High
Effectiveness	Does not meet objective.	Provides the least amount of vegetation establishment (approximately 650 acres). Rank: Low	Provides slightly less than 1,700 acres of vegetation establishment. Does not provide significant acres of full range of habitats. Rank: Moderate	Provides approximately 1,700 acres of vegetation establishment. Rank: High	Provides the greatest amount of vegetation establishment (approximately 2,200 acres). Rank: High
Efficiency	Does not meet objective.	Provides the least output (389 AAFCUs) for the least cost ($6,500/AAFCU). Rank: Low	Provides more than twice the output (966 AAFCUs) of Alternative A2 for 48 percent greater cost per unit ($9,600/AAFCU). Rank: High	Provides more than twice the output (1,006 AAFCUs) of Alternative A2 for 55 percent greater cost per unit ($10,100/AAFCU). Rank: High	Provides the most output; 1,084 AAFCUs; more than 2.5 times that of Alternative A2; but at more than twice the cost per unit ($15,300/AAFCU). Rank: Moderate
Acceptability	Does not meet objective.	Currently not supported by non-Federal sponsors. Rank: Low	Non-federal sponsors have not indicated support for Alternative E2. Local satisfaction will be assessed during the public review of the draft document. Rank: Low	Non-federal sponsors indicated support for Alternative O2. Local satisfaction will be assessed during the public review of the draft document. Rank: High	Currently not supported by non-Federal sponsors. Rank: Low

5.9 Alternatives Considered for Recommendation in the Feasibility Report

The NER Plan that was identified in this draft Feasibility Report is described below. It should be noted that the Locally Preferred Plan (LPP), if different from the NER Plan, and which may be ultimately recommended for implementation based on public acceptance and non-Federal sponsor input, would not be officially selected or approved until after the public review process. The Recommended Plan will not be finalized, and cost-sharing determined, until the Final Feasibility Report.

5.9.1 National Economic Development Plan

A tentative NED Plan has been identified as Recreation Alternative C, which possesses the highest net benefit and benefit to cost ratio of the three plans in the final array. However, this plan is subject to further refinement following the Public Meeting held to present the results of the study. Refinements may lead to a change in the costs and features of each plan, and therefore, the selection of the NED Plan. Cost-sharing of the recreation elements of the recommended plan will be 50-50 or 0-100, Federal and non-Federal, respectively, depending upon the features. Those features currently recommended for cost-sharing would be cost-shared at 50 percent Federal and 50 percent non-Federal.

5.9.2 National Ecosystem Restoration Plan

The NER Plan is identified by the Federal government as the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. It is cost-effective and justified to achieve the desired level of outputs. The NER Plan is the restoration alternative that the Federal government will recommend in the Final Feasibility Report, unless an exemption from the NER is required, as with an LPP, for example. The Federal government will cost share up to the price of the NER Plan, at 65 percent Federal and 35 percent non-Federal for ecosystem restoration features including provisions of all lands, easements, rights-of-way, relocations, and disposal areas (LERRDs).

5.9.3 Locally Preferred Plan

A Locally Preferred Plan (LPP) may be identified in the Final Feasibility Report if the results of the Public Meeting and further coordination efforts indicates the unacceptability of the NER Plan. If increments of the NER Plan are not supported by the public; do not include particular increments desirable to the local sponsor; or are not capable of implementation because of management or funding constraints of the local sponsor, it will not be recommended for implementation. When the LPP is clearly of lesser scope and cost and meets the Administration's policies for high-priority outputs, the Assistant Secretary for the Army (ASA) usually grants an exception for deviation. The increased scope of any plan more expensive than the NER would not warrant Federal cost-sharing participation. Thus, if the LPP is larger in scope than the NER, the local sponsor would pay 100 percent of the difference between that plan and the NER.

5.9.4 Selection of the Tentatively Recommended Plan

Alternative O2 was determined to be a best-buy plan during the cost-effectiveness and incremental cost analysis. Alternative O2 provides significant habitat benefits at one of the lowest costs per unit. And while Alternative O2 provides only an extra 40 AAFCUs and 70 total acres of habitat relative to Alternative E2, the additional cost is justified due to the types of habitats restored.

In the HGM model, all four vegetation types (Cottonwood-Willow, Mesquite, Sonoran Desert Scrub Shrub, and Wetlands) were assigned the same overall value. In other words, the FCU value of an acre of Cottonwood-Willow vegetation was assigned an equal value to that of Sonoran Desert Scrub Shrub. While it can be said that it is not possible to value one habitat type over another, there are inherent differences that should be taken into account. Given the rarity of Cottonwood-Willow and Wetlands habitats in this part of the American southwest, relative to desert scrub shrub, there would be more environmental gain if the more rare habitat were restored. For example, in the arid southwest, roughly 70 percent of listed threatened and endangered vertebrate species are considered riparian obligates (Johnson, 1989). Alternative O2 re-establishes approximately 883 acres of Cottonwood-Willow and 200 acres of Wetlands. Alternative E2 established only 287 acres of Cottonwood-Willow and 52 acres of Wetlands, a difference of 596 acres and 148 acres, respectively. Alternative O2 would reestablish considerably more riparian habitat, and therefore provide a larger benefit to species associated with the riparian zone. It is the rarity of riparian vegetation, and its inherent value, that justifies the additional cost of Alternative O2.

For these reasons, Alternative O2 is identified as the NER Plan. This Plan meets the maximum number of feasibility study criteria discussed earlier in Chapter 5, on the basis of completeness, effectiveness, efficiency, and tentative measures of public acceptability.

Because of its ability to meet, to the greatest degree of those alternatives identified, all of the established criteria for evaluation, and appears to possess strong non-Federal sponsor support, Alternative O2 is also identified as the "tentatively recommended plan".

The Final Draft Feasibility Report will present a final recommendation based on the results of public input expressed at the public meeting and through written and verbal feedback. The final recommended plan might be the NER Plan, the LPP, or a plan that is a combination thereof. Based on continuing coordination with the non-Federal sponsors, results of the public involvement/review process, and continuing refined evaluation of the final array of alternatives, a recommended plan will be identified for the Final Feasibility Report and Final EIS.

Table 76 provides a summary of project costs, apportioned between the Federal and non-Federal sponsors, for the tentatively recommended plan. The total project cost is currently estimated at between $146,226,000, and $148,092,000, depending on the recreation plan to be selected, at October 2004 price levels, and at a current Federal discount rate of $5^{5}/_{8}$ percent. Based on the requirements of WRDA 1986, cost-sharing for ecosystem restoration features including provisions of all LERRDs would be 65 percent Federal and 35 percent non-Federal. Cost-sharing for recreation features would be 50 percent Federal and 50 percent non-Federal. Thus, the Federal share would be between $90,241,600 and $91,174,600, and the non-Federal share would be between $48,903,400 and $49,836,400. Cultural resources mitigation (such as data recovery activities associated with historic preservation) costs under 1 percent of the total Federal cost amount authorized to be appropriated for the project would be 100 percent Federal; those costs in excess of 1 percent of the total Federal cost would be 65 percent Federal and 35 percent non-Federal.

USACE guidance (ER 1105-2-100, Appendix E) specifies that the level of financial participation by the Corps in recreation development may not increase the Federal cost of the project by more than 10 percent. Recreation costs for this project currently range from $1,351,000 and 3,217,000, a maximum of approximately 2 percent. The cost for all operations and maintenance would be the responsibility of the non-Federal sponsor. Operations and maintenance is currently estimated at $131,000 annually. In addition, all water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsor. The value of this water has been estimated at $1,283,000 annually.

Table 76. Cost Apportionment – Tentatively Recommended Plan

Item	Federal	Non-Federal	Total
Construction of Ecosystem Restoration Features*	70,527,990	37,976,610	108,504,600
Monitoring and Adaptive Management	2,821,000	1,519,000	4,340,000
LERRDs**	-	24,949,400	24,949,400
Total First Cost of Ecosystem Restoration	**73,348,990**	**64,445,010**	**137,794,000**
Cost Share Adjustment	16,217,110	-16,217,110	
Total Cost-Shared Costs for Ecosystem Restoration	**89,566,100**	**48,227,900**	**137,794,000**
Percentage of Total Cost-Shared Amount – Ecosystem Restoration	*65%*	*35%*	
Total Cost-Shared Costs for Recreation	**TBD**	**TBD**	**TBD**
Percentage of Total Cost-Shared Amount – Recreation	*50%*	*50%*	
TOTAL FIRST COSTS	**TBD**	**TBD**	**TBD**
Total Percentage	*TBD*	*TBD*	

* Construction, S&A, PED/EDC, Contingency, Monitoring, and Adaptive Management. Does not include IDC or annual O&M.

** Lands, easements, rights-of-way, relocations, and disposal areas

Cost-sharing for the entire project would remain to be determined. The Federal share is currently estimated at $90,241,600 to $91,174,600, depending on the recreation plan selected ($89,566,100 for ecosystem restoration and $675,500 to $1,608,500 for recreation). The non-Federal share is currently estimated at $48,903,400 to $49,836,400, depending on the recreation plan selected.

CHAPTER VI
DESCRIPTION OF THE TENTATIVELY RECOMMENDED PLAN

6.1 The Tentatively Recommended Plan

Based on the results of the analyses conducted during the most recent phases of the feasibility study, including the Cost-Effectiveness and Incremental Cost Analyses, Alternative O2 has been identified as the NER Plan. In addition, based on its achievement of project objectives, and its meeting of completeness, efficiency, effectiveness, and preliminary public acceptability criteria, Alternative O2 is also identified as the tentatively recommended plan.

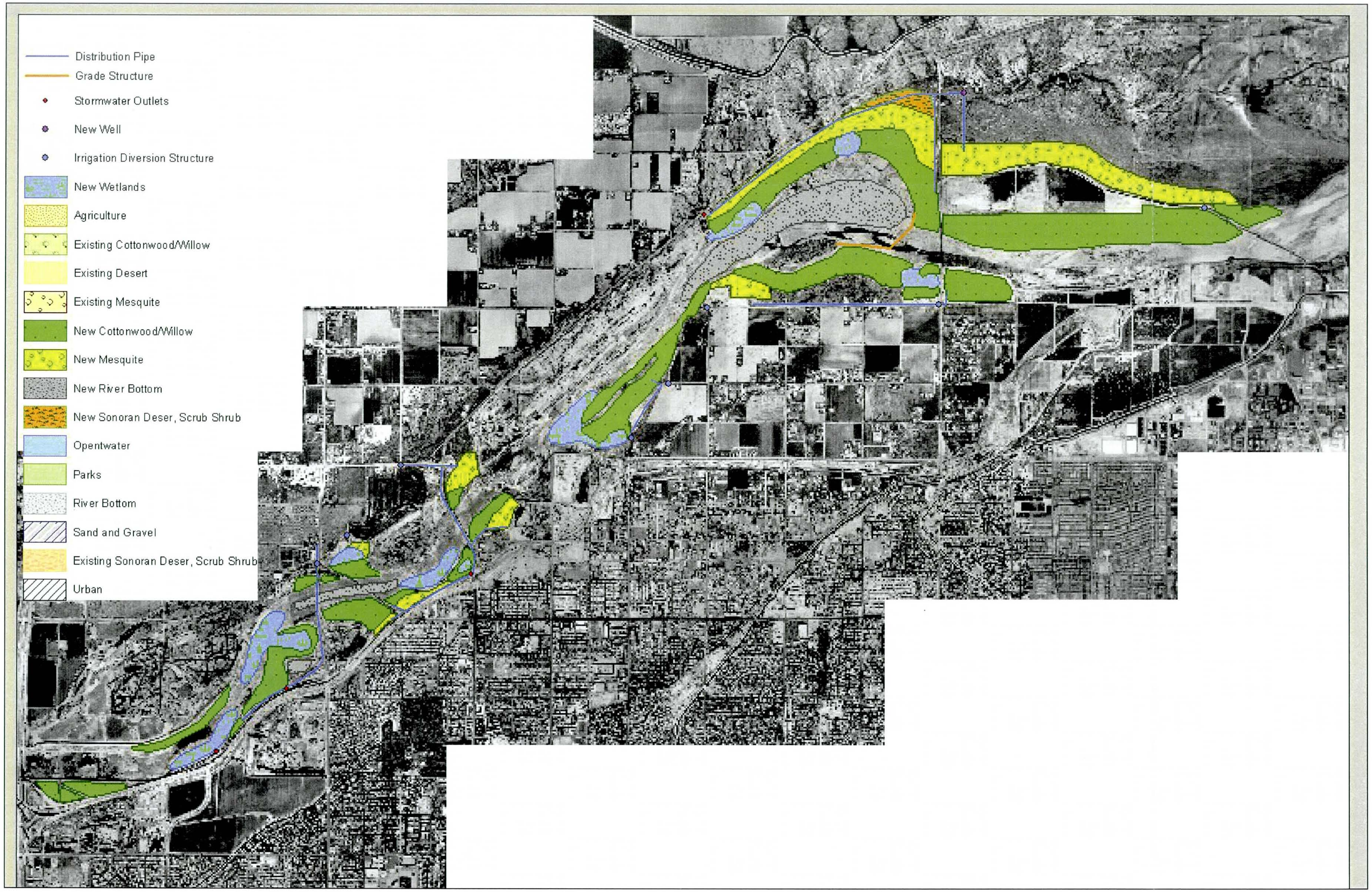
6.2 Plan Features

The Tentatively Recommended Plan (Alternative O2) consists of a broad restoration of four key habitat types within all nine reaches of the study area (see Figure 55). These include the following habitat types with their associated acreages shown: Cottonwood-Willow (883 acres), Wetlands including River Bottom (200 acres), Mesquite (380 acres), and Sonoran Desert Scrub Shrub (24 acres).

The water demand of the Tentatively Recommended Plan is 8,550 acre-feet/year.

Reach 1 would support four wetland features and three cottonwood-willow stands within Sub-area 1.1. One wetland would continue from Sub-area 2.2 while a second smaller wetland would be located to the north within the main channel and would connect with a cottonwood-willow stand to the north. The remaining two wetland features would be created to the west of the existing quarry. A cottonwood-willow stand would be established within the main channel, at the far west end of Sub-area 1.1. Finally, a small cottonwood-willow stand would be established to the north of the existing quarry. The percolation ponds found immediately outside of the southern bank in Sub-area 1.2 would be planted with cottonwood and willow. This area would be supported using the existing irrigation infrastructure.

Figure 55. The Tentatively Recommended Plan (Alternative O2)



Reach 2 would support would support a wetland feature surrounded by cottonwood-willow to the west, south, and east of Sub-area 2.4. These features would be supported by surface water outlets and maintained using a braided irrigation network (SBIN). Along the south bank of the river, in Sub-area 2.3, the alternative would support two wetland features and small areas of cottonwood-willow and mesquite habitat. One small stand of cottonwood-willow would surround the wetland; a second larger stand would be established in the eastern edge of Sub-area 2.3 and extend into Sub-area 2.2. The wetland would be located near the Country Club Storm Drain on the existing river bottom. In Sub-area 2.2, three wetland features would be created at Alma School Road downstream of the old quarry. The small wetland to the west would be flanked by cottonwood-willow to the north while the larger wetland to the east would be surrounded by a cottonwood-willow stand. The Cottonwood-Willow would be irrigated using a SBIN. A small area, south of the wetlands, would be reshaped and converted to new river bottom.

Reach 3 would contain a cottonwood-willow stand in Sub-area 3.1. A channel would be constructed to drain Reach 4.2 to supply water to the vegetation in this reach. Water would be dispersed using a SBIN.

Reach 4 would contain cottonwood-willow and mesquite habitat and wetlands. The majority of Sub-area 4.1 would be left un-vegetated due to the presence of the Tri-City Landfill. However, a narrow strip of Cottonwood-Willow habitat would be established along the north bank at the edge of the main channel. The area would be irrigated using surface water and stormwater via a SBIN. Sub-area 4.2, along the south bank, would support cottonwood-willow and mesquite habitat, and a large wetland feature. Two south bank surface water outlets would supply water to the SBIN used to irrigate the vegetation. The western outlet would support the wetland feature as well as surrounding cottonwood-willow and mesquite habitat.

Reach 5 would contain cottonwood-willow, mesquite, and Sonoran desert habitat. The SRS&R Beeline One Plant pit would be reshaped and converted to new river bottom in Sub-area 5.2. Cottonwood-Willow and Mesquite habitat, and a small pocket of Sonoran desert habitat would be located on the overbank area. The mesquite and Sonoran desert would be irrigated using groundwater from a new well. The Cottonwood-Willow would be irrigated using surface water diverted from an irrigation canal. The water would be distributed using a SBIN. The channel in Sub-area 5.1 and the western half of Sub-area 5.3 would be reshaped and converted to new river bottom. A wetland feature as well as cottonwood-willow habitat would be established at the Evergreen Drain. The cottonwood-willow habitat would be irrigated using groundwater from the new well, and the wetland would be supported by runoff from the Evergreen Drain. Sub-area 5.3, located along the south bank, would be vegetated with Cottonwood-Willow and small stand of mesquite habitat. Surface water and stormwater would be used to irrigate these areas. Irrigation of the cottonwood-willow and mesquite habitat would be done by a SBIN. The drop structure discussed earlier would be placed in Sub-area 5.2, in the main channel at the center point of the SRS&R Beeline One Plant. This structure would protect the restored habitat and other riparian features within Reach 5. The structure would span the entire width of the riverbed, approximately 1,500 feet, and would be constructed of soil cement.

Reach 6 would contain large areas of cottonwood-willow and mesquite habitat within Sub-area 6.1. The cottonwood-willow habitat located south of the GRUSP site would be irrigated using SRPMIC surface water from the Hennessey Drain. The mesquite habitat would be located on the north bank immediately outside the active channel and the 10-year floodplain and would be irrigated using groundwater from the new well. In both areas, the water would be distributed using a SBIN. Because the vegetated areas are near the GRUSP, water that has infiltrated can be used to support vegetation. In Sub-area 6.2, located on the south bank of the river, two areas of cottonwood-willow habitat would be planted: one in the abandoned quarry depression directly east of Gilbert Road, and a second narrow strip along the southern edge of the main channel. Both areas would be irrigated using surface water, and stormwater when available. Sub-area 6.3 would have a wetland feature. This would be constructed on the riverbed near the existing Hennessey Drain outlet. A berm of coarse rock would be constructed on the upstream side of the wetland. This would provide some protection during flow events and contribute to forcing flow away from the south bank. The wetland would consist of a low permeability liner system to maintain the surface water level and allow for vegetation growth. The wetland would be flanked by a relatively large cottonwood-willow stand to the east, taking advantage of the saturated soil conditions, and would be irrigated using surface water from the Hennessey Drain and a SBIN.

Reach 7 would contain no restoration features due to the presence of an existing quarry. The quarry operators would be encouraged to preserve a corridor within the existing main channel to convey flows and bed load material to Reach 6. By reducing the deposition, bed load material would continue to flow downstream, maintaining the stability of the channel within Reach 6.

Reaches 8 and 9 would contain only removal of invasive plant species, primarily saltcedar (*Tamarisk sp),* and only in those areas in which no threatened or endangered wildlife species are found. To prevent rapid reestablishment of the invasive species, native vegetation would be planted in its place.

Nine new irrigation diversion structures and one new well are required under the Tentatively Recommended Plan.

The Tentatively Recommended Plan would require excavation and stockpiling of 233,333 cubic yards of material for the low-flow channel, all of which would be spread on-site. Re-shaping of the riverbed outside the low-flow channel would require the excavation and stockpiling of 1,320,489 cubic yards of material, fill of 751,803 cubic yards, the spreading of 568,686 cubic yards of material, and vegetation grading of 2,186,969 cubic yards.

Wetland feature restoration would require excavation and stockpiling of 1,689,960 cubic yards of material, the construction of a two-foot deep lining of clay totaling 422,490 cubic yards, the spreading of 422,490 cubic yards of coarser material two-feet thick on top of that lining, and the spreading of 1,689,960 cubic yards of excess material on-site.

Planting components include 74,172 Cottonwood and Willow trees, 24,700 Mesquite, 3,048 Sonoran Desert plants, and 200 acres of wetland vegetation plantings. A new water well is required in Reach 5. This well nourishes the vegetation planted on the terraces along the river.

The required grade control structure consists of 31,111 cubic yards of concrete used in the soil cement. Excavation and stockpiling of 58,331 cubic yards of material in the upstream area are required in its construction. The backfilling and compaction of 58,331 cubic yards of material in the upstream area are also required. Excavation and stockpiling of 8,332 cubic yards of material in the downstream upstream area are required in its construction. The backfilling and compaction of 3,000 cubic yards of material in the downstream area are required. Spreading of 5,332 cubic yards of excess material, and the installation of 8,888 cubic yards of rip-rap are required for construction of this feature.

The water distribution system utilized by the Tentatively Recommended Plan would require 40,617 linear feet of 12-inch PVC pipe. Pump stations would be constructed at Alma School and Country Club Roads. A bridge crossing of 1,700 linear feet are required for each pump station.

Road crossings for the pipeline system would require 89 cubic yards of excavation, twelve tons of asphalt laid three-inches thick. 0.25 tons of ABC, and 55 cubic yards of backfill and compaction would be required.

The plant irrigation system would consist of 66 acres delivering 949 acre-feet in Reach 1, 226 acres delivering 3,140 acre-feet in Reach 2, 29 acres delivering 362 acre-feet in Reach 3, 152 acres delivering 2,113 acre-feet in Reach 4, 434 acres delivering 4,449 acre-feet in Reach 5, and 580 acres delivering 6,097 acre-feet in Reach 6.

An Irrigation Channel T-Junction is also a required feature of the plan. Debris removal totaling 118,000 cubic yards of material would be required.

6.3 Project Outputs

The Tentatively Recommended Plan provides a net habitat value of 1,717 FCUs, or 239 percent of the functional capacity units under existing conditions. This is an increase of 1,006 units above existing conditions.

6.4 Cost Estimate

The ecosystem restoration component of the Tentatively Recommended Plan would require $76,143,600 in construction costs, $19,035,900 in contingency costs, $7,614,400 in Pre-construction Engineering and Design (PED), $761,400 in Engineering During Construction (EDC), and $4,949,300 in Supervision and Administration (S&A), for a total construction cost of $108,504,600.

Additionally, $4,340,000 would be required for Monitoring and Adaptive Management, and $24,949,400 for Real Estate. The total First Cost of the restoration project would be $137,794,000. Interest during construction would amount to $7,751,000.

Current estimates for the recreation component of the project range between $1,351,000 and $3,217,000. Operations and maintenance costs for the recreation component have not been completed.

Operations, Maintenance, Rehabilitation and Repair for the ecosystem restoration component has been estimated at $131,000 per year. Associated costs for water supply are currently estimated at $1,283,000 per year.

6.5 Maintenance Considerations

Maintenance for the project would consist of examination, repair, and possible replacement of pumps, water lines, and other devices subject to wear. The low-flow channel, grade control structure, guide dikes, protection structures, and wetland liners would be periodically examined and repaired, if necessary. Debris removal is expected, following runoff events, and at areas subject to deposition within the low-flow channel and elsewhere. The irrigation channel and distribution and irrigation application systems are all subject to on-going maintenance, repair, and periodic upgrade, if needed. Replanting of vegetation during the period outside the adaptive management period may be required, particularly in the event of destructive floodflows.

6.6 Recreation Plan

Finalization of the selected Recreation Plan will be done following the presentation of the Tentatively Recommended Ecosystem Restoration Plan (NER) at the Public Meeting. Current estimates for the recreation component of the project range between $1,351,000 and $3,217,000. The Final Feasibility Report will contain a full cost estimate and details for that plan.

6.7 Associated Non-Federal Considerations

The non-Federal sponsors for the project would be required to purchase all lands, easements, rights-of-way and disposal costs (LERRD) needed for project implementation, currently estimated at $24,949,400. The non-Federal sponsors would be responsible for remaining implementation costs required to bring the total non-Federal share to 35 percent of the total first cost of construction. The Total First Cost of the project would be $137,794,000, resulting in a non-Federal share of $48,227,900. Potential recreation cost-sharing would amount to an estimated $675,500 to $1,608,500, depending on the plan selected by the non-Federal sponsors. The non-Federal sponsors would also be responsible for Operations, Maintenance, Rehabilitation and Repair costs estimated at $131,000 per year, and associated costs for water supply currently estimated at $1,283,000 per year.

6.8 Monitoring and Adaptive Management Plan

Monitoring and adaptive management consists of the examination of terrestrial and aquatic plantings for a period of five years following construction to ensure survival of all plants needed in the restoration effort. Plants that expire within this period would be replaced in-kind. Areas that exhibit high rates of die-off may be evaluated and adaptive measures undertaken to re-establish either more appropriate plant types, or to modify features of the project, such as irrigation rates or locations, to achieve appropriate and maximum habitat value for that area of the project. It is expected that monitoring, and potential modification of irrigation rates and locations may be required to ultimately achieve maximum habitat value, structure, and potential diversity.

CHAPTER VII
PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the Tentatively Recommended Plan.

7.1 Study Recommendation

The Tentatively Recommended Plan provides the maximum National Ecosystem Restoration (NER) benefits, while achieving the stated project objectives, and while meeting the criteria established by the study team and Federal Procedures and Guidelines. Because of its highly positive environmental contribution to restoration within the study area, the Tentatively Recommended Plan is recommended for implementation.

7.2 Division of Plan Responsibilities

The Water Resources Development Act (WRDA) of 1986 (P.L. 99-662) and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource projects accomplished under the direction of the Corps of Engineers. Anticipated Federal and non-Federal responsibilities are described in this section. The final division of specific responsibilities will be formalized in the project cooperation agreement (PCA).

7.2.1 Federal Responsibilities

The estimated Federal share of the total first cost of the project is 65 percent of first costs [first costs are all costs to implement project less lands, easements, rights-of-way, relocations, and disposals (LERRD) and O&M costs]. The Federal government responsibilities are anticipated to be:

a. Design and prepare detailed plans and specifications.

b. Administer contracts for construction and supervision of the project after authorization, funding, and receipt of non-Federal assurances.

c. Conduct all necessary cultural resource investigations and coordinate and implement any necessary preservation or mitigation measures.

d. Conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements

e. Identify the real estate needs for implementation of environmental work on Federal and private land.

7.2.2 Non-Federal Responsibilities

Non-Federal or local responsibilities are anticipated to be:

a. Provide 35 percent of the separable project costs allocated to ecosystem restoration and 50 percent of the separate project costs allocated to recreation, as further specified below:

   1. Enter into an agreement which provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs;

   2. Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

   3. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

   4. Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

   5. Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to ecosystem restoration and 50 percent of the separable project costs allocated to recreation.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, including mitigation features, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

Some of FCD's contribution will go toward maintenance

c. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

e. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

Hold harmless

f. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

g. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

h. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

i. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project and otherwise perform its obligations in a manner that will not cause liability to arise under CERCLA.

j. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

l. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

m. Provide the non-Federal share of that portion of the costs of archeological data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with cost sharing provisions of the agreement;

n. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

o. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

p. For so long as the project remains authorized, provide the quantity of water for such periods that the Government determines is necessary to construct, operate, repair, replace, rehabilitate, and otherwise maintain the project.

7.3 Cost Apportionment

Cost sharing for construction of this project would be in accordance with applicable law whereby for environmental restoration projects, the non-Federal sponsor shall provide all lands, easements and rights-of-way, and dredged material disposal areas; provide relocations of bridges and roadways; provide alteration of utilities which do no not pass under or through the project's structure; and maintain and operate the project after construction. During the construction phase, the non-Federal sponsor shall contribute any additional funds as are necessary so that the non-Federal contribution would be at least 35 percent of total environmental restoration costs. The 35 percent non-Federal share of the ecosystem restoration component of this project is currently estimated at $50,706,000. The non-Federal share of recreation features, which is 50 percent of the cost of these features, has not yet been finalized, but is estimated at between $2,784,000 and $3,717,000. All water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsor. The value of this water has been estimated at $1,283,000 annually. The estimated annual cost of Operations and Maintenance is $131,000. Additional studies and analyses of the Recommended Plan will be accomplished during PED. As a result of these studies, additional necessary project features may be identified that could be part of the Federal cost sharing for this project. In this event, Federal project cost sharing would be adjusted in accordance with the terms that will be included in the PCA.

7.4 Current and Future Work Eligible for Credits

There is no current and future work planned or in construction which is part of the Corps' Selected Plans, or which would be eligible for Section 104 credit.

7.5 Institutional Requirements

Upon implementation of the cost-shared project, the non-Federal sponsor will prepare the following preliminary financial analysis.

a. Assess project-related yearly cash flows (both expenditures and receipts where cost recovery is proposed), including provisions for major rehabilitation and operational contingencies and anticipated but uncertain repair costs resulting from damages from natural events.

b. Demonstrate ability to finance their current and projected-future share of the project cost and to carry out project implementation operation, maintenance, repair, and rehabilitation responsibilities.

c. Investigate the means for raising additional non-Federal financial resources including, but not limited to, special assessment districts.

d. Complete any other necessary steps to ensure that they are prepared to execute their project-related responsibilities at the time of project implementation.

7.6 Environmental Requirements

The Selected Plan would result in discharge of fill material into waters of the United States during the period of construction. It also may result in discharges associated with operation and maintenance activities. A Section 404(b)(1) evaluation has been prepared to address practicable alternatives. An NPDES permit will also be required for any water discharged to the river.

The EIS includes a 404(b)(1) analysis as part of the feasibility study. Based on this analysis, the feasibility report recommends that the project receive a 404(r) exemption, when Congress authorizes the project. The 404(r) exemption would cover both the construction period and the operation and maintenance activities, for as long as the project remains authorized.

An archeological field survey of the proposed project Area of Potential Effects (APE) has been conducted in accordance with the National Historic Preservation Act of 1966 (36 CFR 800). If cultural resources are discovered during construction and cannot be avoided, work will be suspended in that area until the properties are evaluated for eligibility for listing in the NRHP in consultation with the Arizona State Historic

Preservation Officer (SHPO). If the properties are determined to be eligible for the NRHP, the effects of the proposed construction will be taken into consideration in consultation with the SHPO; the Advisory Council on Historic Preservation will be provided the opportunity to comment in accordance with 36 CFR 800.11.

Other requirements relating to the Arizona Game and Fish Department and the Arizona Department of Environmental Quality would need to be addressed by the non-Federal sponsor. Mitigation measures and environmental commitments are presented in Chapter 8 of the EIS.

7.7 Sponsorship Agreements

The Salt River Pima-Maricopa Indian Community (SRPMIC) and the City of Mesa, Arizona, have provided a Letter of Intent acknowledging sponsorship requirements for the Va Shly'ay Akimel Salt River Restoration Project. Prior to the start of construction, the non-Federal sponsor will be required to enter into an agreement with the Federal Government that it will comply with Section 221 of the Flood Control Act of 1970 (P.L. 91-611), and the Water Resources Development Act of 1986 (P.L. 99-662), as amended.

7.8 Procedures for Implementation

Future actions necessary for authorization and construction of the Selected Plan are summarized as follow:

a. This report will be reviewed by the Headquarters of the U.S. Army Corps of Engineers, Washington, D.C.

b. The Chief of Engineers will seek formal review and comments by the Governor of the State of Arizona and interested Federal agencies.

c. Following State and Agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

d. Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget (OMB) to obtain the relationship of the project to programs of the President.

e. The final report of the Chief of Engineers will then be forwarded by the Assistant Secretary of the Army for Civil Works to Congress.

f. Congressional review of the feasibility report and possible authorization of the project would follow.

g. Pending project authorization for construction, the Chief of Engineers could include funds, where appropriate, in his budget requests for preconstruction engineering and design of the project. The objective is to ready each project for construction start established with the feasibility study.

h. Following receipt of funds, preconstruction engineering and design would be initiated and surveys and detailed engineering designs would be accomplished.

i. Following Congressional authorization of the project, plans and specifications would be accomplished by the District Engineer.

j. Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-Federal interests.

k. Bids for construction would be initiated and contracts awarded.

CHAPTER VIII
SUMMARY OF COORDINATION AND PUBLIC VIEWS

8.1 Non-Federal Views and Preferences

The non-Federal views and preferences regarding environmental restoration measures, and the problems they addressed, in general were obtained through coordination with the local sponsor and with the other various local and regional public agencies, community activists, resource conservation groups, and the general public. These coordination efforts consisted of a series of public meetings held during the reconnaissance and feasibility phases, through surveys, through the maintenance of a point-of-contact that any interested party could discuss matters with, and a mailing list by which invitations to public meetings were distributed. Announcement of public meetings was made in local newspapers, giving date, time, place, and subject matter.

8.2 Views of Non-Federal Sponsor

The Salt River Pima Maricopa Indian Community and the City of Mesa have expressed willingness in continuing to be non-Federal sponsors for project implementation. Both have indicated support for the project and willingness to assume cost-shared financial obligations for its implementation. A Letter of Support acknowledging sponsorship requirements for the Va Shly'ay Akimel Salt River Project is presented as Figure 56.

The non-Federal sponsors generally support the results of the feasibility study. The non-Federal sponsors' interest in implementing environmental restoration solutions for the Va Shly'ay Akimel Salt River area is reflected by their willingness to enter into a cost-shared feasibility study to determine Federal interest. There currently exists within the community, and with the non-Federal sponsors, significant interest for providing environmental restoration solutions and recreation opportunities for the Va Shly'ay Akimel Salt River area.

8.3 Summary of Study Management, Coordination, Public Views, and Comments

The study team consisted of a multi-disciplinary group of several functional elements of the Corps and the non-Federal sponsors. The team included project managers, planners, hydrologic and hydraulic engineers, environmental specialists, cost estimators, designers, economists, appraisers, geotechnical specialists, real estate specialists, archeologists, and landscape architects.

The study was coordinated with a variety of agencies, interest groups, and individuals. Feedback from the public was incorporated in the plan formulation and evaluation process. Additional public views are summarized in the EIS.

Figure 56. Letter of Support from the Local Sponsor

CITY OF MESA
Great People, Quality Service!

April 28, 2004

Colonel Richard G. Thompson
United States Army Corps of Engineers
915 Wilshire Boulevard, Suite 14P00
Los Angeles, California 90017

Re: Letter of Support for the Va Shly'ay Akimel Recommended Plan
Va Shly'ay Akimel, Salt River Ecosystem Restoration Feasibility Study
Salt River Pima-Maricopa Indian Community and the City of Mesa, Arizona

Dear Colonel Thompson:

The Salt River Pima-Maricopa Indian Community (SRPMIC) and the City of Mesa, as local sponsors, extend our support for the recommended plan contained in the Va Shly'ay Akimel Salt River Ecosystem Restoration Feasibility Report as an appropriate measure to restore riparian habitat to the Salt River. A majority of habitat has been lost due to urban development and construction of upstream water supply dams that have significantly altered the perennial flow from the Granite Reef Dam downstream through the lower Salt River. The project is located within the jurisdictions of the SRPMIC and the City of Mesa, along the Salt River between Granite Reef Dam and State Route 101.

This restoration project is consistent with the SRPMIC's and City of Mesa's overall goals for protection and restoration of our natural resources. Following the opportunity to review the public response to the recommended plan during the review period of the Draft Feasibility Document and the Draft Environmental Impact Statement, the SRPMIC and the City of Mesa are prepared to move forward, as the local sponsors, with the U.S. Army Corps of Engineers to design the Va Shly'ay Akimel Salt River Ecosystem Restoration project. Anticipating Congressional authorization of the project, the sponsors are prepared to commit to their local share of 25% of preconstruction engineering and design (PED) costs.

The sponsors will assume their obligation to acquire all Lands, Easements, Rights of Way, Relocations and Disposal areas and upon completion of construction, operate and maintain the project. We are prepared to meet our financial obligations to ensure completion of this project and look forward to executing an agreement for the Design phase of the Va Shly'ay Akimel project.

Sincerely,

Bryan Myers
Community Director
Salt River Pima Maricopa Indian Community

Mike Hutchinson
City Manager
City of Mesa

CHAPTER IX
RECOMMENDATIONS

I recommend that the plan herein for environmental restoration and recreation be authorized for implementation as a Federal project. The total first cost of the project is currently estimated at between $139,145,000 and $141,011,000 under October 2004 prices ($137,794,000 for ecosystem restoration; and $1,351,000 to $3,217,000 for recreation). The Federal share is currently estimated at $90,241,600 to $91,174,600, depending on the recreation plan selected ($89,566,100 for ecosystem restoration and $675,500 to $1,608,500 for recreation).

I recommend that the plans recommended herein be exempt from regulations of the Clean Water Act, pursuant to Section 404(r) of the Act. The 404(r) will cover the construction phase and the operation and maintenance phase of the project, as described in the feasibility report and EIS.

My recommendation is subject to cost-sharing, financing, and other applicable requirements of Federal and State laws and policies, including Public Law 99-663, the Water Resources Development Act of 1986, as amended by Section 202 of Public Law 104-303, the Water Resources Development Act of 1996, and in accordance with the following requirements, which the non-Federal sponsor must agree to prior to project implementation.

a. Provide 35 percent of the separable project costs allocated to ecosystem restoration and 50 percent of the separate project costs allocated to recreation, as further specified below:

   1. Enter into an agreement which provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs;

   2. Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

   3. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure

the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

4. Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

5. Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to ecosystem restoration and 50 percent of the separable project costs allocated to recreation.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, including mitigation features, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

c. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

e. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

f. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

g. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

h. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

i. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project and otherwise perform its obligations in a manner that will not cause liability to arise under CERCLA.

j. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

l. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

m. Provide the non-Federal share of that portion of the costs of archeological data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with cost sharing provisions of the agreement;

n. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

o. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

p. For so long as the project remains authorized, provide the quantity of water for such periods that the Government determines is necessary to construct, operate, repair, replace, rehabilitate, and otherwise maintain the project.

The plans presented herein are recommended with such modification thereof as in the discretion of the Commander, HQUSACE, may be advisable.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified as needed.

CHAPTER X
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